**BIOLOGY (231/2) REVISION QUESTIONS (ESSAYS): EXPECTED RESPONSES**

**1. Explain the various ways in which a typical cell is adapted to its functions**

Has a cell membrane; with pores; that regulates substances entering and leaving the cell; cytoplasm; contain sugars and salts; for maintaining its osmotic pressure; also has a liquid medium; for all biochemical reactions; nucleus; contain chromosomes having hereditary material; and controls all the activities of the cell; ribosomes; are sites for protein synthesis; golgi bodies/apparatus; for secretion of hormones and enzymes; formation of lysosomes; lysosomes; contain lytic enzymes for breaking down worn-out organelles; secretory vesicles; formed from golgi apparatus for secreting substances; smooth endoplasmic reticulum; synthesizes and transports lipids; rough endoplasmic reticulum; transport proteins; nucleolus; controls the activities of the nucleus; produces ribosomes; mitochondria; form sites for energy production; centrioles; formation of cilia and flagella; forms spindle fibres used in cell division; plant sap vacuoles; store salts and other dissolved substances; controls osmotic pressure and turgidity of cells; food vacuoles involved in digestion of engulfed food; chloroplasts; form sites for photosynthesis in plant cells; **Max. 20 mks**

**2. Explain how the various specialized cells are modified to carry out their functions in plants and animals**

Animal cells: Sperm cell; has acrosome containing lytic enzymes; that digest the egg membranes for penetration during fertilization; has a long tail; containing numerous mitochondria; to generate maximum energy for propulsion/swimming in the vaginal fluid after ejaculation; Red blood cells; are flattened, circular/spherical biconcave in shape; to increase the surface area for packaging of haemoglobin; has haemoglobin; that combines with respiratory gases; for transport to and from body tissues; White blood cells; are amoeboid in shape hence able to change shape; to engulf pathogens through phagocytosis; lymphocytes produce antibodies to fight pathogens; Nerve cell; has extensions/dentrites; to receive and send information for sensation; Ciliated epithelial cells; have cilia for propulsion of mucus that traps dust and micro-organisms in the respiratory tract; Muscle cells; elongated, striated and contractile; to bring about movement; Plant cells: Guard cells; bean-shaped; to regulate the size of the stomata allowing gaseous exchange; and control water loss; has chloroplasts with chlorophyll; for photosynthesis; Root hair cell; elongated; thin-walled; with dense cytoplasm for absorption of water and mineral salts; Epidermal cell; thin; for protection of inner tissues from mechanical and micro-organism attack; Palisade cell; contains numerous chloroplasts with chlorophyll; for photosynthesis; elongated; to increase surface area for trapping maximum amounts of light energy; Meristematic cell; thinwalled; with dense cytoplasm; for primary and secondary growth; **Max. 20 mks**

**3. Describe how the mammalian body protects itself against infections**

Pathogenic microbes are found on the skin, respiratory tract, mouth, vagina and the intestinal tract; the skin; has a keratinised and waterproof cornified outer layer; that provides a mechanical barrier to microbes/prevents entry of microbes; sebaceous gland; produces sebum; which has antiseptic properties; the respiratory tract; produce mucus secretions that trap dust; cilia sweep/waft/propel the microbes to the pharynx for swallowing or to be coughed out; reflex actions of coughing/sneezing/vomiting help remove foreign materials from the respiratory tract/digestive

tract; lysozymes/enzymes in saliva/nasal secretions/tears; digest walls of bacteria destroying them; gastric secretions such as hydrochloric acid lowers the pH in the stomach killing micro-organisms; clotting of blood; prevents entry of microbes after damage of blood vessels; phagocytosis; by phagocytes engulf and destroy microbes and other foreign bodies; lymphocytes are stimulated to produce antibodies; by proteins present in microbes protecting the body; antibodies destroy/kill micro-organisms through various ways: agglutinins; bind to pathogens making them clump together; killing them; Lysins; bind to pathogens and make them burst or disintegrate; opsonins; bind to pathogens making them easily recognized hence be engulfed/destroyed by other lymphocytes; anti-toxins; bind and neutralize toxins produced by micro-organisms; vagina is acidic; hence making it not conducive for growth and reproduction of micro-organisms; **Max: 20 mks**

**4. How are the leaves of higher plants adapted to their functions?**

Broad and flattened lamina; to increase surface area; for absorption of light; thin blade; to reduce distance for diffusion of gases and penetration of light waves; transparent epidermis and cuticle; to allow light to penetrate to tissues; cuticle layer absent on stomata; to allow for gaseous exchange; one-cell thick epidermal layer; to reduce the distance over which sunlight penetrates; palisade cells have numerous chloroplasts containing chlorophyll; to trap maximum amounts of light energy; have stomata on the epidermis; to allow for gaseous exchange; and control of water loss through transpiration; palisade layer have elongated cells located at right angles to the leaf surface; for maximum absorption of light energy; spongy mesophyll; consists of spherical and loosely-packed cells; to create air spaces; which communicate with the atmosphere through stomata; for purposes of gaseous exchange and control of water loss; veins have conducting tissues: xylem; for movement of water and dissolved mineral salts; phloem; for translocation of manufactured food; **Max. 20 mks**

**5. Explain how the various teeth adapt mammals for nutrition**

Incisor; sharp; chisel-shaped; for biting; and cutting food; one root for support in the jaw bone; Canines; long; sharp; pointed; for holding prey; piercing; and tearing flesh from prey; single root; for support in the jaw bone; Premolars; large/wide; to increase surface area for grinding food; highly cusped; to increase surface area for grinding food; two roots; for firm support/anchorage in the jaw bone; molars; large/wide; to increase surface area for grinding food; highly cusped; to increase surface area for grinding food; **Max. 20 mks**

**6. Describe what happens to a meal of oily beans and maize from the time of ingestion up to the time of absorption**

In the mouth; starch in maize; is digested by salivary amylase/ptyalin/diastase into maltose; food is chewed and mixed by teeth and the tongue; rolled into boluses by peristalsis; it enters into the stomach via the cardiac sphincter; in the stomach, gastric juice containing pepsinogen that is activated to pepsin; digests proteins in the beans; into shorter peptides; food is churned and allowed into the duodenum; via the pyloric sphincter muscle; in the duodenum; bile juice secreted by the gall bladder; emulsifies the oils in the beans into tiny oil droplets; pancreatic juice; secreted by the pancrease; contains pancreatic amylase; that digests starch to maltose; pancreatic lipase; that digests the oil in the beans to fatty acids and glycerol; trypsin; digests proteins into shorter peptides; food enters into the ileum; where succus entericus is secreted; it contains maltase enzyme; that digests the maltose into glucose; that is absorbed; peptidase; digests peptides into amino acids;

lipase digests the remaining lipids (oil) into fatty acids and glycerol; which is absorbed through the lacteals of the villi; **Max. 20 mks**

**7. How are the small intestines in mammals adapted to their functions?**

Small intestines consists of the duodenum and the ileum; most digestion of food occurs in the duodenum; bile from the gall bladder of the liver is secreted through the bile ducts; and it is used to emulsify fats/break fat particles into tiny droplets; to increase the surface area for enzyme action; the pancrease~~t~~ secretes pancreatic juice to the duodenum; the juice contains pancreatic amylase; that helps to breakdown the remaining starch into maltose; trypsin; (that is secreted in its inactive form, trypsinogen, and activated by enterokinase enzyme); hydrolyses proteins into shorter peptides; pancreatic lipase; converts lipids into fatty acids and glycerol; sodium hydrogen carbonate is also produced; to neutralize the acidic chyme from the stomach; and provide a suitable alkaline medium for pancreatic and other intestinal enzymes; the ileum is long; and narrow; to increase the surface area for complete digestion of food; and maximum absorption of digested food; highly-coiled; to reduce speed of food flow; for maximum digestion; and absorption; presence of villi; and microvilli; to increase surface area; for maximum absorption; dense network of capillaries; to transport blood; for efficient transport of absorbed food; presence of lacteals in the villi; for absorption of fatty acids and glycerol molecules; presence of enzymes: Lipase; for digestion of lipids into fatty acids and glycerol; maltase; for digestion of maltose to glucose molecules; peptidase; for breakdown of peptides into amino acids; sucrase; for digestion of sucrose into glucose and fructose; lactase; for digestion of lactose into glucose and galactose; goblet cells; produce mucus; to lubricate the walls of the ileum; for smooth flow of food; coats the walls of ileum to prevent digestion by peptidase enzyme; **Max. 20 mks**

**8. Outline and explain the various homeostatic functions of the liver in mammals**

Deamination; process of removal of an amino group from an amino acid molecule; the process gets rid of excess amino acids in the body; as the body is not able to store them; the amino group enters the ornithine cycle; where it is combined with carbon (IV) oxide to form urea; which is excreted in urine through the kidney; Heat production; many metabolic activities take place in the liver; releasing heat energy; that is distributed by the blood to other parts of the body; this helps in thermoregulation; Storage of vitamins and mineral salts; Vitamins A, B, D, E and K; are stored in the liver; worn-out red blood cells, are broken down to yield iron; which is stored in the liver in form of ferritin; this is used later in case of shortage; Formation of red blood cells; occurs in the liver of the foetus; the liver also breaks down old/exhausted red blood cells; leading to formation of more in the bone marrow to replace the worn-out cells; to enhance oxygen and carbon (IV) oxide distribution; Regulation of blood sugar level; liver cells convert excess glucose into glycogen and fats under the influence of insulin hormone; the stored glycogen is however converted back to glucose; when glucose levels are low; by the liver cells; under the influence of glucagon hormone; Regulation of plasma proteins; plasma proteins such as prothrombin and fibrinogen are manufactured in the liver using the amino acids found in the liver; they play a major role in blood clotting; that prevents excessive blood loss and infection at the injured area; other plasma proteins produced by the liver such as serum and albumen; contribute to the maintenance of osmotic pressure in the body; non-essential amino acids are also synthesized by the liver; for use by the body; Storage of blood; the liver is highly vascularised; hence it is capable of holding a large volume of blood when the blood vessels dilate during hot conditions; when the temperatures are low, the blood vessels constrict under the influence of the endocrine and nervous systems; hence less blood is stored in the liver; this contributes to thermoregulation; Detoxification; this is the

process where harmful compounds such as drugs and poisons; are converted to less toxic compounds in the liver; toxicity is caused by medication, drugs and microorganisms; the toxic compounds are later excreted in urine; detoxification prevents the accumulation of toxins in body cells; which could lead to death or malfunctioning of the body cells; **Max. 20 mks**

