ADVANCED LEVEL BIOLOGY

SEMINAR

ANSWER BOOKLET

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JINJA PROGRESSIVE SSECONDARY SCHOOL

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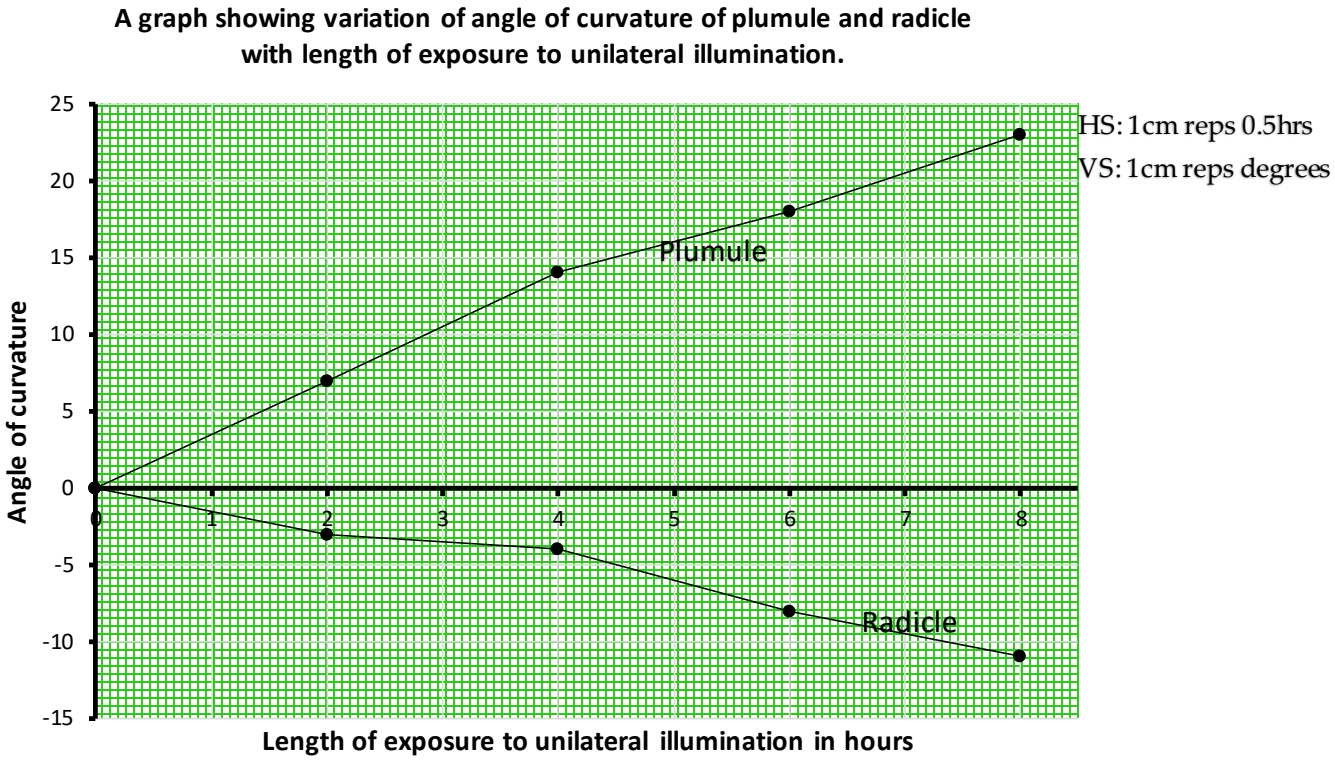
1)

a) i)



b) the plumule curves positively while the radicle curves negatively; unilateral light causes redistribution of auxins, more on the lower dark side and less in the light upper side of the seedling; in the plumule higher auxin concentration in the shaded side cause higher rate of cell elongation than the light side; the plumule grows toward the light source, positive phototropism, and upwards, negative geotropism for the shoot to obtain light for photosynthesis while in the radicle, higher auxin concentration in the illuminated side cause more cell elongation than the shaded side; the radicle curves away from the source of light, negative phototropism and downwards, positive geotropism for anchorage and absorption.

c) i) W; Apical buds removed and no further treatment causes moderate increase in average total length of side buds and shoot per plant.

X; Apical buds replaced with plugs containing auxin; cause very low increase in average total length of side buds and shoot.

Y; Apical buds replaced with plain lanolin plugs causes moderate increase in average total length of side buds and shoot.

Z; Apical buds removed replaced with lanolin plugs containing gibberellin causes highest increase in average total length of side buds and shoot.

ii) W and Y; the removal of the apical bud in W and the replacement with plain lanolin plug in Y eliminates the source of auxins; which is primarily produced by apical meristem; this reduces auxin concentration removing inhibition on lateral bud growth; lateral buds grow, leading to an increase in the average total length of side buds and shoot.

X; Application of auxin through lanolin plug maintains a high concentration of auxin that inhibit lateral bud growth; leading to apical dominance and very little growth of side bud.

Z; Gibberellins promote cell division and elongation; adding gibberellins contained in the lanolin plugs; stimulate rapid cell division and elongation of the lateral buds; breaking apical dominance.

iii) Ensure a larger sample size, which increase reliability reducing impact of individual variations.

d) Allows plants to grow upwards rapidly; competing for light in shaded/dense environments, this enable the plant to maximize light capture which is required for photosynthesis; and is a limiting factor in such environments.

e) They perform the following:

- ✓ Rooting hormones to stimulate root formation in cuttings e.g. auxin.
- ✓ Induce fruit ripening.
- ✓ Prevent fruit fall/abscission.
- ✓ Selective weed killers.
- ✓ Induce parthonocarpy.
- ✓ Promote flowering.
- ✓ Used in brewing promoting α amylase production.
- ✓ Promote apical dominancy.

2)

2) a) i) Let G represent allele for grey body

Let g represent allele for yellow body

Let R represent allele for red eyes

Let r represent allele for white eyes

Let XY represent female sex chromosome

Let XY represent male sex chromosome

Phenotype: grey body red eyed female x yellow body white eyed male

Genotype (2n) $^{G}X^{R\ g}X^{r}$ x $^{G}X^{R}Y$

Meiosis

Gametes (n) $^{G}X^{R}$ $^{g}X^{r}$ $^{g}X^{R}$ $^{G}X^{r}$ $^{G}X^{R}$ Y

Male gametes

Female gametes	$^{G}X^{R}$	Y
$^{G}X^{R}$	$^{G}X^{R}$ $^{G}X^{R}$	$^{G}X^{R}Y$ Grey bodied Red eyed male
$^{g}X^{r}$	$^{G}X^{R}$ $^{g}X^{r}$	$^{g}X^{r}Y$ Black body White eyed male
$^{G}X^{r}$	$^{G}X^{R}$ $^{G}X^{r}$	$^{G}X^{r}Y$ Grey body white eyed male
$^{g}X^{R}$	$^{G}X^{R}$ $^{g}X^{R}$	$^{g}X^{R}Y$ Black body red eyed male

Male phenotype ratios;

1 grey body red eye: 1 blue body red eye : 1 blue body white eye: 1 grey body white eye

ii) Parental phenotype: Grey body red eyed female x yellow body white eyed male

Genotype (2n) : $X^{GR}X^{gr}$ x $X^{gr}Y$

meiosis

Gametes(n) : X^{GR} X^{gr} X^{gr} Y

Using Punnett square:

Male gametes

Female gametes	X^{gr}	Y
X^{GR}	$X^{GR}X^{gr}$ Grey body red eye	$X^{GR}Y$ Grey body red eye
X^{gr}	$X^{gr}X^{gr}$ Yellow body white eye	$X^{gr}Y$ Yellow body white eye

Offspring phenotype of females: 1 grey bodied red eyed: 1 yellow bodied white eyed

f) i) Hybrid vigour result from increased heterozygosity arising from mixing of alleles, harmful recessive alleles are less likely to be present in the homozygous condition, and from interaction between particular combination of alleles in the hybrid.

ii) ABO blood group determined by autosomal gene; ISO haemoglutinogen which occur in three/ multiple allele, I^A, I^B and I^O, I^A and I^B are codominant while I^O is recessive to both I^A and I^B I^A I^A , I^A I^O genotype result in blood group A, I^B I^B I^B I^O result in blood group B, I^A I^B genotype result AB blood group, I^O I^O genotype result into group O.

3) a) i)

Similarities

Number of both beetles species A and C;

- From 60 to 80 days increase rapidly
- From 50 to 60 days remain constant
- Attain maximum
- Equal at 48 days

Differences

Number of species A	*Number of species B*
Attain higher maximum	Attain lower maximum
From 50 to 80 days, number is higher	From 50 to 80 days, number is lower
From 0 to 50 days, number is lower	From 0 to 50 days, number is higher
From 0 to 20 days, number increase gradually	From 0 to 20 days, number increasing rapidly

ii) **Similarities**

Number of beetles of both species A and C;

- Attain maximum
- Equal at 20 days
- From 0 to 10 days increase

Differences

Number of species A	*Number of species B*
Attains higher maximum	Attains lower maximum
Does not attain peak	Attains peak
Attains maximum earlier/ at 10 days	Attains maximum later/ at 80 days
From 0 to 10 days, number increase gradually	From 0 to 10 days, number increases rapidly
From 10 to 80 days, number increases	From 10 to 80 days, number decreases

b) From 0 to 80 days, number of both beetles A and C increased; narrow glass tubing creates micro habitat for species C; reducing interspecific competition for food and space; allowing co-existence so both species survive;

From 0 to 50 days, number of C is higher than A; because individuals of C are small with low requirements of food and space; therefore, able to get resources and reproduce quickly in both glass tubing and container.

From 50 to 80 days, number of A is higher than C; because increase in the numbers of the two species increase interspecific competition; individuals of A are large with a competitive advantage; therefore, A only live in the glass tubing.

ii) From 0 to 10 days, number of C increase rapidly while number of A increase gradually; this is because of low interspecific and intraspecific competition for food and space; individuals of C are small with low requirements so reproduce more rapidly than individuals of A.

From 10 to 80 days, numbers of C decrease while numbers of A increase; increase in the numbers of two species increase interspecific competition for food and space; species A is a better competitor due to large size; therefore, can access resources and reproduce while species C is a weak competitor, unable to get resources and; do not reproduce.

At the end; number of C decrease to extinction because they are outcompeted while number of A increase gradually/ remain almost constant due to environmental resistance/carrying capacity almost reached.

c)i) Resources partitioning/ niche differentiation where two different species share the same resource allowing co-existence and so both species survive.

ii) Competitive exclusion; where two species competing for the same resources cannot co-exist, the weak species is out competed to extinction.

d) i) Numbers of A would increase and numbers of C would decrease; because A is a better competitor; the numbers of both A and C then decreases to extinction due to food becoming scarce, and accumulation of wastes.

ii) Number of C would increase rapidly, then gradually to the carrying capacity where it stabilizes and later decreases due to food scarcity and waste accumulation.

4) a) From 0 to 20km, as average number of lichen species increase gradually, percentage of melanic moth is high and constant.

From 20 to 40km, as average number of lichen is low and constant, percentage number of melanic moth is high and constant.

