Zig Zag Education

Biology **A2 Level | CCEA | 1014**

Topic Tests

for A2 Level CCEA Biology

zigzageducation.co.uk

POD 8125

Contents

Teacher's Introduction

These topic tests have been designed to help you and your students assess their knowledge of a topic after you have taught each part of Topics 3–4 of the **CCEA A Level Biology course**, comprising the A2 section of the course.

Each topic test closely follows the content of the specification and includes:

- **Factual questions**: Some shorter factual response, gap-fill and match-up questions are included to ensure that all the content and basics are covered, and to allow less-able or less-engaged learners access to some marks.
- **Short-answer questions**: These are not in exam style, and the purpose of these is to test different elements, knowledge and skills from the specification in a variety of styles.
- **Long-answer questions**: Where appropriate, topics may contain one or more extended-response questions to prepare students for what they might meet in the exam, and to test exam skills.
- Questions will also regularly test students' ability to interpret and use graphs, understand diagrams and apply maths skills.

Mathematical and practical skills are also covered in these topic tests.

Test Number	Test Title	Specification Reference	Number of Marks
1	Homeostasis and the Kidney	4.1.1–4.1.10	40
2	Immunity: Responding to Infection	4.2.1–4.2.7	35
3	The Immune System and Medical Development	4.2.8–4.2.13	40
4	Coordination: Plants and Nerves	4.3.1–4.3.5	40
5	Coordination: The Eye and Muscle	4.3.6–4.3.9	28
6	Ecosystems: Interactions between Populations	4.4.1–4.4.4	35
7	Ecosystems: Population and Community Dynamics	4.4.5–4.4.9	33
8	Ecosystems: Communities	4.4.10–4.4.15	31
9	Respiration	5.1.1–5.1.9	40
10	Photosynthesis	5.2.1–5.2.6	38
11	DNA: The Genetic Code	5.3.1–5.3.5	36
12	DNA: Gene Technology	5.4.1–5.4.6	34
13	DNA: Genetic Modifications	5.4.7–5.4.14	39
14	Inheritance	5.5.1–5.5.6	29
15	Population Genetics	5.6.1–5.6.5	38
16	Kingdom Plantae	5.7.1–5.7.4	31
17	Kingdom Animalia	5.8.1–5.8.6	30

Tests have been designed to take approximately 25–35 minutes to complete.

Students are able to see the number of marks awarded for each question, allowing them to gauge the level of detail they will require for the answers. Full answers with marks are included at the end of each test. Additionally, it makes the resource a suitable tool for students to use independently.

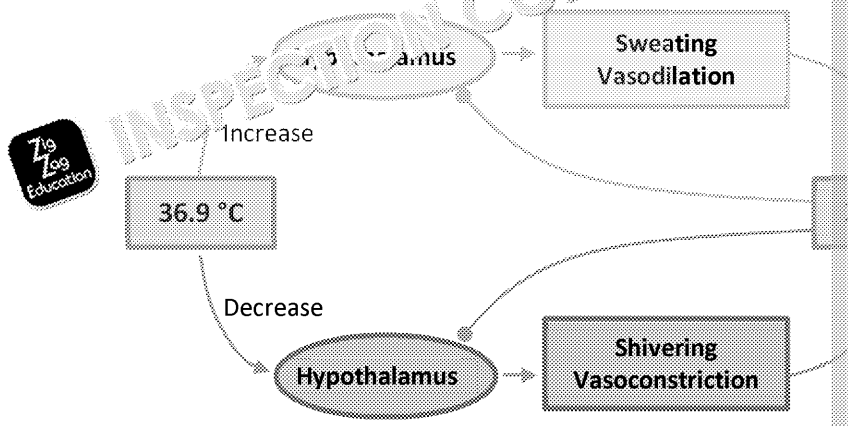
The topic tests are suitable for a classroom assessment, revision aid or homework task and are, therefore, suitable for use immediately after a topic is completed in class or at the end of teaching the course.

It is recommended that students have access to a calculator to complete the questions. We hope you find these tests useful during your teaching.

January 2018

1. Define 'homeostasis'.

2. The diagram below shows homeostasis of body temperature in a healthy hu

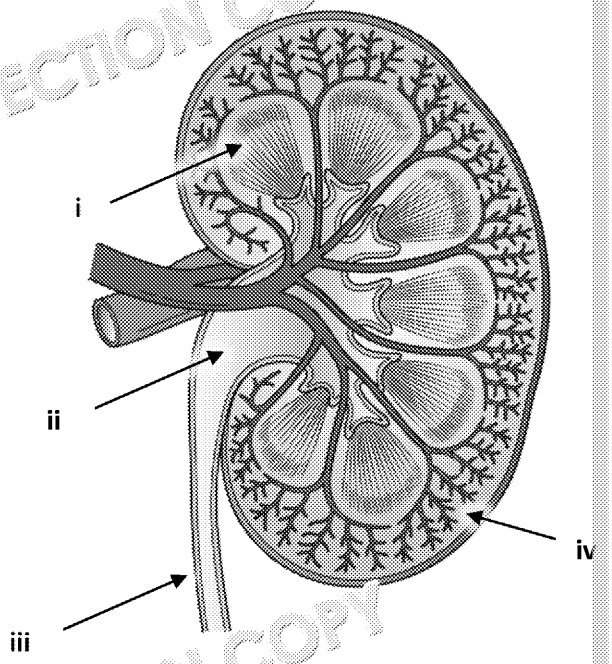


   a) What type of feedback does this diagram illustrate?

   b) Describe how this feedback works.

3. Name the process that controls the water potential of the blood.

4. The picture below shows a cross section through a ki



   Name structures i-

5. The diagram below shows a nephron from a human kidney.

   a) Label features i to iii.

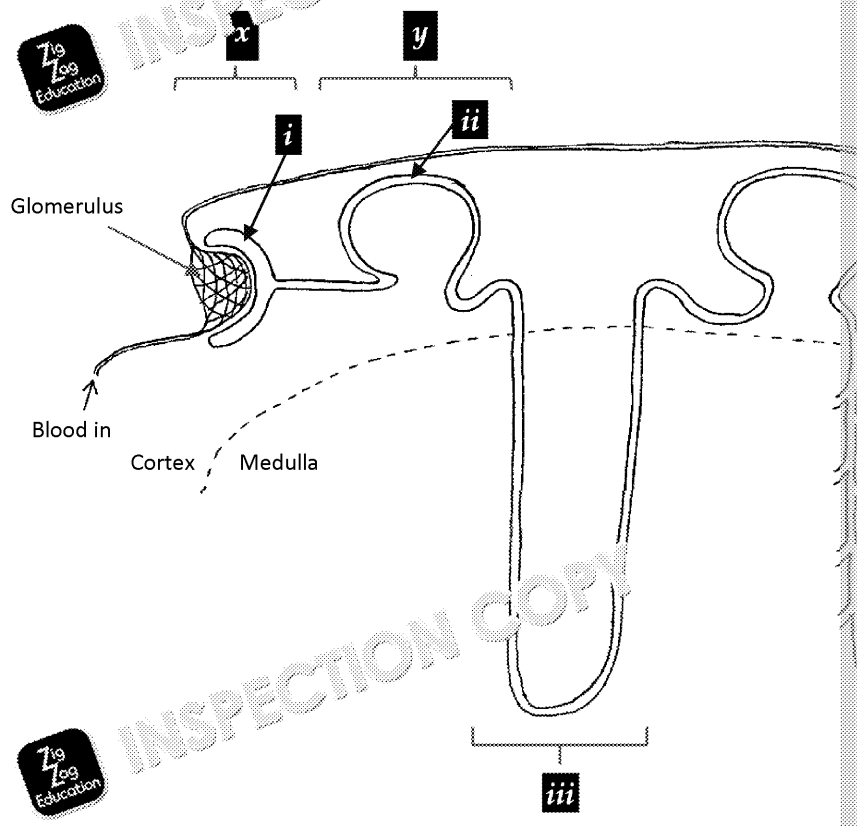
   b) What type of cell is typically found in feature i?

   c) What process occurs in region x?

   d) Outline the key steps of the mechanism named in c.

   e) Describe one adaptation of the cells in region y that adapts them to their

   f) Describe how the permeability of structure *iii* changes across its length.



6. Describe the process of water reabsorption in feature ii of the diagram above.

7. Describe the movement of ions and water in feature iii of the diagram above.

8. Copy, and fill in the missing words in, the process below:

   The ..... contains ..... cells that are sensitive to solute concentration is high, they stimulate thirst centres and the ....

9. Explain how ADH affects the collecting ducts and, therefore, the concentration

Immunity: Responding to Infe

1. a) Name two non-specific defences that animals have against pathogens.

   b) State how **one** of these defences works.

2. Contrast the terms 'antigen' and 'antibody'.

3. Copy out the table below about t[illegible] o[illegible] the three main T-lymphocyte ce[illegible] missing words.

[illegible]ll [illegible]e:	Role:
T-helper cells	Detect ..... and stimulate other T-[illegible]
..... T-cells	Kill infected cells by creating a hole in their [illegible]
Memory T-cells	Remain in the ..... to provide a ra[illegible]

4. Describe how B-lymphocytes provide a response to infection.

5. Compare and contrast the way in which B-cells and T-cells are stimulated to [illegible]

6. Describe how agglutination prevents pathogens from entering host cells.

7. Immunity can be active or passive.

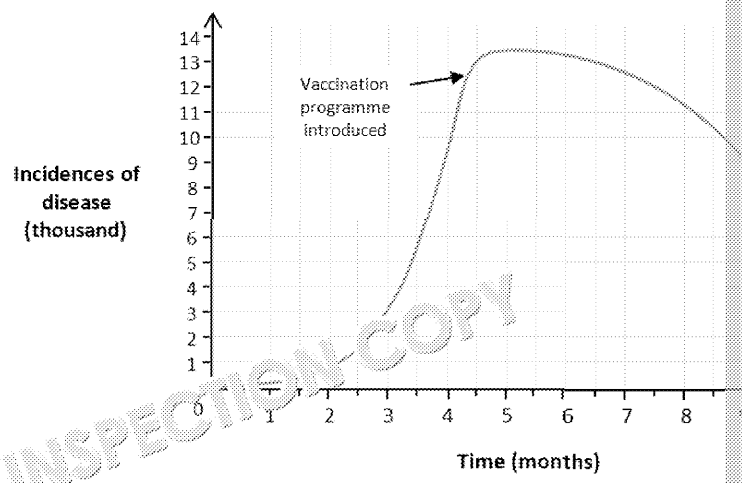
   a) What type of immunity is involved in ear[illegible] [illegible]e[illegible] feeding?

   b) How do active immunity and p[illegible]ss[illegible] mmunity differ in terms of natura[illegible]

8. The graph below s[illegible]ch [illegible]spread of a disease before and after vaccine dev[illegible]

   a) D[illegible] the incidence of the disease before vaccination.

   b) Calculate the rate of decrease in disease incidences four months after t[illegible] was developed (to 3 s.f.). Summarise your answer in a short sentence.



9. The imm[illegible]system can limit the success of transplantation.

   a) Explain how the immune system can threaten a transplanted organ.

   b) Doctors can protect transplants by irradiating immune cells with X-rays[illegible] method works, and why it is not universally used.

1. a) Identify which statement about the ABO rhesus system is correct.
   1. People with the AB blood group produce anti-A and anti-B antibod
   2. Universal donors normally have the blood gr… AB.
   3. A reaction to anti-D antibody indica…es h… …lood is Rh-.
   4. O blood group samples d… …e ABO antigens on the cell surfa…

   b) Explain why dono… …a… …e O blood group can be described as 'univer…

   c) Su… wh… …hesus-negative expectant mother might be given an ant…

2. a) Copy out the sentence below and complete it using words from the list t… ABO blood system is used in blood transfusions. You do not need to use…

recipients	antigens	transplant	antibodies	donors	

   Care must be taken to ensure that blood …… do no… which match …… in the plasma of blood …… an individual with the A- blood type can only receive a blood …… who has the A- or O- blood type.

   b) Due to a laboratory error, a patient with the blood type B- is given an A… Explain why this is a serious problem.

3. a) Suggest why there is great pressure to disco… …w forms of antibiotic…

   b) In 2015, scientists discovered a … …ia… …ew type of antibiotic in soil… and other natural envir… …ight offer new antibiotic options.

4. a) Defi… …he … …epidemic' and 'pandemic'.

   b) Ou… …e factors that make viruses more likely threats for widesprea…

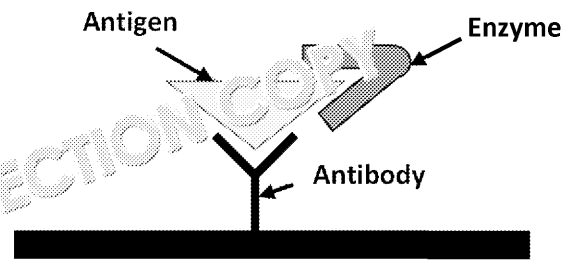
5. Describe the role played by bats in disease transmission and severity.

