PIPADOR REVISION

MRCOG Part 1 Revision Notes

Chromosomes and Karyotyping

CELL BIOLOGY • LECTURE 104

VISUAL EXAMINATION REVISION NOTES

2026 Edition

MRCOG Part 1 Revision Notes

Lecture 104: Chromosome Structure and Karyotyping

Cell biology • Visual revision edition

COLOUR CODE USED THROUGHOUT THESE NOTES

CHROMOSOME / NORMAL	CENTROMERE / ANEUPLOIDY	ACROCENTRIC / TRANSLOCATION	STRUCTURAL / MOSAIC	TELOMERE / CLINIC

LEARNING OBJECTIVES — tick off as you go

- ☐ Describe chromosome anatomy and classify by centromere position.
- ☐ Know the normal karyotype, Denver groups and banding methods.
- ☐ Explain karyotype preparation, timing and limitations.
- ☐ Read and write ISCN nomenclature, including mosaicism and arrays.
- ☐ Recognise structural abnormalities and clinical indications for karyotyping.

1 Chromosome Structure

IN ONE LINE: *46 chromosomes = 22 autosome pairs + XX/XY. Each has a centromere, p (short) and q (long) arms and telomeres; position of the centromere defines its shape.*

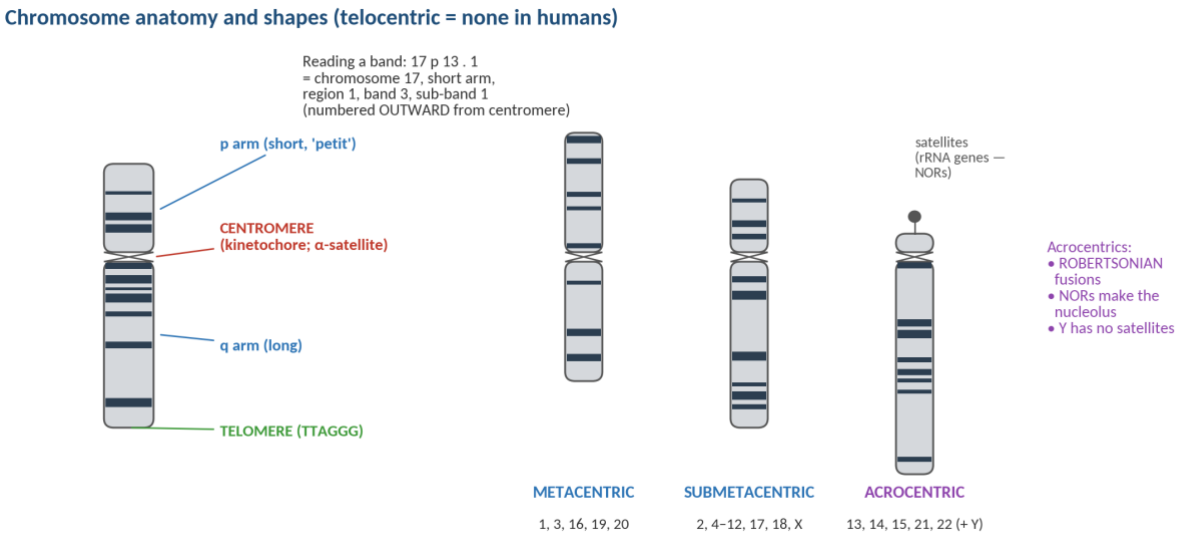


Figure 1. Chromosome anatomy and shapes.

MNEMONIC / MEMORY HOOK

'p = petit' (short arm). Acrocentrics **13, 14, 15, 21, 22** — 'thirteen to fifteen, twenty-one, twenty-two: the Robertsonian crew'.

