PIPADOR REVISION

MRCOG Part 1 Revision Notes

Cell Culture and Stem Cells

MOLECULAR BIOLOGY • LECTURE 96

VISUAL EXAMINATION REVISION NOTES

2026 Edition

MRCOG Part 1 Revision Notes

Lecture 96: Cell Culture and Stem Cells

Molecular biology • Visual revision edition

COLOUR CODE USED THROUGHOUT THESE NOTES

CULTURE / MULTIPOTENT	TOTIPOTENT / RISK	PLURIPOTENT / ESC	ADULT / PUBLIC BANK	iPSC

LEARNING OBJECTIVES — tick off as you go

- ☐ Describe cell culture conditions, primary vs continuous cultures, and common problems.
- ☐ Explain how cultured cells are used for karyotyping.
- ☐ Define stem cell potency levels with examples.
- ☐ Compare embryonic and induced pluripotent stem cells.
- ☐ Discuss cord blood banking, clinical applications and UK regulation.

1 Cell Culture

IN ONE LINE: *Cells grown outside the body in sterile medium at 37 °C, 5% CO_2 and high humidity — the basis of karyotyping, IVF embryology and stem cell work.*

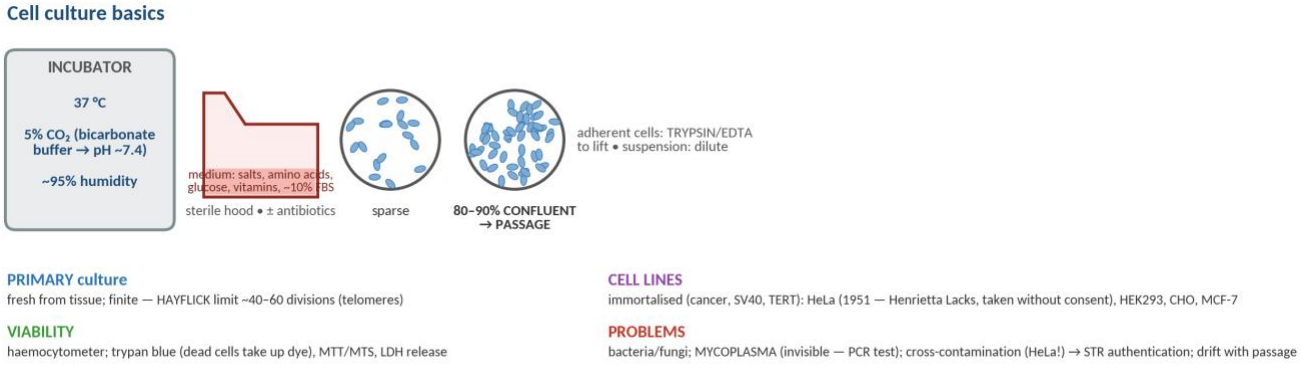


Figure 1. Culture basics.

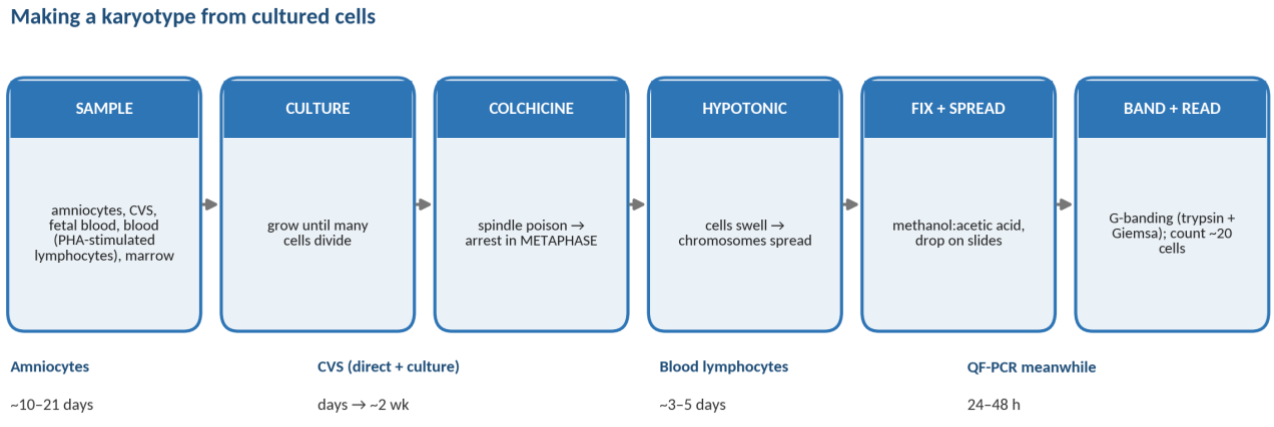


Figure 2. Karyotyping from cultured cells.