From 40 to 50km, as average number of lichen species remain constant, percentage number of melanic moth decreases gradually,

From 50 to 60km, as average number of lichen species increase gradually, percentage number of melanic moth decreases gradually

From 60 to 100km, as average number of lichen species increase rapidly, percentage number of melanic moth decreases rapidly

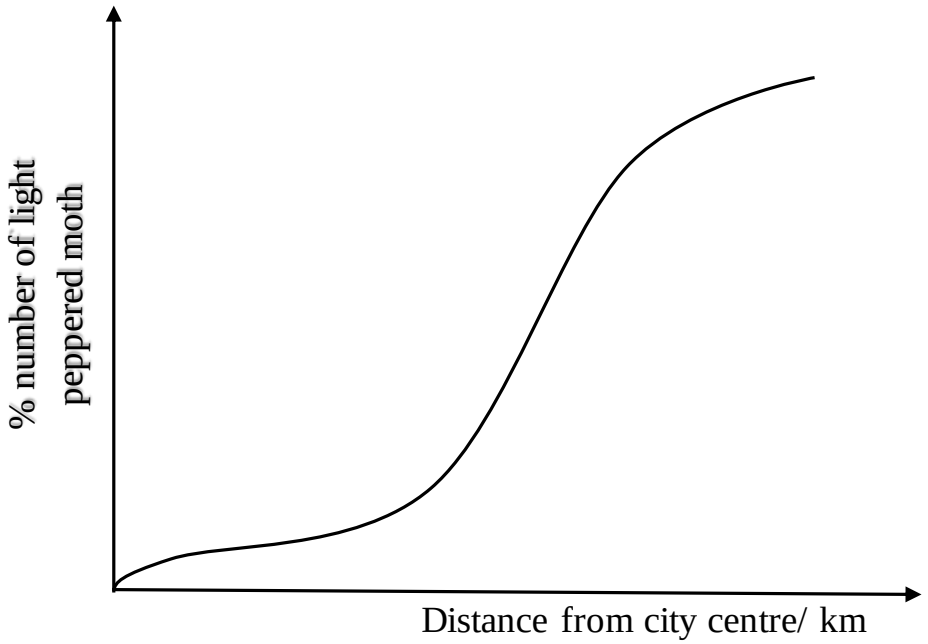
From 100 to 120km, as average number of lichen species increase gradually, percentage number of melanic moth decreases gradually

b) From 0 to 40km, percentage number of melanic moth is high and constant; Near city centre there is high environmental pollution from industries; due to release of smoke, Sulphur dioxide which

blacken environment and kill lichens respectively; melanic moths can better camouflage against the dark/ black background and avoid predatory birds; many survive and reproduce.

From 40 to 120km percentage number of melanic moth decrease; Away from the city centre, industries decrease in number, production of Sulphur dioxide and soot/smoke decrease; number of lichens on tree barks increase and buildings are not blackened/ darkened; the back ground becomes light; melanic moths cannot camouflage against the light background; are easily spotted / are more conspicuous to the predatory birds; many are eaten and fail to reproduce.

c) *Graph showing variation of the number of light coloured peppered moth with distance from city centre*



Distance from city centre is low because of high pollution darkening environment; light moths are easily spotted by predatory birds and eaten intensively; as distance from city increase; environmental pollution decrease; lichens are not killed; background remain light; light moths camouflage against background, not easily spotted by predatory birds; and survive to reproduce.

d)

- ✓ Contributes to acid rain which can acidify soil and water bodies harming plants and aquatic life.
- ✓ Damage plant tissues directly reducing photosynthesis.

- ✓ Cause lung diseases, irritation of the eye surface.

e) The change in the number of melanic moths demonstrate natural selection; where predation favors melanism; differential survival and reproduction of melanic moths in the polluted areas near city and their decrease in less polluted areas far away from city centre show adaptation to changing environmental conditions.

5) i) There is higher concentration of ions in cell sap than pond water: with highest concentration of chloride ions, and lowest concentration of magnesium ions; highest accumulation for potassium ions.

ii) Accumulation ratio = $\frac{ion\ concentration\ in\ cell\ sap}{ion\ concentration\ in\ pond}$

for potassium ions:

accumulation ratio = $\frac{2400}{2}$

=1200

For sodium ions:

Accumulation ratio = $\frac{1988}{28}$

= 71

iii) The higher concentration of the ions in the cell sap than pond water indicates uptake of ions by active transport. The different accumulation ratios for the ion shows selective absorption due to presence of specific carrier protein molecules that move specific ions against concentration gradient.

a) Bright light causes higher units of ions absorbed than dim light; at bright light the light intensity is higher than at dim light leading to higher photosynthetic rates producing more sugars broken down in respiration producing more ATP for the active uptake of more ions.

Increasing time causes units of ion uptake to remain constant at both dim light and bright light; because light intensity is no longer a limiting factor for the ion uptake.

b) i) Increasing oxygen concentration from 0% to 30% leads to an increase in units of potassium ions absorbed; because of increase in aerobic respiration/ breakdown of sugars producing much ATP for active uptake of potassium ions; and at the beginning a steep concentration gradient of potassium ions leading to high diffusion rate of potassium ions.

ii) Aerobic respiration cause accumulation of carbon dioxide, lowering pH which denature/inhibit action of respiratory enzymes; the high oxygen concentration also causes depletion of sugars; no ATP production for active uptake of ions into the cells.

iii) As units of sugar in cell sap decrease rapidly, units of ions absorbed increase rapidly; as units of sugar in cell sap remain low and constant, units of ions absorbed remain high and constant. Sugars are aerobically broken down in respiration to form many ATP molecules for active uptake of ions into the cells. Units of sugar in cell sap remain low and constant due to aerobic respiration producing carbon dioxide which lowers pH inhibiting action of respiratory enzymes; no ATP production for active up take of ions; and high oxygen concentration cause depletion of sugars.

c) Very high temperature cause vibrations of atoms in the respiratory enzymes, which become denatured; no ATP production occur in cellular respiration for active uptake of ions.

d) Increased aeration of the soil allowing aerobic respiration in the roots producing more ATP for active uptake of ions/ mineral salts.

Reduction of leaching of nutrients ensuring that more ions remain within root zone for absorption.

6) a***) Short term effects***

- Increase in stroke volume
- Increase in heart rate
- Vasodilation and vasoconstriction of different arterioles redistributing blood towards muscles
- Rise in systolic blood pressure, diastolic pressure remains unchanged

Long term effects

- Hypertrophy of the heart / increase in size of the heart; number of cardiac muscle increases
- Increase in stroke volume
- Decrease in resting heart rate
- Increased maximum cardiac output.

b)

- ✓ Reduced risk of coronary heart diseases
- ✓ Reduced risk of hypertension, due to improved elasticity of artery walls and greater dilation.
- ✓ Less obesity due to high uses of energy
- ✓ Lowering of blood cholesterol reducing atherosclerosis
- ✓ Maintaining sensitivity of cells to insulin keeping blood sugars within normal range
- ✓ Reduced risk of strokes due to increased blood flow through the brain
- ✓ Lower risk of osteoporosis, because exercise builds up calcium content of bones
- ✓ Stronger ligaments and tendons and greater body flexibility with less risk of falls and strains.
- ✓ Better mental health

7) a)

- ✓ The walls of both alveoli and capillaries are very thin and therefore the distance over which diffusion of respiratory gases occur is very short
- ✓ Alveoli and pulmonary capillaries have a very large total surface area
- ✓ Red blood cells are slowed as they pass through pulmonary allowing more time for diffusion of respiratory gases
- ✓ The distance between alveolar air and red blood cells is reduced as the red blood cells are flattened against the capillary walls
- ✓ Breathing movements constantly ventilate the lungs and the action of the heart constantly circulates blood around alveoli, together these ensure a steep concentration gradient of respiratory of respiratory gases to be exchanged.

b) Active contraction of intercostal muscles and diaphragm muscles provide enough force to overcome a series of resistance i.e. the recoil of elastic tissue of the lungs and thorax, their resistance to be stretched, the frictional resistance of air as it passes through small bronchioles leading to the alveoli; and the resistance created by surface tension at the fluid gas interfaces in the alveoli.

c)

- ✓ Hair in the nasal passages trap dust particles in the inhaled air

- ✓ Surfactant secreted by septal cells to destroy bacteria in inhaled air
- ✓ Macrophages in the alveolar lining engulf and destroy microorganisms that reach the alveoli
- ✓ Goblet cells and mucous glands produce mucus layer which act as a barrier preventing pathogens entering the cells, mucus is sticky and so bacteria, other pathogens allergens and dust particles are trapped from air, as air flows along the air ways
- ✓ Layer of ciliated epithelium, the cilia move in a coordinated manner moving mucus containing trapped microorganisms up towards the pharynx, mucus is swallowed exposing microorganisms to stomach acid.

8) a)

- ✓ Development of an ovary, stigma and the style, the style provides a pathway guiding the male nuclei of the pollen tube to the embryo sac
- ✓ Reduction of the female gametophyte to embryo sac enclosed within the ovary for protection
- ✓ Double fertilization resulting in the embryo and endosperm, the endosperm stores food for nourishment of the embryo
- ✓ The fertilized ovules which develop into seed remain attached to the parent plant from which it obtains protection and food
- ✓ Fertilization is not dependent on water thus gametes are produced with in specialized organs, flowers that produce nectar to attract pollination that transfer male gametes
- ✓ Development of fruit from ovary with dispersed mechanisms, reducing competition among off springs
- ✓ Have short life cycle forming seeds in a short period when conditions are favourable
- ✓ Production of vegetative organs with food reserves used for propagation and organs can withstand adverse conditions and generate large numbers of new plants within short time

b) Ensure survival of the plant species by allowing the plant to colonise new areas, increasing their range and population size

Prevents overcrowding and competition between parents and off springs for the limited resources

Decrease vulnerability of plant population to epidemic attacks because of being dispersed

Reduces the changes of backcrossing to the parents and the resultant problems of inbreeding.

9) *Hearing.*

- ✓ Auricle / pinna which funnels sound waves from air into the auditory canal.
- ✓ Stretched ear drum which vibrates on reception of sound waves transmitting the sound waves to the ear ossicles.
- ✓ Ear ossicles, malleus, incus, and stapes form a lever system which amplify the pressure; and transfer vibrations from ear drum to inner ear.
- ✓ Flexible membrane, oval window, transmit vibrations of the stapes to the cochlea; vibrations of oval window set up pressure waves in the fluid in the cochlea.
- ✓ Reissner's membrane transmit perilymph vibrations from the vestibular canal to the endolymph of the median canal.
- ✓ Cochlea contain endolymph inside surrounded by perilymph which are fluids that transmit vibrations.
- ✓ Basilar membrane is flexible causing sensory hairs to be stretched and receptor cell to become distorted, and stimulated.
- ✓ Tectorial membrane to which sensory hair of sensory receptor is embedded is fixed/rigid.
- ✓ Branches of auditory nerves in the organ of corti transmits impulses to the brain.
- ✓ Cochlea is narrow and under high tension; the basilar membrane vibrates at high frequency while the apex is broad and under low tension, therefore basilar membrane vibrates at low frequency sound leading to pitch discrimination.
- ✓ Cochlea is coiled to increase surface area to receive vibrations.

Balance

- ✓ Three semilunar canals are arranged in three at right angles to each other detecting the direction and rate of change of position of the head in any direction.
- ✓ Each semilunar canal possess ampulla, containing cupula; and filled with fluid which move in same direction as head movement; causing cupula to move in separate directions stimulating receptor cells.
- ✓ Utricle and saccule possess maculae containing hair like processes embedded in otoconium which respond to the pull of gravity; detecting the direction of movements of the head with respect to gravity.
- ✓ Utricle responds to vertical movement of the head, otocoma produce maximum stimulation when pulling receptors downwards when the body is upside down.

- ✓ Saccule responds to lateral movement of the head; the hair cells of the saccule are horizontal when head is upright.
- ✓ Vestibular nerves transmit impulses to the brain.

10) a) Meristematic cells are small, isodiametric with dense cytoplasm and prominent nuclei; as they differentiate into xylem vessel elements; they elongate after osmotic gain of water; the cell walls become thickened and lignified; the protoplasm degenerates and the cells die forming hollow tube. End walls between adjacent cells break down forming continuous vessel tubes.

ii) Meristematic cells are small with dense cytoplasm and prominent nuclei; the cells elongate after osmotic uptake of water; the nuclei degenerate and disappear; a thin layer of cytoplasm remains lining the cell wall; most organelles present are pushed to the periphery; end walls develop into sieve plates with sieve pores, allowing continuous strands of cytoplasm between sieve tube elements.

b) ***Xylem vessels***

- End walls of xylem vessels have broken down to give an uninterrupted flow of water from roots to leaves
- Walls are impregnated with lignin making them rigid preventing collapse under tension forces set by transpiration pull
- Lignification of walls increases adhesion of water molecules keeping water rise by capillarity
- Narrow lumen increasing capillarity forces
- Pits in the lignified wall permitting lateral flow of water

Sieve elements

- Peripheral cytoplasm; with few organelles creating space for the flow of materials.
- Sieve plates perforated by sieve pores to allow movement of materials
- Cytoplasmic strands connecting individual sieve elements allowing continuous flow of materials

11) a) **Carbon dioxide** from cellular respiration, in animals carbon dioxide is excreted at the respiratory surfaces in plants carbon dioxide is used in photosynthesis during day

Oxygen from photosynthesis in plants and algae, some oxygen is used in aerobic respiration; excess oxygen during day diffuse out of the plant through stomata and lenticels.

