Chromosome structure and Karyotyping

طريقة دراسة الكروموسوم

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Genetic terms

The genetic material: Genome

- Genome as a term was suggested in 1920 by Hans Winkler, professor of biology (botany) at the University of Hamburg. Genome word is a blend of the words ***gene*** and ***chromosome.***

- The **genome** can be defined as the **genetic material** of an organism. It consists of DNA (or RNA in RNA viruses). The genome includes both the genes, (the coding regions), the non-coding DNA and the genomes of the mitochondria and chloroplasts.

في حالة عدم وجود DNA
تمثل تقريبًا ٣٪
non-coding DNA
ما بطلعوا بروتين
أو بطلعوا RNA
* عند الإنسان الـ genetic material هي
* nuculeus موجود بال
* mitochondria
كلمة genome تتضمن جميع المعلومات الوراثية

Cytogenetics: the study of chromosomes

1. numerical
2. structural
3. composition

2 دراسة الكروموسومات ومعرفة الطبيعي من الغير الطبيعي وعلاقتهم مع الأمراض الوراثية

- **Cytogenetics** is the study of chromosomes and their role in heredity. Cytogenetics focuses on studying structure, composition of chromosomes as well as, diagnosis of chromosomal abnormalities associated with diseases.

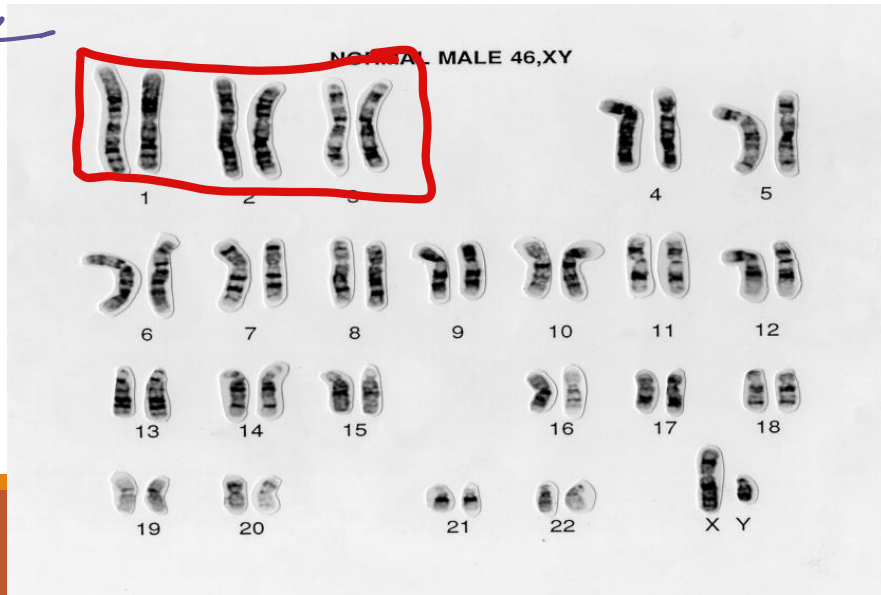
3 أخذ صورة كاملة لجميع الكروموسومات ← (Cytogenetics) كيفية دراسة الكروموسومات ← karyotype

- A **karyotype** refers to the number and appearance of chromosomes in the nucleus of a eukaryotic cell.* It is also refers to the complete set of chromosomes in a species.

- Among the members of a species, the number of chromosomes is uniform.

هاد كل ما بحكي عنه ← karyotype

- A normal human karyotype contains 22 pairs of autosomes and one pair of sex chromosomes.



→ karyotyping is the mechanism of cytogenetics

* عدد الكروموسومات الكامل ٤٦ كروموسوم , ٢٣ زوج.

