SAWA UNIVERSITY

اسم المادة و الكورس

LAB. 6 CHROMOSOME BANDING TECHNIQUES (TYPES OF BANDING)

Sawa University	جامعـــــة ســـــــاوة الاهلية
College of health and medical techniques	كليـــــة التقنيـــات الصحيـة والطبيـة
Department of Medical Laboratories	قسم تقنيات المختبرات الطبية
Third Stage	المرحلـــــــــــة الثالثة

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محاضرة رقم 6

الجانب العملي:الوراثة الطبية

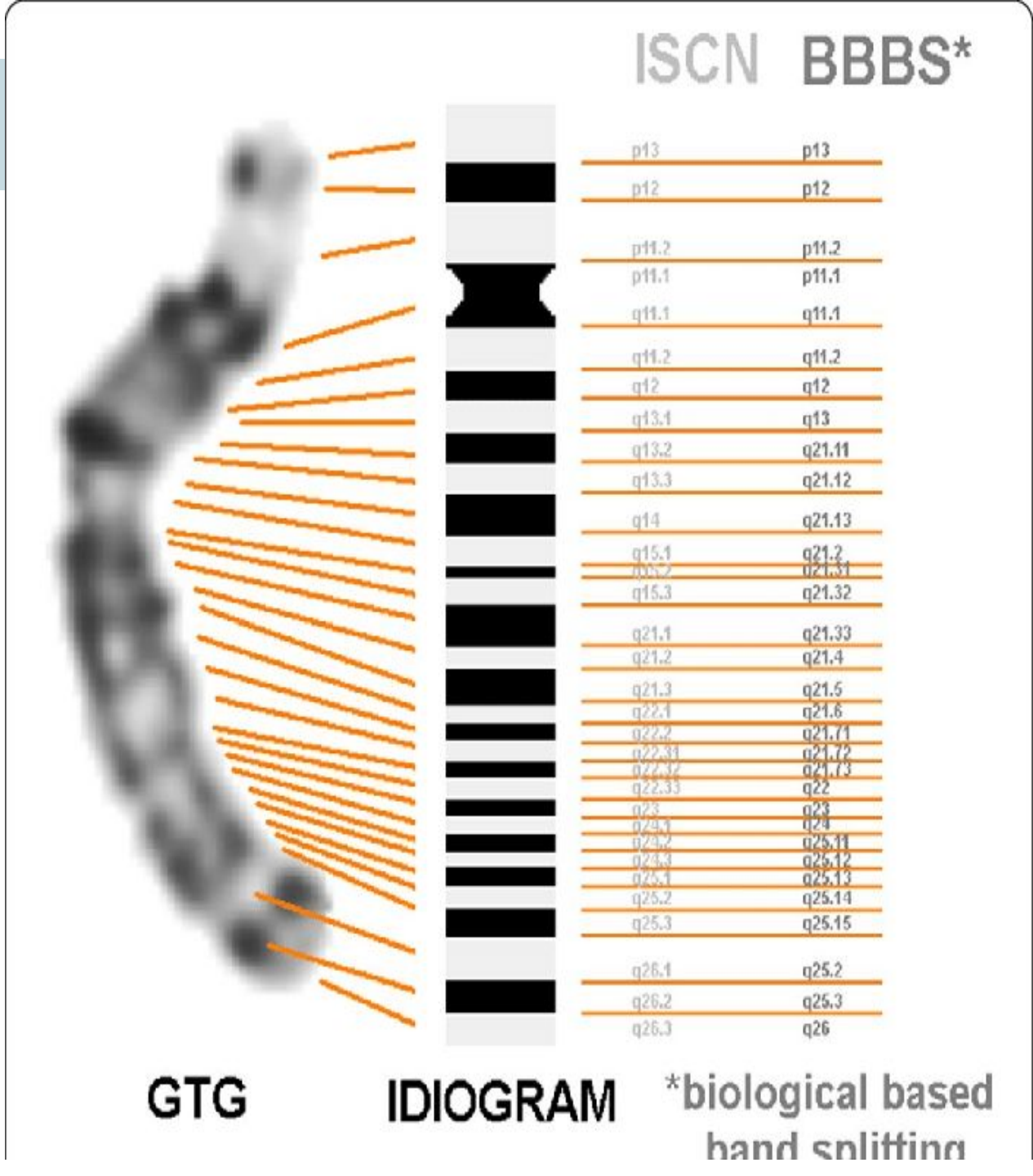
Lecture No. 6

Medical genetics-Practical

Objectives of Banding

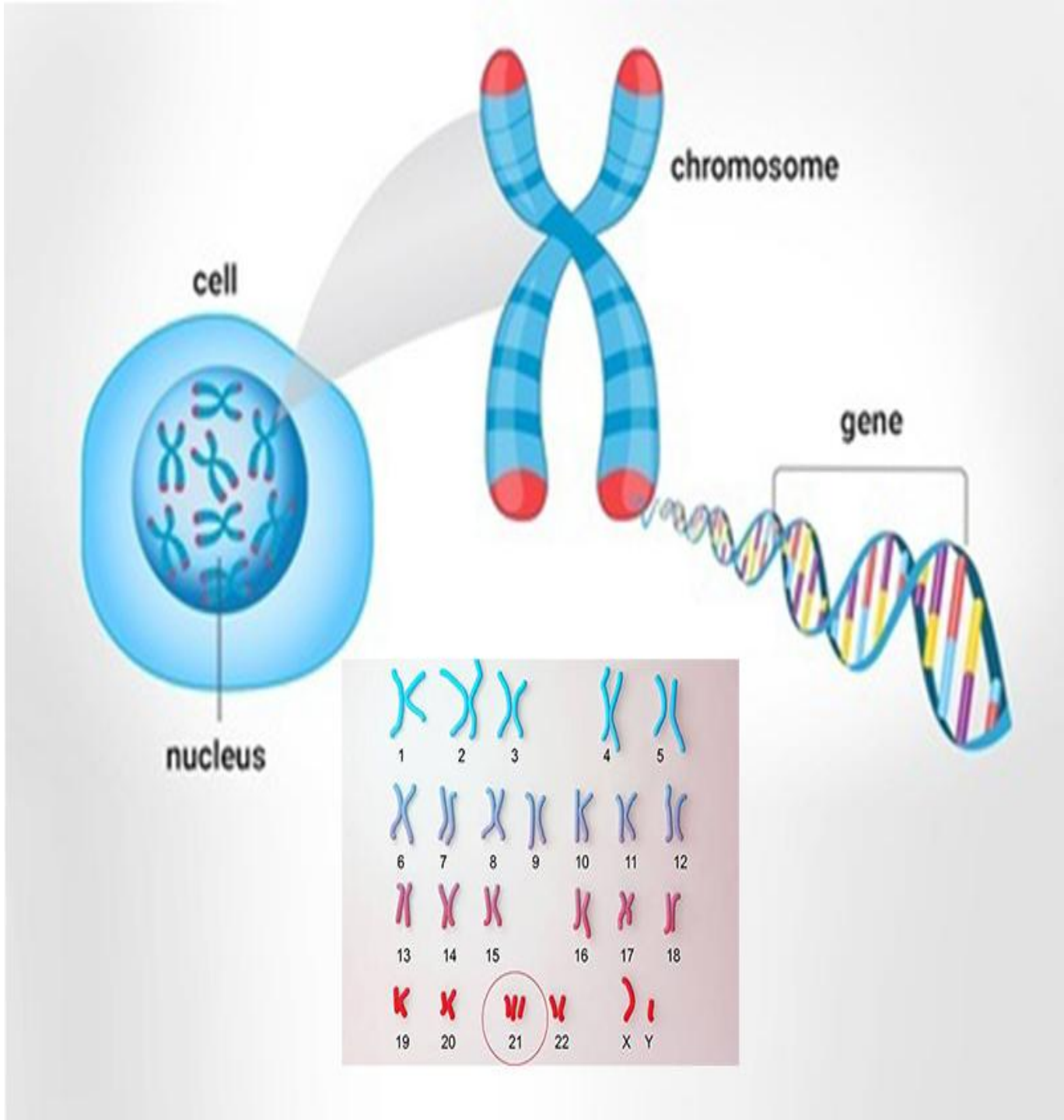
By the end of this lab, students should be able to:

1. **Describe the principle of chromosome banding.**
2. **Identify major banding techniques (G, Q, R, C, T, NOR).**
3. **Differentiate between the staining mechanisms of each type.**
4. **Explain the diagnostic applications of banding in medical genetics.**



