Mark Scheme & Worked Solutions

Biology — International Advanced Subsidiary / Advanced Level • Unit 1: Molecules, Diet, Transport and Health

Examination Date: Monday 12 October 2026 **Paper Reference:** WBI11/01 (P87884RA) **Maximum Mark:** 80

General Marking Guidance: All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last. Mark schemes should be applied positively: candidates are rewarded for what they have shown they can do rather than penalised for omissions. Where a question asks for a specific number of points, mark the first responses given up to that limit. In questions marked with an asterisk (*), marks are awarded holistically using a levels-based mark scheme assessing both biological content and logical structure.

Question 1 (Total: 6 marks)

Question	Answer & Worked Explanation	Additional Guidance	Mark
1(a)(i)	**D** (2 and 3 only) *Explanation:* Statement 1 is incorrect because starch is an energy store in plants only (animals store glycogen). Statement 2 is correct (α-glucose joined by 1,4 and 1,6 glycosidic bonds). Statement 3 is correct (composed of helical amylose and branched amylopectin).	Reject A, B, C	**(1)**
1(a)(ii)	**B** ($C_{12}H_{22}O_{11}$) *Explanation:* Maltose is a disaccharide formed by a condensation reaction between two glucose molecules (2 × $C_6H_{12}O_6$) with the removal of one water molecule (H_2O): $C_{12}H_{24}O_{12} - H_2O = C_{12}H_{22}O_{11}$.	Reject A, C, D	**(1)**
1(b)(i)	**B** (2 only) *Explanation:* Statement 1 is incorrect because triglycerides also contain oxygen atoms. Statement 2 is correct (one glycerol joined to three fatty acids). Statement 3 is incorrect because the bond formed is an ester bond.	Reject A, C, D	**(1)**
1(b)(ii)	**D** (Saturated: lower carbon : hydrogen ratio than an unsaturated fatty acid | Unsaturated: have carbon-carbon double bonds) *Explanation:* Saturated fatty acids have no C=C double bonds and therefore contain the maximum number of hydrogen atoms per carbon atom, giving a lower C : H ratio than unsaturated fatty acids.	Reject A, B, C	**(1)**

Question	Answer & Worked Explanation	Additional Guidance	Mark
1(c)(i)	**D** (Between a carboxyl group and an amino group) *Explanation:* A peptide bond forms by a condensation reaction between the carboxyl group (−COOH) of one amino acid and the amino group ($-NH_2$) of an adjacent amino acid.	Reject A, B, C	**(1)**
1(c)(ii)	**B** (2 only) *Explanation:* Statement 1 is incorrect because proteins also contain nitrogen (and sometimes sulfur). Statement 2 is correct (enzymes are biological catalysts that lower activation energy). Statement 3 is incorrect because enzymes can also act extracellularly (e.g., digestive enzymes).	Reject A, C, D	**(1)**
Total for Question 1			**6**

Question 2 (Total: 9 marks)

Question	Answer & Worked Explanation	Additional Guidance	Mark
2(a)(i)	Any three comparative points (must include at least one similarity and one difference for full marks): • **Similarity:** Both contain a phosphate group, a pentose sugar, and a nitrogenous/organic base (or both contain adenine, guanine, and cytosine) (1) • **Difference (sugar):** DNA mononucleotides contain **deoxyribose** whereas RNA mononucleotides contain **ribose** (1) • **Difference (base):** DNA mononucleotides contain **thymine** whereas RNA mononucleotides contain **uracil** (1)	Accept deoxyribose has one fewer oxygen atom than ribose.	**(3)**
2(a)(ii)	• DNA double helix unwinds / unzips and hydrogen bonds between complementary bases break (catalysed by DNA helicase) (1) • Free DNA mononucleotides align with exposed bases on both template strands by **complementary base pairing** (A with T, C with G) forming hydrogen bonds (1) • Adjacent mononucleotides are joined by condensation reactions forming **phosphodiester bonds**, catalysed by **DNA polymerase** (producing two semi-conservative DNA molecules) (1)	Must refer to complementary base pairing and phosphodiester bond formation.	**(3)**
2(a)(iii)	**A** (transcription | antisense) *Explanation:* mRNA is synthesised during transcription using the DNA antisense (template) strand so that the resulting mRNA codons match the sense strand sequence (with U replacing T).	Reject B, C, D	**(1)**

