ACADEMIC ASSOCIATES

STUDY GUIDE

BIOLOGY

YEAR 12 ATAR COURSE – UNITS 3 & 4

THIRD EDITION

Peter Walster

ACADEMIC ASSOCIATES

WACE STUDY GUIDE

BIOLOGY

YEAR 12 ATAR COURSE

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Academic Group Pty Ltd
P.O. Box 627, Applecross
Perth, Western Australia 6953

Tel: (08) 9314 9500
Email: learn@academicgroup.com.au
Website: www.academicgroup.com.au

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About the Author

Peter Walster was Head of Science in several WA government schools. With a science degree and Masters in Education, he has taught biology and human biology both in Western Australia and in the UK. Peter has been a WACE examiner whilst serving on a number of syllabus committees and reference groups.

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- Mike and Rita for their support and encouragement.
- Paul Appleton for his thorough editing.

TO THE STUDENT

This revision guide has been written specifically for the Year 12 Biological syllabus (ATAR course) Units 3 and 4.

The guide is divided into five sections:
- Terminology and Review Questions
- Trial Tests
- Answers to Terminology and Review Questions
- Solutions to Trial Tests
- Glossary

Terminology and Review Questions

Terms have been included at the beginning of each section. It is recommended that you develop an understanding of these before you attempt the questions that follow them. Check their meaning before proceeding to the review questions. A mastery of the vocabulary is very important and will help you to understand the subject's concepts.

It is also recommended that you complete the review questions after you have covered the work at school. Use them when appropriate to prepare for section tests. Carefully make additions and corrections to your own answers using the answers near the back of the book. If you do this consistently you should develop a better understanding of each area. This will help you to prepare for tests and examinations.

Trial Tests

This section has been expanded and improved in this new guide. There are now more trial tests. Each test has twenty multiple choice questions, a short answer section and an extended answer question.

In self-marking the extended answers, note that in the answer section each dot point is allocated one mark. Study the answers carefully; this will assist you to gauge how comprehensive your answers need to be to achieve good marks. An answer given may not be the only acceptable one, however where appropriate use it as a model for your own. In the short answer section, when, for example, four marks are allocated to a question, try to find four distinct parts to your answer. In biology exams (as with many others) the number of marks allocated is usually indicative of the number of distinct points required in your answer. A single word or phrase is therefore unlikely to score more than one mark.

Glossary

With the exciting changes in the Year 12 biology course, there was a need to add a number of terms to the glossary. Use the glossary as you would use a dictionary. It should help you to master the vocabulary of the course. It will be very useful to look in the glossary for any words that are unfamiliar to you and to record each new word with its meaning in your own notes.

I hope this revision book will help you to enjoy, understand and succeed in biology.

Good luck in your studies!

Peter Walster

CONTENTS

UNIT 4 – SURVIVING IN A CHANGING ENVIRONMENT

BIOLOGY

UNIT 3

HEREDITY

1

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

1.1 REPLICATION OF GENETIC MATERIAL

- [ ] Continuity of life requires the replication of genetic material and its transfer to the next generation through processes, including binary fission, mitosis, meiosis and fertilisation.

1.2 DNA

- [ ] DNA is a helical double-stranded molecule that occurs bound to proteins in chromosomes in the nucleus, as unbound circular DNA in the cytosol of prokaryotes and is found in the mitochondria and chloroplasts of eukaryotic cells.
- [ ] The structural properties of the DNA molecule, including nucleotide composition and pairing and the hydrogen bonds between strands of DNA, allow for replication.
- [ ] The genetic code is a base triplet code; genes include 'coding' and 'non-coding' DNA, and many genes contain information for protein production.

1.3 PROTEINS AND PROTEIN SYNTHESIS

- [ ] Protein synthesis involves transcription of a gene into messenger RNA in the nucleus, and translation into an amino acid sequence at the ribosome.
- [ ] Proteins, including enzymes and structural proteins, are essential to cell structure and functioning.

1.4 GENES AND GENOTYPES

- [ ] The phenotypic expression of genes depends on the interaction of genes and the environment (epigenics not required).
- [ ] Mutations in genes and chromosomes can result from errors in DNA replication or cell division, or from damage by physical or chemical factors in the environment.
- [ ] Variations in the genotype of offspring arise as a result of the processes of meiosis, including crossing over and random assortment of chromosomes, and fertilisation, as well as a result of mutations.

1.5 PATTERNS OF INHERITANCE

- ☐ Frequencies of genotypes and phenotypes of offspring can be predicted using Punnett squares and are determined by patterns of inheritance, including dominance (dominant/recessive, co-dominance, incomplete dominance), autosomal and sex-linked alleles, multiple alleles and polygenes.
- ☐ Pedigree charts can be used to reveal patterns of inheritance and assist in determining the probability of inheriting particular alleles in future generations.

1.6 DNA SEQUENCING, DNA PROFILING AND APPLICATIONS OF DNA TECHNOLOGIES

- ☐ DNA sequencing enables mapping of species genomes; DNA profiling identifies the unique genetic makeup of individuals; processes such as PCR (to amplify minute samples of DNA to testable amounts) and gel electrophoresis can be used to facilitate DNA sequencing of genomes.
- ☐ Recombinant DNA technology and DNA identification technologies are applied in agriculture and environmental conservation.

1.1 REPLICATION OF GENETIC MATERIAL

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) asexual reproduction

____

(ii) binary fission

____

(iii) cell cycle

____

(iv) daughter cell

____

(v) DNA replication

____

(vi) fertilisation

____

(vii) meiosis

____

(viii) mitosis

____

(ix) reproduction

____

(x) sexual reproduction

Review Questions

1. Why do living things need to reproduce?

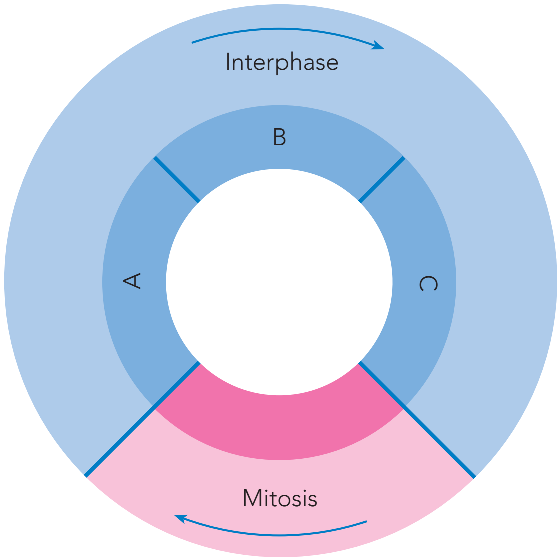
2. What is the main difference between asexual and sexual reproduction?

3. (i) Explain how binary fission occurs – use a labelled diagram to illustrate your answer.

   (ii) Which organisms reproduce in this way?

   (iii) Is this sexual or asexual reproduction? Explain

4. The cell cycle can be represented in the following way:



(i) What occurs in the cell during the stage labelled A?

____

____

(ii) The chromosomes are replicated during stage B. Explain why their replication is necessary.

____

____

(iii) During stage C, proteins are synthesised which are used in the construction of microtubules. When are these microtubules used?

____

____

(iv) After mitosis, some cells go into a stage where they do not divide further but remain apparently inactive either for long periods or indefinitely. In general terms, what might be their role in the body at this stage?

____

____

(v) Mitosis occurs in two main stages a) karyokinesis, and b) cytokinesis. Describe in broad terms, what occurs in each of these stages?

(a)

____

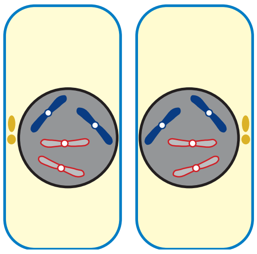
____

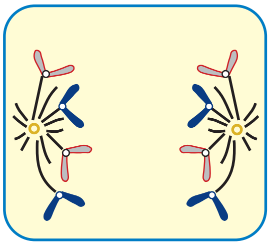
(b)

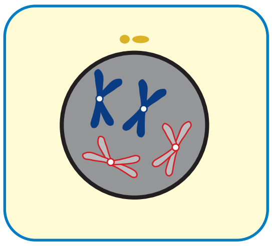
____

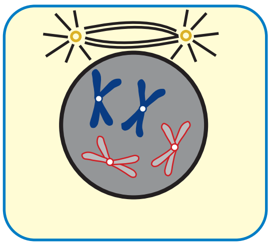
____

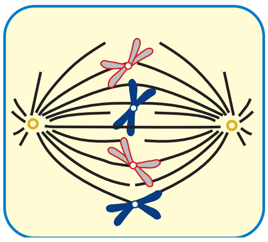
5. (i) The following diagrams show various stages of **mitosis**. They are in a jumbled order. Alongside each diagram write the name of the phase and describe what is occurring during the phase.

(a) 

(b) 

(c) 

(d) 

(e) 

(ii) List the order in which these phases would occur.

(iii) (a) In the sequence shown above, what is the number of chromosomes in the 'parent' cell?

(b) How many pairs of chromosomes does it have?

(c) How many chromosomes does each of the daughter cells have?

(d) How many **pairs** of chromosomes does each daughter cell have?

(e) What, therefore, is the total number of chromosomes in the daughter cells?

(iv)

(a) Since the total number of chromosomes in the daughter cells is twice that of the parent cell, explain briefly how this doubling in the number of chromosomes has come about.

(b) At what stage in the sequence does this replication of chromosomes occur?

(c) Explain why the replication is necessary.

6. (i) How does mitosis contribute to:

(a) growth?

(b) repair?

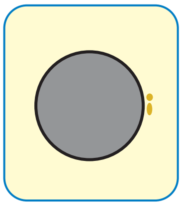
(c) asexual reproduction?

(ii) When a multicellular organism increases in size as it grows, besides mitosis two other processes occur. These are enlargement and differentiation. Explain clearly what occurs in each of these processes.

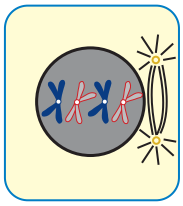
(a) enlargement

(b) differentiation

7. (i) The following sequence shows a cell undergoing **meiosis**. In the spaces provided, describe what is occurring in and to the cell.



(a)



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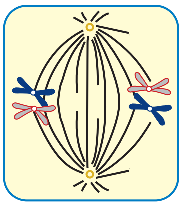

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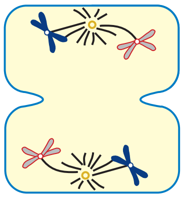

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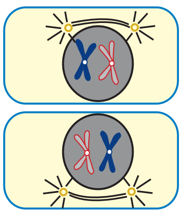

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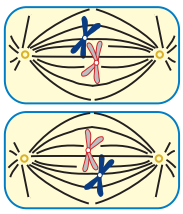

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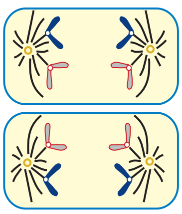

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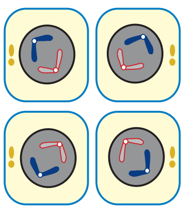


(h)

In the above diagrams:

(ii) How many chromosomes did the parent cell contain? ________

(iii) How many chromosomes do each of the gametes contain? ________

(iv) What is the total number of chromosomes in the four daughter cells? ________

(v) How do you account for the apparent increase in the total number of chromosomes?

(vi) Why must the gametes contain less chromosomes than the parent cell?

(vii) At which stages does karyokinesis occur?

(viii) When does cytokinesis occur?

8. (i) Explain why a zygote with forty chromosomes probably contains twenty maternal and twenty paternal chromosomes.

(ii) What proportion of DNA is acquired from each parent?

9. (i) Describe what occurs to the gametes when fertilisation occurs.

(ii) Explain why meiosis is necessary before gametes fuse in fertilisation.

1.2 DNA

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) base triplet

(ii) chloroplast

(iii) coding DNA

(iv) cytosol

(v) eukaryote

(vi) histone

(vii) mDNA

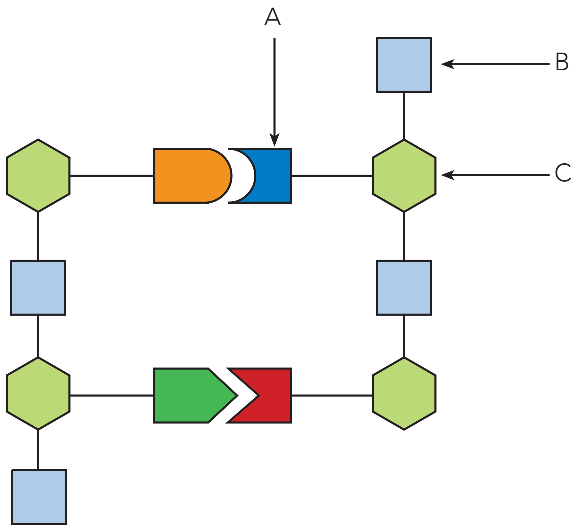
(viii) nucleotide

(ix) prokaryote

(x) protein synthesis

Review Questions

1. The following diagram represents a short segment of DNA.



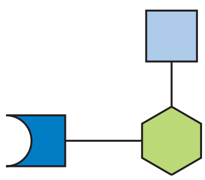
Name the substances labelled A, B and C.

A ____

B ____

C ____

2. If a small part of the molecule is isolated, it could be represented by:



(i) What is this unit called ? ____________________________

(ii) Where might it be found in this separated form?

____

3. There are four different nitrogenous bases in DNA. What are they called?

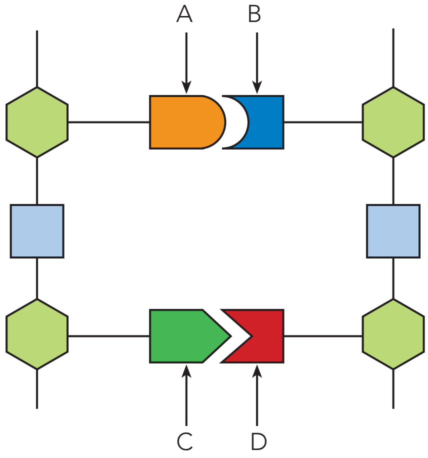
____

____

____

____

4. In the following diagram:



If A is cytosine, then B is ____________________________

If C is thymine, then D is ____________________________

5. Explain briefly why the *sequence* of nitrogenous bases in DNA is important.

____

____

6. Name the **three** organelles in which DNA is found in normal cells.

____

7. (i) What is the importance of mitochondrial DNA (mDNA)?

____

____

(ii) What is the importance of chloroplast DNA (cpDNA)?

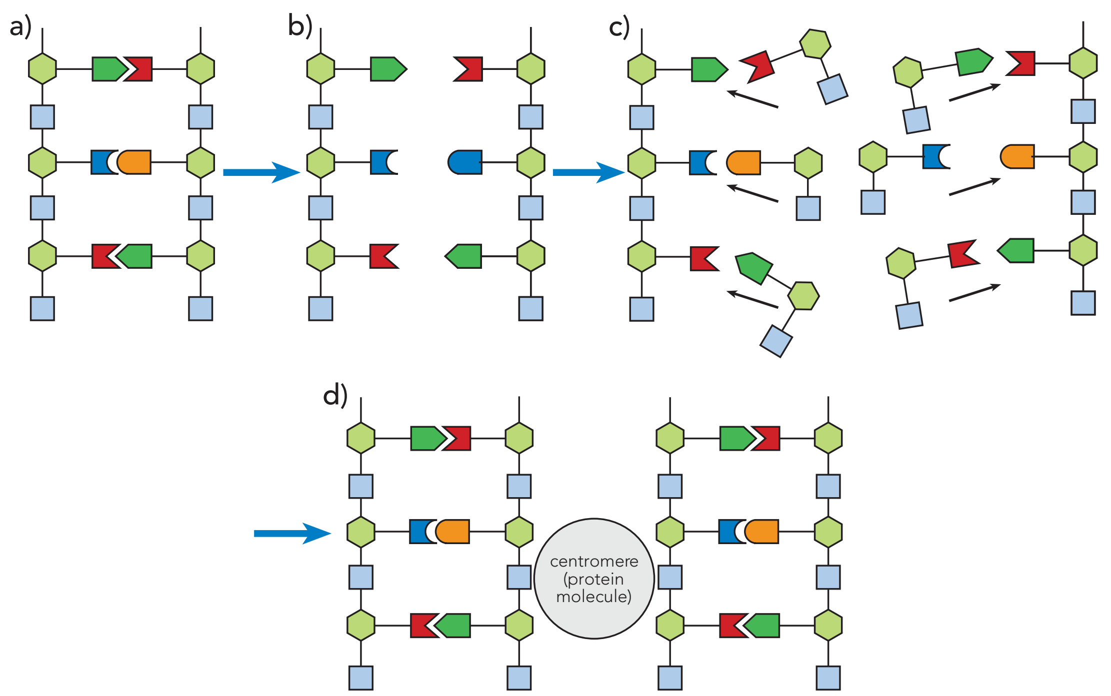
____

____

8. Describe how DNA and histones are bound together in a chromosome. Illustrate this with a simple labelled diagram below.

9. DNA replicates before a cell divides. Explain why this is necessary?

10. Study the sequences of changes in the section of a DNA molecule shown below. Then answer the questions that follow them.



(i) Describe the changes to the DNA molecule which have occurred between diagrams (a) and (b).

(ii) What appears to be occurring in diagram (c)?

(iii) Describe the two new DNA molecules in diagram (d).

(iv) What is this process (in which DNA is copied) called?

____

(v) During which part of the cell cycle do DNA molecules replicate?

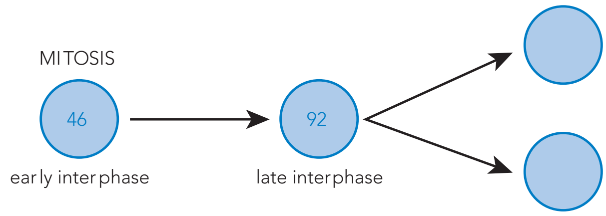
____

____

____

(vi) Complete the diagrams below to show the number of DNA molecules present in human cells at the end of both mitosis and meiosis.

(a)



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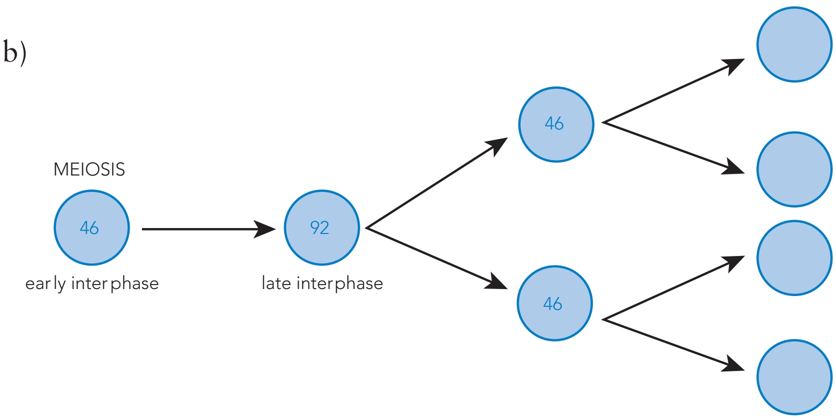


11. (i) How are the two strands of DNA held together in the double helix?

____

(ii) Are these hydrogen bonds strong or weak? ______________________

(iii) Explain why this is important in DNA replication.

____

____

____

____

____

1.3 PROTEINS AND PROTEIN SYNTHESIS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) amino acid

(ii) enzyme

(iii) mRNA

(iv) polypeptide

(v) protein

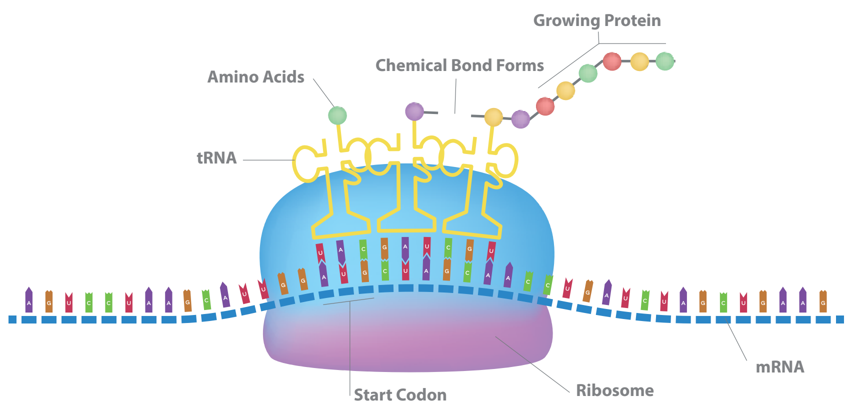
(vi) ribosome

(vii) structural proteins

(viii) transcription

(ix) translation

(x) tRNA



Review Questions

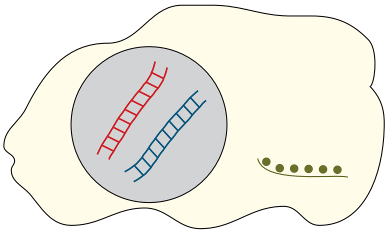
1. Proteins have important roles in the body. Name six of these roles.

2. (i) What do the abbreviations DNA and RNA stand for?

   (ii) List four differences (functional and structural) between DNA and RNA.

3. The series of diagrams below show diagrammatically how protein synthesis occurs in cells. Beside each diagram write down what is occurring in that stage.

(a)



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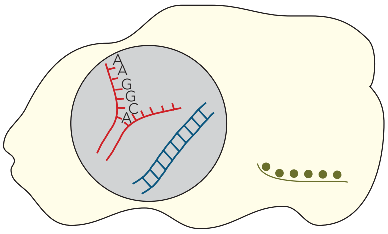

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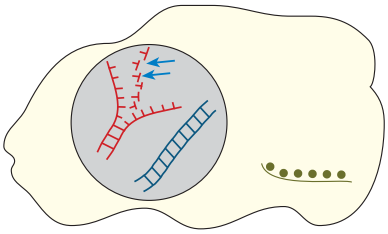

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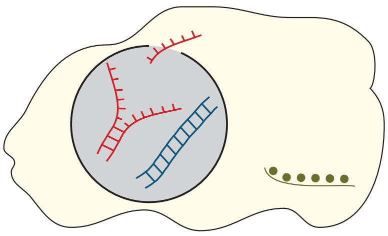

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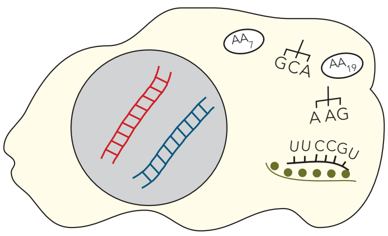

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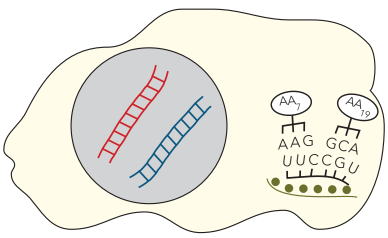

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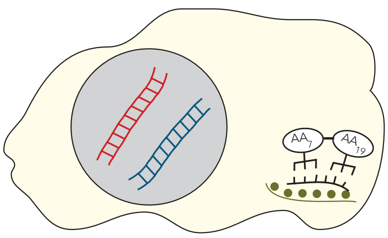


4. For a protein to be made or synthesised, the information has to be taken off the DNA molecule and used to arrange many amino acids in a specific sequence. This involves two processes—transcription and translation. Distinguish between transcription and translation by completing the table below.

TRANSCRIPTION	TRANSLATION
• occurs inside the ____________________. • is the process that copies the code on part of the ______________________ onto a strand of mRNA. • the ______________ molecule unwinds and one strand of the helix is used as a template. • an enzyme (RNA ________________) joins _________________ together to form a strand of messenger RNA. • the sequence of bases on mRNA is complimentary to the sequence of bases on the strand of ____________________.	• occurs in the ______________________. • is the process in which ______________ acids are assembled to form proteins. • ______________ leaves the nucleus and moves into the cytoplasm. • mRNA attaches onto a ______________. • the anticodon on __________________ attaches to the ___________ on the mRNA. • the amino acids from tRNA are linked together to form the amino acid chain or ______________________.

5. The genetic code is described as a **triplet code** and **degenerate**. Explain what is meant by these two terms.

____

____

____

____

6. Use the genetic code below to answer the questions that follow.

		Second base of codon					
		U	C	A	G		
First base of codon	U	phe phe leu leu	ser ser ser ser	tyr tyr STOP STOP	cys cys STOP trp	U C A G	Third base of codon
	C	leu leu leu leu	pro pro pro pro	his his glu glu	arg arg arg arg	U C A G	
	A	ile ile ile met+start	thr thr thr thr	asp asp lys lys	ser ser arg arg	U C A G	
	G	val val val val	ala ala ala ala	asp asp glu glu	gly gly gly gly	U C A G	

(i) What would be the sequence of amino acids that the following strands of mRNA represent?

(a) AUGCAUGGCAAAAUCCUAGAUUAG

(b) GGGCAUAUCGUUAUAUGAUCUGGC

(ii) Complete this table

Strand of DNA that is 'read'	Transcribed mRNA strand	tRNA anticodons
G	C	
	C	G
	C	
T	A	
A		A
G	C	
T	A	
	A	U
	U	

(iii) Which amino acids does this strand of DNA code for?

(iv) (a) What is a "start codon"?

(b) Why is it important in protein synthesis?

(c) What is the most common start codon in eukaryotic organisms?

(v) Describe the function of a "stop codon".

---

7. (i) What are introns and exons?

(ii) Discuss what happens to introns and exons during transcription and translation.

1.4 GENES AND GENOTYPES

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) crossing over

(ii) fertilisation

(iii) genotype

(iv) mutagen

(v) mutant

(vi) mutation

(vii) non-disjunction

(viii) phenotype

(ix) random assortment (of chromosomes)

(x) variation

Review Questions

1. Explain the difference between the terms **genotype** and **phenotype**.

2. Make a list of 5 features of a named animal or plant which are:

   (i) determined primarily by its heredity;

   (ii) determined by both its heredity and environmental factors.

3. Jarrah trees that grow on the coastal plain (e.g. in Kings Park) are often different (in size and shape) from those that grow in the Darling Scarp (e.g. around Kalamunda).

   (i) Write a hypothesis to explain why there is a difference in their growth.

   (ii) Outline how you could test your hypothesis.

4. Hydrangeas are a flowering plant which may produce white, pink or blue flowers.

If a plant, which has pink flowers, is fertilised by adding aluminium sulphate to its soil, its flowers change to blue. However, if a hydrangea which has white flowers is fertilised by adding the same aluminium compound, no such change occurs.

(i) What reason can you give for these observations?

(ii) If you had a blue flowering hydrangea, how could you get it to change flower colour to pink?

(iii) How practical would this be?

(iv) Hydrangeas take up aluminium best at lower soil pH levels (when the soil is acidic). How could you use this knowledge to change blue flowering hydrangeas to pink flowering?

(v) It is reasonable to assume that the flower colour of pink and blue flowering hydrangeas is determined by a combination of their genes and their environment. Is this true of white flowering hydrangeas? Explain.

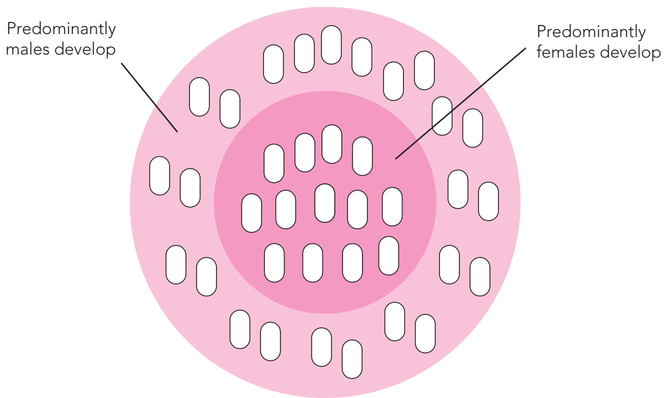
5. In mammals, males have XY sex chromosomes, females have XX sex chromosomes.

(i) How is the sex of a mammal determined at fertilisation?

In birds, males have two similar sex chromosomes ZZ and females have ZW sex chromosomes.

(ii) How is the sex of a bird determined at fertilisation?

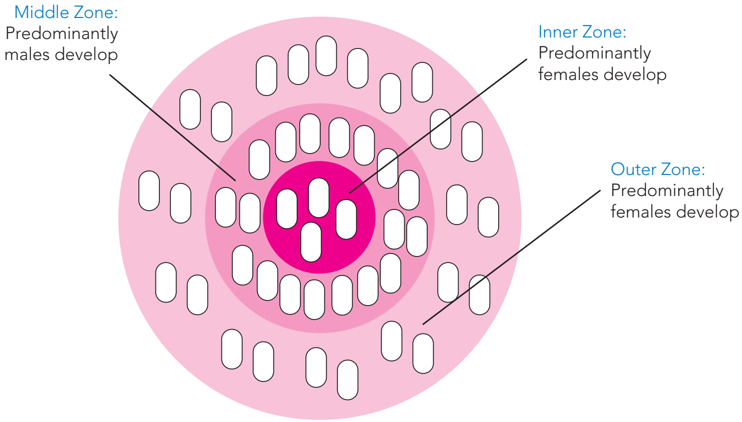
6. The sex of many reptiles is determined by their position in the nest. In some species eggs which incubate nearest the outside are likely to become males, while those nearest the centre are likely to develop as females.



(i) Explain the above observation.

(ii) How could you test your hypothesis?

In other reptiles, the sex determination is a little more complex. There are three zones within the cluster of eggs. The sex which develops is temperature dependent but, as the diagram below shows, not quite in the same way as in the first.



(iii) Explain what might cause this difference in sex determination.

7. Explain what is meant by 'gene expression'.

8. Name two things that could permanently change the expression of the genes in a cell.

9. Gene expression can be modified by the environment. Two examples are:

(i)

(ii)

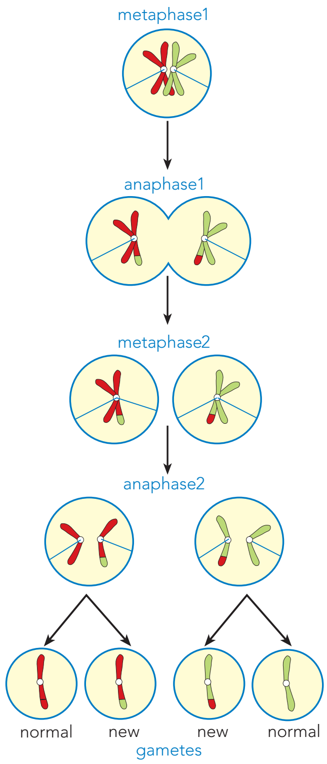
10. Explain how UV light affects melanin production in humans and why this is important.

11. Why does meiosis occur?

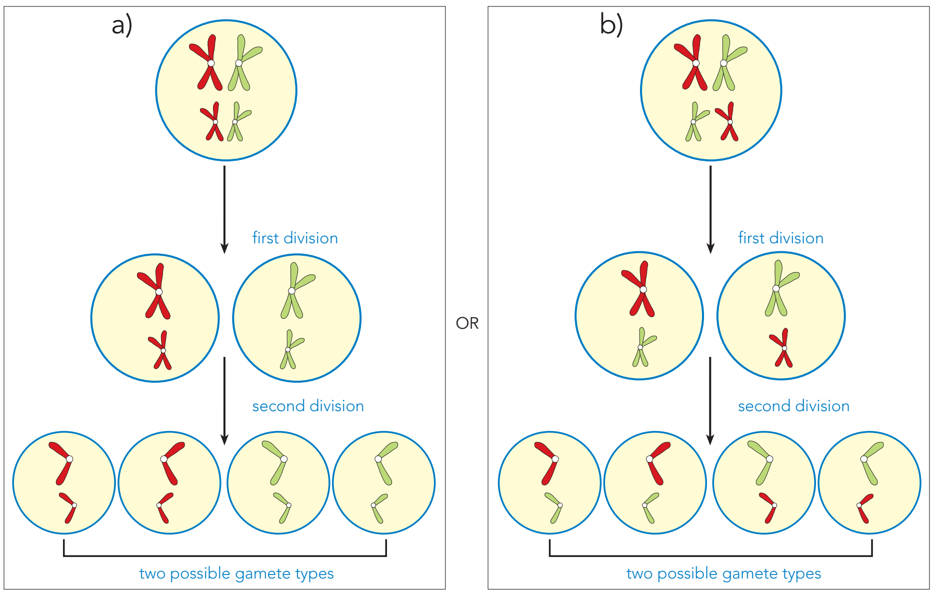
12. How does 'random fertilisation' affect variation within a sexually reproducing population?

13. Use the diagrams below to **explain** the causes of variation in the gametes and therefore the causes of variation in offspring.

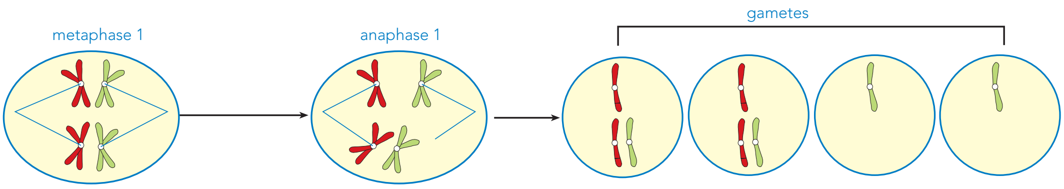
(i) Crossing Over during meiosis (only some stages shown).



(ii) Random Assortment during Meiosis.



(iii) Non-disjunction during meiosis



____

____

____

____

____

____

(iv) What do the three examples shown above have in common?

____

____

____

____

14. Complete the following:

Variation in offspring results from the fact that when fertilisation occurs, each sperm type that is produced has an ____________________ likelihood of fertilisation and each ______________ type that is produced also has an ________________ likelihood of fertilisation. The way in which individual organisms meet is also usually a ______________ process which therefore creates variation. If blondes were only attracted to blondes, there would be less variation in hair colour in human populations.

15. (i) What is a mutation?

____

____

____

(ii) Why are most mutations of no use to the organism?

____

____

(iii) What are the most likely causes of mutations?

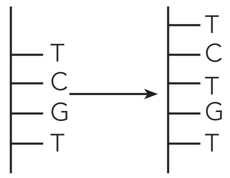
(iv) How do mutations contribute to variations within a species?

16. Why do organisms that reproduce sexually show greater variation than those that reproduce asexually?

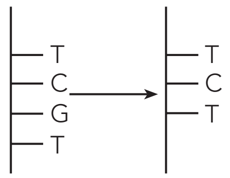
17. (i) Mutations may fall into a number of categories. Use the terms below to classify the mutations which are illustrated. (Write the appropriate word in the box beside each diagram.)

"Inversion" "Deletion" "Substitution" "Insertion"

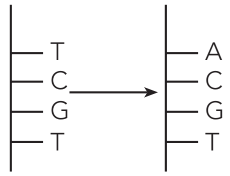
(a)



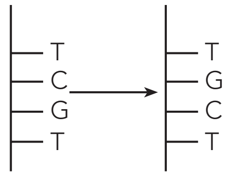
(b)



(c)



(d)



(ii) Briefly explain why any of these changes can result in a mutation.

(iii) Mutations are seldom a problem for an organism. Generally they have a neutral effect on its phenotype. Why is this?

1.5 PATTERNS OF INHERITANCE

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) allele

(ii) autosome

(iii) codominance

(iv) dominant gene

(v) gene frequency

(vi) multiple alleles

(vii) polygenic trait

(viii) probability

(ix) recessive gene

(x) sex-linked

Review Questions

1. For mammals, explain what is meant by each of the following terms:

   (i) autosomal inheritance

   (ii) sex-linked inheritance / x-linked inheritance

2. Complete the table below for humans.

	Total number of autosomal chromosomes in each somatic cell	Type of sex chromosomes in each somatic cell	Total number of chromosomes in each somatic cell
Female			
Male			

3. Suppose right handedness is due to a dominant allele (R) and left handedness to its recessive allele (r). A right handed woman with a left handed husband has one left handed child and three right handed children.

   (i) Write the genotypes of the parents.

   Woman __________ Man _________

   (ii) Using a punnet square, show what the genotypes of their children could be.

	Man	
Woman		

   (iii) What is the **phenotypic** ratio expected in their children?

   (iv) In theory if this couple have four children, how many would be expected to be right handed and how many left handed?

   (v) Why did their children not show these proportions?

4. (i) For the ABO blood grouping in humans complete the table below using the symbols I^A, I^B and i.

Blood Group	Possible Genotypes
A	
B	
AB	
O	

(ii) How many different **phenotypes** are present in this blood grouping? ___________

(iii) How many different **genotypes** are present? __________

(iv) Which genotype/s illustrates **dominance**? _____________

(v) Which genotype/s illustrates **codominance**? _____________

(vi) Why is the ABO system of blood grouping described as "multiple allelic"?

____

____

5. Use the punnet squares to answer the following questions.

(i) A man with blood group O marries a woman with blood group O. What is the probability of them having a child with group B?

____

____

Man

Woman

(ii) A woman with blood group O marries a man with blood group B. What is the probability of them producing a child with blood group A?

____

____

Man

Woman

OR

Man

Woman

(iii) A man with blood group AB marries a woman with blood group B. What is the probability of them producing a child with blood group A?

____

____

Man

Woman		

OR

Man

Woman		

(iv) A man with blood group B had a mother with group O. He marries a woman who is I^AI^A. Show the ratio of the genotypes and phenotypes they could expect in their children.

Man

Woman		

6. Haemophilia is a human sex-linked disease. The gene for haemophilia is on the X chromosome which can be represented as X^h. The normal gene can be represented as X^H.

(i) If a man who has haemophilia marries a normal woman who has no history of haemophilia in her family, what would be the expected genotypic and phenotypic ratios in their offspring?

Man

Woman		

(ii) A woman who is a 'carrier' marries a normal male, if they have children what is the probability that they will have a son who has haemophilia?

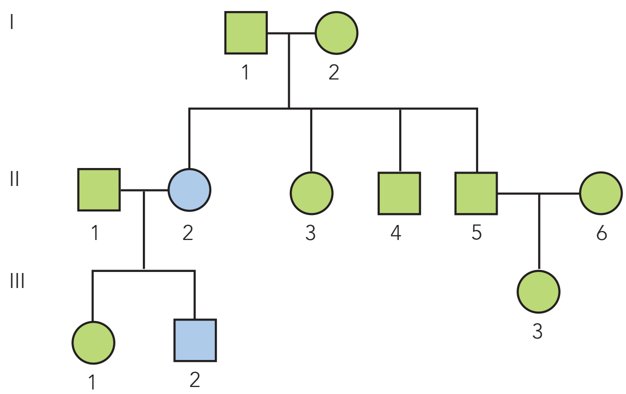
Man

Woman		

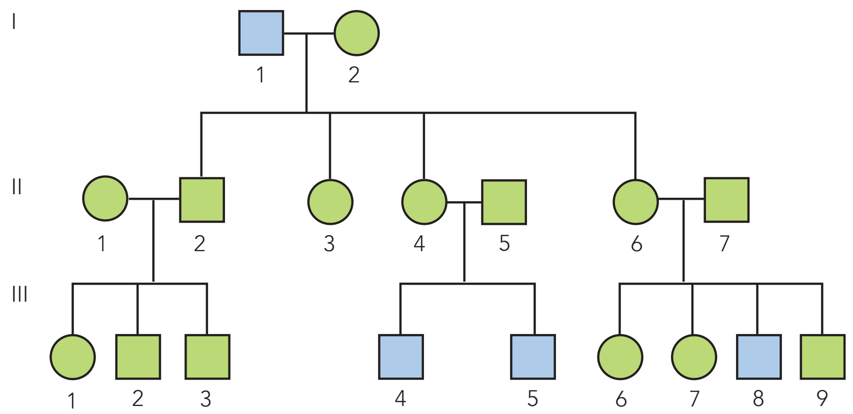
7. A breeder of rabbits needs to find out if a rabbit, which is not an albino, is homozygous or heterozygous for hair colour (i.e. she wishes to find out if the rabbit has the genotype AA or Aa, where 'A' is the gene for normal hair and 'a' the gene for albinism). Explain how she might find out using a 'test cross'.

8. For each of the pedigrees below, determine the most likely mode of inheritance (i.e. whether sex-linked or autosomal **and** whether dominant or recessive). Explain how you arrived at your answer in each. In each example individuals with blue shading have the condition.

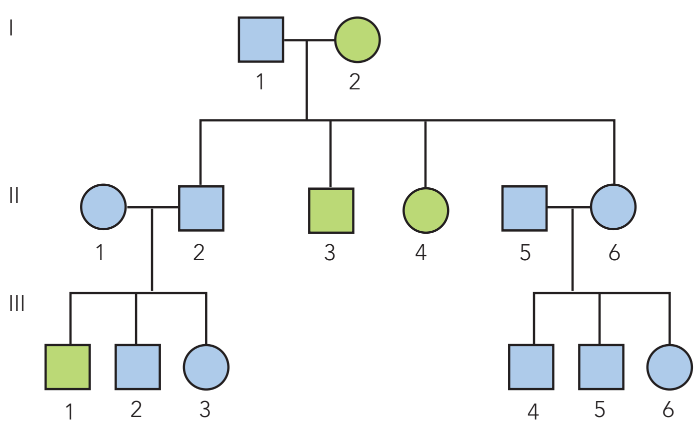
(i)



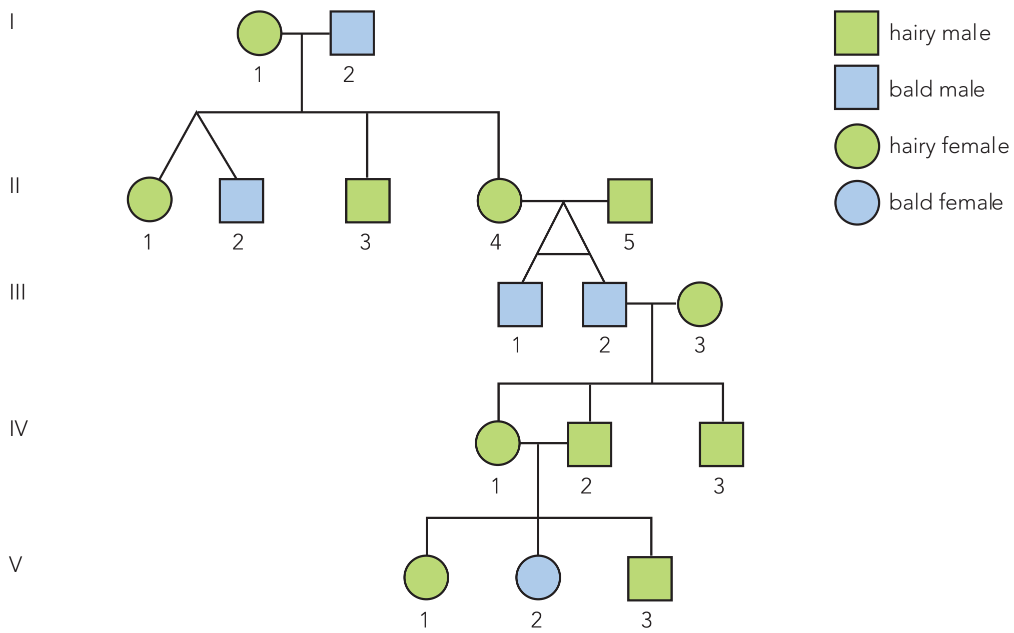
(ii)



(iii)



9. The pedigree below shows the incidence of a disease which causes total baldness in mammals.



(i) (a) How is this disease inherited, i.e. what is its mode of inheritance?

(b) Explain how you arrived at your answer.

(ii) Write down the possible genotypes of each individual in the pedigree. Include a key in your answer.

I 1_______ I 2_______

II 1_______ II 2_______ II 3_______ II 4_______ II 5_______

III 1_______ III 2_______ III 3_______

IV 1_______ IV 2_______ IV 3_______

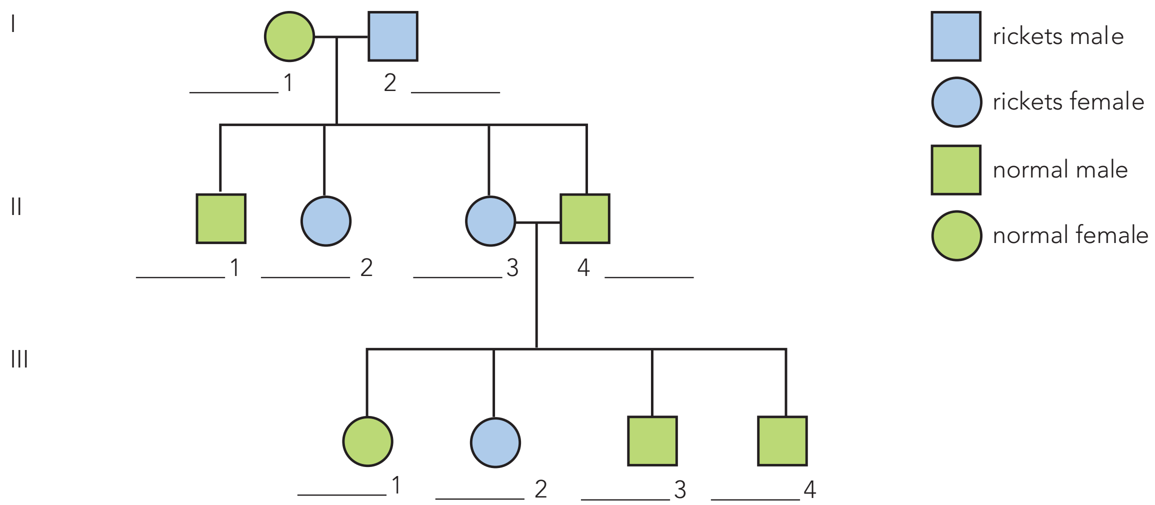
V 1_______ V 2_______ V 3_______

(iii) Which individuals are twins in this pedigree?

(iv) Which twins are monozygotic and which are dizygotic?

(v) Where did the genes which gave rise to V 2's baldness come from?

10. A rare inherited form of rickets which affects mammals is shown on the pedigree below.



This disease is unusual because it is caused by a gene carried on the X chromosome (sex-linked).

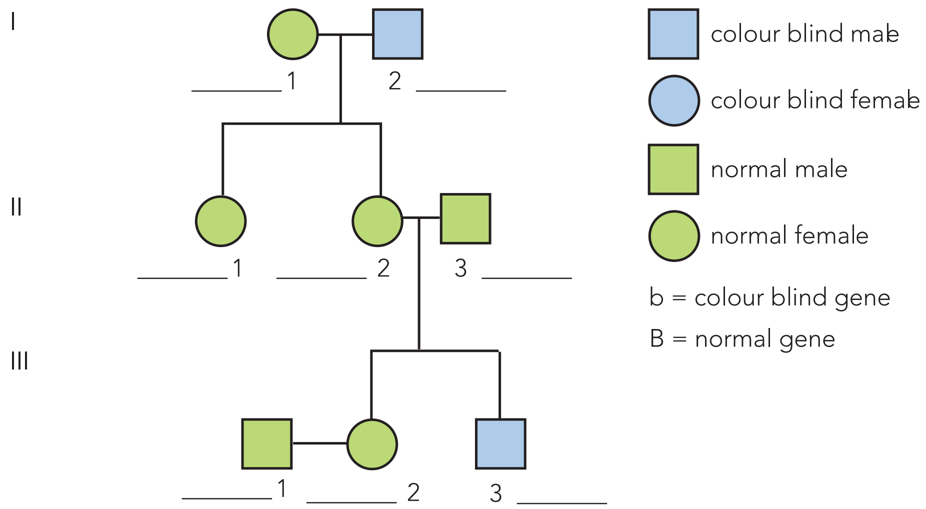
(i) How is this defective gene different from the usual sex-linked defective gene?

(ii) Under each individual in the spaces provided, write possible genotypes. (Use a key to indicate what your letters stand for.)

(iii) From which parent did individual II 2 inherit the defective gene?

(iv) Would you expect more males or more females to inherit this disease? Explain.

11. (i) A family with a history of colour blindness (an x-linked recessive trait) has the pedigree shown below. Write the possible genotypes for each individual in the spaces provided.



(ii) If individuals 1 and 2 in generation III have children, what is the probability of each of the following genotypes in their offspring? (Use the punnet squares to work out your answers).

X^bY ______________________________

X^BY ______________________________

X^BX^B ______________________________

X^BX^b ______________________________

X^bX^b ______________________________

Man

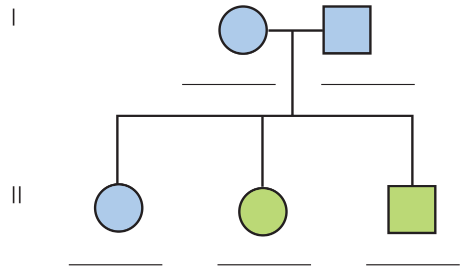
Woman		

OR

Man

Woman		

12. In the pedigree below, an autosomal dominant condition represented by R is shown. Individuals with blue shading have the condition.



(i) Write the possible genotypes in the spaces below each individual.

(ii) If this couple has another child, what is the probability that it will have the condition?

Man

Woman		

____

(iii) What is the probability that the child is homozygous (RR or rr)?

____

(iv) If the child has the condition, what is the probability that he or she is homozygous?

____

(v) If the child does not have the condition, what is the probability that he or she is homozygous?

____

13. Many traits are controlled polygenically. For example height may be controlled by at least three pairs of genes with their loci on different chromosomes. The three pairs could be represented as A and a, B and b and C and c.

Suppose a tall man whose genotype is aabbCc marries a short woman whose genotype is AaBbCC

(i) Show the types of gametes each individual could produce.

____

____

(ii) What are the possible genotypes of their children, if they have children? Show your workings in a table.

____

____

____

(iii) How many different genotypes could the children inherit?

(iv) What do your answers to (ii) and (iii) indicate regarding the variation in height that could be shown in a large family?

(v) Discuss the evidence you look for in deciding whether a trait is polygenic or not.

1.6 DNA SEQUENCING, DNA PROFILING AND APPLICATIONS OF DNA TECHNOLOGIES

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) DNA profiling

(ii) DNA sequencing

(iii) gel electrophoresis

(iv) gene cloning

(v) gene vector

(vi) genome

(vii) ligation (DNA)

(viii) polymerase

(ix) restriction enzyme

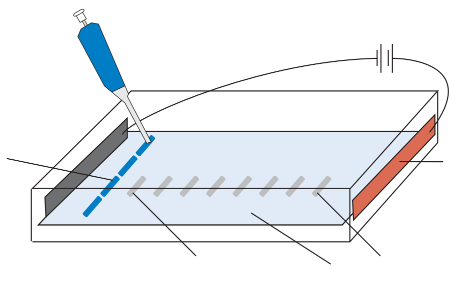
(x) transgenic organism

Review Questions

1. Discuss what is meant by "mapping a species genome"?

2. Describe briefly the Frederick Sanger method used in DNA sequencing.

3. The diagram below illustrates gel electrophoresis.



(i) With the appropriate letters shown below mark on the diagram:

A – The gel
B – The part of the gel (wells) where the DNA fragments are placed at the beginning of the test
C – The position of the smallest fragments of DNA in the sample after they have moved through the gel
D – The positive terminal
E – The position of the largest fragments of DNA in the sample after they have moved through the gel.

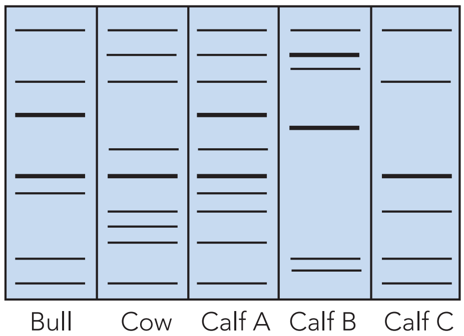
(ii) What is electrophoresis used for?

(iii) Explain why the DNA moves through the gel.

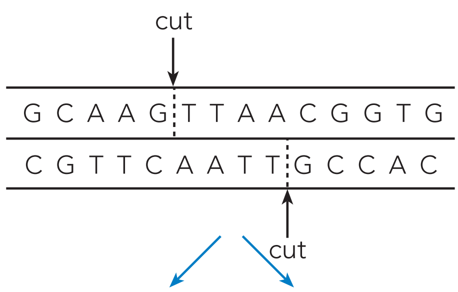
(iv) What charge do the DNA fragments carry? Explain what evidence there is for this from the observations seen in gel electrophoresis

(v) Why do the fragments of DNA separate into bands when the voltage is applied?

(vi) If the DNA profiles of some cattle obtained through electrophoresis appeared as shown, which of the three calves does not belong to the cow and the bull shown? Explain your answer.



4. (i) A restriction enzyme was used to cut the section of DNA shown below. Draw the resulting DNA fragments below the diagram.



(ii) On your diagram, mark clearly the 'sticky' ends of each DNA fragment.

(iii) Why are they called 'sticky'?

(iv) Where do restriction enzymes occur naturally?

5. (i) What is a gene probe used for?

(ii) If the gene probe was being used to locate the following sequence of bases in a gene:

A T T C G T A C C G

what sequence of bases would the gene probe need to have?

(iii) How is the probe made detectable?

(iv) Outline briefly how the probe is used. (List the main steps in the process.)

(v) What might be an application of this biotechnology?

6. The use of genetic probes can be described as an example of recombinant gene technology. Why?

7. (i) What is a plasmid?

(ii) If foreign DNA is 'spliced' onto a plasmid (or a virus) how can the bacteria be used to transfer a gene to another host cell?

(iii) What general name is given to the plasmid or virus used in this process?

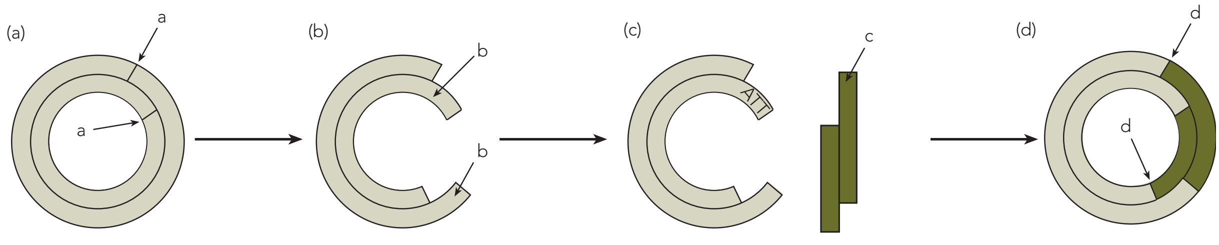
(iv) How can a bacterium be used to mass produce a particular gene?

8. Explain briefly the process involved in:

(i) gene cloning.

(ii) DNA profiling.

9. The sequence of four diagrams below show how a segment of DNA can be inserted or spliced onto a bacterial plasmid DNA molecule. Use the diagrams to answer the questions that follow them.



(i) What is used to cut the DNA at the points labelled 'a'?

(ii) Name the segments shown as 'b'.

(iii) What are the three bases on the end of the single strands at 'c'?

(iv) What is used to join the single strands at 'd'?

(v) Describe how the new recombinant DNA could change the function of a bacterium.

10. Discuss one way in which the genotype and phenotype of an organism can be modified.

11. (i) What are some advantages of modifying genotypes in plants?

(ii) What problems could arise with genetic modification?

12. What do DNA microarrays enable scientists to do relatively quickly?

13. Complete the following to describe a use of DNA microarrays:

To determine which ______________ are switched on in the nuclei of a particular cell type, the following procedure may be used:

(i) All the mRNA being produced by the cells' ______________ is extracted.

(ii) This mRNA is then copied to form ____________________________ .

(iii) The ______________ is "labelled" using a _______________________ .

(iv) All the labelled complimentary DNA (cDNA) is then placed on a

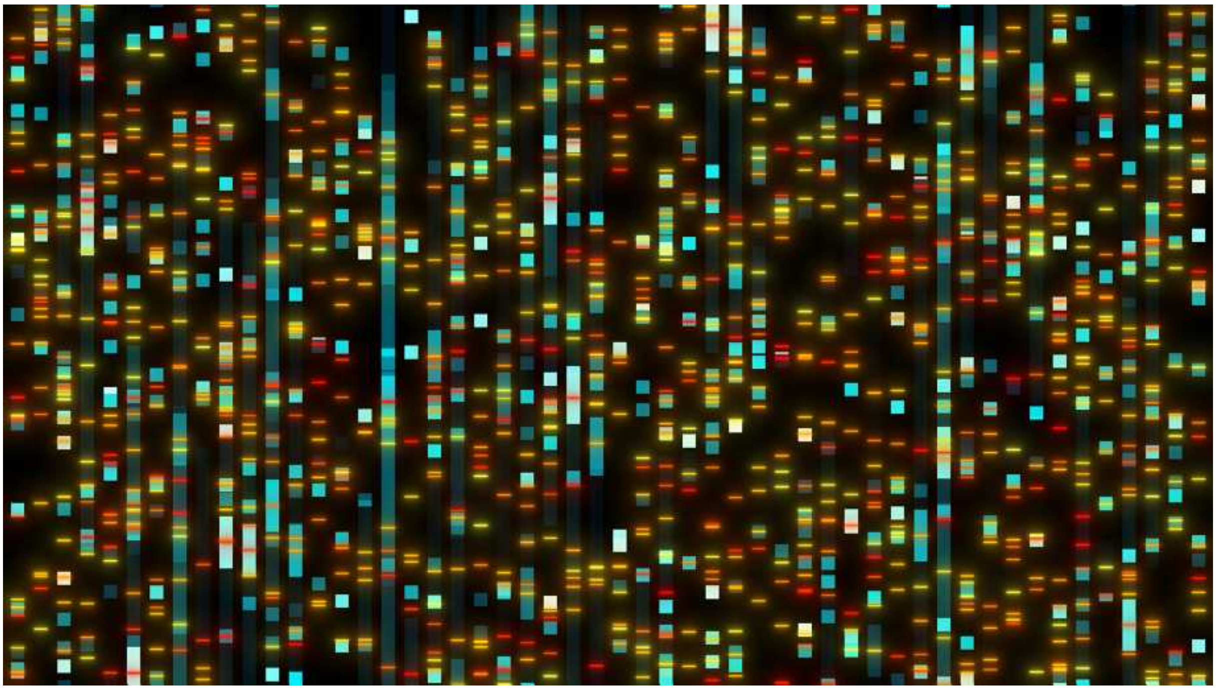
___________________________.

The microarray consists of rows of ______________ probes, nucleotide sequences corresponding to particular ______________ in the cell's genome.

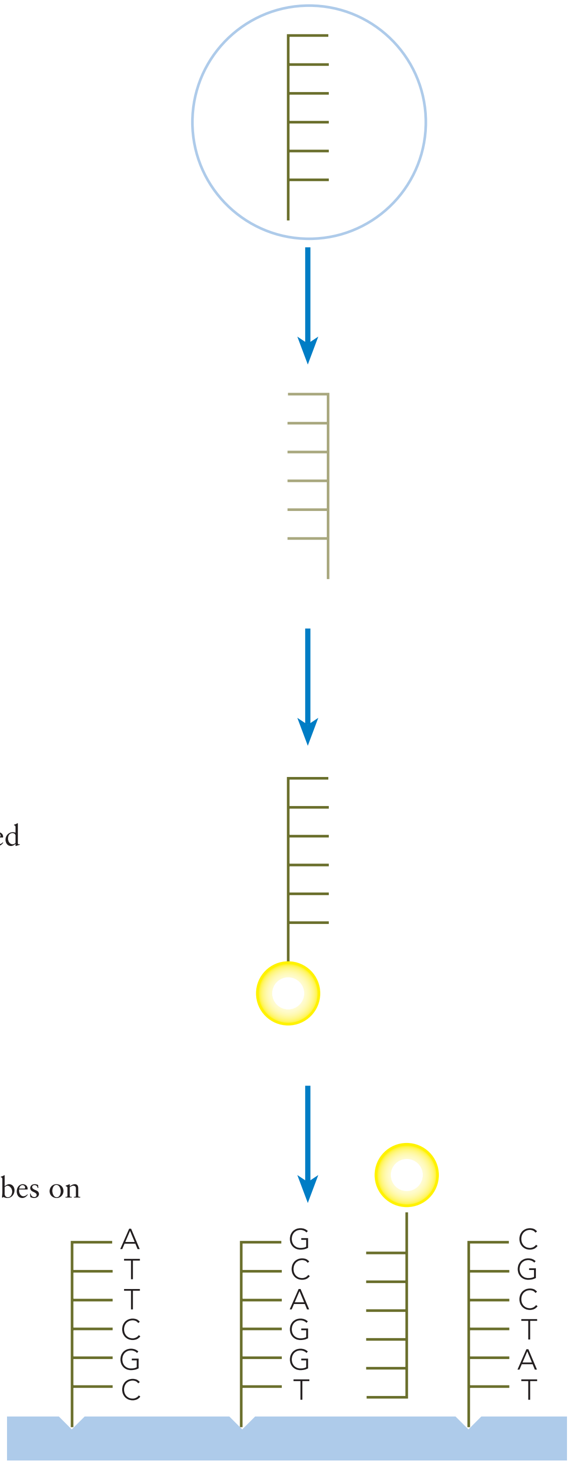
(v) The cDNA fragments ______________ to their matching DNA probes on the microarray.

(vi) The position of the hybridised fragments on the microarray is determined by an automated ____________________________ microscope.

(vii) The fluorescent spots indicate which ________________________ are switched _____ in the cells' nuclei.



14. The diagram below shows four stages in a DNA microarray experiment. Write brief notes to describe each stage. Use the information provided in stage (iv) to determine each nucleotide which is not labelled and show each nucleotide on the nucleic acids.



Stage (i): A small section of DNA is switched on

____

____

____

Stage (ii): mRNA

____

____

____

Stage (iii): cDNA with flourescent molecule attached

____

____

____

Stage (iv): cDNA attached to one of three gene probes on microarray

____

____

____

15. (i) What is a 'genetically modified' organism?

____

(ii) How can a gene be modified?

____

(iii) Why do many scientists wish to modify genes?

____

(iv) Give an example of the use of genetic modification to improve:

(a) a plant

(b) an animal

(v) Traditional methods of artificial selection of livestock and crops can be used to improve the genetic makeup of organisms. Why is genetic modification a more efficient way of improving such human resources?

16. (i) Insect resistant food crops may have a direct advantage to the consumer. What is this advantage?

(ii) How might the use of insect resistant food crops assist farmers?

(iii) Explain why a herbicide-resistant food crop may be of practical use to a farmer.

(iv) How could a gene which controls the production of an antifreeze protein in fish that live in cold waters be used to assist farmers in growing crops in frost prone areas?

(v) In many countries, rice is the staple diet. However, it does not contain the complete range of vitamins required for healthy human growth and development. How could genetic modification be used to promote the health of malnourished people in these countries?

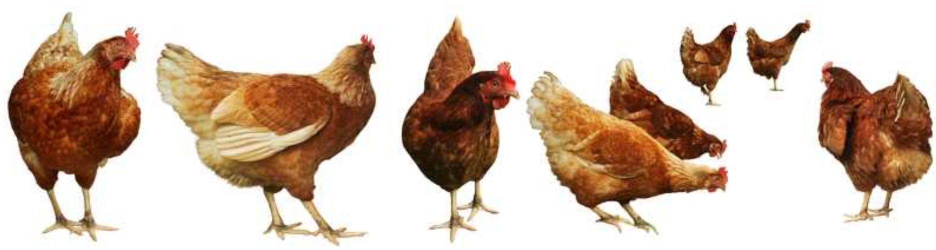
17. What role might genetically modified organisms have in environmental conservation?

18. (i) What is a vaccine?

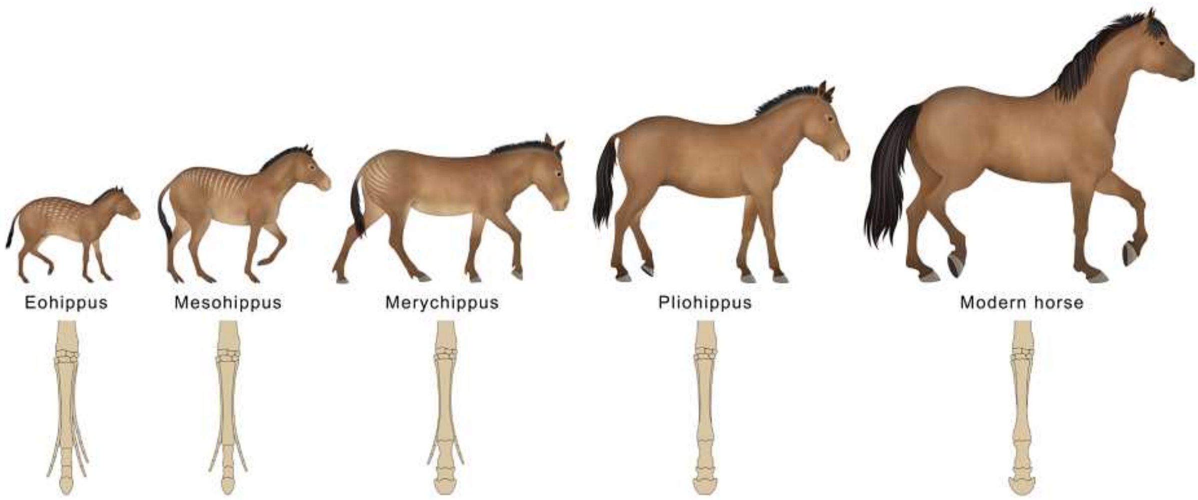
(ii) How are vaccines administered normally?

(iii) What might be the advantages of 'edible' vaccines in fruit or vegetables?

19. Scientists have bred genetically modified chickens that lay eggs which contain anti-cancer drugs (in the white of their eggs). What is likely to be the main advantage of this modification?



2 CONTINUITY OF LIFE ON EARTH



SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

2.1 EVOLUTION AND THE EVIDENCE FOR EVOLUTION

- ☐ Life has existed on Earth for approximately 3.5 billion years and has changed and diversified over time.
- ☐ Evidence for the theory of evolution includes:
  - comparative genomics (molecular evidence)
  - comparative studies of proteins (amino acid sequences)
  - the fossil record
  - comparative anatomy and embryology.
- ☐ Construction of phylogenetic trees, informed by protein, genomic and/or anatomical information, shows evolutionary relationships between groups.

2.2 MECHANISMS OF EVOLUTION

- ☐ Mutation is the ultimate source of genetic variation as it introduces new alleles into a population.
- ☐ Natural selection occurs when selection pressures in the environment confer a selective advantage on a specific phenotype to enhance its survival and reproduction; this results in changes in allele frequency in the gene pool of a population.
- ☐ Gene pools are dynamic, with changes in allele frequency caused by:
  - mutations
  - differing selection pressures
  - random genetic drift, including the founder effect
  - changes in gene flow between adjoining groups
- ☐ Speciation and macro-evolutionary changes result from an accumulation of micro-evolutionary changes over time.

2.3 ARTIFICIAL SELECTION, ALLOPATRIC SPECIATION AND GENETIC DIVERSITY

- [ ] Selective breeding (artificial selection) through the intentional reproduction of individuals with desirable characteristics results in changes in allele frequencies in the gene pools over time.
- [ ] Differing selection pressures between geographically isolated populations may lead to allopatric speciation.
- [ ] Populations with reduced genetic diversity face increased risk of extinction.

2.1 EVOLUTION AND THE EVIDENCE FOR EVOLUTION

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) anatomy

___

(ii) common ancestor

___

(iii) comparative embryology

___

(iv) evolution

___

(v) fossil

___

(vi) fossil record

___

(vii) genomics

___

(viii) paleontology

___

(ix) phylogenic tree

___

(x) vestigial organ

___

Review Questions

1. (i) What is the theory of evolution?

   (ii) Why is it called a theory?

2. Using examples, show how each of the following areas may support the theory of evolution.

   (i) Comparative anatomy

   (ii) Distributional studies

   (iii) Embryology

(iv) DNA and Protein Analysis

____

____

____

____

____

(v) Palaeontology

____

____

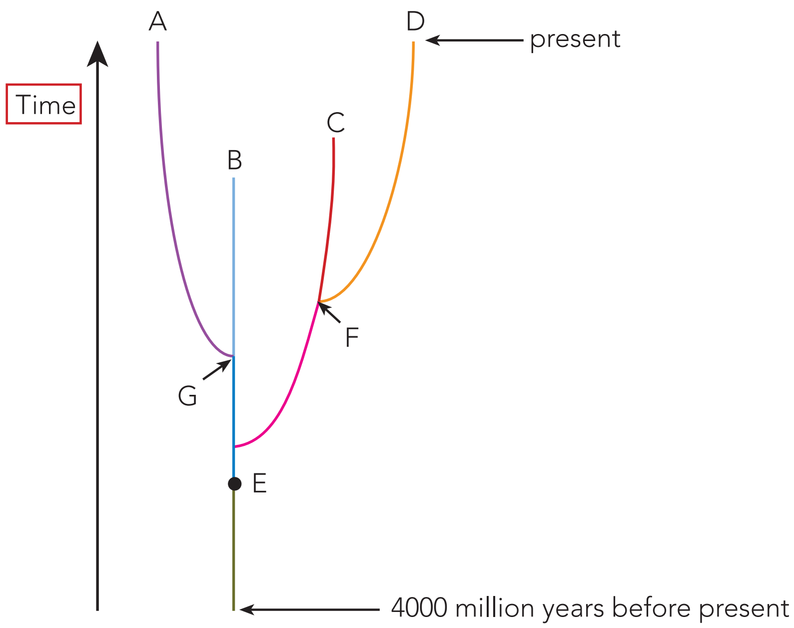
____

____

____

3. (i) An evolutionary tree of life can be called a ________________

Study the diagram of an evolutionary tree shown below then answer the questions which follow it:



Note: A, B, C, D and E represent different species. G and F represent processes

(ii) Which living species appears to be most closely related to species C?

____

(iii) How would its position on this tree have been determined?

____

____

(iv) Which species appears/appear to be extinct?

(v) What do the lengths of each branch indicate?

(vi) What do the nodes, like ‘F’, show?

(vii) When species diverge, as at G, what is this process called?

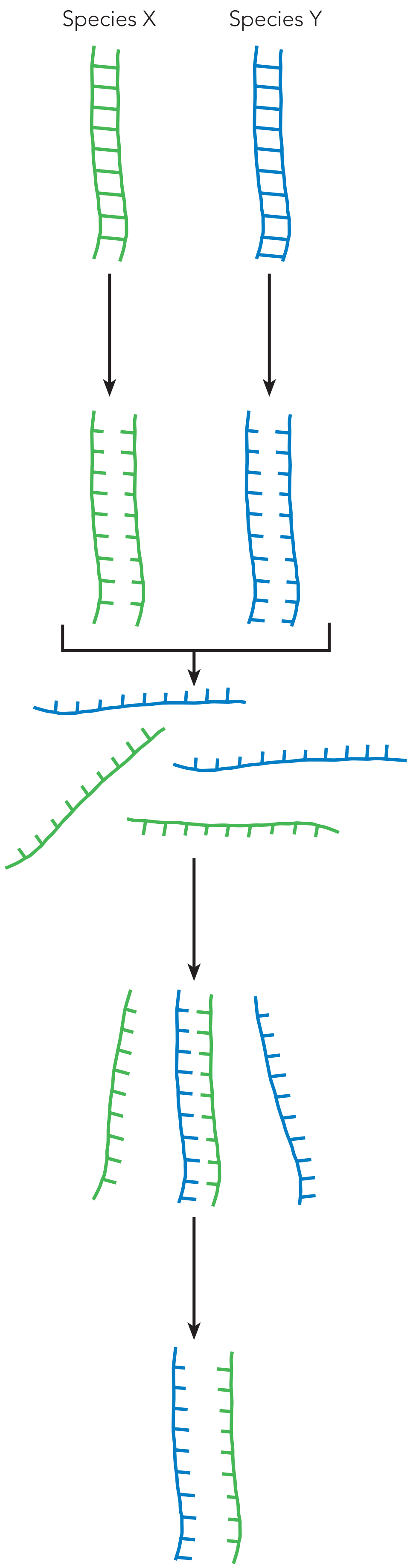
(viii) Which living species appears to be the most recent?

(ix) Which species is the most recent common ancestor to A and D?

(x) This diagram is only a very small section of a much larger evolutionary tree. What kind of organisms may have existed 4000 million years before the present time?

4. The diagram below illustrates how the degree of similarity between DNA from two species can be determined and therefore how closely related the two species are likely to be.

(i) In the boxes, write brief notes that describe each step in the process.



(a)

(b)

(c)

(d)

(e)

(ii) What is this process called? ______________________________

(iii) If two species were thought to be closely related on the evolutionary tree, how could this process support this hypothesis?

____

____

(iv) If two species were very distantly related, what results would indicate this?

____

____

(v) What can be inferred about the bases in the DNA segments which do hybridise strongly?

____

(vi) When separate strands of DNA (homologous DNA strands) do join together what is this joining called?

____

(vii) If two species have a very distant common ancestor, how would this reflect in the degree of hybridisation and the temperature necessary to ‘melt’ their hybridised DNA?

____

____

____

____

(viii) At what stage in this process would DNA polymerase be used?

____

2.2 MECHANISMS OF EVOLUTION

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) allele frequency

(ii) gene pool

(iii) genetic drift

(iv) genetic variation

(v) natural selection

(vi) phenotype

(vii) population

(viii) selection pressure

(ix) sexual selection

(x) speciation

Review Questions

1. (i) What is meant by natural selection?

(ii) What is meant by a ‘selection pressure’?

(iii) In each of the examples of natural selection below name the selection pressure.

(a) changing allele frequencies of the British peppered moth

(b) bacteria developing a resistance to an antibiotic

(c) mosquito populations becoming tolerant to a particular pesticide

2. The mechanism of natural selection involves four steps.

(i) Inherited variation exists due to (list four causes):

(ii) A small proportion of offspring reach maturity. The high mortality rate is due to:

(iii) Certain members of a species are more successful in particular environments. This is because:

(iv) The characteristics of the whole population change to suit the environment. This is because:

3. How might allele frequencies in a population change?

____

____

____

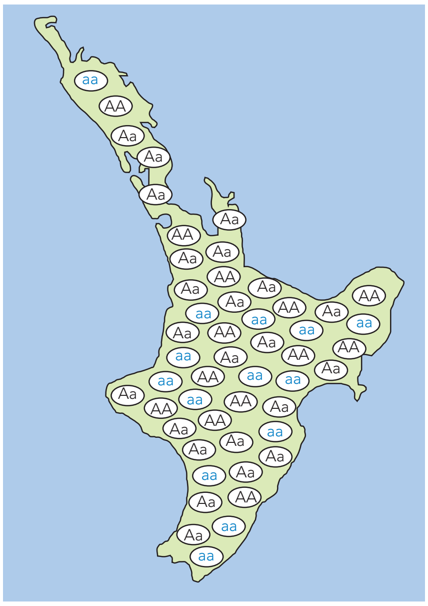
4. The ability of populations to survive environmental changes may depend on:

____

____

____

5. Albinism is a monogenic trait. The allele for normal pigmentation, A, is dominant to the allele for albinism, a. Imagine a population of mammals living on an island as represented below. The circles represent individuals. Each individual's genotype is shown.



(i) (a) What is the genotype of an albino? _______________

(b) Count the number of albinos in this population. _______________

(ii) (a) What is the genotype of a normal heterozygote? _______________

(b) How many heterozygotes are there in this population? _______________

(iii) (a) What is the genotype of a normal homozygote? _______________

(b) Count the number of normal homozygotes in this population.

____

(iv) Assuming each individual only has two genes, calculate the number of normal genes in this population.

____

(v) Assuming each individual only has two genes, calculate the number of albino genes in the population.

____

(vi) What is the frequency of the allele 'A'? (show your working)

(vii) What is the frequency of the allele 'a'? (show your working)

(viii) Describe the gene pool for this gene in this population.

6. Suppose a change in the climate occurred affecting the island in question 5. It became cooler and snow covered much of the island for much of the year. The albino phenotype became better camouflaged from its predators.

(i) How would this affect the survival of each phenotype?

(ii) Would this affect the gene pool? Explain.

Suppose that in several generations the gene frequencies followed the following trend:

Frequency of allele %		
year	A	a
1	49	51
2	45	55
3	41	59
4	37	63
5	32	68

(iii) Describe the pattern of change in the alleles.

