

Biology Topics Overview

- o Cells (tissues, organs, systems, structure and function; factors affecting human health; physiology; vaccination)
- o Organisms (habitat, ecosystems, interdependency, unity and diversity in life forms; energy transfer and cycles [including nutrient, carbon, nitrogen]; classification)
- o Processes (photosynthesis, cell respiration, aerobic and anaerobic, word and chemical equations)
- o Metabolism (nutrition, digestion, biochemistry and enzymes; movement and transport, diffusion; osmosis; gas exchange; circulation, transpiration and translocation; homeostasis)
- o Evolution (life cycles, natural selection; cell division, mitosis, meiosis; reproduction; biodiversity; inheritance and variation, DNA and genetics)
- o Interactions with the environment (tropism, senses, nervous system, receptors and hormones) o Interactions between organisms (pathogens/parasites, predator/prey, food chains and webs; competition, speciation and extinction)
- o Human interactions with environments (human influences, habitat change or destruction, pollution/conservation; overexploitation, mitigation of adverse effects)
- o Biotechnology (genetic modification, cloning; ethical implications, genome mapping and application, 3D tissue and organ printing)

The objectives of MYP Science are categorized into four criteria, which contain descriptions of specific targets that are accomplished by studying this programme:

- A Knowing and understanding
- B Inquiring and designing
- C Processing and evaluating
- D Reflecting on the impacts of science

Three main concepts: Change, Systems, Relationships.

This revision booklet is divided into three parts based on concepts.

Each concept has questions based on the topics covered under that concept.

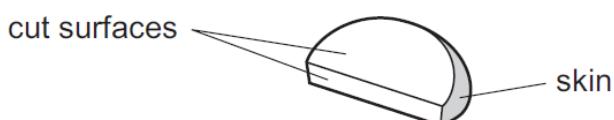
Concept-change

Topics-

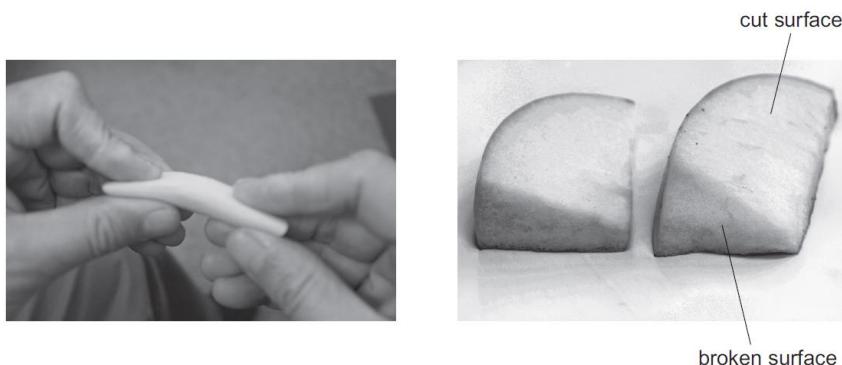
Biochemistry and enzymes

Apple tissue changes colour in the air. Apple cells are thought to contain an enzyme which is a catalyst for the reaction: colourless compounds + oxygen in the air coloured compounds enzyme
Some students investigated this reaction.

The students cut a slice of apple with a knife as shown in Fig below



This slice was broken into two pieces as shown in Fig below



Each piece was put into a different dish. The dishes were labelled 1 and 2.

A few drops of water were put on the cut surface and the broken surface of the piece of apple in dish 1.

A few drops of lemon juice were put on the cut surface and the broken surface of the piece of apple in dish 2.

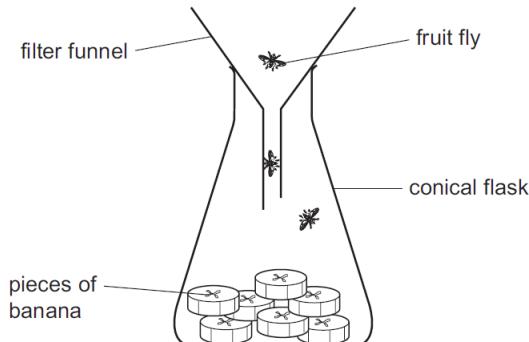
Every five minutes for 20 minutes the students observed the pieces of apple and recorded their observations in Table 1.1.

time / minutes	dish 1, apple with water		dish 2, apple with lemon juice	
	broken surface	cut surface	broken surface	cut surface
5	no change	very light brown	no change	no change
10	no change	light brown	no change	no change
15	very light brown	light brown with dark brown patches	no change	no change
20	light brown	dark brown	no change	no change

The lemon juice was tested with litmus paper. It changed colour from blue to red.

- (a) State the meaning of this colour change. [1]
- (b) Look at Table 1.1. Describe the differences between the appearance of the cut surfaces in dish 1 and dish 2 during the experiment [1]
- (c) The colour changes are thought to involve enzyme activity.
 - (i) Explain how the observations in Table 1.1 and your description in (b) support this statement. [3]
 - (ii) Using your knowledge of enzyme activity, describe another experiment that would test the idea that enzymes are involved in this colour change [3]
- (d) (i) Look at Table 1.1. Describe the differences between the appearance of the broken surface and the cut surface in dish 1 during the experiment. [2]
- (ii) Cutting the apple with a knife damages cells, releasing the contents. Suggest, from the observations in Table above and your description in (d)(i), how breaking instead of cutting the apple may affect the cells. [1]

2. Figure below shows a trap which can be used to catch other insects such as fruit flies.



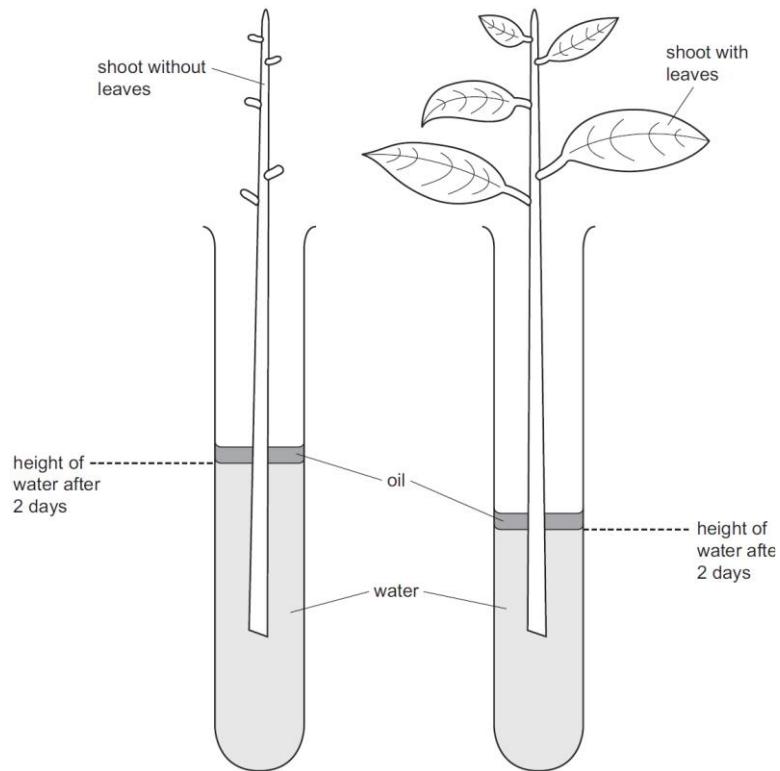
- (i) Fruit flies feed on fruits such as bananas. Bananas contain carbohydrates. Describe how you could safely test a piece of banana for two different carbohydrates. [6]
- (ii) Describe the observations expected if these two carbohydrates are present. [2]
- (d) Fig shows a banana and a similar fruit called a plantain.



Suggest an investigation to find out if fruit flies are more likely to feed on banana or plantain. [3]

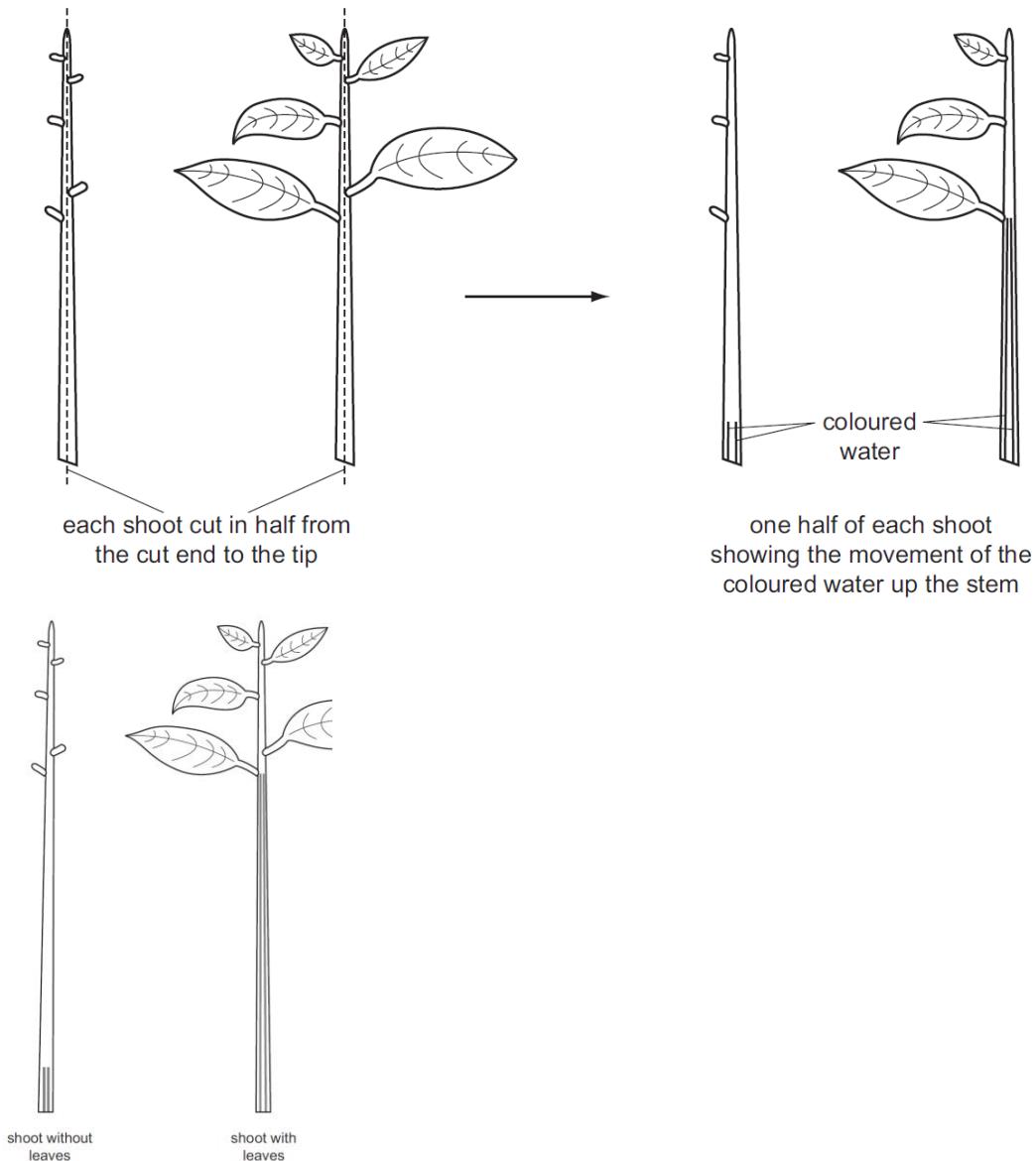
Photosynthesis:

Fig below shows two similar cut shoots in test-tubes that contained 20 cm³ of water at the start. One shoot has its leaves attached and the other shoot has had its leaves removed. The shoots were placed in the water immediately after being cut. A small quantity of oil was added to cover the water in these test-tubes. The two test-tubes with the shoots were left in the light for two days.

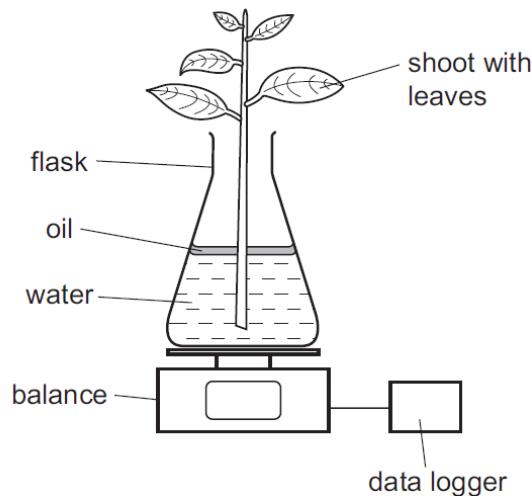


- (a) (i) Identify the variable that was changed (independent variable) in this investigation [1]
(ii) Suggest why oil was placed on top of the water in both test-tubes. [1]
(iii) Use a ruler to measure the height of the water in the two test-tubes, shown in Fig
test-tube containing shoot without leaves.....mm
test-tube containing shoot with leaves.....mm [1]
(iv) Describe and explain your observations
(b) The two shoots were removed from the test-tubes.
Both shoots were immediately placed in a beaker of coloured water and left for 10 minutes.

After 10 minutes the shoots were removed from the coloured water. The shoots were cut in half, as shown in Fig below, to see how far up the stem the coloured water had moved.



- (i) Use a ruler to measure the distance moved by the coloured water, shown in Fig above
shoot without leaves.....mm
shoot with leaves.....mm [1]
 - (ii) Do the measurements in (b)(i) support the measurements in (a)(iii)? Explain your answer [3]
 - (iii) (iii) Describe how you could carry out a similar investigation to determine whether temperature affects the rate of water uptake of shoots with leaves [3]
- (c) A group of students measured the mass lost from a flask containing a shoot with leaves. The shoot was placed in water, on a balance as shown in Fig below.
- (i) An automatic data logger recorded the mass every six hours for two days.

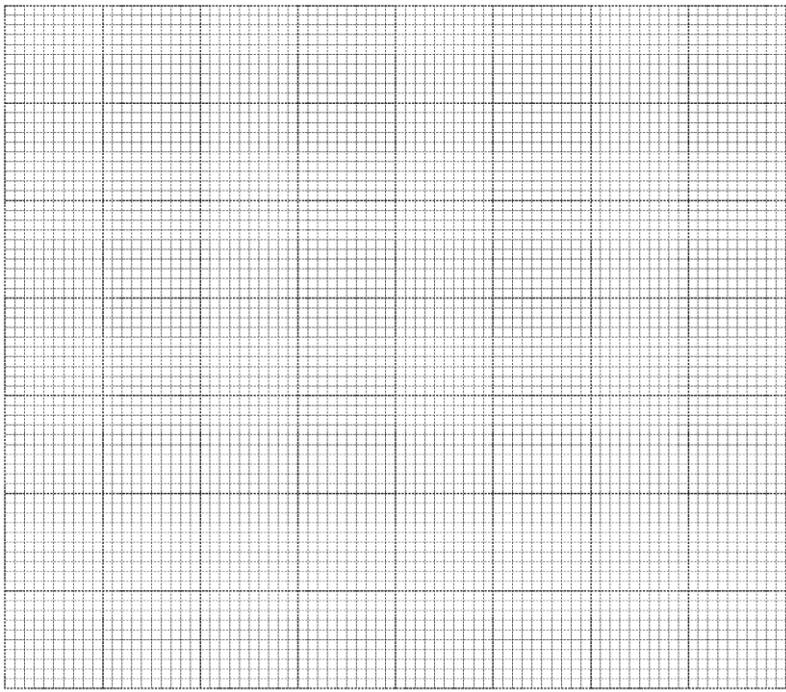


Only natural light from the sun was allowed to fall on the shoot.