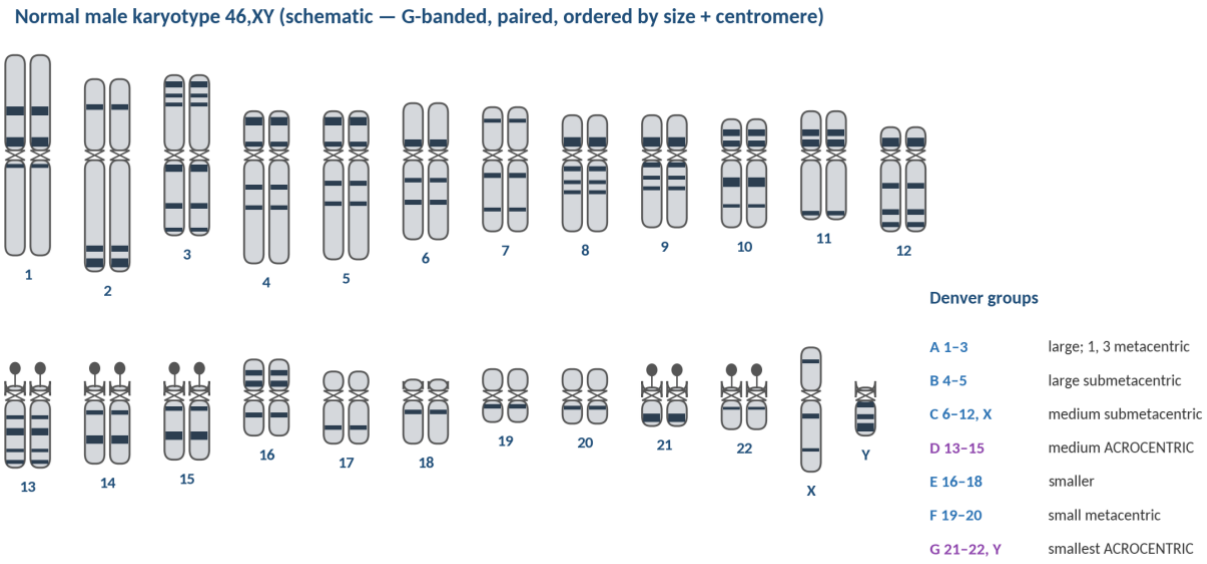


Figure 2. Normal karyogram and Denver groups.

2 Banding and Preparation

Banding	Key points
G-banding (standard)	Trypsin + Giemsa: DARK = AT-rich, gene-poor, late-replicating; LIGHT = GC-rich, gene-rich; ~400–550 bands per haploid set (up to ~850 high-resolution)
R-banding	Reverse of G
Q-banding	Quinacrine fluorescence — similar to G
C-banding	Constitutive (centromeric) heterochromatin, e.g. 1q, 9q, 16q, Yq variants
NOR (silver)	Active nucleolus organiser regions on acrocentric satellites

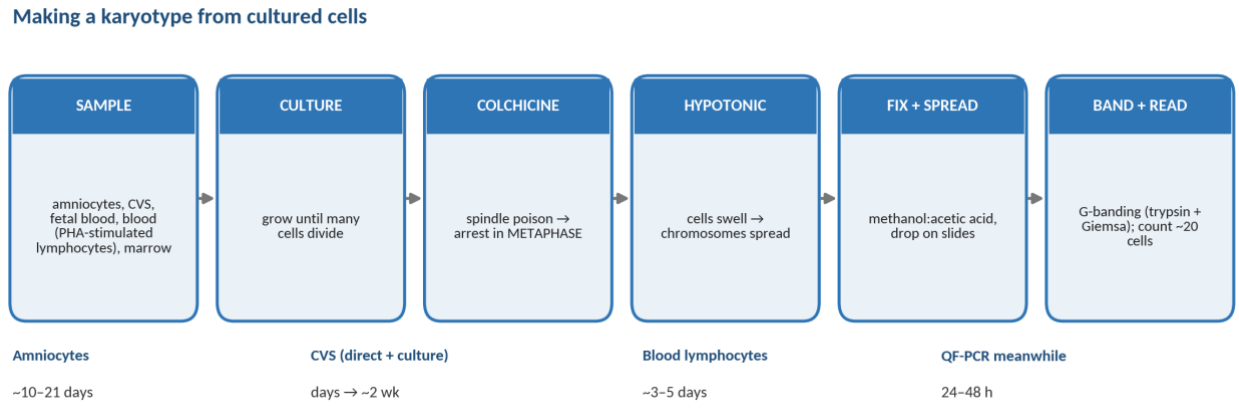


Figure 3. Preparation workflow (from Lecture 96).

- **Timing**: blood (PHA-stimulated lymphocytes) 3–5 days; amniocytes ~7–14 days; CVS direct 24–48 h (+ culture); marrow 1–3 days. Usually ~20 cells counted (more if mosaicism suspected). QF-PCR gives the rapid answer meanwhile.

