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## BIOLOGY ESSAY QUESTIONS AND ANSWERS

### Photosynthesis

**Write an essay describing the process of photosynthesis.**

Photosynthesis occurs in two stages, that is, light stage and dark stage. During light stage, light energy is trapped by chlorophyll in the chloroplast and converted into chemical energy. The chemical energy is used to split water molecules into hydrogen and oxygen atoms. The hydrogen is used in the dark stage, while oxygen molecules are released into the atmosphere as oxygen gas or used for aerobic respiration. Some of the chemical energy is used to combine a molecule called adenosine diphosphate with a phosphate group to form the rich energy molecule called adenosine tri-phosphate.

During dark stage, the hydrogen atoms formed in light stage are combined with carbon dioxide to form glucose using energy from ATP.

**Describe any *five* ways in which a plant leaf is adapted to its function. Your answer should be in essay form.**

Firstly, the leaf has broad and flattened surface. This increases the surface area for absorption of carbon dioxide and sunlight.

Secondly, the leaf is supported by a stem and a petiole. This exposes as much of the leaf as possible to sunlight and air.

Thirdly, the leaf has thin lamina. This reduces the distance across which carbon dioxide diffuses from stomata to photosynthetic cells.

Fourthly, the leaf has network of veins. This provides a good water supply to the photosynthesing mesophyll cells.

Lastly, the leaf has stomata on its surface. These allow carbon dioxide to enter the leaf.

**Explain *five* ways in which glucose is used by the plant after photosynthesis. (2004)**

Firstly, glucose is used for respiration which produces energy for growth and active

transport of substances across membranes.

Secondly, glucose is converted to cellulose which is used to form cell walls that protect the cell from bursting due to osmosis.

Glucose is combined with nitrogen to form proteins which is used to form enzymes.

Fourthly, glucose is converted to fats which are used to form cell membrane that controls substances getting into the cell.

Lastly, glucose is transported to storage organs where it is converted to starch for storage.

**Describe an experiment that could be carried out to show that fresh green leaves contain three types of pigments. Your answer should include procedures, results and conclusion in an essay form. (2008)**

In this as a method, one would collect green leaves from plants in a school garden. The leaves should then be grinded using a pestle and mortar. The grinded leaves should then be squeezed to obtain an extract. Cut a 2 cm by 10 cm strip of filter paper. Put a drop of the extract on the strip about 4 cm from the bottom edge. Dip the bottom edge of the filter paper with a drop of extract in alcohol in a beaker about 2 cm from the spot of the extract.

After some few minutes, the alcohol rises up the strip of filter paper dissolving the leaf extract. As alcohol passes the spot of extract, the different pigments in the extract move up at different rates, smaller ones will move faster than the bigger ones. This will separate the pigments in the extract into three different coloured spots.

The three different coloured spots indicate that leaves have three different types of pigments.

### **Transport in Plants**

**Describe briefly the process by which water enters the root hairs and escapes from the leaves at the top of a tall tree. (1995)**

Because of the higher solute (sugar and salts) concentration of the root hair cell sap than soil solution, water is drawn from the soil into the root hair. This dilutes root hair cell sap. So water moves further into neighbouring cells of cortex. The process will continue so that water travels through cortex into the xylem vessels.

Xylem vessels are long tubes made of elongated cells. The vessels extend from the root into stem to leaves. When the absorbed water enters the xylem it moves through the stem, branches, leaf petioles and finally into leaves.

The movement of water through the plant is also assisted by transpiration stream, the pulling (suction) force exerted due to loss of water from leaves.

In the leaves water would be distributed to all leaf cells by the net work of veins. Since air spaces in the leaf are connected to atmospheric air through stomata, water diffuses from leaf cells where it is more concentrated into the air spaces and out into the atmosphere where it is less concentrated.

**Describe an experiment you would do to show that transpiration from leaves affects uptake of water. Your answer should be in essay form. (2005)**

Prepare a shoot and fix it in a potometer. Fill the potometer with water of known volume.

Leave the plant on the ground where air is circulating and where there is enough light. As water transpires from the aerial surface of the shoot, it draws it from the potometer tube. The potometer will measure the amount of water taken up by the plant as a result of transpiration.

This then shows that transpiration affects water uptake in plants.

**Describe the *five* conditions in the environment that speed up the rate of transpiration in plants. (1997)**

Low humidity is one condition that speeds up the rate of transpiration in plants. When there is low humidity there is a bigger difference in concentration of water vapour between leaf and atmosphere, such that more water diffuses from the leaf into the atmosphere so increasing transpiration.

High light intensity causes the opening of stomata. The more the stomata are open the more water will be lost from the leaf.

Wind is another condition. Wind carries away water vapour from around the leaves so reducing the concentration of water in the air around the leaves. This encourages more water loss from the leaves through diffusion.

High temperature is the fourth condition. High temperature increases kinetic energy of water vapour so that the water vapour escapes faster from the leaves hence increasing transpiration rate.

High water supply is the last condition that speeds up the rate of transpiration in plants. High water supply makes the leaves not close their stomata to allow carbon dioxide to diffuse from the surrounding air into the leaf for photosynthesis even if the temperatures are very high. This increases rate of transpiration since transpiration mostly occur through stomata.

