Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

central C with H, NH_2 and COOH; R group labelled on the central carbon

2.2

a condensation reaction; between the carboxyl group of one and the amine group of the other; forming a peptide bond and releasing water

2.3

heat makes the molecules vibrate; bonds that hold the folded shape break, e.g. hydrogen bonds; the protein is denatured: it unfolds and cannot refold, so the change is permanent

2.4

secondary: α-helix / β-sheet held by hydrogen bonds between backbone groups; tertiary: the overall 3-D folding of the chain, held by bonds between R groups

2.5

quaternary: made of more than one polypeptide chain (four in haemoglobin); conjugated: contains a non-protein part, the haem group

3.1

(a) $20^4 = \mathbf{160\,000}$

(b) the sequence decides where the chain bonds and folds; the folded shape decides function, e.g. the shape of an active site

(c) an amino acid the body cannot make, so it must come from food

(d) some plant proteins are low in certain essential amino acids; a mix (e.g. beans and grains) supplies all of them

3.2

(a) pH 2

(b) the stomach

(c) the pH changes the charges on R groups, breaking ionic / hydrogen bonds; the enzyme is denatured, so the active site changes shape and the substrate no longer fits

(d) any two: hydrogen bonds; ionic bonds; disulfide bridges; hydrophobic interactions