GENERAL EMBRYOLOGY

2019

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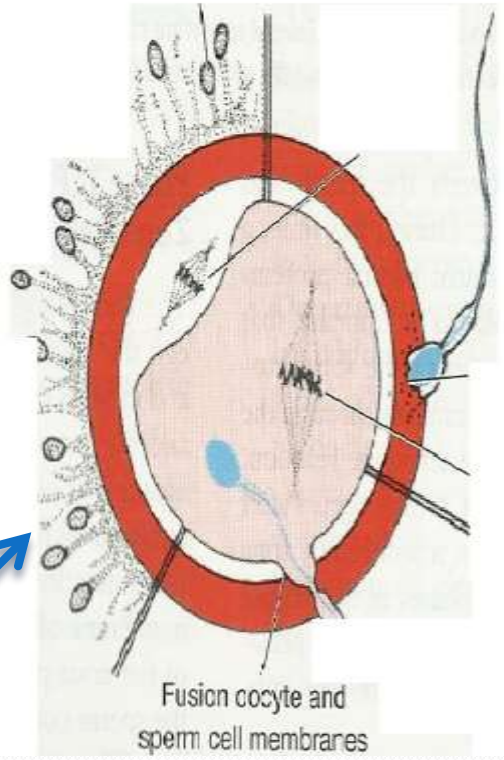
WHAT IS EMBRYOLOGY ?

Is the science that deals with
the development of the embryo from a single cell to a baby in 9 months

Development begins with
F E R T A L I Z A T I O N

What is fertilization?

Fertilization is the process by which *the male gamete* the *sperm* and *the female gamete* the *oocyte* unite to form the zygote



Why do we need the union of **two cells** to form **the zygote**?

According to the number of chromosomes in the nucleus of the human cells we Have **two** types :

1- Somatic cells

2- Reproductive cells **(also called sex cells)**

A **somatic cell (*soma body) is any cell of the*** body other than a germ cell.

A **germ cell is a gamete**
(sperm or oocyte)
or **any precursor cell destined to become a gamete**

Somatic cells : contain ***two sets*** ***of chromosomes***:
first set contains 23 chromosomes coming from the ***mother*** called ***maternal***
The second set contains 23 chromosomes coming from the ***father*** called ***paternal***

Therefore, **Somatic cells** called

diploid

cells (*dipl- double; -oid form), symbolized* ***2n***

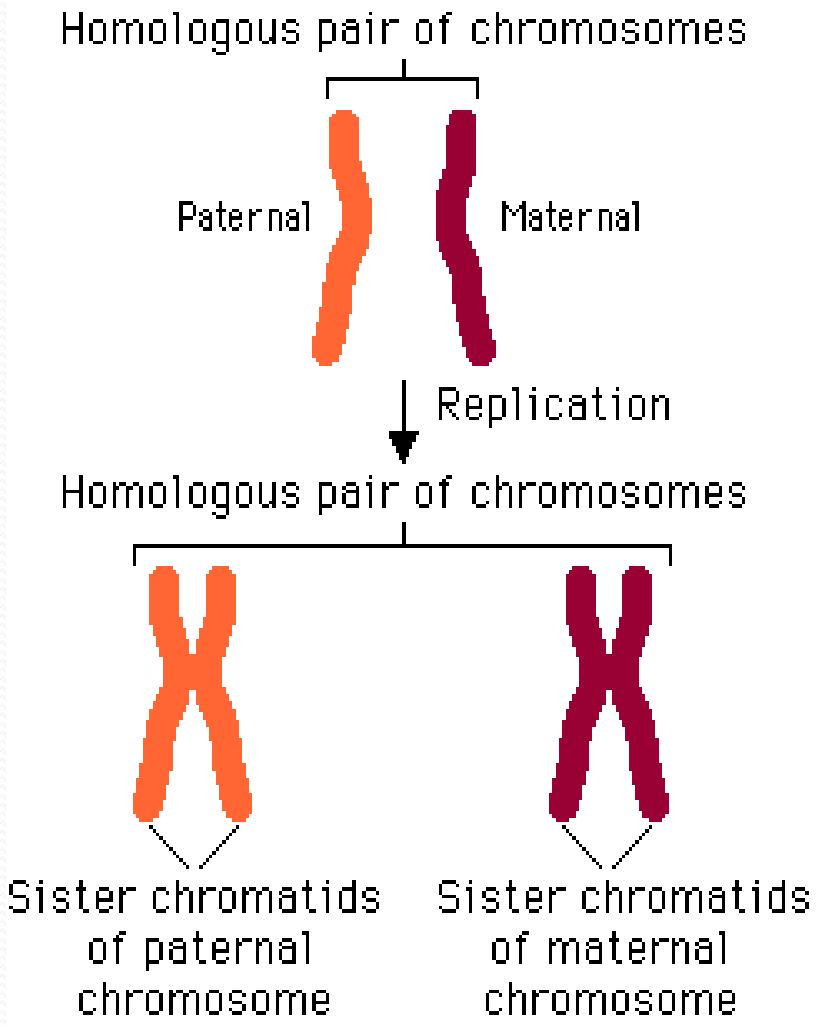
The two chromosomes that make up each pair are called homologous chromosomes
(homo- same) they
contain similar genes arranged in the same (or almost the same) order

What are

HOMOLOGOUS CHROMOSOMES

When examined under a light microscope generally they look very similar.
The exception to this rule is one pair of chromosomes called the **sex chromosomes, designated** X and Y.
In females the homologous pair of sex chromosomes consists of two large X chromosomes;
in males the pair consists of an X and a much smaller Y chromosome

Note : If the sex pair is XX the individual is **genetically female** If the sex pair is XY the individual is genetically **male**

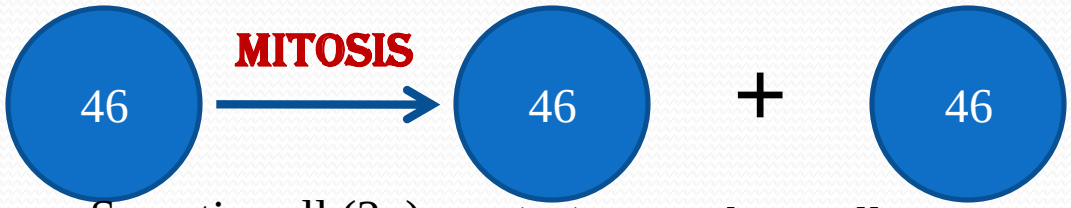


Where can we find somatic cells?

All the cells in the human body are somatic except the ***sperm*** and the ***oocyte***

How they divide?

Somatic cells divide by **mitosis** for growth and to replace cells that die from tear and wear



important

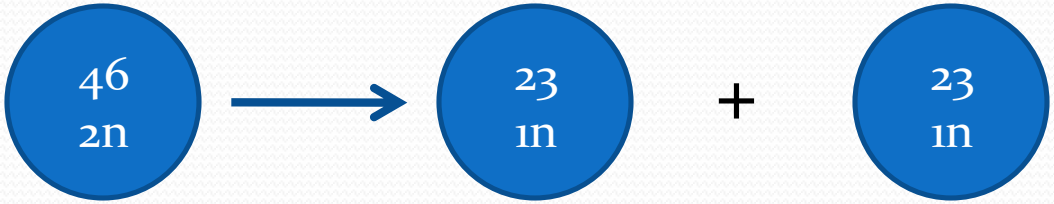
MITOSIS CONSERVES CHROMOSOMES NUMBER

2- Reproductive cells (also called sex cells)

Reproductive cells develop in gonads (ovaries in female and testes in male)

They contain only **23** chromosomes that is why they are called **haploid** cells (1n)

Reproductive cells divide by meiosis



Reproductive cell
Diploid 46 chromosomes

Gametes haploid cells 23 chromosomes

Meiosis does not conserve Chromosomes number instead It reduces it by half

important

precursor cell destined to become a gamete

Thus,

It is impossible for a female to reproduce here self simply because here sex cells (the oocytes are haploid (23, 1n)

It is impossible for a male to reproduce him self simply because his sex cells (the sperms are haploid (23, 1n)

What to do?

Union

Fertilization

Oocyte
23 chromosomes
1n, haploid

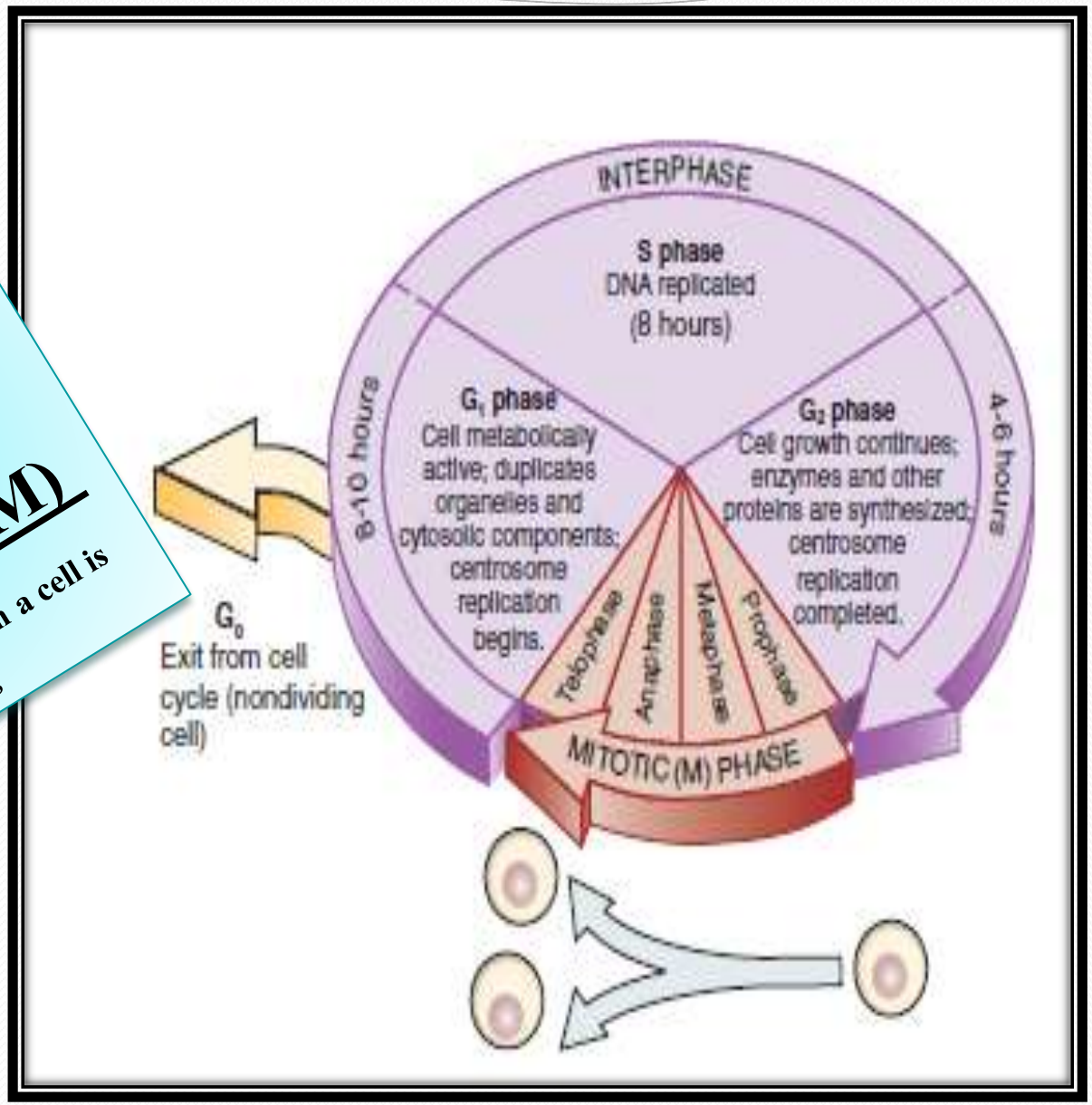
Sperm
23 chromosomes
1n, haploid

Zygote
46 chromosomes
2n, diploid

Cell Division

When a cell reproduces, it must replicate (duplicate) all its chromosomes to pass its genes to the next generation of cells

The cell cycle consists of two *major periods:* **INTERPHASE,** when a cell is not dividing, and the **MITOTIC (M) PHASE,** when a cell is dividing



INTERPHASE

The Interphase

Interphase is a state of high metabolic activity; it is
during this time that the cell does most of its growing.

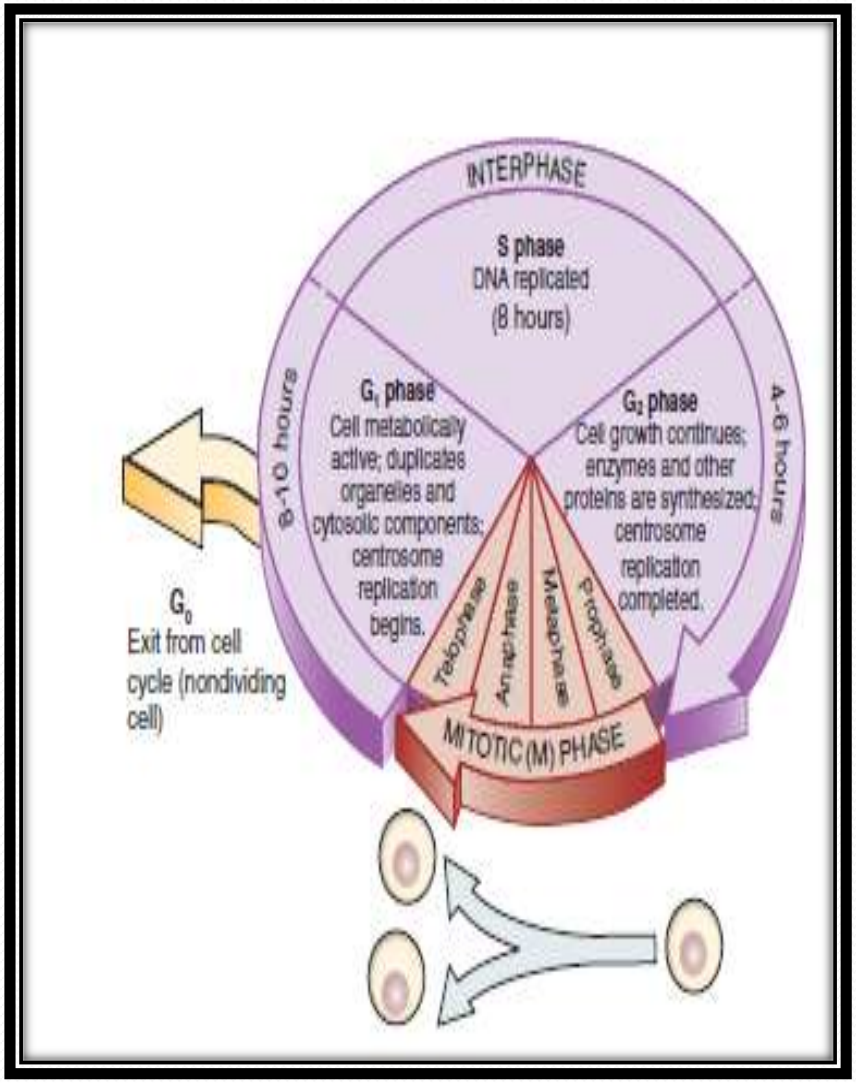
During **interphase**
1- The cell replicates its DNA
2-Produces additional organelles and cytosolic components

