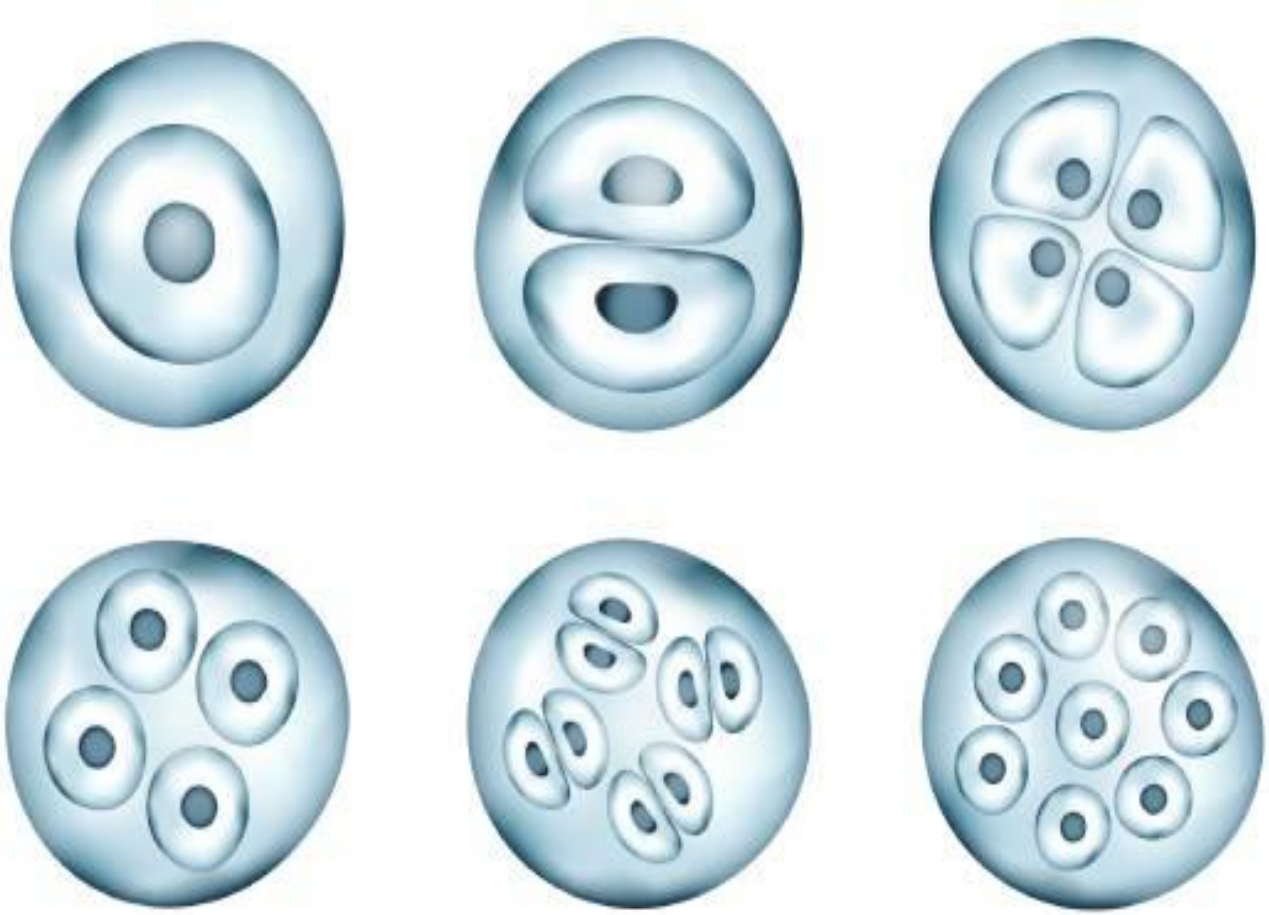


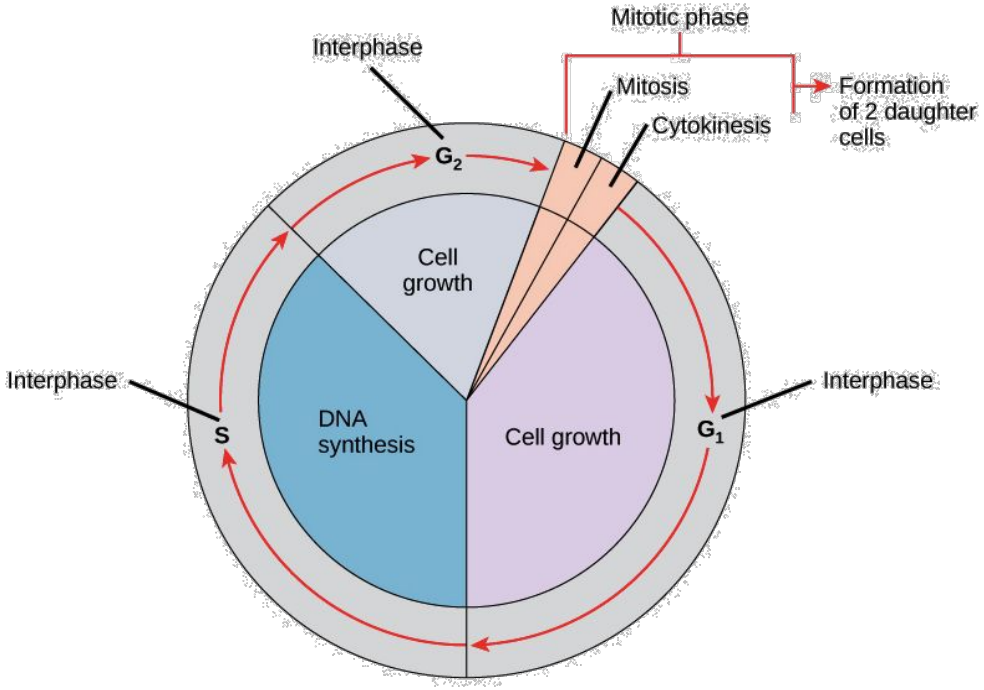
Introduction to Biology
BIO 101

Cell Division
Lecture 04

BRAC UNIVERSITY
Inspiring Excellence

CELL CYCLE

The cell cycle is an ordered series of events involving cell growth and cell division that produces two new daughter cells.



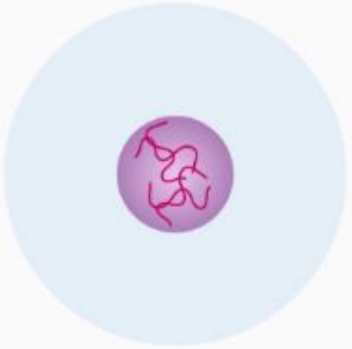
CELL DIVISION

Cell division is the process by which a parent cell divides into two or more daughter cells. Cell division usually occurs as part of a larger cell cycle.

Cell Cycle

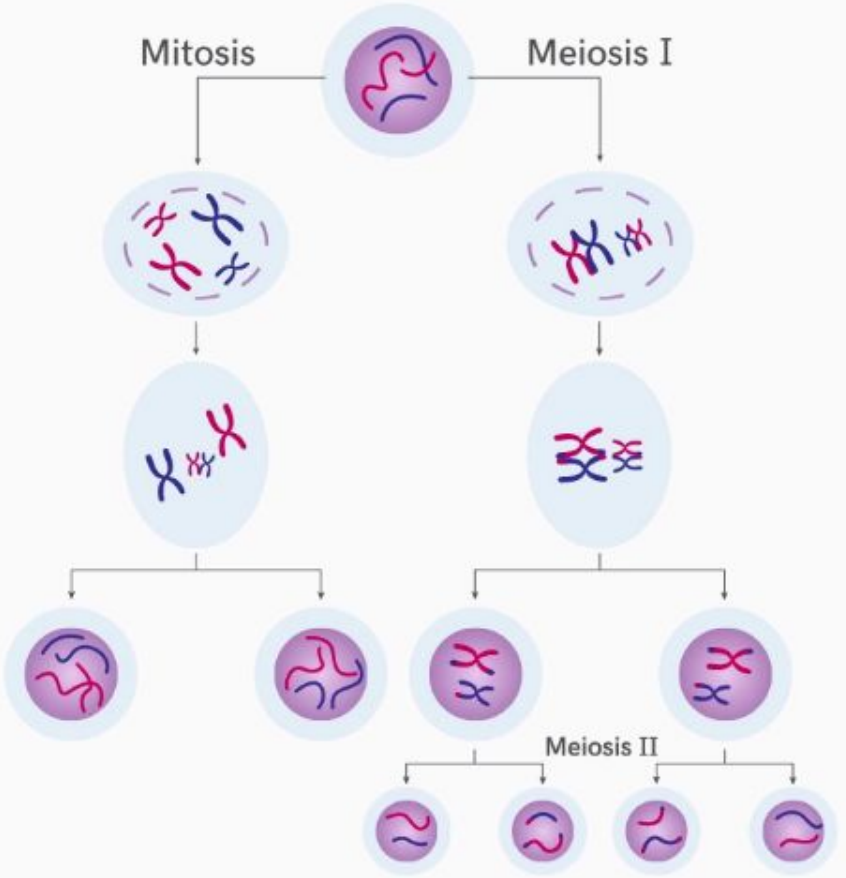
Interphase
(Preparatory Phase)

- Cell Growth
- DNA replication



M Phase
(Mitotic/Meiotic Phase)