**9. Explain why the following conditions are necessary for photosynthesis**

**a) Carbon (IV) Oxide**

Required in the dark stage of photosynthesis; it combines with the hydrogen ion from the light stage; to form glucose, proteins and lipids; low concentrations reduces the rate of production of energy and food; while high concentrations leads to an increase in the amount of energy and food formed;

**b) Light**

It is used to break down water molecules (through photolysis); into hydrogen ions, oxygen and energy; the energy and hydrogen ions formed are used in the dark stage;

**c) Chlorophyll**

Green pigment that traps light energy from the sun; that is used in photolysis of water molecules;

**d) Suitable temperature and pH**

Temperature affects the enzymes involved in photosynthesis; suitable/optimum temperatures activate enzymes; for maximum production of food; while extremely low temperatures inactivate enzymes; leading to less or no production of food; high temperatures denature enzymes; stopping the process of photosynthesis; photosynthetic enzymes work well in low pH; so the rate is high; while higher pH reduces enzyme activity; lowering the rate of photosynthesis;

**e) Water**

Forms a medium for the chemical reactions; it is split to yield hydrogen ions, oxygen and energy for use in the dark stage; solvent for the materials used in photosynthesis; **Max. 20 mks**

**10. How is the ileum adapted to its functions?**

Long; and narrow; to increase the surface area for complete digestion of food; and maximum absorption of digested food; highly-coiled; to reduce speed of food flow; for maximum digestion; and absorption; presence of villi; and microvilli; to increase surface area; for maximum absorption; dense network of capillaries; to transport blood; for efficient transport of absorbed food; presence of lacteals; for absorption of fatty acids and glycerol molecules; presence of enzymes: Lipase; for digestion of lipids into fatty acids and glycerol; maltase; for digestion of maltose to glucose molecules; peptidase; for breakdown of peptides into amino acids; sucrase; for digestion of sucrose into glucose and fructose; lactase; for digestion of lactose into glucose and galactose; goblet cells; produce mucus; to lubricate the walls of the ileum; for smooth flow of food; coats the walls of ileum to prevent digestion by peptidase enzyme; **Max. 20 mks**

**11. a) What is homeostasis?**

(Mechanisms of) control and maintenance of a constant internal environment regardless of the external conditions; **2 mks**

**b) Name any three factors that must be maintained constant in mammalian bodies**

Temperature; Water; Salt or ion content; Carbon (IV) oxide; Glucose; amino acids; **Max. 3 mks**

**c) Explain how endotherms respond to heat and cold conditions in their environment**

Heat/hot conditions: Increased sweating; to lose heat through latent heat of vaporization; dilation of arterioles under the skin; to bring more blood to the skin surface to lose heat to the atmosphere; decreased body metabolism; to reduce heat generation; erector pili muscles relax; making hair follicles to relax hence hair lies flat on skin, no air is trapped; to lose heat; slow/reduced muscular activity due to slow metabolism; to reduce heat production; panting to expose tongue and mouth; to release heat; moving to shades to avoid direct heat; aestivation; to escape the extreme heat; flapping of ears to create currents to carry away heat; Cold conditions: stamping of feet; to generate heat; basking in the sun to gain heat directly; less production of sweat; to reduce water loss through latent heat of vaporization; vasoconstriction of arterioles; hence less blood flow to the skin surface to reduce heat loss; increased metabolism through release of more thyroxine hormone; to generate heat; erector pili muscles contract; pulling hair follicles hence hair is raised; to trap a layer of moist air; to prevent heat loss; shivering/rapid contraction of muscles; to yield heat to warm body; **Max.**

**15 mks**

**12. Describe the route taken by water from the soil up to the evaporating surface of a plant**

Water is drawn into the root hair cells by osmosis; due to the presence of dissolved substances in the cell sap of root hairs, the concentration of cell sap is greater than that of the surrounding solution in the soil/concentration gradient; this exerts a higher osmotic pressure, thus drawing the water molecules across the cell wall and cell membrane into the root hair cells; more water drawn into the root hair cells dilutes the cell sap; making it less concentrated than that in the adjacent cortex cell of the root; due to osmotic gradient, water moves from the adjacent cells to the next by osmosis; until it enters the xylem vessels located in the center of the root; the xylem vessels of the root then conduct the water up into the xylem vessels in the stem into the leaves; there is a force in the roots which pushes water up the stem; this force is known as root pressure; and can be considerably high in some plants; energy from the endodermal cells of the root is responsible for driving this force; in the xylem vessels, water would rise up by capillarity; to some extent because the vessels are narrower and there is a high attractive force between the water molecules and the cell walls; the cohesive; and adhesive forces are important in the maintenance of a continuous and uninterrupted water column in the xylem vessels up the tree to the leaves; water vaporizes from the spongy mesophyll cells; their cell sap becomes concentrated than the adjacent cells. This increases the osmotic pressure of the spongy mesophyll cells; as a result of this, water flows into the cell from other surrounding cell, which in turn takes in water from xylem vessels within the leaf veins; this creates a pull/suction force that pulls a stream of water from xylem vessels in the stem and roots. This force, known as transpiration pull; helps in maintaining a continuous column of water from the roots to the leaves; water flows from the midrib into leaf veins from where it enters leaf cells; from the mesophyll cells, it enters the airspaces; then the substomatal air chambers; from where it evaporates through the stomata; to the atmosphere; **Max. 20 mks**

**13. How is the mammalian heart adapted to its functions?**

Heart is enclosed in a pericardial membrane/pericardium; that produces a fluid; to lubricate it; the membrane also keeps the heart in position; It is covered in a fatty layer; that acts as a shock absorber; made up of cardiac muscles; which are interconnected/interacted hence contract and relax without fatigue or nervous stimulation/myogenic; for continuous pumping of blood throughout the lifespan of the animal; the muscles are supplied by nutrients and oxygen; by the

coronary arteries; and the coronary veins take away wastes and carbon (IV) oxide; heart is divided into 4 chambers; for efficient double circulation/ avoid mixing of oxygenated and deoxygenated blood/carry large volume of blood; has interventricular septum; to separate oxygenated and deoxygenated blood; ventricles are thick/muscular; to generate high pressure to pump blood out of the heart; left ventricle has thick muscles/more muscular; to pump blood to all body tissues; heart has bicuspid; and tricuspid valves; to prevent back flow of blood to left auricle; and right auricle respectively; valves have tendinous cords/valve tendons; to prevent them from turning inside out; semi lunar valves located at the beginning of major arteries; prevent backflow of blood into the ventricles; has sino-artrio node located in the muscles of the right auricle; to initiate heart beat/contractions of heart muscles/cardiac muscles, rate of heart beat is controlled by nerves; vagus nerve; slows down heartbeat; while sympathetic nerve; speeds up the heartbeat; has aorta; to transport oxygenated blood to all body parts; has pulmonary artery; that transports deoxygenated blood from right ventricles to lungs for oxygenation; has pulmonary vein; that transports oxygenated blood from lungs to the left ventricles; for distribution to all body parts; has the venacava; that receives deoxygenated blood from all body parts to right ventricles; **Max. 20 mks**

**14. Describe double circulation in mammals**

Deoxygenated blood from body tissues (except lungs); enters the heart via the right auricle; through the venacava; it flows to the right ventricle; via the tricuspid valve; the right ventricle contracts; pumping blood; via the semi lunar valves; through the pulmonary artery; to the lungs for oxygenation; the oxygenated blood from the lungs; flow through the pulmonary vein; to the left auricle; via the bicuspid valve; to the left ventricle; the left ventricle contracts; pumping blood via the semi lunar valves; through the aorta; to the rest of the body tissues; **Max. 20 mks**

**15. Describe the process of urine formation in the mammalian kidneys**

The afferent arteriole which is a branch of the renal artery supplies blood to the glomerulus; the afferent arteriole has a wider lumen/diameter than the efferent arteriole; which takes away blood from the glomerulus; the differences in the diameter of the afferent and the afferent vessels causes high pressure; leading to ultrafiltration of blood; the walls of the blood capillaries are one-cell thick; hence glucose, amino acids, vitamins, hormones, salts, creatine, urea and water filter into the Bowman's capsule; to form glomerular filtrate; white blood cells, red blood cells, plasma proteins such as globulin and platelets are too large to pass through the capillary wall; hence remain in the blood capillaries; useful substances in the human body are selectively reabsorbed; back into the blood stream at the proximal convoluted tubule; the tubule is highly coiled; to increase the surface area for reabsorption of the substances; the useful substances include amino acids, glucose, vitamins, hormones, sodium chloride and water; many mitochondria found at the proximal convoluted tubule; provide energy for reabsorption of these substances against a concentration gradient; the glomerular filtrate flows into the descending and the ascending limb of the loop of Henle; blood in the capillaries and the glomerular filtrate in the loop of Henle move in opposite directions/counter-current flow; this provides a steep concentration gradient that leads to maximum absorption of water through osmosis; sodium chloride is actively absorbed from the ascending limb into the blood capillaries; under the influence of aldosterone hormone; the glomerular filtrate flows into the collecting tubule from where, more water is reabsorbed into the blood stream; antidiuretic hormone influences the amount of water to be reabsorbed depending on the osmotic pressure of the blood; the glomerular filtrate from several collecting tubules now referred to as urine; is emptied into the collecting duct; the urine passes through

pyramid, pelvis and ureter into the bladder; where it is stored for some time. The sphincter on the urethra relaxes to allow urine to be released from the body; **Max. 20 mks**

**16. Explain the role of the following hormones during homeostasis**

**a) Antidiuretic Hormone (ADH)**

Secreted by the (posterior lobe/end) pituitary gland; in response to an increase in the osmotic pressure of blood; the hormone stimulates the distal convoluted tubules and the collecting ducts; to increase their permeability to water; this increases the reabsorption of water into the bloodstream; concentrated and less urine is excreted; when the osmotic pressure decreases, less or no hormone is produced; hence the tubules become impermeable to water; less water is reabsorbed into the bloodstream; hence more dilute urine is excreted; fluctuations in the osmotic pressure is detected by the hypothalamus;

**b) Insulin**

Secreted by the pancrease; in response to a rise in blood sugar level; it stimulates liver cells to convert the excess glucose into glycogen and fats for storage in the liver and muscle cells; increases the oxidation of glucose in respiration to yield water energy and carbon (IV) oxide/increases metabolism in the body; this leads to a fall in blood glucose to normal level;

**c) Glucagon**

Secreted by the pancrease; in response to a decline in blood glucose level; it stimulates liver cells to convert the stored glycogen and fats back to glucose; stimulates the conversion of amino acids to glucose; and stops the oxidation of glucose in the body cells; the glucose formed is released to the bloodsteream causing a rise of blood glucose level to normal; **Max. 20 mks**

