a) Account for the absence of glucose in urine for a healthy person. (04marks)

*In a healthy person, glucose is **filtered** by the kidneys but **reabsorbed** in the proximal convoluted tubule back into the bloodstream. This prevents glucose from being lost in urine. If glucose appears in urine, it may indicate a condition like diabetes or kidney dysfunction.*

b) Compare the concentrations of dissolved substances for the two people. (05marks)

***Similarities**:*

*Both individuals have the same concentrations of **urea** and **mineral ions**, and neither has amino acids in their urine.*

Differences

*The person with kidney disease has **protein and glucose** in their urine, while a healthy person retains these substances in the bloodstream.*

c) Suggest an explanation for the difference in composition of urine between a healthy person and the person with the kidney disease. (03marks)

*The presence of **protein and glucose** in the urine of the person with kidney disease suggests **damage to the kidney's filtration system**. Normally, proteins and glucose are reabsorbed, but kidney disease can impair this process, leading to their loss in urine.*

d) Person with kidney disease could be treated either by using a dialysis machine or by having a kidney transplant operation.
What are the advantages and disadvantages of having a kidney transplant rather than dialysis? (04marks)

Advantages of a kidney transplant:

- ✓ *Provides a long-term solution with better quality of life.*
- ✓ *No need for frequent dialysis sessions.*
- ✓ *Restores normal kidney function.*

Disadvantages of a kidney transplant:

- ✓ *Requires a compatible donor, which can be difficult to find.*
- ✓ *Risk of organ rejection, requiring lifelong immunosuppressive drugs.*
- ✓ *Surgical risks and post-transplant complications.*

From graph 1.

e) Calculate the volume of blood ejected from the heart;

i. Between 0 minute and first minute. (03 marks)

Stroke volume = 80 cm^3/beat
Heartbeats in the 1 st minute = 80 times
Voulume of blood is 80 x 80cm^3= 6400cm^3 of blood was ejected.

ii. Between 3rd and 4th minute. (03 marks)

Stroke volume = 80 cm^3/beat
Heartbeats in the 4th minute = 124 times
Voulume of blood is 124 x 80cm^3= 9920cm^3 of blood was ejected.

f) Suggest reasons for the changes in heart rate between 0 and 14 minutes. (10marks)

Increase in heart rate (0–5 minutes - Exercise phase)

- *Increased **oxygen demand** by muscles during exercise.*
- *Higher **carbon dioxide levels** stimulate faster heart rate.*
- ***Adrenaline release** speeds up heart contractions.*
- *Increased **body temperature** enhances metabolic activity.*
- ***Sympathetic nervous system activation** accelerates heart rate.*

Decrease in heart rate (5–14 minutes - Recovery phase)

- ***Reduced oxygen demand** as exercise stops.*
- ***Parasympathetic nervous system activation** slows heart rate.*
- ***Removal of excess carbon dioxide** lowers stimulation.*
- ***Decrease in adrenaline levels** reduces heart rate.*
- ***Cooling of body temperature** helps return heart* rate to normal.

g) Explain five factors that alter the rate of heart beat in mammals, other than level of exercise/ activity. (08 marks)

- ✓ ***Hormones** – Adrenaline increases heart rate by stimulating the heart muscles, while acetylcholine slows it down.*
- ✓ ***Body Temperature** – Higher temperatures speed up the heart rate, while lower temperatures slow it down.*
- ✓ ***Emotional State** – Stress, fear, or excitement trigger the release of hormones that increase heart rate.*
- ✓ ***Blood Pressure** – Low blood pressure causes the heart to beat faster to maintain circulation, while high blood pressure can slow it down.*
- ✓ ***Oxygen Levels** – Low oxygen levels stimulate the heart to beat faster to ensure adequate oxygen supply to tissues.*

SECTION B

2 a) Compare organisms in Kingdom fungi and kingdom Plantae. (08 marks)

