

**HIGHER  
AND TRIPLE  
BIOLOGY**

**LONG ANSWER  
QUESTION  
PRACTICE**

## How to use this booklet

A selection of longer written questions have been selected from past GCSE papers for you to practice answering. You should revise the content first to ensure you have a good knowledge and then have a go at answering the questions. A model full mark answer has been provided at the end of the booklet for every question so you can compare your answer to see if there are any other details you could have included.

All the questions are challenging and are the equivalent of either the end of the foundation paper (level 2) or the end of the higher paper (level 3). They are however a good representation of what to expect in your exams.

The questions that are printed in bold font are from the triple science curriculum only.

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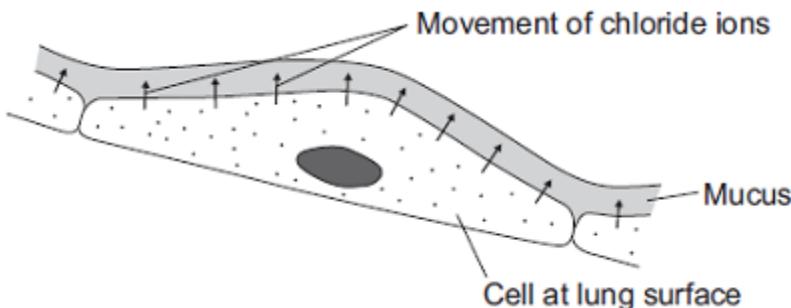
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# Cell Biology

- 1) Describe what happens in each of the three stages of the cell cycle. (5)
- 2) Look at the diagram below.



The movement of chloride ions causes water to pass out of the cells into the mucus. Explain why. (3)

- 3) Read the information about stem cells.

Stem cells are used to treat some human diseases.

Stem cells can be collected from early embryos. These stem cells have not begun to differentiate, so they could be used to produce any kind of cell, tissue or organ. The use of embryonic stem cells to treat human diseases is new and, for some diseases, trials on patients are happening now.

Stem cells can also be collected from adult bone marrow. The operation is simple but may be painful. Stem cells in bone marrow mainly differentiate to form blood cells. These stem cells have been used successfully for many years to treat some kinds of blood disease. Recently there have been trials of other types of stem cell from bone marrow. These stem cells are used to treat diseases such as heart disease.

Evaluate the use of stem cells from embryos or from adult bone marrow for treating human diseases.

You should give a conclusion to your evaluation. (5)

- 4) Meiosis and mitosis are different types of division in human cells. Compare the two processes by referring to where each takes place and the kind of products that are made. (6)
- 5a) The diagram below shows two model cells.



Describe how the surface area to volume ratio changes as the length of the side of the model cell increases. You should include calculations in your answer. (3)

5b) Using the answer from question 5 to help you. Explain why a bacterium can rely on diffusion for gas exchange, but animals need a transport system. (3)

6) Some sugar molecules are absorbed from the small intestine into the blood by active transport.

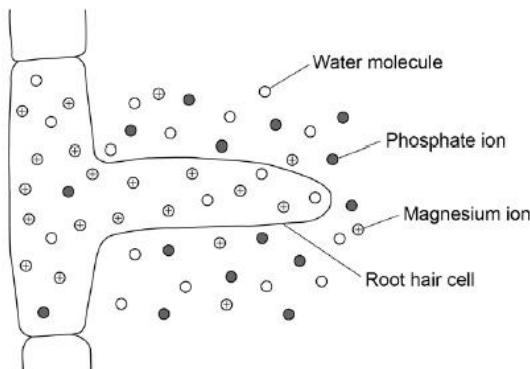
Explain why the rate of absorption of these sugar molecules can depend on the concentration of oxygen in the cells lining the small intestine. (3)

7) Plants need nitrate ions in order to make proteins. A plant is growing in soil flooded with water. Explain why the plant cannot absorb enough nitrate ions. (5)

8) Describe and explain how the villi are adapted to maximise the rate of absorption of the products of digestion. (5)

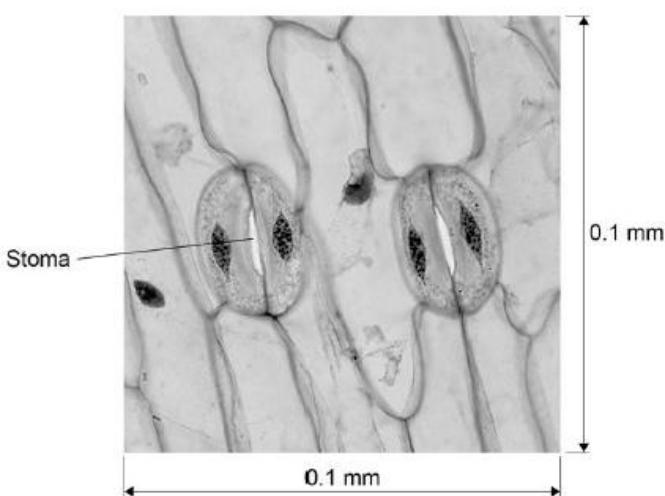
9) Particles can move into and out of cells by different processes.

**Figure 2** shows different particles inside and outside a root hair cell.



Explain the processes by which the different particles would enter the root hair cell. (6)

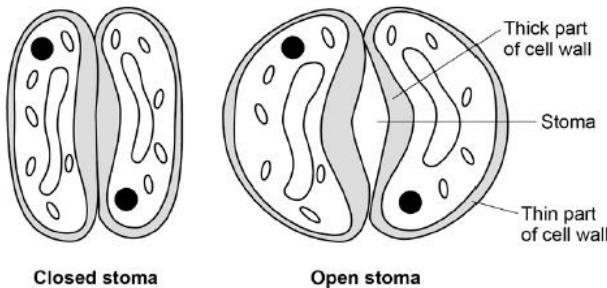
10)



Calculate the number of stomata per  $\text{mm}^2$  for the leaf shown above. (2)

# Organisation

- 1) What is meant by the *transpiration stream*? (3)
- 2) Look at the diagram below.



When light intensity is high potassium ions are moved into the guard cells.

Describe how the movement of potassium ions into the guard cells causes the stoma to open. (4)

- 3) Some athletes train at high altitude. Training at high altitude increases the number of red blood cells per  $\text{cm}^3$  of blood. Explain why having more red blood cells per  $\text{cm}^3$  of blood is an advantage to an athlete. (3)
- 4) Compare the structure of an artery with the structure of a vein. (3)
- 5) Describe how a student could test cow's milk to show whether it contains protein and different types of carbohydrate. (6)
- 6) A large amount of untreated sewage entered a river. Many fish died. Untreated sewage contains organic matter and bacteria. Explain why many fish died. (5)
- 7) Describe the route taken by oxygenated blood from the lungs to the body cells. (4)
- 8) Enzymes speed up chemical reactions. Explain how amylase breaks down starch. (3)
- 9) Many people suffer from stomach ulcers caused by a species of bacteria called *Helicobacter pylori*.