٢٣ كروموسوم
germ cells ← بنحكي عنهم
Haploid number

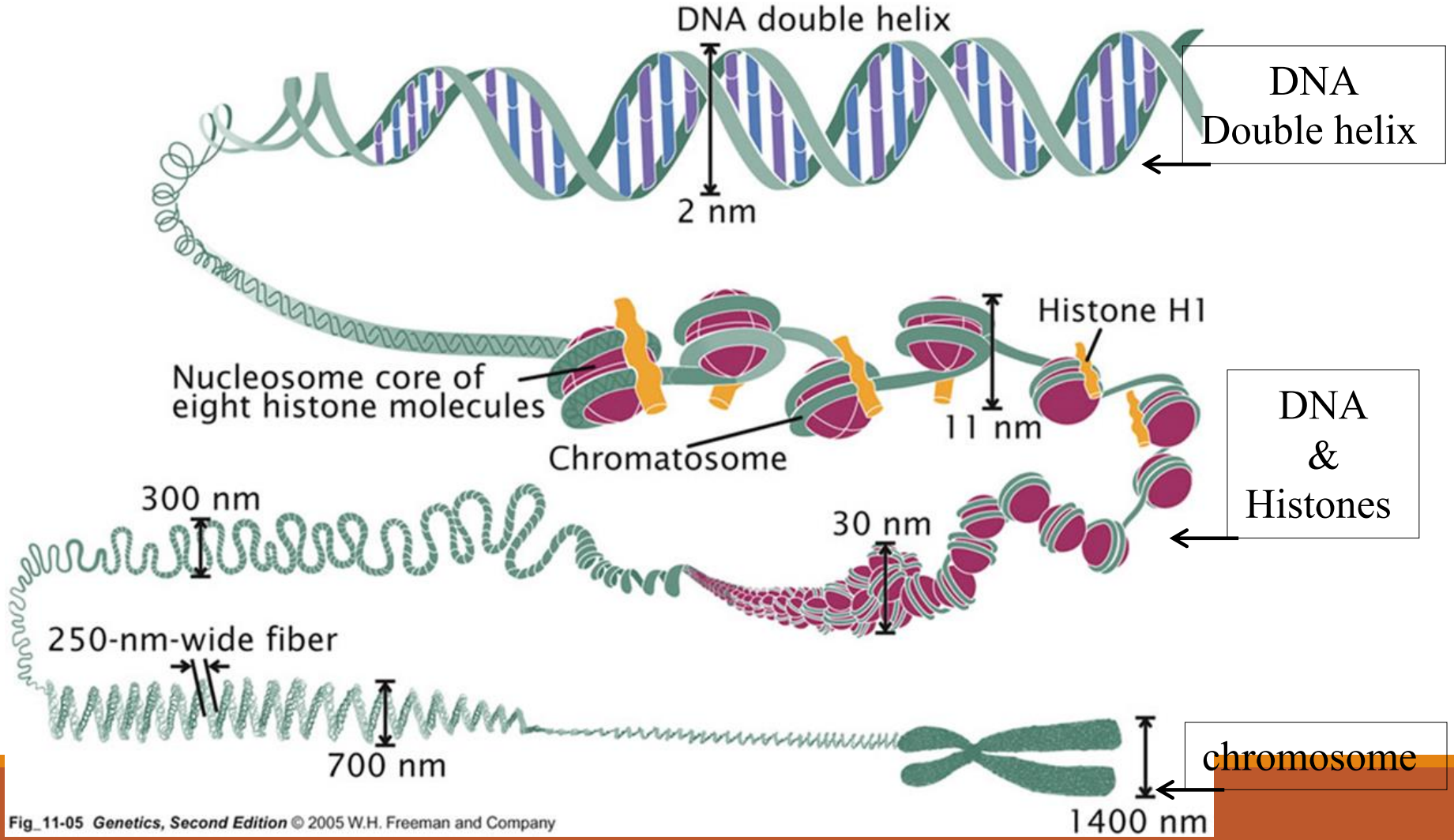
٢٣ زوج موجودين بال
somatic cells ← بنحكي
diploid number عنهم
٤٦ كروموسوم ← بنحكي
euploid number عنه
يعني عدد حقيقي من
الكروموسومات

← أي تغير في عدد
الكروموسومات اسمه
aneuploidy ← أي زيادة أو نقصان.

* كل species الها عدد الكروموسومات الخاص فيها
و بضل دائمًا ثابت.