**Describe an experiment that could be carried out to show that light intensity affects rate of transpiration in leafy shoots. Your answer should include procedure, expected results and conclusion. (2011)**

In this as method, two leafy shoots of similar stages of growth should be prepared and each should be fixed into a potometer. The potometers should then be filled with water of known volumes. One leafy shoot should be placed on the ground where there is enough light and the other should be placed in a room where there is dark.

After eight hours, the two leafy should be removed from the potometers and then the transpiration rates from each leafy should be calculated by measuring the amount of water lost from each potometer for eight hours and then divide the amount of water lost by eight hours.

After calculating the transpiration rates per hour for the leafy shoots placed on light and in dark, the transpiration rates should be compared. The results would show that the transpiration rate for the shoot that was placed on light is greater than the transpiration rate for the shoot that was placed in dark. This gives a conclusion that light intensity increases the rate of transpiration.

**Describe any *five* ways in which a phloem is adapted to its function. Your answer should be in essay form.**

Firstly, the phloem has companion cell with numerous mitochondria which provide energy for translocation.

The phloem has sieve plate which provides support to the phloem tissue.

The phloem has sieve pores which act as a pathway for movement of materials.

The sieve elements lack other components of cell such as nucleus, in order to create space for transportation.

Lastly, the phloem has cytoplasmic filaments which aid in the flow of food along the sieve tube.

### **Human Digestive System**

**Describe *five* problems associated with human digestive system and state how each problem can be controlled. Your answer should be in essay form. (2007)**

The first problem associated with human digestive system is constipation. Constipation occurs when one faces difficulties in expelling undigested waste matter from the body. It is caused by lack of roughage in the diet and not drinking enough water. It can be controlled by drinking enough water after meals and doing physical exercises. It can also be controlled by using drugs such as laxatives.

Another problem is the heartburn. This is a burning feeling in the chest followed by a sour or bitter taste in the mouth. It develops when the acid contents of the stomach flows back into the oesophagus. It can be controlled by taking anti-acid medication.

Ulcers are another problem of human digestive system. An ulcer is an area of damage to the lining of the stomach, oesophagus and duodenum. It is caused by over production of acids in the stomach so that the acid corrodes the stomach walls. It can be prevented by eating diets with less acids and spices.

The fourth problem is appendicitis. This is inflammation of the appendix. This can be cured by removing the appendix in an operation.

The last problem is diarrhoea. This is a situation where by the large intestine fail to absorb water leading to production of watery faeces. It is caused by micro-organisms like bacteria taken together with food or water. Diarrhoea can be prevented by drinking treated water and observing food hygiene rules.

**Describe an experiment that could be conducted to show that germinating bean seeds contain an enzyme that digests starch. Your answer should include procedure expected results and conclusions. (2009)**

In the procedure for this experiment, crush germinating bean seeds in a mortar. Then add water to obtain the (enzyme) extract. After that put starch solution in test

tubes A and B and in test tube A add the extract, but leave test tube B intact. Leave both test tubes to stand for some time. Later, add drops of iodine solution to both test tubes and observe colour changes.

You will observe that in test tube A there will be brown colour. This shows there is no starch in test tube A. In test tube B a blue black colour will be observed showing that starch is present. This gives a conclusion that germinating bean seeds contain an enzyme that digests starch.

**Describe how cooked starch and proteins are chemically digested in the human gut. (1997)**

In the mouth, salivary glands produce saliva which contains an enzyme called salivary amylase. Salivary amylase digests cooked starch to maltose.

When the food reaches the stomach, gastric glands produce gastric juice which contains an enzyme called pepsin. Pepsin digests proteins to polypeptides.

When the food reaches the duodenum, pancreatic amylase in pancreatic juice produced by pancreas will continue digestion of starch to maltose. Trypsin in pancreatic juice digests polypeptides to peptides.

Finally in the ileum, the ileum lining secretes intestinal juice which contains enzymes that complete digestion of starch and proteins. Maltase digests maltose to glucose and peptidase digests peptides to amino acids.

**Explain five functions of the liver related to digestion.**

The liver controls glucose concentration in the blood. The liver converts excess glucose in the blood to glycogen for storage. If there is insufficient glucose in the blood, the liver converts glycogen to glucose for immediate use.

The liver breaks down excess amino acids. If too much protein is eaten, the excess amino acids are broken down in the liver into urea and carbohydrate.

The liver acts as a storage organ. The liver stores vitamins A, D, E, K and B<sub>12</sub> together with some mineral elements such as iron, copper and potassium until they are required by the body.

The liver regulates the level of lipids circulating in the blood. The liver converts fatty acids and glycerol into fats for storage under the skin. The liver also converts fatty acids and glycerol into glucose which can be used for respiration to

release energy.

The liver produces bile which emulsifies fats and regulates pH in the intestines for proper action of pancreatic enzymes.

**State any *five* vitamins and their respective functions. Your answer should be in answer form. (2013)**

The first vitamin is retinol. This vitamin is needed for seeing in dim light.

Another vitamin is vitamin B<sub>1</sub>. This vitamin is needed for normal functioning of the heart and the nervous system.

The third vitamin is niacin. This helps in the release of energy in cells.

Another vitamin is ascorbic acid. This vitamin makes the blood vessel walls strong.

The last vitamin is vitamin K. This helps in making an enzyme called thrombin that is involved in blood clotting process.

**Describe the fate of the end products of digestion in the bodies of human beings.**

### **Human Circulatory System**

**Write an essay describing problems associated with circulatory system and ways of preventing them.**

High blood pressure is one of the problems associated with circulatory system. The onset of high blood pressure is accumulation of yellow fats inside arteries called cholesterol. This cholesterol causes narrowing and hardening of arteries. Due to the narrowing of arteries pressure rises up. High blood pressure may damage the kidneys heart and arteries.