The students calculated the mass lost every six hours. The data is shown in Table below

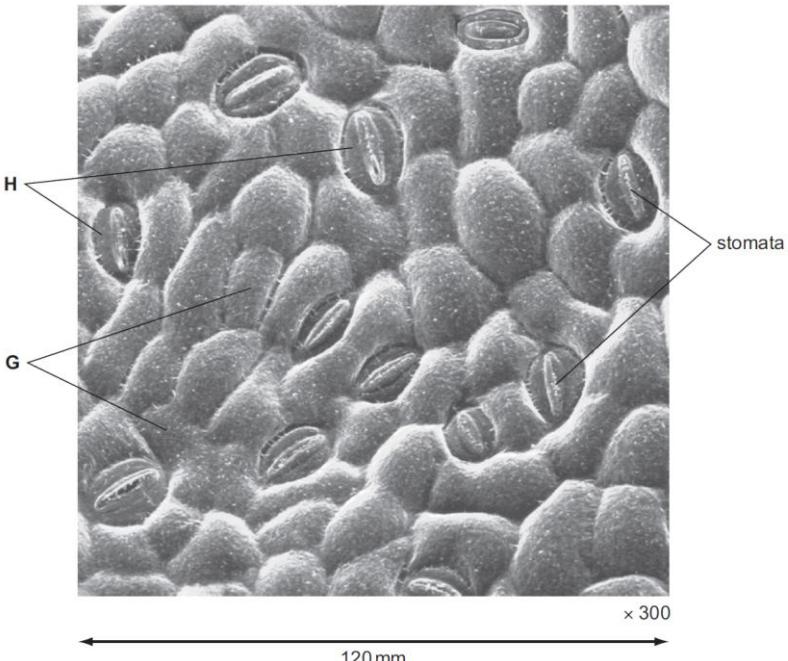
time of day	mass lost/g
10:00	0.0
16:00	3.0
22:00	5.0
04:00	5.0
10:00	7.0
16:00	10.0
22:00	11.5
04:00	11.5
10.00	13.5

(b) (i) Plot the data from Table below



[4]

- (ii) Describe and explain the results [3]
(iii) Fig below shows part of the lower surface of a leaf as viewed under a microscope



- (c) Name the structures labelled G and H. [2]
(e) The number of stomata on the lower surface of the leaf can be calculated by using Fig above
(i) Count the number of stomata visible in Fig, number of stomata [1]
(ii) The magnification of the image in Fig. 1.6 is $\times 300$. The length of one side of the image is 120 mm. The image is a square. You can calculate the actual length of one side of the square of leaf surface shown in Fig above by dividing the length of one side of the image by the magnification.

Calculate the actual length of one side of the square of leaf surface shown in Fig above. Show your working.

actual length of one side of the square of leaf surface mm [1]

(iii) Calculate the actual total area of the square of leaf surface shown in Fig above. Show your working.

actual total area of the square of leaf surface mm². [2]

(iv) The number of stomata per mm² can be calculated from the number of stomata and the actual total area of the square of leaf surface shown in Fig. Calculate the number of stomata per mm² of this leaf. Show your working.

number of stomata per mm² [2]

(v) The total area of the lower surface of this leaf was measured and found to be 9000 mm².

Calculate the total number of stomata on the lower surface of this leaf. Show your working.

total number of stomata [2]

2.

In a previous activity you were asked to **design** an experiment to measure the effect of light intensity on the rate of photosynthesis. In this activity you will carry out this experiment and develop your own conclusions.

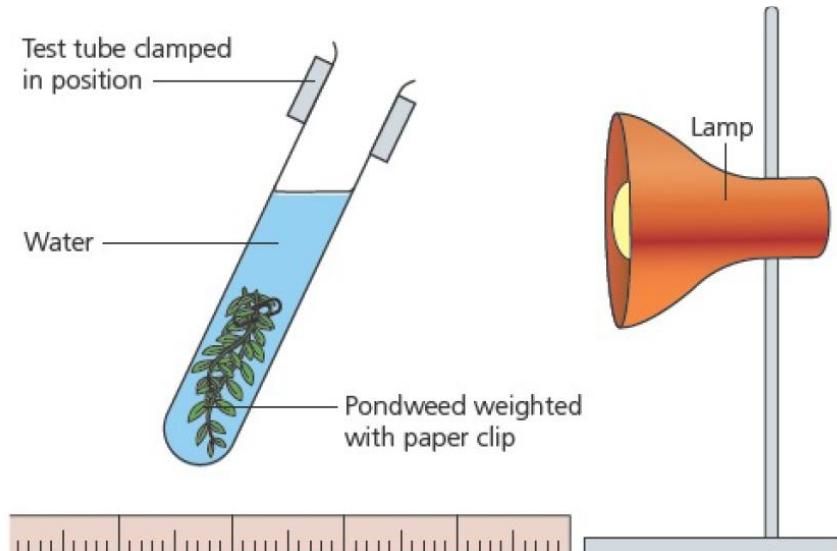


Figure 2.22 The pondweed experiment

1 Take a test tube and fill it two-thirds with water. Add a spatula measure of bicarbonate to add a controlled measure of carbon dioxide to the water.

2 Take a piece of pondweed (*Elodea*) and cut the bottom of the stem at a 45-degree angle (so that oxygen bubbles will be readily released from the stem in water).

3 Put the pondweed in the test tube so that the cut stem is uppermost. Make sure the cut end is not touching the side of the test tube. Add a paperclip to the bottom end of the pondweed to weigh it down so it does not float.

4 Take a desk lamp and put it a measured distance from the pondweed, e.g. 5 cm. Let the plant acclimatize for one minute, until a regular stream of bubbles is given off, and then record the number of bubbles emitted in one minute.

5 Move the plant a further fixed distance from the lamp, for example 10 cm, and repeat the procedure.

- 6** Continue the experiment until you have measured the number of bubbles given off per minute for at least 10 distances.
- 7** Repeat the experiment three times to ensure that you have reliable, valid, quantitative results.
- 8** Once you have correctly collected, **organized**, transformed and **presented** your data in a table, **plot** a graph of your mean results.
- 9** Apply a line of best fit to your mean data. The line of best fit is drawn so that the points are evenly distributed on either side of the line. If you are drawing the line with a ruler, you will only be expected to draw the line ‘by eye’.
- 10** Accurately **interpret** your data and **explain** your results using correct scientific reasoning.
- 11 Evaluate** the validity of the hypothesis based on the outcome of the investigation.
- 12 Evaluate** the validity of the method based on the outcome of the investigation.
- 13 Explain** improvements or extensions to the method that would benefit the investigation.

Diffusion and osmosis

1. The cell in Fig. below was placed in a concentrated glucose solution.

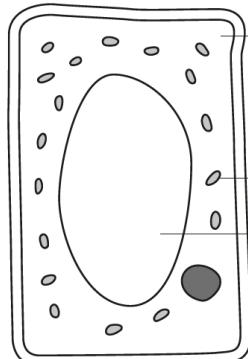
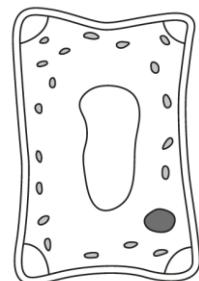


Fig. below shows the appearance of the cell after ten minutes in the glucose solution.



- (i)** State **two** ways in which the cell has changed.

1
2 [2]

- (ii)** Water moves into and out of the cell by osmosis.

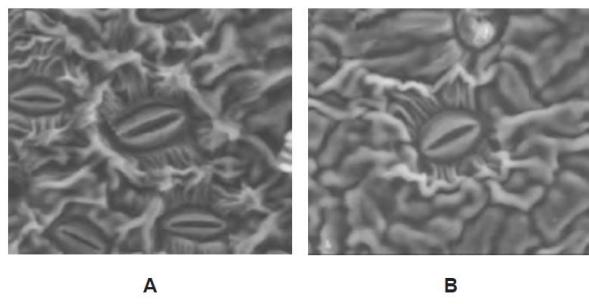
Osmosis is a form of diffusion.

Describe the ways in which diffusion is different to active transport. [3]

2. Water moves into plants from the soil and exits through the leaves.

- (a)** Explain how water moves from the soil into the root. [4]

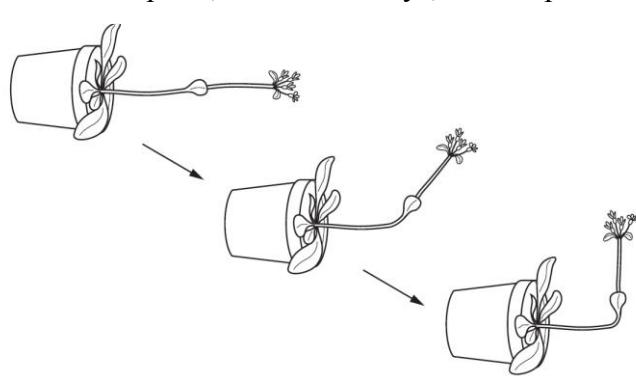
Water reaches the leaves from the roots through the xylem. Fig below shows images of stomata on the lower surfaces of leaves of two varieties of olive plant, **A** and **B**. Both are shown at the same magnification



- (b) (i) Describe the function of stomata. [2]
- (ii) Compare the density of stomata between the two varieties of olive plant, **A** and **B**, shown in Fig above. [2]
- (iii) Under identical environmental conditions the rate of water uptake in plant **A** is higher than plant **B**. Explain why [3]
- (c) The density of stomata is an example of a leaf adaptation to the environmental conditions. State **two** other adaptations of leaves for survival in a **dry** environment. [2]
- (d) Water lost from the leaves enters the atmosphere. Describe how water is recycled from the atmosphere back to the roots. [2]

Tropism

A plant, *Arabidopsis thaliana*, was placed on its side in the dark. Fig. 2.2 is a series of drawings made of the plant, over seven days, as it responded to a change in its surroundings.



- (i) State the stimulus to which the plant responded. [1]
- (ii) Name the growth response shown by the plant. [2]
- (iii) Explain the advantage to plants of the growth response shown in Fig above [2]
- (iv) Auxins control the growth responses of seedlings. Explain how auxins control the growth response of *A. thaliana*, shown in Fig above [4]

Transpiration and translocation

1. Fig. 4.1 shows a cross section of part of a stem of buttercup, *Ranunculus*. Fig. 4.2 is an outline drawing of one vascular bundle from the stem of *Ranunculus*.

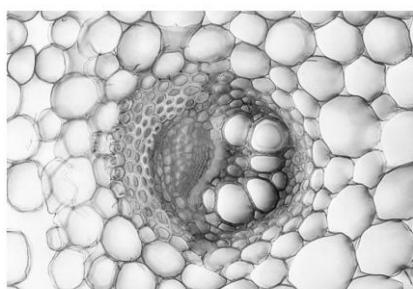


Fig. 4.1

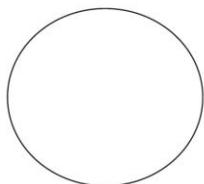
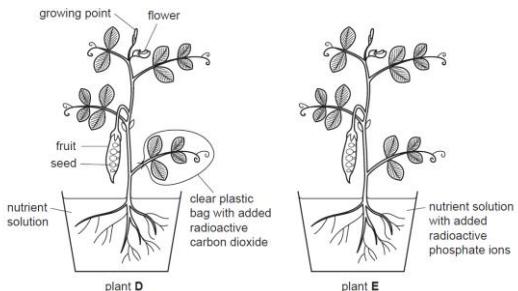


Fig. 4.2

- (a) Draw and label the position of the xylem and the phloem in the outline of the vascular bundle in Fig. 4.2. [2]
- (b) Name the carbohydrate that is transported in the phloem. [1]
- (c) Substances transported in the phloem are carried upwards in the stem at some times of the year and downwards at other times. Explain why substances are transported in the phloem upwards at one time of the year and downwards at another. [4]
- (d) Define the term transpiration [3]
- (e) The rattan palm is a plant that climbs on rainforest trees to heights of about 40 metres. Explain how water is moved to the tops of tall plants, such as the rattan palm. [4]

2. This question is about transport in plants. (a) Two pea plants, D and E, were supplied with substances containing the radioactive isotopes, carbon-14 (^{14}C) or phosphorus-32 (^{32}P), as shown in Fig. below. A leaf of plant D was exposed to radioactive carbon dioxide. Plant E was placed into a solution containing radioactive phosphate ions.



After several hours the plants were analysed for the presence of the radioactive isotopes. Sucrose containing ^{14}C was found throughout plant D. Compounds containing ^{32}P were found throughout plant E. Complete Table below to show:

- the tissue in which each substance is transported;
- one possible sink for each substance.

pea plant	D		
substance transported	sucrose	ph	ions
transport tissue			
sink			

[4]

(b) State one substance, other than sucrose, that is produced in leaves and translocated to other parts of the plant. [1]

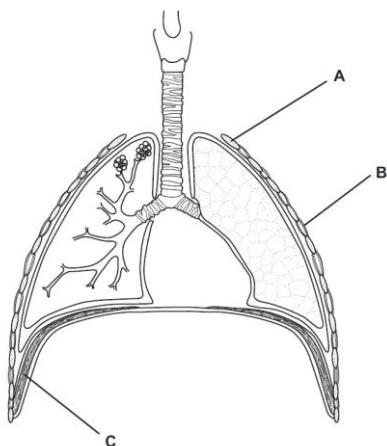
(c) Outline how sucrose is produced from carbon dioxide in pea plants. [3]

(d) State two uses of sucrose within a pea plant. [2]

(e) Explain how ions, such as phosphate ions, are absorbed by plant roots. [3]

Gas exchange

1. Fig below shows structures in the human thorax

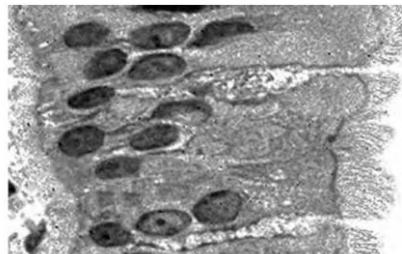


(a) Complete the table by identifying parts A, B and C and describing their roles in breathing in.

part	name	role in breathing in
A
B
C

[6]

Fig below shows some cells from the lining of the bronchus.

