# 8.1 Proteins

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

**KEY WORDS** amino acid • peptide bond • polypeptide • denaturation • R group R • essential amino acid

## Objective

Build the skills to answer exam questions on **proteins** : amino acids, peptide bonds, the variety of proteins and denaturation.

**You must be able to:**

- draw the general structure of an amino acid and show how a peptide bond forms
- explain how the sequence of amino acids gives proteins their great variety
- explain how heat and pH denature proteins
- explain why some amino acids are essential in the diet

## 1 Key knowledge and worked examples

### Proteins

**Amino acid:** a central carbon with an **amine group** ($-NH_2$), a **carboxyl group** ($-COOH$), a hydrogen and an **R group**. There are **20** amino acids in proteins; they differ only in the R group. **Essential** amino acids cannot be made by the body, so they must come from the diet.

**Peptide bond:** a condensation reaction joins the carboxyl group of one amino acid to the amine group of the next, releasing water. A chain is a **polypeptide**.

**Variety:** a chain of $n$ amino acids can have $20^n$ sequences, so the number of possible proteins is huge. The sequence decides how the chain folds, and the shape decides the function.

**Denaturation:** high temperature or extreme pH breaks the bonds that hold the shape (hydrogen bonds, ionic bonds), so the protein loses its shape and function. It is usually **permanent**.

**Worked example.** A dipeptide forms from two amino acids: **one** peptide bond, **one** water released. A chain of 3: $20^3 = \mathbf{8000}$ possible sequences.

**Answer shapes:** heat → bonds break → shape changes → active site / function lost.

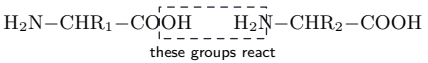


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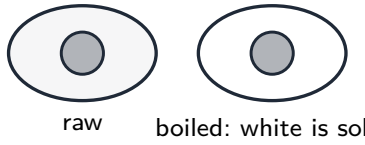
## 2 Practice

**2.1** Draw the general structure of an amino acid and label the R group. [2]

**2.2** Explain how two amino acids join to form a dipeptide. [3]

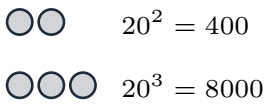



**2.3** Explain why boiling an egg changes the egg-white protein permanently. [3]



## 3 Exam-style questions

**3.1** A student counted the possible sequences of short polypeptides.



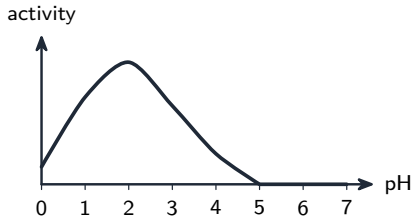

(a) Calculate the number of possible sequences for a chain of 4 amino acids. [1]

(b) Explain why the sequence of amino acids decides the function of a protein. [2]

(c) State what is meant by an essential amino acid. [1]

(d) Suggest why a vegan diet should include a mix of plant proteins. [2]

**3.2** The graph shows the activity of a protein-digesting enzyme at different pH values.




(a) State the optimum pH of this enzyme. [1]

(b) Suggest where in the body this enzyme works. [1]



(c) Explain why the activity is zero at pH 6. [2]

(d) State two types of bond that hold the shape of a protein. [2]



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