Differences between fungi and Plantae kingdom

Kingdom Fungi	Kingdom Plantae
Undergoes heterotrophic nutrition	Undergoes autotrophic nutrition
Has a chitin cell wall	Has a cellulose cell wall
Does not have chlorophyll	Has chlorophyll
Undergoes reproduction by spores	Undergoes reproduction by seeds or spores
Has filamentous growth (hyphae)	Has structured growth (roots, stems, leaves)
Has a role as a decomposer	Has a role as a producer

Similarities

Both plants and fungi have eukaryotic cells, meaning their cells contain a nucleus and other membrane-bound organelles.
Both possess a rigid cell wall that provides structural support, although the composition differs—plants have cell walls made of cellulose, whereas fungi have cell walls made of chitin.
Additionally, both organisms reproduce using spores in some species, allowing them to spread and propagate efficiently.
Both fungi and plants have vacuoles within their cells, which play a role in storage and maintaining cell pressure.
Both exhibit stationary growth, meaning they remain fixed in place and do not move from one location to another.

b) Account for the success of organisms in Kingdom fungi. (08 marks)

- ✓ ***Efficient Nutrient Absorption*** *– Fungi secrete digestive enzymes that break down complex organic matter, allowing them to absorb nutrients effectively.*
- ✓ ***Wide Habitat Range*** *– They thrive in diverse environments, including soil, decaying matter, and even extreme conditions like deep-sea vents.*
- ✓ ***Rapid Reproduction*** *– Fungi reproduce through spores, which can spread easily and survive harsh conditions, ensuring continuity.*
- ✓ ***Symbiotic Relationships*** *– Many fungi form mutualistic associations, such as mycorrhizae with plant roots, enhancing nutrient uptake.*
- ✓ ***Decomposers in Ecosystems*** *– They play a crucial role in breaking down dead organic material, recycling nutrients back into the environment.*
- ✓ ***Resistance to Harsh Conditions*** *– Some fungi can withstand extreme temperatures, drought, and radiation, making them highly adaptable.*
- ✓ ***Medicinal and Industrial Importance*** *– Fungi contribute to antibiotics (e.g., penicillin), food production (yeast in bread and alcohol), and biotechnology.*
- ✓ ***Genetic Diversity*** *– Their ability to undergo sexual and asexual reproduction increases genetic variation, enhancing survival chances.*

c) Explain the role of fungi in crop production. (04 marks)

- ✓ ***Soil Fertility Improvement*** *– Fungi decompose organic matter, enriching the soil with nutrients essential for plant growth.*
- ✓ ***Mycorrhizal Associations*** *– Some fungi form symbiotic relationships with plant roots, enhancing water and nutrient absorption.*
- ✓ ***Biological Pest Control*** *– Certain fungi act as natural pesticides, helping to control harmful insects and plant pathogens.*
- ✓ ***Disease Resistance*** *– Some fungi stimulate plant immunity, making crops more resistant to diseases and environmental stress.*

3. a) Explain any two evidences to show that translocation occurs in the phloem.(05 marks)

Translocation is the process by which organic substances, such as sugars, are transported through the phloem from sources (like leaves) to sinks (such as roots and fruits). The key pieces of evidence that demonstrate translocation occurs in the phloem:

- ✓ ***Ringing Experiment****: When a ring of bark (including the phloem) is removed from a stem, the region above the ring swells due to the accumulation of sugars, while the lower part is deprived of nutrients. This indicates that translocation occurs in the phloem.*
- ✓ ***Radioactive Tracer Studies****: Plants exposed to radioactive carbon dioxide incorporate the isotope into sugars during photosynthesis. These labeled sugars are then detected in the phloem, proving that translocation occurs in this tissue.*
- ✓ ***Aphid Stylet Experiment****: Aphids, which feed on phloem sap, can be used to study translocation. When their stylets remain inserted into the phloem after removal, sap continues to flow out, confirming that the phloem is responsible for transporting nutrients.*
- ✓ ***Effect of Metabolic Inhibitors****: When metabolic inhibitors are applied to phloem tissue, translocation slows down or stops, indicating that the process requires energy and occurs in the phloem.*

b) Explain how pressure gradient is developed between the source and the sink according to the mass flow hypothesis. (09 marks)