6. The image below outlines a technique which is used to diagnose a number o…

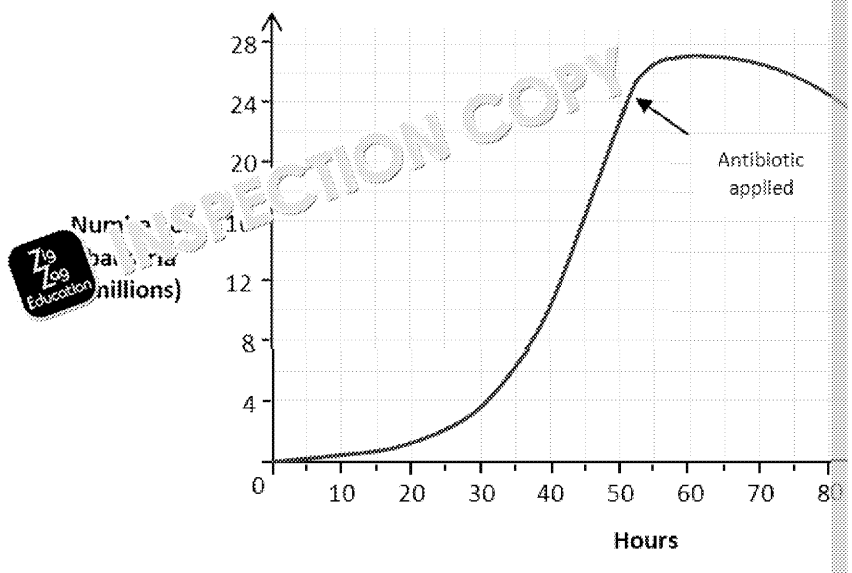
   a) What is the name of the technique shown?

   b) How can this technique be used to diagnose a disease?

   c) Suggest how this technique increases both the speed and efficiency of d…



7. A medical researcher conducted an experiment to determine the effect of a
a pathogenic bacterium. They grew the bacterial colony, applied the antibio
decline.



a) Explain why it was necessary for the experiment to be carried out in as

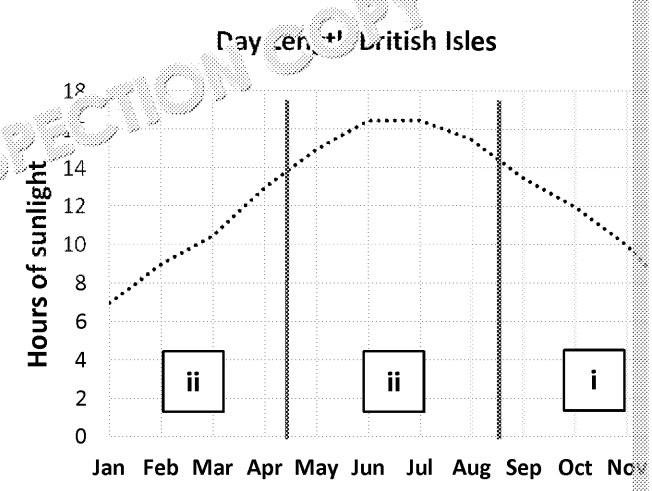
b) State **two** methods used to maintain aseptic technique.

c) Predict the effect e-strips would have on the appearance of the culture

d) Calculate the rate of decrease in bacteria 40 hours after the antibiotics
applied (3 s.f.). Summarise your answer in a sentence.

1. What is the name of the pigment that regulates plant flowering?

2. The graph below shows day length across the year in the British Isles.



   a) Which label on the graph represents LDP (long day plant) flowering tim

   b) Which label on the graph represents days where the P_{660} pigment is sta

   c) Which label on the graph represents days with a higher proportion of f

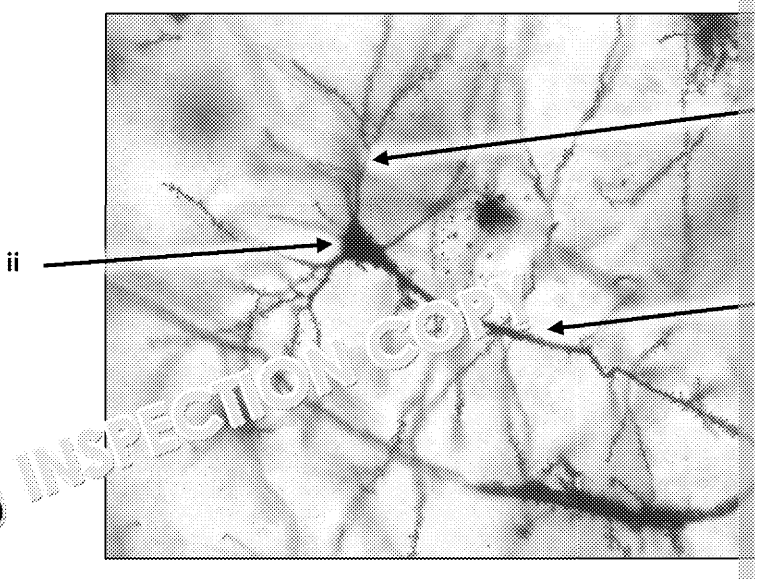
   d) Henbane is an LDP. Suggest how Henbane can be made to flower out o

3. A scientist applies a plant growth su[illegible] tip of a germinating plant the same conditions with no [illegible] growth substance. The length of the in the test plant.

   a) W[illegible] is given to represent the area of stalk between leaves?

   b) Identify the growth substance applied to the test plant.

4. The image below shows an electron micrograph of a neuron.



   Identify the structures labelled i–iii.

5. Copy out the following process describing establishment of resting potentia
missing words.

The ..... actively transports three .....
brings two ..... ions in. These ions then leave the cell b
..... . This creates a ..... charge w
is ..... .

6. Explain how ion movement is involv... ...ting action potentials.

7. The oscilloscope trace... ...ow the effect of a stimulus on a sensory ne

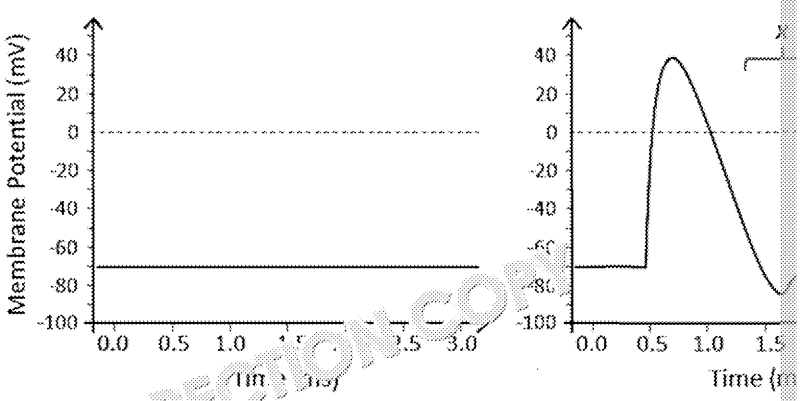
a) E... ...vh... ...nciple is being shown in Graph A.

b) De... ...what happens in Period x of Graph B.

c) What would happen if another stimulus was applied during Period x?

d) What three purposes does Period x serve?

Graph A **Graph**



8. How do the fol... ...ctors affect speed of conductance?

a) Inc... ...d axon diameter

b) Increased temperature

9. Copy out the following process of synaptic transmission and fill in the missin

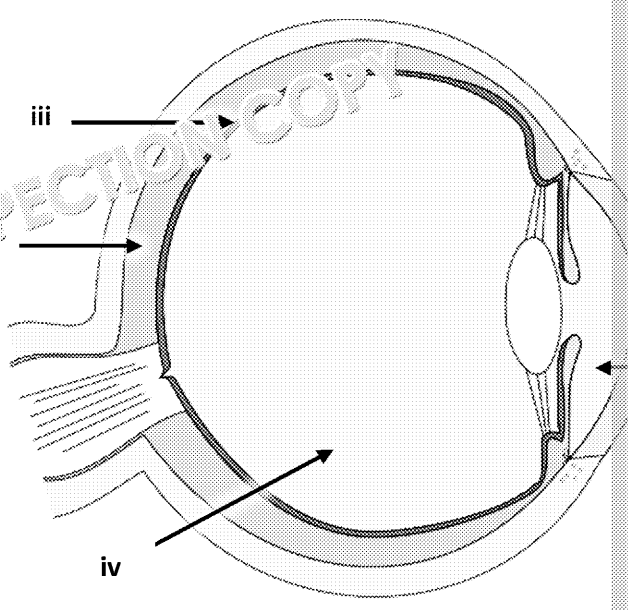
Presynaptic neurons produce ..... . When the nerve impu
presynaptic neuron, it causes these chemicals to leave through .....
..... across the synaptic cleft and bind with specific .....
postsynaptic neuron that trigger ..... to open and generate

10. Describe how inhibitory synapses prevent an action potential from being ge

11. What role do acetylcholine and acetylcholine ... ...play in synapses?

Coordination: The Eye and Mu

1. The figure below shows a section through a human eye.



Copy out the following table and fill in the gaps:

Structure	Label	Fu
		P… s t…e front of the eye a
		Maintains the shape of the fr
Vitreous hum…		Maintains the shape of the b…
Choro…		
Retina	iii	

2. The eye works as a result of the presence of photoreceptor cells. The photor…

a) Copy out this table describing the photoreceptors of the eye, and fill in t…

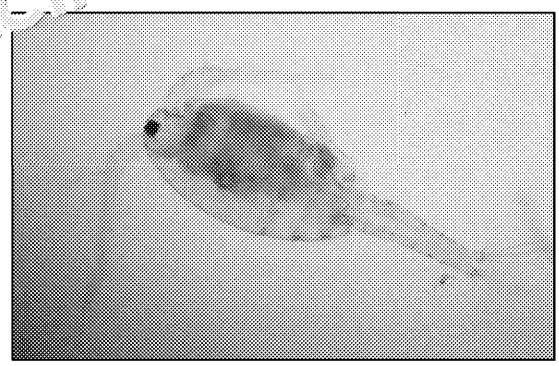
	Rods	Cones
Relative number		
Visual acuity		High
Colour vision		Yes
C…ivel…nce	Yes	
Site of rhodopsin synthesis	Yes	

b) What benefit does convergence provide to rods?

3. Copy out this description of the steps taken to focus on distant objects, and f

The ..... is a ring of muscle that circles the pupil. This structure a ..... . In order to focus light from a distant object, the ..... to the ....., which pulls on the ..... . The pull causes t become refracted.

4. Copepods are small crustaceans. They ar m on ar, meaning that they ha centre of their heads. Explain wh is volutionary adaptation is likely to b

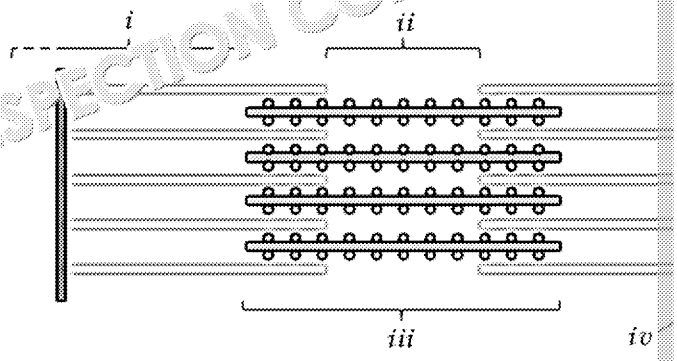


5. Muscle fibres are made up of myofibrils, which have repeating patterns of p

a) What is the name of the structure shown in the diagram below?

b) Name the two proteins that overlap within the structure.

c) Label features i to iv.



6. Describe the sliding filament theory of muscle contraction.

Ecosystems: Interactions between P

1. Identify whether the statements below are true or false, and correct the fal

   a) Competition can be described as a +/- interaction

   b) If two very similar species are competing for s ar es in an ecosystem, will usually be eliminated from the e os ste

   c) Competition is caused b availability of resources.

   d) Intraspecific c h di n occurs between members of different species

2. Copy o ollowing table and fill in the gaps to complete the terms and d

Term	Definition
	The maximum population of an organism th
..... potential	The maximum rate of population ..... conditions are perfect and resources are abu
Population	The number of organisms of one .....
..... resistance	The aspects of an ec ystem which stop a po indefini

3. Describe the ty acteristics of r-selected species.

4. Classify f these relationships as predation, mutualism, grazing or para explain your answer.

   a) A rabbit eats grass and clover plants, although the plants are able to re

   b) An isopod survives by destroying and replacing the tongue of a fish, an fish's nutrients.

   c) Clownfish live in sea anemone colonies, receiving protection; in return, anemones oxygenated by moving water across them.

5. Fill in the gaps to complete the paragraph:

   A pest species is one which damages a ..... plant. In th damage is mostly ....., costi g m s money because i species can also cause serious food sho s. ost pest species are ..... and aphids. Sometimes, pes p e controlled using a ..... the pest populatio by ding its available resources.

6. Describe the features of an effective biological control programme which us
population size.

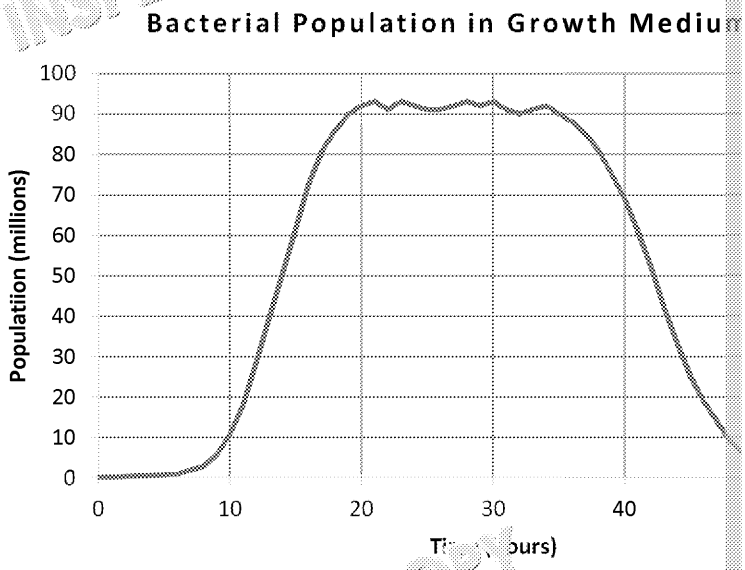
7. A growth curve for a bacterial population is shown below.

   a) Name the phase which occurs from 10–20 hours.