Bile pigments; from break down of red blood cells/ haemoglobin; excreted in bile by the liver and eliminated through faeces.

Excess water from cellular respiration, water can be used as reactant in other metabolic processes, excess is excreted.

Mineral salts produced from metabolic activities; excreted by the kidney as urine and by the skin as sweat in animals.

Ammonia from breakdown of excess amino acids, and nuclei acids; in fresh water animals, ammonia is excreted, in mammals and amphibians is converted to **urea** and excreted; in birds, reptiles and insects, ammonia is converted to **uric acid,** which is also excreted.

Organic acids produced as by-products of metabolic pathways, the organic acids are stored in dead tissues of plants periodically shed off.

b)

- ✓ Removal of unwanted by products of metabolic pathways; preventing unbalancing of chemical equilibria of reactions.
- ✓ Removal of toxic wastes of metabolism which if accumulated would affect metabolic activity because some act as inhibitors of enzymes.
- ✓ Regulation of water content of body fluids
- ✓ Regulation of pH; excreting of hydrogen ions and hydrogen carbonate ions help maintain normal pH.
- ✓ Regulating ionic concentration of the body fluids.

12) i)

- ✓ Kidney has long loops of Henle resulting in high water reabsorption enabling rat to produce a concentrated urine minimizing water loss.
- ✓ Have few sweat glands confined to pads on toes reducing evaporative water loss.
- ✓ Produce very few faeces due to high water absorption from the food eaten.
- ✓ Have small and few glomeruli to reduce glomerular filtration rate.
- ✓ Oxidation of carbohydrates in the food eaten producing metabolic water.
- ✓ Respiratory moisture in exhaled air is absorbed by stored dry seeds which the rats eat.

- ✓ During day, the rats stay in cool burrows which is more humid than outside environment.
- ✓ Having counter current system in nasal passages that condense vapour in expired air to conserve water.
- ✓ Nocturnal to minimize water loss and heat absorption during the hot day.
- ✓ Having some fur to minimize water loss.
- ✓ Keratinized skin to reduce water loss.

ii)

- ✓ Hydrophytes live wholly or partly submerged in water; the main problem is obtaining oxygen as oxygen is not very soluble in water, and getting rid of excess water gained:
- ✓ Have large air spaces, lacunae between stem and leaf cells forming an extensive network which stores oxygen produced by photosynthesis from where it diffused towards roots for respiration
- ✓ Aerating tissue confers buoyancy raising leaves to surface where they can take maximum advantage of light.
- ✓ Lack supporting tissue like sclerenchyma because support is provided by the more dense water; the mechanical tissues would make plant more rigid liable to breaking by water currents.
- ✓ Xylem poorly developed and found at centre of the stem; this allows stem flexibility in response to water movements, at the same time enabling resist pulling strains.
- ✓ Submerged leaves are narrow in shape or finely divided preventing them from being tone by water currents
- ✓ Submerged leaves lack stomata and floating leaves have all their stomata in the upper epidermis.
- ✓ Floating leaves have long leaf stalks which prevent stomata from being flooded when water levels rise.
- ✓ Large leaves with thin cuticle increasing water loss by transpiration.

iii) Halophytes live in waterlogged estuarine muds and salt marshes; are faced with water supply problem; the surrounding water is often very salty; they overcome this problem by actively absorbing salts into roots lowering water potential of roots below surrounding water; and water is absorbed by osmosis.

Have xeromorphic features like reduced stomata number, thick waxy cuticle, small leaves; which reduce water loss by transpiration.

13) a) i) A membrane forms around the worn out organelles forming a vesicle; primary lysosome fuses with the vesicle to form autophagic vacuole, enzymes are released, and catalytic hydrolysis/ break down of chemicals in the organelle, soluble useful products are absorbed into the cytoplasm of the cell; any insoluble debris is egested any exocytosis

ii)

- ✓ Lytic enzymes are enclosed in membrane bound structures called lysosomes until the right time for their activities
- ✓ Negative feedback inhibition; where accumulation of final product in metabolic pathway inhibit first enzymes in the pathway
- ✓ Genetic control, genes of DNA are switched on or off for the synthesis of enzymes
- ✓ Precursor activation, accumulation of potential substrate activates enzymes.
- ✓ Spatial arrangement, enzymes controlling a series of chemical reactions in metabolic pathway; products are transferred to the enzymes that catalyse the next reaction.
- ✓ Secreted in inactive form e.g. pepsinogen.

b) Proteins are synthesized at the ribosomes on the rough endoplasmic reticulum; proteins enter the cisternae of rough endoplasmic reticulum, packaged in vesicles that transport proteins to the Golgi body; proteins move through the cisternae of Golgi apparatus, the proteins are modified ; and packaged in secretory vesicles that build off the Golgi body towards the cell surface membrane; secretory vesicle membrane fuse with cell surface membrane releasing the proteins by exocytosis out of cells.

14) a)

- ✓ Growth
- ✓ Cell replacement
- ✓ Repair of tissues
- ✓ Asexual reproduction

b) DNA replication in the parent cell before mitosis ensure that parent contain twice its normal chromosome number

The arrangement of chromosome on the spindle ensure that the chromosomes are distributed evenly between the two daughter cells

c) Survival of a species depends on its ability to adapt to constantly changing environment and able to colonise a range of new environments, to achieve these off springs should be different from their parents as well as from each other; therefore, meiosis brings about variation by; production of haploid gametes which randomly fuse during fertilization mixing paternal and maternal genes forming new gene combinations in the off springs.

Crossing over, during prophase 1 equivalent portions of homologous chromosomes are exchanged at chiasmata, new gene gamete combinations are produced and linked genes are separated.

Random distribution of chromosomes during metaphase 1 and consequent independent segregation during anaphase 1 produce new gamete combination.

The variations meiosis brings about are essential to the process of natural selection.

15) a)

- ✓ Control entry and exit of material in organelles
- ✓ Isolate organelles so that specific metabolic reactions can take place within them
- ✓ Provide an internal transport system e.g. endoplasmic reticulum
- ✓ Isolate enzymes that might damage the cells e.g. lysosomes
- ✓ Provide surfaces on which processes occur e.g. protein synthesis on ribosomes present on rough endoplasmic reticulum

b) i) Reduces lateral movement of phospholipid proteins.

Regulate membrane fluidity depending on temperature

Prevent passage of dissolved polar molecules and ions across the membrane.

ii) Act as recognition sites for hormones neurotransmitter.

Help cells attach to one another and so form tissues.

Allow cells to recognize one another e.g. lymphocytes

iii) Act as recognition sites e.g. ABO blood system

Maintains stability of the membrane.

Help cells attach to one another and so form tissues

iv)

- ✓ Provide structural support.
- ✓ Act as carrier proteins transporting polar molecules.
- ✓ Function as enzymes
- ✓ Act as energy transducers
- ✓ Form cell surface antigens to allow recognition.
- ✓ Act as cell surface receptors.
- ✓ Help cells adhere together
- ✓ Form channel proteins for facilitated diffusion

16) a) i) phospholipids have hydrophilic head and hydrophobic tails; when phospholipids are placed in water they take up positions, hydrophilic heads close to water and hydrophobic tails far away from water; in the cell membrane phospholipids form a bilayer, one layer with hydrophilic heads pointing to / attracted by water in cell cytoplasm , and the other layer with hydrophilic heads attracted by watery environment surrounding the cell, the hydrophobic tails of both layers pointing within the centre repelled by water on both sides forming hydrophobic core.

ii) Surfactant consist of lipoproteins and act as the air-water interface of the alveoli; the hydrophilic end interacts with water layer on the alveolar lining; while the hydrophobic end orients themselves at the surface / outwards disrupting the cohesive forces between water molecules which cause high tension; this reduction in surface tension prevents the collapse of alveoli during expiration.

b) i)

- ✓ Hydrolysis; water is used to hydrolyse many substances.
- ✓ Medium of chemical reactions because chemical reactions occur in aqueous medium.
- ✓ Diffusion and osmosis, water is essential to diffusion of materials across surfaces.
- ✓ Photosynthetic substrate/ raw material.

ii) Water readily dissolve polar substances and important in transport, removal of water, and secretion.

iii) Water viscosity make it a useful lubricant in living systems/ in different lubricating fluids i.e. mucus used externally to aid movement, synovial fluids lubricating joints, pleural fluid lubricating lungs during breathing, pericardiac fluids lubricates heart movement, and perivisceral fluid lubricate movement of internal organs.

iv) Water has large cohesive forces and its incompressibility makes it a useful means of supporting organisms e.g. hydrostatic skeleton in animals, turgor pressure in herbaceous plants; humor of the

eye maintaining eye shape, amniotic fluid supporting and protecting mammalian foetus and erection of the penis due to pressure of the blood.

17) a)

- ✓ Soften the testa/ seed coat for rapid entry of oxygen and emergence of embryo.
- ✓ Leaches / removes growth inhibitor substances / ABA.
- ✓ Stimulate secretion of growth promoter substances / GA3.
- ✓ Stimulate increased metabolic activities in the seed.

b) i) Increasing soaking time decreased percentage germination; prolonged soaking of seeds leads to anaerobic conditions inhibiting aerobic respiration, which reduce energy production; leaching of essential nutrients from seed; and potential damage to embryonic tissues reducing ability to develop.

ii) Dry mass of root and shoot decreased with prolonged soaking time; soaking for few days activate enzymes, and stimulate secretion of growth promoter substances, food reserves are mobilized and transferred to the growth points of the embryo;

increasing soaking time, create anaerobic conditions, soluble products/nutrients are lost/leach, reducing energy production, and nutrients respectively for the growth of radicle and shoot.

Dry mass of the cotyledon increased with increase of time of soaking. This is due to excessive water absorption by the cotyledon; and reduced efficiency in the translocation of the stoned food reserves from cotyledon to the growing roots and shoot as a result of reduced metabolic activity.

c) Long day causes higher percentage germination than short day.

During long day exposure of seeds, phytochrome red absorb red light and is converted to phytochrome far red; high levels of phytochrome red induce excretion of gibberellic acid; which break dormancy by activating the DNA of embryo to synthesize more hydrolytic enzymes that breakdown stored food molecules into soluble products translocated to the growth points of the embryo for oxidation to release energy required in germination and make structural component of new cells.

d) Increasing exposure of the fruit and seeds to air causes increase in percentage germination and replacing air with pure oxygen cause higher percentage germination; because germination involves growth which requires energy; energy is released by respiration which yield more energy in presence of oxygen.

Lowest germination in intact fruits in air due to low oxygen diffusion into seeds

Moderate germination in fruits with pericarp cut due to more oxygen diffusion into the seeds

18) a) As individual cells increase in size, the distance over which the nucleus exert its control is limited; and the surface area to volume ratio decreases reducing effectiveness of exchanging materials therefore as cells increases in size they divide into small daughter cells

b)

- ✓ Cells may become differentiated in order to perform a particular function unlike in unicellular organisms
- ✓ Specialized cells performing one particular function lead to greater efficiency in multicellular organisms.
- ✓ Multicellular organisms store more materials and so better able to withstand periods when material are scarce unlike unicellular organisms.
- ✓ When some cells are damaged in multi cellular organisms, enough may still remain to carry out the repair unlike unicellular organisms.
- ✓ Multicellular organisms may have a competitive advantage over unicellular organisms.
- ✓ Multi cellular organisms are large providing some protection from predators because organisms are simply too large to ingest.
- ✓ Some processes require a range of conditions like digestion require acidic and alkaline phases; it is easier to separate regions of opposing conditions in multicellular organisms than in unicellular organisms.

c)

- ✓ Provides space in which internal organs can grow, develop, and function independently of each other.
- ✓ Contain fluid that bathes the organ and can act as a hydrostatic skeleton.
- ✓ Allows the animal's internal organs to move independently of each other and of the body wall.
- ✓ Increasing size and complexity are possible
- ✓ Coelomic fluid may help circulate food, waste materials and respiratory gases.

19) a) i) Oxygen, water, soluble food molecules and salts pass from maternal to foetal blood

Carbon dioxide and nitrogenous waste products pass from foetal blood to maternal blood for removal by the mother.