Question	Answer & Worked Explanation	Additional Guidance	Mark
2(b)(i)	A (random/spontaneous) change in the **base / nucleotide sequence** of DNA (or of a gene / allele) (1)	Accept change in order/number of bases in DNA.	**(1)**
2(b)(ii)	Any two from: **substitution**, **deletion**, **insertion** (1)	Accept addition, duplication, or inversion. Both needed for 1 mark.	**(1)**
Total for Question 2			**9**

Question 3 (Total: 10 marks)

Question	Answer & Worked Explanation	Additional Guidance	Mark
3(a)(i)	**33.3** (kg m^{-2}) Height in metres = 173 cm ÷ 100 = 1.73 m BMI = 99.8 ÷ $(1.73)^2$ = 99.8 ÷ 2.9929 = 33.3456... Rounded to 3 significant figures = **33.3**	M1: 99.8 ÷ 1.73^2 (or 33.35) M2: 33.3 (3 s.f.)	**(2)**
3(a)(ii)	**B** (0.87 : 1) *Calculation:* 103 cm ÷ 119 cm = 0.8655... → **0.87 : 1**	Reject A, C, D	**(1)**
3(a)(iii)	• BMI uses total body mass and does not distinguish between **fat mass and muscle mass** (e.g., high muscle mass increases BMI) (1) • Waist-to-hip ratio reflects fat distribution; body fat may be stored around the hips/thighs rather than around the waist/abdomen (or excess mass is muscle rather than abdominal/visceral fat) (1)	Accept reference to dense bone mass or athletic build.	**(2)**
3(b)(i)	• 7000 steps requires 6000 additional steps (7000 − 1000), which takes **60 minutes** (1 hour) of walking (at 100 steps per minute), whereas 10 000 steps requires 9000 additional steps taking **90 minutes** (1.5 hours) (1) • Walking for 60 minutes (30 minutes less per day) is easier to fit into a daily routine / less time-consuming / more achievable for people with busy schedules or lower fitness/mobility (1)	M1: correct time calculation (60 min vs 90 min, or 30 min difference) M2: contextual justification	**(2)**

Question	Answer & Worked Explanation	Additional Guidance	Mark
3(b)(ii)	• Both graphs show that above ~2000 steps per day, the risk of both CVD incidence and death from cancer decreases below the baseline (dashed line) (1) • The greatest / steepest reduction in risk occurs between 0 and ~6000–7000 steps per day (1) • Above ~6000–7000 steps per day (between 7000 and 10 000 steps), both curves **level off / plateau**, showing very little further reduction in risk of CVD or cancer death (1)	Must reference both graphs / aspects of health and the plateau effect after ~6000–7000 steps.	**(3)**
Total for Question 3			**10**

Question 4 (Total: 8 marks)

Question	Answer & Worked Explanation	Additional Guidance	Mark
4(a)(i)	Water molecules that are **not bound to / interacting with solute** molecules or ions (and are free to move randomly / diffuse) (1)	Accept water molecules not forming hydration shells around solutes.	**(1)**
4(a)(ii)	The **difference in water potential** (or concentration of free water molecules) between two regions / across a membrane (over a given distance) (1)	Accept from a region of higher water potential to a region of lower water potential.	**(1)**
4(b)(i)	• Glucose and fructose are **monosaccharides** (smaller molecules), so they are small enough to pass through the pores in the artificial membrane (1) • Sucrose is a **disaccharide** (larger molecule composed of two monosaccharides), so it is too large to pass through the pores in the membrane (1)	Must link molecular size / monosaccharide vs disaccharide to membrane pore size.	**(2)**

Question	Answer & Worked Explanation	Additional Guidance	Mark
4(b)(ii)	• **Glucose** diffuses out of the sac into the beaker down its concentration gradient (from 300 to 100 g dm^{-3}) until concentrations are equal on both sides (1) • **Fructose** diffuses out of the sac into the beaker down its concentration gradient (from 600 to 100 g dm^{-3}) until concentrations are equal on both sides (1) • **Sucrose** cannot cross the membrane, leaving a higher sucrose concentration in the beaker (500 g dm^{-3}) than in the sac (200 g dm^{-3}), giving the beaker a lower water potential (1) • **Water** moves out of the sac into the beaker by **osmosis** (down a water potential gradient), which increases the sucrose concentration inside the sac (above 200 g dm^{-3}) and decreases the sucrose concentration in the beaker (below 500 g dm^{-3}) until water potentials reach equilibrium (1)	Award marks for directional movement, equilibrium of glucose/fructose, osmotic water efflux, and resulting change in sucrose concentrations.	**(4)**
Total for Question 4			**8**