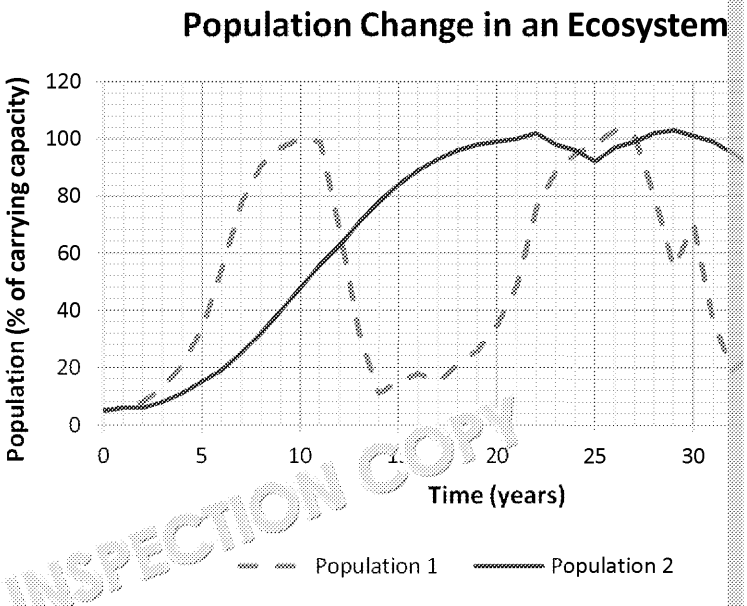
   b) Why does this phase not begin immediately wh cteria are incubate

   c) Describe the phase which occurs fro 2 –3 ours.

   d) Suggest factors which m e change in the growth curve after 3



8. Two species are introduced i n ecosystem. The graph below show
species over time. W s is likely to be r-selected, and which is likel
Explain an



Ecosystems: Population and Commun

1. Which of the following factors in an ecosystem are abiotic: rock type, prese cover, hours of sunlight, mean temperature, presence of decomposers.

2. Copy out the following table and fill in the gaps:

Term	Definition
Autotroph	^ species which produces its own nutrients usi
	Species relying on one another, and being mut in population
Ecosystem	All of the interlinked ..... and abiot
	A species which gets its energy and nutrients b

3. **Figure 1** shows a forest ecosystem. Suggest seasonal factors which might af of a herbivore (organism which eats plant material) in this ecosystem.

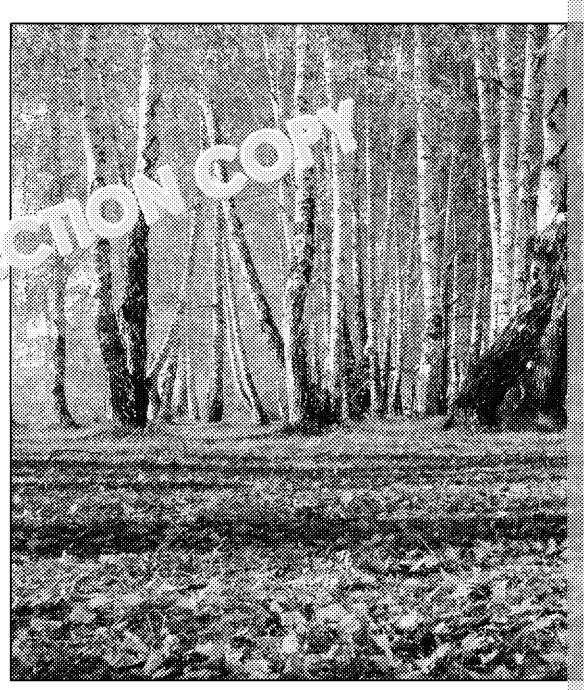


Figure 1

4. **Table 1** shows the changes in a population over two ... Calculate the po of the two-year period.

	Year 1
Births	46
Deaths	35
Immigration	60
Emigration	9

Table 1

5. The mark-release-recapture technique is used to estimate the size of a popu

   a) List **three** assumptions made when using the mark-release-recapture te

   b) Suggest why scientists using the mark-release-recapture technique mig
   than ordinary paint, to mark animals.

   c) A team of scientists carries out a mark-release-rec ture sample to est
   population in a cave system. In the first sa pl , 52 ats are caught and
   paint. In the second sample, 70 ba s are ught; of these, 12 have UV m
   size of the bat population to the nearest whole number.

6. Copy out the table below, and fill in the gaps to complete the sentences. Th
   the bla es to put the stages of succession in order.

	Given enough time, a ..... community develops. This comm – it is not easily disrupted by new species. This process is known a
	These species gradually ..... the existing pioneer species ar
	..... species colonise an ecosystem that is harsh and where ..... . They tend to be species which are well adapted to ... high salt or low moisture levels.
	..... builds up as a result of these species dying. As a result, able to colonise the environment.
	Another type of succession is .... cession, which occurs damaged by a natural disa e

7. The hills the District were once part of a deciduous forest, but the tr
   allow s p to graze. The sheep have since prevented the forest ecosystem
   Which t e of community is this an example of?

8. A haemocytometer is used to count red blood cells in a sample. Two type B
   of the haemocytometer are shown in **Figure 2**. Each square has an assumed
   Using these squares and counting partial cells on the upper and left sides on
   of blood cells in a 1 mm^3 sample.

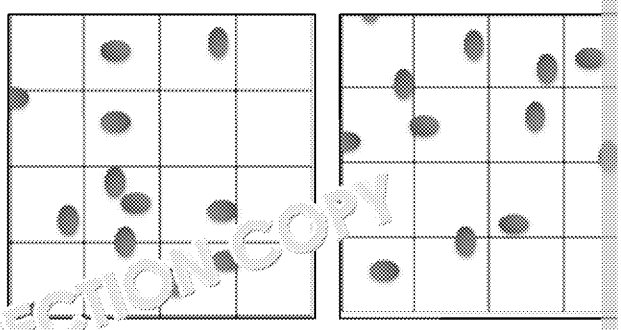
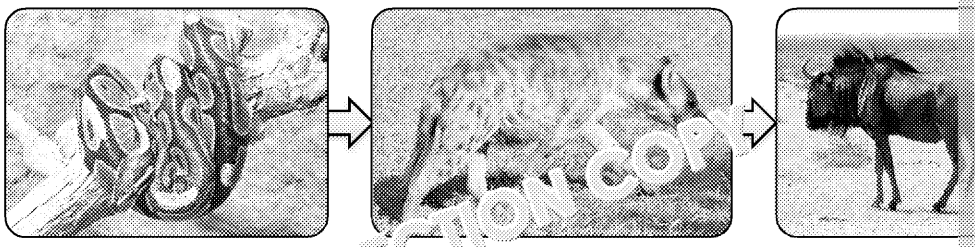


Figure 2



1. The Afric[an] wild dog has been known to eat spotted hyenas on occasion packs, [but] usually on larger animals such as wildebeest. Wildebeest are grazers dry savannah grasslands of southern Africa. In this food chain, name:

   a) a primary consumer

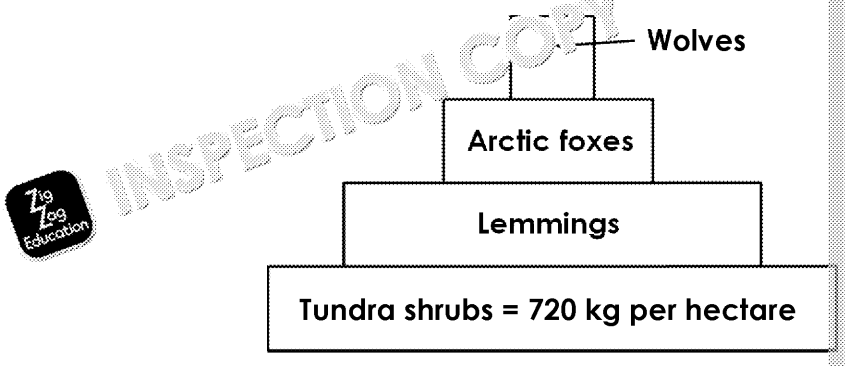
   b) a primary producer

   c) a tertiary consumer

   d) an organism which is at the second trophic level

2. Describe the difference between a detritivore and a decomposer.

3. A hectare (10 000 m^2) of coniferous forest in northern Europe has a gross pri[mary] 16 000 kJ yr^{-1}. 28 % of this energy is lost to respiration. What is the net prim[ary] section of forest?



4. The pyramid of biomass above shows transfers of energy in an ecosystem in

   a) If the efficiency of transfer from the tundra shrubs to the lemmings is 1[0] lemmings to the foxes is 7 %, how much biomass are the foxes able to c[onsume]

   b) Suggest why the wolf population will need a very large territory to surv[ive]

   c) Explain why pyramids of numbers are inconsistent in shape from ecosy[stems]

5. Copy out the following paragraph and fill in the gaps.

   At higher ..... l[evels] w[ithin] an ecosystem, there is progressi[ve] because energy is lost at [each] level. For example, not all herbivores are eaten other ca[rnivores] su[ccessfully] ..... ase. Energy is also lost through ..... food w[hich] [passes] m the body, and ..... – the removal of metabo[lic] organisms lose some of their assimilated energy as heat when they carry out particularly true of ..... such as birds and mammals, which [must] internal body temperature.

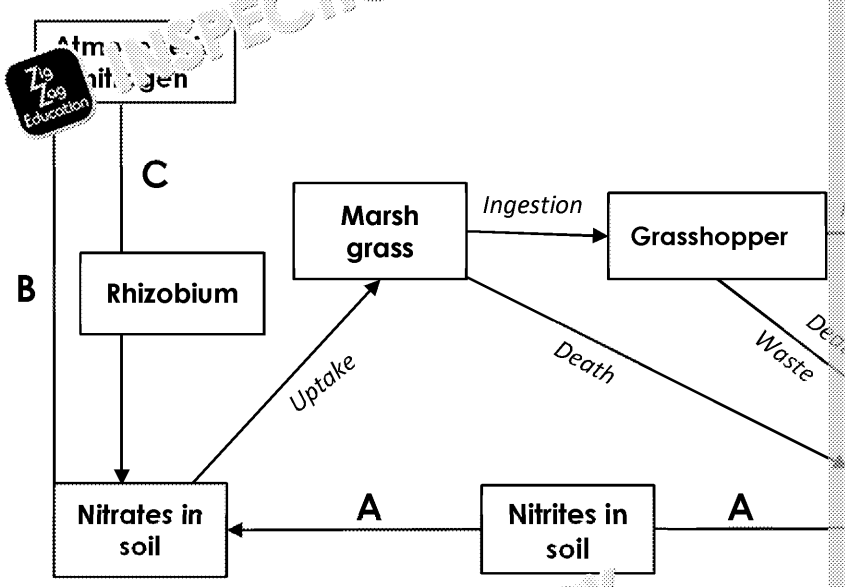
6. A farmer is trying to improve the yield of milk produced by his goats. He bu
insulated walls for the winter, and adds soybean to their feed to increase th
Explain why the farmer makes these decisions.

7. Why do farmers use fertilisers on plant crops?

8. The diagram below shows an example of the nitrogen cycle in a swamp fore

   a) Name processes A, B and C.

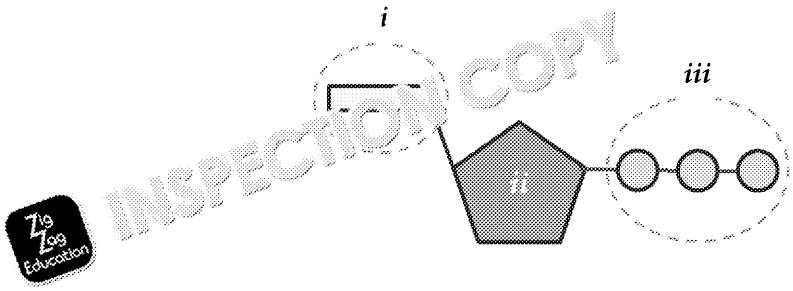
   b) Which type of organism p... es ammonium compounds from dead o



9. Describe the carbon cycle, and explain ... essential to a functioning ec

Respiration

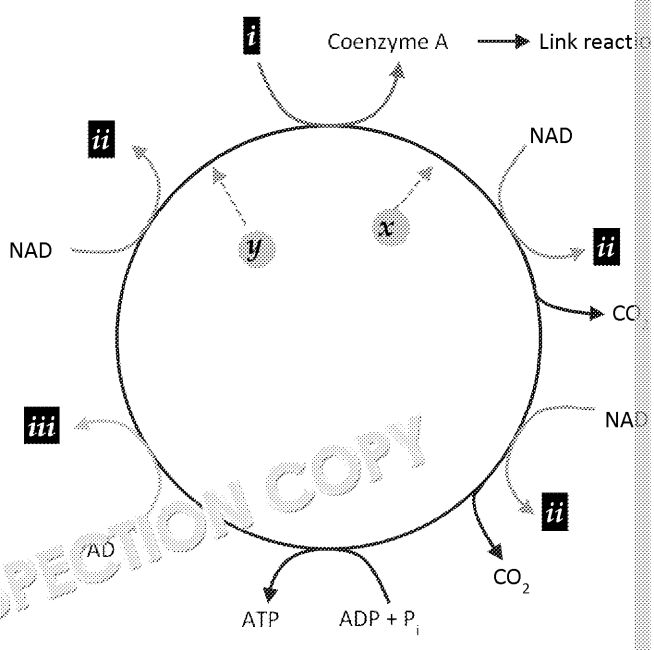
1. Name the nucleotide shown below, and label parts i–iii.