(iv) What could happen to each allele's frequency in the long term?

(v) Explain why this is an example of natural selection.

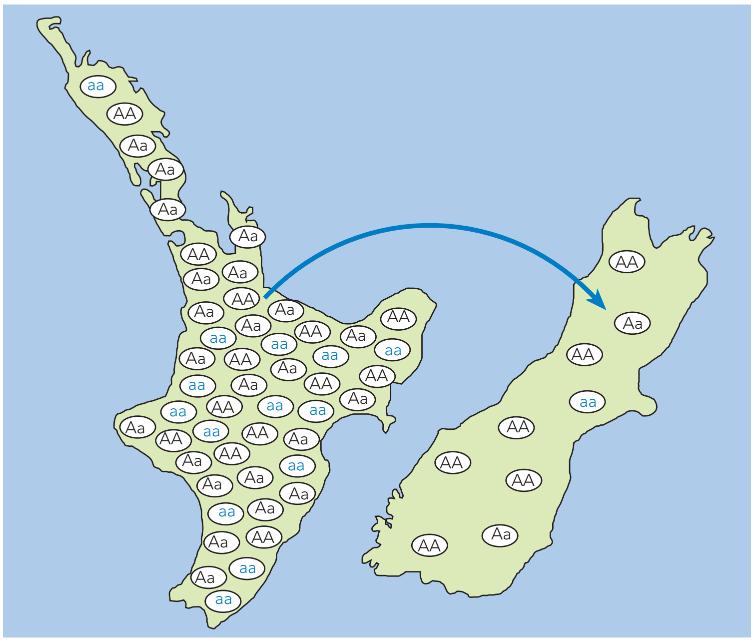
(vi) What is the selection pressure in this case?

(vii) Is this likely to be the only change to the phenotype of this animal?

(viii) What other traits may appear more frequently in the population under this climatic change?

(ix) Does natural selection increase or decrease variation? Explain using this example.

7. In the population described in question 5, imagine a small sample of the population being washed out in a storm to an island nearby as shown. The small population becomes reproductively isolated from the parent population.



(i) Calculate the frequency of allele 'A' in the colonising group.

(ii) Calculate the frequency of allele 'a' in the colonising group.

(iii) Referring to your answers to question 5, how does this compare with the 'parent' population?

(iv) If the climate remains temperate (does not change notably) and the population increases normally, the new population will have a different gene pool from that of the parent population. What is this effect called?

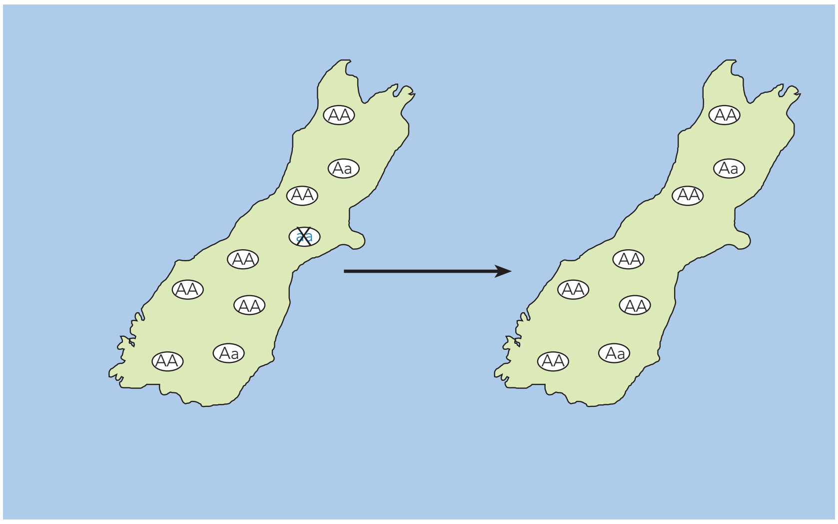
(v) Why did the difference between the two populations occur?

(vi) Why could this be confusing for scientists studying the migratory patterns of animals (and plants)? Explain.

(vii) How could the origin of the colonisers be correctly identified?

(viii) When is the 'founder effect' likely to be most evident?

8. Consider the following scenario on the small island with its new colonisers.



The albino individual dies from natural causes before it reproduces.

(i) How would this affect the frequencies of each allele in the population?

(ii) If the colour of the animal does not affect its likelihood of survival and reproduction, the proportion of each allele is likely to stay fairly constant.

Calculate the frequency of each allele in the growing population.

(iii) The observed frequencies are different from those that were originally expected. What is this phenomenon called?

(iv) How is this different from natural selection?

(v) Can it be considered as a factor in evolution?

(vi) How does 'genetic drift' affect genetic variation?

(vii) In what type of population is it most likely to occur?

9. (i) What is 'sexual selection'?

(ii) Under what circumstances might the evolution of the phenotype of males be affected by sexual selection?

(iii) Under what circumstances might the evolution of the phenotype of females be affected by sexual selection?

(iv) In some species, both sexes may be notably affected by sexual selection. Is this true of humans? Explain.

(v) Sexual selection may lead to dimorphism, give two non-human examples of this phenomenon.

(vi) The colour and appearance of female birds is often dull and inconspicuous. This suggests that there may be competing pressures in the environment. In birds, besides sexual selection, what other pressure/s may influence the evolution of the colour of the female phenotype?

(vii) How is sexual selection different from the founder effect and genetic drift?

(viii) Why might sexual selection be considered as an example of natural selection?

2.3 ARTIFICIAL SELECTION, ALLOPATRIC SPECIATION AND GENETIC DIVERSITY

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) adaptation

(ii) allopatric speciation

(iii) artificial selection

(iv) dispersal

(v) extinct

(vi) genetic bottleneck

(vii) genetic diversity

(viii) geographic isolation

(ix) reproductive isolation

(x) vulnerable

Review Questions

1. How is artificial selection different from natural selection?

2. Give one example of a practical application of artificial selection in the:

   (i) breeding of animals

   (ii) development of crops

3. (i) Explain, using a real or imaginary example, what is meant by 'gene flow'.

   (ii) Give two factors which may affect the rate of gene flow from one population to another.

   (iii) How is gene flow generally different in plants and animals?

   (iv) What are the implications for genetically modified crops such as canola?

   (v) How is pollen dispersed?

4. (i) What may prevent gene flow from occurring?

(ii) Populations may be isolated due to barriers. Name three barriers which may isolate organisms.

(a)

(b)

(c)

5. When barriers between two isolated populations are removed, what are three possible outcomes for interbreeding between the populations?

(i)

(ii)

(iii)

6. (i) If the barrier between two populations is removed, what external factors may prevent the individuals in the populations from interbreeding?

(ii) What internal factors could prevent interbreeding?

7. Describe two kinds of artificial barriers that prevent gene flow.

8. Explain how gene flow can occur between species (i.e. interspecific gene flow).

____

9. (i) Over a period of time a new species may arise from an isolated population.

This is due to a combination of ____________________

and ____________________.

(ii) If isolated populations become genetically so different they are unable to interbreed, they have formed separate ________________.

(iii) What is meant by referring to two species 'common ancestry'?

____

(iv) Give an example of 'adaptive radiation' or 'speciation'.

____

____

(v) Eukaryotic cells may have been formed by the symbiotic union of prokaryotic cells. What evidence is there for this "hypothesis"?

____

____

10. (i) Species that reproduce sexually often have a better chance of surviving extinction in changing environments than species that reproduce asexually. Explain.

____

____

____

____

(ii) When conditions are favourable many microorganisms, e.g. green algae, reproduce asexually. However if conditions become adverse, for example the water temperature rises or the water around them begins to become more concentrated because of evaporation, they revert to a form of sexual reproduction. Explain the advantages of each mode of reproduction in these situations.

____

____

____

____

____

(iii) (a) If the population of an organism is reduced to a critically low number by habitat destruction or hunting, how does this affect the remaining population's genetic variation? Explain the significance of this change.

(b) If this remnant population is protected and recovers, why may it still be vulnerable to extinction for many generations in spite of its increasing numbers?

3 INQUIRY SKILLS AND HUMAN ENDEAVOUR 1

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

3.1 SCIENCE INQUIRY SKILLS 1

- [ ] Identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes.
- [ ] Design investigations, including the procedure(s) to be followed, the materials required and the type and amount of primary and/or secondary data to be collected; conduct risk assessments and consider research ethics, including the ethics of research involving living organisms.
- [ ] Conduct investigations safely, competently and methodically for the collection of valid and reliable data
- [ ] Represent data in meaningful and useful ways, including the use of mean, median, range and probability; organise and analyse data to identify trends, patterns and relationships; discuss the ways in which measurement error, instrumental accuracy, the nature of the procedure and the sample size may influence limitations in data; and select, synthesise and use evidence to make and justify conclusions
- [ ] Interpret a range of scientific and media texts, and evaluate models, processes, claims and conclusions by considering the quality of available evidence, and use reasoning to construct scientific arguments.
- [ ] Select, construct and use appropriate representations, to communicate conceptual understanding, solve problems and make predictions.
- [ ] Communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports.

3.2 SCIENCE AS A HUMAN ENDEAVOUR 1

- [ ] Transgenic organisms have been engineered for desirable traits, including resistance to pests and herbicides, faster growth rate, greater product quality and yield, and tolerance to adverse environmental conditions.

☐ Using transgenic organisms may have adverse effects on genetic diversity and the environment, including:

– the effects on non-target organisms

– more rapid evolution of pesticide-resistant species

– the possibility of gene flow from crop species to weed species resulting in the emergence of 'super weeds'.

☐ Biotechnology can be used in environmental conservation for:

– monitoring endangered species

– assessing gene pools for breeding programs

– quarantine to prevent the translocation of exotic species and the spread of diseases.

☐ Technological developments in the fields of comparative genomics, comparative biochemistry and bioinformatics have enabled identification of further evidence for evolutionary relationships.

☐ Conservation planning to maintain viable gene pools includes consideration of

– biogeography

– reproductive behaviour

– population dynamics.

3.1 SCIENCE INQUIRY SKILLS 1

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) hypothesis

____

(ii) mean (arithmetic)

____

(iii) measurement error

____

(iv) median

____

(v) nomenclature

____

(vi) primary data

(vii) reliable data

(viii) sample size

(ix) secondary data

(x) valid data

Review Questions

1. (i) Distinguish between a hypothesis and a prediction.

(ii) Give an example of a hypothesis.

(iii) Write down a prediction based on your hypothesis.

(iv) In your hypothesis, identify:

(a) the dependent variable.

(b) the independent variable.

2. (i) Design an experiment to test the following hypothesis: 'That using a mulch on vegetable plants during the summer results in better than normal yields.'

(ii) List the variables that need to be controlled in your experiment.

(iii) (a) Name the dependent variable.

(b) Name the independent variable.

(iv) Describe results that would support the hypothesis.

(v) Describe results that would refute the hypothesis.

(vi) How could you be more confident of your results?

3. If an island off the coast of Australia supports a koala population of 20 000 in mid 2015, with a birth rate (b) of 15/1000/year and a death rate (d) of 13/1000/year.

(i) What is the annual growth rate (r) of this population in 2015?

(ii) How many koalas would be expected on the island midway through 2016?

Scientists decide to improve the genetic diversity of this koala population by introducing new stock on a regular basis. They introduce 20/1000/year (i) from other regions of Australia.

(iii) What is the expected annual growth rate of the population under these new conditions?

(iv) How would an increased genetic diversity assist the long term survival of the koalas on the island?

The population of koalas on the island would not grow at the same rate each year.

(v) Explain why growth rates generally vary from one year to the next.

Suppose this population grew to the extent that it was eating and destroying the trees on which it depended faster than the trees could regenerate.

(vi) What options could be taken to conserve the koala population on the island at a sustainable level?

(vii) If biologists chose to translocate some animals to the mainland at a rate of 30/1000/year (e) while continuing to add new stock each year, what would be the expected growth rate?

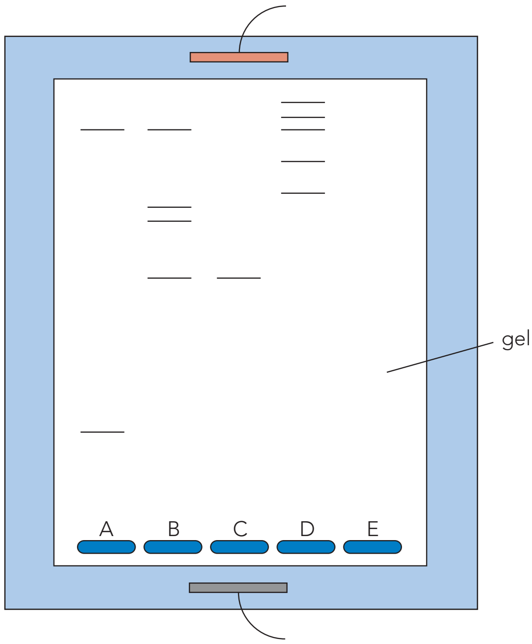
(viii) Explain how sterilising a proportion of the adult females each year would affect the growth rate (r).

4. A scientist obtained a pure sample of a fragment of a yeast DNA. The length of the fragments was approximately 40 000 base pairs. He needed more of this DNA for his experiment.

(i) How could he increase (amplify) the amount of the DNA fragment to use it in the experiment?

___

Having obtained a larger quantity, he used four different restriction enzymes (E1, E2, E3 and E4) to create smaller DNA fragments which he placed in the wells A, B, C and D respectively. The fragments separated as shown on the gel. Study the diagram then answer the questions that follow.



(ii) Which is the positive terminal on this diagram? How can you tell?

___

___

(iii) What factors determine how quickly the DNA fragments move in the gel?

___

___

(iv) The DNA fragments are colourless. How can they be seen on the gel?

___

___

(v) Which well may have contained fragments of equal size? Explain.

___

___

(vi) If enzyme E3 had cut the fragment in half, how long must each half have been? Explain.

(vii) Which enzyme/s probably has/have three recognition sites on this DNA? Explain.

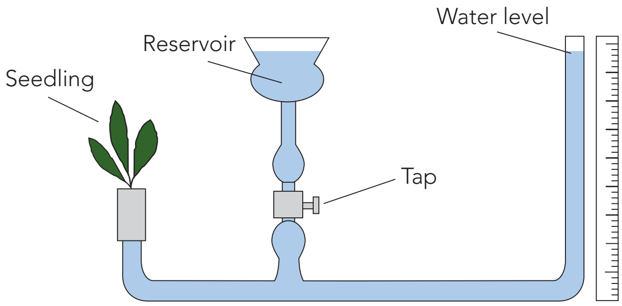
(viii) Which enzyme/s probably has/have two recognition sites on this DNA? Explain.

(ix) Which well appears to have contained the most fragments? Explain.

(x) Which well/s contained the largest and which the smallest fragments? Explain.

(xi) Explain how the scientist could have used well E to determine the approximate size of each fragment in the other wells.

5. An instrument called a potometer was set up to measure the rate of water loss by green plants. The apparatus is shown below.



Using this equipment, a botanist recorded the results which are shown in the table.

Time (mins)	Water level on scale (mm) (ambient temperature 20°C)				Water level on scale (mm) (ambient temperature 40°C)			
	trial 1	trial 2	trial 3	mean	trial 1	trial 2	trial 3	mean
0	0	0	0		0	0	0	
2	6	4	6		12	10	11	
4	12	10	10		25	21	23	
6	18	16	14		36	30	33	
8	22	22	18		45	36	42	
10	30	28	24		61	44	53	
12	38	36	32		76	53	65	
14	48	46	38		95	61	78	
16	52	54	46		96	65	81	
18	58	60	50		98	74	86	
20	62	66	58		98	81	90	
22	72	74	66		98	90	94	
24	78	80	74		98	96	97	
26	86	84	78		98	96	97	
28	92	90	86		98	96	97	
30	99	96	90		98	96	97	

(i) Write down the hypothesis that the biologist was most likely to have been testing.

____

____

____

____

(ii) In the experiment, name the:

(a) independent variable ____________________________

(b) dependent variable ____________________________

(iii) Calculate the mean for each reading and graph these results on the grid below. (Label your graph clearly)

(iv) Why were three trials conducted at each ambient temperature?

(v) Explain the possible causes of the variation between the trials at a given temperature.

(vi) Write a conclusion based on these results.

(vii) What explanation can you give for the graph which appears to plateau?

(viii) How could you test this hypothesis?

(ix) At 30 minutes and at the temperature of 20°C three readings were obtained (i.e. 99, 96, 90). What is the median value of these readings?

(x) If a fourth trial was conducted at the same time and temperature and a reading of 94 was obtained, what would be the new median? (Show how to calculate the answer).

6. Explain why in any experiment:

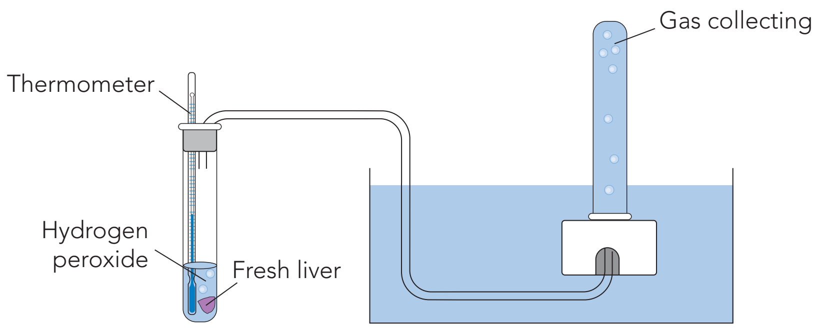
(i) the independent variable is sometimes called the 'manipulated' variable.

(ii) the dependent variable is sometimes called the 'responding variable'.

7. Catalase is an enzyme found in many living cells. It breaks down hydrogen peroxide (H_2O_2), a product of metabolism, which is harmful to cells. The general equation for this can be shown as:

$$2H_2O_2 \xrightarrow{\text{CATALASE}} 2H_2O + O_2$$

A student learned that catalase was present in large quantities in liver. To test the hypothesis that the effect of catalase on hydrogen peroxide is temperature dependent, she set up the equipment which is drawn below.



From the information given and using this equipment:

(i) How might the student measure the rate at which catalase breaks down hydrogen peroxide?

(ii) Name the gas which is collecting in the inverted test tube.

(iii) How could she vary the temperature of the substrate and the enzyme in the upright test tube?

(iv) In her experiment, name:

(a) the dependent variable.

(b) the independent variable.

(v) List other variables that would need to be controlled to make this experiment valid.

(vi) If her hypothesis was supported use the space below to sketch a graph that would indicate the results she is likely to have obtained. Label your axes and give your graph a suitable title.

(vii) If her results refute the hypothesis, what might the graph look like? Sketch it below.

(viii) Which of the two graphs is likely to be closest to reality? Justify your answer.

8. Use the space below to draw a **flow chart** to represent scientific methodology.

9. A biologist conducting research on fresh water crustacean populations in south-east Australia collected and weighed a number of adult yabbies (*Cherax albidus*) from farm creeks. The results from one site are shown below.

Site 1

Weight of specimens (g)

180, 27, 150, 175, 55, 46, 210, 55, 156, 45, 98

(i) Calculate the mean weight of this sample.

(ii) What is the median value? Show how you arrived at your answer.

(iii) What is the mode of these weights? Show how you arrived at your answer.

(iv) Would the scientist be confident that the mean weight of the sample reflects the mean weight of adult yabbies at site 1? Explain your answer.

(v) How could the scientist's confidence in the reliability of the sample mean be improved?

(vi) Why is total reliability in measurements such as this mean weight usually not achievable?

10. (i) In the space below draw a large labelled diagram of a DNA molecule that illustrates the arrangement of nucleotides along part of its length.

(ii) Use a simple series of labelled diagrams to illustrate how a DNA molecule replicates.

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) biochemistry

___

(ii) bioinformatics

___

(iii) biotechnology

___

(iv) conservation

___

(v) crop species

___

(vi) endangered species

___

(vii) pesticide resistance

___

(viii) quarantine

___

(ix) tolerance

___

(x) transgenic organism

___

Review Questions

1. (i) What is the relationship between 'biotechnology' and 'genetic modification'?

   (ii) Give one example of each.

2. (i) What are some of the possible advantages of genetic modification in human medicine.

   (ii) List possible disadvantages of genetic modification in human health care.

3. (i) Genetically modified plants may provide benefits in food production. What are some modifications that could enable plants to produce better crops?

   (ii) What is the most significant difference between practices of artificial selection and genetic modification of organisms to improve crops and stock?

(iii) Discuss problems that could arise from genetically modified crop use.

4. (i) Genetically modified animals (e.g. cattle, sheep) may present greater problems than genetically modified plants for human health. Why?

(ii) What advantages are genetically modified farm animals likely to have over normal farm animals?

5. (i) Genetical modification may have benefits to the environment. Explain how this might come about.

(ii) Discuss the problems that genetically modified organisms may cause in the environment.

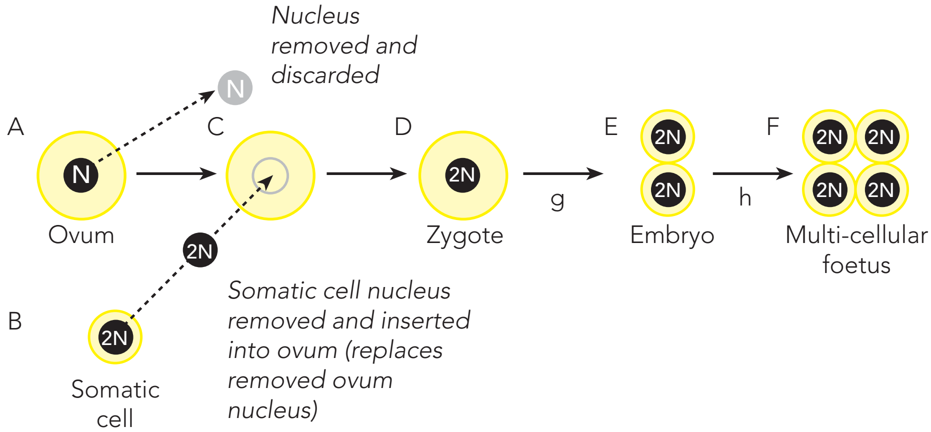
______

______

______

______

6. Study the diagram below that represents the process in which an organism could be cloned. Then answer the questions which follow the diagram.



(i) Choose between the two terms haploid and diploid to describe the cells shown in the diagram above.

a) ovum (A) ______

b) somatic cell (B) ______

c) clonal zygote (D) ______

d) embryo (E) ______

e) foetus (F) ______

(ii) Name the process represented by g and h in the diagram.

______

(iii) Because the cloned foetus has the same genetic material it will resemble which parent?

______

(iv) Cloning plants may be achieved using 'tissue culture'. Briefly describe this procedure.

______

______

______

7. (i) The use of genetically modified and cloned organisms obviously raises very controversial issues. How can scientists help to resolve the problems associated with these issues and make community decisions easier?

(ii) Should scientists determine how biotechnology is applied? Clearly explain your answer.

8. Discuss one example in which biotechnology is or could be used in conservation through:

(i) monitoring endangered species

(ii) assessing a gene pool for a breeding program

(iii) quarantine

9. Discuss one example of how evolutionary relationships can be better understood through:

(i) comparative genomics

(ii) comparative biochemistry

(iii) bioinformatics

10. Explain why conservation to maintain a viable gene pool should involve an understanding of the organism's:

(i) biogeography

(ii) reproductive behaviour

(iii) population dynamics

BIOLOGY

UNIT 4

4 HOMEOSTASIS

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

4.1 HOMEOSTASIS AND NEGATIVE FEEDBACK

- [ ] Homeostasis is the process by which the body maintains a relatively constant internal environment; it can involve a stimulus-response model in which change in external or internal environmental conditions is commonly detected and appropriate responses occur via negative feedback.

4.2 THERMOREGULATION IN ANIMALS

- [ ] Thermoregulatory mechanisms include structural features, behavioural responses and physiological mechanisms to control heat exchange and metabolic activity; animals can be endothermic or ectothermic.

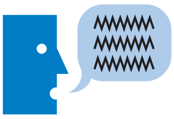
4.3 VERTEBRATE NITROGENOUS WASTES AND ANIMAL WATER AND SALT REGULATION

- [ ] The type of nitrogenous waste produced by different vertebrate groups can be related to the availability of water in the environment.
- [ ] Animals have a variety of behavioural, physiological and structural adaptations to maintain water and salt balance in terrestrial and aquatic environments.

4.4 PLANT ADAPTATIONS FOR STABILITY

- [ ] To maintain water balance and allow for gas exchange, xerophytes and halophytes have a variety of structural and physiological adaptations.

4.1 HOMEOSTASIS AND NEGATIVE FEEDBACK



Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) effector

(ii) external stimulus

(iii) feedback

(iv) homeostasis

(v) internal stimulus

(vi) modulator (coordinating centre)

(vii) negative feedback

(viii) receptor

(ix) response

(x) threshold

Review Questions

1. (i) Why do living cells need a fairly stable external and internal environment?

(ii) What is the maintenance of the organism's stable internal environment called?

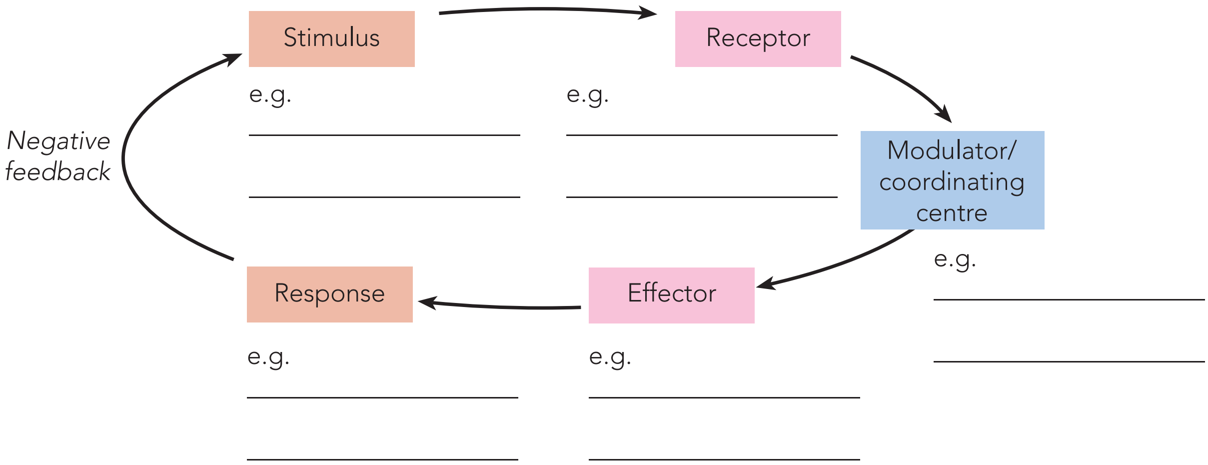
(iii) What is meant by 'tolerance levels'? Give one example.

2. Distinguish between external and internal stimuli and give two examples of each.

(i) external stimulus

(ii) internal stimulus

3. Illustrate the idea of a system controlled by negative feedback by completing the diagram below with a specific example.



4. Match each specific example (the bold part) in the table with one general term shown below that best describes it:

Stimulus(S), Receptor (R), Modulator(M), Effector (E), Response (Rp), Negative Feedback (N)

	Specific Example	General Term
(i)	**A small muscle** in the wall of a narrow artery in the skin contracts and in so doing restricts blood flow through the skin.	
(ii)	**A nerve ending** in a joint is stretched by the movement of the joint. It sends an impulse to the central nervous system.	
(iii)	A person undergoing strenuous exercise becomes overheated. She sweats and this helps **lower her core body temperature**.	
(iv)	**A small area of the brain** receives impulses from nerve endings in an artery. When the impulses reach a threshold it then sends impulses to the respiratory system.	
(v)	**A fall in the blood's glucose level** that is detected by the pancreas.	
(vi)	On seeing the dog, **the hair on a cat becomes erect**.	

4.2 THERMOREGULATION IN ANIMALS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) appendage

(ii) behavioural adaptation

(iii) counter-current

(iv) dehydrate

(v) ectothermic (animal)

(vi) endothermic (animal)

(vii) metabolic rate

(viii) optimum

(ix) peripheral thermoreceptor

(x) physiological adaptation

(xi) piloerection

(xii) structural adaptation

(xiii) vasoconstriction

(xiv) vasodilation

Review Questions

1. (i) An animal's body temperature must be regulated. Why?

(ii) Define each of the following terms and give two examples of animals which belong to each category.

(a) Endotherm

(b) Ectotherm

(iii) Briefly explain why ectothermic animals generally have lower food energy requirements than endothermic animals of similar size living in a similar climate.

(iv) Why does the metabolic rate of an ectothermic animal decrease with a decrease in its external temperature?

(v) Describe three different ways by which an ectothermic animal may increase its body temperature.

2. (i) Explain why changes in an animal's metabolic rate affect its temperature.

(ii) What signs might be evident in a **person** who has an abnormally high metabolic rate?

(iii) What signs might be evident in a **person** who has an abnormally low metabolic rate?

3. For an endothermic animal complete the table below.

Heat Gain – means by which heat is gained	Heat Loss – means by which heat is lost
•	•
•	•
•	•
•	•

4. (i) If **HEAT GAIN > HEAT LOSS**

what are the consequences for an endothermic animal?

____

____

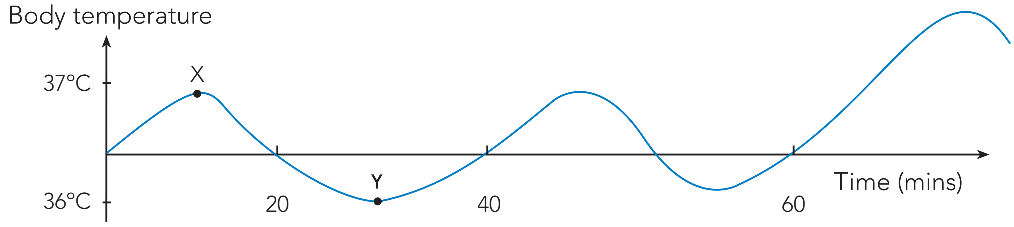
(ii) If **HEAT GAIN < HEAT LOSS**

what are the consequences for an endothermic animal?

____

____

5. A mammal's temperature is not exactly constant but is maintained within a narrow band. It fluctuates about a mean value. This is illustrated below.



(i) List the mechanisms that might reduce the mammal's temperature after point X.

____

____

(ii) List the mechanisms that might increase the mammal's temperature after point Y.

____

____

(iii) After 60 minutes the mammal's temperature seems to have risen more than previously outside the normal range. What might have caused this change?

____

____

6. (i) The table below shows some adaptations that mammals may have in a **cold** climate. Explain how each adaptation assists the animal.

Adaptation	Advantage in a Cold Climate
a) Small appendages (e.g. small ears, legs, snouts)	
b) Thick layer of subcutaneous fat or blubber	
c) Thick, long fur	
d) Capacity to go into state of torpor	
e) High metabolic rate	
f) Ability to burrow	
g) Arteries and veins in limbs close together	
h) Capacity to strongly constrict arteries in limbs	

(ii) In the table, which features are:

mainly structural? ______________________

mainly physiological? ______________________

mainly behavioural? ______________________

7. In a hot climate, an endothermic animal may have a high surface area to volume ratio (SA:Vol).

(i) How might this high SA:Vol be achieved?

____

____

(ii) What advantage might this be in a hot climate?

____

____

8. A mammal may sweat profusely in order to reduce its temperature on a hot day.
How might this affect:

(i) the amount of water in its blood plasma? ______________________

(ii) the osmotic pressure of its blood plasma? ______________________

(iii) the water levels in its cells? ______________________________

(iv) the level of salt in its blood plasma and cells? ______________________________

(v) the volume of urine it produces? ______________________________

4.3 VERTEBRATE NITROGENOUS WASTES AND ANIMAL WATER AND SALT REGULATION

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) ammonia

____

(ii) aquatic (environment)

____

(iii) deamination

____

(iv) differentially permeable (membrane)

____

(v) excretion

____

(vi) hypertonic

____

(vii) hypotonic

____

(viii) isotonic

____

(ix) nitrogenous waste

____

(x) osmoregulation

____

(xi) osmotic pressure

(xii) terrestrial

(xiii) toxicity

(xiv) urea

(xv) uric acid

Review Questions

1. In mammals, the liver removes excess glucose from the blood, storing it as glycogen. The liver also plays a part in the metabolism of nitrogenous compounds like amino acids.

   (i) How does the liver deal with surplus amino acids that are absorbed from the digestive tract and enter the mammal's blood?

   (ii) What happens to the products produced from amino acids by the liver?

2. (i) What type of animal has a high protein diet?

   (ii) How does this diet affect the animal's excretory products?

   (iii) Explain how an animal with a high intake of protein and a low intake of fat and carbohydrate obtains sufficient energy from its diet.

3. (i) In what form do most aquatic organisms (e.g. fish, amphibians, invertebrates) excrete waste nitrogen?

____

____

(ii) Why do most terrestrial animals (e.g. mammals, birds, reptiles, insects) not use this substance to remove nitrogen wastes?

____

____

____

4. Birds and many reptiles (also terrestrial snails and insects) excrete their excess nitrogen as a semi-solid whitish paste.

(i) What is this nitrogen compound called?

____

(ii) What special properties make it particularly suited for excretion by these animals?

____

____

____

____

5. (i) Below is a list of three nitrogen waste types which are excreted by various **vertebrates**. Give at least one example of an animal group which excretes the particular waste.

(a) Ammonia ______________________________

(b) Urea ______________________________

(c) Uric acid ______________________________

(ii) Which of these waste compounds requires the least energy to produce and which requires the most energy to produce? Explain your answer.

____

____

____

____

____

____

6. (i) Why is water such an important constituent of both animals and plants?

(ii) What special properties of water make it suitable for these functions?

7. About 45% to 90% of both animal and plant weight is water. The amount of water in an animal must remain within a narrow range of tolerance. If the amount of water in an animal's body is to remain constant over a period of time, then:

WATER GAIN = WATER LOSS

(i) what will happen if **WATER GAIN > WATER LOSS ?**

(ii) what will happen if **WATER GAIN < WATER LOSS ?**

8. Complete the table for a typical **terrestrial** animal by listing ways in which water can be gained and lost.

Water Gain –	Water Loss –
means by which water is gained	means by which water is lost
•	•
•	•
•	•
	•

9. **Marine** and **freshwater** fish face different problems with regard to water loss and water gain.

(i) Explain why they are different.

(ii) Use diagrams to illustrate your ideas.

(iii) Discuss the adaptations that **marine** fish have to maintain their internal osmotic pressure.

(iv) Discuss the adaptations that **freshwater** fish have to maintain their internal osmotic pressure.

10. In the table below describe two examples of each adaptation type that enable **terrestrial** animals to maintain water and salt balance.

Behavioural Adaptations	Physiological Adaptations	Structural Adaptations

11. The adaptations in the table below contribute to the homeostasis of some organisms. Classify each as either mainly structural (S), physiological (P) or behavioural (B).

	Adaptation	S, P or B
(i)	A bird's core body temperature becomes much lower than normal. A hormone causes its cells to metabolise more rapidly.	
(ii)	People who are born and live in mountainous regions at high altitudes normally develop lungs that have a greater density and number of alveoli than people in lower lying regions of the world.	
(iii)	An animal takes refuge in a cool dark cave during the hottest part of the day. This increases its heat loss.	
(iv)	The level of urea in a carnivore's blood rises following a meal. Its kidneys filter and remove the urea forming concentrated urine.	

	Adaptation	S, P or B
(v)	A person goes without food for five hours. Her liver begins to break down stored glycogen into glucose and releases it into her blood. This provides a source of energy until her next meal.	
(vi)	During the winter months a polar bear has a thick covering of hair that reduces heat loss.	
(vii)	A lizard moves out of the shade and basks on a rock during the day to raise its core body temperature.	
(viii)	On a cold day the blood vessels in a person's skin constrict, reducing blood flow near the surface of their skin and thereby reducing heat loss from the body.	
(ix)	Some herbivores (non-ruminants) may eat their droppings to extract more nutrients from their food.	
(x)	Due to a rodent's increased activity, the carbon dioxide level in its blood rises. This change is detected by chemoreceptors in its brain stem and results in the rodent involuntarily breathing more deeply and rapidly.	
(xi)	A desert reptile coverts ammonia to uric acid as a means of excreting its nitrogenous waste. Uric acid can be voided to the external environment with little water loss.	
(xii)	Some trees that live in very hot dry climates shed their leaves in late spring and regrow new leaves when the weather begins to cool. This reduces water loss during summer.	

4.4 PLANT ADAPTATIONS FOR STABILITY

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) flaccid

___

(ii) halophyte

___

(iii) leaf cuticle

___

(iv) phyllode

(v) salinity

(vi) stoma

(vii) succulent (plant)

(viii) turgid

(ix) xeromorph

(x) xerophyte

Review Questions

1. Terrestrial plants need to maintain a fairly constant amount of water within their cells i.e.

WATER GAIN = WATER LOSS

(i) If **water loss > water gain** for an extended length of time, how does this affect the plant?

(ii) If **water gain > water loss**, how does this affect the plant?

2. For terrestrial plants, the greatest problem is obtaining enough water.

(i) How do its stomata help the plant prevent excessive water loss on a warm dry day?

(ii) How does this change generally affect the plant's rate of photosynthesis?

(iii) Make a list of **five** adaptations that leaves may have which limit excessive water loss. Indicate briefly how the adaptation helps to limit water loss.

(iv) Make a list of **three** adaptations that the roots may have which maximise water gained from the soil. Indicate how each feature assists the plant in gaining water.

(v) What role might a plant's stem play in preventing its dehydration in a hot, dry climate?

3. (i) What are root hair cells and where are they located on the root?

(ii) How do root hair cells contribute to a plant's survival?

4. A terrestrial plant generally loses water by evaporation to the atmosphere.

(i) What three climatic factors affect this rate of water loss?

(ii) What features of the plant itself affect this rate? Briefly describe at least eight features.

(iii) The rate of loss can be measured experimentally. Name an instrument which is commonly used and briefly describe how it is used (draw a diagram to assist in answering this question).

(iv) List two adaptations which may prevent a terrestrial plant from overheating?

(v) Annual desert plants have a short life cycle which features a very rapid growth and flowering period. They produce seeds quickly. Explain why their life cycle follows this pattern and what special adaptations their seeds must have.

5. Complete the table below with examples of **three** structural and **three** physiological adaptations for each plant type.

Plant Type	Structural Adaptations	Physiological Adaptations
Xerophyte		
Halophyte		

INFECTIOUS DISEASE

5

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

5.1 INFECTIOUS DISEASE AND PATHOGENS

- ☐ Infectious disease differs from other disease in that it is caused by invasion by a pathogen and can be transmitted from one host to another.
- ☐ Zoonoses, such as influenza, can be transmitted between vertebrate species.
- ☐ The major groups of organisms that cause disease are bacteria, fungi, protists and viruses; each group can be distinguished by its structural characteristics.
- ☐ Diseases caused by these major pathogen groups include:
  - – tuberculosis, crown gall of plants
  - – chytridiomycosis (amphibian chytrid fungus disease)
  - – malaria, Phytophthora dieback (jarrah dieback)
  - – influenza, Ross River virus, viral diseases of honeybees
- ☐ The life cycle of a pathogen and its associated diseases, including the method of invading the host, the impact on the host, and the mode of transmission, determines its success for survival.

5.2 SPREAD AND TRANSMISSION OF INFECTIOUS DISEASES

- ☐ The spread of a specific disease involves a range of interrelated factors, including
  - – growth of the pathogen population
  - – density of the host population
  - – mode of transmission
- ☐ Transmission and spread of disease is facilitated by regional and global movement of organisms.
- ☐ The distribution of mosquito-borne diseases may be affected by global climatic changes.

5.3 EVOLUTION OF PATHOGENS AND CONTROLLING THE SPREAD OF DISEASES

- [ ] Many pathogens evolve rapidly in a changing environment
- [ ] Management strategies are used to control the spread of infectious diseases, including
  - – quarantine
  - – immunisation – herd immunity
  - – disruption of pathogen life cycle (including antibiotics and antivirals)
  - – physical preventative measures.

5.1 INFECTIOUS DISEASE AND PATHOGENS

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) bacterium

___

(ii) communicable (disease)

___

(iii) fungus

___

(iv) host

___

(v) pathogen

___

(vi) prion disease

___

(vii) protista

___

(viii) transmission

___

(ix) virus

___

(x) zoonosis

___

Review Questions

1. What is disease?

2. (i) How are infectious diseases different from other diseases?

(ii) Describe one non-infectious disease common in:

(a) plants

(b) animals

(iii) How is a pathogenic organism different from other organisms?

(iv) (a) Are all pathogens microorganisms? Explain using examples.

(b) Are all microorganisms pathogens? Explain using examples.

3. In the table below list the four main ways in which infectious diseases can be transmitted. Discuss an example of each in human populations.

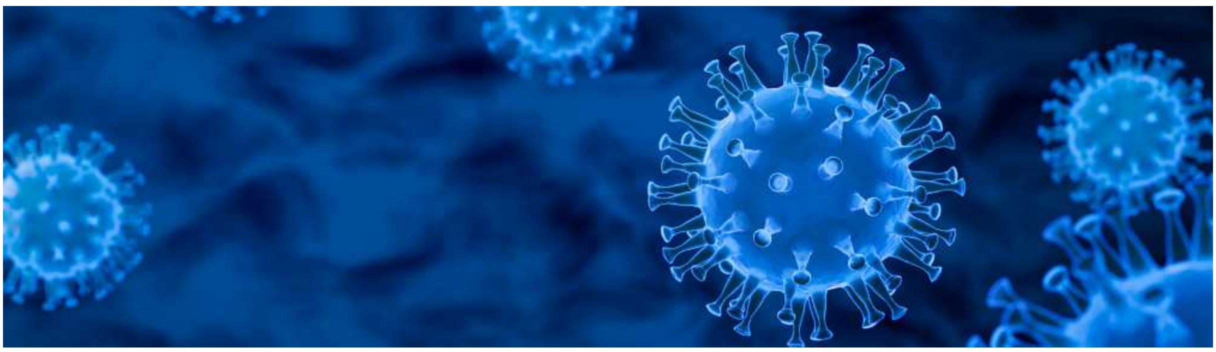
Mode of Transmission	Example in Human Populations

4. (i) How are zoonoses different from other infectious diseases?

(ii) List two examples of:

(a) viral zoonoses

(b) bacterial zoonoses



5. In the table below, for each group, describe its structural features and illustrate each with a simple labelled diagram.

Group	Structural Features	Diagram
Bacteria		
Fungi		
Protista		
Viruses		

6. The list of diseases below is in alphabetical order. For each disease indicate its host/s, write a brief description of each disease and indicate whether it is caused by a bacterium, virus, fungus or protista.

Disease	Host/s	Description	Pathogen Group
Chytridiomycosis			
Crown Gall of Plants			
Influenza			
Phytophthora Dieback			
Tuberculosis			

7. How are the following diseases transmitted and what problems does each disease cause?

(i) Ross River virus

___

___

___

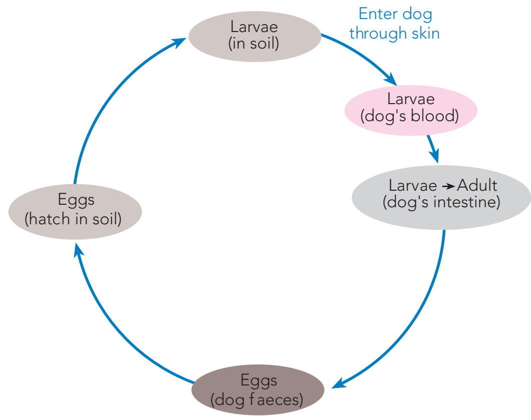
(ii) Viral diseases of honeybees

8. Infectious diseases may be transmitted directly and/or indirectly.

(i) Distinguish between these two modes.

(ii) Describe two examples of each mode.

9. The life cycle of a canine parasite the hookworm is illustrated below. Use this diagram to answer the questions which follow it.



(i) How do the larvae enter the dog's body?

(ii) The larvae move from the dog's blood into its intestine. What do the larvae do on entering the intestine?

(iii) Explain how the eggs produced by the adult find their way to the soil.

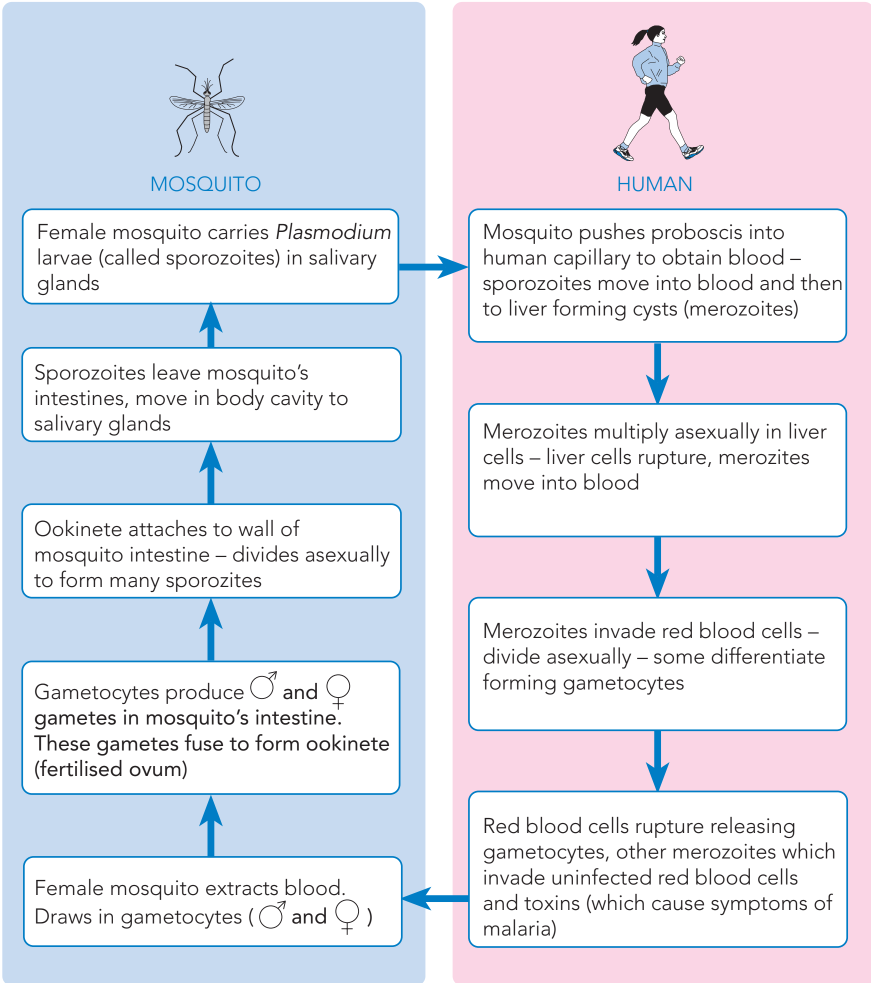
(iv) On entering the soil, the eggs hatch to become larvae. What might happen to these larvae?

(v) Is the mode of transmission of this disease direct or indirect? Explain.

(vi) (a) Where could the life cycle of the hookworm be interrupted so that no new host is found?

(b) Under what conditions might this occur?

10. Another familiar parasite is a type of protozoan (called *Plasmodium*) which causes malaria in humans. Its life cycle is shown below.



From the flow chart above, the mosquito does not appear to be adversely affected by the *Plasmodium*. It just carries the parasite from one human to another.

(i) What name is given to such a disease carrier? ______________________________

(ii) Why are these protozoan parasites a disease causing organism (a pathogen)?

____

(iii) The toxins produced by this protozoan cause the symptoms of malaria. What are these symptoms?

____

(iv) If the toxins, released when the red blood cells of the host burst, were to kill the host how would this affect the protozoa's life cycle?

____

(v) The protozoan appears to have several stages in its life cycle. What are they?

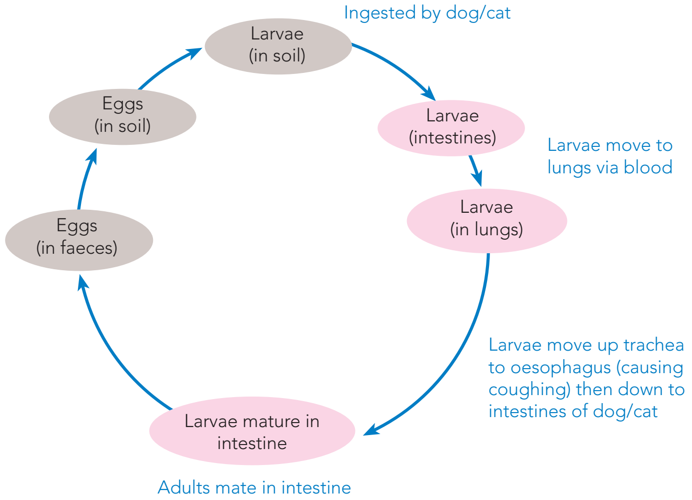
____

____

(vi) How would eliminating the mosquito in those areas of the world where malaria is endemic, affect the incidence of malaria in those areas?

(vii) What other means could be taken to reduce the spread of malaria in those areas?

11. The roundworm is a common parasitic worm which infects dogs and cats. Its life cycle is shown here.



(i) How do dogs and cats become infected by the larvae of the roundworm?

(ii) Explain how the larvae find their way from the intestines to the lungs of their host.

(iii) Why are roundworms a serious health problem for cats and dogs?

(iv) Does the host benefit in any way?

(v) How does the parasite benefit from this association?

(vi) Discuss which parts of this common parasite's life cycle determine its successful survival. Justify your answer.

5.2 SPREAD AND TRANSMISSION OF INFECTIOUS DISEASES

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) climate change

(ii) endemic (disease)

(iii) epidemic

(iv) immunity

(v) mosquito-borne (disease)

(vi) pandemic

(vii) population density

(viii) population growth

(ix) urban environment

(x) vector

Review Questions

1. Discuss **how** each of the following factors impact on the spread of a particular disease. Use an example to illustrate each answer.

   (i) Growth of the pathogen population

   (ii) Density of the host population

   (iii) Mode of transmission

2. (i) How does the migration of organisms enable the spread of disease? Discuss an example.

(ii) Does this principle apply to modern humans? Explain.

(iii) In a recent outbreak of Ebola in west Africa, it was considered unhelpful to restrict the movement of people from these areas. Why was this decision made?

3. While some diseases have almost been eradicated, like smallpox and tuberculosis, they often re-emerge as a threat to our health. How do these diseases re-emerge?

4. Could a disease that affects an animal population spread globally and begin to affect human populations. Explain using an example.

5. Many diseases were introduced to indigenous populations in Australia by the immigration of Europeans in the early days of settlement.

   (i) Why were the indigenous populations so badly affected by diseases to which Europeans exhibited a resistance?

   (ii) What are the implications for health care in these indigenous communities?

6. (i) Which animals are likely to be difficult to confine to one area in order to limit their spread of disease?

(ii) Discuss two examples of diseases which may affect human populations because of the mobility of these animals.

(a)

(b)

7. (i) Epidemics in developing countries are likely to spread rapidly and cause much more sickness and death than in developed countries. Explain this difference in effect.

(ii) If a city like Kolkata in India experiences an outbreak of infectious disease it is likely to be more serious than if the same disease was to occur in Sydney. Discuss the likely reasons for this difference.

8. Diseases that affect plants spread in similar ways to those that affect animals but because most terrestrial plants are not mobile, there are differences.

(i) How can infectious diseases be spread in plant populations?

(ii) Where and when are diseases most likely to seriously affect individual plants?

(iii) How is climate change likely to affect plant health generally?

9. (i) List some of the diseases that are spread by mosquitoes.

(ii) Why are mosquitoes a vector for these diseases?

(iii) How is global climatic change expected to affect mosquito populations?

(iv) Describe how the distribution of mosquito-borne diseases may be affected by global climatic changes.

10. (i) The general health of human populations may be adversely affected by global climatic change. Explain why this deterioration may occur.

(ii) How might this affect the spread of infectious diseases?

5.3 EVOLUTION OF PATHOGENS AND CONTROLLING THE SPREAD OF INFECTIOUS DISEASES

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) antibiotic

(ii) antiviral

(iii) attenuated pathogen

(iv) cure

(v) influenza

(vi) immunisation

(vii) life cycle

(viii) resistant strain (bacterial)

(ix) tumour

(x) vaccine

Review Questions

1. Regular (annual) vaccination for influenza is often recommended for elderly adults in Australia. What are the reasons for this recommendation?

2. (i) Why do microorganisms evolve rapidly in changing environments?

   (ii) Pathogens are often subjected to antibiotics, antivirals and other chemicals. How do the pathogens respond to medications that are initially effective in controlling them?

3. The spread of a facial cancer has decimated the populations of Tasmanian Devils in the wild (about ninety five percent are believed to have died of the disease).

   (i) Populations that are kept in captivity and on islands off the coast of Tasmania are regarded as "insurance" against the animal's extinction. Why are they considered insurance?

   (ii) How does the isolation of healthy animals prevent the spread of the disease?

   (iii) A vaccine to help protect the animal from this disease is being developed. An experiment using dead cells from the tumour has been conducted. Explain how this vaccine may protect the Tasmanian Devil.

4. In each of the examples below discuss how the strategy helps to limit the spread of disease and give one example of its use:

   (i) quarantine

   (ii) immunisation – herd immunity

   (iii) disruption of pathogen life cycle

(iv) medications – antibiotics and antivirals

(v) physical preventative measures

5. Each of the strategies in question 4 may fail from time to time – no single strategy alone is likely to be totally effective. Discuss how and why each strategy may prove ineffective.

(i) quarantine

(ii) immunisation – herd immunity

(iii) disruption of pathogen life cycle

(iv) medications – antibiotics and antivirals

(v) physical preventative measures

6. Why is each of these strategies regarded as a "management strategy"?

____

____

7. Complete the following sentences by writing in the missing words. Use the words from the following list: "*all*, *cause*, *culture*, *disease*, *healthy*, *host*, *particular*, *present*, *pure*, *same*"

Robert Koch (1843-1910) devised four postulates or criteria to identify the

pathogenic (i) ____________ of a (ii) ____________ disease.

To be accepted as the cause of a particular disease, the pathogen:

(a) must be (iii) ___________ in (iv) _______ cases of the disease.

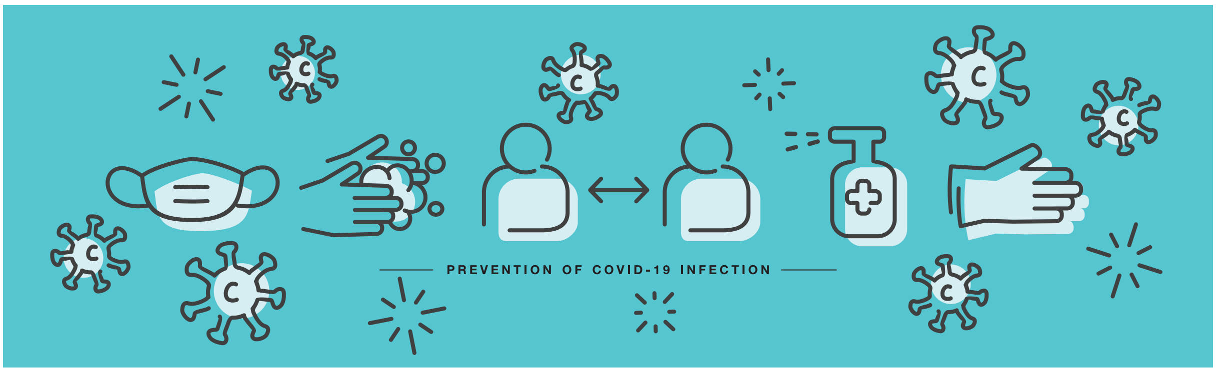
(b) must be isolated from the (v) _________ and grown in pure (vi) ___________.

(c) from the pure culture must cause the (vii) ____________ when

inoculated into a (viii) ______________ host.

(d) must be re-isolated from its second host, grown in (ix) ___________

culture and shown to be the (x) ___________ as the originally inoculated pathogen.



6 INQUIRY SKILLS AND HUMAN ENDEAVOUR 2

SYLLABUS CHECKLIST

This is the knowledge that you should understand upon completing this section:

6.1 SCIENCE INQUIRY SKILLS 2

- ☐ Identify, research and construct questions for investigation; propose hypotheses and predict possible outcomes.
- ☐ Design investigations, including the procedure(s) to be followed, the materials required and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including the ethics of research involving living organisms.
- ☐ Conduct investigations, safely, competently and methodically for valid and reliable collection of data.
- ☐ Represent data in meaningful and useful ways, including the use of mean, median, range and probability; organise and analyse data to identify trends, patterns and relationships; discuss the ways in which measurement error, instrumental accuracy, the nature of the procedure and sample size may influence limitations in data; and select, synthesise and use evidence to make and justify conclusions.
- ☐ Interpret a range of scientific and media texts, and evaluate models, processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments.
- ☐ Select, construct and use appropriate representations, to communicate conceptual understanding, solve problems and make predictions.
- ☐ Communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports.

6.2 SCIENCE AS A HUMAN ENDEAVOUR 2

- ☐ Susceptibility of urban areas to epidemics and pandemics of infectious disease can be due to population density, variation in living conditions and healthcare provisions.

☐ Contemporary models can predict the spread of disease and simulate the effects of possible interventions. Supercomputing has enabled models to predict the relationships between epidemic frequency and location, and factors such as population size, environmental change, persistence and antibiotic resistance.

☐ International cooperation and communication are needed to evaluate the risk of the spread of disease, including the emergence of new viral diseases.

☐ Quarantine measures protect Australia's agriculture industry and environment against the influx of disease-carrying materials and organisms in the face of increasing global trade and travel.

6.1 SCIENCE INQUIRY SKILLS 2

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) conclusion

____

(ii) controlled variable

____

(iii) dependent variable

____

(iv) independent variable

____

(v) instrument accuracy

____

(vi) limitations of experimental design

____

(vii) mode

____

(viii) prediction

____

(ix) research ethics

____

(x) risk assessment

____

Review Questions

1. In an experiment designed to test the hypothesis that salt in food increases a person's blood pressure, a scientist carried out the following experiment.
   - She randomly selected 200 healthy adult rats.
   - She divided the group into two equal subgroups, again selecting the individuals at random.
   - Each group was allowed 15 minutes rest and then she measured each rat's blood pressure, recording an average for the group.
   - Then each rat in one group was given food pellets containing 5 mg of salt and 5 minutes later had its blood pressure measured again. A new average blood pressure was calculated for this group.
   - Each rat in the second group was given food pellets, which contained no salt (0 mg).
   - These rats then had their blood pressures measured and averaged as in the first group.

   In this experiment,

   (i) What was the sample size? ________________

   (ii) What is meant by 'randomly selected'?

   ____

   ____

   ____

   (iii) Why was the second group given food pellets containing no salt?

   ____

   ____

   (iv) In this experiment which variables were controlled?

   ____

   ____

   (v) Name the independent variable.

   ____

   (vi) Name the dependent variable.

   ____

   (vii) Describe results that support the hypothesis.

   ____

   ____

   (viii) Describe results that refute the hypothesis.

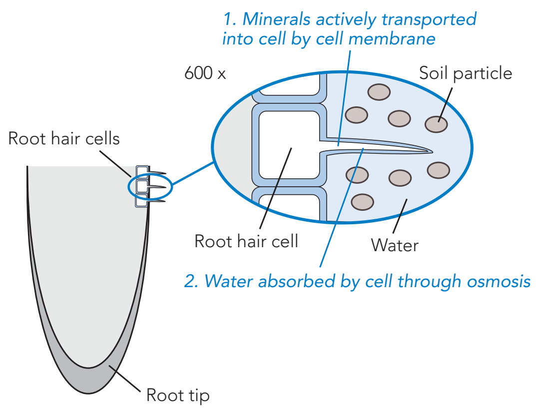
   ____

   ____

(ix) How might you improve this experiment so that the results are more reliable?

(x) Comment on the validity of this experiment.

2. Botanists have discovered that the root hairs of terrestrial plants take up mineral ions by active transport to create a mineral concentration gradient between the fluid in the root hair cells and the soil water. Water then moves into the root hair cells from the soil by osmosis. This is how water is believed to enter the plant's transpiration stream. The idea is illustrated below.



A student, considering xerophytic adaptations, put forward the hypothesis that plants living in an increasingly dry environment during the summer increase their mineral absorption in order to increase the rate at which water is absorbed.

(i) How might the student test this hypothesis? Describe the design of an investigation that she might use.

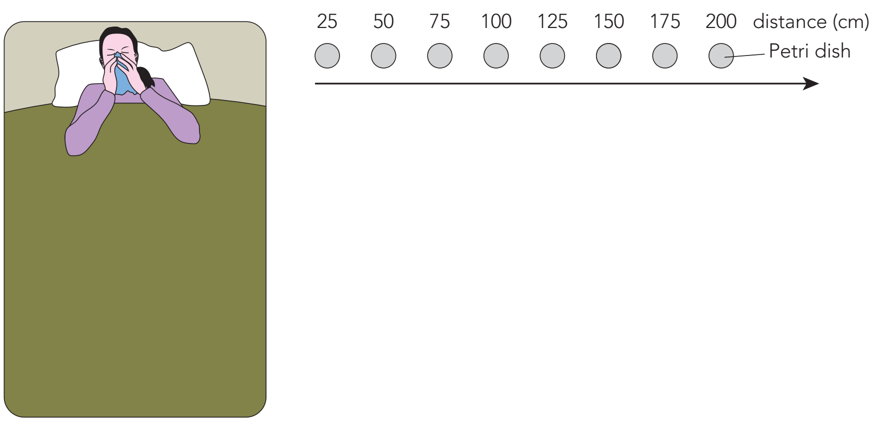
(ii) Construct a table that might be used to enter the data she would collect.

(iii) Describe results which would support the hypothesis.

(iv) List five ways in which you could improve the experimental design.

(v) What applications could be made of this research?

3. Sneezing, coughing, laughing and talking by an infected person are known means by which some diseases are spread. The pathogen may be suspended in the warm droplets that are dispersed into the air by these actions and then inhaled (or come in contact with mucous membranes, e.g. the eyes) by uninfected persons nearby. Suppose that in an investigation to determine the safe distance that health workers could work without masks near patients suffering from a particular bacterial respiratory disease, a medical scientist placed exposed petri dishes (traps) containing suitable nutrient agar at varying distances from ten different patients confined to hospital beds with the disease.



The dishes were left in place for two hours and then placed in an incubator for twenty four hours. The number of colonies of the specific pathogenic bacterium in each petri dish was then recorded as shown in the table below.

Petri dish distance from patient's bed (cm)	Number of Pathogen Colonies in each Petri Dish										
	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Patient 10	Mean number of colonies at each distance
25	16	25	21	16	14	28	26	7	12	23	
50	34	18	33	13	15	43	17	14	17	12	
75	15	9	35	12	38	61	11	34	36	23	
100	12	54	45	5	17	26	43	33	35	27	
125	32	43	23	8	25	36	16	38	20	26	
150	24	13	17	8	14	46	24	46	17	14	
175	15	10	28	0	9	31	16	26	18	17	
200	13	15	16	0	15	28	13	15	7	22	
225	6	16	8	1	5	16	17	11	3	15	
250	3	6	9	0	3	7	5	9	2	5	
275	3	7	6	0	14	9	6	11	4	3	
300	0	5	0	0	3	7	0	2	4	0	
Total No. of Colonies											

(i) Before carrying out any investigation of this nature a risk assessment would need to be conducted. What would this assessment require and what dangers and precautions would need to be considered in this particular experiment?

(ii) Why would permission to conduct this experiment (from the appropriate authority) be difficult to obtain?

(iii) The investigation appears to have no control. Describe a suitable control.

(iv) Calculate the mean number of colonies at each distance shown. Write these in the last column of the table.

(v) In the table show the total number of colonies collected from each patient.

(vi) Show how the median value of the mean number of colonies at each distance is obtained.

(vii) Over what range of distances were the petri dishes placed?

(viii) Considering the results that were obtained, was this range sufficient to establish a safe distance? Explain.

(ix) What is the sample size at each distance?

(x) List probable reasons for the different results for each patient.

(xi) Which patient appears to be:

(a) most infectious? Justify your answer.

(b) least infectious? Justify your answer.

(xii) Use the grid below to graph the petri dish distance from patient's head (cm) against mean number of colonies at each distance.

(xiii) Describe the apparent relationship between the distance from a patient and the risk of catching the infection.

(xiv) Could this graph be used to determine a safe distance for health workers to remove their masks? Explain.

4. (i) Use a flow diagram to illustrate the feedback loop which maintains an endothermic animal's body temperature when its temperature becomes significantly **lower** than normal.

(ii) Use a flow diagram to illustrate the feedback loop which maintains an endothermic animal's body temperature when it becomes significantly **higher** than normal.

6.2 SCIENCE AS A HUMAN ENDEAVOUR 2

Terminology

These are some of the terms from this section which you should know. Write the meaning of each term in the space provided.

(i) developing country

(ii) disease intervention

(iii) epidemic frequency

(iv) infectious disease

(v) living conditions

(vi) mucous membrane

(vii) persistence (of an infection)

(viii) rural area

(ix) susceptibility to disease

(x) symptom

Review Questions

1. The recent outbreak of Ebola in west Africa is believed to have arisen in a small village in Guinea. The virus which causes Ebola is found in several wild animal species that the people in this region eat.

   (i) What is the general name for a pathogen which can be transferred from animals to humans?

   The Ebola virus is transferred either directly or indirectly in the blood, body fluids, vomit, faeces, saliva, sweat and semen of infected people, entering through the mucous membranes.

   (ii) Distinguish between direct and indirect transmission using an appropriate example of each.

   In developing countries like Guinea, Sierra Leone and Liberia, where this outbreak occurred, it generally takes longer to diagnose a patient with the disease. The incubation period is between three and twenty-one days. The first symptoms of the disease include headaches, sore throat, muscle pain and fever. As it progresses rashes appear, vomiting, diarrhoea, internal bleeding (faeces may contain blood) and external bleeding (e.g. from the gums). In west African communities over fifty percent of cases are likely to be fatal.

   (iii) What is meant by the "incubation period" of a disease?

   During the incubation period the Ebola patient is not infectious. A blood sample is often tested for the virus.

   (iv) Why is early diagnosis of this disease critical?

   (v) Why would it probably take longer to diagnose a disease in a developing country than in Australia?

   (vi) What are the likely dangers of testing blood samples for Ebola?

(vii) The disease has transferred to urban areas in these countries. Once in an urban area, it spreads more rapidly. Explain why this disease spreads more rapidly in urban areas.

(viii) In many communities in this region deceased persons are traditionally handled, hugged and washed by their relatives and friends before burial. Why are these practices dangerous?

(ix) What can be done to help reduce the risk of transfer to relatives and friends?

(x) Which areas of a person's body could allow the virus to enter and cause an infection?

(xi) What can be done to prevent the occurrence of future outbreaks of this disease in west Africa?

(xii) The outbreak of this disease in west Africa can be described as an epidemic. If it was to become a pandemic what would this mean and how might this occur?

2. Plant diseases may be infectious or non-infectious.

(i) Describe briefly three abiotic factors that could cause a non-infectious plant disease.

(ii) If a plant disease is infectious what are the likely causes of the disease?

(iii) Describe the ways in which pathogens could be transferred to other plants?

(iv) List the parts of a vascular plant that could be occupied by a pathogen?

(v) Describe **how** insects may function as a vector in pathogenic transfer of diseases to the phloem.

(vi) If a pathogen was to affect the xylem of a vascular plant describe the plant's likely symptoms.

(vii) Some plant diseases spread in soil. How might these diseases spread from one plant to another plant:

(a) in the immediate locality?

(b) many kilometres away?

(viii) Discuss factors that may affect the **rate of transmission** in both (a) and (b) above.

(a)

(b)

(ix) Which plant diseases are likely to be dispersed by the wind? Explain.

(x) How are plant diseases most likely to be spread from one continent to another?

(xi) Describe three management strategies that may reduce the incidents of international transmission of diseases into Australia.

3. (i) Discuss the relationship between persistent disease and antibiotic resistance in humans.

(ii) Describe how antibiotic resistance is likely to develop.

(iii) Patients who are using antibiotics are strongly encouraged to complete the course of use even after symptoms of the disease have disappeared. Discuss two reasons for this requirement.

(iv) Why is there a need for pharmaceutical companies to continuously develop new antibiotics?

4. Bird flu (avian influenza) is a potentially dangerous disease. It is transferred from wild birds to domestic birds (e.g. ducks, chickens) and can be transmitted to humans who handle infected birds. It is usually fatal to domestic birds and humans. It appears that the virus is unlikely to be transmitted from human to human. However scientists are concerned that this virus could combine with the influenza virus and mutate.

   (i) How would this make the disease more dangerous?

   (ii) Should this mutation occur, international cooperation to evaluate the risk of the spread of this disease would be particularly important. Explain.

5. (i) In what ways do quarantine restrictions protect Australian agriculture?

   (ii) How are these restrictions enforced?

   (iii) When are these restrictions likely to be breached and Australia's biosecurity put at risk?

   (iv) Most bananas traded around the world are of one cloned variety (Cavendish). Explain why crops of this nature are particularly vulnerable to disease?

TRIAL TEST 1: REPLICATION, DNA & PROTEIN SYNTHESIS

Time allowed:	**60 minutes**	**Section One –**	Multiple Choice	20 marks
Total marks:	**100**	**Section Two –**	Short Answer	60 marks
		Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

1. During which stage of mitosis does DNA replication occur?
   (a) interphase
   (b) prophase
   (c) metaphase
   (d) anaphase

2. When bacteria reproduce, their single doughnut shaped DNA molecule replicates and the cell then divides into two, each receiving one copy of the DNA molecule. This is an example of:
   (a) mitosis enabling asexual reproduction
   (b) meiosis enabling asexual reproduction
   (c) mitosis enabling sexual reproduction
   (d) meiosis enabling sexual reproduction

3. A gardener who takes a cutting from a mature plant, places her cutting in a pot and produces a new plant, is using as a means of reproduction:
   (a) regeneration
   (b) vegetative reproduction
   (c) budding
   (d) binary fission

4. Parthenogenesis is unusual in more complex animals but not uncommon in social insects. It involves an ovum dividing by mitosis repeatedly until a new organism is formed i.e. no fertilisation occurs. Which of the following would be true of the offspring's cells?
   (a) They could be either haploid or diploid
   (b) They would all be diploid
   (c) They would be both haploid and diploid
   (d) They could only be haploid

5. Sexual reproduction occurs in flowering plants when:
   (a) gametes are formed in the gonads
   (b) gametes fuse in the ovary
   (c) pollen reaches the stigma of a flower
   (d) pollen forms a tubule which grows down inside the style

6. Fertilisation in aquatic animals usually takes place:
   (a) inside the female's reproductory system
   (b) in the watery medium in which it lives
   (c) in the ovaries of the female of the species
   (d) inside a body cavity of either sex

7. The doubling of the amount of DNA in the cell occurs before mitosis and meiosis so that the:
   (a) daughter cells have the diploid number of chromosomes
   (b) daughter cells are haploid
   (c) number of chromosomes in the daughter cells is appropriate
   (d) number of chromosomes in the parent cell is maintained

8. During DNA replication, which of the following sequences is followed?
   (a) A DNA molecule unzips along its entire length, free nucleotides occupy each of the unzipped DNA strands, a protein molecule joins the two DNA copies
   (b) A DNA molecule unzips along part of its length, free nucleotides occupy the exposed nitrogen bases, the molecule which is formed moves out of the nucleus
   (c) A DNA molecule separates into individual nucleotides, free nucleotides in the nucleoplasm join the separated nucleotides, the pairs come together to form two DNA strands
   (d) DNA molecules divide by binary fission, each strand formed is joined to another by a centromere, the two DNA molecules are then separated by a spindle fibre

9. The importance of mitochondrial DNA is that it codes for enzymes which are directly involved in the process of:
   (a) protein synthesis
   (b) endocytosis
   (c) nuclear division
   (d) respiration

10. Proteins that are closely associated with gene expression and, together with DNA, form chromosomes are called:
   (a) centrioles
   (b) nucleosomes
   (c) histones
   (d) lysines

11. A doughnut shaped DNA molecule found in many bacterial cells which is not part of the bacterial cell's own chromosomal DNA is called:
   (a) a plasmid
   (b) an inclusion
   (c) an organelle
   (d) an extension

12. Which of the following nitrogen bases pairs with adenine in a DNA molecule?
   (a) cytosine
   (b) guanine
   (c) uracil
   (d) thymine

13. Which of the following statements is correct? DNA has:
   (a) a molecular shape that creates an 'active site'
   (b) nitrogen bases bonded to phosphate molecules
   (c) equal amounts of cytosine and guanine
   (d) paired bases of guanine and thymine

14. The basic building blocks which make up a DNA molecule are called:
   (a) nucleotides
   (b) amino acids
   (c) nitrogenous bases
   (d) monosaccharides

15. DNA in the cell nucleus is important because it carries codes for:
   (a) chromosome replication
   (b) new mitochondria
   (c) protein synthesis
   (d) carbohydrate synthesis

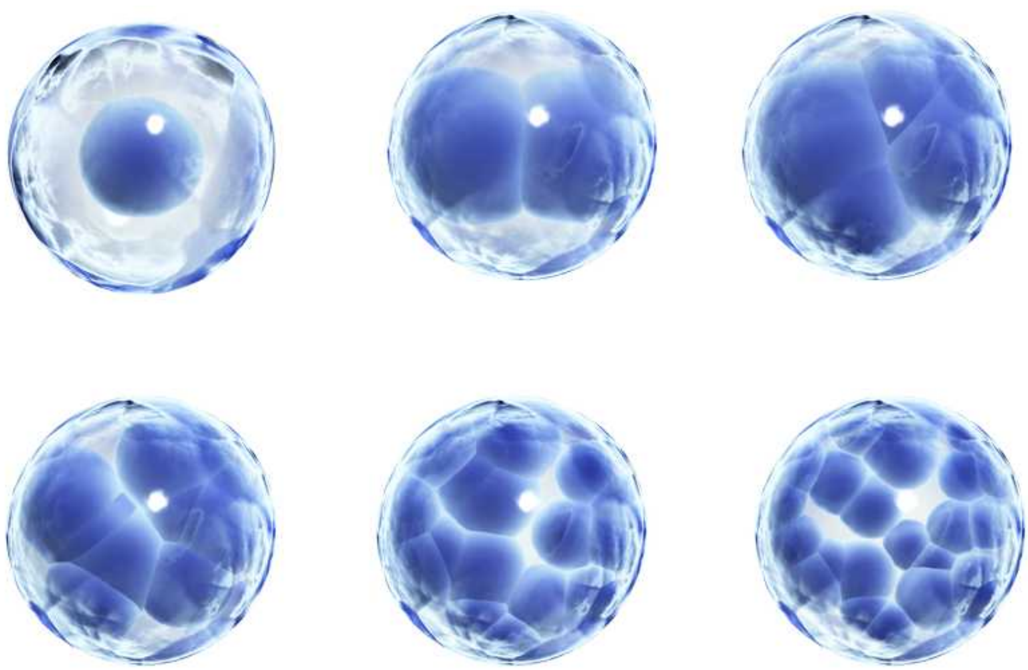
16. The molecule which transfers information to the ribosomes where protein synthesis occurs is called:
   (a) messenger RNA (mRNA)
   (b) transfer RNA (tRNA)
   (c) carrier RNA (cRNA)
   (d) messenger DNA (mDNA)

17. Which of the following nucleotides is found in DNA but not in RNA molecules?
   (a) adenine
   (b) cytosine
   (c) guanine
   (d) thymine

18. When protein synthesis occurs, the type of protein produced is determined by:
   (a) the order of nucleotides that is copied by mRNA
   (b) the temperature of the cell
   (c) the tRNA available to carry amino acids
   (d) enzymes present in the nucleoplasm and cytoplasm

19. DNA is too large to pass out of a nuclear pore. Therefore the code which is located on DNA is carried to the cytoplasm by:
   (a) transfer RNA
   (b) recombinant DNA
   (c) messenger RNA
   (d) nucleotides

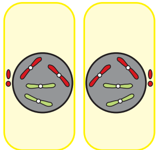
20. In protein synthesis, the role of the ribosomes is to:
   (a) copy the DNA code
   (b) send mRNA into the nucleus to obtain a code
   (c) provide a site for the transcription of the DNA code
   (d) provide a site for the translation of the mRNA code



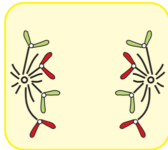
SECTION TWO – SHORT ANSWER (60 MARKS)

Answer each question in the space provided.