Heart attack is another problem associated with circulatory system. This is a condition in which heart muscles are not contracting due to insufficient energy. Heart attack occurs when a coronary artery is blocked. The part of the heart which the coronary artery serves is deprived of oxygen and nutrients. If only a small area of the heart is affected the person may recover; otherwise a large area implies a fatal result.

These problems can be prevented by taking exercises, keeping the body weight at

reasonable level and avoid smoking. Exercises increase the flow of blood through the muscles which may stop the fatty substance from settling down in the inner lining arteries. Keeping the body weight at reasonable level by avoid overeating helps to prevent cholesterol from accumulating in the lining of arteries. Avoid smoking removes the possibility of blood clotting caused by nicotine and carbon monoxide in the coronary artery.

**Write an essay describing the process of blood clotting.**

When a blood vessel is damaged platelets releases a chemical called thromboplastin. Thromboplastin converts a blood protein called prothrombin to an enzyme called thrombin. Both calcium ions and vitamin K are necessary for this to occur.

The enzyme thrombin catalyses the conversion of soluble plasma protein called fibrinogen into insoluble protein fibrin. Fibrin consists of fibrous strands which form thread – like net work over the damaged blood vessel. Blood cells get caught in the meshwork of fibrin fibres, forming a blood clot.

**Explain how the blood circulatory system is adapted to transpiration of oxygen from the air to cell in a mammal. Your answer should be in essay form. (1998)**

In the lungs there are numerous blood capillaries surrounding every alveolus. This increase the surface area for diffusion and so more oxygen is absorbed. The red blood cells are adapted to oxygen transportation in two ways. They contain an oxygen carrying compound called haemoglobin. Their biconcave shape provides more surface area for more haemoglobin and hence more oxygen is carried.

In addition, the red blood cells are large in numbers. This also increases the amount of oxygen transported to cells.

The tireless and constantly beating cardiac muscles enable oxygen to be transported continuously to cells.

The extensive net work of arteries and arterioles enables all corners of the body to be supplied with oxygen.

Another adaptation of circulatory system is the capillaries. Every tissue of the body is surrounded by a dense network of capillaries. This increases the surface area for more diffusion of oxygen from blood to tissue cells. Finally the capillaries are one – cell thick. This enables fast and easy movement of oxygen from blood to tissue cells.



**Write an essay stating five components of human blood and explain their functions. (2005)**

Plasma is one of the components of the human blood. Plasma is the liquid part of blood. It transports food substance from the alimentary canal to all parts of the body. It contains antibodies that fight against infections.

Another component of human blood is white blood cells. There are two types of white blood cells i.e. phagocytes and lymphocytes. Phagocytes engulf and digest bacteria; lymphocytes produce antibodies.

Red blood cells form another component of the human blood. Red blood cells determine the blood group of individuals since they have antigens.

Haemoglobin which transports oxygen throughout the body tissues is another important component of the human blood.

Another component of human blood comprises of platelets. Platelets prevent entry of germs into the body by forming clots.

**A heartbeat is made up of three stages. State the three stages of a heartbeat and describe what happens during each stage.**

Atria systole is the first stage of heartbeat. During this stage the atria contracts thereby opening the bicuspid and tricuspid valves. Blood is then forced into the ventricles. The ventricles are relaxed to receive blood. The semi-lunar valves are closed, preventing blood from flowing back into the ventricles from pulmonary artery and aorta. The pulmonary vein and venacava contracts to prevent blood from being squeezed out of the atria back into the veins.

The second stage is the ventricular systole. During the stage the ventricles contracts thereby creating blood pressure in the ventricles which opens the semi-lunar valves and closes bicuspid and tricuspid valves. Blood is forced into aorta and pulmonary artery. The atria are relaxed to receive blood from venacava and pulmonary vein.

The last stage is diastole. During this stage the atrial and ventricles walls relax briefly. The semi-lunar valves close. More blood flows into the atria which are dilated. When they are fill up a new heart cycle begin.

## **Respiratory System**

**Describe an experiment that could be carried out to investigate the effect of exercise on breathing rate in human beings. Your essay should include procedure, expected results and conclusion. (2010)**

In this as a method one would need a stop watch, a rope and a student. The student should be allowed to breathe for five minutes while seating. The number of breaths taken in five minutes should be recorded and then breathing rate per minute should be calculated by dividing the number of breaths taken by time taken.

Secondly the same student should skip twenty times the rope and immediately count the number of breaths taken in five minutes and then record. The breathing rate per minute after exercise should be calculated by dividing the number of breaths taken by time taken.

After calculating the breathing rates per minute before and after exercise, the breathing rate should be compared. The result would show that the breathing rate made before exercise is lower than after exercise. This gives a conclusion that exercises the rate of breathing.

## **Explain the mechanism of breathing in fish (2004)**

For inhalation, a fish opens its mouth while muscular contractions lower the floor of the buccal cavity and pharynx. This increases the volume of, and decreases the water pressure in, the buccal cavity and pharynx. Water flows into the mouth from the outside because the internal water pressure is lower than external water pressure.

Operculum muscles bulge. This increases the volume and decreases the pressure in the gill region. Water flows from the mouth cavity over the gills. As water pass the gill filament, oxygen diffuses out of the water into the blood and carbon dioxide diffuses out of the blood into the water.

