PIPADOR REVISION

MRCOG Part 1 Revision Notes

Meiosis

CELL BIOLOGY • LECTURE 103

VISUAL EXAMINATION REVISION NOTES

2026 Edition

MRCOG Part 1 Revision Notes

Lecture 103: Meiosis

Cell biology • Visual revision edition — follows Lecture 102

COLOUR CODE USED THROUGHOUT THESE NOTES

MATERNAL / RISK	PATERNAL	MEIOSIS I	MEIOSIS II	OOGENESIS

LEARNING OBJECTIVES — tick off as you go

- ☐ Describe meiosis I (reductional) and II (equational) and the substages of prophase I.
- ☐ Explain recombination, independent assortment and linkage.
- ☐ Compare oogenesis and spermatogenesis, including arrests.
- ☐ Explain non-disjunction and the maternal age effect.
- ☐ Apply to translocations, triploidy, recurrent miscarriage and IVF.

1 The Process

IN ONE LINE: *One DNA replication, two divisions: meiosis I separates HOMOLOGUES (46 → 23), meiosis II separates SISTER CHROMATIDS — four genetically unique haploid cells.*

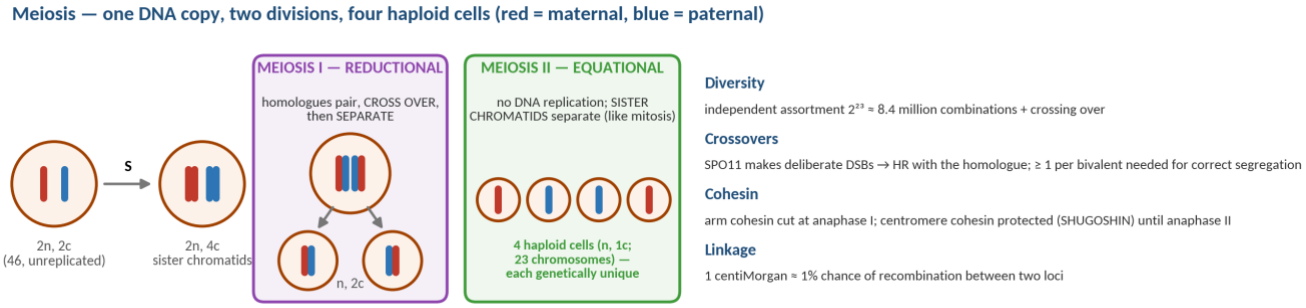


Figure 1. Meiosis overview.

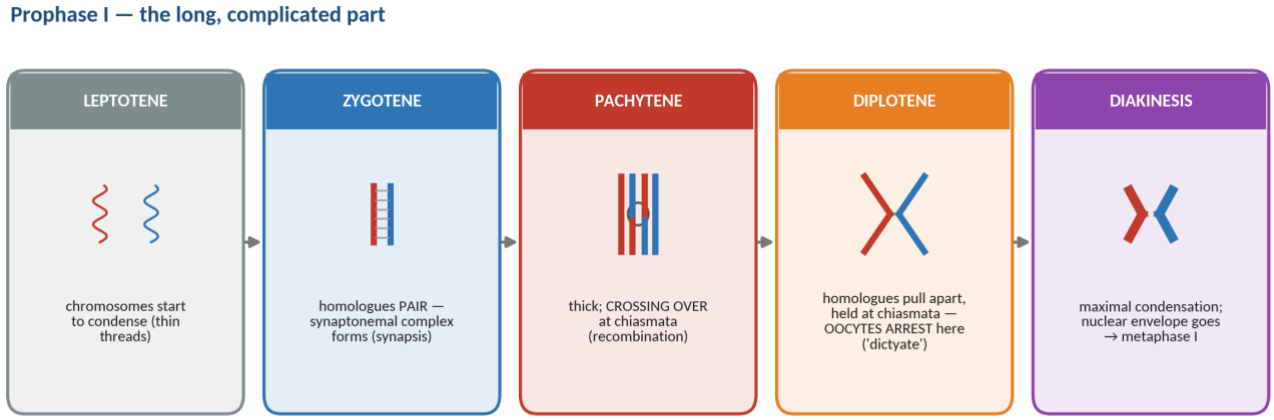


Figure 2. Prophase I substages.