Question 5 (Total: 9 marks)

Question	Answer & Worked Explanation	Additional Guidance	Mark
5(a)(i)	• EDS is caused by a **recessive allele** (while the unaffected allele is dominant) (1) • Both parents (individuals 4 and 5) are **heterozygous / carriers** (each possessing one dominant normal allele and one recessive EDS allele, so neither displays the condition) (1) • Individual 6 inherited a recessive allele from **both** parent 4 and parent 5 (so is homozygous recessive and expresses EDS) (1)	Accept clear genetic symbols if defined (e.g. Ee × Ee → ee).	**(3)**
5(a)(ii)	• **Implication for individuals 4 and 5:** Positive test results could lead to difficult ethical/moral decisions regarding termination of the pregnancy (or invasive sampling such as amniocentesis/CVS carries a risk of miscarriage, or allows emotional/medical preparation for a child with EDS) (1) • **Implication for individual 3:** Screening results in the family confirm that the recessive allele is inherited in this lineage, indicating that individual 3 may also be a carrier (inherited from parents 1 or 2), which may affect individual 3's own reproductive/family planning decisions or prompt carrier testing (1)	One distinct implication required for 4 & 5 and one for 3.	**(2)**

Question	Answer & Worked Explanation	Additional Guidance	Mark
5(b)(i)	• Consists of **three polypeptide chains** wound tightly together in a **triple helix** (with glycine at every third amino acid allowing close packing) (1) • Held together by numerous **hydrogen bonds** between the polypeptide chains, with **covalent cross-links** joining adjacent collagen molecules into staggered fibrils/fibres (1)	Must mention triple helix / three chains and bonding (hydrogen bonds and covalent cross-links).	**(2)**
5(b)(ii)	• Artery walls normally contain collagen fibres to provide **tensile strength** and withstand the **high blood pressure** generated by ventricular contraction (1) • Weakened collagen reduces the structural strength of the artery wall, so it cannot withstand high blood pressure and is more likely to bulge (aneurysm) and rupture/burst (1)	Link collagen role in resisting high blood pressure to wall weakness/rupture.	**(2)**
Total for Question 5			**9**

Question 6 (Total: 12 marks)

Question	Answer & Worked Explanation	Additional Guidance	Mark
6(a)	• BSP is a **heteropolysaccharide** made up of three different types of monosaccharide monomers (mannose, glucose, and galactose) joined by glycosidic bonds (1) • **Glucose** is the most abundant monomer (more than half / ~56.3% of the sugars), followed by mannose (~33.3%), while galactose is the least abundant (~10.4%) (1) • Because the ratio is non-integer (3.2 : 5.4 : 1.0, equivalent to 16 : 27 : 5), BSP is a **large macromolecule** containing many monosaccharide residues (at least 48 monomers per repeating unit/molecule, or chains of varying length) (1)	Accept correct proportional comparisons between the three monosaccharides.	**(3)**
6(b)(i)	• BSP inhibits **amylase** more strongly than **glucosidase** at every concentration tested (e.g., 58–70% inhibition for amylase compared with 44–52% for glucosidase) (1) • Increasing the concentration of BSP (from 0.2 to 4.0 mg cm^{-3}) generally increases the percentage inhibition of both enzymes (e.g., amylase rises steadily from 58% to 70%; glucosidase rises overall from 44% to 52%, plateauing slightly between 1.0 and 3.0 mg cm^{-3}) (1)	Award 1 mark per valid comparative conclusion supported by the bar chart.	**(2)**

Question	Answer & Worked Explanation	Additional Guidance	Mark
6(b)(ii)	• BSP is a polysaccharide (containing glucose monomers), so part of its structure has a complementary/similar shape to starch (the substrate) or binds to an allosteric site on the enzyme (1) • It binds to the **active site** (competitive inhibition) or alters the tertiary structure/shape of the active site (non-competitive inhibition), preventing starch/substrate binding and reducing formation of **enzyme-substrate complexes** (1)	Accept either competitive or non-competitive inhibition mechanism clearly explained.	**(2)**
6(b)(iii)	• Inhibiting amylase and glucosidase reduces / slows down the **hydrolysis (digestion) of starch into glucose** in the digestive tract (1) • Less glucose is absorbed into the blood (or glucose is absorbed more slowly), preventing large spikes / high concentrations in **blood glucose levels** after eating (1)	Must link slower starch digestion to reduced/slower glucose absorption into blood.	**(2)**
6(c)	• **Below 37 °C:** Increasing temperature increases the kinetic energy of molecules, increasing the **rate of successful enzyme-substrate collisions** while the active site remains fully functional, so the actual rate of reaction increases (1) • **At ~37 °C (optimum):** The combination of a high collision rate and intact active site function produces the maximum actual rate of reaction (1) • **Above 37 °C:** Although collision rate continues to increase, excessive kinetic energy breaks hydrogen/ionic bonds in the enzyme's tertiary structure, changing the shape/function of the **active site (denaturation)** so substrates can no longer bind, causing the actual rate of reaction to drop sharply to zero (1)	Must address both factors (collision rate and active site function) across temperatures below and above optimum.	**(3)**
Total for Question 6			**12**