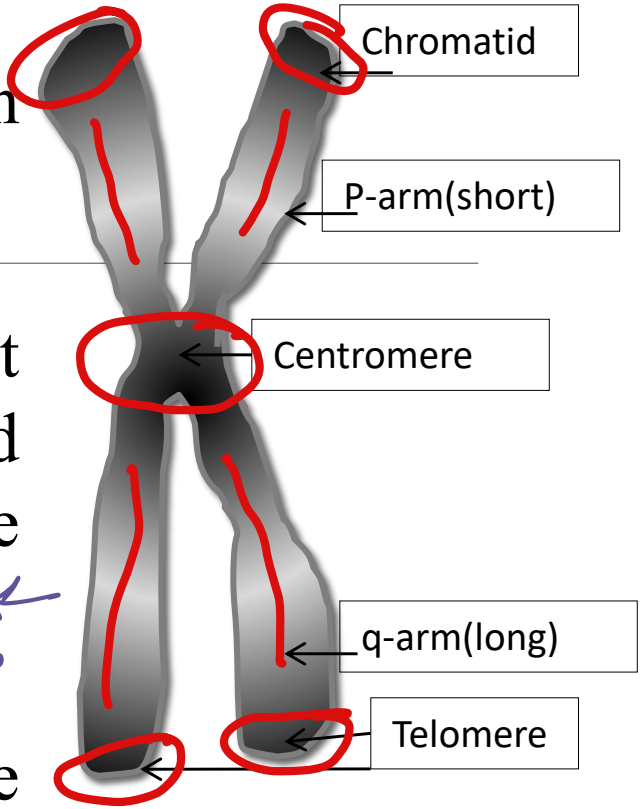
What is chromosome?

Chromosome is a thread-like structures, it is consisted of DNA molecule packed tightly and coiled around a specific proteins called histones. Chromosomes are located in the nucleus of eukaryotic cells.



The structure of the chromosome

* شكل الكروموسوم

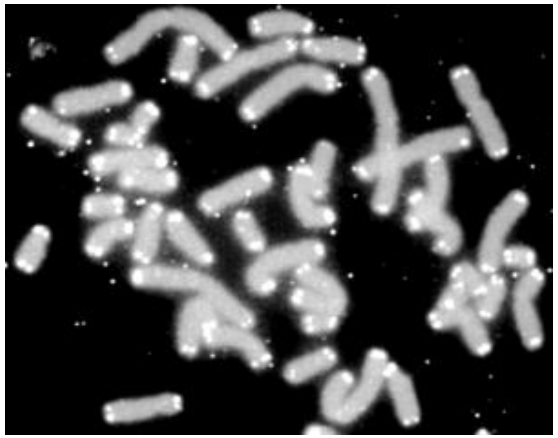


- **Chromatids** are two identical parts of each chromosomes.

- These chromatids are held together at a point named the **centromere**, which can be located at any point along the length of the chromosome.

لازم نعرف إنه الكروموسوم إله طرفين مو شابكين باشي.

- **Telomere** (إنزيم) is a region of repetitive nucleotide sequences. Telomere is located at each end of a chromosome, it protects the end of the chromosome from deterioration or from fusion with neighbouring chromosomes



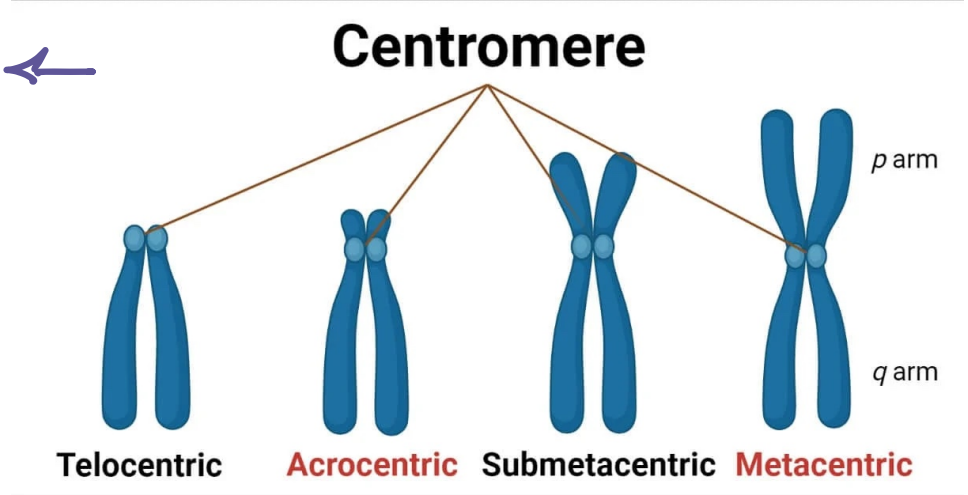
Replication بحالة ←

* الـ centromere لو كان موجود بالمنتصف يكون metacentric ←

* لو كان أبعد عن المنتصف يكون ← submetacentric

* لو كان أقرب إلى الأطراف يكون ← Acrocentric

← صورة توضيحية ن



* الـ centromere بقسم الكروموسوم لقسمين

(p) short arm ↙ ↘ (q) long arm

* وظيفة الـ Telomere

↳ يعمل على حماية الكروموسوم من خلال إضافة non-coding sequence بحيث إنه الكروموسوم بعملية الـ Replication بيقصر.

