PIPADOR REVISION

MRCOG Part 1 Revision Notes

Mitosis and the Cell Cycle

CELL BIOLOGY • LECTURE 102

VISUAL EXAMINATION REVISION NOTES

2026 Edition

MRCOG Part 1 Revision Notes

Lecture 102: Mitosis and the Cell Cycle

Cell biology • Visual revision edition

COLOUR CODE USED THROUGHOUT THESE NOTES

G1 / GO SIGNALS	S PHASE	G2 / CHECKPOINTS	M PHASE / CANCER	DAMAGE / DRUGS

LEARNING OBJECTIVES — tick off as you go

- ☐ Describe the phases of the cell cycle and their timing.
- ☐ Explain cyclin–CDK control, CDK inhibitors, Rb–E2F and p53.
- ☐ List the checkpoints and the stages of mitosis.
- ☐ Describe mitotic errors, apoptosis and links to cancer.
- ☐ Apply cell-cycle drugs to O&G — methotrexate, taxanes, platinum, fertility preservation.

1 The Cell Cycle

IN ONE LINE: *Grow (G1) → copy DNA (S) → check (G2) → divide (M). Cyclin–CDK pairs push the cycle forward; Rb and p53 are the brakes; checkpoints stop it when something is wrong.*

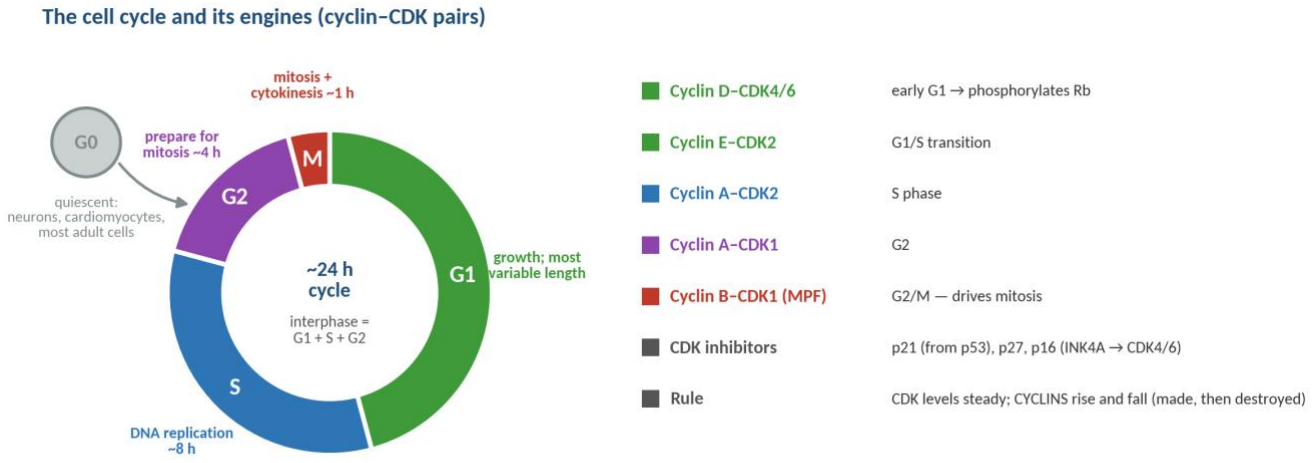


Figure 1. Cell cycle phases and cyclin–CDKs.