Question 7 (Total: 13 marks)

Question	Answer & Worked Explanation	Additional Guidance	Mark
7(a)(i)	**×0.20** (accept range **×0.19 to ×0.22** depending on print scaling) Measured image length of mantle scale bar = 2.5 cm (25 mm) Actual length of mantle = 12.5 cm (125 mm) Magnification = Image length ÷ Actual length = 2.5 ÷ 12.5 = **×0.20**	Accept 0.2 or ×0.20 (no units). Allow ecf if scale bar measured accurately on printed sheet.	**(1)**

Question	Answer & Worked Explanation	Additional Guidance	Mark
7(a)(ii)	• Measure the image length of each visible arm on the photograph (using a piece of thread/string along curved arms and measuring against a ruler) and calculate the **mean image length** (1) • Divide the mean image length by the **magnification** (from (a)(i)) to estimate the actual mean arm length (noting that arms may be foreshortened/angled or partially hidden) (1)	M1: method to find mean image length (accounting for curvature) M2: divide by magnification	**(2)**
7(b)	Completed table for **Human haemoglobin**: • **Row 1:** Found inside **red blood cells / erythrocytes** (1) • **Row 2:** Consists of **four** polypeptide / protein subunits (two α-globin and two β-globin chains) (1) • **Row 3:** One subunit (haem group) binds **one iron ion (Fe^{2+})** (1) • **Row 4: One iron ion (Fe^{2+}) / one haem group** binds one oxygen molecule (so one haemoglobin molecule binds four oxygen molecules) (1)	1 mark per correctly completed row.	**(4)**
7(c)*	**Indicative Biological Content (6 marks — Level-based QWC):** • **Gills (Gas Exchange):** Provide a large surface area, thin epithelium (short diffusion distance), and constant ventilation with seawater to maintain steep concentration gradients; oxygen diffuses from water into blood (binding to haemocyanin) and carbon dioxide diffuses from blood into water. • **Two Brachial Hearts:** Receive deoxygenated blood from the tissues/arms and pump it directly through the gill capillaries (one brachial heart supplying each gill), maintaining blood flow and steep diffusion gradients across the gills. • **Systemic Heart:** Blood loses pressure as it passes through the narrow capillaries of the gills; the systemic heart receives oxygenated blood from both gills and pumps it under high pressure to the rest of the body/arms/tissues. • **Circulatory System & Haemocyanin Adaptation:** Closed vessels ensure rapid mass transport of oxygen to respiring tissues (for aerobic respiration) and removal of CO_2 from tissues. Because haemocyanin has a lower oxygen-carrying capacity than haemoglobin, having three hearts boosts blood pressure and flow rate (cardiac output) to maintain oxygen delivery, while crawling rather than swimming lowers metabolic oxygen demand.	Apply Levels-based Marking Grid below.	**(6)**
Total for Question 7			**13**

Level	Marks	Descriptor for Question 7(c)*
Level 0	**0**	No awardable content.
Level 1	**1–2**	Demonstrates isolated elements of biological knowledge (e.g., states that gills carry out gas exchange or hearts pump blood). Explanations lack coherence and make minimal use of information provided in the question.
Level 2	**3–4**	Explains the roles of the gills and at least two hearts (brachial vs systemic) in oxygenating and distributing blood, with some reference to pressure or haemocyanin/crawling. Structure is mostly logical with occasional omissions.
Level 3	**5–6**	Comprehensive, logically sequenced explanation integrating gas exchange at the gills, pressure generation by both brachial hearts (to gills) and the systemic heart (to tissues after gill pressure drop), mass transport of O_2/CO_2, and compensation for haemocyanin's lower oxygen-carrying capacity and crawling lifestyle.