For inhalation, a fish closes couth while the muscles raise the floor of buccal cavity and pharynx. This decreases the volume of, and increases the water pressure in the buccal cavity. The internal water pressure exceeds external water pressure and the

flexible edge of the operculum is forced open. The remaining water is forced out over the gills and through operculum.

**Describe the breathing mechanism in human beings. Your answer should be in essay form. (2006)**

Breathing involves two phases that is inspiration and expiration. During inspiration the muscles of the diaphragm contract. This pulls the diaphragm downwards causing it to flatten hence increasing the volume of the thorax. At the same time, the external intercostal muscles contract and internal intercostal muscles relax. This pulls the ribcage upwards and outwards. Together, these movement increases the volume of the thorax. As the volume of the thorax increases, the pressure inside it falls below atmospheric pressure hence air rushes into the lungs.

During expiration the muscles of the diaphragm relax. This allows the diaphragm to return to its dome shape, which decreases volume in the thorax. The external intercostal muscles relax and internal intercostal muscles contract. This pulls the rib cage downwards and inwards. This also decreases the volume of the thorax. As the volume of the thorax decreases, the pressure inside it rises above atmospheric pressure so that air is forced out of the lungs.

**Explain how breathing rate is controlled in human beings.**

Breathing rate is controlled by part of the brain called medulla oblongata. The main factor that affects breathing rate is carbon dioxide concentration. When the concentration of carbon dioxide in the blood increases during exercises, the receptors in the aorta and carotid arteries detect this. As a result, receptors send the nerve impulses to the medulla oblongata. The medulla oblongata sends impulses to the intercostal muscles and diaphragm to increase the rate and depth of breathing. More air is forced in and out of the lungs and finally, the level of carbon dioxide falls and breathing rate goes back to normal.

**During winter, a farmer decided to light a charcoal burner to warm calves in a modern cattle khola. Before the charcoal completely got burnt, it was taken into the khola which had the windows closed. The following morning the calves were found dead. In an essay form, explain the steps that lead to the *death* of the calves. (2011)**

The charcoal burner produced carbon monoxide which was inhaled by the calves. The carbon monoxide then diffused into the red blood cells where it combined

with haemoglobin to form carboxyhaemoglobin. Carboxyhaemoglobin does not split easily hence it lowered the capacity of red blood cells to take up oxygen. Lack of oxygen resulted into no respiration in the living cells hence the calves lacked energy. Due to lack of energy, the body processes stopped taking place and the calves died.

### **Locomotion**

**Flight in bird involves downward beat and upward beat. Write an essay describing what happens during downward beat and upward beat.**

During downward beat the pectoralis major muscles contract, pulling the wing down and the pectoralis minor muscle relax. The flight feathers overlap in a way as to trap much air so that there is more resistance below the wing to generate lift.

During up ward beat, the pectoralis minor muscles contracts and pectoralis major muscles relax, thus raising the wing up. The flight feathers overlap in a way as to let air pass between them so that air resistance is reduced below the wing. As a result there is no upthrust below the wing and the force of gravity pull down the bird so that it losses height.

**Describe *five* ways in which a bird is adapted to overcoming gravity and effect of drag in flight your answers should be in an essay form. (2007)**

Birds have streamlined body which reduces the effect of drag.

Birds have large and power pectoral muscles that provide power to flap wings in flight. This helps to overcome gravity.

Thirdly birds contain air sacs attached to the lungs and these make them lighter hence overcoming gravity.

Fourthly, birds have bones lighter hence overcoming gravity.

Lastly the feathers of a bird provide an aerofoil which generates lift hence overcoming gravity.

**Describe *five* ways in which a fish is adapted for swimming. Your answer should be in essay form.**

Fish has streamlined body which reduces drag as it moves through the water.

Fish has mucus glands which secrete slimy substance which moisten the scales.

Fish has flexible vertebral column which allows the fish's body to curve.

Fish has swim bladder which controls buoyancy and depth at which the fish swims in water.

The scales of fish overlap facing backwards. This reduces drag as the fish moves through water.

### **Reproduction**

**State any *five* contraceptive methods and explain how each one works your answer should be in an essay form.(2003, 2009)**

The first contraceptive method is contraceptive pills. Contraceptive pills contain oestrogen and progesterone-like hormones. These hormones prevent ovulation.

Another contraceptive method is vasectomy. This is an operation that is carried out on a man where the sperm ducts are cut. This prevents fertilization as sperms from testis cannot pass to vagina.

The third type of contraceptive methods is the use of the diaphragm. This is a dome-shaped rubber cap with an elastic rim inserted on the top of the vagina and placed over the cervix in this way the diaphragm prevents sperms from entry into uterus hence prevents fertilization.

Another contraceptive method is the use of the condom. A condom is a thin rubber which is used to cover erect before intercourse so that fertilization should not take place as the sperms cannot enter the vagina.

The last contraceptive method is the rhythm method. Rhythm method prevents fertilization as sexual intercourse occurs in safe days only.

**Explain any *five* ways in which breast feeding is important. (2012)**

Breastfeeding acts as a birth control. Breastfeeding delays the onset of menstruation for the mother hence delaying pregnancy.

Breast milk provides passive natural immunity to an infant ensuring that the infant

is able to resist disease infections in its early stages as its body develops.

The baby develops sense of closeness to the mother while feeding and this helps in baby's emotional development.