**17. a) Distinguish between *Diabetes mellitus* and *Diabetes insipidus***

Diabetes mellitus is a condition/disease caused by failure of the pancrease to produce adequate insulin hormone; leading to excess glucose levels in the body some of which is released in urine while diabetes insipidus is a condition caused by failure/inability of the kidney tubules to control the amount of water in urine as a result of a defect in production of antidiuretic hormone (ADH) leading to production of more dilute urine; **Max. 2 mks**

**b) Explain how mammalian bodies regulate glucose and protein levels in their blood**

When glucose level is high (above 90mg/100cm$^3$), the brain sends impulses to the (β cells of islets of Langerhans) pancrease cells; to release insulin hormone; the hormone stimulates liver cells to convert the excess glucose into glycogen and fats for storage in the liver and muscle cells; increases the oxidation of glucose in respiration to yield water energy and carbon (IV) oxide/increases metabolism in the body; this leads to a fall in blood glucose to normal level; However, when the glucose level falls below normal (below 90mg/100cm$^3$); the brain sends impulses to the (α cells of the islets of Langerhans) pancrease cells; which are stimulated to release glucagon hormone; the hormone stimulates liver cells to convert the stored glycogen and fats back to glucose; stimulates the conversion of amino acids to glucose; and stops the oxidation of glucose in the body cells to avail more glucose; the glucose formed is released to the bloodstream causing a rise of blood glucose level to normal; The level of plasma proteins such as prothrombin, globulins, albumins and fibrinogen; which play a major role in osmoregulation and blood clotting; are controlled by the liver; which

manufactures them using the amino acids found in the liver; when their levels reduce, more is produced; but when the level is high, less of the proteins is produced in the liver; excess amino acids are deaminated; as the body is not able to store them; the process involves removal of an amino group from an amino acid molecule; the amino group enters the ornithine cycle; where it is combined with carbon (IV) oxide to form urea; which is excreted in urine through the kidneys; **Max. 18 mks**

**18. Explain how the various abiotic factors may affect plants**

Temperature; affects soil formation and distribution of plants; affect transpiration rate as high temperatures lead to high rates of transpiration; It also affects the rate of photosynthesis with the direct influence on enzyme activity; Light intensity; affects the rate of photosynthesis; Wind; increase the transpiration rates; affects dispersal of seeds and fruits; agents of pollination; affect distribution in terms of wind storms/breakages; Atmospheric pressure; high atmospheric pressure leads to low rates of transpiration; high oxygen and carbon (IV) oxide concentration; high photosynthetic rates; while low atmospheric pressure leads to high transpiration rates; less concentration of oxygen and carbon (IV) oxide; leading to low rates of photosynthesis; Water/Rainfall; forms a raw material for photosynthesis; helps in support in plant tissues; affects distribution of plants; Humidity; low humidity leads to high transpiration rates; while high humidity leads to low rates of transpiration; pH; affects distribution of plants; some grow in acidic soils; others in alkaline soils; Edaphic/soil factors; affects plant distribution; in terms of being sources of water and mineral salts; provide a substratum for anchorage of plants; **Max. 20 mks**

**19. Discuss the causes, effects and control measures for water pollution**

Causes of water pollution are varied: industrial effluents; have heavy metals that poison aquatic organisms; untreated organic matter has phosphates/sulphates/nitrates/salts; that cause eutrophication; causing algal bloom that deprives the water of nutrients; when the algae die, they lead to an increase in putrefying bacteria whose decomposition activities lead to the release of awful smells/odours; oil effluents clog respiratory surfaces of aquatic organisms/death due to suffocation; domestic effluents/sewage; form a habitat of pathogens that spread water borne diseases; decomposing sewage promotes eutrophication leading to algal bloom; death promotes/attracts saprophytic bacteria that use up oxygen in water; causing suffocation/death to aquatic organisms; agrochemicals/fertilizers; phosphates/nitrates; cause eutrophication; heavy metals in agrochemicals (herbicides/pesticides); affect respiratory surfaces/cause breathing problems; Hot water; raise temperature of water; killing organisms; dissolves less oxygen; reducing its content in water; Oil spillage; in oceans from tanks/refineries; soak feathers of marine birds preventing flight; clogs respiratory surfaces leading to death; coats photosynthetic phytoplanktons; reduces light penetration hampering photosynthesis; Sediments; from soil erosion makes water dirty; making it unfit for consumption; clogs respiratory surfaces hindering gaseous exchange; reduces light penetration hindering photosynthesis; Control methods: Enforcement of environmental laws; Use of unleaded fuel/petroleum products; Proper treatment and disposal of sewage wastes; Treatment of industrial effluents before release; Public education on correct use of inorganic fertilizers and agrochemicals; and use of alternatives such as biological control of weeds/pests/organic manure; Use of undersea pipelines instead of tankers to transport oil products; Cooling hot water before release to water bodies; **Max. 20 mks**

**20. How are xerophytes and hydrophytes adapted to their habitats?**

Xerophytes: thick waxy cuticle; minimize water loss; leaves are folded and reduced in size; to minimize stomatal transpiration; sunken stomata; to reduce rate of transpiration; thick/succulent leaves, side branches or stems; for water storage; shedding of leaves during the dry periods; to reduce surface area exposed for transpiration; reversed stomatal rhythm; prevent excessive loss of water; deep penetrating roots; to absorb water from deep below the surface; superficial roots; to absorb surface water run-off; leaves covered in scales/hairs; to trap a moist layer of air; to reduce the rate of transpiration; drought-resistant seeds; that remain dormant till favourable weather resumes; underground organs (corms/bulbs); for storage of water and reproduction; most stomata located on the lower leaf surface; to avoid exposure to direct light; to reduce evaporation; reduced number of stomata; to reduce the rate of transpiration; Hydrophytes: stomata on the upper surface of leaves; to provide a large surface area for gaseous exchange; and loss of excess water; poorly-developed roots that lack root hairs; to reduce/avoid absorption of water; aerenchyma tissue in leaves, stems and roots; to store air; and for buoyancy; deeply-dissected leaves; to provide a large surface area for absorption of light; highly-sensitive; and numerous chloroplasts; for photosynthesis; greatlyreduced vascular bundle; to avoid absorption of water; flowers raised above the water; to allow for pollination; lack of a cuticle or very thin cuticle; for faster loss of water; **Max. 20 mks**

**21. Outline the differences between wind and insect pollinated flowers**

Flowers of wind pollinated plants are small; with no bracts, sepals or petals; if present the petals are small, inconspicuous; often white or green in colour; while insect pollinated flowers are large; often with brightly coloured petals, bracts or inflorescence; to attract insects. Flowers of wind pollinated plants have no nectaries; and no scent; while flowers of insect pollinated plants are scented; and produce nectar; in wind pollinated flowers, the anthers are large; and loosely attached on a flexible filament; to allow pollen grains to be readily released when wind blows on the anthers; while anthers of insect pollinated flowers are usually small; and firmly attached on the filaments; this ensures that the insect rub against the anther; as they crawl into the flower collecting pollen grains onto their bodies; in wind pollinated flowers, the stigmas are feathery; widely spread; this acts as nets to catch pollen as it floats through the air; while in insect pollinated flowers the stigmas are small; smooth; and sticky; and are also enclosed; this feature ensures that pollen grains from the body of an insect stick onto it; in wind pollinated flowers, the flowers are simple with no particular shape; while some flowers that are insect pollinated have petals with grooves or dark lines; leading from the petal boarder to the nectaries; some have tubular or funnel-shaped corolla; and landing platforms; to guide the insect to the source of the nectar for their food; flowers of wind pollinated plants are either on long stalks above the leaves; or develop from flower buds that open before the leaf buds; to increase the flower exposure to air currents; while flowers of insect pollinated plants are on short stalks; often enclosed by the corolla; **Max. 20 mks**

**22. Describe what happens in a flower from the time of pollination up to the time of seed and fruit development**

After pollination, the pollen grain absorbs nutrients from the stigma; and develops a pollen tube; it grows down the style to the embryosac; taking along the male nuclei; the tube nuclei initiates and maintains pollen tube growth; while the generative nucleus divides by mitosis; to form two male gamete nuclei; which follow behind the tube nucleus as the pollen tube grows down the style; pollen tube enters the ovule through the micropyle; its tip bursts open; while the tube

nucleus disintegrates; one of the male gamete nucleus fuses with the egg cell nucleus/oosphere/megaspore; to form the zygote; while the other fuses with the two polar nuclei; to form a triploid nucleus; called the primary endosperm nucleus; after fertilization, the zygote undergoes repeated mitotic divisions; to form an embryo consisting of the plumule, radicle and seed leaves/cotyledons; primary endosperm nucleus divide repeatedly, become separated by membranes; to form an (semi-fluid nutritive) endosperm; ovary walls change into the pericarp; ovary changes/develops into a fruit; while ovules lose water and become seeds; the integuments; change into seed coats/testa; style/filaments/petals/sepals wither and fall off (or may persist); **Max. 20 mks**

**23. Discuss the adaptations of the female reproductive system of humans**

Elastic uterine walls; to expand so as to accommodate the growing foetus; muscular foot of the pelvis and bladder support the weight of the growing foetus; funnel-shaped ends of the oviduct; direct the ova released to the uterus; muscular uterine walls; contract and relax to expel the foetus at birth; long vaginal canal; allow sufficient entry of penis to avoid wastage of sperms; the two ovaries maximize chances of releasing ovum after every circle (28 days); ovaries are well vascularised/have good blood supply; to ensure nourishment of cells involved in oogenesis (primordial mother/germ cells) or egg formation; high number of potential mother cells; ensures maximum number of ova which develop to maturity; plenty of yolk in egg cells; which nourish the foetus before the placenta becomes functional; the vitelline membrane of the ovum thickens after fertilization; preventing further entry of sperms; the oviduct wall is able to contract; in order to facilitate movement of ovum down the oviduct; has cilia to waft the ovum forward; wall of the vagina/vulva produce mucus; to lubricate the penis during copulation; clitoris; has many nerve endings; to provide maximum stimulation during copulation for maximum ejaculation and faster movement of spermatozoa; **Max. 20 mks**

**24. Describe the process of gaseous exchange in terrestrial plants**

Gaseous exchange occurs in the spongy mesophyll; During the day, air diffuses into large air spaces of the spongy mesophyll; through the stomata; the carbon (IV) oxide in the air diffuses into photosynthetic cells; in solution form; during photosynthesis, carbon (IV) oxide is used up; while oxygen is produced; some of the oxygen is used in respiration; while the rest diffuses out of the leaf; through the stomata; During the night, air diffuses into the air spaces; through the stomata; the air dissolves into the film of moisture; oxygen in the air diffuses into the cells; and is used for respiration; carbon (IV) oxide produced; diffuses out through stomata; due to a concentration gradient/diffusion gradient; At night, carbon (IV) oxide accumulates in the leaf since photosynthesis does not occur; some gaseous exchange also takes place through the cuticle; and through the epidermis of young leaves, roots and stems; some plants exchange gases through breathing roots/pneumatophores; older stems exchange gases through lenticels; **Max 20 mks**