2. All organisms depend on respiration to some extent to provide energy.
   a) What is the first stage of respiration?
   b) Where does this occur?
   c) Copy, and fill in the missing words in, the process below:

   During the first part of this reaction, glucose is phosphorylated to make ..... . This molecule immediately splits into two m..... and then becomes oxidised to form ..... atoms released during this are accepted by ..... . Th... during the first stage are accepted to make two molecules of .....

3. The diagram below represents a major part of respir... .
   a) Name the stage shown below and ...ere it takes place.
   b) Write the names of m...ing ...ecules i–iii.
   c) State how ... carbon atoms are within the molecules at stages x and ...



4. Explain the reasons for the difference in ATP yield between aerobic respirat
stating the importance of both methods of respiration.

5. a) Which molecules provide the electrons for the electron transport chain?

b) Identify the molecules that are missing from this description of the elec

NAD → _____ → Coenzy[illegible] → _____

c) Describe the process that involves hydrogen ion transfer into and out of
mitochondrial membran[illegible] this generates ATP.

d) What is the n[illegible] process of ATP formation within this stage?

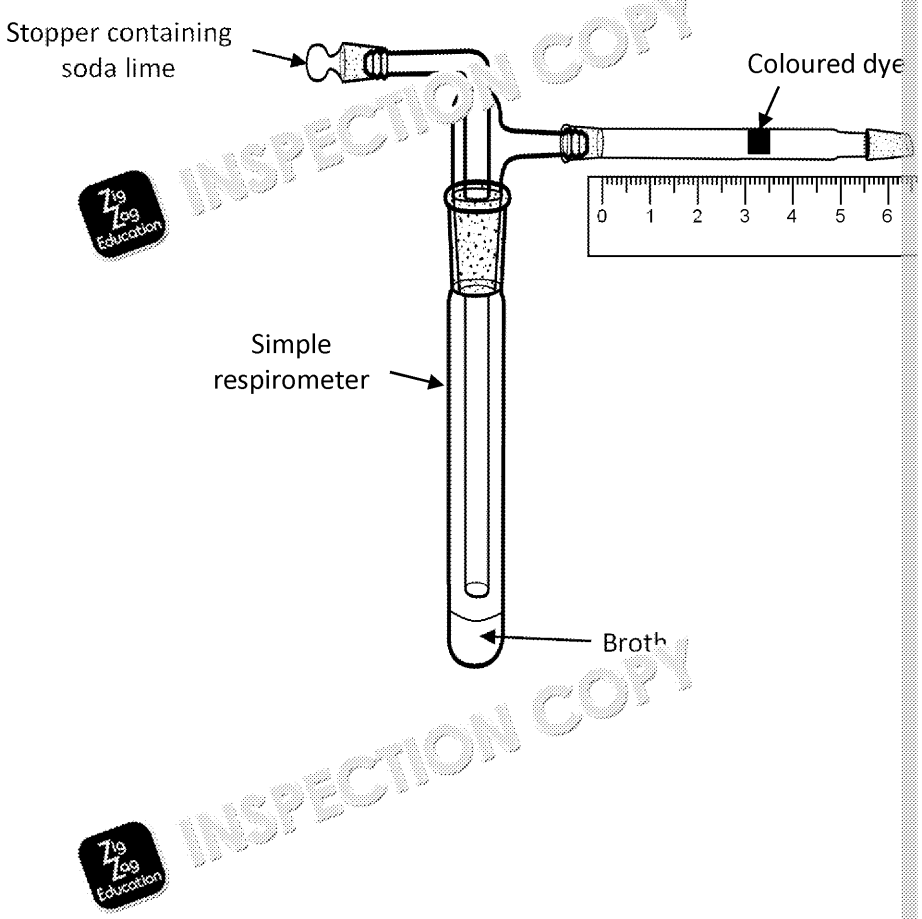
6. a) Or[illegible]bohydrates, lipids and proteins in terms of their relative energy

b) A fatty acid is fully respired by a cardiac muscle fibre. In this process, 3
are consumed, and 41 molecules of carbon dioxide are produced. What
quotient of the fatty acid?

7. The apparatus drawn below shows a simple respirometer which is used by s
respiratory quotient of respiring yeast cells. The soda lime is used to absorb

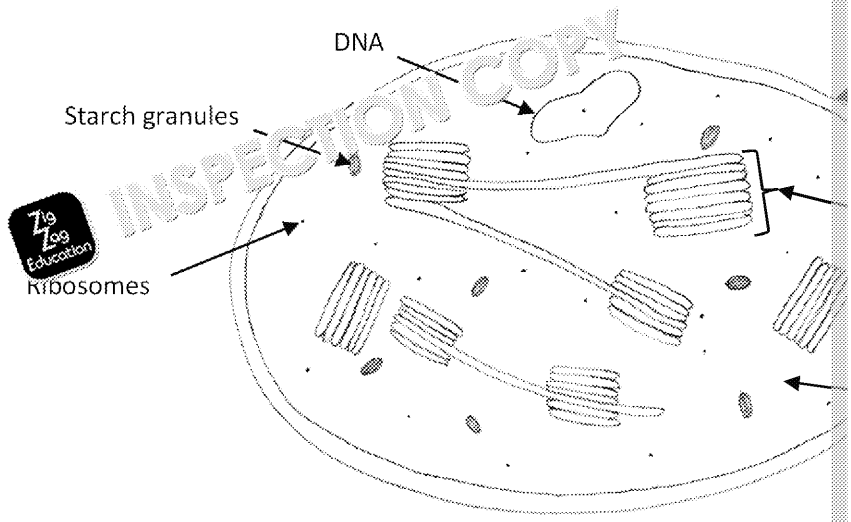
a) Over a period of 30 minutes, the coloured dye in the apparatus moves 2
radius of 0.45 cm, calculate the volume of oxygen consumed by the yea

b) 1.17 g of carbon dioxide is absorbed by the soda lime in the same perio
the RQ of the yeast cells.



Photosynthesis

1. Identify the letters that represent the site of the light-independent and light photosynthesis. Name each label.



2. Explain how water stress decreases production of starch and other organic s

3. Using the figure shown below, answer the following questions:

   a) What is the name of Process 1, where chlorophyll is oxidised by light?

   b) What is happening in Process 2?

   c) Describe what happens to the c... during Process 3.

   d) Describe how chemi... osis ...es electron transfer to make ATP.

   e) Wh... e ... s x and y?

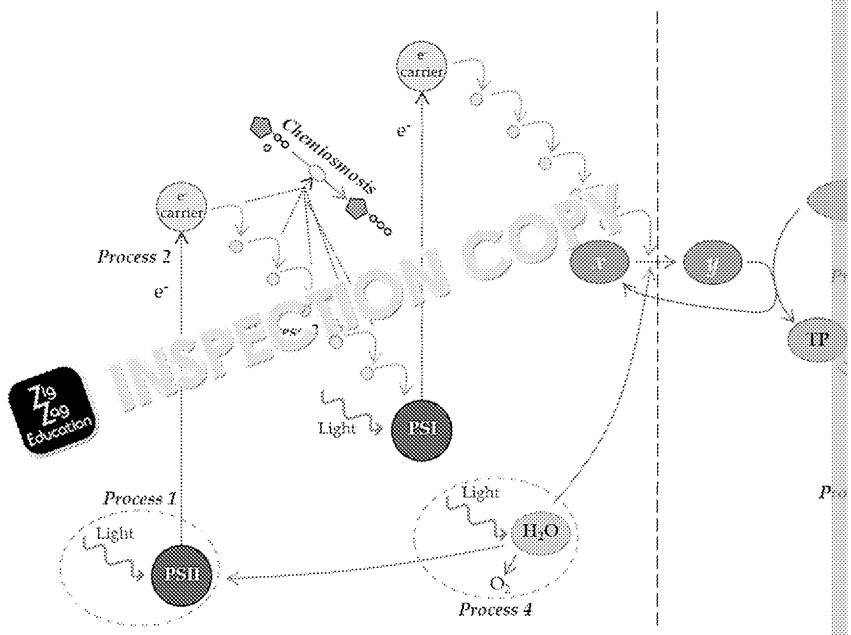
   f) W... he name of Process 4?

   g) How does Process 4 help convert molecule x into molecule y?

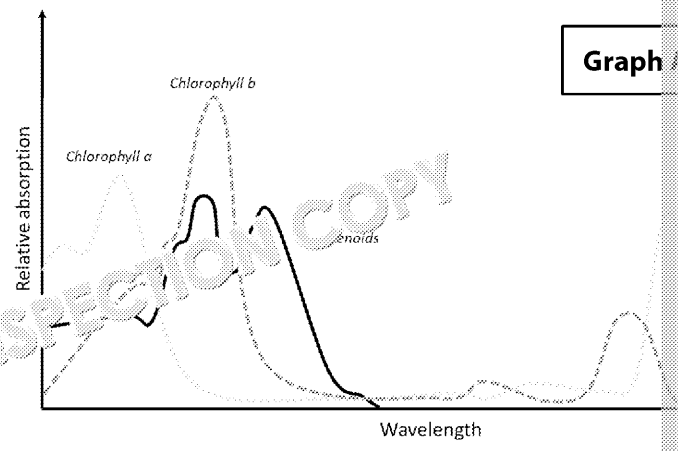
   h) How are the electrons of Photosystem I (PSI) and Photosystem II (PSII)

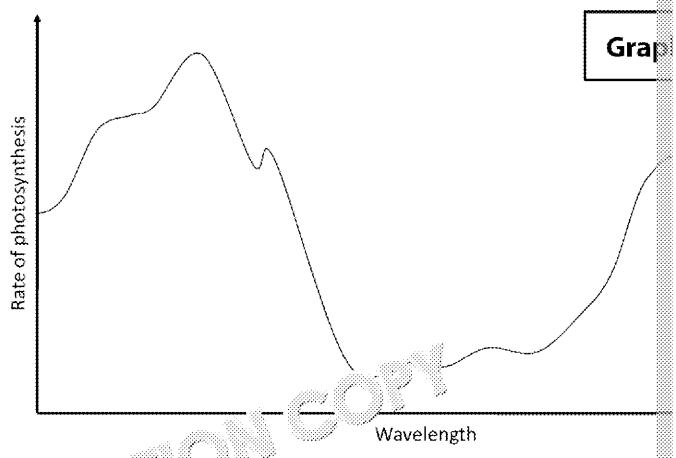
   i) Explain how Process 5 creates triose phosphate.

   j) What two roles does triose phosphate have?



4. Graph A shows an absorption spectrum. Explain what Graph B is, and how i





5. The envi ne r that limits the slowest process in photosynthesis

   a) Ho s an increase in carbon dioxide affect photosynthesis?

   b) Explain why increasing light intensity increases photosynthesis, but onl

6. Calculate the R_f value of the pigment below, and identify the pigment using

Pigment	R_f value
Carotene	0.99
Chlorophyll a	0.72
Chlorophyll	0.64
P h	0.81
Xa ophyll 1	0.42
Xanthophyll 2	0.61

DNA: The Genetic Code

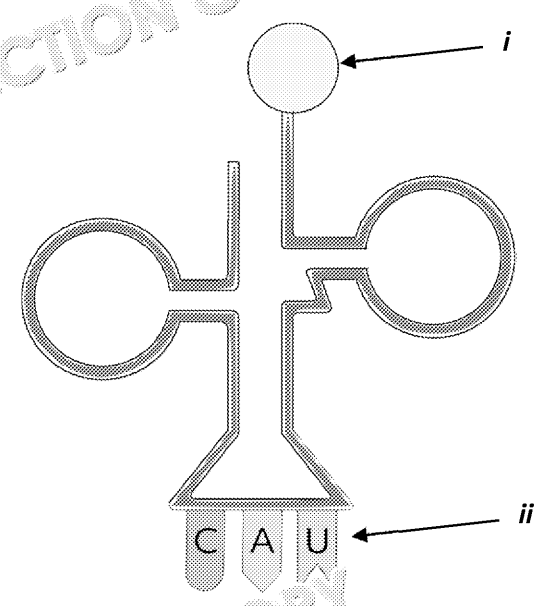
1. Copy, and fill in the missing words in, the following statement describing the code:

   The ..... code of DNA codes for specific ..... . The c... overlapping and ....., which mea...s t...at m...ost amino acids have m... broadly be divided into coding and no...-coding regions. The coding regions ... while the non-coding pa...e ..... .

2. Copy c... ta... below, complete the stages of transcription, and then pu... correct...

Step	Description
	The DNA reforms a ..... behind the RNA polymerase.
	..... takes place between free nucleotides and the DNA
	RNA polymerase forms ..... between the nucleotides.
	The enzyme ..... separates the DNA strands by breaki...
	The enzyme ..... binds to the transcription start site.

