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

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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

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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**

END