Question 8 (Total: 13 marks)

Question	Answer & Worked Explanation	Additional Guidance	Mark
8(a)	**2.03 million tonnes** (or **2 030 000 tonnes**) Mass in 2024 = Mass in 2023 × (1 + 0.291) = Mass in 2023 × 1.291 Mass in 2023 = 2.62 ÷ 1.291 = 2.02943... million tonnes Rounded to 3 significant figures = **2.03 million tonnes**	M1: 2.62 ÷ 1.291 M2: 2.03 million tonnes (accept 2.029 million tonnes / 2 029 435 tonnes)	**(2)**
8(b)	• **Reduces LDL-cholesterol:** Less cholesterol is deposited in artery walls / endothelium, reducing the formation of **atheroma / atherosclerotic plaques** and narrowing of the artery lumen (1) • **Contains antioxidants:** Prevents oxidation of LDL-cholesterol (and reduces free radical damage to endothelial cells), further reducing plaque formation (1) • **Reduces blood pressure:** Reduces mechanical stress and damage to the endothelial lining of arteries, lowering the risk of atherosclerosis developing (1) • **Breaks down blood clots:** Prevents **thrombosis** / blockage of coronary or cerebral arteries, reducing the risk of myocardial infarction or stroke (1) • **Improves circulation:** Maintains blood flow and continuous delivery of **oxygen and glucose** to cardiac muscle cells for aerobic respiration, preventing tissue ischaemia/death (1)	1 mark for each benefit clearly linked to reducing CVD pathology.	**(5)**

Question	Answer & Worked Explanation	Additional Guidance	Mark
8(c)*	**Indicative Biological & Data Evaluation Content (6 marks — Level-based QWC):** • **Antioxidant properties of stored garlic:** Stored garlic has a substantially higher mean antioxidant activity than fresh garlic (19.0 vs 12.0 a.u., a difference of 7.0 a.u.) with non-overlapping standard deviations (18.9–19.1 vs 11.3–12.7), indicating a genuine increase upon storage. Stored garlic has almost the same antioxidant activity as vitamin C (19.0 vs 19.5 a.u.) and very low variation (±0.1 a.u.). • **Effect on lowering SBP:** Mean SBP decreased in all four groups over 12 weeks, including the placebo group G4 (from ~149.2 to 133.0 mm Hg), demonstrating a strong placebo effect. Only G3 (4 capsules/day) reduced mean SBP below the placebo group at week 8 (131.0 vs 132.5 mm Hg) and week 12 (126.2 vs 133.0 mm Hg). Lower doses (G1: 1 capsule, 137.5 mm Hg; G2: 2 capsules, 139.0 mm Hg) were no more effective than placebo, and G2 rose after week 8. • **Effect on lowering DBP:** Mean DBP also fell in all four groups over 12 weeks. Up to week 8, the placebo group G4 had a lower mean DBP (68.6 mm Hg) than all garlic groups; only at week 12 did G3 (4 capsules) fall below placebo (67.2 vs 68.8 mm Hg), while G1 (69.9 mm Hg) and G2 (69.4 mm Hg) remained higher than placebo. • **Limitations / Validity:** No SDs / error bars or statistical tests are given for the SBP/DBP graphs, baseline pressures at week 0 varied slightly, and participants were limited to older Australian adults (70 ± 12 years), restricting generalisability.	Apply Levels-based Marking Grid below.	**(6)**
Total for Question 8			**13**

Level	Marks	Descriptor for Question 8(c)*
Level 0	**0**	No awardable content.
Level 1	**1–2**	Identifies basic trends from the table or graphs (e.g., stored garlic has higher antioxidant activity than fresh garlic, or blood pressure falls over time) without comparing against the placebo control or using data values.
Level 2	**3–4**	Addresses all three bullet points using quoted data values, comparing stored garlic with fresh garlic/vitamin C and noting that G3 (4 capsules) reduces SBP and DBP most, with some recognition of the placebo group (G4).
Level 3	**5–6**	Thorough, well-structured discussion covering all three areas with precise data manipulation, SD comparison for antioxidant activity, critical comparison of G1–G3 against the placebo group (G4) across 0–12 weeks for both SBP and DBP, and valid evaluation of study limitations.

Paper Summary	Section Breakdown	Reference	Marks
TOTAL	**Q1 (6) + Q2 (9) + Q3 (10) + Q4 (8) + Q5 (9) + Q6 (12) + Q7 (13) + Q8 (13)**	**WBI11/01**	**80**