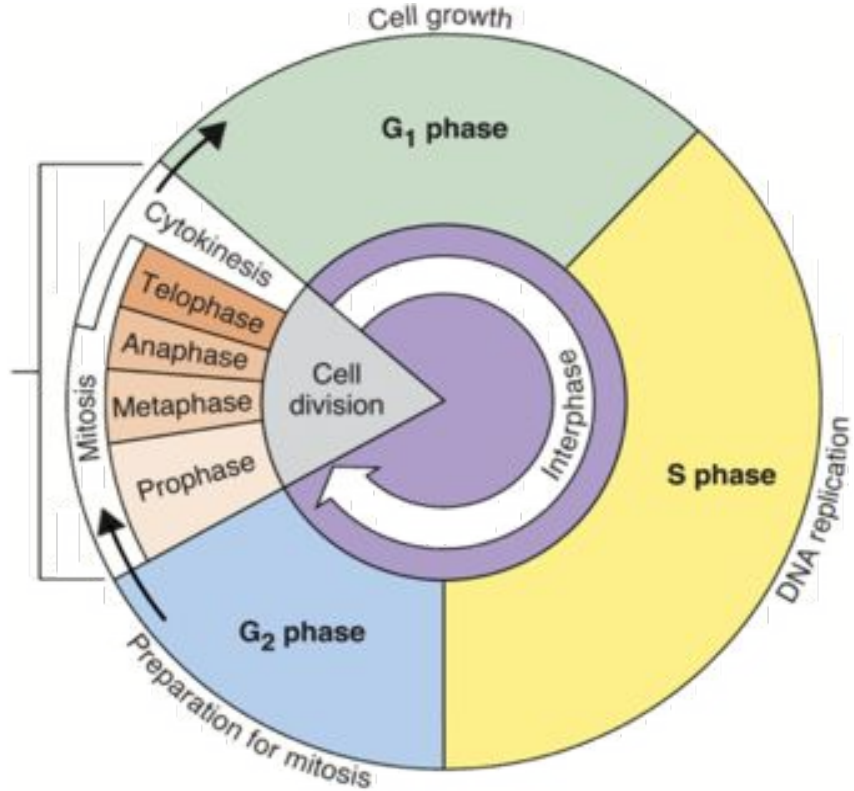
- Cell Division

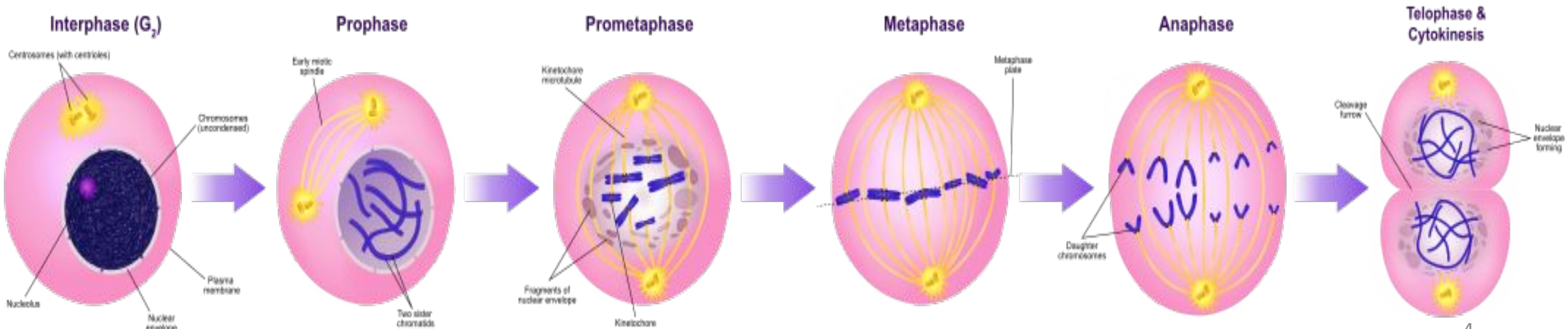


~ 24 hours to complete one cycle

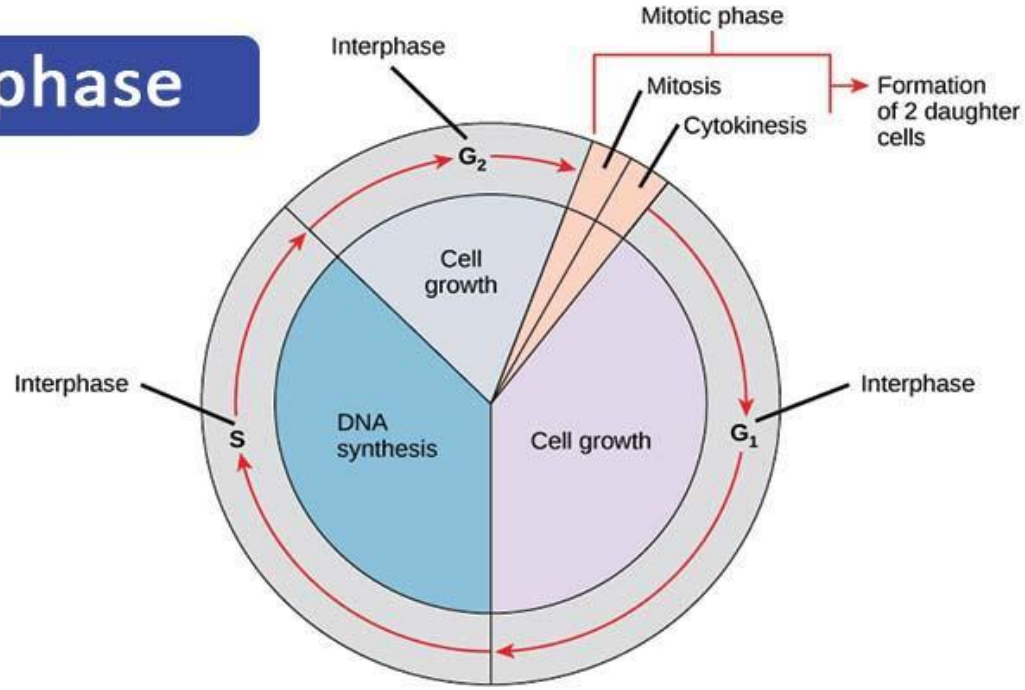
Interphase → More than 90% of total time of Cell Cycle

M Phase → Less than 10% of total time of Cell Cycle


Cell growth
G1 phase
Cytokinesis
Telophase
Anaphase
Metaphase
Prophase
Mitosis
Cell division
Interphase
S phase
DNA replication
G2 phase
Preparation for mitosis


Interphase (G2)
Centrosomes (with centrioles)
Chromosomes (uncondensed)
Nucleolus
Plasma membrane
Nuclear envelope
Prophase
Early mitotic spindle
Two sister chromatids
Prometaphase
Kinetochore microtubule
Fragments of nuclear envelope
Kinetochore
Metaphase
Metaphase plate
Anaphase
Daughter chromosomes
Telophase & Cytokinesis
Cleavage furrow
Nuclear envelope forming

Interphase



1. Usually longest part of the cycle
2. Cell increases in mass
3. Number of cytoplasmic components doubles
4. DNA is duplicated

G1

Interval or gap after cell division

S

Time of DNA synthesis (replication)