Interphase consists of three phases:

1-G1 phase

2-S phase

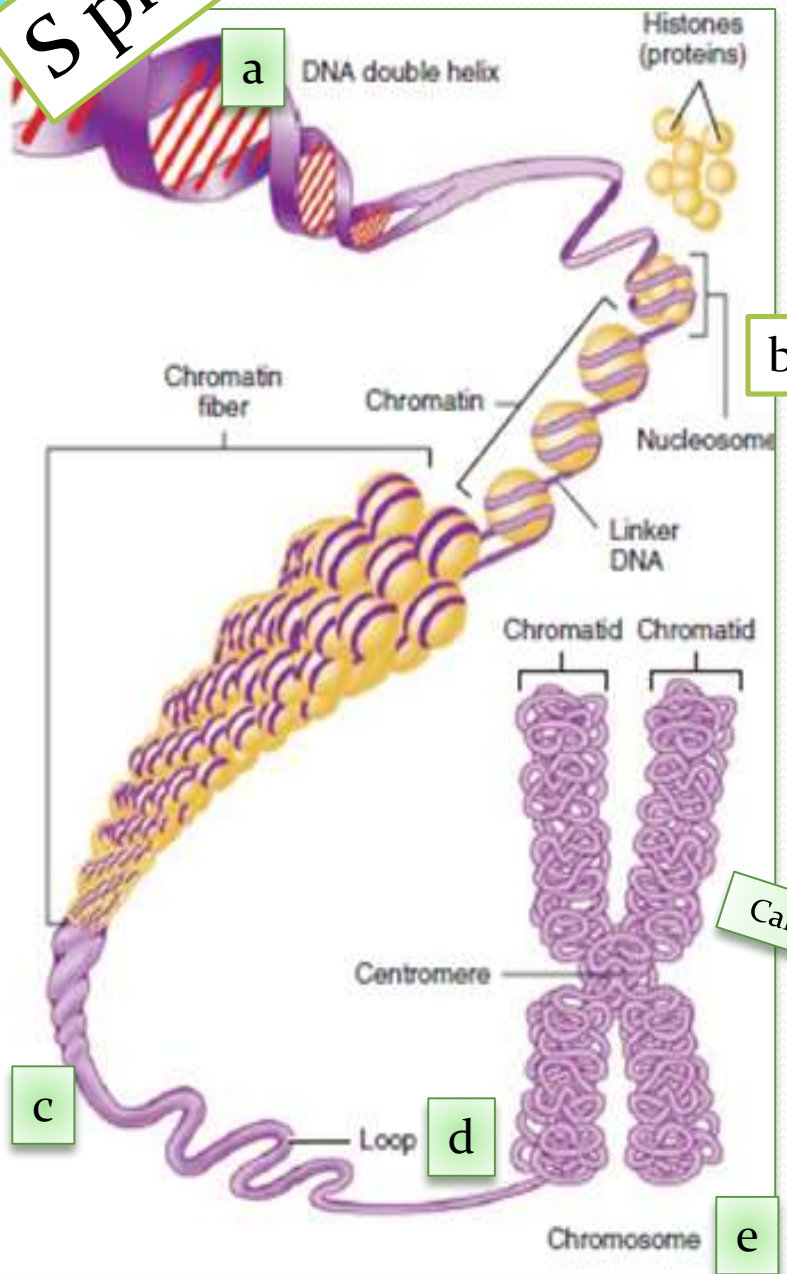
3-G2 phase

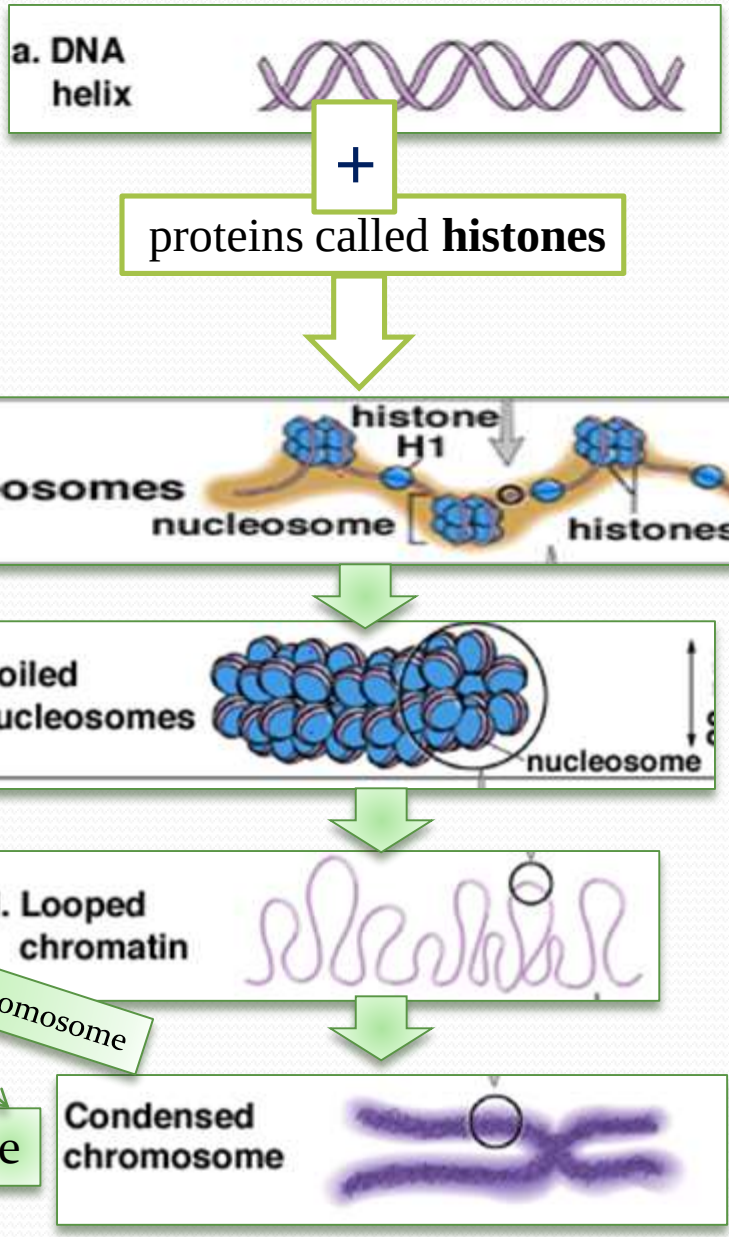


S phase

ells before division undergo DNA synthesis during the Interphase

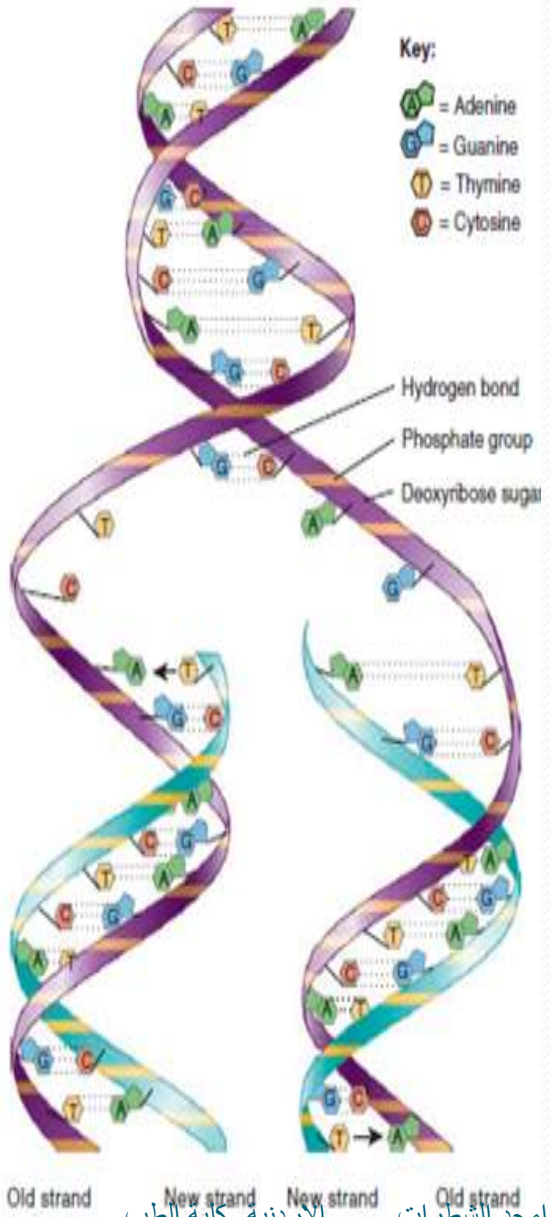
Chromosome's structure



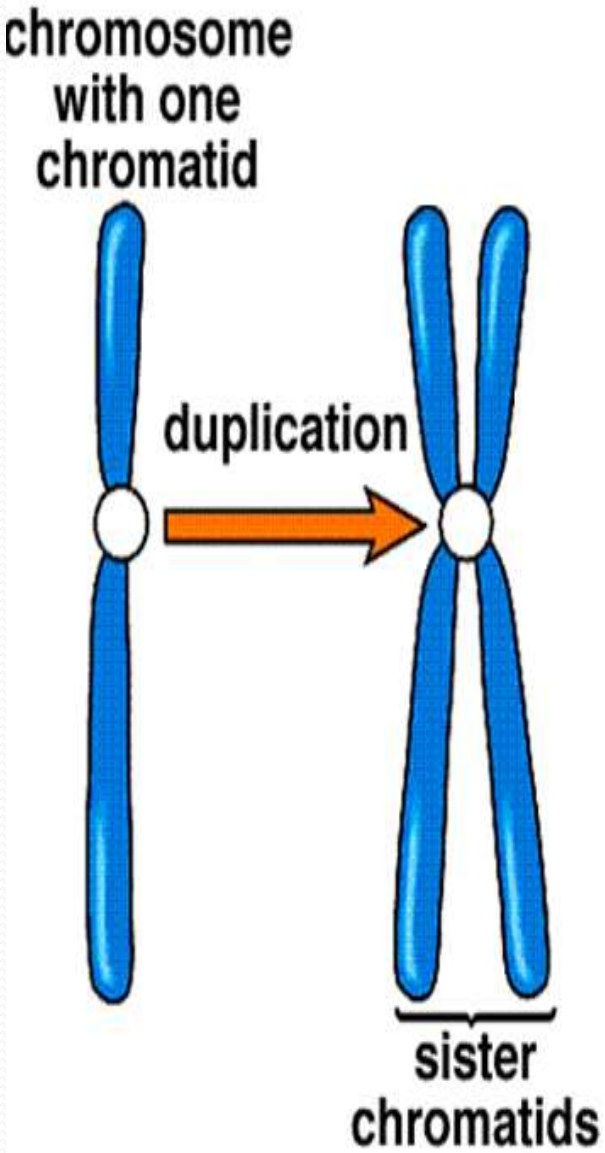


Interphase

DNA replicates (duplicates)



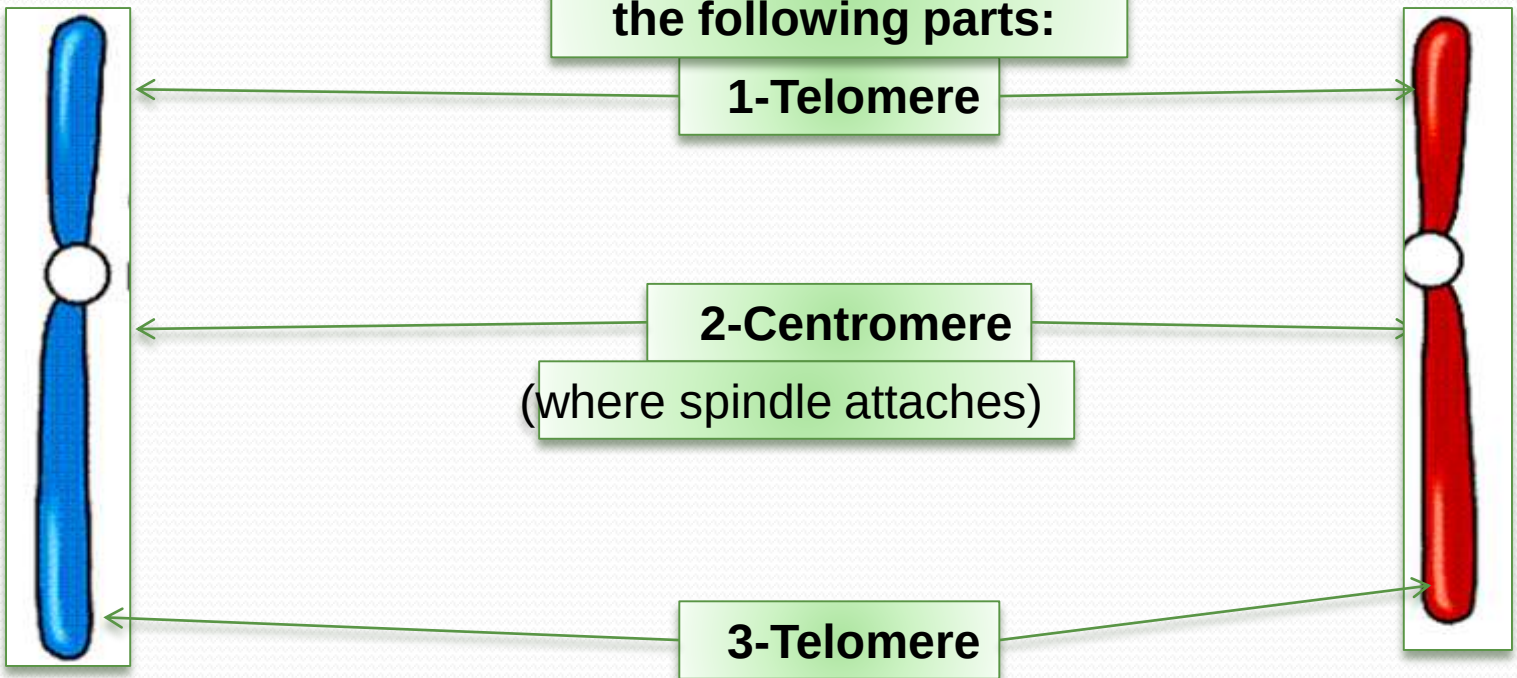
Can condensed to form chromosome



The **S** stands for ***synthesis*** *of DNA.*

The chromatin of nucleus condense into a chromosome

Each chromosome has the following parts:



1-Telomere

2-Centromere

(where spindle attaches)

3-Telomere

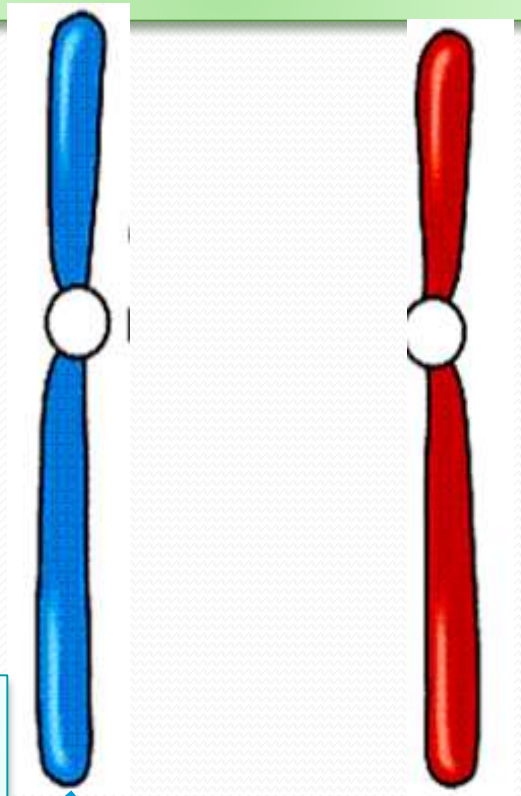
(special structures at the ends)

depending on the stage of the cell cycle chromosomes come in 2 forms:

1- The monad form consists of a single chromatid, a single piece of DNA containing a centromere and telomeres at the ends.