↳ يعمل على منع اشتباك الكروموسومات ببعضها.

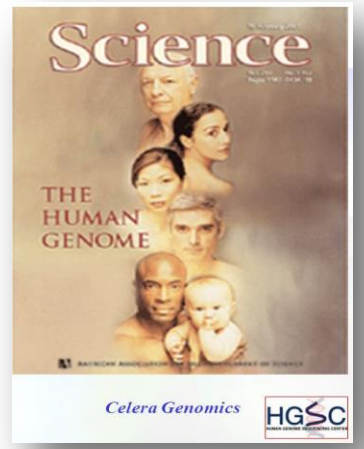
* خصوصًا بالـ metaphase.

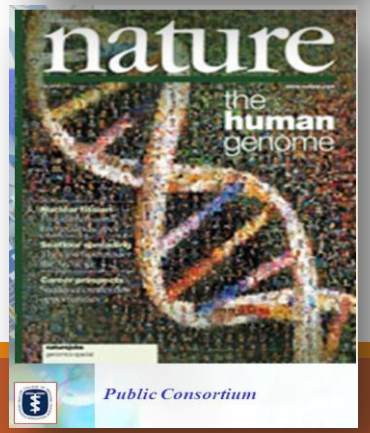
The Human Genome Project (HGP)

Images obtained from
http://www.online-sciences.com/HGP

- The **Human Genome Project** (**HGP**) is an international scientific research project aims to determine the sequence of DNA, to identify and to map all of the genes of the human genome from both a physical and a functional standpoint.

- The **International Human Genome Sequencing Consortium** published the first draft of the human genome in 2001 with the sequence of the entire genome's three billion base pairs some 90 percent complete.
- The full sequence was completed and published in April 2003, the number of human genes appeared to be ranged between **50,000** genes and **140,000** genes.





Methods in Cytogenetics

من خلال وضع stain تعمل على صبغ الكروموسومات

1. • STANDARD CHROMOSOME TESTING → in the metaphase

بنختار segment من الـ DNA و بنحط عليه مادة

2. • FLUORESCENT IN SITU HYBRIDIZATION

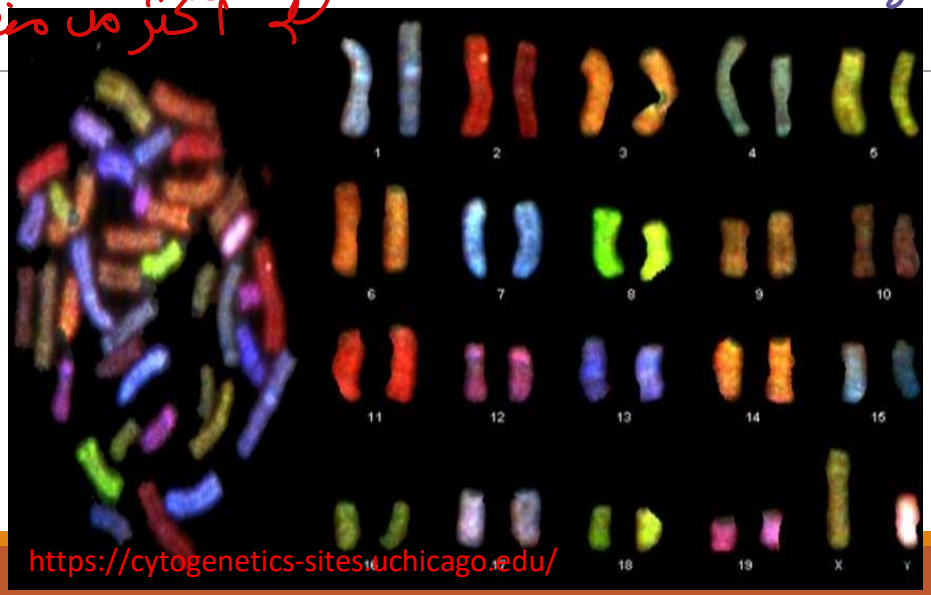
→ نفس مبدأ العمل

- FISH

3. • COMPARATIVE GENOMIC HYBRIDIZATION MICROARRAY

هون بندرس جينوم كامل و بنقدر نقارنه بجينوم تاني.
يعني مو بس segment.