The stomach is lined with a protective lining of mucus. *Helicobacter pylori* are acid-tolerant bacteria which can damage this mucus lining.

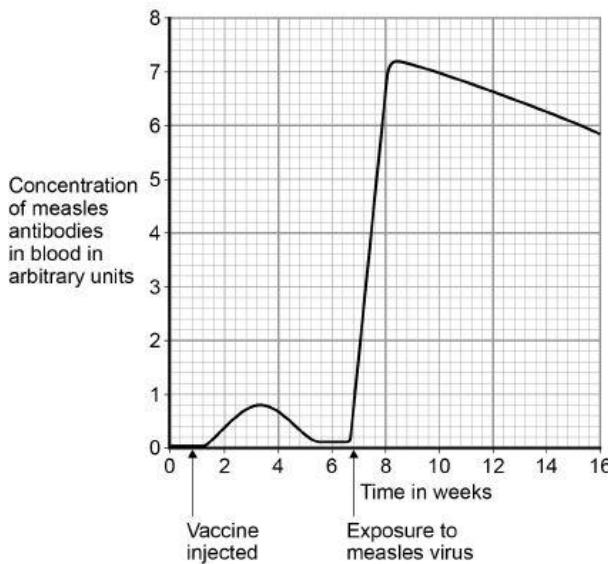
Suggest how an infection with *Helicobacter pylori* might result in a stomach ulcer developing. (2)

- 10) The pancreas cell makes enzymes. Enzymes are proteins. Describe how the ribosomes and the mitochondria help the cell to make enzymes. (3)

# Infection & response

1) The graph below shows the concentration of measles antibodies in the blood of a boy.

Explain the differences between antibody production after the vaccine injection and after exposure to the measles virus.  
You should include data from the graph. (6)



2) Explain fully why antibiotics cannot be used to cure viral diseases. (2)

3) A person can be immunised against a disease by injecting them with an inactive form of a pathogen. Explain how this makes the person immune to the disease. (3)

4) Explain why drugs must be trialled before the drugs can be used on patients. (3)

5) Read the information about cholesterol and ways of treating high cholesterol levels.

Diet and inherited factors affect the level of cholesterol in a person's blood. Too much cholesterol may cause deposits of fat to build up in blood vessels and reduce the flow of blood. This may cause the person to have a heart attack. Some drugs can lower the amount of cholesterol in the blood.

The body needs cholesterol. Cells use cholesterol to make new cell membranes and some hormones. The liver makes cholesterol for the body.

Some drugs can help people with high cholesterol levels.

**Statins** block the enzyme in the liver that is used to produce cholesterol. People will normally have to take statins for the rest of their lives. Statins can lead to muscle damage and kidney problems. Using some statins for a long time has caused high numbers of deaths.

**Cholesterol blockers** reduce the absorption of cholesterol from the intestine into the blood.

Cholesterol blockers can sometimes cause problems if the person is using other drugs.

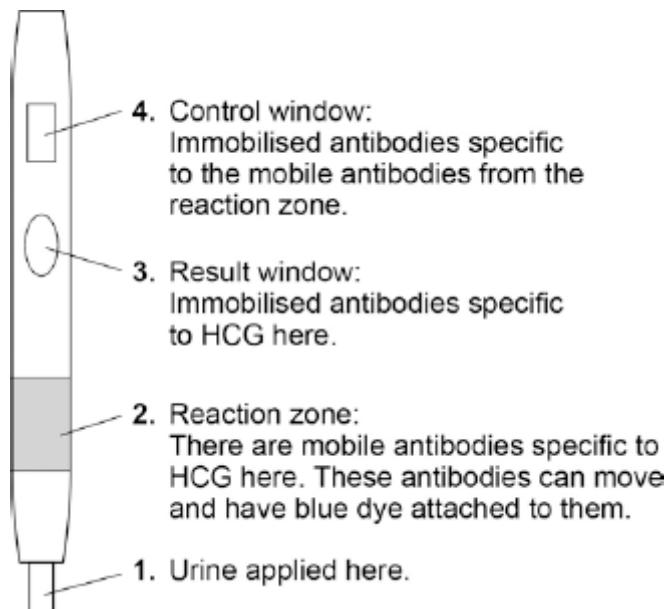
Evaluate the use of the two types of drug for a person with high cholesterol levels. (6)

6) Antibiotic-resistant strains of bacteria are causing problems in most hospitals. Explain, as fully as you can, why there has been a large increase in the number of antibiotic-resistant strains of bacteria. (4)

7) Pathogenic bacteria and viruses may make us feel ill if they enter our bodies. Why do bacteria and viruses make us feel ill? (2)

8) Explain, as fully as you can, how the body's white blood cells respond to infections. (4)

9) **The pregnancy test strip below will show a positive test result when a woman is pregnant.**



**Explain how the pregnancy test strip works to show a positive result. (6)**

10) **Plants infected with aphids may show symptoms of magnesium deficiency.**

**Magnesium deficiency symptoms include:**

- **yellow leaves**
- **stunted growth.**

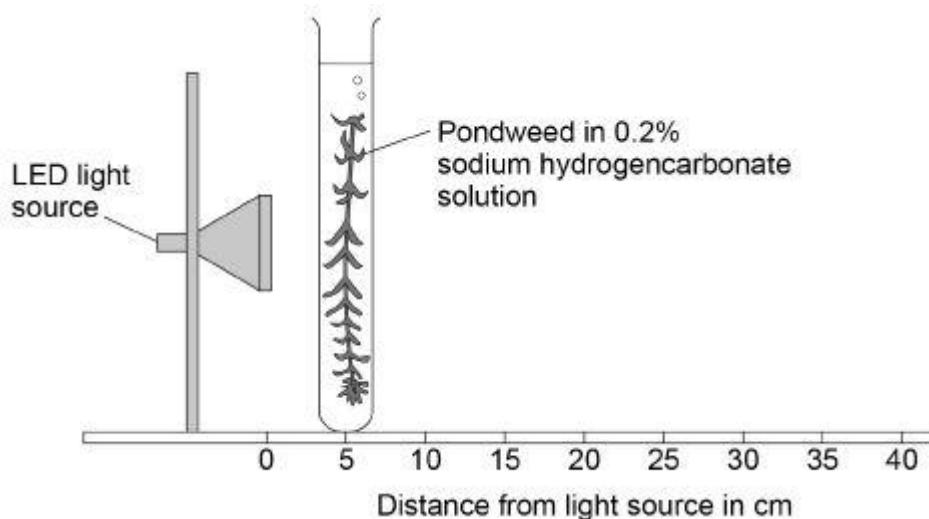
**Explain how a deficiency of magnesium could cause these symptoms. (5)**

11) **A farmer thinks a potato crop is infected with potato virus Y (PVY). The farmer obtains a monoclonal antibody test kit for PVY.**

**To make the monoclonal antibodies a scientist first isolates the PVY protein from the virus. Describe how the scientist would use the protein to produce the PVY monoclonal antibody. (4)**

# Bioenergetics

- 1) Plants need energy to make glucose. How do plants get this energy? (2)
- 2) Plants can use the glucose they have made to supply them with energy. Give **four** other ways in which plants use the glucose they have made. (4)
- 3) A student investigated the effect of light intensity on the rate of photosynthesis. The diagram below shows the apparatus used.