2- The dyad form consists of 2 identical chromatids (sister chromatids) attached together at the centromere

The chromatin of nucleus condense into a chromosome



One chromosome coming from the father called paternal

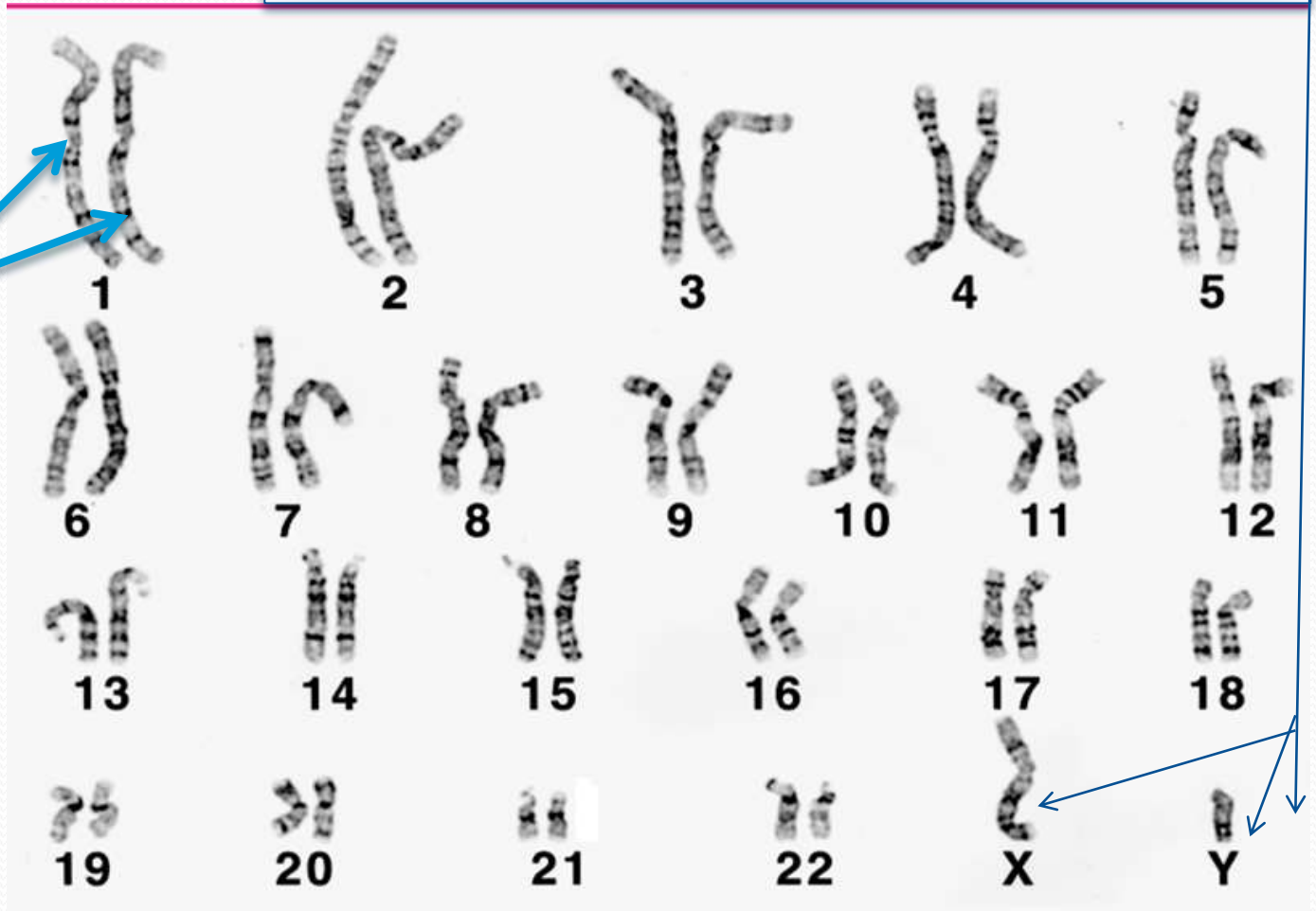
One chromosome coming from the mother called maternal

HOMOLOGOUS CHROMOSOMES

HOMOLOGOUS CHROMOSOMES

Notice that chromosomes number 23 are not homologous, what does this mean?

Notice that in this picture There are two chromosomes Numbered 1 and etc. These Chromosomes are called homologous chromosomes; one comes from the mother and the other comes from the father During fertilization



Picture of the 46 chromosomes (23 pairs of chromosomes)

G phases

Because the G phases are periods when there is no activity related to DNA duplication, they are thought of as ***gaps or interruptions in DNA duplication.***

The **G1 phase is the interval between** the mitotic phase and the S phase.

During G1,

the cell replicates most of its

organelles and cytosolic components but

not its DNA.

➢**Replication of centrosomes also begins in the G1 phase.**

For a cell with a total cell cycle time of 24 hours, G1 lasts 8 to 10 hours. However, the duration of this phase is quite variable. It is very short in many embryonic cells or cancer cells. Cells that remain in G1 for a very long time, perhaps destined never to divide again, are said to be in the G0 phase.

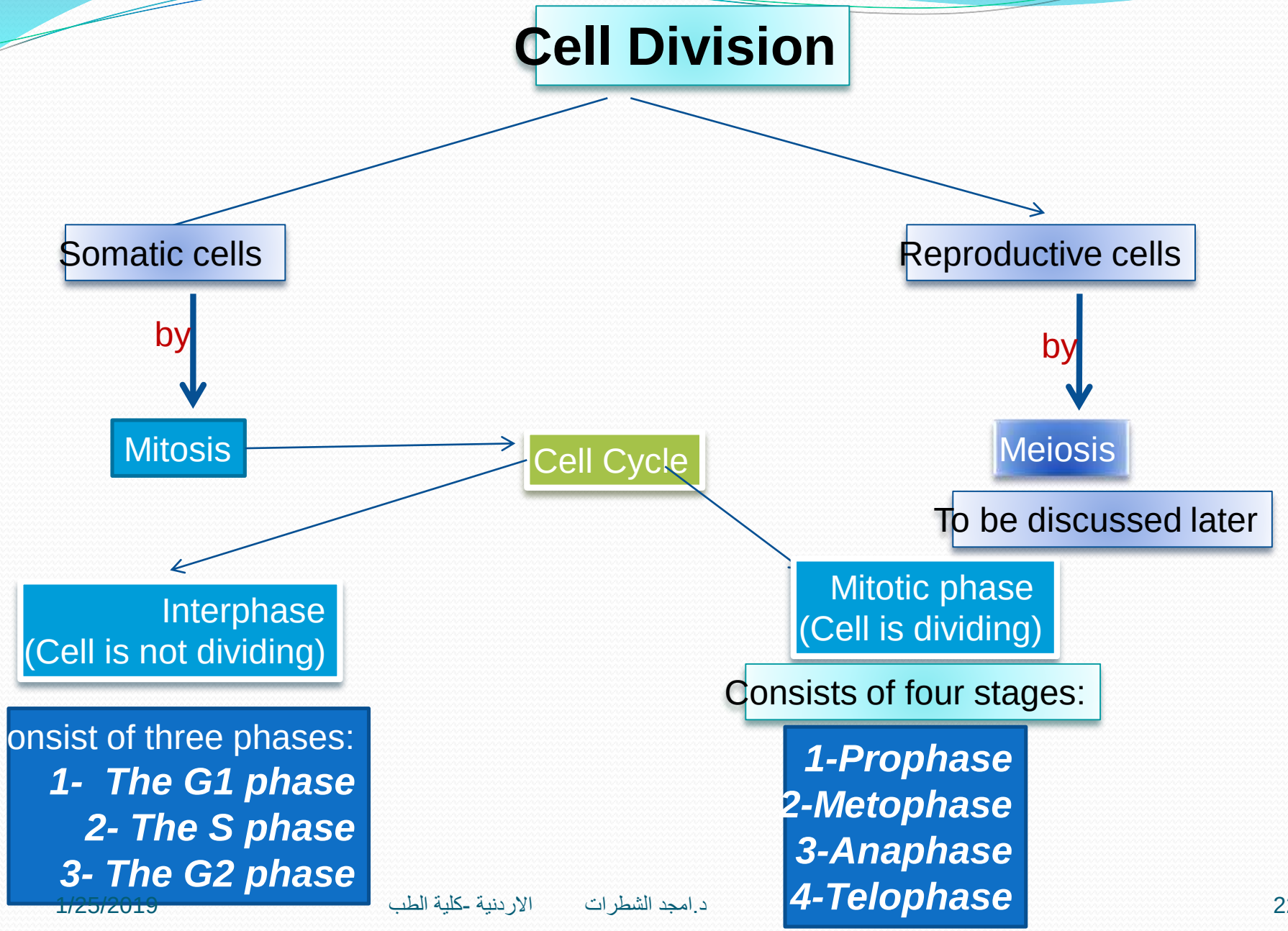
Most nerve cells **are in the G0 phase. Once a cell enters the S phase, however, it is committed to go through the rest of the cell cycle.**

The G2 phase is the interval between the S phase and the mitotic phase. It lasts 4 to 6 hours.

During G2, cell growth continues, enzymes and other proteins are synthesized in preparation for cell division, and replication of centrosomes is completed.

MITOTIC (M) PHASE

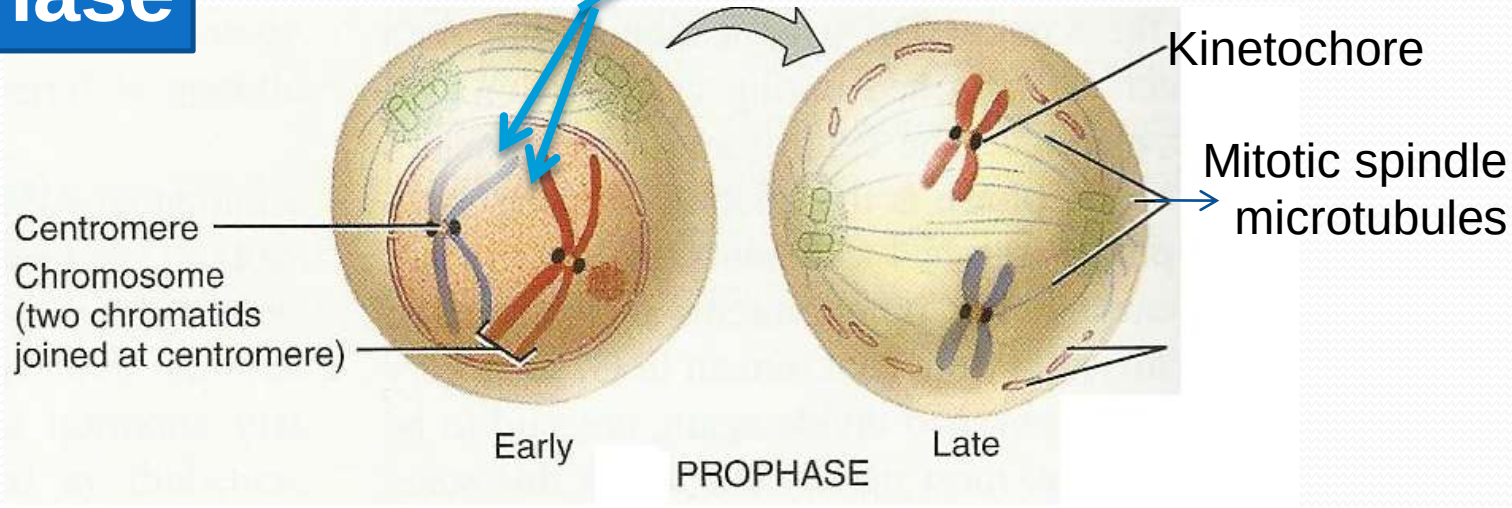
Cell Division



rophase

2n

it has two sets of Chromosomes (two copies) One chromosome is paternal and the other maternal



Centromere (a constricted region holds the chromatid pair together)

↓

Outside of each centromere is a protein complex called Kinetochore

Later in prophase tubulins in the pericentriolar material of the centrosomes start to form the mitotic spindle