أكثر من منطقة



https://cytogenetics-sites.uchicago.edu/

Standard chromosome testing ← الطريقة عند

1. Setting Up Blood Chromosomes عينة دم

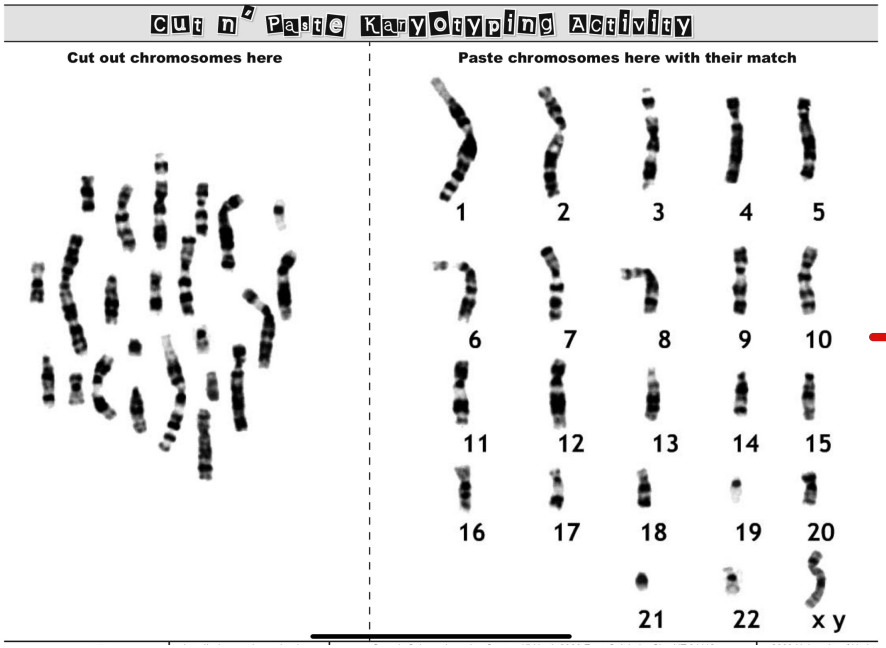
* شرط رئيسي لل karyotyping إنه الخلية تكون في بال zero stage أو divided
بتوقف بال metaphase.

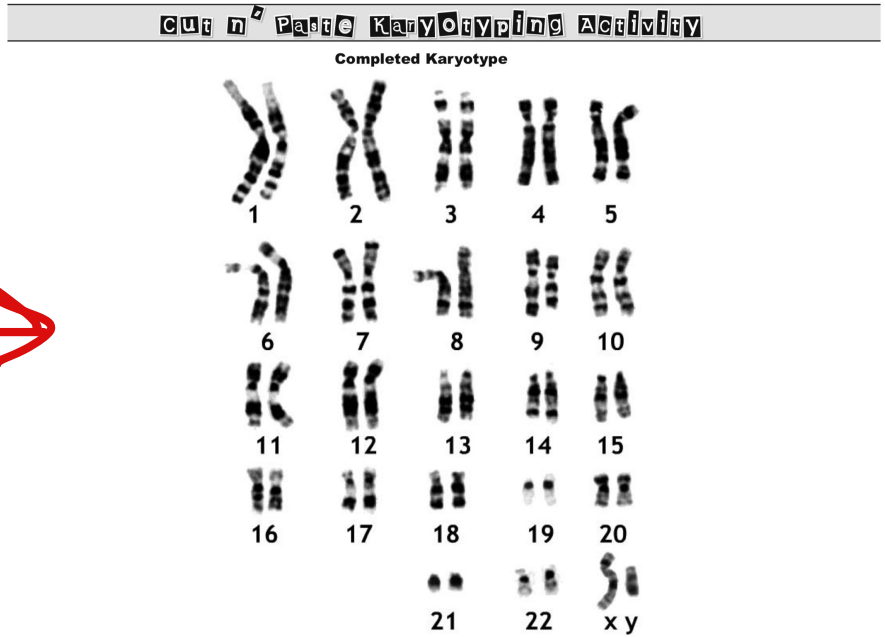
* أسهل مكان نأخذ عينة (الدم)