**25. How is the mammalian gaseous exchange system adapted to its functions?**

Nasal cavity; has cells that produce mucus; that together with hairs/cilia; trap and propel dust/microbes to the pharynx to be breathed out/swallowed; cavity is supplied with capillaries; that warm the air for faster flow in the channels; epiglottis; covers the trachea during swallowing; so that particles of food and water may not enter the trachea; trachea and bronchi; have cartilage rings; to keep the passages open/prevent them from collapsing; so that air moves in and out freely

and continuously; are also lined with mucous membranes which have hairs/ciliated; whose movement/wafting push out dust particles collected in the passages into the pharynx; richly-supplied with blood vessels; to warm the air; for faster flow; lungs; have numerous alveoli; to increase the surface area for gaseous exchange; alveoli have a thin epithelium; to reduce the distance through which gases diffuse for easier and faster diffusion; alveoli are moist; to dissolve oxygen for faster transport; lungs are spongy; because of many air sacs that contain a large amount of/volume of air; Lungs are also supplied with many blood vessels; for transportation of gases; they are also supplied with a network system of trachea, bronchi and bronchioles; to provide an efficient system/large surface area for gaseous exchange; Lungs are enclosed in a pleural membrane; which secrete pleural fluid; that protect the lung surface; lubricate the chest cavity; allowing smooth movement of lungs as they change volumes; ribs have intercostal muscles; that moves/contracts and relaxes to allow for inhalation and exhalation; ribs also protect the lungs; has the diaphragm muscles whose contraction and relaxation leads to inhalation and exhalation respectively; **Max. 20 mks**

**26. Describe the structure and function of the mammalian skin**

It has a cornified layer made up of dead cells and is tough and impermeable to water; to protect the skin against mechanical damage; bacterial infections and water loss; granular layer; whose cells divide to form the cornified layer; malpighian layer; which is made up of diving cells that give rise to a new granular layer; contains melanin; to protect skin against ultra-violet rays/radiations; Sebaceous glands; which secrete sebum; to make the skin supple/soft and waterproof; sebum is also antiseptic; Blood vessels; dilate during hot weather; increasing blood flow near the skin surface; heat loss is enhanced; constrict; in cold weather; less blood flow; minimize heat loss; Sensory nerve endings and receptors; enable detection of external environmental changes; Highly coiled sweat glands; secrete sweat; to control body temperature; when hot sweat evaporates cooling the body; sweat contains excretory products; subcutaneous fat/adipose tissue in dermis; for insulation; hair; to regulate body temperature; in cold weather erector pili muscles contract; hair is raised, air trapped to insulate the body; in hot weather, erector pili muscles relax; hair lies flat reducing insulation; dense network of blood capillaries; supply nutrients/oxygen to skin tissues; as well as carrying away wastes and carbon (IV) oxide away from the skin tissues; adipose tissue/sub-cutaneous layer; serves as an insulator; helping in temperature control; helps in manufacture of vitamin D; **Max. 20 mks**

**27. Describe the role of the following hormones in the menstrual cycle**

**a) Luteinising Hormone (LH)**

Produced by the pituitary gland; under the influence of oestrogen hormone; cause the bursting of the Graafian follicle; to release a mature egg/ovum/causes ovulation; stimulates the change/conversion of the Graafian follicle; into the corpus luteum; stimulates the corpus luteum; to secrete progesterone hormone;

**b) Follicle Stimulating Hormone (FSH)**

Produced by the anterior lobe of the pituitary gland; it stimulates the maturation of the Graafian follicle in the ovaries; stimulates the ovarian tissue/wall to secrete oestrogen;

**c) Oestrogen**

Brings about/stimulates the healing and repair of the uterine wall; after menstruation; stimulates the pituitary gland; to secrete luteinising hormone;

**d) Progesterone**

Secreted by the corpus luteum; it stimulates the thickening of the endometrium/uterine wall; in preparation for implantation; inhibits secretion of the Follicle Stimulating Hormone; therefore preventing further development of the Graafian follicle; **Max. 20 mks**

**28. a) What is secondary growth?**

Type of growth that occurs due to cambium activity in woody plants/stems; resulting in an increase in girth/width of plants; **2 mks**

**b) Describe the process of secondary thickening in a woody stem**

Facilitated by meristematic cells (cambium) located between the phloem and the xylem (intervascular cambium); it divides radially to form cambium tissues; with xylem forming the outer ring/to the inside; while the phloem forming the outer ring/to the outside; division of the cambium ring; form a secondary parenchyma; hence increases/forms the medullary rays; other xylems (secondary xylem) are formed; hence pushes the phloem and cambium ring outwards; this creates pressure on the outer cells; resulting in stretching and eventual rupturing of epidermal cells; a new band/volume of cambium cells are formed in the cortex beneath the epidermis (cork cambium cells/phellogen); to replace these ruptured cells; the phellogen cells divide on either side; where the inner cells become the secondary cortex; while those produced on the outside become cork cells; which are tightly packed; and become coated with an oily/waxy water-proof material/suberin; further multiplication of cork cells; lead to formation of the bark; which forms a protective layer (against water loss and damage by organisms); seasons results into annual rings; some cork cells form a loose mass/lenticels that allow gaseous exchange through the stem; **Max. 18 mks**

**29. Discuss the various mechanisms of opening and closing of stomata**

Photosynthetic theory; during the day, guard cells carry out photosynthesis manufacturing glucose; This increases the osmotic pressure of the sap vacuole; which becomes higher than that of the neighbouring epidermal cells; guard cells therefore take in water by osmosis; and become turgid; the outer thin wall stretches easily; pulling the thicker inner wall outwards; thus the stomata opens; At night, there is no light hence no photosynthesis takes place; plant cells respire using up more glucose; the osmotic pressure of the sap vacuole of the guard cells reduces; becoming lower than the neighbouring epidermal cells; the guard cells lose water by osmosis; to adjacent epidermal cells; they then become flaccid; pulling together the thick inner walls; and stomata closes; Enzymatic inter-conversion between starch and glucose/sugar; At day time, plants continuously use carbon (IV) oxide for photosynthesis; leading to an increase in the pH of the guard cells; this causes starch to be converted to sugar/glucose; the glucose increases the osmotic pressure of the guard cells; hence water is taken in by osmosis; the cells become turgid and bulge outwards; causing the stomata to open; At night, no photosynthesis occurs but respiration takes place; carbon (IV) oxide accumulates in guard cells; lowering the pH; the low pH favours conversion of glucose into starch; starch is osmotically inactive; this lowers the

osmotic pressure of guard cells; guard cells therefore lose water by osmosis to the adjacent epidermal cells; become flaccid; pulling together the thick inner walls; and the
stomata closes; Active ion exudation; during the day, there's an accumulation of potassium and sodium ions; as a result of active pumping of the ions by the ATP formed through photosynthesis; carbon (IV) oxide fixation occurs in the guard cells; the guard cells become turgid; and stomata open; At night, before the stomata close, the ions diffuse out of the guard cells into epidermal cells; the osmotic pressure of guard cells is lowered; they lose water to epidermal cells by osmosis; and become flaccid; thereby closing the stomata; **Max. 20 mks**

**30. a) What is natural selection?**

(Theory put forward by Charles Darwin that explains that) Nature selects for individuals that are well adapted to a particular environment; and against those that are less adapted; **2 mks**

**b) Discuss three examples of natural selection in action**

Melanic forms of peppered moths; in Europe, there are two forms of peppered moths; white and black; before industrialization, the tree trunks were white; therefore the white peppered moths were white; hence were camouflaged; the black varieties were easily noticed and fed upon by predatory birds; the white form therefore reproduced and increased in number; during industrialization, the smoke from industries coated tree trunks black; the black variety became camouflaged; reproduced and increased in population; the white variety were easily noticed and fed upon by predators; they reduced in population; Resistance against drugs and antibiotics; where microorganisms are continually exposed to a certain drug; their cells synthesise specific proteins; which counter the drug; this ability to synthesize the protein is passed onto the offspring; Resistance to pesticides by insects; insects such as mosquitoes when continually exposed to a particular pesticide; synthesize a specific protein which make them resistant to the pesticide; this is then inherited by their offspring; **Max. 18 mks**

**31. Discuss Lamarck's and Darwin's theories of evolution**

Larmarck's theory states that when the environment demands the need or use of a particular structure in the body; the body develops it in response; for example giraffes used to have short necks; when all the grass was exhausted, they started stretching their necks in search of leaves on trees; therefore they developed long necks; which then were inherited by their offspring; however, when a structure is not continually used, it reduces in size and becomes dysfunctional; this theory fails to explain how acquired characteristics become inherited; Darwin's theory suggests that in nature there occur struggle for existence; only those individuals with the desired adaptations survive; those poorly adapted fail to compete; and become extinct; there also occurs variation in nature; where organisms with desired adaptations pass on their characteristics to offspring during reproduction; those poorly adapted fail to reach maturity; and do not reproduce; therefore, nature selects for individuals best suited to an environment; and against those poorly adapted (natural selection); as there occurs survival of the fittest; **Max. 20 mks**

**32. a) Explain how the following blood cells are adapted to their functions**

**i) Red Blood Cell**

Presence of haemoglobin molecules; with a high affinity to combine with oxygen as/to form oxyhaemoglobin; bi-concave shape; to increase the surface area for packaging of

haemoglobin; absence of nucleus; to accommodate maximum/more haemoglobin molecules; thin membrane; for faster diffusion of gases; **Max. 6 mks**

**ii) White blood cell**

Irregular in shape/amoeboid; which changes to enable the cell to squeeze through the capillaries; lymphocytes produce antibodies; which help to prevent diseases; phagocytes are amoeboid-shaped; to change shape and engulf bacteria cells; **Max. 6 mks**

**b) Explain the different ways in which Carbon (IV) Oxide is transported by blood**

Carbon (IV) oxide diffuses out of the tissues into the red blood cells where it reacts with water; in the presence of carbonic anhydrase enzyme; to produce carbonic acid; The acid dissociates into hydrogen and hydrogen carbonate ions; the hydrogen carbonate ions then diffuse out of the red blood cells into the plasma; where it further dissociates to produce carbon (IV) oxide on reaching the alveolar cavities of the lungs and diffuses into the alveoli; some carbon (IV) oxide combines with the amine group in the haemoglobin molecule forming carbaminohaemoglobin; which dissociates in the lungs producing carbon (IV) oxide; some carbon (IV) oxide dissolves in the blood plasma forming carbonic acid, which dissociates to carbon (IV) oxide on reaching the lungs; **Max. 8 mks**