↓

he mitotic spindle attaches to the Kinetochore

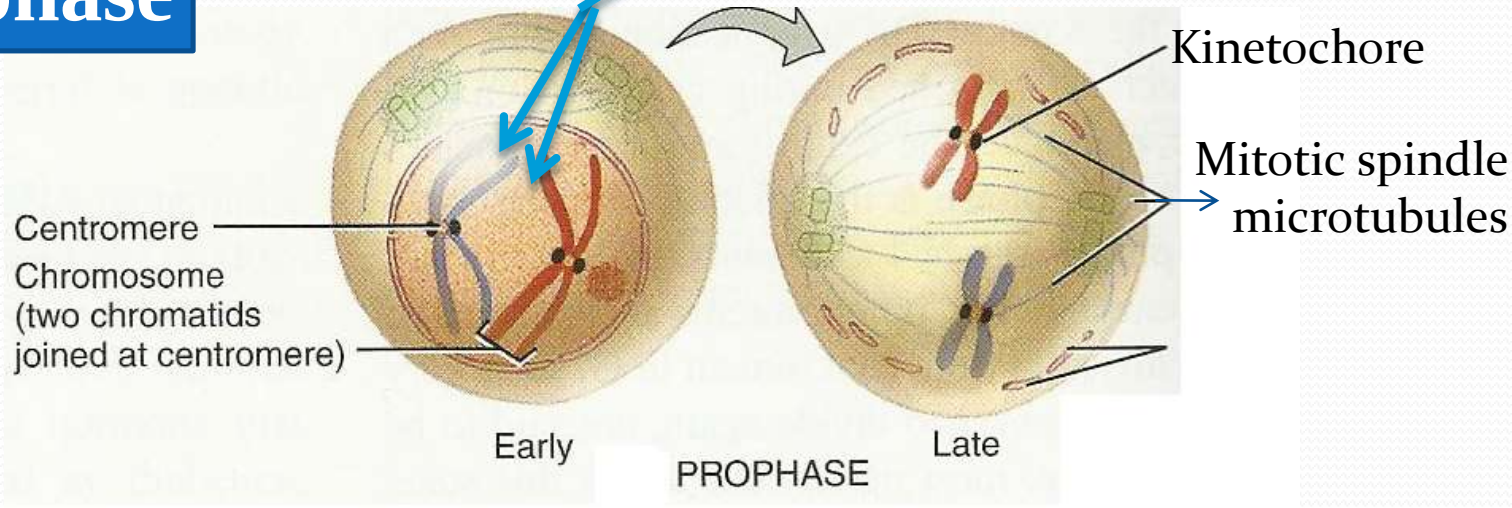
↓

e mitotic spindle (microtubules) lengthen they push the centrosomes to the poles

Prophase

2n

it has two sets of
Chromosomes (two copies)
One chromosome is
paternal and the other maternal



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Later in prophase tubulins in the pericentriolar material of the centrosomes start to form the mitotic spindle

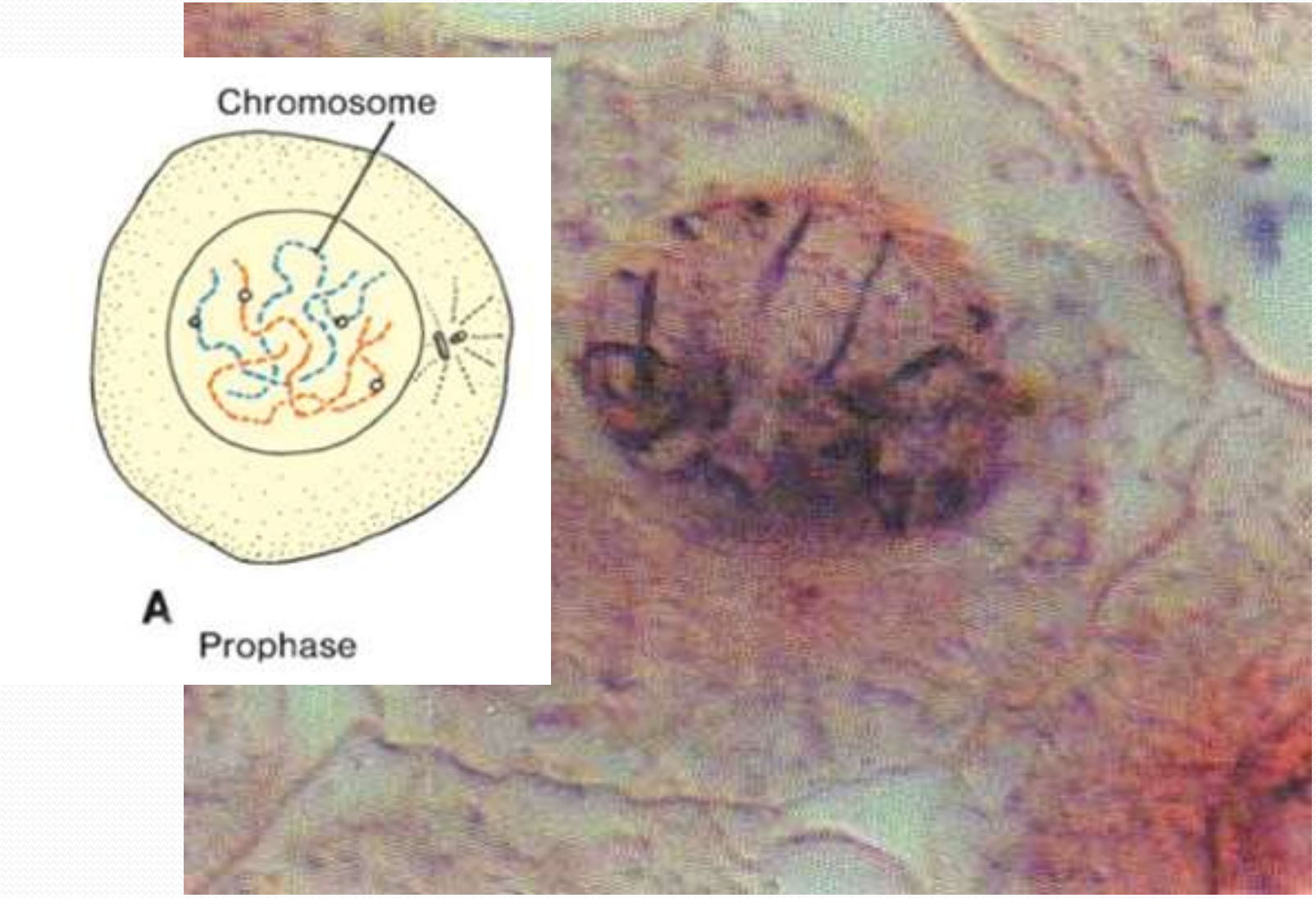
↓

the mitotic spindle attaches to the Kinetochore

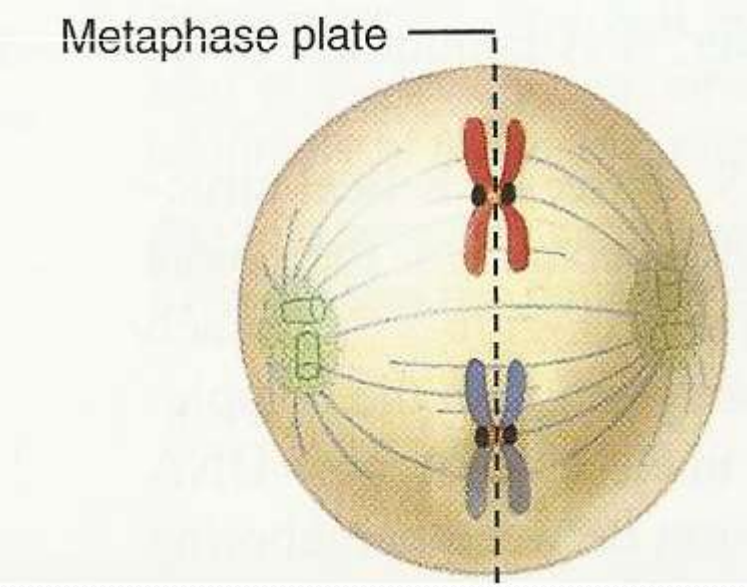
↓

As the mitotic spindle (microtubules) lengthen they push the centrosomes to the poles

Mitosis Prophase



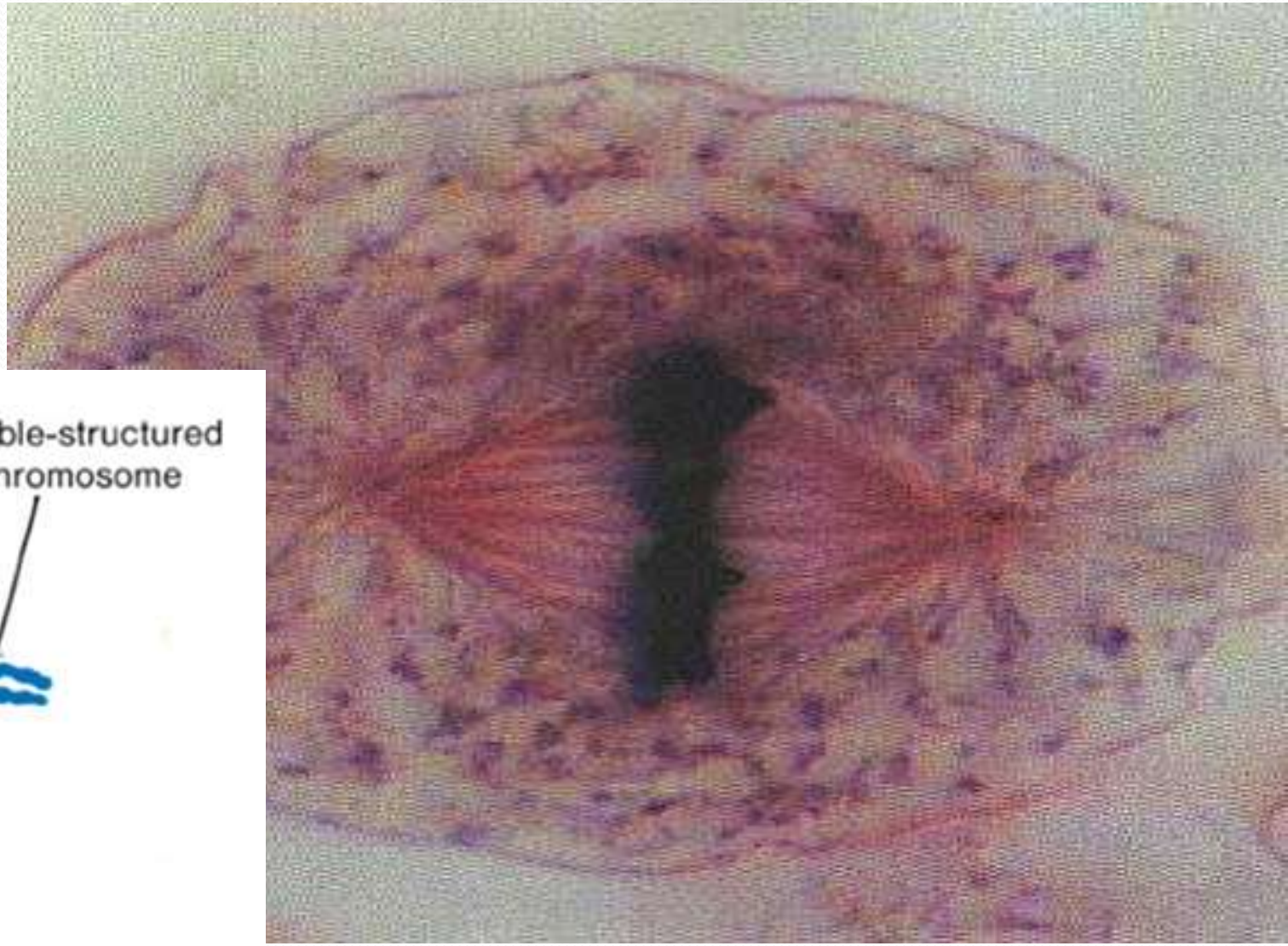
METAPHASE

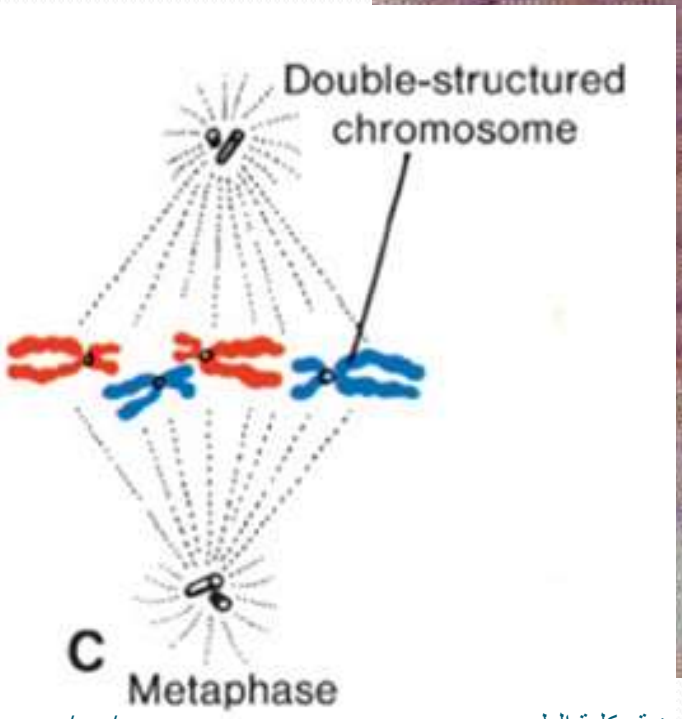


The Kinetochore microtubules align the centromeres at the exact center of the mitotic spindle

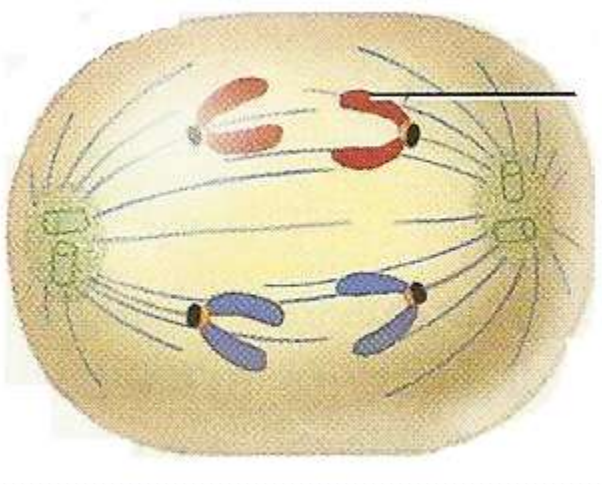
This midpoint region called **metaphase plate**