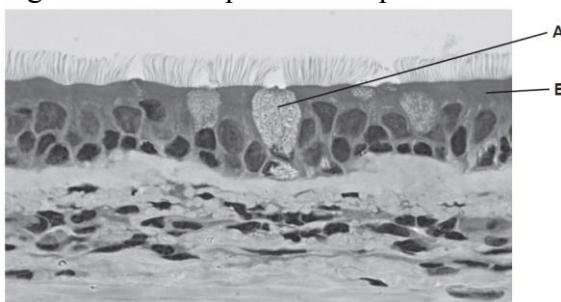


x 1000

(b) (i) Explain how these cells help to keep the bronchus free from dust and bacteria. [4]

Describe the actions of one named compound of tobacco smoke. [2]

- Fig below shows part of the epithelium that lines the trachea



Explain how the cells labelled A and B in Fig above protect the gas exchange system [4]

Transport and circulation

- Table below shows the composition of blood plasma.

component	concentration in the plasma
adrenaline/ng dm ⁻³	10 – 100
fibrinogen/g dm ⁻³	1.7 – 4.0
glucose/mg dm ⁻³	700 – 1000
hydrogencarbonate ions/g dm ⁻³	1.1 – 1.4
insulin/µg dm ⁻³	0.33 – 0.40
lactic acid/mg dm ⁻³	50 – 200
sodium ions/g dm ⁻³	3.1 – 3.4
urea/mg dm ⁻³	70 – 200

- (a) From Table 4.1, name: (i) an excretory product[1] (ii) a plasma protein....[1]
- (b) (i) State what could cause the lactic acid concentration in the blood to increase to 200 mg dm⁻³. [1]
- (ii) State the function of fibrinogen. [1]
- (iii) State **two** effects that a concentration of adrenaline of 100 ng dm⁻³ might have on the body. [2]
- (iii) State **two** effects that a concentration of adrenaline of 100 ng dm⁻³ might have on the body.[3]
- (d) Lymphocytes and phagocytes are white blood cells. A woman had some blood tests taken before and during a bacterial infection. Table below shows the number of white blood cells in the two blood samples.

white blood cells	mean number of cells per mm ³ of blood	
	before infection	during infection
lymphocytes	1300	3500
phagocytes	2000	7500

(i) Calculate the percentage increase in lymphocytes that occurred during the bacterial infection. Show your working and give your answer to the **nearest whole number**. answer% [2]

(ii) Describe the role of phagocytes in defence against disease. [3]

(iii) Describe the roles of white blood cells in tissue rejection.[3]

Habitat, habitat change and destruction

1. A student found the following information about the feeding relationships between some organisms in a soil habitat.

Dead organic matter, such as leaves, provides food for bacteria and soil fungi.
Earthworms eat dead leaves.

Many millipedes feed on dead plant matter and also on soil fungi.

Nematodes feed on bacteria and are eaten by springtails.

Centipedes are predators that feed on earthworms, millipedes and springtails.

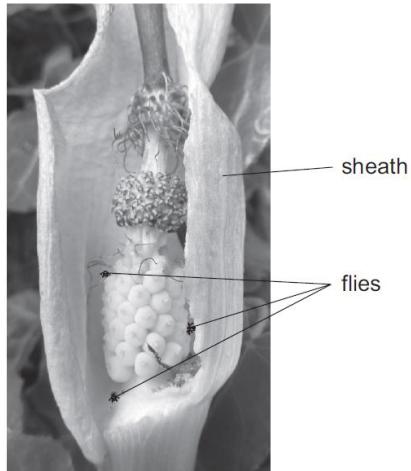
(i) Draw a food web to show the feeding relationships described above. [4]

(ii) Describe the roles of the soil organisms in the **carbon** cycle.[2]

2. Arum lilies, such as *Arum maculatum*, are plants that have a smell like rotting meat. The smell attracts flies so that the flowers can be pollinated.

Some arum lilies have a purple coloured sheath and some have a light green coloured sheath.

1. Fig. below shows an arum lily with part of the sheath cut away to show the inside.



A group of students collected arum lilies from the same habitat, two with purple coloured sheaths and three with light green coloured sheaths.

They opened the sheaths of each lily and counted the number of flies inside.

The results are shown in Table below

colour of sheath	number of flies	total number of flies	mean number of flies
purple	3		
purple	5		
light green	5		
light green	6		
light green	4		

(a) Calculate the total and mean number of flies found in each colour of sheath.

Write your answers in Table above [2]

(c) Suggest two ways in which this investigation could be improved. [2]

3. In 2003, 25 000 square kilometres of Amazon rainforest were cut down and cleared. The land was then used for agriculture, producing beef and soya beans for export. However, within three years the land was no longer suitable for agriculture and had to be abandoned.

- (a) (i) State the term used for cutting down and clearing areas of forest. [1]
(ii) Complete Table below, to state different reasons why forests are cut down. The first has been done for you.

	reason
1	for agricultural land
2	
3	

[2]

- (iii) Outline and explain the likely effects of clearing forests. [6]

- (b) Soya beans and beef produced on the land are both good sources of protein. Table below shows the nutritional content of products made from soya and beef.

	nutritional content per 100 g of product			
product	energy / kJ	protein / g	saturated fat / g	fibre / g
corned beef	905	26.9	12.1	0.0
soya sausages	1128	19.0	2.1	2.0

- (i) Using data from Table 3.2, state and explain two reasons why soya sausages may be healthier than corned beef as a major item in the diet. [4]

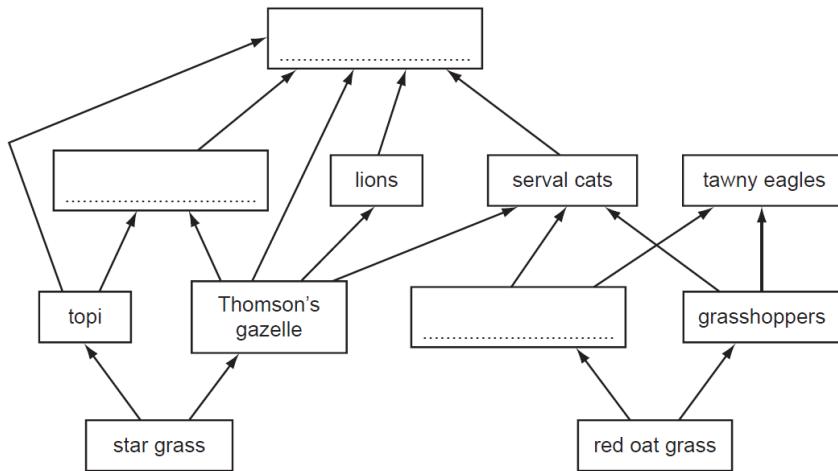
- (ii) Soya beans are harvested from plants. Corned beef is produced from cattle that have fed on grass. Explain why it is more energy efficient for humans to eat soya products as a source of protein than corned beef. Use the food chains involved to support your answer. [4]

Pollution/Conservation/ predator/ prey/ interdependency/

The Galápagos Islands in the Pacific Ocean have many species of animals and plants that live nowhere else. Iguanas are large herbivorous reptiles. Four species of iguana live on the Galápagos Islands: • marine iguana, • land iguana, • Santa Fe land iguana, • pink land iguana, Amblyrhynchus cristatus Conolophus subcristatus Conolophus pallidus Conolophus rosada Fig. below shows a marine iguana.



- (a) Reptiles and mammals are both vertebrates. State three features of mammals that are not found in reptiles [3]
- (b) The marine iguana, *A. cristatus*, feeds on seaweed and must therefore dive several metres into the cold waters that surround the Galápagos Islands. Iguanas can only stay in the water for a short length of time, until their body temperature drops too low. Mammals of an equivalent size, such as sea otters, can stay in cold water for a long time. Explain how some mammals are able to stay in cold water for a long time. [5]
- Land iguanas live on Isabela, the largest island in the Galápagos. In 1986, some rangers from the Galápagos National Park found a population of pink land iguanas living at the northern end of the island. These iguanas have been studied in detail and are now classified as a new species, *C. rosada*. (c) Define the term population. [2]
- (d) Suggest how a study of the DNA of iguanas helps to classify them. [1]
- (e) The International Union for the Conservation of Nature describes these iguanas as vulnerable. This means that their populations are likely to become extinct. Suggest two reasons why it is important to conserve individual species, such as the four species of iguana on the Galápagos Islands. [2]
2. The passage describes the feeding relationships between some of the organisms in an African grassland ecosystem. The dominant grass species in the African grassland ecosystem are star grass and red oat grass. Star grass is eaten by antelope species, such as topi and Thomson's gazelle. Smaller animals such as mice and grasshoppers also feed on grass. Antelopes are eaten by predators such as cheetahs, lions and serval cats. Grasshoppers and mice are eaten by serval cats and tawny eagles. Ruppell's vulture feeds on dead mammals.
Fig. below shows part of the food web for this ecosystem.



- (a) Complete the food web in Fig. above by writing the names of the organisms in the boxes. Write your answers in the boxes in Fig. above [3]
- (b) Name the trophic level of the following species: star grass topic [2]
- (c) State the source of energy for the food web shown in Fig above [1]
- (ii) State what happens to energy when it leaves an ecosystem, such as the African grassland. [1]
- (d) Nutrients are recycled in ecosystems but energy is not recycled. Explain why there are no more than four trophic levels in the ecosystem shown in Fig. above [3]
- (e) Fish, such as salmon reared in fish farms, are fed on high protein food made from animals. When eating this food, these fish are feeding as secondary consumers. Discuss the disadvantages of farming fish, such as salmon, for human food. [3]

3. Pollution by heavy metals and acid is one concern about the making of **paper** bags. There are additional concerns about the making and recycling of **paper** bags. Discuss the implications of these additional concerns. [5]

Inheritance and variation, Natural selection, Speciation and extinction

1.(c) Two brothers have to make a difficult decision. One brother, with blood group AB, has kidney failure and is on dialysis. The healthy brother has agreed to donate one of his kidneys to his brother. He has to have a blood test. Their father has blood group A and their mother has blood group B. The brothers have a sister who has blood group O.

(i) Explain how this girl has blood group O when her parents have different blood groups. You must use the space below for a genetic diagram to help your answer. Use the symbols IA, IB and IO to represent the alleles involved in the inheritance of blood groups.

<i>parental phenotypes</i>	blood group A	×	blood group B
<i>parental genotypes</i>	×
<i>gametes</i>	+
<i>girl's genotype</i>		
<i>girl's phenotype</i>		[4]

(ii) The healthy brother can only donate the kidney to his brother if they both have the same blood group. What is the probability that the healthy brother also has blood group AB? [1]

2. Four definitions of terms used in genetics are shown in Table below

definitions	
the outward appearance of an organism
a length of DNA that codes for a protein
having one set of chromosomes
type of nuclear division which gives daughter nuclei that are genetically identical

For each of the definitions, select an appropriate term from the list and write it in the box provided.

(mitosis mutation phenotype chromosome diploid dominant gene genotype haploid heterozygous homozygous recessive) [4]

(b) A couple who have blood groups A and B have four children. Each child has a different blood group. Use the space below to draw a genetic diagram to show how this is possible. Use the symbols, IA , IB and Io, for the alleles.

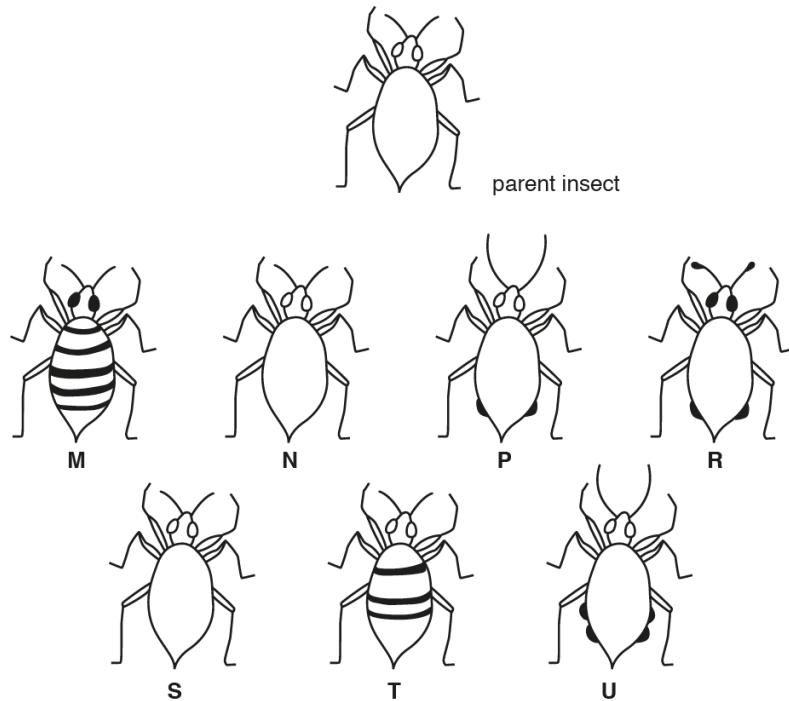
parental blood groups	A	×	B
parental genotypes	×
gamete genotypes	
children's genotypes
children's blood groups

[4]

(c) Explain what is meant by codominance. You may refer to the genetic diagram in (b) to help you with your answer. [3]

3. Some insects can reproduce by sexual reproduction **and** asexual reproduction. In both types of reproduction chromosomes are passed from the parent or parents, to the offspring.

Fig. below shows a drawing of a parent insect and seven of her offspring: **M**, **N**, **P**, **R**, **S**, **T** and **U**.



(a) (i) Two of the offspring were produced by asexual reproduction.
Suggest the letters representing these **two** offspring [1]

(ii) Insect **R** was produced by sexual reproduction.
Use the information from the diagram to support this statement. [1]

(iii) State the term that is defined as the observable features of an organism. [1]

(b) Fig. 9.2 shows a group of male students. They are all the same age



(i) The students in Fig. 9.2 show continuous variation in some of their characteristics. State **three** characteristics in which these students show continuous variation. [3]

(ii) State **one** example of discontinuous variation [1]

4. Fig. below shows a photograph of *Ursus maritimus* (polar bear).



(a) Polar bears live in and around the Arctic Circle, surviving in extremely cold conditions. Describe **and** explain **one visible** adaptive feature that enables the polar bear to survive in a cold environment.

Feature [1] explanation [1]

(b) Polar bears have adapted over time to live in the cold arctic environment through a process called natural selection.

Describe the process of natural selection. [4]

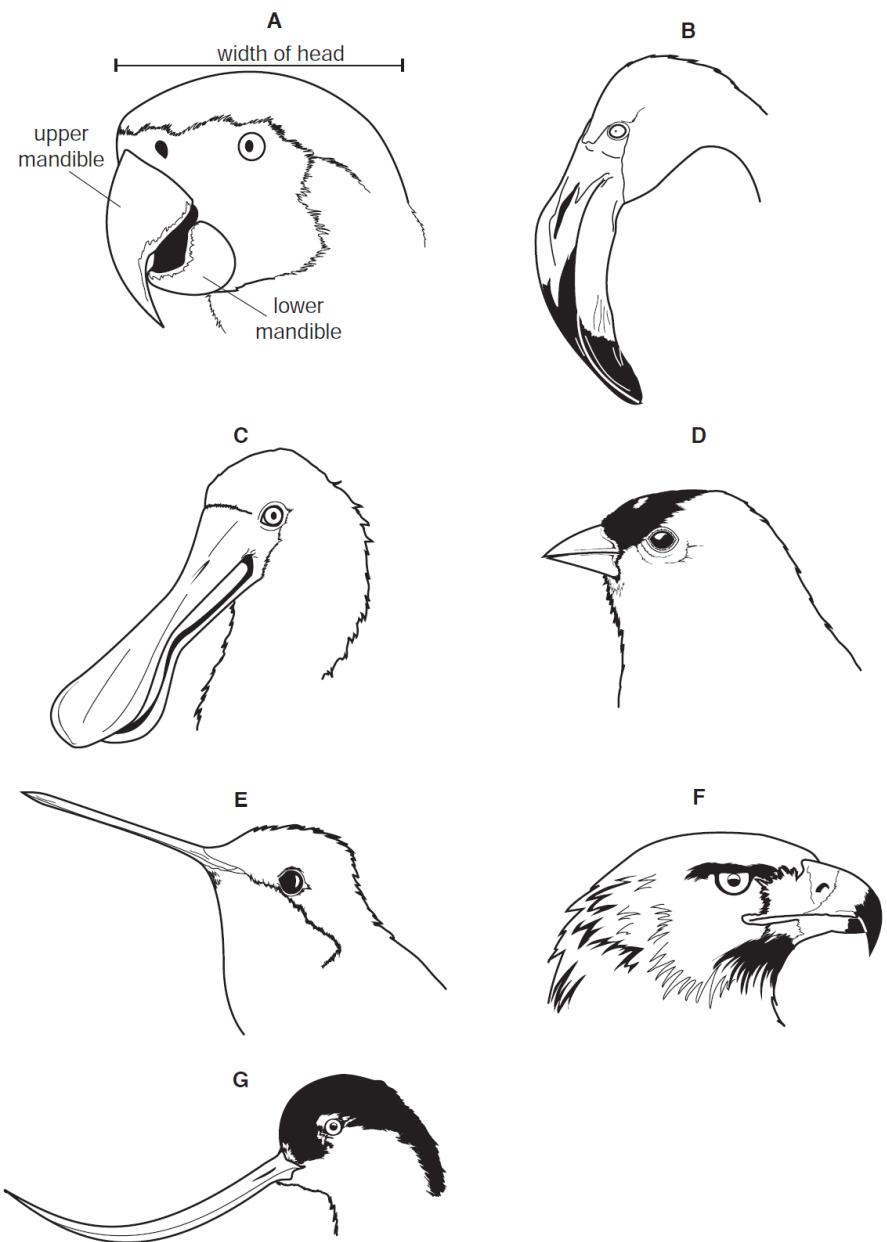
(c) Polar bears are an endangered species.

