Biology practice questions

Set 1:

Q1 (Cell Biology) — Fig 1 shows a plant cell and an animal cell.
State **two** structural differences between a plant cell and an animal cell, other than the presence of chloroplasts. **[2]**

Q2 (Movement of Substances)
A student places a potato strip into a concentrated salt solution.
(a) Name the process by which water moves out of the potato cells. **[1]**
(b) Explain, in terms of water potential, why water moves out of the cells. **[3]**

Q3 (Nutrition — Enzymes)
An experiment tested the effect of pH on the activity of amylase, using the iodine test to monitor starch breakdown at 2-minute intervals.
(a) Describe how the iodine test is used to show that starch has been broken down. **[2]**
(b) Sketch and describe the shape of a graph of enzyme activity against pH for a typical human enzyme. **[3]**

Q4 (Transport in Humans)
(a) State **two** differences between arteries and veins. **[2]**
(b) Explain why the left ventricle has a thicker muscular wall than the right ventricle. **[2]**

Q5 (Respiration)
(a) Write the word equation for anaerobic respiration in muscle cells. **[1]**
(b) Explain why muscle cells respire anaerobically during vigorous exercise. **[2]**

Q6 (Molecular Genetics)
(a) Describe the process of transcription. **[3]**
(b) Explain how a mutation in the base sequence of DNA could result in a non-functional protein. **[3]**

Q7 (Homeostasis)
Explain how the body responds to a rise in blood glucose concentration after a meal, including the role of insulin. **[4]**

Q8 (Reproduction)
State **two** functions of amniotic fluid during pregnancy. **[2]**

Set 2:

Q1 (Molecular Genetics)
(a) State the base pairing rule in DNA. **[1]**
(b) A gene has the DNA template strand base sequence: TAC GGA CTT. State the mRNA sequence produced from this template. **[2]**

Q2 (Genetic Engineering)
Describe how a human gene (e.g. the insulin gene) can be inserted into a bacterium to produce a genetically modified organism. **[4]**

Q3 (Enzymes)
A student investigated the effect of temperature on the rate of an enzyme-catalysed reaction.
(a) Describe how the rate of reaction changes as temperature increases from 10°C to 80°C. **[3]**
(b) Explain, in terms of enzyme structure, why the rate of reaction decreases sharply above the optimum temperature. **[3]**

Q4 (Photosynthesis)
(a) Write the word equation for photosynthesis. **[1]**
(b) A plant is placed in a beaker of water containing sodium hydrogencarbonate under a lamp. Explain why the number of bubbles produced increases as the lamp is moved closer to the plant. **[3]**

Q5 (Respiratory System)
(a) State **two** features of alveoli that adapt them for efficient gas exchange. **[2]**
(b) Explain why smoking can lead to a decrease in the efficiency of gas exchange. **[3]**

Q6 (Excretion)
(a) Name the structure in the kidney responsible for ultrafiltration. **[1]**
(b) Explain why glucose is normally completely reabsorbed in the kidney tubule, but is present in the urine of a person with untreated diabetes. **[3]**

Q7 (Coordination — Nervous System)
Describe the pathway of a reflex arc when a person accidentally touches a hot object, from stimulus to response. **[4]**

Q8 (Reproduction — Hormones)
State the roles of oestrogen and progesterone in the menstrual cycle. **[3]**

Set 3:

Q1 (Excretion)
Explain why urea, but not glucose, is normally found in urine. [3]

Q2 (Classification)
State three features used to classify an organism as belonging to the phylum Arthropoda. [3]

Q3 (Nutrition — Digestion)
(a) Name the enzyme that digests protein in the stomach, and state the substrate and products of this reaction. [3]
(b) Explain why pepsin requires an acidic environment to function effectively, and name the structure that produces this acid. [2]

Q4 (Transport in Plants)
(a) Define transpiration. [1]
(b) Explain how a decrease in humidity would affect the rate of transpiration. [2]

Q5 (Homeostasis — Temperature Regulation)
Explain how the body responds when core body temperature rises above normal, with reference to sweat glands and blood vessels in the skin. [4]

Q6 (Ecology)
(a) Define the term "food chain." [1]
(b) Explain why there are usually no more than 4–5 trophic levels in a food chain. [2]

Q7 (Molecular Genetics — Cell Division)
(a) State one difference between mitosis and meiosis in terms of the number of daughter cells produced. [1]

(b) Explain why meiosis, but not mitosis, is important for genetic variation. [3]

Q8 (Respiration)
Compare aerobic and anaerobic respiration in terms of the amount of energy released. [2]

Answers:

Set 1

Q1 (Cell Biology) — Two differences between plant and animal cells (other than chloroplasts):

- Plant cells have a **cell wall** (made of cellulose); animal cells do not.
- Plant cells have **one large, permanent central vacuole**; animal cells have small/temporary vacuoles (if any).