The LED light source does **not** get hot. Explain why it is important that the pondweed remains at a constant temperature. (2)

- 4) Light intensity can be calculated using the inverse square law:

$$I \propto \frac{1}{d^2}$$

Where  $I$  is light intensity and  $d$  is the distance of the pondweed from the light source.

The student placed the pondweed at 5, 10 and 20 cm from the light source.

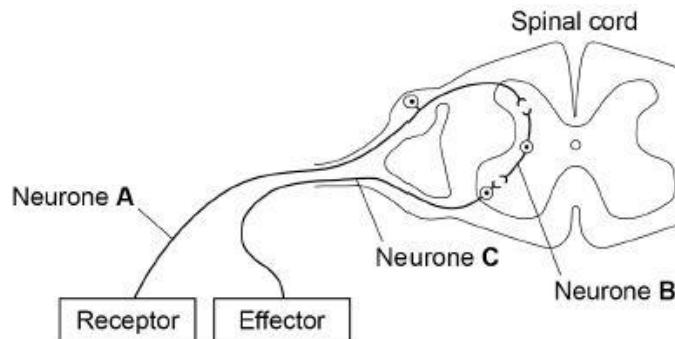
Explain how light intensity changes as the distance of the pondweed from the light source is doubled.

You **must** include calculations in your answer. (3)

- 5) Muscle cells and plant cells can respire anaerobically. Compare the processes of anaerobic respiration in muscle and plant cells. (4)
- 6) Plants need nitrate ions in order to make proteins. A plant is growing in soil flooded with water. Explain why the plant cannot absorb enough nitrate ions. (5)

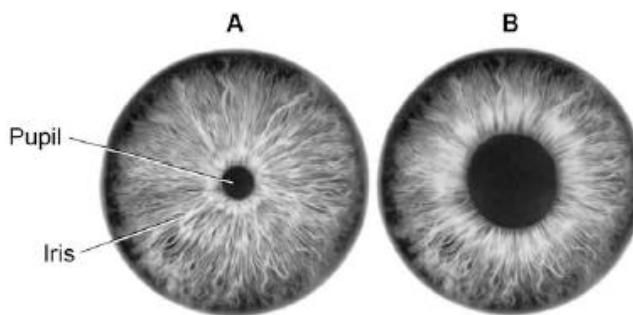
# Homeostasis & response

1) The figure below shows some structures involved in the coordination of a reflex action.



Describe how the structures shown in **Figure 2** help to coordinate a reflex action. (6)

2) The figure below shows a reflex in the iris of the human eye in response to changes in light levels.

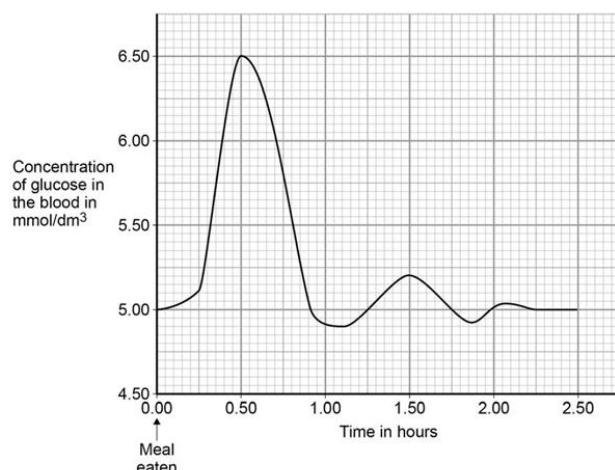


Describe the changes in the pupil and iris going from A to B in the figure. Explain how these changes occur. Refer to the changes in light level in your answer. (4)

3) Describe how information passes from the relay neurone to the motor neurone. (3)

4) Many functions of the human body are controlled by chemicals called hormones. What is a hormone? (3)

5) The graph shows changes in the concentration of glucose in the blood of a healthy person following a meal. Explain how negative feedback controls the blood glucose concentration during the first one and a half hours after the meal. (4)



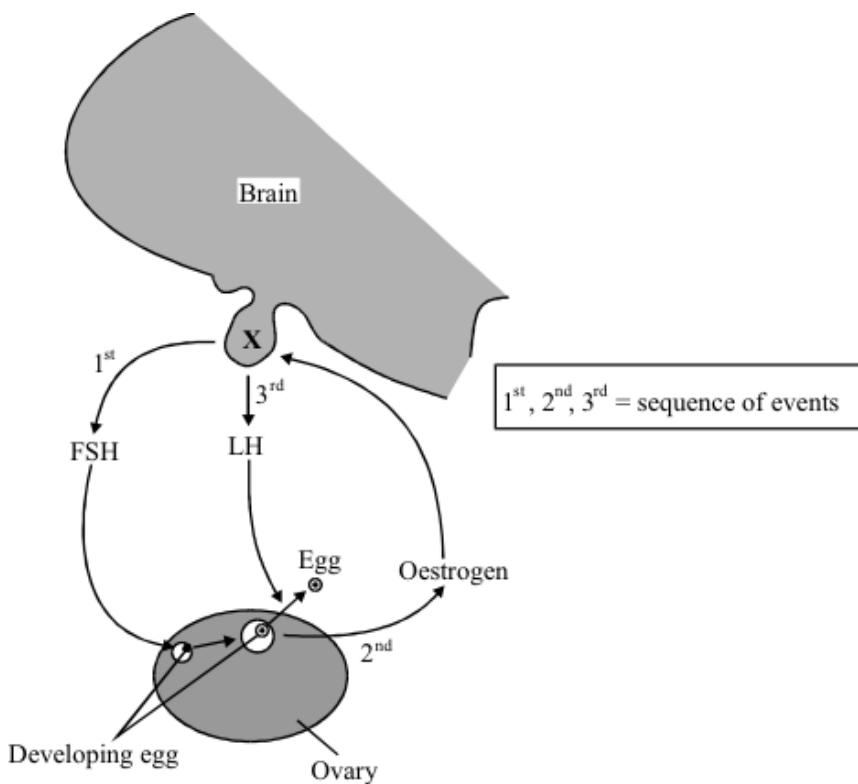
6) Humans keep their internal conditions almost constant. Body temperature is kept within a narrow range. When the core body temperature is too low, this is detected by the thermoregulatory centre in the brain.

Describe how the body responds when a decrease in core body temperature is detected. (6)

7) Describe what happens to the glucose in the blood of a healthy person when the blood enters the kidney. (3)

8) A diabetic person's blood often contains a high concentration of glucose. The urine of a diabetic person may contain glucose. Suggest an explanation why. (2)

9) The diagram shows how three hormones, FSH, LH and oestrogen, work together in a woman's body.



