Chromosomal Abnormalities: It is a disorder characterized by a morphological or numerical alteration in single or multiple chromosomes, affecting autosomes, sex chromosomes, or both.

- Factors which increase the risk of chromosomal abnormality

1. Maternal age: older women are at higher risk of get babies with chromosome abnormalities than younger

2. Environmental such exposure to radiation, formaldehyde, food preservatives etc.

Types of Chromosome Abnormalities	
A. Abnormal Chromosome Number: Includes changes in the number of chromosomes. Involves **a. Aneuploidy** **b. Polyploidy**	**B. Abnormal Chromosome Structure**: Involves alterations in the physical structure of chromosomes. Involves a. Duplications b. deletions c. Inversions d. translocations

a. Abnormal Chromosome Number

Aneuploidy

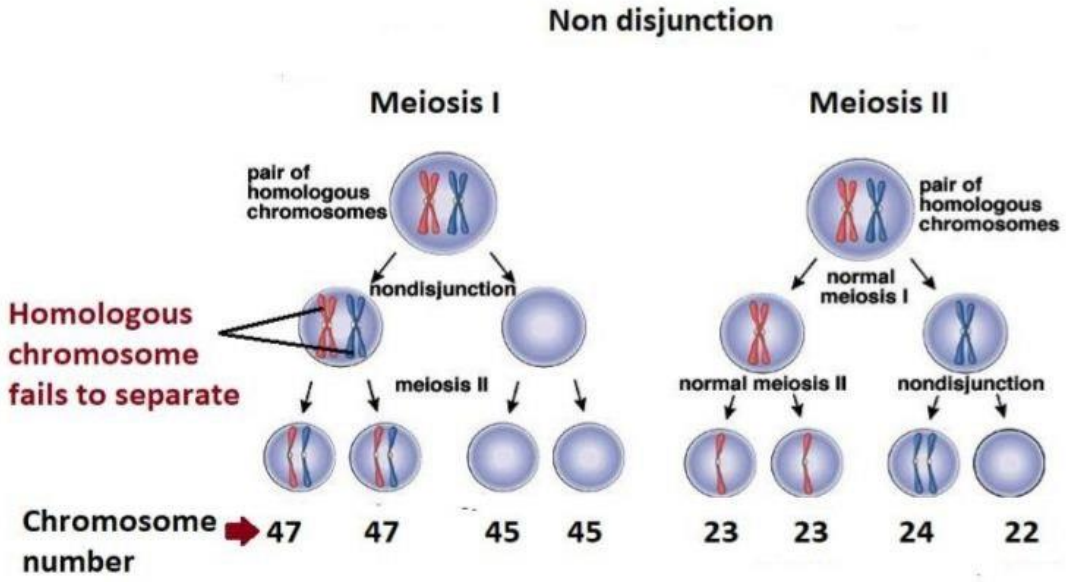
Aneuploidy: Involves the loss or gain of individual chromosomes, which disrupts gene dosage, often resulting in severe phenotypic effects.

Causes: Aneuploidy can arise due to:

1. Chromosome loss in mitosis/meiosis or during DNA duplication.
2. ***Nondisjunction***: Failure of chromosomes or chromatids to separate in meiosis or mitosis, leading to cells or gametes with an extra or missing chromosome.

Types of Aneuploidy

1. Monosomy (2n - 1): Loss of a single chromosome. Example: Humans with 45 chromosomes. Ex: turners syndrome (xo)
2. Nullisomy (2n - 2): Loss of both members of a homologous chromosome pair. Example: Humans with 44 chromosomes instead of the normal 46.
3. Trisomy (2n + 1): Gain of one chromosome, resulting in three copies of a particular chromosome. Example: Humans with 47 chromosomes (e.g in Down syndrome 2 and Klinefilter (xxy).
4. Tetrasomy (2n + 2): Gain of two homologous chromosomes, resulting in four copies of a particular chromosome. Example: Humans with 48 chromosomes.



B .Abnormal Chromosome Structure

Structural Chromosome Abnormalities: are changes in the chromosome's structure. These abnormalities can result from breaks in the chromosome, followed by incorrect rejoining or rearrangement. Structural abnormalities can lead to various genetic disorders depending on the type of alteration, the size and location of the affected segment, and whether essential genes are involved. Some individuals may be asymptomatic carriers, especially in cases of balanced translocations, while others may present with congenital abnormalities or developmental issues.

❖ ***Structural Chromosome Abnormalities OCCURS as result of :***

a. ***De novo (Spontaneous)****:* Structural abnormalities can occur randomly during the formation of reproductive cells or in early embryonic development.

b. ***Inherited***: They may also be passed down from a parent carrying the abnormality.