2 Stem Cells and Potency

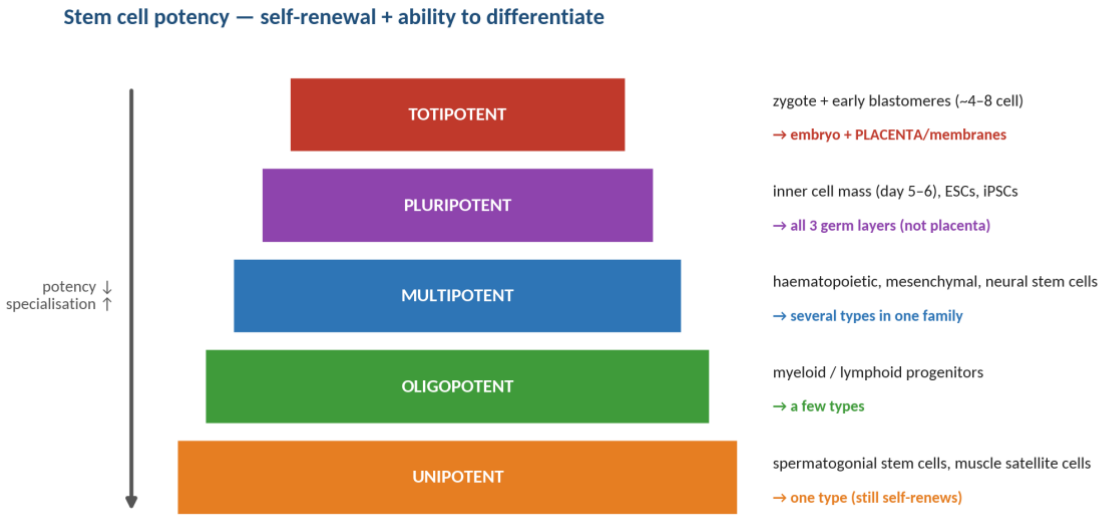


Figure 3. The potency ladder.

MNEMONIC / MEMORY HOOK

'Total → Plural → Multiple → One' — Totipotent (embryo + placenta) → Pluripotent (all germ layers) → Multipotent (one family) → Unipotent (one type).

3 Embryonic vs Induced Pluripotent Stem Cells

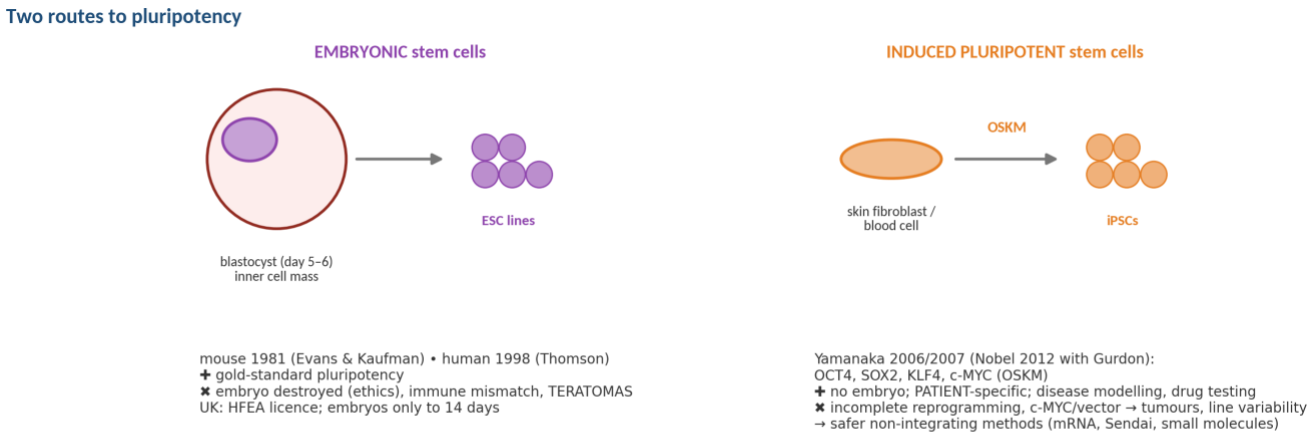


Figure 4. ESCs and iPSCs.