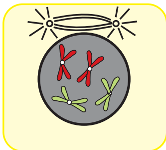
1. (i) The diagrams below show some stages of mitosis in a jumbled order. Write the correct name of each stage under each diagram.



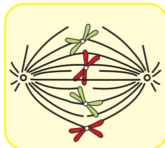
a) ______________________________



b) ______________________________



c) ______________________________



d) ______________________________

[2 marks]

(ii) Write the order in which these phases occur.

____

[1 mark]

2. Cells which are undergoing mitosis can be 'fixed' and stained so that their chromosomes can be viewed with the aid of a microscope. Describe how you would distinguish between the following:

(i) cells in interphase and cells in prophase;

____

____

____

____

[2 marks]

(ii) cells in metaphase and cells in anaphase;

____

____

____

____

[2 marks]

(iii) telophase in plant cells and telophase in animal cells;

____

____

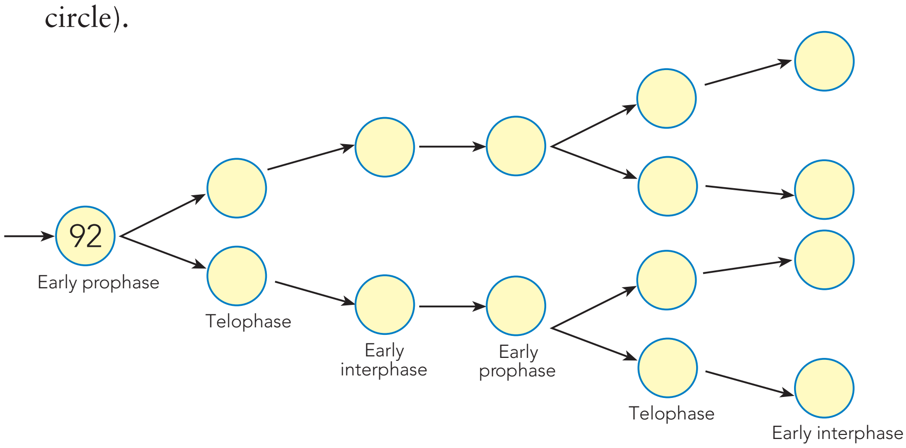
____

____

[2 marks]

3. The first circle below represents a human cell which in the early prophase of mitotic division has 92 DNA units.

(i) A number of mitotic divisions occur. Complete the diagram to illustrate how many DNA units are present at each stage shown (write the numbers in each circle).



[3 marks]

(ii) How many mitotic divisions are represented in this diagram? __________

[1 mark]

(iii) What is the total number of chromosomes in the final cells that have been formed?

__________________________ [1 mark]

(iv) Where have the extra DNA molecules come from?

____

____

[1 mark]

4. Write a word or phrase for each of the following sentences.

(i) A nucleic acid which transfers free amino acids in the cytoplasm to the ribosomes where amino acids are linked to form proteins

____

(ii) The copying of DNA which occurs in cells during the interphase

____

(iii) Mitochondria and mitochondrial DNA are inherited from this mammalian parent

____

(iv) The order of these determines the message carried from the nucleus to the ribosomes

____

(v) The fluid in which free nucleotides are available for DNA copying

____

(vi) The "D" stands for this substance in DNA

____

(vii) The formation of a complimentary strand of mRNA from a section of DNA in the nucleus

____

(viii) Weak bonds involved in base pairing between the complementary strands of a DNA molecule

____

(ix) A molecule consisting of a long chain of about one hundred amino acids

____

(x) The basic building blocks of DNA and RNA.

____

[10 marks]

5. (i) A human cell normally has 46 chromosomes (diploid number). When a human cell undergoes mitosis, each of the two cells formed has 46 chromosomes. Explain how the number of chromosomes in each cell is maintained.

____

____

____

[3 marks]

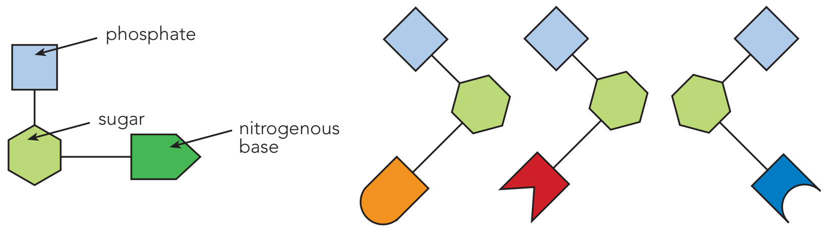
(ii) Where do the extra nucleotides come from to create the extra 46 DNA molecules?

____

____

[1 mark]

6. The diagrams below show four different nucleotides.



(i) In what way is each nucleotide shown different?

____

[1 mark]

(ii) Draw a diagram below to show how these four nucleotides could be linked to form part of a DNA molecule.

[2 marks]

(iii) A molecule of DNA normally contains thousands of nucleotides, not just four. In which part of the DNA molecule is the cell's genetic information stored?

____

[1 mark]

(iv) Explain briefly **how** this information is stored and **how** it is translated.

____

____

____

____

____

____

____

____

____

[8 marks]

7. A freshwater amoeba may have as many as 600 chromosomes whereas a cat cell has only 38. Does this imply that the amoeba is a more complex animal than the cat?

____

Explain:

____

____

____

[2 marks]

8. (i) When DNA replicates, it unzips along its entire length. How does this compare to the changes it undergoes when protein synthesis occurs?

____

____

[2 marks]

(ii) Name the four nucleotides which move to the unzipped section of DNA for protein synthesis.

____

[4 marks]

(iii) Name the smaller nucleic acid which is formed on the exposed nitrogenous bases of the DNA molecule

____

[1 mark]

(iv) Describe what happens to this smaller nucleic acid from when it is formed until when it reaches a ribosome

____

____

[2 marks]

(v) Amino acids are assembled at the ribosome according to the code on the nucleic acids. How are the correct amino acids brought to the appropriate codon on the nucleic acid?

____

____

____

[3 marks]

(vi) How are amino acids held together or bonded?

[1 mark]

(vii) Proteins which form at the ribosomes have several possible uses in the cell. Name two of these uses:

[2 marks]

(viii) Place the five molecules below into an increasing order of size and complexity:

DNA, tRNA, amino acid, mRNA, protein

[2 marks]

SECTION THREE – EXTENDED ANSWER (20 MARKS)

(i) Describe how DNA molecules replicate before cell division occurs. Use diagrams to illustrate your answer.

[10 marks]

(ii) Transcription and translation are the two main stages in protein synthesis. Describe the steps in each stage in their correct order. [10 marks]

END OF TEST (100 MARKS)

TRIAL TEST 2:
GENES, INHERITANCE AND DNA TECHNOLOGIES

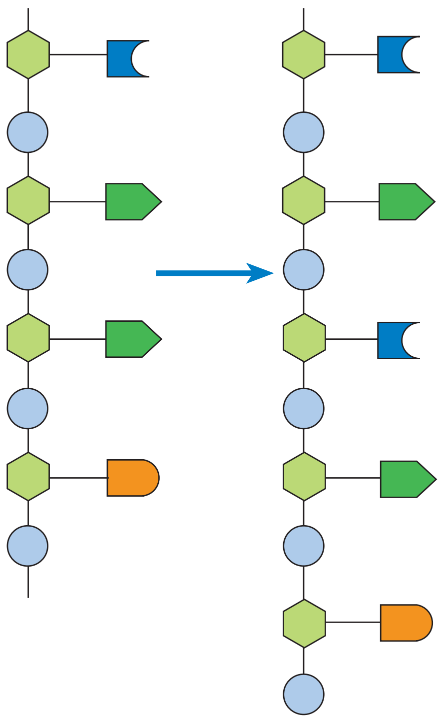
Time allowed: 60 minutes	**Section One –**	Multiple Choice	20 marks
Total marks: 100	**Section Two –**	Short Answer	60 marks
	Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

1. Marri trees *(Corymbia calophylla)* that grow on the sandy coastal plain near Perth are smaller and more branched than those that grow in the clay soils of the Darling Scarp. An explanation for this difference in growth form may include:
   (a) Marri trees on the coastal plain are a different species to those on the Darling Scarp
   (b) both populations have similar genotypes but they show a difference in their phenotypes because of their different environments
   (c) every tree has a different genotype and therefore different phenotype
   (d) the populations have a range of different phenotypes because of both their genes and their different environments

2. If a large number of turtle eggs are laid in a carefully excavated hole on a beach and only the top half of the eggs hatch as males, the best explanation for this observation is that:
   (a) the sex of the turtles is determined by sperm carrying either an X chromosome or a Y chromosome
   (b) the environment in which the eggs are incubated determines the sex of the offspring
   (c) the sex is determined by both the genotype and the environment in which the eggs are incubated
   (d) the sex of the turtles is determined by how close to the water the eggs are laid

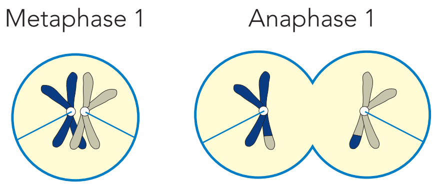
3. If a mutation occurred due to the addition of a nucleotide as is illustrated below:



Which of the following types of mutation does this example show:
(a) deletion
(b) substitution
(c) inversion
(d) insertion

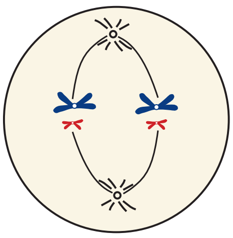
4. A mutation of the kind in question 3 could be caused by:
(a) predation
(b) disease
(c) any selective pressure
(d) radiation

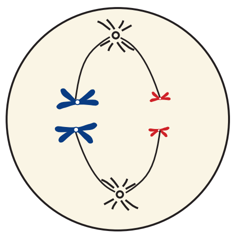
5. The following diagram shows a process which may occur during meiosis. (It illustrates the exchange of genetic material that can occur between homologous chromosomes.)

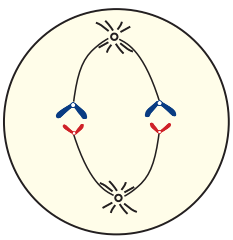


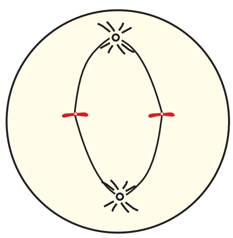
This process is most likely to result in:
(a) linked genes which are very close to one another on a DNA molecule becoming separated
(b) recombinant genes on a DNA molecule becoming separated
(c) linked genes which are at opposite ends of a DNA molecule becoming separated
(d) any genes which are linked becoming separated with equal probability

6. Which of the following diagrams represent a stage in meiosis?

(a)


(c)


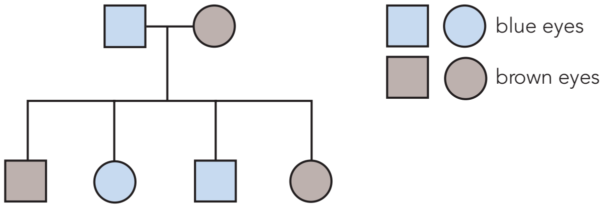
(b)


(d)


7. The random assortment of chromosomes during meiosis results in germ cells producing many various combinations of chromosomes in gametes. Because of this, how many variations would result from a germ cell which contained three pairs of chromosomes?
(a) 2
(b) 4
(c) 6
(d) 8

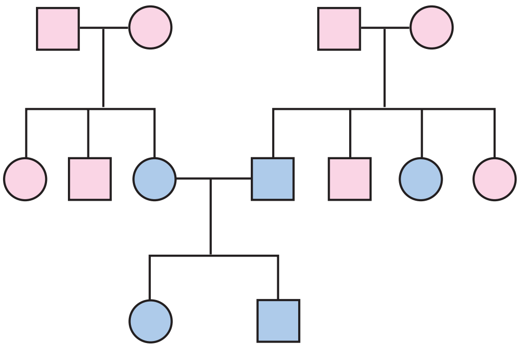
8. There is less likelihood of mistakes being made during mitosis than meiosis because:
(a) mitosis begins with fewer chromosomes
(b) mitosis does not occur in the gonads
(c) meiosis is a longer process which involves more divisions and opportunity for error
(d) meiosis occurs in more mature cells

9. Study the information below the pedigree to answer the next question.



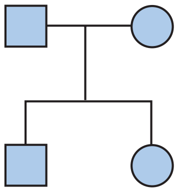
Given the brown allele is dominant and the ratio of brown-eyed to blue-eyed offspring matches the theoretical ratio determined by Mendelian inheritance in this family pedigree, which of the following is true?
(a) The mother is homozygous and the father heterozygous for eye colour
(b) The father is homozygous and the mother is heterozygous for eye colour
(c) The father and mother are both homozygous for eye colour
(d) The father and mother are both heterozygous for eye colour

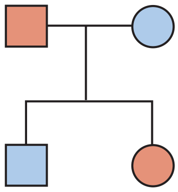
10. In the pedigree below, individuals who have a genetic disease are shadedn blue.

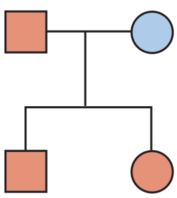


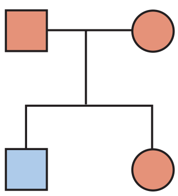
From this pedigree it appears that the grandparents:
(a) each carries a gene for the disease
(b) at least one of each grandparent couple carries a gene for the disease
(c) are all homozygous
(d) only one couple is homozygous

11. Some people can taste a substance called phenylthiocarbamide (PTC), others cannot. Non-tasters are shaded blue in the pedigrees shown. Which pedigree indicates that the non-tasting gene is recessive?

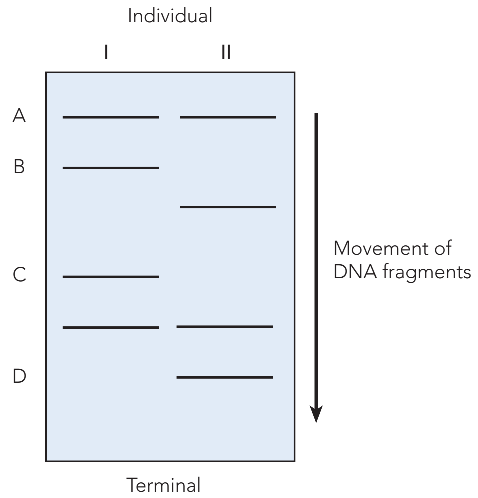
(a)


(c)


(b)


(d)


The diagram below shows the movement of DNA fragments through a gel in electrophoresis. The fragments were taken at the same loci from two different individuals. Use this information to answer questions 12 and 13.



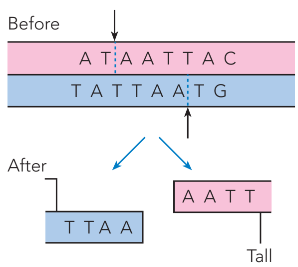
12. The smallest fragments shown would be at:
(a) A (b) B (c) C (d) D

13. The fragments move through the gel because they:
(a) are drawn down by gravity
(b) diffuse through a semi-fluid gel
(c) are attracted by an electrical charge
(d) are actively transported

14. DNA profiling may be used in all but one of the following applications. Which one is it **not** used for?
(a) Paternity suits, e.g. determining the biological father of a child
(b) Forensics, e.g. identifying a murderer or rapist
(c) Cross pollination studies, e.g. to determine whether or not GM plants have contaminated non-GM plant crops
(d) Cloning organisms, e.g. using an ovum and a somatic cell nucleus to produce a zygote

15. A recombinant gene is:
(a) a DNA sequence that has been changed
(b) a gene that has been inserted on a foreign organism's DNA
(c) a gene which has been deleted from an organism's DNA
(d) a vector which transfers foreign DNA into a host cell

Use the information below for questions 16 and 17.
If an enzyme is used to cut a DNA strand as shown below:



16. The 'sticky' ends in this example would be represented by:
(a) AATT and TTAA
(b) AT and TG
(c) AATTAC and TATTAA
(d) ATAATT and TTAATG

17. Which DNA segments could be inserted onto these 'sticky ends':
(a) AAGGTT and AACCAA
(b) AATTGG and CCTTAA
(c) AATTGG and TTAAGG
(d) TTAAGG and CCAATT

18. Restriction enzymes occur naturally in:
(a) all living things
(b) bacteria
(c) viruses
(d) protozoa

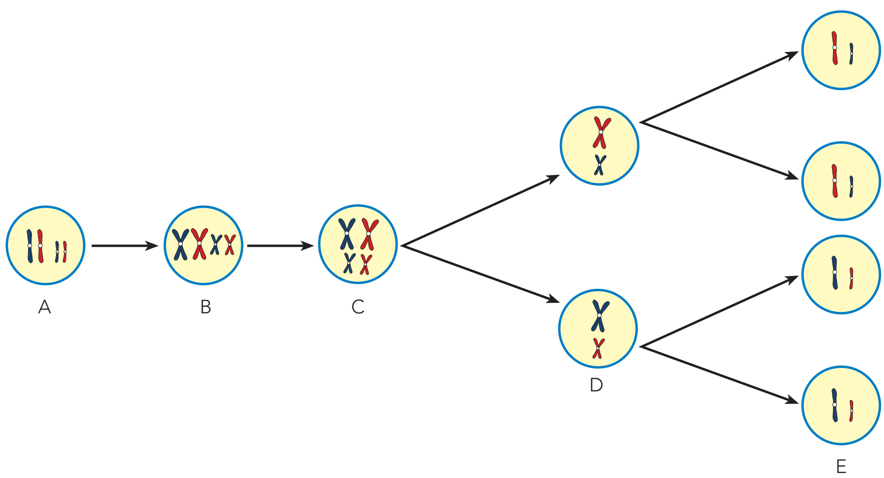
19. Tracing the owners of dogs which have defaecated on the streets of a city may be achieved by looking at the DNA of cells in the dogs' faeces. In order to prosecute the dogs' owners, there would need to be:
(a) a central record of all the owners' DNA profiles
(b) a central record of the owners' DNA profiles and the dogs' names
(c) a central record of the dogs' DNA profiles with their owners' names
(d) a central record of both the dogs' and the owners' DNA profiles.

20. Genetically modified wheat which has a gene which makes it resistant to many insects may be most useful because:
(a) the wheat farmers will need to produce less wheat
(b) consumers of wheat products are less likely to ingest insecticides
(c) less insects will be found near the crops
(d) wheat products will not be contaminated by insects

SECTION TWO – SHORT ANSWER (60 MARKS)

Answer each question in the space provided.

1. The diagram below illustrates a cell undergoing meiosis (highly simplified).



(i) When is each chromosome copied to become a double-stranded chromosome?

___

[1 mark]

(ii) Name the stage in which the chromosomes form pairs.

___

[1 mark]

(iii) How many chromosomes does this parent cell contain?

___

[1 mark]

(iv) How many chromosomes does each gamete contain?

___

[1 mark]

(v) How many types of gametes are possible in this "organism"?

___

[1 mark]

(vi) If the parent cell had a diploid number of six, how many different gametes could it produce?

___

[1 mark]

(vii) If the parent's diploid number was eight, how many different gametes could it produce?

___

[1 mark]

(viii) At which stages would the spindles attach to the centromeres in the division shown?

___

[1 mark]

(ix) Why must the gametes produced be haploid?

___

___

___

[1 mark]

(x) Where does this type of cell division occur?

___

[1 mark]

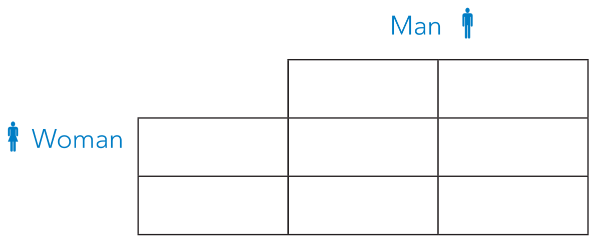
2. Sickle-cell anaemia is a genetic disease in which the homozygote ss causes the red blood cells to become sickle shaped and lose their oxygen carrying capacity. In the heterozygote Ss, both types of red blood cells are formed, i.e. both normal and sickling. The person is said to have sickle-cell trait (not anaemia). People who have Ss are quite healthy but they can suffer a shortage of oxygen at high altitudes or under extreme physical exertion. A person who is a homozygote SS is normal.

(i) What is this disease's mode of inheritance?

____

____

[2 marks]

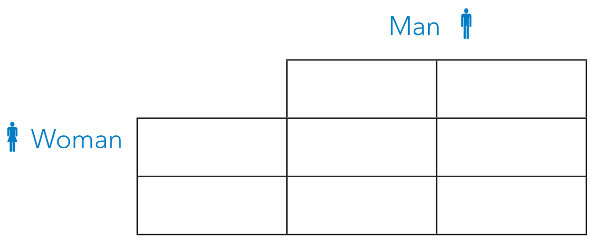


(ii) If a couple who both have the sickle-cell trait have children, what is the probability that their first child will have the sickle-cell trait?

____

____

[2 marks]



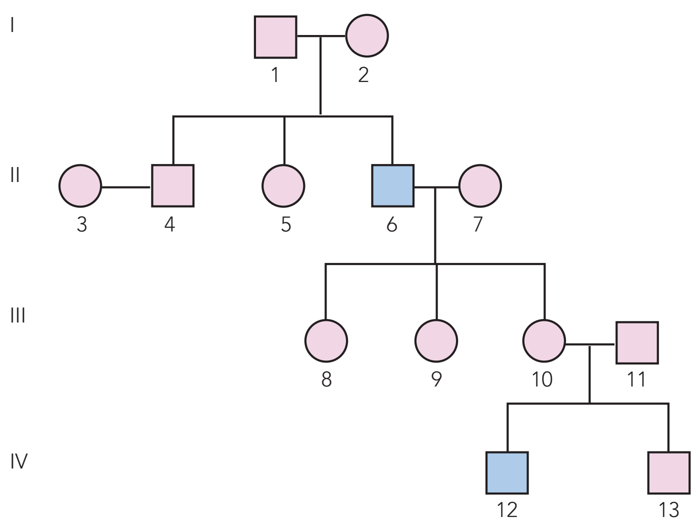
(iii) If a person who has sickle-cell trait marries a normal homozygote, what is the probability that any of their children will have sickle-cell anaemia?

____

____

[2 marks]

3. The pedigree below shows the incidence of haemophilia (blue shaded individuals), which is a rare blood disease in humans.



(i) What is the "mode of inheritance" of haemophilia? ______________________

[2 marks]

(ii) What is the chance of 10 and 11's next child having haemophilia? __________

[1 mark]

(iii) What is the chance of 10 and 11 having a daughter who is a haemophiliac?

__________ [1 mark]

(iv) The chance that 3 and 4's next son being a haemophilic is low. Why?

____

[1 mark]

(v) Write the genotypes of the following individuals in the blank spaces:

1 __________ 2 __________ 4 __________ 6 __________

10 __________ 11 __________ 12 __________ 13 __________

[4 marks]

(vi) Fifty years ago very few haemophiliacs reached maturity. As a result, haemophilia was unheard of in females. Explain why females rarely inherited the disease.

____

____

____

____

[2 marks]

4. Hydrangeas are flowering plants which show a range of flower colour. The flowers may be pink, white or blue. If a gardener lowers the pH of the soil by adding suitable compounds or enriching the soil with manure, the flowers become blue. If the gardener raises the pH of the soil, the flowers become pink.

(i) Describe how the acidity of the soil affects the flower colour of hydrangeas.

____

____

[2 marks]

(ii) What does this example show about the effect of the environment on this plant's expression of its phenotype?

____

____

[2 marks]

(iii) How does the environment affect the hydrangea's genotype? Explain.

____

____

[2 marks]

5. Human identical twins (monozygotic twins) are often used to help determine the influence of the environment on our development.

(i) Explain why this type of twin is useful to do this.

____

____

[2 marks]

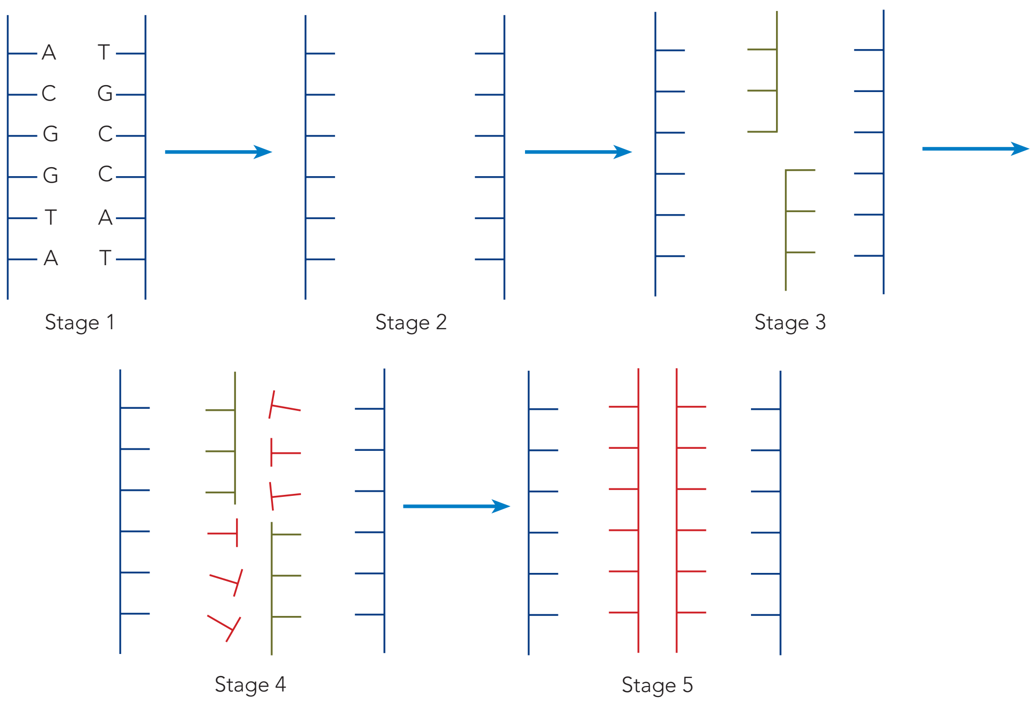
(ii) How are dizygotic twins different from monozygotic twins?

____

____

[2 marks]

6. One cycle of a polymerase chain reaction (PCR) is shown diagrammatically below. Use this sequence to answer the questions below the diagrams.



(i) At which stage/s are the DNA fragments heated? ______________________

[1 mark]

(ii) At which stage/s are the DNA fragments cooled?______________________

[1 mark]

(iii) At which stage/s do the free nucleotides attach to the separated DNA strands?

________________________ [1 mark]

(iv) Stage three (3) shows small fragments of DNA attaching to the separated DNA strands.What are these fragments called and what is their function?

____

____

[2 marks]

(v) Name the type of enzyme which attaches the free nucleotides to the separated DNA strands.

________________________ [1 mark]

(vi) What is special about this enzyme?

____

____

[1 mark]

(vii) If one PCR cycle produces two copies of the DNA strand, how many copies would be produced by

(a) two cycles? ________ (b) four cycles? ________

(c) ten cycles? ________ (d) forty cycles? ________

[2 marks]

(viii) If a foreign DNA molecule were to contaminate the sample to be amplified at the commencement of the PCR, how would this affect the outcome?

____

[1 mark]

7. (i) A restriction enzyme is used to cut a section of DNA at a particular place. In many cases it produces ‘sticky ends’ on the cut DNA and the piece of DNA that is removed.

(a) Why are these ends called ‘sticky’?

____

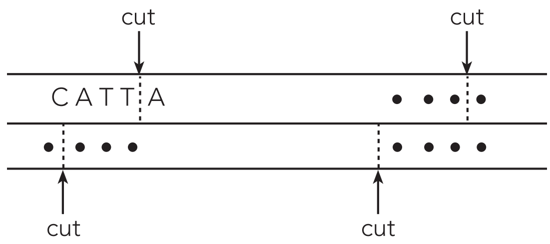
[1 mark]

(b) What is likely to ‘stick’ to them?

____

[1 mark]

(ii) If in a particular segment of DNA a restriction enzyme was used to cut the double stranded DNA at the sites shown below.



(a) Draw the resulting DNA fragment which would be removed. On your diagram, mark clearly which nucleotides would make up the 'sticky ends' of the DNA fragment. (These are shown as dots on the diagram above.)

[2 marks]

(b) Draw the two ends of the DNA molecule from which the segment of DNA has been removed – showing again which nucleotides occupy the places shown with a dot.

[2 marks]

(c) Explain how the same restriction enzyme could be used to transfer the segment of DNA above, to another organism's DNA.

[3 marks]

(d) What role does DNA ligase play in the process of joining (or annealing) the DNA segment to the recipient DNA?

[2 marks]

(e) In the example shown at (ii) explain what is meant by the 'recombinant gene'.

[2 marks]

SECTION THREE – EXTENDED ANSWER (20 MARKS)

Discuss what is meant by and the technologies involved in:

(i) Recombinant DNA [10 marks]

(ii) DNA identification [10 marks]

END OF TEST (100 MARKS)

TRIAL TEST 3: EVOLUTION

Time allowed:	**60 minutes**	**Section One –**	Multiple Choice	20 marks
Total marks:	**100**	**Section Two –**	Short Answer	60 marks
		Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

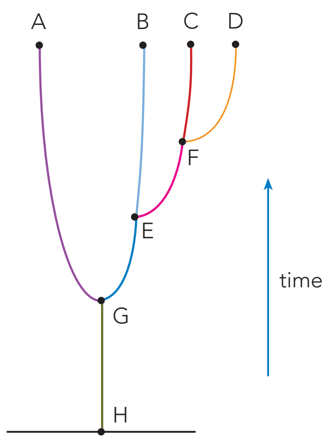
1. Life has existed on Earth for approximately:
   (a) 4 500 000 years
   (b) 35 000 000 years
   (c) 3 500 000 000 years
   (d) 35 000 000 000 years

2. Evidence that life began as simple single-celled organisms has been found in:
   (a) rocks many kilometres below the surface of the ocean.
   (b) sedimentary rocks in north west Australia.
   (c) in metamorphic rock in western New South Wales.
   (d) in Antarctic ice.

3. Vertebrates are likely to be fossilised if they are:
   (a) buried quickly in alkaline soil.
   (b) allowed to dry slowly in the open air.
   (c) carried out to sea in tidal currents.
   (d) deposited in a deep anaerobic water body.

4. Which of the following organisms are most likely to be found as fossils?
   (a) Parasites
   (b) Fish
   (c) Primates
   (d) Jellyfish

In the following phylogenic tree each of the letters represents a different species:



5. Which of the two species are likely to be most closely related:
   (a) A and B (b) B and C (c) C and D (d) A and D

6. The most recent common ancestor of A and D is:
   (a) F
   (b) E
   (c) G
   (d) H

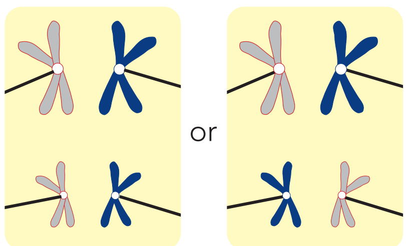
7. Which of the following is the primary source of variation in sexually reproducing species?
   (a) Radiation from the sun and other cosmic bodies
   (b) Sudden changes in environmental temperature
   (c) Meiosis in the somatic cells
   (d) Mutations that occur in the gametes

8. There is less likelihood of mistakes being made during mitosis than meiosis because:
   (a) mitosis begins with fewer chromosomes
   (b) mitosis does not occur in the gonads
   (c) meiosis is a longer process which involves more opportunity for error
   (d) meiosis occurs in more mature cells

9. Variation in the offspring of sexually reproducing organisms, including humans, occurs because of:
   (a) random fertilisation of gametes
   (b) random assortment of chromosomes during meiosis
   (c) non-disjunction of chromosomes during cell division
   (d) all of the above

10. Mutations which occur in the gametes or in the germ cells that produce gametes are most likely to:
   (a) cause a problem in the resulting offspring
   (b) be of benefit to the resulting offspring
   (c) contribute to the evolution of a new species
   (d) have no apparent effect on the offspring

11. The following diagrams show alternative arrangements of chromosomes during the first metaphase of meiosis.



This illustrates:
   (a) 'crossing over' during meiosis
   (b) recombinant chromosomes
   (c) independent assortment of chromosomes
   (d) random 'crossing over'

12. How many different combinations of chromosomes could be expected in the gametes produced by an organism with four pairs of homologous chromosomes?
   (a) 4
   (b) 8
   (c) 16
   (d) 32

The next two questions refer to the following imaginary situation:

A population of rabbits on an island was reaching its carrying capacity for the species when foxes were introduced to the island. While the number of rabbits declined, over several generations they became better camouflaged (a darker colour) in their environment.

13. In this situation, the selection pressure on the rabbits appears to be:
    (a) predation
    (b) colour
    (c) starvation
    (d) isolation

14. The colour change which occurred in the population of rabbits demonstrates:
    (a) artificial selection
    (b) natural selection
    (c) population control
    (d) biological control

Use the information below to answer questions 15, 16 and 17.

In the trials of 'Roundup® Ready' canola in Western Australia, the canola planted was resistant to the herbicide called 'Roundup®'. It was possible to use more 'Roundup®' to eliminate weeds from these canola crops without affecting the crops.

15. Some weed species may become extinct in the trial areas. This would indicate the weeds':
    (a) adaptation to the environment
    (b) inability to adapt to sudden change
    (c) extensive gene pool
    (d) limited populations

16. If, in the above example, some weeds survived and became more numerous in spite of an increasing use of the herbicide this would illustrate:
    (a) the development of resistant strains
    (b) the absence of resistant genes in the original weed population
    (c) a slow reproductive rate in the weed populations
    (d) canola's inability to compete with weeds

17. Some farmers claim that the use of genetically modified canola will lead to the development of weeds which are resistant to the herbicide 'Roundup®'. 'Roundup®' is regarded by farmers as a very useful herbicide. They think that its use should be carefully controlled. The concerned farmers believe therefore that:
    (a) their crops may be infested with 'Roundup®' resistant canola
    (b) their crops may be infested with 'Roundup®' resistant weeds
    (c) 'Roundup®' will not be able to control cross pollination
    (d) 'Roundup®' will drift across from the trial crops and cause damage to their crops

18. The marked differences in the colours of male and female baboons and the dull colours of female birds in many species are probably due respectively to:
    (a) natural selection and artificial selection
    (b) natural selection and isolation
    (c) sexual selection and natural selection
    (d) natural selection and sexual selection

19. Which of the following represent random events:
    (a) natural selection and sexual selection
    (b) artificial selection and sexual selection
    (c) founder effect and natural selection
    (d) founder effect and genetic drift

20. Genetic drift is most likely to occur in a population which is:
(a) small and genetically isolated
(b) large and genetically isolated
(c) small and not genetically isolated
(d) large and not genetically isolated

SECTION TWO – SHORT ANSWER (60 MARKS)

Answer each question in the space provided.

1. (i) Explain what is meant by each of the following statements.

(a) "Mutations arise spontaneously; they are not directed by the environment."

[2 marks]

(b) "Mutations are relatively persistent."

[2 marks]

(c) "Mutations, the vast majority, confer neither an advantage nor a disadvantage to the organism that inherits them."

[2 marks]

(ii) (a) What kind of mutations are likely to be most important in evolution? Explain.

[2 marks]

(b) What happens to unfavourable mutations?

[2 marks]

2. (i) Why are mutations regarded as the ultimate source of genetic variation in a population?

[2 marks]

(ii) When might a mutation have little effect on allele frequencies in a population?

[1 mark]

(iii) Mutations occur in both gametes and somatic cells. Discuss why these mutations result in different outcomes.

[2 marks]

(iv) Why are mutations more likely to occur in animal and plant populations that reproduce sexually than in those animals and plants that reproduce asexually?

[2 marks]

(v) When are harmful mutations likely to become evident?

[2 marks]

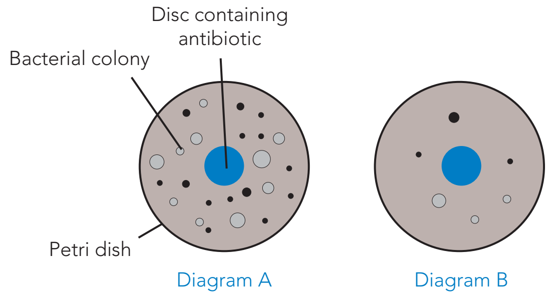
3. In order to determine how closely related two organisms might be, DNA hybridisation can be used. Use simple annotated diagrams to illustrate the main steps involved.

[10 marks]

4. (i) How might the majority of a population of bacteria become resistant to an antibiotic such as streptomycin? List the steps in sequence.

[3 marks]

A small disc containing an antibiotic is placed on a petri dish containing a bacterial culture as below. (Diagram A.)



Soon afterwards many colonies are no longer visible (Diagram B). However some colonies remain. If these remaining colonies are cultured on new nutrient agar:

(ii) How will the same antibiotic affect the new cultured bacteria?

[1 mark]

(iii) What is the significance of this to the control of pathogenic bacteria?

[1 mark]

5.

(i) (a) What kinds of forces or pressures might act upon the native frog populations of the south-west of Western Australia? List two biotic and two abiotic forces.

[2 marks]

(b) Give an example of how each of the forces you have mentioned above might affect the frequency of particular genes in the frog population.

[4 marks]

(c) How might any one of the forces you have described lead to the extinction of frog species?

[2 marks]

(d) On what does the ability of any population to survive environmental changes depend?

[2 marks]

(ii) (a) The black cockatoos of WA have a particular requirement for reproduction. They need large holes in tree trunks. These holes normally occur when a large branch falls off a tree and may take many years to form. How might the removal of old trees from the jarrah forest affect the black cockatoo population?

[2 marks]

(b) What conservation strategies could be used to reduce this selection pressure which could cause such species to become extinct?

[1 mark]

6. (i) Sexual reproduction tends to create variation within a population. How does natural selection affect this variation? Illustrate your answer with an example.

[4 marks]

(ii) The mechanism of natural selection involves four basic steps. These can be summarised by completing the following.

(a) Inherited variation exists due to:

[2 marks]

(b) A small proportion of offspring reaches sexual maturity. This high mortality rate is due to:

[1 mark]

(c) Certain members of a species survive better in particular environments because:

[1 mark]

(d) The characteristics of the whole population change to suit the environment because:

[1 mark]

7. (i) In the peppered moth population in England, which came first, the gene controlling dark colour or the darkening of the environment through pollution? Explain.

[2 marks]

(ii) How did the Industrial Revolution affect gene frequencies in the peppered moth population?

[2 marks]

SECTION THREE – EXTENDED ANSWER (20 MARKS)

(i) If you needed to establish how closely related the wombats on mainland Australia were to those in Tasmania, you could use anatomical, physiological, molecular and genetic features. Discuss the nature of each of these features and how each could be used.

[10 marks]

(ii) Discuss, using examples, how each of the following can provide evidence for evolution:
(a) fossils
(b) homologous structures
(c) comparative anatomy
(d) embryology
(e) biochemistry [10 marks]

END OF TEST (100 MARKS)

TRIAL TEST 4: SELECTION, SPECIATION AND DIVERSITY

Time allowed:	**60 minutes**	**Section One –**	Multiple Choice	20 marks
Total marks:	**100**	**Section Two –**	Short Answer	60 marks
		Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

1. Which of the following comparisons between natural selection and artificial selection is correct:

	Natural Selection	Artificial Selection
(a)	A change in the gene pool occurs	No change in the gene pool occurs
(b)	The population becomes better suited to its environment	The population may become less suited to its environment
(c)	Mutations are a necessary part of this process	Mutations are never involved in this process
(d)	The number of variants is increased by this process	The number of variants is reduced by this process

2. Artificial selection and natural selection are both similar in that each:
   (a) results in a better adapted organism.
   (b) results in a higher natural growth rate.
   (c) require selection pressures.
   (d) produces greater genetic diversity in a population.

3. The domestic pig is very different from most feral pigs in that it:
   (a) can survive better in the wild than feral pigs.
   (b) has fewer inherited diseases.
   (c) has more traits that make it useful to humans.
   (d) requires a more balanced diet than wild pigs.

4. The webbed feet of a domestic duck could best be described as:
   (a) a mutation.
   (b) an adaptation.
   (c) an allele.
   (d) a selective pressure.

5. A species may be at great risk of extinction if:
   (a) its population is reduced.
   (b) it has traits that are useful to man.
   (c) its population is confined to a particular environment.
   (d) it has low genetic diversity.

6. A species that is numerous and appears to be thriving may still be vulnerable to extinction because it:
   (a) does not have any special adaptations.
   (b) has a short reproductive cycle.
   (c) has a short life span.
   (d) has little variation.

7. A barrier that separates two populations of the same species making them reproductively isolated from one another over a long period of time is likely to result in:
   (a) speciation or adaptive radiation.
   (b) random genetic drift or natural selection.
   (c) speciation and random genetic drift.
   (d) natural selection.

8. Changes to the gene pool of a small human population are likely to be the result of:
   (a) selective breeding.
   (b) artificial selection.
   (c) harmful mutations.
   (d) genetic drift.

9. Plant seeds may be dispersed when:
   (a) the wind carries pollen from one plant to another.
   (b) insects carry pollen from flower to flower.
   (c) seeds are carried in subterranean water flow.
   (d) seeds are carried by the wind.

10. The dispersal of seeds is important in the development of new plant species because this:
   (a) enables plants to find better soil.
   (b) leads to natural succession.
   (c) begins new communities.
   (d) facilitates the isolation of populations.

11. Organisms are likely to be reproductively isolated by physical barriers that include:
   (a) courtship behaviour.
   (b) sexual selection.
   (c) water bodies.
   (d) bush tracks.

12. Reproductive isolation may lead to:
   (a) an increase in the growth rate.
   (b) a tendency to migrate and increase diversity.
   (c) inbreeding and a reduction in population growth rate.
   (d) an increase in the rate of mutations.

13. When two plant populations are reproductively isolated for a long period they may become two separate species. This is an example of:
   (a) diversification.
   (b) dispersal.
   (c) specialisation.
   (d) adaptive radiation.

14. Where remnant bush is surrounded by cleared land for agriculture, indigenous organisms that remain on these "islands" may be reproductively isolated from other populations of the same species. Their survival may not be sustainable. A viable solution to the problem may be to:
   (a) translocate organisms from other sites.
   (b) create corridors of vegetation to connect similar remnant populations.
   (c) return the cleared land to its original state.
   (d) enlarge the perimeter of all remnant sites.

15. Allopatric speciation is often referred to as:
    (a) specialisation.
    (b) adaptive radiation.
    (c) species replication.
    (d) isolation.

16. Allopatric speciation would not occur without:
    (a) sexual reproduction.
    (b) mutations.
    (c) changing selection pressures.
    (d) short reproductive cycles.

17. Many marsupials that survive in Tasmania have become extinct on the mainland of Australia. This is probably due to:
    (a) increased selection pressures on the mainland.
    (b) less intensive farming in Tasmania.
    (c) later European colonisation of Tasmania.
    (d) the introduction of the domestic cat to the mainland.

18. It is likely that as an Australian environment becomes drier through climate disruption (or change), ecosystems will become fragmented. The effect of this fragmentation will create 'islands' of populations of plants and animals. The main barriers to gene flow in this scenario are most likely to be:
    (a) water bodies.
    (b) mountains.
    (c) distances.
    (d) deserts.

19. A small population of a flowering plant discovered in remnant bush on a farming property may represent the last survivors of a once abundant plant. What is the most likely cause of such population decline?
    (a) Habitat destruction.
    (b) Competition with introduced plants.
    (c) Failure to adapt to land clearing.
    (d) Natural selection.

20. In question 19, the small population of plants is likely to have:
    (a) been protected by the early settlers.
    (b) limited genetic diversity.
    (c) great diversity because it reproduces sexually.
    (d) a good chance of survival as it appears tolerant to change.

SECTION TWO – SHORT ANSWER (60 MARKS)

Answer each question in the space provided.

1. Provide a word or phrase that matches the following descriptions:

(i)	A severe reduction in the size of a population This can reduce the genetic variation in the population's gene pool.	
(ii)	The movement of organisms from where they are produced to sites where they breed and reproduce.	
(iii)	The selection by humans of animals or plants that have useful features for breeding programmes.	
(iv)	The development of two or more species that may occur when populations of the same species are reproductively isolated by barriers for an extended of time.	
(v)	A trait which enables an organism to survive and reproduce better in its environment.	
(vi)	The isolation of populations of the same species that prevents interbreeding between them. This may be due to geographical barriers or behavioural differences between them.	
(vii)	The variety of different genes in a population or community.	
(viii)	A species which has not been sighted live for fifty years or more.	
(ix)	The isolation of populations of the same species due to barriers such as rivers, oceans, mountain ranges and deserts	
(x)	The process which leads to differential survival and reproduction of organisms which are better suited to their environment.	

[10 marks]

2. The Swift Parrot (*Lathamus discolour*), a small green bird, lives in south-eastern Australia in winter and migrates to Tasmania to breed in summer. Its population appears to have been reduced to less than two thousand in recent years. Swift Parrots nest in the hollows of old trees in areas that can provide food for their young.

(i) What changes may have caused a decline in the parrot's population?

[2 marks]

(ii) Compare the different pressures that might act on this species while on the mainland with those that might occur in Tasmania.

[4 marks]

(iii) If birds that are slightly lighter in colour are predated upon by nocturnal predators more often than darker coloured ones, describe how this would affect allele frequencies.

[2 marks]

(iv) The main authority on the conservation status of all species in the world is the IUCN (International Union for Conservation of Nature). How might this organisation rate the conservation of this species? Justify your answer.

[2 marks]

(v) Bringing this bird back from the brink of extinction may require a great deal of work. How important is cooperation between state governments in this process?

[2 marks]

(vi) If measures were taken to protect the Swift Parrot and its population was to increase significantly, the species may still remain threatened for many years due to its reduced genetic diversity. Explain this phenomenon.

[4 marks]

3. Over the last ten thousand years the sea level around Australia has risen by over ten metres. As it has risen some areas of land around the coast have been inundated with water. Many islands have been created near the present coastline which were once part of the mainland. One such island is Rottnest Island, about twenty kilometres from the mainland coast, near Fremantle.

As the sea surrounded this part of Australia many organisms were marooned on the island. One animal being the Quokka *(Setonix brachyurus)*, a small marsupial whose population has been split by this gradual change. Most of these wallabies probably remained on the mainland but some were isolated on the island. Aboriginal people appeared not to frequent the island.

(i) Some other organisms on the island are **not** reproductively isolated from populations on the mainland. Explain.

[2 marks]

(ii) How would the selection pressures acting on this small wallaby population on the island have differed from selection pressures on the mainland **before** European settlement in Australia?

[2 marks]

(iii) Discuss how these pressures are likely to have changed **after** European settlement.

[2 marks]

(iv) The population of quokkas on Rottnest Island is now between eight and twelve thousand. On the mainland small isolated populations live in generally decreasing numbers in the forests of south-west of Western Australia. What factors might explain this change in relative numbers?

[2 marks]

(v) The genetic diversity within the island population would be expected to be lower than the mainland population. Explain.

[2 marks]

(vi) How could the genetic diversity of the island population be artificially increased?

[2 marks]

(vi) Describe a sequence of events that may have caused this lower genetic diversity in the island's population.

[3 marks]

(vii) Animals like the quokka, which are genetically isolated from similar animals on the mainland, may in time become a separate species. How?

____

____

[3 marks]

(viii) The removal of the barrier would result in three possible outcomes. What are they?

(a) ______________________________________

(b) ______________________________________

(c) ______________________________________

[6 marks]

(ix) Name three other barriers that could prevent gene flow between two animal populations.

____

____

____

[3 marks]

4. (i) Describe one example of the use of artificial selection to improve agricultural produce.

____

____

[2 marks]

(ii) List four reasons why Australia has a very high rate of small mammal and bird extinctions.

____

____

____

____

[4 marks]

(iii) What is one way in which the pressures leading to this high rate of extinction can be reduced?

____

[1 mark]

SECTION THREE – EXTENDED ANSWER (20 MARKS)

Describe how two species could arise from one gene pool. Illustrate your answer using annotated diagrams. Discuss how this might occur in the case of both a plant and an animal. Use named examples of plant and animal species in which this process appears to have taken place.

END OF TEST (100 MARKS)

TRIAL TEST 5:
INQUIRY SKILLS AND HUMAN ENDEAVOUR 1

Time allowed:	**60 minutes**	**Section One –**	Multiple Choice	20 marks
Total marks:	**100**	**Section Two –**	Short Answer	60 marks
		Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

Use the information below to answer questions 1-6.

To determine the effect of a synthetic growth hormone on domestic pigs, a scientist selected ten piglets which he regularly injected with the hormone and ten piglets which were regularly injected with an isotonic solution, similar in composition to their blood plasma. He measured each group's weight, before, during and after the course of injections.

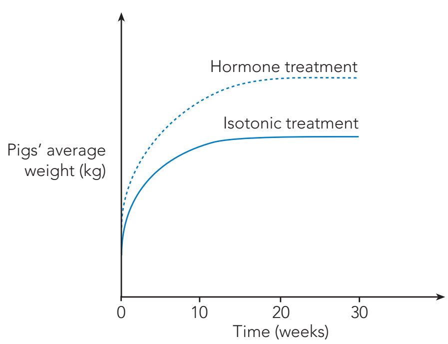
1. In the experiment, it is likely that the scientist's hypothesis was:
   (a) "the growth hormone promotes pig maturation".
   (b) "does the growth hormone promote healthy growth in pigs?"
   (c) "the growth hormone inhibits excessive development".
   (d) "the growth hormone promotes weight gain in pigs".

2. The independent variable in this experiment was:
   (a) the growth hormone.
   (b) the piglets' growth.
   (c) the isotonic solution.
   (d) the duration of the experiment.

3. The group which was given the isotonic solution as an injection is called the:
   (a) experimental group.
   (b) control group.
   (c) dependent group.
   (d) placebo group.

4. To improve this experiment, which of the following procedures would be most appropriate?
   (a) use mature pigs.
   (b) use more growth hormone.
   (c) use another hormone.
   (d) use a larger sample of piglets.

If the experiment produced results, which when graphed, appeared as shown below:



5. It would be reasonable to conclude that:
   (a) both groups' growth rate was highest during the first 10 weeks.
   (b) the control group had the higher growth rate during the first 10 weeks.
   (c) if the control group had been given a growth hormone after week 10, its average weight would have increased further.
   (d) neither group appears to have reached its maximum expected average weight.

6. If the scientist wished to publish his results in a scientific journal, it is likely and appropriate that before publication:
   (a) his conclusions would be scrutinised by his publisher.
   (b) the scientific community would reject the experiment because of its reliability.
   (c) he would require government funding.
   (d) his procedures and conclusions would be peer reviewed.

7. A good definition of a scientific sample is:
   (a) a small number of individuals which are carefully selected to represent a typical group.
   (b) a small number of individuals which are randomly selected to represent a population.
   (c) a large group that approximates the total population.
   (d) a large group that is not likely to contain any atypical individuals.

8. One advantage of scientific experimentation over other human endeavours is that:
   (a) it can provide reliable evidence on which to make sound judgements.
   (b) it will develop all the answers to what is not understood at present.
   (c) it can determine the decisions for the wider community.
   (d) it can provide unquestionable facts which become fixed laws.

9. The probability that couple's first three children are all boys is:
   (a) ½ + ½ + ½
   (b) ½ × ½ × ½
   (c) ½
   (d) 3 × ½

10. If in humans left handedness is recessive to right handedness , what would the probability of a right handed heterozygote man and a left handed woman having two children who are both left handed?
   (a) ½ × ½
   (b) ½ + ½
   (c) ½
   (d) 2 × ½

11. The rate of growth of a population(r), where b = birth rate, d = death rate, i = immigration rate and e = emigration rate, can be expressed in the following equation:
   (a) $r = b + e - d + i$
   (b) $r = b + i - d + e$
   (c) $r = (b + i) - (d + e)$
   (d) $r = (b + e) - (d + i)$

12. If the doubling time of a population of bacterium is twenty minutes, a population of 10^6 bacteria in one hour will have increased to:
   (a) 2×10^6
   (b) 4×10^6
   (c) 8×10^6
   (d) 6×10^6

13. A new vaccine developed to help control a communicable disease must be trialled on a sample of people before it can be used on the wider population.
This sample is likely to be:
(a) a group of older people who are most susceptible to the disease
(b) people who have previously had the disease and are therefore at little risk of developing complications from the vaccine
(c) young people who are under the care of their parents
(d) healthy volunteers who are chosen at random

14. "Roundup® Ready" canola has been transgenically engineered to tolerate high levels of the herbicide called "Roundup®". The most likely reason for this was to:
(a) develop better weed control.
(b) enable the use of more Roundup®.
(c) increase the variety of canola crops.
(d) develop more Roundup® resistant weeds.

15. The gene that has given the "Roundup® Ready" canola its tolerance could be accidently transferred to a weed. If this were to happen it is likely that:
(a) "Roundup®" would no longer kill weeds.
(b) "Roundup® Ready" canola would no longer be a viable crop.
(c) "Roundup® Ready" canola would no longer be a useful alternative to normal canola.
(d) "Roundup®" would have to be used with a second herbicide on "Roundup® Ready" crops

16. Biotechnology can be appropriately applied in environmental conservation for:
(a) estimating population numbers using the capture recapture method.
(b) radio tracking animals in the bush.
(c) assessing changing salinity in water bodies.
(d) assessing gene pools for breeding programmes.

17. Where two organisms have similar proteins it can be assumed that they:
(a) belong to the same species.
(b) have similar DNA.
(c) illustrate convergent evolution.
(d) are distantly related.

18. The hybridisation of the DNA taken from two different species is most likely to determine:
(a) how closely related the organisms are to one another.
(b) whether a third species could be created from the two species.
(c) if the two species could interbreed in the wild.
(d) whether infectious diseases are likely to spread from one species to the other.

19. If two organisms have a very distant ancestor or are not closely related on the phylogenic tree, it is likely that their hybridised DNA will have:
(a) a low "melting" point.
(b) a high "boiling" point.
(c) a tendency to combine strongly.
(d) a particularly high density.

20. Gel electrophoresis is a useful means of separating DNA fragments because DNA fragments:
(a) all have a different size electrical charge on their phosphate molecule.
(b) move through the gel at a rate determined by their code.
(c) are easily stained and can therefore be seen easily.
(d) move through the gel at a speed determined by their size.

SECTION TWO – SHORT ANSWER (60 MARKS)

Answer each question in the space provided.

1. Into which of the following categories does each of the statements in the box below fit? Choose from: (a) an hypothesis (b) an observation (c) an inference (d) a prediction (e) a generalisation (f) a theory. Give a reason for each choice.

(i) "I can smell a pleasant odour in the room."

(ii) "If I open a door the pleasant odour will become less strong."

(iii) "Someone must have used air freshener in this room before we arrived to leave it smelling so pleasant."

(iv) "Most flowers are sweet smelling."

(v) "The air freshener was made mainly from crushed sweet smelling flowers."

(vi) "Flowers were probably the cause of the extinction of dinosaurs as they evolved to displace the green ferns which made up the diet of these huge animals."

(i)

(ii)

(iii)

(iv)

(v)

(vi)

[6 marks]

2. A student wanted to test her hypothesis that Blackbutt, a species of gum found in Western Australia, only grow in soils that have a high water content. She had limited time, so she could not attempt to grow the plants in the required conditions.

(i) Briefly describe an experiment she could conduct in the field to test her hypothesis.

[4 marks]

(ii) If the student's hypothesis was correct, what results should she obtain?

[1 mark]

(iii) What results would refute her hypothesis?

[2 marks]

3. Suppose you were given the task of comparing the heights of two human populations of different ethnic origin. You randomly collected data but being a little disorganised jotted results down in the following way:

Population 1: Heights (cm): 160 , 115 , 145 , 180 , 190 , 134 , 156 , 134 , 176 , 154 , 189 , 108 , 165 , 145 , 165 , 184 , 134 , 123 , 143 , 154 , 123 , 157 , 154 , 132 , 146 , 65 , 87 , 178 , 149 , 137 , 128, 167 , 145 , 180 , 190 , 134 , 156 , 134 , 176 , 154 , 75 , 156 , 134 , 176 , 154 , 89 , 108 , 165 , 145, 165

Population 2: Heights (cm): 141 , 156 , 134 , 167 , 165 , 154 , 187 , 163 , 197 , 143, 187, 156 , 145 , 143 , 132 , 148 , 176 , 167 , 187 , 165 , 144 , 153 , 167 , 194 , 154 , 134 , 142 , 154 143 , 125 , 127 , 165 , 164 , 135 , 178 , 143 , 176 , 198 , 195 , 167 , 178 , 167, 175 , 145 , 165 145 , 176 , 187 , 167 , 183

Having collected this data, show how you might present it:

(i) in a table so that the height distribution of the two populations could be easily compared and

[5 marks]

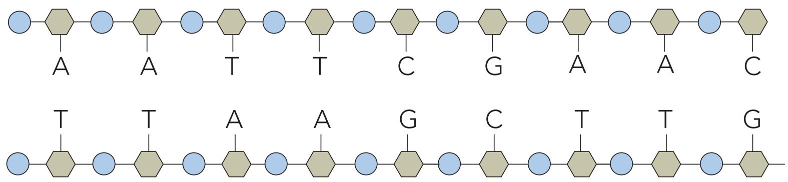
(ii) in a graph to make the comparison clearer still.

[5 marks]

(i) Table

(ii) Graph

4. The diagram below shows a section of DNA from a cell nucleus.



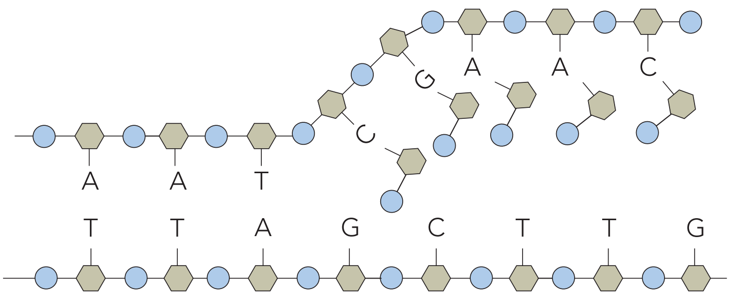
(i) Use the key below to label this diagram. (Only label one of each).

Sugar molecule – S	**Nitrogenous base – N**	**Phosphate – P**

[3 marks]

(ii) Also on the diagram, draw a line around any nucleotide. [1 mark]

This section of the DNA, unzipped during protein synthesis, is shown below.



In the diagram free nucleotides are attaching to exposed nitrogen bases.

(iii) (a) Where do these free nucleotides come from?

____

[1 mark]

(b) Name the type of molecule that is forming along the strand of DNA.

____

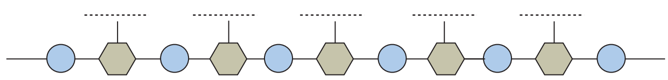
[1 mark]

(c) What is the formation of this molecule called?

____

[1 mark]

(d) On the diagram below, mark clearly the nitrogen bases (in their correct order) that this newly formed molecule would have.



[2 marks]

(e) Describe briefly what the molecule which forms does after it separates from the DNA strand.

____

____

[2 marks]

(iv) (a) Another molecule is directly involved in transporting amino acids in the cytoplasm.

What is the general name given to this molecule?

____

[1 mark]

(b) How does it differ from DNA?

[2 marks]

(v) What roles do proteins have in cells?

[2 marks]

(vi) Explain how small changes to the DNA molecule can affect protein synthesis. Use an example to illustrate your answer.

[3 marks]

5. Make a list of the **main headings** that are likely to be contained in a scientific report. Write them in their logical order.

[7 marks]

6. (i) Describe what is meant by the process of 'genetic modification'.

[3 marks]

(ii) Describe an example of the use of genetic modification to improve a plant crop for human use:

____

____

____

[2 marks]

(iii) Describe an example of the use of genetic modification to improve a domestic animal species for human use:

____

____

____

____

[2 marks]

(iv) Discuss one problem that may arise from both genetically modified (a) animals and (b) plants:

(a)

____

____

____

(b)

____

____

____

[4 marks]

SECTION THREE – EXTENDED ANSWER (20 MARKS)

The last capture of a Tasmanian Tiger took place in 1931 and the species is now generally regarded as being extinct. This species of carnivore was driven to extinction by a variety of environmental pressures with which it could not cope.

(i) Explain the possible causes for the extinction of this animal. [4 marks]

(ii) If the Tasmanian tiger were on the brink of extinction today, conservation planning to maintain a viable gene pool could be applied to reduce the threat of extinction. Describe how an understanding of each of the following areas related to this species could have assisted in this planning:

- biogeography
- reproductive behavior
- population dynamics [9 marks]

(iii) When an animal or plant species is brought back from the brink of extinction, its population may be very small. What effect does a low population have on species diversity and why is this effect a special problem.

[3 marks]

(iv) Discuss how technological developments in the field of genomics and comparative biochemistry could be used to establish evolutionary links between the Tasmanian Tiger and other animals in Australia.

[4 marks]

END OF TEST (100 MARKS)

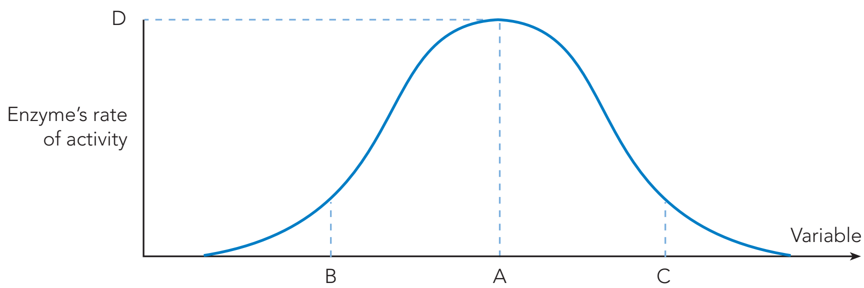
TRIAL TEST 6:
HOMEOSTASIS & THERMOREGULATION

Time allowed:	**60 minutes**	**Section One –**	Multiple Choice	20 marks
Total marks:	**100**	**Section Two –**	Short Answer	60 marks
		Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

1. A living cell will function within a narrow temperature range. The range of conditions between which it can live is called its:
(a) optimum range
(b) range of tolerance
(c) range of fluctuation
(d) limits of fluctuation

2. Any enzyme within an organism's cells is sensitive to changes. This is represented in the following graph. The X axis could represent any one of several variables.



The optimum conditions for these cells is shown at point:
(a) A
(b) B
(c) C
(d) D

3. Which of the following is the correct order:
(a) Stimulus → Response → Coordinating Centre → Receptor → Effector
(b) Stimulus → Receptor → Coordinating Centre → Response → Effector
(c) Receptor → Stimulus → Effector → Coordinating Centre → Response
(d) Stimulus → Receptor → Coordinating Centre → Effector → Response

4. A feedback system operates when:
(a) the stimulus brings about a response
(b) the response reduces the stimulus
(c) the stimulus reduces the response
(d) the response affects the stimulus

5. A baby suckling on its mother's breast causes a sequence of changes which bring about a further release of its mother's milk. This could be regarded as:
(a) a negative feedback loop
(b) a feedback loop
(c) a positive feedback loop
(d) a homeostatic feedback

6. If a response **reduces** a stimulus, this is an example of:
   (a) negative feedback
   (b) positive feedback
   (c) homeostasis
   (d) temperature control

7. It has often been stated that "negative feedback loops are a feature of all homeostatic mechanisms". The statement implies that:
   (a) there are no positive feedback loops in a normal healthy body.
   (b) some homeostatic mechanisms do not require a negative feedback loop.
   (c) feedback loops are only found in homeostatic mechanisms.
   (d) all homeostatic mechanisms involve the reversal of a stimulus.

8. Which list below contains only internal stimuli? Changes in:
   (a) the osmotic pressure of plasma, light intensity, atmospheric humidity.
   (b) blood pressure, carbon dioxide levels in interstitial fluid, nitrogen levels in air.
   (c) oxygen levels in intercellular fluid, blood pressure, sound vibrations in the atmosphere.
   (d) core body temperature, blood glucose levels, pH of the body fluids.

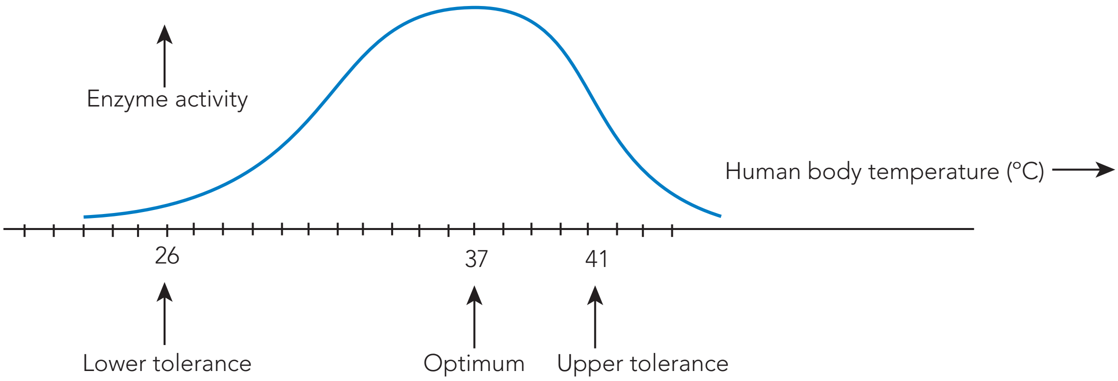
9. Which of the following adaptations is likely to be found in an animal which lives in a cold climate:
   (a) a large SA:Vol. ratio
   (b) long, highly vasculated appendages
   (c) the ability to strongly constrict arteries which service the legs
   (d) white fur and pale skin

10. Animal cells placed in a strong salt solution are likely to:
   (a) shrivel through loss of water
   (b) become turgid and burst (lyse)
   (c) remove salt by endocytosis
   (d) absorb water through osmosis

11. As winter approaches and the weather becomes colder which of the following is likely to occur in an **ectothermic** animal?
   (a) Its rate of metabolism will increase to generate more heat production from within.
   (b) It will often seek an exposed part of the environment in order to absorb radiant energy from the sun.
   (c) It will migrate to a warmer environment.
   (d) It will develop a thick coating of hair or feathers that better insulate it from the cold external environment.

12. In order to maintain the internal osmotic pressure of its body fluids, a desert mammal may have specially adapted respiratory surfaces structured to absorb water from its exhaled air. This will help the animal by:
(a) retaining water that would otherwise be lost.
(b) raising the osmotic pressure within its body cells.
(c) enabling longer time in a burrow with limited oxygen.
(d) lowering the humidity of its exhaled air.

The graph below indicates a mean optimum temperature and mean upper and mean lower tolerance levels for humans. Use this to answer questions 13 and 14.



13. As a person's temperature begins to move towards the upper tolerance level it would be normal for a person's:
(a) skeletal muscles to contract and relax involuntarily, i.e. shivering.
(b) sweat glands to produce more fluid, i.e. increase perspiration.
(c) blood vessels in the skin to constrict, i.e. vasoconstriction.
(d) rate of metabolism to increase, i.e. hypermetabolism.

14. A logical interpretation of the graph is that:
(a) mammals can only survive if their body temperature is maintained between 26° C and 41°C.
(b) the human body is more sensitive to increases than decreases in its normal temperature.
(c) all humans will die if their body temperature falls below 26° C.
(d) humans are not well adapted to live in extremes of temperature.

15. A structural feature that some reptiles have to help absorb energy from the sun is:
(a) a long slender body.
(b) a dark colour on the upper side of the body.
(c) long legs to raise the animal above the surface of the ground.
(d) reduced appendages such as ears and nose sizes.

16. An ectothermic animal may be able to maintain its internal body temperature within reasonable limits by:
(a) vasoconstriction and vasodilation of blood vessels close to its skin surface.
(b) raising or lowering its hair follicles.
(c) reducing or increasing its rate of metabolism.
(d) moving into or out of a warmer part of its environment.

17. If an ectothermic animal's heat loss is greater than its heat gain, then its temperature is likely to:
(a) rise.
(b) fall.
(c) remain the same.
(d) cause stress.

18. On a cool day, a carnivorous mammal would lose heat as a result of:
   (a) eating live food
   (b) shivering
   (c) vasoconstriction of blood vessels in its skin
   (d) warming inhaled air

19. Which of the following would most accurately show the relationship between the variables shown in an endothermic animal?
   (a) Heat Gain = Heat Loss + Heat Production
   (b) Heat Gain = Heat Loss
   (c) Heat Gain + Heat Production = Heat Loss
   (d) Heat Production = Heat Loss

20. Which of the following lists contains a **physiological** adaptation principally associated with reducing heat loss?
   (a) Small ears and short legs.
   (b) Long, thick hair covering the body.
   (c) An increase in metabolic rate.
   (d) Reduced blood flow to the skin.

SECTION TWO – SHORT ANSWER (60 MARKS)

Answer each question in the space provided.

1. When the hypothalamus of a mammal detects a rise in the body's blood temperature, it sends out nerve impulses which cause the vasodilation of blood vessels close to the skin. This vasodilation results in more blood flowing close to the surface of the skin and consequently a greater loss of heat from the body by radiation and conduction to the atmosphere (provided the atmosphere is cooler than the body).

In the above discussion, what is:

(i) the stimulus? ______________________________

[1 mark]

(ii) the receptor? ______________________________

[1 mark]

(iii) the effector? ______________________________

[1 mark]

(iv) the response? ______________________________

[1 mark]

(v) Why is this called a negative feedback system?

____

____

____

[1 mark]

(vi) In this example, where is the coordinating centre and what does it do?

____

____

____

[2 marks]

2. How do **vertebrates** generally respond to:

(i) a rise in the level of **carbon dioxide** in their blood plasma?

____

____

____

[2 marks]

(ii) a fall in the level of **glucose** in their blood?

[2 marks]

(iii) a rise in the concentration of **nitrogenous wastes**, e.g. urea, in their blood?

[2 marks]

(iv) a fall in their normal body **temperature**?

[2 marks]

(v) a fall in the **osmotic pressure** of their blood plasma?

[2 marks]

For each of the examples above, outline the consequences for the animal if the mechanisms you have described did not occur.

(vi) carbon dioxide

[1 mark]

(vii) glucose

[1 mark]

(viii) nitrogenous wastes

[1 mark]

(ix) temperature

[1 mark]

(x) osmotic pressure

[1 mark]

3. (i) Explain why an animal such as a mouse has a higher metabolic rate than a donkey when both animals live in a cool temperate environment.

[4 marks]

(ii) Marsupials such as wombats which live on the Australian mainland are smaller in general than their counter-parts that live in Tasmania. What advantage would their greater size give to the Tasmanian wombats?

[2 marks]

(iii) The hypothalamus, a small area of the brain just above the pituitary gland, detects changes in the internal temperature of mammals and birds.

Discuss **two** responses (other than vasodilation or vasoconstriction of blood vessels) which occur in mammals when the hypothalamus detects a:

(a) rise in body temperature.

[2 marks]

(b) fall in body temperature?

[2 marks]

(iv) To maintain a constant body temperature a numbat must balance heat gain and heat loss.

(a) Show this in a simple word equation.

[1 mark]

(b) How does heat enter the numbat's body?

[2 marks]

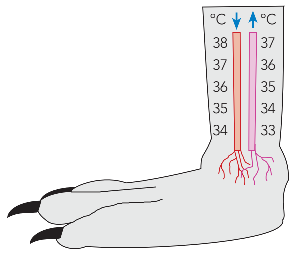
(c) Describe how heat is produced within this animal's body.

[2 marks]

(d) How is heat lost from this animal's body?

[4 marks]

(iv) The following diagram shows how the temperature varies along the length of an artery and a nearby vein, which carry blood to and from the foot of an Antarctic bird that is standing on ice.



(a) What is the exchange of heat between the artery and the vein called?

[1 mark]

(b) Of what advantage to the bird is there in having the artery and the vein so close to one another in the leg?

[2 marks]

(c) What category of adaptation is this example: behavioural, structural or physiological? Justify your choice.

[1 mark]

4. (i) How does **temperature** affect the rate of metabolism in an animal?

[2 marks]

(ii) What factor limits this change?

[1 mark]

(iii) A rise in the environmental temperature of 10°C may result in an increase in the activity of a reptile but a decrease in the activity of a mammal. Explain why there is this difference between the two animals.

[4 marks]

A mouse living in a Jarrah forest in the south-west of W.A. requires a greater intake of food energy than a reptile of a similar size living nearby.

(iv) Why does the mouse require more energy?

[4 marks]

(v) How does this reflect in their relative growth rates?

[2 marks]

(vi) What special problem might this cause for the mouse?

[1 mark]

(vii) What advantage does it give the mouse?

[1 mark]

SECTION THREE – EXTENDED ANSWER (20 MARKS)

(i) What is meant by 'homeostasis' in living organisms? Explain how an organism's survival depends on its ability to respond to changes in its external and internal environments. Use the negative feedback model to illustrate your answer.

[10 marks]

(ii) Discuss how both endothermic and ectothermic animals respond to changes in the temperature of their environment in order to maintain a steady state.

[10 marks]

END OF TEST (100 MARKS)

TRIAL TEST 7: ANIMAL NITROGENOUS WASTES, WATER & SALT REGULATION & PLANT ADAPTATIONS

Time allowed:	**60 minutes**	**Section One –**	Multiple Choice	20 marks
Total marks:	**100**	**Section Two –**	Short Answer	60 marks
		Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

1. If a mammal was losing water at a higher rate than it was gaining water, it would be expected to:
   (a) dehydrate.
   (b) seek water.
   (c) begin to perspire and produce more dilute urine.
   (d) seek water and produce more concentrated urine.

2. On a hot, dry day a mammal would lose water in all but one of the following ways:
   (a) through evaporation from its lungs.
   (b) in its faeces and urine.
   (c) through evaporation from its skin.
   (d) through respiration.

The five statements below relate to questions 3-9 which follow. Read each statement carefully before answering the questions:

A. Burrowing into the soil and seeking refuge there during the hottest months of the year.
B. The capacity to produce extremely concentrated urine while maintaining a normal amount of water in the body fluids.
C. A small surface area to volume ratio as a result of small appendages, small ears and a larger than normal body size.
D. An ability to excrete salt against a concentration gradient.
E. A special organelle in a single-celled animal which collects water from the animal's cytoplasm and periodically contracts to expel the water into its surroundings.

3. Which statement refers to a **behavioural** adaptation?
   (a) A
   (b) B
   (c) C
   (d) D
   (e) E

4. Which statement refers to an adaptation/s possessed by an animal which probably lives in a cold environment?
   (a) A
   (b) B
   (c) C
   (d) D
   (e) E

5. Which **physiological** adaptation is likely to be possessed by a small desert dwelling mammal?
   (a) A
   (b) B
   (c) C
   (d) D
   (e) E

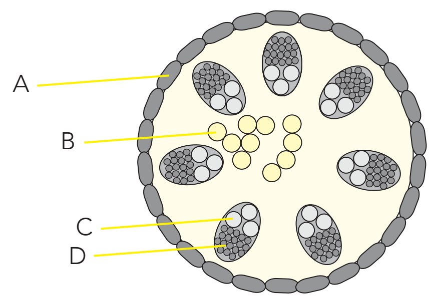
6. The adaptation which allows an organism to live in a freshwater lake is:
   (a) A
   (b) B
   (c) C
   (d) D
   (e) E

7. The adaptation which allows an organism to maintain the concentration of its cells at a level which is within the limits of their tolerance in a marine environment is:
   (a) A
   (b) B
   (c) C
   (d) D
   (e) E

8. Which of the following are both **physiological** adaptations?
   (a) A and B
   (b) B and C
   (c) C and D
   (d) B and D

9. Which of the following are both **structural** adaptations?
   (a) A and B
   (b) B and C
   (c) C and E
   (d) D and E

The diagram below shows a transverse section of the stem of a vascular plant.