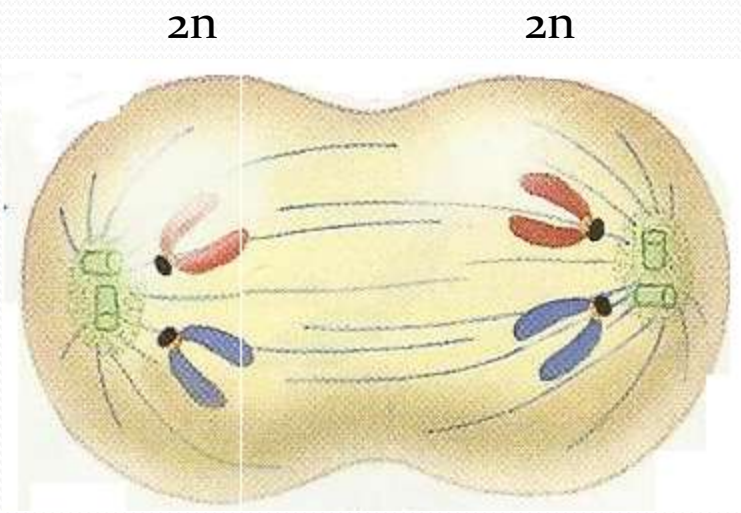
Mitosis Metaphase





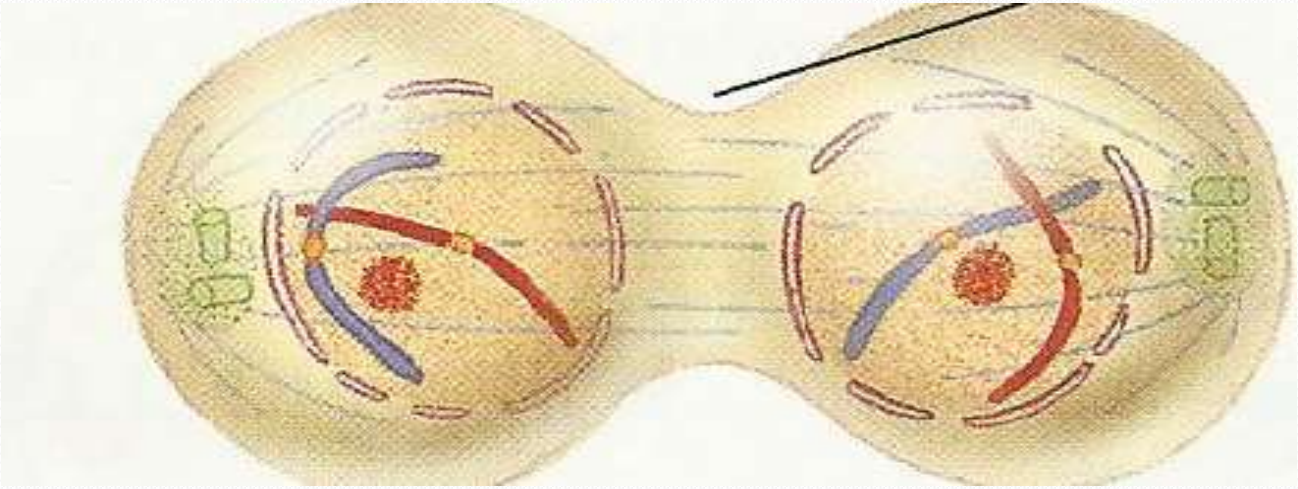
ANAPHASE





The **centromeres split** leading to the **separation** of the two members of the chromatid pair
once separated the chromatids are termed chromosomes

TELOPHASE

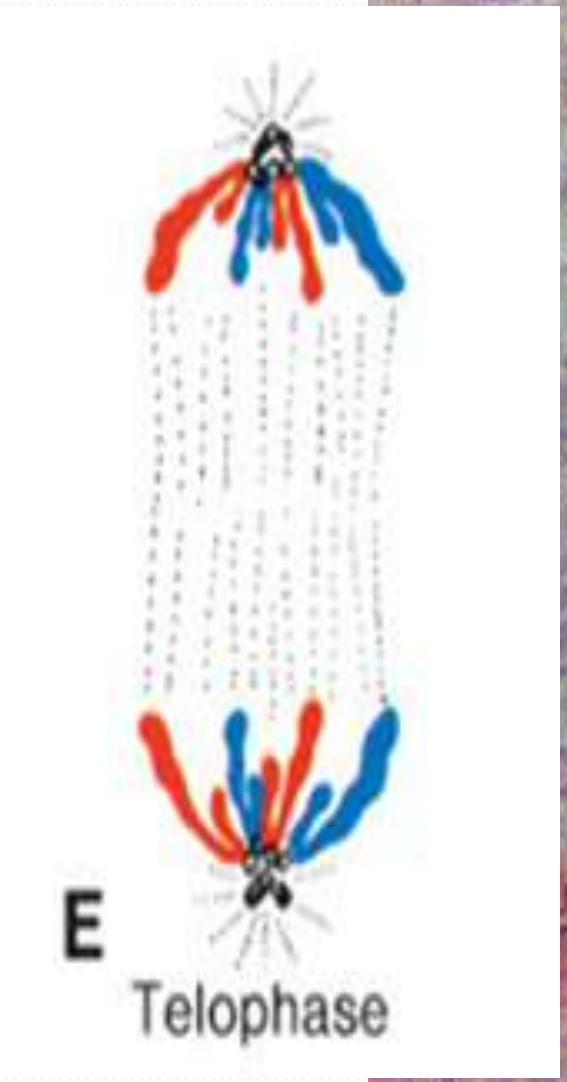


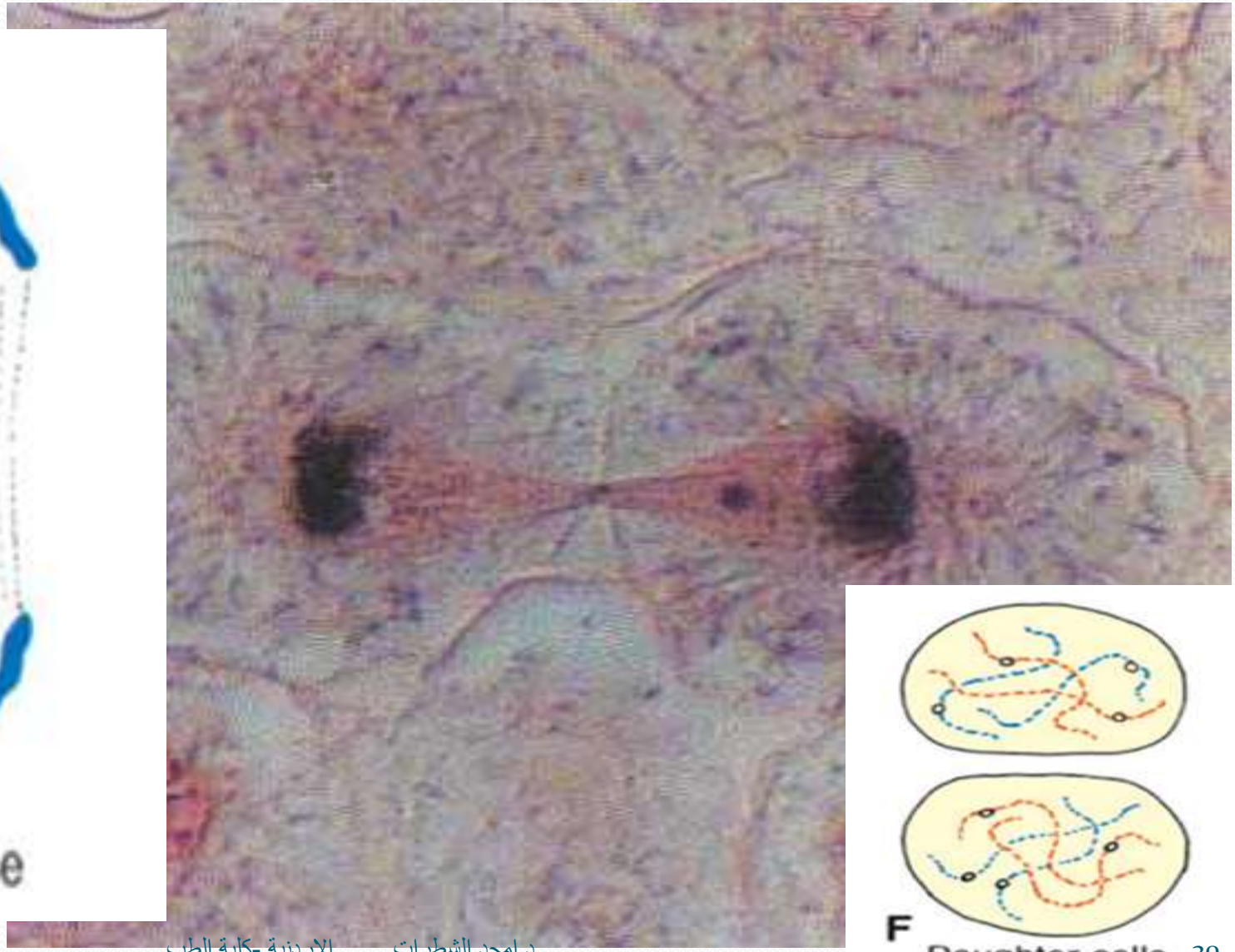
The identical sets of chromosomes now at apposite poles of the cell

A nuclear envelope forms around each chromatin mass

The mitotic spindle disappears

Mitosis Telophase



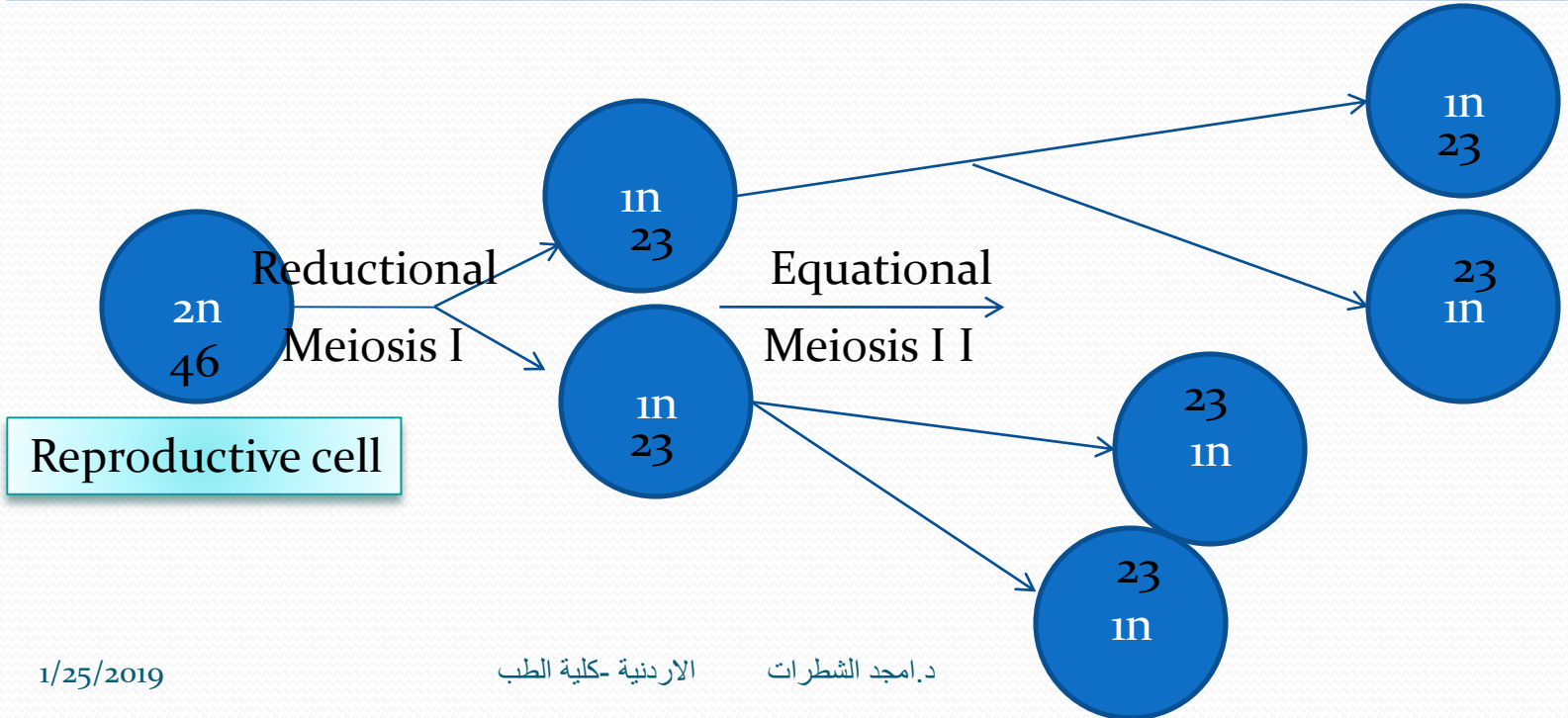


Meiosis

Meiosis occurs in two successive stages :

Meiosis I (also known as reductional meiosis) which deals with the number of chromosomes it halves the number of chromosomes

Meiosis I I (also known as equational meiosis) which deals with the conditions of chromosomes



Reproductive cell

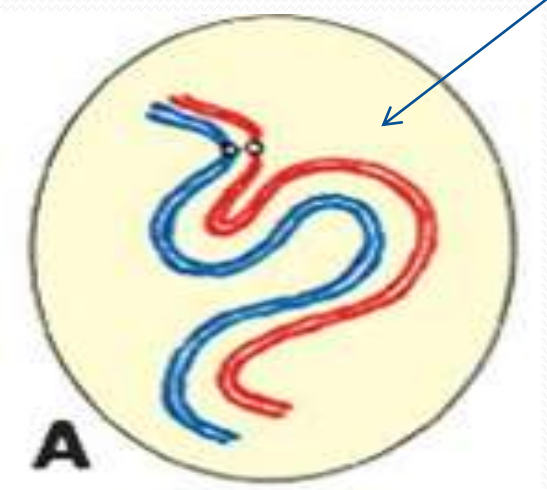
Meiosis I is generally divided into four stages:

1-Propahse
2-metaphase
3-Anophase

1-Prophase is running into stages

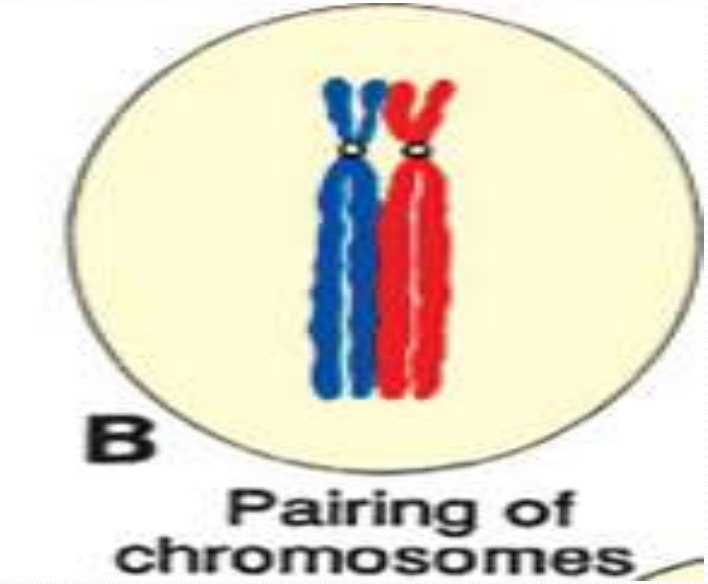
A- LEPTOTEN stage, (lepto means long)

