PIPADOR REVISION

MRCOG Part 1 Revision Notes

Proteins: Amino Acid and Protein Structure

BIOCHEMISTRY • LECTURE 221

VISUAL EXAMINATION REVISION NOTES

2026 Edition

221

MRCOG PART 1 REVISION NOTES | BIOCHEMISTRY

Proteins: Amino Acid and Protein Structure

Amino acids, the peptide bond, levels of protein structure, functions and post-translational modification

20	Peptide bond	4 levels	4 kcal/g
Standard amino acids (L-form)	Amide link; planar	Primary → quaternary structure	Energy from protein

■ **KEY FACTS: Learning objectives**

- Describe the general structure and properties of amino acids, including ionisation.
- Describe the peptide bond and the four levels of protein structure and the bonds that stabilise them.
- Describe protein functions, denaturation, misfolding and post-translational modification, with clinical examples.

221.1 Amino acids and the peptide bond

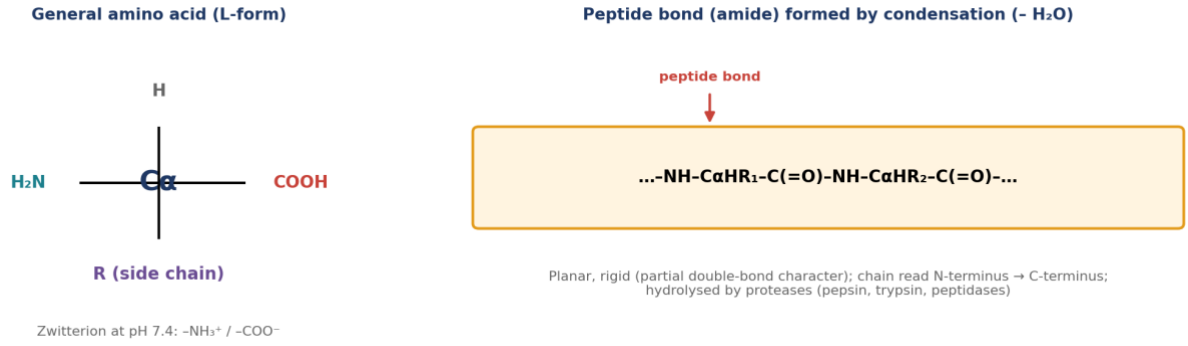


Figure 221.1 — Amino acid structure and the peptide bond

- Each amino acid has an **α-carbon** bearing an amino group, a carboxyl group, H and a variable **R side chain** (which determines its class — Lecture 224). Humans use **L-amino acids** (glycine is achiral).
- At physiological pH amino acids exist as **zwitterions**; the **isoelectric point (pI)** is the pH of zero net charge. Charged side chains (Glu, Asp, Lys, Arg, His) underlie **electrophoresis** — e.g. **HbS** (Glu → Val, less negative) migrates differently from HbA.
- **Histidine** (imidazole pKa ≈ 6–7) makes proteins such as haemoglobin effective **buffers**.

221.2 Levels of protein structure

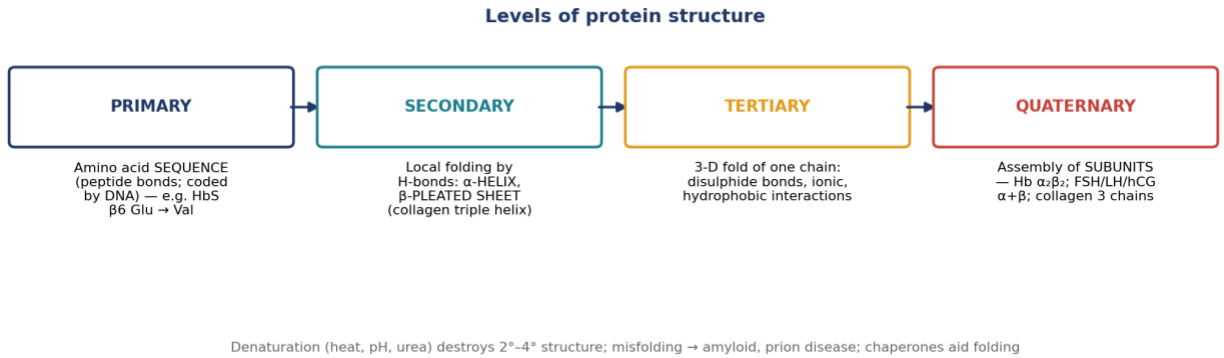


Figure 221.2 — Primary to quaternary structure

Bond / interaction	Level	Examples
Peptide (covalent)	Primary	Sequence encoded by gene; a single change (point mutation) can alter function (HbS, CFTR ΔF508)
Hydrogen bonds	Secondary (α-helix, β-sheet), tertiary	α-helices in membrane receptors (7-TM GPCR); β-sheets in amyloid
Disulphide bridges (Cys–Cys)	Tertiary / quaternary	Insulin A + B chains, immunoglobulins, glycoprotein hormones, keratin
Ionic (salt bridges), hydrophobic, van der Waals	Tertiary / quaternary	Hydrophobic core of globular proteins; deoxy-Hb 'T state' salt bridges (2,3-BPG)

221.3 Protein function and modification

Function	Examples
Structural	Collagen (Lecture 227), elastin, keratin, actin/myosin
Enzymes	Catalysis — e.g. aromatase, 21-hydroxylase, carbonic anhydrase
Transport / storage	Haemoglobin (Lecture 226), albumin, transferrin, ferritin, SHBG, TBG, CBG, lipoproteins
Signalling	Peptide hormones (insulin, oxytocin), receptors, growth factors
Defence / clotting	Immunoglobulins, complement, clotting factors, fibrinogen

Post-translational modification	Examples
Glycosylation	FSH, LH, hCG (half-life), ZP proteins, mucins, immunoglobulins
Phosphorylation	Kinase signalling (PKA, PKC, tyrosine kinases) — switches activity
Proteolytic cleavage	Pro-insulin → insulin + C-peptide; POMC → ACTH, MSH, β-endorphin; zymogens (trypsinogen, clotting factors)
Hydroxylation	Proline/lysine in collagen (vitamin C)
γ-Carboxylation	Glutamate → γ-carboxyglutamate in factors II, VII, IX, X, proteins C/S (vitamin K; warfarin)
Others	Acetylation (histones — epigenetics), ubiquitination (proteasome), lipidation, sulphation

■ CLINICAL CORRELATION

- **Denaturation** (heat, extreme pH, urea, alcohol) destroys 2°–4° structure, not the primary sequence.
- **Misfolding/aggregation**: amyloidosis, prion disease, α_1-antitrypsin deficiency (liver retention), cystic fibrosis ΔF508 (CFTR degraded in ER).
- **Proteinuria** (pre-eclampsia, nephrotic syndrome): albumin loss through damaged glomerular barrier.

221.4 Must-know summary

■ EXAM TIP

- Amino acid = α-carbon + NH_2 + COOH + H + **R group**; zwitterion at pH 7.4; pI.
- Peptide bond: condensation, planar; N → C terminus.
- 1° sequence; 2° α-helix/β-sheet (H-bonds); 3° fold (disulphides, hydrophobic); 4° subunits (Hb $\alpha_2\beta_2$, hCG α+β).
- PTMs: glycosylation (hCG), cleavage (C-peptide), hydroxylation (vitamin C), **γ-carboxylation (vitamin K)**.

■ MNEMONIC / MEMORY AID

Protein structure — 'Sequence, Spirals & Sheets, Shape, Subunits' (1° → 4°).