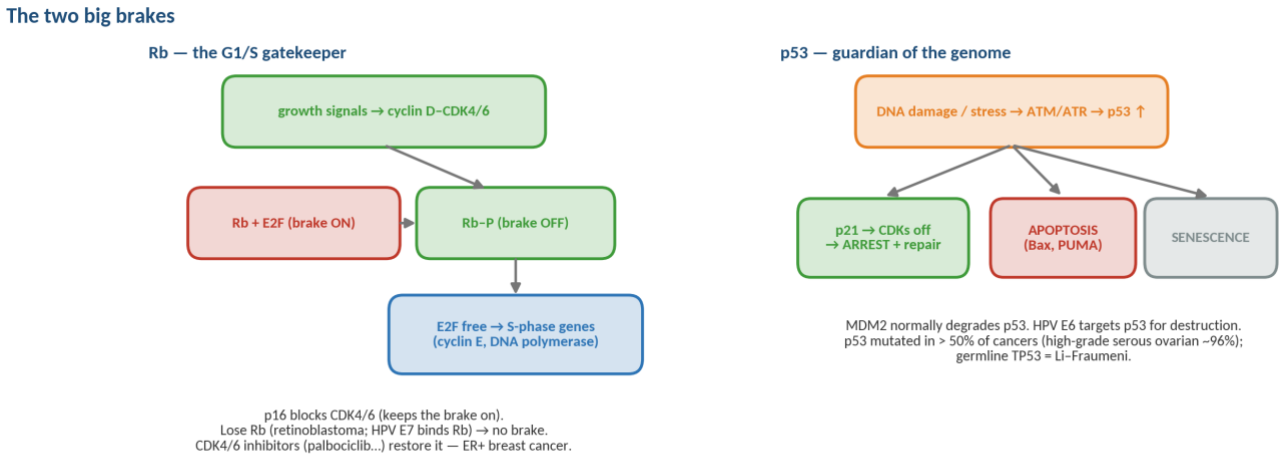


Figure 2. Rb and p53.

2 Checkpoints

Checkpoint	What it checks / key players
G1/S (restriction point)	Growth signals, size, DNA damage — p53 → p21; Rb–E2F. Point of no return
Intra-S	Replication stress — ATR
G2/M	Complete, undamaged DNA before mitosis — ATM (double-strand breaks)
Spindle assembly (SAC)	Every kinetochore attached to both poles before anaphase — MAD2, BUB1, BUBR1; failure → aneuploidy

3 Mitosis

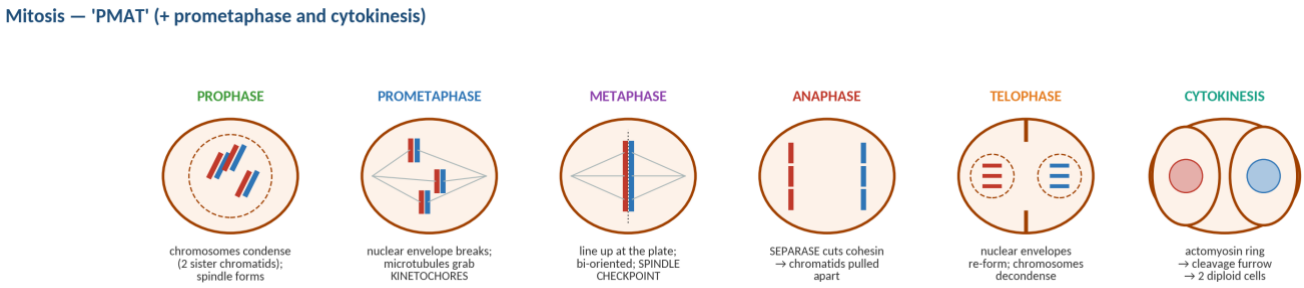


Figure 3. Stages of mitosis.

MNEMONIC / MEMORY HOOK

'I Picked My Apples Today' — Interphase, Prophase, Metaphase, Anaphase, Telophase (prometaphase sits between P and M; cytokinesis finishes).

Feature	Mitosis	Meiosis (Lecture 103)
Purpose	Growth, repair	Gametes
Divisions / products	One → 2 diploid identical cells	Two → 4 haploid unique cells
Homologue pairing / crossing over	No	Yes (prophase I, pachytene)

Duration	~1 hour	Days (sperm) to decades (oocytes)

- **Mitotic errors**: non-disjunction in early embryo → **mosaicism** (most embryonic and confined placental mosaicism is post-zygotic); lagging chromosomes → micronuclei; failed cytokinesis → tetraploidy (normal in megakaryocytes, hepatocytes); **chromothripsis** — one chromosome shattered and rejoined in one catastrophic event.