Use information from the diagram and your own knowledge to name the part labelled X and explain why some oral contraceptive pills contain oestrogen. (4)

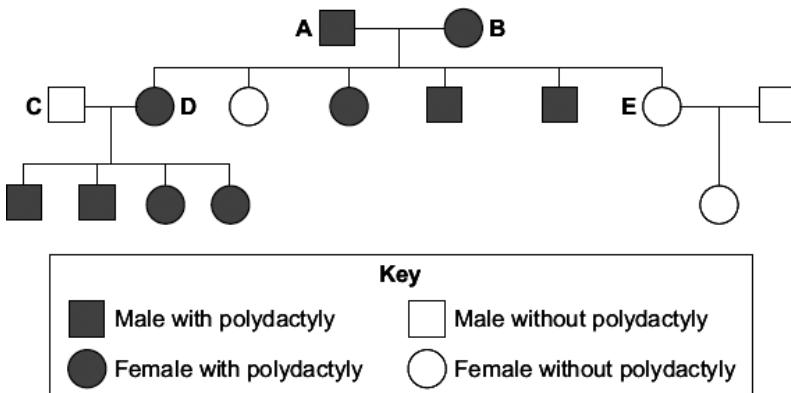
10) Plants respond to different environmental factors. Describe how different environmental factors affect:

- The direction of growth of the roots
- The direction of growth of the shoots

In your answer you should refer to the role of plant hormones. Do not refer to the artificial use of plant hormones by gardeners or scientists. (6)

# Inheritance, variation & evolution

- Meiosis and mitosis are different types of division in human cells. Compare the two processes by referring to where each takes place and the kind of products that are made. (6)
- The family tree shows the inheritance of polydactyly in three generations of cats.



What combination of alleles did the original parents, **A** and **B**, have?

Explain how you work out your answer. You may use a genetic diagram in your answer.

Use the symbol **H** to represent the dominant allele. Use the symbol **h** to represent the recessive allele. (4)

- Read the following.

In the 1950s farmers in India could not grow enough rice to feed the rapidly increasing population.

At the International Rice Research Institute (IRRI) scientists began a selective breeding programme with 10 000 different varieties of rice plants.

In 1966 the IRRI produced a new variety called IR8 which gave a yield of up to ten times the traditional varieties. IR8 has short stems and large rice grains.

IR8 was grown by farmers all over India so people had enough to eat.

The IR8 variety of rice was produced by selective breeding.

Describe the steps the scientists would have taken to produce IR8. (4)

- Following on from the above question:  
The IRRI has now developed several new varieties of genetically modified (GM) rice plants. Some people in India agree and some people disagree with GM varieties of rice being grown.  
Explain why. (4)

5) A poisonous chemical has been used to kill head lice for many years. Recently, the chemical has not been as successful at killing head lice. Many head lice now survive treatment with the chemical. Explain in terms of **natural selection** why most head lice are no longer killed by the chemical. (3)

6) Giraffes feed on the leaves of trees and other plants in areas of Africa. Darwin explained the evolution of the long neck in terms of getting leaves from the tall trees. Recently, scientists have tried to explain how the long neck of the giraffe might have evolved. These are some of the scientists' observations.

- Giraffes spend almost all the dry season, when there is not much food, feeding from low bushes.
- Only in the wet season do they feed from tall trees when there are plenty of new leaves.
- Females spend over 50 % of their time feeding with their necks horizontal.
- Both sexes feed faster and most often with their necks bent.
- Long giraffe necks are very important in male-to-male combat. Males fight each other with their long, powerful necks.

Do the observations support or reject the explanation that the long neck of the giraffe evolved to get leaves from tall trees?

Draw a ring around your answer. **Support / Reject**

Explain the reason for your answer. (3)

7) Following on from the above questions:  
Use the scientists' recent observations to give another explanation for the evolution of the long neck of the male giraffe. (3)

8) *Bacillus thuringiensis* (Bt) is a soil bacterium. It produces a poison that kills several different species of insect that feed on cotton plants. Over 90% of the cotton plants grown in Australia, the USA and China today are genetically modified to produce the Bt poison, resulting in less crop damage. Explain in detail how cotton plants can be genetically modified to produce the Bt poison. (4)

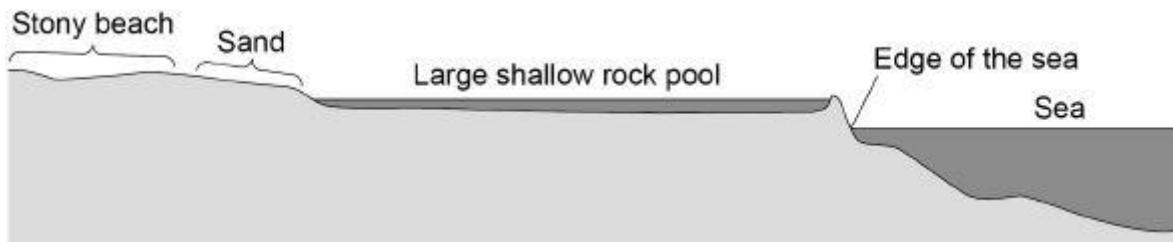
9) Carl Woese developed the 'three-domain system' of classification. Describe the 'three-domain system' of classification. (3)

10) **Panama is a narrow strip of land which today joins North America and South America.**  
It was formed by land moving up from beneath the sea. Panama has separated the Pacific Ocean and the Caribbean Sea for the past 3 million years.  
Explain how two different species of pistol shrimp could have developed from an ancestral species of shrimp. (6)

11) **Flamingos feed on organisms that live in mud at the bottom of lakes. Leopards prey on them. They find it difficult to fly if their feathers get wet. Flamingos have evolved very long legs.**  
How would each of the following theories explain the evolution of these long legs?  
**Darwin's theory? (3)**  
**Lamarck's theory? (2)**