Q2 (Movement of Substances) (a) **Osmosis**. (b) The salt solution has a **lower (more negative) water potential** than the cell sap inside the potato cells. Water moves from a region of **higher water potential** (inside the cell) to a region of **lower water potential** (the salt solution), through the **partially permeable cell membrane**.

Q3 (Enzymes — Amylase) (a) Add iodine solution to the sample at intervals. If starch is present, the iodine turns from **orange-brown to blue-black**. As starch is broken down, the colour change becomes less intense/eventually stays orange-brown, showing starch has disappeared. (b) Enzyme activity is **low at low pH**, rises to a **peak at the optimum pH** (~pH 7 for most human enzymes), then **falls sharply** past the optimum. The curve is roughly bell-shaped — extreme pH **denatures** the enzyme, changing the shape of its active site.

Q4 (Transport in Humans) (a) Arteries have **thick, muscular, elastic walls** and a **narrow lumen**; veins have **thinner walls**, a **wider lumen**, and contain **valves** (arteries do not). (b) The left ventricle pumps blood to the **whole body** (a longer distance, against higher resistance), so it needs **higher pressure**, requiring a

thicker muscular wall. The right ventricle only pumps blood to the **nearby lungs**, needing less pressure.

Q5 (Respiration) (a) Glucose → lactic acid. (b) During vigorous exercise, **oxygen supply cannot meet the increased oxygen demand** of the muscle cells, so cells switch to **anaerobic respiration** to continue releasing energy.

Q6 (Molecular Genetics) (a) DNA unwinds and strands separate; one strand acts as a **template**. Free RNA nucleotides pair with the template strand by **complementary base pairing** (A–U, T–A, C–G, G–C), joined by **RNA polymerase** to form mRNA, which leaves the nucleus via a nuclear pore. (b) A mutation changes the DNA base sequence → changes the **codon sequence on mRNA** → changes the **amino acid sequence** during translation → alters the protein's folding/**tertiary structure**. If it's an enzyme, this can distort the **active site**, making it no longer complementary to its substrate — the enzyme becomes non-functional.

Q7 (Homeostasis — Blood Glucose) When blood glucose rises above normal, the **islets of Langerhans** in the pancreas are stimulated to secrete **insulin** into the blood. Insulin increases the **permeability of cell membranes** (liver and muscle cells) to glucose, increasing glucose uptake and the rate of respiration, and causes excess glucose to be converted to **glycogen** for storage in the liver and muscles — lowering blood glucose back to normal.

Q8 (Reproduction) Amniotic fluid: (1) **protects the foetus from physical shocks/injury**; (2) acts as a **lubricant**, reducing friction during birth.

Set 2

Q1 (Molecular Genetics) (a) Bases pair specifically across the two DNA strands: **adenine (A) with thymine (T)**, **cytosine (C) with guanine (G)**. (b) Template: TAC GGA CTT → mRNA: **AUG CCU GAA** (note: T is replaced by **U**, not T, in mRNA).

Q2 (Genetic Engineering) The insulin gene is **cut out of human DNA using a restriction enzyme**. A bacterial **plasmid** is cut using the **same restriction enzyme**, producing complementary **sticky ends**. The gene is inserted into the

plasmid and joined using **DNA ligase**, forming a **recombinant plasmid**. Bacteria are treated (e.g. **heat shock with calcium chloride**) to become permeable and take up the plasmid. A **marker gene** (e.g. antibiotic resistance) is used to identify/select bacteria that successfully took up the plasmid. These **transgenic bacteria** are then cultured to produce insulin.

Q3 (Enzymes — Temperature) (a) As temperature rises, **kinetic energy of molecules increases**, increasing the rate of **effective collisions** between enzyme and substrate, so **rate of enzyme-substrate complex formation (and reaction rate) increases**. (b) Above the optimum temperature, the enzyme **denatures** — its **tertiary structure/shape is altered**, so the active site is **no longer complementary** to the substrate, and the enzyme can no longer catalyse the reaction effectively — reaction rate falls sharply.