4 Cell Death

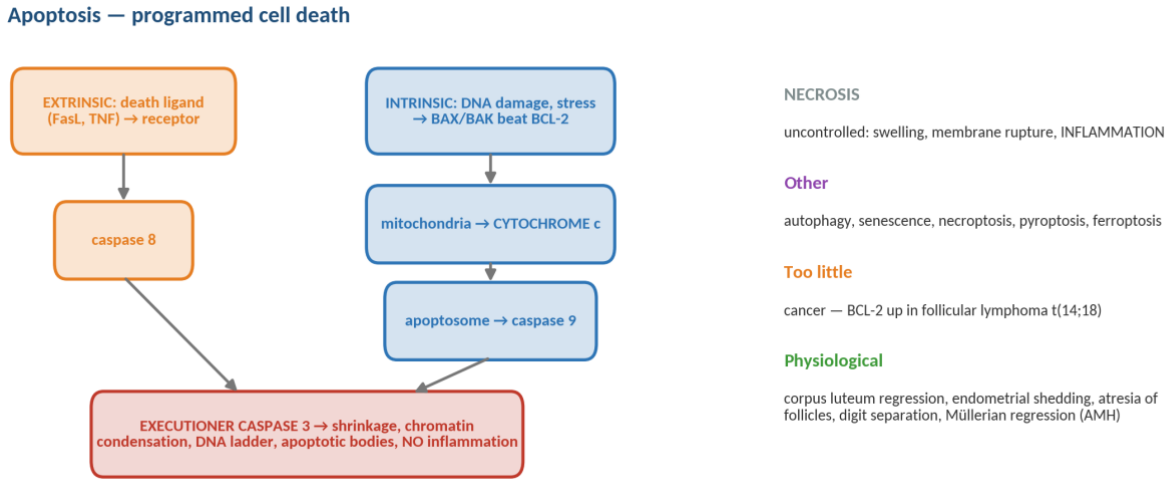


Figure 4. Apoptosis vs necrosis.

5 Cancer and Drugs

- **Tumour suppressors**: Rb, TP53, p16 (CDKN2A), APC, BRCA1/2. **Oncogenes**: MYC, cyclin D1, CDK4, RAS. **Stem cells**: short G1, long quiescent G0, asymmetric division; embryonic stem cells have a weak G1/S checkpoint.

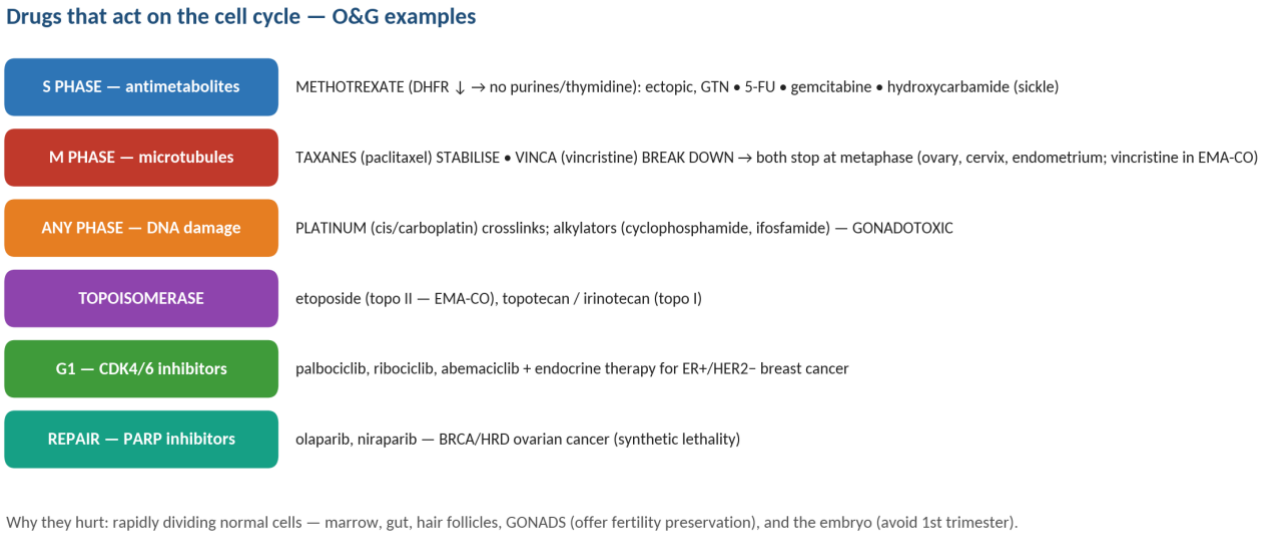


Figure 5. Cell-cycle drugs.