# Ecology

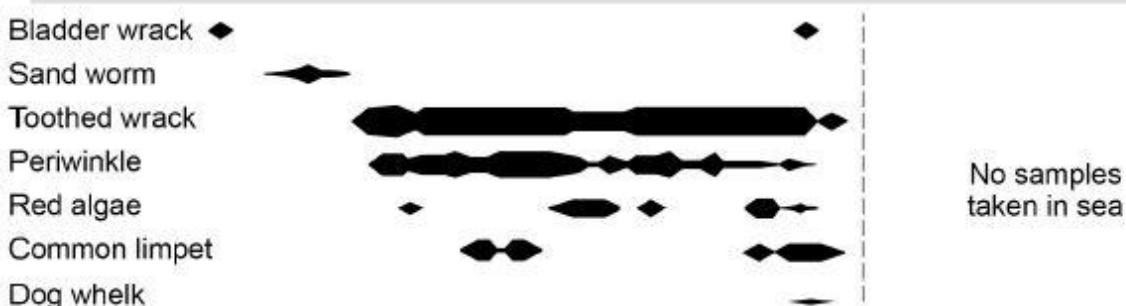
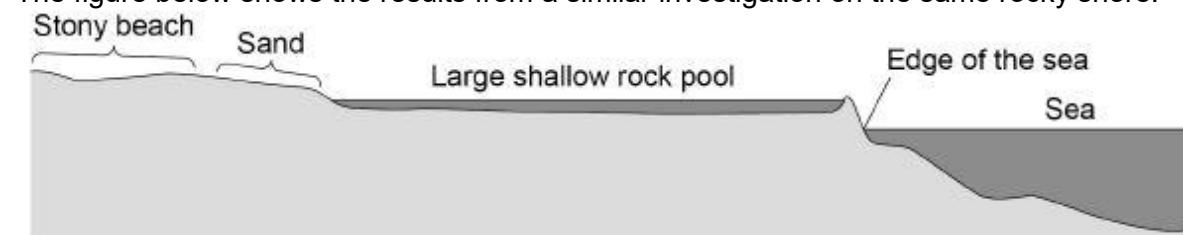
1) The figure below shows a rocky shore.



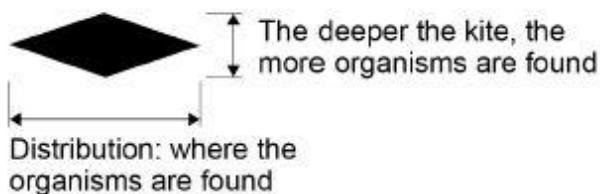
Students were asked to investigate how the abundance and distribution of different organisms change as you move from the edge of the sea to the stony beach.

Describe a method the students could use. (6)

2) The figure below shows the results from a similar investigation on the same rocky shore.



## Key



The shallow rock pool in the figure above has a **higher biodiversity** than the sand or the stony beach. Suggest **three** reasons why. (3)

3) In the last 200 years the concentration of carbon dioxide in the Earth's atmosphere has risen. Explain how a rise in carbon dioxide concentration in the atmosphere can decrease biodiversity. (6)

4) A dairy farmer washes out his cow shed each day. The waste water contains urine and faeces. The waste water overflows into a stream by mistake. The waste water will have an effect on the plants and invertebrates living in the stream.

Explain why. (6)

5) Describe how carbon is recycled in a woodland community. (6)

6) In January 2011 more than 600 000 people collected results for the UK national bird survey. People recorded the number of each species of bird they saw in 1 hour on 1 day in their garden. Some of the results are shown in the table below.

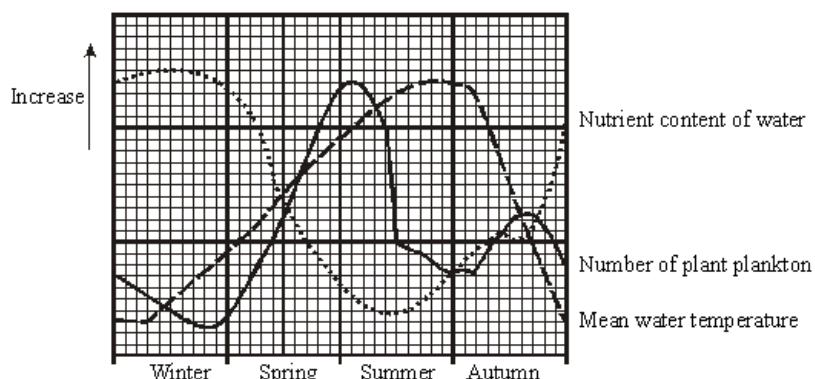
Species	Mean number of birds seen per garden	Percentage of gardens in which the bird was seen
House sparrow	4.1	64.5
Starling	3.9	51.3
Blackbird	3.2	95.2
Goldfinch	1.5	33.5

A student looked at the table and said:

"In the UK, house sparrows are more common than blackbirds."

Suggest **three** reasons why the student's statement may **not** be true. (3)

7) Plant plankton are aquatic microscopic organisms that photosynthesise. The graph shows the numbers of plant plankton in the North Sea at different times of the year.

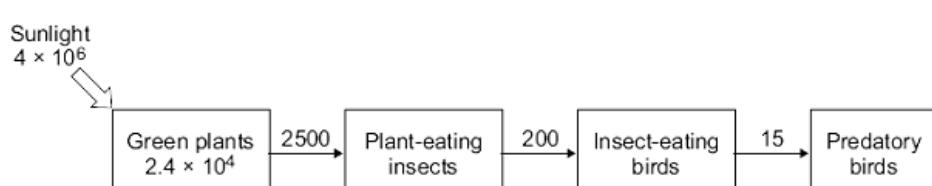


Use the data and your knowledge of photosynthesis and growth to explain:

a) why numbers of plant plankton were low in winter but increased rapidly during the spring. (3)

b) the reduction in numbers of plant plankton in the early summer. (1)

8) The diagram shows the annual flow of energy through a habitat. The figures are in  $\text{kJ/m}^2$



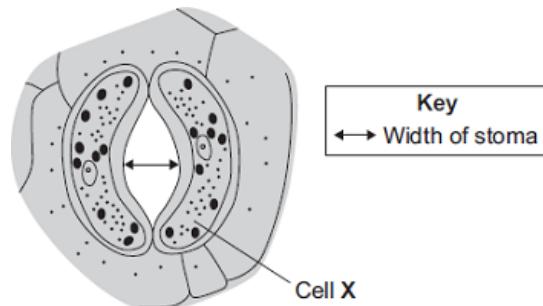
Compare the amount of energy transferred to the insect-eating birds with the amount transferred to the predatory birds. Suggest explanations for the difference in the amount of energy transferred to the two types of bird. (3)

9) Plant leaves have many stomata. The diagram below shows a stoma.

The table shows the mean widths of the stomata at different times of the day for two different species of plant.

Species **A** grows in hot, dry deserts.

Species **B** grows in the UK.



	Time of day in hours	Mean width of stomata as a percentage of their maximum width	
		Species A	Species B
Dark	0	95	5
	2	86	5
	4	52	6
Light	6	6	40
	8	4	92
	10	2	98
	12	1	100
	14	0	100
	16	1	96
	18	5	54
Dark	20	86	6
	22	93	5
	24	95	5

The data in the table show that species **A** is better adapted than species **B** to living in hot, dry deserts. Explain how. (4)

10) Some farmers use the battery method. They keep large numbers of chickens in a small indoor space. The food yield from these chickens is higher than that from free-range chickens. Explain why, as fully as you can. (4)