*The **mass flow hypothesis**, also known as the **pressure flow hypothesis**, explains how organic substances like sucrose are transported through the phloem from sources (e.g., leaves) to sinks (e.g., roots, fruits). The pressure gradient between the source and sink develops through the following steps:*

- ✓ ***Loading at the Source****:*
  - *Photosynthetic cells in leaves produce sucrose, which is actively transported into companion cells and then into sieve tube elements.*
  - *This increases the solute concentration in the phloem, lowering the water potential.*
- ✓ ***Water Influx and Pressure Build-Up****:*
  - *Water moves into the sieve tube elements from the adjacent xylem by osmosis due to the low water potential.*
  - *This influx of water generates **hydrostatic pressure** at the source, pushing the phloem sap towards the sink.*
- ✓ ***Transport Through the Phloem****:*
  - *The pressure difference between the source (high pressure) and the sink (low pressure) drives the bulk flow of phloem sap.*
  - *The movement occurs through sieve tube elements, facilitated by the pressure gradient.*
- ✓ ***Unloading at the Sink****:*
  - *At the sink, sucrose is actively or passively removed from the phloem into surrounding cells.*
  - *This increases the water potential in the sieve tube elements, causing water to exit into the xylem.*
  - *The loss of water reduces hydrostatic pressure at the sink, maintaining the pressure gradient.*

c) How may absorbed nitrogen be assimilated into proteins in a plant? (06 marks)

Absorbed nitrogen is assimilated into proteins in plants through a series of biochemical processes that convert inorganic nitrogen into organic compounds;

- ✓ ***Nitrogen Uptake**: Plants absorb nitrogen from the soil in the form of **nitrate (NO_3^-) or ammonium (NH_4^+)** through their roots.*
- ✓ ***Reduction of Nitrate to Ammonium**:*
  - ***Nitrate reductase** converts nitrate into nitrite (NO_2^-).*
  - ***Nitrite reductase** further reduces nitrite to ammonium (NH_4^+), which is the usable form for amino acid synthesis.*
- ✓ ***Incorporation into Amino Acids**:*
  - *Ammonium is incorporated into organic molecules through the **glutamine synthetase-glutamate synthase (GS-GOGAT) pathway**.*
  - ***Glutamine synthetase** converts ammonium into glutamine.*
  - ***Glutamate synthase** transfers nitrogen from glutamine to form glutamate, a key precursor for amino acid synthesis.*
- ✓ ***Amino Acid and Protein Formation**:*
  - *Glutamate serves as a nitrogen donor for the synthesis of other amino acids.*
  - *These amino acids are then used to build proteins, which are essential for plant growth and metabolism.*

4 a) How is the structure of the voluntary muscle adapted to its function? (08 marks)

*Voluntary muscles, also known as **skeletal muscles**, are specialized for movement and controlled actions. Their structure is adapted to their function in the following ways:*

- ✓ ***Striated Appearance**: Skeletal muscle fibers have alternating light and dark bands due to the arrangement of **actin and myosin filaments**. This striation allows for efficient contraction and force generation.*
- ✓ ***Multinucleated Fibers**: Each muscle fiber contains multiple nuclei, which help in rapid protein synthesis and repair, ensuring sustained muscle function.*
- ✓ ***Presence of Myofibrils**: Muscle fibers are packed with **myofibrils**, which contain repeating units called **sarcomeres**. Sarcomeres are the functional units of contraction, allowing muscles to shorten and generate movement.*
- ✓ ***Abundant Mitochondria**: Skeletal muscle cells have numerous **mitochondria**, which provide the energy (ATP) required for continuous contraction, especially in endurance activities.*
- ✓ ***Highly Vascularized**: These muscles have an extensive **blood supply**, ensuring a steady delivery of oxygen and nutrients while removing metabolic waste, supporting prolonged activity.*
- ✓ ***Innervation by Motor Neurons**: Skeletal muscles are connected to **motor neurons**, which transmit signals from the brain and spinal cord, enabling voluntary control over movements.*
- ✓ ***Elastic and Contractile Properties**: The muscle fibers are **elastic** and can stretch without damage, while their contractile proteins allow for powerful and controlled movements.*
- ✓ ***Attachment to Bones via Tendons**: Skeletal muscles are anchored to bones through **tendons**, allowing them to exert force and facilitate movement when they contract.*