Suggest reasons **why** polar bears have become endangered and how they could be conserved. [4]

5. Fig below shows a common emerald dove, *Chalcophaps indica*



- (a) Two distinguishing features of birds are beaks and wings. State **one other** feature shown **only** by birds that is visible in Fig above [1]
- (b) Birds show variation in the sizes and shapes of their beaks. A beak is composed of an upper mandible and a lower mandible. Fig. 1.2 shows the heads of seven different species of bird.



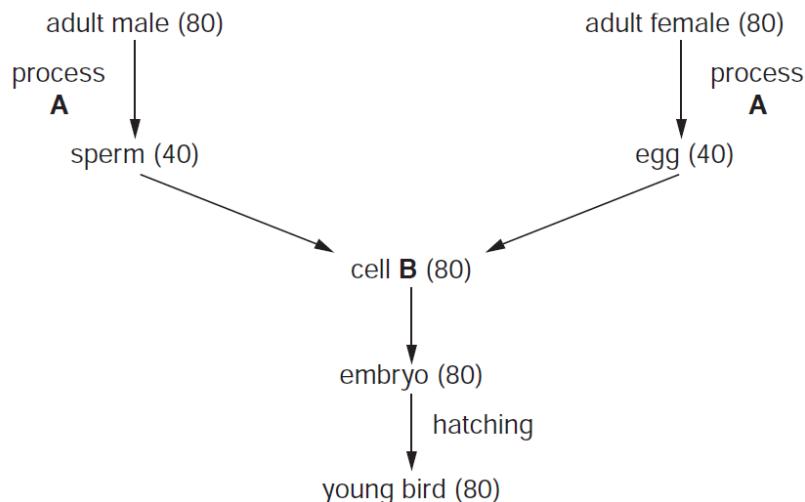
not drawn to scale

Use the key to identify each species. Write the letter of each species (A to G) in the correct box beside the key. One has been done for you. **Key**

1	(a) beak is shorter than the width of the head	go to 2	
	(b) beak is longer than the width of the head	go to 4	
2	(a) upper mandible is same length as the lower mandible	<i>Spinus tristis</i>	
	(b) upper mandible is longer than the lower mandible	go to 3	
3	(a) lower mandible is about half the length of the upper mandible	<i>Ara ararauna</i>	A
	(b) lower mandible is more than half the length of the upper mandible	<i>Aquila chrysaetos</i>	
4	(a) both mandibles widen at the end of the beak	<i>Platalea regia</i>	
	(b) both mandibles are a similar width along their whole length	go to 5	
5	(a) beak is straight	<i>Trochilus polytmus</i>	
	(b) beak is curved	go to 6	
6	(a) beak curves upwards	<i>Recurvirostra americana</i>	
	(b) beak curves downwards	<i>Phoenicopterus minor</i>	

[3]

(c) Fig. 1.3 shows the events that occur during sexual reproduction in birds. The numbers in brackets indicate the number of chromosomes in the nuclei of the cells of the common emerald dove.



- (i) Name process A and cell B. [2]
- (ii) State why cell B is described as a diploid cell. [1]

(iii) The embryo of the bird develops from cell **B**. State what is meant by the term *development*. [1]

(v) Sexual reproduction usually leads to variation. Explain why variation is an advantage for a species such as the common emerald dove. [2]

6. The garden pea, *Pisum sativum*, is a plant which has flowers that have both male and female parts. *P. sativum* is naturally self-pollinating.

(a) Discuss the advantages and disadvantages of self-pollination. [4]

Genetic modification, Cloning, Ethical implications

1. (a) Define the term *genetic engineering*. [2]

(b) Fig below is a flow diagram that shows how insulin can be produced using genetic engineering.

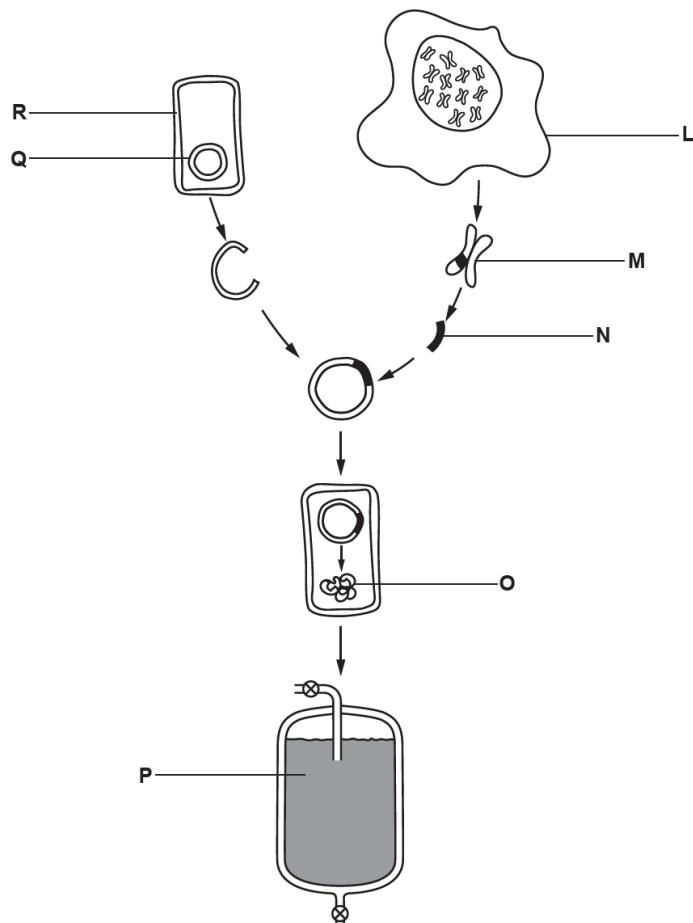


Table below shows stages in the production of insulin by genetic engineering.
Complete Table below The first row has been done for you.

letter from Fig. 6.1	name	description
M	chromosomes	threads of DNA found in the nucleus
		section of DNA removed from human cell
	plasmid	
		type of cell that is genetically engineered
		specific chain of amino acids coded by the section of DNA removed from the human cell
	fermenter	

[5]

(c) The genetically engineered cells in Fig. 6.1 reproduce asexually.

Explain the advantages of asexual reproduction for insulin production by genetic engineering. [3]

2. Dairy cattle are kept for milk production. Approximately half of all the calves born are male.

(a) Sex is determined in cattle in exactly the same way as it is in humans. Explain why 50% of all cattle are born male. You may draw a genetic diagram to help your explanation. [4]

(b) Dairy farmers only need a very small number of male calves. They limit the number by using sex selection. Sperm cells are identified and sorted before they are used in artificial insemination (AI). Explain how artificial insemination is carried out. [2]

(c) Table 2.1 shows the composition of 100 g of cow's milk compared with the same quantities of commercial formula milk and human milk

nutrient	cow's milk	formula milk	human milk
carbohydrate/g	6.5	7.3	7.5
protein/g	3.3	1.3	1.3 – 1.6
fat/g	3.9	3.6	4.1
calcium/mg	120	42	34
iron/mg	0.02	0.64	0.07
vitamin D/µg	0.05	1.20	0.06
vitamin A/µg	19	66	58

Some women do not breast-feed their babies but bottle-feed them using formula milk. Health authorities advise against the use of cow's milk until babies are about 9 months old. Use the information in Table 2.1 to explain the advantages of using formula milk rather than cow's milk. [4]

One of the components of human milk is the enzyme lysozyme that is present in many body fluids and is responsible for breaking down the cell walls of bacteria.

(d) Define the term *enzyme*. [2]

(e) The effect of human lysozyme on two common species of bacteria, **A** and **B**, was investigated at two different values of pH. The investigation was set up as shown in Fig. below. The test-tubes were kept at 37 °C for 24 hours.

tube number	1	2	3	
species of bacteria	A	A	A	B
pH of medium	4.0	4.0	9.0	4.0
fresh lysozyme	✓		✓	✓
boiled lysozyme		✓		

After 24 hours, samples were taken from each test-tube. Each sample was placed onto nutrient agar in Petri dishes. The dishes were incubated at 28 °C for a further 24 hours to allow any bacteria to grow. The results are shown in Fig. below

sample from test-tube	1	2	3	
result after incubation for 24 hours	○	●	●	●

Key:

no growth of bacteria

growth of bacteria

Explain the results shown in Fig. 2.2 by comparing the following pairs:

1 and 3 [2]

1 and 4 [2]

1 and 2 [2]

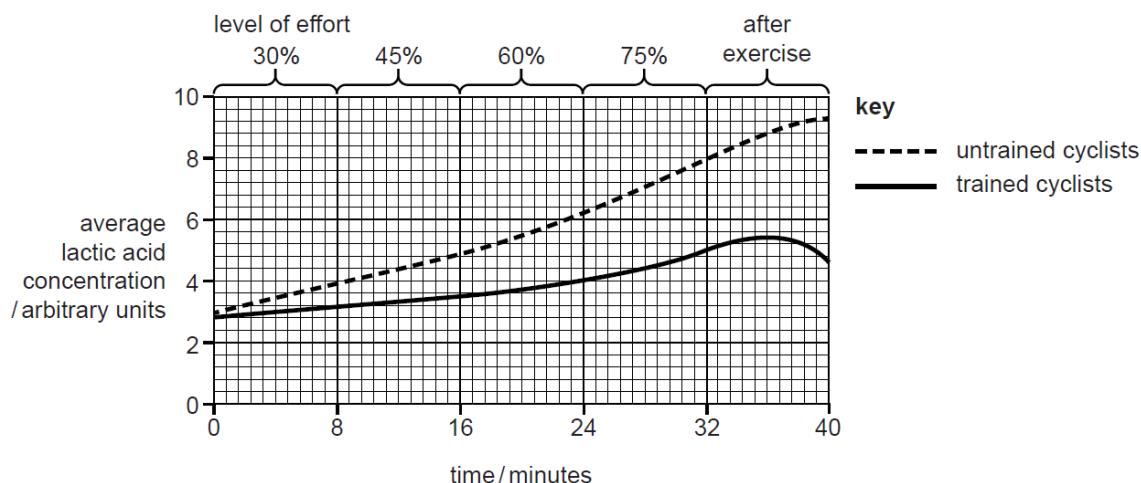
(f) Human milk also contains antibodies. Explain the benefits of antibodies to a newborn child. [2]

Concept-Systems

Cell respiration, aerobic and anaerobic

Researchers designed an investigation to find the effect of increasing levels of exercise on two groups of people. The first group of people were trained cyclists and the second group were untrained cyclists. The researchers asked all the people to cycle at four levels of effort: 30%, 45%, 60% and 75% of their maximum cycle speed. They cycled for eight minutes at each level of effort. (a) The researchers predicted that the pulse rate of all the cyclists would increase during exercise. Explain this prediction. [2]

Fig below shows the average concentration of lactic acid in the blood of the trained cyclists and untrained cyclists in the investigation.



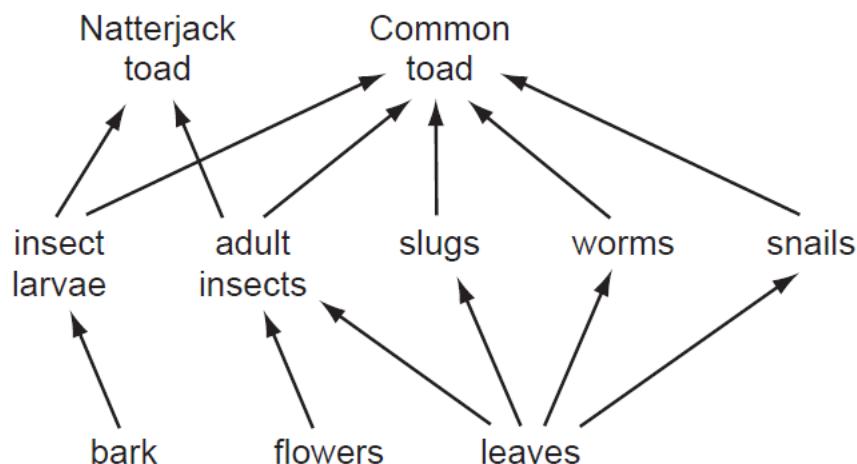
- (b) Describe the effect of the increasing levels of effort on the average lactic acid concentration in the blood of the **untrained** cyclists. You should use data from Fig. above in your answer [3]
- (c) Lactic acid is produced in the muscles during anaerobic respiration.
- Define the term *anaerobic respiration* [2]
 - Describe how the lactic acid produced in muscle cells enters the blood. [1]
 - Name the component of the blood that transports lactic acid. [1]
- (d) Explain why the lactic acid concentration in the blood in trained cyclists is different from the untrained cyclists eight minutes **after** the exercise. You should use data from Fig. 3.1 in your answer. [4]

Food chains and webs, Ecosystem, C, N, water cycles

1. Toads are amphibians. Only two species are native to Britain, the Common toad (*Bufo bufo*) and the Natterjack toad (*Bufo calamita*). Natterjack toads like warm sandy soil in open and sunny habitats, with shallow pools for breeding. Examples of these habitats are heathland and sand dunes. Common toads like cooler, more shady habitats, such as woodland. Many areas of sand dunes are being developed for camp sites. Heathland can easily change to woodland as trees grow on it. In the summer, woodland is colder than heathland due to the shade the trees create. These conditions suit the Common toad, but not the Natterjack. As a result of the changing habitats the Natterjack toad is becoming an endangered species.

- (a) (i) Name one external feature that identifies an animal as an amphibian. [1]
- (ii) Amphibians are a class of vertebrate. Name two other vertebrate classes. [2]
- (b) State one piece of information from the passage to show that the Common toad and Natterjack toad are closely related species. [1]
- (c) From the information provided, state two reasons why Natterjack toads are becoming endangered. [2]
- (d) Suggest measures that could be taken to protect the Natterjack toad from extinction [2]

Fig below shows a food web for British toads.