- **SCNT** (somatic cell nuclear transfer — Dolly, 1996) showed an adult nucleus can be reprogrammed; therapeutic cloning is now largely superseded by iPSCs. **Reproductive cloning is illegal** in the UK.

4 Adult Stem Cells and Cord Blood

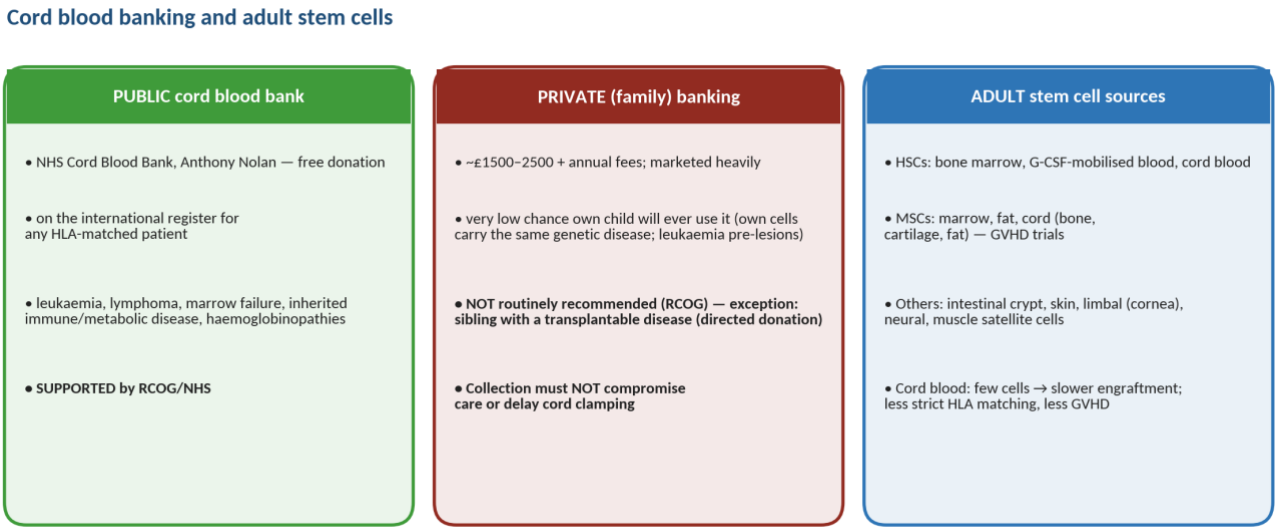


Figure 5. Cord blood banking and adult stem cells.

- **O&G point**: cord blood collection (public donation or private banking) must never alter the birth plan or **shorten deferred cord clamping** — the baby's own placental transfusion comes first (RCOG).