G2

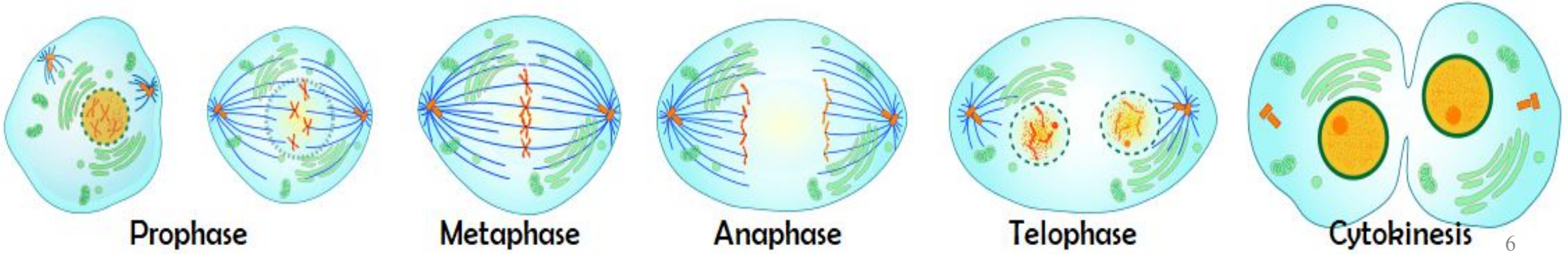
Interval or gap after DNA replication

MITOSIS CELL DIVISION

Period of nuclear division
Usually followed by cytoplasmic division

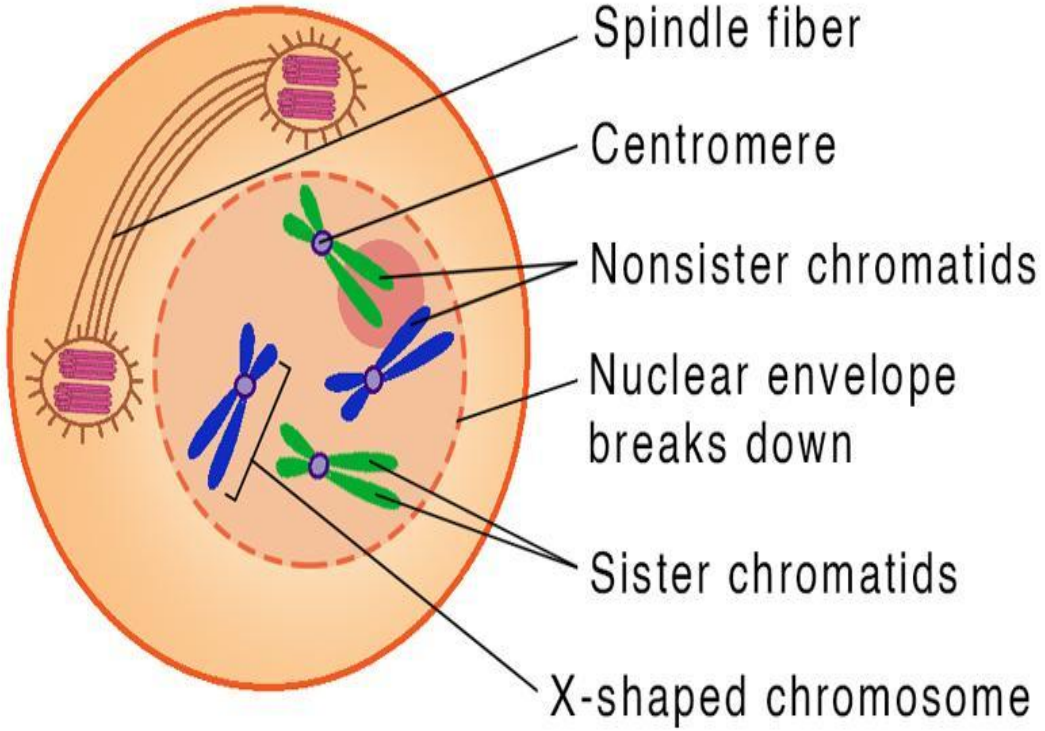
Four stages

Prophase
Metaphase
Anaphase
Telophase



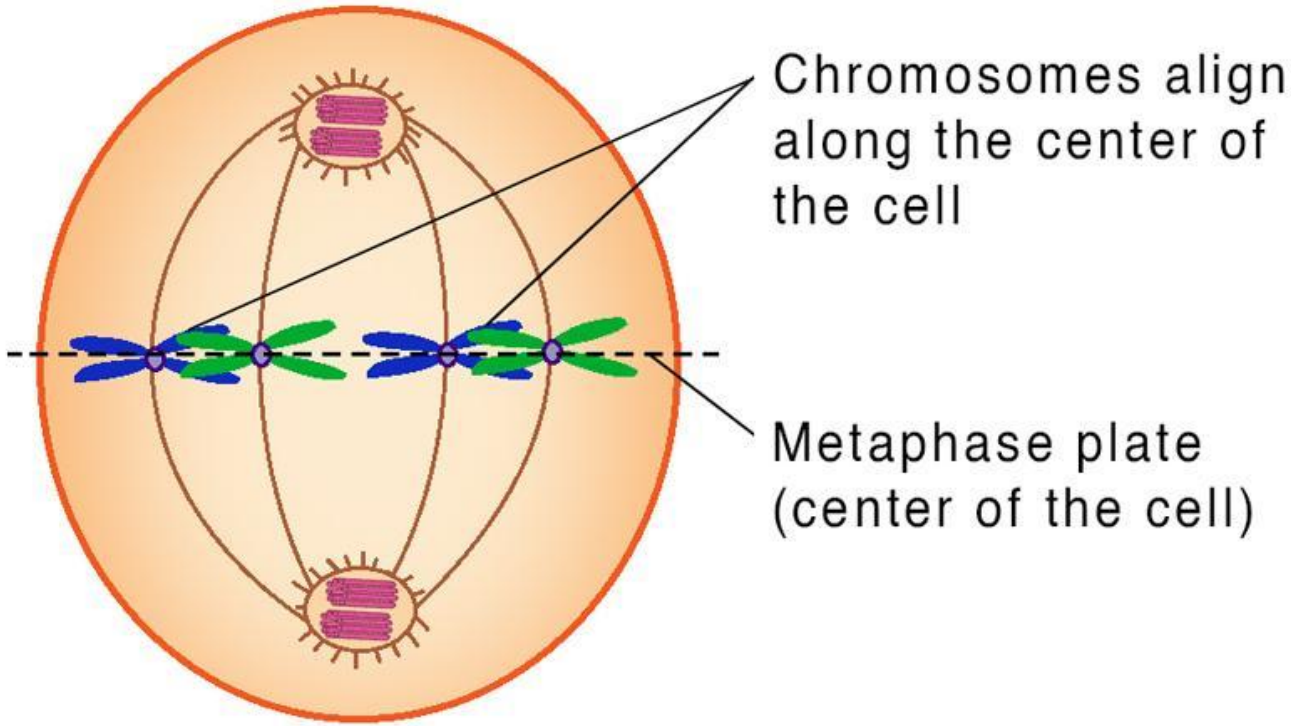
PROPHASE

1. Duplicated chromosomes begin to condense
2. New microtubules are assembled
3. One centriole pair is moved toward opposite pole of spindle
4. Nuclear envelope starts to break up
5. Spindle forms
6. Spindle microtubules become attached to the two sister chromatids of each chromosome



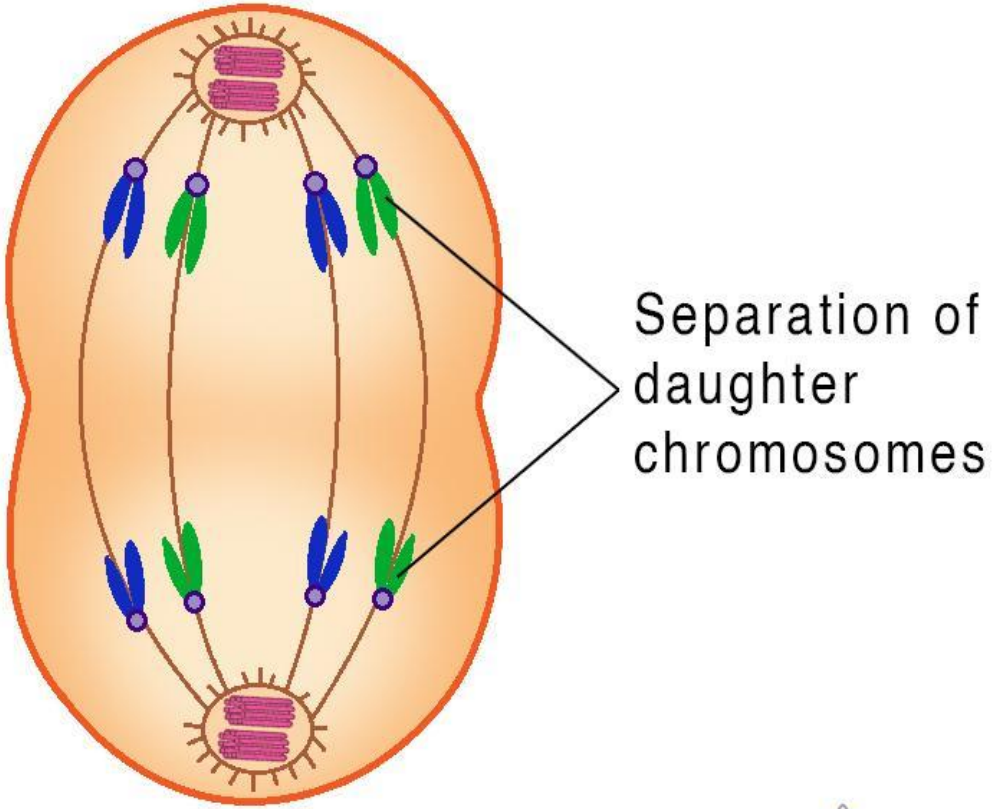
METAPHASE

1. All chromosomes are lined up at the spindle equator
2. Chromosomes are maximally condensed



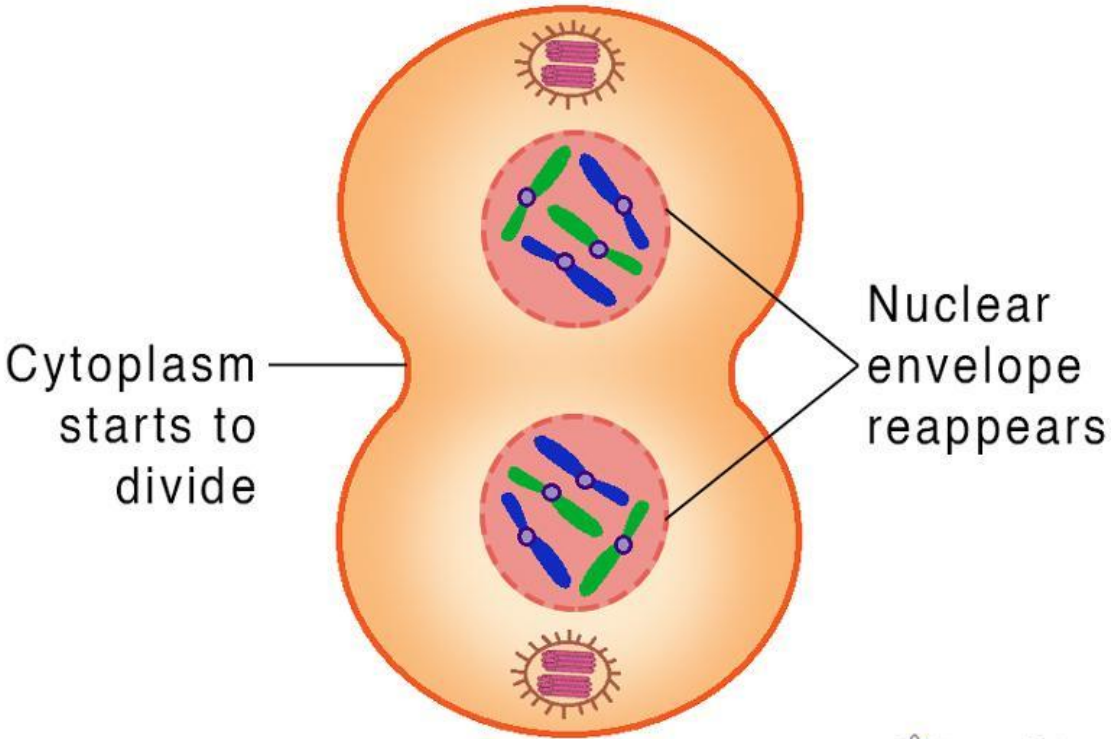
ANAPHASE

1. It starts by splitting each paired chromosome into two sister chromatids, now known as daughter chromosomes.
2. The daughter chromosomes are pulled towards the opposite end of the cell due to the contraction of the spindle fibers.
3. At the end of this phase, each pole contains a complete set of chromosomes.