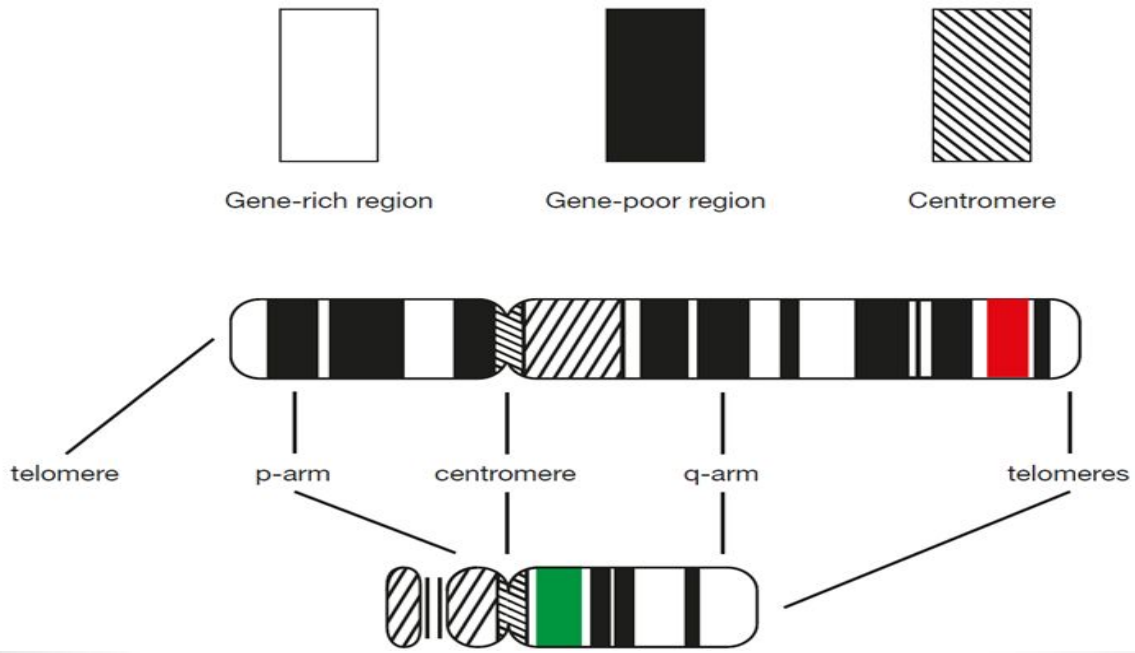
Introduction

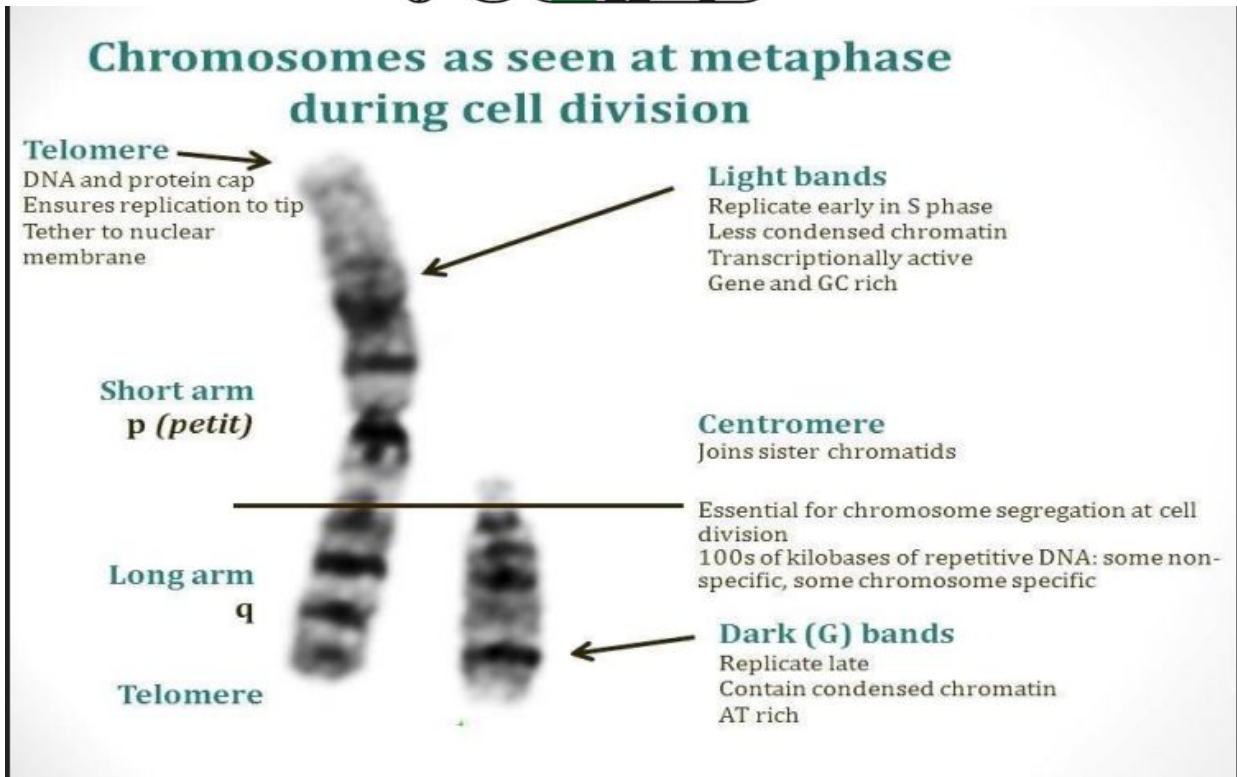
- **Chromosome banding is a cytogenetic technique used to produce a characteristic pattern of light and dark bands along the length of chromosomes. These banding patterns allow the precise identification of individual chromosomes, detection of structural abnormalities, and accurate karyotyping.**
- **Each technique produces a distinct banding pattern based on differences in DNA composition, chromatin structure, and staining properties.**