- (e) (i) State the trophic level of toads. [1]
- (ii) State which foods the two species of toad both eat. [1]
- (iii) With reference only to food, suggest why the Common toad is more likely to survive when the two species are in competition. [1]

2. Fig below is a photograph of some root nodules from a pea plant, which is a type of legume.



- (b) Nodules like those in Fig above develop on the roots of pea plants and other legumes when the soil is lacking in nitrate ions.

Explain what happens inside the nodule to help legume plants grow in soils lacking nitrate ions. [3]

(c) After the peas have been harvested, the plants are ploughed back into the soil.

Describe impacts to the soil to convert dead plant material into nitrate ions that plants can absorb.[6]

(d) Nutrients in the soil can act as a limiting factor for crop growth.

List three other factors that may limit the growth of a crop plant. [3]

(e) When wild dogs die, nitrogen compounds in their bodies may become available for plants.

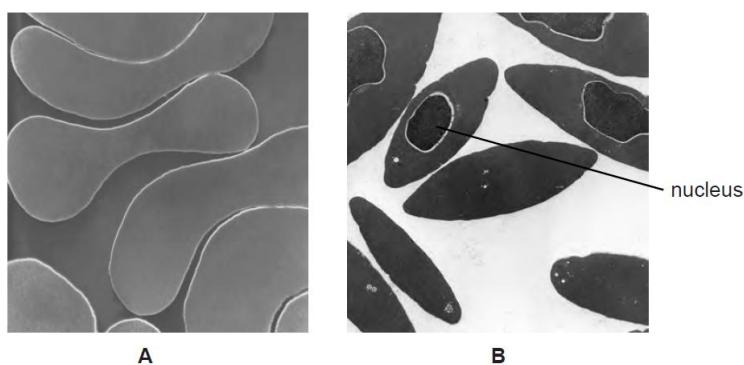
Outline the processes that occur to make these nitrogen compounds in the bodies of dead animals available for plants to absorb. [5]

(f) Fish, such as salmon reared in fish farms, are fed on high protein food made from animals. When eating this food, these fish are feeding as secondary consumers.

Discuss the impacts of farming fish, such as salmon, for human food.[6]

Cell structure, Tissues, Organs, Systems, Cell functions

1. Fig below shows images of red blood cells from a human, **A**, and a bird, **B**.



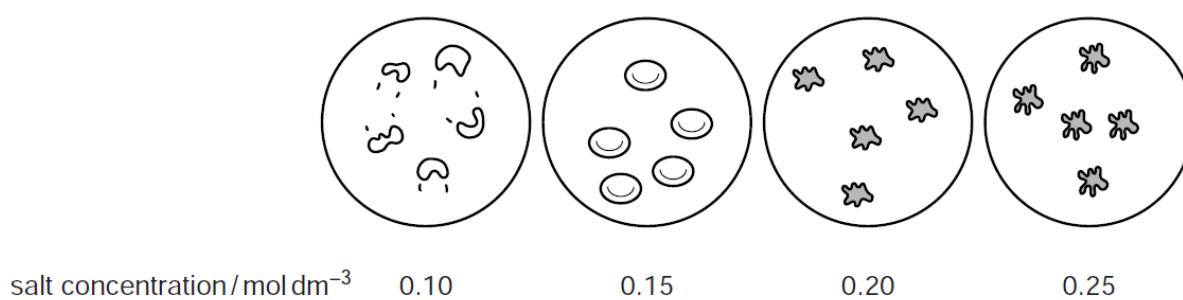
(a) State the function of red blood cells. [1]

(b) There is a nucleus present in each of the red blood cells of the bird, as shown in Fig. 3.1.

(i) State the function of a nucleus [1]

(ii) Human red blood cells do not contain a nucleus. State an advantage of this. [1]

Red blood cells from humans were placed into three test-tubes. Each test-tube contained a salt solution of a different concentration. A sample was taken from each test-tube and viewed using a microscope. The results are shown in Fig below



(c) (i) Describe the appearance of the red blood cells in the 0.15 mol dm^{-3} salt solution and the red blood cells in the 0.20 mol dm^{-3} salt solution.

0.15 mol dm^{-3} and 0.20 mol dm^{-3} [2]

(ii) The red blood cells in the 0.10 mol dm^{-3} salt solution burst. Explain why the red blood cells burst.

Explain why the red blood cells burst. [3]

(iii) Suggest why a plant cell in 0.10 mol dm^{-3} salt solution would not burst. [1]

(d) Some people in accidents lose a lot of blood. Doctors give patients fluid to replace lost blood.

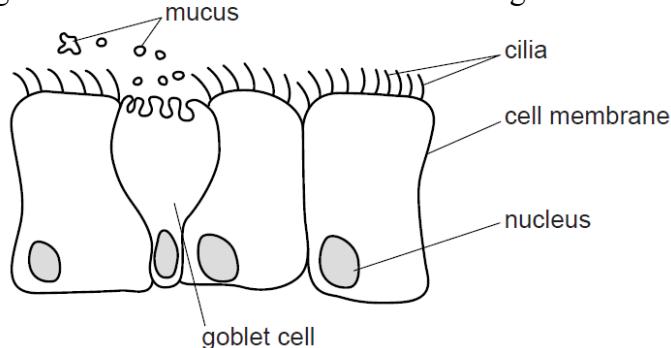
(i) Use the information in Fig 2 above to predict and explain the concentration of fluid replacement given to patients who have lost blood.

prediction

explanation.....[2]

(ii) Describe the process of blood clotting. [3]

2. Fig below shows some cells from the lining of the trachea.

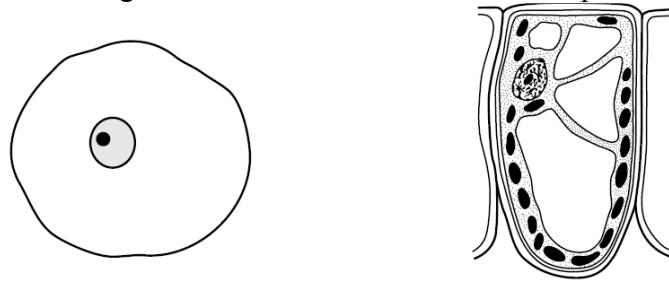


(a) Describe the functions of the nucleus and cell membrane. [4]

(b) The cells in Fig above form a tissue. Define the term *tissue*. [2]

(c) The goblet cell secretes mucus. Describe the role of mucus and cilia in the trachea [3]

3. Fig below shows an animal cell and a plant cell as seen with a light microscope.



animal cell

plant cell

(a) Table below shows some structural features of the animal cell and the plant cell in Fig above. Complete the table by • finishing the row for nucleus • adding **three** structural features,

visible in Fig. above, and indicating whether they are present (✓) or absent (✗) in the animal cell and in the plant cell.

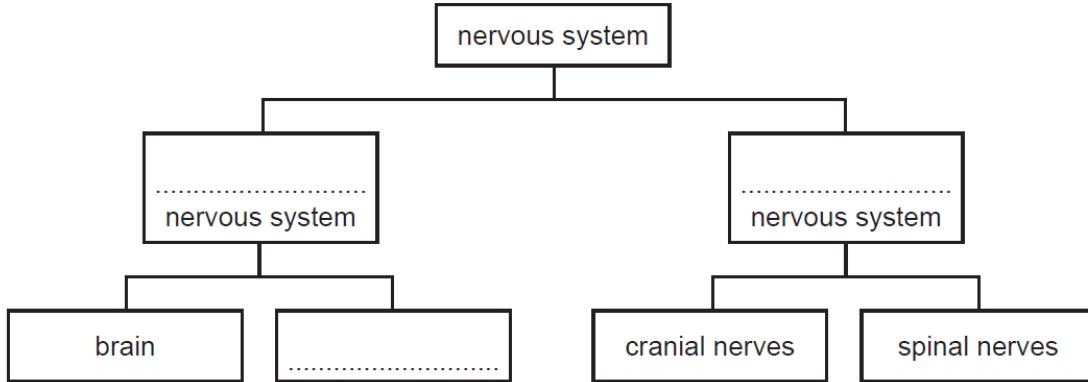
structural feature	animal cell	plant cell
cell wall	✗	✓
nucleus		

[4]

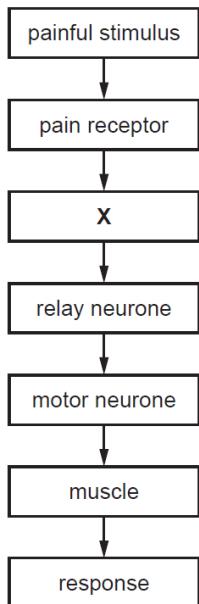
Response, coordination, Receptors, Senses, Nervous system, Homeostasis, Hormones

1. The nervous system coordinates the responses of animals to changes in their environment.

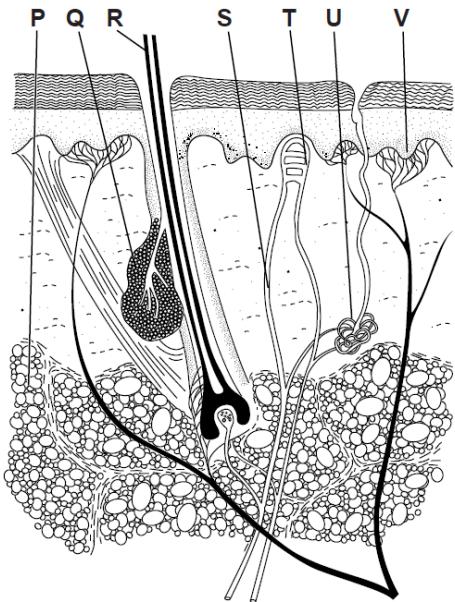
Fig below shows the arrangement of the nervous system in a mammal. Complete Fig below by writing the names of the missing parts of the mammalian nervous system in the boxes.



- (b) Fig below is a flow chart that shows how an involuntary action is controlled.



- (i) State the structure found at X. [1]
- (ii) State the type of involuntary action shown by the flow chart. [1]
- (iii) State **two** ways in which a voluntary action differs from an involuntary action. [2]
2. Fig below is a diagram of human skin in cold weather



- (a) Table below shows the responses of the skin to cold weather.
 Complete the table by:
- naming the parts of the skin that respond to cold weather
 - using the letters (P to V) from Fig above to identify these parts of the skin.

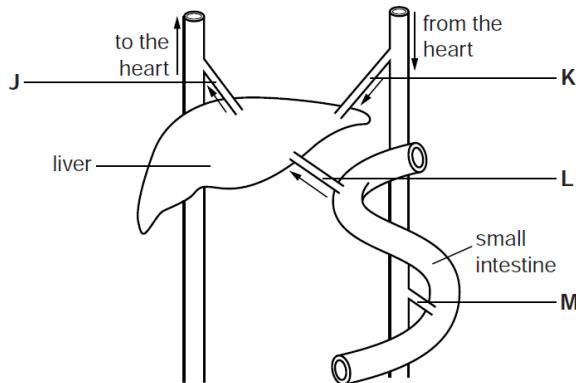
responses of skin to cold weather	name of part	letter from Fig. 3.1
stands upright to trap air		
constricts to reduce blood flow to skin		
stops producing sweat		

(b) The response of the skin to cold weather is an involuntary action. Explain how an involuntary action differs from a voluntary action [3]

(c) Describe how the nervous system coordinates the response of the skin to cold weather [4]

(d) Explain how negative feedback is involved in the control of body temperature. [3]

3. Fig below shows a diagram of the liver and the blood vessels that enter and exit from it.



(a) Name blood vessel L.[1]

(b) Blood vessel J is a vein.

State **two** structural features of veins and explain how each feature is related to its function of returning blood to the heart.

Feature.....

.....

explanation

feature

explanation [4]

(c) Blood samples were taken from each of the blood vessels J, K, L and M two hours after a meal of rice. Table below shows the concentration of glucose in these blood samples.

blood vessel	blood glucose concentration /mg per 100 cm ³
J	135
K	128
L	181
M	133

Calculate the percentage increase in blood glucose concentration between blood vessel J compared with L. Express your answer to the nearest whole number.

Show your working % [2]

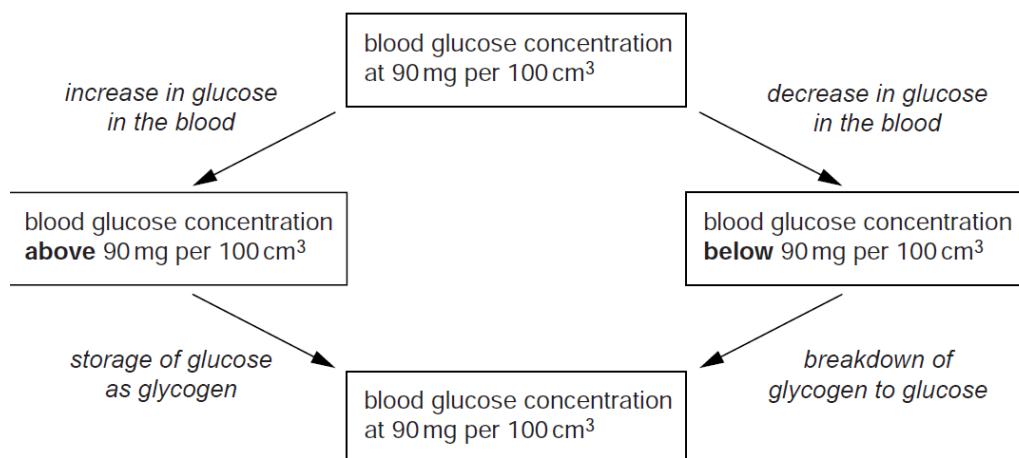
(d) Control of blood glucose by the liver is an example of homeostasis. (i) Explain how the liver lowers blood glucose concentration when it is too high. [2]

(ii) Name **one other** factor in the human body that is also controlled by homeostasis. [1]

(e) Amino acids are processed by the liver. Describe this process. [3]

(f) State **one other** function of the liver, besides homeostasis and processing amino acids. [1]

4. Fig below is a diagram that shows the control of blood glucose concentration.



(a) (i) State **one** reason why the concentration of glucose in the blood **increases**. [1]

(ii) State **one** reason why the concentration of glucose in the blood **decreases**. [1]

(iii) Name **two** places in the body where glycogen is stored.

1..... 2 [2]

(b) Explain how an increase in glucose concentration is controlled in the body. [3]

(c) If the blood glucose concentration is very high there is a decrease in the water potential of the blood. This may damage the red blood cells. Explain how a decrease in water potential of the blood may damage red blood cells. [3]

Overexploitation, Mitigation of adverse effects, Human influences

1. Some information about pollutants, their sources and their effects on the environment are shown in Table below

(a) Complete Table 1.1. [5]

(b) Explain the impacts in streams, lakes and rivers when eutrophication occurs. [7]

(c) Sulfur dioxide dissolves in rain water to form acid rain. Describe **two** measures that can be taken to reduce the effects of acid rain. [5]

(d) Herbicides are used by farmers to control weeds. Explain the environmental impacts that may be caused by herbicides. [6]

3. In South America, forests have been cut down to provide land for cattle grazing and for growing crops, such as soya beans.

Fig below shows an area before deforestation and after the planting of soya. Occasionally small areas of forest are left if the land cannot support agriculture.

(a) Suggest the disadvantages of removing the forest from all but small areas of land. [3]

(b) Much of the soya is used to feed farm animals rather than to make foods that humans can eat. Explain the advantages of using soya as food for humans rather than for farm animals. [3]

(c) Much of the cleared forest in South America is used as land for cattle grazing. The clearing of forest and keeping large numbers of cattle have severe effects on the environment, especially the atmosphere.