b) Explain the series of events that occur in the muscle fibre when the end plate potential exceeds threshold value. (12 marks)

*When the **end plate potential** exceeds the **threshold value**, it triggers a sequence of events leading to muscle contraction. It unfolds in the following ways:*

- ✓ ***Generation of Action Potential**:*
  - *The depolarization at the neuromuscular junction spreads across the muscle fiber membrane.*
  - *Voltage-gated **sodium (Na^+) channels** open, allowing Na^+ influx, generating an **action potential**.*
- ✓ ***Propagation of Action Potential**:*
  - *The action potential travels along the **sarcolemma** and enters the muscle fiber through **T-tubules**.*
  - *This ensures deep penetration of the signal into the muscle.*
- ✓ ***Calcium Release from Sarcoplasmic Reticulum**:*
  - *The action potential activates **voltage-sensitive receptors** in the T-tubules.*
  - *These receptors trigger the opening of **ryanodine receptors**, releasing **calcium ions (Ca^{2+})** into the cytoplasm.*
- ✓ ***Binding of Calcium to Troponin**:*
  - *Calcium binds to **troponin**, causing a conformational change.*
  - *This shifts **tropomyosin**, exposing **myosin-binding sites** on actin filaments.*
- ✓ ***Cross-Bridge Formation**:*
  - *Myosin heads attach to actin, forming **cross-bridges**.*
  - *ATP hydrolysis provides energy for myosin to pull actin, leading to muscle contraction.*
- ✓ ***Power Stroke and Muscle Shortening**:*
  - *Myosin heads pivot, pulling actin filaments toward the center of the sarcomere.*
  - *This shortens the muscle fiber, producing contraction.*
- ✓ ***Relaxation Phase**:*
  - *When stimulation ceases, **calcium ions** are pumped back into the sarcoplasmic reticulum.*
  - *Tropomyosin re-covers the binding sites, preventing further contraction.*

5a) Of what importance is osmoregulation to organisms? (04 marks)

- ✓ ***Maintains Cellular Homeostasis**: Osmoregulation prevents excessive water loss or gain, ensuring that cells maintain their optimal shape and function.*
- ✓ ***Regulates Blood and Body Fluid Composition**: It helps control the concentration of salts and other solutes in body fluids, which is essential for metabolic processes.*
- ✓ ***Supports Excretion and Waste Removal**: By regulating water balance, osmoregulation aids in the efficient removal of metabolic waste products through organs like the kidneys.*
- ✓ ***Adapts Organisms to Different Environments**: It enables organisms to survive in varying habitats, such as freshwater, marine, or terrestrial environments, by adjusting their internal water and solute levels.*

b) Compare osmoregulation in a fresh water teleost and marine water teleost. (08 marks)

Similarities

- ✓ *Both types of teleosts regulate ion balance using specialized cells in their gills, actively transporting ions to maintain homeostasis.*
- ✓ ***Both use** kidneys to play a crucial role in osmoregulation, filtering waste and adjusting urine concentration to control water and ion levels.*

- ✓ *Both rely on hormones like **cortisol** and **prolactin** to regulate osmoregulatory processes, adapting to environmental changes.*
- ✓ *Both possess **ionocytes** in their gill epithelium, which facilitate ion exchange and maintain osmotic balance.*