TELOPHASE

1. Chromosomes de-condense
2. Two nuclear membranes form, one around each set of unduplicated chromosomes

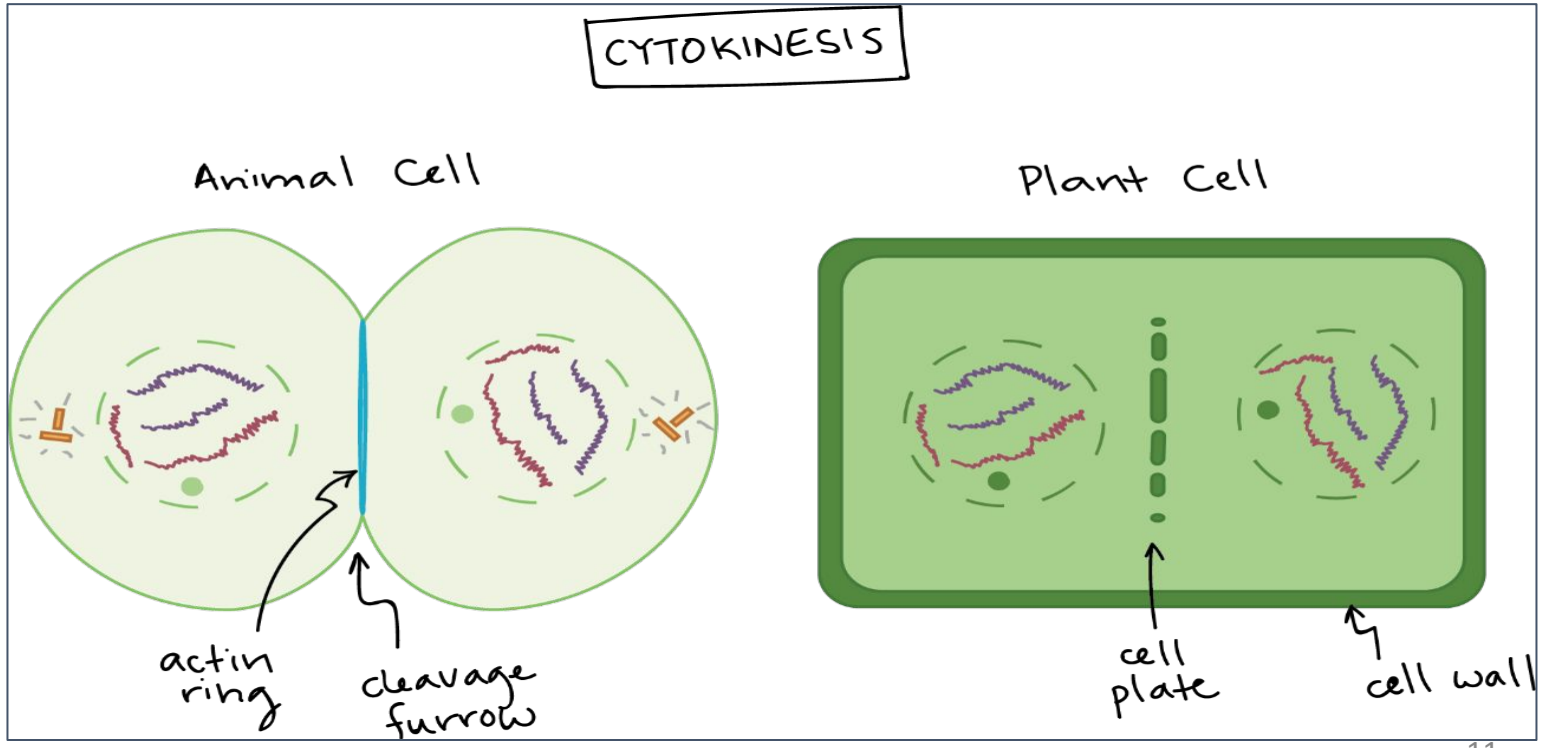


CYTOKINESIS

1. Cytoplasmic Division
2. Usually occurs between late anaphase and end of telophase

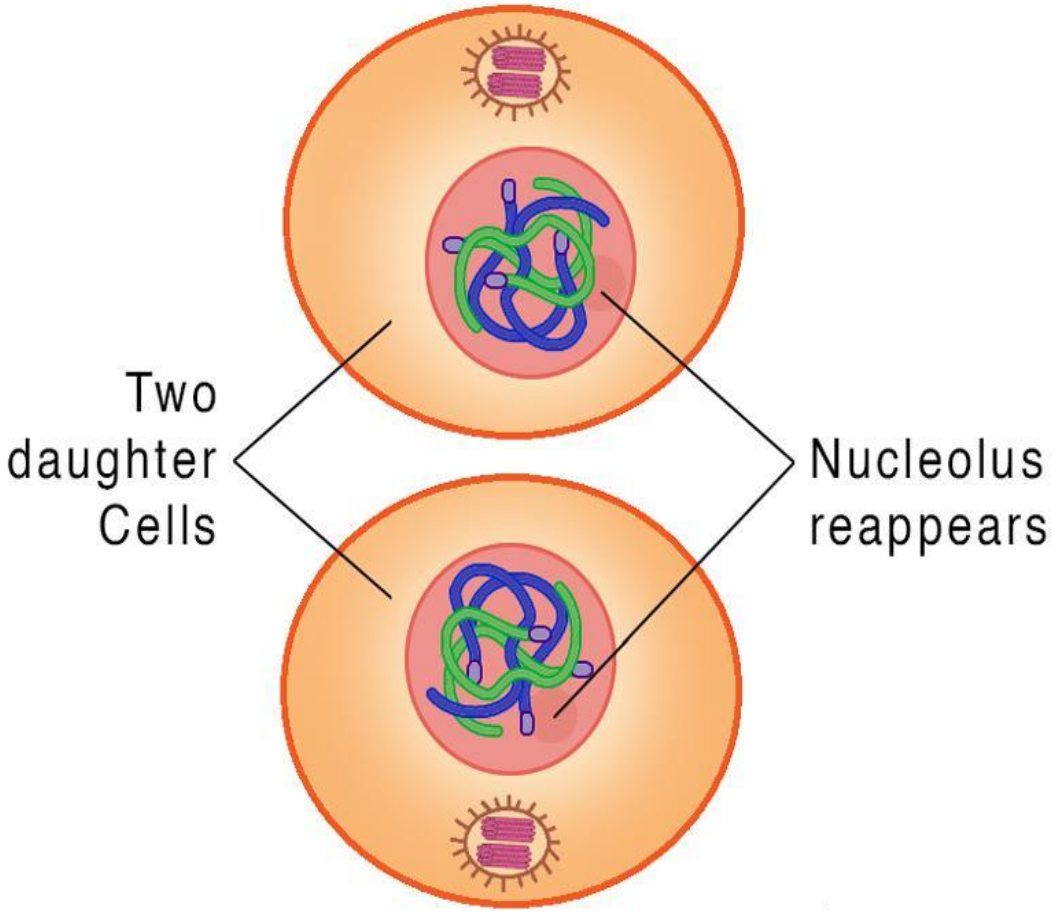
Two mechanisms

1. Cleavage (animals)
2. Cell plate formation (plants)



RESULTS OF MITOSIS

1. Two daughter nuclei
2. Each with same chromosome number as parent cell
3. Chromosomes in unduplicated form



SIGNIFICANCE OF MITOSIS

1. It is responsible for the growth and development of multi-cellular organisms.

2. Mitosis facilitates the development of a single-cell zygote into a full-grown adult.

3. It is responsible for the growth and development of multi-cellular organisms.

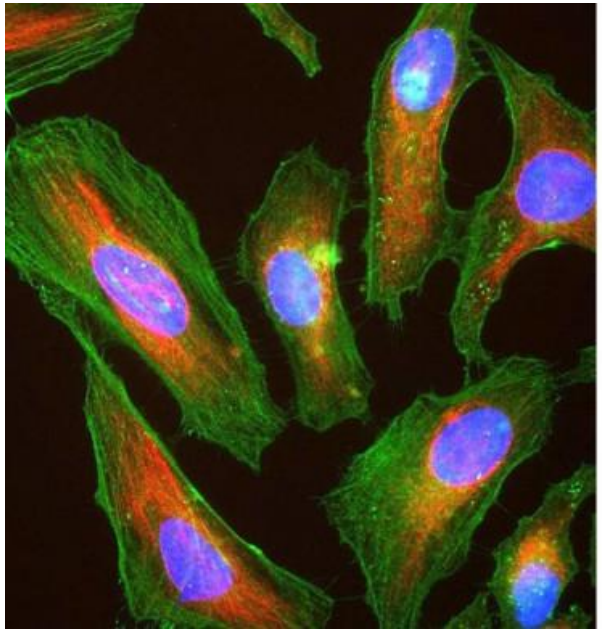
4. It helps in repairing damaged or worn-out tissues.