Allow antibodies to cross from mother to foetus for immunity

ii)

- ✓ Prevent mixing of foetal and maternal blood because the foetus may inherit father's group which if incompatible with mother's would damage the foetus if mixing occurred.
- ✓ Allows maternal and foetal blood pressure to differ from one another.
- ✓ Prevent passage of some pathogens from the mother to the foetus.
- ✓ Prevents passage of some maternal hormones into foetus that could adversely affect foetal development.

iii)

- ✓ Secretion of progesterone.
- ✓ Secretion of oestrogen
- ✓ Secretion of placental lactogen
- ✓ Secretion of chorionic gonadotrophin
- ✓ Secretion of relaxin hormone

b) Chorionic villi present a large surface area over which maternal and foetal blood come into close contact with out mixing.

Maternal and foetal blood are constantly being replaced in the placenta to maintain a diffusion gradient.

Thin placenta lining presenting a small distance between maternal and foetal blood speeding up diffusion.

c)

- ✓ Development of secondary sex characteristics to allow sexually mature individuals to recognize and mate with each other.
- ✓ Seasonal breeding cycles that restrict copulation to times that ensure birth at seasons most favourable for the survival of off springs.
- ✓ Female receptiveness to male only when ovulation is taking place or even ovulation being stimulated by the act of copulation.
- ✓ Internal fertilization bringing sperm and egg close together with relative safety and stability of female gametal tract
- ✓ Internal development of the embryo in stable and protected conditions

- ✓ Development of placenta acting as barrier to harmful substances and an exchange mechanism for beneficial ones.
- ✓ Breast feeding providing the newly born with a secure source of food ideally suited for early development and contain antibodies providing immunity.
- ✓ Parental care allowing development of the young ones in controlled and protected conditions with maximum use of learned behaviour, which has the advantage of being adaptable to meet to varying circumstances.

20) a) i) Maintenance of blood circulation is mainly by the pumping action of the heart; high pressure is created by contraction of the ventricles; as blood is forced into arteries, the elastic walls expand causing distension; the recoil of the elastic walls pushes blood away from the heart; this pulse continue throughout the arterial system, maintaining blood flow in arteries; back flow to the heart is prevented by semilunar valves.

The return of blood to the heart through veins is maintained by residual heart pressure; contraction of muscles squeezing veins and force blood towards the heart, back flow is prevented by pocket valves. Inspiratory movement create lower thoracic pressure in drawing blood along major veins towards the heart; and gravity help return blood from regions above the heart.

ii) Control of circulation is achieved by control of heart beat and control of peripheral flow/ flow of blood in arteries/ blood vessels.

Chemical / Hormonal and nervous systems control blood circulation by changing heart rate and stroke volume according to demands of the body.

Vasomotor centre/autonomic nervous system control vasoconstriction and vasodilation of blood vessels decreasing and increasing blood flow to different body parts respectively.

b)

- ✓ Transport of soluble organic compounds from gut to various parts
- ✓ Transport of soluble excreting materials to organs of excretion
- ✓ Transport of hormones from glands where they are produced to target organs
- ✓ Distribution of heat from the deeply sealed organs, maintaining a constant body temperature.
- ✓ Transport of oxygen from respiratory organs to all parts of the body.
- ✓ Defense against diseases
- ✓ Maintaining of constant soluble potential and pH as a result of plasma protein activity.

21) a) ***Similarities***

- In both lakes A and B, the biomass of phytoplanktons decrease with increase in depth
- In both lakes A and B, the biomass of phytoplanktons is highest at zero depth.
- In both lakes A and B, the biomass of phytoplanktons decreases gradually from 4m to 5m

Differences

Biomass of phytoplanktons in lake A	***Biomass of phytoplanktons in lake B***
Decreases gradually from 0 to 0.5m	Remains constant from 0 to 0.5m
Decreases gradually from 0.5 to 4m	Decreases rapidly from 0.5 to 4m
Continues to decrease gradually from 5 to 13m	Is zero from 5 to 13m

b) i) Low depth causes high biomass of phytoplanktons, due to high light penetration, high photosynthetic rate, high productivity

Increase in depth causes decrease in phytoplankton biomass, because of reduced light penetration, reduced photosynthetic rate, reduced productivity, reduction in biomass.

ii) The biomass of phytoplanktons in lake A decreases gradually from 0 to 0.5 while in lake B, it remains high and constant, this is because a high nutrient content in lake B which support phytoplankton growth.

The biomass of phytoplankton decrease rapidly then gradually to zero from 0.5 to 5m while in lake A decreases slowly because lake B is characterized with algal blooms, more turbid waters as compared to lake A, which has clear waters, the degree of light penetration decreases rapidly with increase in depth in lake B as compared to lake A.

Beyond 5m, the biomass is zero in lake B while in lake A the biomass decrease gradually because lake B being a eutrophic lake, the profundal region is nearer to the surface that's to say at 5m, therefore beyond 5m there is zero light penetration but lake A being oligotrophic, the profundal zone is at a more distance from the surface, therefore phytoplanktons can still inhibit deeper layers of the lake.

c) i) Nitrate fertilizers are washed into the lake, increasing nitrate concentration in the lake, eutrophication; leading to multiplication of algae and phytoplanktons; the phytoplanktons die after a short period; decomposition by aerobic microbes; increasing oxygen consumption reducing amount of dissolved oxygen; leading to suffocation of other aerobic animals like fish. Decomposing phytoplanktons also lead to bad smell within the water body which effects the water quality, thus not suitable for living by organisms.

ii) Biochemical oxygen demand decreases when the biomass of phytoplanktons increase; because phytoplanktons carry out photosynthesis which increase oxygen concentration in water body. Death and decomposition of phytoplankton increases biochemical oxygen demand because aerobic activity of decomposers, which decrease amount of dissolved oxygen.

d) i) Indicator species are organisms that are very sensitive to the environment; provide information about the amount of given pollutants in the environment, for example presence of sewage fungus in a water body shows the presence of sewage and the presence of the may flies shows that the water is clean

d) ii) The index of species diversity can provide information about environment health; a high species diversity indicates a reduced level of pollution; because many species of organisms inhabit areas of low level of pollution; and when the level of pollution increase, species diversity decreases as only a few species can inhabit polluted environment.

e) Leads to increase in water toxicity; due to release of ammonia from the process of decomposition.

Leads to increased competition; for oxygen by aerobic organisms.

Leads to decrease in pH levels of water; as a respiratory activities exceed photosynthesis.

Leads to decline in population of fish and other aquatic organisms.

Leads to extinction of some species of organisms, due to competition.

22) a) Similarities

Rate of evaporation of water in both woodlice and caterpillar:

- Attain maximum
- Increase rapidly between 40^0C and 60^0C
- From 20^0C to 30^0C increase gradually

Differences

Rate of evaporation in caterpillar	***Rate of evaporation of water in woodlice***
Attain a lower maximum	Attain higher maximum
Lower	Higher
From 10^0C to 20^0C there is no water loss	From 10^0C to 20^0C there is a gradual increase in water loss

a) At 20^0C rate of water loss is low.

At 20^0C to 30^0C rate of water loss increase gradually

At 30^0C rate of water loss increase rapidly

From 30^0C to 43^0C rate of water loss increase gradually to maximum.

b) From 20^0C to 30^0C; water loss increase gradually; increasing cuticular temperature increase kinetic energy of water molecules/ vapour leading to high rate of evaporation of water from cuticle surface.

At critical temperature of 30^0C; water loss increase rapidly; at critical temperature the arrangement of wax molecules changes due to melting; and its water proofing properties significantly reduce; increasing permeability of cuticle to water

From 30^0C to 43^0C water loss increase with increasing cuticular temperature; due to high kinetic energy of water molecules; and already the primary water barrier has been removed.

c) Graph 2 shows the effect of cuticle temperature on water from an insect; highlighting the role of the wax and its critical temperature; from graph 1, increasing temperature increase cuticle temperature of both woodlice and caterpillar disrupting waxy layer; increasing water loss from the insect.

Caterpillar has higher critical temperature than woodlice; explaining lower rate of water loss in caterpillar at high temperature than woodlice.

Caterpillar cuticle maintains waxy integrity and water proofing properties throughout the temperature range in graph 1 leading to lower water loss while woodlice lack extensive waxy cuticle; making them more susceptible to water loss by evaporation throughout the whole temperature range in graph 1

d) Caterpillar; lives in tropical forests/open habitats with moderate humidity; because of low water loss at high temperatures indicating a thick waxy layer on exoskeleton which increase water retention.

Woodlice; lives in damp humid places under logs, leaves, because there is less efficient water retention mechanisms makes them highly susceptible to desiccation and significantly impacted by exceeding their critical temperature.

e) Detritivores feed on dead organic matter; this break down large organic materials into small pieces that can easily be decomposed by fungi and bacteria; detritivores increase nitrogen content of plant organic materials increasing activity of decomposers; resulting in nutrient recycling in the ecosystem.

23) a) Saturation of haemoglobin with oxygen in the capillaries is higher in the lung capillaries throughout while saturation of haemoglobin with oxygen in the skeletal muscles capillaries is lower; because at the lungs; there are higher partial pressures of oxygen; that increases haemoglobin affinity for oxygen; oxygen easily binds to the haem groups; forming

oxyhaemoglobin; while at skeletal muscle capillaries, the increased carbon dioxide concentration; due to cellular respiration; lowers haemoglobin affinity for oxygen; carbon dioxide lowers pH; increases hydrogen ions concentration causing dissociation of oxyhaemoglobin; (Bohrs effect).

b) Higher percentage saturation of haemoglobin with oxygen at the lung capillaries and lower saturation at the skeletal muscle capillaries; so that demonstrates its ability to:

bind with oxygen in the lungs; where partial pressure of oxygen is high; so haemoglobin becomes saturated with oxygen indicating its capacity to pick up oxygen.

Also haemoglobin easily releases oxygen at the skeletal muscle; where partial pressures of oxygen is lower; showing its ability to deliver oxygen.

c. Similarities:

In both percentage saturations with oxygen;

- Increased from 0 to 10kpa of oxygen
- Attained a maximum
- Was low at low oxygen partial pressures.

Differences

Percentage saturation of myoglobin with oxygen	***Percentage saturation of adult haemoglobin with oxygen***
Higher throughout	Lower throughout
Attained maximum at lower partial pressures of oxygen	Attained maximum at higher partial pressures of oxygen
Increased rapidly from 0 to 10Kpa of oxygen	Increased gradually from 0 to 10Kpa of oxygen
Remained constant from 10 to 13Kpa of oxygen	Increased from 10 to 13Kpa of oxygen

d. i) Oxygen dissociation curve of myoglobin is more to the left and upwards; indicating its high affinity for oxygen; than normal haemoglobin; this enables myoglobin to store oxygen; and only release it when all the oxyhaemoglobin reserves are depleted; also myoglobin picks up its oxygen

from normal haemoglobin; so must possess high affinity for oxygen for it to extract enough oxygen from the haemoglobin.

ii) ODC of fetal haemoglobin is to the left and upwards of that of adult haemoglobin; to allow fetal haemoglobin extract enough oxygen from the maternal haemoglobin; fetal haemoglobin gets/extracts its oxygen from maternal haemoglobin; so must possess higher affinity for oxygen.

e. The percentage saturation of myoglobin is higher than that of adult haemoglobin; because myoglobin has a higher affinity for oxygen than haemoglobin; haemoglobin; haemoglobin is adapted for oxygen transport in the blood to tissues while myoglobin is adapted for oxygen storage; only releases it when the partial pressure of oxygen is very low in muscles.

f.

Differences

Myoglobin	***Haemoglobin***
Oxygen store molecule	Oxygen carrier molecule
Higher affinity for oxygen	Lower affinity for oxygen than myoglobin
Found in muscle cells	Found in red blood cells
Composed of single polypeptide chain	Four(4) polypeptide chains
One haem group	Four haem groups
Hyperbolic oxygen dissociation curve	Sigmoid oxygen dissociation curve

Myoglobin has higher affinity for oxygen so easily combines even at lower atrial pressures of oxygen; while haemoglobin affinity for oxygen decreases with decrease in oxygen partial pressures.

24) a)

Cellulose	***Glycogen***
Structural polysaccharide	Storage polysaccharide
Consist of beta glucose	Consist of alpha glucose
Has only 1-4 glycosidic bonds	Has both 1-4 and 1-6 glycosidic bonds
Polysaccharide chains associate/linked by hydrogen bonds	Chains do not link by hydrogen bonds
Consist of unbranched chains	Consist of branched chains
Chains are straight and parallel	Chains are coiled to form helices
Not easily hydrolysed	Easily hydrolysed
Hydroxyl groups project in all directions of the chain	Hydroxyl groups project into interior of the polysaccharide

a) Lipids are compact for a given quantity of energy than carbohydrates; making them a preferable store where organisms or part of it is to move from place to place.