**33. Describe how the following vertebrae are adapted to their functions**

**a) Atlas**

Has a wide neural canal; to accommodate the large spinal cord at the neck region; has large/broad wing-like cervical ribs; to increase the surface area for attachment of the neck muscles; has facets on the anterior side; for articulation with the occipital condyles of the skull; allowing up and down movement/nodding of the head; has posterior facets for articulation with the anterior facets of the axis; forming a joint that allows sideways movement of the head;

**b) Axis**

Has a broad centrum; that projects to form the odontoid process; for articulation with the neural canal of the atlas; a joint that allows turning of the head; has a large and broad/flattened neural spine; and flat cervical ribs; to increase the surface area for attachment of neck muscles;

**c) Lumbar**

Has many transverse processes; and additional projections (metapophyses, hypapophyses, anapophyses); to offer a large surface area for attachment of abdominal muscles; broad neural canal; to allow passage of the large spinal cord at the upper abdominal area; large/thick centrum; to support the weight of the body; and withstand strains/upthrust force due to movement;

**d) Thoracic**

Long/elongated neural spine; to offer a large surface area for attachment of the large back muscles; have a large centrum and neural canal; to offer support to the thoracic cage; has tubercular facet on the transverse processes; to articulate with the tuberculum of the ribs; while the capitular demifacets on the centrum; articulates with the capitula of the ribs; together with the ribs and the sternum form the thoracic/rib cage; for protection of heart and lungs; and for breathing process; **Max. 20 mks**

**34. a) Why is locomotion necessary in higher animals?**

Animals move in order to look for food; mates; escape danger/predators; look for shelter/ suitable environmental conditions; **4 mks**

**b) Explain how bony fish are adapted to their habitats**

Have streamlined bodies; to reduce friction; body is covered with scales; which overlap backwards; to reduce friction; skin produces mucus; which covers the body making it slippery; reducing friction; have swim bladder; which stores air; for buoyancy hence make the fish float; myotomes/muscle blocks; that contract alternately; for forward thrust in water; lateral line system; on either side of the body which is sensitive to pressure and water currents; possess fins; that are used for locomotion: tail/caudal fins; for propulsion; dorsal; and anal fins; prevent rolling; pectoral fin; used for breaking/steering; prevents yawing/side to side movement; controls pitching; pelvic fins; for steering/pitching; **Max. 16 mks**

**35. Describe how the various supportive tissues in plants adapt them to their habitats**

Sclerenchyma tissue; long, slender cells with tapering ends; with walls thickened with lignin; provide support and protection to the more delicate tissues; and resistance to storms and strong winds; main constituent of wood; Xylem vessels; longitudinally-elongated cells; with perforated end walls; with heavily lignified walls; to increase rigidity and strength to the plant;
a main constituent of wood; Tracheids; mainly found in angiosperms; made up of long tapering dead cells; cell walls are highly lignified; and pitted; cells lie in large overlapping groups; to offer extra support; Collenchyma tissue; longitudinally elongated living cells; located beneath the epidermis and mid rib of leaf veins; thickened at the corners by cellulose and pectin compounds; to provide support in leaves, herbaceous plants and young woody plants; Parenchyma tissue; large; spherical cells; with thin cellulose walls; forming the bulk of cortex and pith of most plants; become tightly packed and rigid when turgid; to attain and maintain an erect posture of plants; main support structures in herbaceous stems/plants; **Max. 20 mks**

**36. a) What is a reflex action?**

Rapid and automatic; response to a particular stimulus; **2 mks**

**b) Outline the activities that occur in the body when one touches a hot object**

When the hot object is touched, the pain receptors; in the skin of the finger are stimulated; nerve impulses are initiated and transmitted through the sensory neurone; to the grey matter; of the spinal cord to the brain; for interpretation; the impulses are then transmitted through the relay neurone; via a synapse; the impulses from the relay neurone are transmitted via the motor neurone; through another synapse; to the effector; which are the biceps muscles of the upper arm; making the muscles to contract; straightening the arm; and the arm is withdrawn from the hot object; **Max. 18 mks**

**37. Describe the nitrogen cycle**

This is the cycling of nitrogen and its compounds in nature; plants absorb nitrogen in form of nitrates and then assimilate it into plant proteins; animals obtain this nitrogen in plant proteins through feeding on plants; when the animals die and decompose, they release the nitrogen in form of ammonia to the soil; free atmospheric nitrogen is converted into nitrates through a process known as nitrogen fixation; the process occurs in two ways: biological and nonbiological; biological fixation of nitrogen is done by nitrogen-fixing bacteria; which are either free-living or symbiotic; symbiotic bacteria are of the genus *Rhizobium*; and are found in root nodules of legumes (such as pea, clover and alfalfa); the bacteria convert atmospheric nitrogen into ammonia; that is used directly by the leguminous plants to form nitrogen containing organic compounds (amino acids, nucleic acids, proteins); when plants die, the nodules release ammonium compounds into the soil; which are then converted to nitrites; by nitrifying bacteria of genus *Nitrosomonas* and *Nitrococcus* (nitrite bacteria) and then to nitrates by *Nitrobacter* (nitrate) bacteria; free-living micro-organisms that fix nitrogen include putrefying/saprophytic bacteria; (such as *Azobacter* spp, *Clostridium* and some algae such as *Anabaena*, *Chlorella* and *Nostoc*); the organisms fix nitrogen into ammonia by break down of protein material in dead organisms; the ammonia is converted to nitrites; then to nitrates; However, denitrifying bacteria (e.g. *Pseudomonas denitrificans* and *Thiobacillus denitrificans*); break down/reduce nitrates to nitrites, ammonium compounds and even gaseous nitrogen; a process known as denitrification; the process helps to release free nitrogen into the air for recycling; nonbiological nitrogen fixing is carried out by lightning during thunderstorms; the lightning energy, causes atmospheric

nitrogen and oxygen to combine forming oxides of nitrogen; which dissolve in rain water to form nitrous acid/nitric acid; that is washed down into the soil; the nitric acid formed reacts with other chemical compounds dissolved in soil water; to form nitrates; the nitrates are then utilized by plants; **Max. 20 mks**

**38. Discuss how the various tropisms adapt plants to their habitats**

Phototropism; growth curvature in response to direction of light; enables plant shoots to grow and get light for maximum photosynthesis; allows for leaf mosaic; Thigmotropism; growth curvature in response to contact/hard surface; makes plants with weak stems to get support on large plant/trees; this makes them to reach and get light for maximum photosynthesis; Geotropism; growth curvature in response to gravity; enables plant roots to grow deep into the soil for maximum support/anchorage; Hydrotropism; growth curvature in response to moisture/water; water is then used as a raw material during photolysis stage of photosynthesis; Chemotropism; growth curvature in response to chemical concentration gradient; enables pollen tubes to grow down the style and into the ovary for fertilization to occur in plant flowers; Thermotropism; growth curvature in response to temperature changes; enables plants to grow to where they can acquire optimum temperature for effective plant process (e.g. sunflower orientates towards the direction of the sun); **Max. 20 mks**

**39. Discuss the various evidences of organic evolution**

Comparative anatomy/taxonomy; members of a phylum/group show similarities; organs have similar structure/organs performing the same function such as the digestive system, urinary system, vertebrate heart; homologous structures are structures with the same embryonic origin but have been modified to perform different and specific functions; show a form of divergent evolution; e.g. the pentadactyl limb in vertebrates which has been modified for racing; swimming and flight or beaks of finches and birds; while analogous structures are those with different embryonic origin but have been modified to perform the same function e.g. wings of insects, bats and birds; eyes in octopuses and humans; show a form of convergent evolution; vestigial structures; have been reduced in size and become functionless; in the course of evolution; e.g. limbs in snakes, human hair and tail; Cell biology/cytology; occurrence of similar organelles such as the mitochondria and the endoplasmic reticula point to common ancestry; Fossil records/Paleontology; remains of organisms preserved in naturally-occurring materials for many years; fossil records show morphological changes of organisms over a long period of time e.g. skull of humans and horse; they provide a direct evidence of existence of organisms at a particular ecological era; however, since only hard parts are preserved, no evidence is available for existence of soft-bodied organisms; and there are many missing links; since remains are accidentally preserved in rudimentary rocks and resins; Comparative embryology; vertebrate embryos are morphologically similar during the early stages of development; suggesting that the organisms had a common ancestry/origin e.g. larvae of mollusks/annelids, embryos of chicken, humans, sheep; the closer the semblance between embryos, the closer their ancestral backgrounds; Geographical distribution; present continents are thought to have been a large land mass joined together; as a result of continental drift; isolation occurred bringing about different patterns of evolution; where plants and animals from different continents yet with common ancestry can no longer interbreed; because they evolved into different species; examples of animals that moved to different areas are the jaguars and Llamas in south America, lions in Africa, Tigers in Asia, marsupials in Australia; Comparative serology/physiology; semblance in blood components such as blood proteins, antigen-antibody reactions, structure of haemoglobin

in all vertebrates; reveal some phylogenic relationship among organisms/show common ancestry; **Max. 20 mks**

**40. Describe the structure and functions of the various parts of the mammalian ear**

Pinna; is wide/funnel-shaped to collect/gather sound waves; and direct them to the auditory canal into the ear; Eardrum/tympanic membrane is thin and light; to convert sound waves into vibrations; Ear ossicles/maleus, incus and stapes are of high density; to magnify/amplify sound waves; Oval window is smaller than eardrum; to magnify the sound waves; and direct them to the inner ear; Cochlea is long and coiled; to increase surface area; for attachment of receptor cells/sensory hairs; cochlea has many sensory hairs; which receive sound vibrations and generate impulses; Liquid or fluid/endolymph in cochlea; transmit sound vibrations; auditory nerve; transmit impulses to the brain for interpretation; Eustachian tube; link the mouth and middle ear to equalise pressure; between middle and outer ear to prevent damage to delicate eardrum; Round window; lose excess vibrations; to avoid continuous stimulation; Semicircular canals; contain receptors for body balance and posture; External auditory canal cells produce/secrete wax; to trap dust particles/solid/micro-organisms that can damage eardrum; **Max. 20 mks**