10. Which label shows the plant tissue that transports water and minerals in the plant?
   (a) A
   (b) B
   (c) C
   (d) D

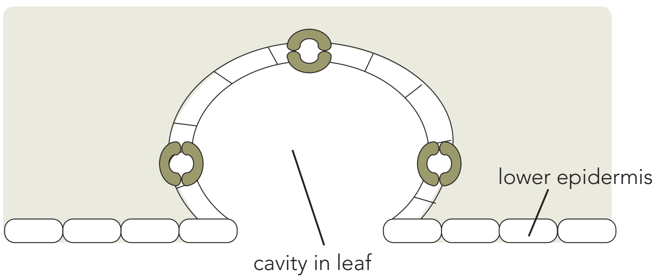
11. A tadpole is placed in water that has dissolved solutes at a much higher concentration than that of its normal fresh water environment. The effect on the tadpole's body would be to:
    (a) increase in size because water is absorbed into its body.
    (b) be more active because of the dissolved solutes.
    (c) lose water and eventually die because of a lack of water in its body.
    (d) neither decrease nor increase in size because it is adapted to an aquatic environment.

12. A terrestrial plant may control its water loss by:
    (a) reducing its rate of photosynthesis.
    (b) absorbing water through its root hair cells.
    (c) changing the aperture of its stomata.
    (d) reducing its stomatal guard cells.

13. When a plant wilts during hot weather, this can best be regarded as a:
    (a) physiological adaptation that reduces water loss.
    (b) signal to reduce its rate of photosynthesis.
    (c) signal that it needs water.
    (d) structural adaptation as its shape and the shape of its cells are changed.

14. The turgidity of plant cells depends **directly** on the:
    (a) rate at which the plant gains water.
    (b) amount of water pressure in the cells.
    (c) rate of photosynthesis in the cells.
    (d) rate at which the plant is gaining and losing water.

15. The diagram below shows the recessed stomata on the underside of a plant leaf which lives in a hot dry climate.



    The effect of the recessed stomata is to:
    (a) prevent insects entering the leaf.
    (b) create a cool micro-environment within the leaf.
    (c) assist in cooling the leaf.
    (d) create a humid micro-environment outside the stomata.

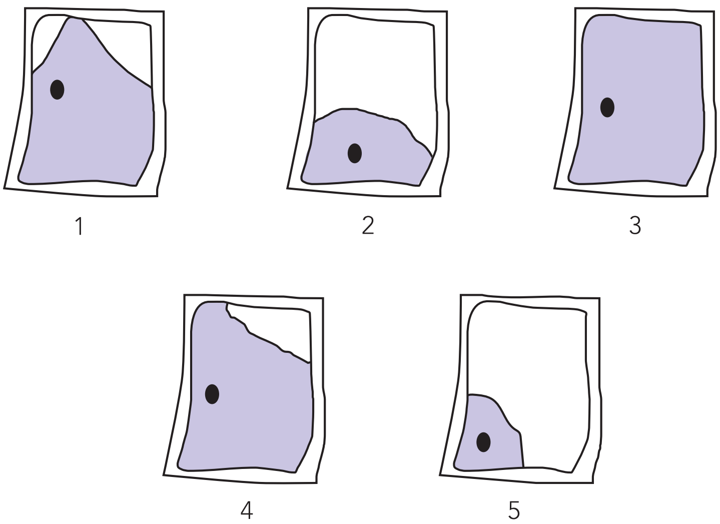
16. Plant cells placed in fresh water are likely to:
    (a) swell and burst (lyse).
    (b) become flaccid or soft.
    (c) become turgid.
    (d) shrivel and sink.

17. Halophytes are able to tolerate high salt levels in the soil whereas other plants cannot. This is generally because non-halophytes:
    (a) tend to take up the salt which is toxic to them whereas all halophytes exclude the salt.
    (b) cannot absorb water from saline soil whereas halophytes can absorb water.
    (c) dehydrate because more water leaves the plant than enters by osmosis whereas halophytes have mechanisms to absorb more water than they lose to the soil.
    (d) have roots which grow just under the surface of the soil which is usually more heavily contaminated with salt.

18. Some halophytes have a very short life cycle which normally begins immediately after heavy rainfall. The advantage of this adaptation is that the plant:
(a) is able to store a large amount of water to dilute the effect of the salt.
(b) can avoid the dehydrating effect of salt in its immediate environment.
(c) is able to excrete salt in a diluted form.
(d) can store salt in some leaves and thoroughly dilute it when the heavy rain occurs.

19. Which combination of weather conditions would lead to the greatest water loss in land plants?
(a) High humidity, low temperature and no wind.
(b) High humidity, low temperature and high winds.
(c) Low humidity, high temperature and no wind.
(d) Low humidity, high temperature and high winds.

20. Which of the following is the correct sequence of changes occurring in a pigmented cell of a leaf epidermis which has been placed in a concentrated salt water solution?



(a) 3, 1, 4, 5, 2
(b) 2, 1, 4, 3, 5
(c) 5, 2, 4, 3, 1
(d) 3, 4, 1, 2, 5

SECTION TWO – SHORT ANSWER (60 MARKS)

Answer each question in the space provided.

1. Provide a word or phrase that matches the following descriptions. Write your answer in the last column of the table:

(i)	The removal of metabolic wastes, including carbon dioxide, urea, and uric acid from an organism's body.	
(ii)	A gas which dissolves readily in water. It is a metabolic waste that is very toxic to cells.	
(iii)	The maintenance of suitable concentrations of water and dissolved salts in an organism's body cells.	
(iv)	The breakdown of excess amino acids in the liver that involves the removal of the amino group of atoms (NH_2) from the amino acid.	
(v)	A flattened stem or petiole which photosynthesises and therefore functions as a leaf but with fewer stomata.	
(vi)	A type of plant which is adapted to live in a dry environment.	
(vii)	A type of plant which has water storing cells in either or both its leaves and stem.	
(viii)	An opening or pore for gas exchange in the epidermis of a leaf or stem which is created by two guard cells.	
(ix)	A measure of the salt concentration in a liquid.	

[9 marks]

2. To compare the three most common nitrogenous wastes, complete the table below.

Nitrogenous Waste	Advantages	Disadvantages	Animal Examples
Ammonia NH_3			
Urea $CO(NH_2)_2$			
Uric Acid $C_5H_4N_4O_3$			

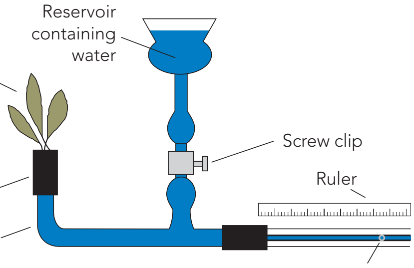
[9 marks]

3. Complete the table below to compare osmoregulation in marine and freshwater fish.

	Marine environment	Freshwater environment
Dissolved solutes in external environment of fish		
Dissolved solutes in internal environment of fish		
Practical osmoregulatory problems fish need to overcome		
Two adaptations fish may have that are related to the osmoregulatory problems		

[10 marks]

4. A potometer was set up as shown in the diagram to carry out an investigation into factors that influence transpiration in vascular plants.



The distance that water travelled along the capillary tube, in still dry air was measured every five minutes for two different plant species at two different temperatures. The results are shown in the table below.

	Plant A		Plant B	
Time (minutes)	Distance travelled (mm) at 20°C	Distance travelled (mm) at 40°C	Distance travelled (mm) at 20°C	Distance travelled (mm) at 40°C
0	0	0	0	0
5	21	44	12	24
10	58	86	28	43
15	85	105	40	44
20	122	108	56	45
25	140	110	64	45

(i) Graph these results on the grid below.

[6 marks]

(ii) What appears to be the relationship between transpiration rates and temperature?

[3 marks]

(iii) What happens to the water that enters the plant?

[2 marks]

(iv) What types of plant cells/tissue facilitate water movement in vascular plants?

[3 marks]

(v) Besides temperature what other environmental factors may influence the transpiration rate?

[2 marks]

(vi) If the two plant samples used were the same mass and size, what explanation can be given for the differences seen in the data at 20°C?

[2 marks]

(vii) Provide an explanation for the difference in data for plant B at 20°C and 40°C.

[2 marks]

5. Describe and explain one adaptation that a **terrestrial** plant may have to:

(i) reduce heat absorption in a hot dry environment.

(ii) reduce water loss on a hot dry day.

(iii) increase water absorption in a hot dry environment.

(iv) remove salt from its cells in high saline soil conditions.

(v) remove salt filled leaves in high saline soil conditions.

(vi) exclude salt absorption in high saline soil conditions.

[12 marks]

SECTION THREE – EXTENDED ANSWER (20 MARKS)

(i) Discuss how a terrestrial and an aquatic animal gain and lose water. [8 marks]

(ii) Describe two ways in which terrestrial animals and two ways in which marine fish are adapted to reduce water loss. [6 marks]

(iii) The type of nitrogenous waste an animal produces is largely dependent on available water. Explain why available water is an important factor in this regard. [6 marks]

END OF TEST (100 MARKS)

TRIAL TEST 8:
INFECTIOUS DISEASES AND PATHOGENS

Time allowed:	**60 minutes**	**Section One –**	Multiple Choice	20 marks
Total marks:	**100**	**Section Two –**	Short Answer	60 marks
		Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

1. All infectious diseases are transmitted from one organism to another by:
   (a) contact.
   (b) vectors.
   (c) pathogens.
   (d) indirectly.

2. A pathogen is likely to be:
   (a) a virus, an insect or a bacterium.
   (b) a bacterium, a vector or a protozoan.
   (c) a protozoan, an insect or a fungus.
   (d) a virus, a bacterium, a protozoan or a fungus.

3. An organism that carries a pathogen is called its:
   (a) patient.
   (b) carrier.
   (c) transmitter.
   (d) host.

4. Any disease that can be transmitted from animals to humans is called:
   (a) a zoonosis.
   (b) a prion.
   (c) a virus.
   (d) an interspecific.

5. Pathogens that can be transmitted from one mammal species to another are likely to cause:
   (a) similar reactions in each host but be different in their severity.
   (b) the same effect on all host species.
   (c) different symptoms in each host species.
   (d) different symptoms in each individual host.

6. Viruses are distinguished from most other pathogens in that that they are:
   (a) more complex and difficult to control.
   (b) all zoonoses.
   (c) more virulent.
   (d) smaller and less complex.

7. Bacteria are described as prokaryote partly because they all have:
   (a) pairs of homologous chromosomes.
   (b) DNA in their nuclei.
   (c) no membrane bounded organelles.
   (d) plasmids.

8. Bacteria often have two kinds of DNA within their cytosol. Their most important DNA is:
   (a) chromosomal.
   (b) mitochondrial.
   (c) plasmid.
   (d) nuclear.

9. Protists that are pathogens are different from other pathogens in that many are:
   (a) macroscopic.
   (b) parasites.
   (c) freeliving.
   (d) vertebrates.

10. Parasitic protists that live in the gut of their host often have no means of digestion. This is mainly because they:
   (a) lack mouth parts.
   (b) are bathed in digested food.
   (c) do not ingest food at this stage of their life cycle.
   (d) absorb undigested food.

11. A distinguishing structural characteristic of multicellular fungi is its:
   (a) branching hypha.
   (b) cellulose cell wall.
   (c) capacity to secrete digestive enzymes.
   (d) membrane bounded nucleus.

12. Bacteria are all microscopic single-celled organisms but they can form colonies due to:
   (a) an interdependence that develops between individuals.
   (b) the medium in which they might be growing.
   (c) the filamentous nature of their growth.
   (d) the exchange of nutrients that they share.

13. A protozoan causes one serious tropical disease that affects millions of people each year. The disease is:
   (a) tuberculosis.
   (b) cholera.
   (c) Ebola.
   (d) malaria.

14. Malaria is a common human disease in tropical and sub-tropical regions of the world because the climate in these areas is:
   (a) suitable for the development of a particular protozoan genus that needs warmth.
   (b) creates vast bodies of still water.
   (c) promotes the development of many mosquito species.
   (d) results in great biodiversity.

15. A disease called chytridiomyosis has decimated amphibian populations around the world. Its causative agent is a:
   (a) virus.
   (b) bacterium.
   (c) fungus.
   (d) protista.

16. Viruses are generally not considered as living organisms. This is because:
   (a) they rely on their host to reproduce them.
   (b) they do not grow and mature.
   (c) they do not respire.
   (d) all of the above.

17. Viruses often consist of a nucleic acid with a protein coat; some have additional layers of protein and/or lipid around the inner protein layer. Their nucleic acid may be either:
    (a) cDNA or RNA.
    (b) cDNA or mRNA.
    (c) DNA or RNA.
    (d) DNA or mRNA.

18. Viruses often invade their host by first:
    (a) attaching to a receptor molecule on the membrane of the host cell.
    (b) punching a hole in the host's cell membrane.
    (c) dissolving lipid molecules in the host's cell membrane.
    (d) moving into the nucleus of a host cell.

19. Those bacteria that enter host cells generally do so when the host cell:
    (a) has damage to its outside surface.
    (b) engulfs the bacterium by phagocytosis.
    (c) is in the process of cell division and is vulnerable to attack.
    (d) is engulfed by the bacterium.

20. Some viruses attack many different organs in the body of a host whereas others may only infect one tissue type. The viruses that only affect one tissue type probably:
    (a) find specific receptor molecules only on one tissue type.
    (b) have a limited amount of nucleic acid.
    (c) have very specific requirements within the host organism.
    (d) cannot move around freely within the host organism.

SECTION TWO – SHORT ANSWER (60 MARKS)

Answer each question in the space provided.

1. Provide a single word or phrase that matches the following descriptions. Write your answer in the last column:

(i)	General name for a disease which persists, can be treated but not cured.	
(ii)	Any organism in or on which a parasite lives.	
(iii)	Mechanism in which a pathogen moves from organism to organism by contact.	
(iv)	Any sexually transmitted infection.	
(v)	Disease that is able to be transmitted from one organism to another.	
(vi)	The way in which a communicable disease spreads.	
(vii)	A kingdom in which member organisms are mostly multicellular and form threadlike filaments.	
(viii)	A malfunction of an organism caused by injury, microorganisms or incorrect biochemistry.	
(ix)	Any organism that transmits a pathogen from one organism to another.	
(x)	Microscopic organism which has no membrane bounded organelles.	

[10 marks]

2. (i) Compare non-infectious disease with infectious disease. Use one example of each to illustrate your answer.

____

____

____

____

[4 marks]

(ii) Are infectious diseases more serious than non-infectious diseases? Support your answer with examples.

[4 marks]

(iii) Define the term "pathogen".

[2 marks]

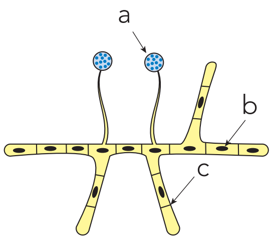
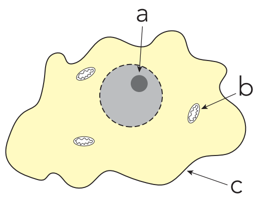
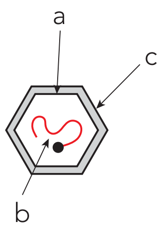
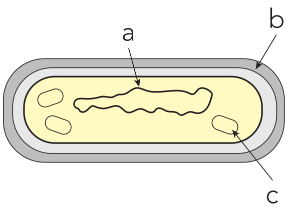
(iv) Not all diseases caused by pathogens are highly infectious or infectious at all. Explain this statement using examples to support your answer.

[4 marks]

(v) Make a list of five pathogen types writing your list in ascending order of size.

[2 marks]

3. The diagrams in the first column of the table below illustrate the major groups of organisms that cause disease. In the table label the parts shown by label lines, name the group and describe the structural characteristics of the group.

Diagram	Labels	Group name	Structural characteristics
	a b c		
	a b c		
	a b c		
	a b c		

[20 marks]

4. In the table below describe the mode of transmission of each of the diseases shown and provide the name of the major pathogen group to which the pathogen belongs.

Disease	Mode of transmission	Pathogen group
Tuberculosis		
Phytophthora Dieback		
Sleeping Sickness		
AIDS		
Crown gall		
Malaria		
Influenza		

[14 marks]

SECTION THREE – EXTENDED ANSWER (20 MARKS)

For the survival and success of a pathogen it normally must follow the steps below:
(i) infect a host
(ii) avoid the defences that the host may have
(iii) move to a suitable microhabitat within the host
(iv) replicate and
(v) leave the infected host and spread to another host.

Explain each of these stages in the life cycle of pathogens, use examples to show how they manage to succeed and describe pathogenic adaptations that enable them to survive.

END OF TEST (100 MARKS)

TRIAL TEST 9: SPREAD, TRANSMISSION, PATHOGENIC EVOLUTION AND CONTROL OF INFECTIOUS DISEASE

Time allowed:	**60 minutes**	**Section One –**	Multiple Choice	20 marks
Total marks:	**100**	**Section Two –**	Short Answer	60 marks
		Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

1. The growth of a virus "population" is most often dependent on:
   (a) the population of its hosts.
   (b) the efficiency of its transmission to each new host.
   (c) its nutrient requirements.
   (d) its method of reproduction.

2. The spread of a particular pathogen is likely to increase in a vertebrate population if:
   (a) it begins to infect other species.
   (b) weather conditions deteriorate.
   (c) the population of its insect vector increases.
   (d) the climate becomes dryer and hotter.

3. The density of a host population may affect the rate of transmission of a pathogen when:
   (a) the host population is part of a developed economy.
   (b) the disease is spread through air-borne droplets.
   (c) the pathogen has a long incubation period.
   (d) the host population has a high growth rate.

4. HIV has not spread as rapidly as the influenza virus in Australia mainly because:
   (a) people in this country are well educated.
   (b) the two viruses are transmitted differently.
   (c) the influenza virus mutates.
   (d) the influenza virus reproduces rapidly.

5. The severity of a particular disease depends on:
   (a) the total number of hosts it affects in a population.
   (b) the rapidity of its spread through the host population.
   (c) the range of different host tissue types it affects.
   (d) the extent of damage it causes to any host organ.

6. Malaria is spread by mosquitoes because:
   (a) the protozoan pathogen can survive and reproduce within the body of the vector.
   (b) the biochemistry of the mosquito is similar to that of humans.
   (c) the body temperature of mosquitoes is approximately 37ºC.
   (d) the protozoan parasite is adapted to live inside any insect.

7. To spread malaria rapidly a mosquito is required to feed on:
   (a) many infected hosts then on some uninfected hosts.
   (b) one infected host then on one other uninfected host.
   (c) an infected host and then on many other uninfected hosts.
   (d) an uninfected host then on may infected hosts.

8. Most vertebrate skin forms an almost impermeable physical barrier that prevents the entry of pathogens. However this barrier is breached in the case of malaria by:
   (a) a female mosquito's stinging tail.
   (b) a mosquito's sharp rasp-like tongue.
   (c) a mosquito's proboscis.
   (d) the sharp penetrating jaws of the female mosquito.

9. A person who has a communicable disease but is asymptomatic:
   (a) has not yet had time to develop symptoms but will develop them later.
   (b) will never develop symptoms for the disease
   (c) will develop severe symptoms for the disease later
   (d) has had symptoms but has almost recovered from them.

10. HIV is not transmitted by insect vectors because:
   (a) it is not likely to be ingested by insects that feed on human blood.
   (b) it cannot tolerate the conditions inside insects.
   (c) it is able to hide inside white blood cells and avoid detection.
   (d) viruses only reproduce in specific hosts.

11. The isolation of a host organism that has a serious infectious disease is generally necessary to:
   (a) allow the host to recover without disturbance by others.
   (b) allow the host to receive specialised treatment.
   (c) prevent the spread of the pathogen to uninfected organisms.
   (d) prevent the host from contracting other infectious diseases.

12. People often develop colds and even the flu after being confined for long periods with large numbers of other people as in cinemas and on airline flights. The reason for this is probably that:
   (a) our immune system is affected by environmental change.
   (b) our immune system is compromised by stress.
   (c) these diseases are transmitted by air-borne droplets.
   (d) air-conditioning systems often harbour bacterial spores.

13. Travellers who are entering or returning to Australia from overseas are required by law to disclose to customs officers whether or not they have recently visited farms on their travels. Compliance is required in order to:
   (a) eliminate any likelihood of introducing exotic diseases into the country.
   (b) prevent the entry of zoonoses that infected travellers may carry.
   (c) inspect soiled shoes that may carry pathogens likely to damage our agricultural industry.
   (d) protect the unwary traveller who may be carrying a serious disease from these locations.

14. "Epidemic" is a term that usually applies if a disease has:
   (a) serious effects and affects many people in many countries.
   (b) no cure and is highly contagious.
   (c) the potential to be transmitted easily either indirectly or directly.
   (d) spread widely in a region or country.

15. Diseases that are spread by mosquitoes are likely to become more prevalent in a human population when the weather is wet and warm. This is due to a combination of several factors that include:
    (a) people being less likely to take precautions when they are on holidays, mosquitoes are opportunistic feeders that take advantage of this situation and a higher density of mosquitoes present in these conditions.
    (b) pathogens favour warm weather to reproduce, pathogen populations increase in warm water and the insect vector is able to travel longer distances in higher temperatures.
    (c) the reservoir of pathogens in animal populations increases as more food becomes available to these animals, more pathogens are ingested with each mosquito meal and the increased pathogen density in each mosquito makes the mosquito a more efficient vector.
    (d) more water bodies become available for mosquito breeding, people are more likely to be outdoors and the vector is an insect that is more active in warm weather.

16. Infectious diseases are likely to be spread in plant populations through:
    (a) direct contact, windborne spores and insect vectors.
    (b) soil movement, indirect contact and insect vectors.
    (c) windborne spores, insect vectors and water movement in soil.
    (d) windborne spores, airborne droplets and insect vectors.

17. Plants are most often infected by disease when:
    (a) insects feed on their leaves damaging their first line of defence.
    (b) their leaves are damaged by accidents that occur in nature.
    (c) soil organisms attack their roots.
    (d) birds visit their flowers to feed on nectar.

18. When almost the whole of a population is vaccinated for a particular disease this provides some protection for those who are not vaccinated. This "herd immunity" however breaks down when:
    (a) significant numbers of people opt out of vaccinations.
    (b) epidemics occur in nearby populations.
    (c) an infected person from another population enters the vaccinated population.
    (d) vaccinated people become carriers of the disease.

19. In which of the following situations is an antibiotic resistant strain of bacteria likely to develop?
    (a) Antibiotics are sold without the requirement of a prescription from a doctor.
    (b) The course for taking the antibiotic is not completed by the patient.
    (c) The antibiotic is mistakenly used to treat a viral infection.
    (d) All of the above.

20. The wearing of protective clothing and masks by health professionals in the treatment of covid-19 patients represents a strategy to prevent the spread of the disease. This is most useful because it facilitates:
    (a) a physical preventative measure.
    (b) disruption to the pathogen's life cycle.
    (c) a non-invasive treatment.
    (d) patient isolation from other hospital infections.

SECTION TWO – SHORT ANSWER (60 MARKS)

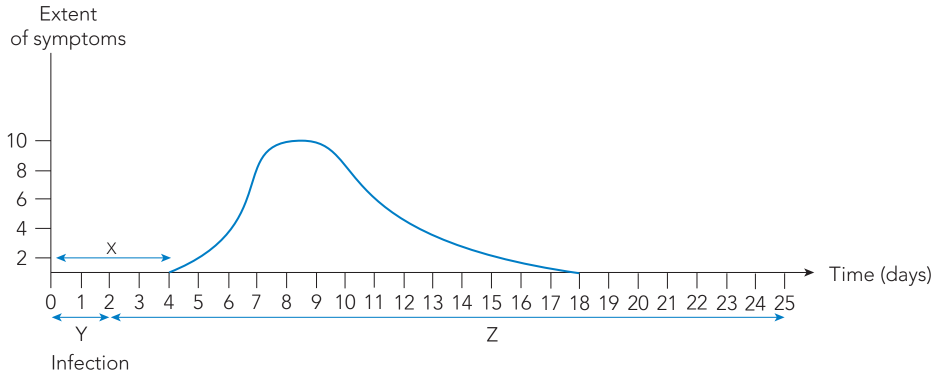
Answer each question in the space provided.

1. Provide a word or phrase that matches the following descriptions. Write your answer in the last column of the table:

(i)	Describes a type of disease which is regularly found in a particular population.	
(ii)	The capacity of an organism to resist disease by means of its lymphocytes and other white blood cells.	
(iii)	The intermediate host which carries the protozoan that causes malaria from one human to another.	
(iv)	Any drug used to treat (kill or inhibit) infections of microorganisms without seriously affecting the host.	
(v)	The rapid spread of a communicable disease from one population to other populations over large regions.	
(vi)	Describes a strain of pathogenic bacterium that is no longer affected or much less affected by a particular antibiotic.	
(vii)	An antigen preparation generally injected into an animal so that the animal artificially develops immunity to the disease caused by a particular pathogen.	
(viii)	The changes which an organism undergoes in passing through its development.	
(ix)	The restriction of the movement of living things considered to be pests, potential pests or to harbour pests from one region to another.	
(x)	The successful remedial treatment of a disease.	

[10 marks]

2. The following diagram represents an example of the course of an infectious disease in a human host.



The labels X, Y and Z represent the incubation period, the latent period and the period during which the disease is infectious respectively.

Use this information to help answer the following:

(i) How long is the incubation period of this disease?

______________________________ [1 mark]

(ii) Would the patient have been aware that he was infected? Explain.

____

____

[2 marks]

(iii) What do pathogens do during their incubation period?

____

____

[2 marks]

(iv) For how many days is the host infectious in this example?

______________________________ [1 mark]

(v) During the initial stages of this disease when is the patient most likely to transfer this disease to others? Explain.

____

____

[2 marks]

(vi) Describe the latent period of the infection.

____

____

[2 marks]

(vii) When is the patient most likely to suffer most from this disease. Explain.

[2 marks]

(viii) How many days does it appear for the patient to recover from the worst symptoms of this disease? Explain

[2 marks]

(ix) Is the patient infectious after his symptoms have disappeared?

[2 marks]

(x) Not all diseases follow the course shown in the graph.

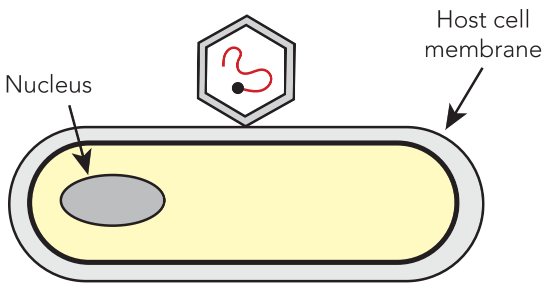
(a) In the space below sketch a labelled graph, similar to the one shown above, to illustrate a disease in which the latent period is longer than the incubation period.

[2 marks]

(b) In the space below sketch a labelled graph, similar to the one shown above, to illustrate a disease in which the patient is no longer infectious before the symptoms disappear.

[2 marks]

3. The diagram below shows the stages in which a virus infects a host cell. Alongside each write down the main events that are occurring in that stage.



(i) ______________________________

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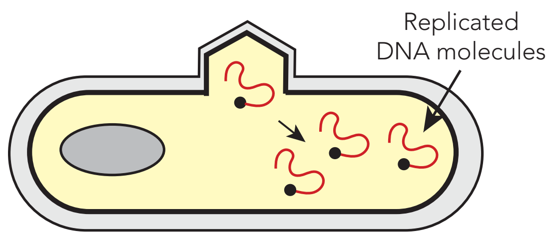
____

____

[2 marks]



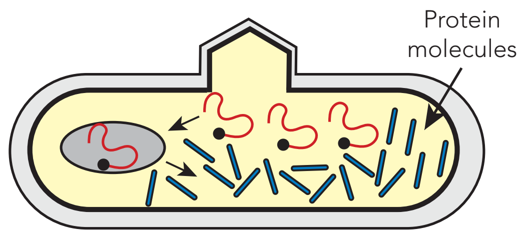
(ii) ______________________________

____

____

____

[2 marks]



(iii) ______________________________

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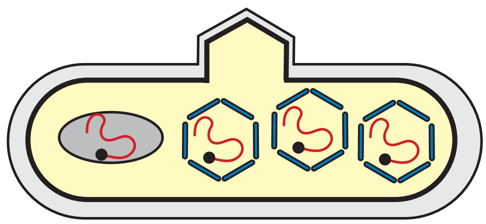
____

[2 marks]



(iv) ______________________________

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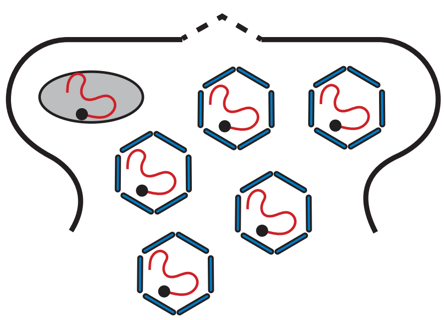
[2 marks]



(v) ______________________________

____

____

____

[2 marks]

4. (i) Distinguish between direct and indirect transmission of pathogens.
Discuss one example of each.

[4 marks]

(ii) Describe three different types of indirect transmission with an example of each.

[6 marks]

(iii) Describe a disease that can be spread both directly and indirectly.

[4 marks]

5. The Pork Tapeworm *(Taenia solium)* is a parasite that occasionally lives in human hosts. The adult stage attaches to the lining of the intestines. It is a hermaphrodite producing both male and female gametes. Its eggs leave the human host in the host's faeces. These eggs may be consumed by a pig in contaminated food, develop as larvae in its intestine and move to its muscle tissue where they remain as cysts until eaten by another animal or human.

In those developing countries where large quantities of pork are consumed this disease may be a serious problem, especially if the eggs are consumed by people, as the larvae are then more likely to move to other organs out of the human intestines.

(i) How does thoroughly cooking pork interrupt the life cycle of this parasite?

____

____

[2 marks]

(ii) Why is the disease less of a problem in Australia than in some other countries?

____

____

[2 marks]

(iii) How does the adult tapeworm obtain its nutrient?

____

____

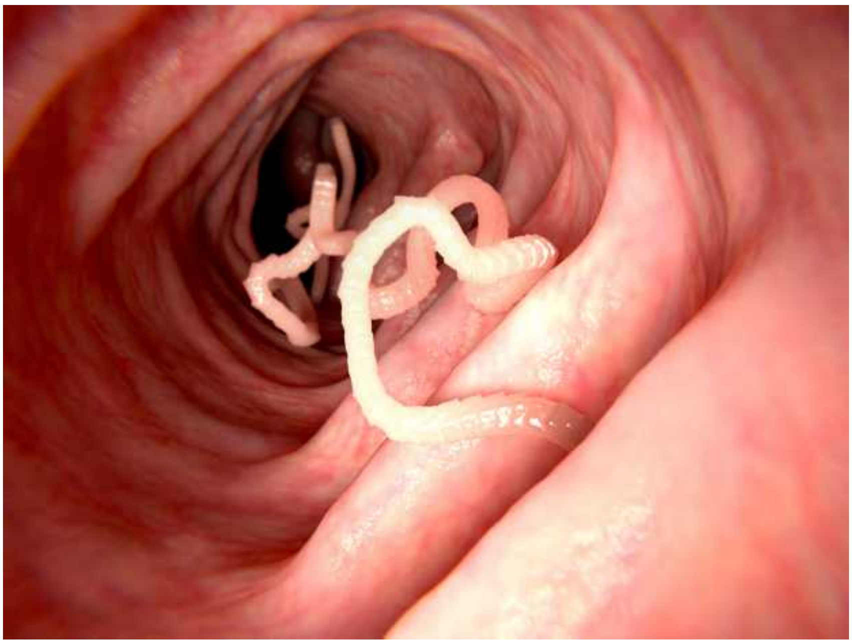
[1 mark]

(iv) What effect might the tapeworm's nutrition have on its host?

____

____

[1 mark]



SECTION THREE – EXTENDED ANSWER (20 MARKS)

(i) Describe how a pathogenic bacterium can develop a resistance to an antibiotic.
[5 marks]

(ii) Discuss why resistance to medications occurs very rapidly in both bacteria and viruses.
[5 marks]

(iii) Outline an experiment that can be used to demonstrate the development of bacterial resistance to an antibiotic.
[5 marks]

(iv) Discuss the problems that occur when antibiotic resistant strains of bacteria evolve and the measures that can be taken to limit the rate at which resistant strains do develop.
[5 marks]

END OF TEST (100 MARKS)

TRIAL TEST 10: INQUIRY SKILLS AND HUMAN ENDEAVOUR 2

Time allowed:	**60 minutes**	**Section One –**	Multiple Choice	20 marks
Total marks:	**100**	**Section Two –**	Short Answer	60 marks
		Section Three –	Extended Answer	20 marks

SECTION ONE – MULTIPLE CHOICE (20 MARKS)

1. A student proposed the hypothesis that "the core body temperature of a mammal rises immediately following strenuous activity." In any experiment designed to test the validity of this hypothesis the dependent variable would be:
   (a) a mammal's core body temperature following strenuous activity.
   (b) a mammal's change in core body temperature following strenuous activity.
   (c) time.
   (d) strenuous activity.

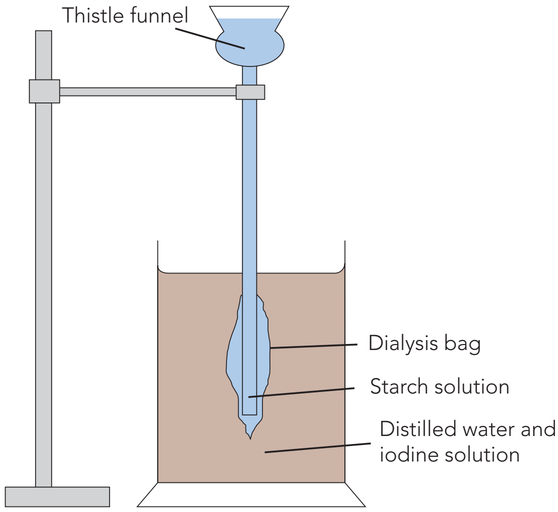
2. Amongst the greatest practical problems scientists have faced in studying viruses has been the viruses':
   (a) mutation rate.
   (b) size.
   (c) complexity.
   (d) inability to reproduce.

3. A science student noticed that one healthy tree in a forest of similar trees very quickly lost its green leaves and died while the other trees around it remained healthy. Which of the student's following hypotheses is most likely to be correct?
   (a) Rising salt levels in the soil have killed the tree.
   (b) A fungal zoospore in the soil may have infected the tree.
   (c) A windborne pathogen has infected the tree.
   (d) The tree has reached the end of its useful life span.

4. Which of the following pathogens would be considered most dangerous to culture and study in a laboratory?
   (a) A virus that causes almost ninety-five percent fatalities of larvae in bee hives.
   (b) A bacterium that infects chimps and attacks their haemoglobin molecules.
   (c) A fungus that devastates banana plantations.
   (d) A protozoan that causes serious diarrhoea in domestic dogs and cats.

5. Before conducting an experiment to investigate the pathogen in the previous question the scientist would be required to carry out a risk assessment. This is so that the experiment is:
   (a) properly controlled.
   (b) monitored fairly by her peers.
   (c) safer for all those concerned.
   (d) valid and produces reliable data.

In the experiment shown below, a thistle funnel with dialysis tubing fixed to one end was filled with starch solution and placed in a solution of distilled water which had a small quantity of iodine solution added to it, giving the water a slightly yellow colour. Dialysis tubing is a differentially permeable membrane.



After about 30 minutes, the colour of the starch solution in the dialysis bag began to go blue-black. The colour of the distilled water and the iodine solution became clearer.

Use this information to answer questions 6 to 8.

6. The best interpretation of these observations is that:
   (a) water and iodine are entering the bag.
   (b) iodine is entering the bag and reacting with the starch.
   (c) iodine is entering and leaving the bag freely as it is a small molecule.
   (d) starch is moving out of the bag and reacting with the iodine, reducing its concentration in the distilled water.

7. If the bag was also observed to become swollen during the first 30 minutes, the best interpretation of these observations would be that:
   (a) only water enters the bag by osmosis.
   (b) only water enters the bag at a greater rate than it leaves during this time.
   (c) iodine enters the bag but starch does not leave the bag.
   (d) iodine and water enter the bag at a greater rate than either leaves the bag during the first 30 minutes.

8. The use of dialysis tubing in this experiment provides some evidence as to how cell membranes behave in cells. It can be regarded as:
   (a) an exact replica of a cell membrane.
   (b) a model, showing some similarities to cell membranes.
   (c) functionally the same as a cell membrane.
   (d) structurally the same as a cell membrane.

9. If the result of an experiment was different from the expected result, which of the following is the appropriate scientific response?
   (a) Always conduct experiments before making predictions.
   (b) Improve the equipment used.
   (c) Change the procedure so that the results obtained more closely match the expected results.
   (d) Examine critically the prediction, procedure and observations.

10. A hypothesis can only be regarded as supported by an experiment if:
   (a) all the data collected support the hypothesis.
   (b) the sample size tested is over 50% of the total population.
   (c) the experiment is conducted by others and similar results are obtained.
   (d) the experimental results are different from those of the control.

11. Scientific instruments are improving with advances in technology to the point at which:
   (a) their error is becoming very small.
   (b) their error will soon be eliminated altogether.
   (c) their error has been eliminated in many cases.
   (d) the only cause of error is human error in their use.

12. People living in urban areas are often more susceptible to infectious diseases than those who live in rural areas because:
   (a) there are generally more people living in urban areas than in rural areas.
   (b) people who live in urban areas are more likely to carry diseases.
   (c) urban areas are usually more heavily polluted.
   (d) people living in urban areas are generally in close contact with a greater number other people.

13. If a person has contracted a serious infectious disease in a rural environment, it is likely that she will:
   (a) be diagnosed quickly as there are fewer people and there is less disease in country areas.
   (b) remain undiagnosed longer as health services are limited more in country areas.
   (c) be transported immediately to a city for treatment.
   (d) be misdiagnosed by health providers in the country as they are less experienced.

14. Variations in living conditions have a significant effect on the susceptibility of diseases in different communities. This is evident particularly in the area of:
   (a) provision of adequate warm clothing.
   (b) provision of clean drinking water.
   (c) food inspection by health inspectors.
   (d) adequate fuels for cooking.

15. Poor human sanitation is most likely to lead to the transmission of diseases associated with the human:
   (a) digestive system.
   (b) feet and skin.
   (c) nervous system.
   (d) excretory system.

16. Which of the following variables is likely to enable the most accurate prediction of the spread of a particular viral pathogen? The virus's:
   (a) virulence.
   (b) capacity to survive in a mosquito.
   (c) antibiotic resistance.
   (d) mode of transmission.

A student conducting research into the frequency of epidemics of a particular disease in five large cities, all in developing countries, gathered the results shown below. Use this data to answer questions 17 and 18.

City	Frequency of epidemics over past 10 year period
A	9
B	4
C	9
D	13
E	10

17. The student added all these numbers to obtain a total of 45 then divided that total by 5. She was calculating for this disease the:
(a) likelihood of further epidemics in these cities.
(b) average number of epidemics in developing countries.
(c) mean number of epidemics in these cities.
(d) mode of the number of epidemics in these cities.

18. It is apparent from these results that city D has had, in the last ten years, more epidemics than the other cities. The most likely reason for this is:
(a) City D is in a developing country.
(b) City D's population size.
(c) City D has poor health services.
(d) City D has the highest population density.

19. In order to help control the spread of an infectious disease like covid-19, health authorities may introduce a system of "contact tracing". The principle behind this control measure involves:
(a) isolating all infected people and their contacts so that no trace of the infection is able to escape into the general population.
(b) quarantining all travelers moving from state to state for a fixed period of time to enable health authorities to determine whether or not they are infected before allowing them to contact other uninfected people.
(c) tracing and contacting all the friends and relatives of an infected person to make them aware that they could have become infected.
(d) identifying all those people who could have been in direct or indirect contact with an infected person so that they can be tested and isolated for a fix period.

20. Serious life threatening epidemics are of great international concern when they occur in developing countries because of:
(a) the damage they can do to the world's economy.
(b) the resulting human suffering in these populations and risk of spread to other countries.
(c) the risk of the pathogens mutating and becoming more virulent strains.
(d) the inadequacies of the health services in developing countries.

SECTION TWO – SHORT ANSWER (60 MARKS)

Answer each question in the space provided.

1. Provide a single word or phrase that matches the following descriptions. Write your answer in the last column of the table:

(i)	Describes a condition in which a person has an infection and could be contagious but does not show any signs or symptoms of the disease.	
(ii)	The likelihood of a person contracting an infectious disease because of their health and location.	
(iii)	A feeling of being ill, fatigued or anxious that is associated with an infection and is experienced by the sufferer of a disease.	
(iv)	The most frequently occurring number in a set of values	
(v)	The regularity with which a particular communicable disease occurs in a population.	
(vi)	Any infection that lasts for a long time. It may cause a chronic condition i.e. one that appears not to "clear up".	
(vii)	A disease that can be transmitted from one person or organism to another.	
(viii)	An estimate of how close an instrument measurement is to a "true" measurement.	
(ix)	A forecast of what a future observation might be.	
(x)	The processes that health services can take in order to limit the spread of and the suffering caused by disease.	

[10 marks]

2. While investigating the effects of extreme heat on the human body a science student carried out the experiment outlined below.
   - She randomly selected 20 students of about the same age and the same gender from her year.
   - She sat all twenty in an air-conditioned room at 22ºC for twenty minutes.
   - She randomly split the group into two, leaving one group (group A) in the room and taking the other (group B) to an adjoining room that had been heated to 35ºC.
   - With the help of others, the temperatures of the subjects of each group were measured every minute for the next twelve minutes while they sat quietly on seats in the adjoining rooms.
   - The subjects in both groups were monitored carefully during the experiment for any visible signs of stress. Notes were recorded of any visible changes in their skin and general appearance.

The results of the temperatures obtained from the two groups are shown below.

Group	Mean Body Temperature of Group (ºC)												
	Time elapsed (minutes)												
	0	1	2	3	4	5	6	7	8	9	10	11	12
A	36.8	36.9	37.0	37.0	36.9	36.9	36.8	36.9	37.0	37.1	36.9	37.0	36.9
B	36.9	37.1	37.3	37.4	36.9	36.7	36.9	37.1	37.2	37.1	37.0	36.9	37.0

(i) Use the grid below to graph both groups' temperatures over the time period shown.

[5 marks]

(ii) What was the sample size?________________________

[1 mark]

(iii) Compare the results from both groups

[2 marks]

(iv) What signs of thermoregulation may have been visible in group B at three (3) minutes?

[2 marks]

(v) What may have caused these changes? Justify your answer.

[2 marks]

(vi) Explain how these changes would contribute to lowering the subjects' temperature.

[2 marks]

(vii) Describe and explain the temperature of group B after five (5 minutes)?

[2 marks]

(viii) Were the risks associated with this experiment adequately addressed? How could this aspect of the experiment have been improved?

[4 marks]

3. What is:

(i) a variable?

(ii) data?

[2 marks]

(iii) meant by describing an experiment as controlled?

[2 marks]

4. A biologist put forward the hypothesis that the temperature of wheat seeds alters the rate at which they use oxygen while germinating. To test this hypothesis she took samples of one hundred seeds, germinated them at different temperatures and obtained the following results.

Temperature (°C)	Oxygen used (mm^3/hr)
10	96
11	140
15	265
22	460
25	625
28	514
34	156
38	45
43	10

(i) Name the independent variable and the dependent variable in this experiment.

[2 marks]

(ii) List four other variables which would need to be controlled if her experiment was to be considered valid.

[2 marks]

(iii) Graph the results.

[5 marks]

(iv) Was the biologist's hypothesis supported (or not) by these results? Justify your answer.

[2 marks]

(v) What appeared to be the optimum temperature for oxygen use by the seeds?

[1 mark]

(vi) How could she make her experiment more reliable? List two ways.

[2 marks]

(vii) Having completed this experiment she proceeded to test other types of seed and obtained similar results in every case that she examined. What generalisation could she then make?

[1 mark]

5. (i) Discuss three measures that can be taken to limit the spread in human populations of serious infectious diseases in urban areas.

(a)

(b)

(c)

[6 marks]

(ii) What measures are available to individual people living in Australia of avoiding the influenza virus during the time of the year when it is most prevalent?

[3 marks]

(iii) Why is the spread of infectious disease less likely in Australia than in a developing country?

[2 marks]

SECTION THREE – EXTENDED ANSWER (20 MARKS)

(i) Outline the main elements of a scientific report. Discuss why each part is important. Where appropriate illustrate your answer with examples taken from your Biology experiences at school.

[16 marks]

(ii) When a scientific experiment is complete and its report written, peer review is essential before the findings are published. What does peer review involve and why is it important?

[4 marks]

END OF TEST (100 MARKS)

ANSWERS TO TERMINOLOGY AND REVIEW QUESTIONS

1. HEREDITY

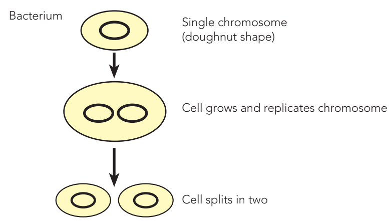
1.1 Replication of genetic material

Terminology

(i) asexual reproduction – reproduction which does not involve the fusion of gametes, e.g. binary fission, budding, spore formation.
(ii) binary fission – cell division which results in two similar organisms.
(iii) cell cycle – a series of changes that take place in a cell leading to division that produces two daughter cells. In eukaryotic cells the cycle has three main stages: interphase, mitosis and cytokinesis.
(iv) daughter cell – one of the cells resulting from cell division.
(v) DNA replication – a process that involves the formation of two identical copies of the original DNA. Normally occurs in the early stage of interphase.
(vi) fertilisation – the fusion of two gametes to produce a zygote during sexual reproduction.
(vii) meiosis – a type of cell division which results in gametes. The number of chromosomes in the original cell (parent/germ cell) is reduced to half, i.e. the cells become haploid.
(viii) mitosis – a cell division type in which the two cells produced are identical to the parent cell. Used for growth and repair.
(ix) reproduction – the process in which organisms produce young.
(x) sexual reproduction – reproduction which involves the fusion of two sex cells called gametes. The resulting cell is called a zygote. The zygote gives rise to the new organism.

Review Questions

1. All living things have a life-span. Some live for a very short time, while others live for many decades. However, all organisms eventually die and therefore if a species is to survive some members of that species must reproduce.
2. Sexual reproduction always involves the fusion of two gametes in a process called fertilisation. Asexual reproduction does not require gametes; no fertilisation occurs.
3.
(i) A cell first replicates its DNA, that is it makes a copy of its DNA molecule. The cell then splits in half and a copy of each DNA molecule is contained in both of the new cells. Two identical cells develop from the original parent cell.



(ii) Prokaryotes and protista, e.g. bacteria, cyanobacteria, amoeba.
(iii) This is an example of asexual reproduction as the fusion of two sex cells does not occur.
4.
(i) A large number of proteins, including enzymes, are synthesised in the cell. Also growth occurs.
(ii) In mitosis this is to maintain the number of chromosomes in the daughter cells.
(iii) Microtubules are used for spindles during mitosis, as part of the cytoskeleton and as cilia and flagella when they are present in cells.
(iv) During this stage the cells may carry out the normal functions of the tissue to which they belong.
(v) (a) Karyokinesis is the process in which the chromosomes are separated and form two separate nuclei.
(b) Cytokinesis is the process in which the cell's cytoplasm divides into two separate cells. This follows karyokinesis.
5.
(i) (a) Telophase – cell has divided, new nuclear membranes grow to enclose each cluster of chromosomes. Centrioles have duplicated. Chromosomes unravel to form chromatin.
(b) Anaphase – chromatids are drawn to opposite sides of the cell – when separated they are called chromosomes. In plants a new cell wall begins to form between the two groups of chromosomes.
(c) Early prophase – chromosomes shorten and thicken ("condense") – become visible (under microscope) – two chromatids are held together at centromere.
(d) Mid prophase – centrioles moving to opposite sides of nucleus, spindles – network of fibres.
(e) Metaphase – chromosomes are arranged

across the 'equator' of the cell, each chromosome has a spindle attached at its centromere.

(ii) Early prophase, mid prophase, metaphase, anaphase, telophase.

(iii)

(a) four (b) two

(c) four (d) two (e) eight

(iv)

(a) During the interphase each chromosome makes a copy of itself (the DNA 'unzips' along its entire length and free nucleotides move to the exposed nitrogenous bases). This is called replication.

(b) Before the chromosomes condense – during interphase (middle stage).

(c) Because each of the two daughter cells must have the complete set of chromosomes to be identical to the parent cell.

6.

(i) (a) When mitosis occurs the number of cells is doubled. These small daughter cells then enlarge to the size of the original parent cell. This contributes to the enlargement of a multicellular organism.

(b) When cells are damaged, those healthy cells that remain will often divide by mitosis to replace the damaged cells.

(c) Some organisms divide by mitosis to produce clones of themselves, e.g. bacteria, protozoa, algae, as a means of asexual reproduction.

(ii) (a) When the daughter cells produced by mitosis absorb nutrients, synthesise further proteins and begin to store food, their overall size increases.

(b) The daughter cells which form during mitosis often have a potential to develop into a number of different types of cell. This is called their potency. As they develop into specialised cells they are said to have differentiated, e.g. some may become muscle cells, others bone cells etc.

7.

(i) ***Stage (a):*** *At this stage chromosomes are not visible. Chromosomes replicate (each copy is called a chromatid), chromatids are attached by a centromere (protein molecule).*

Stage (b): *Chromosomes appear, each chromosome is recognisable as a pair of chromatids – begin to shorten and thicken. Centrioles move towards opposite "poles" of nucleus, begin to form spindles. Chromosomes pair with homologous partner. Nuclear membrane disintegrates.*

Stage (c): *Homologous chromosome pairs arranged together across the "equator" of cell. Each chromosome attached at its centromere to spindle fibres.*

Stage (d): *Spindles draw homologous chromosomes apart. Whole cell begins to constrict around the "equator".*

Stage (e): *Whole cell divides. New nuclear membranes appear around separated chromosomes. Each cell contains only one of each homologous pair (but it consists of two chromatids). Centrioles duplicate and move towards opposite poles once again. Nuclear membranes disintegrate.*

Stage (f): *Individual chromosomes arrange themselves on spindles across cell equator.*

Stage (g): *Spindles separate chromatids, as centromeres are divided. A copy of each chromosome moves towards the opposite pole.*

Stage (h): *New nuclear membranes appear. Each cell has one copy of each homologous chromosome in its nucleus. Four 'daughter' cells formed from single 'parent' cell. Each 'daughter' cell is haploid.*

(ii) Four (two pairs)

(iii) Two (one of each homologous pair)

(iv) Eight

(v) Each chromosome was replicated (duplicated) in the interphase, before the first division.

(vi) Two gametes fuse to form the zygote. The zygote then undergoes mitosis to form a multicellular organism. If the species is to maintain a constant number of chromosomes, before fertilisation takes place, the number of chromosomes must be reduced in the gamete (and then restored in the zygote when fertilisation has occurred).

(vii) Stages (d) and (g)

(viii) Stages (e) and (h)

8.

(i) Each parent gamete contributes one of each homologous pair of chromosomes to the zygote.

(ii) About half (a little less from the father for male mammals as they have a short Y chromosome).

9.

(i) The gametes fuse. A sperm cell enters the ovum, where the nucleus of the sperm and the nucleus of the ovum combine to form a new nucleus, with the diploid number of chromosomes (2N).

(ii) Meiosis reduces the number of chromosomes to half (i.e. 23 in humans) the haploid number. This is so that when fertilisation occurs, the new cell, the zygote, will have two full sets of chromosomes (ie. it will be restored to 46 (the diploid number) in humans).

1.2 DNA

Terminology

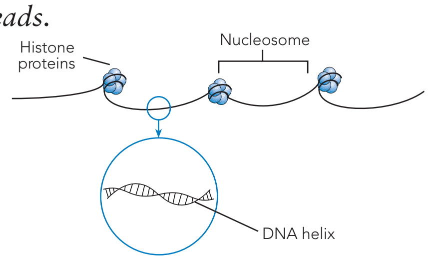
(i) base triplet – three nitrogenous bases on a DNA molecule that code for a particular amino acid.

(ii) chloroplast – a membrane bounded organelle which contains chlorophyll that is the site of photosynthesis in eukaryotic cells.

(iii) *coding DNA – region of a gene that codes for a protein. It is made up of exons.*
(iv) *cytosol – the liquid inside cells.*
(v) *eukaryote – a cell which has membrane bounded organelles, including a nucleus, e.g. amoeba, human cells.*
(vi) *histone – protein which together with a DNA molecule makes up a chromosome. DNA is wrapped around histone molecules.*
(vii) *mDNA – the DNA which is present in the mitochondria which enables mitochondria to divide independently of the nucleus and which controls the synthesis of enzymes associated with respiration.*
(viii) *nucleotide – the basic building block or subunit of a nucleic acid molecule (DNA, RNA). It consists of a nitrogenous base, a sugar molecule and a phosphate group.*
(ix) *prokaryote – a single-celled organism which has no membrane bounded organelles, e.g. bacteria and cyanobacteria.*
(x) *protein synthesis – the making of proteins which occurs on ribosomes by joining amino acids together to form a long chain.*

Review Questions

1. *A – nitrogenous base*
   B – phosphate group
   C – ribose sugar.
2. *(i) Nucleotide (ii) Found in nucleoplasm.*
3. *Cytosine, guanine, adenine, thymine.*
4. *If A is cytosine*
   Then B is guanine
   If C is thymine
   Then D is adenine
5. *The sequence of nitrogenous bases in DNA is important because it provides a code which determines the sequence of amino acids in the proteins the cell can synthesise.*
6. *Nucleus, mitochondrion and chloroplast.*
7.
(i) *Mitochondrial DNA (mDNA) directs the production of several enzymes which are needed in cellular respiration.*
(ii) *Chloroplast DNA (CpDNA) contains genes associated with protein synthesis and photosynthesis*
8. *The DNA molecule is wound around clusters of 8 histone molecules as shown. This forms a long chain that resembles a necklace of beads.*



9. *When a cell divides in mitosis, two identical cells are produced from the original cell. Each has the same number of chromosomes (and the same amount of DNA) as the parent cell. Therefore the DNA must replicate before mitotic division occurs. In meiosis, four gametes are produced, each has one full set of chromosomes (one of each homologous pair). Therefore, there needs to be a doubling of the DNA before meiosis begins also.*
10.
(i) *The molecule appears to have 'unzipped' along its length. The matching nitrogenous bases have become separated.*
(ii) *'Free' nucleotides which are present in the nucleoplasm are attracted to their corresponding exposed nitrogenous bases and are attaching to the unzipped DNA halves.*
(iii) *Each new DNA molecule is identical to the original DNA molecule and identical to the other copy.*
Each is held to the other identical copy by a protein molecule called the 'centromere'.
(iv) *Replication.*
(v) *They replicate during 'interphase' so that when chromosomes begin to appear in the early prophase at the beginning of both mitosis and meiosis, the amount of DNA has been doubled.*
(vi) *(a) 46, 46 (b) 23, 23, 23, 23*
11.
(i) *Hydrogen bonds between the complimentary nitrogen bases.*
(ii) *Hydrogen bonds are weak – however because there are many bonds, the DNA molecule is relatively stable.*
(iii) *Each bond can be broken and the two DNA strands can therefore separate to enable replication to occur.*

1.3 PROTEINS AND PROTEIN SYNTHESIS

Terminology

(i) *amino acid – the basic organic molecular unit which when linked in a chain forms a protein molecule. Amino acids contain nitrogen.*
(ii) *enzyme – a protein molecule which acts as an organic catalyst by lowering the activation energy of a reaction.*
(iii) *mRNA (messenger RNA) – a nucleic acid formed in the nucleus of a cell which carries a code from a DNA molecule through a nuclear pore to a ribosome and from which a particular protein molecule is assembled according to the code which it carries.*
(iv) *polypeptide – a long chain of approximately one hundred amino acids.*
(v) *protein – an organic compound containing carbon, hydrogen, oxygen, nitrogen and sometimes sulphur. Proteins are made up of long chains of amino acids (more than one hundred) joined by peptide bonds. Proteins*

are essential components of cells being used for structure and enzymes.

(vi) *ribosome – an organelle, which is either attached to the endoplasmic reticulum or free in the cytoplasm, on which protein synthesis occurs.*

(vii) *structural proteins – proteins that provide mechanical support especially in eukaryotic cells. they are also involved in moving organelles (e.g. microtubules) and the movement of cells (e.g. actin in muscle cells).*

(viii) *transcription (DNA transcription) – the copying of part of a DNA molecule by the formation of mRNA.*

(ix) *translation (DNA translation) – the process in which tRNA carry amino acids to the mRNA on the ribosomes so that a particular protein is synthesised according to the DNA code.*

(x) *tRNA (transfer RNA) – a nucleic acid which transports free amino acids in the cytoplasm to the ribosomes where the amino acids are linked to form proteins. Specific tRNA molecules lock onto each amino acid and transport it to a particular part of the mRNA, on the ribosome, which has a codon matching the anti-codon on the tRNA.*

Review Questions

1. *Enzymes (biological catalysts); structural components of the body (such as muscles, hair); some hormones; haemoglobin in red blood cells; antibodies; carrier proteins involved in facilitated diffusion and active transport of substances through the cell membrane.*

2.

(i) *D̲eoxyribon̲ucleic a̲cid, R̲ibon̲ucleic a̲cid*

(ii) *DNA is a twisted ladder shape – a double helix. The backbone of the ladder is made up of alternative deoxyribose sugar molecules and a phosphate molecule. Between each pair of sugar molecules is a pair of nitrogenous bases, forming the 'rungs' of the ladder. These bases bond in a particular way- always adenine and thymine together, guanine and cytosine together. The group composed of a deoxyribose sugar molecule, a phosphate group and a nitrogenous base is known as a nucleotide. DNA is found as chromosomes in the nucleus of a eukaryotic cell and in mitochondria, or in the cytoplasm of a prokaryotic cell. It is capable of replication and is a more stable molecule than RNA.*

RNA is made up of a single strand of nucleotides. Each nucleotide consists of a ribose sugar molecule, a phosphate group and a nitrogenous base (adenine, guanine, cytosine or uracil).

(NOTE: uracil replaces thymine). RNA is found in the nucleus, cytoplasm and in ribosomes.

3. *(See next page).*

4.

TRANSCRIPTION	TRANSLATION
• occurs inside the **nucleus**. • is the process that copies the code on part of the **DNA** onto a strand of mRNA. • the **DNA** molecule unwinds and one strand of the helix is used as a template. • an enzyme (**RNA polymerase**) joins **nucleotides** together to form a strand of messenger-RNA. • the sequence of bases on mRNA is complimentary to the sequence of bases on the strand of **DNA**.	• occurs in the **cytoplasm**. • is the process in which **amino** acids are assembled to form proteins. • **mRNA** leaves the nucleus and moves into the cytoplasm. • mRNA attaches onto a **ribosome**. • the anticodon on **tRNA** attaches to the **codon** on the mRNA. • the amino acids from the tRNA are linked together to form the amino acid chain or **protein**.

5. *It is a triplet because three bases specify each amino acid. It is degenerate because most of the 20 possible amino acids are determined by more than one codon.*

6.

(i) *(a) met(START)- his- gly- lys- ile- leu- asp- STOP*

(b) gly-his-ile-val-ile-STOP

(ii)

STRAND OF DNA THAT IS 'READ'	TRANSCRIBED mRNA STRAND	tRNA ANTICODONS
G G G T A G T T A	C C C A U C A A U	G G G U A G U U A

(iii) *pro – ile – asp (Remember: read the code from the mRNA!)*

(iv) *(a) A start codon is the codon of a messenger RNA where translation by a ribosome begins.*

(b) If translation were to begin at a different codon, the synthesized protein would be different and therefore not necessarily required by the cell.

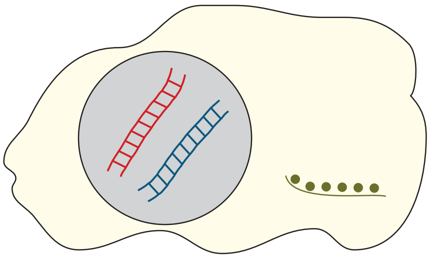
(c) AUG

(v) *A stop codon determines where on the mRNA molecule translation by the ribosome should cease.*

7. (i) *Introns are regions of nucleotides within a gene which do not code for proteins, exons are sequences of nucleotides which do code for proteins.*

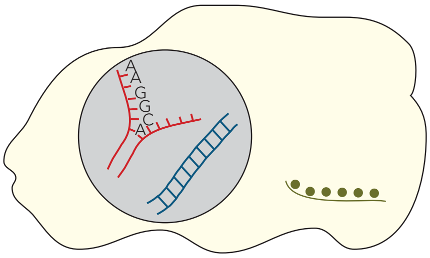
3.

(a)



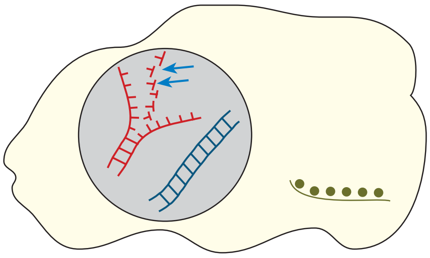
Chromosomes are in their normal condition in the nucleus. Ribosomes are located on endoplasmic reticulum (or free in the cytoplasm).

(b)



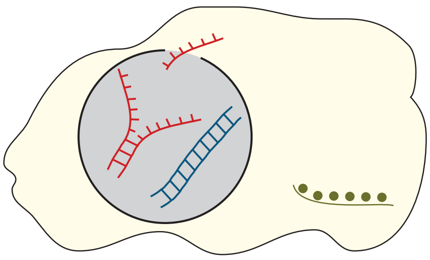
A section of the DNA unzips, exposing a number of nitrogenous basis (in this example AAGGCA).

(c)



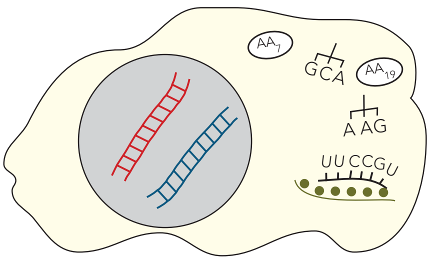
Free nucleotides which are in the nucleoplasm move to the exposed nitrogen bases. mRNA forms along the exposed section of DNA (this is called transcription). Note: the uracil (U) nucleotide replaces the thymine (T) nucleotide in the formation of mRNA.

(d)



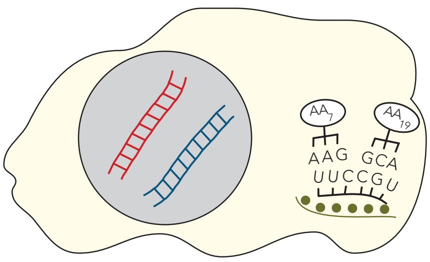
The introns are removed and the mRNA then moves out of the nucleus through a nuclear pore to a ribosome. (The nuclear pores are too small to allow DNA molecules to escape).

(e)



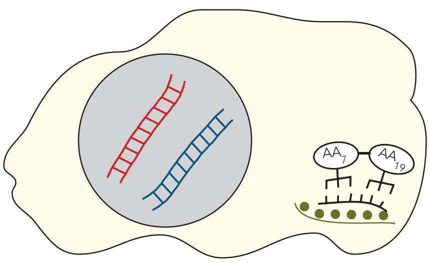
The mRNA is 'read' by the ribosome and acts like a template on the ribosome. Transfer RNA (tRNA) molecules bond to specific amino acids and carry them over to their matching exposed nitrogenous bases (this is called ***translation****). The anticodons on the tRNA match the codons on the mRNA.*

(f)



A specific amino acid (numbered 7 in the diagram) is brought by the tRNA to the beginning of the mRNA molecule shown. The next amino acid (here numbered 19) is brought by a second tRNA and positioned next to amino acid 7.

(g)



A chemical bond forms between the amino acids (called a peptide bond). In this example two amino acids are joined to form a dipepide molecule (proteins have at least 100 amino acids). Longer peptides and proteins require a much longer mRNA molecule and therefore a greater length of DNA molecule to unzip.

(ii) Following the transcription of a sequence of nucleotides, the mRNA contains both introns and exons. Before leaving the nucleus and before translation by ribosomes, the introns are removed, the remaining exons are joined together and proceed to the ribosome for translation.

1.4 Genes and genotypes

Terminology

(i) crossing over – the exchange of genes which often occurs between two homologous chromatids during metaphase I of meiosis. It results in greater variation in the offspring than would be expected.
(ii) fertilisation – the fusion of two gametes to produce a zygote during sexual reproduction.
(iii) genotype – the genetic makeup of an organism for a particular trait, e.g. Tt
(iv) mutagen – any agent which induces mutations, e.g. radiation, synthetic auxin (2,4-D and 2,4,5-T, used as herbicides).
(v) mutant – an organism which shows a mutation.
(vi) mutation – a sudden change to genetic material which may make an organism notably different from its parents. Where the change occurs in the genes in gametes it may be inherited by offspring.
(vii) non-disjunction – when homologous chromosomes fail to separate during the anaphase of cell division. Some resulting cells have extra chromosomes and some cells have fewer chromosomes than the normal haploid number.
(viii) phenotype – the expression of a particular genotype. Phenotype may also be influenced by the environment.
(ix) random assortment of chromosomes – the pairing of homologous chromosomes that occurs during the first prophase of meiosis. It occurs such that the chromosomes have either the maternal or the paternal chromosome on either side in an unbiased arrangement.
(x) variation – a feature or characteristic which is different within a species. Variation in the offspring of sexually reproducing organisms is greater than that found in the offspring of asexually reproducing organisms.

Review Questions

1. An organism's genotype is not visible. It consists of the genes or the arrangement of nitrogenous bases on chromosomes that the organism possesses for a particular feature. The phenotype may be visible, although physiological characteristics like blood group are only measurable. Some phenotypic traits may be influenced by the environment (e.g. skin colour) but others (e.g. eye colour) are not.

2. e.g. dog
(i) heredity: maximum number of teeth, eye colour, head shape, number of legs, hair length.
(ii) heredity and environment: intelligence, weight, size, resistance to disease, wear on teeth, claw length.

3.
(i) (This is one of several possible hypotheses) Jarrah trees growing on the coastal sand are spindly and shorter than the less branched and taller Jarrah trees of the Darling Scarp because the soil in the Darling Scarp is richer in nutrients than the soil of the coastal plain.
(ii)
- *Collect soil from both sites – many random samples.*
- *Measure the nutrient content of each.*
- *Compare the amounts of various minerals in each.*

(Note: Your findings might support the hypothesis however soil may be only one factor/variable of influence).

4.
(i) The pink flowering Hydrangea has a phenotype which can be influenced by the soil nutrients, but the white flowering Hydrangea has a phenotype which is not influenced by soil nutrients.
(ii) Remove the aluminium sulphate from the soil in which it is growing.
(iii) Very impractical. The disturbance of the soil, which would be required, is very likely to be detrimental to the plant and kill it.
(iv) Raise the pH level of the soil (thus preventing the uptake of aluminium) may change the flower colour from blue to pink.
(v) No. From the evidence given the white phenotype is determined by its genotype and this is not influenced by the aluminium sulphate in the soil.

5.
(i) ***Mammals***
- *50% of sperm carry an X chromosome*
- *50% of sperm carry a Y chromosome*
- *100% of ova carry an X chromosome*
- *If an X carrying sperm fertilises an X ovum a female (XX) is produced*
- *If a Y carrying sperm fertilises an X ovum a male (XY) is produced*

(ii) ***Birds***
- *50% of ova carry a Z chromosome*
- *50% of ova carry a W chromosome*
- *100% of sperm carry a Z chromosome*
- *If a Z carrying ovum is fertilised by a Z carrying sperm a male (ZZ) is produced*
- *If a W carrying ovum is fertilised by a Z carrying sperm a female (ZW) is produced*

6.

(i) *The sex of the offspring is not genetically determined. The sex of these reptiles is determined by the incubation temperature. When eggs are incubated at a lower temperature they produce males. When eggs are incubated at a higher temperature they produce females.*

(ii) *Incubate the eggs at various temperatures above and below that which is normally experienced in the ground where they reproduce. Observe and record the sex of the offspring produced at these various incubation temperatures.*

(iii) *Warmer and cooler temperatures may produce females. Temperatures which are in between may produce males, e.g. at less than 25°C (outer zone) → females produced, at more than 30°C (inner zone) → females produced, at 25-30°C (middle zone) → males produced. Again the sex is temperature dependent but different from the reptiles in (i). The reptiles' chromosomes and genes do not determine their sex.*

7. *Every cell in an organism is identical genetically but only some of the genes are active in a specific cell type. The end result of the active gene(s) is the "expression" of the gene(s) and determines the function (phenotype) of that cell. Consequently, the phenotype of organism is the total sum of all the gene activity of that organism.*

8. *Mutation and disease.*

9.

(i) *The effect of ultraviolet light on melanin production.*

(ii) *The effect of diet on adipose tissue.*

10. *Melanocytes are cells in the skin that produce melanin, a pigment that gives the skin its colour. When skin is exposed to sunlight, the ultraviolet light in it stimulates the melanocytes to produce melanin pigment. This then absorbs the UV light and protects the cells.*

11. *Meiosis is the cell division which reduces the number of chromosomes in the daughter cells (gametes) to one half – only one of each homologous pair of chromosomes is found in each gamete. This occurs so that the zygote, which may result from the fusion of two gametes, will have the normal number of chromosomes for that species.*

12. *Variation in offspring results partly from the fact that when fertilisation occurs, each sperm type that is produced has an* ***equal*** *likelihood of fertilisation and each* ***ovum*** *type that is produced also has an* ***equal*** *likelihood of fertilisation.*

The way in which individual organisms meet is generally a ***random*** *process which therefore creates variation.*

13.

(i) *During the first division of meiosis, at metaphase I, chromatids may overlap and exchange part of their genetic material. An exchange is evident in anaphase I. During the second division, the chromatids are separated as normal and four gametes are formed. It is clear that two gamete types are normal, however two gametes show chromosomes that have combinations of genetic material that are not present in either parent. If either of the new chromosomes is involved in the formation of a zygote, genes that may not usually be inherited together may be inherited by the new individual. Genes that are normally linked and inherited together have separated and been linked to different genes. This will cause variations in the offspring.*

(ii) *The diagram shows a cell with a diploid number of 4 (2 pairs). In (a) the chromosomes have arranged themselves so that the paternal chromosomes are in line on the left and the maternal chromosomes are in line on the right. However because this arrangement is random, another parent cell may show the assortment of the chromosomes as in (b).*

These diagrams show therefore that gametes will carry different combinations of maternal and paternal chromosomes. There are 4 types of gametes produced by this parent cell which has a diploid number of 4. The number of different gametes can be calculated using the formula:

No. of gametes types $= 2^N$

where N is number of pairs

Here, No. of gamete types $= 2^2$

$= 4$

In humans, the number of pairs is 23.

Therefore, No. of gamete types $= 2^{23}$

$= 8{,}388{,}608$

(Check this calculation on your own calculator).

This shows that each individual person, without any other change like crossing over occurring during meiosis, produces over eight million different gamete types. Therefore the chance of a couple producing two genetically identical children, unless they are monozygotic twins, is very, very small.

(iii) *This shows the spindle has not successfully separated the homologous pairs of chromosomes in anaphase I. This has resulted in some gametes having an extra chromosome and others having one chromosome too few. If a zygote has more or less than the normal number of chromosomes, this may result in the development of an individual who is different from his/her parents. This is what causes Down Syndrome in humans.*

(iv) They all result in variations in the offspring. They may make offspring different from their parents and different from other offspring.

14. Variation in offspring results from the fact that when fertilisation occurs, each sperm type that is produced has an ***equal*** *likelihood of fertilisation and each* ***ovum*** *type that is produced also has an* ***equal*** *likelihood of fertilisation.*

The way in which individual organisms meet is also a ***random*** *process which therefore creates variation. If blondes were only attracted to blondes, there would be less variation in hair colour in human populations.*

15.

(i) A mutation is a random change to a gene or a number of genes or a whole chromosome. If the change occurs in gametes it can be inherited by offspring. If the change occurs in a somatic cell, it is not inherited. However, the latter mutation could be harmful, as it is in the case of cancer.

(ii) Because mutations are random and occur to genes or chromosomes in normal healthy cells they have an extremely high probability of making the gene or chromosome less functional.

(iii) Mutations are caused by chemicals (e.g. mustard gas, some pesticides, some drugs), radiation (e.g. x-rays, radioactivity) and sudden rises in temperature.

(iv) Mutations add to the number of variations within a population increasing its genetic biodiversity.

16. Those organisms that reproduce sexually must produce gametes by meiosis first. The likelihood of 'mistakes' occurring during meiosis is much greater than in mitosis. Therefore, sexually reproducing organisms show greater variation in their offspring. Random combinations also create variation in sexually reproducing organisms.

17.

(i) (a) Insertion
(b) Deletion
(c) Substitution
(d) Inversion

(ii) Each of these mutations causes a change in the DNA code. They will result in the sequence of amino acids being assembled at the ribosomes being different from the normal sequence. Therefore the protein synthesised will be different and this is likely to affect the organism's chemical metabolism and/or structure.

(iii) When a mutation occurs to a segment of DNA on one homologous chromosome, the corresponding DNA on the other homologous chromosome is unlikely to be affected. The normal DNA will be expressed in the organism and the mutant gene hidden or masked by the normal gene. Mutant genes are generally recessive.

1.5 Patterns of inheritance

Terminology

(i) allele – alternative form of a gene which occurs at the same locus on homologous chromosomes.

(ii) autosome – a chromosome which is not a sex chromosome.

(iii) codominance (or incomplete dominance) – when two different alleles are present in an organism but neither is dominant. Both genes are expressed, e.g. group AB, in the ABO blood grouping, results from the genotype I^AI^B, where both the gene I^A and the gene I^B are expressed.

(iv) dominant gene – an allele expressed by a heterozygote, which hides or masks another allele.

(v) gene frequency – the proportion of a particular allele in a population.

(vi) multiple alleles – more than two genes, any of which may occupy the same locus in a chromosome.

(vii) polygenic trait – a feature in an individual organism that is controlled by more than one pair of genes.

(viii) probability – a number ranging from zero to one which expresses the likelihood of an event occurring.

(ix) recessive gene – a gene which is not expressed in the heterozygote. A recessive gene is hidden due to the expression of the allele for the dominant gene.

(x) sex-linked – refers to genes which have their loci on sex chromosomes. In mammals this refers to genes on the X chromosome only.

Review Questions

1.

(i) Inheritance controlled by genes on the autosomal chromosomes. These chromosomes are described as non-sex chromosomes. (In humans they are numbers 1 to 22).

(ii) Inheritance controlled by genes on the X chromosome.

2.

	Total number of autosomal chromosomes in each somatic cell	Type of sex chromosomes in each somatic cell	Total number of chromosomes in each somatic cell
Female	44 (22 pairs)	XX	46 (23 pairs)
Male	44 (22 pairs)	XY	46 (23 pairs)

3.

(i) Woman Rr Man rr

(ii)

Man

Woman	r	r
R	Rr	Rr
r	rr	rr

(iii) Right handed : Left handed = 1:1

(iv) Expected: Two right handed and two left handed.

(v) The observed ratios do not always match the expected ratios due to the laws of probability and the small sample size.

4.

(i)

Blood Group	Possible Genotypes
A	I^AI^A or I^Ai
B	I^BI^B or I^Bi
AB	I^AI^B
O	ii

(ii) 4 (iii) 6 (iv) I^Ai and I^Bi (v) I^AI^B

(vi) ABO blood grouping is described as "multiple allelic" because more than two alleles can occupy the particular chromosome locus that determines blood grouping in this system. That is the locus may be occupied by one of I^A, I^B or i.

5.

(i) Man, group O : genotype ii
Woman, group O : genotype ii

∴ Parents : ii × ii

Man

Woman	i	i
i	ii	ii
i	ii	ii

This shows the probability of a couple having a group B child is zero, i.e. P(child group B) = O.

(ii) Woman, group O: genotype ii
Man, group B: genotypes I^BI^B or I^Bi
If parents are ii × I^BI^B

Man

Woman	I^B	I^B
i	I^Bi	I^Bi
i	I^Bi	I^Bi

∴ Probability (child with group A) = O.
If parents are ii × I^Bi

Man

Woman	I^B	i
i	I^Bi	ii
i	I^Bi	ii

∴ Probability (child with group A) = O.
(Either way, there is a zero probability of them having a child with group A).