In this stage chromosomes are elongated and extended and become gradually visible



B- ZYGOTEN stage, (zygo means joined)

In this stage identical chromosomes pair up together (synapsis)



C- PACHYTENE stage, (pachy means short)

In this stage chromosomes become shorter and more condensed

D- DIPLOTENE stage,

Chromosomes come together and cross each other by certain segments of their bodies

forming what we called CHIASMATA: X- shaped structure

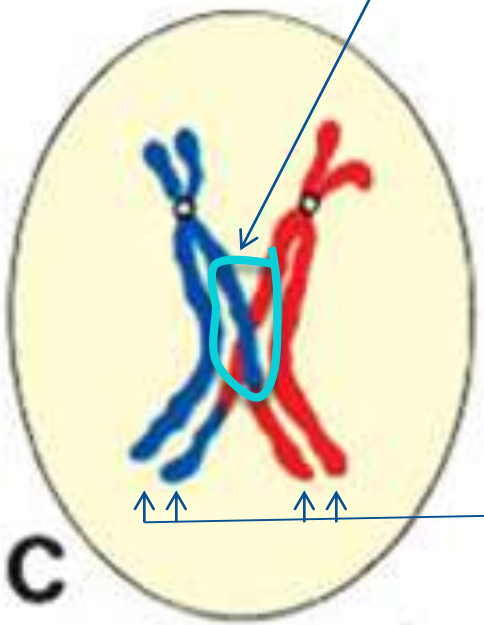
Formed by the junction of two chromatids of the for chromatids (tetrad)

In Prophase I

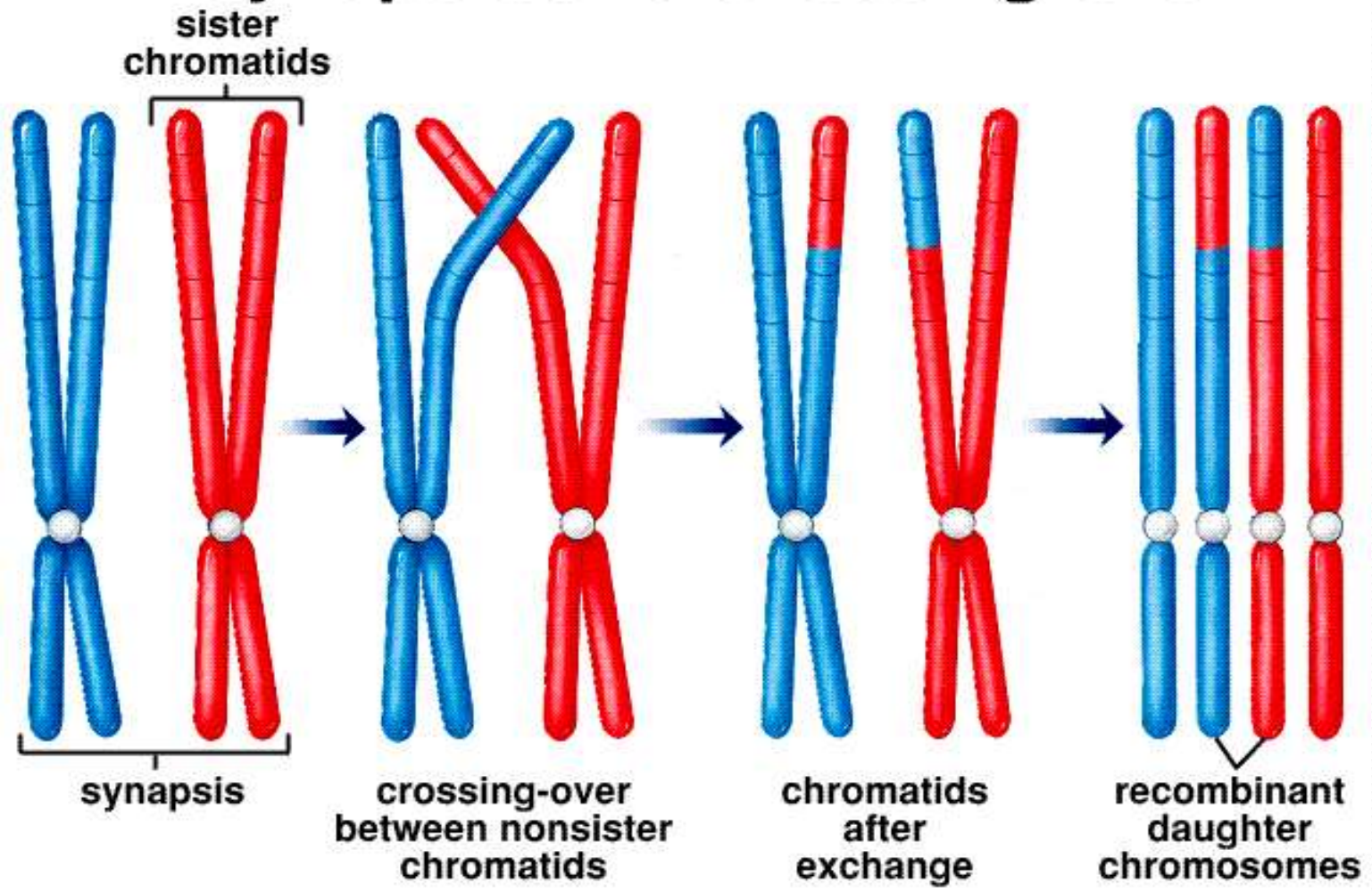
Crossing over of non-sister chromatids

During prophase I, non-sister chromatids can undergo synapsis, in which the chromatids line up side-by-side & exchange genetic information between them

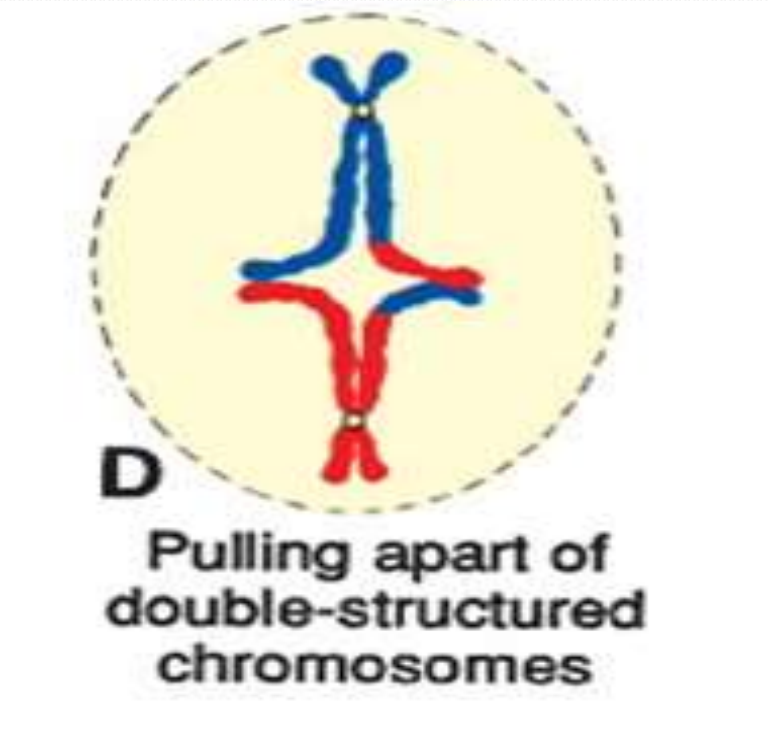
This allows new combination of genetic material which will become part of a new offspring



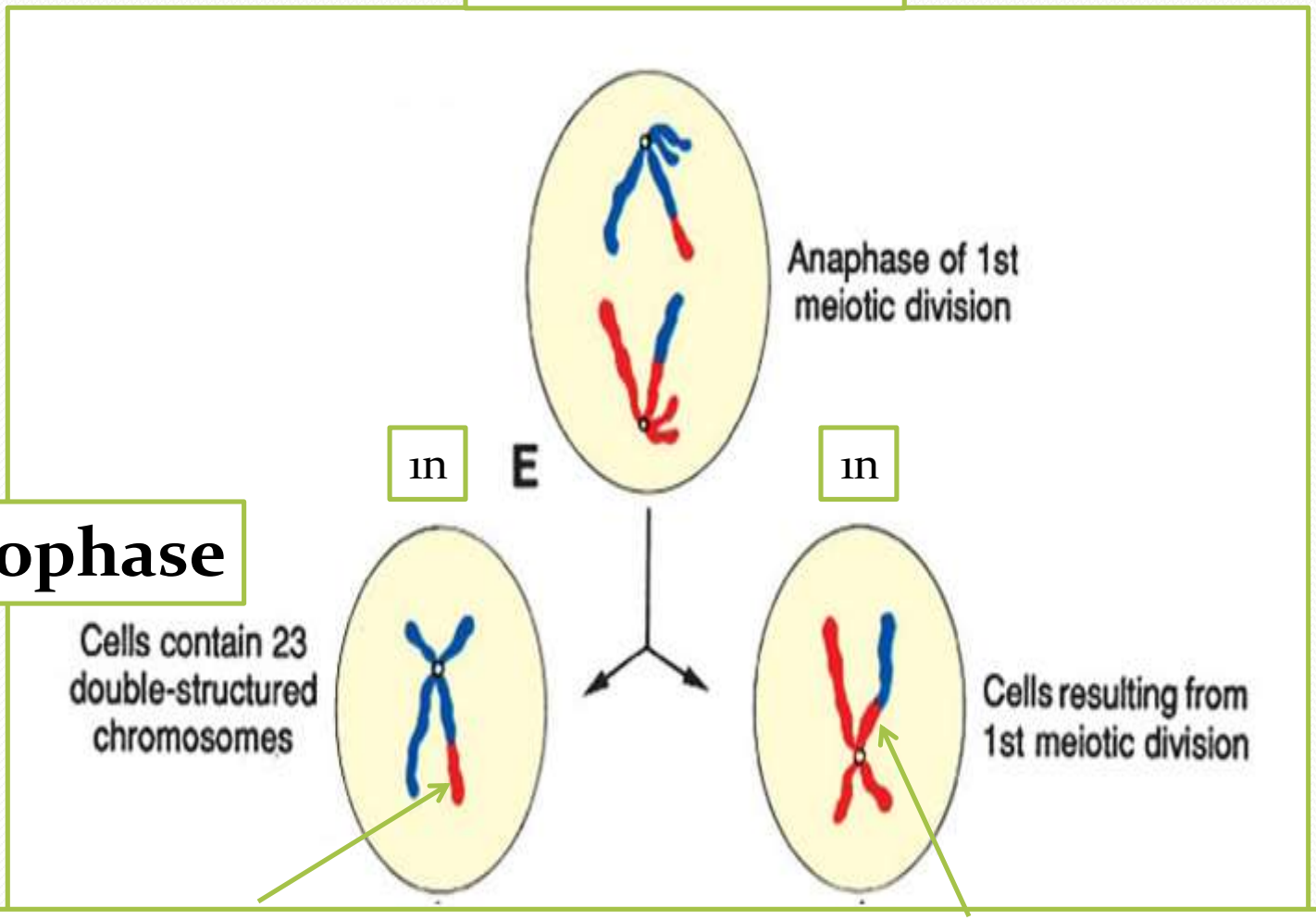
Synapsis and Crossing-over



2-Metaphase



3-Anophase

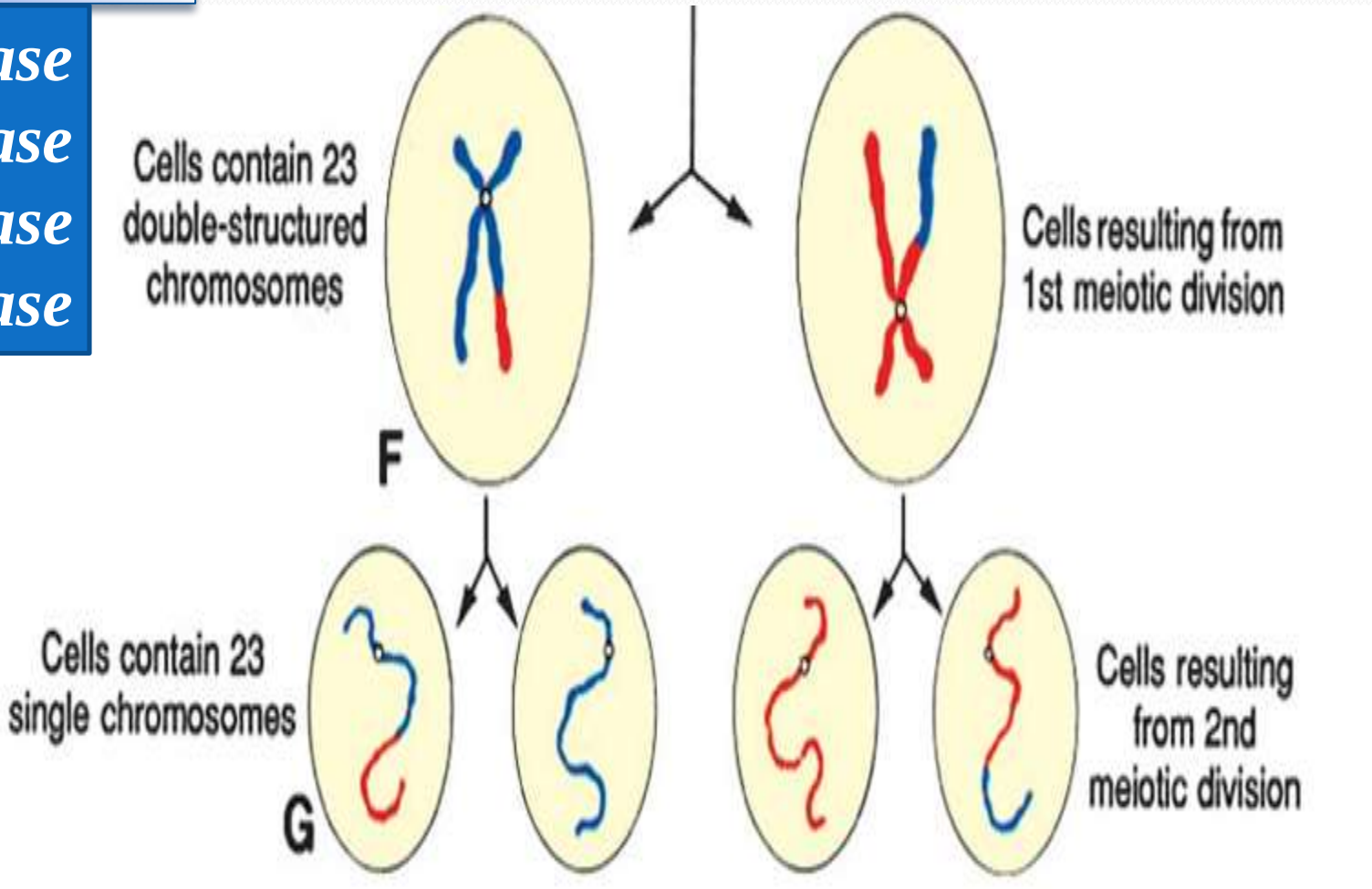


4-Telophase

rom the original cel
ation

Meiosis II runs into 4 stages:

1-Prophase
2-Metophase
3-Anaphase
4-Telophase



Meiosis I

Pairing of chromosomes

Homologous chromosomes separate

Daughter cells are haploid

Mitosis

No pairing

Sister chromatids separate,

Daughter cells are diploid

Chromosomal abnormalities

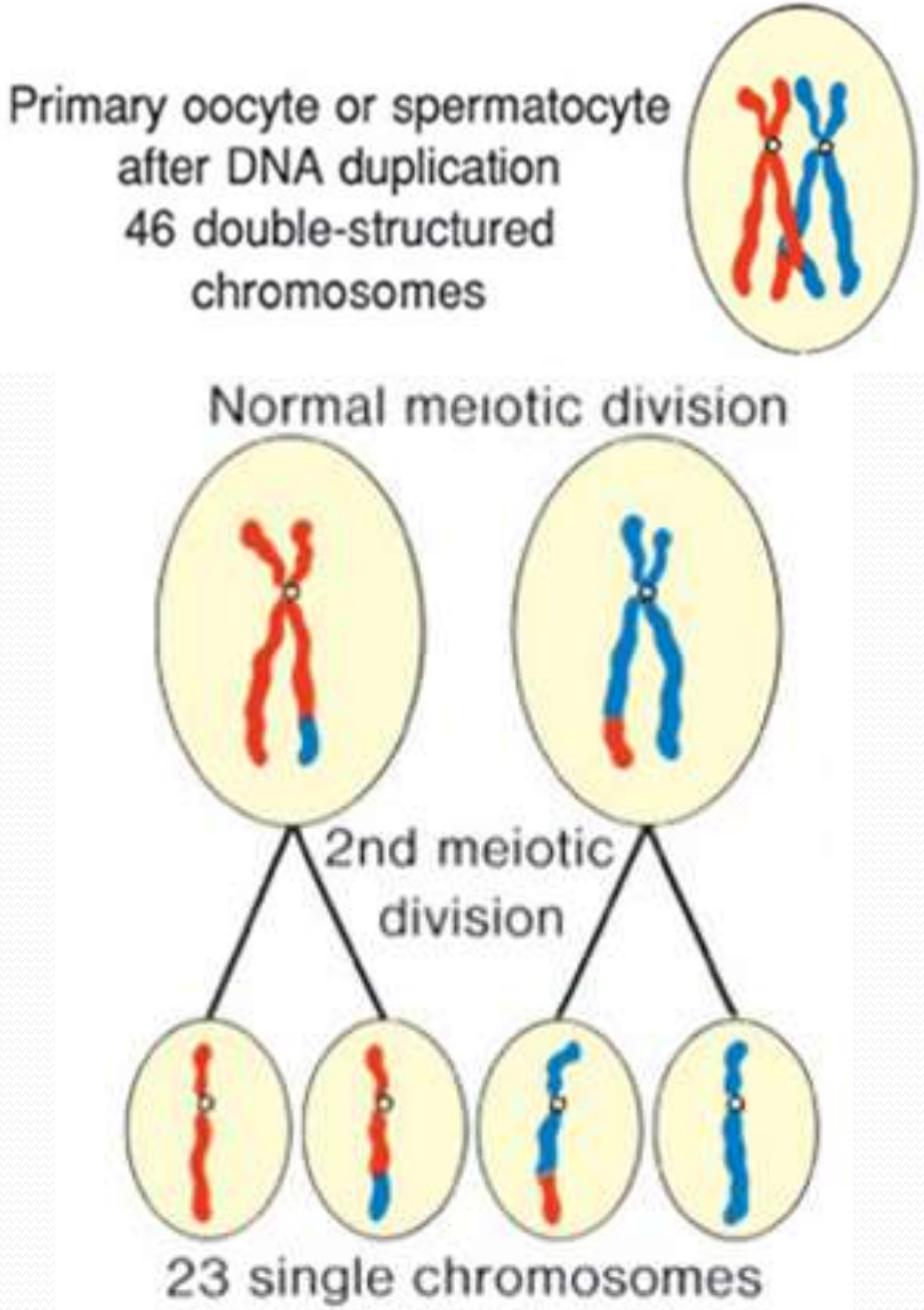
may be

numerical or structural

Abnormalities in chromosome number may originate during meiotic or mitotic divisions.

Normal

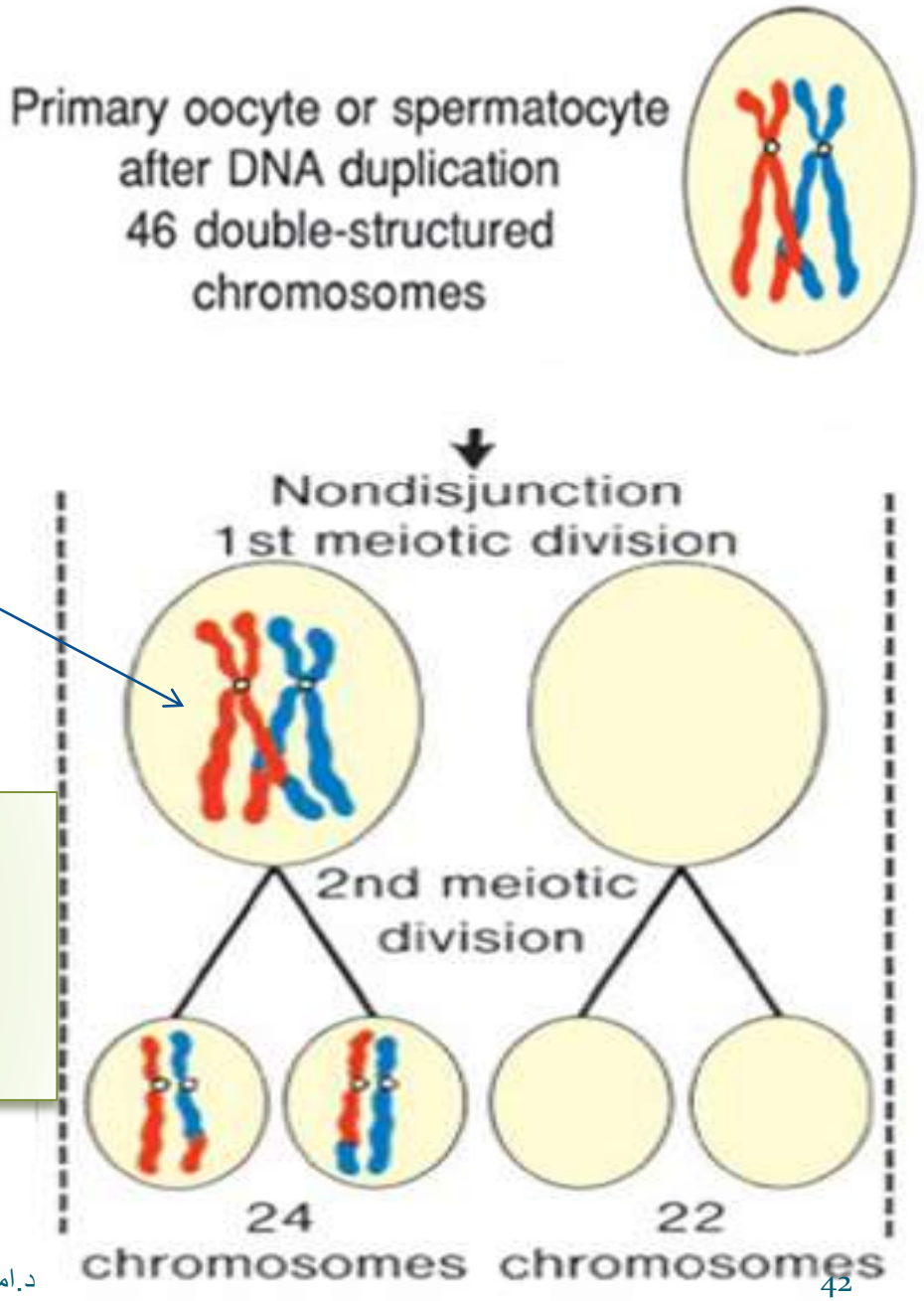
In **meiosis, two members of a pair** of homologous chromosomes normally separate during the first meiotic division so that each daughter cell receives one member of each pair

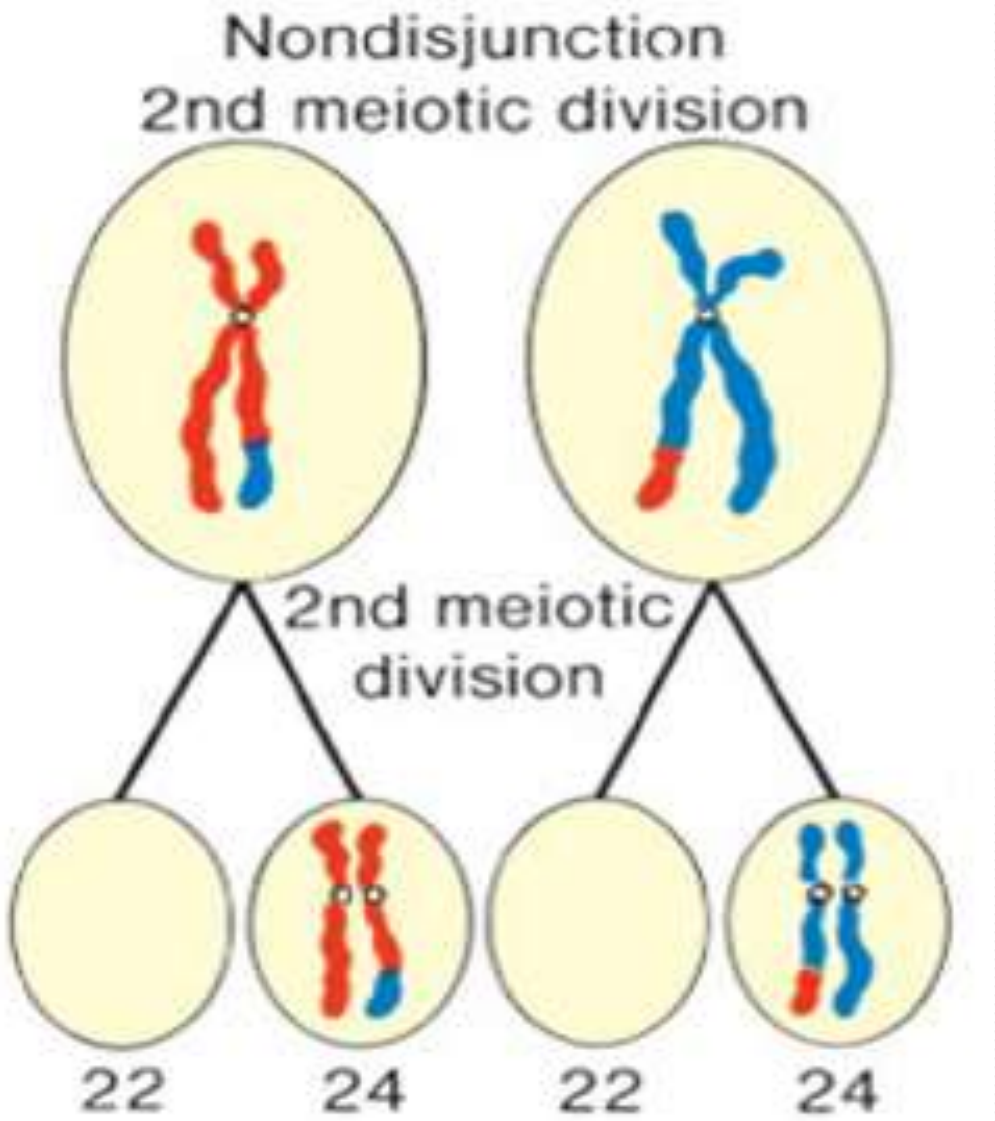


Sometimes, however, separation does not occur (**nondisjunction**)

Both
members of a pair move into one cell .

As a result of
nondisjunction of the chromosomes, one cell receives 24 chromosomes, and the other receives 22 instead of the normal 23.




Nondisjunction
2nd meiotic division
2nd meiotic division
22
24
22
24

Translocations

Sometimes chromosomes break, and pieces of one chromosome attach to another.