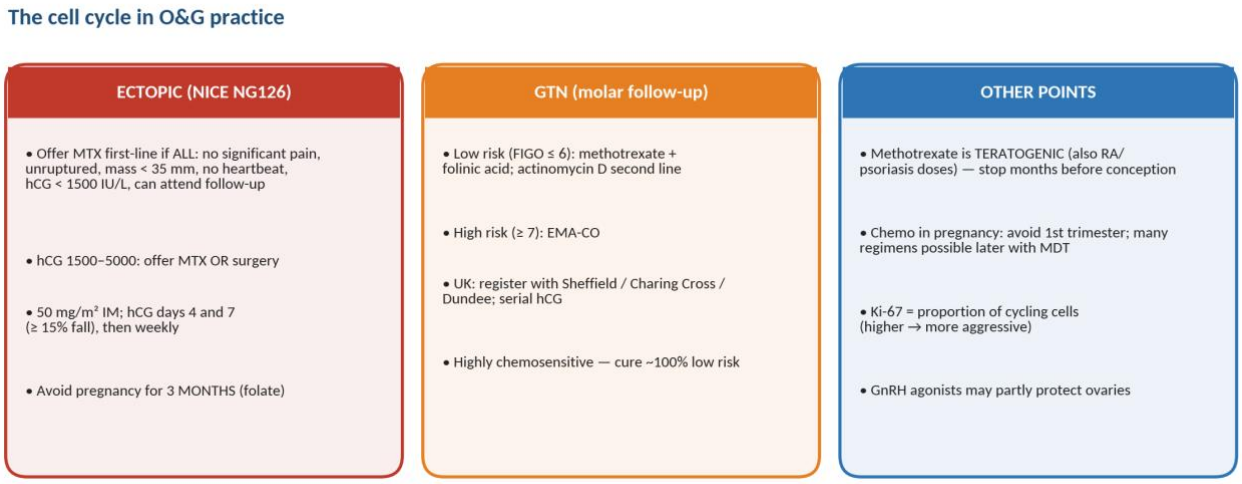


Figure 6. Methotrexate and GTN in O&G.

★ PEARL

Cyclin D–CDK4/6 phosphorylates Rb → E2F free → S phase. p53 → p21 → arrest (or apoptosis). Taxanes stabilise, vinca alkaloids break down microtubules.

Ectopic: MTX first-line if hCG < 1500, unruptured, no heartbeat, mass < 35 mm, little pain (NICE); avoid pregnancy 3 months after.

6 MRCOG Exam Pearls — Last-Minute Page

Numbers to know

~24 h Typical cycle	**~8 / 4 / 1 h** S / G2 / M	**> 50%** Cancers with TP53 mutation	**50 mg/m²** MTX ectopic dose
< 1500 hCG for 1st-line MTX	**≥ 15%** hCG fall day 4→7	**3 months** Avoid pregnancy after MTX	**≤ 6 / ≥ 7** GTN low / high risk

HIGH-YIELD CHECKLIST

- ☐ G0, G1, S, G2, M; interphase = G1 + S + G2; G1 most variable.
- ☐ Cyclin D–CDK4/6, E–CDK2, A–CDK2, A–CDK1, B–CDK1 (MPF).
- ☐ Inhibitors p21, p27, p16; Rb–E2F; HPV E7 → Rb, E6 → p53.
- ☐ p53 → p21 arrest, apoptosis, senescence; Li–Fraumeni.
- ☐ Checkpoints: G1/S, intra-S (ATR), G2/M (ATM), spindle (MAD2).
- ☐ PMAT + prometaphase; separase cuts cohesin at anaphase.
- ☐ Mitotic non-disjunction → mosaicism; chromothripsis.
- ☐ Apoptosis: extrinsic caspase 8, intrinsic cytochrome c → caspase 9 → caspase 3.
- ☐ Taxanes stabilise, vinca destabilise; MTX, 5-FU (S); platinum; CDK4/6 inhibitors.
- ☐ MTX for ectopic/GTN; teratogenic; fertility preservation.

Self-assessment — cover the right-hand column

Question	Answer
Most variable phase of the cycle?	G1
Cyclin–CDK that drives mitosis?	Cyclin B–CDK1 (MPF)
What frees E2F?	Phosphorylation of Rb by cyclin D–CDK4/6
How does p53 arrest the cycle?	Induces p21, a CDK inhibitor
Which HPV protein targets Rb?	E7
Enzyme that releases sister chromatids?	Separase (cleaves cohesin)
Origin of most embryonic mosaicism?	Post-zygotic mitotic errors
Taxane vs vinca mechanism?	Taxanes stabilise; vinca prevent assembly
NICE first-line MTX hCG threshold for ectopic?	< 1500 IU/L (choice MTX or surgery 1500–5000)
Low-risk GTN first-line drug?	Methotrexate with folinic acid

7 References

- Alberts B et al. Molecular Biology of the Cell. 7th ed. 2022.
- NICE NG126. Ectopic pregnancy and miscarriage. 2019 (updated 2023).
- RCOG Green-top Guideline No. 38. Management of Gestational Trophoblastic Disease. 2020.