Q4 (Photosynthesis) (a) Carbon dioxide + water --(light energy, chlorophyll)--> glucose + oxygen. (b) As the lamp moves closer, **light intensity increases**, providing **more light energy** for photosynthesis, so the **rate of photosynthesis increases**, producing **more oxygen**, which is released as bubbles.

Q5 (Respiratory System) (a) Alveolus walls are **one cell thick**, giving a **short diffusion distance**; alveoli are **richly supplied with blood capillaries**, maintaining a steep **concentration gradient** for gas exchange. (Also acceptable: large surface area, moist lining.) (b) **Carbon monoxide** in tobacco smoke binds **permanently/irreversibly to haemoglobin**, reducing the blood's capacity to transport oxygen, decreasing gas exchange efficiency. (Tar can also damage alveoli/reduce surface area, and irritants damage cilia, allowing mucus/pathogens to accumulate.)

Q6 (Excretion) (a) **Glomerulus** (inside the Bowman's capsule). (b) Glucose is normally **completely reabsorbed by active transport** in the proximal convoluted tubule. In untreated diabetes, blood/filtered glucose is so high it **exceeds the tubule's transport maximum**, so excess glucose cannot be reabsorbed and remains in the filtrate, appearing in urine.

Q7 (Reflex Arc) Heat stimulates a **receptor** in the skin, generating a nerve impulse. This travels along a **sensory neurone** to the spinal cord, across a **synapse** to a **relay neurone**, across another synapse to a **motor neurone**, which carries the impulse to the **effector** (biceps muscle). The muscle **contracts**, withdrawing the hand.

Q8 (Menstrual Cycle Hormones) Oestrogen: causes repair and thickening of the uterine lining (endometrium); stimulates LH surge leading to ovulation. **Progesterone**: maintains the thickened uterine lining (keeping it ready for/ supporting implantation); inhibits FSH/LH, preventing further egg development and ovulation.

Set 3

Q1 (Excretion) — Urea vs glucose in urine Both urea and glucose pass into the filtrate during **ultrafiltration**. Glucose is **completely reabsorbed** back into the blood by **active transport** in the tubule (as it is needed and is within the transport maximum), whereas urea is a **waste product** and is **not reabsorbed**, so it remains in the filtrate and is excreted as urine.

Q2 (Classification — Arthropoda) — any three:

- Hard **exoskeleton** (made of chitin)
- **Jointed limbs/appendages**
- **Segmented body**
- Bilateral symmetry

Q3 (Digestion) (a) Enzyme: **pepsin**. Substrate: **protein**. Products: **peptides/polypeptides**. (b) Pepsin works optimally at **low (acidic) pH**; acid also denatures food proteins and kills bacteria. The acid (**hydrochloric acid**) is produced by the **gastric glands/cells lining the stomach wall**.

Q4 (Transport in Plants) (a) Transpiration: the **loss of water vapour** from a plant's surface (mainly via stomata) by evaporation. (b) Lower humidity → **steeper water potential/concentration gradient** between the leaf's air spaces and outside air → **faster diffusion** of water vapour out of stomata → transpiration rate **increases**.

Q5 (Temperature Regulation) When core temperature rises: **sweat glands produce more sweat**; evaporation of sweat **absorbs latent heat** from the body, cooling it. **Blood vessels near the skin dilate (vasodilation)**, increasing blood flow near the surface, so more heat is lost by **radiation**.

Q6 (Ecology) (a) A food chain shows the **feeding relationships** between organisms and the **transfer of energy**, starting from a producer. (b) At each trophic level, most energy is **lost** (as heat via respiration, in movement, in egested/undigested material, in excretion) — only about **10%** passes to the next level, so after 4–5 levels there is **too little energy** to support another level.

Q7 (Cell Division) (a) Mitosis produces **2** daughter cells; meiosis produces **4**. (b) Meiosis involves **crossing over** and **independent assortment**, producing genetically **different** gametes — a source of variation. Mitosis produces genetically **identical** daughter cells and does not contribute to variation.

Q8 (Respiration — Energy Comparison) Aerobic respiration releases **much more energy** per glucose molecule, as glucose is **completely broken down** into CO_2 and water. Anaerobic respiration releases **much less energy**, as glucose is only **partially broken down** (incomplete oxidation) into lactic acid (animals) or ethanol + CO_2 (plants/yeast).