Principle of Chromosome Banding

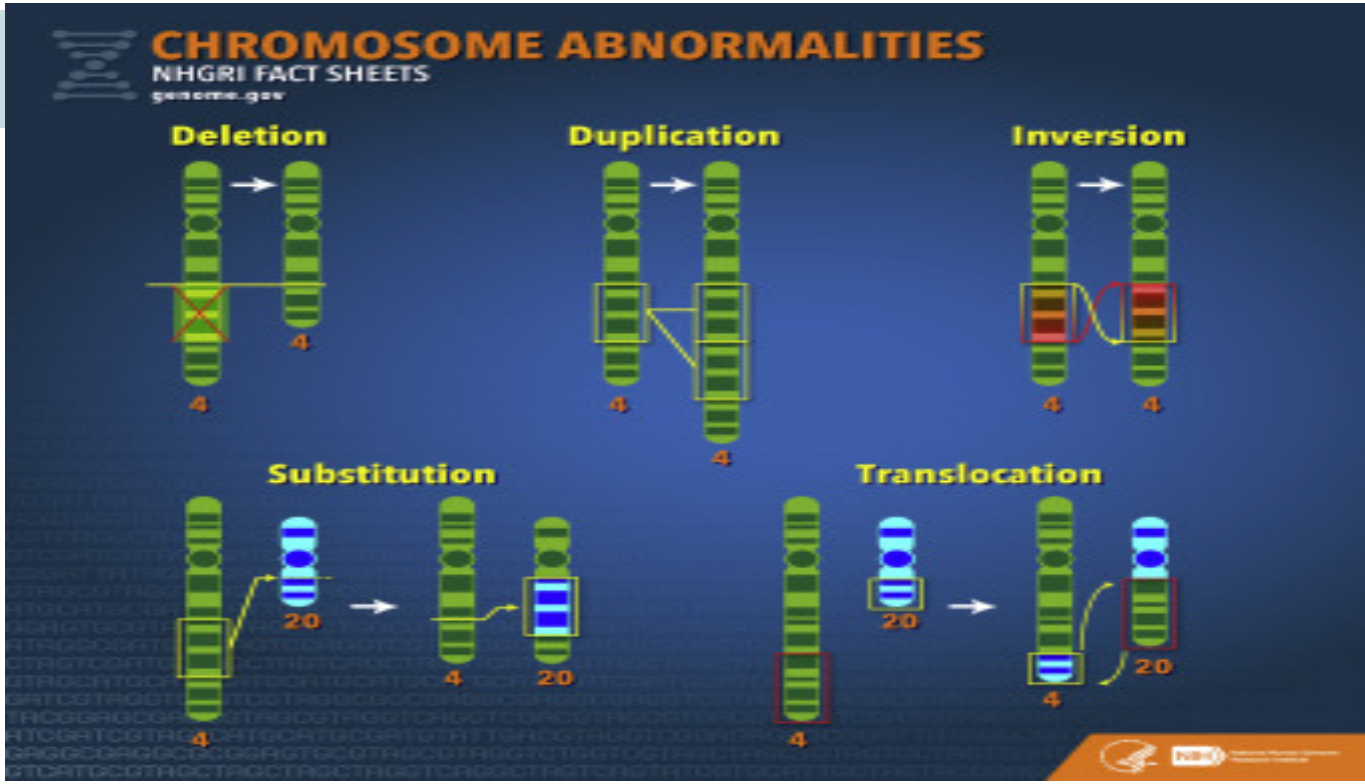
- **Banding techniques rely on the differential staining of chromosomal regions depending on DNA base composition (AT- or GC-rich regions) and chromatin condensation.**
- **Dark bands (G-positive): AT-rich, gene-poor, late-replicating heterochromatin.**
- **Light bands (G-negative): GC-rich, gene-dense, early-replicating euchromatin.**
- **The alternation of these bands forms a unique fingerprint for each chromosome.**

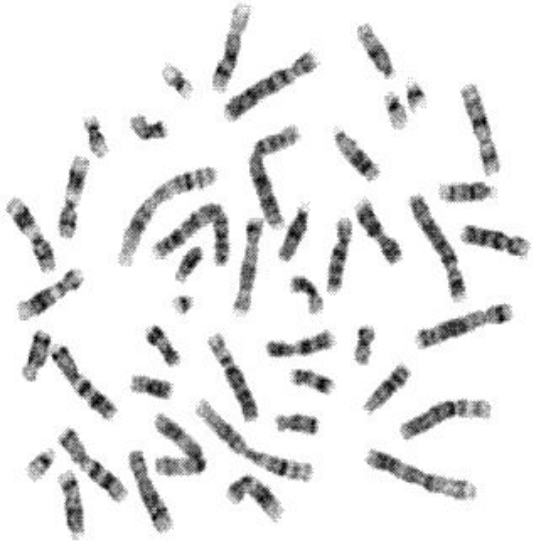


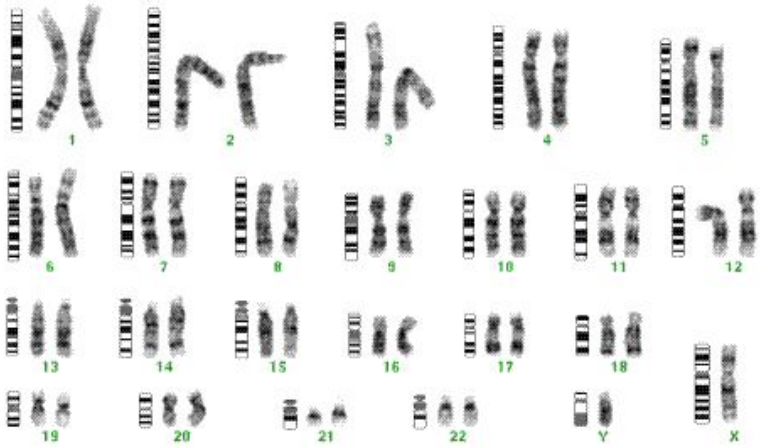


G-Banding (GTG Banding)

- G-banding is the most widely used technique in human cytogenetics.
- It involves pretreatment of slides with trypsin followed by staining with Giemsa.
- Produces alternating dark and light bands.
- Dark bands = AT-rich heterochromatic regions.
- Light bands = GC-rich euchromatic regions.
- Applications: Standard karyotyping, detecting deletions, duplications, and translocations.