MNEMONIC / MEMORY HOOK

'Lazy Zebras Prefer Dark Dens' — Leptotene, Zygotene, Pachytene (crossing over), Diplotene (oocyte arrest), Diakinesis.

2 Female vs Male

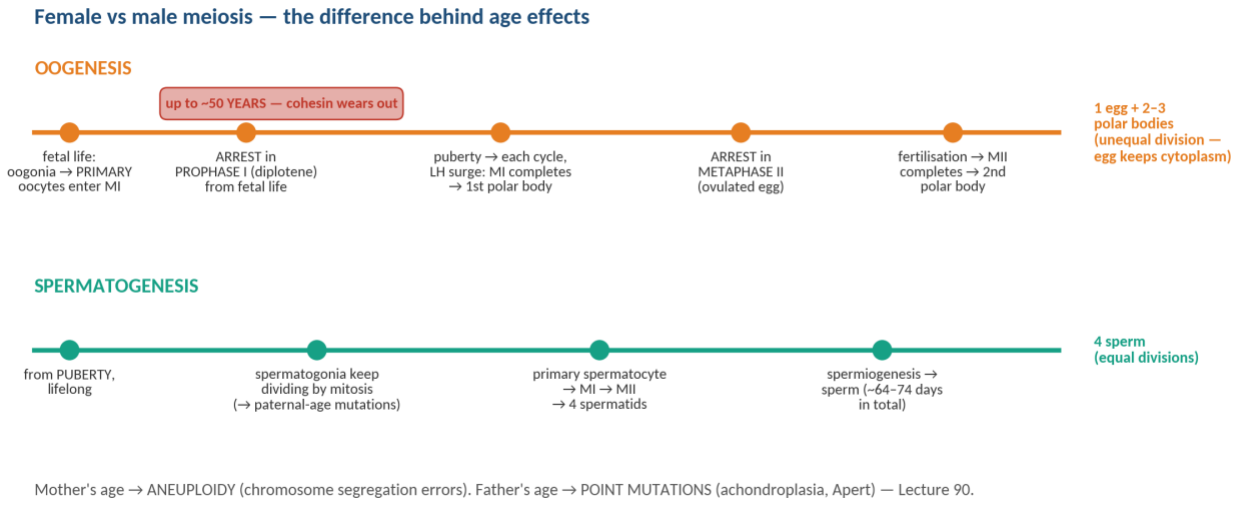


Figure 3. Oogenesis vs spermatogenesis.

Feature	Spermatogenesis	Oogenesis
Starts	Puberty	Fetal life (primary oocytes arrest in prophase I)
Products per meiosis	4 sperm	1 egg + 2–3 polar bodies
Arrests	None	Prophase I (diplotene, up to ~50 y) and metaphase II (until fertilisation)
Time	~64–74 days	Decades
Age effect	Point mutations ↑ (~2/yr)	Aneuploidy ↑ sharply; point mutations rise only a little