5. The way in which the skin cells that cover a child's body grow and divide is an illustration of mitosis

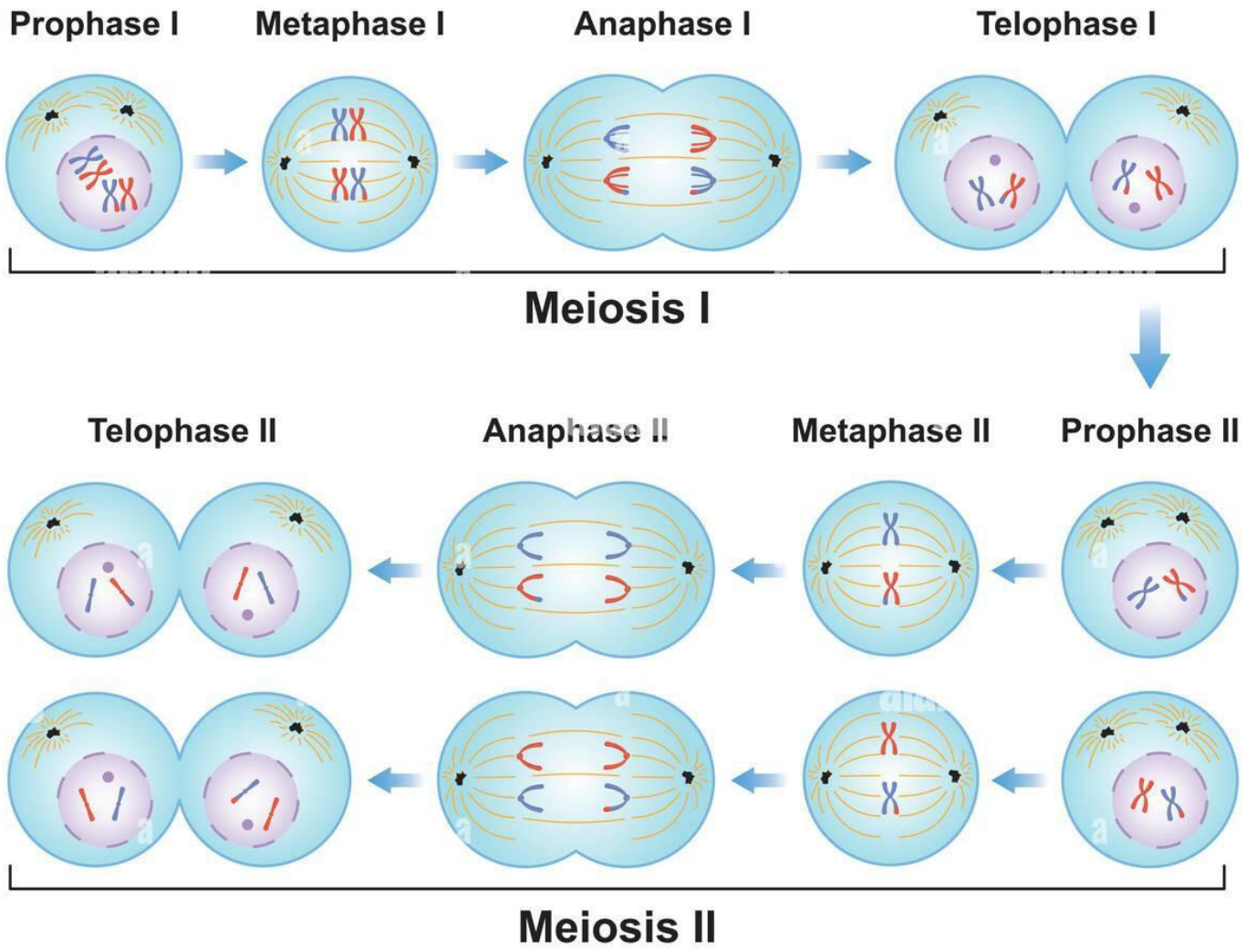
HELA CELLS

- Growing cells in culture allows researchers to investigate processes and test treatments without danger to patients
- Most cells cannot be grown in culture
- Line of human cancer cells that can be grown in culture
- Descendants of tumor cells from a woman named Henrietta Lacks
- Lacks died at 31, but her cells continue to live and divide in labs around the world.
- These cells have been invaluable for medical research.

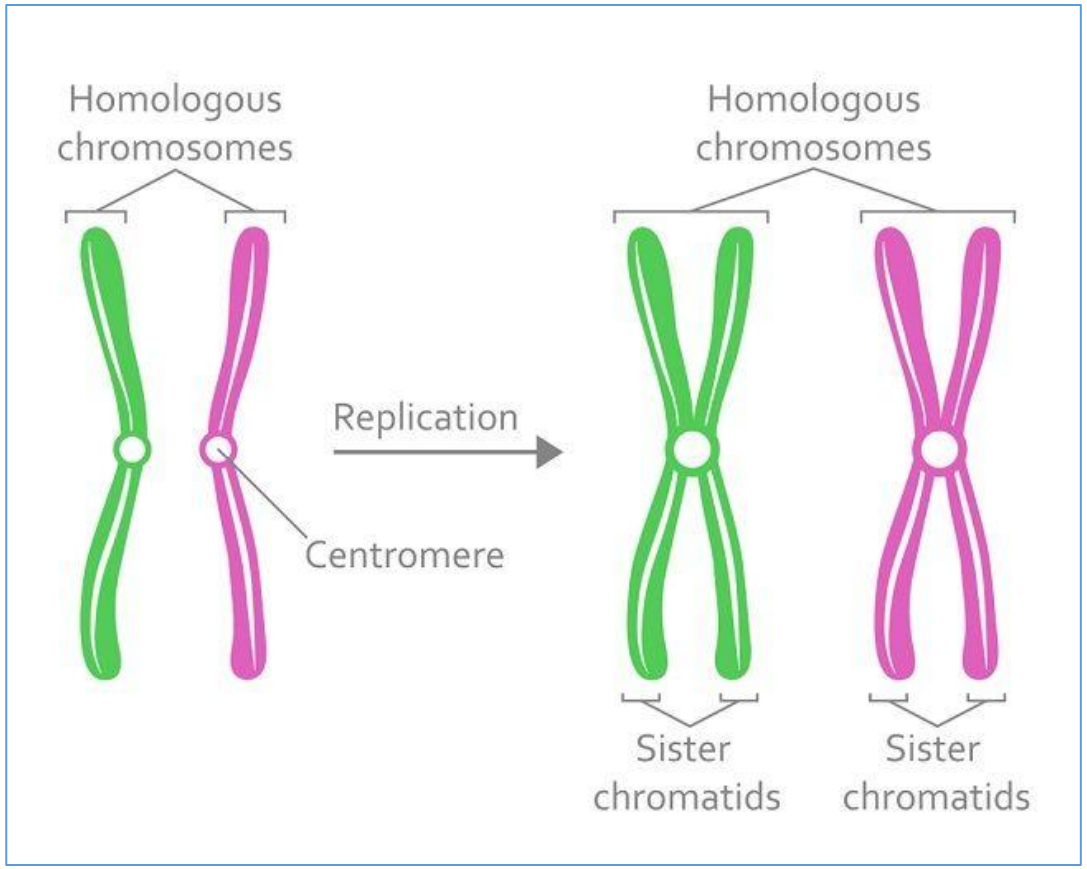
- They've been used to create the polio vaccine
- They were the first human cells to go up in space to see the effect of zero gravity
- Vital in cloning
- In vitro fertilization
- Gene mapping