Breast milk contains substances that cleans and activates the alimentary canal of an infant to enable it to carry out digestion.

Breast milk reduces infant mortality by ensuring that the infants grow without any nutritional deficiency diseases.

**Describe any *five* adaptations of the human male reproductive system. Your answer should be in essay form.**

The human male reproductive system has testis that have highly coiled tubules called seminiferous tubules. These tubules produce spermatozoa.

Secondly, the testis lies outside the abdominal cavity in the scrotum. This keeps them at lower temperature than the body which is conducive for the sperm production.

Thirdly, the male reproductive system has epididymis which is highly coiled and lie next to the testis. In the epididymis is where the sperms are store.

Fourthly, the male reproductive system has sperm duct which transfer the sperms from epididymis to the urethra.

Lastly, the male reproductive system has seminal vesicle that secretes an alkaline secretion that forms semen. The secretion helps in nourishment of sperms.

**Describe the process of mitosis. Your answer should be in essay form.**

Mitosis occurs in four stages. The first stage is called prophase, during this stage the chromosomes shorten and become visible under the light microscope. The centriole divides, separate and start to move to the opposite poles of the cell forming spindle fibres. Each chromosome is seen to contain two strands joined together at the centromere. Nuclear membrane disintegrates. Nucleolus disappears making the end of prophase.

The second stage is metaphase. During this stage the spindle fibres increase in length. Chromosomes move and arrange themselves at the equator of the cell.

Each centriole is at the pole.

The third stage is anaphase. During this stage chromosomes separate into sister chromatids and then move to the opposite poles of the cell. Shortening of spindle fibres brings about the movement of the chromatids. At the end of anaphase, spindle fibres disappear.

The last stage is telophase. During this stage the sister chromatids have reached the opposite poles of the cell, the nuclear membrane reforms around each of the two sets of chromatids which have now become chromosomes. Nucleolus reappears.

**Describe *five* functions of the placenta. Your answer should be in essay form.**

The placenta is a place for exchange of substances between the mother's blood and the embryo's blood. The placenta allows dissolved food substances such as glucose, amino acids and oxygen to diffuse from the mother's blood into that of the embryo.

The placenta allows antibodies to diffuse from the mother's blood into that of the embryo. Antibodies protect the embryo against certain diseases.

The placenta secretes progesterone hormone that maintains pregnancy by ensuring proliferation of uterine wall.

The placenta secretes human placental lactogen hormone which stimulates the development of mammary glands in preparation of lactation.

Lastly, the placenta forms a barrier separating the embryo's blood system and the mother's blood system. This prevents the mother's high blood pressure from damaging the embryo's delicate blood vessels.

**Describe the process of meiosis. Your answer should be in essay form. (10 marks)**

**Describe the process of fertilization in human beings. Your answer should be in essay form. (10 marks)**

## Human Diseases

**Suppose there is an outbreak of diarrhoea in a boarding school. Describe how you would establish the cause of the outbreak your answer should be in an essay form. (2005)**

To establish the cause of diarrhoeal diseases, the following can be done:  
Firstly, I would find out about personal hygiene of student because unhygienic conditions results in breeding of various types of germs.

I would also establish how food is prepared at the cafeteria and surroundings where food is prepared.

I would also find out about the source of water used by students whether it is from a hygienic source. If it is from boreholes, then I would advise that the boreholes should be re-located away from pit latrines.

Knowing whether the students had been vaccinated against diseases like cholera before would be necessary.

Besides all these, I would find out the methods of waste disposal used at the school. Waste management is crucial since waste disposal areas are breeding grounds for microbes that cause diarrhoeal diseases.

**The mode of transmission of a disease determines how people try to prevent it. Discuss the above statement by referring to sleeping sickness and cholera. (1994)**

Sleeping sickness is caused by *Trypanosoma rhodesiense* which is transmitted from one person to another by tsetse flies. Sleeping sickness can be controlled by killing the tsetse flies and preventing their multiplication. This can be done by sterilizing the male tsetse flies so that if they mate the females, the latter should not lay eggs. Tsetse flies can be killed by spraying the bushes with the pesticides. Another way of preventing sleeping sickness is to avoid making settlements close to humid conditions along the river banks and thicker vegetation where the tsetse flies live. This helps to prevent the tsetse flies bites.



Cholera is caused by a bacterium called *Vibrio cholerae* which is transmitted to humans by infected water. Cholera can be prevented by chlorinating or boiling drinking water and by ensuring that human wastes do not contaminate water supplies.

Cholera can also be transmitted by flies from infected faeces to food. This can be prevented by maintaining proper hygiene such as covering foods and also proper use of latrines. In addition, keeping the public places clean helps to prevent the flies from finding the breeding places.

**Describe two diseases of human beings caused by protozoa, and explain how each affects the body and how it may be controlled. (1999)**

Malaria is one of the diseases caused by protozoa. Malaria is caused by plasmodium which is transmitted by female anopheles mosquito. When the plasmodium enters the body through mosquito bites, they multiply and enter the bloodstream where they destroy the red blood cells. The destruction of red blood cells leads to anaemia. Apart from anaemia, the waste products left by plasmodium lead to fever, headache and high body temperature accompanied by excessive sweating.