Lipids are insoluble in water hence cannot dissolve out of storage structures.

Lipids release much more energy for the same mass when oxidized in respiration, and release more metabolic water.

Lipids serve other functions like insulation against heat loss, store vitamins A, D, E and K, used for water proofing, formation of cell membrane, contribute to buoyancy in aquatic animals, protecting delicate organisms.

b)

- Ribulose forms RuBP which in the carbon dioxide acceptor
- Glyceraldehyde and dihydroxyacetone are intermediates in different metabolic pathways.
- Ribose form ATP, co enzymes NAD, FAD and NADP.
- Deoxyribose forms DNA
- Hexose form disaccharide and polysaccharide.
- Hexose are oxidized to release energy during cellular respiration.

25) a) Photo autotrophs, synthesize large organic molecules from carbon dioxide using light energy e.g. purple and green bacteria.

Chemo autotrophs, use carbon dioxide as a raw material for making organic compounds using energy from oxidation of inorganic chemicals.

Heterotrophs, which can be predators eating other microorganisms, parasites infecting other organisms and causing diseases, saprotrophs breaking down dead organisms, and mutualistic, living in mutual harmony with their host.

b)

- ✓ Recycling of materials in the ecosystem e.g. carbon, nitrogen.
- ✓ Food source for other organisms.
- ✓ Pathogenic organisms cause organisms.
- ✓ Mutualistic relationships with other organisms aid formation of certain compounds.
- ✓ Breakdown of organic matter into simpler soluble products.

26) a)

- ✓ Competition
- ✓ Parasitism
- ✓ Predation
- ✓ Saprophytism
- ✓ Mutualism
- ✓ Commensalism
- ✓ Mimicry
- ✓ Allelopathy / antibiosis

(*describe specifying organisms in each association*)

b)i) Fungi and bacteria aerobically break down dead organic matter, releasing carbon dioxide back into atmosphere through respiration.

Anaerobic decomposition result in formation of fossil fuels

ii) Bacteria and fungi decompose organic nitrogen compounds in organic matter converting them into ammonia or ammonium ions.

Bacteria convert atmospheric nitrogen into ammonia; these can be mutualistic bacteria e.g. rhizobium or free living bacteria like azotobacter.

Specific bacteria convert ammonia/ ammonium ions into nitrites then into nitrates, by the nitrifying bacteria

Denitrifying bacteria convert nitrates into nitrogen in aerobic conditions.

27) Negative feedback regulate population size by countering deviations from carrying capacity. When the population size increases above carrying capacity density, density dependent factors become more pronounced; competition for food, space increase, predation increases, incidences of diseases increase, the increased pressure from limiting factors decrease birth rates and/or increase death rates, decreasing population size.

When the population size decreases below carrying capacity; there are low competitors for food, space, low predation; birth rates increase and/or death rates decrease; the population increase

b) A population size can temporarily increase above its carrying capacity due to disruption of natural regulatory mechanisms or introduction of sudden advantages, this may include:

- temporary increase in resource availability
- decrease in predators/ parasites
- decrease in disease prevalence
- decrease in/ low competition allowing the population size to grow unchecked
- high reproductive/biotic potential

c) Resource depletion due to over exploitation, making it difficult for the environment to sustain even the original carrying capacity

lead to habitat destruction/ degradation through overgrazing, deforestation, increased waste production.

Competition and resource scarcity lead to reduced bio diversity within the ecosystem

Increased spread of diseases due to overcrowding/ over population

28) a) Chloroplasts are found in the cytoplasm of plant cells usually in leaves, numerous in palisade mesophyll cells, nearer the upper surface of leaf, some chloroplasts are in spongy mesophyll cells, some in guard cells; within cells chloroplasts may move towards light allowing them to arrange into best positions within cells for most efficient light absorption.

Chlorophyll and carotenoids / photosynthetic pigments located on membranes on thylakoids/ grana, different pigments trap different wavelengths of light.

Flattened fluid filled thylakoids form stacks/ grana linked by intergranal lamellae, this mosaic/tessellated arrangement of chlorophyll in layer increases chances of light striking chlorophyll molecules

b) Chlorophyll a in photosystems I and II absorb light energy; exciting electrons in chlorophyll molecules which move to high energy levels; electrons flow through a chain of electron carrier molecules to the primary electron acceptor molecules; from where electrons flow in cyclic and non-cyclic pathways; from high energy levels to low energy levels; releasing energy used to combine ADP with inorganic phosphate forming ATP

29) a)

- ✓ septum separate the heart into left and right sides; separating oxygenated and deoxygenated blood; septum becomes rigid fast before the heart contracts so that it serves as fulcrum for the action of heart muscle
- ✓ Atrio ventricular valves and semi lunar valves prevent back flow of blood maintaining unidirectional flow of blood
- ✓ Left ventricle has very thick muscle walls which enable it to contract strongly and exert pressure to pump blood into aorta and all the way around the body
- ✓ Right atrium is thin walled to pump de oxygenated blood to the lungs which are near
- ✓ The atria are thin walled and elastic and expand as they collect blood from the main veins
- ✓ Ventricles have much thicker muscular walls as they pump blood some distance either to the lungs or the rest of the body
- ✓ Tendinous chords attach to papillary muscles preventing the valves from turning inside out; papillary muscles increase tension on the tendinous chords so they can resist back pressure of blood
- ✓ Possession of SAN, which is the pace maker determining the rate of contraction of the heart muscles
- ✓ Atrio ventricular septum separating atria and ventricles consist of a non-conducting tissue delays electrical impulse giving time for the wave to pass over atria to cause a contraction
- ✓ Innervation of the of SAN by sympathetic and vagus / parasympathetic nerves which allow control of heart action

- ✓ AVN provides a route of transmission for cardiac impulses; and act as a second pace maker relaying cardiac impulses to the ventricles.
- ✓ Atrio ventricular bundle/ bundle of HIS branches into the purkinje fibres through which cardiac impulses pass to the apex of ventricles
- ✓ Purkinje fibres close to AVN are thin carrying impulses more slowly than the thicker fibres supplying more distant parts of ventricles ensuring that all parts of ventricle contract more or less simultaneously

b) Acetylcholine decreases heart rate and stroke volume while adrenaline increase heart rate and stroke volume.

Acetylcholine is released by nerves of parasympathetic/ vagus nerve at the SAN, decreasing release of depolarising / hyper polarizing SAN cells; while adrenaline is released at nerve ends of sympathetic nerves at the SAN increasing heart rate

The opposing effects of Acetylcholine and Adrenaline allow regulation of heart rate and stroke volume regulating cardiac output according to body demand.

30) i) Vibrations of oval window cause pressure vibrations in the perilymph of vestibular canal; the vibrations are transmitted to endolymph of the median canal; vibrations of the endolymph cause the flexible basilar membrane to move/vibrate displacing/distorting the sensory hair cells at its surface; sensory cells are displaced against rigid tectorial membrane leading to formation of generator potential in hair cells.

ii) Sound of different pitches stimulate different parts of the cochlea/basilar membrane; high pitched sound stimulates the base of the basilar membrane which are narrow and under high tension, and vibrate at high pitched sound stimulating sensory cells.

Sound of low pitch stimulate the apex of the basilar membrane; which is broad and under low tension and vibrate at low pitched sound stimulating sensory cells.

The brain interprete information from receptor cells at different parts of basilar membrane.

b)i) Wide pupils allows maximum light entry into the eye in low light conditions maximizing the amount of light reaching the retina for better vision at night.

ii) A reflection layer behind the retina that reflects light back through retina increasing the chance of photoreceptor stimulation and enhancing vision in dim light.

iii) Rod cells are sensitive to low light/dim light; many rod cells connect to a single bipolar neuron leading to convergence; this results in summation increasing chances of forming impulses; increasing sensitivity of the eye to dim light.

c) In bright light; many photoreceptors cells of retina are stimulated forming many impulses along sensory neurons to the brain; which send impulses along parasympathetic nerves to the to the iris; circular muscles contract while radial muscles relax; pupil constricts reducing amount of light entering the eye.

In dim light few photoreceptor cells of retina are stimulated, few impulses are sent to the brain; the brain send impulses along sympathetic nerves to the iris stimulating contraction of radial muscles and relaxation of circular muscles; the pupil dilates increasing amount of light entering the eye.

31) (a) The skin plays a crucial role in temperature regulation; skin contain sweat glands that release sweat which evaporate cooling the body; contain blood vessels that constrict or dilate to regulate heat loss or retention; possess hair follicles with erector pili muscles that contract raising hair trapping a layer of air for insulation and has thermos receptors and cold receptors detecting changes in environmental temperature.

ii) Pancreas is vital for blood glucose regulation. Pancreas produces insulin hormone which lowers blood glucose by promoting glucose uptake by liver cells; and produce glucagon hormone which increase blood glucose by stimulating liver cells to release stored glucose.

iii) Heart and blood vessels are central in maintaining blood pressure and temperature; the heart pumps blood and blood vessels regulate blood flow to different parts of the body; vasoconstriction and vasodilation control blood pressure and control heat gain and retention

changes in heart rate and stroke volume adjust blood pressure to ensure circulation and nutrient delivery.

b) The responses are due to body's thermoregulatory mechanisms attempting to cool down the immersed arm by extension to the rest of the body through sympathetic responses;

Thermoreceptors in skin detect rise in temperature from hot water immersion; skin thermoreceptors send impulses to the heat loss centre of the hypothalamus; which stimulate sympathetic nervous system to stimulate sweat glands to produce sweat, leading to sweating of exposed arm to facilitate evaporative cooling; dilation of blood vessels in the skin including those of exposed arm; increased blood flow to the skin surface causes it to turn pink and allows for more heat to dissipate through radiation and convection.

32) a) Like amphibians, liverworts and mosses are only partially adapted to life on land, having bodies which easily lose water; and rely on water for sexual reproduction to transfer male gametes to female gametes.

b)

- True roots which enable water in the soil to be reached
- Plants are protected from desiccation by an epidermis with water proof cuticle or cork after secondary growth
- Epidermis of aerial plants mainly leaves have stomata which allows gaseous exchange
- Fertilization is not dependent on water; male gametes are not motile and carried with pollen grains dispersed by wind or insects; final transfer of male gametes to the female gametes is by means of pollen tubes
- Many seed plants show secondary growth with production of large wood; this provides support; such plants become large trees and shrubs able to compete effectively for light and other resources
- Fertilized ovule/ seed remain on the parent sporophyte for some time from which it obtains protection and food before dispersal.
- Gametophyte is very reduced; always protected inside a sporophyte which is well adapted for life on land; and totally dependent on the sporophyte.

33) a)

- ✓ Vascular tissues extensively finely branching throughout the leaf to form a network, for conduction of water and mineral salts, remove products of photosynthesis; providing a supporting skeleton to the lamina.
- ✓ Spongy mesophyll consists of irregular cells fitting together loosely with large air spaces, which maintain a steep gradient for gaseous exchange via stomata.
- ✓ Palisade mesophyll consist of column shaped cells with numerous chloroplasts in a thin layer of cytoplasm; to maximally trap sunlight for photosynthesis.
- ✓ Upper and lower epidermis are one cell thick; cells are flattened lacking chloroplasts external walls covered with cuticle of cutin for protection from desiccation and infections.
- ✓ Cells contain stomata, more in the lower epidermis; for gaseous exchange.
- ✓ Each stomata is surrounded by a pair of guard cells; to regulate opening and closing of stomata.

b)

Light of dependent stage	*Light independent stage*
Occur in the grana/thylakoid	Occur in the stoma
Produces ATP and NADPH	Uses ATP and NADPH
Involve election flow	No electron flow, occur
Requires light to occur	Does not require light but require products from light stage
Not much affected by temperature	Much affected by temperature.

