IB Biology B1.2 Proteins

Worksheet 01 — Amino acids and peptide bonds

Worksheet	Amino acids and peptide bonds
Recommended time	45–55 minutes
Indicative marks	31
Coverage	Common amino acid structure, condensation, dipeptides, peptide bonds, sequence and protein identity.
Teacher note	SL questions are included throughout. HL-labelled items can be used for extension, differentiation, or separate HL assessment.

This worksheet focuses on the common features of amino acids, how condensation reactions produce peptide bonds, and why sequence matters in determining protein identity. HL items extend into the structural consequences of primary sequence.

Section A — Multiple choice

Choose the best answer for each question. 1 mark each.

1. [SL] Which set of features is present in every amino acid found in proteins?
A. A phosphate group, a pentose sugar and an R-group
B. An amine group, a carboxyl group, a hydrogen and an R-group attached to an alpha carbon
C. Three fatty acids joined to glycerol
D. Only carbon, hydrogen and oxygen

2. [SL] What is produced when two amino acids join by condensation?
A. A monosaccharide and water
B. A dipeptide and water
C. A triglyceride and carbon dioxide
D. A nucleotide and water

3. [SL] A polypeptide containing 18 amino acids contains how many peptide bonds?
A. 17
B. 18
C. 19
D. 36

4. [SL] Essential amino acids are best described as amino acids that
A. are never used in proteins
B. must be obtained from food because they cannot all be synthesized by human cells
C. can only be found in meat
D. have disulfide bonds

5. [HL] Why can a change in the primary structure of a protein alter its final shape?
A. Because the number and order of amino acids determine which intramolecular interactions can form
B. Because peptide bonds spontaneously become glycosidic bonds
C. Because amino acids no longer contain carbon
D. Because quaternary structure always disappears

Section B — Short answer

6. [SL] State four structural features common to all amino acids. (4 marks)

7. [SL] Write the word equation for the condensation reaction between two generalized amino acids. (2 marks)

8. [SL] Explain why a polypeptide with 166 amino acids contains 165 peptide bonds. (2 marks)

9. [HL] Explain how changing the order of amino acids can change the properties of a protein even if the same 20 amino acids are available to cells. (4 marks)

Section C — Data response / case study

A nutrition class compared three lunch plans for a student following a plant-based diet. The goal was to determine which plan most reliably supplied all essential amino acids over the day.

Meal plan	Main protein source(s)	Reported result by end of day
Plan A	White rice only	Low lysine intake
Plan B	Beans only	Low methionine intake
Plan C	White rice + beans	All essential amino acids met

10a. [SL] Identify the meal plan that best supplied essential amino acids. (1 marks)

10b. [SL] Use the table to explain why combining white rice with beans is more effective than relying on either food alone. (3 marks)

10c. [HL] Explain why the availability of all essential amino acids is important for protein synthesis in cells. (3 marks)

Section D — Extended response

11. [SL/HL] Explain the relationship between amino acid sequence and the diversity of proteins found in organisms. (8 marks)

Answer key and marking guidance

Use the guidance flexibly. Equivalent scientific wording should receive credit where it is biologically accurate and consistent with the source material.

Section A — Multiple choice answers

Q1	B	Q2	B	Q3	A	Q4	B
Q5	A						

Section B — Short answer guidance

6. [SL] Award 1 mark each for any four of: alpha/central carbon; amine group; carboxyl group; hydrogen attached to alpha carbon; R-group/side chain attached to alpha carbon.

7. [SL] 2 marks for “amino acid + amino acid → dipeptide + water”. Accept “amino acid 1 + amino acid 2 → dipeptide + water”.

8. [SL] 1 mark for stating that each peptide bond forms between two adjacent amino acids; 1 mark for explaining that the number of peptide bonds is always one less than the number of amino acids in a single chain.

9. [HL] Award up to 4 marks for linking sequence to primary structure, primary structure to later bonding opportunities, bonding to three-dimensional conformation, and conformation to specific biological function.

Section C — Data response guidance

10a. [SL] 1 mark for Plan C.

10b. [SL] Up to 3 marks: white rice is low in lysine; beans are low in methionine; eating both provides complementary amino acid profiles so the essential amino acids missing from one source are supplied by the other.

10c. [HL] Award up to 3 marks for explaining that proteins require specific amino acid sequences, cells cannot complete synthesis of a required polypeptide if essential amino acids are absent, and a shortage limits normal growth/repair or specific protein production.

Section D — Extended response guidance

11. [SL/HL] Award up to 8 marks for a logically organized explanation including: DNA/gene determines amino acid number and sequence; 20 naturally occurring amino acids are available; amino acids can occur in many orders and lengths from a few to thousands; condensation reactions link them via peptide bonds; the sequence is the primary structure; different sequences generate different folding patterns and shapes; shape determines function; this leads to a very large diversity of proteins such as enzymes, hormones, structural proteins and transport proteins.