Malaria can be controlled by reducing the population of mosquitoes through spraying the rooms with insecticides that kill mosquitoes, draining stagnant water to prevent egg laying by mosquitoes by destroying their breeding grounds, breeding fish and ducks in slow running water to eat mosquito larvae and spraying oil on stagnant water that cannot be drained to prevent the larvae from breathing hence killing them by suffocation.

Another disease caused by protozoa is sleeping sickness. Sleeping sickness is caused by *Trypanosoma rhodesiense* which is transmitted from one person to another by tsetse flies. When the *Trypanosoma rhodesiense* enters the body through tsetse flies bites, it leads to fever, severe headache, swollen lymph nodes and insomnia at night.

Sleeping sickness can be controlled by killing the tsetse flies and preventing their multiplication. This can be done by sterilizing the male tsetse flies so that if they mate the females, the latter should not lay eggs. Tsetse flies can be killed by spraying the bushes with the pesticides. Another way of preventing sleeping sickness is to avoid making settlements close to humid conditions along the river banks and thicker vegetation where the tsetse flies live. This helps to prevent the tsetse flies bites.

**Suppose you are a Health Assistant in a community where there is high prevalence of malaria, what advice would you give to the community on prevention of malaria. Explain any *five* points in essay form. (2008)**

### **Human Population**

**Describe *five* problems which result from rapid growth of human population and how they be controlled. Your answer should be in essay form.**

The first problem from rapid growth of human population is deforestation. This is the clearing of large areas of natural woodland and forest either for settlement or agriculture. Deforestation disturbs rainfall pattern which eventually leads to desertification.

Another problem is overgrazing. When people have occupied almost all lands including where animals would be feeding, the animals are forced to graze on small piece of land for long time. This leads to soil to soil erosion and therefore loss of fertility.

Scarcity of land forces people and companies to dump waste material some of which can be toxic into the environment. This pollution can lead to contamination and therefore diseases.

Over population can also lead to food insecurity. This is due to scarcity of land and due to lowering of quality of agricultural land.

Overpopulation can lead to overcrowding and this can encourage spread of diseases e.g. tuberculosis.

Rapid population growth can be controlled by reducing birth rate, conservation of resources, improved sanitation and reducing over – consumption of food.

**Explain any *five* factors that may increase human population growth.**

### **Tropisms**

**Describe an experiment that would be used to find out the effect of unequal distribution of light on growing shoot. In your answer include method, expected results and conclusion. (2004)**

In this as a method, one would need two potted bean seedlings of similar stages of growth, one of which is placed in cardboard box with a window cut in one side to allow light to penetrate from one direction. The other should be in a similar situation but placed on a rotating clinostat. This exposes each side of the shoot to light equally. This is a control.

After two days, the two plants should be removed from boxes and compared. The results would show that the stem of the plant with one-sided illumination has changed direction of growth and is growing towards the light. The one in clinostat does not bend.

This gives a conclusion that unequal distribution of light affects a growing shoot since it has responded to one-sided lighting by growing towards it.

**Design an experiment that you would conduct to find out the region that responds to stimulus of gravity in bean seedlings. Your answer should be in essay form. (2006)**

In this as a method, one would need two newly germinated bean seedlings with straight radicles, one of which is pinned to a cork which is then placed in the mouth of a jar. The jar is then left on its side. The radicle being horizontal will be subjected to gravitational force perpendicular to its length. The other should be in similar situation but placed on rotating clinostat. This ensures that gravity acts equally on all sides of the radicle. In both cases, put moist cotton wool so as to keep the seedlings moist. The apparatus should then be left in darkness to eliminate the possibility of phototropic response.

After two days, the bean seedlings should be removed from the jars and compared. The results would show that the radicle (root) of seedlings in the stationary jar has changed its direction of growth and is growing towards gravity. The one on the clinostat does not bend.

This gives a conclusion that roots responds to gravity by growing towards it.

### **Excretion**

**One of the forms of treatment for people who have lost both their kidneys is through the use of dialysis machine. Write an essay describing how a dialysis**

**machine works.**

A dialysis machine receives blood through tube connected to an artery. Inside the machine, blood flows through dialysis tubing. The tubing has partly permeable walls and is bathed in dialysis fluid, which has the same concentration of substances found in blood plasma but does not contain any waste substances. This means that waste products such as urea are more concentrated in the blood than dialysis fluid so they diffuse out of blood into dialysis. Useful substances such as glucose and salts do not diffuse out of blood because the concentration of these substances in dialysis fluid and blood are the same. Large molecules, such as blood proteins and red blood cells, are too large to pass through the dialysis tube wall.

After the blood has circulated through the dialysis machine, most of waste substances are removed from it. The purified blood is re-introduced into the patient's body via a vein of the arm.

**Describe how nitrogen atoms eaten in a bean meal can eventually be excreted in urine. (2002)**

When one has taken a bean meal, the proteins in the meal are digested into polypeptides by pepsin in the stomach. Polypeptides are digested to peptides by trypsin in the duodenum which are later digested into amino acid by peptidase in the ileum.

Amino acids are then absorbed into the small intestine where they are transported together with blood to the liver by the hepatic vein. Here excess amino acids are deaminated by the liver, where nitrogen is removed from the amino acid. The nitrogenous compounds combine with carbon dioxide to form urea. Urea is transported to the kidneys through blood by the renal artery. The kidney removes urea through ultra filtration and reabsorption. Urea is then excreted as urine.