Outline the impacts of forest clearance and cattle farming on the atmosphere. [3]

(d) Yields from crops grown on soils like those in Fig. 6.1 are likely to decrease over time. State 2 reasons for the likely decrease in yields. [2]

(e) Forest products are used in the manufacture of paper. Explain the environmental advantages of recycling paper. [2]

4. Explain why it is important to recycle paper rather than burn it. [5]

3D tissues and organ printing

What are the impacts of 3D tissues and organ printing

Nutrition and digestion

A herbivore is an animal that gets its energy by eating plants. A carnivore is an animal that gets its energy by eating other animals. Fig. below shows the skulls with teeth of a sheep and of a dog.

Sheep



Dog



(a) (i) Describe one similarity, related to nutrition, that you can observe between the teeth of the two skulls. [1]

(ii) Complete Table below to give two differences, related to nutrition, that you can observe between the teeth of the two skulls. [2]

	sheep	dog
difference 1		
difference 2		

(b) Fig below shows one 'back' tooth of the sheep and one 'back' tooth of a dog.



sheep



dog

Fig

(ii) Look carefully at the 'contact' surfaces of the tooth of the sheep and the tooth of the dog. Complete the Table below to give two differences between the 'contact' surfaces of these teeth. [2]

Table

herbivore - sheep	carnivore - dog

(c) The nutrient content of green leaves and animal flesh are compared in Table below

nutrient content / percentage of fresh mass			
	carbohydrate	protein	fat
green leaves	5 to 6	1 to 4	trace
animal flesh (meat)	trace	20	5 to 10

Using the data in Table below, suggest why herbivores spend more time eating than carnivores.

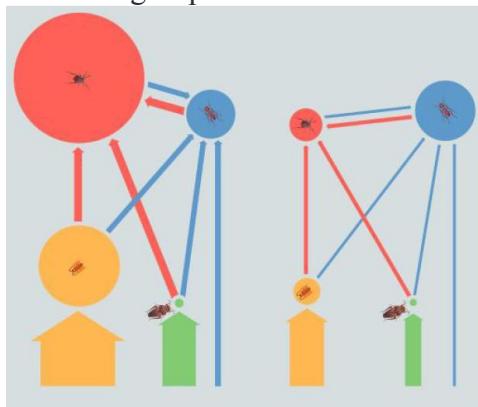
(d) Describe how you would safely test samples of green leaves and meat to find out which has more fat. [6]

Energy transfer and movement

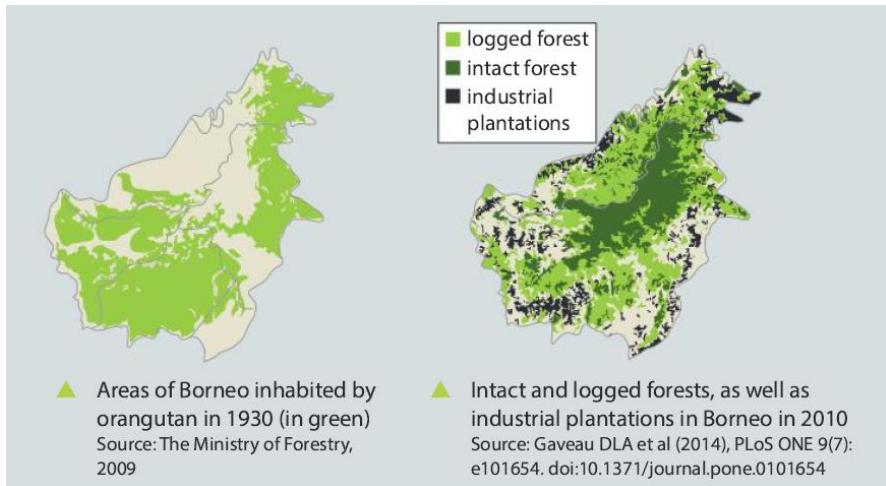
1. Energy cannot be created or destroyed but can change from one form to another. Deduce what change happens in these cases.

- a) Rainforest is cut down and burned to clear land for oil palm plantations. [1]
- b) Peat swamps are drained, allowing the peat to oxidize. [1]
- c) Sunlight is absorbed by palm leaves and oil is produced. [1]
- d) Palm oil is used as biodiesel in a vehicle. [1]
- e) Food containing palm oil is eaten by a person in Europe or the USA. [1]

2. The diagrams here show energy flows between trophic groups of animals in a natural rainforest (left) and an oil palm plantation (right). The animal groups are primary consumers (green), detritivores (yellow), carnivores (red) and omnivores (blue). The size of the circles indicates the biomass of the groups of animals and the width of the arrows indicates the amount of energy flowing from one group to another.



- a) Compare and contrast the source of energy for herbivores and detritivores in the natural rainforest. [2]
 - b) What changes in energy flow happen when an area of natural rainforest is replaced by an oil palm plantation? [1]
 - c) State the reason for the much lower biomass of carnivores in the oil plantation than in the natural rainforest. [1]
 - d) Suggest a reason for a higher biomass of omnivores in the oil palm plantation than the natural rainforest. [1]
3. One hundred years ago there were probably more than 230,000 orangutan (*Pongo pygmaeus*) in their natural tropical rainforest habitats on Borneo and Sumatra. Population estimates by the World Wide Fund for Nature in 2016 were 41,000 on Borneo and 7,500 on Sumatra. The maps here show the parts of Borneo that orangutan inhabited in 1930 and the parts of the island where there was natural intact forest, logged forest, and plantations of rubber trees and oil palms in 2010.



- a) Analyse the information in the maps to assess whether or not:
- orangutan originally inhabited all areas of forest on Borneo [1]
 - plantations of rubber or palm oil have been established in areas formerly inhabited by orangutan [1]
 - areas of intact forest remain where orangutan were living in 1930. [1]
- b) Discuss whether logging or clearance of forest for plantations has had more harmful effects on orangutan. [2]
4. The table shows how much oil is produced per hectare ($100\text{ m} \times 100\text{ m}$) when four different crops are grown and also the total global area of their production.

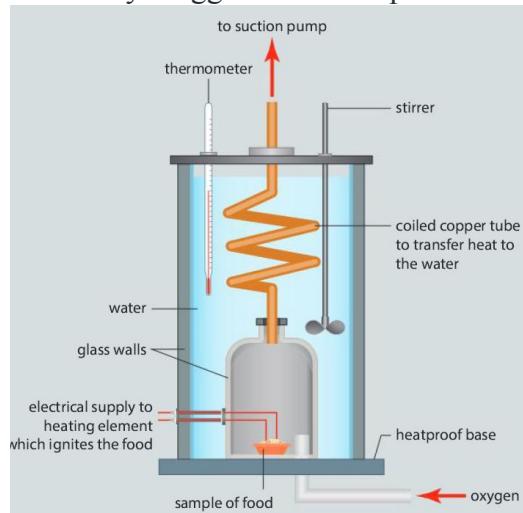
Oil crop	Average oil yield ($\text{kg ha}^{-1} \text{ year}^{-1}$)	Planted area (million hectares)
Soybean	400	94.15
Sunflower	460	23.91
Rapeseed (canola)	680	27.22
Oil palm	3620	10.55

The yield of oil palm crops in kilograms per hectare is much higher than the other three crops, but to determine whether the energy yield per hectare is higher, the energy content of the different oils is needed.

- a) Suggest a testable hypothesis for the relative amount of energy in palm oil and one other oil from the table. [2]
- b) Design an experiment to test your hypothesis by measuring the energy content of the two oils. This should include:
- the types of oil that you will test [2]
 - how you will measure the energy content of the oil [5]
 - details of the variables you must keep constant in the experiment [3]
 - risks and how you will minimize them. [3]

5. a) Present the results of your experiment to measure the energy content of oils in a clear and detailed results table. Remember to include row and column headings and SI units for quantitative variables. [3]
- b) Display the results using a suitable type of graph or chart. [3]

- c) Use calculations to evaluate the energy yields per hectare of palm oil and the other crop that you have investigated. [3]
- d) Suggest scientific reasons for the differences in energy yield between the crops. [3]
- e) The diagram shows a food calorimeter which is designed to measure the energy content of foods accurately. Suggest how it improves on your method in three ways. [3]



The article here was posted online in 2015 at <http://theconversation.com/palm-oil-scourge-of-the-earth-or-wondercrop-42165>.

It was written by Denis J Murphy, who is Professor of Biotechnology at the University of South Wales, where he is an independent researcher and advisor to organizations that include the Food and Agriculture Organization of the United Nations and the Malaysian Palm Oil Board. Read the passage and then answer the questions below.

Palm oil: scourge of the earth, or wonder crop?

If you happen to mention palm oil to most people outside of Asia you are unlikely to get a particularly positive reaction. Over recent years, media coverage of palm oil has typically included images of displaced orangutan and burning, degraded tropical forests. There has been a feeling that palm oil is an evil that needs to be stopped. Indeed, in some of the richer countries there have been attempts to organize consumer boycotts of palm oil products ranging from cosmetics to chocolate. Examples include France, the United Kingdom and Australia. But there is another story about palm oil that is much less frequently heard, especially in richer countries. This is a story about an ancient and bountiful African tree whose fruits provide a wholesome, vitamin-rich oil that feeds 2 billion to 3 billion people in 150 countries every day.

The oil palm tree has been cultivated as a source of food and fibre by people in western Africa for as much as 4,000 years and was harvested by our hunter gatherer ancestors for tens of millennia. Palm oil is a uniquely productive crop. On a per hectare basis, oil palm trees are 6–10 times more efficient at producing oil than temperate oilseed crops such as rapeseed (canola), soybean, olive and sunflower. The trees also have a productive lifetime of around 30 years. Soil in oil palm plantations is rich in organic content and is less disrupted compared to temperate, annual oil crops where highly destructive annual ploughing of the soil is required.

In 2014, the total estimated global production of palm oil was almost 70 million tonnes (Mt). Over 85% is exported from Indonesia and Malaysia, mostly to India and China, where the fruit oil is used in food, including as a cooking or salad oil, and in a wide range of processed food products. If oilseed crops were to replace palm oil, it would require at least 50 million additional hectares of prime farmland just to produce the same amount of edible oil.

The seed oil from palm is rich in lauric acid, a critical component in many cosmetics and cleaning products. Much of this type of palm oil is exported to Europe where it is used in toothpaste, washing up liquids, shower gels and laundry detergents. The only viable alternative oil that is rich in lauric acid comes from coconut, but the oil yield of this plant is less than 10% of palm oil. To completely substitute coconut for palm oil would require cultivating ten times as much tropical land. This is rarely realized by consumers who choose to use products containing coconut oil instead of palm oil.

Another misconception is that palm oil is overwhelmingly a “big business” crop. In fact, there are about 3 million smallholder growers, nearly all of whom farm individual family-owned plots. In Indonesia, which is the largest palm oil producing country, smallholder plots account for 40% of the total crop area. I have recently returned from a fact-finding visit to Sarawak where we saw some of the

innovative ways that local people are growing oil palm alongside other crops.

Over the past year or so the pendulum of informed opinion has started to swing away from a simplistic view of palm oil as an unmitigated environmental scourge and towards a more nuanced approach that recognizes the genuine pros and cons of this bountiful tropical crop. One of the most encouraging developments has been the establishment of a reasonably robust and independent body to certify the environmental and social credentials of palm oil. The Roundtable on Sustainable Palm Oil, or RSPO, has a vision to "transform the markets by making sustainable palm oil the norm". The RSPO has over 2,000 members globally that represent 40% of the palm oil industry, covering all sectors of the supply chain.

There is also an increasingly active international research effort aimed at understanding the ecological and environmental impact of oil palm compared to other habitats such as rainforests and rapeseed or soybean farms. One example of this research is a recent analysis of tropical peat soils, some of which have been targeted for oil palm cultivation. When improperly farmed these soils can release large amounts of CO₂ and grow poor crops. But the analysis found some types of peat can readily support oil palm crops without high CO₂ emissions, while others should be left un-farmed and

6. List examples mentioned in the article of science helping to address problems caused by palm oil production. [5]
7. Denis Murphy gives a strong argument in support of palm oil production. Write a counterargument based on the harm that palm oil production has caused to tropical ecosystems in South-East Asia. Apply scientific language effectively in your argument. [5]
8. There are links in the online version of this article to the sources of information used, which are scientific papers published in journals. Explain the importance of giving sources of information. [5]

Concept-Relationships

conserved. They conclude that rather than a blanket-ban on farming peat soils, decisions should be made on a case-by-case basis depending on the type of peat.

Another study did a more rigorous life cycle assessment of oil crops, which is a measure of their overall environmental impact and found the overall ecological impact of palm oil is comparable, and sometimes superior to temperate crops. Two other studies examine the potential impact of land use and climate change on biodiversity in Borneo where a great deal of oil palm planting has occurred. The conclusions include the need to establish nature reserves in upland areas where climate change will be less severe and to improve connections between reserves and plantations with wildlife corridors.

There are undoubtedly many significant challenges facing oil palm, and further encroachment onto sensitive native forest areas should be minimized and eventually halted. But palm oil is also a uniquely efficient edible crop that is essential for food security in Africa and Asia. By working together as an international community that includes scientists, farmers, processors and consumers we aim to develop solutions to many of the problems faced by oil palm. Hopefully this will soon enable palm oil to regain its rightful place as one of the stars in the pantheon of global crops.

Classification, Unity and Diversity in life forms

- Cicadas are insects that make a lot of noise. Fig below shows an adult chorus cicada, *Amphipsalta zelandica*, that is only found in New Zealand.

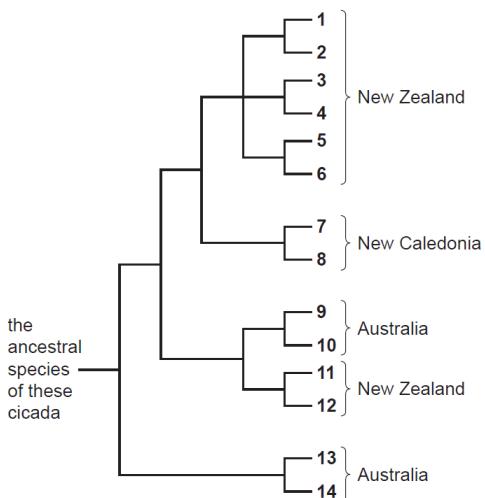


- State three features, visible in Fig. 1.1, that show that the chorus cicada is an insect. [3]
- Insects are classified in the same group as crustaceans, arachnids and myriapods. Name the group that contains all these animals. [1]

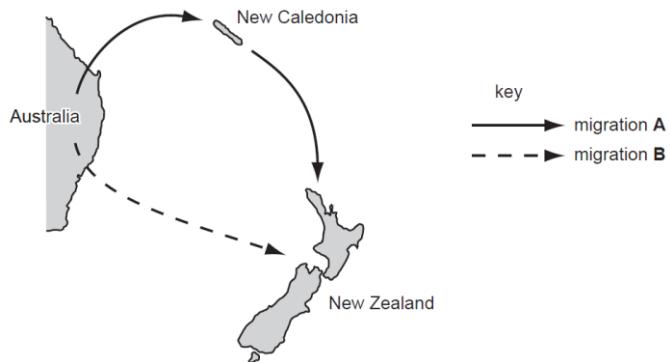
Evolutionary relationships between different species are investigated by examining DNA.