# MODEL ANSWERS

## Cell biology

- 1) The cell cycle is split into three sections. Section 1 is called the growth stage and it is where the cell produces new organelles, such as ribosomes and mitochondria, and the DNA replicates in the nucleus. In section 2 the cell undergoes mitosis. This is where the nucleus dissolves, the chromosomes move to either end of the cell and the nucleus reforms as two smaller nuclei. Section 3 is called cytokinesis and it is where the membrane and cytoplasm divides into two separate, genetically identical cells.
- 2) As the chloride ions move out of the cell into the mucus it increases the concentration of the solution outside of the cell and reduces the concentration inside. As the two sides are separated by a partially permeable membrane water molecules will move from the dilute solution into the more concentrated solution by osmosis.
- 3) Stem cells from embryos are undifferentiated. This means that they can be used to treat a wide variety of diseases. Whilst embryonic stem cells require the death of an embryo to collect, many embryos are wasted when an embryo is aborted. Using their cells to treat disease prevents this waste. The main ethical problem here though is that the embryo cannot give consent. Bone marrow stem cells on the other hand have little ethical issues as permission can be given by the patient. They have been tested more often and in comparison, to the embryonic cells are relatively safe to collect. Unfortunately, there are only a few diseases that can be treated with them due to the cells being mostly differentiated already. In conclusion, the embryonic stem cells provide the best option in treating human disease due to the fact that they can be used for a wide variety of diseases and the use of otherwise wasted embryonic cells from aborted embryos.
- 4) Mitosis and meiosis are two forms of cell division. Mitosis is a form of asexual cell division that takes place in somatic (body) cells. Meiosis is a form of sexual cell division that takes place in the ovaries and testes. Mitosis produces 2 identical diploid cells during a single cell division whereas meiosis produces 4 haploid cells that show variation. This happens during two divisions.
- 5a) The surface area of the model 1 is  $(0.5 \times 0.5) \times 6 = 1.5 \text{ cm}^2$ . Its volume is  $0.5 \times 0.5 \times 0.5 = 0.125 \text{ cm}^3$ . Its SA:Vol ratio is therefore  $1.5:0.125$ . For model 2 the surface area is  $(1 \times 1) \times 6 = 6 \text{ cm}^2$ . Its volume is  $1 \times 1 \times 1 = 1 \text{ cm}^3$ . Its SA:Vol ratio is therefore  $6:1$ . So that I can compare them the ratio for model 1 should be converted to the same scale.

Model 1's ratio becomes  $12:1$  and model 2's is  $6:1$ .

This shows that as the length of a side increases the surface area to volume ratio decreases.
- 5b) An animal has a smaller surface area to volume ratio than the bacterium and therefore oxygen in the air would have a greater distance to diffuse to reach the middle of the organism. This means that the centre of the organism would not receive the enough oxygen for respiration. A transportation system such as the circulatory system is required to transport the oxygen from a surface to deeper within the organism.

- 6) Active transport is a process which requires energy. This energy used in active transport is released during respiration, a chemical reaction involving oxygen and glucose. A higher concentration of oxygen in the tissue surrounding the small intestine allows a greater rate of respiration and therefore more energy to be made available for the active transport.
- 7) Due to the Nitrate ions being in a greater concentration inside the plant cells than the surrounding area they are absorbed from the soil by active transport. The process of active transport requires energy that is released by respiration. Respiration requires oxygen which would not be available if the surrounding ground was flooded. This means less respiration, less energy available and therefore less active transport.
- 8) Villi have many adaptations that make them efficient at their job. They have microvilli which increase the surface area through which molecules can diffuse. They have a very good blood supply which takes the nutrients away as soon as they are absorbed. This maintains a steep concentration gradient to maximise the rate of diffusion. They have a wall which is one cell thick meaning that there is a very short distance for the food to travel to pass into the blood. Finally, the cells in the small intestine tissue contain large numbers of mitochondria which provide energy for active transport.
- 9) As the water is in a higher concentration outside of the cell and it is separated by a partially permeable membrane the water will move by osmosis from outside the cell to inside the cell down the water's concentration gradient. This is a passive process and requires no energy transfer. The phosphate ions are found in a higher concentration outside of the cell. They will move by diffusion through the cell membrane down their concentration gradient. This is also a passive process and requires no energy. The magnesium however is found in a higher concentration inside the cell meaning that the ions will need to move up their concentration gradient. This requires a process called active transport which transfers energy from respiration.
- 10) There are 2 stomata in an area  $0.1 \times 0.1 \text{ mm}$  ( $0.01\text{mm}^2$ ).  $1\text{mm}^2$  is 100x bigger and therefore there would be 200 stomata in this area.

## Organisation

- 1) The transpiration stream is the movement of water from the root hairs where it is absorbed by osmosis to the leaves, via the xylem, where it evaporates through the stomata.
- 2) The potassium ions move into and increase the concentration of the solution inside the guard cells. The high solute concentration is separated from the lower concentration outside of the cell by a partially permeable membrane. This causes water to move into the cells by osmosis. The water makes the cells swell up unevenly as the inner cell wall is thicker than the outer wall.
- 3) Oxygen combines with haemoglobin in the red blood cells to form oxy-haemoglobin. The oxy-haemoglobin carries the oxygen around the body where it is released into muscle tissue. If there are more red blood cells then there is more haemoglobin to carry oxygen and therefore more oxygen is carried. This extra oxygen is used to increase aerobic respiration, releasing more energy for the muscles.

- 4) Blood is carried away from the heart by arteries. They have a thick layer of muscle and elastic tissue with a narrow lumen. Conversely veins have thinner muscle and elastic tissue and a much wider lumen. Due to the lower blood pressure that this causes in the veins they also have valves to prevent backflow. Arteries do not need these valves as their pressure is higher.
- 5) To test for protein the student should use biuret reagent. They should add it to the milk and it will turn from blue to lilac if protein is present. To test for starch iodine should be used. It should be added to the milk and if starch is present it will change from orange to blue/black. Finally, to test for glucose benedict's reagent should be used. The student should add it to the milk and heat the milk to above 60 °C. If glucose is present then the solution will change from blue to a brick red.
- 6) Bacteria begin to decompose the organic matter in the sewage by digestion. The bacteria require a lot of energy to do this which they gain through aerobic respiration by using the oxygen in the water. The concentration of oxygen in the water decreases meaning less oxygen for the fish to do aerobic respiration. This reduction in aerobic respiration reduces energy available for the fish and they die.
- 7) Blood leaves the lungs through the pulmonary vein, enters the left atrium of the heart and then into the left ventricle. It is then squeezed out of the left ventricle through the aorta which carries it to the rest of the body.
- 8) Starch is the substrate for amylase as its active site a complementary shape to that of the starch. When the starch is held in the active site bonds within the starch molecule are broken.
- 9) The role of the stomach acid is to kill bacteria. If the Helicobacter are resistant to the acid then they will not be killed. They could instead damage the mucus lining of the stomach allowing the stomach acid to come in contact with the stomach tissue. This would damage the stomach tissue and allow an ulcer to form.
- 10) The mitochondria are the site of respiration. They release the energy that is required for all metabolic processes. Some of this energy is used by the ribosomes to make chains of amino acids from an mRNA template. These amino acid chains are then folded in to enzymes and other proteins.