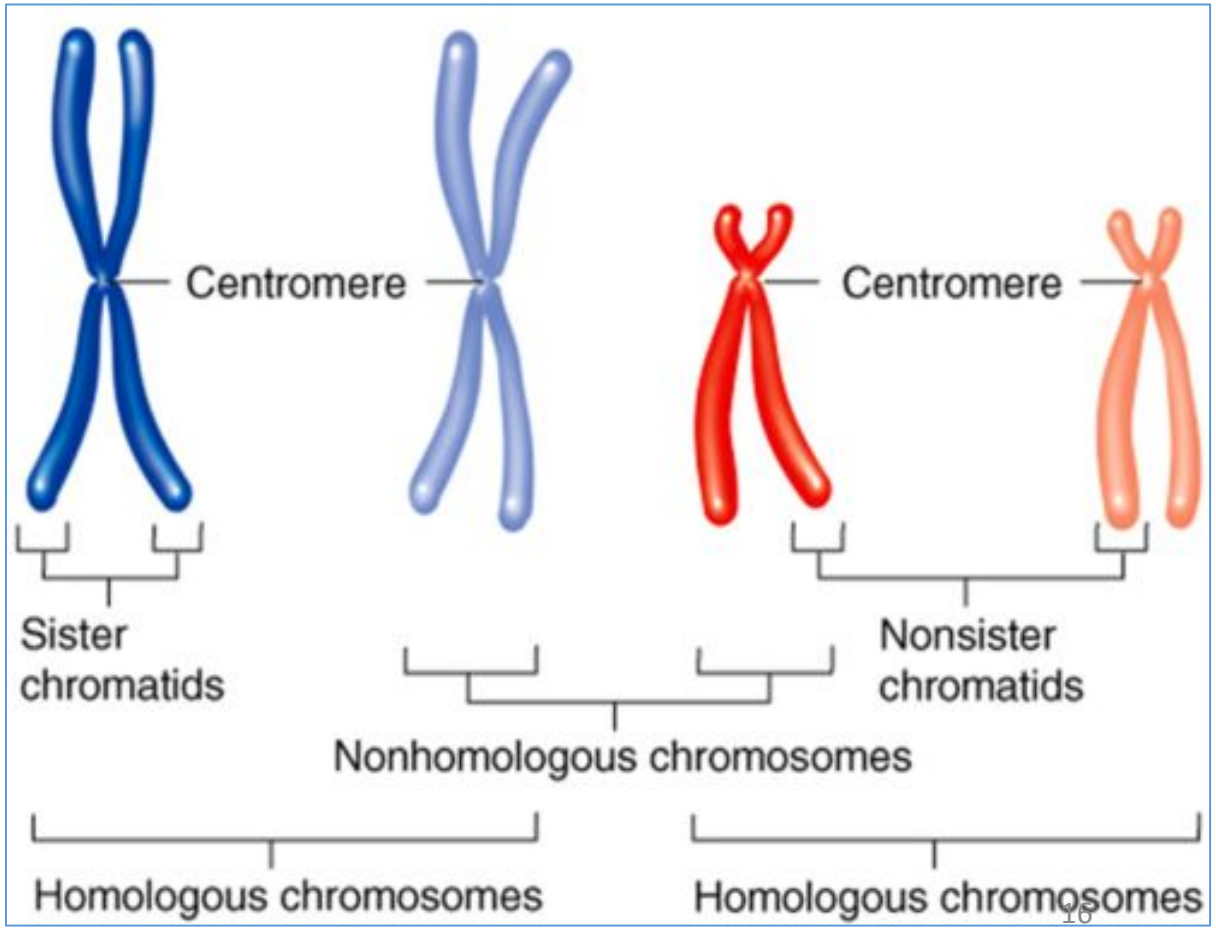


MEIOSIS CELL DIVISION



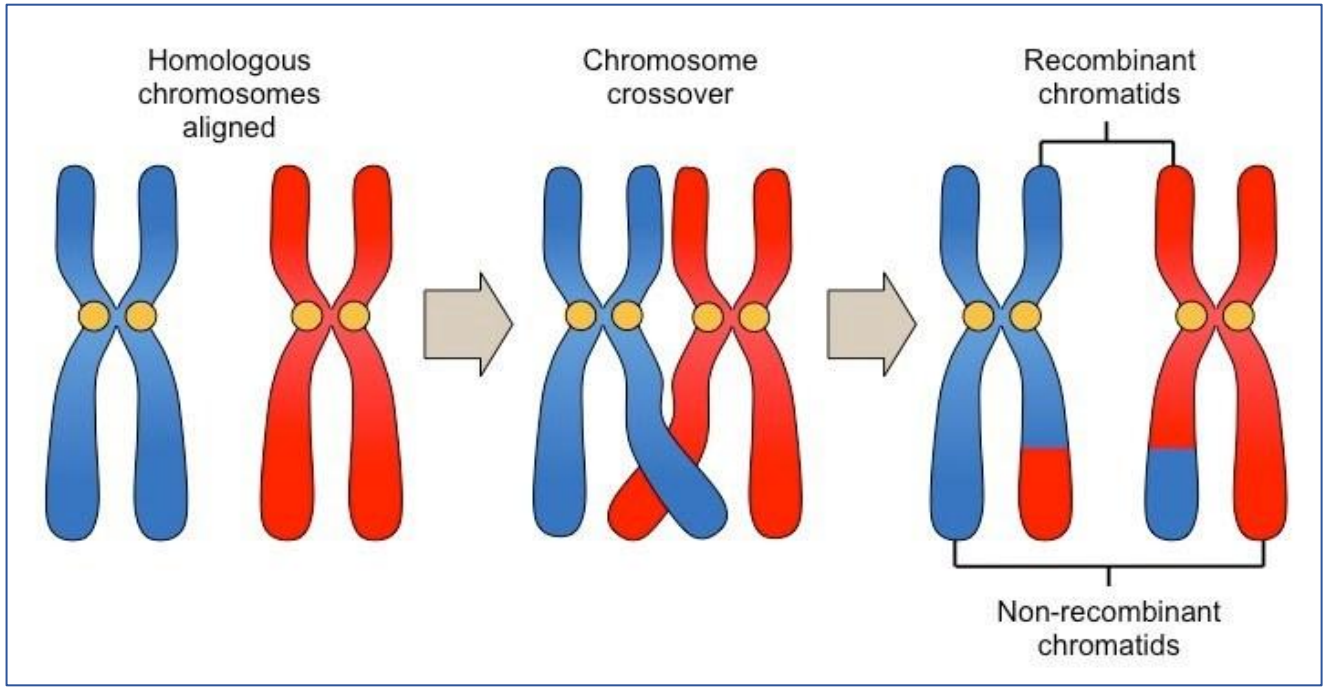
HOMOLOGOUS CHROMOSOMES



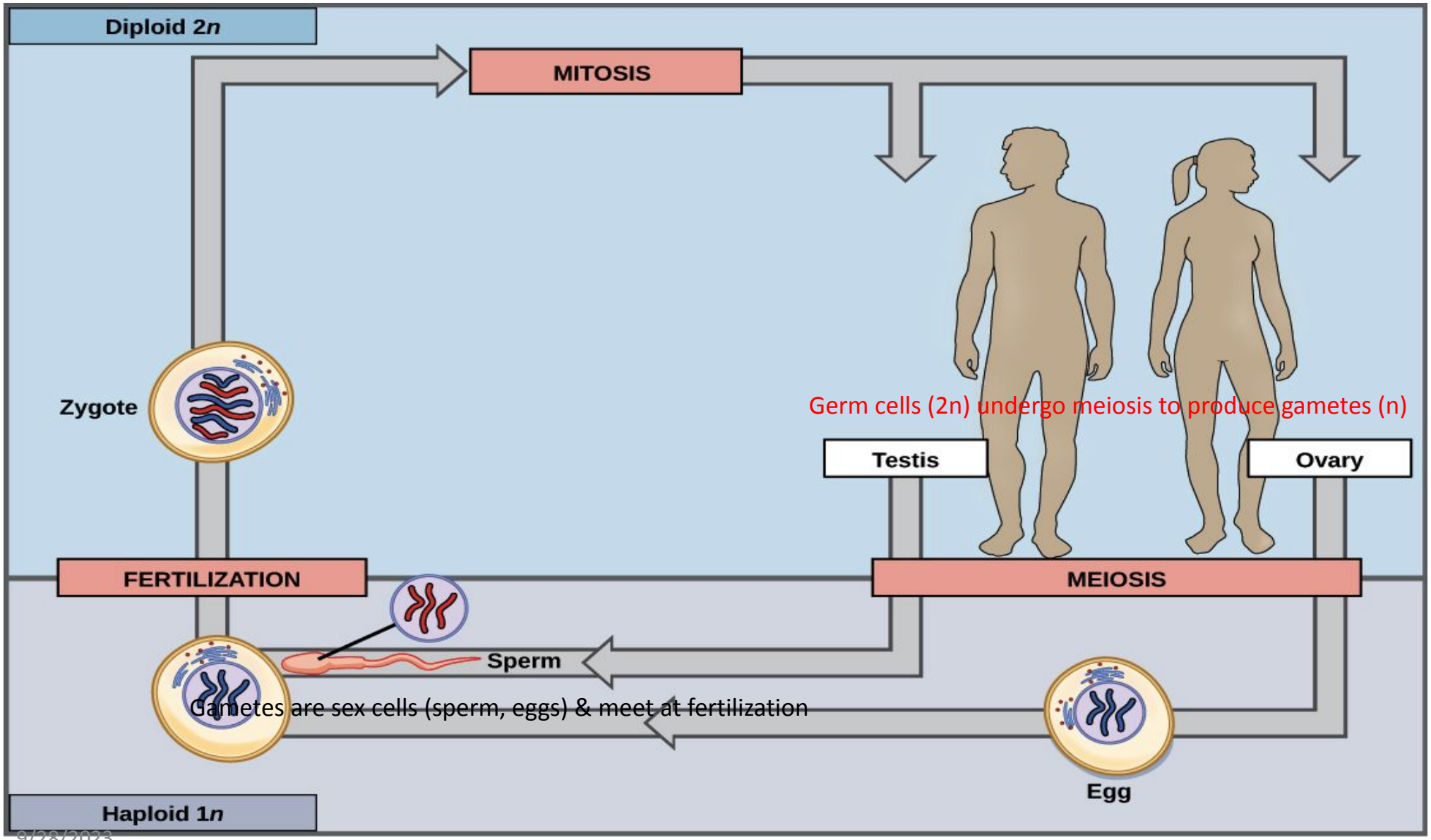


CROSSING OVER

- Each chromosome becomes zippered to its homologue
- All four chromatids are closely aligned
- Non-sister chromosomes exchange segments
- After crossing over, each chromosome contains both maternal and parental segments



M PHASES IN HUMAN



MEIOSIS

Two consecutive nuclear divisions

Meiosis I

Meiosis II

DNA is NOT duplicated between divisions

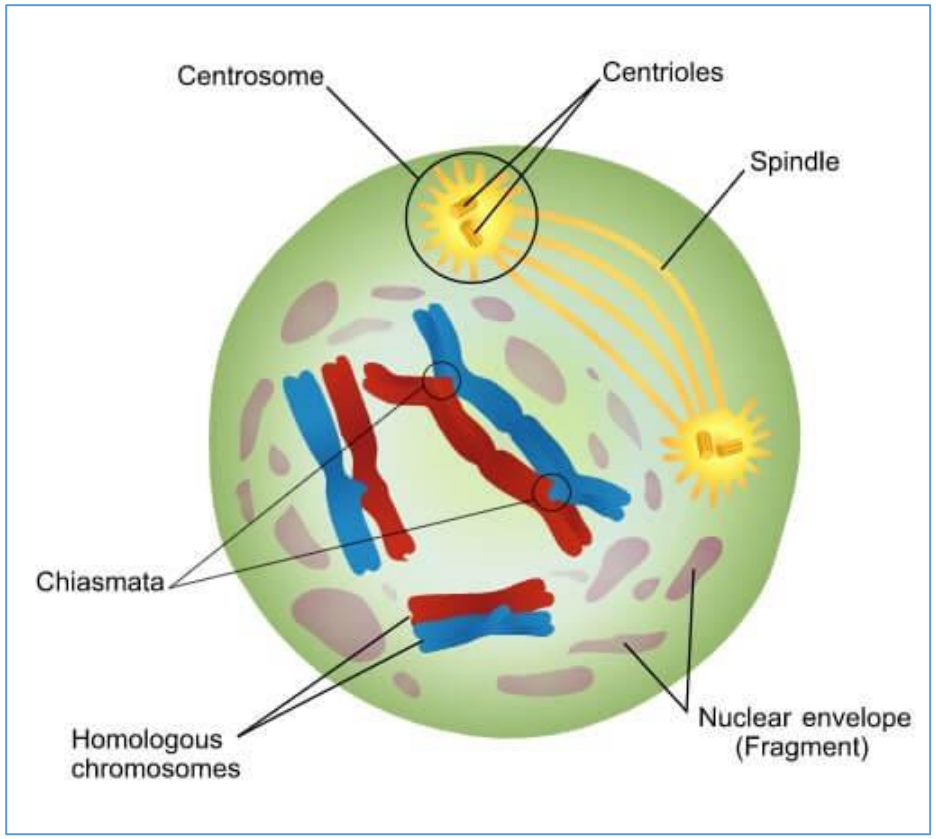
Four haploid nuclei are formed

Meiosis I	Meiosis II
Prophase I	Prophase II
Metaphase I	Metaphase II
Anaphase I	Anaphase II
Telophase I	Telophase II