- State precisely where DNA is found in a cell [1]

Small sections of DNA in 14 species of cicada found in Australia, New Caledonia and New Zealand (1 to 14) were examined for similarities and differences. The results of the DNA examination of these species were used to make a diagram showing how these cicada species may have evolved. Species that are closely related are grouped together on the right of Fig below. The brackets show that the cicada species in New Zealand are in two separate groups.



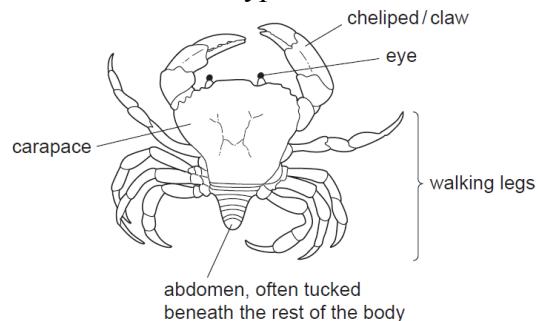
- It is suggested that the eight cicada species in New Zealand originated from two migrations, A and B, from Australia as shown in Fig below



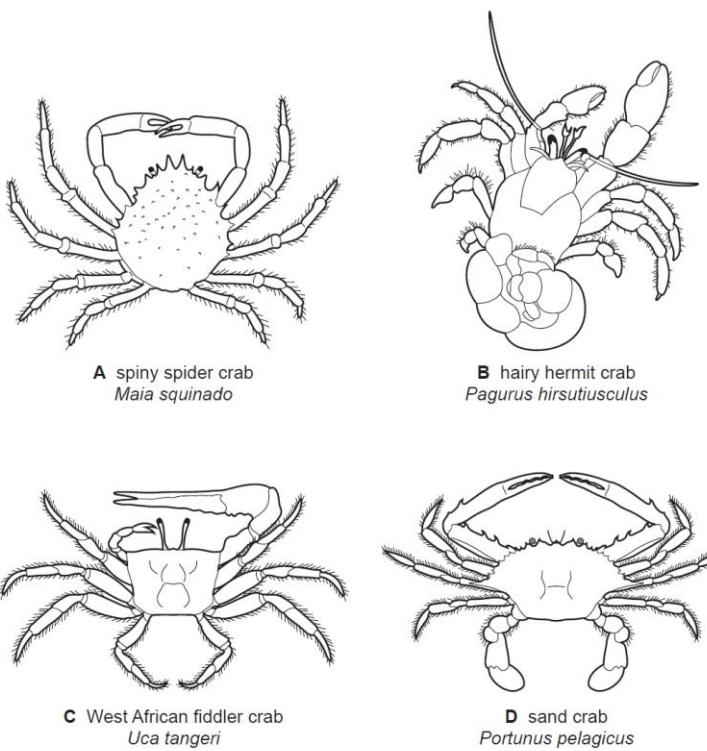
Explain how the results in Fig 2 support the idea that the eight cicada species in New Zealand originated from two migrations of cicadas as shown in Fig 3. You can use the numbers from Fig 2 in your answer.

2. Table 1.1 shows some features of the five groups of vertebrates. Complete Table below to compare the five groups of vertebrates using a tick () to indicate if the group shows the feature, or a cross () if not. The first row has been completed for you.

3. Crabs are classified, along with prawns, shrimps and lobsters, as crustaceans. Most crabs live in the sea, although some live in freshwater and there are a few land-dwelling crabs. Fig below shows the structure of a typical crab.



(a) State the group of animals that includes crustaceans, insects, arachnids and myriapods. [1]
Fig below shows four different species of crab.



(b) Biologists use dichotomous keys to identify different species.

Use Fig. 1.1 and Fig. 1.2 to state one visible feature of each species of crab A, B, C and D, that could be used in a dichotomous key to identify crabs. [4]

(c) Crabs show variation in many features.

(i) State one feature of crabs that shows continuous variation. [1]

(ii) Describe how you would measure variation in the feature you have given in (i). [1]

(d) Crabs produce huge numbers of offspring, but their populations remain fairly constant from year to year. Explain why. [3]

(e) Emergency medical packs contain bandages made from chitosan. Chitosan comes from the exoskeleton of crustaceans and has a positive charge to attract red blood cells. It helps blood clot quickly and also has antibacterial properties.

Explain the impacts of using bandages made from chitosan. [3]

DNA, Genome mapping and application

Mitochondria are cell structures that contain a small quantity of DNA.

Scientists are sequencing the DNA of one particular gene in mitochondria to help identify different species of many animals including myriapods. The sequences that they find are called 'barcodes'.

(i) State the part of the cell that contains most of the DNA. [1]

(ii) Suggest how DNA barcoding might be useful in the conservation of animals, such as myriapods. [2]

(iii) State the function of DNA in cells [3]

2. Fungi were often classified as different species according to their visible reproductive structures.

Penicillium dodgei and *Eupenicillium brefeldianum* were classified as different species because

they had different types of spores.

However, recently it was recognised that the spores of *P. dodgei* were asexual spores, while those of *E. brefeldianum* were sexual spores. A comparison of the DNA of these two fungi shows that they are the same species.

This fungus is now known as *Penicillium brefeldianum*.

(a) State how DNA analysis can show that *P. dodgei* and *E. brefeldianum* are the same species [3]

Cell division, Reproduction, Life cycles

1. (a) There are two types of cell division, meiosis and mitosis.

Cells produced by each type of division have different characteristics and functions.

Complete Table below by placing a tick in two of the boxes in each row to show the characteristics and functions of the cells made by each type of cell division.

Tick only four boxes.

type of cell division	characteristics of cells		uses	
	genetically different	genetically similar	to produce gametes	for growth and repair
meiosis				
mitosis				

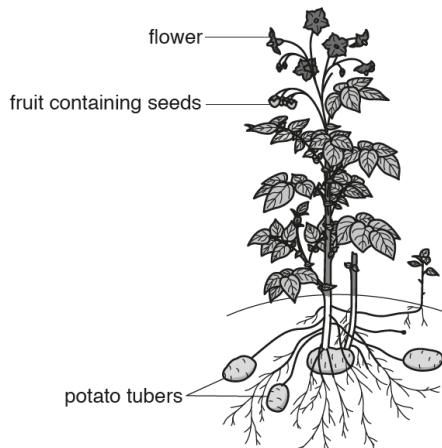
(b) One way of producing more potatoes is by planting tubers.

Potato tubers are produced by asexual reproduction.

Another way of producing potato plants is by planting seeds.

Seeds are a result of sexual reproduction.

Fig below shows a potato plant.



A farmer uses selective breeding to produce a new variety of potato.

Describe the stages in selective breeding. [3]

(c) Genetic engineering can also be used to provide new varieties of crop plants.

Using an example, explain what is meant by genetic engineering. [4]

(d) State **two** ways of improving the yield of crops, **other than** selective breeding or genetic engineering. [2]

2.

Sexual reproduction occurs in all mammals. A zygote is formed from the fertilisation of a male gamete and a female gamete.

(i) Name the process that results in the formation of haploid gametes. [1]

(ii) Explain the importance of sexual reproduction in mammals.[3]

(c) Marsupials differ from other mammals by giving birth to relatively undeveloped offspring. Female humans have a placenta and therefore give birth to more developed offspring.

(i) Describe the role of the placenta in humans [4]

(ii) In humans, the placenta is connected to the amniotic sac which contains amniotic fluid.

State **two** functions of the amniotic fluid. [2]

3. Some insects can reproduce by sexual reproduction **and** asexual reproduction. In both types of reproduction chromosomes are passed from the parent or parents, to the offspring.

Fig below shows a drawing of a parent insect and seven of her offspring: **M, N, P, R, S, T** and **U**.

(a) (i) Two of the offspring were produced by asexual reproduction.

Suggest the letters representing these **two** offspring.

1

2[1]

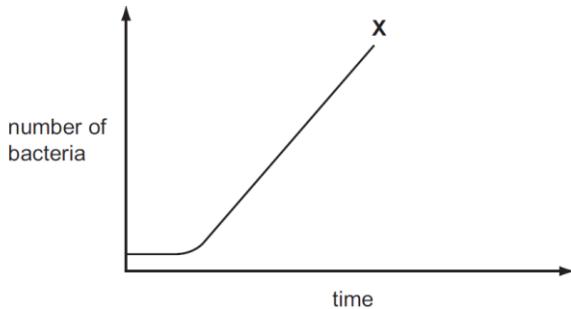
(ii) Insect **R** was produced by sexual reproduction.

Use the information from the diagram to support this statement. [1]

(iii) State the term that is defined as the observable features of an organism. [1]

Factors affecting human health, Vaccination, Pathogens/ parasites

Bacteria can multiply quickly when grown in a nutrient rich medium in a flask. Fig below shows how the numbers increase with time.



(a) After point X on the curve, the population growth continues at a different rate.

(i) Extend the curve to show what might happen to an ageing bacterial population. [1]

(ii) Suggest a reason for the change you have shown.

An antibiotic is a chemical substance which is produced by one type of microorganism.

This chemical kills or stops the growth of another microorganism.

The antibiotic penicillin is produced by culturing the fungus *Penicillium chrysogenum*

Fig below shows part of the fungus as seen with the aid of a microscope

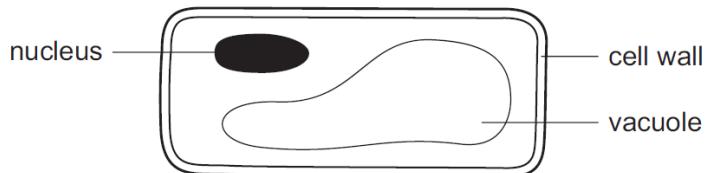


(b) On Fig.3.2, label the following structures,

(i) a hypha;

(ii) a spore. [2]

(c) Fig below shows the cell of a fungus.



Compare the cell of a fungus shown in Fig below with a green plant cell and an animal cell.

difference from a green plant cell....

similarity to a plant cell....

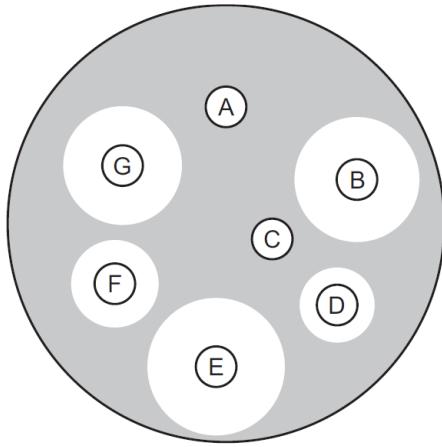
difference from an animal cell....

(d) Penicillin can be used to treat bacterial infections. It stops the formation of cell walls in bacteria.

Suggest why penicillin can be used to treat bacterial infections in humans.

(e) Seven small paper discs were soaked in solutions of different antibiotics, A to G.

The paper discs were placed on an agar plate which was evenly covered with growing bacteria. This was left for a short time. The results are shown in Fig below



- (i) Select which antibiotic, A to G, is most effective.
(ii) Give a reason for this choice of antibiotic in (i).

2. The spread of meningitis can be controlled by using vaccines.

(i) Explain how vaccination provides active immunity. [8]

(ii) If meningitis disappears from a country, explain why the vaccine should continue to be used in that country. [6]

Glossary:

3D printing is the printing process that involves making three-dimensional objects by applying repeated thin layers of quick-drying material following digital models.

Abiotic factors are the non-living factors which influence the environment, including climatic factors and edaphic factors.

Acquired characteristics are physical characteristics which are acquired by an individual organism during its lifetime.

Active transport is the movement of substances such as mineral salts through a membrane in living cells against a concentration gradient: i.e. from low to high concentration.

Adaptation gradually over a period of time, each generation of a particular organism will become better adapted to its environment.

ADH anti-diuretic hormone, from the pituitary gland, secreted when quantity of water in the blood gets low, allows kidneys to reabsorb water.

Adhesion is the sticking together of unlike molecules.

Alien species are species which do not normally occur in an area but have been introduced by accident or intentionally.

Alveoli (singular alveolus) are the tiny air sacs at the end of each bronchiole through which oxygen diffuses in and carbon dioxide diffuses out.

Amino acids are the monomer units of all proteins and contain the –COOH and –NH₂ groups at either end of the molecule.

Anabolism is the phase of metabolism that is concerned with the building up of complicated molecules from simpler ones, e.g. formation of glycogen.

Anaphase is the stage of nuclear division between metaphase and telophase that results in the splitting of chromatids (mitosis) or homologous chromosomes (meiosis).

Angiosperms (flowering plants) are seed-bearing plants that produce flowers.

Aorta is the largest artery in the body, carrying oxygenated blood out from the left ventricle of the heart.

Archaea is a domain of life that includes prokaryotes that live in extreme environments and prokaryotes that are more closely related to eukaryotes than bacteria.

Artery an artery is a wide muscular-walled blood vessel that carries blood away from the heart towards the body tissue.

Artificial classification is a system of classifying organisms based on something other than evolutionary relationships.

Asthma is a disease of the lungs characterized by inflammation and reversible airway narrowing.

ATP adenine triphosphate is a substance used as a store of chemical energy by living cells.

Baroreceptor is a sensory receptor in blood vessels that detects blood pressure.

Biceps is the flexor muscle in the upper arm which bends the forearm.

Biopsy is a surgical extraction of a sample of cells or tissue.

Biotechnology is the use of living organisms for the production of useful substances or processes.

Biotic factors are factors arising from the activities of living organisms (including humans) which influence the environment.

Blood plasma is the liquid part of blood, which is about 90% water.

Bryophytes are primitive plants, liverworts and mosses, with simple stems, leaves and roots.

Cancer is a disease characterized by uncontrolled cell division.

Capillaries are the narrowest type of blood vessel.

Carbon cycle the carbon cycle is the constant circulation of carbon between the atmosphere, plants, animals and the soil.

Carbon footprint a carbon footprint is the amount of carbon dioxide or greenhouse gas equivalents emitted into the atmosphere by the activities of an individual, a community or a company

Carcinogen a chemical agent that can cause cancer

Catalyst a catalyst is a substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change.

Cell membrane the cell membrane forms the outer boundary of the cell.

Cell wall the cell wall is a rigid outer wall of plant cells, made of cellulose.

Chemical change a chemical change occurs in a chemical reaction and produces a new chemical substance. This substance often looks quite different from the starting substances. For example, when hydrogen burns in oxygen, water is formed. This water is a colourless liquid and has none of the properties of its constituent elements, which are both gases.

Chemoreceptor is a sensory receptor that detects chemical changes.

Chromosome a chromosome is a long coil of DNA which is made up of genes in a linear sequence which are found in the nucleus of plant and animal cells.

Class a class is part of the biological classification system. This system classifies living organisms into very large groups called kingdoms, kingdoms are broken down into phyla, each phylum is broken down into classes, which are then subdivided into orders.

Clone a clone is a genetically identical descendant produced by vegetative reproduction from an original plant seedling.

Closed system a closed system is one in which no material can escape, though energy can.

Cohesion is a force of attraction between two identical molecules.

Competition is a form of interaction between individuals in an ecosystem involving a struggle for access to the same resource.

Condensation (1; in physics) is the change of state from gas (or vapour) to a liquid; (2; in chemistry) is a reaction in which two molecules are joined together to make a larger molecule, with the loss of water.

Conditioned reflex a conditioned reflex is reaction that is learned in response to a specific situation or stimulus.

Coronary heart disease is a heart disease due to blockage of the arteries that supply blood to the heart.

Cytoplasm is the protoplasm of a living cell which is found outside the nucleus.

Detritivore is a consumer that ingests dead organic material.