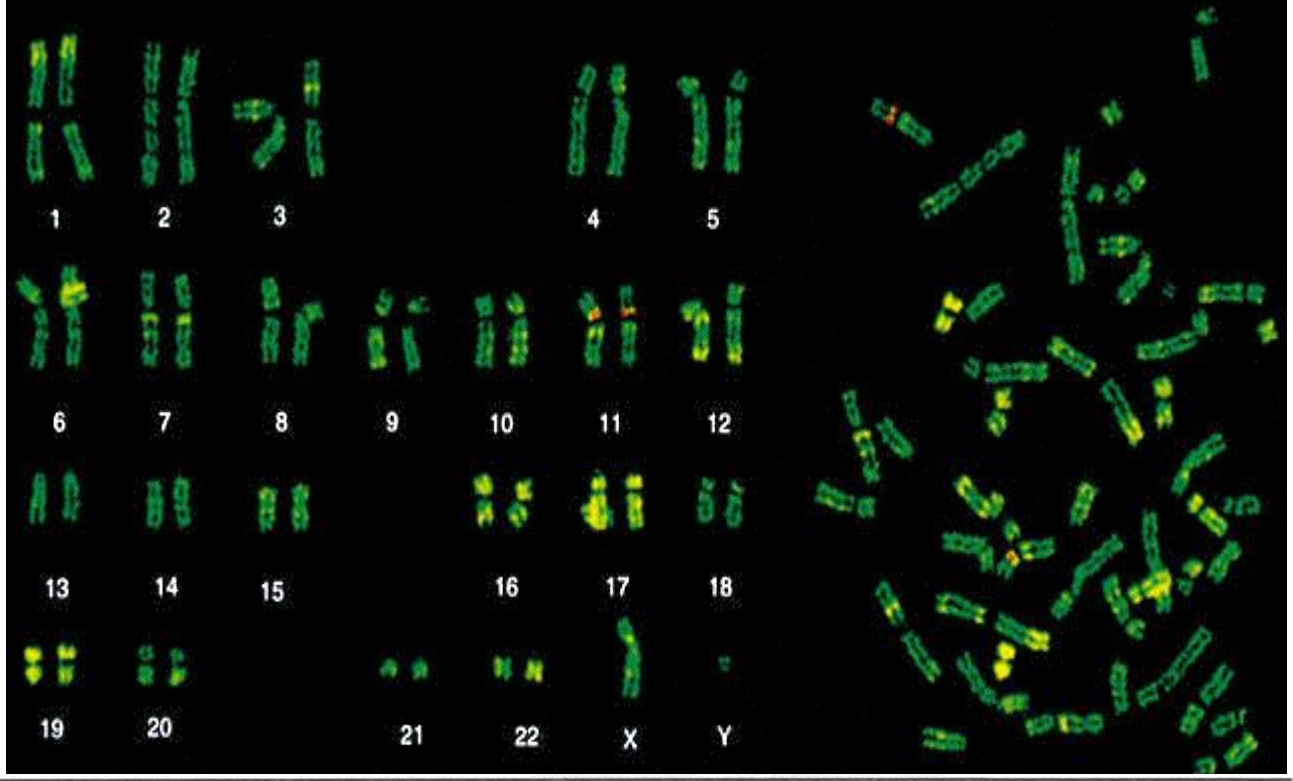


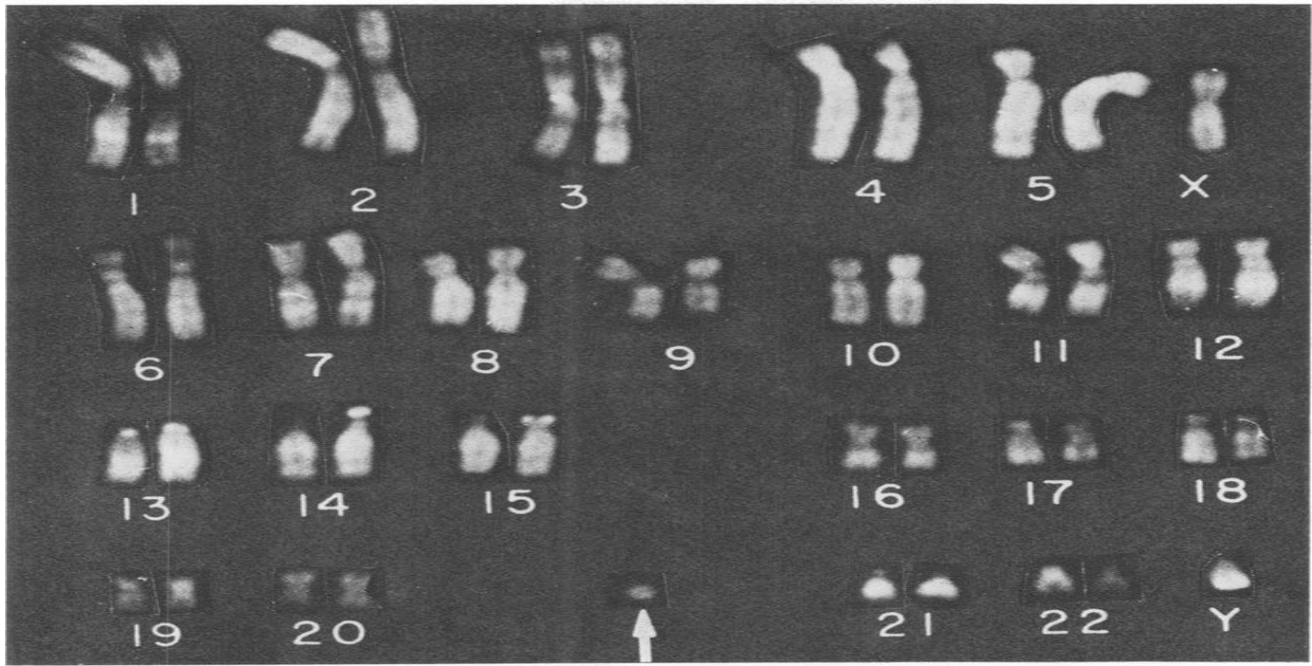




Q-Banding (Fluorescent Banding)

- Q-banding uses quinacrine mustard, a fluorescent dye that binds preferentially to AT-rich DNA.
- Viewed under a fluorescence microscope, AT-rich regions appear bright yellow, while GC-rich regions are dark.
- This pattern corresponds exactly to G-banding but is visualized with fluorescence.
- Applications: Historical method; useful for detecting the Y chromosome and heterochromatic regions.





R-Banding (Reverse Banding)

- **R-banding produces the reverse pattern of G-banding.**
- **Chromosomes are pretreated with heat (80–87 °C) before staining with Giemsa.**
- **Light bands in G-banding appear dark in R-banding and vice versa.**
- **Highlights GC-rich telomeric regions and is useful for identifying terminal structural abnormalities.**