5 Applications, Ethics and Regulation

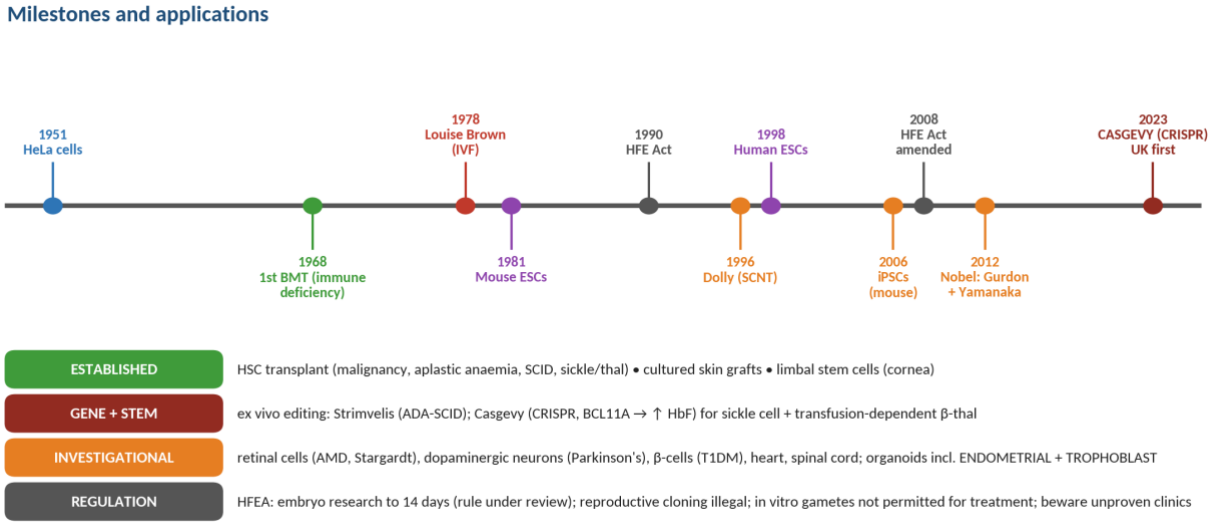


Figure 6. Milestones and applications.

Topic	Key points
Casgevy (exa-cel)	Patient's own HSCs edited by CRISPR at the BCL11A enhancer → fetal haemoglobin switched back on. MHRA approved Nov 2023 (world first) for sickle cell disease and transfusion-dependent β-thal; NICE-approved (2024–25). (Lyfgenia is a US-licensed lentiviral alternative.)
HSC transplant in sickle cell	Curative with an HLA-matched sibling; cord blood from an affected family's healthy sibling can be banked (directed donation)
HFEA	Licenses embryo creation/use for research; 14-day limit (HFEA has recommended the law be reviewed); PGT, mitochondrial donation

Topic	Key points
Organoids	3D mini-organs — gut, brain, retina, liver, ENDOMETRIUM and TROPHOBLAST (placenta) organoids for disease models and drug testing
Unproven therapies	Stem cell 'clinics' abroad — risks of infection, tumours, harm; advise caution

★ PEARL

Totipotent = zygote (makes placenta too); pluripotent = inner cell mass/ESCs/iPSCs; multipotent = HSCs, MSCs.

Yamanaka factors OCT4, SOX2, KLF4, c-MYC. Public cord blood donation supported; private banking not routinely recommended.

6 MRCOG Exam Pearls — Last-Minute Page

Numbers to know

37 °C / 5% CO_2 Culture conditions	**~40–60** Hayflick divisions	**80–90%** Confluence → passage	**day 5–6** Blastocyst (ICM)
14 days UK embryo research limit	**4** Yamanaka factors	**1998 / 2006** Human ESC / iPSC	**2023** Casgevy (UK)

HIGH-YIELD CHECKLIST

- ☐ Culture: 37 °C, 5% CO_2, humidity, sterile; trypsin to passage.
- ☐ Primary (Hayflick limit) vs immortal lines (HeLa); mycoplasma; STR authentication.
- ☐ Karyotype: culture → colchicine → hypotonic → fix → G-band.
- ☐ Potency: toti > pluri > multi > oligo > uni.
- ☐ ESCs: ICM, 1998, embryo destruction, teratomas, HFEA 14 days.
- ☐ iPSCs: Yamanaka OSKM; patient-specific; tumour risk.
- ☐ HSCs: marrow, mobilised blood, cord blood; BMT indications.
- ☐ Public cord banking supported; private not routinely; don't shorten DCC.
- ☐ Casgevy: CRISPR HSCs for sickle cell + β-thal (UK 2023).
- ☐ Reproductive cloning illegal; organoids; unproven clinics.

Self-assessment — cover the right-hand column

Question	Answer
Why is 5% CO_2 used in culture?	Maintains pH with the bicarbonate buffer
Which contaminant is invisible under the microscope?	Mycoplasma
What does colchicine do in karyotyping?	Blocks the spindle → arrests cells in metaphase
Which stem cells can form the placenta?	Totipotent (zygote, early blastomeres)
Source of embryonic stem cells?	Inner cell mass of the blastocyst
Name the Yamanaka factors.	OCT4, SOX2, KLF4, c-MYC
Main safety concern with pluripotent cells?	Teratoma / tumour formation

Question	Answer
UK limit for embryo research?	14 days
RCOG view on private cord blood banking?	Not routinely recommended; public donation supported
How does Casgevy work?	CRISPR-edited own HSCs re-activate fetal haemoglobin

7 References

- Takahashi K, Yamanaka S. Induction of pluripotent stem cells from fibroblast cultures. Cell 2006.
- RCOG Scientific Impact Paper No. 2. Umbilical Cord Blood Banking.
- Human Fertilisation and Embryology Act 1990 (as amended 2008); MHRA approval of exagamglogene autotemcel (Casgevy), 2023.