(iii) Man, group AB: genotype I^AI^B.
Woman, group B: genotypes I^BI^B or I^Bi.
If parents are I^AI^B × I^BI^B

Man

Woman	I^A	I^B
I^B	I^AI^B	I^BI^B
I^B	I^AI^B	I^BI^B

∴ Probability (child will be A) = O.
If parents are I^AI^B × I^Bi

Man

Woman	I^A	I^B
I^B	I^AI^B	I^BI^B
i	I^Ai*	I^Bi

** (Child with I^Ai genotype is group A.)*

∴ Probability (child will be group A) = ¼.

(iv) Man group B: genotype I^Bi (not I^BI^B as one of his parents is ii)
Woman group A: genotype I^AI^A

		Man
	I^B	i
Woman I^A	$I^A I^B$	I^A i
I^A	$I^A I^B$	I^A i

Ratio of genotypes: I^AI^B : I^Ai = 1:1
Ratio of phenotypes:
Group AB : Group A = 1:1

6. (i) *Man, genotype* X^bY
Woman, genotype X^HX^H
(not X^HX^b *as there is no history of haemophilia in her family)*

		Man
	X^h	Y
Woman X^H	$X^H X^h$	X^HY
X^H	$X^H X^h$	X^HY

∴ *Genotypic ratio:* $X^HX^b : X^HY$ = 1:1
Phenotypic ratio: female normal (but 'carrier') : male normal = 1:1

(ii) *Woman, genotype* X^HX^b
Man, genotype X^HY.
∴ *parents are* $X^HX^b \times X^bY$.

		Man
	X^H	Y
Woman X^H	$X^H X^H$	X^hY
X^h	$X^H X^h$	X^hY

Probability (child has X^bY*) = ¼.*

7. *The 'test cross' means crossing the organism of the dominant phenotype with an organism with the recessive phenotype (i.e. homozygous recessive organism).*
Here we want to discover whether the organism is AA or Aa, so we cross it with aa (an albino). This is called the 'test cross'.
If the animal is AA, then the cross will be:

	A	A
a	Aa	Aa
a	Aa	Aa

∴ *all the offspring will have genotype Aa*
∴ *all will appear with normal colour.*

If the animal is Aa, then the cross will be:

	A	a
a	Aa	aa
a	Aa	aa

∴ *½ the offspring will have genotype Aa, ½ will have genotype aa.*
∴ *½ will be normal colour and ½ will be albino.*
If after producing many offspring no albinos result, the test cross suggests that the animal is probably homozygous. However, if just one albino offspring results, the animal must be heterozygous.

8.
(i) *Since I 1 and I 2 give rise to II 2, the shaded characteristic must be recessive. If it were dominant I 1 or I 2 would have to have the condition.*
Since II 2 is female it cannot be sex-linked, because if it were I 1 would have the characteristic.
Therefore it is recessive and autosomal.
(ii) *It is recessive because, for example, II 4 and II 5 do not show condition but III 4 and III 5 do. It may also be sex-linked as only males in the pedigree inherit the condition.*
I 1 may therefore have genotype
X^bY *where b = condition*
None of his sons would have the condition, if I 2 has the genotype X^BX^B*. All his daughters II 3 II 4 and II 6 would be "carriers"* X^BX^b*. III 4, III 5 and III 8 could then be* X^bY.
∴*The most likely mode of inheritance is recessive and sex-linked.*
(iii) *This condition is dominant, because II 1 and II 2 both have the condition but III 1 does not. It cannot be recessive.*
It is not sex-linked because II 2 would have to be X^BY *(where B is the dominant gene), and he would have to have acquired the* X^B *from I 2 (his mother), then she would have to be either* X^BX^B *or* X^BX^b *which she clearly is not (as she does not show the condition).*
It is dominant and autosomal.

9.
(i) (a) *Recessive and autosomal.*
(b) *It appears to be recessive as individuals II 4 and II 5 are not bald but have offspring some of which are bald (IV 1 and 2 confirm this). It appears to be autosomal as individuals IV 1 and IV 2 are normal but have female offspring V2 who is bald. If this was a sex-linked trait, male individual IV 2 would have to be bald too.*

(ii) *Key: Let B = normal hair gene*
b = bald gene
I 1 Bb, 2 bb
II 1 Bb, 2 bb, 3 Bb, 4 Bb, 5 Bb
III 1 bb, 2 bb, 3 BB/Bb
IV 1 Bb, 2 Bb, 3 Bb
V 1 BB/Bb, 2 bb, BB/Bb

(iii) *twins II 1 and II 2 and III 1 and III 2.*

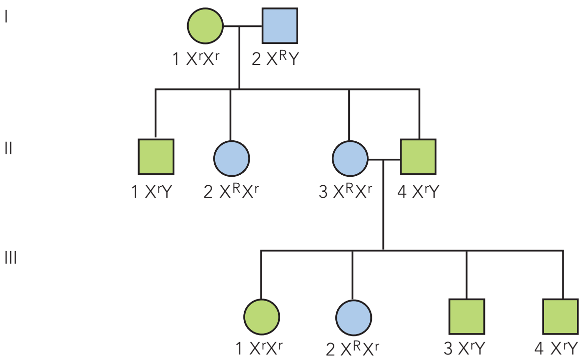
(iv) *monozygotic III 1 and III 2*
dizygotic II 1 and II 2

(v) *From V 2's parents, but they received the genes from individual III 2 since they were siblings.*

10.

(i) *This gene is dominant (most defective X-linked genes are recessive).*

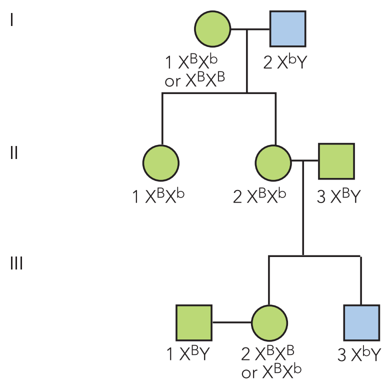
(ii) *Key: Let X^R = gene for rickets*
X^r = gene for normal development



(iii) *I 2 (her father)*

(iv) *More females would be expected to inherit this dominant disease as they have two X chromosomes (and therefore two chances to inherit the rare disease) whereas males have only one X chromosome (and therefore have only one chance to inherit it).*

11. (i)



(ii) *If III 2 is X^BX^B then:*

Man

Woman

	X^B	Y
X^B	X^BX^B	X^BY
X^B	X^BX^B	X^BY

OR if III 2 is X^BX^b then:

Man

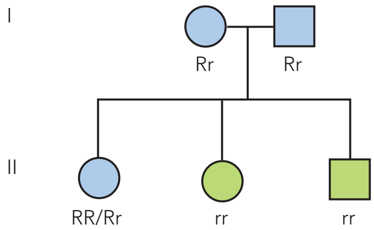
Woman

	X^B	Y
X^B	X^BX^B	X^BY
X^b	X^BX^b	X^bY

$\therefore$ *probability of X^bY = 0 or ¼*
X^BY = ½ or ¼
X^BX^B = ½ or ¼
X^BX^b = 0 or ¼
X^bX^b = 0 or 0

12.

(i)



(ii) *Parents genotypes Rr × Rr*

Man

Woman

	R	r
R	RR	Rr
r	Rr	rr

$\therefore$ *P (child is RR or Rr) = ¾ (0.75)*
$\therefore$ *P (child will have condition) = ¾ (0.75)*

(iii) *P (Child is RR or rr) = ½*

(iv) *P (RR) = $^1/_3$*

(v) *P (rr) = 1*

13.

(i) *The man could produce the following gametes – abC and abc*
The woman could produce the following gametes – ABC, AbC, aBC, abc

(ii) *The possible genotypes of children from this union for height are:*
AaBbCC, AaBbCc, AabbCC, AabbCc, aaBbCC, aaBbCc, aabbCC, aabbCc

		Woman ABC	AbC	aBC	abC
Man	abC	AaBbCC	AabbCC	aaBbCC	aabbCC
	abc	AaBbCc	AabbCc	aaBbCc	aabbCc

(iii) There are eight (8) different genotypes.

(iv) In a large family there could be many variations in height.

(v) A trait is likely to be polygenically controlled if there is great variation in the phenotypes within a population and where such variations form a continuum, e.g. height, skin colour.
Where the phenotypes are discontinuous and there is little variation, it is probably a monogenetic trait that is controlled by just genes on one locus, e.g. blood groups in the ABO system.

1.6 DNA sequencing, DNA profiling and applications of DNA technologies

Terminology

(i) DNA profiling – identification of an individual organism from part of its DNA (also called DNA fingerprinting).

(ii) DNA sequencing – any method used to determine the order of nucleotides (A, C, G and T) in a DNA molecule.

(iii) gel electrophoresis – a technique used to separate DNA fragments (also RNA and proteins) which uses an electric field and a gel (agarose).

(iv) gene cloning – making many copies of a particular gene. This can be achieved through recombinant DNA technology and PCR.

(v) gene vector – a means of transferring genes from one organism to another, e.g. agrobacteria, plasmid molecule.

(vi) genome – one complete set of chromosomes and their genes.

(vii) ligation (DNA) – joining the 'sticky' or the 'blunt ends' of DNA fragments together using ligase. The latter joining requires a much greater concentration of ligase.

(viii) polymerase – an enzyme which catalyses the formation of DNA using a single strand of DNA as a template and linking matching nucleotides to this original strand.

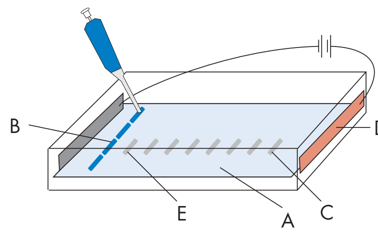
(ix) restriction enzyme – an enzyme which cuts DNA at a particular base sequence (called the recognition site). Different restriction enzymes have different recognition sites.

(x) transgenic organism – an organism which has an altered phenotype as a result of its genetic modification.

Review Questions

1. *This means determining the sequence of nucleotides along the chromosomes of the species so that the location of each gene on its chromosomes can be found.*
2.
- *A DNA molecule is dissociated so that two separate single strands are formed*
- *Free nucleotides of all four bases are added to the strands to grow new double strands.*
- *However some of one of the four bases added are defective (they lack the OH group necessary for the next base to attach to the growing strand so that they prevent further elongation of a strand).*
- *The free nucleotides join their complimentary bases on the single strand but where a defective base joins the strand the strand stops elongation.*
- *Many different DNA fragments are formed each terminating at the base with the defect (except for one strand type which will be complete with any of the four bases at its terminus).*
- *The fragments are separated by gel electrophoresis, the DNA fragments will form bands according to their length.*
- *From the banding the locations of one of the four bases along the DNA sequence can be determined.*
- *The same procedure is repeated for each of the other three bases until the sequence of all four bases is determined and the chromosome is mapped.*

3. *(i)*



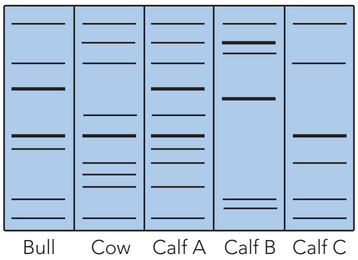
(ii) To separate DNA fragments in order to identify the DNA's source to provide a DNA profile.

(iii) The DNA moves through the gel because of the positive and negative terminals placed on opposite ends of the gel. The DNA fragments are attracted to the positive terminal and repelled by the negative terminal.

(iv) A negative charge. The fragments of DNA move towards the positive terminal.

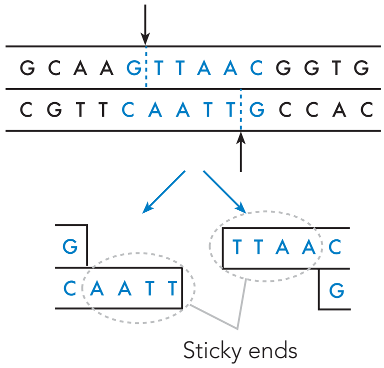
(v) The smaller DNA fragments move more quickly through the gel than the larger DNA fragments.

(vi) Calf B. It has DNA fragments which are not evident in the DNA profiles of the bull or the cow.



4.

(i)



(ii) See diagram above.

(iii) They are called sticky because they can readily join complimentary single strands of DNA from another source.

(iv) Restriction enzymes occur naturally in bacteria.

5.

(i) A gene probe is used to find a sequence of bases that make up part of a particular gene and it is therefore used to locate a particular gene.

(ii) T A A G C A T G G C

(iii) The probe needs to be fluorescent or radioactive.

(iv)

- DNA is extracted from the cell.
- The strands of DNA are separated.
- The probe is added to the mixture.
- The mixture is allowed to cool.
- If the probe has attached to the DNA, this indicates the presence of a particular gene.

(v) It may be used to determine whether an organism has a particular disease gene. It can also be used to make a map of the loci of particular genes on an organism's DNA.

6. The use of genetic probes involves connecting segments of DNA from different sources.

7.

(i) A plasmid is a doughnut shaped DNA molecule found in many bacterial cells, which is not part of their own chromosomal DNA.

(ii) The bacteria (or virus) injects its DNA (including the plasmid) into a host cell nucleus.

(iii) The bacteria or virus is called a 'vector' in this situation.

(iv) A bacterium which has a recombinant gene spliced to its plasmid, will replicate its entire DNA, including the recombinant gene, each time it divides. Therefore, if kept in optimum conditions, millions of copies of the gene can be made in a very short period of time (bacteria divides approximately once every 20 minutes).

8.

(i) **Gene cloning** entails the production of many copies of a particular gene. To reproduce copies of a particular gene the following steps are taken

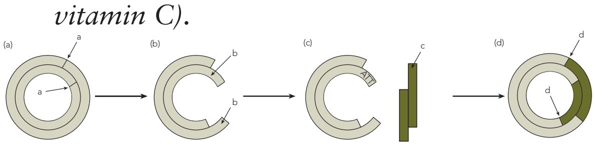
- a section of DNA which contains the gene is removed from a chromosome using restriction enzymes
- a plasmid is cut using the same restriction enzymes
- using ligase enzymes, the section of DNA is then joined to the cut plasmid at its sticky ends
- the recombinant DNA is then fused into the bacterial cell, its host cell
- under optimum conditions, the host cell begins to divide, making copies of both its normal DNA and its recombinant plasmid DNA. In so doing the gene is copied and sufficient amounts of it become available for use in research or industry.

(ii) **DNA profiling (or DNA fingerprinting)** Most of the DNA possessed by complex organisms of the same species is identical. However, each organism has a small amount of DNA (about 0.1%) which is unique. It is this small amount called the polymorphic fragments which enable scientists to distinguish one organism within a species from another.

- To compare these fragments of unique DNA and provide a DNA profile of an individual organism a process called Restriction Fragment Length Polymorphism (PFLP) is used;
- DNA is firstly obtained from the organism. This in humans for example may entail a mouth swab, a sample of cells taken from the mouth which then have their DNA extracted.
- Restriction enzymes are then used to cut the DNA into small fragments – all the DNA is fragmented – both polymorphic fragments and non-polymorphic fragments are created.
- Electrophoresis is then used to separate all the fragments.
- The fragments are transferred to a very thin nylon sheet which is laid over the gel. The sheet is called the "blot" as it absorbs the fragments like blotting paper absorbs ink.
- Radioactive synthetic DNA (called DNA probe) is added to the blot. This is designed to attach only to the polymorphic fragments.
- Radiation sensitive film placed over the blot will then provide a lined pattern which indicates the position of the polymorphic fragments – it is this lined pattern which is unique to the organism and is the DNA profile of that organism.

9. (i) A restriction enzyme
(ii) 'Sticky ends'
(iii) T A A
(iv) A ligase enzyme
(v) The bacterium has a gene which it did not previously have. Therefore it may synthesise a protein which a normal unmodified bacterium would not synthesise.

10. To change the genotype of a plant, a section of its DNA (a gene) needs to be changed. If the change occurs in a gamete or a zygote, it may be inherited.
A cell may have a gene replaced or a gene added to its DNA.
For example, a section of DNA that codes for a protein which helps synthesise vitamin C may be removed from an orange plant cell and transferred to say a plum seed cell (so that the plums produced contain more vitamin C).



To transfer the gene, two methods are used:
a) Biological ballistics (biolistics) involves firing tiny particles of gold or tungsten which have been coated with the DNA into the cell nucleus of the recipient cells.
b) A bacterium which infects many plant cells may be used. The bacterium (**Agrobacterium**) normally transfers some of its own DNA to host plants.
If the DNA which it normally transfers to the host is removed and replaced by foreign DNA, the bacterium then transfers this new DNA to the host cell. This is sometimes called the '**Agrobacterium**-mediated gene delivery system'.

11.
(i) Genetically modified plants may be engineered to:
a) resist disease
b) resist herbicides
c) grow in adverse conditions, e.g. high salinity, dry, hot climates.
Therefore, they may provide more reliable and greater quantities of food for the growing human population.
G.M. organisms may also limit the need to clear more land for farming and assist in the conservation of threatened species.
(ii) Organisms may be created which have an adverse effect on the environment and in turn humans. The use of G.M. plants which are resistant to herbicides, may encourage the overuse of herbicides. Safe organisms may become toxic.

12. Allow the determination simultaneously of all the types of mRNA produced by a cell at any given time. Scientists can therefore determine which genes are "switched on" (and which are not) in the nucleus at any time during a cell's development.

13. To determine which **genes** are switched on in the nuclei of a particular cell type, the following procedure may be used.
(i) All the mRNA being produced by the cells' **DNA (or nucleus)** is extracted.
(ii) This mRNA is then copied to form **complementary DNA (cDNA)**.
(iii) The **cDNA** is "labelled" using a **fluorescent marker molecule.**
(iv) All the labelled cDNA is then placed on a **DNA microarray** or **DNA chip**. The microarray consists of rows of **DNA** probes, nucleotide sequences corresponding to particular **genes** in the cell's genome.
(v) The cDNA fragments **bind (or hybridise)** to their matching DNA probes on the microarray.
(vi) The position of the hybridised fragments on the microarray is determined by an automated **scanning-laser** microscope.
(vii) The fluorescent spots indicate which **genes** are switched **on** in the cells' nuclei.

14.

Stage (i) The section of DNA is transcribed so that a complementary mRNA molecule is formed.

Stage (ii) The mRNA is separated from other molecules in the cell's cytoplasm including other RNA molecules.

Stage (iii) Using the mRNA molecules, complementary DNA (cDNA) is synthesised with a flourescent molecule attached.

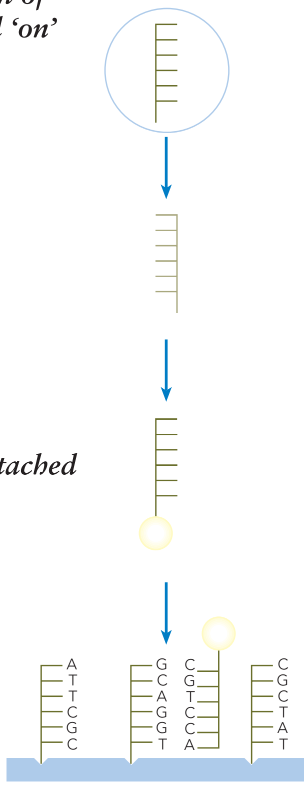
Stage (iv) The cDNA is placed on the microarray where it hybridises with a specific DNA probe. The DNA probe represents a particular gene which must be switched 'on' in the cell in stage (i) to produce the mRNA in stage (ii).

Stage (i): a small section of DNA which is switched 'on'

Stage (ii): mRNA

Stage (iii): cDNA with flourescent molecule attached

Stage (iv): cDNA attached to one of the three gene probes on microarray



15.
(i) A genetically modified organism (G.M.O.) is one in which a gene (or genes) have been changed in some way.
(ii) A gene can be substituted, altered, deleted or 'switched off'.
(iii) Genes are modified to produce more desirable traits in organisms.
(iv) a) A gene which produces a natural insecticide taken from soil bacteria can be spliced onto the DNA of cotton plants to produce insect resistant cotton.
b) A rat's gene that promotes the production of its growth hormone has been spliced onto the DNA of a mouse embryo, resulting in a much enlarged mouse. This could be useful in developing large livestock for human food. In a similar way, mice can be made to produce human growth hormone which can be extracted from the mice and used by humans who do not produce sufficient quantities of that hormone.
(v) Breeding two animals or plants to obtain offspring with the most desirable genes is a long process. Producing a population of animals or plants which have only the best genes takes many generations and depending on their lifecycle can be a very time consuming process. Genetic modification is more precise and can be achieved more quickly.

16.
(i) If the food crop is not sprayed with insecticide, then the consumer will not ingest insecticide contaminated fruit and vegetables.
(ii) The cost of spraying food crops with insecticides is very high.
The use of insect resistant crops therefore should reduce the farmers' cost of growing the food.
(iii) Many weeds grow in cereal crops, e.g. wheat, grown for food production. Because of the scale of these operations, the weeds cannot be removed by hand or by other physical means. Herbicides are therefore used. However care must be taken to avoid killing the crop and contaminating the soil and water. Herbicide resistant crops often require only one application of a herbicide to remove weeds from them. Less herbicide is used, which is a saving for the farmer and is also less polluting.
(iv) The 'antifreeze' gene spliced onto the DNA of the plants could prevent the crops spoiling during unusually cold weather in the growing season. The cost of 'frost damage' could be greatly reduced.
(v) Genes which control the production of those vitamins which are either low or absent in rice (e.g. vitamin A) can be spliced onto the DNA of rice plants to alleviate these problems.

17. G.M. plants may reduce farmers' use of pesticides (herbicides, fungicides, insecticides) on crops. In so doing, this may reduce the flow of these as pollutants into rivers which inevitably affect fish, frogs and other aquatic life.
G.M. plants which may more effectively use soil minerals and produce more nutritious foods require less fertiliser and fuel energy, thus reducing pollution of the soil, waterways and the air.
G.M. plants which are more drought tolerant may require less water use and less irrigation. The need to clear more forests and natural ecosystems in order to grow crops may be reduced by the use of G.M. plants and animals.

18.
(i) A vaccine is a weakened or dead strain of a disease causing microorganism (pathogen).
(ii) Vaccines are normally injected using a syringe (needle).
(iii) Transgenic fruit or vegetables which produce vaccines could be grown in the vicinity of those people who need them. The cost of transport, refrigeration and medical administration would be greatly reduced. The risk of infection due to contaminated syringes would also be eliminated.

19. The drugs can be produced more cheaply and in greater quantities than by the normal chemical means.

2. CONTINUITY OF LIFE ON EARTH

2.1 Evolution and the evidence for evolution

Terminology

(i) *anatomy – a branch of biology which involves the study of bodily structure.*

(ii) *common ancestor – where two or more species have evolved from the same organism, that organism is called their common ancestor.*

(iii) *comparative embryology – a branch of embryology that compares embryos of different species.*

(iv) *evolution – the gradual change in a species which occurs over thousands of years due to the cumulative effect of mutations and natural selection.*

(v) *fossil – a trace of an organism that has previously lived on the earth, generally found embedded in sedimentary rock.*

(vi) *fossil record – the fossils of a particular type of organism ranging in age which may indicate the organism's evolution in time.*

(vii) *genomics – the area of genetics involved in studying genomes, DNA sequencing and its use in biology.*

(viii) *paleontology – the scientific study of fossils*

(ix) *phylogenic tree – a diagram which shows the evolutionary development of organisms. It indicates when and where adaptive radiation has occurred and most recent common ancestors. Sometimes called an evolutionary 'tree of life'.*

(x) *vestigial organ – an organ which has little or no apparent use but which may have been functional (and usually larger) in an ancestral organism, e.g. coccyx and appendix in humans.*

Review Questions

1.

(i) *The theory of evolution is that species change, sometimes rapidly, sometimes slowly, as they become better adapted to their surroundings.*

(ii) *A theory is a hypothesis that has a large amount of evidence to support it but needs more evidence for it to be accepted generally as a law. The theory of evolution has a large amount of supporting evidence.*

2.

(i) *Comparative anatomy, e.g. the limbs of most vertebrates are built on the same basic plan. This suggests that a common ancestor possessed this limb structure, the pentadactyl limb.*

(ii) *Distributional studies: the location of present day and recently extinct large flightless birds, e.g. emu, ostrich, rhea, elephant bird, moa and cassowary suggests that they all evolved from a large flightless bird which inhabited a super continent which once consisted of South America, Australia, India, New Zealand, Africa and the Antarctica. Adaptive radiation occurred when these continents became separated through continental drift some 65 million years ago.*

(iii) *Embryology: the study of the embryos of the vertebrates shows that they have great similarities during their early development. They are very difficult to distinguish between – they have tails, 'gill slits' and similar shapes. This suggests that they possess a number of similar genes and it supports the notion that they have a common ancestor. It appears that they have evolved to suit particular environments.*

(iv) *DNA and Protein Analysis: the DNA and proteins which all living things possess suggest a common ancestry. The more closely related two animal or plant species appear, the more DNA and protein they share as a general rule – which supports the idea that they have a recent common ancestor.*

(v) *Palaeontology: the fossil record suggests that both the variety and the complexity of life on Earth has increased with time, since the first simple prokaryates appeared some 3½–4 billion years ago. The changes that appear to have taken place in the structure of some animals and plants is also almost completely represented in the fossil record (e.g. the horse).*

3.

(i) *A phylogenic tree.*

(ii) *Species D.*

(iii) *By comparisons of its anatomical, physiological, molecular and genetic features with those of all other organisms possible.*

(iv) *Species B, C and E.*

(v) *The duration of their existence on the earth.*

(vi) *Two species diverging from one species.*

(vii) *Adaptive radiation/speciation.*

(viii) *Species D.*

(ix) *Species E.*

(x) *Simple single-celled prokaryotes (probably heterotrophic organisms).*

4.

(i) *See diagram next page.*

(ii) *DNA hybridisation/Chemical hybridisation.*

(iii) *If the two species are closely related, the temperature required to separate the hybridised strands is likely to be closer to the 'DNA melting points' of their original DNA.*

(iv) *If the two species were distantly related, then the temperature at which the hybridised DNA separates (or melts) would be much lower than the melting point of the original DNA.*

(v) *There must be a close correspondence in the base pairs.*

(vi) Annealing.

(vii) If two species are very distantly related, there would be a low level of DNA hybridisation and the temperature necessary to separate the annealed hybridised DNA would be low.

(viii) During the annealing (stages c and d).

2.2 Mechanisms of evolution

Terminology

(i) allele frequency – the number of occurrences of an allele on a chromosome locus in a population (how often a particular allele is found in a population).

(ii) gene pool – the total set of genes in a particular population.

(iii) genetic drift – a random process in which the gene pool changes with time due to chance rather than natural selection. More likely to occur in small genetically isolated populations.

(iv) genetic variation – the number of different alleles in a population. The genetic variation of all the species in a community can be used as a measure of the community's biodiversity.

(v) natural selection – the process which leads to differential survival and reproduction of organisms which are better suited to their environment. It results in those better suited contributing proportionally more offspring to subsequent generations.

(vi) phenotype – the expression of a particular genotype. Phenotype may also be influenced by the environment.

(vii) population – a group of organisms of the same species living in the same place at the same time.

(viii) selection pressure – a factor present in the environment of a species which affects its survival.

(ix) sexual selection – the development of traits in either or both of the sexes of a species which is due to competition for mates.

(x) speciation – the evolution of two or more species from one original species. Often called adaptive radiation.

Review Questions

1.

(i) Natural selection is the process that results in differential survival rates and reproduction rates of organisms that are better suited to their environment. The better suited contribute proportionally more offspring to the following generations.

(ii) The survival of a species is always dependent on many factors in its environment. The presence of particular predators, diseases and competitors all impact on its likelihood of survival. A 'selection pressure' refers to any one of many variable factors which may affect the survival of a species, e.g. predatory birds affect the chances of survival of moth species, the predatory bird is a 'selection pressure' on the moth species.

(iii) (a) predatory bird
(b) antibiotic
(c) pesticide.

2 .

(i) – Crossing over during meiosis producing new combinations of genes;
– Random assortment of chromosomes during meiosis;
– Random fertilisation of gametes; and
– Mutations.

(ii) Competition for scarce resources in nature (e.g. food, shelter, mates), disease and predators.

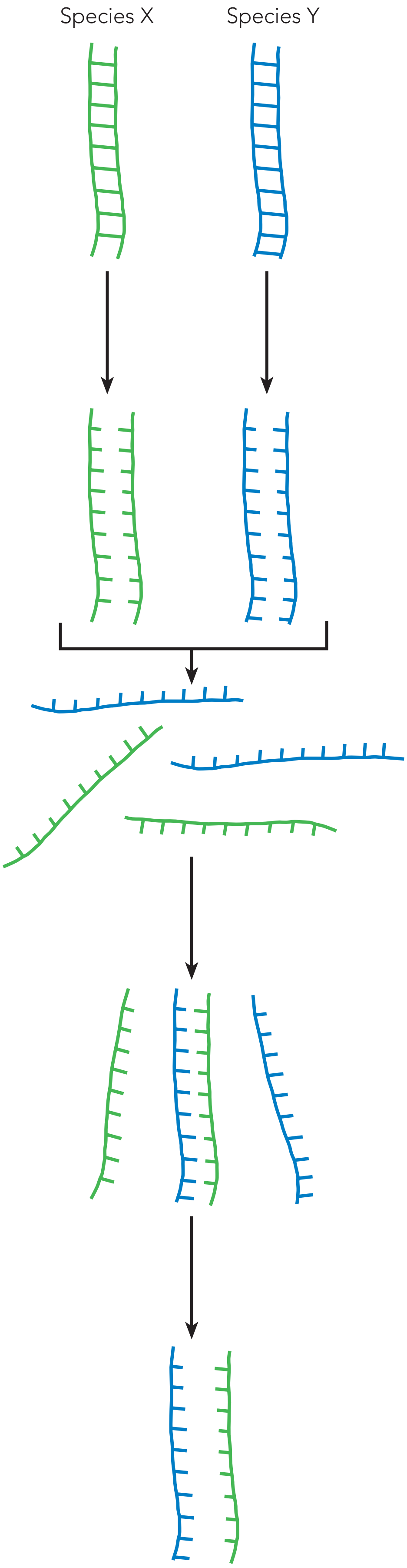
(iii) They have inherited particular genes which give them an advantage in competition with others of the same species.

(iv) Those organisms with favoured genes are more likely to live and to reproduce in greater numbers than other organisms. Their offspring inherit their favourable genes. The gene pool changes so that a greater proportion of the genes are favourable alleles.

3. The cause of change in allele frequencies in large populations is usually natural selection. Certain genes are favoured, e.g. the gene for white colour in small mammals is likely to be favoured in an alpine environment (because snow provides a white animal with camouflage from predators). If a population with a range of colours (dark brown to white) but with mostly normal brown colour were to migrate to an alpine environment, the change in environment (with the change in selection pressures) would result over time in a greater proportion of white genes in the population. The "gene pool" would change over several generations such that a greater proportion of white genes would occur. Other alleles would be selected against and so they would become less frequent.

4. The range of variation in the population. If there is a great number of different types in a population, then some of these variants might survive and flourish in the new environment. If there is little variation in the population, a significant change is likely to cause the population to become extinct because none of the population is able to tolerate the change.

4. (i)



(a) DNA segments are collected from both species.

(b) Each solution of DNA is heated to about 80 to 90°C. This treatment causes the strands of DNA to separate (this process is called DNA melting).

(c) The two solutions are combined into one and then cooled to enable DNA from the different species to anneal (or hybridise).

(d) The hybridised DNA is then heated a second time to determine the temperature at which the hybrid DNA separates (i.e. to determine its new "melting temperature").

(e) If the hybrid DNA separates at a low temperature, the degree of DNA matching is low, i.e. few bases correspond in the two species. The species are therefore not closely related. If on the other hand the melting temperature is high (close to the original), the organisms are likely to be closely related.

5.

(i) (a) aa

(b) 14

(ii) (a) Aa

(b) 23

(iii) (a) AA

(b) 13

(iv) (23 × 1) + (13 × 2) = 23 + 26 = 49

(v) (23 × 1) + (14 × 2) = 23 + 28 = 51

(vi) freq. of 'A' in population

$$= \frac{\text{number of 'A' alleles}}{\text{total number of alleles}} \times \frac{100\%}{1}$$

$$= \frac{49}{100} \times \frac{100}{1}$$

$$= 49\%$$

(vii) Freq. of 'a' $= \frac{51}{100} \times \frac{100}{1}$

$$= 51\%$$

(viii) The gene pool is the total % of all the alleles for this trait in the population i.e. 49% 'A' alleles and 51% 'a' alleles.

6.

(i) Normal phenotypes are less likely to survive than albino phenotypes.

(ii) The gene pool would change in favour of the 'a' allele.

(iii) The frequency of 'A' is decreasing while the frequency of 'a' is increasing.

(iv) 'A' may disappear almost entirely while 'a' approaches 100%.

(v) The albino phenotype is more likely to survive and reproduce than the normal phenotype. Therefore the proportion of albinos in the population gradually increases with each new generation.

(vi) The predators are the selection pressure.

(vii) No. The animals are likely to become better adapted to cold weather.

(viii) Larger body size, increase fat and fur insulation, small extremities (ears, nose, limbs).

(ix) Natural selection reduces variation. In the example, the normal gene 'A' may disappears as it is at a distinct disadvantage in the colder climate. This reduces the number of alleles for coat colour.

7.

(i) Frequency of 'A' $= \frac{14}{18} \times \frac{100}{1} = 78\%$

(ii) Frequency of 'a' $= \frac{4}{18} \times \frac{100}{1} = 22\%$

(iii) There is a greater proportion of allele 'A' in the colonising population.

(iv) The 'Founder Effect'.

(v) Because by chance the original small colonising population had different gene frequencies from the parent population.

(vi) The origin of the immigrant population may be uncertain. If scientists are endeavouring to map the migratory paths of these organisms, this may suggest that they have come from another parent population somewhere else in the world.

(vii) By studying the gene frequencies of other alleles, those that do not control coat colour. Other genes may reflect the parent population more closely.

(viii) The Founder Effect is likely to be most evident when the founding sample is small and remains reproductively isolated.

8.

(i) The proportion of allele 'A' would increase while that of 'a' would decrease.

(ii) Given that the 'aa' has died:

frequency of 'A' $\frac{14}{16} \times \frac{100}{1} = 87.5\%$

frequency of 'a' $\frac{2}{16} \times \frac{100}{1} = 12.5\%$

(iii) Random genetic drift.

(iv) There is no selection pressure causing the change in allele frequencies.

(v) Like natural selection, it may result in gradual change in gene and phenotypic ratios, therefore it contributes to evolution.

(vi) It may reduce variation if genes disappear by chance.

(vii) Genetic drift is most likely to occur in small isolated populations.

9.

(i) Sexual selection is the gradual change in allele frequencies due to either competition between members of the same sex for mates **or** *the selection of a particular phenotype by the opposite sex.*

(ii) If males compete for females by fighting over territory, then normally larger, stronger males result, e.g. large male gorillas.

If males compete for females using courtship displays, then more colourful, spectacular appearances may result, e.g. most bird species and some mammals (e.g. Mandrills).

(iii) Females of some animal species develop more spectacular appearances to attract males. Competition through aggression and territorial defence is less likely.

(iv) It does appear that humans show significant unexplained differences. They are dimorphic. Facial hair on males, body shape and large penises suggest sexual competition in human evolution as do larger breasts and body shape in females.

(v) The male peacock and the female peahen, the male and female Orangutan, the male and female gorilla, colouration in some species of gibbon.

(vi) The female often sits on and incubates her eggs. While she is on the nest, she may be the target of predators. Therefore, while there may be some pressure to attract a male through different colours and length of feathers, this is outweighed by the need to be dull and well camouflaged.

(vii) Sexual selection is not due to random events, it is directed by a selection pressure.

(viii) Because, due to the selection pressure, the gene pool is directed towards those with the most favoured alleles. It also results in a reduction of variation within the gene pool.

2.3 Artificial selection, allopatric speciation and genetic diversity

Terminology

(i) adaptation – a trait which enables an organism to survive and reproduce better in its environment.
(ii) allopatric speciation – the development of two or more species that may occur when populations of the same species are reproductively isolated by barriers for an extended period of time.
(iii) artificial selection – the selection by humans of animals or plants that have useful features for breeding programmes.
(iv) dispersal – the movement of organisms from where they are produced to sites where they breed and reproduce.
(v) extinct – a species which has not been sighted live for fifty years or more.
(vi) genetic bottleneck – a severe reduction in the size of a population. This can reduce the genetic variation in the population's gene pool.
(vii) genetic diversity – the variety of different genes in a population or community.
(viii) geographic isolation – the isolation of populations of the same species due to barriers such as rivers, oceans, mountain ranges and deserts
(ix) reproductive isolation – the isolation of populations of the same species that prevents interbreeding between them. This may be due to geographical barriers or behavioural differences between them.
(x) vulnerable – an assessment of the risk of extinction of a species. Threatened species can be divided into three categories of risk. These are in ascending order – Vulnerable (VU), Endangered (EN) and Critically Endangered (CR).

Review Questions

1. *Artificial selection occurs when human breeders select particular varieties of plants or animals which suit their purposes (e.g. grapes which are seedless) and promote the growth and proliferation of the selected variety.*
   Natural selection occurs when a particular variety of plant or animal is able to survive better in nature, because it has adaptations which give it a competitive advantage over other varieties of the same species. The variety is more likely to survive and reproduce – passing the competitive advantage on to its offspring.

2.
(i) Cows which have larger udders and which produce greater than the normal amounts of milk may be selected by a farmer for breeding purposes. The calves they produce are more likely to inherit this advantage (for the dairy farmer and the consumer).
(ii) Wheat may be selected by agriculturalists on the basis of its height, the number of seeds on each head, its resistance to fungal diseases, its rate of growth, drought tolerance and a number of other traits. Seeds are taken from those plants which naturally develop such features and are selected for planting subsequent crops.

3.
(i) Two populations of the same species may occupy nearby habitats. Occasionally individuals from each population migrate to the area occupied by the other population and may mate with members of that population. Therefore, if a mutation occurs in one of the populations which results in a new allele for a particular trait, that new allele may spread from one population to the other. The two populations are not reproductively isolated. Therefore the gene pools in each population over time will remain similar. Genes may move or flow from one population to the other.
(ii) The rate of flow may be affected by the distance between the populations, the degree of difficulty in crossing any barriers between them, the reproductive rate of the species, in animals the mobility of the individuals or in the case of plants the rate of seed or pollen dispersal.
(iii) Gene flow in animals is facilitated by the movement of individuals, whereas in plants it is facilitated by the dispersal of seeds and pollen.
(iv) The genetically modified DNA in G.M. crops could be dispersed into nearby non-G.M. crops by seed or pollen dispersal.
(v) Pollen may be naturally dispersed by the wind, insects, birds and small mammals.

4.
(i) Gene flow may be prevented by natural or artificial barriers.
(ii) (a) Water – channels, sea, rivers.
(b) Mountains or deserts.
(c) Behaviour.

5.
(i) The isolated populations may interbreed (where isolation has been short).
(ii) The isolated populations may interbreed at the boundaries to produce a third hybrid population.
(iii) No interbreeding occurs – speciation has occurred.

6.

(i) *External factors may include a changed behaviour, e.g. courtship behaviour may have changed because of the different environments or food preferences may have changed because of differences in the availability of different foods in the environments. Therefore while the genes or DNA may still be compatible in the two populations, they may no longer interbreed.*

(ii) *Changes in the DNA due to mutations, while the populations were isolated, may make the two populations unable to breed when the physical barrier is removed.*

7. *Artificial barriers may include physical barriers that humans may construct, e.g. dam walls may prevent populations of fish and other aquatic animals from interbreeding or social barriers that may arise in different human cultures due to class or religion.*

8. *Viruses and bacteria may transfer genes from one species to another. This is utilised in genetic engineering but also occurs naturally.*

9.

(i) *Mutations and natural selection.*

(ii) *Species. (This process is called speciation or adaptive radiation.)*

(iii) *Common ancestry – two species have evolved from the same species. That species is their common ancestor.*

(iv) *The finches on the Galapagos Islands.*

(v) *Eurkaryotic cells contain organelles such as mitochondria and chloroplasts. Both these organelles contain DNA and are capable of dividing. Mitochondria resemble prokaryotic bacteria and chloroplasts single-celled algae.*

10.

(i) *Sexual reproduction generally results in greater genetic variation than asexual reproduction in the population. As environments change variation often provides a species with an opportunity to adapt to different selection pressures. Where there is little variation, as is the case in asexually reproducing populations, environmental change may result in extinction because the population has no variants that are suited to or can tolerate the different environment.*

(ii) *While the environment is stable, the population is well adapted to it and reproducing successfully, random genetic changes are likely to be neutral or even harmful to the chances of an organism's survival. In situations that are stable asexual reproduction is therefore likely to be more efficient and successful than sexual reproduction.*

Where change to an environment occurs, producing variation through changes like mutations is likely to produce variants that can cope with the change. Sexual reproduction produces more variation. Some microorganisms, e.g. green algae can form a conjugation tube which enables nuclei to cross from one to the other and fuse forming a zygote.

(iii)(a) *If the size of the population is reduced, the amount of genetic variation is likely to be reduced also. The smaller the population, the less variety of alleles is likely to remain. Some alleles will disappear altogether. This adds to the probability of extinction of the small population in the face of rapid environmental change, e.g. like that brought about by climate change.*

(b) Given time under suitable conditions a small population may grow significantly. However it may still have a low genetic biodiversity and still be vulnerable, until mutations accumulate, which may take a great deal of time depending on the organism. The reduction in the population size and its biodiversity in the gene pool is referred to as a "genetic bottleneck".

3. INQUIRY SKILLS AND HUMAN ENDEAVOUR 1

3.1 Science Inquiry Skills 1

Terminology

(i) *hypothesis – an educated guess proposed to explain an observation. A hypothesis must be testable.*

(ii) *mean (arithmetic) – the average of a number of observations.*

(iii) *measurement error – the difference between the 'true' value of a variable and the experimental measure of that variable.*

(iv) *median – the middle number of a series of numbers, e.g. the median of 1,3,4,5,7 is 4. If there is an even number in the series the two middle numbers are averaged.*

(v) *nomenclature – system of agreed names or terms used in science or a particular branch of science*

(vi) *primary data – data you collect yourself.*

(vii) *reliable data – data that is reasonably accurate, close to the 'true' data, such that when the experiment is repeated similar data are obtained.*

(viii) *sample size – the number of observations or measures of a particular variable a scientist chooses to make in order to determine the mean value for the variable under investigation.*

(ix) *secondary data – data you obtain from the work of others.*

(x) *valid data – data that accurately reflects what was intended to be measured. Valid data can only be obtained from an experiment that is properly controlled and that uses accurate instruments and procedures.*

Review Questions

1.

(i) *A hypothesis is a testable, educated guess put forward to explain an observation, whereas a prediction is an educated guess as to what might happen in the future (usually based on a hypothesis).*

(ii) *A person who is under stress is more likely to become ill.*

(iii) *If a person lives a more stress-free lifestyle then she is less likely to require medical assistance during her lifetime.*

(iv)

(a) Dependent variable: events of illness.

(b) Independent variable: stress.

2.

(i)

- *Select two areas of land, both in the same locality (e.g. 100m^2), similar soil, aspect, drainage and near to each other.*
- *Prepare each soil for planting vegetables, e.g. fertilise each, remove weeds.*
- *Plant each with a range of the same types of vegetable seedlings.*
- *During the summer mulch one area, the experimental area, while leaving the other area, the control area, unmulched.*
- *Water and fertilise each area regularly in the same way during the growing season (summer).*
- *Weigh the vegetables produced by each plot.*
- *Compare the total weight of vegetables produced by the control plot with that produced by the experimental plot.*

(ii)

- *Amount of water given to each plot.*
- *Age of seedlings.*
- *Health of seedlings.*
- *Light received by each plot.*

(iii) *(a) Weight of vegetables produced.*

(b) Amount of mulch.

(iv) *If the weight of the vegetables produced in the mulched area is significantly greater than the weight of the vegetables produced in the unmulched area, this would support the hypothesis.*

(v) *The weight of the vegetables produced by each area is the same or the weight of the vegetables produced by the unmulched area is significantly greater than that of the mulched area.*

(vi)

- *Repeat the whole experiment several times.*
- *Use larger plot areas.*
- *Use a greater range of vegetables.*
- *Use more plants of each vegetable type.*

3.

(i) ***Growth rate,*** $r = b - d$

$= 15 - 13 \ /1000/\text{year}$

$= 2 \ /1000/\text{year}$

(ii) ***Increase in population to mid 2016 =***

$$\frac{r \times \text{population in mid 2015}}{1000}$$

$$= \frac{2 \times 20\,000}{1000}$$

$$= 40$$

Population in mid-2016 = population in mid 2015 + increase in population to mid 2016

$= 20\,000 + 40$

$= 20\,040$

(iii) ***Growth rate,*** $r = (b + i) - d$

$= (15 + 20) - 13$

$= 22 \ /1000/\text{year}$

(iv) *The population would be less threatened by extinction because of its increased genetic diversity.*

(v) *If there is no migration, the growth rate is dependent on the birth and death rates. The birth rate is determined by many factors including the availability of food and water which are weather dependent. If there is less food and water the birth rate will decline. Disease may also reduce the birth rate, e.g. the bacterial disease called Chlamydiosis. The death rate is also dependent on resources, disease and predation. Lack of food will lead to starvation, disease may kill some animals and they may be killed by dogs and large birds of prey (especially juvenile animals). Motor vehicles also account for some animal deaths as koalas attempt to cross roads.*

All these factors are likely to vary from one year to the next and therefore change the growth rate.

(vi) *To reduce the population to a sustainable level so that mass starvation does not occur, the population growth rate may need to be reduced to below zero, to become negative, for a number of years. This requires reducing the birth rate or increasing the death rate or both.*

Increasing the death rate may not be an acceptable strategy in the case of koalas. Some animals may need to be removed from the island and relocated to the mainland or to another island on a regular basis instead. The birth rate may be manipulated by sterilising a proportion of the population or by using hormones to render some adults infertile.

(vii)

Growth rate, r = (b + i) – (d + e)

= (15 + 20) – (13 + 30)

= 35 – 43 /1000/year

= – 8 /1000/year

(A negative value represents a decline in the population)

(viii) Adult females that have been sterilised will not become pregnant and give birth to joeys. Therefore the expected birth rate would be reduced.

4.

(i) Use PCR to amplify the small sample.

(ii) The higher end of the gel tray in this diagram, furthest from the wells. The DNA fragments are negatively charged and therefore move towards the positive electrode terminal.

(iii)

- The size of the fragments.
- Whether the DNA is linear or coiled.
- The type of gel used.
- The potential difference between the electrodes.
- The buffer solution used on the gel.

(iv)

- The bands may be stained with a dye which fluoresces under UV light.
- They may be stained with a dye which is visible in normal light or
- Radioactive dyes can be used which can produce an autoradiograph (photo image of the bands).

(v) Well C. We know the enzyme has cut the DNA, as it has moved further than the largest fragments in well A. It is likely therefore to have cut the fragment in half as the fragments have not separated into two bands.

(vi) Since the original DNA fragment was approx. 40 000 base pairs long, each of the halves must be approx. 20 000 base pairs long.

(vii) Enzyme E2. It has cut the original DNA fragment into 4 smaller fragments; it must therefore have cut it in three places.

(viii) None, as none of the enzymes appear to have cut the fragment into three smaller fragments. There is a remote possibility that E3 could cut a DNA fragment in two places creating three equal lengths (but this is not possible here as there are 40 000 bases which is not divisible by three).

(ix) Well D. Its lane contains 5 bands suggesting 5 different length fragments.

(x) Well A had the largest fragments. They have created a band which has moved the least distance from the well.

Well D had the smallest fragment. It has created a band which has moved furthest from the well.

(xi) A mixture of many fragments of known lengths could have been placed in well E when the other fragments were put into their wells before the power was turned on. These fragments would have created a lane of **size markers** against which the other bands could have been compared.

5.

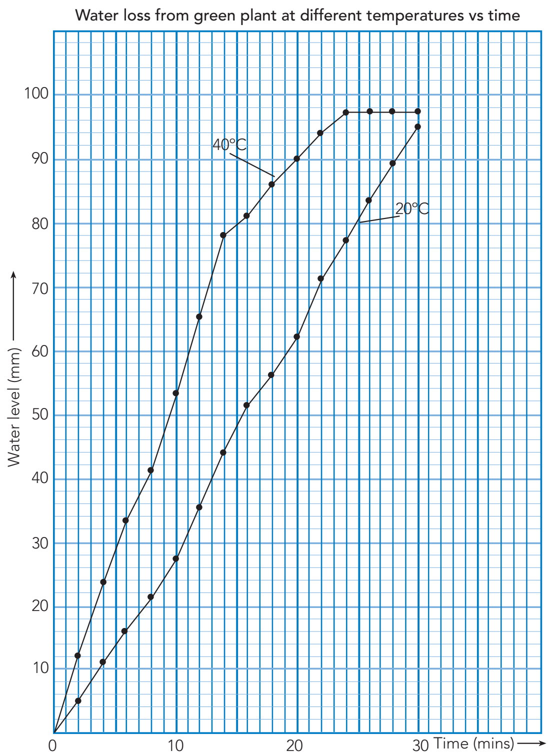
(i) The rate of evaporation from the plant's leaves (the transpiration rate) rises with increases in the surrounding air temperature.

(ii) a) Independent variable: surrounding air temperature.

b) Dependent variable: rate at which the water level moves down in the glass tubing (i.e. the rate of water loss).

(iii)

Time (mins)	Water level on scale (ambient temperature 20°C) mm				Water level on scale (ambient temperature 40°C) mm			
	trial 1	trial 2	trial 3	mean	trial 1	trial 2	trial 3	mean
0	0	0	0	0	0	0	0	0
2	6	4	6	5	12	10	11	11
4	12	10	10	11	25	21	23	23
6	18	16	14	16	36	30	33	33
8	22	22	18	21	45	36	42	41
10	30	28	24	27	61	44	53	53
12	38	36	32	35	76	53	65	65
14	48	46	38	44	95	61	78	78
16	52	54	46	51	96	65	81	81
18	58	60	50	56	98	74	86	86
20	62	66	58	62	98	81	90	90
22	72	74	66	71	98	90	94	94
24	78	80	74	77	98	96	97	97
26	86	84	78	83	98	96	97	97
28	92	90	86	89	98	96	97	97
30	99	96	90	95	98	96	97	97



(iv) Three trials were used to reduce error so that the results obtained would be more reliable.

(v) Variation may have occurred because:

- different plant leaves were used
- the density of stomata on different leaves may differ
- younger leaves may respond to water loss more rapidly
- the diameters of the leafy stem may differ slightly

(vi) Conclusion: The hypothesis given is supported. However, the leaves kept in an air temperature of 40°C, appeared to stop losing water after 24 minutes. The hypothesis does not account for this change.

(vii) The leaves' loss of water exceeded their gain at this temperature. After 24 minutes, the guard cells had wilted to the extent of closing the stomata and their closure had prevented further water loss.

(viii) At this temperature, 40°C, the stomata with guard cells could be removed by painting with a transparent latex solution, tearing off the epidermal cells with the solid latex and examined under the microscope.

(ix) 96 mm

(x) New median = (96 + 94) / 2 = 95 mm

6.

(i) In an experiment, the independent variable is deliberately altered to see what affect this has on another variable, the dependent variable. The independent variable is therefore deliberately 'manipulated'.

(ii) The dependent variable changes because of changes to the independent variable. That is, it 'responds' to changes to the independent variable.

7.

(i) She could measure the rate at which the gas collected in the test tube.

(ii) Oxygen.

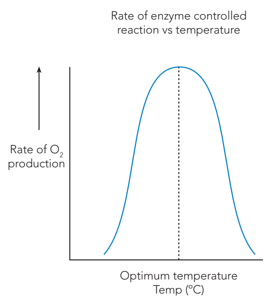
(iii) She could place the test tube in a water bath and raise or lower the temperature of the test tube by warming or cooling the water in the water bath.

(iv) a) The dependent variable: rate at which oxygen is collected in test tube.
b) The independent variable: temperature of the mixture in the test tube.

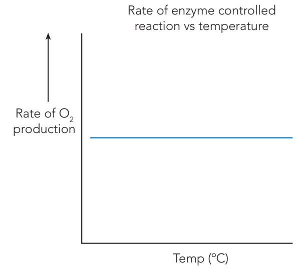
(v)

- Weight of liver
- Volume of hydrogen peroxide
- Concentration of hydrogen peroxide
- Freshness of liver

(vi)

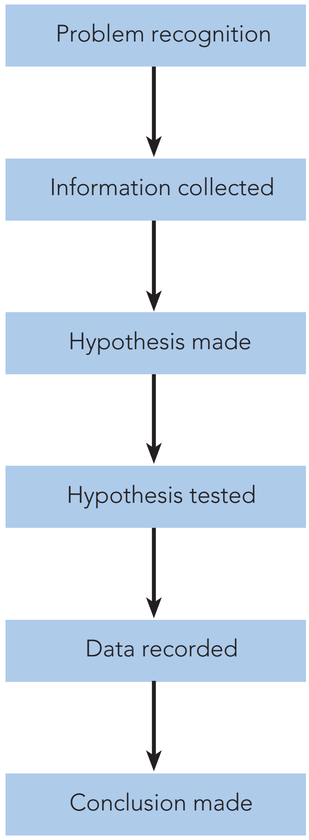


(vii)



(viii) The first graph. Enzymes, including catalase, have a specific molecular shape which is most suited to their function. If the shape is changed, by temperature changes, either cooled or heated, the enzyme is no longer able to function at its optimum rate.

8.



9.

(i) Mean weight, X = total weight / number of yabbies
= 1197 / 11 g
= 108.82 g

(ii) Numbers arranged in ascending order: 27, 45, 46, 55, 55, 98, 150, 156, 175, 180, 210
The middle number (median) is 98 – it has five numbers below and five above it in the sequence.

(iii) The mode is the most frequently occurring number. Only the value 55 occurs twice, therefore 55 is the mode.

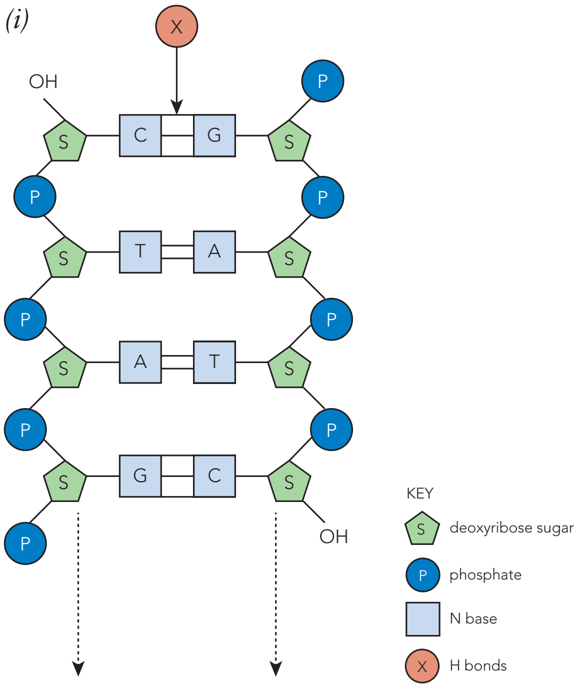
(iv) If the sample was representative of the population, she could be confident. The sample would need to be large relative to the total population. In this case the population is not known therefore she has no reason to be confident.

(v) If she repeated the sampling many times, obtained larger samples and/or estimated the population size by the capture- recapture method she may have greater confidence in the reliability of the observed mean.

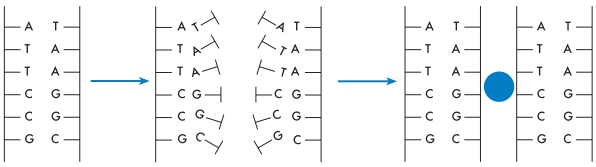
(vi) Unless every adult yabby at the site was captured and measured then the mean weight is only an estimate based on the samples' mean weight.

10.

(i)



(ii)



3.2 Science as a Human Endeavour 1

Terminology

(i) biochemistry – the study of the chemistry associated with living things.

(ii) bioinformatics – the use of computers and computer software in the study of biology and biological processes and in biotechnology.

(iii) biotechnology – the industrial use of biological processes, e.g. fermentation, genetic engineering.

(iv) conservation – the preservation of living things and their environments for future generations.

(v) crop species – a plant species that is cultivated for food or useful materials.

(vi) endangered species – a species considered at risk of extinction. An endangered species is under serious threat of extinction but has not reached the highest level of "critically endangered".

(vii) pesticide resistance – indicates that a pest, e.g. a weed, is not adversely affected by a particular pesticide, e.g. a particular herbicide. When pests have a resistance to a pesticide they become more difficult to control.

(viii) quarantine – the restriction of the movement of living things considered to be pests, potential pests or to harbour pests from one region to another. This usually occurs at the borders that separate states and countries. People may also be quarantined i.e. placed in isolation, if they are travelling from a region affected by a serious infectious disease. They may have to wait in quarantine until they are determined to be uninfected before entering another region.

(ix) tolerance – the extent to which an organism can survive change in an environmental factor, e.g. a particular bacterium may only live in water which has a temperature range of 10° – 30°C. Outside this range is beyond the tolerance of this bacterium.

(x) transgenic organism – an organism which has an altered phenotype as a result of its genetic modification.

Review Questions

1.

(i) Genetic modification is a subset of biotechnology. Biotechnology covers a broader area – the use of organisms to make food products, medicines and cleaning products. G.M. is a part of biotechnology – the modification of the genetic make-up of organisms (bacteria, plants, animals).

(ii) Biotechnology, e.g. the use of the yeast to make bread, the use of bacteria to make insulin.
G.M., e.g. insertion of a pesticide resistant genes in the DNA of plants, insertion of a gene which results in more vitamin A production in rice.

2.

(i) G.M. in human medicine – 'switching off' of genes which cause disease, gene therapy – replacement of defective genes in embryonic cells and in adult somatic cells (this is in the early stages of research).

(ii) The introduction of 'foreign' substances including viruses which act as vectors for gene transfer may cause immune responses in the patients which have undesirable effects of their health.
Changes in the human genome may have serious side effects which are yet to be determined.

3.

(i) Plants may have genes inserted or modified to provide:
(a) herbicide protection to them,

(b) pesticide production by them,
(c) greater drought, salt or temperature tolerance,
(d) enhanced taste,
(e) quicker maturation time,
(f) better utilisation and absorption of mineral nutrients from the soil,
(g) greater yield,
(h) better nutritional value (e.g. more vitamins).

(ii) Artificial selection involves selecting genes within a particular species and encouraging their reproduction – thus artificially changing the gene pool for our benefit. Genetic modification may involve interspecific transfer of genes, i.e. inserting the genes from one species into another related or unrelated species. It may also involve the creation of new genes or the modification of existing genes.

(iii) G.M. plants may pollinate normal plants so that contamination of other plant population occurs (both interspecifically and intraspecifically). This may have unintended and irreversible consequences to these normal species.

4.

(i) There is always a possibility that genes may be transferred from one animal species to another by viral and bacterial vectors. Altered genes may be transferred which have previously not occurred. This transfer between animals and humans is more likely than the transfer between plants and humans, because animals are more likely to share common bacterial and viral parasites.

(ii) G.M. animals may have:
(a) better health, higher resistance to disease
(b) higher yields (e.g. milk, meat, eggs)
(c) better feed efficiency, i.e. conversion of food to meat.

5.

(i) If food crops can be grown more efficiently on existing cleared and degraded land, then less clearing of forests and natural environments may be required to sustain the world's population.
G.M. crops may produce more vitamins and minerals necessary for the improvement of the health of people in developing countries.
G.M. crops may produce vaccines which could be made available through food rather than costly and disease prone injections in developing countries.

(ii) G.M. plants which are tolerant to herbicides could encourage the greater use of herbicides on weeds. These herbicides could then pollute the environment more than they do now.
If genes, which confer insect resistance, are accidentally transferred to weeds (e.g. by viruses) then weed problems will increase.
The introduction of new genes into a natural environment may have a similar effect to the introduction of feral plants and animals, changing the natural environment in ways which reduce biodiversity.

6.

(i) (a) Haploid
(b) Diploid
(c) Diploid
(d) Diploid
(e) Diploid

(ii) Mitosis.

(iii) The donor of the somatic cell nucleus.

(iv) A few cells are separated from a parent plant, placed in a special tissue culture and kept under optimum conditions for regeneration to occur. A small plant develops with roots, stem and leaves which can be planted in soil.

7.

(i) Scientists need to provide, without bias, all the facts that are available. They need to present this scientific information to the public in a form which is understandable to the non-scientist.

(ii) Scientists cannot make value judgements for others in the community. They are not in a position to determine what is right or wrong. The community must be able to make decisions as to what scientific research is conducted and how discoveries are applied. Scientific experiments do not determine community values.

8.

(i) ***Monitoring endangered species***
The genetic diversity of a population can be estimated through the collection of individual animal and plant DNA profiles. The extent to which a species is threatened with extinction can be more easily assessed with this data.
The knowledge of the genome of a population can help to determine why some animals succumb to diseases while others do not. Particular genes associated with natural immunity may help in deciding which animals should be allowed to breed and which should be sterilised.
Knowledge of a genome may be useful in the development of vaccines to combat particular diseases, e.g. Chlamydia in koala populations.

(ii) ***Assessing a gene pool for a breeding program***
Individuals may be chosen to breed because their alleles are more different, e.g. captive breeding programmes for Orangutans – introducing a breeding animal that has different genes from those of an existing population will improve the biodiversity of the group.
Breeding programs also require that the organisms selected for breeding are not creating a hybrid that does not exist in the wild. DNA profiles can help ensure that this does not happen.

(iii) ***Quarantine***
Government authorities can test the DNA profile of imported timber to determine whether or not it is legal and plantation grown. Preventing the importation of illegally logged timber can help to preserve plant species.

9.

(i) ***Comparative genomics***
Comparison of organisms' DNA, genes and nucleotide sequences enables scientists to more accurately construct phylogenic trees and to determine how closely related species are to one another; that is to determine whether or not they have a recent common ancestor.
Knowledge of the genes in related organisms can help understand which alleles have been naturally selected and which have disappeared in particular populations.

(ii) ***Comparative biochemistry***
Comparative studies of the proteins of two species can indicate their common ancestry, e.g. the haemoglobin molecule in chimps and humans has exactly the same amino acid sequence. This supports other evidence (e.g. anatomical) that the two species are closely related and have a very recent common ancestor.

(iii) ***Bioinformatics***
The use of computers and computing software has made possible the technology that robotically conducts tests, e.g. analysis of fluorescence in DNA microarray experiments. Computers are used in hybridisation tests that determine the similarity of two species' DNA and in PCR when larger quantities of DNA are required for testing.

10.

(i) ***Biogeography:*** *Knowledge of an organism's distribution over its geographic range is important in understanding the organism's tolerance levels to change. The abiotic factors over an organism's range are not likely to be uniform. It is useful to understand what conditions the organism can tolerate in order to help determine its vulnerability to change and also to determine whether it can be successfully relocated to a new environment.*

(ii) ***Reproductive behaviour:*** *In captive breeding programs it is essential to understand the organism's reproductive behaviour, including courtship behaviour, in order to artificially recreate the conditions that are conducive to successful mating and raising of the young.*
The creation of suitable nesting sites for birds and mammals is often an important part of re-establishing viable populations in the wild, especially where habitats have been disturbed.

(iii) ***Population dynamics:*** *Understanding of an organism's population dynamics means understanding when its population will grow and when it will decline. This often requires understanding the factors that influence its birth and death rates. In order to intervene and prevent a population becoming extinct, knowledge of these factors is essential.*
The population structure is also important as this indicates the proportion of adults of reproductive age and the proportion of juveniles. Where a population is large but most individuals are old and approaching the end of their reproductive life, numbers can decline to critical levels in a very short period of time, e.g. White-tailed Black Cockatoos. If the population structure can be changed so that there is a greater proportion of younger organisms then the species may be sustainable.

4. HOMEOSTASIS

4.1 Homeostasis and negative feedback

Terminology

(i) *effector – a part of an organism which responds to a stimulus, e.g. muscle, gland.*

(ii) *external stimulus – a change in the outside environment (e.g. air, soil) of an organism which can be detected by it and that may induce a response in the organism.*

(iii) *feedback – the effect which a response may have on a stimulus. If the response reverses the stimulus it is called a negative feedback. If the response enhances the stimulus it is a positive feedback.*

(iv) *homeostasis – the maintenance of stability within the body of an organism.*

(v) *internal stimulus – a change in the inside environment (e.g. blood plasma, intercellular fluid) of an organism which can be detected by it and that may induce a response in the organism.*

(vi) *modulator (coordinating centre) – an area of cells or tissue (e.g. in hypothalamus, medullar oblongata) which receives information from receptors, processes that information and if the stimulus is sufficiently strong, i.e. it has reached a threshold, sends messages to an effector which responds to the stimulus.*

(vii) *negative feedback – a feedback in which the stimulus is reversed by the response, e.g. when the mammalian body temperature becomes too high, responses occur to lower the temperature – sweating, vasodilation of blood vessels in the skin, panting, reduced metabolic rate.*

(viii) *receptor – a special cell, tissue or organ which is sensitive to specific changes in the environment and reacts to that change, e.g.*

some nerve endings are sensitive to changes in temperature and when stimulated send impulses via sensory neurones to a modulator in the central nervous system.

(ix) response – a specific reaction or change which occurs in an organism brought about by a particular stimulus.

(x) threshold – the strength a stimulus must reach in order to induce a response.

Review Questions

1.

(i) The conditions must be relatively stable for the metabolic processes to proceed at a suitable rate.

(ii) Homeostasis.

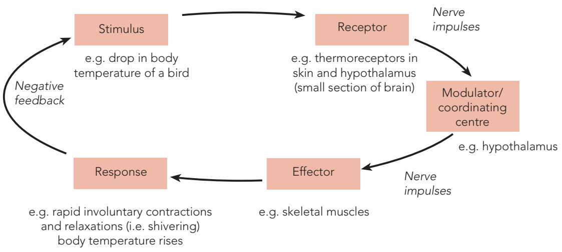
(iii) Tolerance levels are the limits beyond which a cell or an organism ceases to function normally, e.g. the pH of human blood has a tolerance range of between 6.8 and 7.8.

2.

(i) An external stimulus is a change which occurs in an organism's external environment and which is detected by that organism, e.g. a rise in temperature, a change in light intensity.

(ii) An internal stimulus is a change which occurs and is detected in the organism's internal environment, e.g. blood sugar level, water level (osmotic pressure) of blood.

3.



Note: This is only one of several responses that the bird's body would make. Other responses include vasoconstriction of blood vessels close to skin, fluffing up of feathers and in the long term an increase in thyroxine levels (a hormone which increases metabolic rate) in the blood stream.

4.

	Specific Example	General Term
(i)	A small muscle in the wall of a narrow artery in the skin contracts and in so doing restricts blood flow through the skin.	E
(ii)	A nerve ending in a joint is stretched by the movement of the joint. It sends an impulse to the central nervous system.	R
(iii)	A person undergoing strenuous exercise becomes overheated. She sweats and this helps lower her core body temperature.	N
(iv)	A small area of the brain receives impulses from nerve endings in an artery. When the impulses reach a threshold it then sends impulses to the respiratory system.	M
(v)	A fall in the blood's glucose level that is detected by the pancreas.	S
(vi)	On seeing the dog, the cat's hair becomes erect.	Rp

4.2 Thermoregulation in animals

Terminology

(i) appendage – a limb or extension from the main part (apex) of the body, e.g. arm, leg, antenna, ear, nose.

(ii) behavioural adaptation – the way in which an animal acts which enables it to survive and reproduce better in its environment, e.g. burrowing in hot climates, nocturnal activity.

(iii) counter-current – a flow of liquid in the opposite direction to another. This occurs in the appendages of animals when blood flowing in the arteries passes the blood flowing in the veins. It also occurs between blood flowing through fish gills and the water flowing over them.

(iv) dehydrate – to remove water from an organism or a chemical.

(v) ectothermic (animal) – an animal whose body temperature mainly depends on the temperature of its surroundings, e.g. fish, reptiles.

(vi) endothermic (animal) – an animal that is capable of maintaining a fairly constant internal temperature regardless of the temperature of the environment (within limits), e.g. mammals and birds.

(vii) metabolic rate – the rate at which chemical processes occur within the body of an organism.

(viii) optimum – the best or most favourable condition, e.g. the temperature at which an enzyme has its maximum effect on a substrate is called the optimum temperature for that enzyme.

(ix) peripheral thermoreceptor – temperature receptor located near the outside of an animal's body generally in the skin that

detects changes in the temperature of the skin and the external environment.

(x) *physiological adaptation – the way in which an organism's body functions that enables it to survive and reproduce better in its environment, e.g. a green plant growing towards the light, piloerection of feathers to reduce heat loss.*

(xi) *piloerection – when the hair or feathers are raised due to the contraction of small muscles attached to the base of the hair follicles or feathers. This mechanism reduces heat loss in mammals and birds.*

(xii) *structural adaptation – a part of the anatomy of an organism that enables it to survive and reproduce better in its environment, e.g. leaf hairs that reflect heat, webbed feet of many aquatic birds.*

(xiii) *vasoconstriction – a reduction in the diameter of blood vessels caused by smooth muscle tissue that reduces blood flow through them.*

(xiv) *vasodilation – an increase in the diameter of blood vessels caused by smooth muscle tissue that increases blood flow through them.*

Review Questions

1.

(i) *Enzymes operate best at an optimum temperature. If the temperature is too low or too high, the rates of reactions slow. Extreme heat denatures enzymes and will cause the death of a cell.*

(ii) *a) The capacity of an animal to maintain a relatively constant body temperature independent of the surrounding temperature. This is achieved by varying the rate at which heat is produced within the animal's body and controlling heat gain and loss by physiological and structural adaptations, e.g. mammals, birds.*

b) The condition in which an animal's body temperature is largely determined by the temperature of the surrounding environment. The animal uses external sources of heat (e.g. sun) to increase its body temperature when necessary, e.g. fish, amphibians, reptiles, invertebrates.

(iii) *Because ectothermic animals use external sources of heat energy, for example to increase body heat they may bask in the sun, they do not require the use of as much food energy. Therefore they have lower food energy requirements than endothermic animals. Endotherms may use food to produce the heat necessary to maintain a constant temperature when their normal body temperature exceeds that of the environment.*

(iv) *As the external temperature drops, so too does the internal temperature of an ectotherm. Chemical reactions slow down as temperature is reduced. Therefore the ectotherm's metabolism slows down with a fall in temperature.*

(v) *To increase its body temperature an ectothermic animal may move into a warmer part of its environment (e.g. shade to sun), increase activity (e.g. bees move rapidly to generate heat in the hive), change the orientation of its body to maximise heat gain from the sun (i.e. lie at right angles to the sun's rays).*

2. (i) *Metabolism produces and releases heat; the higher the rate of metabolism, the higher the rate of heat production. Therefore as an organism's metabolic rate increases so too does its temperature. Its temperature will continue to rise unless it is able to lose heat at the same rate that it is gaining the heat energy.*

(ii) *An abnormally high rate of metabolism is likely to be evident in excess sweating, red skin due to the vasodilation of blood vessels in the skin (particularly in face) and high energy levels resulting in hyperactivity, anxiety and restlessness. In the long term hypermetabolism will cause muscle fatigue, weight loss and lethargy.*

(iii) *An abnormally low rate of metabolism is likely to be evident in pale skin due to the vasoconstriction of blood vessels in the skin, goosebumps due to piloerector muscles contracting and low energy levels. In the longer term hypometabolism is likely to result in weight gain.*

3.

Heat gain	Heat loss
Radiation (from sun)	Radiation (to surrounding objects – if body is warmer)
Conduction (from surroundings)	Conduction (to surrounding air or water – if body is warmer)
Metabolism	Evaporation of water from lungs, mouth and skin
Movement/shivering	Sweating

4.

(i) *If* ***heat gain > heat loss****, then the animal's body temperature will gradually rise. This may cause enzymes to denature if it is extreme.*

(ii) *If* ***heat gain < heat loss****, then the animal's body temperature will gradually fall. Enzymes cease to function efficiently.*

5.

(i) *Sweating, panting, vasodilation of blood vessels near surface of skin, hairs lie flat, reduction in metabolic rate.*

(ii) *Shivering, vasoconstriction of blood vessels near the surface of skin, hairs become erect (piloerection), increase in metabolic rate.*

(iii) *Animal may have become more physically active (seeking food, running from a predator or after a mate); it may have moved into a warm part of the environment.*

6.

(i)

Adaptation	Advantage in a cold climate
a) Small appendages (e.g. small ears, legs, snouts)	Reduces SA:Vol therefore lowers the rate of heat loss per unit mass.
b) Thick layer of subcutaneous fat or blubber	Provides better thermal insulation therefore reduces rate of heat loss.
c) Thick, long fur	Traps a layer of air around body which acts as a good thermal insulator therefore reduces rate of heat loss.
d) Capacity to go into state of torpor	Torpor reduces the rate at which stored energy is used therefore less food is needed when food is scarce.
e) High metabolic rate	Metabolism releases heat and increases body temperature. An increased metabolic rate may temporarily compensate for excessive heat loss.
f) Ability to burrow	Enables animal to escape direct contact with extremely cold air. In the burrow it is insulated in a warmed chamber.
g) Arteries and veins in limbs close together	Enables counter-current heat exchange, which reduces heat loss at the extremities.
h) Capacity to strongly constrict arteries in limbs	Reduces blood flow to the peripheries and therefore reduces the amount of heat loss from the appendages.

(ii) *mainly structural:* *(a) (b) (c) (g)*
mainly physiological: *(d) (e) (h)*
mainly behavioural: *(f)*

7.

(i) *A high SA:Vol may be achieved by having large and flat appendages (ears, legs, body, torso) or a relatively small body*

(ii) *A high SA:Vol may be useful to help the endothermic animal lose heat more rapidly in a hot environment.*

8.

(i) *Reduces the water level in plasma (decreases)*

(ii) *Osmotic pressure increases in plasma (increases)*

(iii) *Cells, in turn, will lose water and become dehydrated (decreases)*

(iv) *Salt concentration will increase as water is lost (increases)*

(v) *Volume of urine will become smaller (decreases).*

4.3 Vertebrate nitrogenous wastes and animal water and salt regulation

Terminology

(i) *ammonia – a gas (NH_3) which dissolves readily in water. It is a metabolic waste that is toxic to cells and if not immediately excreted, must be converted to urea or uric acid that are less toxic compounds.*

(ii) *aquatic (environment) – a water environment, marine or fresh water.*

(iii) *deamination – the breakdown of excess amino acids in the liver. This involves the removal of the amino group of atoms (NH_2) from the amino acid. Ammonia (NH_3) is formed. This is excreted by many aquatic animals, which have no 'water problem'. It is converted to urea ($CO(NH_2)_2$), by mammals and adult amphibians and uric acid ($C_5H_4N_4O_3$) by birds and most reptiles for excretion.*

(iv) *differentially permeable (membrane) – a membrane which allows some substances to pass through but prevents others, e.g. cell membrane.*

(v) *excretion – the removal of metabolic wastes. These include carbon dioxide, urea, and uric acid.*

(vi) *hypertonic – a solution which because of its higher concentration of dissolved solutes gains water by osmosis from another solution less concentrated through a differentially permeable membrane.*

(vii) *hypotonic – a solution which being less concentrated loses water to another more concentrated solution by osmosis through a differentially permeable membrane.*

(viii) *isotonic – when two solutions have the same concentration of dissolved solutes they are said to be isotonic.*

(ix) *nitrogenous waste – one of several compounds containing nitrogen formed mainly in the liver of animals from the breakdown of excess amino acids and proteins, e.g. ammonia, urea, uric acid.*

(x) *osmoregulation – the maintenance of suitable concentrations of water and dissolved salts in an organism's body cells. This is achieved in a variety of ways depending on the organism's environment. Osmoregulation may involve contractile vacuoles, kidneys, impermeable body coverings, special gill cells which secrete salts, the production of dry wastes (e.g. uric acid) and various behavioural adaptations including burrowing and nocturnal activity.*

(xi) *osmotic pressure – the pressure which is due to osmosis. Where a cell has a high concentration of dissolved solutes its osmotic pressure is high. Water will enter the cell if the extracellular solution is less concentrated.*

(xii) *terrestrial – living on land.*

(xiii) *toxicity – a measure of how poisonous a substance is to an organism.*

(xiv) *urea – an organic compound, formula $CO(NH_2)_2$, which is a waste product of the breakdown of excess amino acids in mammals. This nitrogenous metabolic waste is toxic and is excreted by the kidneys. It is soluble in water.*

(xv) *uric acid – a nitrogenous waste formed in birds, many reptiles and invertebrates from the breakdown of excess amino acids. It is sparingly soluble in water (formula ($C_5H_4N_4O_3$) and non-toxic.*

Review Questions

1.