3. A molecule of tRNA is shown in the figure below.



   a) Identify the parts labelled i and ii.

   b) Outline the roles of tRNA molecule in translation.

   c) D... t... structure of a ribosome.

4. The central dogma of molecular biology has established the idea of 'one gen

   Suggest why the one gene–one polypeptide theory replaced the one gene–o

5. a) What is epigenetic inheritance?

   b) What role does the environment play in epigenetic inheritance?

6. How is DNA methylation involved in epigene tics.

7. Histone proteins hold DNA in pla contain information on the fate of th

   a) How es cetylation affect gene expression?

   b) Ho is information inherited?

8. If these control pathways are disrupted, how would cells be affected?

DNA: Gene Technology

1. What is the purpose of the polymerase chain reaction (PCR)?

2. Copy the table below and fill in the missing information on the stages of PCR.

Stage	Temperature °C	Description
	95	DNA strands separate
Annealing	55	
DNA synthesis	72	

3. Why is *Taq* polymerase used?

4. Give **two** possible uses of PCR in modern science.

5. The table below gives an outline of the method used to probe for a specific sequence of DNA. Read through the table, and complete the missing parts of the method.

Step
DNA is hydrolysed, meaning that ..... are broken.
..... are used to cut the DNA into fragments.
The fragments of DNA are separated using ..... .
DNA fragments are transferred to a nylon membrane and a DNA probe is added.
If the correct sequence is present, the probe ..... .
The probe can be detected as it is ..... or radiolabelled.

6. What are microsatellite repeat sequences (MRSs), and why are they important in DNA fingerprinting?

7. How do SNPs give rise to genetic disorders?

8. a) Outline the process of microarray technology.
   b) How does this technique differ from DNA fingerprinting?

9. A sample of cells are found to produce a protein that can be used as a drug in humans.
   a) Suggest a method for producing DNA from the mRNA expressed in these cells.
   b) Name a technique that can be used to produce a large quantity of the desired gene.
   c) Why is the desired gene inserted into a vector?
   d) What feature of bacteriophages makes them useful in genetic technology?
   e) Describe how restriction enzymes are used in genetic technology.

DNA: Genetic Modification

1. Name two products of genetic modification that can be used in medicine.
2. The use of gene therapy to treat diseases and disorders has the potential to quality of life for many people.
   a) How can viruses potentially be used to treat cancer?
   b) What is the risk of using viruses to insert genes into an individual's cell
3. The use of genetically modified crops needs to be carefully considered for ea supporting arguments from both sides of the debate about:
   a) whether even if they are opposed to it, people should be forced to gro healthier and will protect the environment
   b) whether we should engineer crops such as bananas that are currently g developing countries to grow successfully in the UK
4. Describe how scientists can manage and reduce risks when genetically modi
5. Gene therapy can take advantage of knowledge of genetic modification in o
   a) Outline the process of gene therapy.
   b) Define the terms 'somatic cell gene therapy' and 'germ-line gene thera
   c) Identify **one** method for introducing a functional gene into a diseased c
   d) State one problem with using the method identified in c).
   e) Explain how gene therapy has been used to treat cystic fibrosis, and wh had limited success.
6. DNA sequencing methods can now map genomes
   a) Define the term 'genom
   b) How has DNA sequencing technology developed over time?
7. Identify whether the statements are true or false. For each false statement

i	The Human Genome Project mapped the human genome and iden different genes.
ii	Scientists can use information from gene sequencing to predict the
iii	Genome sequencing can only be used to study organisms that are l

8. Genome sequencing represents many benefits to biologists. In each case, s has benefitted the field.
   a) Pharmacogenetics
   b) Gene therapy
9. Genes can be inactivated in living organisms.
   a) What name is given to an organism in which a gene has been inactivate
   b) How can this type of organism be beneficial to medicine?
   c) Why might a defective gene be intentionally inserted into an organism?
10. a) Suggest why instructions for gel electrophoresis include warnings to ke ha equipment.
    b) The acrylamide gel used is a nerve toxin. Describe three safety procedu implement to reduce the risk of the gel causing any harm.

Inheritance

1. a) Define 'genotype' and 'phenotype'.

   b) How many alleles can a gene have?

2. Pea plants can have either green or yellow pods. When two pea plants were had yellow pods. 'G' can be used to represent green and 'g' can be used to r questions.

   a) What is the genotype of the parent plants?

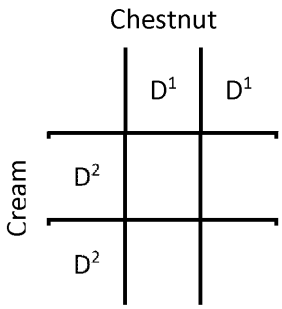
   b) An organism can have two different alleles of the same gene. Stat

   c) How can the genotype of the yellow offspring be described?

3. The diagram below shows how a chestnut horse and a cream horse can have

   a) What proportion of the offspring are palomino?

   b) What type of allele is this an example of?



4. The allele for red-green colour blindness can only be found on the X chromo colour blind. Their son has red-green colour blindness.

   a) Give the term used to describe this type of condition.

   b) Determine the probability of their child being colour-blind.

   c) Give the term used to describe the mother.

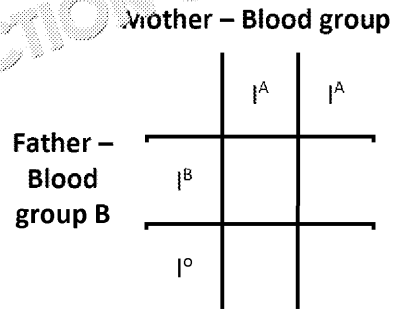
5. Define 'autosomal linkage'.

6. Describe how chromosome division during meiosis can lead to genetic varia

7. ABO human blood groups are a good example of multiple alleles.

   a) What is meant by 'multiple alleles'?

   b) Calculate what proportion of children would have matching genotype to their parents in the following exampl



8. The colour of wild mice coats depends on two genes. The 'colour' gene dete
brown or black (represented by the letter 'b'); the 'pigment' gene determine
called melanin, is produced or not (represented by the letter 'm').

All of the mice are brown.

One group of parent mice are homozygous for coat colour and heterozygous

The other group of parent mice are heterozygous for coat colour and hetero

a) State the dominant alleles for the two genes.

b) What is the term used to describe the effect of the 'pigment' gene on th

c) What proportion of the offspring is expected to be albino?

9. a) What is the difference between the type of variation shown in height an

b) Typically, how many genes influence each of these traits?

c) What other non-genetic factors can affect height?

Population Genetics

1. Copy out the following paragraph and fill in the gaps:

   Genetic variation is present in virtually all populations. It is created by muta
   ..... which change the ..... sequence of th
   ..... mutations inv... lo... of one or more bases, while
   involve swapping one mut... on ... another. Mutations can also happen at t
   causing entire gro... g...es to be duplicated or lost.

2. Explain... ...fference between allele frequency and a gene pool.

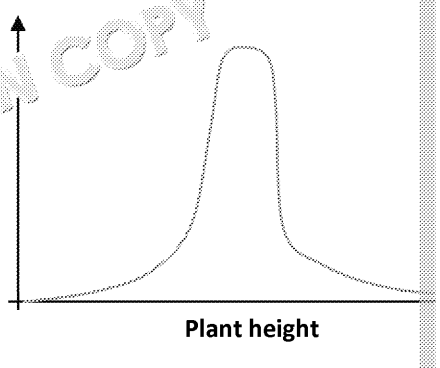
3. a) What does the Hardy–Weinberg equation allow us to calculate?
   b) State the Hardy–Weinberg equation.
   c) If allele A has a frequency of 0.735, what is the frequency of allele a?

4. People with cystic fibrosis have two recessive alleles. In 2015, the populatio
   one out of every 2,500 babies born had cystic fibrosis.
   a) What was the frequency of the dominant allele?
   b) Approximately how many people in the UK were carriers?

5. a) State three conditions that are assumed about a population when appl
   principle.
   b) Based on your answers to part a), ...ss... th... ...elihood of the Hardy–W
   natural population.

6. A period of lon... ...rs caused mortality among Arctic foxes. Adults with
   enoug... ...e ...th and could more successfully rear their young.
   a) How could you describe the foxes that managed to reproduce?
   b) What type of selection is acting on the Arctic foxes?
   c) Sketch a graph showing this selection acting on Arctic foxes.
   d) Describe how the allele frequencies for short and long hair will change i

7. The graph below shows the heights of meadow plants that are grazed when
   outcompeted for light when they are too short.
   a) What type of selection are they undergoing?
   b) Draw arrows in the graph to show the selection pressures.



8. a) What is the difference between allopatric speciation and sympatric spe

   b) Suggest two mechanisms for sympatric speciation.

9. A few frogs are separated from a larger population by a storm and establish
   island. Their population grows until a rockslide reduces their numbers.

   a) Describe the possible consequences of the rock[illegible]on the new popula
   allele frequencies.

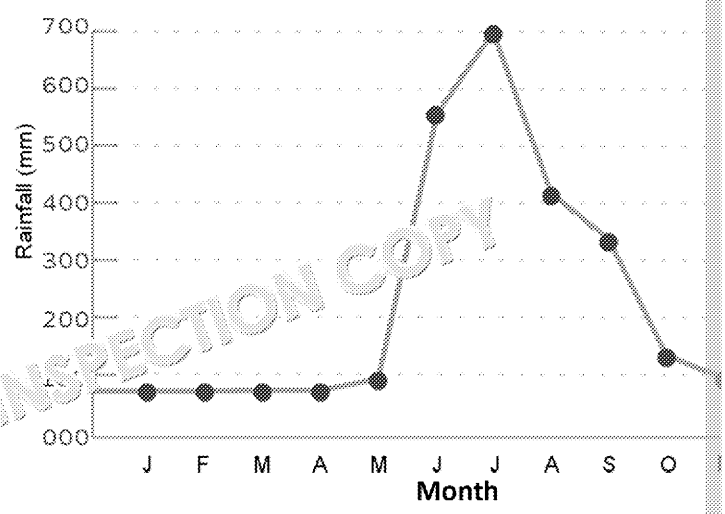
   b) What differences would [illegible] to see in the allele frequencies of t
   population, the [illegible]on pre rockslide, and the new population

Kingdom Plantae

1. Copy out this description of the kingdom Plantae, and fill in the gaps.

   All organisms that exist with the kingdom are ....., meani
   and membrane-bound organelles. Additionally, all c n cell walls that ar
   Plantae feed by ..... – their th ergy from the sun to pr
   ..... within th in , distinct parts of the plants are sp
   The kingdom is divide ..... which exclusively c
   tracheop s, include ..... plants.

2. a) Sta w mosses are able to support their structure.
   b) Explain how mosses are able to survive without stomata or a cuticle.
   c) Name the root-like structure of mosses.
   d) How do the structures named in c) differ from true roots?
   e) The graph below shows annual rainfall in a region. Explain why mosses area.



3. a) Suggest why ferns are able to grow to much larger sizes than mosses.
   b) How do ferns differ from flowering plants?
   c) Explain why ferns may be absent from an ecosystem that has recently b by drought.

4. a) Define the term 'angiosperm'.
   b) Why are seeds better adapted to dry conditions than spores?
   c) How does the presence of xylem assist plants w rrestrial life?

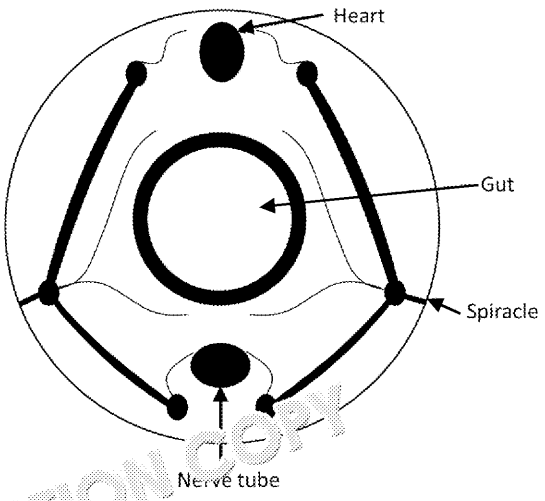
1. To which phyla do the following organisms belong?
   a) Earthworm
   b) Spider
   c) Liver fluke
   d) Hydra

2. a) Co[illegible] t[illegible] symmetry and shape of a liver fluke and a hydra.
   b) Wh[illegible]vantage does this type of symmetry offer the liver fluke?

3. a) How do the feeding tubes of Platyhelminthes and Annelida differ?
   b) The feeding tube of a human is most similar to which of these phyla? Ex
   c) What features of the human digestion tube differentiate it from that of

4. Annelids are the simplest organisms with metameric segmentation.
   a) Define 'metameric segmentation'.
   b) How are annelid bodies supported?
   c) What advantages (other than support) does this system provide?

5. a) Explain why the body plan of arthropods has ma[illegible]em highly success
   b) Name the three major sections of th[illegible]d body.
   c) Consider the cross secti[illegible] Suggest one feature which indicates t not a chordate.
   d) Su[illegible]on [illegible]eature which indicates that the organism is an arthropod.



6. a) Describe th[illegible]l system of chordates. Why is the skeletal system w e[illegible]m:
   b) Wh[illegible]e is segmentation most evident in chordates?