**41. Discuss the various ways employed by preys to avoid the predators**

Some preys resemble inedible inanimate and animate objects; this is called mimicry; e.g. walking stick insect resembles dry twigs of plants, some moths look like bees or flowers of some plants; this prevents birds from easily notifying and eating them; many have the ability to run very fast; because of having muscular bodies; and long legs; enabling them to escape predators e.g. antelopes, zebras; some have a body colour that resembles the surrounding; which helps them to camouflage or conceal in the background environment; e.g. zebras, giraffes; some graze in large herds; this enables them to fight off predators; e.g. wildebeests and buffaloes; some have evolved tough skin or coverings like shells; which can not be broken by some predators e.g. snails, tortoises, armadillo; production of foul smell e.g. in skunks; that discourages the predators; confrontational display that can scare away the predator e.g. porcupine; large eyes on both sides of the head give animals such as zebra a wide field of vision; enabling them to keep track of their enemies from far; and take precautions; **Max. 20 mks**

**42. a) What is meant by the term symbiosis?**

Nutritional association of two different organisms (2 plants or between an animal and plant); for mutual benefit; the relationship enables the composite organism to survive where neither can live on its own; **Max. 2 mks**

**b) Describe five types of symbiotic relationships in a natural ecosystem**

Lichens; these are composite plants consisting of blue-green algae; within a mycelial mass of a fungus; algal cells are provided with support, obtain water, carbon (IV) oxide and minerals and protection from fungus; while the fungus obtains oxygen and the carbohydrates made by algae; this enables the plants to survive on hard bare rocks in high attitudes and polar regions; Leguminous plants and nitrogen-fixing bacteria; the bacteria multiply and fix nitrogen from air into nitrates for the benefit of the plant; bacteria are protected and obtain nutrients from the plants; Ruminants and bacteria; the rumen has bacteria that secrete cellulose; that digests cellulose in the food/vegetation consumed by the animal to glucose for the animal; while the

bacteria get shelter and use part of digested food; Mycorrhizal fungi and higher plants; the fungi found on forest trees gain photosynthetic organic products made by the trees; while the trees get nutrients/minerals absorbed by the fungus from the soil; Tryconympha and termites; the former is a protozoan living in gut of termites; and produce cellulase enzyme; that digests cellulose from the plant into digestible products for the benefit of the termite; the termite on the other hand provides shelter and protection; and absorbs some of the food for its use; **Max. 18 mks**

**43. a) Describe the adaptations of *Schistosoma spp* to their parasitic mode of life**

The parasite utilizes two hosts; the snail and humans; to increase chances of transfer of the parasite from one place to another; have suckers for attachment to host walls; to prevent them from being dislodged; the parasite produces many larval forms (e.g. miracidia, cercariae and redia) in snails; to increase chances of transmission and survival; as this feature poses barriers/difficulties in efforts aimed at eradicating the parasite; cercariae larvae and eggs of the parasite have glands that secrete lytic enzymes; which soften the tissues of humans/snails; to allow for penetration; chemical substances produced by the adult worm; protects the parasite from the action of the hosts' defense mechanisms; they exist as separate sexes; with the male carrying the female; this ensures that eggs produced by the female are fertilized before being shed into the blood stream; **Max. 15 mks**

**b) Outline five measures that can be employed to prevent and control the spread of the parasite**

Proper disposal of human waste; urine and faecal material should not be disposed in water bodies to avoid contamination by the eggs or adult worms; drainage of stagnant water pools and use of molluscides to kill the intermediate hosts (snails); avoid swimming/bathing in snail-infested water bodies; wearing protective clothing such as gloves and gumboots when working or walking in swampy areas; personal hygiene that includes washing hands after visiting the toilet and drinking of boiled or chemically treated water to kill the eggs and the larval forms in the water; proper treatment of infected persons; **Max. 5 mks**

**44. Describe the process of mitosis**

Occurs in somatic/body cells; through five main stages/phases: Interphase/Resting stage; intense internal activities occur in the cell at this stage in preparation for the division; the activities include; replication of each chromosome to multiply genetic material to retain chromosomal number in daughter cells; chromosomes appear as a diffuse tangle of threads (chromatin); synthesis of new cellular organelles; build-up of energy stores (ATP) to drive the entire cell division process; Prophase; chromosomes become visible; as they shorten and thicken appearing as discrete strands (chromatids) lying parallel to each other; in animal cells, centrioles separate and move to opposite ends (poles) of the cell; they radiate from each of the ends forming spindle fibres; nuclear membrane begins to breakdown; nucleolus disappear; Metaphase; chromosomes migrate/move to the centre of the cell; and align themselves along the equatorial plane of the spindle; they get attached to the chromosomes, by their centromeres; nuclear membrane breaks down and disappears; spindle fibres lengthen; and attach to the centrioles at both poles forming asters; Anaphase; chromatids separate at the centromere; shortening of the spindle fibres occurs; resulting in the chromatids migrating to opposite poles of the cell; spindle apparatus begins to

disappear; Telophase; final stage where chromatids reach the poles; become densely packed together and uncoil; a nuclear membrane forms around each mass/set of chromatids (now referred to as chromosomes); cytoplasm divides into two (cytokinesis); in animal cells, the cytoplasm divides by constriction of the cell membrane; while in plant cells, a cell plate forms within the cytoplasm and grows to separate the cell into two; spindle fibres disappear within the cytoplasm; and nucleoli reappear in the nuclei; of the two daughter cells formed at the end of telophase; **Max. 20 mks**

**45. Discuss the various mechanisms that hinder self-pollination and self-fertilisation in plants**

Protandry and protogyny; these are mechanisms where either the male or female parts of the reproductive organs ripen at different times in some flowers; Protandry is a case where stamens ripen earlier; and anthers release their pollen grains before the stigma is mature; while protogyny refers to a case where the stigma matures earlier; and hence becomes ready to receive pollen grains before the anthers are ready/ripe to shed the pollen grains; common in plants of the grass family; Self-sterility or incompatibility; is a case where pollen grains cannot germinate on stigma of the same plant; but only germinate on a different plant of the same species; hindering self-pollination; Heterostyly; condition of having different arrangements of style and stigma; for instance flowers could have shorter stamens than pistils; hence becomes impossible for the pollen to land, germinate and fertilise the ovules of the same flower; pistils on some flowers could also be shorter than the stamens therefore other mechanisms that hinder self-pollination are utilized; Dioecius and monoecius plants; dioecius plants have reproductive parts located separately on different plants of the same species; discouraging self-pollination; while monoecius plants have the parts located at different parts of the same plant body; encouraging cross-pollination; **Max. 20 mks**

**46. How are seeds and fruits of plants adapted to their mode of dispersal?**

Water; Fruit mesocarp/seed testa has air spaces; thus light/buoyant to float; carried away by water; fruits/seeds protected from soaking by waterproof pericarp/testa; Animal; have hooks for attachment to animals; thus carried to other places; fruits are brightly coloured; succulent/fleshy; aromatic/scented; to attract animals; which feed on them; the seed coats/hard seeds are resistant to digestive enzymes; thus are unaffected; seeds dropped away from parent in faeces/droppings; Wind; have hairs/wing-like structures/floss/extensions; which increase surface area/for buoyancy; making it easy to be blown away; fruits/seeds are light due to small size; therefore easily carried away by wind; censor mechanism; perforated/open/split/capsule; usually loosely attached to the stalk/long stalk; is swayed by wind; scattering seeds; Selfdispersal/Explosive mechanism; tension/pressure is created inside a dry pod; pod opens (violently) along lines of weaknesses; the two halves curl outwards; scattering the seeds; **Max.**

**20 mks**

**47. a) Distinguish between mutations, mutants and mutagens**

Mutations are sudden, spontaneous and permanent changes; in an individual's genetic material; Mutants are individuals who develop and exhibit unusual characteristics that were not previously present in the population; due to mutations; while mutagens are factors in the environment; that cause mutations to occur; **6 mks**

**b) Give two causes of mutations**

Irradiations such as gamma rays and ultra violet rays; chemical substances such as mustard gas and other heavy metals (mercury, lead, asbestos); sudden extreme (high or low) temperatures; **Max. 2 mks**

**c) Describe the causes and effects of chromosomal mutations**

Deletion; refers to the absence of a portion of a chromosome; it results from breakage and falling off of a portion of a chromosome; leading to loss of a group of genes that may have a disastrous effect on the development of an organism; Inversion; refers to reversal of normal sequence of genes in portion of a chromosome; occurs when a middle portion of a chromosome breaks, turns or rotates (inverts) through $180^{o}$ and joins up again; this does not change the genetic constitution of the organism; but may bring into close proximity genes whose combined effects to an organism produce a beneficial effect to an organism; or cause disadvantages to the organism; Translocation; attachment of a portion of a chromosome to a non-homologous chromosome; occurs when a chromosome breaks and the portion joins another non-homologous chromosome; this may lead to serious consequences, even death depending on what genes are missing; Duplication; situation where a set of genes is represented twice in a chromosome; a part of a chromatid formed during cell division may replicate further to form an extra piece; which may attach onto the same or another chromatid; resulting to traits controlled by some genes being excessively expressed; Non-disjunction; this is failure of a pair of homologous chromosomes to separate during the first stage of meiosis; resulting in one of the daughter cells formed after division of the cell having two of one kind of a chromosome; while the other cell has less or none; diseases or disorders known as syndromes are known to result from this aberration e.g. Down's Syndrome (Mongolism),Turner's Syndrome, Klinefelter's Syndrome; Polyploidy; this is the presence of more than two sets of chromosomes in a cell; occurs due to a failure of a cell to divide after the first stage of meiosis or after the chromosomes have replicated in mitosis; common in plants than animals; in plants, it causes some improvements such as resistance to drought, certain diseases and pests, improved yields and early maturity; **Max. 20 mks**

**48. a) What is transpiration?**

Process by which plants lose water to the atmosphere; in form of vapour (through lenticels, stomata and cuticle); **2 mks**

**b) Explain how the various environmental factors affect the rate of transpiration**

Temperature; an increase in temperature increase the water vapour holding capacity of air in the spaces between mesophyll cells due to increased evaporation; therefore more water diffuses from the cells increasing the water vapour pressure; this causes an increase in the diffusion gradient between the intercellular spaces and the atmosphere; hence increasing the rate of transpiration; low temperature decreases water vapour pressure and the diffusion gradient hence; lowering the rate of transpiration; Light intensity; high light intensity increases the rate of photosynthesis in the guard cells; causing the opening of stomata; leading to increased water loss; it also increases the internal temperature of the leaf; that increases the evaporation rate in the intercellular spaces; leading to a higher rate of transpiration; low light intensity; reduces the rate of water loss; Humidity; a humid atmosphere lowers the water vapour diffusion gradient; hence lowering the rate of water loss; in a less humid/dry

atmosphere, water diffusion gradient is high/steep; hence the rate of transpiration increases; Availability of water in the soil; more water will diffuse to the atmosphere when there is adequate or excess water; as more will be absorbed; increasing the rate of water loss; the guard cell will also remain turgid; hence stomata are open; leading to more water loss; however, less water in the soil leads to a reduced diffusion gradient between the mesophyll cells and the atmosphere; thereby reducing the rate of transpiration; Wind/air currents; wind blowing over a leaf surface carries pockets of moisture away from the leaf; creating a steep diffusion gradient between the atmosphere and the leaf; increasing the rate of water loss; in still air/on a calm day however, water vapour at the leaf area becomes saturated; and the diffusion gradient is lowered; reducing the rate of transpiration; Atmospheric pressure; low atmospheric pressure leads to a high rate of diffusion of water vapour; since air molecules move at a faster rate; and this increases the rate of water loss; in high atmospheric pressure conditions however, there is low rate of diffusion of water vapour; hence the rate of water loss is lowered; **Max. 20 mks**