**Describe how urine is formed in the kidneys of the human body. Write your answer in essay form. (2010)**

Urine is formed in two stages, namely: ultrafiltration and selective reabsorption. Ultrafiltration is a mechanical process that takes place in the Bowman's capsule producing glomerular filtrate. Ultrafiltration occurs due to a combination of high blood pressure in the glomerulus, and the structure of glomerulus and Bowman's capsule. The high blood pressure develops in the glomerulus because the afferent arteriole is wider than the efferent arteriole. The high blood pressure squeezes the

blood against the walls of the capillaries of glomerulus. The walls of these capillaries are semi-permeable so that substances with small molecules such as water, glucose and urea are forced out of capillaries and Bowman's capsule into the renal tubule while blood cells and blood proteins remain in the blood in the glomerulus since they have large molecules.

As glomerular filtrate passes along the renal tubule, some substances that are useful to the body are selectively reabsorbed into the blood capillary network surrounding the nephron. These substances are reabsorbed either by osmosis (for water) or diffusion or active transport leaving behind substances in the renal tubule called urine.

**Describe any *five* adaptations of a nephron to its function. Your answer should be in essay form.**

### **Ecosystems**

**Nitrogen is an important element in synthesis of proteins which are essential for growth. Starting with atmospheric nitrogen, describe how this element is recycled in nature. (1990)**

Atmospheric nitrogen is converted to nitrates by free-living bacteria in the soil and by nitrogen-fixing bacteria in the root nodules of legumes. The nitrates are then absorbed by plants and later the plants convert them into organic material. These organic materials form tissues of plants. Animals feed on plants and obtain these organic materials. When both plants and animals die, the organic materials forming the tissues are broken down through decay and decomposition to release ammonium compounds into the soil. The ammonium compounds in the soil are in turn converted back into nitrates which are usually available to the existing plants. Some of these nitrates are lost by leaching process or converted to nitrogen of the air through the process called denitrification.

**Describe how the population of a plant in an open field can be estimated. Your answer should be in essay form. (2007)**

Firstly choose one type of weed from the field. Use a 0.25 square metre quadrat to estimate the population size of the weed by dropping it anywhere in the field. Then count and record the number of chosen plants inside the quadrat. Drop the quadrat at random in different parts of the field so that you have ten readings altogether. Use your ten readings to work out the average number of plants in a quadrat.

Secondly measure and calculate the total area of the field in square metre. The population of a plant is then estimated by multiplying the area of the field by average numbers of plants in a quadrat divided by the area of the quadrat.

**Design an experiment that would be used to estimate the density of grasshoppers in a school garden (2003)**

In this as a method, one would use the sweep net to capture the grasshoppers in 15 minutes from the garden. The captured grasshoppers should then be kept in well ventilated containers and they should not be harmed in any way. Carefully mark each grasshopper with a nail varnish and then count the total number of grasshopper marked. Then release the grasshoppers into the garden.

After two hours, repeat the capturing exercise in which one should collect both marked and unmarked grasshoppers. The recapturing exercise should also take 15 minutes in the same garden. One should then count the marked and unmarked grasshoppers in the second sample. The population of grasshoppers will then be estimated by multiplying the number of grasshoppers in the first catch by number of grasshoppers in the second catch divided by numbers of marked grasshoppers recaptured.

After estimating the population of grasshoppers, measure and calculate the total area of school garden in square metre and then calculate the population density of grasshoppers by dividing the total population to grasshoppers by total area of the school garden.

**Suppose you are an environmental officer in an area where people are not aware of the cause of environmental degradation. Explain any *five* causes and effects of environmental degradation you would include in your advice. Your answer should be in an essay form (2009)**

Overgrazing is an environmental degradation that results from feeding large herd of animals on a small piece of land continuously. It causes depletion of plant species or may lead to desertification or siltation of rivers siltation can cause floods.

Deforestation results from wanton cutting down of trees. It leaves the soil bare. When there is heavy wind or rain, top soil is lost through soil erosion. Loss of top soil can lead to siltation in river and also loss of soil fertility.

Another environmental degradation arises from pollution. This is when humans or

industries dump waste toxic materials in the environment. Pollution can cause death of organisms or loss of habitat or acid rains.

Introduction of alien species to a habit or community may lead to new species feeding on indigenous species or competing for food and light with indigenous species. This may lead to extinction of indigenous species.

Bush fires are environmental degradation which destroys the ecosystem. This may also reduce total number of species in the environment or cause soil erosion or siltation of rivers or air pollution. These may lead to global warming or loss of habitat.

**Explain the ways in which Shire River could become polluted by human activities. (1991)**

Agricultural, industrial and domestic activities are some of the human activities which can cause pollution to Shire River.

When fertilizers are used on agriculture land, rain water may carry nitrates and phosphates into the river. This may result into rapid increase in algae population and cause reduction in the amount of dissolved oxygen in the water. The oxygen is depleted by bacteria which decompose the dead algae.

Pesticides used in farming may also be washed into the river by rain water. These may poison the organisms at higher trophic levels in the food chain. This effect is caused by pesticides such as DDT which do not compose and become more concentrated along the food chain.

Industrial activities which could cause pollution include discharging of chemicals into the water. These may poison the living organisms in the river. Heated water from industrial processes may affect river organisms by, for example, increasing algae growth.

Domestic activities like disposal of human wastes into the river may result into rapid increase in algae population and cause reduction in the amount of dissolved oxygen in the water.