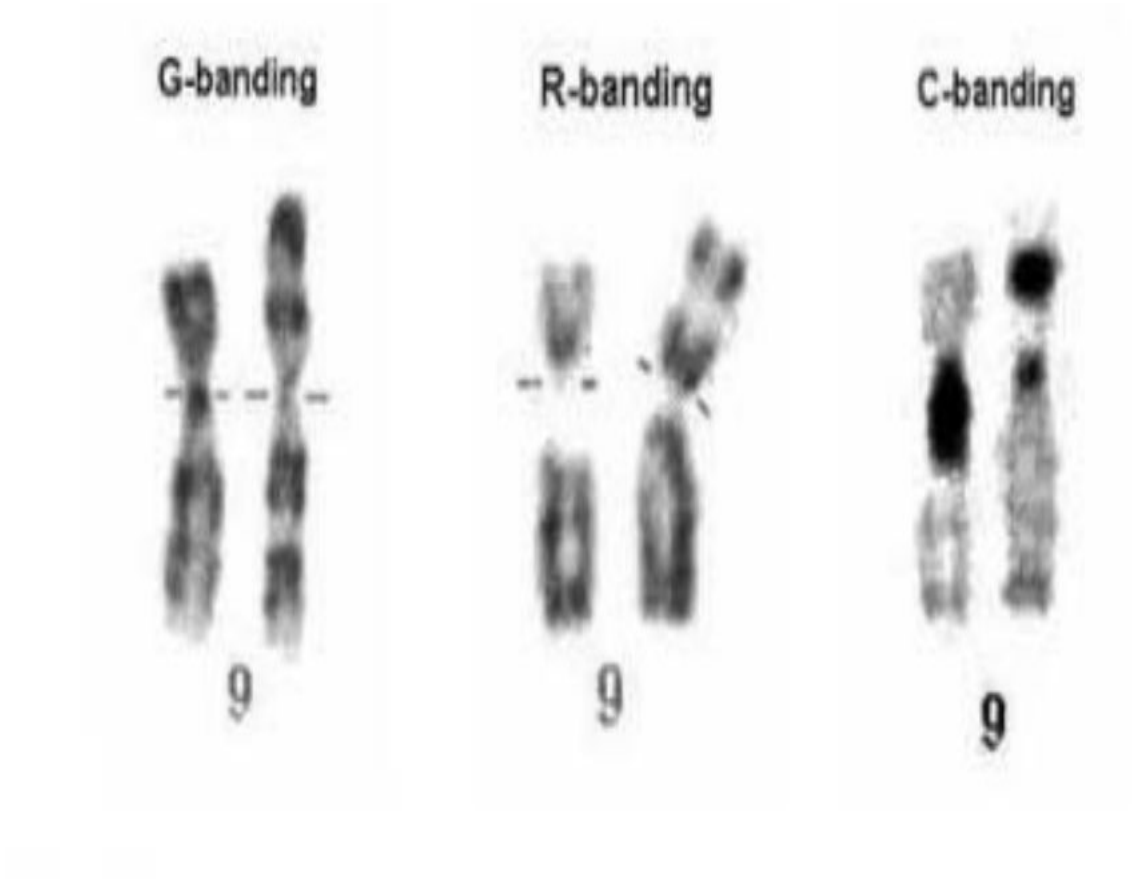
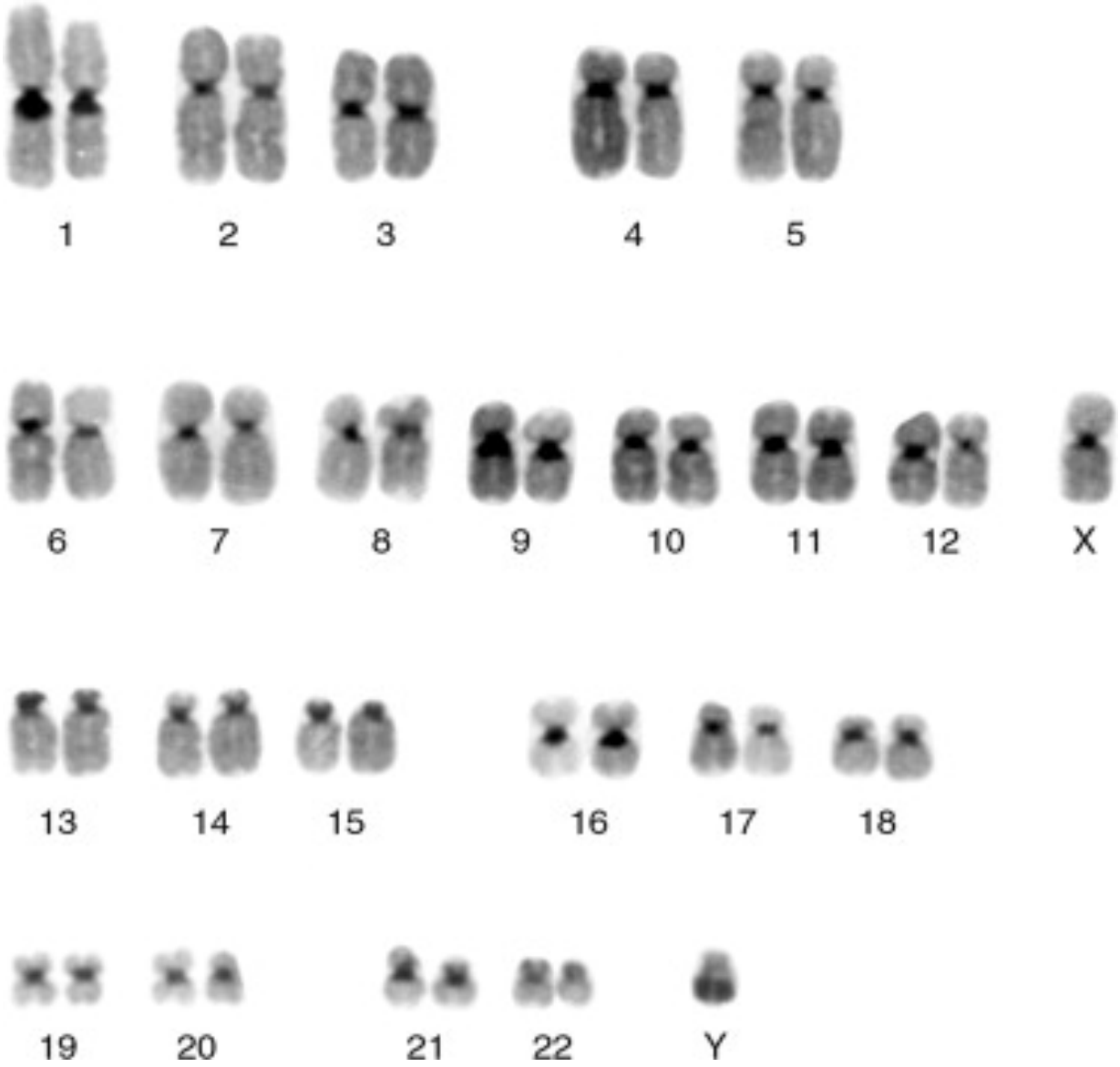


Figure 2
Conventional cytogenetic analysis results of the fetus. G and R-banding results showing the addition of chromosomal materiel in the short arm of one chromosome 9 (der(9)). C-banding results showing an presence of heterochromatin into the der(9).

C-Banding

- C-banding selectively stains constitutive heterochromatin, particularly around centromeres.
- Slides are treated with alkali ($Ba(OH)_2$) and saline–SSC buffer, then stained with Giemsa.
- Only centromeric regions show strong dark bands.
- Applications: Detection of polymorphisms, marker chromosomes, and satellite DNA regions.