Diabetes-type 1 is a disorder caused by the lack of the hormone insulin.

Dichotomous keys are the simplest type of key, made up of brief descriptions arranged in numbered pairs.

Dicotyledons (abbreviation: dicots) are a class of angiosperm with two seed leaves (cotyledons).

Differentiation involves cells or tissues undergoing a change toward a more specialized function and form.

Diffusion is the mixing of two liquids without mechanical help.

Diploid describes a cell which has paired sets of homologous chromosomes in its nucleus.

Diving reflex is a response to diving in mammals and birds that involves changes in body activities that decrease oxygen consumption.

DNA (abbreviation for deoxyribonucleic acid) is a nucleic acid which contains the genetic information carried by every cell.

DNA replication is the production of identical copies of DNA.

DNA transcription is the copying of the genetic code.

Domain the largest taxonomic group that includes a group of similar phyla

Dominant a dominant phenotype masks the presence of the recessive phenotype.

Ecosystem an ecosystem is a biological community and the physical environment that is associated with it.

El Nino is an abnormality of ocean currents that results in significant climate and ecological effects.

Electromagnetic

radiation

is energy that travels in the form of waves at the speed of light in a vacuum.

Electron micrograph is a photograph of the image produced by an electron microscope.

Emergent property is a property of a system that emerges from the interaction of the elements of the system.

Endoplasmic reticulum is a network of membranes joined to the nuclear membrane. It has a large surface area and is a site of protein and lipid synthesis.

Endothermic reaction a chemical reaction during which heat energy is taken in from the surroundings.

Energy is the capacity of a system to do work.

Environment the environment consists of all the conditions which surround an organism and in which it lives.

Enzymes are catalysts in biochemical reactions.

Epidemic is the spread of an infectious disease from person to person in a place where the disease is not normally present at such a high rate of occurrence.

Esophagus (or gullet) the esophagus is the section of the alimentary canal between the mouth and the stomach.

Eukaryote is an organism that contain compartmentalized cells with a true nucleus.

Evolution is the gradual changing of a species of living organism over a long period of time.

Exoskeleton is a skeleton found on the outside of the animal.

Exothermic reaction a chemical reaction during which heat energy is transferred to the surroundings.

Exponential growth occurs when a population size grows at a faster rate as the population size increases

Extinction is the complete and irreversible disappearance of all living members of a species or group of organisms from the Earth.

F1 generation (first filial generation) is the first generation of offspring in a genetic cross (in humans, the children).

F2 generation (second filial generation) is the second generation of offspring in a genetic cross (in humans, the grandchildren).

Family in biological classification, each genus belongs to a family and each family belongs to an order.

Fertilization (in plants) fertilization is the fusion of the male nucleus (from the pollen) with the female nucleus (in the ovule); (in animals) fertilization is the fusion of the nuclei of the male and female gametes during sexual reproduction to form a single cell called the zygote.

Filtrate is the clear liquid that passes through the filter during filtration.

Food chain a food chain is a feeding relationship between organisms in an ecosystem.

Gamete a gamete is a specialized sex cell formed by meiosis which contains only half the number of chromosomes (haploid).

Gametogenesis is the formation of sex cells.

Gene a gene is the unit of hereditary information, composed of a section of DNA which acts as a chemical instruction for protein synthesis.

Genetic code the genetic code is the code sequence of different bases of a DNA molecule, which controls protein synthesis in cells.

Genetic drift is the change in the ratio of genotypes within a population due to random events

Genome the genome is the entire genetic material of an organism

Genome mapping the process of determining the location and function of genes within a genome

Genotype is the genetic information about a particular organism as specified by its alleles.

Genotypic ratio is the proportion of offspring possessing different combinations of alleles

Genus a genus is a group of closely related species.

Germination is the initial stages of growth of a seed to form a seedling.

Global warming is the gradual change in world climate caused by the greenhouse effect.

Glomerulus a glomerulus is a tangle of blood capillaries located in each Bowman's capsule of the kidney.

Glycogen is a polysaccharide found in vertebrate animals and is the main energy store in the liver and muscles.

Gonads are reproductive organs of an animal.

Greenhouse effect is the trapping of heat energy in the atmosphere because of the effects of greenhouse gases.

Greenhouse gases are gases in the atmosphere which absorb infra-red radiation, causing an increase in air temperature.

Habitat is a place in which an organism or a community of organisms live.

Haploid describes a cell which has a single set of unpaired chromosomes in its nucleus.

Heat energy is the energy that flows from one place to another as a result of a difference in temperature.

Hepatocyte is a liver cell.

Herbivores are organisms which feed on plants.

Heredity is genetic information passing from parents to offspring.

Heterozygous describes an organism that possesses two different alleles of a particular gene in a given pair of chromosomes.

Homeostasis is the maintenance of a constant internal environment of an organism.

Homozygous describes an organism that possesses identical alleles of a particular gene in a given pair of chromosomes.

Horizontal transfer is the transfer of genetic information in either direction between two individuals. Genes from a donor are added to the existing genome of a recipient.

Hormones plant hormones are specific chemicals produced by the cells of plants, which, at very low concentration, can affect growth and development.

Animal hormones are special chemical “messengers” secreted in small quantities directly into the bloodstream by an endocrine gland.

Human Genome Project in 1988 the international Human Genome Project began to identify all the genes in the 46 chromosomes of every human cell. This project was completed in 2003.

Hybrid a hybrid is the offspring of plants or animals produced from the cross of two closely related species.

Hydrogen bonding is the strong force of attraction between certain molecules that contain hydrogen, such as water molecules.

Hydrolysis is the chemical reaction of a compound with water which causes it to break down.

Immunity is protection of an organism against infection.

Inductive reasoning is the formation of generalizations based on the observation of patterns

Infrared radiation is the way in which heat energy is transferred from a hotter to a colder place without a medium such as air or water being present.

Insulin is a hormone secreted when blood glucose level rises above normal. It stimulates the liver to remove glucose by converting it into glycogen.

Invasive species are an introduced species that significantly impacts the biological community structure in an area where it is not normally found.

Involuntary actions are actions which are not controlled by conscious activity of the brain.

Iris the iris is the coloured part of the eye and controls the amount of light that reaches the retina.

Keystone species are species whose population fluctuations have a disproportionate effect on the structure of a biological community.

Kilo- is a metric prefix meaning 1×10^3

Kinesis is an increase in the rate of movement in response to a stimulus

Kingdom a kingdom is the highest rank in the classification of living organisms.

Koch's postulates is a method for establishing the specific cause of an infectious disease

Ligament a tough, elastic structure of connective tissue that connects bones together at movable joints.

Liver the liver is a large and important organ which acts as a “chemical factory” and has a wide range of functions.

Mammals are warm-blooded vertebrates whose skin is covered with hair and has sweat glands.

Mechanoreceptor is a sensory receptor that detects touch, movement, stretching or pressure.

Meiosis (or reductive cell division) is division of a cell which results in each daughter cell receiving exactly half the number of chromosomes.

Metabolism (or metabolic activity) is the sum of all the various biochemical reactions that occur in a living organism.

Metamorphosis is the transformation that occurs in the life cycle of many arthropods from the egg through the larval and pupal stages to the adult form (imago).

Metaphase is a phase of nuclear division that occurs between prophase and anaphase and involves genetic material lining up at the equator of the cell.

Micro- is a metric prefix meaning 1×10^{-6}

Microtubules are protein based structures that are the components of the cytoskeleton of cells.

Milli- is a metric prefix meaning 1×10^{-3}

Mitochondria (singular mitochondrion) the mitochondria are the organelles in the cytoplasm where energy is produced from chemical reactions.

Mitosis is a division of a cell to form two daughter cells, each with a nucleus containing the same number of chromosomes as the mother cell.

Mitotic index is the proportion of the number of cells in metaphase to the total number of cells in a sample.

Models are simplified representations used to explore complex systems.

Model organisms are species that are chosen for study to represent other species. They are similar enough but they are chosen because they breed in large numbers and have a short generation time, so they can be studied more easily under laboratory conditions.

Mole is the SI unit of “amount of substance”.

Monocotyledons (abbreviation: monocots) are a class of angiosperm with only one seed leaf (cotyledon) within the seed.

mRNA is messenger ribonucleic acid. It takes part in the transcription (copying) of the genetic code.

Mutation is a sudden random change in the genetic material of a cell, which may result in faulty DNA replication or faulty division of chromosomes.

Mutualism (or symbiosis) is a feeding relationship between two organisms from which both benefit.

Nano- is a metric prefix meaning 1×10^{-9}

Natural classification involves grouping organisms based on evolutionary relationships.

Natural selection the theory of natural selection states that the individual organism which

is best adapted to its environment will survive to reproduce.

Negative feedback is the process by which information about deviation from a norm passes to a controlling organ and produces a correction of the deviation.

Nerve impulse is an electrical signal which moves along a nerve fibre.

Neurone (or nerve cell) is an elongated, branched cell that is the basic unit of the nervous system.

Neurotransmitter is the chemical released by the axon end of one neurone to transmit (or inhibit) the transmission of a nerve impulse across a synapse to an adjacent neurone.

Nucleus the nucleus in the cell's control centre and is contained within a nuclear membrane.

Nymph is the immature form of some invertebrates which resembles the adult form.

Oligopeptide is a short chain of amino acids.

Open system an open system is one in which materials and energy can escape or enter.

Order in biological classification, family is part of an order, and an order is part of a class.

Organ an organ is a collection of different tissues which work together to perform some function in the organism.

Osmosis is the movement of a solvent (usually water) from a dilute to a more concentrated solution by diffusion across a semipermeable membrane.

Ovum (plural ova) an ovum is the female gamete of animals.

Oval window is a membrane-covered opening between the middle and inner ear.

Ovulation is the periodic release of an ovum (egg cell) from the ovaries to travel down the oviduct (or Fallopian tube) to the uterus, where it is available for fertilization.

Parallel connections occur where flowing material has more than one pathway to follow.

Phenology is the study of the timing of cyclical events such as bud formation or nesting or migration

Phenotype is the observable characteristics of an organism produced by the interaction of its genes.

Phenotypic ratio is the ratio of organisms possessing different patterns of a certain observable feature.

Photon is a unit of light energy.

Photosynthesis is the chemical process of separating hydrogen from water (light stage or photolysis) which then combines with carbon dioxide (dark stage) to synthesize simple foodstuffs such as glucose.

Phylum is a large group of organisms sharing a similar basic structure. A phylum of plants is often called a division.

Physical change a physical change is one which results in no new chemical substance being formed.

Physiology is the study of the functions and activities of a living system.

Pico- is a metric prefix meaning 1×10^{-12}

Pituitary gland found at the base of the brain, it controls the production of hormones by the endocrine glands.

Plasmid is a piece of DNA found outside of the chromosome within a prokaryote.

Population a population is a group of individuals of the same species within a community.

Positive feedback occurs where the end product of a process further amplifies the process that created the product.

Post-synaptic neuron is the neuron that receives neurotransmitter from the pre-synaptic neuron.

Potometer is an apparatus which measures transpiration rates under natural or artificial conditions.

Predators are animals that hunt, kill and eat other animals called their prey.

Presynaptic neuron is the neuron that releases neurotransmitter into a synapse.

Prey is an animal that is a source of food for a predator.

Primary consumers feed on producers (plants).

Producers are animals that can make their own food by autotrophic nutrition and are therefore considered as a source of energy.

Products are the chemical elements or compounds that are produced during the chemical reaction.

Prokaryotes are organisms whose genetic material is not surrounded by a nuclear membrane, such as bacteria.

Prophase is the first stage of nuclear division where genetic material condenses and the nuclear membrane breaks down.

Puberty (or adolescence) is a stage of development when the reproductive organs begin to function.

Pulmonary artery the pulmonary artery carries deoxygenated blood from the right ventricle to the lungs (the only artery to carry deoxygenated blood).

Pulmonary vein the pulmonary vein carries oxygenated blood from the lungs to the left atrium (the only vein to carry oxygenated blood).

Pupil the pupil is the hole at the centre of the iris which appears as a black circle.

R group is the variable part of a chemical compound, such as an amino acid.

Random sample is a sample from a population where every member has an equal chance of being selected.

Reactants are the chemical elements or compounds that a chemical reaction starts with.

Reaction rate is the rate at which reactants are used up or products are formed in a chemical reaction.

Recessive allele a recessive allele is a gene that only affects an individual's phenotype if it is part of a homozygous pair.

Reflex actions are special types of involuntary action of which we are aware, like swallowing, coughing, etc.

Reptiles are cold-blooded vertebrates which lay soft-shelled eggs on land.

Respiration is the release of energy in a living organism which occurs when simple products are made from the breaking down of food molecules.

Restriction

endonuclease

is an enzyme that cuts DNA at specific sequences.

Retina the retina is the layer of light-sensitive cells at the back of the eye.

Ribosomes are tiny particles attached to the endoplasmic reticulum. They are involved in the synthesis of proteins.

Sarcomere the unit of contraction within a skeletal muscle.

Secondary consumers feed on primary consumers.

Sexual reproduction involves the joining of male and female gametes (sex cells).

Skeleton a skeleton is a structure in an animal that provides support for the body, protection for internal organs and a framework for anchoring muscles and ligaments.

Speciation is the formation of new species.

Species is a group containing living organisms of the same kind.

Sperm is the male gamete of animals.

Starch is a polysaccharide found in plants, especially in the roots, tubers, seeds and fruit. It is an important carbohydrate energy source

Statistic a number which represents a fact about a sample

Stoma (plural stomata) a stoma is a pore found in the lower epidermis of a leaf, surrounded by a pair of guard cells.

Synapse is the junction between two adjacent neurones.

System a collection of interacting elements that has emergent properties.

Taxis (or tactic movement) is the movement of an organism with respect to a stimulus from a specific direction.

Taxonomy is the study of the theory, practice and rules of classification of living and extinct organisms.

Telomere the ends of chromosomes that shortens with repeated cell divisions

Tendon (or sinew) is tough connective tissue that connects a muscle to a bone.

Tendons consist of collagen fibres which are non-elastic, and therefore transmit the contraction or relaxation of the muscle to the bone.

Tertiary consumers feed on secondary consumers.

Tissue is a collection of cells which perform a specific function.

Trachea (windpipe) is a tube through which air is drawn into the lungs.

Transcription is the copying of the genetic code.

Transformation is the uptake of donor DNA.

Translation transfer RNA and ribosomal RNA take part in translation (protein synthesis).

Translocation is the transport of minerals and products of photosynthesis within a plant.

Transpiration is the process in which water is lost by evaporation from the leaves through the stomata.

Triceps is the extensor muscle in the upper arm which straightens the forearm.

tRNA is transfer ribonucleic acid. It takes part in protein synthesis (translation).

Tropism a tropism is a growth or movement in plants that occurs due to a specific stimulus.

Tumor a mass of unspecialized cells formed by uncontrolled cell division.

Unicellular describes living organisms which are made up of only one single cell, such as bacteria and protozoans.

Ureters are two tubes which carry urine from the kidneys to the bladder.

Vaccine a vaccine is a liquid preparation of treated disease-producing

microorganisms which can stimulate the immune system to produce antibodies in the blood.

Vector a vector is an agent (organism) responsible for carrying pathogens from one organism to another.

Ventilation is the movement of air in and out of the lungs.

Vertical transfer is the transfer of genetic information from parent to offspring.

Voluntary actions are actions which are controlled by conscious activity of the brain.

Zygote is a fertilized egg produced by the fusion of the nucleus of the male and female sex cells.