PIPADOR REVISION

MRCOG Part 1 Revision Notes

Proteins: Subclasses of Amino Acids

BIOCHEMISTRY • LECTURE 224

VISUAL EXAMINATION REVISION NOTES

2026 Edition

MRCOG PART 1 REVISION NOTES | BIOCHEMISTRY

224 Proteins: Subclasses of Amino Acids

Side-chain classes, charge and function, branched-chain and sulphur amino acids, glucogenic/ketogenic fate and derivatives

Acidic	Basic	Aromatic	Glucogenic / ketogenic
Asp, Glu (− at pH 7.4)	Lys, Arg, His (+ at pH 7.4)	Phe, Tyr, Trp	Metabolic fate of carbon skeleton

■ KEY FACTS: Learning objectives

- Classify amino acids by side-chain chemistry (non-polar, polar, acidic, basic, aromatic, sulphur-containing, branched-chain).
- Relate side-chain properties to protein structure, function and laboratory methods.
- Classify amino acids by metabolic fate (glucogenic vs ketogenic) and give clinically relevant derivatives.

224.1 Classification by side chain

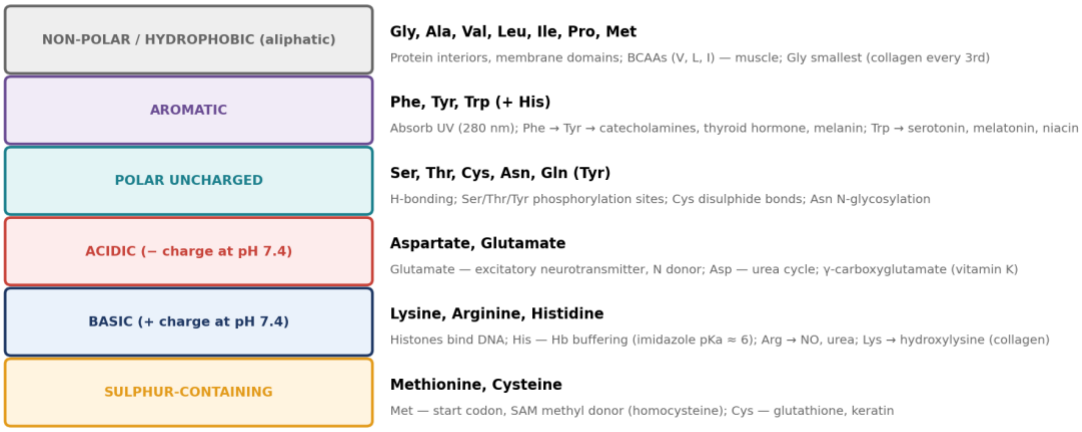


Figure 224.1 — Amino acid subclasses and key functions

Property	Clinical / physiological consequence
Charge	Determines electrophoretic mobility (Hb electrophoresis: HbS Glu → Val loses a negative charge; HbC Glu → Lys gains a positive one), protein solubility, enzyme active sites
Hydrophobicity	Transmembrane domains (receptors, channels), protein folding cores; HbS — hydrophobic valine promotes polymerisation of deoxy-Hb
Glycine (smallest)	Every 3rd residue in collagen (Gly-X-Y) — allows tight triple helix; glycine substitutions → osteogenesis imperfecta
Proline	Helix breaker; hydroxyproline stabilises collagen
Cysteine	Disulphide bonds (insulin, antibodies, glycoprotein hormones); glutathione (antioxidant — paracetamol toxicity, N-acetylcysteine)
Serine/threonine/tyrosine	Phosphorylation sites — signalling; Ser/Thr O-glycosylation; Asn N-glycosylation
Histidine	Imidazole buffer (pKa ≈ 6–7) — Hb Bohr effect and CO_2 buffering
Aromatic	Absorb UV at 280 nm (protein quantification)

224.2 Branched-chain and sulphur amino acids

Group	Members	Notes
Branched-chain (BCAAs)	Leucine, isoleucine, valine	Oxidised mainly in muscle; maple syrup urine disease; leucine activates mTOR (protein synthesis)
Sulphur-containing	Methionine, cysteine	Met → SAM → homocysteine; Cys → taurine, glutathione; homocystinuria; cystinuria (Cys, Orn, Arg, Lys — stones)
Hydroxy	Serine, threonine, tyrosine	Phosphorylation; serine → glycine (one-carbon metabolism with folate)
Amides	Asparagine, glutamine	Glutamine — main nitrogen carrier in blood, gut/kidney fuel, renal ammoniagenesis (acid–base)

224.3 Glucogenic and ketogenic amino acids

Category	Amino acids	Fate
Purely ketogenic	Leucine, lysine	→ Acetyl-CoA / acetoacetate — cannot make glucose
Both	Isoleucine, phenylalanine, tyrosine, tryptophan, threonine	Part glucogenic, part ketogenic
Purely glucogenic	All others (e.g. alanine, glutamine, aspartate, glycine, serine)	→ Pyruvate or TCA intermediates → gluconeogenesis (fasting, pregnancy late-night fast, starvation)

224.4 Clinically important derivatives

Precursor	Product	Relevance
Tyrosine	Catecholamines, T_3/T_4, melanin	Phaeochromocytoma, thyroid disease, albinism
Tryptophan	Serotonin, melatonin, niacin	SSRIs, carcinoid, pellagra
Arginine	Nitric oxide (NOS), urea, creatine	Vasodilatation in pregnancy; ↓ NO bioavailability in pre-eclampsia (ADMA)
Glutamate	GABA (glutamate decarboxylase, B_6), glutathione	Excitatory/inhibitory neurotransmission; $MgSO_4$ blocks NMDA
Histidine	Histamine	Allergy, gastric acid (H_2)
Glycine + succinyl-CoA	Haem (porphyrins)	Lecture 226
Glycine, arginine, methionine	Creatine	Muscle energy (phosphocreatine)
Ornithine	Polyamines	Cell growth; placenta

224.5 Must-know summary

■ EXAM TIP

- Acidic: **Asp, Glu**; basic: **Lys, Arg, His**; aromatic: **Phe, Tyr, Trp**; sulphur: **Met, Cys**; BCAAs: **Leu, Ile, Val**.
- Charge changes explain Hb electrophoresis (HbS, HbC); Gly every 3rd in collagen; Cys disulphides; Ser/Thr/Tyr phosphorylation.
- **Leucine and lysine are purely ketogenic**; alanine/glutamine are key gluconeogenic carriers.
- Arg → NO; Tyr → catecholamines/thyroid; Trp → serotonin; Glu → GABA; His → histamine.

■ MNEMONIC / MEMORY AID

Basic amino acids — 'His Lys Args' (positive). **Purely ketogenic — 'the two Ls: Leucine, Lysine'**.