❖ *Cell Distribution*:

a. **All Cells Affected**: If the abnormality is present in all cells, it likely originated from one of the parent's gametes or occurred very early in development.
b. **Mosaicism**: If the abnormality is present in only a subset of cells, where the mutation occurred after fertilization in a particular cell population.

❖ **Detection**:

Techniques like karyotyping, FISH, and chromosomal microarray analysis are used to identify structural chromosome abnormalities and assess the extent of mosaicism if present.

❖ *Types of Structural Abnormalities*:

1. **Duplications**: When a chromosome segment is duplicated, leading to two types:

✓ Tandem Duplication: The duplicated region is adjacent to the original.
✓ Displaced Duplication: The duplicated region is at a distance from the original or on another chromosome.

2. **Deletions**: Involves the loss of a chromosome segment:

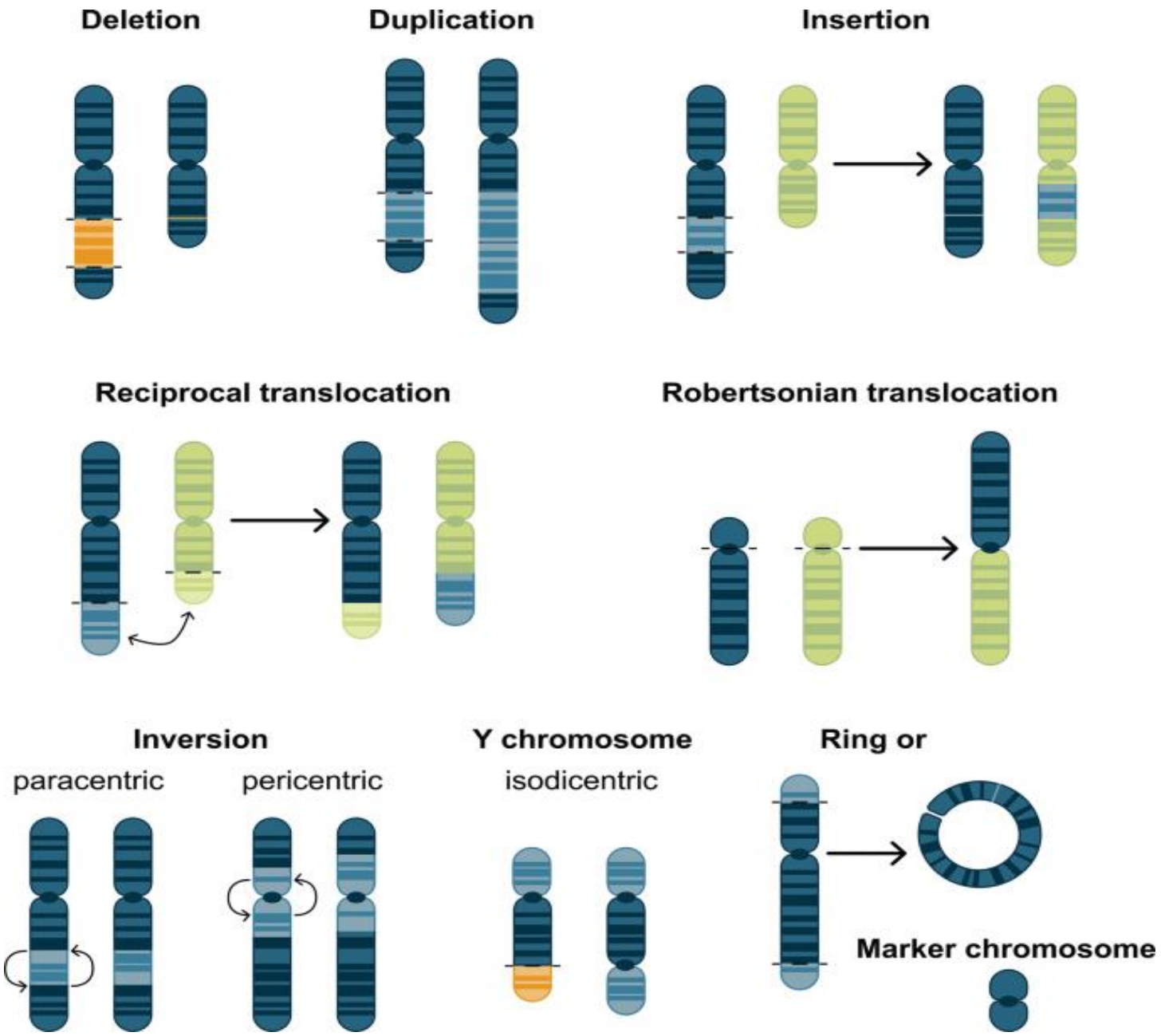
- Terminal Deletion: A single break occurs, losing a distal segment.
- Interstitial Deletion: Two breaks occur in one arm, removing an internal segment.