## Infection & response

- 1) After the exposure to the measles virus there is a much greater number of antibodies produced, 0.8 after the vaccine compared to 7.2 after the exposure. The antibodies are also produced much more quickly in response to the exposure, 0.4 of a week after the vaccine compared to 0.2 of a week after exposure. Finally, the antibodies stayed at a higher concentration for longer after the exposure. All these differences are due to the white blood cells having been previously exposed to the measles antigen from the vaccine. The immune system is able to recognise the pathogen more quickly and the memory cells produced after the vaccination are able to produce the correct antibodies more rapidly.

2) Viruses live inside the host's cells and therefore antibiotics are not able to come in contact with the virus particles.

3) The inactive form of the pathogen is recognised as foreign in the body. The lymphocytes are stimulated to produce antibodies that are specific to the antigens of the pathogen. Memory cells remain after the initial infection clears up and these can rapidly produce the specific antibodies if the body becomes re-infected.

4) New drugs must be tested before use for several reasons. Firstly, it is important to check that they are not harmful to the patient. Secondly, the drug has to be evaluated on how well it treats the disease and finally it is important to check that the new drug does not interact with any other medication that the patient might be taking.

5) Both medicines can be dangerous. The statins can damage body tissues such as muscles or the kidneys whilst the cholesterol blockers can interfere with the action of other drugs. Having said that only the statins can cause death. Statins must be taken for life whilst the cholesterol blockers do not. However, statins can reduce cholesterol down to zero whilst cholesterol blockers can only reduce the levels in the body. Whilst they are both dangerous, they both have their uses. Statins would be better for use in patients that have inherited high cholesterol whilst cholesterol blockers would be the better choice for those with dietary cholesterol problems.

6) Antibiotics have not been kept for when they are most needed and instead have been overused. Genetic mutation in the bacteria leads to variation in the effectiveness of the antibiotics. The most susceptible cells are killed leaving the more resistant ones. These reproduce creating populations of antibiotic resistant bacteria.

7) Bacteria produce toxins which damage cells. Viruses damage or kill cells when they leave them after reproducing.

8) Upon recognising a pathogen, the immune system fights an infection on multiple fronts. Phagocytes engulf invading microbes. Lymphocytes produce specific antibodies which bind to and clump the microbes for the phagocytes to engulf. Lymphocytes also produce antitoxins to neutralise the effects of the toxins released by the microbes. After the infection has been removed memory cells remain to recognise and fight the infection more rapidly next time.

9) As urine passes through the reaction zone HCG hormone binds to an immobile HCG antibody in the reaction zone. The urine passes up the stick where the HCG hormone also binds to the immobilised HCG antibodies in the results zone. In the control zone there are other antibodies which do not bind HCG but do bind other chemicals in the urine. Blue dye appears in both the control and results zone to show a positive result.

10) Magnesium is required to produce chlorophyll and therefore if there is a magnesium deficiency there will be less chlorophyll produced. This results in less light being absorbed and therefore a lower rate of photosynthesis. As there is less glucose being made there will be less glucose converted into proteins for growth. Growth will therefore be stunted.

11) The PVY protein is injected into a mouse to stimulate the replication of lymphocytes and the production of antibodies. The lymphocytes are extracted and combined with a tumour cell to form a hybridoma. The hybridoma which makes an antibody specific to PVY would be located and then cloned to produce many cells that produce the antibody.

# Bioenergetics

- 1) Light is absorbed by the chlorophyll in the chloroplasts.
- 2) The glucose that is produced in photosynthesis can be used in a variety of ways. It can be turned into starch for storage, into fats and oils for storage, to make amino acids for the production of proteins or it can be combined into cellulose for cell walls.
- 3) Photosynthesis is an enzyme driven chemical reaction and therefore it is affected by temperature. If the temperature decreases so will the rate of reaction. If the temperature increases the rate will increase until the enzyme denatures at which point the reaction will stop.
- 4) If the plant is placed 5cm from the light source then the light intensity would be  $1/5^2 = 0.04$ . When the light is moved to 10cm away the light intensity would be  $1/10^2 = 0.01$ . Therefore, as the distance to the light doubles the light intensity is quartered.
- 5) Anaerobic respiration in muscle and plant cells both occur without oxygen and they both release a small amount of energy. However, during the process plant cells produce ethanol and carbon dioxide, whilst muscle cells produce lactic acid.
- 6) Due to the Nitrate ions being in a greater concentration inside the plant cells than the surrounding area they are absorbed from the soil by active transport. The process of active transport requires energy that is released by respiration. Respiration requires oxygen which would not be available if the surrounding ground was flooded. This means less respiration, less energy available and therefore less active transport.

# Homeostasis & response

- 1) The receptor detects a stimulus for example pressure or temperature. The receptor generates an electrical impulse which travels down neurone A, the sensory neurone, to the spinal cord. The impulse passes from the sensory neurone to a synapse by triggering the release of a chemical called a neurotransmitter. This chemical diffuses across the gap and stimulates a new electrical impulse in neurone B, the relay neurone. The spinal cord acts as a coordination centre and passes the impulse to motor neurones across another synapse. This travels to the effector, usually a muscle, which carries out the response such as to move the arm.
- 2) The pupils have dilated in picture B. This happens in dim light to allow additional light to enter the eye. This happens when the circular muscles in the iris relax and the radial muscles contract.
- 3) The electrical impulse stimulates the release of neurotransmitters from the relay neurone. The chemical diffuses across the gap where it binds to the surface of the motor neurone. This stimulates a new electrical impulse to be generated in the motor neurone.
- 4) A hormone is a chemical messenger that is produced by glands in the endocrine system which travels in the blood and binds to receptors on the surface of specific organs or tissues.

- 5) Within the first 0.5 hours the glucose from the meal enters the blood which increases the blood glucose concentration from 5 to 6.5 mmol/dm<sup>3</sup>. The glucose is detected by the pancreas which secretes insulin to start moving the glucose out of the blood and into the body cells or liver. The liver will then convert the glucose to glycogen for storage. This results in the decrease of glucose in the blood after 0.5 hours until the glucose concentration falls below 5 mmol/dm<sup>3</sup>. The low glucose concentration is once again detected by the pancreas which begins to release glucagon. Some of the glycogen in the liver is reconverted back to glucose and released into the blood. The blood glucose concentration rises back up to 5.2 mmol/dm<sup>3</sup> at 1.5 hours. This negative feedback loop continues until the glucose concentration stabilises.
- 6) When a decrease in core temperature is detected the blood vessels supplying the skin constrict in a process called vasoconstriction which results in less blood flow to the skin and therefore less energy being lost to the surroundings. The muscles fibres are also stimulated to rapidly contract causing shivering. The additional movement increases the rate of respiration, an exothermic reaction, which supplies more heat.
- 7) Glucose is filtered out of the blood into the kidney tubule. It is then all reabsorbed back into the blood as it leaves the kidney.
- 8) Not all the glucose is reabsorbed as it should due to the concentration of the glucose in the blood being too high. There is not enough time to reabsorb it all before the blood leaves the kidney.
- 9) The part labelled X is the pituitary gland and is the site of production for many of the reproductive hormones. Normally FSH is released from the pituitary which stimulates follicle development during ovulation. Oestrogen in the contraceptive pill artificially inhibits the release of FSH from the pituitary and therefore there is no ovulation or egg release.
- 10) The roots and shoots respond to light, known as phototropism, and gravity, known as geotropism. The roots also respond to water, known as hydrotropism. Environmental effects lead to an unequal distribution of auxins in the roots and the shoots. In the shoots the higher concentration of auxins leads to faster growth whereas in the roots it inhibits growth. This causes the shoots to grow towards the light and against the force of gravity. Whereas the opposite happens in the roots. Roots also grow towards moisture.