34) a) **Similarities**

In both left ventricle and left atrium blood pressure;

- Increased from 0.1 seconds to 0.2 seconds
- Decreased from 0.5 seconds to 0.6 seconds
- Remained constant from 0.7 seconds to 0.8 seconds
- Was equal/same at 0.13 seconds and 0.66 seconds

Differences

Blood pressure in left ventricle	*Blood pressure in left atrium*
Increased from 0.2 seconds to 0.3 seconds	Decreased from 0.2 seconds to 0.3 seconds
Decreased from 0.4 seconds to 0.5 seconds	Increased from o.4 seconds to 0.5 seconds
Decreased from 0.6 seconds to 0.7 seconds	Remained almost constant from 0.6 seconds to 0.7 seconds
Higher from 0.13 seconds to 0.66 seconds	Lower from 0.13 seconds to 0.66 seconds

b) From 0.1 seconds to 0.13 seconds; atrial blood pressure is higher while ventricular blood pressure is lower; because atrium contracts; its volume decreases as pressure increases; pumping blood via the open bicuspid valve; to the relaxed; ventricle.

From 0.13 seconds to 0.4 seconds; blood pressure in ventricles increase while blood pressure in atrium decrease because ventricles contract and atrium relax as they're filled with blood; ventricular volume decrease and pressure exceeds that of atrium; closing the bicuspid valves; ventricular pressure continue to increase to exceed aortic pressure; forcing aortic valves to open pumping blood into aorta.

From 0.4 seconds to 0.7 seconds; blood pressure in the ventricle decreases rapidly to fall below that of the atrium; while blood pressure in atrium increases gradually; because ventricles are relaxing and atrial systole starts again; and the cycle repeats.

c)Blood pressure decreases rapidly, then gradually; because the ventricles relax; increasing ventricular volume; as they are filled with blood; decreasing pressure.

d) Mean wall thickness of pulmonary artery is higher than mean wall thickness of the pulmonary vein; so as to enable the pulmonary artery to withstand high pressure of blood; caused by ventricular contraction; while pulmonary vein carries blood under low pressure; and its flow is slow/sluggish so walls of pulmonary vein has fewer elastic and muscular fibres.

e) Mean wall thickness of the aorta is highest; so as to withstand very high pressure of blood caused by powerful ventricular contraction; also the aorta is close to the heart and receives blood from the eft ventricles whose walls are thicker and contract more powerfully; increasing blood pressure in aorta.

Hint/note

The diameter of an artery and its walls thickness steadily decreases as its distance from the heart increases; vice versa to veins.

f) Systolic pressure increases with exercise; so as to meet the oxygen and nutrient demands from muscles involved; while diastolic pressure increases gradually/remains relatively stable; due to vasodilation; which reduces resistance in the arteries.

g) Cardiac volume = stroke volume x pulse rate(heart rate)

= 55 x 62

= 3410 m|s per minute

35) a)

Similarities

In both, rate of urine production:

- Decreased from 5 minutes to 10
- Decreased from 5 minutes to 10 minutes
- Increased from 15 minutes to 30 minutes
- Was the same at: 7.5 minutes, 14.5 minutes, and 15.8

Differences

Rate of urine production after injection of ADH	*Rate of urine production after injection of sodium chloride*
Decreased from 0 to 5 minutes	Increased from 0 to 5 minutes
Decreased gradually from 5 minutes to 10 minutes	Decreased rapidly from 5 minutes to 10 minutes
Decreased from 10 minutes to 15 minutes	Increased from 10 minutes to 15 minutes
Lower initially	Higher initially

(b) ADH injection caused decrease in urine production from 0 to 15 ml/minute because injected ADH is transported to the distal convoluted tubules and collecting ducts where it binds to specific receptors of the cell surface membrane, increasing permeability of walls of DCT and CDs to water by increasing number of water channels. More water is reabsorbed from the glomerular filtrate into the cortex and medulla by osmosis.

Also, ADH increases the permeability of the collecting ducts to urea, which diffuses out of the urine into the tissue fluid of medulla; increasing osmotic concentration, resulting in osmotic loss of water from glomerular filtrate in the thin descending limb.

ADH injection caused an increase in urine production from 15 minutes to 30 minutes because injected ADH was broken down/degraded in the liver and kidney; its concentration decreased; walls of DCT and CDs became impermeable to water; less or no water is reabsorbed by osmosis from glomerular filtrate, resulting into production of large volumes of dilute urine.

c) Rate of urine production decreased rapidly with injection of sodium chloride from 5 minutes to 10 minutes because sodium chloride increases the osmotic pressure of blood above the norm; detected by osmoreceptors in the hypothalamus that send impulses to the posterior pituitary gland to stimulate release of ADH (Anti diuretic hormone) into blood stream. ADH is transported to the DCT and CDs where it increases the permeability of walls of DCT and CDs to water; more water is reabsorbed back to blood by osmosis; resulting into production of little volumes of concentrated urine. Also ADH increases permeability of CD to urea; that diffuses out of urine into the cortex and medulla; increasing medulla salt concentration; causing osmotic efflux of water from glomerular filtrate of thin descending limb.

Rate of urine production increased with injection of sodium chloride from 10 minutes to 30 minutes because the reabsorbed water into blood decreased the osmotic pressure of blood, osmoreceptors are no longer stimulated, hence ADH release from the posterior pituitary gland is inhibited; walls of DCT and CDs remain impermeable to water; little or no water is reabsorbed; producing large volume of dilute urine.

d) Injection of sodium chloride decreases amount of ADH stored in the posterior pituitary gland; because of decrease in solute potential/increase in blood osmotic pressure that stimulates

osmoreceptors in hypothalamus to send impulse to cause release of ADH by posterior pituitary gland.

e) Loop of Henle results in counter current multiplier effect which increase water re absorption from the renal fluid; fluids in descending and ascending limbs flow in opposite directions. As renal fluids flow up the ascending limb, salts are actively pumped out into the medulla by the sodium potassium pump; increasing medulla concentration; water is drawn by osmosis from the collecting duct and thin descending limb fluid since its permeable to ions; the concentration of renal fluid in the descending limb increases more and more as fluid flows down while renal fluid in the ascending limb becomes more and more dilute; the overall effect is increasing the solute concentration of deep part of the medulla; that causes osmotic gain of water from the renal fluid; in collecting ducts; resulting into production of very little concentrated urine.

36) a) **Similarities**

In both level of blood glucose:

- Increased from 0 to 0.5 hours
- Attained a peak/maximum
- Decreased from 4 to 6.5 hours
- Increased from 2.5 to 4 hours
- Was the same at 1.8 and 6.5 hours

Differences

Blood glucose level after carbohydrate meal	***Blood glucose level after protein meal***
Attained higher peak	Attained lower peak
Increased rapidly from 0 to 0.5 hours	Increased gradually from 0 to 0.5 hours
Higher from 0 to 1.8 hours	Lower from 0 to 1.8 hours
Lower from 1.8 to 6.5 hours	Higher from 1.8 to 6.5 hours
Attained peak earlier	Attained peak later
Decreased from 0.5 to 2.5 hours	Increased from 0.5 to 2.5 hours

b) i)00 to 2.5 hours

Glucose levels in blood increased rapidly to a peak; because the carbohydrates were digested/broken down by enzymes in mouth, and small intestines to glucose; which was absorbed into the blood stream; from 0 to 0.5 hours.

From 0.5 to 2.5 hours; glucose levels in blood decreased rapidly to minimum, because the high blood glucose stimulated the beta cells of the islets of Langerhans in the pancreas to secrete insulin hormone into the blood stream; insulin was transported to the liver and muscle cells; binded to cells with insulin receptor; and caused mechanisms that decreased blood glucose levels such as increased cellular respiration; conversions of excess glucose to fats; glycogenesis.

ii) From 2.5 to 6.5 hours; blood glucose levels increased gradually from norm (90mg/100cm^3 of blood) because; low blood glucose levels stimulated the alpha cells of islets of Langerhans to secrete glucagon hormone into blood stream; glucagon was transported to the liver; bind to liver cells with glycogen receptors; caused mechanisms that increased blood glucose back to the norm like increased gluconeogenesis, glycogenolysis; decreased cellular respiration.

c) i) Blood glucose level increases gradually to a peak from 0 to 4 hours; because protein intake stimulates the release of glucagon hormone, that raises glucose levels through gluconeogenesis where amino acids from protein digestion can be converted into glucose and through glycogenolysis from 4 to 6.5 hours; blood glucose then decreased back to norm; due to secretion of insulin hormone.

ii) Glucose levels in blood increase slowly from 0 to 3 hours; due to conversion of glycerol from lipid metabolism in the liver to glucose(gluconeogenesis)

3 hours to 6.5 hours; glucose in blood decreased due to cellular respiration and insulin secretion.

d) From 0 to 0.5 hours; glucose levels in blood after carbohydrate meal increased rapidly while blood glucose level after protein meal increased gradually because carbohydrates are rapidly digested into glucose which is directly absorbed into blood stream while proteins are not primarily converted to glucose during digestion; but gradually stimulates glucagon release; which gradually increase glucose in blood through gluconeogenesis.

From 0.5 hours to 2.5 hours; blood glucose levels after carbohydrate meal decreased rapidly while blood glucose level after protein meal continued to increase because carbohydrate meal causes rapid increase in glucose that rapidly stimulate release insulin by the beta cells of islets of Langerhans; that rapidly increase uptake of glucose by cells; glycogenesis and hence decrease in blood glucose levels.

h) Blood glucose levels would remain abnormally high after carbohydrate meal; because diabetic individual cannot regulate sugar levels due to failure of pancreas to secrete enough insulin or insulin resistance by the cells with insulin receptors; the gradual decrease would be due to cellular respiration of glucose.

i) Regulate glucose levels in blood; where deviation from the norm triggers corrective measures; avoiding hyper glycaemia; and hypo glycaemia; which promotes normal functioning of body cells and system.

37) a) (i) Comparison of net productivity and litter production

Similarities

- At 0 years, both net productivity and litter production are at zero;
- Both increased between 0 and 30 years;
- Both decreased between 90 years and 140 years;

Differences

Net productivity	Litter production
• Between 0 and 30 years increased rapidly • Peaks once/forms one peak • Between 80 to 90 years decreased gradually • Between 90 and 140 years decreases rapidly	• Between 0 to 30 years increased gradually; • Peaks twice/forms two peaks; • Between 80 and 90 years increased rapidly; • Between 90 and 140 years decreased gradually;

(ii) Explanation for the changes

- **Total net productivity**

  From 0 to 50 years, total net productivity increased rapidly; because number of leaves and photosynthetic tissues increased; increasing photosynthetic surface; therefore the rate of photosynthesis is greater than the rate of respiration;

  From 50 to 140 years, total net productivity decreased; because most of the trees had reached their maximum size and accumulated a large volume of support tissues; rate of respiration is greater than rate of photosynthesis;

- **Root production**

  From 0 to 80 years, root productivity increased gradually; as more trees develop; roots grow faster; to increase the surface area for water absorption;

  From 80 to 140 years, root production decreased gradually; because most of the trees had reached their maximum size; no more root production/development; roots increase in size to provide extra support;

iii) Tree density increases; plant organs such as leaves, branches, stems, fruits and flowers grow faster; which fall off as litter; upon reaching senescence;

(b) (i) **Description**

Net primary productivity; from 0 to 30 years; productivity increases gradually; from 30 to 60 years; productivity increases rapidly; to maximum; and remains constant; from 60 to 140 years;

Biomass; from 0 to 140 years, biomass increased gradually/slowly throughout;

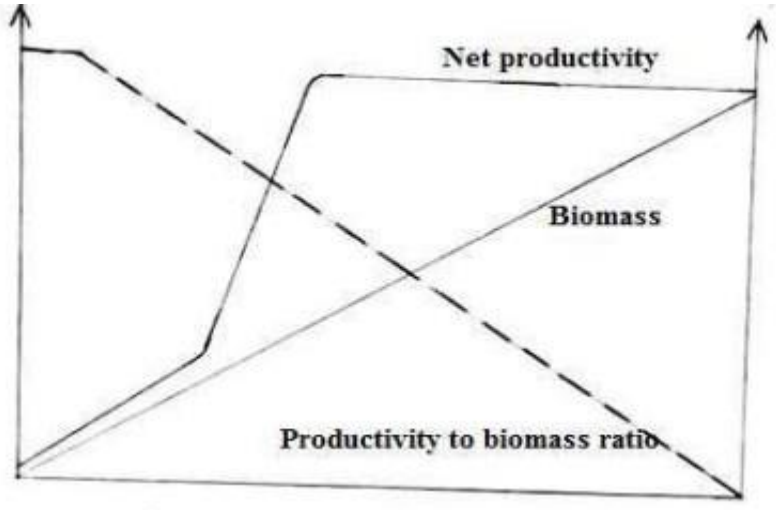
(ii) **Explanation for the changes.**

Biomass; as succession proceeds, there is a gradual replacement of the shrubs with trees which have large biomass and the young trees germinating after the fire also grow to large sizes so that the biomass goes on increasing;

Net productivity; at first, there are few survivors of the fire; hence the net productivity is very low; as more plants germinate from the fire resistant seeds/ perennating organs grow more leaves increasing the photosynthetic tissues gradually, at first gradually and the rapidly; making net productivity greater; as succession proceeds, gradual replacement of the species occurs; towards woody types until the climax community is established whose productivity levels remain constant for further replacement of species by others/species composition remains constant;

05 marks

(iii) **A sketch graph showing variation of productivity to biomass ratio with time**



(iv)

Initially the productivity to biomass ratio was constant; because productivity in most stored in terms of supporting tissues but most is lost in respiration; it increases gradually; because species that dominate later are slow growing but they eventually achieve large sizes; hence they monopolize both space and use of light; they therefore outcompete herbaceous plant species; their large structures is composed of more

photosynthetic tissues; and dead tissues which causes biomass to exceed productivity; as a result the productivity to biomass ratio is reduced

37) a)At 0 percentage concentration of ethanol, the rate of starch hydrolysis is low.