3 ISCN Nomenclature

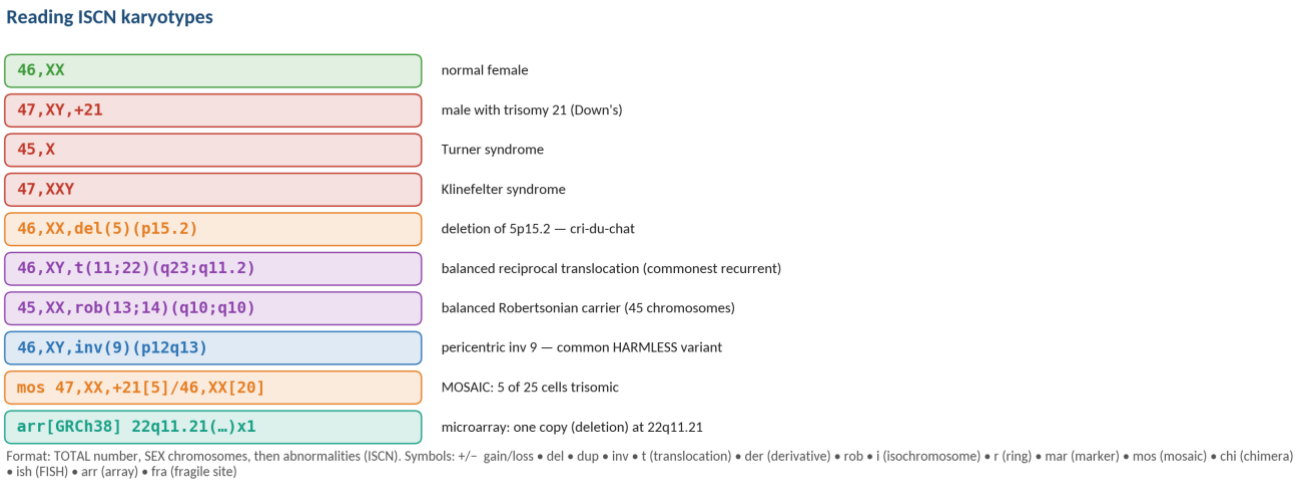


Figure 4. Reading karyotypes.

- ISCN is updated regularly (2020, 2024 editions); array results start **arr** and name the genome build. Brackets [ ] give cell counts in mosaics.

4 Abnormalities



Figure 5. Structural and numerical abnormalities.

Chromosome	Clinically important features
11p15	Imprinted: Beckwith–Wiedemann (overgrowth) / Silver–Russell (undergrowth); 11p13 WT1 (WAGR); 11q23 KMT2A leukaemias
15q11–q13	Imprinted: Prader–Willi (paternal loss) / Angelman (maternal loss)
21	Smallest autosome; T21 commonest viable autosomal trisomy; rob(14;21), rob(21;21)
22	22q11.2 deletion; 22q13 Phelan–McDermid; BCR (Philadelphia t(9;22))
X / Y	X ~800 genes, random X-inactivation (largely random in human placenta too); Y ~57 Mb — SRY (Yp), AZF (Yq11), PAR1/2

5 Clinical Use and Limits

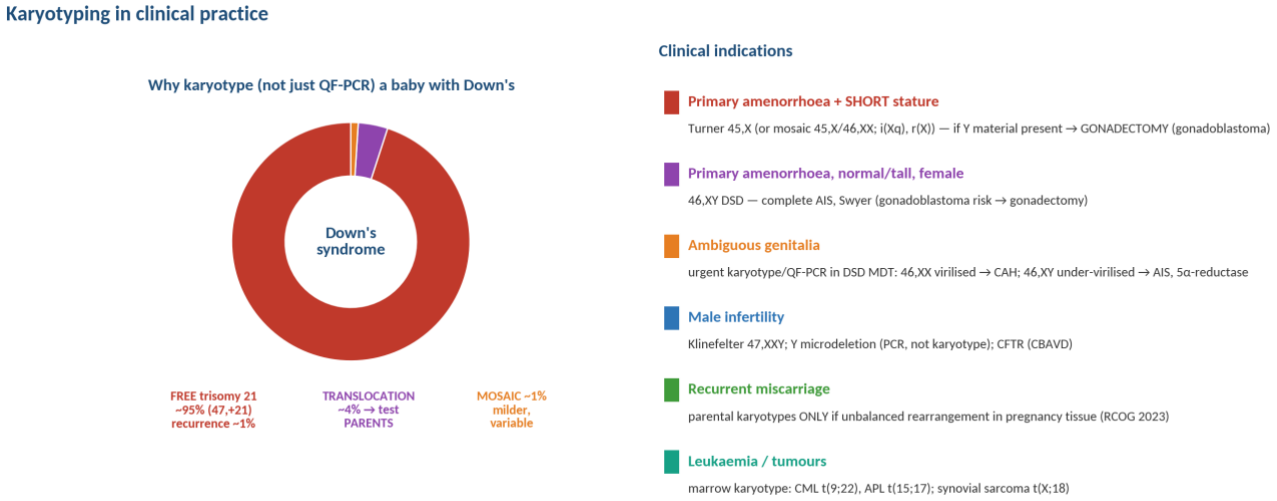


Figure 6. Clinical indications.