Answers

Homeostasis and the Kidney

1. Processes to maintain a constant internal environment (1)

2. a) Negative feedback (1)
   b) Deviation from norm detected by hypothalamus (1). [illegible]ulates physiological p
   Turns off receptor / decreases activity of eff[illegible] returned to norm (1).

3. Osmoregulation (1)

4. i. Renal pyramid/m[illegible]
   ii. Re[illegible]lvi[illegible]
   iii. U[illegible]
   iv. Co[illegible] (2)

5. a) i = Bowman's/renal capsule (1)
   ii = Proximal convoluted tubule (1)
   iii = Loop of Henlé (1) [Accept without accent over e]
   b) Podocytes (1)
   c) Ultrafiltration (1)
   d) Blood pressure is high / increases as it enters the glomerulus (1)
   Because: Afferent arteriole is wider than glomerular capillaries and efferent ar
   kidneys is short / coiling of the glomerulus restricts blood flow (1)
   High blood pressure provides force for filtration (1)
   Osmotic gradient from nephron opposes blood pressure (1)
   Pressure in nephron opposes backwards filtration (1)
   e) [One from:]
   - Cells have many mitochondria (1) to provide ATP/energy for active transp
   - Cells have microvilli (1) to increase the surf[illegible]a for transport (1)
   - Subcellular and intercellular spaces (1) a[illegible]ow [illegible]ate to be closer to blood ve
   f) Descending limb is permeable t[illegible]D impermeable to ions (1)
   Ascending limb is imper[illegible]t [illegible]ater AND highly permeable to (sodium an

6. Active trans[illegible]ort [illegible] and other solutes into the cuboidal epithelium / into capi
potent[illegible]e [illegible]helium/capillaries) / creates a water potential gradient (1), so w

7. The desc[illegible]ding limb is permeable to water (1) so water diffuses out / leaves by osm
vessel / vasa recta (1) [Must have something about water removal for mark]. The d
ions than the ascending limb (1). The ascending limb is not permeable to water (1).
chloride ions are reabsorbed in the ascending limb from the filtrate into the blood b

8. The ***hypothalamus*** (1) contains ***osmoreceptor*** (1) cells that are sensitive to blood so
concentration is high they stimulate thirst centres and the ***pituitary gland / posteri***
anti-diuretic hormone (1). [Do not accept ADH for first usage here]

9. ADH makes the collecting duct membrane permeable (1). The medulla has an extre
extremely high ion concentration (1); therefore, water diffuses out of the filtrate / l
resulting in more concentrated/hypertonic urine (1).

Immunity: Responding to Infection

1. a) [Any two from:]
   - Skin
   - Stomach acid
   - Lysozyme in tears/sweat/saliva
   - Mucus in respiratory tract
   - Blood clotting

   b) [One that matches answer to a) from:]
   - Skin acts as a barrier
   - Acid destroys pathogens
   - Lysozyme destroys pathogens
   - Mucus traps pathogens to move out of body / to stomach
   - Blood clotting forms a barrier

2. Antigens are detected by the immune system, while antibodies are produced by the the body (1)

3.

Cell type:	Role:
T-helper cells	Detect ***antigens*** and stimulate other T-cells to divide
Cytotoxic/killer T-cells	Kill infected cells by creating a hole in their ***cell mem***
Memory T-cells	Remain in the ***blood / body fluids*** to provide a rapid ***reinfection / infection by the same pathogen***

4. B-plasma cells produce antibodies (1) which bind with antigens to form an antigen– is stopped from moving, and can be destroyed by phagocytosis (1).
   B-memory cells (1) remain in the tissues to provide a rapid response to future reinfe pathogen (1). This forms a secondary response (1) (4 marks)

5. Both types of cell are stimulated to divide by cytokines to potentially harmful antige antigens on the body's own cells (1) – cells displaying viral antigens (1) and inc tumours (1), while B-cells respond to antigens in the blood / antigens on pathogens they can then be antigen-presenting cells to stimulate other cells (1).

6. Agglutination involves antibodies that bind to many pathogens (1), forming a struct

7. a) Passive immunity (1)
   b) Active natural is response of body to a pathogen (1)
   Active artificial is response of the body to an artificially introduced antigen, su
   Passive natural is transfer of antibodies via natural means, such as in colostrum
   Passive artificial is transfer of antibodies via an artificial means, such as by inje

8. a) Rapidly/Exponentially increases (1)
   b) [1 mark for good tangent placed at 8.25 months]
   [1 mark for equation:]

   $$\text{Rate} = \frac{\text{change in y}}{\text{change in x}}$$

   [1 mark for appropriate calculation]

   $$\text{Rate} = \frac{9\,800 - 13\,100}{9 - 7} = \frac{-3\,300}{2} = -1650$$

   [1 mark for summarised answers in the range 1450–1850 per m
   Four months after the injection is introduced, the rate of new incidences is de

9. a) T-helper cells are activated by the transplant antigens (1)
   Killer T-cells develop following mitotic cloning of lymphocytes (1)
   Killer T-cells destroy the transplanted tissue/organ (1)
   b) Inactivates key immune cells, including B- and T-lymphocytes / Inhibits produc
   Prevents recognition of antigens on the transplanted tissue (1)
   Weakens immune system / Makes patient more vulnerable to infection / Increase

1. a) 4. O blood group samples do not have ABO antigens on the cell surface (1)
   b) No blood group produces antibodies to the O antigen / Blood of group O does
   meaning an immune response to type O blood does not occur (1)
   c) Possibility of mother bearing a baby that is rhesus positive (1)
   In this case, the mother's immune system will respond to D antigens (1)
   The mother is given the anti-D to reduce chance of corresponding to the antigen

2. a) [1 mark for each two correct words]
   Care must be taken to ensure ... blood ***donors*** do not have antigens on their
   plasma of blood ***recipients*** For example, an individual with A- blood type can
   from someb... ...has the A- or O- blood type.
   b) [A... fro...]
   B a...us-positive antigen on donor blood cells will trigger immune system
   Immune system will destroy foreign cells, causing fever
   Antibody–antigen complexes may block blood vessels
   Blockage of blood vessels may cause tissue damage, heart attack or stroke

3. a) [Any three from:]
   Global increase in antibiotic resistance
   Means common bacterial infections may become untreatable / difficult to trea
   Increases risk of widespread infection / epidemic
   New antibiotics can increase economic productivity / improve quality of life
   b) Many bacteria and microbes live in soil (1)
   These organisms naturally produce antibiotic substances as defence mechanis

4. a) Epidemic = disease that spreads rapidly within a region (1)
   Pandemic = disease that spreads rapidly across regions/countries (1)
   b) Prone to mutation (1)
   Genetic material in retroviruses / RNA is unstable (1)
   Antibiotics not effective against viruses (1)

5. Bats are a potential reservoir for disease (1)
   Humans and bats have very sim... ...logy (1)
   Bats are highly social org... ...facilitating rapid spread (1)
   Bats can fly large ... ..., spreading diseases over large distances (1)

6. a) E... ...nked immunosorbent assay (accept ELISA) (1)
   b) Bo... ...ds are mixed with antibodies in a well (1)
   Antibody binds to test antigen if present (1)
   Interaction between antibody and antigen causes enzyme to activate and prod
   c) Many different test fluids can be tested simultaneously (1)
   Many different antigens can be tested for simultaneously (1)

7. a) If the bacteria were contaminated by another organism, the experiment would
   that organism (1) which might not be killed by the antibiotic and change the re
   b) [Any two from:]
   Disinfect surfaces
   Sterilise equipment / Autoclave before use
   Complete processes quickly to limit exposure to contamination
   If Petri dishes are used, only open partially when inoculating / incubate Petri d
   c) Large-scale bacterial death at high-concentration end of ... (1) with progress
   concentrations (1)
   d) [1 mark for good tangent placed at approximately 2.5 generations]
   [1 mark for equation:]

   Rate = change in ... / ... in x

   [1 ... calculation:]

$$\text{Rate} = \frac{17\,800\,000 - 24\,000\,000}{95 - 85} = \frac{-6\,200\,000}{10} = -620\,000$$

   [1 mark for summarised answer; accept answers in the range 550 000–700 000
   At 92 hours, the population size is falling at a rate of 620 000 bacteria per hou

1. Photochrome (1)

2. a) ii (1)
   b) i (1)
   c) i (1)
   d) Use artificial light during night-time to reduce the period of darkness the plant

3. a) Internode (1)
   b) Gibberellin (1)

4. i. Dendrite (1)
   ii. Cell body (1)
   iii. Axon (1)

5. The ***sodium-potassium ion pump*** (1) actively transports three ***sodium*** (1) ions out of the cell and two ***potassium*** (1) ions in. These ions then leave the cell by facilitated diffusion through ***potassium*** ion channels. This creates a ***negative*** (1) charge within the axon so the membrane is ***polarised*** (1).

6. Stimulus causes sodium ion channels to open (1)
   Diffusion of positive sodium ions into the axon creates electrical charge / action potential
   The axon becomes depolarised / positively charged (1),
   which stimulates more sodium ion channels to open, so the action potential spreads

7. a) The stimulus is too weak to reach the threshold / trigger an action potential (1), all or nothing principle (1)
   b) This is the refractory period (1) when sodium ion channels are closed and resting potential is restored
   c) There would be no response (1)
   d) Ensures impulses travel in one direction / are unidirectional (1)
      Impulses are discrete signals (1)
      Only a limited number of action potentials can be generated at one time (1)

8. a) Reduces ion leakage; therefore, increases speed (1)
   b) Increases diffusion of ions and increases speed (1) but if temperature is too high denatures and decrease speed

9. Presynaptic neurons produce ***neurotransmitters*** (1). When the nerve impulse reaches it causes these chemicals to leave through ***exocytosis*** (1). These chemicals ***diffuse*** (1) and bind with specific ***receptors*** (1) in the postsynaptic neuron that trigger ***ion channel*** (1)s to open and an action potential.

10. Neurotransmitters cause hyperpolarisation of the postsynaptic membrane (1) so an action potential cannot be generated (1)

11. Acetylcholine is an excitatory neurotransmitter (1); acetylcholinesterases are enzymes

Coordination: The Eye and Muscle

1.

Structure	Label	Function
Cornea	***i***	Protects the front of the eye and refracts light
Aqueous humour	***v***	Maintains the shape of the f[illegible]f the eye
Vitreous humour	***iv***	Maintains the shape [illegible]k of the eye
Choroid	***ii***	***Pigment[illegible] ent internal reflection / Contains bl[illegible]***
Retina	iii	***[illegible]ptor[illegible]ceptor layer***

2. a)

	Rods	Cones
Relative number	***Many***	***Few***
Visual acuity	***Low***	High
Colour vision	***No***	Yes
Convergence	Yes	***No***
Site of rhodopsin synthesis	Yes	***No***
	(1)	**(1)**

b) Builds up the strength of impulses in low light (1)
Allows visual sensation in low light (1)

3. The ***ciliary body*** (1) is a ring of muscle that circles the pupil. This structure attaches [illegible] (1). In order to focus light from a distant object, the ***ciliary muscles*** (1) relax. This a[illegible] ***ligaments*** (1), which pulls on the ***lens*** (1). The pull causes the [illegible]ens to thin and light [illegible]

4. [Any two from:]
Binocular vision allows organisms to co[illegible]s[illegible]he [illegible]tance of objects more effective[illegible]
Binocular vision allows for a wid[illegible]e[illegible]f [illegible]sion to be perceived (than monocular vi[illegible]
Organisms with limited [illegible]a[illegible]rception / narrower field of vision less able to cha[illegible]
Binocular [illegible]ion [illegible]s[illegible] better depth perception (than monocular vision).
Organi[illegible]n w[illegible]k depth perception less able to make fine movements.

5. a) Sarcomere (1)
b) Actin (1) and myosin (1)
c) i = Isotropic band (1)
ii = H-zone (1)
iii = Anisotropic band (1)
iv = Z-line (1)

6. **Calcium** ions are released into the **sarcoplasm** (1); this causes **myosin** heads to atta[illegible]
Once attached, the heads of the myosin molecule change angle; (1) this causes the [illegible]
(1). In order for the myosin heads to detach and return to their original position, **AT**[illegible]

1. A) False; it is a -/- interaction because both organisms have to expend energy on
   B) True (1)
   C) True (1)
   D) False; it occurs between members of the same species / **inter**specific competi
   different species (1)

2.

Term	Definition
Carrying capacity (1)	Th[illegible] axin[illegible] population of an organism that an ecosyste
Biotic [illegible]	[illegible]he maximum rate of population ***growth/increase*** (1) if e and resources are abundant
P[illegible]ion	The number of organisms of one ***species*** (1) in an area or
Environmental (1) resistance	The aspects of an ecosystem which stop a population from

3. [Any three from:]
   Produces large number of offspring
   Shorter proportion of life spent in childhood / Quicker to reach maturity
   Very little parental care
   Shorter lifespan
   Smaller body size
   More mobile; tendency to colonise new habitats quickly
   Rapid evolution of new traits
   Population size fluctuates dramatically
   Less likely to become dominant species
   More likely to inhabit unstable / quickly changing ecosystem

4. a) Grazing (1); a consumer species feeds on pr[illegible]duc[illegible]but in a way that doesn't
   b) Parasitism (1); parasites such as th[illegible]d species live on or in their hosts, co
   c) Mutualism (1); both spec[illegible]ge[illegible]kind of benefit / the clownfish is protecte respiration (1)

5. A pest [illegible]is [illegible] which damages a ***crop*** (1) plant. In the modern world, this kin because[illegible]ces yields and costs farmers money. However, pest species can also pest species are ***insects*** (1), such as locusts and aphids. Sometimes, pest species ar species, which reduces the pest population size by limiting its available resources.