From 0 to 10 percentage concentration of ethanol, rate of starch hydrolysis increases gradually.

From 10 to 30 percentage concentration of ethanol, rate of starch hydrolysis decreases rapidly.

b) Increasing ethanol concentration from 0 to 10 causes time required for complete starch hydrolysis to decrease; low ethanol concentration might act as activator slightly increasing activity of pancreatic amylase, thus reducing the time for hydrolysis.

Increasing ethanol concentration from 10 to 70 causes time required for complete starch hydrolysis to increase; high ethanol concentration cause enzyme denaturation; Ethanol is an organic solvent disrupting pancreatic amylase tertiary structure by breaking hydrogen bonds and hydrophobic interactions; leading to loss of enzyme active site shape and catalytic activity, reducing formation of enzyme –substrate complexes increasing time for complete hydrolysis of starch.

c)

- ✓ liver damage
- ✓ pancreatitis
- ✓ lead to impaired coordination
- ✓ high blood pressure, weakened heart muscle
- ✓ increased risk of stroke
- ✓ nutritional deficiency, due to interfering with nutrient absorption.

d) A; this is control experiment; to show expected activity of the un treated enzyme.

Phenol oxidase was active and catalyzed oxidation of colourless phenols into coloured products.

B; protease catalytic breakdown/hydrolysis of phenol oxidase since if a protein; no oxidation of colourless phenol to coloured products

C; Trichloro acetic acid is a strong acid, lowering pH extremely; this cause denaturation of phenol oxidase enzyme; destroying the specific shape of active site; therefore, no oxidation of colourless phenol into coloured products.

D; mercury is a heavy metal; and act as an inhibitor by binding to negatively charged carbonyl groups breaking down ionic bonds destroying the shape of active sites; however, inhibition is not complete; leading to low oxidation of colourless phenol into very bright yellow.

38) a)i) At 0 min volume of oil displace is 0, because glucose molecules have not been broken down by yeast enzymes, no production of carbon dioxide.

From 0 to 8 minutes, volume of oil displaced increase gradually; low breakdown of glucose by yeast enzymes anaerobically therefore low production of carbo dioxide

From 8 to 20 minutes, volume of oil displaced increase rapidly; due to high breakdown of glucose molecules by yeast enzymes producing much carbon dioxide.

From 20 to 32 minutes, volume of oil displaced increase gradually; due to low breakdown of few remaining glucose molecules; producing little carbon dioxide; accumulation of wastes and low pH decrease yeast breakdown of glucose.

ii) Volume of oil displaced remain constant and then decreases with increase in time; because glucose becomes fully consumed; yeast activity is significantly inhibited by accumulated wastes like ethanol, and low pH; no carbon dioxide production, and volume of oil displaced decreases.

b) i)

- ✓ Temperature
- ✓ pH of the solution
- ✓ Oxygen availability
- ✓ Initial volume of solution and oil
- ✓ Concentration and type of yeast

ii) To serve as control, this allows for detection of any carbon dioxide produced by metabolism other than added carbohydrate, residual respiration by yeast using internal reserves, such that displacement is directly attributed to metabolism of carbohydrates.

c) i) Highest volumes of oil displaced because both are monosaccharides; which are readily and directly used by yeast for respiration without prior breakdown/ hydrolysis producing much carbon dioxide.

ii) Moderate volume of oil displaced because sucrose is a disaccharide. First hydrolysed by invertase enzyme to glucose and fructose; which are utilized in cellular respiration.

iii) Very low volume of oil displaced; because yeast lack lactase enzyme to breakdown lactose into glucose and galactose; therefore, no breakdown of glucose in cellular respiration and no carbon dioxide produced.

iv) Starch is a polysaccharide; yeast lack enzymes to breakdown starch into glucose molecules; starch cannot be metabolized by yeast for respiration therefore no carbon dioxide production.

39) a) Similarities

Rate of oxygen consumption in both athlete and non-athlete;

- Is low at $600jmm^{-1}kg^{-1}$
- Attain maximum
- From 1200 to $1400jmm^{-1}kg^{-1}$ increase rapidly
- From 600 to $800jmm^{-1}kg^{-1}$ increase rapidly

Differences

Rate of oxygen consumption in athlete	***Rate of oxygen consumption in non-athlete***
From 600 to $800jmm^{-1}kg^{-1}$ increase more rapidly	From 600 to $800jmm^{-1}kg^{-1}$ increase less rapidly
Attain higher maximum	Attain lower maximum
Higher	Lower
From 800 to $1000jmm^{-1}kg^{-1}$ increase rapidly	From 800 to $1000jmm^{-1}kg^{-1}$ increase gradually

b) i) *Oxygen consumption*

Increasing level of exercise from 600 to $1400jmm^{-1}kg^{-1}$ leads to increase in rate of oxygen consumption; increasing level of exercise increase energy demand; rate and depth of breathing increase; cardiac output increases; this increase oxygen intake and transport to the active tissues for aerobic respiration to produce/ release energy to sustain the exercise.

Rate of lactic acid production.

Increasing level of exercise from 600 to $1000jmm^{-1}kg^{-1}$ leads to no lactic acid production; due to full aerobic respiration; no anaerobic respiration in the muscles, no production of lactic acid.

Increasing level of exercise from 1000 to 1400jmm^{-1}kg^{-1} cause increase in rate of lactic acid production; due to insufficient supply of oxygen to sustain aerobic respiration; anaerobic respiration occurs producing lactic acid.

ii) *Rate of oxygen consumption.*

Increasing level of exercise from 600 to 1400jmm^{-1}kg^{-1} due to increasing energy demand; breathing rate and depth increase, cardiac output increase; this increase oxygen intake and transport to active tissues for aerobic respiration.

Rate of lactic acid production.

Increasing level of exercise from 600 to 800jmm^{-1}kg^{-1} causes no lactic acid production; because increasing oxygen intake sustains aerobic respiration in active muscles; no anaerobic respiration; no lactic acid production.

Increasing level of exercise from 800 to 1400jmm^{-1}kg^{-1} causes increase in lactic acid production; due to insufficient oxygen delivery to active muscles to sustain aerobic respiration; anaerobic respiration occurs producing lactic acid.

c) Athlete take in more oxygen that allow more aerobic respiration liberating more energy for same amount of food molecules

more complete oxidation of food molecules leading to lower lactic acid production.

a) Oxygen debt occur after exercise; the extra oxygen consumed is due to;

replace oxygen reserves in the body; including restoring normal levels of oxygen in the lungs, tissue fluid, haemoglobin and myoglobin.

Restore creatine phosphate; using energy from aerobic respiration.

Breakdown of lactic resulting from anaerobic respiration.

40) a) **Similarities**

- Both heat loss by evaporation and metabolic rate attain maximum
- Both are equal at 40^0C
- Form 20^0C to 48^0C both increase

Differences

Heat loss by evaporation	***Metabolic rate***
From 12^0C to 20^0C, heat loss remain constant	From 12^0C to 20^0C metabolic rate decreases

Attains higher maximum	Attains lower maximum
Attains maximum at 48^0C	Attains maximum at 12^0C
From 20^0C to 44^0C heat loss increase gradually	From 20^0C to 44^0C metabolic rate remains almost constant
From 40^0C to 48^0C heat loss increase rapidly	From 40^0C to 48^0C metabolic rate increase gradually

b) i) At 12^0C metabolic rate is high; because of lower air temperature than body temperature; high heat loss occurs by radiation, convection and conduction along the thermos gradient; metabolism increase due to stimulation of heat gain centre of the hypothalamus to increase heat production to maintain internal temperature constant.

From 12^0C to 20^0C metabolic rate decreases rapidly, increasing air temperature increase heat gain by radiation by the body; heat loss centre by the hypothalamus is stimulated decreasing metabolic rate to reduce heat generation.

From 20^0C to 44^0C metabolic rate remain almost constant; this is the efficiency range of the organism; the body temperature is maintained by the body's cooling mechanisms; and no significant increase in metabolic rate.

From 44^0C to 48^0C metabolic rate increase gradually; the body's cooling mechanisms break down, as air temperature increase, the heat gained activate more enzymes which cause increase in metabolic rate.

ii) From 12 to 24^0C heat loss by evaporation is low and constant; because environmental temperature is low; therefore, low heat loss through sweating, and evaporation through buccal, nasal and tracheal cavities.

From 24 to 32^0C heat loss by evaporation increase gradually; as air temperature increase, heat gain by radiation, conduction by the body increases; core body temperature increases; stimulating heat loss by sweating.

From 32 to 48^0C heat loss by evaporation increase rapidly; increase in air temperature increase heat gain; core body temperature increase far above norm; this stimulate heat loss centre; of the hypothalamus; which cause vasodilation of the skin blood vessels; increased sweat production; increasing heat loss by sweating; more evaporative heat loss through buccal, nasal and tracheal cavities.

c) From 12 to 48^0C as skin temperature increase, internal body temperature remains almost constant. Internal body temperature remains almost constant due to body's effective thermoregulation to maintain core body temperature; skin temperature increase with increase in air temperature because the skin is the primary interphase for heat exchange with the environment and indicate temperature of the environment.

At low air temperature, internal body temperature is much higher than skin temperature due to very low blood flow to skin from core body to minimize heat loss.

At high air temperature, the difference between internal body temperature and skin temperature decrease due to increased blood flow to the skin, greatly transferring heat from the core body to the skin for dissipation.

d) i) Snake is an ectotherm; its internal body temperature would increase with increasing air temperature, as snake lacks internal mechanism for significant thermoregulation.

ii) Metabolic rate will be slightly lower in female subject because females have lower muscle mass, high fat percentage.

41) a) = Time at start of depolarization –Time at peak of depolarization

= 3.4ms-1.8ms

= 1.6ms

b) Neuromuscular delay/synaptic delay; the delay is due to release of acetylcholine, its diffusion across synaptic cleft; binding of acetylcholine to receptors on sarcolemma; and generation of endplate potential and subsequent action potentials in muscle fibre.

b) i) depolarization occur; stimulation cause rapid opening of sodium voltage gated channels; increasing permeability of nerve cell membrane to sodium ions; sodium ions rapidly diffuse; along electro chemical gradient; in the nerve cell depolarising nerve cell membrane; this cause opening of sodium voltage channels; by positive feedback at threshold of forming action potential is reached.

ii) At the peak of depolarization; Sodium voltage gated channels are closed and/or inacted. Decreasing sodium in permeability potassium voltage gates channels open increasing permeability of nerve cell membrane to potassium ions; potassium ions diffuse out of the nerve cell; making the inside more negative/ repolarising nerve cell membrane; delay in closure of potassium gates cause more diffusion of potassium ions; hyper polarizing the membrane; action of Na^+/K^+ pump restores the resting potential.

c)i) Muscle contraction occur; following action potential in the muscle fibre; Ca^{2+} are released from sarcoplasmic reticula, and T-system; Ca^{2+} bind to troponin causing a conformational change that moves tropomyosin from action forming cross bridges and initiating power stroke leading to muscle shortening and force

ii) Muscle relaxation occur; Ca^{2+} are actively pumped back into sarcoplasmic reticular leading to detachment of myosin heads from actin and muscle fibres returning to their resting length.

d)i) Cobra toxin bind to/ compete for / blocks the acetyl choline receptors on the sarcolemma/ post synaptic membrane; acetyl choline cannot depolarise the muscle cell; and not subsequent formation of action potentials in the muscle fibres.