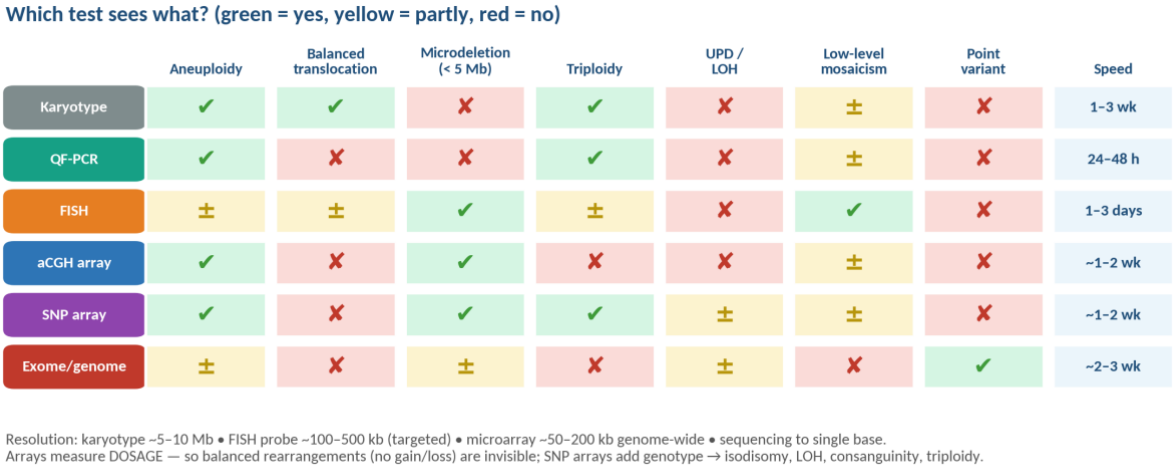


Figure 7. Karyotype vs other tests (from Lecture 94).

- **Limits**: ~5–10 Mb resolution, needs culture, operator-dependent, misses CNVs, UPD and point variants. **Still essential** for balanced rearrangements, Robertsonian/translocation Down's, mosaic sex chromosome disorders, DSD and leukaemia.

> ★ **PEARL**
>
> **Karyotype = the only routine test that sees BALANCED translocations. Microarray first-line for anomalies/developmental delay.**
>
> **Primary amenorrhoea + SHORT stature → Turner (45,X); look for Y material (gonadoblastoma).**
> **Translocation Down's → karyotype the parents.**

6 MRCOG Exam Pearls — Last-Minute Page

Numbers to know

46	**5**	**7**	**400–550**
Chromosomes	Acrocentrics (+ Y)	Denver groups (A–G)	Bands per haploid set

~5–10 Mb	~20	95 / 4 / 1%	~57 Mb
Resolution	Cells counted	DS: free / transloc / mosaic	Y chromosome

HIGH-YIELD CHECKLIST

- ☐ Centromere, p/q arms, telomeres; bands numbered outward (17p13.1).
- ☐ Metacentric 1, 3, 16, 19, 20; acrocentric 13, 14, 15, 21, 22 (+Y).
- ☐ Denver A–G; acrocentric D and G.
- ☐ G-banding: dark = AT-rich, gene-poor.
- ☐ Blood + PHA, colchicine, hypotonic, fix, band; ~20 cells.
- ☐ ISCN: number, sex chromosomes, abnormality; mos [cells]; arr[GRCh38].
- ☐ del, dup, inv (peri/para), t, der, rob, i, r, mar, ins; polyploidy.
- ☐ DS 95% free / 4% translocation / 1% mosaic → parental karyotype if translocation.
- ☐ Turner short stature; tall 46,XY DSD; Klinefelter; DSD MDT.
- ☐ Karyotype misses CNVs, UPD, point variants; sees balanced rearrangements.

Self-assessment — cover the right-hand column

Question	Answer
Which chromosomes are acrocentric?	13, 14, 15, 21, 22 (and Y)
What do dark G-bands represent?	AT-rich, gene-poor, late-replicating DNA
Mitogen used for blood karyotypes?	Phytohaemagglutinin (PHA)
ISCN for Turner syndrome?	45,X
ISCN for mosaic T21 in 5 of 25 cells (female)?	mos 47,XX,+21[5]/46,XX[20]
Isochromosome seen in Turner?	i(Xq)
Common harmless inversion?	inv(9)(p12q13)
Which DS type needs parental karyotypes?	Translocation Down's (~4%)
Short girl with primary amenorrhoea — test?	Karyotype (Turner); check for Y material
What can karyotyping NOT detect?	Submicroscopic CNVs, UPD, point variants

7 References

- McGowan-Jordan J et al. ISCN 2020/2024: An International System for Human Cytogenomic Nomenclature.
- Gardner RJM, Amor DJ. Chromosome Abnormalities and Genetic Counselling. 5th ed. 2018.
- RCOG Green-top Guideline No. 17. Recurrent miscarriage. 2023.