**49. How is the mammalian eye adapted to its functions?**

Sclera/sclerotic layer; white fibrous layer; made up of thick connective tissue; protects the eye; maintains shape of eyeball; Cornea; transparent; disc-shaped layer; that allows light to enter the eye; refracts light towards the retina; Conjunctiva; delicate membrane; lining the inside of the eyelid; protects the cornea/eye; Eyelids and eye lashes; thin muscle with hairs; protects the cornea/eye from mechanical/chemical damage/protects the eye from entry of foreign particles; protects retina from bright light; Choroid; dark pigmented and membranous layer; that prevents light reflection within the eye/absorbs light; to prevent distortion of the image; has blood vessels; that nourish eye/retina/supply oxygen/remove carbon (IV) oxide and wastes; extends to form the ciliary body and iris; Ciliary muscles; have elastic muscles that contract and relax; to alter shape/curvature of lens during accommodation; Ciliary body; thickened front edge of the choroids layer; that produces aqueous humour; Suspensory ligaments; made up of elastic connective tissue whose contraction and relaxation helps to adjust the shape of lens during accommodation/holds lens in position; Lens; transparent; biconvex; balloon-like; it refracts light rays/focus light onto the retina; Vitreous humour; nourishes cornea/lens; refraction of light; maintains eyeball shape; Iris; thin circular ring; with circular and radial muscles; it gives eye colour/absorbs light; controls the amount of light entering the eye/adjusts size of pupil; Pupil; an aperture through which light enters the eye; Retina; has photoreceptor cells/rods/cones for image formation; generates impulses to the brain for interpretation; Fovea/Yellow spot; with only cones; for high visual acuity/most sensitive part of the retina Blind spot; point where nerve fibres emerge from the optic nerve/where optic nerve leaves eye/point where nerve fibres and blood vessels enter the eye; Optic nerve; transmits impulses to the brain; Muscles; inferior and superior oblique muscles; move eye from left to right; superior and inferior rectus muscles; move the eye up and down; external and internal rectus muscles steady the eye in its up and down movement; Tear/Lachrymal glands; secrete a watery and saline fluid containing lysozymes/lytic enzymes/is antiseptic (tears); that moisten the conjunctiva and cornea; washes away dust and other foreign objects; kills microorganisms entering the eye; **Max. 20 mks**

**50. Discuss the role of the various hormones in plant growth and development**

Indole Acetic Acid/Auxins; influences/promotes cell division/elongation (in cambium causing secondary thickening); induces tropisms; promotes fruit formation/parthenocarpy; promotes formation of abscission layer/leaf fall; promotes cell differentiation (of vascular tissue); causes

apical dominance/inhibits lateral bud formation; promotes growth of adventitious roots; in conjunction with cytokinins, it induces callous tissue formation; Gibberellins/Gibberellic acid; promotes cell division/elongation in dwarf plants; promotes parthenocarpy; setting of fruit after fertilization initiating formation of fruits; formation of side branches of stems/ends apical bud dormancy; inhibits adventitious root growth; activates hydrolytic enzymes in germination/promotes germination of seeds/breaks seed dormancy; affects leaf expansion and shape/retards leaf abscission; Cytokinins (e.g. Zeatin or Kinetin); promotes flowering in some plant species; breaks dormancy in some plant species; promotes cell division in presence of auxins; stabilizes protein and chlorophyll; promotes root formation on a shoot; low concentration encourages leaf senescence/increases cell enlargement in leaves; stimulates lateral bud formation; Ethylene/Ethene; promotes ripening of fruits; induces thickening of stem/inhibits stem elongation; promotes flower morphogenesis/formation or flowering in pineapples; causes abscission of leaves/fruit/leaf fall; Abscissic acid; high concentration causes stomatal closure; inhibits stem elongation/growth; inhibits sprouting of buds/induces bud dormancy; inhibits seed germination/growth/causes/promotes seed dormancy; causes abscission of leaves/fruits/leaf fall; Traumatin; heals wounds by promoting callous formation; Florigen; promotes flowering; **Max. 20 mks**

**51. Explain how the process of evolution may result to the formation of a new species**

For a new species to be formed, a population of organisms must become completely isolated or separated from others; over long periods of time so that any new variations that arise will not therefore flow to the other population; there are various isolation mechanisms: Geographical isolation; this is due to physical barriers such as oceans/seas/deserts; Ecological isolation; a barrier resulting from the occupation of different types of habitats from the original type; it may be due to isolation for reasons of feeding/predation/breeding; as well as environmental changes such as climate and vegetation; which may result in a population living in different habitats; to become ecologically separated from one another; Behavioural isolation; alteration of behaviour proceeding mating; which include courtship behaviour/lack of attraction between males and females in different populations; due to production of different chemicals or pheromones or colouration/songs; Reproduction isolation; a barrier to successful mating between individuals of a population; due to structural differences in reproductive organs; as well as failure in fertilization/incompatibility; Genetic isolation; even if fertilization takes place; the zygote may be inferior/fails to develop; however if the zygote develops, the offspring may be inferior or infertile/sterile; **Max. 20 mks**

**52. Discuss the various ways in which anaerobic respiration is utilized in industries and homes**

Bread making; yeast is used to ferment sugar in wheat flour into carbon (IV) oxide and energy; the carbon (IV) oxide is produced in form of bubbles that causes the dough to rise and become porous; Beer making; yeast is used to ferment sugars in malt/grapes/fruits; to form beer, wines and spirits; Sewage treatment; anaerobes break down raw sewage and harmful industrial effluents; to harmless products of water, energy/heat and carbon (IV) oxide; Silage formation; vegetation is fermented by bacteria to produce nutritious and good-scented/flavoured animal feed that increases production/yields; Production of acids and strong liquors; special bacteria and fungi ferment food products; to produce acids such as citric acid, oxalic acid and vinegar; the products are used as food preservatives and flavouring agents; Manufacture of dairy products; under controlled environments; anaerobes help in fermentation hence manufacture of milk

products such as butter, cheese, ghee and yorghurt; Production of fuels such as biogas; and gasohol; cane sugar is fermented by yeast; to produce gasohol for running engines or operating machinery; animal wastes such as guano and cow dung; can be used to produce a mixture of methane and carbon (IV) oxide gas; by exposing it to fermentation agents; methane is used to run simple machines such as water pumps and for cooking; Production of fermented porridge and milk; maize or wheat flour and milk is exposed to microbes in the air which ferment it; to produce sour and sweet tasting porridge or milk; **Max. 20 mks**

**53. a) What is digestion?**

Digestion is (mechanical and chemical) the process by which large complex food molecules; are broken down into soluble molecules (for absorption across intestinal wall to bloodstream); **2 mks**

**b) What is the importance of a balance diet in human nutrition?**

A balanced diet consists of all the food types in their right proportions; it includes proteins, carbohydrates, minerals, lipids, water, vitamins and roughage; Proteins; used for growth and repair of worn out tissues; provide energy incase of acute shortage of carbohydrates/starvation; bind and transport specific molecules from one part of the body to another; structural proteins support tissues in the body e.g. bone and cartilage tissues; act as metabolic regulators such as enzymes and hormones; Carbohydrates; used to produce energy/store energy; Lipids produce energy; form of storage of energy; insulate the body; major structural components of the cell membrane; when oxidised, it provides metabolic water; Vitamins; defense against infections; form coenzymes which activate enzymes; Water; a universal solvent; medium for chemical reactions; used as coolant because of its high specific heat capacity; maintains the shape of cells; hydrolysis of many substances; transport medium in the body; Mineral salts; formation of teeth and bones; formation of hormones (e.g. thyroxine); formation of blood; maintenance of osmotic pressure of body fluid; transmission of nerve impulses; Roughage; makes food to be bulk; promotes peristalsis; and absorption of water in the large intestines; induces mucus production; **Max. 18 mks**

**54. Explain the factors that affect enzyme activity**

Temperature; enzymes are protein in nature; and hence sensitive to temperature changes; as temperature increases, enzyme activity also increases until optimum/maximum; above this optimum the reaction decreases sharply; due to the destruction of the enzyme structure/become denatured; making the enzyme ineffective/non-functional; most enzymes have optimum temperature of between 35$^{o}$C and 40$^{o}$C; when temperature decreases, the rate of enzyme reaction decreases as the enzyme becomes inactivated; pH/acidity or alkalinity; most enzymes have optimum pH of close to 7/neutral which is the intracellular pH; however some enzymes work best in an alkaline medium while others work best in an acidic medium/condition; as the pH exceeds optimum, the enzyme activity decreases; extreme acidity or alkalinity denatures most enzymes; Substrate concentration and enzyme concentration; enzyme reaction increases with increase in substrate concentration; up to a certain level where further increase in substrate concentration does not increase the rate of enzyme reaction; this is because when substrate concentration is increased, all the active sites of the enzyme are occupied; however, when the enzyme molecules are increased, there is a proportional increase in the maximum rate of enzyme action; enzymes are however required in small amounts hence; they speed up the rate of biochemical reactions without altering the equilibrium; Enzyme cofactors/coenzymes; these are non-proteinous substances which activate the enzymes; most enzymes will not work without them; examples of cofactors are metallic ions such as iron, magnesium, zinc, copper and also vitamins as enzyme coenzymes; these substances are required in small amounts and are used repeatedly/can be recycled; Enzyme inhibitors; these are substances that inhibit enzyme action by competing with the normal substrate for the active sites; there are two types: competitive and non-competitive; competitive inhibitors have no permanent effect on the enzyme action; while non-competitive inhibitors combine permanently with the enzyme molecules thus distorting or blocking the active sites permanently; examples of these inhibitors include cyanides, mercury, silver; inhibition can be reduced by reducing the concentration of the inhibitors; or by increasing the substrate concentration; **Max. 20 mks**