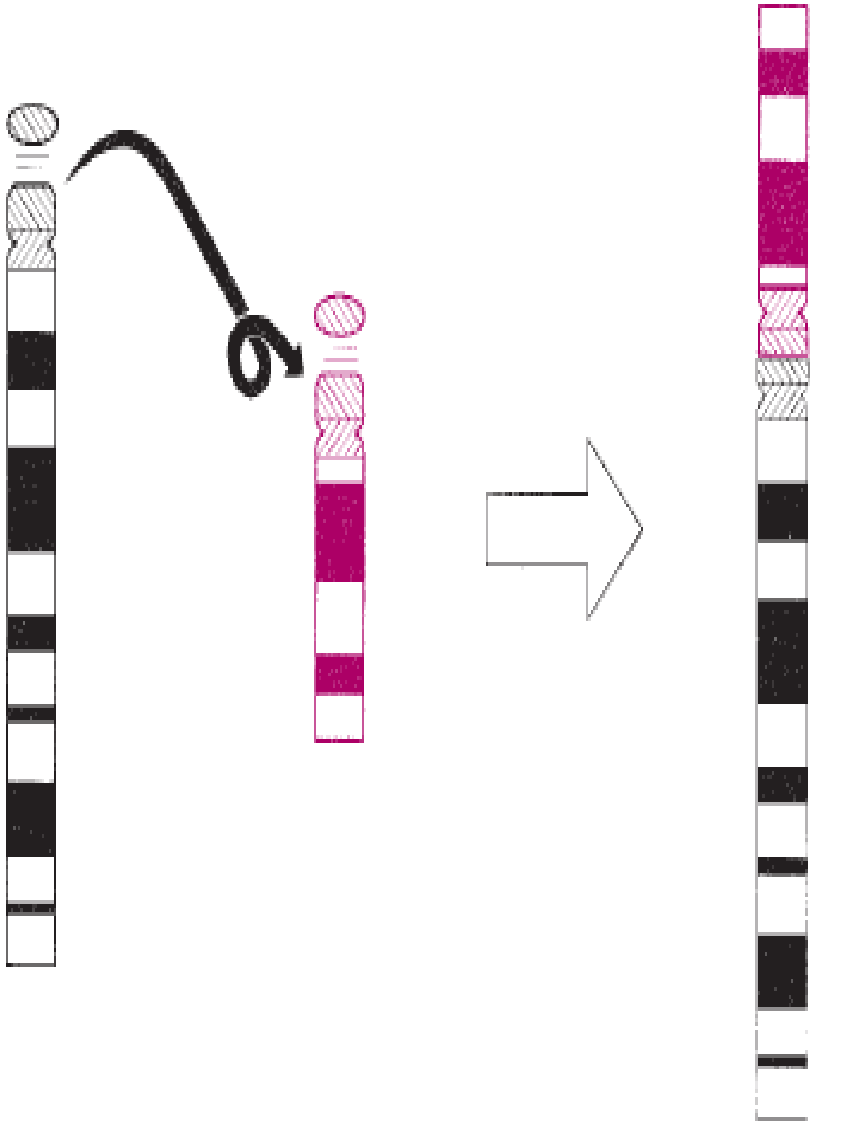
may be

1- **Balanced**, in which case breakage and reunion occur between two chromosomes but no critical genetic material is lost and individuals are normal

2-**Unbalanced**, in which case part of one chromosome is lost and an altered phenotype is produced.

An example,

unbalanced translocations between the long arms of chromosomes 14 and **21** during meiosis I or II produce gametes with an extra copy of chromosome **21**, **one** of the causes of Down syndrome



at fertilization,
a gamete having 23 chromosomes fuses with
a gamete having 24 or
22 chromosomes, the result is an individual
with either 47 chromosomes

Trisomy

or 45 chromosomes

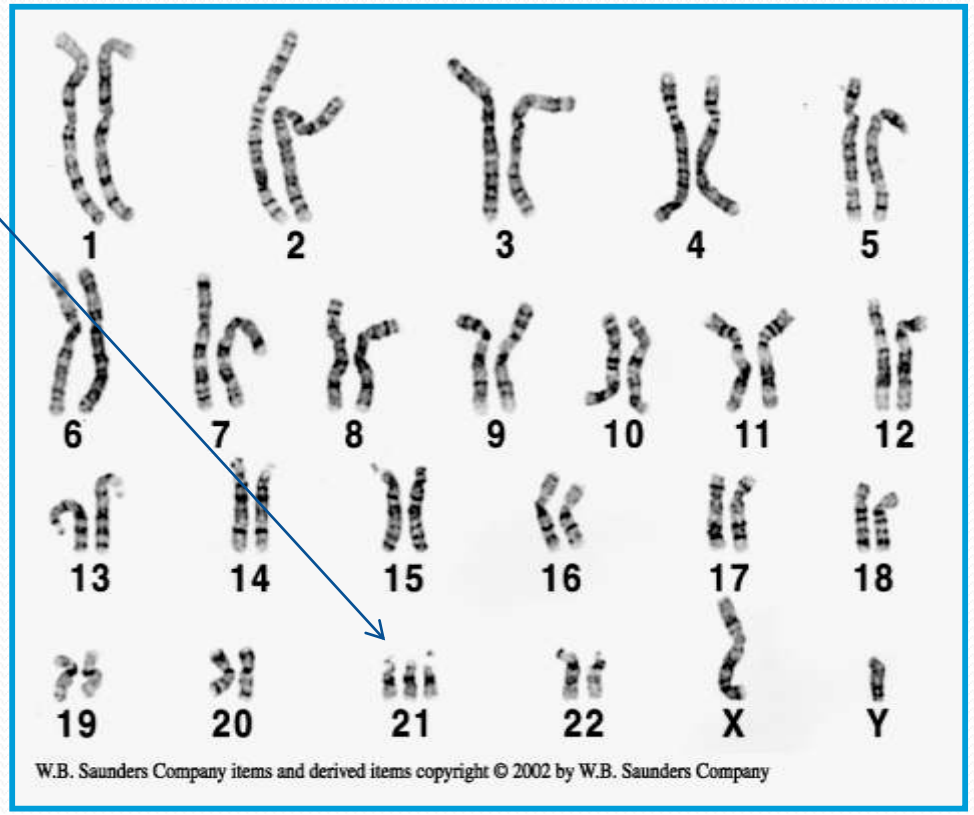
Monosomy

Down syndrome

Trisomy 21

Is usually caused by an extra copy of **chromosome 21**

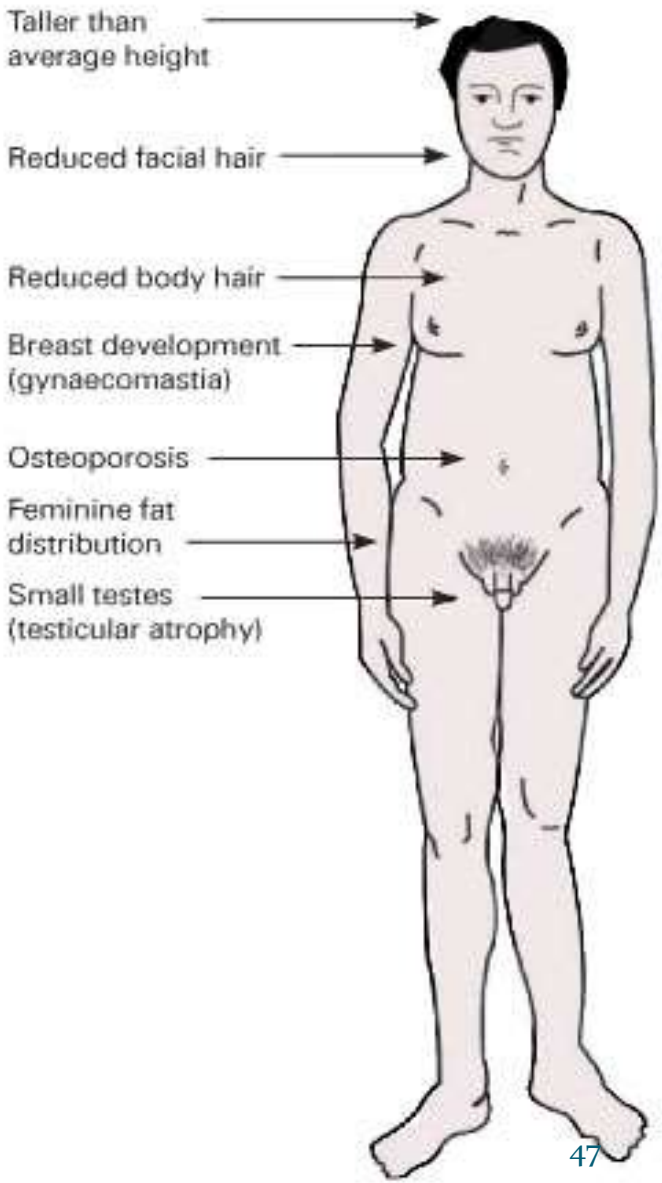
Mat… Frequency	…at birth
1/1250	15-19
1/1400	20-24
1/1100	25-29
1/900	30
1/900	31
1/750	31
1/625	32
1/500	33
1/386	34
1/300	35
1/225	36
1/175	37
1/140	38
1/100	39
1/80	40
1/65	41
1/50	
1/40	
1/25	



90%: Meiotic nondisjunction during meiosis II of oogenesis
10%: Meiotic nondisjunction during meiosis I of spermatogenesis

Klinefelter's Syndrome

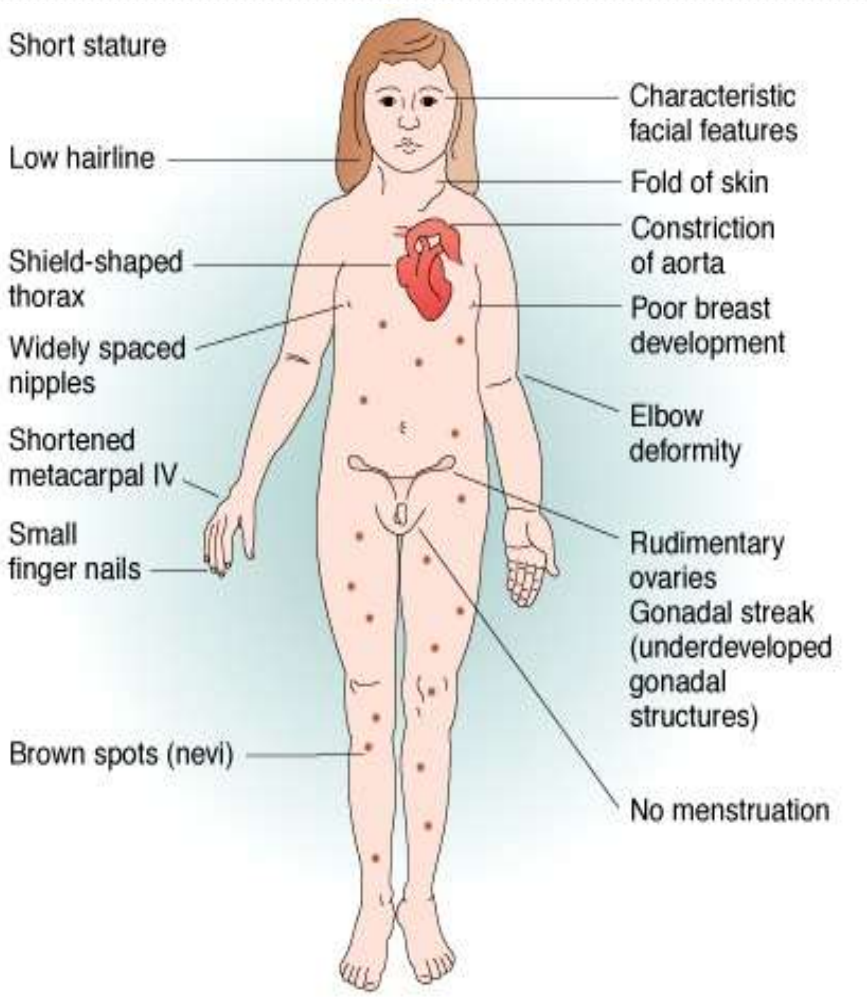
XXY – Phenotypically male with an **extra X** chromosome

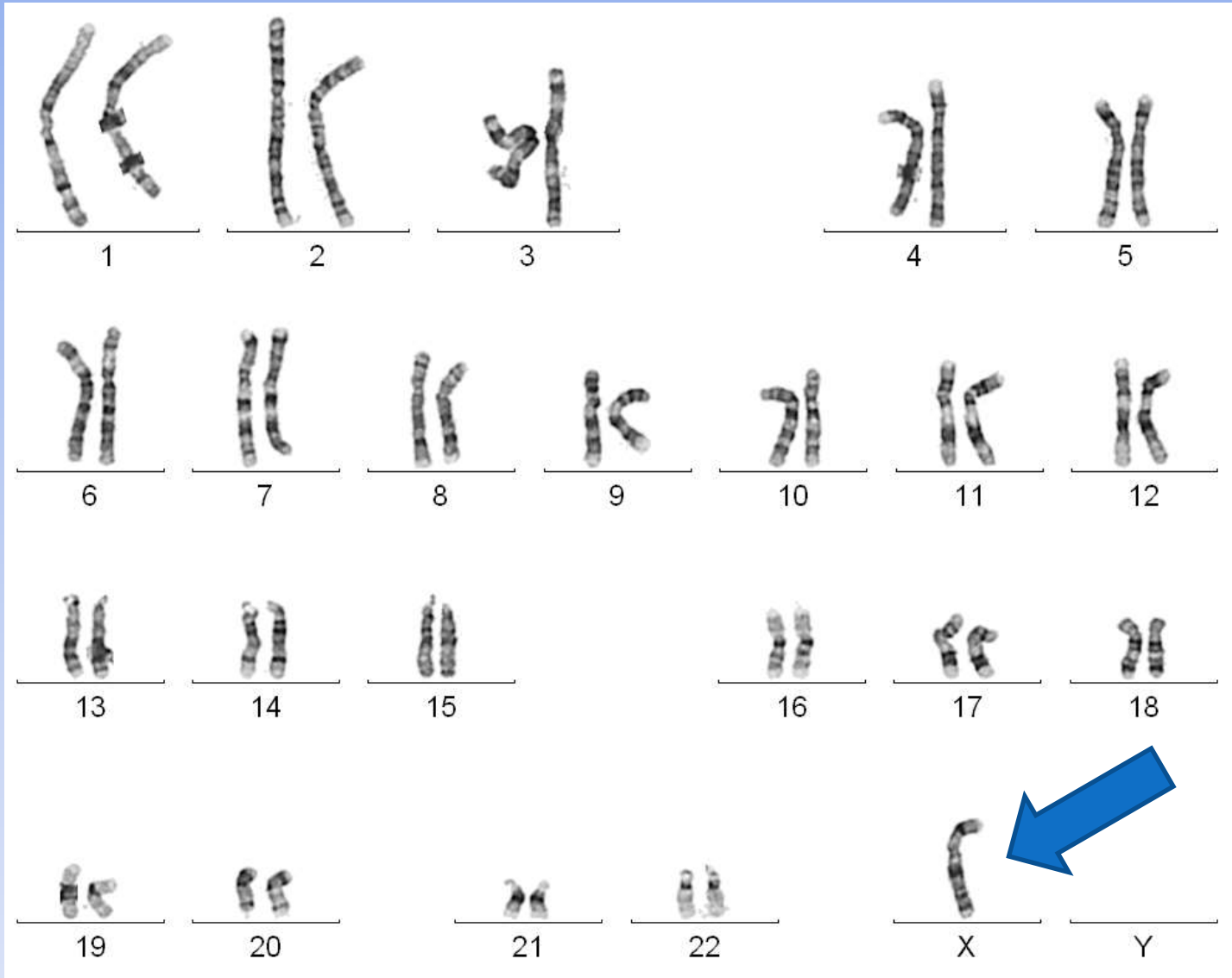


Turner's Syndrome

XO – Phenotypically female missing an **X** chromosome

is the only monosomy compatible with life.
Even then, 98% of all fetuses with the syndrome are spontaneously aborted.
The few that survive are unmistakably female in appearance
and are characterized by the absence of ovaries (**gonadal dysgenesis**)

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Thank you