3 Non-Disjunction and Maternal Age

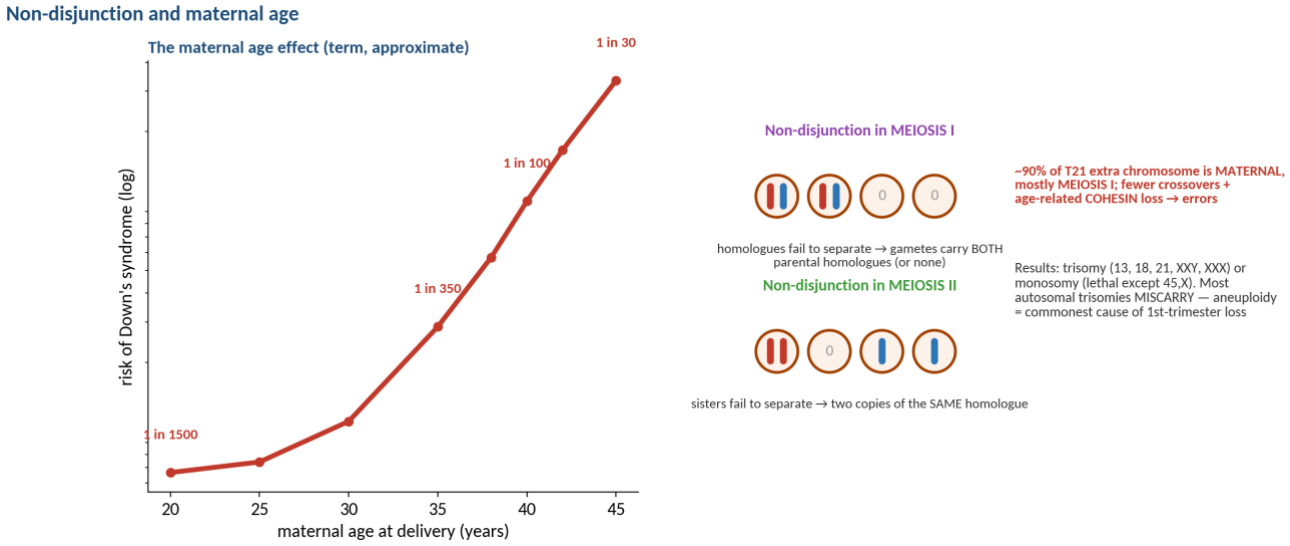


Figure 4. Non-disjunction and maternal age.

- **Why age?** Cohesin holding chromatids together is laid down in fetal life and not renewed — it decays over decades of arrest; older oocytes also have fewer/poorly placed crossovers and a weaker spindle checkpoint. **Uniparental disomy** can follow trisomy rescue or monosomy rescue (Lecture 94).

4 Rearrangements and Triploidy

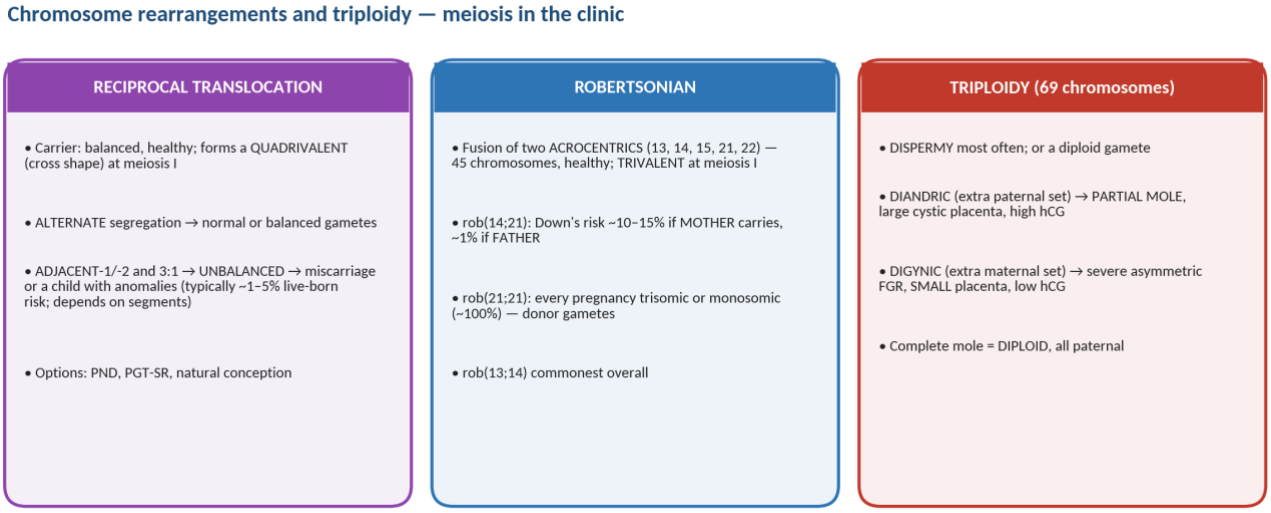


Figure 5. Translocations and triploidy.