Differences

Freshwater Teleosts	***Marine Teleosts***
Risk of water influx and ion loss due to a hypotonic environment	*Risk of water loss and ion gain due to a hypertonic environment*
Excretes large amounts of dilute urine to remove excess water	*Drinks seawater to compensate for water loss*
Actively absorbs essential ions (Na^+, Cl^-) through gills and food	*Actively excretes excess salts through specialized chloride cells in gills*
Produces large amounts of dilute urine	*Produces small amounts of concentrated urine to conserve water*

c) Explain why plants lack special excretory organs. (08 marks)

- ✓ *Plants eliminate waste products through natural processes like transpiration, diffusion, and guttation, reducing the need for specialized organs.*
- ✓ *Unlike animals, plants produce very little nitrogenous waste since they recycle nitrogen efficiently within their metabolic processes.*
- ✓ *Some waste substances, such as tannins and alkaloids, are stored in vacuoles or deposited in non-essential tissues like bark and leaves, preventing toxicity.*
- ✓ *Plants release oxygen as a byproduct of photosynthesis and expel carbon dioxide during respiration, effectively managing gaseous waste without specialized organs.*
- ✓ *Some waste products are accumulated in leaves and bark, which are periodically shed, serving as a natural excretion method.*
- ✓ *Plants interact with soil microbes that help break down and recycle waste materials, further reducing the need for dedicated excretory organs.*
- ✓ *Compared to animals, plants have a lower metabolic rate, producing fewer harmful waste products that require immediate removal.*
- ✓ *Some waste products are repurposed into secondary metabolites, such as pigments and defensive chemicals, benefiting the plant.*

6. a) Describe how each of the following factors affect growth in plants.
i) Temperature (05 marks)

Temperature plays a crucial role in plant growth by influencing various physiological processes:

- ✓ ***Photosynthesis Rate** – Optimal temperatures enhance photosynthesis, while extreme heat or cold can slow down or halt the process.*
- ✓ ***Respiration and Metabolism** – Warmer temperatures accelerate metabolic activities, increasing energy production for growth.*
- ✓ ***Seed Germination** – Each plant species has an optimal temperature range for germination; too high or too low temperatures can inhibit seed sprouting.*

- ✓ ***Flowering and Fruiting*** *– Temperature affects flowering timing and fruit development, with extreme temperatures potentially causing sterility.*
- ✓ ***Water Loss and Transpiration*** *– High temperatures increase transpiration rates, which can lead to dehydration if water availability is low*

ii) Amount of soil water. (08 marks)

- ✓ *Water dissolves nutrients in the soil, making them accessible to plant roots.*
- ✓ *Adequate water maintains cell turgor, preventing wilting and ensuring structural integrity.*
- ✓ *Water is a key reactant in photosynthesis; insufficient water limits energy production.*
- ✓ *Proper soil moisture encourages deep root growth, improving stability and nutrient absorption.*
- ✓ *Water helps regulate plant temperature through transpiration, preventing heat stress.*
- ✓ *Plants with sufficient water grow faster, while drought conditions stunt growth.*
- ✓ *Well-hydrated plants are more resilient against pests and diseases.*
- ✓ *Moist* soil supports beneficial microbes that aid in nutrient cycling and plant health

b) Explain the significance of larval forms in life cycle of many insects. (07 marks)

- ✓ *The larval stage allows insects to grow rapidly before undergoing metamorphosis, enabling them to reach their adult form efficiently.*
- ✓ *Larvae often have different feeding habits from adults, reducing competition for food and ensuring efficient resource utilization.*
- ✓ *Many larvae are adapted to specific environments that provide protection from predators, harsh conditions, or competition.*
- ✓ *During the larval stage, insects accumulate energy reserves that sustain them through metamorphosis and into adulthood.*
- ✓ *Some larvae are mobile and help spread insect populations to new habitats, increasing their chances of survival.*
- ✓ *Larvae contribute to nutrient cycling, decomposition, and food chains, playing essential roles in ecosystems.*
- ✓ *The larval stage allows insects to adapt to environmental conditions before transitioning into their reproductive adult phase*

END