**Discuss the energy flow in tropical woodland. Your answer should be in essay form. (1992, 2008)**

**Describe any *five* characteristics that enable fresh water plants to survive in**

their habitat. Your answer should be in essay form. (2013)

### Co-ordination

**Describe *five* problems associated with the nervous system and state how each problem can be controlled. Your answer should be in essay form.**

The first problem is poliomyelitis. This is a situation where there is a permanent damage of the motor neurones to the legs, arms so that there is no response of these organs. This leads to poor development of bones and limbs wither. Polio is caused by a virus which multiplies in the spinal cord. Polio can be prevented by vaccinating the children.

Tetanus is another problem. This is a situation whereby there is a permanent contraction of muscles. Tetanus is caused by *Clostridium tetani* which multiplies in deep wounds. Injections of antitoxins and muscle relaxing drugs help to cure tetanus.

Leprosy is another problem. The infection attacks the skin and the sensory neurones so that the sensation is lost in some parts of the skin. Leprosy is caused by *Mycobacterium leprae*. It can be controlled by drugs.

Meningitis is another problem. Meningitis is the inflammation of the meninges. It may be caused by physical injury, a reaction to certain drugs or infection by certain viruses, bacteria, fungi or parasites. Use of antibiotics such as benzyl penicillin helps to cure meningitis.

The last problem is stroke. Stroke is brain damage caused by lack of blood flow to any part of the brain. It occurs when blood flow to a part of brain is interrupted because of blockage of an artery in the brain or bursting of capillary in the brain leading to a blood clot. The brain cells starve to death due to lack of oxygen. Stroke can be managed by prompt medical attention to remove the blood clot.

### Immunity

**Describe *five* barriers which the body uses to prevent entry of disease causing organism into it. Explain how each works. (2003)**

The first barrier is the skin. The skin secretes an oily substance called sebum which kills bacteria.



In case the skin is cut, the mechanism of blood clotting act as another barrier. Blood clotting prevents the entry of germs into the bloodstream through cuts in the skin.

Tears also act as a barrier. Tears contain an enzyme called lysozyme which digests and break down harmful micro-organisms into harmless substances. Therefore, harmful micro-organisms cannot enter the body through the openings around the eye.

Another barrier is mucus. Mucus is a sticky liquid in certain body openings like the nose and throat. It traps micro-organisms entering through these openings hence preventing the entry of micro-organisms into the body.

The last barrier is cilia. Cilia are tiny hair like structures that line the inside of some parts of the body such as trachea. Cilia move back and forth to sweep micro-organisms in the trachea and prevent them from entering the lungs

### **Describe how one can acquire natural and artificial immunity. (1998)**

Natural immunity occurs when lymphocytes produces the antibodies in response to arrival of foreign antigens (pathogens). When the lymphocytes come in contact with the foreign antigen they produce plasma cell clones and memory cells. Plasma cell clones produce antibodies which destroy the pathogens. Memory cells remain inactive and remain in the blood for a very long time after the infection. If the same pathogen gets into the body again, the memory cells recognise it at the same time. The immune response is immediate to the pathogen, killing it before it has any chance of breeding.

Natural immunity also occurs when antibodies are passed from mother to child through placenta and also breast milk. These antibodies protect the baby against certain infections.

Artificial immunity is established by injecting a small quantity of antigens, the vaccine, into the body. This stimulates the body to recognise antigens and to respond to them.

Artificial immunity is also acquired when serum containing antibodies is extracted from one organism and injected into another organism, protecting it from a specific disease.

**Suppose you are a medical doctor and you have a patient who requires blood**

**transfusion. Explain any *five* factors that you would consider before carrying out a blood transfusion. You should be in essay form. (2010)**

### **Evolution**

**Using Darwin's theory evolution, describe how a population of fast running Zebras would involve from slow running ancestor in an environment where lions are predators. Your answer should be in an essay form. (2007 Leaked Paper)**

According to Darwin's theory of evolution, species arise by natural selection acting on a wide range of inheritable variations. In a such a population of slow running Zebras, there were some Zebras that were born fast runners. In such environment where Lions are predators, the fast running Zebras will be able to survive and produce young ones. Slow running Zebras will be caught and slowly be eliminated from the population. The gene for fast running in the fast running zebras will therefore be preserved and extended to successive generations and the gene slow running will be eliminated from the population.

After a long period of time the population will be left with only the species of fast running Zebras.

**Explain any *five* evidence of evolution. Your answer should be in essay form.**

The first evidence is fossil records. Fossils are the remains of dead organisms that have been preserved in sedimentary rocks. The records from fossils show the gradual change in animals over a period of time. Fossil records also reveal the extinction of organisms due to presence of fossils of organisms that do not exist today.

Another evidence is comparative anatomy. Comparative anatomy looks for structures, though may serve different functions in adult, and is similar, suggesting a common ancestral origin. For example the forelimbs for different vertebrates have similar bones built on the same plan which suggest that they share a common ancestor.

Geographical distribution is another evidence. The mammals that are found on all continents are similar. The similarities support the idea that they arose from a common ancestor many millions years ago and have evolved differently due to geographical isolation.

Comparative embryology is the fourth evidence. This refers to comparison of

embryos in different organisms. When the development patterns in embryos of vertebrates are compared, many similarities are noted in the early stages of embryonic development. The similarities suggest a common ancestral origin.

Cell biology is the last evidence of evolution. Study of cells making up living organisms show that they have similar cell organelles e.g. nucleus and cell membrane. Presences of similar organelles suggest that those organisms have common ancestral origin.