3. **Inversions**: A segment within a chromosome is flipped by 180 degrees:

- Paracentric Inversion: Does not include the centromere.
- **Pericentric Inversion**: Includes the centromere

4. **Translocations**: Transfer of chromosome material between non-homologous chromosomes or within the same chromosome. Reciprocal Translocation: Chromosome segments swap between two non-homologous chromosomes, possibly leading to no phenotype but impacting fertility. Robertsonian Translocation: long arms OF two acrocentric chromosomes ARE FusED (e.g., chromosomes 13, 14, 15, 21, 22), reducing the total chromosome number and raising specific genetic risks, such as Down syndrome.

5. Transposition: Refers to the movement of small DNA segments from one genome location to another.


Deletion
Duplication
Insertion
Reciprocal translocation
Robertsonian translocation
Inversion
paracentric
pericentric
Y chromosome
isodicentric
Ring or
Marker chromosome

MCQ

1. Which factor is known to increase the risk of chromosomal abnormalities?
A) Paternal age
B) Maternal age
C) Height of the parents
D) Number of siblings

2. Aneuploidy can be caused by:
A) Incomplete DNA replication
B) Excessive exposure to radiation
C) Chromosome loss or nondisjunction during meiosis/mitosis
D) Mutations in all cells

3. Which of the following is an example of monosomy?
A) Down syndrome
B) Klinefelter syndrome
C) Turner syndrome
D) Robertsonian translocation

4. Which type of structural abnormality involves a 180-degree flip of a chromosome segment without changing its length?
A) Duplication
B) Deletion
C) Inversion
D) Translocation

5. What is mosaicism?
A) Loss of a chromosome segment
B) A mutation affecting all body cells
C) The presence of two or more populations of cells with different genetic makeup within an individual
D) A type of translocation

11. Which detection method can assess mosaicism?
A) PCR
B) Karyotyping
C) ELISA
D) Flow cytometry

12. A pericentric inversion includes:
A) Only the p arm of the chromosome
B) The centromere
C) A loss of a chromosome segment
D) A fusion of two acrocentric chromosomes

13. Robertsonian translocations most commonly involve which type of chromosomes?
A) Autosomes
B) Sex chromosomes
C) Metacentric chromosomes
D) Acrocentric chromosomes

14. Which of the following describes nullisomy?
A) Loss of both members of a homologous chromosome pair
B) Gain of two chromosomes
C) Presence of a single chromosome
D) Gain of multiple sets of chromosomes

15. What term describes a duplicated region that is at a distance from the original location?
A) Tandem duplication
B) Interstitial duplication
C) Displaced duplication
D) Terminal duplication

16. Inversions can lead to genetic abnormalities if:
A) They result in gene loss
B) Essential genes are disrupted
C) They involve only one chromosome arm
D) They occur in non-coding regions

6. Which of the following types of chromosomal translocations involves two non-homologous chromosomes exchanging segments?
A) Tandem duplication
B) Displaced duplication
C) Reciprocal translocation
D) Robertsonian translocation

7. A person with 47 chromosomes due to an extra chromosome on pair 21 has which condition?
A) Turner syndrome
B) Down syndrome
C) Klinefelter syndrome
D) Tetrasomy

8. What type of chromosomal abnormality is defined by a gain of two homologous chromosomes, leading to a total of four copies?
A) Monosomy
B) Nullisomy
C) Trisomy
D) Tetrasomy

9. Which structural abnormality results from a break and incorrect rejoining of chromosome segments?
A) Polyploidy
B) Deletion
C) Aneuploidy
D) Mosaicism

10. De novo structural abnormalities are:
A) Inherited from both parents
B) Acquired after fertilization
C) Spontaneously occurring in reproductive cells or early development

17. A structural abnormality detected in only some cells is classified as:
A) Nullisomic
B) Polyploid
C) Monosomic
D) MosaiC

18. The loss of a chromosome segment resulting from a single break at the end of the chromosome is known as:
A) Tandem duplication
B) Terminal deletion
C) Interstitial deletion
D) Inversion

19. Which chromosomal abnormality is commonly associated with a person having an extra X chromosome (XXY)?
A) Down syndrome
B) Klinefelter syndrome
C) Turner syndrome
D) Patau syndrome

20. Chromosome abnormalities in all cells are most likely:
A) De novo
B) Inherited from both parents
C) Arising from parental gametes or occurring very early in development
D) Caused by environmental factors alone