5 Reproductive Implications

Situation	Key points
Older mother	Not modifiable once pregnant — main RISK factor for trisomy; screening (combined/NIPT) or diagnostic testing offered at any age
Recurrent miscarriage	Array on pregnancy tissue; parental karyotypes ONLY if an unbalanced rearrangement is found (RCOG 2023); balanced translocation in ~2–5% of couples

Situation	Key points
PGT-A	Picks euploid blastocysts, but HFEA rates it as NOT shown to raise live-birth rates; mosaic embryos can still give healthy babies
Donor eggs	Aneuploidy risk follows the DONOR's age
Male factor	Klinefelter (47,XXY: sperm sometimes found by micro-TESE); Y microdeletions (AZFa/b/c)
POI	Fragile X premutation (~20%), Turner (rapid follicle loss), galactosaemia, autoimmune, chemotherapy — fertility preservation before gonadotoxic treatment

★ **PEARL**

Meiosis I = reductional (homologues), meiosis II = equational (sisters). Oocytes arrest in prophase I (diplotene) from fetal life and in metaphase II until fertilisation.

Maternal age → aneuploidy (mostly maternal meiosis I); paternal age → point mutations. Diandric triploidy = partial mole; digynic = small placenta + severe FGR.

6 MRCOG Exam Pearls — Last-Minute Page

Numbers to know

2^{23} ≈ 8.4 million combinations	**1 cM** ≈ 1% recombination	**~64–74 days** Spermatogenesis	**~50 years** Longest oocyte arrest
1 in 1500 / 350 T21 at 20 / 35	**1 in 100 / 30** T21 at 40 / 45	**~10–15%** Rob(14;21) mother → T21	**~90%** T21 maternal origin

HIGH-YIELD CHECKLIST

- ☐ 1 replication, 2 divisions, 4 haploid cells.
- ☐ Prophase I: leptotene, zygotene (synapsis), pachytene (crossing over), diplotene, diakinesis.
- ☐ SPO11 DSBs → HR; chiasmata; ≥ 1 crossover per bivalent.
- ☐ Shugoshin protects centromeric cohesin until meiosis II.
- ☐ Independent assortment 2^{23}; 1 cM ≈ 1%.
- ☐ Oocyte arrests: prophase I (fetal) + metaphase II; 1 egg + polar bodies.
- ☐ Maternal age → cohesin loss → MI non-disjunction → trisomy.
- ☐ Reciprocal → quadrivalent; Robertsonian → trivalent; 14;21 mother ~10–15%.
- ☐ Triploidy: diandric = partial mole; digynic = small placenta, FGR.
- ☐ RM: parental karyotype only if unbalanced POC; PGT-A unproven.

Self-assessment — cover the right-hand column

Question	Answer
In which stage does crossing over occur?	Pachytene (prophase I)
Which division halves the chromosome number?	Meiosis I
Where do oocytes arrest before birth?	Diplotene of prophase I

Question	Answer
Where does the ovulated egg arrest?	Metaphase II
Main mechanism of the maternal age effect?	Cohesin loss → non-disjunction
Most common origin of the extra chromosome 21?	Maternal meiosis I
Structure formed by a reciprocal translocation carrier?	Quadrivalent
Down's risk if mother carries rob(14;21)?	~10–15%
Triploidy with an extra paternal set gives…	Partial hydatidiform mole
Are parental karyotypes routine for recurrent miscarriage?	No — only if unbalanced rearrangement in pregnancy tissue

7 References

- Gardner RJM, Amor DJ. Chromosome Abnormalities and Genetic Counselling. 5th ed. 2018.
- RCOG Green-top Guideline No. 17. Recurrent miscarriage. 2023.
- Nagaoka SI, Hassold TJ, Hunt PA. Human aneuploidy: mechanisms and new insights. Nat Rev Genet 2012.