2. Cells Growing → (في وسط مخصص)
3. Cells Dropped On Slide
4. Cells Stained With Giemsa Stain (Metaphase)
5. Chromosomes Viewed Under Microscope
6. Chromosomes Cut Out
7. Final Karyotype

* تقسيم الكروموسومات كان بناء"
على:
- الطول (من أكبر لأصغر)
- موضع الـ centromere
- وجود الـ Bands

*Bands: light and dark regions along the chromosome





https://learn.genetics.utah.edu/content/basics/karyotype

Normal human karyotypes are designated as follows:

46,XX Normal female 46,XY Normal male

Chromosomal abnormalities

- Almost every cell in our body contains **23 pairs** of chromosomes, for a total of 46 chromosomes.

- **22** pairs are called **autosomes** and **1 pair of sex** chromosomes, XX in female and XY in male in each cell.

* حكينا من قبل لما يكون في أي تغير في عدد الكروموسومات بنسميه (aneuploidy).
* غالباً هاي الـ abnormalities بتصير بال meiosis

- **Chromosomal abnormalities** can be categorised as:

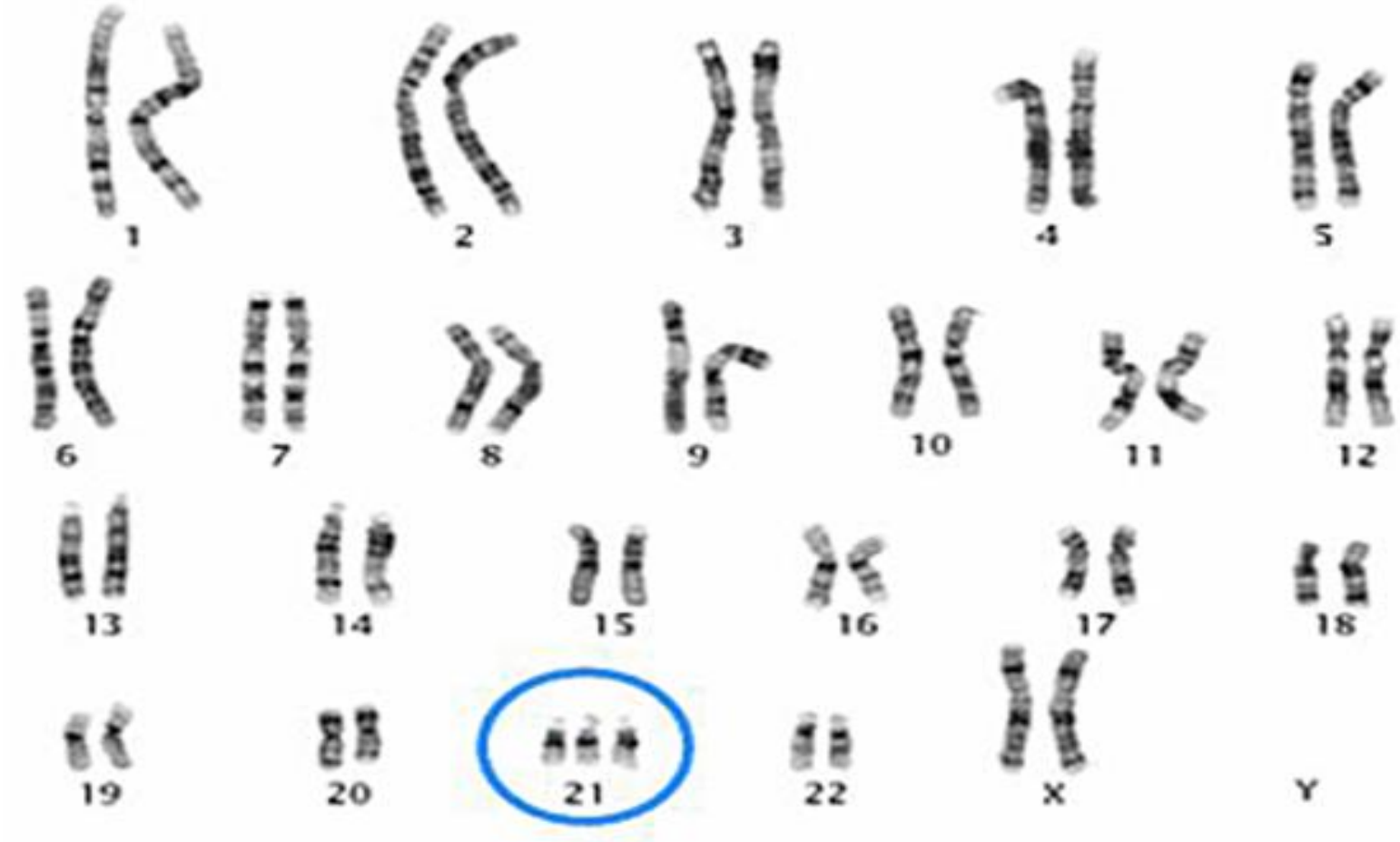
زيادة ← نقصان

1- **Numerical abnormalities** refer to a missing or existing of a whole chromosome to the normal pair.

* لما يكون النقصان بالكروموسومات بالخلايا الجسدية الجنين ما بعيش أما لما يكون النقصان في كروموسومات الخلايا الجنسية بكون في نسبة نجاة وتعايش مع الحالة مثلاً Turner Syndrome

2- **Structural abnormalities** occur when part of an individual chromosome is missing, extra, switched to another chromosome, or turned upside down.

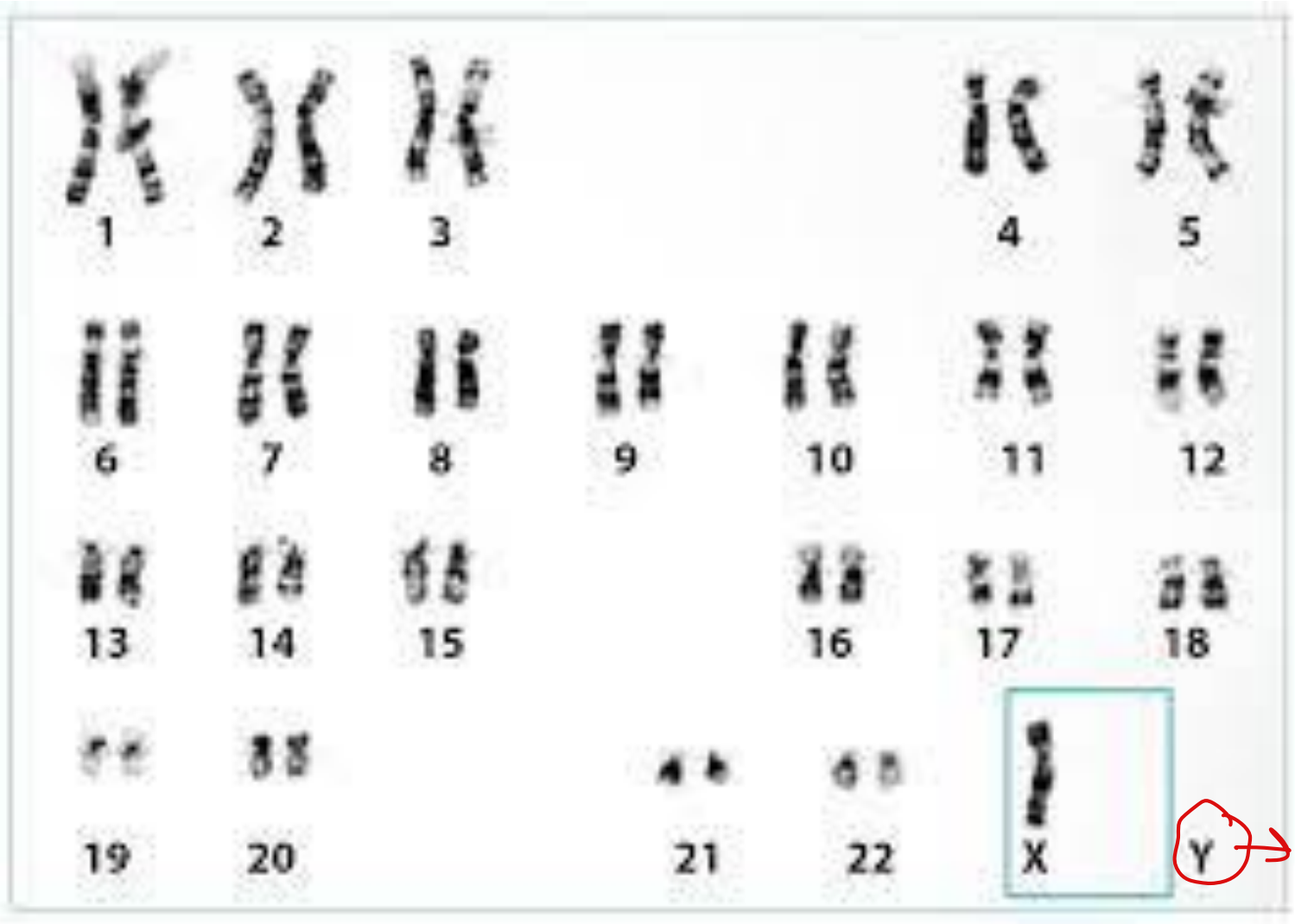
- جزء مفقود.
- جزء زيادة.
- أجزاء متغير مكانها.