## Inheritance, variation & evolution

- 1) Mitosis and meiosis are two forms of cell division. Mitosis is a form of asexual cell division that takes place in somatic (body) cells. Meiosis is a form of sexual cell division that takes place in the ovaries and testes. Mitosis produces 2 identical diploid cells during a single cell division whereas meiosis produces 4 haploid cells that show variation. This happens during two divisions.
- 2) Polydactyly is a dominant trait and therefore the allele must be H. Non-polydactyly must be recessive and therefore is represented by a h. As some of the offspring of A and B do not suffer from polydactyly, they must have the genotype hh. The only way this could happen is if both parents were heterozygous Hh.

- 3) The scientists chose varieties of rice that have short stems and rice with large grains. They cross bred the rice plants and chose the offspring with the desired characteristics. They repeated this process until all the plants have the desired characteristics.
- 4) GM can provide crops which are resistant to disease, produce higher yields or better nutritional content leading to improved health. However, there are some concerns that they may affect wild plants and pass any resistances to them or they could potentially affect the health of those who eat the rice as not enough research has been completed.
- 5) A mutation in the population of head lice led to variation of resistance against the chemical. Those with greater resistance survive the use of the chemical and breed. They pass the allele for the resistance onto the offspring leading to a resistant next generation.
- 6) From the observations the hypothesis should be rejected. Having a long neck would not be an advantage for feeding in the dry season and therefore would have little effect on survival rates. It is unlikely that the characteristic would be selected for.
- 7) A more likely explanation is that the long necks allow males to fight. Males with the strongest and longest necks are more likely to win, mate with females and pass their alleles for long necks onto the next generation.
- 8) The gene for the Bt poison is cut from the bacterial chromosome using transcription enzymes and transferred to the chromosomes of the cotton plants where it is expressed.
- 9) The three-domain system includes the archaea, simple primitive bacteria, the prokaryota, the true bacteria and the eukaryote, which includes plants and animals.
- 10) A population of shrimp is separated by a barrier of some kind. Different random mutations occur in each population. If the two populations of shrimp experience different environmental conditions, then natural selection will favour different phenotypes (characteristics). For example, a mutation which allows an organism to survive in a colder climate may be an advantage for one population but not the other. The alleles which cause these phenotypes will be passed onto the next generation. Eventually the two populations will be so different that they can no longer interbreed and have become separate species.
- 11) Darwin's theory – There is variation of leg length within a population. The ones with longer legs could feed in deeper water and are less likely to get their feathers wet. They are more likely to survive, breed and pass on their alleles for long legs onto their offspring.  
Lamarck's theory – Flamingos stretched their legs to be able to feed in deeper water and keep their feathers dry. The longer legs are an acquired characteristic that is inherited by the offspring.

## Ecology

- 1) The student lays a transect line from the edge of the sea up to the stony beach. They should place a quadrat at regular intervals along the same side of this line and count the number of species present in the quadrat. A key can be used to identify the species present. The transect should be moved further up the beach and laid parallel to the original line and the

experiment repeated. It should be done at least 3 times in total and means calculated for each quadrat up the shore.

- 2) The shallow rock pool has a greater biodiversity due to its stability of conditions. It does not dry out regularly so more plants can grow there, its temperature will remain more constant due to the water and there will be a greater range of food sources for the organisms to eat.
- 3) A rise in carbon dioxide levels leads to the enhanced greenhouse effect and an increase in global temperatures. This can cause extreme weather patterns, rising sea levels, changing patterns of rainfall and more frequent storms. Increasing sea levels will cause habitats to change due to flooding or introducing salt from the sea further in land. Changing climate will affect which plants and animals are adapted to survive in an area. More frequent storms or changing weather patterns can affect the access to sunlight from different species of plants. All of these things will eventually decrease biodiversity as the climate will change faster than organisms can adapt by natural selection.
- 4) The waste water contains a lot of minerals and organic material which increases the growth rate of algae and water plants. Plants that are lower down in the water have their light blocked and die due to lack of photosynthesis. Decomposers such as bacteria feed on the decaying matter and reproduce rapidly. The decomposers do respiration which uses up all of the oxygen in the water. The invertebrates living in the water die due to lack of oxygen. This is Eutrophication.
- 5) Plants take in carbon dioxide from the atmosphere and undertake photosynthesis. The carbon is locked into molecules of carbohydrates, fats and proteins. The carbon is transferred to animals by feeding and used in many different metabolic processes. One of these processes, respiration, releases the carbon back into the atmosphere as carbon dioxide. Excretion releases some more of the carbon back into the environment. The rest of the carbon is integrated into the body of the animal. When an animal or a plant dies it is broken down by decomposers. They also do respiration which releases this final carbon back into the atmosphere.
- 6) There are a number of reasons why the statement could be incorrect. First the study only happened for 1 hour, this is not enough time to produce reliable numbers. These birds were all counted in gardens, it is possible that not all these birds have gardens as their main habitat. The public was asked to identify the birds, it is possible that they may have misidentified. Finally, if 4.1 house sparrows were found per garden and they were found in 64.5 gardens that would give a value of 264 house sparrows. If you do the same calculation for the blackbirds, you find 305 blackbirds showing that blackbirds were more common.
- 7) A) The light levels and temperature is too low in the winter. The increasing light and warmth of spring increased photosynthesis which increased the growth rate.  
B) The nutrient content of the water decreases showing that the plankton have run out of minerals.
- 8) Less energy is transferred to the predatory birds than the insect-eating birds. This is due to the loss of biomass as undigested waste which is excreted and the energy that is lost through respiration in the insect-eating birds. Finally, when the insect-eating birds eats an insect the majority of the animal is eaten however when the predatory bird eats the insect-eating bird a much larger proportion is inedible, such as the bones and beak.
- 9) In species A the stomata open during the night, when it is cool, and close during the day, when it is hottest. Heat causes the rate of evaporation from the leaves to increase which

would in turn increase the rate of transpiration. Species B lives in a place where water is in plentiful supply and therefore does not need to limit transpiration.

- 10) The chickens that are kept in small areas are not able to move as much and therefore lose less energy as respiration. They also live in a temperature-controlled space. This means that energy is lost to the environment as heat. These two factors increase the amount of energy that can be used in growth or producing eggs in the chicken's body.