T-Banding and NOR-Banding

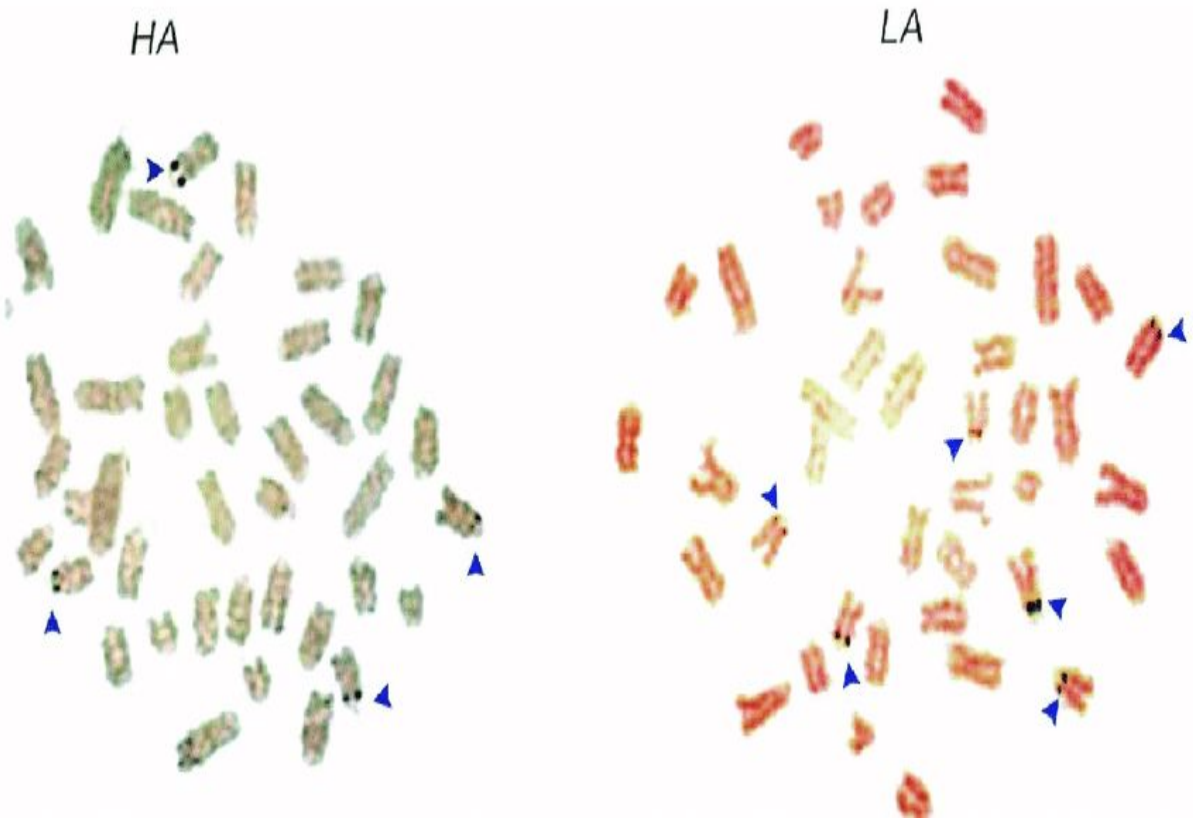
- **T-Banding:**

- **A modified R-banding emphasizing telomeric DNA, using hot phosphate buffer and Giemsa.**
- **Useful for detecting terminal deletions or translocations.**

Image courtesy: https://legumelaboratory.wordpress.com/

- **NOR-Banding (Ag-NOR):**

- **Stains nucleolar organizer regions (NORs) containing ribosomal RNA genes on acrocentric chromosomes (13, 14, 15, 21, 22).**
- **Silver nitrate ($AgNO_3$) produces dark spots where active rDNA transcription occurs.**



Comparison of Banding Techniques

Banding Type	Stain Used	Target Region	Color Pattern	Major Use
G-banding	Trypsin + Giemsa	AT-rich	Dark / Light	Routine karyotyping
Q-banding	Quinacrine	AT-rich	Fluorescent yellow	Y chromosome ID
R-banding	Heat / Giemsa	GC-rich	Reverse G	Terminal regions
C-banding	$Ba(OH)_2$ + Giemsa	Centromeric heterochromatin	Dark centromeres	Polymorphism analysis
T-banding	Hot phosphate + Giemsa	Telomeres	Intense ends	Terminal deletions
NOR-banding	$AgNO_3$ (Silver)	rDNA genes	Black dots	NOR activity

Clinical Applications

- **Chromosome banding is vital for identifying**
- **Numerical abnormalities: Trisomy 21, 45, X.**
- **Structural rearrangements: Translocations t(9;22), deletions del(5q), inversions.**
- **Cancer cytogenetics: Chromosomal markers in leukemia and solid tumors.**
- **Banding remains the foundation for karyotyping and ISCN nomenclature used worldwide.**

QUIZ

Q1. Make a simple comparison between the types of chromosome bandings.

Any questions?