Down Syndrome

Trisomoy 21

عندي ٣ نسخ
زيادة في العدد



مكانها فاضي

Turner Syndrome

Monosomoy (XO)

← نقصان في العدد

هل هو normal ؟ ذكر ولا أنثى ؟

* ممكن يجي karyotyping كسؤال

STRUCTURAL ABNORMALITIES

- **DELETION - (PARTIAL MONOSOMY) -** LOSS OF PART OF A CHROMOSOME.
- **DUPLICATION - (PARTIAL TRISOMY) -** DUPLICATION OF PART OF A CHROMOSOME.
- **INVERSION -** STRUCTURAL REARRANGEMENT WITHIN A CHROMOSOME WITH A SEGMENT OF THE CHROMOSOME IN REVERSED ORDER. DURING MEIOSIS, CROSSING OVER BETWEEN THE INVERTED CHROMOSOME SEGMENT AND ITS NORMAL HOMOLOGY MAY RESULT IN GENETICALLY ABNORMAL RECOMBINANT CHROMOSOMES WITH DUPLICATION AND DELETION FOR PART OF THE CHROMOSOME.

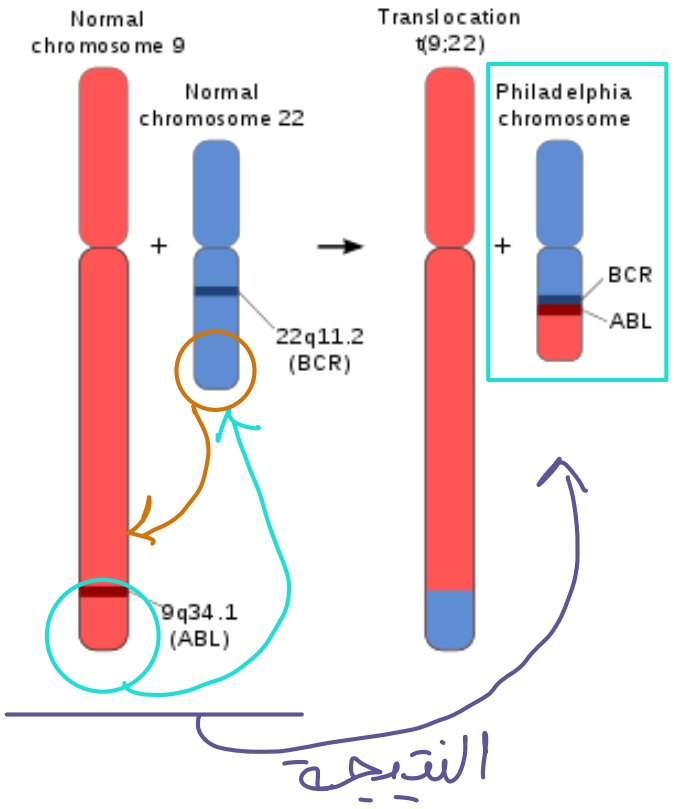
……Continued

1. Paracentric inversion - not involving centromere and results in no change in arm ratio.

2. Pericentric inversion - involving centromere, with change in arm ratio.

- **Translocation -** An exchange of parts between two or more chromosomes (Philadelphia Chromosome as an example)

* التبادل يصير بين كروموسوم رقم ٩ و ٢٢ . ممكن نشوف هاد التبادل بحالات اللوكيميا.



Causes of chromosomal abnormalities

* السبب الرئيسي موعرف بنقدر نحكي عنا risk factors

1) Some medicines
2) Street drugs
3) Alcohol
4) Tobacco
5) Toxic chemicals
6) Some viruses and bacteria
7) Some kinds of radiation
8) Certain health conditions, such as uncontrolled diabetes