6. The predator should mostly target the pest species to minimise disruption to other have suitable habitats and conditions to thrive in the ecosystem (1); the predator sh and drive them to extinction (1)

7. a) Exponential/log phase (1)
   b) Initially, the bacteria have to synthesise necessary proteins and turn on genes reproducing (by binary fission) (1)
   c) (Stationary phase); the bacteria have reached their carrying capacity (1) and a their ability to reproduce (1)
   d) Build-up of toxic waste products (1); nutrients in growth medium used up (1)

8. [Accept reverse argument based on k-selected speci[illegible]
   Species 1 is likely to be r-selected, while Sp[illegible]s [illegible]is [illegible]obably k-selected (1). Specie carrying capacity than Species 2 (1)[illegible]al[illegible]shows more dramatic fluctuations in p

1. rock type (1); hours of sunlight (1); mean temperature (1)

2.

Term	Definition
Autotroph	A species which produces its own nutrients using ***sunlight***
Interdependence (1)	Species relying on one another and being mutually affected
Ecosystem	All of the interacting ***biotic*** (1) and abiotic factors in a partic
Heterotroph (1)	A species which gets its energy and nutrients by feeding on

3. [Any three from:
Change in average/daily low temperature
Reduced/increased availability of food, due to leaf growth / leaf fall / fruit production
Change in weather conditions, e.g. average rainfall, extreme weather conditions
Change in habitat availability, e.g. tree canopy, availability of branches for nests

4. [1 mark for year 1 calculation; 1 mark for year 2 calculation. ECF]
180 + (46 + 60) – (35 + 9) = 242
241 + (15 + 0) – (55 + 0) = 202

5. a) [Any three from:]
Negligible/no immigration or emigration in between sampling events
Negligible/no birth or death between sampling events
Organisms move about randomly within the population, and become mixed be
The process of capturing animals doesn't harm their survival odds
All organisms in the population are equally likely to be captured

b) Visible paint could make animals targets for predators (1) these organisms may could be seen as unethical to put specific organisms at risk (1)

c) [1 mark for any valid mark-release-recapture equation; 1 mark for correct subst
$N = \frac{n_1 \times n_2}{m}$, where N is the estimated total population, n_1 is the number of ca
n_2 is the number caught in the second sample, and m is the number of marke
$N = \frac{82 \times 70}{}$ [to nearest whole number)

6. [1 mark for numbers in correct order]

4	Given enough time, a ***climax*** (1) community develops. This community is re disrupted by new species. This process is known as ***primary*** (1) succession.
3	These species gradually ***outcompete*** (1) the existing pioneer species and re
1	***Pioneer*** (1) species colonise an ecosystem that is harsh and where nutrient a tend to be species which are well adapted to ***extreme*** (1) conditions, such as
2	***Soil*** (1) builds up as a result of these species dying. As a result, new, less-spe the environment.
5	Another type of succession is ***secondary*** (1) succession, which occurs after a a natural disaster.

7. Biotic climax community (1). [ACCEPT plagioclimax]

8. Volume of each grid = 0.04 mm × 0.[illegible] = 0.0032 mm^3 (1)
First sample = 11 cells; second sample = 12 cells; $\left(\frac{11+12}{2}\right)$ =11.5 cells in 0.0032 mm^3 (1
1 = 0.[illegible] 3[illegible], therefore, cell number in 1 mm^3 = 11.5 ×312.5=3593.75 or 3

Ecosystems: Communities

1. a) the wildebeest (1)
   b) the grasses/shrubs (1)
   c) the African rock python (1)
   d) the wildebeest (1)

2. Detritivores eat dead/decaying matter and break it down [illegible] ir digestive tract (1)
   break decaying matter down externally before ab[illegible]trients (1)

3. NPP = GPP – R
   R = 16 000 × 0.28 = 4 480 [illegible] (1)
   16 000 – 4 480 = 1[illegible]d [illegible] (1)

4. a) 72[illegible]2 = 86.4 kg per hectare (1)
   86.[illegible].07 = 6.048 kg per hectare (or 6.0 kg per hectare to 2 s.f.) (1)
   b) Of the total energy transferred through an ecosystem, only a very small propo
   like the wolf (1)
   c) Pyramids of number can be skewed by large organisms (such as trees) (1) whic
   (such as insects) (1)

5. At higher ***trophic*** (1) levels within an ecosystem, there is progressively less energy a
   lost at each level. For example, not all herbivores are eaten by carnivores – some w
   disease. Energy is also lost through ***egestion*** (1) – the removable of indigestible foo
   excretion (1) – the removal of metabolic waste products. Finally, organisms lose so
   heat when they carry out ***respiration*** (1). This is particularly true of ***endotherms*** (1)
   require a permanently high internal body temperature.

6. New barn – keeps animals warm so reduces necessary rate of respiration (1)
   Soybean – additional protein can be used to create more biomass (1)

7. Fertilisers provide nitrate/phosphate/potassium ions [illegible]pl[illegible]nts need to grow (1)
   farmland (1)

8. a) A = Nitrification (1); B = De[illegible] (1); C = Nitrogen fixation (1)
   b) Decomposers (1)

9. Carbon [illegible]ac[illegible]e of essential biological molecules (AND if the carbon cycle st
   be recy[illegible] no growth could happen (1).
   [And any four from:]
   Photosynthesis fixes carbon from CO_2 into complex organic molecules.
   Complex organic molecules containing carbon are ingested by heterotrophs/animal
   Carbon compounds are respired, producing atmospheric CO_2.
   Carbon compounds are released when organisms die or produce waste, and are bro
   Decomposers release carbon compounds into the soil and atmosphere.
   Carbon compounds from some aquatic organisms fall to the bottom of the sea / lak
   Time and pressure can turn carbon-containing sediment into sedimentary rock or fo
   Burning fossil fuels releases CO_2 into the atmosphere.

Respiration

1. Adenosine triphosphate (1) [Do not accept ATP for first usage]
   i = adenine base (1)
   ii = ribose (1)
   iii = (three inorganic) phosphate groups (1)

2. a) Glycolysis (1)
   b) Cytoplasm (1)
   c) During the first part of this reactio[n] [glu]se [is] phosphorylated to make a sing[le] (1). This molecule immedi[ately] [split]s into two molecules of ***triose phosphate*** (1 form ***pyruvate*** (1) [and] hydrogen atoms released during this are accepted by N added [dur]i[ng] the stage are accepted to make two molecules of ***ATP*** (1).

3. a) Kr[ebs] [cycl]e (1) takes place in matrix of mitochondria (1)
   b) i = acetyl coenzyme A (1)
      ii = reduced NAD / NADH (1)
      iii = reduced FAD / $FADH_2$ (1)
   c) Six C atoms (1)
      Four C atoms (1)

4. Aerobic produces a lot more ATP due to the electron transfer / electron transport ch[ain] produces little ATP because it only has glycolysis stage (1). Aerobic allows most effi[cient] produce a lot of energy in optimal conditions (1); however, anaerobic provides a su[pply] when oxygen is limited (1).

5. a) Reduced NAD / NADH (1) and reduced FAD / $FADH_2$ (1)
   b) Flavoprotein (1), Cytochrome (1)
   c) Hydrogen ions enter the mitochondrial membrane by cotransport, when carrie[d] leave through channel proteins that are associated with ATP synthase (1) by a p[roton] thereby stimulating ATP synthase to form ATP / [con]v[ert] ADP to ATP (1)
   d) Oxidative phosphorylation (1) [Do not accept [pho]tophosphorylation]

6. a) Lipids highest (1), then carbo[hydrate] (1), then proteins lowest (1)
   b) [1 mark for correct [equation], 1 mark for correct answer]

   $$RQ = \frac{\text{carbon dioxide produced}}{\text{oxygen consumed}}$$

   $$RQ = \frac{41}{36} = 1.14 \text{ (2 d.p.)}$$

7. a) Cross sectional area $= \pi r^2$
   $CSA = \pi \times (0.45)^2 = 0.636 \text{ cm}^2$ (1)
   Volume = CSA × distance
   $V = 0.636 \times 2 = 1.28 \text{ cm}^3$ (1)

   b) $RQ = \frac{\text{carbon dioxide produced}}{\text{oxygen consumed}}$ (1)

   $RQ = \frac{1.17 \text{ g}}{1.28 \text{ g}} = 0.91$ (2 dp) (1)

Photosynthesis

1. Light-dependent = ii (1)
   Granum (1)
   Light-independent = iii (1)
   Stroma (1)

2. Water stress stimulates stomatal closure, which decrease[s] ... on dioxide available f
   less carbon dioxide is fixed in the Calvin cycle (1) ... the p...oduction of triose phosp
   organic substances) decreases (1)

3. a) Process 1 is photoionisation (1)
   b) In Process 2 an ... becomes photoexcited / gains a lot of energy (1) and bin
   c) D... oc... the electron moves down the electron transfer chain (1), rele...
      fo... of ATP (1)
   d) As the electron binds with a carrier, H^+ ions/protons enter the inter-membran...
      enter through protein channels (1) connected to ATP synthase (1), which is the...
      inorganic phosphate to ATP (1)
   e) x = NADP (1)
      y = reduced NADP / NADPH (1)
   f) Process 4 is photolysis (1)
   g) Photolysis of water provides H^+ ions/protons (1)
   h) Photosystem I's electrons are replaced by the electrons from the first electron ...
      Photosystem II's electrons are replaced by the electrons produced from the ph...
      [If cannot answer 1g) and, therefore, do not mention photolysis in 1h) and 1i), ...
      1 mark from 1i)]
   i) Ribulose bisphosphate combines with carbon dioxide (1) catalysed by the enzy...
      phosphate (1) [Accept glycerate phosphate]. Glycerate 3-phosphate oxidises re...
      phosphate (1).
      [Remove 2 marks for using given abbreviations inste... full molecule names]
   j) Most regenerates ribulose bisphosphate (1) ... re... orms organic substances

4. Graph B is an action spectrum (1) ... ...ors ... action of photosynthesis at differen...
   directly related to the abso... ...n ra... of the different (photosynthetic) pigments ...

5. a) Incr... ...g c... ...oxide increases rate of photosynthesis (1)
   b) Ph... ...hesis increases as light increases until the compensation point (1), wi...
      ph... ...nthesis balances gas exchange for respiration (1). After this point, eith...
      temperature limits the photosynthetic rate (1).

6. [1 mark for correct calculation:]

$$R_f = \frac{\text{distance travelled by spot front}}{\text{distance travelled by solvent front}}$$

   [1 mark for correct answer:]

   $R_f = \frac{3.7}{6.1} = 0.606$ [Accept 0.59 – 0.62]

   Pigment is xanthophyll 2 (1)

DNA: The Genetic Code

1. The ***triplet*** (1) code of DNA codes for specific ***amino acids*** (1). The code is ***degenera***
degenerate/universal (1) which means that most amino acids have more than one c
into coding and non-coding regions. The coding regions are termed ***exons*** (1) while t
[Accept codon in place of triplet – this would be awkwardly phrased but still correct

2.

Step	Description
5	The DNA reforms a ***doubl*** ***ix*** behind the RNA polymerase.
3	***Complementar*** ***ng*** (1) takes place between free nucleotides ar
4	forms ***phosphodiester bonds*** (1) between the nucleotide
1	nzyme ***DNA helicase*** (1) separates the DNA strands by breaking ***hyd***
2	The enzyme ***RNA polymerase*** (1) binds to the transcription start site.

[(1) for all stages in correct order]

3. a) i = amino acid (1)
ii = anticodon (1)
b) Transport of amino acids around cytoplasm to ribosome (1)
Place amino acids in correct order according to mRNA (1)
c) [Any four from:]
Small organelle
Large subunit and small subunit
Made of protein and ribosomal RNA
Contains aminoacyl site for linking together of tRNA
Contains peptidyl site where amino acids are bound together

4. One gene–one protein suggests each enzyme is coded for by a single gene (1)
Some are quaternary proteins, coded for by multiple genes (1)

5. a) The process whereby daughter cells inherit the same specialisation/phenotype information that is not contained in DNA without any changes being made to the D
b) Environmental factors (such as starvation) can cause epigenetic changes to the DN
Th[illegible] be inherited by offspring (1)

6. DNA methylation prevents gene expression (1) and the methyl groups remain on the is inherited

7. a) Acetylation stimulates transcription so the gene is expressed (1), deacetylation is not expressed (1)
b) Histones are split between daughter DNA, and new ones fill in the gaps (1); the still in place on the histones (1)

8. Uncontrolled gene expression would cause cells to lose their specialisation / proper cell division (1), causing cancer (1)

DNA: Gene Technology

1. To multiply/replicate/amplify DNA fragments (1)

2. [1 mark for each correct box. Accept ± 5 °C for temperatures]

Stage	Temperature	Descripti
Separation	95 °C	DNA strands separate
Annealing	55 °C	**Primer binds to complementary sec of ion stranded DNA**
DNA synthesis	[illegible]	**Free nucleotides bind to compleme polymerase joins new strand togeth**

3 *Taq* polymerase is thermostable than other DNA polymerases; therefore works

4. [Any tw]
Amplify crime scene DNA
Medical research
Scientific research
Human genome project
Genetic fingerprinting

5.