MEIOSIS I

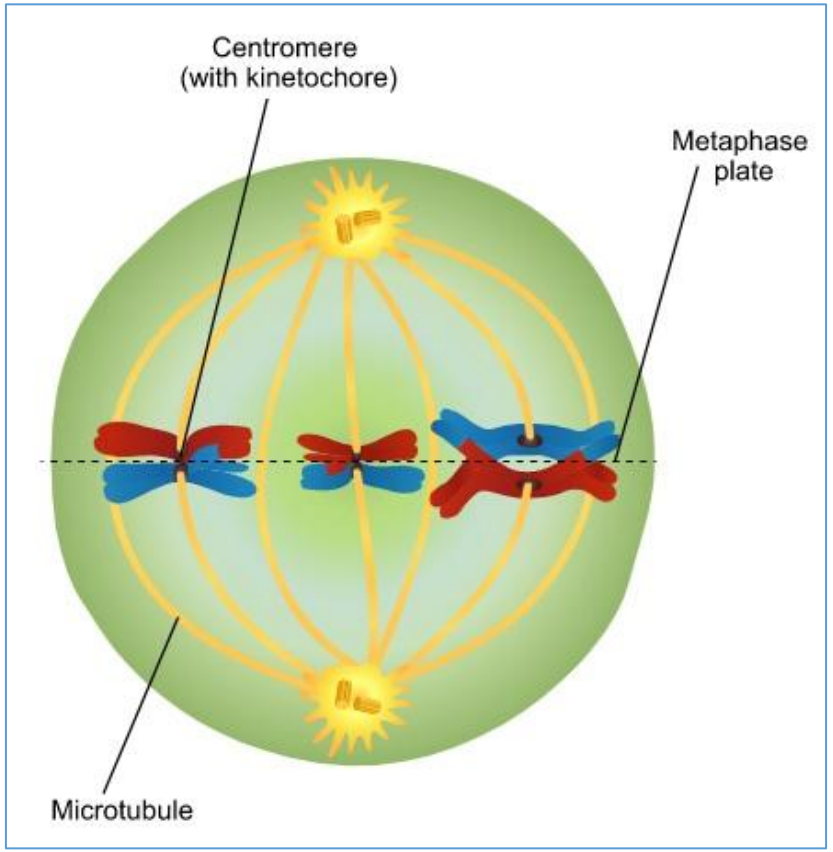
PROPHASE I

1. Each duplicated, condensed chromosome pairs with its homologue
2. Homologues swap segments
3. Each chromosome becomes attached to microtubules of newly forming spindle



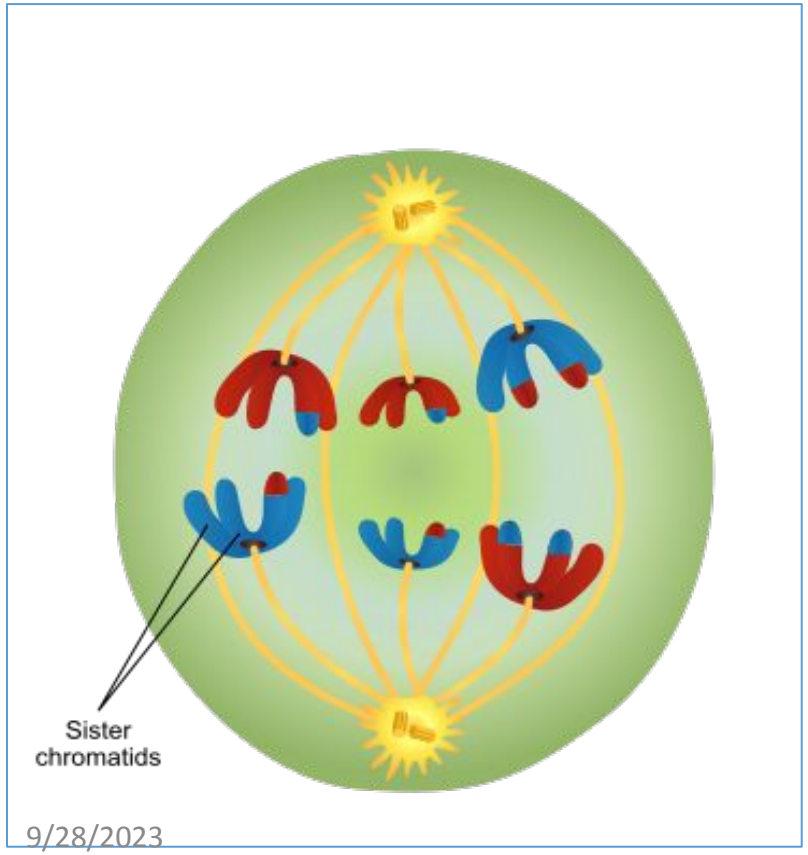
METAPHASE I

1. Chromosomes are pushed and pulled into the middle of cell
2. Sister chromatids of one homologue orient toward one pole, and those of other homologue toward opposite pole
3. The spindle is now fully formed



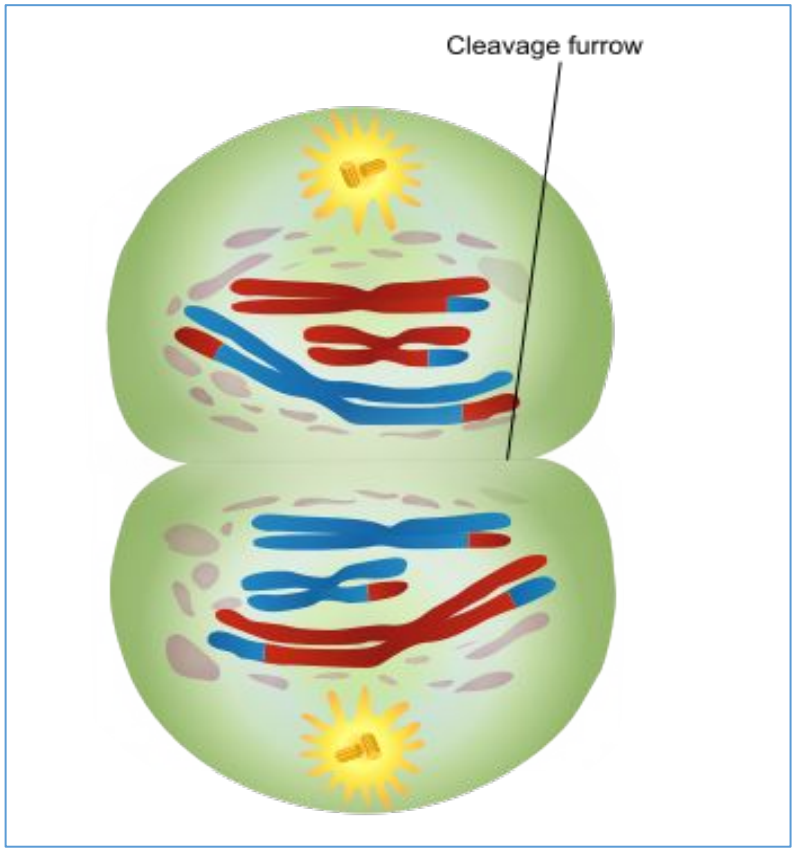
ANAPHASE I

1. Homologous chromosomes segregate from each other
2. The sister chromatids of each chromosome remain attached



TELOPHASE I

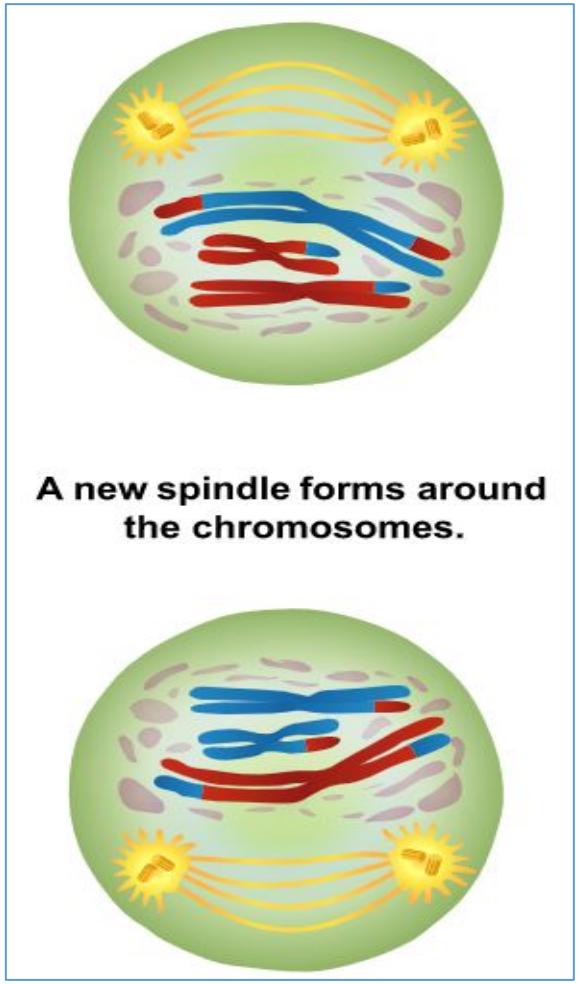
1. The chromosomes arrive at opposite poles
2. The cytoplasm divides
3. There are now two haploid cells
4. This completes Meiosis I