(i) *The liver breaks down excess amino acids, converting them, first to ammonia, then to urea and carbohydrates. This process is called deamination.*

(ii) *The urea is excreted. The carbohydrates may be used as a source of energy.*

2.

(i) *Animals which eat other animals, i.e. carnivorous, e.g. eagle, dingo, numbat.*

(ii) *Animals with a high protein intake produce larger amounts of nitrogenous wastes, e.g. ammonia, urea, uric acid.*

(iii) *The energy may be obtained from the carbohydrate produced in the deamination of excess proteins.*

3.

(i) *Ammonia – lost dissolved in water.*

(ii) *Ammonia being very toxic must be greatly diluted with water to make it less poisonous when excreted. Terrestrial animals need to conserve water. Therefore, losing nitrogen waste in this form would be too expensive in terms of water loss.*

4.

(i) *Uric acid.*

(ii) *It is less toxic than urea and ammonia. It is also much less soluble than urea. Because of these properties it may be lost with little water. Birds save weight in excreting uric acid as they are required to carry less water than would be needed if urea was to be excreted.*

5.

(i) *(a) Fish (also tadpoles)*
(b) Mammals (also adult frogs and aquatic reptiles)
(c) Birds, reptiles

(ii) *Ammonia requires the least energy.*
Uric acid requires the most.
Uric acid ($C_5H_4N_4O_3$) is a more complex compound than ammonia (NH_3). Therefore its synthesis (uricogenesis) requires the most energy and ammonia requires the least amount of energy.

6.

(i) *Water is the universal solvent. All the chemical reactions that make up the metabolism of the organism occur in this medium; it allows the substances to move and react. Water is also required for excretion, transport in the animal and plants transport systems, temperature control and the support of plants to prevent wilting.*

(ii) *Water dissolves many chemicals. It flows readily and is a small molecule which moves readily through membranes.*

7.

(i) *If water gain > water loss, the plant or animal will become turgid, excess water may need to be eliminated. Animal cells may burst (or lyse) as they have no cell wall.*

(ii) *If water gain < water loss, the plant or animal will become dehydrated, shrivel and the concentration of dissolved chemicals may increase to the point where some reactions may become too rapid, too much heat may be produced. The cell's metabolism may fail to function efficiently; the cell may die.*

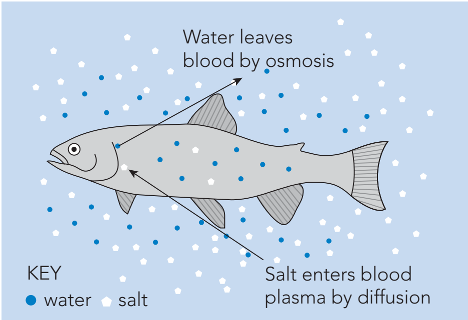
8.

Water Gain	Water Loss
drink	evaporation from lungs, mouth and skin
food	faeces
respiration	urine
	perspiration

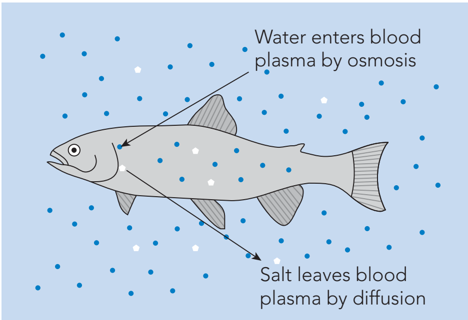
9.

(i) *Marine fish are surrounded by water that has a higher concentration of dissolved salts than their blood plasma and body fluids. It is hypertonic. Freshwater fish are surrounded by water that has a lower concentration of dissolved salts than their blood plasma and body fluids. It is hypotonic.*
Water will therefore tend to leave the body of the marine fish by osmosis and salts will diffuse into the body (through membranes like the gills and the mucosa of the gut). Water will tend to enter the body of the freshwater fish by osmosis and salts will leave by diffusion.
The marine fish tends to lose water and gain salts while the freshwater fish tends to gain water and lose salts. Each therefore requires different adaptations to cope with its respective water and salts problems.

(ii) Marine environment



Freshwater environment



(iii)

- *Marine fish may actively secrete salt from cells in their gills.*
- *Marine fish often excrete concentrated urine.*
- *Marine fish may drink sea water, extract and retain the water and excrete the salt.*
- *Some marine fish (cartilaginous) retain urea in their blood plasma to raise the blood's osmotic pressure and reduce the loss of water via osmosis.*

(iv)

- *Freshwater fish actively transport salts from the water across their gills and into their blood plasma.*
- *Freshwater fish excrete copious quantities of dilute urine.*
- *Freshwater fish avoid drinking water.*

10.

Behavioural Adaptations	Physiological Adaptations	Structural Adaptations
In dry hot areas mammals may be active only at night – nocturnal, e.g. bandicoots (most other desert mammals)	Some animals rely on the water produced in the respiration of carbohydrates. They may not need to drink, e.g. Desert Hopping Mouse	Kidneys may have a capacity to reabsorb more water from urine than normal by having a very long loop of Henle in the nephrons, e.g. Spinifex Hopping Mouse
Many animals burrow and spend the hottest times underground. This reduces water loss, e.g. Great Desert Skink	Some animals are able to tolerate a much higher concentration of solutes and wastes (e.g. urea) in their blood plasma, e.g. desert frogs	Some animals have special glands to secrete excess salts, e.g. Mountain Duck. Others have modified respiratory tracts that maximise the reabsorption of water from exhaled air, e.g. Kangaroo Rat

11.

	Adaptation Which Contributes Towards an Organism's Homeostasis	S, P or B
(i)	A bird's core body temperature becomes much lower than normal. A hormone causes its cells to metabolise more rapidly.	P
(ii)	People who are born and live in mountainous regions at very high altitudes normally have lungs with a greater number and density of alveoli than people in lower lying regions of the world.	S
(iii)	An animal takes refuge in a cool dark cave during the hottest part of the day. This increases its heat loss.	B
(iv)	The level of urea in a carnivore's blood rises following a meal. Its kidneys filter and remove the urea forming concentrated urine.	P
(v)	A person goes without food for five hours. Her liver begins to break down stored glycogen into glucose and releases it into her blood. This provides a source of energy until her next meal.	P
(vi)	During the winter months a polar bear has a thick covering of hair that reduces heat loss.	S
(vii)	A lizard moves out of the shade and basks on a rock during the day to raise its core body temperature.	B
(viii)	On a cold day the blood vessels in a person's skin constrict reducing blood flow near the surface of their skin and thereby reducing heat loss from the body.	P
(ix)	Some herbivores (non-ruminants) may eat their droppings to extract more nutrients from their food.	B
(x)	Due to a rodent's increased activity, the carbon dioxide level in its blood rises. This change is detected by chemoreceptors in its brain stem and results in the rodent involuntarily breathing more deeply and rapidly.	P
(xi)	A desert reptile coverts ammonia to uric acid as a means of excreting its nitrogenous waste. Uric acid can be voided to the external environment with little water loss.	P
(xii)	Some trees that live in very hot dry climates shed their leaves in late spring and grow new leaves when the weather begins to cool. This reduces water loss during summer.	P

4.4 Plant adaptations for stability

Terminology

(i) flaccid – a condition of cells when they lose water and become soft and limp.

(ii) halophyte – a plant which is adapted to live in a salty environment.

(iii) leaf cuticle – a waxy substance secreted by the epidermal cells of a plant leaf which reduces the rate of water loss from the leaf.

(iv) phyllode – a flattened stem or petiole which photosynthesises and therefore functions as a leaf but with fewer stomata. This is an adaptation possessed by xerophytes, e.g. acacia (wattles), in which the leaves are often reduced to spines or prickles.

(v) salinity – a measure of the salt concentration in a liqiud.

(vi) stoma – (plural stomata) an opening or pore for gas exchange in the epidermis of a leaf or stem which is created by two guard cells.

(vii) succulent (plant) – a plant which has water storing cells in either or both its leaves and stem. This is a xerophytic adaptation.

(viii) turgid – describes a cell which is filled with water. Plant cells become turgid when surrounded by distilled water but do not lyse because their cell wall prevents this from occurring.

(ix) xeromorph – a plant which is adapted to survive almost total dehydration, e.g. some plants which live in very dry areas like granite outcrops over the summer.

(x) xerophyte – a plant which is adapted to live in a dry environment. It may have reduced leaf size, phyllodes instead of leaves, stomata on one side of the leaf only, water storage cells, leaves reduced to spines, thick waxy cuticle, extensive root system, mallee form of growth.

Review Questions

1.

(i) The cells lose their turgidity, they become flaccid. As a result, the plant wilts and if the cells continue to dehydrate, eventually the cells (and the plant) will die.

(ii) The cells become turgid; this is not normally a problem as this helps the plant remain rigid, with its leaves well presented towards the sunlight.

2.

(i) If the cells begin to dehydrate, they become flaccid; the stomata close and this reduces further water loss through the transpiration stream. However, it does not stop the loss altogether. The plant must always have some water available to it (unless it is xeromorphic).

(ii) If the stomata are closed, this prevents carbon dioxide entering the plant. If the plant has no store of carbon dioxide, its photosynthesis will slow down and cease.

(iii) (a) Long narrow leaves – reduces S.A. exposed to the sun's heat.
(b) Reduced numbers of stomata – less stomata from which water can be lost.
(c) Recessed stomata – creates a humid microenvironment which slows water loss through evaporation from stomata.
(d) Stomata located only on the underside of the leaf – reduces rate of evaporation from the upper surface.
(e) Hairs on the leaf – reflect sun's heat and reduces the temperature of the leaf – and therefore the rate of water evaporation.
(other features – thick waxy cuticle, leaves that hang vertically, leaves reduced to spines – photosynthetic stem, stomata which close during the hottest part of day, leaves that fall – deciduous during the summer, phyllodes instead of leaves).

(iv) (a) An extensive, large root system which taps water from a large volume of the soil – maximises the intake of water from the soil.
(b) Roots which form a network along the surface of the soil – these absorb any dew which may form at night.
(c) Tap roots – a long root which generally grows down in the opposite direction to the stem or trunk and penetrates the aquifer or ground water – this increases water gained by the plant, even in a dry climate.

(v) (a) The stem may have cells which store water – succulent plants commonly possess this adaptation (their leaves may also store water).
(b) The stem may carry out photosynthesis but it has very few stomata from which to lose water by evaporation (e.g. cacti).

3.

(i) Root hair cells are plant cells which have an extension of the protoplasm which gives them the appearance of having hair. They are located in an area just behind the growing tip of a root.

(ii) The extension (or 'hair') gives the root hair cell a large SA:Vol. This increases the rate at which the cell can absorb minerals and water.

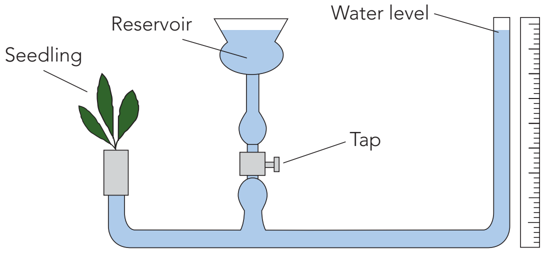
4.

(i) Atmospheric humidity: higher humidity reduces evaporation rate.
Temperature: increased temperature increases evaporation rate.
Wind speed: increased wind speed increases evaporation rate.

(ii) - density of stomata on leaf surface
- location of stomata, i.e. only underside of leaf, only upper surface or on both sides

- amount of waterproof wax cuticle on leaf surfaces
- shiny hairs on leaves may reduce evaporation
- stomata may be deeply recessed into leaf
- stomata may only be open at night in some plants, carbon dioxide is taken in during the night for photosynthesis during the day
- reduced leaf surface, e.g. sheoak has long cylindrical leaves
- some leaves roll up to reduce surface exposed to atmosphere and enclose stomata
- leaves which hang vertically are not exposed to the full intensity of the sun during the middle of the day when evaporation is at its greatest.

(iii) A ***potometer*** *may be used to measure the rate of transpiration from a plant.*
A leafy shoot is placed in the apparatus as shown below.



The rate at which the water level moves down is dependent on the rate at which water evaporates from the leaves.

(iv)
Light coloured pigments in leaves that reflect heat.
Hairs that reflect heat.
Leaves that hang vertically.

(v) When significant rain falls over a short period, their seeds germinate and grow quickly while the available moisture is present. This may last for only a few weeks and accounts for the profusion of wildflowers which sometimes occurs for a short time in desert areas. The seeds must be heat and drought tolerant to survive long, hot, dry periods.

5.

	Structural Adaptations	Physiological Adaptations
XEROPHYTE	Extensive root system to maximise water absorption.	Leaves curl in hot weather to minimise surface area exposed – reduces water loss.
	Stomata on the underside of leaves only to minimise water loss.	Stomata close during the hottest part of the day to minimise water loss.
	Leaves reduced to spines – photosynthesis takes place on stem – less stomata on stem – minimises water loss.	Rapid life cycle – during wet weather, flowering and seed formation takes place within a few weeks. Seeds then remain dormant until next rains. Plants avoid water loss in hot weather.
HALOPHYTE	Salt glands on the leaves that store salt – when levels become too high these leaves are shed.	Germination in wet weather, as seedlings are then surrounded by less saline conditions.
	A root epidermis that excludes salt ions from entering the plant.	Store salt in the seed coat in order to limit salt contact with the embryo.
	A special vacuole in cells that stores salt, thereby excluding it from the rest of the cell.	Cells that are tolerant to much higher levels of salt than non-halophytes.

5. INFECTIOUS DISEASE

5.1 Infectious disease and pathogens

Terminology

(i) bacterium (plural: bacteria) – microscopic organism which has no membrane bounded organelles. Bacteria are therefore called prokaryotes.

(ii) communicable (disease) – able to be transmitted from one organism to another. Disease that is communicable is described as infectious or contagious.

(iii) fungus (plural: fungi) – a member of a kingdom which is mostly multicellular, forms threadlike filaments called hyphae from spores. The hyphae branch to form a network called a mycelium. The cell walls are chitin and the organism is heterotrophic.

(iv) host – an organism in or on which a parasite lives.

(v) pathogen – a disease causing agent, e.g. bacterium, virus, protista, fungus.

(vi) prion disease – an infectious disease caused by a small protein called a prion that has a distinct folding structure. It causes other similar proteins to fold when it infects mammals. Prions cause diseases associated with the nervous system, e.g. Mad Cow disease and other mammalian encephalopathies (diseases that affect the brain and nervous system).

(vii) protista – a single-celled eukaryotic organism, e.g. protozoa, eukaryotic algae.

(viii) transmission – the way in which a communicable disease spreads.

(ix) virus – a structure comprised of a protein coat and a core of either DNA or RNA. Viruses can only reproduce in host cells and are therefore all regarded as pathogenic parasites.

(x) zoonosis (plural: zoonoses)– a communicable disease of animals that can be transmitted to humans, e.g. Ross River virus disease, Ebola virus disease.

Review Questions

1. *A disease is any malfunction of the body or part of the body of an organism.*

2.

(i) *Infectious diseases can be transmitted from one organism to another. Non-infectious diseases cannot be passed to another organism. Infectious diseases are caused by pathogens whereas non-infectious diseases are not.*

(ii) *(a) Deficiency diseases in plants, often caused by a lack of trace elements in the soil.*
(b) Diabetes a condition in which either the liver does not respond to insulin or the pancreas does not release sufficient insulin for normal glucose metabolism.

(iii) *A pathogenic organism causes a disease in an organism (its host). A non-pathogen does not cause disease.*

(iv) *(a) Not all pathogens are microorganisms some pathogens are macroscopic, e.g. tapeworms, nematodes. Viruses, the cause of many diseases, are not considered true microorganisms because they rely on the chemistry of a host to reproduce them. Prions are proteins.*
(b) Many microorganisms do not cause disease. Most bacteria and fungi are essential for the decay of dead plants and animals and the recycling of nutrients to the abiotic environment.

3.

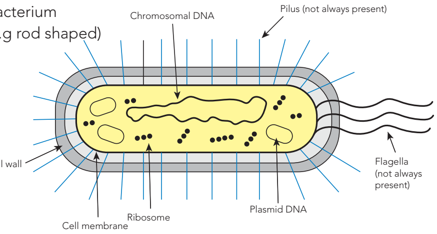
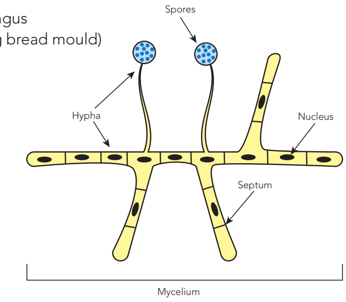
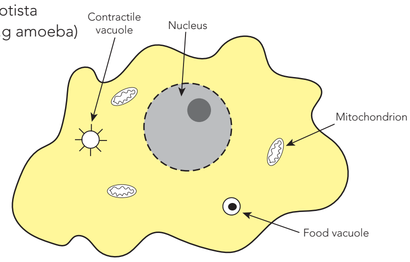
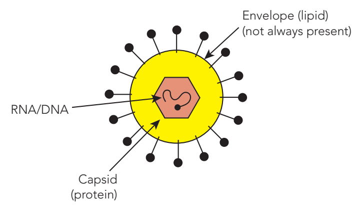
Mode of Transmission	Example in Human Populations
(i) Through direct contact	Sexual contact, e.g. herpes virus, gonorrhoea bacterium
(ii) From an object	Intravenous needle used by an infected person then used by someone else who becomes infected, e.g. HIV, hepatitis virus
(iii) Via a vector	Mosquito vector – mosquito carries the pathogen from an infected host to another uninfected person, e.g. Ross River virus, malaria protozoan
(iv) From airborne droplets	Droplets created by sneezing or coughing – the infected person releases warm droplets containing the pathogen into the air – an uninfected person inhales these droplets with their pathogens, e.g. influenza virus, tuberculosis bacterium

4.

(i) *A zoonosis is a disease that can be passed from an animal to a human, e.g. Hendra virus disease can be transmitted from a horse to a human. Other pathogens are not able to be transmitted from animal species to humans.*

(ii) *(a) Rabies and bird flu (avian influenza) (b) Salmonella and anthrax*

5.

Group	Structural Features	Diagram
Bacteria	Microscopic single-celled prokaryotes. They do not have membrane bound organelles and nuclei. Have a cell wall which is made of sugars and amino acids. Four basic shapes – spherical, rod shaped, spiral and filamentous. Single "doughnut" shaped DNA molecule.	Bacterium (e.g rod shaped) 
Fungi	Generally multicellular with a few unicellular exceptions, e.g. yeast. Most consist of branching threads called hyphae forming a mass called the mycelium. The hyphae are usually divided along their length by walls called septa that have pores in them to allow nutrients to pass from one cell to the next. The cell walls are composed of chitin, a carbohydrate.	Fungus (e.g bread mould) 
Protistas	Eukaryotic cells but with no complex systems. Either unicellular, e.g. protozoa or multicellular e.g. kelp. Protozoa have a variety of shapes depending on their locomotion, e.g. amoeboid, flagella or cilia. Those protistas that are parasites generally have no means of moving themselves.	Protista (e.g amoeba) 
Viruses	Much smaller than bacteria – at least half or as small as one hundredth the size. Consist of RNA or DNA molecule encased in a protein layer (or two protein layers) which may be covered by a lipid layer. They vary greatly in shape.	Virus 

6.

Disease	Host/s	Description – Signs and Symptoms	Pathogen Group
Chytridiomycosis	Amphibians e.g. frogs	Causes a loss in body weight, lethargy, changes in the skin colour, shedding of skin, convulsions and death.	Fungus
Crown Gall of Plants	Stone fruit, roses, grapes, olives, etc.	Small pale lumps on upper root or stem that develop into large asymmetrical growths that may stunt the growth of a young plant and may kill plants that are stressed in dry conditions.	Bacterium
Influenza	Many different animals (birds and mammals including humans)	In humans, fever, sore throat, "runny" nose, cough which may persist and gradually worsen for several weeks, headache, muscle pains and lethargy.	Virus
Phytophthora Dieback	Many native species of plants e.g. banksias, grass trees, eucalyptuses	A plant's leaves may wilt, this can occur in the outer leaves first and death of the leaves progresses inwards towards the trunk. Roots may darken in colour. Most plants die, especially if under water stress.	Protista
Tuberculosis	Humans, cattle, pigs, cats, birds, dogs	In humans, chronic cough, coughing blood, lethargy, sweating, loss of weight.	Bacterium

7.

(i) *Ross River virus (RRV) may be transmitted by a mosquito, acting as a vector, from an animal (e.g. kangaroo) to a human. The disease causes stiff painful joints like arthritis, a rash and swollen lymph nodes. The joints may be painful for several months or even longer, seriously reducing a person's mobility.*

(ii) *Viral diseases of honeybees: there are many viral diseases that affect bee hives. They are thought to be transmitted by mites. Sometimes these are believed to cause the collapse of the hive. In many regions of the world this has lead to a shortage of honey and a serious reduction in plant pollination.*

8.

(i) *Direct transmission may occur through touching, kissing or sexual contact with infected person. Indirect transmission may occur through handling an object, e.g. a blanket that has been in contact with an infected person, through inhaling airborne droplets that are spread by an infected person when he coughs or sneezes or through being bitten by an insect which has previously fed on an infected animal or person.*

(ii) ***Direct***

(a) HIV may be transmitted from one person to another through unprotected sex, either during heterosexual or homosexual intercourse. The virus passes from body fluids (e.g. semen) of an infected person across the mucous membranes of the newly infected person. (Note: this is not the only mode of transmission of this virus).

(b) The Cold Sore virus (Herpes simplex). A person who has an active cold sore especially in the first few days of a blister can transmit the virus by kissing another person on the lips or on the eyes.

Indirect

(a) The Ebola virus can be transmitted if the blood, semen, vomit or faeces of an infected person is touched and contacts the mucosa of an uninfected person.

(b) Crown gall bacteria can remain in soil for two years (or more if attached to decomposing galls in the soil). This bacterium can infect new plants especially if the new host has damage to its roots or lower stems. It is likely to be carried to the wound site by soil water or contaminated soil.

9.

(i) *They may burrow through the dog's skin when the dog is lying on the ground.*

(ii) *They feed and develop into the adult stage.*

(iii) *They pass out of the dog in it faeces.*

(iv) *Many will die but some may infect another animal, e.g. another dog.*

(v) *The mode of transmission is indirect. The larvae are in the soil and pass through the skin of the newly affected dog without that dog coming into direct contact with the infected dog.*

(vi) *(a) Infected dogs could be treated with an appropriate drug to eliminate the adult hookworm and prevent it producing eggs that are passed out in its faeces.*

(b) This may require all dog owners to treat their dogs with the drug. This would remove the problem in any area in which this strategy could implemented. Wild dogs may provide a challenge that would not be easily solved.

10.

(i) *The mosquito is the vector.*

(ii) *They destroy liver cells, lyse (burst) red blood cells and release toxins into the human host's blood.*

(iii) *Malaria symptoms include a fever, hot and cold spells and shaking, headaches, muscle aches and weakness (not unlike a serious flu).*

(iv) *This would interrupt the parasite's life cycle. It would not be in the interests of the protozoan's survival as a species to kill its host quickly.*

(v) *Sporozoites → Merozoites → Gametocytes Ookinete → Sporozoites.*

(vi) *Removing the mosquito would break the* ***Plasmodium*** *life cycle and eliminate the spread of the disease. (Until this happens the development of a vaccine for malaria is a pressing need).*

(vii) *Those people who are infected by the protozoan could be treated with drugs to remove it from their systems. The development of an effective vaccine would greatly reduce the incidence of malaria.*

Infected people should avoid exposure to mosquito bites: cover up and use repellants. Uninfected people should also use repellants and wear clothing that covers them well especially at times when mosquitoes are most active.

11.

(i) *Dogs and cats which eat food on soil that is contaminated with the roundworm larvae.*

(ii) *Larvae move from the host's intestines into its blood. From the blood they move into the lungs.*

(iii) *Because they absorb nutrients from their hosts' intestines, reducing the food available to their host.*

(iv) *No, its health is compromised.*

(v) *The host provides a safe, protected, stable environment for the worms own reproduction and also the nutrients that the worm needs to mature.*

(vi)

- *The roundworm larvae live in the soil; it is natural for dogs and cats to eat food which is on the ground and therefore ingest this pathogen with their food.*

- *The respiratory system is well placed with the digestive system in the host animal to allow the larvae to move from the lungs into the intestines (from trachea into oesophagus).*
- *The host's digestive tract provides all the nutrients essential for the parasites development from larvae into sexually mature adults.*
- *The eggs produced in the host's intestines can remain in the soil with the dog's faeces until conditions are suitable for their development into larvae.*

5.2 Spread and transmission of infectious diseases

Terminology

(i) climate change – the gradual change in the weather patterns over time. Change may be accelerated greatly by air pollution (greenhouse gases, e.g. carbon dioxide, methane).

(ii) endemic (disease) – a disease which is regularly found in a particular population.

(iii) epidemic – is the rapid spread of a communicable disease in a given population to a large number of organisms.

(iv) immunity – capacity of an organism to resist disease by means of its immune system.

(v) mosquito-borne (disease) – a disease that is spread from one organism to another by mosquitoes acting as vectors.

(vi) pandemic – is the rapid spread of a communicable disease from one population to other populations over large regions. Usually refers to intercontinental spread in human populations.

(vii) population density – the number of individuals of a particular species in a given area (or volume) in an environment at a particular time.

(viii) population growth – a measure of the rate at which a population is increasing at a particular time.

(ix) urban environment – an environment in which people have aggregated in towns and cities.

(x) vector – an intermediate host which carries a pathogen from one organism to another.

Review Questions

1.

(i) Growth of the pathogen population:

An increase in a pathogen population is likely to result in an increase in the spread of a particular disease.

A soil pathogen like Phytophthora which causes dieback in plants may increase in numbers because the weather conditions become wet and warm. Its zoospores are able to spread in soil water from an infected plant to many uninfected plants nearby, especially those at lower levels in the landscape as the water flows downwards. The zoospores are motile but water movement is thought to increase their speed. Once new plants are colonised by the ***Phytophthora****, it will grow and produce more zoospores which infect more plants in the same manner.*

(ii) Density of the host population:

Where a host population is dense the spread of an infectious disease is likely to be more rapid than if the host population was less dense. Other factors do play a role and there are exceptions to this depending on the mode of transmission.

In human populations infectious diseases usually spread more rapidly in urban areas than in rural areas. This is because an infected person is likely to be near more people in any given time period than an infected person in a rural environment e.g. a person with influenza who is coughing is more likely to expose a greater number of other people to airborne droplets in a city. There are more opportunities for the transfer of the pathogen to occur.

(iii) Mode of transmission:

The mode of transmission also affects the spread of a disease. Some disease spread rapidly as they are highly contagious.

The Ebola virus can move from one person to another very quickly. This is due to the large quantities of the virus released from the infected person in body fluids, blood, semen, vomit, saliva, tears and faeces. It does not appear to be transferred by airborne droplets.

HIV does not spread rapidly. Because it is disrupted by exposure to the air, its rate of transmission is reduced.

If the disease is spread by a vector, the density of the vector population and the availability of the pathogen in reservoir hosts, largely determine how rapidly it will spread. This applies to the Ross River virus; cases increase significantly in human populations when conditions suit the growth of mosquito populations (wet warm weather) provided the virus is present as a reservoir in nearby kangaroos and other animals.

2.

(i) Organisms that move from one area to another and integrate with an existing population may carry diseases with them and infect the host population.

The spread of the rabies virus in dogs and other animals appears to have occurred from east to west across Europe in past centuries. In developed countries it is now well controlled but it can be spread when dogs that are not vaccinated are illegally moved across borders avoiding quarantine.

Domestic dogs which carry intestinal parasites can introduce them to wild dog populations when they roam into wild dog territories (infectious diseases can also be transferred the other way).

(ii) *Human movement can also transfer infectious diseases from region to region. This is more relevant in recent times as people travel more for work, leisure and migration.*

(iii) *This was due to the strategy adopted to control the spread of the disease. It was thought that if some people who had had contact with the infection or even had early symptoms did not disclose this fact because of a need to travel, the disease would spread more rapidly. If regulations prevented the free travel of people from areas where the infection had been reported many people would move illegally and authorities in these areas could not prevent them from doing so. Legal movements could be monitored more effectively.*

3. *Where people become lax or object to immunisation and significant numbers do not become vaccinated against an infectious disease the population as a whole becomes vulnerable to infection again; the disease usually still exists in reservoirs (animal or human). Often it can mutate and present a new and greater threat.*

4. *Yes. The avian or bird flu is caused by viruses found in wild birds that can affect poultry with a more damaging impact because the domestic birds are kept in closer contact with one another. Some strains of the virus are transmitted to people who handle infected or dead birds. However, they do not appear to transfer easily from person to person. If a bird flu virus was to merge with a human strain of the influenza virus then it would probably become as easily transmitted from person to person as the influenza virus. Its impact on human populations could be very serious depending on its severity.*

5.

(i) *Indigenous populations living in isolation for thousands of years, had not been exposed to these diseases prior to European arrival. The indigenous populations would have had few individuals with an inherited resistance (gained through natural selection over many years).*

Europeans had through hundreds of years and many, many generations developed a resistance or partial resistance to many diseases. Aboriginal populations had not been exposed to serious infections like smallpox, tuberculosis and venereal diseases (e.g. syphilis and gonorrhoea); these diseases are believed to have decimated many of their populations soon after contact with the early settlers. Other diseases less severe in Europeans, e.g. influenza, measles and whooping-cough, also took a heavy toll.

(ii) *The indigenous populations need greater health care, more of the indigenous population need vaccinations and access to appropriate medications, especially for those diseases that they are more likely to contract. More education in the need for initial vaccinations and boosters is also required.*

6.

(i) *Animals that can move freely from one region to another, e.g. birds, flying insects, bats.*

(ii) *(a) Psittacosis is a disease in humans caused by a bacterium carried by parrots, canaries, pigeons and poultry. Humans who inhale the dust from infected birds' feathers or dropping may develop a lung infection caused by this bacterium.*

(b) One form of sleeping sickness is caused by a microscopic single-celled protozoan called trypanosomes. It is carried from person to person by a flying insect called the tsetse fly. The fly has a long proboscis that it uses to extract and feed on human (and other vertebrate) blood. In drawing the blood from an infected person and then biting another uninfected person the disease is transferred by the tsetse fly. Sleeping sickness is endemic in central Africa.

7.

(i) *Developing countries generally have inadequate health services that are located mainly in the larger cities.*

When an outbreak of a serious infectious disease occurs, diagnosis of new cases is usually slow as specimens, e.g. blood, faeces, urine, may take some days to reach the appropriate medical laboratory and by that time the infectious person may be seriously ill and have transferred the pathogen to many others.

In developed countries medical facilities are more accessible, often new cases can be identified before they become infectious. The rapid spread of the infectious disease can be reduced and in most instances stopped.

(ii) *The density of the population in Kolkata, India is higher than in Sydney, the health care services are mostly inferior and the general health of many of the poorer people (due in part to poor nutrition) is below that of people in Sydney. Therefore the spread of the disease will be more rapid, the response by health care services slower and less effective and the susceptibility of the people on average greater. These factors are all likely to contribute to any outbreak of infectious disease becoming more serious in Kolkata than in Sydney.*

8.

(i) *Many diseases spread in the soil, e.g. Panama disease, a serious fungal disease in bananas. Some pathogens spread by means of spores carried in the wind, e.g. bacterial and fungal spores. Some are carried by animal vectors, e.g. bees, birds.*

(ii) *As with other organisms, plants are susceptible through areas of broken tissue. In plants these may occur through wind damage, herbivores feeding on leaves or through other natural causes. An opening in the bark or leaves can allow the entry of bacteria or fungi.*

The roots may be affected by some diseases, e.g. Phytophthora a protista that moves in soil water, prevents a plant taking up sufficient mineral ions and water from the soil.

Some diseases affect the vascular system, which therefore prevents the movement of water and ions up to the leaves (e.g. Dutch elm disease caused by a fungus) or the movement of sugar in the phloem (e.g. bacteria and viruses). The latter are often introduced via a vector like an aphid that pushes its proboscis into the phloem to withdraw the sugar.

Other diseases affect the leaves, reducing the plant's capacity to photosynthesise, e.g. powdery mildew, a fungal disease that affects many plants and results in the loss of infected leaves.

(iii) *In regions that have become hotter and dryer many plants including large trees have begun to show water stress. They often lose leaves and exhibit slower growth. In some areas many trees have died.*

Plants that are under water stress are also more susceptible to diseases. Just as animals that are in poor health or have compromised immune systems are more prone to disease, so too are plants.

9.

(i) *In humans – malaria, yellow fever, Ross River virus, dengue fever, Barmah Forest virus and Murray Valley encephalitis. In dogs – heart worm. In horses – equine encephalomyelitis.*

(ii) *They rely on blood as food. They push their proboscis into a small blood vessel of an infected animal drawing blood and sometimes pathogens from the host. They then feed on a second animal. In drawing blood from the second animal the pathogen collected from the first moves into the new host thereby infecting this second animal.*

(iii) *Many areas are experiencing heavier and more frequent storms. More water remains pooled on road verges, in lakes and swamps for longer periods. In warmer areas these are perfect conditions for the growth of mosquito populations.*

(iv) *Mosquito-borne diseases may become more prevalent in areas which are experiencing heavier rain and more frequent storms as an increase in mosquitoes may enable the spread of these diseases to occur at an increased rate.*

10.

(i) *More extremes of temperature, particularly longer hotter summers are likely to cause heat stress especially in the very young and the elderly. The frequency of flooding and cyclones in some areas of the world is likely to reduce crops and damage plantations. This may result in less food and an increase in malnutrition especially in poorer countries. The general health of many millions of people may therefore deteriorate.*

(ii) *Some infectious diseases are likely to spread more rapidly as people become more susceptible to them due to their poorer health. The frequency of epidemics may also increase.*

5.3 Evolution of pathogens and controlling the spread of infectious diseases

Terminology

(i) *antibiotic – a drug used to treat (kill or inhibit) infections of microorganisms without seriously affecting the host.*

(ii) *antiviral – a drug used to treat a viral infection.*

(iii) *attenuated pathogen – a pathogen with a reduced virulence, i.e. it does not produce the severe symptoms of the disease but causes the body to produce antibodies that resist the disease and the body to develop an immunity to the disease.*

(iv) *cure – the successful remedial treatment of a disease.*

(v) *influenza – a common infectious disease in human populations caused by the influenza virus. Transmitted from the sufferer through coughing or indirectly by first touching objects which have the virus on them.*

(vi) *immunisation – a process which provides an organism with the capacity to resist a particular disease. This is brought about by the development of antibodies in response to a particular antigen associated with the pathogen.*

(vii) *life cycle – the changes which an organism undergoes in passing through its development. In sexually reproducing organisms this follows the pathway from adult to gametes to juvenile and back to adult.*

(viii) *resistant strain (bacterial) – a variety of pathogenic bacterium that is no longer affected or much less affected by a particular antibiotic.*

(ix) *tumour – an abnormal growth of cells that divide uncontrollably and has no use in the body. A tumour may be benign or malignant.*

(x) *vaccine – an antigen preparation that may contain attenuated pathogens, just parts of the pathogen, dead pathogens or the toxins that have been made safe (toxoids) from the pathogen. These are generally injected into an animal (including human) so that it develops an immunity to the disease caused by the particular pathogen.*

Review Questions

1. *Older people generally have less efficient immune systems. As a result they become more susceptible to infectious diseases. They are more prone to become seriously ill with the flu. The influenza virus also frequently mutates and the previous year's vaccination may be ineffective against a new strain of the virus. In order to avoid the risk of contracting the disease elderly people are therefore encouraged to have annual vaccinations.*

2.

(i) *The rate at which bacteria divide and reproduce in ideal conditions is about once every twenty minutes. This means that there are huge opportunities for these microorganisms to mutate. New strains are produced constantly and the opportunity for a more virulent strain is ever present.*
Viruses which contain RNA, e.g. influenza, HIV, mutate at a rapid rate. A new strain has an opportunity to avoid being recognised and attacked by the host's immune system. Therefore these viruses are constantly evolving.

(ii) *Pathogens generally develop a resistance to the drugs. As they mutate, normally at a very frequent rate, those mutants that have any degree of resistance to a drug will survive better when subjected to that drug than the normal strain. A new generation that is resistant is "naturally" selected. Therefore new drugs are constantly required to replace drugs that are no longer effective. Some new strains of bacteria now appear resistant to every drug available, e.g. strains of staphylococcus.*

3.

(i) *If the entire mainland population of Tasmanian Devils (where the disease is now spreading) becomes extinct in the wild, when a cure or a vaccine is developed, Devils may be translocated back to the mainland. It is therefore most important that the disease is not transferred to the island populations and they remain isolated from infection.*

(ii) *The disease is highly contagious and is believed to be transferred through direct contact often through biting. Therefore, if healthy animals are isolated effectively they should avoid infection.*

(iii) *The dead tumour cells should be recognised as foreign by the healthy animal's immune system. The animal should then produce specific antibodies in response to the vaccine and more importantly memory cells that will be retained in the animal's lymphatic system. Later, should the animal become infected with a virulent form of the disease, the memory cells are likely to produce a rapid response, e.g. a strong production of antibodies that could protect it and prevent any serious symptoms from developing.*

4.

(i) ***Quarantine*** *regulations help to prevent specific pathogens from crossing borders. For example, fresh bananas are a prohibited import into Australia. This is to avoid the importation of diseases that affect bananas grown in other countries. Particularly serious is the threat of Panama disease a fungal disease which wipes out plantations of bananas. At present the fungus cannot be removed from contaminated soil.*

(ii) ***Immunisation – herd immunity:*** *If a large proportion on a population has immunity to a specific disease then the small number of people who live in that population who are not immune are protected to some extent; they live in a population in which the spread of that disease will be interrupted or stopped by those who are immune. The greater the proportion of people who are immune, the greater the protection of those within the population who are not immune.*
There is therefore a strong argument that as many people in a population as possible should be vaccinated for serious infectious diseases. This mass vaccination creates what is known as "herd immunity", the whole population is protected.

(iii) ***Disruption of pathogen life cycle:*** *If a disease is spread by a vector then its transmission can be interrupted if the vector is eradicated. Ross River virus requires transmission by mosquitoes. The incidence of the disease increases in the warm, wetter months generally spring in southern Australia because there are more mosquitoes at this time.*
People working or at leisure outside during these months and especially in the late afternoon and early evening when mosquitoes are most active are encouraged to wear loose clothing that covers as much of their skin as possible and to use repellants.
Where possible, water that is left in gutters and open drains that is exposed to mosquitoes should be removed, either by local councils or individual home owners. This helps prevent mosquitoes from breeding and disrupts the pathogen's life cycle.

(iv) ***Medications – antibiotics and antivirals:*** *When patients are successfully treated, for an infectious disease, e.g. using antibiotics,* *this normally results in reduced transmission to others. When the intervention is early and ideally before the patient becomes contagious then the spread can be minimised. Treatment of people suffering from tuberculosis who have recovered using several antibiotics no longer transmit the disease to others through coughing, sneezing or laughing, although they are contagious for several weeks after the commencement of the course of drugs.*

(v) ***Physical preventative measures:*** *Isolation of patients with serious highly infectious diseases is a necessary part of the strategy to reduce the spread. Heath workers and those that care for such patients may be at greatest risk of contracting these diseases. As a result, respirators, gloves and special clothing are often worn in those areas where the patients are isolated. These measures have been employed in the recent Ebola epidemic in west Africa.*

Other physical preventative methods, depending on the particular disease, may involve the proper sterilisation of all soiled equipment, the disposal of soiled clothing and bedding and the treatment of human wastes. Condoms are a barrier to the transmission of several venereal diseases including HIV.

Early diagnosis is an essential part of this containment, as some diseases are contagious before symptoms appear.

5.

(i) ***Quarantine:*** *Sometimes diseases enter a country because of inadequate checks by customs, borders are "porous" to human and other organisms' movements, illegal activities and ignorance on the part of some travellers. Areas that are infected by dieback caused by a soil pathogen are often quarantined from the public by government agencies. However, the disease may spread when illegal entry to these areas for hunting or recreation occurs. It is carried in soil on vehicle tyres and shoes to other uninfected parts of the bush.*

(ii) ***Immunisation – herd immunity:*** *Immunisation usually protects the individual who has the vaccine. However if a large proportion of the population decide not to have the treatment for themselves or for their children, then that large proportion of the population is at risk. Epidemics become much more likely. Resistant strains are more likely to develop in these circumstances that in time can affect the vaccinated.*

(iii) ***Disruption of pathogen life cycle:*** *malaria relies on mosquitoes to transfer it from host to host. Mosquito eradication programs will not remove the disease entirely as they cannot remove the mosquito entirely. Insects become resistant to insecticides and the removal of suitable breeding places is not possible in the tropics and sub tropics where the disease is endemic.*

(iv) ***Medications – antibiotics and antivirals:*** *Pathogens frequently develop a resistance to drugs. An example, the bacterium that causes gonorrhoea is increasingly difficult to treat because it has developed resistance to a number of antibiotics that have been effective treatments in the past.*

(v) ***Physical preventative measures:*** *In spite of efforts to put barriers between infectious patients and other people, communicable diseases are still transferred to health workers and those closest to the patients. This may occur through error or ignorance of the disease. In spite of their protective clothing and masks, some health workers in west Africa including doctors have contracted Ebola from infected patients.*

6. *Each strategy involves planning and regulations by governing bodies at every level of control.*

7. *(i) cause, (ii) particular, (iii) present, (iv) all, (v) host, (vi) culture, (vii) disease, (viii) healthy, (ix) pure, (x) same.*

6. INQUIRY SKILLS AND HUMAN ENDEAVOUR 2

6.1 Science Inquiry Skills 2

Terminology

(i) *conclusion – this is the analysis of the results in an experimental report. It usually includes an assessment of whether or not the hypothesis is supported by the results.*

(ii) *controlled variable – a variable which is held constant in both the control and the experiment. It is constant in both so that it does not affect the dependent variable.*

(iii) *dependent variable – the variable in an experiment that responds to changes in the independent or manipulated variable.*

(iv) *independent variable – the variable in an experiment which is deliberately changed in order to measure its possible effect on another variable called the dependent variable.*

(v) *instrument accuracy – an estimate of how close an instrument measurement is to a "true" measurement. Instruments are never perfectly accurate; they all have a degree of error.*

(vi) *limitations of experimental design – experiments are often conducted in artificial situations, because of the cost, sample sizes may be limited and therefore may not accurately reflect the population and while hypotheses may be supported, experiments cannot measure beliefs and enable value judgments.*

(vii) *mode – the most frequently occurring number in a set of values, e.g. the mode of the following numbers – 13,6,7,19,34,7 is 7.*

(viii) *prediction – a forecast of what a future observation might be.*

(ix) research ethics – the use of moral principles to evaluate the conduct of experiments or whether experiments are morally justified.

(x) risk assessment – to determine the dangers involved before conducting a new experiment in order to plan to minimise them for the safety of all involved.

Review Questions

1.

(i) 200.

(ii) Selected without bias, chosen regardless of size, health or any other predetermined characteristic.

(iii) This was the control group, used to determine the effect of changes to the independent variable (dietary salt) on the dependent variable (blood pressure).

(iv)

- *Time of rest before measurements.*
- *Rat numbers in each treatment.*
- *Healthy rats in each group.*
- *Time of measurement after food pellet.*
- *Method of measuring blood pressure.*

(v) Dietary salt.

(vi) Blood pressure.

(vii) The rats that were given the salt (experimental group) would have an average blood pressure significantly higher than the rats that were not (the control).

(viii) The rats that were given the salt (experimental group) would have an average blood pressure the same as or significantly less than the rats that were not (the control).

(ix)

- *Repeat the experiment a number of times.*
- *Use a larger sample size, e.g. 500 rats.*
- *Use larger and/or smaller measured amounts of salt, e.g. 2 mg, 10 mg.*
- *Use more accurate measures.*
- *Measure the blood pressure at regular intervals after the food pellets were ingested.*
- *Get others to carry out the same experiment to verify the results.*

(x) The experiment measures the effect of changes to the independent variable (salt) on the dependent variable (blood pressure) in ***rats****. However, by using rats the hypothesis has not been properly tested. A similar experiment must be safely carried out on a sample of* ***people****. It is not a valid test of the hypothesis until people are used.*

2.

(i) (a) Two similar sized greenhouses could be used. One with conditions that simulate those that exist in semi-arid climes, i.e. cool wet winters, dry hot summers, the other greenhouse conditions are made similar to those of more temperate climes, cold wet winter, warm moist summer.

(b) Into each greenhouse, hundreds of plants of many different species of xerophytic and non-xerophytic plants could be placed in pots.

(c) Each month, for one year, a sample (e.g. 100) of plants of each species could be removed, root hair cells separated and the mineral content in the cytoplasm measured by chemical means.

(d) Data collected is then entered in a suitable table.

(e) Graphical representation of the changes in mineral content in the root hair cells for both plant types in different climates could then be drawn.

(f) Comparisons of the mineral content at different times of the year in both climates in xerophytic plant root hair cells could be made.

(g) Similarly, comparisons of the mineral content at different times of the year in both climates in non-xerophytic plant root hair cells would be made.

(h) Compare the differences in xerophytic and non-xerophytic plants.

(Note: this is only one example of an investigation- there are other suitable designs.)

(ii)

		Mineral Concentration in Root Hair Cells (Arbitrary Units)																							
	Plant species	Semi-arid climate												Temperate climate											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
	A																								
	B																								
	C																								
XEROPHYTIC	D																								
	E																								
	F																								
	G																								
	H																								
	I																								
	J																								
NON-XEROPHYTIC	K																								
	L																								
	M																								
	N																								

(Note: this is an example only, the table format is dependent on the design of your experiment.)

(iii) If xerophytic plants take up more minerals in response to high rates of transpiration from their leaves, the mineral ion content in their root hair cells would be expected to increase noticeably in these cells during the hottest driest months of the year. In non-xerophytic plants, i.e. those that are not adapted to survive in hot dry conditions, the change in the mineral content of the root hair cells would not be evident.

(iv) (a) The number of plant species tested could be increased (e.g. from 7 to 14 of each type).
(b) The regularity of testing could be increased (e.g. from monthly to weekly).
(c) The experiment could be conducted over a greater length of time (e.g. extended from one year to five years).
(d) The range of artificial climates could be extended to include other climates (e.g. tropical and desert).
(e) The plants could be collected from natural ecosystems from different climatic zones (instead of using glasshouses).

(v) The discovery that only xerophytic plants take up minerals more rapidly in response to dry hot conditions might suggest that a gene controls this trait. If this gene could be isolated, then it may be possible to use recombinant gene technology to modify the genotype of crop plants so that their tolerance to dry conditions could be improved.

3.

(i) Any dangers involved in conducting a new experiment need to be evaluated before the experiment in order to minimise them for the safety of all involved.
In this experiment the researcher needs to know what pathogens she is likely to trap, how to avoid contact with all microorganisms in handling them and the safest way to dispose of any samples collected. Others working in the area need to be briefed on the nature of the experiment and warned not to interfere with it. All visitors may need to be excluded from the area while the plates are exposed.

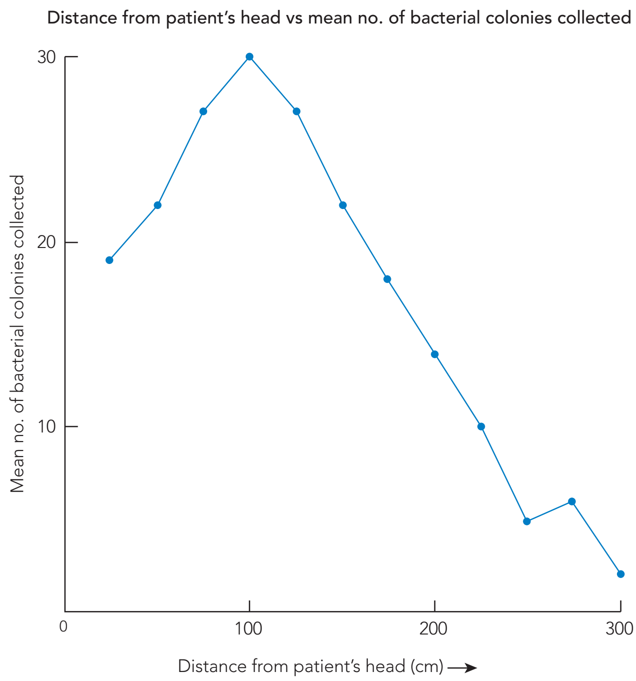
(ii) Permission could be difficult to obtain because of the risk of culturing dangerous pathogens that are likely to be collected in a hospital environment.

(iii) *The same procedure but with petri dishes set up around the beds of patients who were not suffering from a respiratory disease.*

Petri Dish Distance From Patient's Head (cm)	Number of Pathogen Colonies Observed in each Petri Dish										
	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Patient 10	Mean Number of Colonies at each Distance
25	16	25	21	16	14	28	26	7	12	23	19
50	34	18	33	13	15	43	17	14	17	12	22
75	15	9	35	12	38	61	11	34	36	23	27
100	12	54	45	5	17	26	43	33	35	27	30
125	32	43	23	8	25	36	16	38	20	26	27
150	24	13	17	8	14	46	24	46	17	14	22
175	15	10	28	0	9	31	16	26	18	17	17
200	13	15	16	0	15	28	13	15	7	22	14
225	6	16	8	1	5	16	17	11	3	15	10
250	3	6	9	0	3	7	5	9	2	5	5
275	3	7	6	0	14	9	6	11	4	3	6
300	0	5	0	0	3	7	0	2	4	0	2
Total Colonies	173	221	241	63	172	338	194	246	175	187	

(iv) *Means (rounded to whole numbers) are shown in the last column of table.*
(v) *Total numbers of colonies collected from each patient are shown in the last row of the table.*
(vi) *First write the numbers in ascending order as below.*
2, 5, 6, 10, 14, 17, 19, 22, 22, 27, 27, 30
There are twelve numbers; the middle two numbers are 17 and 19.
Therefore the median is (17 +19) /2 = 18.
(vii) *The range was from 25cm to 300 cm.*
(viii) *In view of the aim of the test, the range was inadequate as at 300 cm a mean of two colonies was collected. The limit of the spread of the bacteria was therefore still unknown.*
(ix) *Sample size at each distance was ten (10 patients were trialed at each distance)*
(x) *Each patient may have been at a different stage of the disease; some stages are likely to be more infectious than others.*
The force of air expulsion in a cough or sneeze would vary from person to person due to differences in age, general health, training and gender.
Location within the room may affect air flow around the hospital ward, e.g. proximity to windows and doors.
(xi) *(a) Patient number 6. The total number of bacterial colonies collected near this patient was 338.*
(b) Patient number 4. The total number of bacterial colonies collected near this patient was 63.

(xii)



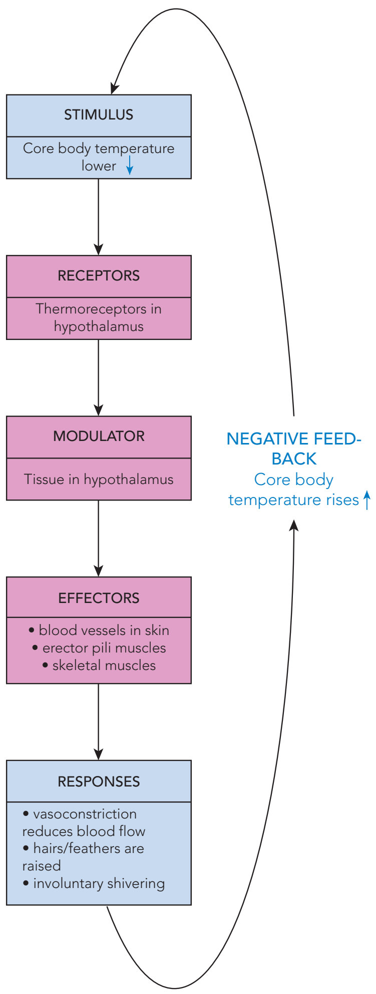
(xiii) As the distance increases to 100 cm the risk increases, beyond this distance the likelihood of infection gradually decreases (with one anomalous result at 275 cm).

(xiv) In principle this graph could help to determine a safe distance, however this was an uncontrolled experiment. The results cannot be regarded as valid.

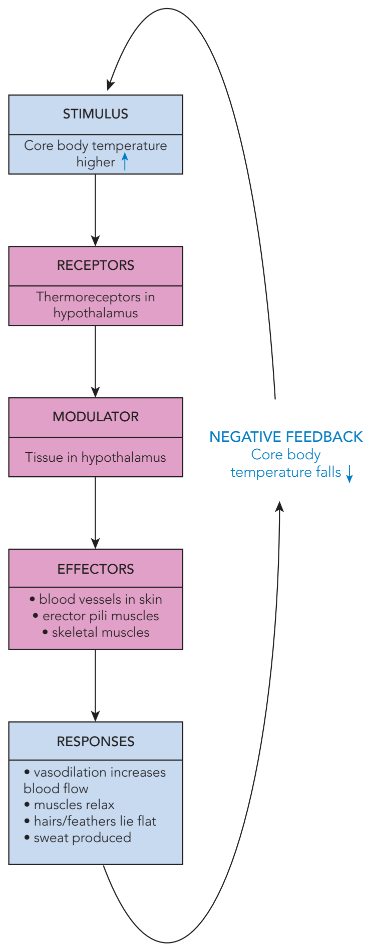
A valid experiment would also need to be conducted many more times to increase the reliability of the results.

Even if it was valid, the safe distance has not been determined as colonies (a total of 21) were collected on the most distant petri dishes (300 cm).

4. (i)



(ii)



6.2 Science as a Human Endeavour 2

Terminology

(i) developing country – a country in which incomes are low, people generally have poor living standards and there is great inequality between the few rich people and the majority who are poor. Health care and education services are inadequate. Most developing countries have a high birth rate and a high death rate.

(ii) disease intervention – the processes that health services can take in order to limit the spread of and the suffering caused by disease.

(iii) epidemic frequency – the regularity with which a particular communicable disease occurs in a population.

(iv) infectious disease – a disease that can be transmitted from one person or organism to another.

(v) living conditions – the conditions that exist in the home that include the provision of clean water, adequate nutritious food, shelter, clothing, electricity, sanitation, removal of waste, privacy and hygiene.

(vi) mucous membrane – a membrane that lines any body cavity opening to the exterior, e.g. digestive, respiratory systems.

(vii) persistence (of an infection) – an infection that lasts for a long time. It may cause a chronic condition, i.e. one that appears not to "clear up".

(viii) rural area – a less densely populated area removed from cities and towns.

(ix) susceptibility to disease – the likelihood of a person contracting an infectious disease because of their health and location.

(x) symptom – a feeling of being ill, fatigue or anxiety that is associated with an infection and is experienced by the sufferer of a disease. It is not necessarily detected by a second person, e.g. a doctor.

Review Questions

1.

(i) Zoonosis (plural:zoonoses)

(ii) Direct transfer occurs through touching, e.g. kissing, sexual intercourse.
Indirect transfer occurs when the infectious person's body fluids are transferred from an object, via a vector or in airborne droplets. An object may be a eating utensil, the vector may be an insect and air borne droplets may be from a sneeze.

(iii) The incubation period is the time between when the pathogen enters the body and when symptoms of a disease become apparent.

(iv) If the disease is diagnosed quickly before the symptoms appear, the patient can be isolated before she becomes infectious. In this way the disease is prevented from spreading to others. (However many diseases are infectious before their symptoms appear).
Early treatment of the patient generally also limits the severity of the disease and promotes recovery. In this case the person may need to rest, receive medication for secondary infections and be rehydrated.

(v) Blood samples may need to be taken, transported to a laboratory (in a city), tested and results returned to the health provider. In a developing country this whole process usually takes longer as laboratory facilities are fewer in number, further away generally and in greater demand.

(vi) Great care is needed in handling blood in order to avoid contact with open sores and mucous membranes as the virus is transferred readily by contact with infected blood.

(vii) An infectious person is likely to transfer the virus to others at a greater rate in the city than an in a rural village. In the city where the population density is greater, there are more people likely to be near the infectious person or object touched or soiled by her in a given period. The higher the rate of transfer the more rapidly the disease will spread.

(viii) The body fluids of the deceased person carry the virus for some time after they have died. Therefore transfer can still occur during these practices.

(ix) The people need to be educated about the modes of transmission of this disease and encouraged to abandon these long held traditions – perhaps by substituting other rituals which allow them to grieve.

(x) As the virus enters the body by way of mucous membranes, it may enter through the lining of the digestive tract, respiratory surfaces (although it appears not to travel via air-borne droplets), eyes or vagina. It may also enter through broken skin and lesions.

(xi) The disease is known to reside in animal reservoirs. Fruit bats are thought to be its natural host. However it can infect many other animals (monkeys, chimps, gorillas, antelopes). When infected animals are eaten or sick animals handled, their body fluids can transfer the virus to humans.
The people in poorer rural areas depend on wild meat for a portion of the protein in their diet. These people need to be educated in the safe handling and thorough cooking of this part of their diet. Ideally another source of protein needs to be sought to substitute for wild animals that may be infected. In these ways future outbreaks may be limited.

(xii) Epidemics are outbreaks of disease that occur in one country or in a limited region within a continent: in this case in several neighbouring countries in west Africa.

Pandemics cover larger regions and spread from continent to continent. If the Ebola virus disease had spread from Africa across Europe, Asia and America and even to Australia, this would be referred to as a pandemic.

This could occur if new cases were not diagnosed rapidly and isolated immediately on diagnosis until recovery. People who had contact with new cases would also need to be isolated and tested for the infection in order to stop its spread. People travelling from areas where the infection is active to other countries need to be carefully monitored and even quarantined until well after the incubation period of up to twenty-one days has elapsed.

2.

(i)

- *Mineral deficiencies, e.g. insufficient trace elements in the soil.*
- *Insufficient soil water, e.g. drought.*
- *Too much soil water, e.g. water logging.*
- *Increasing soil salt levels, e.g. due to rising watertables.*

(ii) A pathogen, e.g. bacteria, virus, fungus, nematode.

(iii) Some diseases are spread by air-borne spores, e.g. bacteria, fungi, some by insect vectors, e.g. viruses, bacteria, some move in the soil – they are motile, e.g. ***Phytothora*** *zoospores have flagella that propel them in soil water attracted by the chemicals released by the roots of plants.*

(iv) The roots, vascular tissue (xylem, phloem), bark, leaves.

(v) An insect may visit a plant to obtain sugar. It pushes its proboscis into the phloem of an infected plant and incidentally acquires a pathogen at the same time. It may then carry the pathogen to another plant and transfer it to the phloem of that plant.

(vi) The xylem carries water and minerals to the leaves. If the flow of water is interrupted by a pathogen then the first sign is likely to be leaves that wilt especially during the warmest part of the day. Over a longer period and if the plant has no water stress, the leaves will begin to show a deficiency of minerals; they may change colour often becoming yellow.

(vii) (a) The pathogen may be able to move in the soil water using cilia or flagella or be carried in the water as it flows through the soil.

(b) The pathogen may be carried by animals that dig in the soil looking for food, e.g. pigs. The pathogen may be carried on the limbs, between toes or on snouts of the animals and infect plants many kilometres away.

(viii) (a) During wet weather the pathogen may move more readily and its spread may be wider. The newly infected plants may not manifest the disease for many months. This is the case with dieback caused by ***Phytophthora****, as it is often not until the plant comes under water stress that the symptoms, leaves wilting from the crown, begin to appear.*

(b) The density and movement of animal populations that carry this disease affect its rate of spread.

These populations fluctuate and their feeding activities are determined by the season.

(ix) Plant diseases dispersed by the wind are mostly bacterial or fungal.

This is because these organisms form spores which are produced in millions, they are very light, can tolerate time exposed to the dry atmosphere and are easily carried by the wind.

(x) Plant diseases could be spread by migratory birds. But they are more likely to be carried in the soil of plants that are imported from other countries or in imported plants or products of plants (e.g. timber).

(xi)

- *Regulations prevent the importation of some fresh fruit into Australia, e.g. bananas.*
- *Timber that is imported is often fumigated to destroy beetles and nematodes, e.g. timber imported from China.*
- *The Australian Government through the Department of Agriculture has a website that is designed to educate and inform importers. This is intended to reduce the inadvertent importation of plant diseases.*
- *Pamphlets and audio visual information regarding quarantine restrictions are also made available to travellers entering Australia.*
- *Customs inspects, may fumigate or confiscate imported items that are likely to carry diseases.*

3.

(i) Persistent infections last for long periods and occur when the body's immune response does not totally remove a pathogen, e.g. human herpes virus, HIV. Some infections may last the lifetime of the host. These are generally viral diseases.

Bacterial and viral infections that become difficult to clear using antibiotics and antivirals have probably developed a resistance to the particular drugs that are being used. The drugs have selected strains that are resistant to them.

(ii) When the antibiotic is first used the drug may be very effective, e.g. 99% of the pathogens may be destroyed. The 1% that do survive because they have a natural inherited resistance to the drug may then multiply in the patient or in the environment so that the next time the drug is used to treat this disease it is far less effective.

(iii) If the patient does not complete the course of use prescribed, some bacteria, particularly those with a degree of resistance to the drug, may remain in his system. These may result in the recurrence of the disease at a later time and it will be more difficult to treat as a greater proportion of the bacteria will have a degree of resistance.

If this patient has a recurrence of the disease and passes the infection to others their treatment will be more difficult because they will have acquired the more resistant strain of the bacteria.

(iv) Pharmaceutical companies are required to develop new drugs as viruses and bacteria mutate frequently. These pathogens change regularly as they divide or are copied by their host and the adaptations that may be selected are those that give them protection from the drugs that are used to eliminate them.

4.

(i) The influenza virus is highly infectious in transferring from human to human. If this degree of contagiousness was coupled to a disease that is generally fatal to humans, like an avian flu virus, then this new strain is likely to cause many deaths.

(ii) The disease would likely become a pandemic just as the influenza virus has been in the past. Therefore, it would be a concern to all nations and require the cooperation of governments worldwide to control.

5.

(i) Quarantine restrictions help to prevent the introduction of exotic pests, diseases and weeds into Australia. All food, plant material and animal products must be declared for inspection on arrival in Australia. Restrictions also apply to each state and territory for the interstate movement of fruit and vegetables to ensure they are free of pests and diseases.

These restrictions help to avoid the introduction of new plant and animal diseases into Australia. The diseases would adversely affect agriculture. Where diseases are already present in some regions, state and territory restrictions help to limit their spread within the country.

(ii) Customs control officers inspect materials that are imported both accompanied and unaccompanied. Heavy fines are imposed where the restrictions are breached. Fines of tens of thousands of dollars can be imposed on companies and individuals can be imprisoned.

(iii) The restrictions can be breached if travellers do not read information regarding the importation of materials or if they are lax in checking carefully what they have acquired overseas. Customs officers cannot inspect every item. Therefore, it is a responsibility of every person to do the right thing. Whether the breach is intentional or not the importation of disease may have devastating effects on plants and animals both native and domestic.

The Australian border is an extensive line that encircles this very large island. People entering the country illegally (especially from the north) pose a risk to Australia's biosecurity as they may bring pets and plant material that have not been quarantined.

(iv) Plants that are cloned or grown from the same cuttings are at great risk from pathogens because they have very little genetic diversity. When a disease infects one plant seriously it is likely to have the same effect on all the other plants as they are genetically the same. The bananas that most people eat from Queensland, northern N.S.W. and Western Australia (Cavendish variety) derive from the same cuttings and are at risk of severe damage by a fungal disease called Panama disease.

SOLUTIONS TO TRIAL TESTS

Trial Test 1 – Replication, DNA & Protein Synthesis

Section One

1. *a*	11. *a*
2. *a*	12. *d*
3. *b*	13. *c*
4. *d*	14. *a*
5. *b*	15. *c*
6. *b*	16. *a*
7. *c*	17. *d*
8. *a*	18. *a*
9. *d*	19. *c*
10. *c*	20. *d*

Section Two

1.
(i) a) Telophase b) Anaphase
c) Prophase d) Metaphase

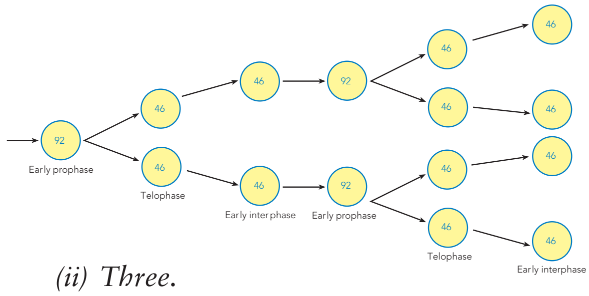
(ii) Prophase, metaphase, anaphase, telophase.

2.
(i) Cells in the interphase have a nucleus with a grainy like appearance. The DNA is not organised as chromosomes but exists as long thin molecules and is called chromatin. In the early prophase, the DNA coils into chromosomes which therefore become visible (with the aid of a light microscope).
In the prophase the nuclear membrane begins to disappear and the centrioles replicate and move to opposite poles of the cell. In late prophase spindles form and attach to the centromere of each chromosome.

(ii) Cells in the metaphase have their chromosomes arranged across the equator of the cell. In the anaphase the spindles appear to pull the centromere apart so that each chromatid is separated from its replicate and moves to opposite sides of the cell.

(iii) Telophase in plant cells is characterised by the development of a cell 'plate' which becomes a common cell wall which separates the two daughter cells. Telophase in animals results in two daughter cells which form through cytoplasmic constriction (cytokinesis).

3. *(i)*



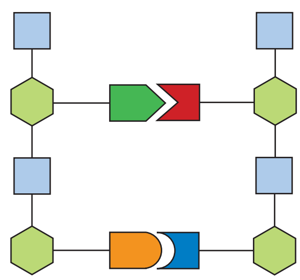
(ii) Three.
(iii) 184.
(iv) The original DNA molecules have replicated before each cell division.

4.
(i) Transfer RNA (tRNA)
(ii) DNA replication
(iii) Mother
(iv) Nitrogen bases (on template strand of DNA)
(v) Nucleoplasm
(vi) Deoxyribose
(vii) Transcription
(viii) Hydrogen bonds
(ix) Polypeptide
(x) Nucleotide.

5.
(i)
- *Each of the 46 chromosomes replicates during interphase.*
- *The result is a total of 92 chromosomes.*
- *Each daughter cell receives one copy of each pair of chromosomes. Therefore each daughter cell receives 46 chromosomes.*

(ii) From the nucleoplasm.

6.
(i) Each nucleotide shown has a different nitrogenous base.
(ii)



(iii) The genetic information is in the sequence of nucleotides.
(iv) The information is stored in the number and

order of the nucleotides. These form a code. The code is translated in the following way:

a) A section of the molecule unzips along part of its length (a gene).

b) Free nucleotides in the nucleoplasm move in to fit on to the exposed nitrogenous bases.

c) These nucleotides join to form mRNA.

d) The mRNA moves out of the nucleus through the nuclear pores and onto ribosomes in the cytoplasm.

e) The mRNA forms a 'template' on the ribosomes. The ribosome 'reads' its three bases at a time.

f) Molecules of tRNA combine temporarily to specific amino acids in the cytoplasm and deliver each to matching parts of the mRNA. Each tRNA molecule will only fit on to a particular section of the mRNA.

g) The order and number of amino acids which are assembled at the ribosome is therefore determined by the type of mRNA which is there.

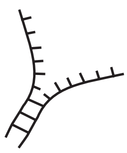
h) The type of mRNA is determined by the type of DNA which is in the nucleus. Therefore the DNA determines the type of proteins which are synthesised at the ribosomes.

7. No. Amoeba chromosomes have few genes. Each cat chromosome has many more genes than an amoeba chromosome.

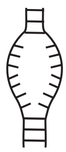
8.

(i) When protein synthesis occurs, the DNA molecule only unzips along part of its length.

e.g.



or



(ii) Adenine, uracil, cytosine, guanine.

(iii) Messenger RNA (mRNA).

(iv) It peels away from the DNA segment on which it is formed, then moves through a nuclear pore to a ribosome.

(v) Each amino acid will link to a particular transfer RNA (tRNA) molecule (like an enzyme fits its substrate). The particular tRNA has a anti-codon which will only match its corresponding codon on the mRNA. So a particular amino acid is carried to its appropriate position by tRNA.

(vi) Amino acids chemically bond to adjacent amino acids by peptide bonds.

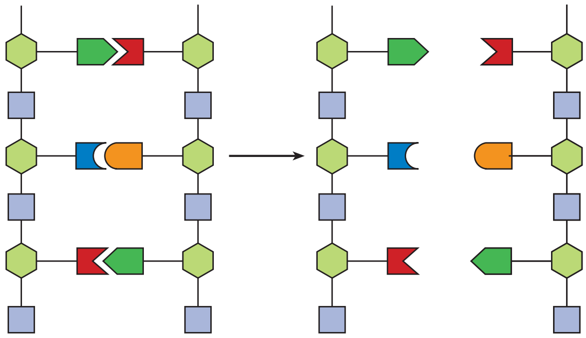
(vii) Some proteins are structural, e.g. they may form part of membranes. Many proteins are enzymes, e.g. amylase. Some proteins are hormones, e.g. insulin.

(viii) Amino acid, tRNA, proteins, mRNA, DNA.

Section Three

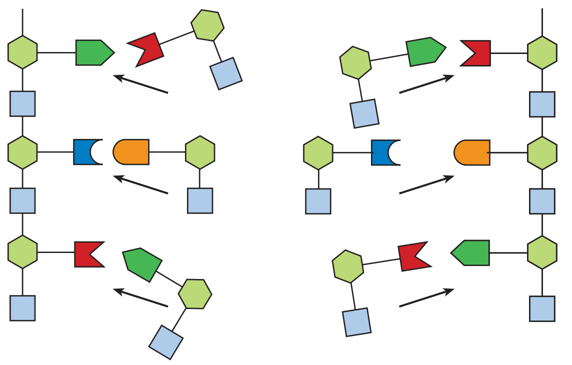
(each dot point = 1 mark unless otherwise stated).

(i) • The DNA unzips along its entire length.



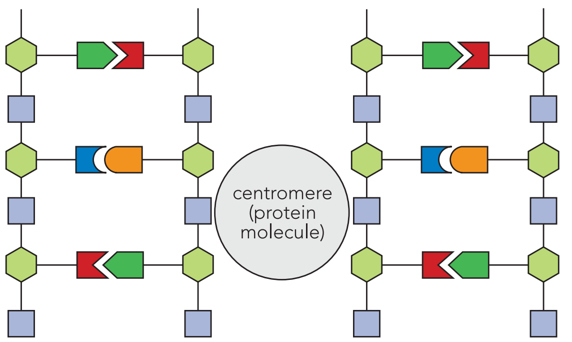
[Diagram – 2 marks]

- Free nucleotides from the nucleoplasm fill the exposed nitrogen bases.



[Diagram – 2 marks]

- The two identifical copies are held together by a centromere molecule.



[Diagram – 2 marks]

- This process occurs during the later stages of interphase in both meiosis and mitosis before any sign of cell division becomes evident.

(ii)

Transcription

- Part of the DNA unwinds and unzips.
- RNA polymerase attaches to DNA at a specific region.
- DNA code is used as a template.
- Only the template strand of DNA is transcribed.

- *Free nucleotides from nucleoplasm are used to form mRNA.*
- *mRNA forms single strand which is complementary to unzipped template strand of DNA.*
- *Uracil replaces thymine in mRNA.*
- *Transcription stops on DNA strand at a terminator sequence.*

Translation
- *mRNA attaches to a ribosome.*
- *Bases on mRNA are in groups of three.*
- *Each three is called a codon.*
- *Start codon (mRNA) indicates where the first amino acid is to be delivered by tRNA.*
- *tRNA contains an anti-codon which matches codon of mRNA.*
- *tRNA brings a specific amino acid to mRNA.*
- *tRNA anticodon binds to complimentary codon on mRNA.*
- *A peptide bond forms between adjacent amino acids.*
- *As more amino acids arrive, an amino acid chain forms a polypeptide or protein.*

Trial Test 2 – Genes, Inheritance & DNA Technologies

Section One

1. b	11. d
2. b	12. d
3. d	13. c
4. d	14. d
5. c	15. b
6. c	16. a
7. d	17. b
8. c	18. b
9. b	19. c
10. a	20. b

Section Two

1.
(i) *Between stage A and stage B, prior to chromosomes becoming visible in the interphase.*
(ii) *They pair up in the late prophase.*
(iii) *Four.*
(iv) *Two.*
(v) *Four (2^2) (provided no 'crossing over' occurs).*
(vi) *Eight (2^3) (provided no 'crossing over' occurs).*
(vii) *Sixteen (2^4) (provided no 'crossing over' occurs).*
(viii) *Stage B.*
(ix) *So that when gametes fuse to produce a zygote it has the same diploid number of chromosomes as both its parents.*
(x) *The gonads (i.e. ovaries, testes, stamens).*

2.
(i) *Autosomal and recessive*
(ii) *Both parents' genotypes are Ss.*

Parent's genotypes Ss × Ss

Punnet square

	S	s
S	SS	Ss
s	Ss	ss

∴ Probability (child is Ss) = ½ (0.5)

(iii) *Parents genotypes Ss × SS*

Punnet square

	S	S
S	SS	SS
s	Ss	Ss

∴ Probability (child is ss) = 0

3.
(i) *Recessive, X-linked*
(ii) ¼
(iii) *0*
(iv) *4 is X^HY and 3 is probably X^HX^H (as it is a rare gene, she is unlikely to be a carrier X^HX^h)*
(v)

1 X^HY	2 X^HX^h
4 X^HY	6 X^hY
10 X^HX^h	11 X^HY
12 X^hY	13 X^HY

(vi) *For a female to inherit the disease, she would have to have a father with the disease (X^hY) (which would be unlikely as haemophiliacs rarely reached maturity) and a mother who would be either X^HX^h or X^hX^h, the later being most unlikely.*

4.
(i) *Acid soil results in blue flowering hydrangeas. Alkaline soil results in pink flowering hydrangeas.*
(ii) *The phenotype of the flower is determined by both the plant's genotype and its environment.*
(iii) *The genotype is not altered by the environment. The genotype is determined by the arrangement of nitrogenous bases on its chromosomes, this is normally not affected by the environment, unless a mutation occurs.*

5.
(i) *Monozygotic twins have the same genotype.*

If monozygotic twins are brought up in different environments (as sometimes occurs if these children are separated at birth) the effects of their different diets, different parental stimulus and exercise regimes can be determined by longitudinal studies of the children as they develop and mature.

(ii) *Dizygotic twins result from two ova being fertilised by different sperm at about the same time in the female reproductive system (when they are produced naturally). They may therefore be two boys, two girls or a brother and sister. They are no more alike than normal siblings.*

6.

(i) *Stages 1 and 2 (above 90°C).*

(ii) *Stages 3 and 4 (cooled to between 50 and 60°C).*

(iii) *Stage 4.*

(iv) *These short fragments of DNA are called 'primers'. In PCR they are synthesised and added to the mixture of target DNA so that once they attach to the DNA strands, polymerase can then add nucleotides and complete the replication process. Polymerase cannot add nucleotides until the primers are attached to the strands.*

(v) *DNA polymerase.*

(vi) *It is heat tolerant – in order to separate the strands of DNA they need to be heated to a temperature of over 90°C. Therefore polymerase needs to be able to withstand these high temperatures.*

(vii) (a) $2 \times 2 = (2^2) = 4$

(b) $2 \times 2 \times 2 \times 2 = (2^4) = 16$

(c) $2^{10} = 1024$

(d) $2^{40} = 1.1 \times 10^{12}$ *(over one billion)*

(viii) *At least some of the foreign DNA would also be amplified, so that the resulting DNA produced would be a mixture which may be of little use for the purpose for which it was intended. It would be contaminated.*

7.