Step
DNA is hydrolysed, meaning that ***hydrogen bonds*** (1) are broken.
Restriction endonucleases (1) are used to cut the DNA into fragments.
The fragments of DNA are separated using ***gel electrophoresis*** (1).
DNA fragments are transferred to a nylon membrane and a DNA probe is added.
If the correct sequence is present, then the probe ***hybridis*** 1).
The probe can be identified as it is ***fluorescent*** ([illegible] abelled.

6. Large repetitions of small DNA [illegible]
Unique number of repeats [illegible] each sequence in each individual (1)
Can be used to assign a specific DNA sequence to an individual (1)

7. SNPs (single nucleotide polymorphisms) are changes to a single nucleotide in DNA (1
They can give rise to a new form of an allele (1)
The new allele can be dysfunctional and can cause genetic disorders (1)

8. a) DNA is amplified by PCR (1)
DNA hybridised to a chip (1)
DNA hybridises to a probe on the chip (1)
Upon binding, probe fluoresces (1)
Fluorescence can be scanned and represents gene expression intensity (1)
b) Microarray measures intensity of the entire genome of an individual to quanti
Genetic fingerprinting quantifies the size of the MRSs/STRs (1)

9. a) Reverse transcription (1)
b) PCR / Polymerase chain reaction (1)
c) Gene must be introduced into a host cell (1)
Vector enables the gene to be introduced int [illegible] without being degraded
d) They infect bacteria, which are comm [illegible] ells (1)
They insert foreign DNA int [illegible] ll's DNA (1)
e) Gene for fluorescen [illegible] introduced alongside target gene (1)
Transform [illegible] screened for fluorescence (1)
Fl [illegible] nc [illegible] dicates successful transformation of the host cell (1)
OR
Gene for antibiotic resistance is introduced alongside target gene (1)
Antibiotic is introduced to culture (1)
Viable cells indicate successful transformation of the host cell (1)

DNA: Genetic Modifications

1. [Any two from:]
insulin, growth hormone, enzymes, lung surfactant, interferon, adhesives, (other co

2. a) Can insert their genetic material into cancer cells (1)
DNA can program the cell to kill itself (1)
b) Viruses may reactivate and become harmful (1) **OR** [illegible]s may transfer genes

3. a) [Any reasonable, balanced answer. For example:]
Would decrease illness and m[illegible]ty to protect biodiversity (1), but goes aga
b) [Any reasonable, bala[illegible]ans[illegible]. For example:]
Would decrea[illegible]s / [illegible] use / greenhouse gas production involved in shippi
gr[illegible]liv[illegible]ood (1)

4. [Any two from:]
Destroy bacteria that are no longer being cultured and sterilise equipment
Implant genes which make bacteria dependent on specific laboratory substances, s
Implant genes which make bacteria 'commit suicide' (undergo programmed cell de
Use strains of bacteria which don't typically live in animals

5. a) Genetic disease can be caused by faulty or absent genes (1)
A functioning version of the gene is prepared and introduced to the patient (1
The functioning gene is incorporated into the patient's genome (1)
Product of the gene is produced by the patient's cells (1)
b) Somatic cell gene therapy = gene therapy where mature body cells are targete
Germ line cell therapy = gene therapy applied to gametes / sperm cells / egg c
order to produce offspring carrying the required gene (1)
c) [One from:]
Adenovirus/Retrovirus/Liposome/Electroporation
d) [One from:]
Adenovirus/retrovirus: some cells might be [illegible]s[illegible] to viral penetration / viru
Liposome: might be destroyed by [illegible]re DNA is incorporated
Electroporation: can only be p[illegible]ed on small numbers of cells / cannot be p
e) An adenovirus/l[illegible]posome vector is used to transfer the 'normal' CF g
into [illegible]ep[illegible]cells (1); however, the gene does not reach the nucleus and
(1) [illegible]an only produce proteins for as long as each epithelial cell survives (1

6. a) The complete/entire DNA sequence of an individual/cell (1)
b) Increasing computer power means DNA sequencing is quicker (1) and more au

7. i) False; there are only around 21,000 genes in the human genome (1)
ii) True (1)
iii) False; if DNA is preserved in the right conditions it can survive for tens of thou
been used to study extinct organisms such as Neanderthal man (1)

8. a) Personalised medicine / Certain patients may respond differently to a medicat
patient's specific need (1)
b) Better understanding of the defective gene / Able to identify defective gene's
effectively / Able to design treatment more effectively (1)

9. a) Knockout (1)
b) [Any two from:]
Can be a model for human disease (1)
Can assess how loss of a gene [illegible]ts [illegible]nt (1)
Can target drugs to tes[illegible]ect of drug on human patient (1)
c) Knock-in can be [illegible]to study disease progression (1)

10. a) G[illegible]oresis involves using electricity (1); therefore, wet hands could re
b) [Ac[illegible]any correct answer, e.g.:] When setting up and carrying out procedure
safety glasses (1) and wash hands immediately if any went on skin (1), and dis
safe way (1)

Inheritance

1. a) Genotype is the genetic make-up/constitution of an organism (1)
   Phenotype is the observable characteristics/expressions of the interaction of g
   b) A single gene can have many alleles (1)

2. a) Gg (1)
   b) Heterozygous (1)
   c) Homozygous (1) recessive (1)

3. a) 100 % / All (1)
   b) Codominant (1)

4. a) Sex[illegible]d/[illegible]ge (1)
   b) Th[illegible] 25 % probability of their child being colour-blind (1)
   c) Ca[illegible] (1)

5. Where two genes are on the same chromosome (1)

6. Independent segregation/assortment of homologous chromosomes (1) during anap
   of chromosomes are divided independently (1)

7. a) Where a gene can have more than two alleles (1)
   b) None of the children has the same alleles/genotype as their parents (1) but ha
   blood group as / will be blood group A like their mother (1)

8. a) Brown is dominant over black for coat colour (1); melanin-producing is domina
   melanin production (1)
   b) The gene has an epistatic effect / shows epistasis (1)
   c) [1 mark for correct deduction of parent genotypes as BMBm and BMbm]
   One quarter are expected to be albino (1)

9. a) Height is an example of continuous variation (1) [illegible]g[illegible]up is an example of
   b) Height influenced by many genes (1), [illegible]d [illegible]p influenced by a single gene
   c) [One for any valid environmen[illegible]xa[illegible], including:]
   Diet/availability of nut[illegible]s d[illegible]g childhood
   Health habits o[illegible]o[illegible]er during gestation (smoking/alcohol, etc.)
   M[illegible]on [illegible] affects hormonal activity

Population Genetics

1. Genetic variation is present in virtually all populations. It is created by mutations – e
which change the ***base pair / nucleotide*** (1) sequence of the DNA molecule. ***Deleti***
of one or more bases, while ***substitution*** (1) mutations involve swapping one mutat
happen at the ***chromosome*** (1) level, causing entire groups of genes to be duplicate

2. Allele frequency is the number of times the same allele o... within the gene pool
in a population (1)

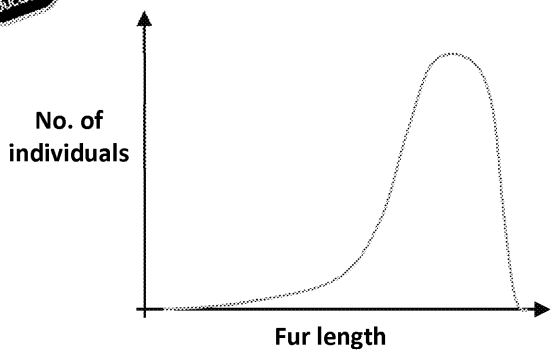
3. a) The allele/genotype frequenc... a ...ulation (1)
   b) $p^2 + 2pq + q^2 = 1$ (1)
   c) $1 - 0.735 = 0.2$...

4. a) Re... allele frequency: $q^2 = 1/2500 = 0.0004$; $q = 0.02$ (1)
   Do... allele frequency: $p = 1 - 0.02 = 0.98$ (1)
   b) 2pq (1) [1 mark for identification of heterozygous 2pq as carriers]
   = 2 x 0.98 x 0.02 (1)
   Carrier frequency = 0.0392 (1)
   53 000 000 x 0.0392 = 2 077 600 people (1)

5. a) [Any three from:]
   - The gene studied does not display any new mutation
   - No selection pressure on the gene / Allele frequencies remain constant o...
   - Random mating between individuals in the population
   - Isolated population / No gene flow between other populations
   - Large population

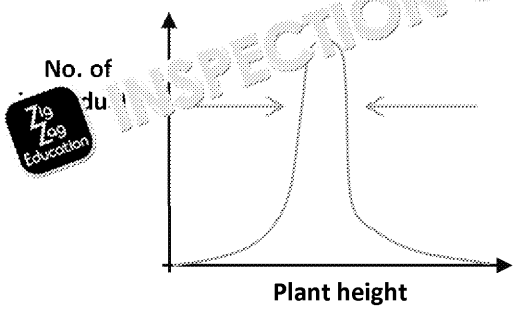
   b) Hardy–Weinberg assumptions are unlikely to be fully met by any natural popu...
   [And one from:]
   - Mutations can arise in any gene during DNA replication
   - Many alleles will be either useful or harmf... ...equencies will change o...
   - Mating in a population is unlikely to be ran...
   - A population is unlikely to ... large and fully isolated from other pop...

6. a) They had increas... ...ve success (1)
   b) Dir... al ...
   c) [M... ...h ...me and axes labels for 1 mark]



   d) Allele frequency for short hair will decrease (1); allele frequency for long hair w...

7. a) Stabilising (1)
   b) [Need both arrows for 1 mark]



8. a) Allopatric speciation occurs when a population is separated by a geographical b
speciation occurs in the same space, but the population is separated by other r
b) [Any two from:]
- Ecological
- Temporal
- Mechanical
- Behavioural

9. a) A rockslide would cause a genetic bottleneck (1), by causing random mortality
changes in allele frequency (1)
b) Allele frequencies of the main population would be fairly even as there is a lot
population (1). In the small population, some alleles would have a higher fre
become fixed while others become extinct by genetic drift (1). After the roc
ex hile others would be at higher frequencies by chance (1).

Kingdom Plantae

1. All organisms that exists with the kingdom are ***eukaryotic/eukaryotes*** (1), meaning
membrane-bound organelles. Additionally, all contain cell walls that are made of ***ce***
(photo)autotrophism (1) – using the energy from the sun to produce nutrition. The
within the plants, as distinct parts of the plants are specialised for specific functions
bryophytes (1), which exclusively contain mosses and tracheophytes, which include

2. a) Turgor of water on cells (1)
b) They live in damp conditions (1)
Water loss is not faced by mosses (1)
c) Rhizoid (1)
d) Unable to penetrate the ground (1)
Do not play a role in water uptake (1)
e) Mosses depend on moist conditions (1)
Their spores desiccate in dry conditions (1)
This region is very dry for the majority of the year (1)
Mosses will not be able to absorb enough water (1)

3. a) Ferns have well differentiated tissues / different parts carry out different roles
Meaning that growth is more efficient, as each tissue can specialise for its role (1)
Ferns have vascular tissue, while mosses do not (1)
Vascular tissue distributes substances where they are needed around the plant
This allows the plant to get larger while still supplying all its tissues with enough

b) [Any three from:]
Ferns produce spores, while flowering plants produce seeds
Flowering plants have more lignin in their vascular tissues
Root systems in flowering plants are generally more complex
The xylem in angiosperms is more extensive, and offers more support to the p
Ferns can produce gametophytes / free-living haploid offspring

c) Spores are not resistant to desiccation, so will be destroyed by drought (1)
Spores will not germinate in dry conditions (1)

4. a) Flowering plants with reproductive structures that produce seeds (1)
b) They are resistant to desiccation (1)
They can lie dormant for extended time periods until favourable conditions ar
c) The xylem is woody and offers support (1)
Allows plants to grow taller and support greater structures (1)

Kingdom Animalia

1. a) Annelid(a) (1)
   b) Arthropod(a) (1)
   c) Platyhelminthes (1)
   d) Cnidaria (1)

2. a) Liver fluke = bilateral symmetry (1) with dorsoventra[illegible]ening (1)
   Hydra = radial symmetry (1)
   b) Bilateral symmetry allows sense or[illegible] be placed at one end (1); this allows stimuli and avoidance of th[illegible]hose stimuli (1)
   OR
   Bilat[illegible]sy[illegible]ows the body to 'plan' its specialisation along an axis (1) m[illegible]ier compared to radial symmetry (1)

3. a) Platyhelminthes have a single opening to the gut (1)
   Annelida have tubular/unidirectional/one-way gut with two openings (1)
   b) Humans (chordates) are most similar to annelids as they have a tubular gut wi
   c) Regional specialisation of the gut tube (1)

4. a) Specialised tissues are repeated in segments across the length of the body (1)
   b) Hydrostatic skeleton that exists across body cavities (1)
   c) Increases surface area relative to metabolic tissue (1)
   Separates gut muscles from muscles of locomotion (1)
   Allows room for organ growth/development (1)

5. a) Body plan is basic/simple (1) so it can be adapted to suit a wide range of ecolo conditions (1)
   b) Head (1); thorax (1); abdomen (1)
   c) Nerve tube with no vertebrae (1)
   d) Spiracles for gas transfer (1)

6. a) Spinal column (1) with calcified bones [illegible]ar[illegible]ited limbs (1)
   Allows support / complex lo[illegible]or / dexterity (1)
   b) The spinal column /