**55. Discuss the adaptations of the male reproductive system of humans**

Consists of two oval-shaped testes; lying outside the abdominal cavity in a special sac known as the scrotal sac/scrotum; for protection; the testes are located outside the body to provide a relatively cooler environment/lower temperature; suitable for sperm production; the inside of the testis is divided into seminiferous tubules; these are three coiled and twisted tubules; having rapidly/actively dividing cells that produce sperms; interstitial cells; found between these tubules produce the male sex hormones/androgens (mainly testosterone); important in promoting the development of secondary sexual characteristics; and maintaining masculinity in males; the tubules join together to form the epididymis; which are smaller ducts; that convey sperms out of the testes; they also form a temporary storage area for sperms; the epididymis is connected to the sperm duct/vas deferens; which has thick muscular walls; that contracts to propel sperms to the urethra; the sperm duct is joined by a duct from the seminal vesicle; a blindly ending sac; that produces an alkaline fluid containing nutrients for the spermatozoa/sperm cells; to provide energy; at the junction of the two sperm ducts (one from each testis) and urinary bladder there is the prostate gland; that secretes an alkaline fluid that neutralizes the acidic vaginal fluids; and also activates the sperms; by addition of enzymes and diluting the sperms; below the prostate gland is the cowper's gland; which secretes an alkaline fluid which neutralizes the acidity caused by urine; along the urethra. The urethra; is a long tube running the length of the penis; used for

conduction and expulsion of urine; as well as passage of sperms during copulation; the urethra follows the penis; that projects from the body at the lower abdomen; it consists of a retractable skin known as the prepuce/foreskin; that covers a swollen/bulbous end region of the penis known as the glans; the glans excites the clitoris of the female as it brushes on it during copulation; to stimulate ejaculation/orgasm; the penis is made up of spongy erectile tissue; consisting of numerous small blood spaces, muscle and blood vessels; the spongy tissue gets filled with blood; making the penis to become erect during sexual stimulation excitement and activity; enabling the penis to penetrate the vagina during coitus/copulation/sexual intercourse; in order to deposit sperms in the vagina of the female; **Max. 20 mks**

**56. Discuss the structure and functions of the various muscle tissues found in humans**

Smooth/Visceral Muscle; consists of spindle-shaped cells; made up of long filaments or myofibrils; the cells lack cross striations and sarcolemma; they are uninucleate/with one cell; they contract and fatigue slowly; to bring about contraction and relaxation of the walls of blood vessels, urino-genital tract and the gut; which aids in blood flow, urine and sperm flow and peristalsis of food respectively; Skeletal/Striated muscles; made up of long cylindrical cells; with long myofibrils running parallel to each other; the cells have cross striations/stripes; are multinucleated; they form bundles of long fibres attached to bones by tendons; they contract and fatigue rapidly; to bring about movement of bones; (on the body) they contain contractile protein myosin and actin; Cardiac/Heart muscle; this is the muscle of the heart; is made up of short cylindrical cells; with parallel myofibrils; the ends of each all are thickened into intercalated discs; that connect adjacent cells; the myofibrils have cross striations; each cell is uninucleate; the myofibrils contract without fatigue; **Max. 20 mks**

**57. State the economic importance of members of Monera and Fungi and for each economic importance name a suitable or appropriate organism (20 mks)**

**Fungi:** Yeast is used in the production of alcohol; and raising dough in baking; production of vitamins $B_2$ and $B_{12}$ and for beer brewing; some mushrooms are used as food; Saprophytic fungi such as *Mucor spp*/*Rhizopus spp* cause food spoilage; are also used in retting of natural fibres such as flax; and in the curing of tea and tobacco; The fungi also decompose organic matter helping to clean the environment and recycle materials. Saprophytic fungi are also used to make silage; compost; and digesting sewage in sewage treatment plants; *Penicillium spp* is used for the manufacture of antibiotics; Fungi is used for making ghee and cheese in dairies; parasitic fungisuch as *Phytophthora spp* infest crops e.g. potatoes and tomatoes and destroy them/cause blight; somefungi such as *Aspergillus spp* produce food poisons and is also used in the synthesis of enzyme amylase; Mycorrizae fungi enable trees e.g. pinus to absorb water amd mineral salts more efficiently in silviculture/man-made forests; some fungi such as and *Tinus spp* cause diseases such as yeast infections (Candidiasis, 'Athlete's foot') and 'ringworms' respectively; some *Candida spp* is used in making enriched food/single-celled proteins used in animal feeds/silage; *Gibberella spp* is used in the synthesis of Gibberellins for plant growth; it also causes poor crop growth through bolting of plants e.g. rice and wheat;

**Bacteria:** Some bacteria e.g. *Vibrio spp* cause disease to humans and other animals (any one disease); *Clostridium spp* and *Bacillus spp* bacteria are used in retting of flax; *Lactobacillus spp* are important in the manufacture of yoghurt/silage; and lactic acid; some bacteria e.g. *Streptomyces* are used in making antibiotics (Streptomycin); organic acids such ac acetic and ethanoic acids are made using *Acetobacter spp* of bacteria; some bacteria like the soil bacteria

(*Bacillus spp*) make enzymes used in detergents; *Escherichia coli (E. coli)*/colon bacteria contaminates drinking water and may cause diseases; bacteria such as *Bacillus spp* and are used in making hormones such as insulin through genetic engineering/modification; all saprophytic bacteria such as *E. coli/Bacillus spp/Pseudomonas spp* are used in the production of methane/biogas; *Rhizobium spp* of bacteria helps in nitrogen fixation making soils fertile; **Max. 20 mks**

**58. Describe the adaptations of the nervous system to its functions (20 mks)**

The central nervous system consists of the brain; and the spinal cord; and nerve fibres; that serve the sensory organs ; and the effector organs and glands; the brain is a collection of millions/billions/$10^9$ neurones; that form the biggest ganglion; it is highly convoluted; to provide a large surface area for impulse reception, processing and transmission; the brain and the spinal cord are protected by the meninges; the brain and the spinal cord have spaces/canals and ventricles; filled with a cerebrospinal fluid; which acts as a bridge/supply medium for oxygen and nutrients; and the removal of metabolic waste; the brain has centres for the storage; retrieval and processing of impulses; the cerebrum processes and stores information; the cerebellum; sends impulses to joints and muscles; to correct balance; the medulla oblongata sends impulses to the cardiovascular; and breathing/ventilation systems; to regulate them; the brain has the hypothalamus that secretes a neurosecretion to influence a pituitary gland that secretes hormones; involved in reproduction; and homeostatic functions; the hypothalamus; detects changes in temperature; and osmotic pressure; and sends impulses to relevant effector organs for their regulation; the thalamus; receives majority of the impulses and channels them to the relevant areas of the brain; both the brain and the spinal cord have regions of the grey matter; that enable very rapid processing/transmission of impulses; the nervous system has neurones (relay/intermediate, motor and sensory); that transmit impulses at a very rapid note/speed (100 $ms^{-1}$) to and from the central nervous system to effect suitable responses; there exists in the central nervous system an electrochemical gradient/concentration gradient; that allows for the generation of electrical impulses; they have numerous mitochondria; for generating energy for the function of the sodium pump; which enables polarization and repolarisation; during impulse transmission and refractory/recovery periods; the spinal cord has no integration/association functions and is therefore suited for reflex actions; needed in emergencies; the spinal cord is long; and connects nerve fibres of the peripheral nerves with the brain for storage of information; the spinal cord has a dorsal root for sensory fibres/neurones; and a ventral root; for motor neurones/fibres; Accept any other correct **Max. 20 mks**

**59. Discuss the composition and functions of mammalian blood (20 mks)**

Mammalian blood consists of two main components: Blood plasma; and the blood cells; (Red blood cells/Erythrocytes, White blood cells/Leucocytes and Platelets/Thrombocytes); Blood plasma transport nutrients (glucose, amino acids, vitamins, fatty acids and glycerol, dissolved oxygen) to tissues; transports hormones, enzymes/metabolic regulators to target organs and tissues; Transport excretory substances/wastes from the cells; to excretory organs for elimination from the body; Distribute heat energy; helping in thermoregulation; transports/contains water, plasma proteins and dissolved mineral salts; important in osmoregulation; Suspends blood cells; Red blood cells transport oxygen; and dissolved carbon (IV) oxide; helps in regulation of pH; White blood cells help in protection/immunity; by engulfing or producing antibodies to kill/destroy invading micro-organisms/pathogens; Platelets help in blood clotting; preventing

excessive blood loss; entry of pathogens; and promotes healing of wounds; **Acc. Adaptive features Max. 20 mks**

**60. Describe the defects that affect the mammalian eye and how they could be corrected**

Short-sightedness (myopia); a condition where light rays from a distant object are focused in front of the retina; while those from a near object are clearly focused on the retina; it is caused by an abnormally elongated eyeball; or too much refractive power of the eye lens; it is corrected by wearing concave/diverging lenses; which help to diverge light rays; or reduce the refractive power of the eye before they reach the eye lens; Long-sightedness (Hypermetropia); light rays from a near object are not focused by the time they reach the retina; or may be focused behind the retina; while the rays from a distant object are sharply focused; the defect is caused by an eyeball that is too short; or a weak lens system (distance between lens and the retina is short); corrected by wearing a convex/converging lens; which refracts light rays before reaching the eye lens; this enhances refraction resulting in rays being sharply focused onto the retina; Astigmatism; rays from an object are brought to focus on different planes; due to unequal curvature of the cornea/lens; causing unequal refraction of light entering the eye; this defect is corrected by wearing special cylindrical lens in front of the eye; the lens corrects the focus in the defective planes; Colour-blindness; a genetic defect; in which an animal is unable to distinguish between colours particularly within the red-green spectrum; the retina lacks cones; pigments that respond to colour vision; Squintedness; an eye defect in which extrinsic muscles of the eye; that controls the turning of the eyeball do not co-ordinate accordingly on stimulation; it affects the paired rectus muscles that move the eyeball up and down; and the lateral rectus muscles that move the eyeball left to right; the eyeballs therefore face different directions; making focusing and accommodation difficult to achieve; corrected by specialized surgery; Old sight (Presbyopia); caused by old age; when supplies of nutrients and oxygen to the lens is far much reduced; hence the cells of the lens die; the lens' elasticity is reduced; and hence cannot change shape; and becomes fixed into a shape that is not suitable for distant vision; managed by use of 'reading glasses' that have converging lenses; to give the eyes an extra power to manage close work; Cataracts; associated with old age; but may also be caused by an eye injury due to a blow; or complications of diabetes mellitus; the eye lens become cloudy; blocking transmission of light rays; protein fibres become denatured; and clump together making the lens opaque; corrected by surgery; to replace the defective lens with a normal one from a donor; or use of artificial lens; **Max. 20 mks**

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