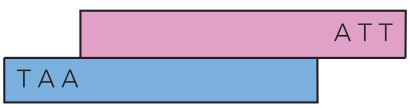
(i)

(a) They are called 'sticky' because they are able to bond to free strands of DNA which have matching codes on their 'sticky' ends.

(b) The corresponding segment of free DNA, i.e. DNA with matching nitrogen bases.

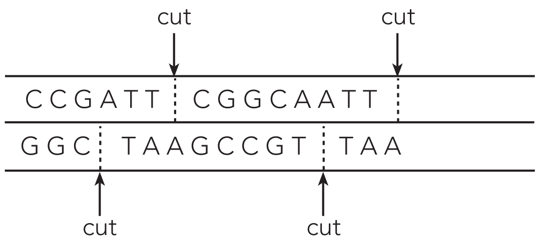
(ii)

(a)



(b)

(c) The same restriction enzyme could be used to cut another organism's DNA where the same order of nitrogen bases is found, for example:



The exposed sticky ends that this would create could then accept the segment of DNA which has been removed from the first organism's DNA segment.

(d) DNA ligase acts like an enzyme speeding up the joining of the 'sticky' ends of the DNA segment to the recipient DNA which has been cut.

(e) The 'recombinant gene' is the segment of foreign DNA which has been inserted onto the DNA of another organism.

Section Three

(i) ***Recombinant DNA***

- *Recombinant DNA is DNA which has been added to DNA to which it does not normally belong.*
- *To create recombinant DNA 'genetic engineering' is required.*
- *This involves cutting DNA from the DNA of one organism and then inserting the DNA fragment obtained onto the DNA of another organism.*
- *This may involve interspecific transfer or intraspecific transfer, i.e. from one species to another or from one organism to another organism of the same species.*
- *The organism which develops containing DNA from another organism is called a transgenic organism.*
- *DNA fragments to be inserted must be isolated.*
- *DNA fragments need to be carried (e.g. by a vector) and transferred to a host organism's DNA.*
- *Restriction enzymes are used to cut both the donor DNA and the host DNA.*
- *Vectors may be mechanical or biological.*
- *Mechanical vectors include micropipettes or microscopic metabolic projectiles coated with the DNA fragments and fired into the host organism's cell.*
- *Biological vectors include viruses and bacteria.*
- *Bacteria can be used to amplify the amount of the recombinant DNA so that huge quantities of the spliced DNA are produced.*

- *Each time the bacteria divides, new copies of the recombinant DNA are produced.*
- *Bacteria which contain recombinant DNA can be used to infect plants, passing the recombinant DNA into the host plant's nuclei.*
- *The host plant (the transgenic) may then produce enzymes (and other compounds) which it would not normally produce.*

(ii) ***DNA identification***
- *This technology enables scientists to determine the organism from which DNA has come, e.g. the plants from which timber is produced can be identified, so that it can be determined whether it has been sourced from a plantation or not.*
- *Every organism that is produced sexually has DNA which is unique, e.g. although 99.9% of human DNA is the same in each individual, the 0.1% that is not still represents hundreds of thousands of nitrogenous bases.*
- *Small fragments of DNA which are non-functional DNA, i.e. parts of the DNA that are 'junk' or have repeated codes, are cut from the small sample of DNA that is collected.*
- *The DNA fragments are copied so that millions are produced.*
- *This process involves PCR or polymerase chain reaction technology.*
- *PCR involves heating the DNA sample so that it unzips along its length, together with an enzyme (polymerase).*
- *Sections of DNA called primers are added to the mixture. These are complimentary to the DNA which is being amplified.*
- *The mixture is cooled, the primer DNA and the single strands join or anneal (the polymerase promotes the annealing).*
- *The process is repeated many times i.e. heating and cooling cycles, adding primers until millions of copies of the DNA fragment are produced.*
- *Using electrophoresis, the different length fragments are separated producing a pattern which is unique to the individual.*

Trial Test 3 – Evolution

Section One

1. c	*11. c*
2. b	*12. c*
3. a	*13. a*
4. b	*14. b*
5. c	*15. b*
6. c	*16. a*
7. d	*17. b*
8. c	*18. c*
9. d	*19. d*
10. d	*20. a*

Section Two

1.

(i) *(a) Environmental influences can affect the rate of mutations in a population. However the environment cannot cause a particular mutation to occur.*

(b) A mutant gene in a gamete may be transmitted through many generations unchanged. It may mutate again producing another unusual feature or it may revert back to the original gene. Because it may persist for many generations it is possible for natural selection to "work" on it (or select it).

(c) Useful mutations are very rare. Random change to a gene which is functioning well is more likely to lead to its dysfunction rather than improvement. However, most mutations are masked by the presence of normal functioning genes. Therefore, they do not adversely affect the organism.

(ii) *(a) Advantageous mutations are most important. They offer increased chances of survival and are selected by the environment. They are responsible for the wide variety of well adapted organisms which have appeared and are still present on the earth.*

(b) Unfavourable phenotypes are selected "against". They are not likely to persist in a population for long. Natural selection works against them and eventually removes the alleles that cause them from the population.

2.

(i) *Mutations are the source of change to existing genes and the addition of new alleles to a population. Other changes such as crossing over and non-disjunction do not add new alleles to the population; they change the ways in which existing alleles are combined in individual organisms.*

(ii) *If a mutation is harmful or deleterious it will disappear due to natural selection.*

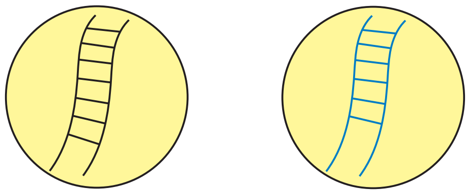
(iii) *Mutations that occur in the gametes may be passed on to offspring. Mutations that occur in the somatic cells of higher animals and most higher plants are not inherited as their somatic cells have no part in sexual reproduction. Mutations that occur in the somatic cells that are involved in asexual reproduction can be passed on to offspring.*

(iv) *Sexual reproduction requires the fusion of two gametes. The gametes are produced through meiosis. Asexual reproduction involves only one parent ; offspring are identical clones and arise through mitosis. Mutations are more likely to occur during meiosis than mitosis as meiosis is more complex, it involves two divisions. Mitosis is a shorter process and involves only one division.*

(v) *Because they are generally recessive, harmful mutations are only likely to become*

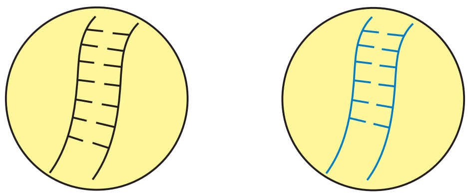
evident if they occur together, that is in the homozygous genotype. This occurs when an organism inherits a recessive mutated gene from both parents.
If a mutation results in a dominant gene it will be evident in the first generation to inherit the gene. However this type of mutation is far less likely to occur.

3.
(i) DNA is collected from both species. Fragments of DNA from their corresponding chromosomes are isolated in separate solutions.



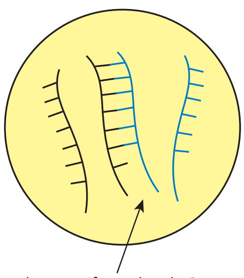
Species A   Species B

(ii) The solutions are heated (to between 80-90°C). Heating to this temperature breaks the hydrogen bonds between the N-bases, it denatures the double DNA fragments. Single fragment strands of DNA are formed.



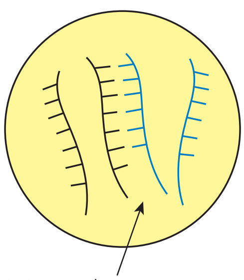
Species A   Species B

(iii) The two solutions are mixed and cooled. This enables hybridisation of the different strands of DNA to occur.



Hybridised DNA (from both Species A and B)

(iv) The mixture of hybridised DNA is then heated a second time. The temperature at which the hybridised DNA separates into separate strands, called the "melting temperature", is recorded.



Hybridised DNA strands separate as a result of heating

(v) Where two species are closely related the "melting temperature" of their hybridised DNA will be relatively high (close to the original "melting temperature"). If the species are distantly, related the "melting temperature" will be relatively low.

4.
(i)
- *Some bacteria have a natural resistance to streptomycin.*
- *The population of the bacteria are exposed to streptomycin.*
- *Most bacteria die.*
- *The few resistant bacteria live and reproduce.*
- *Their offspring inherit a resistance to streptomycin.*
- *The majority of the population of bacteria in a few generations then have an inherited resistance to streptomycin.*

(ii) It is unlikely to kill many of the bacteria colonies as they are derived from a resistant strain (or strains).
(iii) New antibiotics are required to treat the new strain. This means that the pharmaceutical industry must continue to develop new antibiotics (at an alarming rate).

5.
(i) (a) ***Biotic***
- *predators, e.g. snakes, eagles*
- *competition for food, e.g. interspecific and intraspecific.*

Abiotic
- *increase in water turbidity caused by erosion*
- *increase in salinity caused by excessive clearing of plants in the catchment area.*

(b) Predation: selects variety and colour in each environment, reduces the variety of colour and patterns on frog's skin. Those frogs that are best camouflaged are more likely to survive and reproduce.
Competition for food: when food is scarce this selects those that mature most rapidly and are larger and better equipped to obtain food.
Water turbidity: as the water becomes less clear, frogs with enhanced senses – smell and sight may be selected.
Salinity: if salinity increases those frogs and their tadpoles that are more capable of retaining water have an advantage, as they are less likely to dehydrate in the water.
(c) Rising salt levels may reach a concentration which neither the tadpole nor adult can tolerate. If any part of the life cycle becomes threatened the species may disappear.
(d) Its survival largely depends on the variety of its genes and the presence of genes which are suited to a change in the environment. If

no such genes are present, the organism may disappear from an area.

(ii) (a) Removing old trees with suitable sized holes reduces the number of breeding places for the black cockatoo. Unable to reproduce the species will disappear.

(b) Older trees with holes and with the potential to form holes should be left in the forest. This strategy may help these birds to survive.

In areas which have already been logged, nest boxes may help such birds survive until older trees grow.

6.

(i) Natural selection results in better adapted varieties surviving, while less well adapted varieties disappear. Therefore natural selection tends to reduce the variety. In the example above of the bacteria – before the introduction of the antibiotic streptomycin, bacteria may have had genes for a resistance to the antibiotic or genes which offer no resistance. There would appear to be no advantage or disadvantage involved, so the genes controlling these varieties would persist from generation to generation. The frequency of these genes would remain unchanged. With the use of the antibiotic in the environment, one variety ie. the non-resistant strain, would tend to disappear leaving only the resistant strain ie. variation would be reduced.

(ii) (a)

- *Crossing-overs during meiosis.*
- *Random assortment of chromosomes during meiosis.*
- *Random fertilisation by gametes.*
- *mutations.*

(b)

- *Scarce resources – leading to competition.*
- *disease.*
- *Predation.*

(c) They have inherited more favourable genes.

(d) Those with favourable genes are more likely to survive and reproduce offspring which inherit their favourable genes.

7.

(i) The gene controlling dark colour probably came first. This is a mutation which under normal conditions is unfavourable and selected out. However, it is likely to have arisen spontaneously from time to time but not persisted for long (before the countryside became polluted).

(ii) The Industrial Revolution resulted in an outpouring of soot into the environments near industrial centres. The pollution also caused the trees to lose their light coloured lichen. This provided moths of a dark colouring with camouflage. The gene controlling dark colouring offered an advantage in the changed environment. Genes controlling light colours were selected 'against'. Thus the frequency of the gene for dark colour increased while the frequency of the gene for light colouring decreased.

Section Three

(i)

- *Anatomical features may include the examination, measurement and comparison of the average size of the animals in both locations.*
- *Their SA:Vol ratios may be compared.*
- *Their limb and appendage lengths.*
- *Physiological features may include measurements of hormonal levels, growth patterns, red blood cell counts, changes which occur to blood flow in hot and cold conditions.*
- *Physiological differences in the response of the animals to different foods.*
- *Molecular differences include differences in the enzymes and other proteins present in their body fluids and the cells.*
- *A close correlation in their proteins indicates a close correlation of their DNA.*
- *Genetic differences may involve DNA comparisons using the hybridisation of DNA i.e. the thermal splitting of their DNA – its mixing and the degree of annealing that takes place gives an indication of their DNA similarity and therefore how closely related two organisms may be, e.g. chimpanzees and humans have 99% of their DNA which is the same.*
- *E.g. haemoglobin – a blood protein is identical in both chimps and humans.*
- *The population's ability to interbreed and reproduce viable offspring in their natural environment may also be used to determine whether they belong to the same species or not.*

(ii)

(a)

- *Fossils – the remains or imprints of organisms that have lived in the past.*
- *Fossils can be used to compare living populations with their ancestors.*
- *Fossils indicate changes to the anatomy of species, usually gradual change.*

(b)

- *Homologous structures: these are structures which in embryos may look the same but as different species develop, become different and develop different functions, e.g. forelimbs of vertebrates – legs for walking in most mammals, wings for flying in birds.*
- *Homologous structures indicate common ancestors.*

(c)

- *Comparative anatomy: closely related organisms have similar structures.*
- *E.g. the three body parts of insects, i.e. head, thorax and abdomen indicate that all insects have diverged from a common ancestor.*

(d)

- *Embryology: in the vertebrate group all the embryos are very similar in that they have pharyngeal folds (or gill slits), a post-anal tail and a very similar shape.*
- *This suggests that they have many genes in common and that they therefore have a relatively recent common ancestor.*

(e)

- *Biochemistry: comparisons of blood proteins, DNA and other compounds within the body of animals and plants, enables links to be drawn.*
- *The observation that all organisms contain DNA suggests a connection between all organisms that may be traced to the beginning of life on earth.*
- *The similarity of DNA in the primate group indicates that they evolved from a common ancestor (approximately 65 million years ago).*

Trial Test 4 – Selection, Speciation & Diversity

Section One

1. b	*11. c*
2. c	*12. c*
3. c	*13. d*
4. b	*14. b*
5. d	*15. b*
6. d	*16. b*
7. a	*17. a*
8. d	*18. d*
9. d	*19. a*
10. d	*20. b*

Section Two

1.

(i) bottleneck
(ii) dispersal
(iii) artificial selection
(iv) speciation or adaptive radiation
(v) adaptation
(vi) reproductive isolation
(vii) genetic biodiversity
(viii) extinct
(ix) geographic isolation
(x) natural selection

2.

(i)

- *The clearing of forests for timber and farming would result in the removal of old trees with appropriate nesting hollows*
- *and their sources of food, i.e. nectar.*
- *Another factor is the increase in predators such as feral cats.*

(ii)

- *On the mainland available food (nectar) is essential to sustain the populations of Swift Parrot during the winter. If trees that provide food are cleared for farming, urban sprawl or industry this places increased pressure on the population.*
- *Man-made objects such as high wire fences may also impede the movement of these small birds particularly in their migration south.*
- *In Tasmania predators may put greater pressure on the nesting birds as they are more vulnerable at this time.*
- *The food sources must also be close to the hollows in older trees to enable successful breeding. Where they are separated by long distances the parent birds may not be able to feed the young sufficient amounts of nectar for them to survive.*

(iii)

- *Alleles for dark colour would become more frequent in the population than alleles for light colour.*
- *The phenotype of the population would gradually change as more individuals would be a darker colour.*

(iv) The IUCN is likely to rate this population as Critically Endangered as its numbers are low and declining. It is likely to have reduced gene diversity.

(v) The states where this bird lives (Vic, NSW, SA and Queensland in winter and Tasmania in summer) need to provide habitats necessary to sustain viable populations. There is little point in just one state making changes to provide a suitable environment. If Tasmania provides suitable breeding environments, the other states in SE Australia need to provide foraging habitats for the bird in winter.

(vi)

- *While its population increases significantly the species may remain threatened until its biodiversity increases.*
- *When a population declines to a small number, many alleles are generally lost.*
- *A species with a great variety of alleles has a increased capacity to survive change.*
- *However, additional alleles only arise as a result of mutations.*
- *Advantageous alleles accumulate in vertebrate populations slowly as life cycles are comparatively long and most mutations are not useful. Until the gene diversity has increased the species will therefore remain vulnerable.*

3. (i) *Organisms that are capable of crossing the channel between Rottnest Island and the mainland. These include birds, bats and flying insects and plants that disperse seeds and pollen by wind or water.*

(ii)

- *The regularity of bush fires on the island may have differed (probably less frequent on the island). Fire may kill many quokkas but it provides new growth that provides food for the quokkas.*
- *Large predators may not have been able to sustain viable populations on the small island.*
- *Predatory birds may have been different, e.g. resident ospreys do not occur far from the mainland coast.*
- *Wild dogs (dingoes) may not have been present on the island.*
- *Available freshwater may have been scarce on the island particularly in summer.*
- *Infectious diseases that affected mainland populations may not have been transferred to the island population.*
- *Deficiency diseases associated with poor soils on the island may be more prevalent there.*

(iii)

- *Europeans initially introduced cats and dogs to the island (now excluded). These would have preyed on the quokka.*
- *They were probably also hunted for their meat and skins.*
- *Farming on the island (no longer conducted) may have incidentally provided some additional water in summer.*
- *Cars (few) and bicycles (many) kill animals on roadways and paths.*
- *The frequency of fires has probably increased with accidental and deliberately lit fires.*
- *Clearing of forests of pines and melaleucas has diminished suitable protective habitat though created open grass areas on which the animals feed.*

(iv) *The pressures that affect mainland quokkas may be greater than those that affect the island population. There has been more habitat destruction due to land clearing on the mainland and feral cats and foxes not found on the island have increased on the mainland.*

(v) *The population on the island may have suffered severe reductions in the recent past before the quokka was protected and allowed to increase to its present numbers there. It would therefore be expected to show the effects of a "genetic bottleneck" and have little diversity. However, small isolated populations that exist on the mainland now may have even less genetic diversity.*

(vi) *It could be artificially increased by introducing some animals from the mainland to breed with the island population. Alleles that are present on the mainland but not on the island would then be introduced into the island population.*

(vi)

- *When the island was first formed by the rising sea level, the population of quokkas on the island may have had much the same diversity to that of the mainland population.*
- *There may have been no fire on the island over a long period of time. A large amount of dead wood and leaves would accumulate creating a heavy fuel load.*
- *Lightning, in late summer, when the leaf litter and vegetation is dry and the winds strong could start a very hot wildfire killing almost all of the quokka population.*
- *The very small remnant population, because of its size, would have a "genetic bottleneck". (note: the island population could also be decimated by disease or drought)*

(vii) *As the isolated population evolves independently of the mainland population, through mutations and natural selection it may become more and more genetically different, until a point is reached when its DNA is so different that its chromosomes are incompatible with those of the mainland animals. It is then unable to breed with the mainland species.*

(viii) (a) *The two populations may interbreed (likely if their separation has been relatively short).*

(b) *Breeding may take place on the boundaries of their distributions which produces hybrids which form a third population.*

(c) *No interbreeding occurs, since the populations have become genetically too different. Two separate species have arisen during their long isolation from one another.*

(ix) *Deserts, mountain ranges, fast flowing rivers, different courtship behaviour, different mating calls, different feather or coat colours.*

4.

(i) *The development of the variety of Ancon sheep occurred because of a mutation which resulted in a sheep with exceptionally short legs. This animal was bred with others producing some lambs with short legs. These were selected and bred to eventually create a variety which is easier to keep fenced. The Dachshund is a mutant form of a longer legged hunting dog, which was once used to hunt small burrowing animals.*

The development of seedless grapes by taking cuttings from plants which produce fruit with no seeds.

(ii) *The increased pressures on these animals include:*

(a) habitat destruction (removal of food sources and sites for reproduction).
(b) the introduction of feral predators, e.g. cats and foxes.
(c) the hunting of animals for their furs (or pelts), e.g. possums.
(d) the introduction of animals which compete with them for resources like breeding sites and food, e.g. introduced bees occupy cavities and holes in some trees which may normally be occupied by small mammals like possums.

(iii) remove the feral animals by culling or using biological control/restoring natural habitats so that the animals have a source of food and places to breed.

Section Three

- *Initially there is one species with considerable genetic biodiversity.*
- *It exists as one gene pool.*

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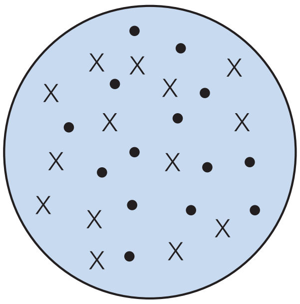

- *The population is divided into two by the formation of a barrier between them (or a small group is separated from the parent population).*
- *The barrier does not allow interbreeding between the two populations – they are "reproductively isolated".*

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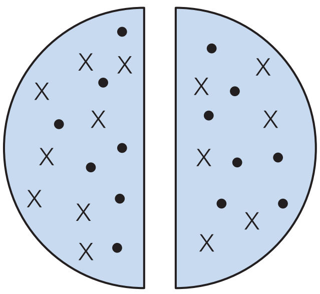

- *Different selection pressures within each environment change the gene frequencies within each population differently.*
- *In several generations the two separated gene pools become two sub species.*

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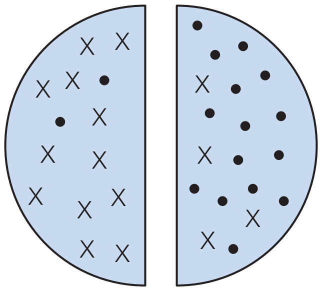
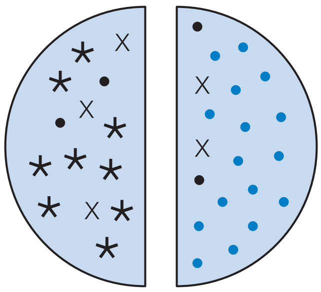


- *Mutations that are advantageous in each environment are naturally selected but not shared by the reproductively isolated gene pools.*
- *The populations become progressively less alike.*
- *Over many generations, if the barrier was removed, the gene pools become so different that interbreeding between individuals from each population would be impossible because their DNA is incompatible.*
- *The two gene pools now represent two separate species.*

••



- *This process could occur in an animal population if part of the population was separated on an island formed by rising sea levels, e.g. the quokkas on Rottnest Island.*
- *The finches that Darwin observed on the Galapagos islands were the descendents of ancestral finches that were probably blown by storms from mainland South America and isolated on a number of islands.*
- *As Australia has moved northwards in the last sixty five million years, climate change has created a southern desert that separates the western side of the continent from the eastern side. Many organisms have been reproductively isolated. Speciation has occurred due to reproductive isolation, represented in the many different species of Eucalyptus, Banksia, Melaleuca and other genera on each side of this desert.*

Trial Test 5 – Inquiry Skills & Human Endeavour 1

Section One

1. d	*11. c*
2. a	*12. c*
3. b	*13. d*
4. d	*14. a*
5. a	*15. d*
6. d	*16. d*
7. b	*17. b*
8. a	*18. a*
9. b	*19. a*
10. a	*20. d*

Section Two

1.

(i) (b) Observation: a statement about something that is sensed.

(ii) (d) Prediction: a guess about something which is likely to happen in the future.

(iii) (c) Inference: an explanation of an observation.

(iv) (e) Generalisation: a comment about a shared characteristic.

(v) (a) Hypothesis: a testable statement.

(vi) (f) Theory: there may be some evidence to support this idea but not enough to call it a law.

2.

(i) The student could:

- *identify areas of the forest where Blackbutt are found and areas where they may be expected but are not present.*
- *collect soil samples from both areas, making sure that they are randomly selected and are from a good range of matched depths.*
- *the percentage of water in each sample can then be measured (by dehydrating each sample).*
- *compare the percentage of water in soil from both areas.*

(ii) If correct, the results should show a greater percentage of water in soil samples taken from the area in which the Blackbutt trees were growing.

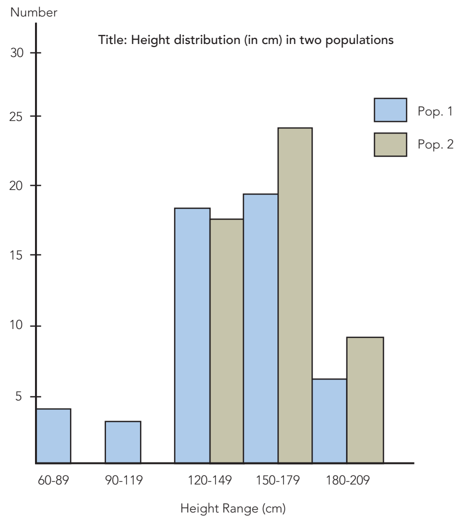
(iii) If there was no difference in the percentage of water in the two areas ***or*** *if the percentage of soil water in the areas where no Blackbutt were found was greater than in those areas where the trees were found.*

3. (i)

Height Range in Two Populations (cm)					
Popn	60 – 89	90 – 119	120 – 149	150 – 179	180 – 209
1	IIII (4)	III (3)	𝍸 𝍸 𝍸 III (18)	𝍸 𝍸 𝍸 IIII (19)	𝍸 I (6)
2			𝍸 𝍸 𝍸 II (17)	𝍸 𝍸 𝍸 𝍸 IIII (24)	𝍸 IIII (9)

(Note: The choice of ranges is up to the student. They could be narrower. However the data given fits these ranges reasonably well.)

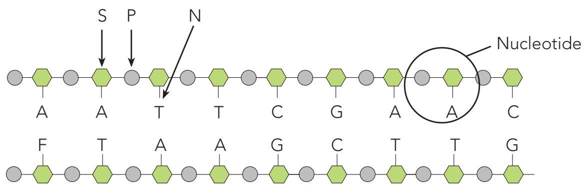
(ii) (Since the data is not continuous, the best choice of graph is a bar graph or histogram.)



Marking guide:
deduct:
1 mark for missing title.
1 mark for each missing axis label.
1 mark for each incorrect height of column.
Total loss cannot exceed 5 marks.

4. (i) and (ii)

••••



(iii)

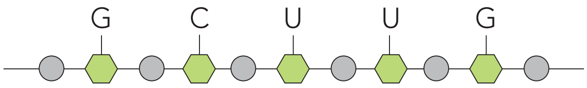
(a) The nucleotides come from the nucleoplasm.

(b) Messenger RNA (mRNA).

(c) Transcription.

(d)

• •



(e) It moves through a nuclear pore and onto a ribosome.

(iv)

(a) Transfer RNA (tRNA)

(b)

- *Uracil (U) replaces thymine (T) in the molecule*
- *tRNA is smaller and has only three nucleotides*
- *Its role is very different in transporting amino acids (AAs), whereas DNA controls the types of proteins that a cell can synthesize*
- *Only single strand.*

(v) *Proteins can be:*

- *enzymes*
- *some hormones*
- *structural components of organelles*
- *transport proteins in cell membranes*
- *channel proteins in cell membranes.*

(vi)

- *A change in the order of the nucleotides.*
- *By an insertion, deletion, substitution or inversion, changes the code on the DNA molecule.*
- *If this happens it may result in a missing AA, an incorrect AA or an extra AA in the protein.*
- *This results in a protein which may not function as it should.*
- *For example, the substitution of one particular AA in the 584 AA chain in the human haemoglobin protein causes a disease called sickle-cell anaemia, this results in the red blood cells becoming misshapen and unable to carry sufficient quantities of oxygen for the body cell's needs.*

5. *(i) Title (ii) Aim (iii) Materials (iv) Procedure (v) Results (vi) Conclusion (vii) References*

6.

(i)

- *A genetic modification occurs when one organism's DNA has a part of another organism's DNA added to it.*
- *A fragment of DNA is removed by restriction enzymes from the donor organism's DNA.*
- *It is then transferred by mechanical or biological means to the DNA of the recipient.*

(ii)

- *The DNA of citrus plant cells which codes for enzymes which result in vitamin C is removed by restriction enzymes.*
- *The DNA fragments which are removed are spliced onto the plasmid DNA of bacteria.*
- *These bacteria are used to infect rice seeds, which produce rice plants that then synthesise more vitamin C.*

(iii)

- *DNA which codes for enzymes needed for antibody production for a disease.*
- *Transferred to an animal which does not produce these antibodies.*
- *Gives the recipient animal an immunity to that disease.*

(iv)

(a) Animals – genes which are recombinant may result in these transgenic organisms developing undesirable, unforeseen features.

(b) Plants – a gene which gives a plant resistance to herbicides could be transferred accidentally by viruses or bacteria from a crop plant, like wheat, to a weed. This would render the herbicide ineffectual in controlling the weed species.

Section Three

(i)

- *Habitat destruction – as European settlement required the clearing of land for pasture and crops.*
- *Hunting – as the animal predated on domestic animals, it was shot and a bounty was paid by government authorities.*
- *Hunting – for sport.*
- *Domestic animals may have introduced new disease pathogens to the population.*
- *Reduction in the populations of its native prey could have reduced its food supply.*

(ii)

- *Biogeography – an understanding of the animal's geographic distribution leads to better understanding of its tolerance and requirements of both its biotic and abiotic environment.*
- *This understanding may result in interventionist measures like the removal of competition, the introduction of prey and the provision of shelters.*
- *Collectively these strategies should enable reproduction and the growth of the population to occur.*
- *Reproductive behaviour – an understanding of the animal's reproductive behaviour including its courtship behaviour, where and how it nurtures and protects its young and the length and degree of parental care given to its young.*
- *This may facilitate effective captive breeding programmes and*
- *the provision of suitable protected areas to enable successful breeding.*
- *Population dynamics – knowledge of the birth rate, death rate and population structure would enable conservationists to estimate the expected growth rate of the population and when necessary implement strategies to increase the rate.*

- *If the death rate is higher than the birth rate over a number of years the population would be in decline.*
- *Measures would need to be established to increase the birth rate and decrease the death rate so that the population grows.*

(iii)

- *When a population becomes very small its genetic biodiversity becomes small – less variants are present(less alleles are present).*
- *The species is then more vulnerable to change – more vulnerable to disease and adverse conditions.*
- *When changes occur there may be no variants within the population capable of living in the new conditions or no variants with a resistance to a disease organism – the species will be in danger of extinction.*

(iv)

- *The degree of similarity in the DNA between the Tasmanian Tiger and other animals in Australia can be determined.*
- *DNA hybridisation can be used as a means of testing their relatedness.*
- *This indicates how closely related the animals are to one another and which animals may have been their common ancestor. It enables the establishment of reliable phylogenic trees.*
- *Comparison of closely related species genomes would indicate which of the Tasmanian Tiger's genes were selected for by its particular environment and which were selected against.*
- *The animal's proteins which reflect its DNA could also be compared to other Australian animals. The degree of similarity indicates how closely related the animals may be.*

Trial Test 6 – Homeostasis & Thermoregulation

Section One

1. b	*11. b*
2. a	*12. a*
3. d	*13. b*
4. d	*14. b*
5. c	*15. b*
6. a	*16. d*
7. d	*17. b*
8. d	*18. d*
9. c	*19. c*
10. a	*20. d*

Section Two

1.

(i) Rise in body temperature.

(ii) Hypothalamus.

(iii) Blood vessels near the skin's surface.

(iv) Dilation of the blood vessels near the skin's surface.

(v) This is a negative feedback because the response causes a drop in the body's temperature, that is, it reduces the stimulus.

(vi) The coordinating centre consists of a group of cells in the hypothalamus near to the thermoreceptor cells of the hypothalamus. It processes the "information" from the thermoreceptors and where the stimulus is sufficiently strong sends messages in the form of nerve impulses(or in some cases hormones) to the effectors.

2.

(i) Most vertebrates generally breathe more rapidly and more deeply. Fish will force more water over their gills. These activities eliminate carbon dioxide from their bodies.

(ii) This may cause a decrease in activity, as less energy becomes available from respiration. If stored glucose (e.g. glycogen in the liver and muscles) is available it will be converted to glucose and released into the blood stream. Other sources of energy can be utilised, e.g. fats. The animals may seek food.

(iii) Most nitrogenous wastes are toxic, therefore the organism will excrete more wastes e.g. ammonia, urea (note: uric acid is non-toxic and therefore its accumulation will not cause the same problems as other nitrogenous wastes).

(iv) Mammals and birds will tend to ***increase heat production*** *(e.g. increased levels of thyroxine from the thyroid glands causes an increased level of metabolism or an increase in involuntary shivering generates heat) and* ***reduce heat loss*** *by vasoconstriction of surface blood vessels and hair/feather erection. Many vertebrates will also seek a warmer part of their environment – that is, use behaviour to reduce heat loss.*

(v) A fall in osmotic pressure, may be due to either an increased level of water concentration in the blood or a loss of dissolved solutes e.g. minerals. The organism may excrete more dilute urine thus reducing the water concentration and/or reabsorb more solutes from the kidney filtrate in order to increase solute concentration in the blood plasma.

(vi) If carbon dioxide accumulated in the vertebrate's body it would decrease the pH of the blood plasma and the cells' cytoplasms. Intracellular and extracellular enzyme activity would decrease. Cells may begin to die.

(vii) If the fall in glucose continued unchecked cells would begin to stop respiring and they would die.

(viii) Nitrogenous wastes such as ammonia and urea are toxic. Their high concentration is harmful to cells. If they are not removed the animal will become sick and eventually die.

(ix) Enzyme activity is sensitive to temperature. If the temperature continues to fall, enzymes will cease to function. The body's metabolism will slow down and eventually stop.

(x) If the level of water in the blood plasma continued to rise, too much water would begin to enter the body cells by osmosis. Because of the dilution factor, chemical reactions, both anabolic and catabolic would slow down. The cells themselves may begin to lyse. The animal may die.

3.

(i) Both animals are endothermic. If the environmental temperature is lower than their body temperature, both will lose heat to the environment. The rate at which each loses heat is largely dependent on their surface area to volume ratio. The surface area to volume ratio of the mouse is greater than the surface area to volume ratio of the donkey. The mouse will lose heat more rapidly per unit volume than the donkey. Its metabolic rate will therefore need to be greater than the donkey's to produce the heat necessary to compensate for the greater heat loss per unit volume.

(ii) The increased size of the wombats on Tasmania results in a reduced surface area to volume ratio. The Tasmanian wombat will therefore lose less heat to its colder environment per gram of body weight than would its mainland counterpart should the counterpart be transported to Tasmania.

(iii) (a) Hair/feathers lay flat: reduces the blanket of air that insulates the animal and keeps in heat, more heat is lost.
Sweat production increases: (only in mammals) which increases heat loss due to evaporation of water from the skin.
The thyroid glands release less thyroxine which reduces cell metabolism (therefore less body heat is produced).
(b) Shivering: increases heat production from within.
Hair follicle/feather erection: increases insulation and reduces heat loss.

(iv) (a) Heat Produced + Heat Gained = Heat Lost
(b) Heat enters the body by conduction and radiation from hot surroundings (when environmental temperature is greater than the animal's body temperature).
Heat may also be absorbed by intake of warm food/drink.
Heat enters the body as radiation from the sun.
(c) Heat energy is released when respiration occurs in body tissue. Heat is produced by muscle contractions in movement.
(d) Heat may be lost by conduction and radiation from the animal's body where the animal's body temperature is higher than its surroundings.
Heat is lost in the wastes the animal produces (e.g. urine, faeces).
Heat is lost as water evaporates from the respiratory surfaces and the skin.
Heat is lost as sweat/saliva evaporates from the skin/mouth.
Heat is lost in warming cool air in the lungs.

(iv) (a) A counter-current heat exchange.
(b) Where the two vessels are close, heat is exchanged from the blood in the artery to the blood in the vein before the blood reaches the extremity of the foot. The temperature difference between the ice and the blood in the foot is therefore reduced and the rate of heat loss is reduced.
(c) The arrangement of vessels in the leg is a ***structural adaptation****. The shape and position of the vessels provide an advantage.*

4.

(i) Temperature increases the rate of chemical reactions in general. Therefore as the temperature of an animal increases its rate of metabolism increases. However, as enzymes are involved and enzymes are very dependent on temperature, as the temperature becomes too high enzymes begin to denature and the rate of metabolism will slow down.

(ii) The presence of enzymes which control metabolic reactions.

(iii) The body temperature of a reptile tends to follow the temperature of its surroundings (as is is ectothermic). A rise in temperature will cause an increase in the reptile's metabolic rate and therefore an increase in its level of activity.
The body temperature of a mammal tends to remain fairly constant regardless of the environmental temperature (within limits). Therefore a rise of 10°C should not affect the metabolic rate of this endothermic animal. In order to maintain a constant temperature this animal may become less active.

(iv) The mouse is endothermic. In order to maintain its temperature at a constant level, when it is cold, it requires more food energy. The reptile is ectothermic. Its body temperature may drop with the environmental temperature. It does not use extra food energy to raise its body temperature in these circumstances.

(v) The growth (and activity) of the mouse is less dependent on the weather than that of the reptile. Its growth rate on average will be greater than that of the reptile.

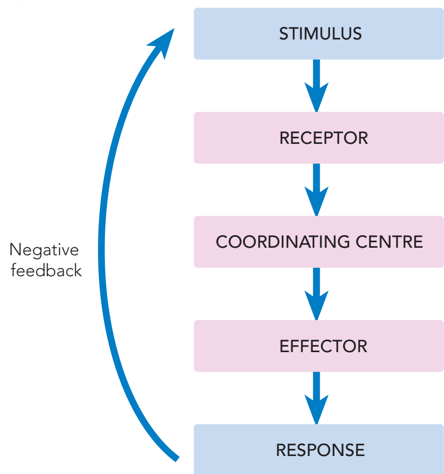
(vi) The mouse will need a constant supply of food. Its need for food is likely to be greater during cold weather when less food is available.

(vii) *The mouse remains active throughout the year. Its activity is less dependent on the weather. Its population is likely to increase more rapidly than that of the reptile.*

Section Three

(i)

- *Homeostasis is the maintenance of stability within the body of an organism.*
- *The conditions within an organism must be kept within fairly narrow limits so that the cells are able to function normally.*
- *e.g. 1. temperature: the human body needs to maintain a core temperature of about 37°C – a shift of two or three degrees above or below this value results in the malfunctioning of cell metabolism.*
- *e.g. 2. osmotic pressure: the body of an organism needs to maintain a given osmotic pressure within its cells and in its extracellular fluids. This means that the osmotic pressure will not cause animal cells or plant cells to shrivel or animal cells to burst (lyse).*
- *The maintenance of internal stability is generally achieved through negative feedback loops.*
- *This involves the following process shown in the flow chart:*



- *The stimulus refers to an internal (or external) change, e.g. rise in body temperature.*
- *The receptor refers to cells/tissue/organ which detects the stimulus, e.g. hypothalamus in higher animals.*
- *The coordinating centre consists of tissue which processes messages, e.g. other non-receptor cells in the hypothalamis near to the thermoreceptors. If the stimulus is sufficiently strong, the coordinating centre sends messages (e.g. nerve impulses/hormones) to an effector/s, e.g. sweat glands.*
- *The effector/s are tissues/organs which receive the messages and carry out a reaction, e.g. produce sweat.*
- *The response is the reaction carried out by the effectors (sweat production).*
- *Sweat evaporation has a cooling effect on the skin, this in turn cools the blood flowing near the surface of the skin and intercellular fluid around the skin cells.*
- *Because it lowers the body's core temperature, it reduces the original stimulus and is therefore an example of a negative feedback.*

(ii) Endothermic animals have the ability to maintain their core body temperature regardless of temperature changes in their external environment (within limits).

- *If cold – lower than normal, they may shiver, blood vessels in skin constrict, hair or feathers may be raised (piloerection) and their metabolism may be increased.*
- *Shivering and increased metabolism increase their heat production.*
- *Vasoconstriction of blood vessels in the skin and piloerection reduce heat loss.*
- *If hot – above normal, some may sweat or pant, hair and feathers lie flat, vasodilation of blood vessels in skin occurs and they may reduce their rate of metabolism.*
- *These changes either increase heat loss – sweating, panting, hairs/feathers lying flat, vasodilation or reduce heat production – lowering metabolism.*
- *Ectothermic animals may tolerate a wider range of internal body temperatures.*
- *They generally do not have physiological means of increasing or decreasing heat production or reducing or increasing heat loss.*
- *They rely on behaviour to maintain their temperature within reasonably narrow limits.*
- *If they are too cold, they may move into a warmer part of their environment.*
- *If they are too warm, they may seek a cool refuge.*
- *E.g. of endotherms: mammals and birds.*
- *E.g. of ectotherms: invertebrates, fish, amphibians, reptiles.*

Trial Test 7 – Animal Nitrogenous Wastes, Water & Salt Regulation & Plant Adaptations

Section One

1. d	11. c
2. d	12. c
3. a	13. a
4. c	14. b
5. b	15. d
6. e	16. c
7. d	17. c
8. d	18. b
9. c	19. d
10. c	20. d

Section Two

1.

(i) excretion
(ii) ammonia
(iii) osmoregulation
(iv) deamination
(v) phyllode
(vi) xerophyte
(vii) succulent
(viii) stoma
(ix) salinity

2. (See next page).
3. (See next page).
4.

(i) (See next page).

(ii)
- The transpiration rate increases with temperature.
- However, where the plant appears to be losing too much water, transpiration slows down (and in plant B it ceases altogether).
- The rate of transpiration varies in different plant species at the same temperature.

(ii)
- Water is used for photosynthesis.
- Or lost through evaporation from the stomata (transpiration) – most of the water is lost in this way.

(iv)
- Root hair cells.
- Xylem and
- Mesophyll (palisade and spongy).

(v)
- Wind strength.
- Humidity of the air.

(vi)
- Plant A may have larger stomates or
- a greater concentration of stomata per unit area of leaf.
- Plant B may be better adapted to reducing water loss from its leaves, e.g. It may have recessed stomata.

(vii)
- Initially the rate of loss was higher at 40°C than at 20°C.
- However it plateaued after 10 minutes at 40°C.
- This suggests that its stomata may have closed and prevented further loss.
- Its rate of water intake at 40°C had not been as high as its rate of loss and therefore its cells (including guard cells) had wilted.

5.

(i)
- Pale to whitish leaf colour.
- Produced by pigments that reflect infrared radiation (heat).
- Hair like projections on the leaves and stem that reflect infrared radiation.

(ii)
- Open stomata in early morning but close towards midday.
- Avoids excessive transpiration during the hottest part of the day.

(iii)
- Extensive root systems.
- Cover a huge volume of soil and absorb a large volume of water.
- Tap roots.
- Long roots that grow almost vertically downwards into the ground water.
- Mallee growth form consists of multiple stems.
- Directs rainfall to the base of the plant.
- Surface roots in the topsoil.
- Tap into dew forming at night.

(iv)
- Cells store salt in vacuoles.
- Removing salt from other organelles.

(v)
- Plant moves salt to particular leaves.
- These are shed when the salt level becomes toxic, removing salt from the plant.

(vi)
- Rapid life cycle that takes place following heavy rain –
- Avoids plant contact with saline conditions.
- Root epidermal cells that actively exclude salt absorption from soil –
- Plant maintains relatively low salt levels.

Section Three

(i)

Animal	Gains water	Lose water
Terrestrial	• Drinking • Contained in food • Respiration	• Wastes – faeces and urine • Evaporation from skin and exposed mucous membranes, e.g. eyes • Sweating • Evaporation from lungs
Aquatic	• Osmosis through gills in fresh water environment • Drinking • Swallowed with food	• Osmosis from gills in marine environment • Wastes – urine and faeces

(ii)

Terrestrial animals reduce water loss by:
- producing concentrated urine
- reabsorbing respiratory water through specially adapted respiratory tracts
- ingesting their own damp faeces.
- producing relatively dry faeces.
- nocturnal activity that avoids the heat during the day.

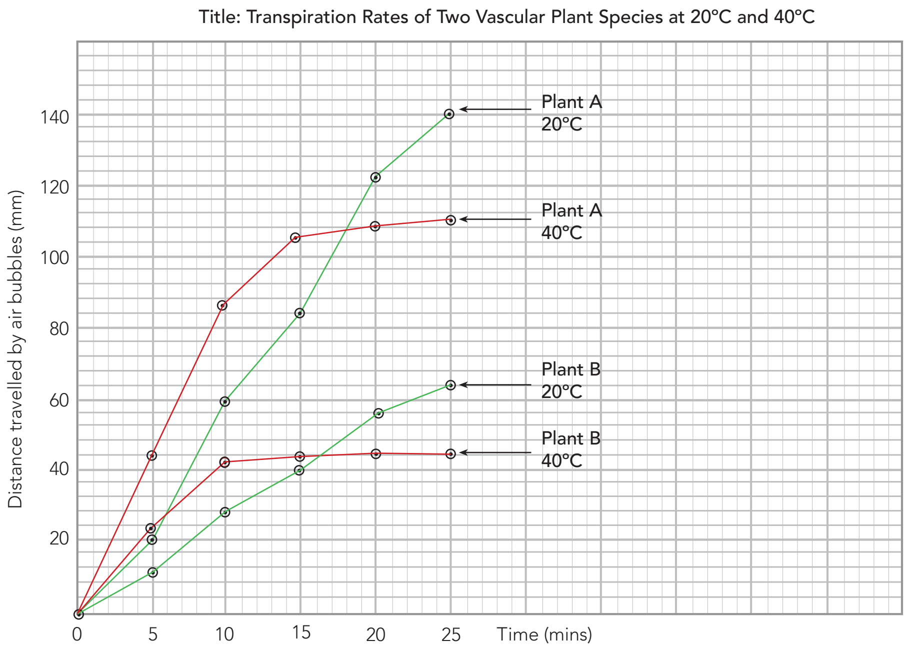
2.

Nitrogenous Waste	Advantages	Disadvantages	Animal Examples
Ammonia NH_3	• Highly soluble in water therefore easily transported within an animal. • Requires little energy to produce.	• Highly toxic. • Requires a copious amount of water to dilute and remove safely. • Must be removed rapidly.	• Amoeba • Tadpoles • Fish
Urea $CO(NH_2)_2$	• Soluble in water therefore can be transported within an animal. • Less toxic than ammonia.	• Requires some water to safely remove from body of animal. • Cannot be allowed to accumulate as it is toxic in higher concentrations. • More energy needed to synthesise than ammonia.	• Mammals • Adult frogs • Cartilaginous fish
Uric Acid $C_5H_4N_4O_3$	• Very low toxicity – less toxic than both urea and ammonia. • Little or no water needed for removal from body.	• More difficult to transport within the body. • More energy to synthesise than urea.	• Reptiles • Birds • Insects

3.

	Marine environment	Freshwater environment
Dissolved solutes in external environment of fish	Higher salt concentration than in the internal fluids of the fish (both intracellular and extracellular fluids)	Lower salt concentration than in the internal fluids of the fish (both intracellular and extracellular fluids)
Dissolved solutes in internal environment of fish	Lower than in the external environment but similar to freshwater fish.	Higher than the external environment.
Practical osmoregulatory problems fish need to overcome	Loss of water by osmosis (mainly via gills) to the external environment. Absorption of salt from the external environment by diffusion across the membranes of the gut and the gills.	Absorption of water by osmosis (mainly via gills) from the external environment. Loss of salts to the external environment by diffusion across the membranes of the gut and gills.
Two adaptations fish may have that are related to the osmoregulatory problems	Produces concentrated urine. Drinks copious marine water but actively excretes salt from the gills.	Produces copious quantities of dilute urine. No water ingested.
	Retains nitrogenous waste in the form of urea to balance the internal concentration of salts with the external concentration (applies to cartilaginous fish, e.g. sharks).	Actively absorbs salt through gills.

4. *(i)*



(Note to student: deduct one mark for any incorrect point, points missing, no title, no units, no key, labels on lines, general untidiness, graph too small, incorrect X and Y axes, axes not divided uniformly – to maximum of 6 marks)

- *burrowing to avoid the hottest part of the day.*
- *seeking a cool shady refuge during the hottest part of the day.*

Marine fish reduce water loss by:

- *producing concentrated urine.*
- *retaining nitrogenous waste in the form of urea to reduce water loss by osmosis.*

(iii)

- *Where water is freely available as in the case of aquatic animals (e.g. fish, juvenile amphibians) the nitrogenous waste is likely to be ammonia.*
- *The available water in an aquatic environment allows the animal to dilute the ammonia so that it becomes far less toxic to the excretory cells that come in contact with its urine.*
- *The animal does not have to expend much energy in producing ammonia.*
- *Where an animal has a moderate amount of water available to it, urea is often the nitrogenous waste (e.g. mammals, adult amphibians).*
- *Urea is soluble and it requires some dilution to make it less toxic but not the copious amounts of water required of ammonia.*
- *It requires more energy to produce than ammonia but less than uric acid.*
- *Animals that live in environments that have little available water generally produce uric acid as a nitrogenous waste (e.g. reptiles, insects, birds).*
- *This is so that when the waste is excreted, being almost non-toxic, little water is required and little is therefore lost.*
- *The extra energy needed to produce uric acid is the cost to the animal of retaining its water. (note: the developing young of terrestrial egg laying animals also produce uric acid because it is able to accumulate in the egg without self-damage)*

Trial Test 8 – Infectious Diseases and Pathogens

Section One

1. c	*11. a*
2. d	*12. b*
3. d	*13. d*
4. a	*14. a*
5. a	*15. c*
6. d	*16. d*
7. c	*17. c*
8. a	*18. a*
9. a	*19. b*
10. b	*20. a*

Section Two

1.

(i) *chronic*
(ii) *host*
(iii) *direct*
(iv) *venereal*
(v) *infectious or contagious*
(vi) *mode of transmission*
(vii) *fungus*
(viii) *disease*
(ix) *vector*
(x) *bacterium*

2.

(i)

- *Non-infectious diseases are not transmitted from one organism to another,*
- *e.g. a person suffering from diabetes that may be caused by damage to their pancreas. Their pancreas does not produce sufficient insulin to reduce glucose levels in their blood when the level is high. This condition is not communicable.*
- *Infectious diseases can be transmitted either directly or indirectly from a diseased organism to a healthy one,*
- *e.g. a person who has the influenza virus is infectious, when they sneeze or cough the virus (in its millions)can be enclosed in thousands of droplets of fluid that can be inhaled by another person who in turn may develop the disease.*

(ii)

- *The seriousness of a disease is not determined by whether or not it is infectious.*
- *While an infectious diseases like the common cold may spread in a population, affect many thousands of people even become pandemic, the symptoms are not necessarily life-threatening.*
- *Some non-communicable diseases are more debilitating.*
- *A genetic disease like Huntingdons disease which causes a gradual break down of the nervous system is not infectious but very serious.*

(iii)

- *Pathogens are infectious agents, usually microorganisms that invade the body of an organism and cause it to malfunction.*

(iv)

- *The ease with which a pathogen is passed from one organism to another determines how highly infectious the disease is.*
- *This is partly determined by the particular pathogen's mode of transmission; whether by direct contact, through airborne droplets, from objects or via a vector.*
- *If the disease is spread through airborne droplets and the pathogen has the capacity to enter a number of tissue types in the target host then it is likely to be more infectious than a disease that only enters an animal through broken skin and requires anaerobic conditions within the host.*

- *It is also dependent on the potential new host's susceptibility to the pathogen.*
- *Some pathogens are not transmitted from person to person*
- *e.g. amoebic meningitis which is caused by an amoeba that often lives in warm fresh water or poorly maintained swimming pools. The amoeba moves through the membranes of the nasal passages when jumping into or swimming in the warm water and migrates to the meninges affecting the nervous system. This disease is normally fatal but is not communicable.*

(v)
- *Prion, virus, bacterium, protista, fungus*
  (note: some protista may be larger than some fungi)

3. (see next page)

4.

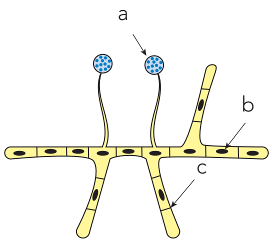
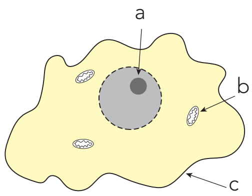
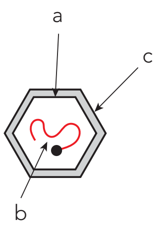
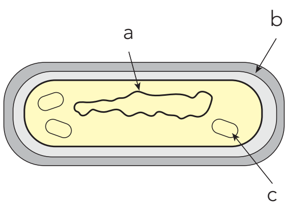
Disease	Mode of transmission	Pathogen group
Tuberculosis	Indirect – airborne droplets	bacterium
Phytophthora dieback	Indirect – motile spores travel in soil water	Protista (fungus like)
Sleeping sickness	Indirect – via vector (tsetse fly)	Protista (protozoan)
AIDS	Direct – through placenta and sexual contact or Indirect – from objects (e.g. syringes) and blood transfusions	virus
Crown Gall	Indirect – in soil water, on garden tools, contaminated soil	bacterium
Malaria	Indirect – via vector (mosquito)	Protista (protozoan)
Influenza	Indirect – airborne droplets and objects	virus

Section Three

(i)
- *The pathogen must have a means of entering a host but the host organism will have a first line of defence, e.g. the skin and mucous membranes (that line the digestive, respiratory and reproductive systems of higher animals) or the bark and/or epidermal tissue of the stem, epidermal tissue of plants' leaves and roots.*
- *In order to enter the host the pathogen must breach these boundary lines.*
- *This may be easier if boundary line is damaged. If the skin or the thin lining of the mucous membrane is broken the pathogen may be able to enter easily.*
- *Lesions or sores may also provide an opening for other pathogens.*
- *Similarly if a plant have been damaged (e.g. by feeding herbivores) an opening may have appeared for opportunistic pathogenic entry.*
- *Many viruses and bacteria rely on a vector insect to breach the otherwise almost impenetrable barrier of the skin or plant epidermis.*
- *e.g. mosquitoes break the skin when they push their proboscis through it to obtain blood from a small blood vessel – thus allowing a pathogen to enter its host's internal environment.*
- *Some bacteria are able to bind to the host's epithelial cells and destroy them, creating an entry point for themselves.*

(ii)
- *Bacteria that enter a host when the host cells phagocytose the microorganism are trapped in a 'food' vacuole.*
- *As part of the host cell's internal defence this will normally be attacked by the digestive enzymes of lysosomes.*
- *The pathogen must have mechanisms to avoid lysosomal digestion.*
- *These include secretion of proteins that break the vacuole's membrane, releasing the pathogen*

3.

Diagram	Labels	Group name	Structural characteristics
	a – spore case b – nucleus c – septum	• fungus	• Consist of branching threads called hyphae forming a mass called the mycelium. • The hyphae are usually divided along their length by walls called septa that have pores in them to allow nutrients to pass from one cell to the next. • The cell walls are composed of chitin, a carbohydrate.
	a – nucleus b – mitochondrion c – cell membrane	• protista (e.g. **Amoeba**)	• Eukaryotic cells – no complex systems. • Many are multicellular. • Unicellular examples may have flagella or cilia. • Amoeba are unicellular, They are protozoa – locomotion is amoeboid.
	a – protein layer b – DNA or RNA c – protein or lipid layer	• virus	• Much smaller than bacteria – at least half or as small as one hundredth the size. • Consist of an RNA or a DNA molecule encased in a protein layer (or two protein layers) which may be covered by a lipid layer. • Vary greatly in shape.
	a – chromosomal DNA b – cell wall c – plasmid DNA	• bacterium	• Microscopic single-celled prokaryotes. • No membrane bound organelles and nuclei. • Cell wall which is made of sugars and amino acids. • Four basic shapes – spherical, rod shaped, spiral and filamentous. • Single “doughnut” shaped chromosomal DNA molecule.

[20 marks]

(Note: one mark only for each three labels correct – total 4 marks for all labels and you must have all group names correct to score full marks for this question)

into the host cell's cytosol or changing the vacuole membrane so that it is no longer attacked by lysosomes.

- *Bacteria and viruses have antigens on their outer membranes that may be attacked by the host cell's antibodies.*
- *Because these pathogens continuously mutate the antigens change continuously so that the antibodies no longer recognise the antigen and the pathogen avoids destruction.*

(iii)

- *Once inside a host's internal environment a pathogen may be carried around the host's body by its circulatory system or body fluids until it finds a suitable microhabitat.*
- *This may be intracellular or extracellular depending on the pathogen.*
- *The viruses attach to receptor cells on particular cell membranes.*
- *The greater the variety of cell membranes that have a virus's particular receptor molecule, the greater the variety of tissues that the virus can infect.*
- *Some viruses like HIV enter only T lymphocytes and macrophages, whereas other viruses affect many tissues and organs, e.g. the Ebola virus.*
- *Viruses move into a host cell by either injecting their nucleic acid molecule into the host cell or when the host cell's membrane engulfs the virus.*
- *Those bacteria (and protozoa) that enter host cells because they a much larger than viruses can only do so when they are phagocytosed by the host's cell membrane.*
- *Within the intracellular fluid they are protected from the host cell's antibodies and phagocytotic cells.*
- *The bacteria that causes tetanus in humans thrives in the anaerobic environment that occur in the extracellular fluids of the body – when its endospores enter the body it multiplies rapidly, releasing a toxin that produces skeletal muscle spasms that can become fatal.*

(iv)

- *Once the pathogen has found its suitable microhabitat within the body of the host it generally begins to reproduce rapidly.*
- *If the virus contains DNA this enters the nucleus of the host cell and the host cell begins to make copies of the virus.*
- *If the virus has RNA, this is first copied to form DNA outside the host's nucleus. The copied DNA moves into the host cell's nucleus and similarly the host begins to manufacture the virus.*
- *Some bacteria and protozoa move to the membranes that enclose the brain and spinal cord, the meninges.*
- *The microhabitat of the membranes provides the optimum conditions for the growth of pathogens that cause amoebic meningitis and bacterial meningitis – these pathogens produce toxins that damage nerve cells.*

(v)

- *As viruses accumulate in their host cell, they begin to increase the pressure in the cytosol – eventually causing the host cell to lyse.*
- *When the host cells burst millions of copies of the virus are released into the host's extracellular fluid.*
- *The viruses are free to infect new host cells or in some cases may be expelled in a sneeze or a cough.*
- *Influenza viruses and the Ebola virus may leave their host to infect a different organism in this way, in airborne droplets of saliva or nasal mucus.*
- *Bacteria that cause tuberculosis are also dispersed via airborne droplets.*
- *The HIV may be transferred when body fluid (e.g. semen) that contains the virus comes in contact with the broken mucous membranes of the vagina or anal canal of a new host.*
- *Some pathogens leave their host when an insect vector (e.g. mosquito, tsetse fly) using a proboscis withdraws blood from a host.*
- *The protozoa that cause malaria and sleeping sickness are transferred to a new host in this way.*
- *Many viruses also move to new hosts via insect vectors e.g. Ross River virus.*
  (Note: a minimum of 4 points in each section required to achieve full marks)

Trial Test 9 – Spread, Transmission, Evolution and Control of Infectious Disease

Section One

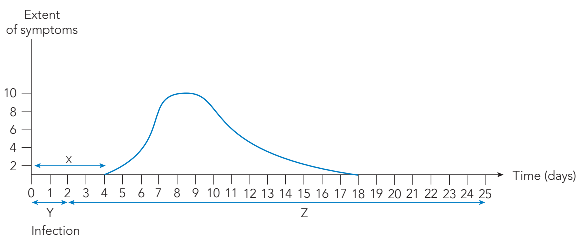
1. b	*11. c*
2. c	*12. c*
3. b	*13. c*
4. b	*14. d*
5. d	*15. d*
6. a	*16. c*
7. c	*17. a*
8. c	*18. a*
9. b	*19. d*
10. b	*20. a*

Section Two

1.
(i) endemic
(ii) immunity
(iii) mosquito
(iv) antibiotic
(v) pandemic
(vi) resistant
(vii) vaccine
(viii) life cycle

(ix) quarantine
(x) cure

2.
(i) Four (4) days
(ii) During this time the patient has no symptoms therefore he is unlikely to be aware that he has the infection.
(iii) This depends on the pathogen. If it is a virus it is likely to be multiplying within a host cell. Bacteria may be migrating to a suitable microhabitat within the host or multiplying but not have reached a threshold population large enough to produce the effects necessary to create the symptoms of the disease.
(iv) Twenty three (23) days.
(v) In this case between days two and four. This is after he becomes infectious but before the symptoms appear.
(vi) During this period (in this case the first two days) while the person has been infected he is not infectious.
(vii) The patient is most likely to suffer when the extent of the symptoms are at their highest. This is around day eight (8) in this example.
(viii) Between days eight (8) and eighteen (18) the patient's symptoms gradually diminish. Beyond day eighteen he appears to have recovered.
(ix) It appears that after day eighteen he is still infectious for a further seven (7) days until day twenty five (25).
(x)
(a)

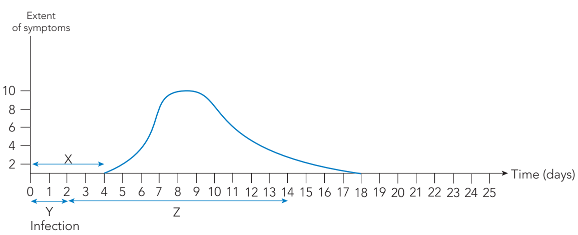


X = incubation period

Y = latent period

Z = infectious period

(b)



X = incubation period

Y = latent period

Z = infectious period

3. (i)
- The virus enters the body of it potential host.
- If a receptor molecule exists on a host cell membrane, the virus will attach itself to that molecule.

(ii)
- The virus injects its DNA or RNA into the host cell's cytosol.
- The DNA (or RNA) replicates in the cytosol.

(iii)
- In a eukaryotic cell some DNA (or a DNA copy of the RNA) moves into the host cell's nucleus and becomes part of its genome.
- The host cell synthesises the virus's protein through transcription and translation.

(iv)
- New viruses are constructed using the replicated DNA (or RNA) and the newly synthesised protein.
- This construction occurs in the cytosol.

(v)
- As the number of viruses increases inside the cell this increases the pressure on the inside of the cell membrane.
- Eventually the cell membrane bursts (lyses) allowing the viruses to escape.

4.
(i)
- Direct transmission may occur through touching, kissing or sexual contact with an infected person.
- An example of direct transmission may occur when a person who has an active cold sore kisses another person on the eyes or lips.
- Indirect transmission may occur through handling an object which has pathogens on it, through inhaling airborne droplets that are spread by an infected person when he coughs or sneezes or through being bitten by an insect which has previously fed on an infected animal or person.
- An example of indirect transmission may occur when a person grasps the door handle in a public toilet that has a deposit of bacteria on it, then later uses the same hand to eat food.

(ii)
- Via an object, e.g. a syringe that has been used by a person who has HIV (or hepatitis) which has not been sterilised correctly may contain the pathogen.
- If this syringe is used by another person that person is likely to become infected.
- Airborne droplets are spread by an infected person when he coughs or sneezes; these may contain bacteria or viruses, e.g. tuberculosis and influenza.
- If these are inhaled by another person that person may become infected.
- Via an insect vector, e.g. a female mosquito feeds on a person who has malaria, draws

some of the pathogen into its gut with the blood.
- The pathogen moves into the salivary glands of the mosquito, then leaves the insect when it feeds on other hosts.

(iii)
- Ebola can be spread both directly or indirectly.
- If a patient with the virus is handled by family, whether the infected person is alive or deceased, the virus can be transmitted directly from the infected person's body fluids through the mucous membranes (including eyes, digestive tract, respiratory and reproductory membranes) of the uninfected person.
- It can also be transmitted directly through sexual intercourse even for some weeks after the infected person may have recovered and shows no symptoms.
- If an uninfected person handles the bedding or soiled clothing of a person with the Ebola virus they can contract the disease indirectly.
- The virus can remain intact on these items for some time.

5.

(i) Thoroughly cooking pork will normally kill the cysts that may be imbedded in the meat (muscle). They will then not develop into the adult stage in the human intestines.

(ii) Better disposal of human waste (sanitation) is normal in Australia therefore the parasite's eggs are unlikely to be ingested by humans or pigs.
People are better educated in the need to cook pork well.
Health care provisions are better and likely to eliminate the adult stage through drugs and surgery.

(iii) The adult tapeworm is bathed in digested and partly digested food in the human intestine. It can absorb this food through its body surface. It body is long and ribbon like which provides a very large surface area for absorption. It therefore has no need for a digestive system of its own.

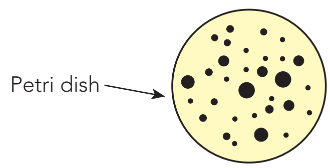
(iv) The tapeworm will deprive its human host of some nutrient. This may cause a loss of weight. Toxins that the parasite produces may lead to nausea and headaches. However infection is generally without symptoms and only human ingestion of the egg stage is dangerous as the larvae which develop from them may move into the nervous system of their host.

Section Three

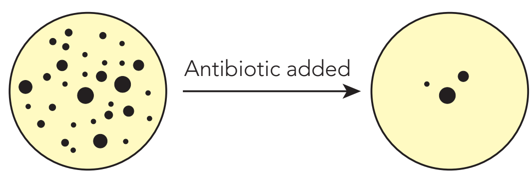
(i)
- A bacterial infection results in millions of bacteria moving into a microhabitat within the body of its host and multiplying rapidly.
- Bacteria mutate frequently and divide frequently.
- Some mutants will have a greater resistance to an antibiotic.
- When that antibiotic is used to treat the infection the resistant bacteria may survive and produce more resistant bacteria. They are "naturally" selected.
- The antibiotic will therefore lose its potency on this strain of bacteria.

(ii)
- Bacteria and viruses reproduce (or are reproduced as is the case with viruses) at a very rapid rate.
- The processes are prone to mistakes especially in the case of viruses. The nucleic acids of viruses vary significantly; they may consist of a single DNA or RNA strand, double DNA or RNA molecules and several other variations. In the complex processes occurring in host cell reproduction of the virus many opportunities for error occur.
- These errors produce a wide variety of mutants.
- The overuse and misuse of antibiotics leads to the rapid development of drug resistance in these pathogens.
- When a patient does not complete the course of an antibiotic treatment some more resistant bacteria may remain in his system.
- These may cause a recurrence of the disease and if the new resistant strain is transmitted to others, new cases will be harder to treat.

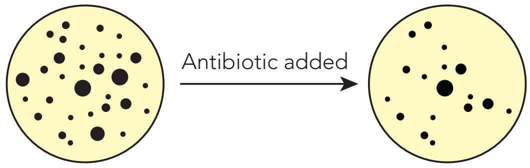
(iii)
- A sterile petri dish containing nutrient agar is inoculated with a normal strain of bacteria and incubated so that numerous colonies of the bacteria grow on the agar.



- The dish is then flooded with the antibiotic. Most of the bacterial colonies disappear.



- Taking a sample of bacteria from a surviving colony, a second sterile dish is inoculated and incubated in the same way.
- New colonies appear which are again flooded with the same antibiotic, however this time fewer colonies disappear.



(iv)

- *As antibiotic resistant strains of bacteria evolve there is a need to develop new drugs that are effective in treating them. Sometimes a combination of several different drugs is required.*
- *This is expensive and a drain on health resources. In some cases bacteria have become resistant to every available antibiotic. Measures that can be taken to limit the rate at which resistant strains do develop include:*
- *patients are required to complete the course of antibiotics so that any slightly resistant strains in their body may be eliminated,*
- *the indiscriminate use of any antibiotic used to treat a viral infection is discouraged,*
- *doctors' prescriptions required for all antibiotics,*
- *the use of antibiotics as a means to produce larger domestic animals, e.g. poultry and pigs, prohibited by law.*

Trial Test 10 – Inquiry Skills & Human Endeavour 2

Section One

1. b	11. a
2. b	12. d
3. c	13. b
4. b	14. b
5. c	15. a
6. b	16. d
7. d	17. c
8. b	18. d
9. d	19. d
10. c	20. b

Section Two

1.
(i) *asymptomatic*
(ii) *susceptibility*
(iii) *symptom*
(iv) *mode*
(v) *epidemic frequency*
(vi) *persistent*
(vii) *communicable /infectious / contagious*
(viii) *instrument accuracy*
(ix) *prediction*
(x) *disease intervention*

2.
(i) *(See next page).*
(ii) *Ten (10).*
(iii)

- *Group B's mean body temperature fluctuated over a greater range (36.7 – 37.4°C) than Group A's (36.8 – 37.1°C) over the time tested (12 minutes).*
- *Group B's mean body temperature rose steeply immediately they were placed in the hot room (to 37.4°C) at 3 minutes but then declined steeply (to 36.7°C) at 5 minutes.*
- *Group A's mean body temperature did not show similar rises and falls but stayed close to 36.9°C.*

(iv) *They may have exhibited an increase in sweating and pinker skin.*

(v)

- *Both are signs that their internal body temperatures have been raised above normal.*
- *Sweat evaporates from the skin and promotes heat loss.*
- *Pink skin due to vasodilation of blood vessels in the skin enables greater heat loss by radiation and conduction from the blood to the atmosphere.*

(vi)

- *Both changes increase the body's rate of heat loss to the environment.*
- *As rate of heat loss increases to exceed the rate of heat gain from the external environment and the rate of heat production from within, body temperature will fall.*

(vii)

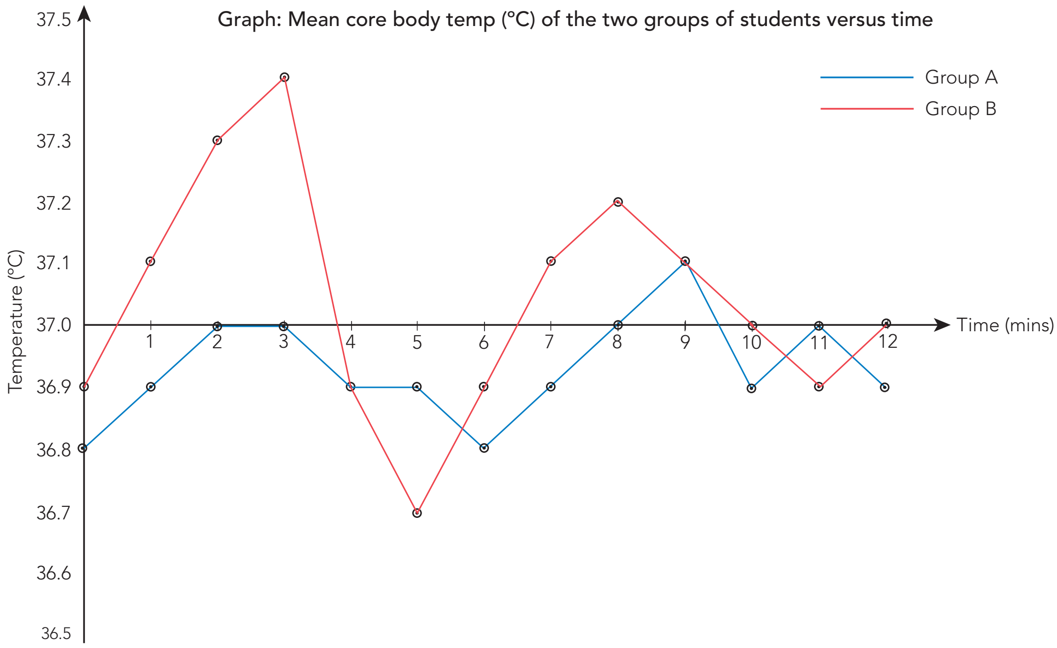
- *The cooling mechanisms have begun to take effect at time 5 minutes.*
- *These mechanisms have overcompensated for the increase in body temperature and reduced it to a lower level than normal.*

(viii)

- *Both groups were monitored frequently for any signs of stress.*
- *However, before conducting the experiment a survey of each subject's health should have been conducted.*
- *Any subject with a cardiovascular problem would need to be excluded.*

- *A plan to deal with any health emergency also needed to be established before commencement of the experiment.*

2. (i)



(Mark allocation: 1 mark for axes correctly divided, 1 mark for axes correct orientation (i.e. dependent variable on Y axis), 2 marks for correct points and lines – accurately drawn with labels (or key), 1 mark for suitable title containing both variables.)

3.

(i) A variable is any factor which can change, e.g. wind speed, humidity.

(ii) Data refers to information, either qualitative or quantitative, that is gained through observation or experiment.

*(iii) A **controlled** experiment is one in which **only** the variable which is being deliberately manipulated, ie. the independent variable, is changed. The effect of this change on the dependent variable is observed and recorded. Experiments are controlled for the validity of conclusions.*

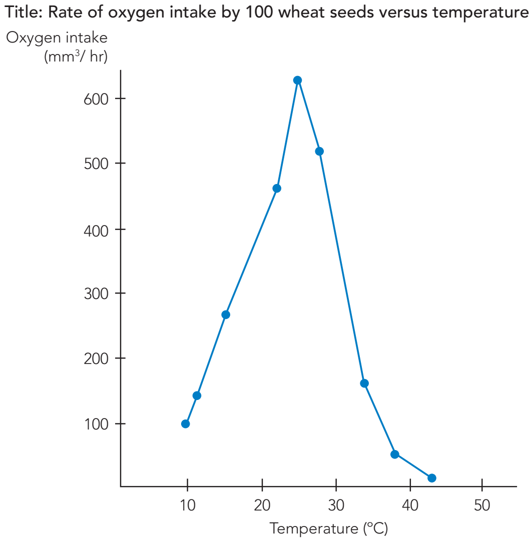
4.

(i) Independent variable: temperature of wheat seeds

Dependent variable: rate of oxygen use.

(ii) Light, moisture, seed type, seed age, seed size.

(iii) Title: Rate of oxygen intake by 100 wheat seeds versus temperature



(iv) Yes: the oxygen intake reached a maximum at about 25°C. At temperatures lower or higher than this, the rate of oxygen use declined rapidly.

(v) The optimum temperature was about 25°C.

(vi) The experiment could be made more reliable by:

- *increasing the range of temperatures used, particularly on either side of the optimum temperature (i.e. include 23°C, 24°C, 26°C, 27°C).*
- *increasing the number of wheat seeds in each sample.*
- *repeat the experiment several times.*
- *use different varieties of wheat seed.*

(vii) Germinating seeds take up oxygen at a rate which is dependent on temperature.

5.

(i) Measures would depend on the modes of transmission of the disease. If the disease is transmitted both directly and indirectly, but not via a vector such as a mosquito, the following general principles apply.

(a)

- *Infected individuals should be isolated from others where possible.*
- *Health carers and visitors should avoid touching the patient without gloves.*
- *Respiratory masks and protective clothing need to be worn near the patient.*

(b)

- *Patients' soiled bedding and clothing needs to be thoroughly washed and sanitised.*
- *The general population should be encouraged to wash hands with soap regularly, especially before handling food.*

- *Coughing and sneezing should be done with hand raised over mouth and nose to minimise airborne transmission.*
- *In the event that this is a life-threatening disease people should be encouraged to avoid large gatherings especially in enclosed spaces (cinemas and shopping centres) where possible.*

(c)

- *Those who are caring for the sick and immediate family, who are likely to be exposed, should be vaccinated immediately (if a vaccine is available).*
- *Vaccinations of the whole population should commence.*

(ii)

- *People in Australia have an option to receive a vaccination.*
- *Vaccination is free at present for more vulnerable groups including some indigenous people in particular age groups, all people over 65 years and all pregnant women.*
- *Frequently washing hands with soap removes the virus. The virus may adhere to objects such as door handles, books and toys.*
- *Avoid "shaking hands" as hands may harbour the virus.*
- *Cover mouth and nose when coughing and sneezing to minimise the spread by aerosols.*

(iii)

- *The spread is less likely because a greater proportion of people are likely to be vaccinated if a vaccine exists.*
- *The general health of people in developed countries makes them less susceptible to disease.*
- *Early diagnosis is more likely as health services are better equipped and more efficient.*
- *Early diagnosis enables a quicker recovery and limits the spread to others.*
- *The population is better educated and understands the precautions needed to avoid infection.*

Section Three

(i)

(a)

- ***Title:** Describes very briefly, the nature of the research.*
- *This is important because it should capture the essential idea of the report so as to attract others' interest in the report, e.g. "The development of antibiotic resistance in a bacterium".*

(b)

- ***Aim:** Describes why the experiment is to be conducted – may include a hypothesis to be tested.*
- *(This heading can be replaced by the heading "Abstract" which as well as the aim and hypothesis may give a brief overview of the experiment in a concise paragraph or two.)*
- *The importance of this part of the report is to enable the reader to decide whether or not the research is of interest to them, e.g. "The experiment was intended to widen our knowledge of the thermoregulatory behavior of lizards...Our hypothesis was that 'Lizards resident on the granite outcrop move onto sunny areas of the rock during the cooler times of the day thereby maintaining their internal body temperatures at these times.'"*

(c)

- ***Materials:** Details what equipment and resources are needed to carry out the investigation.*
- *It is useful to establish this list so that an inventory of equipment can be made for later use and an assessment of the cost of the experiment can be estimated before it begins. To measure the internal body temperature of the lizards, special temperature probes may be required and very specialised equipment may be needed to collect the data. (In a school setting you will probably be restricted to use what is available in the school laboratory – your experiment may have to be modified accordingly!)*

(d)

- ***Procedure:** Lists the steps needed to conduct the investigation.*
- *Details of controls used are also given.*
- *A clear description of the method used to test a hypothesis is important because others, who may wish to test the validity of your findings, will need to follow the same procedures. A hypothesis cannot be accepted until other researchers have conducted similar tests and collected similar supporting data.*

(e)

- ***Results:** Clearly presents the data collected using tables and/or graphs to display findings.*
- *This section of the work does not require discussion or comment – the data needs to be objectively presented so that it is easy to read and all calculations, e.g. means, standard deviations etc. presented with an indication of how they were calculated.*

(f)

- ***Conclusion:** Provides analysis of the results and the experimental error.*
- *Importantly it should include an assessment of whether or not the hypothesis is supported.*
- *If the data supports the hypothesis it is opportune here to propose further related hypotheses that may be useful to test, adding to the body of knowledge. If the data does not support the hypothesis, then an alternative hypothesis to explain the*

observation/phenomenon is required and another appropriate experiment designed to test it.