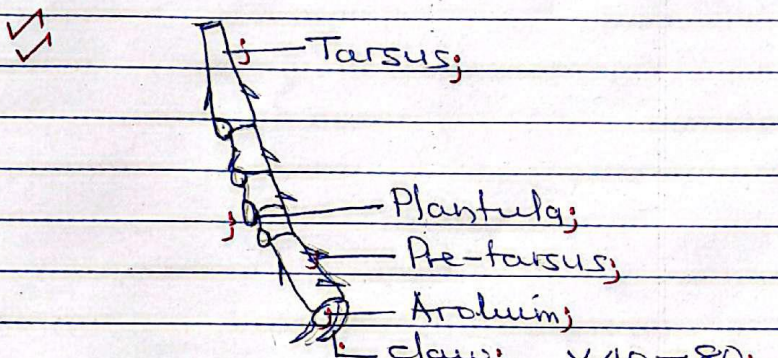
ii) Acetyl choline stores is un able to break down acetyl choline into choline and ethanoic acid; acetyl choline still available/ prolonged presence of acetyl choline in the synaptic cleft; allowing continuous stimulation of muscle fibre to cause sustained muscle contraction/ spastic paralysis.

Solutions to the practical questions

Q1 (a) (i) Antenna length → 50 – 60 mm;
Body length → 40 – 50 mm;

(ii) Antenna slightly longer than body length inorder to sense long distances within the body surrounding;

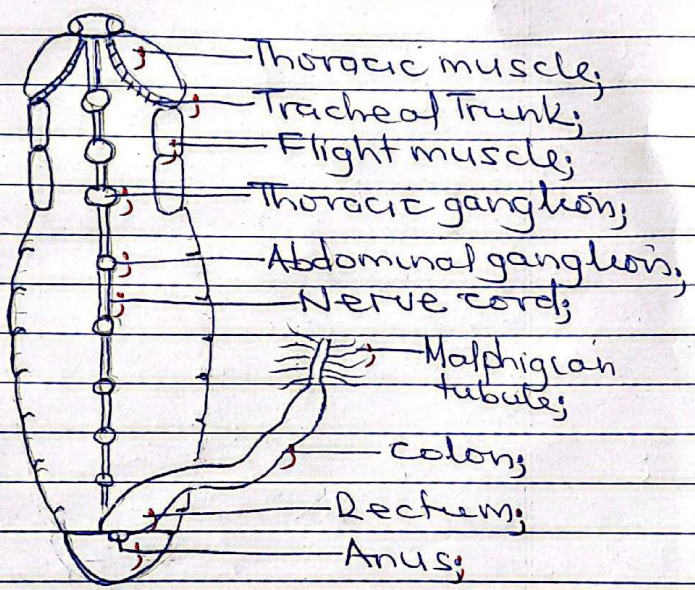
(b) (i) Drawing of the lateral view of foot region viewed under low power of microscope of specimen;



(ii) - claws which are curved and pointed to provide grip during locomotion on rough surface;
- Arolium and plantulae which are swellings that secrete sticky substance to provide grip during locomotion on smooth surface;
- segmented for flexibity during locomotion;

(c) Male;- curved pointed gonapophysis;
Female;- blunt edged gonapophysis;

(d) Drawing showing structures responsible for removal of metabolic wastes and those wholly attached onto the sterna of specimen K;



(e) (ii)

Crop	Gizzard
• Thin walled	Thick walled;
• Inner surface smooth	Inner surfaced serrated/ridged/toothed;

TOAD

Q2 (a) Has webbed digits / webs between digits which increases surface area for pushing more water behind to generate forward force during swimming;

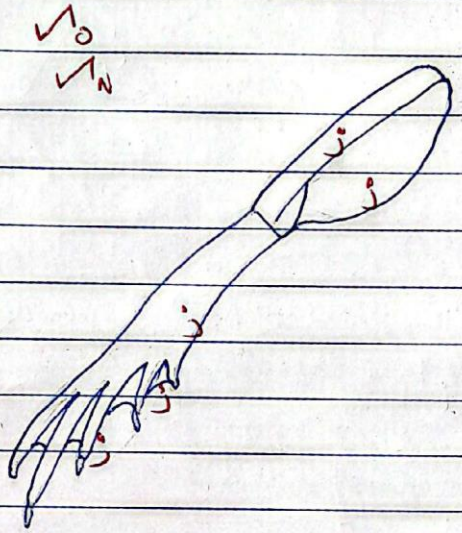
(b) Maxillary teeth and Vomerine teeth which provide ridged surface / rough surface for grip of food;
Movable eye sockets which aid swallowing of food;

(c) (i)

Dorsal skin	Ventral skin
- Thick and tough	Thin and loose;
- Has swellings	Lacks swelling;
- Dark multi-coloured	Light cream coloured;

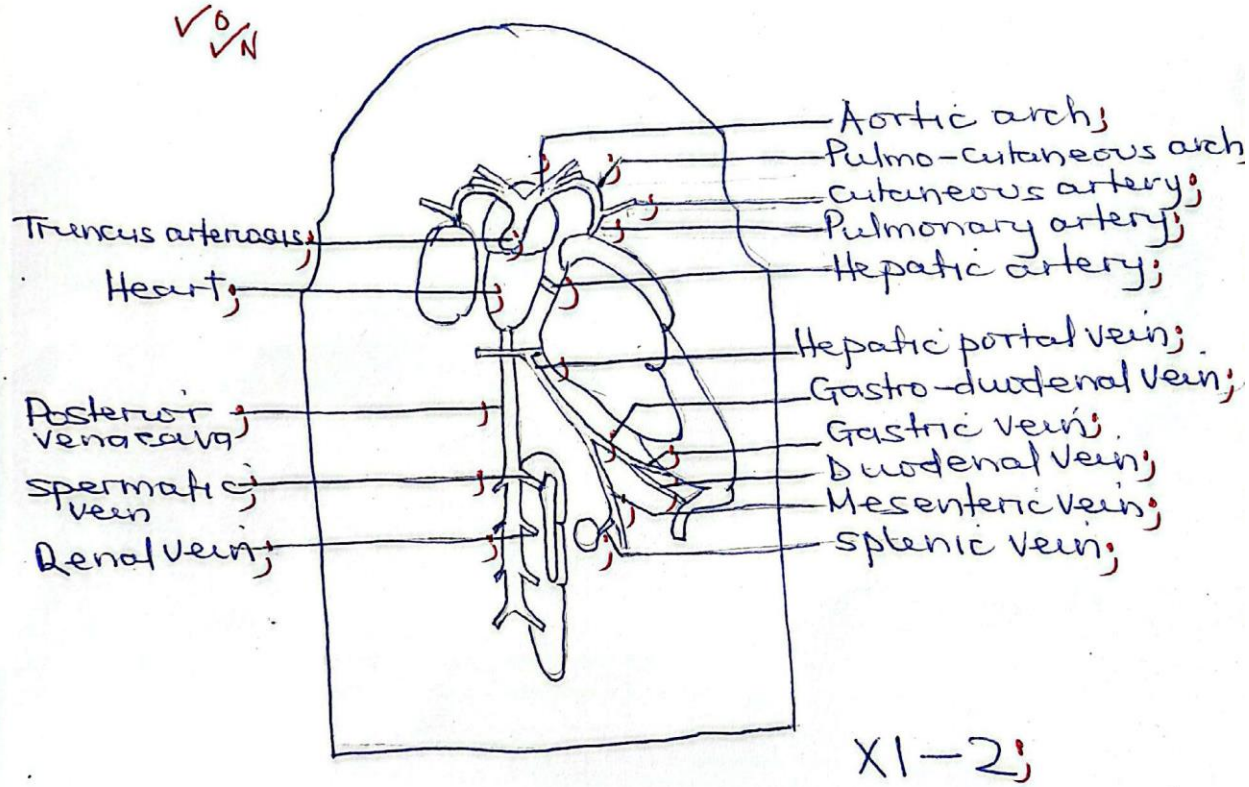
(ii) · Dorsal skin thick and tough for protection against mechanical damage
· Dorsal skin has swellings that secrete · poison for protection against predation / that is detasteful to predators
· Dorsal skin dark multi-coloured for camouflage against dark enviroment for protection against predation
· Ventral skin thin to reduce diffusion distance of gases for effective gaseous exchange.

(d) Drawing of exposed dorsal shank muscles and foot structures of the left hind limb of specimen K;



X1—X2;

Drawing of vessels draining blood from structures located on the left lower body trunk region in-situ and blood vessels supplying blood to structures responsible for gaseous exchange with undisplaced heart of specimen K;.



X1-2;

RAT

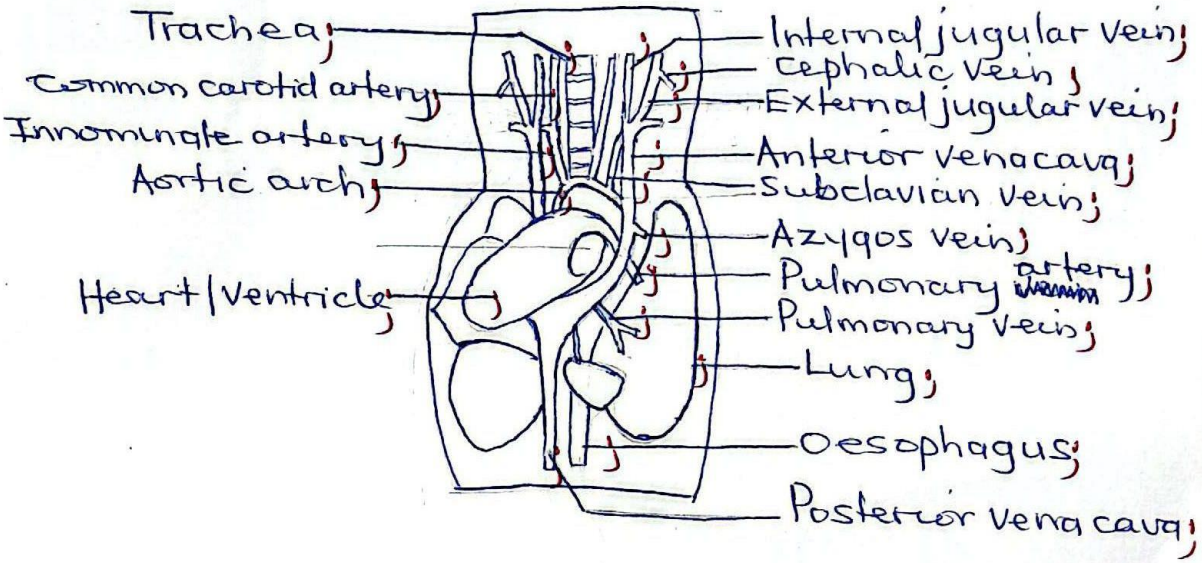
23 (a) • Whiskers; located at the snout / anterior head region; which are long and stiff for sensing longer distances / increased sensitivity over wide area especially estimating sizes of burrows / detecting changes of atmospheric pressure;
• Fur; covering whole body; to insulate against heat loss for temperature regulation; and protection against mechanical damage;
• Scales; covering the tail; to insulate against heat loss for temperature regulation; and protection against mechanical damage;

(b) • Incissor teeth; which are pointed; for grip of food; and protection against predation;
• Molar teeth; with ridged surface / cusps at surface; for crushing food; flattened surface; which increases surface area for crushing food;
• Palate; which has ridged surface for grip of food;
• Diastema; which easy movement of tongue for rolling of food;

(d) Has rings of cartilage to overcome changes of pressure during breathing to avoid its collapse / so as to remain open;
• Tubular to allow free movement of air during breathing;

(c) Drawing of main blood vessels with the heart displaced to the right within the thoracic cavity and lower base of the neck and structures that channel materials and fluids in and out through the thorax of specimen K;.

V°/N



X0·5 — X 2;