IB Biology B1.2 Proteins

Worksheet 02 — Dietary protein and essential amino acids

Worksheet	Dietary protein and essential amino acids
Recommended time	45–55 minutes
Indicative marks	32
Coverage	Essential vs non-essential amino acids, dietary planning, peptide bond calculations, protein identity.
Teacher note	SL questions are included throughout. HL-labelled items can be used for extension, differentiation, or separate HL assessment.

This worksheet explores how human diets must provide essential amino acids and how sequence-based protein synthesis depends on an adequate supply of amino acid building blocks.

Section A — Multiple choice

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

1. [SL] Which statement about essential amino acids is correct?
A. They are synthesized from fatty acids in the liver
B. They must be obtained from the diet
C. They are only present in animal tissues
D. They are not used in polypeptides

2. [SL] A dipeptide forms when
A. two nucleotides join with release of oxygen
B. two amino acids join and water is produced
C. three amino acids join and water is consumed
D. an amino acid is hydrolysed into glycerol

3. [SL] A protein rich in a single food source may be nutritionally limited because
A. all foods contain the same amino acids in the same proportions
B. some food sources may be low in one or more essential amino acids
C. proteins do not affect metabolism
D. only non-essential amino acids are required

4. [SL] What is the role of DNA in protein synthesis according to this topic?
A. It provides fatty acids for membranes
B. It codes for the number and order of amino acids in a protein
C. It hydrolyses peptide bonds directly
D. It donates phosphate groups to glycerol

5. [HL] Why does the sequence of amino acids matter even if two polypeptides contain the same total number of amino acids?
A. Only length determines function
B. Sequence changes which intramolecular interactions can occur and therefore changes conformation
C. Both polypeptides must behave identically
D. Sequence matters only in fibrous proteins

Section B — Short answer

6. [SL] Define the term essential amino acid. (2 marks)

7. [SL] A polypeptide has 42 amino acids. State the number of peptide bonds and explain your answer. (2 marks)

8. [SL] State two reasons why a varied diet can support healthy protein synthesis. (2 marks)

9. [HL] Explain why amino acid deficiency can affect many different proteins rather than only one protein. (4 marks)

Section C — Data response / case study

Four students logged one day of protein intake. The dietician estimated whether the intake pattern was likely to support complete protein synthesis.

Student	Main sources eaten that day	Dietician comment
A	Yogurt, lentils, eggs	Wide amino acid range
B	White rice only	Likely lysine shortfall
C	Beans and rice	Complementary sources
D	Bread and fruit only	Low total protein and limited amino acid balance

10a. [SL] Identify the student most likely to have the poorest amino acid balance. (1 marks)

10b. [SL] Explain why student C is described as having complementary sources. (2 marks)

10c. [HL] Suggest why a dietician would consider both protein amount and amino acid balance when evaluating whether cells can synthesize proteins efficiently. (3 marks)

Section D — Extended response

11. [SL/HL] Discuss how condensation reactions and dietary amino acid supply together allow organisms to build diverse polypeptides. (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	B	Q4	B
Q5	B						

Section B — Short answer guidance

6. [SL] 2 marks for stating that essential amino acids cannot be synthesized (or not in sufficient quantity) by human cells and therefore must be obtained from food.

7. [SL] 1 mark for 41 peptide bonds; 1 mark for noting that the number of peptide bonds is one fewer than the number of amino acids in one chain.

8. [SL] Award 1 mark each for any two of: supplies all essential amino acids; compensates for deficiencies in one protein source; supports synthesis of many different proteins; reduces risk of limited amino acid intake from a single source.

9. [HL] Up to 4 marks: many proteins are constantly synthesized; each requires a specific amino acid sequence; if one essential amino acid is lacking, synthesis of multiple proteins needing that amino acid is limited; therefore growth, repair or signalling proteins may all be affected.

Section C — Data response guidance

10a. [SL] 1 mark for D. Accept B if justified as specifically lysine-limited, but D is the strongest answer because it is low in both total protein and amino acid balance.

10b. [SL] 2 marks for explaining that beans and rice supply different limiting amino acids and together provide a more complete essential amino acid profile.

10c. [HL] Award up to 3 marks for: adequate total amino acids are needed; the full essential set is needed; low amount or missing essential amino acids can both limit protein synthesis.

Section D — Extended response guidance

11. [SL/HL] Award up to 8 marks for linking dietary amino acids to absorbed monomers, DNA-directed sequence, condensation reaction between amine and carboxyl groups, formation of peptide bonds and water, extension from dipeptides to long chains, different chain lengths and orders, role of essential amino acids in permitting synthesis, and the consequence that many different proteins can be produced.