(g)

- ***References:** This lists resource materials that may have been used/quoted in the text of the report.*
- *These are essential to recognise the work of others and to enable the readers to do their own further research if they are interested.*

(h)

- *Peer review involves other scientists, who are working in the same field of research, evaluating an experiment or scientific study before it is published.*
- *Scientists who are working in the same field are more qualified than other scientists (and other persons) to evaluate the work, to assess whether the data is reliable and to determine whether the data supports or refutes a hypothesis.*
- *The more peer involvement in this process the more confident others should be in the ultimate findings.*
- *Peer review is intended to reduce the amount of unreliable and invalid information circulated by reputable scientific journals. When poor information is circulated it lowers public confidence in scientists and in science generally.*

GLOSSARY

Abiotic: Factors in the environment which are not living, e.g. temperature, humidity, are described as abiotic (cf. biotic).

Absorption: The uptake of substances into an organism or cell.

Abundance: The density of organisms in a particular part of their range, e.g. number per hectare of Jarrah trees near Dwellingup.

Acquired Characteristic/Trait: A feature which is not inherited. It is caused by the environment or by use, e.g. enlarged biceps through weight lifting.

Active Process: A process that requires an external source of energy e.g. protein synthesis, active transport.

Active Transport: The movement of a substance (e.g. glucose) across a cell membrane from a region of lower concentration to a region of higher concentration. This process requires energy.

Adaptation: A trait which enables an organism to survive and reproduce better in its environment.

Adaptive Radiation/Speciation: The evolution of two or more species from one original species.

Agarose Gel: A solid jelly like substance made largely from a polysaccharide extracted from red marine algae used in gel electrophoresis.

Agrobacterium: Pathogenic aerobic bacteria that can cause plant diseases. Can be used as a vector to transfer genes to plant cells in genetic engineering.

Allopatric Speciation: The development of two or more species that occurs when populations of the same species are reproductively isolated by barriers for an extended of time.

Anode: The positive terminal of a battery that attracts negatively charged particles.

Antidiuretic Hormone ADH: A hormone released from the pituitary gland which targets the kidneys and increases their reabsorption of water from the filtrate.

Appendage: This is a limb or extension from the main part (apex) of the body, e.g. arm, leg, antenna.

Aerobic: A biological process which requires oxygen (cf. anaerobic).

Aestivation: When an animal becomes inactive during the summer.

Allele: Alternative form of a gene which occurs at the same locus on homologous chromosomes.

Allopatric: Populations of the same species which are separated and are unable to interbreed because of their isolation.

Ambient Temperature: The temperature of the surroundings.

Amino Acid: The basic organic molecular unit which when linked in a chain forms a protein molecule. Amino acids contain nitrogen (attached to two hydrogen atoms, -NH_2). See ‘protein’.

Ammonia: A gas (NH_3) which dissolves readily in water. It is toxic to cells and if not immediately excreted when formed in the body, must be converted to urea or uric acid, less toxic compounds.

Anaerobic: A biological process which occurs in the absence of oxygen, e.g. fermentation (cf. aerobic).

Analogous: Parts of different organisms that have a similar function but which have a different structure, e.g. wings of bats and wasps (cf. homologous).

Anaphase: A phase in both mitosis and meiosis in which the chromatids/chromosomes move from the equator to opposite poles of the cell. Once separated, the chromatids are called chromosomes.

Anatomy: The structure of an animal or plant. (Also used to refer to the study of animal and plant structure.)

Ancestor: A person from whom one has descended or a plant or animal that has lived in the past which has given rise to present day plants or animals.

Animal: An organism which is heterotrophic, able to move and has body cells which do not have a cell wall (cf. plants).

Antibiotic: A substance which destroys or inhibits the growth of microorganisms like bacteria.

Anticodon: Three nitrogenous bases alongside each other on a tRNA molecule. These pair with a matching codon of three nitrogenous bases on a mRNA molecule during protein synthesis.

Antigen: A chemical that stimulates the immune system to produce antibodies when it enters the body.

Antiviral: A drug used to treat a viral infection usually by inhibiting the development of the virus.

Appendix: A human vestigial organ attached to the first part of the large intestine.

Aquatic Environment: A water environment, marine or fresh water.

Arteriole: A small branch of an artery which branches further into capillaries.

Artery: A blood vessel which carries blood away from the heart to other body tissue.

Artificial Selection: The selection by humans of animals or plants, which have useful features, for breeding programmes (cf. natural selection).

Asexual Reproduction: Reproduction which does not involve the fusion of gametes, e.g. binary fission, budding, spore formation.

Asymptomatic: Refers to a condition in which a person has a disease but shows no symptoms or signs of the disease. The asymptomatic person, who is infected, can still spread the disease i.e. they may still be contagious.

Attenuated Pathogens: Pathogens that have intentionally been made less virulent or weakened by heat or radiation.

Autosome: A chromosome which is not a sex chromosome.

Backcross: A cross between an F_1 hybrid and a homozygous parent.

Bacteria: (singular bacterium) Microscopic organisms which have no membrane bounded organelles.

Bacteria are therefore called prokaryotes. Saprophitic bacteria are very important in the decomposition of dead organisms.

Bacterial Plasmid: a small ring of DNA found in bacteria which is not essential to the bacteria. Can be used as a vector in recombinant DNA technologies to transfer genes from one organism to another.

Banding: When chromosomes are treated with stains during cell division they exhibit characteristic stripes or bands.

Base Pair: Two nucleotides that pair in DNA or RNA, e.g. C with G, T or U with A.

Behaviour: The way or pattern in which an animal acts.

Binary Fission: Cell division which results in two similar organisms.

Biochemistry: The study of chemical processes in living organisms.

Biocide: A chemical which is used to kill organisms.

Biodiversity: The range of living things in an environment. May be measured by the total number of species or the total number of genes.

Biogenesis: The theory that states that all living organisms came from pre-existing organisms.

Biogeography: The study of an organism's distribution over its geographic range.

Bioinformatics: The use of computers and computing software in biology.

Biological Ballistics (Biolistics): A technique used to transfer genes from one cell to another. The DNA attached to a plasmid is coated on a tiny particle of heavy metal (tungsten, gold, silver) and fired at the cell nucleus of the target cell.

Biosecurity: Strategies designed to protect organisms (including human populations) against pathogens and harmful biochemical substances.

Biota: The plants and animals in an area.

Biotechnology: Industrial use of biological processes, e.g. fermentation, genetic engineering.

Biotic Factor: Environmental factor which is living, e.g. predators, competitors (cf. abiotic).

Biuret's Test: Test for proteins. A blue alkaline solution with copper sulfate is used. It turns purple if protein is present.

Bivalent: Paired homologous chromosomes during the prophase 1 and metaphase 1 of meiosis.

Blood Sugar: The glucose which is dissolved in blood plasma.

Calibration: The adjusting of an instrument to ensure that its readings are accurate.

Cancer: The uncontrolled growth of cells, often able to spread via the circulatory or lymphatic system to invade other tissue.

Capture Recapture Method: A technique used to estimate the size of a population.

Carbon Dating: A method of dating organic matter which uses the percentage of undecayed carbon-14 as a measure of the age of a fossil. The older the fossil is, the smaller the proportion of carbon-14 that will be left.

Carnivore: A flesh eating animal.

Carrying Capacity: The population of a species which a particular area can support.

Catalase: An enzyme which speeds up the decomposition of toxic hydrogen peroxide (a common metabolic waste) into water and oxygen.

Cathode: The negative terminal of a battery that attracts positively charged particles.

Cell: The basic "building block" of living things (except viruses). Consists of a membrane bounded protoplasm.

Cell Differentiation: The development of specialised cells in multicellular organisms from unspecialised cells in the early stages of the organism's growth.

Cell Division: This occurs when a cell's nucleus divides followed by its cytoplasm. Each time a division occurs two cells are formed (cf. meiosis and mitosis). See 'cytokinesis'.

Cell/Plasma Membrane: The protective differentially permeable layer of lipids and proteins which encloses a cell's protoplasm.

Cell Plate: The disc-shaped structure which forms between the daughter cells, produced when a plant cell divides. It later becomes the common cell wall between the two new cells.

Centriole: Two small organelles which lie just outside the nucleus of animal cells. They form the spindles during cell division.

Centromere: The point of attachment of two chromatids (consisting of a protein molecule). The spindle fibres attach to the centromere during cell division.

Chemoreceptor: A special receptor which is sensitive to specific chemicals, e.g. taste receptors, aortic body receptors (sensitive to CO_2 in the blood).

Chemotaxis: The response by an animal in moving towards a chemical stimulus.

Chemotropism: A plant's response in growing towards or away from a chemical stimulus.

Chiasma: Where two homologous chromosomes cross over they form an X shape, called a chiasma.

Chromatid: Each chromosome replicate held together by the centromere after replication.

Chromatin: Thin uncoiled strands of DNA as it exists during the interphase.

Chromoplast: A membrane bounded organelle which contains a pigment which often gives a leaf or fruit its characteristic colour.

Chromosome: Chromatin which has shortened and thickened ("condensed") to become visible (with the aid of a microscope) as a separate body during cell division.

Chromosome Mapping: Scientific determination of the location of genes on a chromosome.

Cilia: (singular cilium) Short hair-like structures protruding from specialised cells which beat rhythmically to move the cell or move substances over the cell (e.g. in the trachea ciliated epithelial cells help clear the lungs of mucus and dust, etc).

Cline: A gradual change in a trait over a particular species range, e.g. size of a tree species may range from tall near the base of a mountain through to short near the summit.

Clones: Asexually reproduced organisms which have arisen from the same parent.

Cloning: To produce one or many offspring from the DNA of a single cell or tissue taken from one organism.

Codominance: When two different alleles are present in an organism but neither is dominant. Both genes are expressed, e.g. group AB in the ABO blood grouping results from the genotype I^AI^B where both the gene for A, I^A and gene for B, I^B are expressed.

Coding DNA: A region of a gene that codes for a protein. It is made up of exons.

Codon: Three nitrogenous bases on the DNA molecule that code for a particular amino acid.

Communicable Disease: A disease that is able to be transmitted from one organism to another, often described as infectious or contagious.

Community: The plants, animals and microorganisms which live together in a particular place at a particular time.

Competition: An association between two organisms where both strive to obtain the same resource (e.g. food, shelter, mates). May be interspecific (between two species) or intraspecific (within the one species).

Complementary Bases: The nitrogenous bases which fit together in nucleic acids, e.g. guanine and cytosine; thymine and adenine.

Complementary DNA (cDNA): DNA that is made from mRNA. Used in microarrays to determine which genes are switched on.

Congenital: A trait which is possessed from birth.

Conservation: The preservation of plants and animals and their environments for future generations.

Conservation Status: The risk of extinction of a species. Threatened species can be divided into three categories of risk.These are in ascending order – Vulnerable (VU), Endangered (EN) and Critically Endangered (CR).

Contagious: Describes a disease that may be spread from one person to another or one organism to another. Transfer may occur either directly or indirectly. Generally the word infectious has the same meaning as the word contagious. See also "communicable".

Continuous Variation: A feature which is controlled by many genes. Shows a graduated range, e.g. height in the human population.

Controlled Experiment: An experiment in which only the independent variable is manipulated to determine its effect on the dependent variable. Other variables which may affect the dependent variable are held constant.

Controlled Variable: A variable which is kept constant in both the control and the experiment. It is constant in both so that it does not affect the dependent variable.

Convergent Evolution: The evolution of features which are similar in different organisms, e.g. wings in insects and birds, due to similar habitats.

Convolution: A fold in a membrane or tubule which increases its total surface area.

Coordinating Centre: Alternatively called the "modulator" in a feedback system. It is an area of cells or tissue (e.g. in hypothalamus, medulla oblongata) which receives information from receptors, processes that information and when the stimulus is sufficiently strong, i.e. the stimulus has reached a threshold, sends messages to an effector (often more than one effector) which responds to the stimulus.

Coordination: The working together of organs or organ systems in order that the organism functions as a whole, e.g. nervous and endocrine systems work together to maintain stability within a mammal.

Coronavirus: A virus which belongs to a group of viruses that have in common, a large single strand of RNA and a lipid envelop covered by spike proteins. These viruses are known to infect birds and mammals including humans. Examples of diseases caused by coronaviruses include SARS and Covid-19.

Counter-current: A flow of liquid in the opposite direction to another. This occurs in the appendages of animals when blood flowing in the arteries passes the blood flowing in the veins.

Covid-19: A highly contagious disease which is caused by a coronavirus (SARS-CoV-2). Its symptoms may include fever , tiredness, headache, breathing difficulty and loss of smell and taste. The disease is transmitted largely through aerosols in the air that is exhaled by an infected person during speaking, coughing and sneezing but can also be transmitted on contaminated surfaces.

Critique: A critical review of a journal article, experiment or book.

Crop Species: A plant species that is cultivated for food or useful materials, e.g. wheat, cotton.

Cross Fertilisation: The fusion of gametes from two different individuals (cf. self-fertilisation).

Cross Over: The exchange of genes which often occurs between two homologous chromatids during the metaphase I of meiosis. It results in greater variation in the offspring. Often called genetic recombination.

Cross Pollination: When pollen from a different plant settles on the stigma of a particular flower.

Cull: The removal of some animals from a given population.

Cultivar: A variety of a plant species bred to promote a desirable trait that does not occur in nature.

Cultivate: To prepare land for plant growth or to promote the growth of plants.

Cure: The successful remedial treatment of a disease (cf. treatment).

Cytosol: Fluid part of the cell's cytoplasm; excludes organelles that are membrane bounded and cytoskeletal structures.

Cytokinesis: The splitting of a cell's cytoplasm during cell division.

Cytokinins: Plant hormones that stimulate mitosis.

Cytology: The scientific study of cells.

Cytoplasm: The fluid part of the cell containing the organelles (other than the nucleus) and including the cell membrane (cf. protoplasm).

Datum (plural: data): Information gained through observation.

Daughter Cell: One of the cells resulting from cell division (cf. 'parent' cell).

Deamination: The breakdown of excess amino acids in the liver. This involves the removal of the amino group of atoms (NH_2) from the amino acid. Ammonia (NH_3) is formed. This is excreted by many aquatic animals, which have no 'water problem'. It is converted to urea ($CO(NH_2)_2$), by mammals and uric acid ($C_5H_4N_4O_3$) by birds and most reptiles for excretion.

Decay: To breakdown, rot or decompose. This is carried out by bacteria and fungi.

Deciduous: Describes a tree or shrub which annually sheds its leaves. Usually this occurs during autumn, although in arid climates it may occur in early summer.

Decompose: See 'decay'.

Decomposer: A heterotrophic organism which breaks down the remains and wastes of other organisms, returning nutrients to the soil or water.

Dehydrate: To remove water from an organism or a chemical.

Deletion Mutation: A mutation in which a part of a chromosome or sequence of nucleotides is removed.

Dendrochronology: Using the annual rings in tree trunks to determine their age and sometimes the age of associated fossils.

Denaturation: To change the tertiary shape of an enzyme by heat so that it no longer fits its substrate/s. This is usually irreversible. Also used to describe the process of heating DNA, splitting the molecule along its length.

Deoxyribonucleic Acid DNA: This is a molecule made up of a chain of nucleotides. Most chromosomal DNA consists of two complimentary strands which form a double helix structure.

Dependent Variable: The variable in an experiment which responds to changes in the independent or manipulated variable.

Desert: Land in which annual rainfall is low and irregular and therefore vegetation is sparse.

Diagnose: To determine the cause of a disease.

Dieback: A disease caused by pathogenic attack on the roots of a plant, e.g. Jarrah Dieback (which affects many different species) is caused by the protista *Phytophthora cinnamoni*.

Differentially Permeable: Permeable to some particles but not to all, e.g. cell membranes (sometimes called semi-permeable).

Differentiation: The development of specialised cells as they mature.

Diffusion: The passive movement of particles from an area of high concentration to an area of low concentration in a fluid.

Digestion: The breakdown of larger more complex organic matter into simpler compounds so that they can be absorbed by an organism.

Dimorphism: When an species occurs in two distinct phenotypic forms as in the sexual dimorphism of male and female humans.

Diploid: The possession of two of each chromosome type, e.g. in human cells the diploid number is 46 (23 pairs).

Direct Transmission: The transfer of a disease from one organism to another through contact. In humans this may occur through touching, kissing or sexual contact with an infected person.

Disease: A malfunction of the organism caused by injury, microorganisms or incorrect biochemistry.

Disease Intervention: Any process that people can take in order to limit the spread of and the suffering (in the case of higher animals) caused by disease.

Dispersal: The movement of organisms from where they are produced to other sites where they breed and reproduce.

Distribution: The area over which a species can be found.

Distributional Studies: This is the study and the comparison of where animals and plants live and have lived in the past, e.g. different large flightless birds are found on the continents and islands that formed from the supercontinent of Gondwanaland, suggesting that they have evolved from an ancestral flightless bird that once lived in Gondwanaland.

Diurnal: Describes an organism which is active during the day (cf. nocturnal).

Divergence: The evolution of two or more populations as they adapt to different environments and become different.

DNA Annealing: The joining together of complimentary strands of DNA. A polymerase enzyme may be used for the annealing process.

DNA Chip: See 'DNA microarray'.

DNA Fingerprinting: Identification of an individual organism from part of its DNA (also called DNA profiling).

DNA Fragment: A short section of DNA which can be created by cutting a DNA molecule with a restriction enzyme. A DNA fragment may be double or single stranded.

DNA Hybridisation: A technique used to determine how closely related two organisms or species are in the phylogenic tree. It involves determining the degree of similarity of their DNA, by allowing it to hybridise.

DNA Ligase: An enzyme that can link two segments of double strand DNA or two complimentary single DNA strands.

DNA Ligation: Joining the 'sticky' or the 'blunt ends' of DNA fragments together using ligase. The latter joining requires a much greater concentration of ligase.

DNA Microarray (Chip): A grid of microscopic DNA probes, generally attached to a glass slide, that can be used to determine which genes in a cell type are switched on at any given time in its development.

DNA Probe: A technique for identifying a section of DNA. A known sequence of bases is used to detect a complementary sequence.

DNA Profiling: See 'DNA fingerprinting'.

DNA Replication: A process that involves the splitting or 'unzipping' of a DNA molecule along it entire length and the movement of free nucleotides onto the exposed nitrogen bases so that two identical copies of the original DNA are formed. Normally occurs in the middle stage of interphase.

DNA Sequencing: Any scientific method used to determine the order of nucleotides (A, C, G and T) in a DNA molecule.

DNA Transcription: The copying of part of a DNA molecule by the formation of mRNA.

DNA Translation: The process in which tRNA carry amino acids to the mRNA on the ribosomes so that a particular protein is synthesised according to the DNA code.

Dominance: A trait expressed by a heterozygote which hides or masks another trait.

Dominant Gene: An allele expressed by a heterozygote, which hides or masks another allele.

Dormant: A condition in which an organism ceases its activity and growth in order to survive adverse conditions, e.g. hibernation and aestivation.

Dysfunction: When normal function does not occur.

Ecologically Sustainable: An activity involving a natural community which can be maintained without affecting the viability of the community's populations of organisms.

Ectothermic: An animal whose body temperature depends on the temperature of its surroundings (cf. endothermic).

Effector: The part of an organism which responds to a stimulus.

Electron Microscope: A microscope which uses electrons to magnify the image of an object (cf. light microscope). It has higher magnification (up to 2 million) and greater resolution than a light microscope.

Embryo: The early stages of development after the zygote begins to divide and before the organism can be recognised as a particular species.

Embryology: A branch of science that primarily involves the study of embryos.

Endemic Disease: A disease which is regularly found in a particular population.

Endocrine Gland: A gland which secretes its product, a hormone, directly into the circulatory system in animals. Hormones may use the phloem for transport in higher plants. An endocrine gland has no duct and targets cells which are generally well removed from it.

Endocytosis: The process whereby a cell's membrane either folds inwards to absorb a fluid (pinocytosis) or protrudes outwards and engulfs a larger solid particle (phagocytosis).

Endoplasmic Reticulum: (abbreviated as ER) A network of membranes which form channels within the cytoplasm of a eukaryotic cell. Used to transport materials about the cell.

Endothermic: The capability of maintaining a fairly constant internal temperature regardless of the temperature of the environment, e.g. mammals and birds.

Energy: The capacity to do work. Measured in joules.

Enzyme: A protein molecule which acts as an organic catalyst by lowering the activation energy of a reaction.

Epidemic: The rapid spread of a communicable disease in a given population to a large number of its members.

Epidermis: The outer layer of cells which covers an organism.

Equilibrium: The state of stability in an ecosystem.

Eugenics: Applying the principles of genetics to improve the inherited features of human populations.

Eukaryote: A cell which has membrane bounded organelles, including a nucleus, e.g. amoeba, human cells.

Evaporation: The change from a liquid to a gas, e.g. water to water vapour.

Evergreen: A tree which keeps most of its leaves all year (cf. deciduous).

Evolution: The gradual change in the gene pool of a species which occurs over thousands of years due to the cumulative effect of mutations and natural selection.

Excretion: The removal of metabolic wastes. These include carbon dioxide, urea, and uric acid (cf. elimination).

Exocrine Gland: A gland which empties its product into a duct, e.g. salivary glands, lacrimal glands, gastric glands (cf. endocrine).

Exocytosis: The removal, by means of a vacuole, of wastes or secretions via a cell's membrane (cf. endocytosis).

Exon: Part of a DNA molecule which codes for a particular amino acid sequence.

Exotic: An introduced plant or animal.

Ex Situ Conservation: The removal of endangered animals or plants from their natural habitat so that they can be protected and allowed to reproduce. Captive breeding programmes are ex situ and have the aim of reintroducing the animals back into the wild when their survival is more secure.

Extinct: A species which has not been sighted live for fifty years or more.

Extracellular Fluid: The fluid which surrounds a cell inside a multicellular organism.

Faeces: Solid wastes produced by the digestive system eliminated via the anus.

Fat: A compound consisting of glycerol and three fatty acids called triglycerides. Soft greasy solids.

Fauna: The animals that live in a particular area.

Feedback: The effect which a response may have on a stimulus. If the response reduces the stimulus it is called a negative feedback. If the response increases the stimulus it is a positive feedback.

Feral: Domesticated animals that have become "wild" or gone back to a natural way of life.

Fertilisation: The fusion of two gametes to produce a zygote during sexual reproduction.

Field of View: In microscopy this refers to the circular area visible in the ocular at a particular magnification.

Filament: A long chain of connected cells which forms a thread-like structure, as in filamentous algae.

Filial: Offspring produced by two parents in a particular study. The first generation is called the F1 or first filial generation. When the F1 are crossed their offspring are called the second filial generation, F2.

Fission: When a single-celled organism divides into two during asexual reproduction. Often called binary fission,
e.g. bacteria.

Fixation: When cells are killed and preserved in order to prepare a microscope slide.

Flaccid: Condition of cells when they lose water and become soft and limp.

Flora: The plants that live in a particular area.

Follicle Stimulating Hormone: (FSH) A hormone released by the pituitary gland which targets the ovaries and promotes the development of ova and their associated follicle cells.

Forest: An area over which trees are the dominant plant. A large percentage of sky is obscured by leaves in a forest.

Fossil: A trace of an organism that has previously lived on the earth, generally found embedded in sedimentary rock.

Fossil Record: The fossils of a particular type of organism ranging in age which may indicate the organism's evolution in time.

Founder Effect: Refers to the random change or loss of genetic variability that occurs when a small population of organisms colonise a new area (e.g. an island) or when a population is reduced in size by adverse conditions to a 'bottleneck' and then grows again to larger numbers.

Function: What an organ or structure does in carrying out its normal activities.

Fungi: (singular fungus) Plant-like organism which lacks chlorophyll, e.g. mushrooms, toadstools, yeast. They are important in decomposition and disease.

Gamete: A mature sex cell; sperm, ovum, pollen grain and ovule. Gametes are haploid.

Gas Exchange: The absorption of oxygen accompanied by the excretion of carbon dioxide that takes place across a respiratory surface in animals. In photosynthetic plants, during photosynthesis carbon dioxide is absorbed and oxygen released to the environment.

Gel Electrophoresis: A technique used to separate DNA fragments (also RNA and proteins) which uses an electric field and a gel (agarose).

Gene: A section of a chromosome which codes for a particular protein.

Gene Cloning: Making many copies of a particular gene. This can be achieved through recombinant DNA technology and PCR.

Gene Flow: A movement of genes from population to population through interbreeding.

Gene Frequency: The proportion of a particular allele in a population.

Gene Locus: The position on a chromosome where a particular gene is normally located.

Gene Pool: The total set of genes in a particular population.

Gene Splicing: Technique used to cut a DNA molecule in order to graft a segment of DNA to it. Restriction enzymes are used to cut the host DNA at the appropriate points.

Gene Therapy: The treatment of a genetic disease by inserting normal genes into the cells or tissue of an affected organism or by 'switching off' some genes.

Gene Vector: A means of transferring genes from one organism to another, e.g. agrobacteria.

Generalisation: A statement which applies to many cases, e.g. 'living things are made up of cells.'

Genetic Bottleneck: A severe reduction in the size of a population that incidentally also reduces the genetic variation in the population's gene pool.

Genetic Isolation: Reproductive separation, when two populations cannot interbreed because of a barrier between them.

Genetic Drift: A random process in which the gene pool changes with time due to chance rather than natural selection. More likely to occur in small genetically isolated populations.

Genetic Modification: The addition, deletion or 'switching off' of genes in an organism so that its phenotype is altered in some way.

Genetically Modified: An organism (G.M.O.) in which a gene (or genes) has been changed artificially in some way.

Genetics: The scientific study of heredity.

Genome: One complete set of chromosomes and their genes.

Genomics: The area of genetics involved in studying genomes, DNA sequencing and its use in biology.

Genotype: The genetic makeup of an organism for a particular trait, e.g. Tt.

Geographical Distribution: The range over which an organism lives on the Earth.

Geographic Isolation: The isolation of populations (of the same species) from one another due to physical barriers such as rivers, oceans, mountain ranges and deserts.

Germination: When a plant seed or spore begins to grow.

Gland: An organ or tissue which secretes a substance that is used somewhere else in the body.

Global Warming: The gradual increase in the Earth's atmospheric and ocean temperatures caused by an increase in the percentage of Greenhouse Gases, i.e. CO_2 and methane, in the air. Sometimes called 'enhanced' global warming.

Glucagon: A hormone which is released by the pancreas when the blood's glucose level is low and which increases the breakdown of stored glycogen in the liver to glucose, thus increasing the blood's glucose level.

Glucose: A simple sugar (monosaccharide) formed by photosynthesis and used as a source of energy in respiration (formula $C_6H_{12}O_6$).

Glycogen: A carbohydrate (polysaccharide) made up of a long chain of glucose molecules. Animals store glucose in this form in the liver and muscles. It is suitable in this form as it is not as soluble as glucose and therefore exerts less osmotic effect. It is readily converted to glucose and is a convenient source of energy.

Golgi Body/Apparatus: An organelle found in eukaryotic cells which "packages" substances (e.g. enzymes) into vacuoles which the cell secretes.

Gonad: An organ which produces the gametes, e.g. testis, ovary.

Gondwanaland: The southern land mass consisting of Australia, India, Africa, South America and Antarctica which existed before tectonic movement separated these continents (over 65 million years ago).

Gradient: A gradually changing environmental condition, e.g. the concentration of salt may gradually increase in the water from the bottom of a lake.

Greenhouse Effect: The rise in the average temperature of the Earth's atmosphere, together with the rise in the sea level and changing climatic conditions over the Earth generally. See 'global warming'.

Greenhouse Gas: A gas which contributes to global warming e.g. carbon dioxide, methane, nitrous oxide, water vapour.

Growth Hormone: (GH) A hormone released by the pituitary gland which stimulates body growth. Sometimes called somatotropin.

Growth Ring: A concentric ring found in the trunk of a tree which is due to one year's growth.

Guard Cell: A specialised leaf epidermal which paired with another similar 'sausage' shaped cell forms a stomatal pore.

Habitat: The place in an environment where a particular animal or plant lives.

Habitat Destruction: The disruption of the place in an environment where a particular animal or plant lives.

Habitat Fragmentation: When the geographical range of an organism is reduced to smaller pockets or islands of population by environmental change. This has occurred in Australia due to the clearing of land for agriculture, leaving small populations of plants and animals often genetically isolated from one another.

Haemoglobin: An iron containing protein which carries oxygen (and some carbon dioxide) in blood.

Half-life: The length of time it takes for a radioactive substance to lose half of its radioactivity through radioactive decay. The half-life of carbon-14 is 5730 years.

Halophyte: A plant which is adapted to live in a salty environment.

Haploid: One complete set of chromosomes containing one of each homologous pair. In humans the haploid number is twenty three (23).

Healthcare: The provision of medical help in a population for individuals as preventative or remedial treatments and cures.

Heath: Land which is covered by shrubs which have small leaves, are tough and often wind and drought resistant.

Herbivore: A plant eating animal (cf. carnivore and omnivore).

Hereditary: Capable of being passed on through gametes from parents to offspring. An hereditary trait is controlled by genes.

Heterotroph: An organism which cannot make its own food, but relies on the organic matter produced by other organisms, e.g. animals, fungi, bacteria (other than cyanobacteria and chemosynthetic bacteria) (cf. autotrophs).

Heterozygous: When an organism's genome has two alleles that are different, it is described as heterozygous for that particular trait e.g.Tt, I^Ai.

Hibernation: Becoming dormant during the coldest season of the year (cf. aestivation).

Hirsute: Having a covering of hair or hair-like bristles.

Histology: The study of tissue structures and tissue functions in organs.

Homeostasis: The maintenance of stability within the body of an organism.

Homeothermic/Homoiothermic/ Endothermic: The capability of maintaining a fairly constant internal temperature regardless of the temperature of the environment, e.g. mammals, birds.

Homogeneous: Organisms and objects all of the same type.

Homologous Chromosomes: Paired chromosomes which are similar and have the same type of genes although they are not necessarily the same alleles. Diploid cells have a pair of each chromosome type. Human cells have twenty three (23) homologous pairs of chromosomes.

Homologous Structure: Part of an organism which has a common evolutionary origin with a similar structure in another organism, e.g. the wings of birds and the arms of humans.

Homozygous: When an organism's genome has two alleles that are the same, it is described as homozygous (or pure) for that particular trait e.g. TT, tt or I^AI^A.

Hormone: A chemical released in small amounts from special tissue which brings about change in another part of the organism. Endocrine glands produce hormones in animals.

Host: An organism in or on which a parasite or pathogen lives.

Hybrid: A heterozygous organism, e.g. Tt.

Hybrid Vigour: The increased strength of an organism which is due to its being a cross between different varieties or races.

Hybridisation: A process in which two single strands of nucleic acid molecules (often single DNA strands) combine to form a double-stranded molecule. This process is often used to determine the degree of similarity between two DNA strands.

Hydrogen Bond: A weak bond between a hydrogen atom in one molecule (e.g. a nitrogenous base) and another electronegative atom (e.g. oxygen) which is part of another molecule (e.g. another nitrogenous base).

Hydrophyte: A plant which is adapted to live in damp or aquatic conditions.

Hypertonic: A solution which because of its higher concentration gains water by osmosis from another solution less concentrated through a differentially permeable membrane (cf. hypotonic).

Hypothalamus: A small section of the underside of the brain connected to the pituitary gland. The hypothalamus is sensitive to changes in the temperature and the osmotic pressure in the blood. It contains temperature receptors and osmoreceptors. It therefore controls both the body temperature and the level of water in the blood. It also controls the release of pituitary hormones.

Hypothesis: An educated guess put forward to explain an observation. To be described as a hypothesis the proposition must be testable. When evidence accumulates to support the hypothesis it becomes classified as a theory.

Hypotonic: A solution which being less concentrated loses water to another more concentrated solution by osmosis through a differentially permeable membrane (cf. hypertonic).

Immigration: The movement of organisms into a population.

Immunisation: When a person (or animal) is made more resistant to a specific disease. This involves strengthening the person's immune system so that it responds more vigorously to a particular pathogen.

Immunity: The capacity of an organism to resist disease by means of its lymphocytes and other white blood cells.

Impulse: The electrochemical message which travels along nerve cells or neurones.

Inclusion: A particle of non-living material within the cytoplasm, e.g. starch grains.

Incubation period: The time between when a pathogen enters the body of a new host and when symptoms or signs of the disease become apparent.

Incomplete Dominance: See 'codominance'.

Independent/Random Assortment: When the chromosomes pair at metaphase I of meiosis their arrangement is random. Therefore the combinations of various genes in the gametes are random.

Independent Variable: A variable in an experiment which is deliberately changed in order to measure its possible effect on another variable called the dependent variable.

Indigenous: Naturally occurring native animals and plants are indigenous as are the Aboriginal people.

Indirect Transmission: The transfer of a pathogen from one organism to another that does not involve contact between them. This may occur through handling an object, e.g. a blanket that has been in contact with an infected person, through inhaling airborne droplets that are spread by an infected organism when it coughs or sneezes or through being bitten by an insect vector which has previously fed on an infected animal or person.

Infectious: see 'communicable'.

Influenza: A common infectious disease in human populations (and in other mammals and in birds) caused by a (influenza) virus. Transmitted from the sufferer through coughing or indirectly by first touching objects which have the virus on them. The symptoms include – fever, sore throat, "runny" nose, cough which may persist and gradually worsen for several weeks, headache, muscle pains and lethargy.

Ingestion: The taking in of food and water by an animal.

Initiation Factor: A protein which is required to begin the process of translation at a ribosome.

Insecticides: Chemicals used to kill insect pests.

Inseminate: To introduce sperm into the female reproductory tract to fertilise ova.

In Situ: Occupying a natural place.

In Situ Conservation: Taking measures to protect endangered animals or plants within their natural environment. This may include the culling of predators, the removal of pollution and the restoration of damaged habitats.

Insertion Mutation: A mutation in which a part of a chromosome or sequence of nucleotides is added.

Inspiration: To draw or inhale air into the lungs.

Insulin: A hormone which is produced by the pancreas, when blood glucose level rises. It stimulates the liver to convert glucose to glycogen for storage and causes body cells generally to absorb more glucose. Therefore insulin reduces the blood's glucose level.

Integration: The incorporation of a recombinant fragment of DNA (that may contain a gene) into a host DNA molecule.

Intercellular Spaces: Gaps between cells either fluid-filled as in most organs or air-filled as in the leaves of terrestrial plants.

Internal Environment: The factors which create the surroundings of cells within a multicellular organism. This consists of intercellular fluid which surrounds the cells.

Interneurone: A nerve cell which connects a sensory neurone to a motor neurone. (Other names include connecting, association, relay and intermediate neurone.)

Interphase: A stage during the life of a cell when it is actively carrying out its normal functions and not dividing (by mitosis or meiosis). DNA replicates during the interphase in cells which later divide by mitosis or meiosis.

Interspecific: Between species. Competition for resources between two species is described as interspecific (cf. intraspecific).

Interspecific Gene Transfer: The transfer of DNA between different species.

Intracellular: Inside a cell. Organelles are intracellular structures.

Intraspecific: Within a species. Competition between two animals of the same species is intraspecific (cf. interspecific).

Intraspecific Gene Transfer: The transfer of DNA between two organisms of the same species.

Introduced Species: A species which becomes established in an environment in which it had not previously been found.

Intron: Part of a DNA molecule which is transcribed as RNA but is removed before the RNA molecule (mRNA) leaves the nucleus.

Invagination: An infold which occurs in a cell membrane during pinocytosis to form a cavity and later a vacuole.

Inversion Mutation: A mutation in which a part of a chromosome or sequence of nucleotides is reversed.

In Vitro: "In glass". This Latin expression is used to describe experiments or processes carried out in test tubes and in other laboratory equipment.

Involuntary: An action carried out which is not under conscious control, e.g. peristaltic contraction of the muscles of the intestines.

Ion: A negatively or positively charged atom or group of atoms, e.g. Na^+, CO_3^{2-}.

Irritability: The capacity to respond to changes (stimuli) in the environment.

Isotonic: When two solutions have the same concentration of dissolved solutes they are said to be isotonic (cf. hypertonic and hypotonic).

Isotope: An atom which has a different number of neutrons than normal in its nucleus is an isotope of the atom. Although the chemical properties are the same, an isotope has a different mass than the normal atom. It may be unstable and therefore radioactive, e.g. carbon-14.

Jarrah: (*Eucalyptus marginata*) A eucalypt which grows very tall and is indigenous to Western Australia. Noted for its fine hard timber and slow growth.

Juvenile: Young organism which is not sexually mature.

Karri: (*Eucalyptus diversicolor*) A eucalypt which grows naturally in the south-west corner of W.A. and which, like jarrah, is an excellent building timber.

Karyotype: The total number and general appearance of chromosomes within the nucleus of a cell.

Lamarckism: The discredited belief that characteristics acquired during the life of an organism can be passed down via gametes to offspring.

Land Bridge: Land connections which occur between land masses when sea levels fall during Ice Ages. These allow organisms to migrate more freely from one area to another otherwise isolated area.

Larva (plural: larvae): The juvenile form of an animal which is unlike its adult parent. The larva may develop into a pupa which undergoes metamorphosis in changing into the adult body form.

Latent Heat: The heat absorbed by a liquid when it changes into a gas or released by the gas as it condenses into liquid form.

Latent Period: The time between when an organism is infected by a pathogen and when that organism becomes infectious, i.e. likely to pass the disease to others.

Laurasia: The northern land mass consisting of North America, Europe and Asia which existed before tectonic movement separated these continents (cf. Gondwanaland).

Leaf Cuticle: A waxy substance secreted by the epidermal cells of a plant leaf which reduces the rate of water loss from the leaf.

Life Cycle: The sequence of all the various stages from fertilisation to the death of an organism.

Ligase: See 'DNA ligase'.

Lignotuber: A large swelling at the base of some plant stems that store nutrients and produce new shoots if the upper stem is destroyed by fire.

Limiting Factor: A variable in an organism's environment which restricts its growth and reproduction.

Linkage: Genes which occupy loci on the same chromosome and because they are generally inherited together are described as "linked" genes.

Locus: (plural loci) The place occupied on a chromosome by a particular gene.

Lumen: The opening through a tube, e.g. in digestive tract or in xylem vessel.

Lymph: The fluid in the lymphatic system.

Lymphatic System: The system of vessels which drains fluid from tissues which empties into veins at the base of the neck.

Lysis: The process whereby a cell absorbs water to such an extent that it bursts or when a cell is destroyed by antibodies rupturing its cell membrane. Viruses often cause their host cell to lyse.

Lysosome: A cell organelle which is involved in intracellular digestion.

Lysozyme: An enzyme which breaks down the cell walls of bacteria.

Macro-evolutionary Change: Refers to major evolutionary changes when for example two species arise from one ancestral species. Two separate gene pools are formed which can no longer interbreed as a result of allopatric speciation.

Macroinvertebrate: An invertebrate that can be seen with the unaided eye.

Macroscopic: Visible without the aid of a microscope.

Magnification: The extent to which an object is enlarged by a microscope. It is expressed as the ratio of the image size to the actual size. When using a light microscope it is calculated by multiplying the magnifying power of the objective by the magnifying power of the ocular.

Male: Organism which produces gametes which move to fertilise another less mobile gamete. In animals the male is the organism which produces sperm. In angiosperms the male produces pollen.

Mallee: A form of plant which has multiple stems arising from a large underground root.

Manipulated Variable: See 'Independent variable'.

Marine: Living in the sea or ocean or associated with them.

Marker Gene: A DNA sequence with a known location on its chromosome.

Marsupial: Mammals which give birth to their young in a relatively immature stage of development and which have a pouch in which the young develop further, e.g. kangaroos, possums, koalas, chuditch.

Maturation: The developmental process culminating in an adult stage capable of reproducing.

Mean (arithmetic): The average of a number of observations.

Median: The middle number of a series of numbers, e.g. the median of 1, 2, 4, 5 and 10 is 4. If the series consists of an even number of values, to calculate the median, the two middle values are averaged.

Mega: Prefix meaning one million, e.g. a megajoule (MJ) means one million joules.

Meiosis: A type of cell division which results in gametes. The number of chromosomes in the original cell (parent/germ cell) is reduced to half, ie. the cells become haploid.

Melanin: A pigment which occurs in the skin, hair and iris giving them their colour.

Meristem: A region within a plant where mitotic cell division occurs for growth, e.g. apical meristem.

Mesophyte: A plant which favours moderate water conditions (cf. hydrophyte and xerophyte).

Messenger RNA: (mRNA) A nucleic acid formed in the nucleus of a cell which carries a code from a DNA molecule through a nuclear pore to a ribosome and from which a particular protein molecule is assembled according to the code which it carries.

Metabolic Rate: The rate at which chemical processes occur within the body of an organism.

Metabolism: The chemical processes which occur within the body of an organism. These include both anabolic and catabolic processes.

Metaphase: The stage in cell division at which chromosomes are aligned along the equator of the cell.

Methylene Blue: A stain used in microscopy to highlight the cell nucleus. The nuclear material turns blue with methylene blue.

Microbiology: The scientific study of microorganisms.

Microclimate: The abiotic conditions which exist in a microhabitat.

Micro-evolutionary Change: Refers to small evolutionary change, e.g. the change in allele frequencies that may occur in two populations that have recently become geographically separated or exist at different extremes of the species geographical distribution. The two populations (still)belong to the same species.

Microfilament: A thin thread of protein present in the cytoplasm of cells.

Micrograph: A photograph taken with the aid of a microscope, e.g. electron micrograph and light micrograph.

Microhabitat: A very small habitat, e.g. in the bark of a tree.

Micrometre (μm): One millionth of a metre, (often called a micron).

Microorganism: A microscopic single-celled living thing, e.g. bacteria, protozoa, some algae and some fungi.

Microtome: A device used to cut very thin slices of tissue to use in microscope slides.

Mildew: A fungal growth found on plants which is white and powdery.

Millilitre (mL): One thousandth of a litre.

Mimicry: The imitation of another species which may give protection or reproductive advantage, e.g. the stick insect mimics a stick for camouflage.

Mitochondrial DNA (mDNA): DNA which is found in the mitochondrion. It is inherited through the female gamete and replicates independently of the chromosomal DNA.

Mitochondrion: (plural mitochondria). An organelle with a double membrane, the inner one which is highly folded, in which aerobic respiration occurs.

Mitosis: A cell division type in which the two cells produced are identical to the parent cell. Used for growth and repair (cf. meiosis).

Mode: This is the most frequently occurring value in a series of numbers.

Mode of Transmission: The way in which a pathogen spreads from one organism to another.

Model: A scientific idea in which a process is represented by a diagram or a physical structure in order to develop a better understanding of the process and test predictions based on the idea, e.g. the fluid mosaic 'model' of the cell membrane.

Modulator: See 'coordinating centre'.

Monoculture: A crop in which only one plant species is grown, e.g. a field of wheat.

Mortality Rate: The death rate normally expressed as the number per thousand per year in a population.

Mosquito-borne Disease: A disease that is spread from one organism to another by mosquitoes acting as vectors.

Motile: An ability to move independently by using cilia, flagella or amoeboid movement.

mRNA: See 'Messenger RNA'.

Mucous Membrane: A membrane that lines body cavities in direct contact with the external environment, e.g. digestive, respiratory systems.

Multicellular: Many celled organism.

Multiple Allelic: Describes a trait that is controlled by more than two genes in a population, any of which may occupy the same locus in a chromosome, e.g. blood grouping in the ABO system is controlled by three genes I^A, I^B and i.

Mutagen: Any agent which induces mutations, e.g. radiation, synthetic auxin (2,4-D and 2,4,5-T, used as herbicides).

Mutant: An organism which shows a mutation.

Mutation: A sudden change to genetic material which may make an organism notably different from its parents. Where the change occurs in the genes in gametes it may be inherited by offspring.

Nanometre (nm): One thousand millionth or one billionth of a metre (10^{-9} metre).

Natural Selection: The process which leads to differential survival and reproduction of organisms which are better suited to their environment. It results in those better suited contributing proportionally more offspring to subsequent generations.

Negative Feedback: See 'feedback'.

Nephron: The microscopic functional unit of the kidney which filters unwanted materials and wastes from the blood and controls the osmotic pressure of the blood by reabsorbing water.

Nerve: A collection of nerve cells or neurons and associated connective tissue which conveys impulses to and from the central nervous system.

Nerve Impulse: The electrochemical message which is transmitted along a nerve cell or neurone.

Nervous System: The network of nerve cells which transmits impulses from receptors to effectors. It functions to control and coordinate activities in the body of most multicellular animals.

Neurone: A nerve cell. Most neurones have long extensions of the cytoplasm which convey electrochemical impulses (nerve impulses).

Nitrogen: An unreactive, colourless, odourless gas which makes up 78% by volume of our atmosphere.

Nitrogenous Base: Organic substances containing nitrogen which make up the genetic code in DNA and RNA molecules (e.g. cytosine, guanine, adenine, thymine and uracil).

Nitrogenous Waste: A compound containing nitrogen which is not required by the body and which is normally excreted, e.g. urea, ammonia, uric acid, creatinine.

Nocturnal: Describes an animal which is active at night (cf. diurnal).

Nomenclature: An agreed set of names and terms that are used in science (or in other human endeavours). When the agreed names are used correctly, confusion and errors in communication are minimised."

Non-Coding DNA: Region of a chromosome that does not code for a protein. It is made up of introns.

Non-disjunction: When homologous chromosomes fail to separate during the anaphase of cell division. Some resulting cells have extra chromosomes, some fewer chromosomes than the normal haploid number.

Nuclear DNA: Chromosomal DNA which is located in the nucleus of a eukaryotic cell.

Nuclear Membrane: The double layer of membranes perforated by holes or pores which are sufficiently large to allow the passage of mRNA.

Nucleic Acids: Chains of nucleotides which form DNA and RNA molecules in the cell.

Nucleolus: A dark staining area within the nucleus of a cell where RNA is synthesised.

Nucleotide: The basic building block or subunit of a nucleic acid molecule (DNA, RNA). It consists of a nitrogenous base, a sugar molecule and a phosphate group.

Nucleus: (plural nuclei) Large cell organelle bounded by a nuclear membrane which is double layered and has pores. The nucleus contains nucleoplasm with DNA and RNA.

Numbat: A marsupial which feeds mainly on termites. It is restricted to small areas in the south-west of W.A. and is the state's animal emblem.

Objective: The lower microscope lens on a light microscope which is closest to the object under view.

Olfactory: To do with the sense of smell, e.g. olfactory receptors in the nasal cavity.

Omnivorous: An animal which eats both plant and animal food (cf. carnivorous, herbivorous).

Oocyte: A cell which divides to produce ova.

Optimum: The best or most favourable condition, e.g. the temperature at which an enzyme has its maximum effect on a substrate is called the optimum temperature for that enzyme.

Organ: A collection of tissues which together carry out one or more major functions in an organism, e.g. leaf, kidney.

Organelle: A small structure within the cytoplasm of a cell which carries out a particular function, e.g. mitochondrion.

Organism: A living thing, e.g. plant, animal, microorganism.

Osmoregulation: The maintenance of suitable concentrations of water and dissolved salts in an organism's body cells. This is achieved in a variety of ways depending on the organism's environment. Osmoregulation may involve contractile vacuoles, kidneys, impermeable body coverings, special gill cells which secrete salts, the production of dry wastes (e.g. uric acid) and various behavioural adaptations including burrowing and nocturnal activity.

Osmosis: The movement of a solvent (usually water) by diffusion through a differentially permeable membrane.

Osmotic Pressure: The pressure which is due to osmosis. Where a cell has a high concentration of dissolved solutes its osmotic pressure is high. Water has a strong tendency to enter the cell if the extracellular solution is less concentrated.

Ovary: The organ which produces female gametes.

Oxygen: A colourless, odourless and tasteless gas produced during photosynthesis and required in aerobic respiration. The Earth's atmosphere is 21% oxygen by volume. Commonly exists as O_2.

Paleontology: The study of fossils and life from the past.

Palindromic Sequence: A DNA nucleotide sequence which is the same as its complimentary strand when read in the opposite direction, e.g. G A T C
C T A G

Pandemic: The rapid spread of a communicable disease from one population to other populations over large regions.

Parasite: An organism that lives in (endoparasite) or on (ectoparasite) another organism called its host, obtaining nutrients from its host (to the host's detriment).

Passive Process: A process which does not require any external source of energy to proceed, e.g. diffusion, osmosis.

Pathogen: A disease-causing agent.

Peer Review: A procedure in which experts in the same field of research examine and evaluate the work (e.g. the experimental procedure and conclusions) of a fellow scientist.

Pentadactyl Limb: A limb which has five digits common to most vertebrates.

Peptide Bond: The chemical link between two amino acid molecules in a peptide, polypeptide or protein molecule.

Peripheral: On the outside. The peripheral circulation refers to the blood circulation in the appendages and skin.

Permeable: A property of a substance which allows others to pass through it freely (cf. differentially permeable).

Persistent Infection: A disease which lasts for long periods in the individual organism. It often occurs when the body's immune response does not totally remove the pathogen.

Perspiration: The combination of water, urea and organic salts which is secreted by sweat glands. It is produced in order to lose heat. Often called sweat.

Petiole: The stalk which attaches many leaves to a branch or stem.

Petrified: A fossil which has become stone. Left in suitable alkaline soils, minerals in the soil replace the organic molecules of which the organism is made, forming a stone replica of the original organism.

pH: The acidity or alkalinity of a solution. It is dependent on the concentration of H^+ ions. Acid solutions (with higher H^+ ion concentration) have a pH of less than 7, alkaline solutions have a pH greater than 7. A neutral solution has a pH of 7.

Phagocytosis: The process in which a cell extends part of its cytoplasm (called a pseudopod) to engulf food. The food is enclosed within a vacuole in the cytoplasm.

Phenotype: The expression of a particular genotype. Phenotype may also be influenced by the environment.

Phloem: The tissue in vascular plants which carries sucrose and other organic compounds from photosynthesising leaves to the roots and from the roots to other parts of the plant.

Phosphate: A compound containing the phosphate (PO_4^{3-}) group. It is an important constituent of ATP and nucleotides.

Phospholipid: A complex lipid which contains phosphate. The lipids which make up the cell membrane are phospholipids.

Phosphoprotein: A protein which contains phosphate.

Photomicrograph: A photograph taken through a microscope. Often called a micrograph. An electron micrograph is obtained using an electron microscope.

Phyllode: A flattened stem or petiole which photosynthesises and therefore functions as a leaf but with fewer stomata. This is an adaptation possessed by xerophytes, e.g. *Acacia* (wattles), in which the leaves are often reduced to spines or prickles.

Phylogenic Tree: A diagram which shows the evolutionary development of organisms. It indicates when and where adaptive radiation has occurred, where the most recent common ancestor was and is sometimes called a evolutionary 'tree of life'.

Phylogeny: The evolutionary history of a species.

Physiology: The way in which an animal or plant functions. (Also used to refer to the study of animal and plant function, i.e. how they work.)

Piloerection: The involuntary raising of hairs or feathers in response to cold, shock or fear. This is brought about by the sympathetic nervous system in mammals and birds.

Pinocytosis: The process in which a cell forms an infold (or invagination) of its cytoplasm to engulf droplets of food. The liquid is enclosed within a vacuole in the cytoplasm.

Pituitary: The "master" endocrine gland in vertebrates. It is attached to the underside of the hypothalamus and produces several hormones; some of which control other endocrine glands. Hormones released by the pituitary include ADH and oxytocin from the posterior lobe and TSH, FSH, LH and somatotropin from the anterior lobe. See 'hypothalamus'.

Plasma Membrane: See 'cell membrane'.

Plasmid: See 'bacterial plasmid'.

Plasmolysis: The shrinkage of the cell membrane away from the inside of a plant cell or bacterial cell due to water loss.

Plastid: A membrane bounded organelle found in plant cells which contains chlorophyll (chloroplasts), pigment (chromoplasts) or starch (leucoplast).

Poikilothermic: See 'ectothermic'.

Polygenic Trait: A feature in an individual organism that is controlled by more than one pair of genes, e.g. skin colour in humans may be controlled by at least three pairs of genes acting together.

Polymerase: An enzyme which catalyses the formation of DNA using a single strand of DNA as a template and linking matching nucleotides to this original strand.

Polymerase Chain Reaction (PCR): A method for amplifying a DNA segment containing a gene. Used in DNA profiling and DNA sequencing, where large amounts of DNA of interest are required.

Polypeptide: A long chain of approximately one hundred amino acids (cf. protein).

Polyploidy: Having additional sets of chromosomes beyond the normal two sets in a diploid cell.

Population: A group of organisms of the same species living in the same place at the same time (cf. community).

Population Density: The number of organisms of a particular species in a given area (or volume) at a particular time.

Population Dynamics: The changes that occur in the size and structure of a population.

Population Growth: A measure of the rate at which a population is increasing or decreasing at a particular time.

Potometer: A device used to measure the rate of water loss from a terrestrial plant.

Prediction: A forecast, often based on a hypothesis, of what a future observation might be.

Primary Data: Data you collect yourself.

Prion Disease: A disease caused when an infectious misshaped protein causes some other proteins (prions) to become misshaped and to aggregate. These protein aggregations occur in the brain and nervous system and are normally fatal.

Process: In anatomy this refers to a projection from an organ or tissue.

Prokaryote: A single-celled organism which has no membrane bounded organelles, e.g. bacteria and cyanobacteria.

Promoter: The base sequence on a DNA molecule on which RNA polymerase attaches to commence the transcription of a RNA molecule.

Protein: An organic compound containing carbon, hydrogen, oxygen, nitrogen and sometimes sulphur. Proteins are made up of long chains of amino acids (more than 100) joined by peptide bonds. Proteins are essential components of cells being used for structure and enzymes.

Protein Synthesis: The making of proteins which occurs on ribosomes by joining amino acids together to form a long chain.

Protista: A diverse group of single-celled eukaryotic organisms (not including the single-celled fungi), e.g. protozoa, eukaryotic algae.

Protoplasm: The nucleus and the cytoplasm (including the cell membrane) of a cell. The cell wall of a plant cell is the only part not included in the protoplasm.

Putrefaction: Decay or decomposition carried out by bacteria and fungi.

Qualitative: Refers to data which has no numerical values associated with it, e.g. to describe the production of heat energy by active animals as high is to assign a qualitative value to the production (cf. quantitative).

Quantitative: Refers to data which has numerical values, e.g. to express the heat energy released by an organism as 15 J/hour is to assign a quantitative value to this variable.

Quarantine: The restriction of the movement of living things considered to be pests, potential pests or to harbour pests from one region to another. This usually occurs at the borders that separate states and countries. Quarantine may involve the isolation of organisms for a period of time to determine whether or not they are infected by a pathogen or until they recover and are no longer infectious.

Race: Subset of a species.

Radiation: A type of electromagnetic energy flow which occurs in waves, e.g. X-rays, light rays, UV rays. Radiation may also refer to a movement of radioactive particles such as α or β radiation.

Radiocarbon Dating: See 'carbon dating'.

Random Assortment: The pairing of homologous chromosomes that occurs during the first prophase of meiosis. It occurs such that the chromosomes have either the maternal or the paternal chromosome on either side in an unbiased arrangement.

Reaction Time: The period of time between when a stimulus is detected by a receptor and when the corresponding response occurs.

Reagent: A chemical used to test for the presence of another, e.g. iodine solution is a reagent used to test for starch.

Receptor: A special cell, tissue or organ which is sensitive to specific changes in the environment and reacts to that change, e.g. some nerve endings are sensitive to changes in temperature and when stimulated send impulses via sensory neurones to the central nervous system.

Recessive: A gene which is not expressed in the heterozygote. A recessive gene is hidden due to the expression of the allele for the dominant gene.

Recombinant DNA: A DNA fragment which is integrated into a DNA molecule to which it does not normally belong. (Recombinant DNA occurs naturally when chromosomes 'cross over' during meiosis)

Recombinant Gene: A gene which is inserted on a chromosome to which it does not normally belong.

Recombination: This occurs when genes which are not normally inherited together, are inherited by offspring because of crossing-over during meiosis. Genes which are normally linked become separated, while others are recombinant.

Reduction Division: See 'meiosis'.

Reflex: A rapid response which occurs without thought. Nerve impulses travel from the receptor to the effector via the spinal cord without the brain's intervention.

Reflex Arc: The path, usually comprising a receptor, sensory neurone, connecting neurone, motor neurone and effector, over which an impulse travels in bringing about an involuntary response.

Reliable Data: Data that because of sufficient trials and replicates is dependable.

Relic: Refers to a small group of animals which are the survivors of a once greater population with wider distribution, e.g. numbats in the S.W. of W.A. (cf. remnant).

Remnant: A small area of native bush or forest or group of animals that has been left undisturbed by change e.g. habitat destruction.

Reproductive Isolation: The separation of populations such that interbreeding between them cannot occur, due to barriers such as oceans, rivers, deserts. See 'allopatric'.

Research Ethics: The use of moral principles to evaluate the conduct of experiments or to decide whether experiments are morally justified.

Resolving Power: The capacity of a microscope to visually separate two objects which are close together. The resolving power of an electron microscope is much greater than that of a light microscope, so that the former instrument enables much finer detail to be observed.

Resource: A factor in the environment which is used by an organism.

Respiration: The chemical breakdown of organic matter, often glucose, in order to release energy, which takes place in cells.

Responding Variable: See 'dependent variable'.

Response: The reaction or change which occurs in an organism brought about by a particular stimulus.

Restriction Enzyme: An enzyme which cuts DNA at a particular base sequence (called the recognition site). Different restriction enzymes have different recognition sites.

Restriction Nuclease: See 'restriction enzyme'.

Reverse Transcriptase: An enzyme that synthesises a double stranded copy of DNA from a single strand of RNA.

Ribose: A sugar which has five carbon atoms and is a component of RNA molecules.

Ribosome: An organelle, which is either attached to the endoplasmic reticulum or free in the cytoplasm, on which protein synthesis occurs.

Risk Assessment: To determine before conducting a new experiment the dangers involved in order to plan to minimise them for the safety of all involved.

RNA: Ribonucleic acid. A nucleic acid made up of a chain of nucleotides which have ribose sugar molecules (unlike DNA where the sugar molecule has one less oxygen atom).

RNA Splicing: The removal of introns from RNA by restriction enzymes before the mRNA formed leaves the nucleus.

Root: That part of a vascular plant which is normally under the soil and which absorbs water and mineral nutrients for the plant. It also anchors the plant and may store food and minerals.

Root Hair: A special root cell located behind the root tip which has a long cytoplasmic extension that increases its surface area for the absorption of water and minerals.

Rural Area: A less densely populated area removed from cities and towns.

Saline: A solution containing salt, e.g. sea water.

Salinity: A measure of the salt concentration.

Salt: Usually an ionic inorganic compound, e.g. sodium chloride (which is commonly referred to as 'salt').

Sample: A small part of a population used to represent what the whole is like.

Sap: The fluid contents of the phloem.

Scientific Error: Error which occurs in scientific research which is due to unavoidable inaccuracies of instruments and procedures. No measurement is exact.

Secondary Data: Data obtained from the work of others.

Section: To cut through an organ or tissue. Usually thin sections are cut using a microtome in order to produce microscope slides. It may be a transverse, oblique or longitudinal section depending on the direction of the cut chosen.

Sedimentary: Refers to rock which is usually formed by the settling of sediments under water. Over time different layers are formed. These layers often trap the remains of animals and plants which die in or near the water and thus form an important source of fossil material.

Selection: See 'natural selection'.

Selection Pressure: A factor present in a species' environment which affects its survival.

Selective Breeding: See 'artificial selection'.

Semi-permeable: See 'differentially permeable'.

Sense: An ability to detect particular stimuli, e.g. receptors in vertebrate ears provide a sense of hearing.

Sensory Neurone: A special nerve cell which transmits impulses from receptors to the central nervous system in vertebrates.

Sex: Classification which indicates the type of gamete produced. If motile small gametes are produced the organism is referred to as male, larger non-motile (i.e. cannot propel themselves) gametes are produced by females.

Sex Chromosomes: Those chromosomes which determine the sex of the individual organism. In mammals one pair of chromosomes determines the sex. A female has two X chromosomes while a male has an X and a Y chromosome in each body (somatic) cell.

Sex-linked: Describes a trait that is controlled by genes which have their loci on sex chromosomes. In mammals this refers to genes on the X chromosome only.

Sexual Reproduction: Reproduction which involves the fusion of two sex cells called gametes. The resulting cell is called a zygote. The zygote gives rise to the new organism.

Sexual Selection: This is the development of traits in either or both of the sexes of a species which is due to competition for mates.

SI units: A system of measures adopted by the scientific community which should be used in scientific work. This consistency enables comparisons and peer review to be made more easily.

Subcutaneous Fat: Fat that often has an insulatory function which is deposited just below the skin's surface.

Somatic: Refers to cells in the body other than gametes.

Specialised: Structurally developed to carry out a particular function.

Speciation: See 'adaptive radiation'.

Species: A group of organisms which are interbreeding in their natural environment and producing viable offspring or a group of organisms that are structurally and functionally very similar. They have similar DNA.

Specificity: The particular molecular shape or nature which enables only certain molecules to combine, e.g. the active site and its substrate, transfer RNA and its particular amino acid.

Sperm: Male gametes of animals.

Starch: A carbohydrate consisting of a long chain of glucose molecules. Starch is sparingly soluble and therefore is a form in which glucose is stored in plant cells. Because it is sparingly soluble, it does not increase the osmotic pressure in the cell to the extent that glucose will (cf. glycogen in animals).

Stem: That part of a plant which supports the leaves and contains vascular tissue for transport between the roots and leaves. The stem may be woody or herbaceous.

Stimulus: A change in the environment of an organism which can be detected by it and induces a response in the organism.

Stoma: (plural stomata) An opening or pore for gas exchange in the epidermis of a leaf or stem which is created by two guard cells.

Stratum: (plural strata) A compressed mineral layer which makes up sedimentary rock or a layer of plant vegetation which makes up several levels within a forest (e.g. grasses may form one stratum, shrubs another and tall trees a third higher stratum).

Subspecies: See 'race'.

Substitution Mutation: A mutation in which a part of a chromosome or sequence of nucleotides is replaced by another.

Succulent Plant: A plant which has water storing cells in either or both its leaves and stem. This is a xerophytic adaptation.

Susceptibility to Disease: The likelihood of a person contracting an infectious disease because of their health and location.

Sucrose: A disaccharide consisting of the two monosaccharides, glucose and fructose. This is the sugar often added to tea and coffee to sweeten their taste. It is also the form in which glucose is normally transported in the phloem.

Sustainability (ecological): The capacity of an environment to maintain its biodiversity and to continue to flourish in spite of change.

Sweat: See 'perspiration'.

Symbiosis: The living together of two organisms of different species. Parasitism, mutualism and commensalism are all symbiotic relationships.

Symptom: A feeling of being ill, fatigue or anxiety that is associated with an infection and is experienced by the sufferer of a disease. It is not necessarily detected by a second person, e.g. a doctor.

Synthesise: To make.

System: A group of organs which together carry out a major function (or major functions) within the body, e.g. circulatory system.

Tactile: Relating to the sense of touch.

Taproot: A single dominant root which normally grows vertically down. The taproots of some native trees descend many metres to tap water deep below in the water table, e.g. Jarrah. Taproots have lateral roots branching horizontally from their sides.

Taste Bud: A collection of chemoreceptors usually in the tongue which enables vertebrates to distinguish between food types.

Taxis: The response of the whole organism in moving away from or towards a stimulus, e.g. chemotaxis, phototaxis (cf. tropism).

Telophase: The last stage in meiotic or mitotic cell division, when new nuclear membranes enclose the separated chromosomes and the cytoplasm divides into two daughter cells.

Template: A mould from which a copy of something is made, e.g. mRNA.

Terminator: A sequence of bases on a DNA molecule that determines the end of a gene being transcribed.

Terrestrial: Living on land.

Test Cross: The cross between a homozygous recessive organism and an organism which shows the dominant phenotype. The resulting F_1 can reveal whether the organism with the dominant phenotype is homozygous or heterozygous.

Theory: A hypothesis for which supporting evidence has been obtained but which needs more evidence for it to be accepted generally as a law.

Thermoreceptor: Part of a special nerve cell that detects a rise or fall in the temperature of the body.

Thermoregulation: The maintenance of a relatively constant internal body temperature in spite of changes to the temperature of the external environment.

Threatened Species: A species which is at risk of extinction. See 'conservation status'.

Threshold: The strength of a stimulus that is just sufficient to induce a response.

Thyroxine: A vertebrate hormone released by the thyroid gland which increases cell metabolism. Increased metabolism involves an increase in oxygen use and a greater release of heat energy.

Tissue: A group of similar cells which together perform a particular function. Organs are composed of various tissues.

Tissue Culture: A group of cells growing in a special medium.

Tolerance: The extent to which an organism can survive change in an environmental factor, e.g. a particular bacterium may only live in water which has a temperature range of 10°-30°C. Outside this range is beyond the tolerance of this bacterium.

Tonoplast: The membrane which surrounds the vacuoles in cells.

Torpor: A condition in which the metabolic rate of an animal slows down to produce inactivity of the organism. Occurs when an animal hibernates or aestivates.

Touch: The sense involved in detecting objects which contact an animal.

Toxic: Describes a chemical that is poisonous.

Toxin: A poisonous substance produced by an organism, particularly a microorganism.

Toxoid: A toxin which has been altered chemically so that it is no longer toxic. A toxoid still causes the body to produce an immune response and develop immunity to the pathogen that produces the toxin. It may therefore be used as a vaccine.

Trait: An inherited feature or characteristic possessed by an organism.

Transcriptase: An enzyme which catalyses the synthesis of RNA from DNA.

Transcription: see 'DNA transcription'.

Transfer RNA (tRNA): A nucleic acid which transports free amino acids in the cytoplasm to the ribosomes where the amino acids are linked to form proteins. Specific tRNA molecules lock onto each amino acid and transport it to a particular part of the mRNA, on the ribosome, which has a codon matching the anti-codon on the tRNA.

Transgenic Organism: An organism which has an altered phenotype as a result of its genetic modification.

Transgenics: The procedures that result in genetically modified organisms.

Translation: see 'DNA translation'.

Translation Initiation Factor: Protein that enables the ribosomes to read mRNA and begin protein synthesis.

Translocate: Move to another place. In plants this usually refers to the movement of sugar from one part to another in phloem. In ecology this usually refers to the movement of organisms from one area to another as a conservation strategy.

Transpiration: The loss of water by evaporation from the leaves (or stem) of a plant.

Transpiration Stream: The flow of water in xylem vessels from the roots through the stem, into the leaves (and out through the stomata).

Treatment: Medical care given to an organism (usually human) for an illness (does not necessarily result in a cure).

Tropism: A growth response towards or away from a stimulus, e.g. phototropism.

Tumour: An abnormal growth of cells that divide uncontrollably and have no use in the body. A tumour may be benign or malignant.

Turgid: Refers to a cell which is filled with water. Plant cells become turgid when surrounded by distilled water but do not lyse because their cell wall prevents this from occurring (cf. flaccid).

Ultrastructure: Parts of a cell which cannot be seen with the aid of a light microscope but only become visible if an electron microscope is used, e.g. double membranes and pores of the nucleus.

Ultraviolet Light (UV): Electro-magnetic radiation with a wavelength which is shorter than visible light and therefore cannot be detected by human eyes.

Unicellular: Single-celled, e.g. *Amoeba*, bacteria.

Universal Solvent: Water is called the universal solvent as it dissolves the greatest number of organic and inorganic molecules in the living world.

Urban Area: The area in and around a city or town. Urban areas have a dense human population, buildings and associated structures like roads and bridges. The majority of urban inhabitants are not employed in agriculture.

Urbanisation: The movement of people from farms and rural villages to larger towns and cities.

Urea: An organic compound, formula $CO(NH_2)_2$, which is a waste product of the breakdown of excess amino acids in mammals. This nitrogenous metabolic waste is toxic and is excreted by the kidneys. It is soluble in water.

Uric Acid: An important nitrogenous waste formed in birds and many reptiles from the breakdown of excess amino acids. It is sparingly soluble in water (formula $C_5H_4N_4O_3$).

Urine: The liquid waste produced by the kidneys. Urine generally contains water, urea, uric acid, excess minerals, salts and hormones.

Vaccine: An antigen preparation that may contain attenuated pathogens, just parts of the pathogen, dead pathogens or the toxins that have been made safe (toxoids) from the pathogen. These are generally injected into an animal (including human) so that it develops immunity to the disease caused by the particular pathogen.

Vacuole: A membrane (tonoplast) bounded sac found in the cytoplasm which stores water and minerals, pigments, starch, sugars or wastes. Animal vacuoles (called vesicles) are smaller than plant vacuoles.

Valid Data: Data that accurately reflects what was intended to be measured. Valid data can only be obtained from an experiment that is properly controlled and that uses accurate instruments and procedures.

Variant: An organism that is different from others of the same species.

Variable: A factor in the environment or in an experiment which can change.

Variation: A feature or characteristic which is different within a species. Variation in the offspring of sexually reproducing organisms is greater than that found in the offspring of asexually reproducing organisms.

Variety: See 'race'.

Vascular: Referring to the tubes which carry materials within the organism, e.g. the circulatory system in vertebrates is vascular tissue and the phloem and xylem vessels in plants are vascular tissue.

Vascular Bundle: A group of xylem and phloem vessels clustered together with fibre cells found in the roots, stem and leaves of higher terrestrial plants. Sometimes referred to as veins in the leaves.

Vascular System: The circulatory system in vertebrates or the phloem and xylem in plants.

Vasoconstriction: The reduction in the diameter of blood vessels which reduces blood flow through them.

Vasodilation: The increase in the diameter of blood vessels which increases blood flow through them.

Vector: An intermediate host which carries a pathogen from one organism to another.

Vein: A blood vessel which carries blood towards the heart.

Venule: A small vein.

Vertebrate/Vertebrata: Any animal which has a backbone, e.g. fish, amphibians, reptiles, birds and mammals.

Vesicle: A small vacuole found in animal cells.

Vestigial Organ: An organ which has little or no apparent use but which may have been functional (and usually larger) in an ancestral organism, e.g. coccyx and appendix in humans.

Viable: Having the potential to mature and produce healthy offspring.

Virus: A structure comprised of a protein coat and a core of either DNA or RNA. Viruses can only reproduce in host cells and are therefore all regarded as pathogenic parasites.

Vulnerable: An assessment of the risk of extinction of a species. Threatened species can be divided into three categories of risk. These are in ascending order – Vulnerable (VU), Endangered (EN) and Critically Endangered (CR).

Waste: A substance which is present in the body but which is not required and may become harmful if allowed to accumulate. It is therefore eliminated in the urine, faeces, expired air or sweat.

Watertable: The top of the water level in an aquifer.

Wilting: An herbaceous plant which is dehydrating and therefore losing its turgidity. The cells in a wilting plant are becoming flaccid.

X-Chromosome: One of two sex chromosomes found in mammalian cell nuclei. Females have two X-chromosomes in each nucleus (apart from ova which have one). Males have an X and Y chromosome in each somatic cell (sperm have either an X or a Y chromosome).

Xeromorph: A plant which is adapted to survive almost total dehydration, e.g. some plants which live in very dry areas.

Xerophyte: A plant which is adapted to live in a dry environment. It may have reduced leaf size, phyllodes instead of leaves, stomata on only one side of the leaf, water storage cells, leaves reduced to spines, thick waxy cuticle, extensive root system, mallee form of growth (cf. halophyte and xeromorph).

Xylem: Microscopic vessels which carry water and minerals from the roots to the leaves in flowering plants

Y-Chromosome: See 'X-Chromosome'.

Zoonosis (plural: zoonoses): An animal disease that can be transmitted to humans, e.g. Ross River virus disease, Ebola virus disease.

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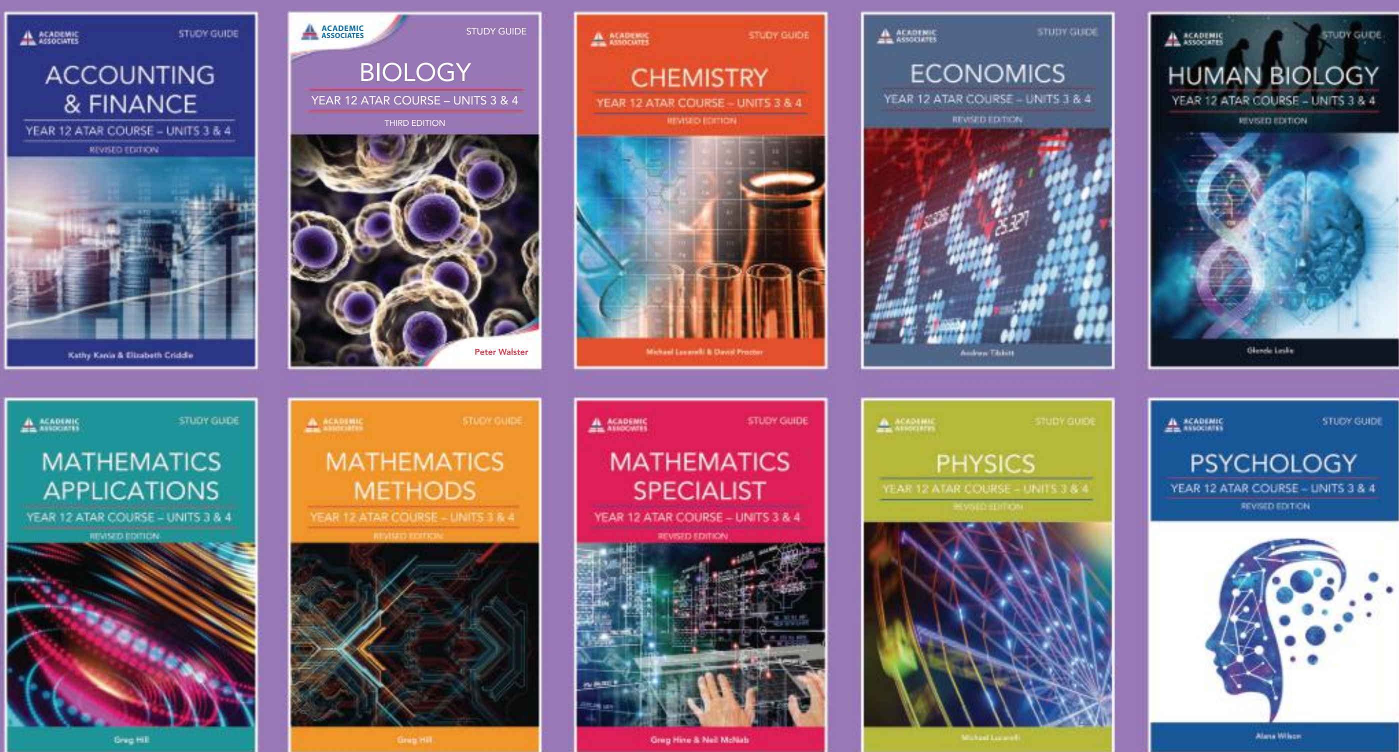

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