PIPADOR REVISION

MRCOG Part 1 Revision Notes

Organelles

BIOCHEMISTRY • LECTURE 204

VISUAL EXAMINATION REVISION NOTES

2026 Edition

MRCOG PART 1 REVISION NOTES | BIOCHEMISTRY

204 Organelles

Nucleus, ribosomes, endoplasmic reticulum, Golgi, lysosomes, peroxisomes and mitochondria — structure, function and disease



■ **KEY FACTS: Learning objectives**

- Describe the structure and functions of the main organelles.
- Describe the secretory pathway and protein targeting.
- Describe mitochondrial energy production and inheritance.
- Relate organelle dysfunction to disease (lysosomal storage, mitochondrial disease, peroxisomal disorders).

204.1 Organelles at a glance

Organelle	Structure	Functions	Clinical relevance
Nucleus	Double membrane envelope with pores; chromatin; nucleolus	DNA replication, transcription, RNA processing (splicing); ribosome assembly	Aneuploidy, imprinting disorders; nuclear size/shape in cytology (CIN)
Ribosomes	rRNA + protein (80S: 60S + 40S)	Translation — free (cytosolic proteins) or ER-bound (secreted/membrane)	Antibiotic targets are bacterial 70S ribosomes
Rough ER	Ribosome-studded membranes	Synthesis, folding, N-glycosylation of secreted/membrane proteins	Abundant in plasma cells, syncytiotrophoblast, pancreatic acinar cells; ER stress in pre-eclampsia placenta
Smooth ER	No ribosomes	Steroid synthesis, lipid synthesis, drug detoxification (CYP450), Ca^{2+} store (SR in muscle)	Abundant in Leydig, theca, adrenal cortex, hepatocytes; enzyme induction
Golgi apparatus	Stacked cisternae (cis → trans)	Modification (O-glycosylation), sorting, packaging; mannose-6-phosphate tag → lysosomes	I-cell disease (tagging failure)
Lysosomes	Acidic (pH ≈ 5) vesicles	Degradation (autophagy, phagocytosis)	Lysosomal storage disorders (Tay–Sachs, Gaucher, Pompe) — carrier screening in some populations
Peroxisomes	Single membrane	Very-long-chain fatty acid β-oxidation, H_2O_2 metabolism (catalase), plasmalogens	Zellweger syndrome, X-linked adrenoleukodystrophy
Mitochondria	Double membrane, cristae, own DNA	ATP (oxidative phosphorylation), apoptosis, Ca^{2+} buffering, heat, steroidogenesis (first step)	Mitochondrial disease; oocyte mitochondria and ageing
Centrosome/centrioles	Microtubule organising centre	Spindle, cilia basal bodies	Sperm centriole required for zygote's first spindle

204.2 The secretory pathway

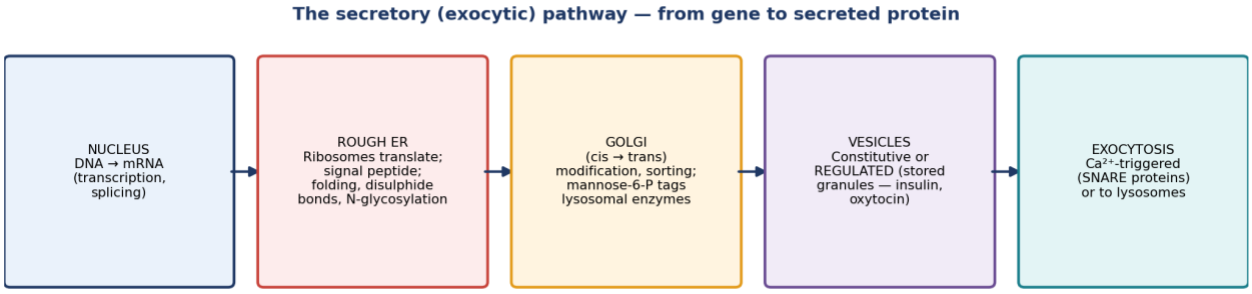


Figure 204.1 — From gene to secreted protein

Proteins destined for secretion or membranes carry an N-terminal **signal peptide** recognised by the signal recognition particle, directing translation onto the rough ER. **Constitutive secretion** is continuous (collagen, albumin, antibodies); **regulated secretion** stores hormones in granules released by a stimulus (Ca^{2+}) — insulin, prolactin, oxytocin. Misfolded proteins undergo ER-associated degradation (proteasome).

204.3 Mitochondria

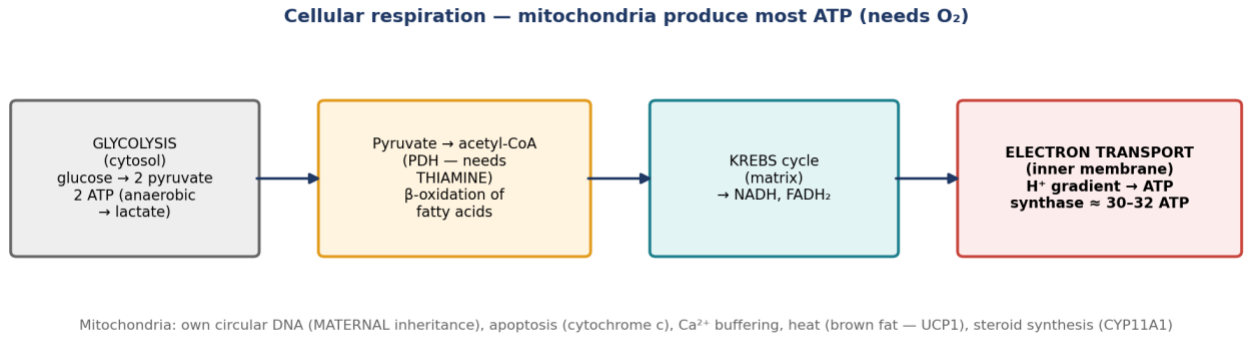


Figure 204.2 — Cellular respiration

- **Mitochondrial DNA** (16.5 kb, 37 genes) is inherited **maternally** — sperm mitochondria are destroyed after fertilisation. **Heteroplasmy** (mixed normal/mutant mtDNA) and the oocyte 'bottleneck' cause variable severity (MELAS, MERRF, Leber's optic neuropathy).
- **Mitochondrial donation** (pronuclear transfer — legal in the UK under HFEA licence) can prevent transmission.
- Mitochondria initiate **intrinsic apoptosis** (cytochrome c release, BCL-2 family) and house the first steps of **steroidogenesis** (StAR transports cholesterol to the inner membrane; CYP11A1).
- **Brown fat** (UCP1) uncouples oxidative phosphorylation → heat (neonatal non-shivering thermogenesis).

204.4 Must-know summary

■ EXAM TIP

- Rough ER = secreted proteins (plasma cells, trophoblast); **smooth ER = steroids** and detoxification (theca, Leydig, adrenal, liver).
- Golgi adds **mannose-6-phosphate** → lysosomes; lysosomal storage diseases (Tay–Sachs, Gaucher).
- Mitochondria: ATP, apoptosis, steroidogenesis; **maternal inheritance**, heteroplasmy; mitochondrial donation.
- Regulated secretion stores hormones in Ca^{2+}-triggered granules.

■ MNEMONIC / MEMORY AID

'Smooth ER makes Steroids, Rough ER makes pRoteins'.