MEIOSIS II

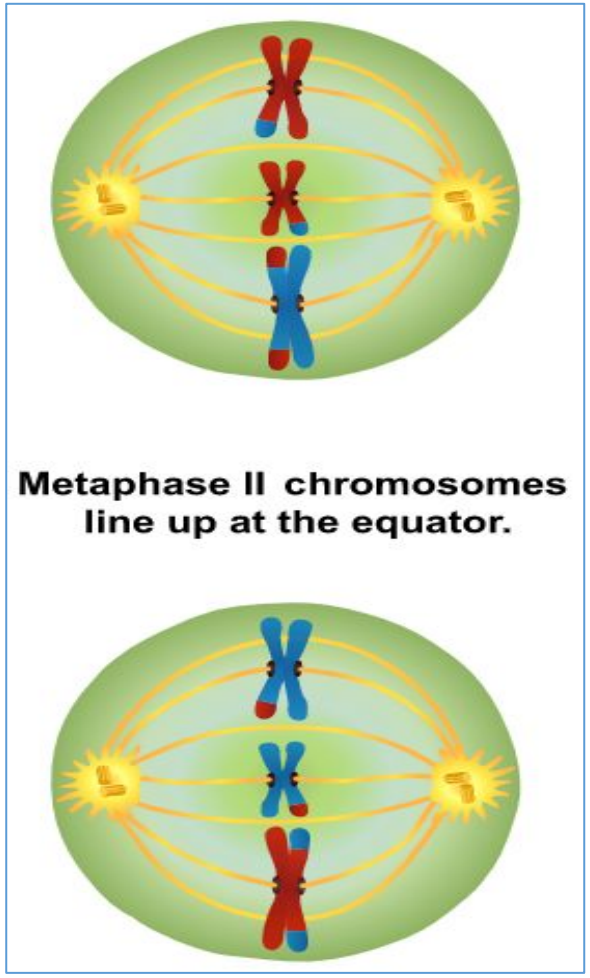
PROPHASE II

1. A new spindle forms around the chromosome
2. Microtubules attach to the kinetochores of the duplicated chromosomes



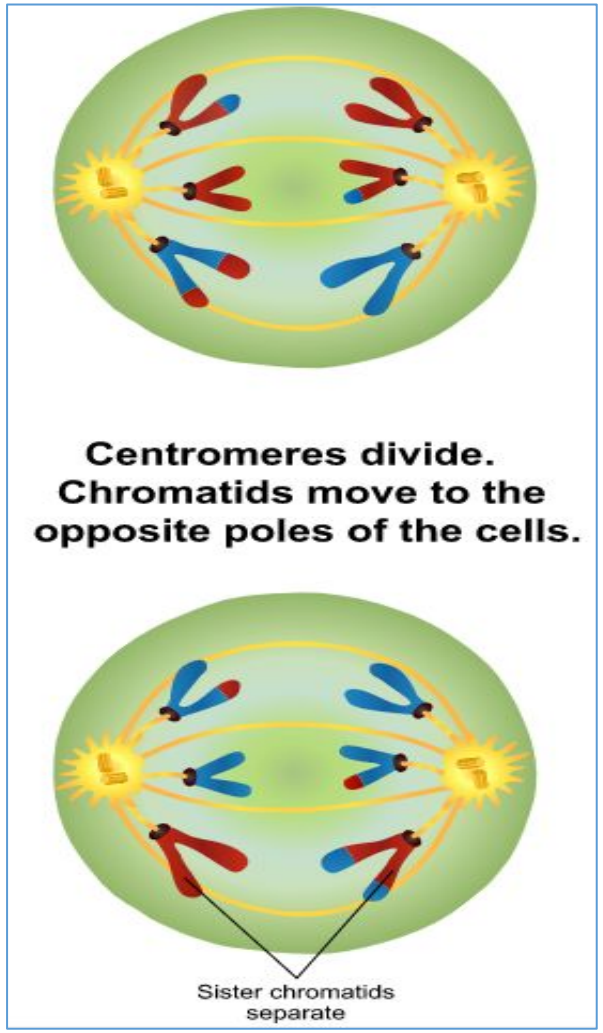
METAPHASE II

1. Chromosomes are pushed and pulled into the middle of cell
2. All of the duplicated chromosomes are lined up at the spindle equator, midway between the poles



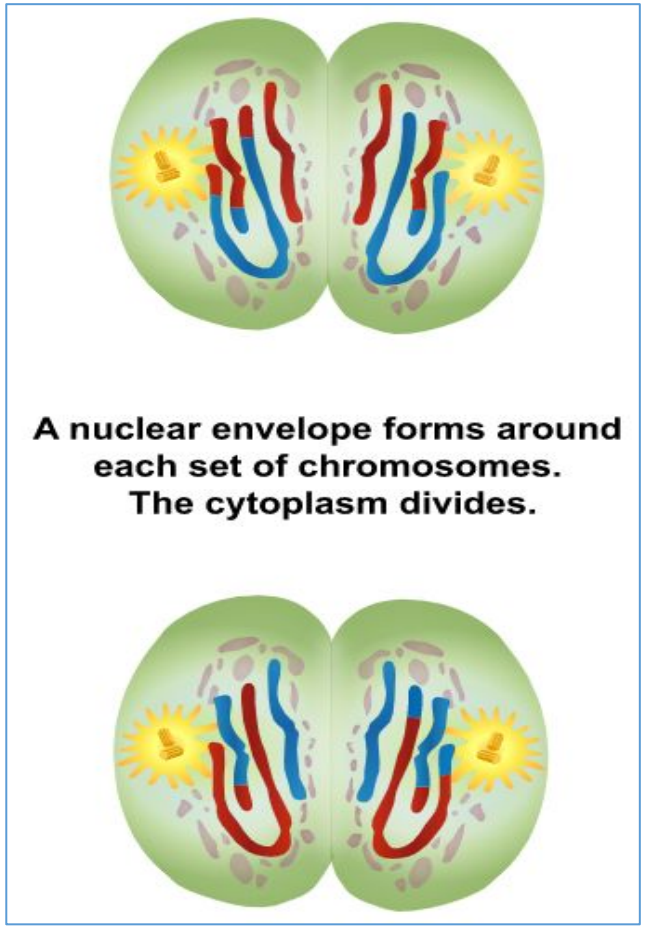
ANAPHASE II

Sister chromatids separate to become independent chromosomes



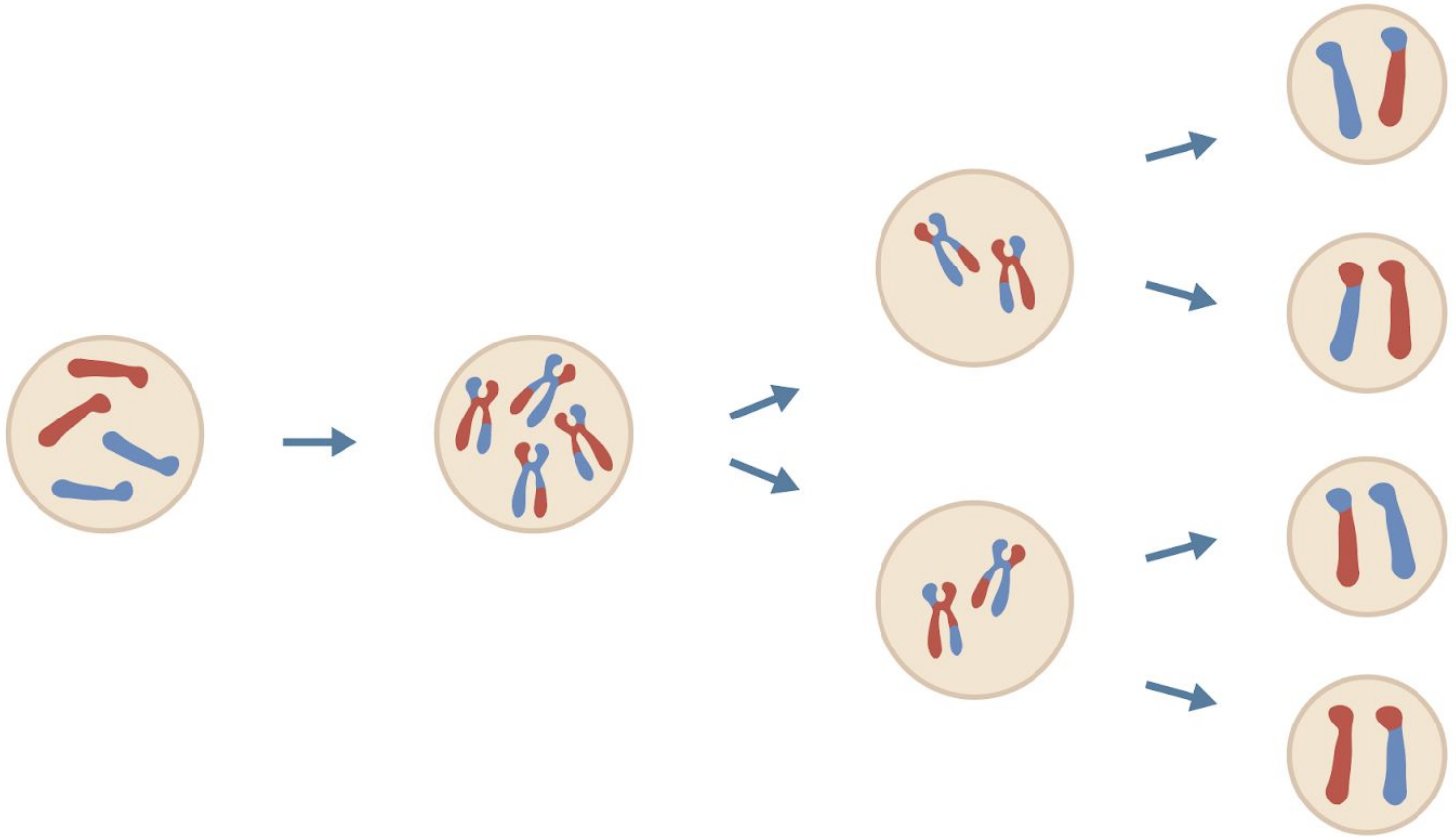
TELOPHASE II

1. The chromosomes arrive at opposite ends of the cell
2. A nuclear envelope forms around each set of chromosomes & the cytoplasm divides
3. There are now four haploid cells



RESULTS OF MEIOSIS

Four haploid cells produced
Differ from parent and one another



SIGNIFICANCE OF MEIOSIS

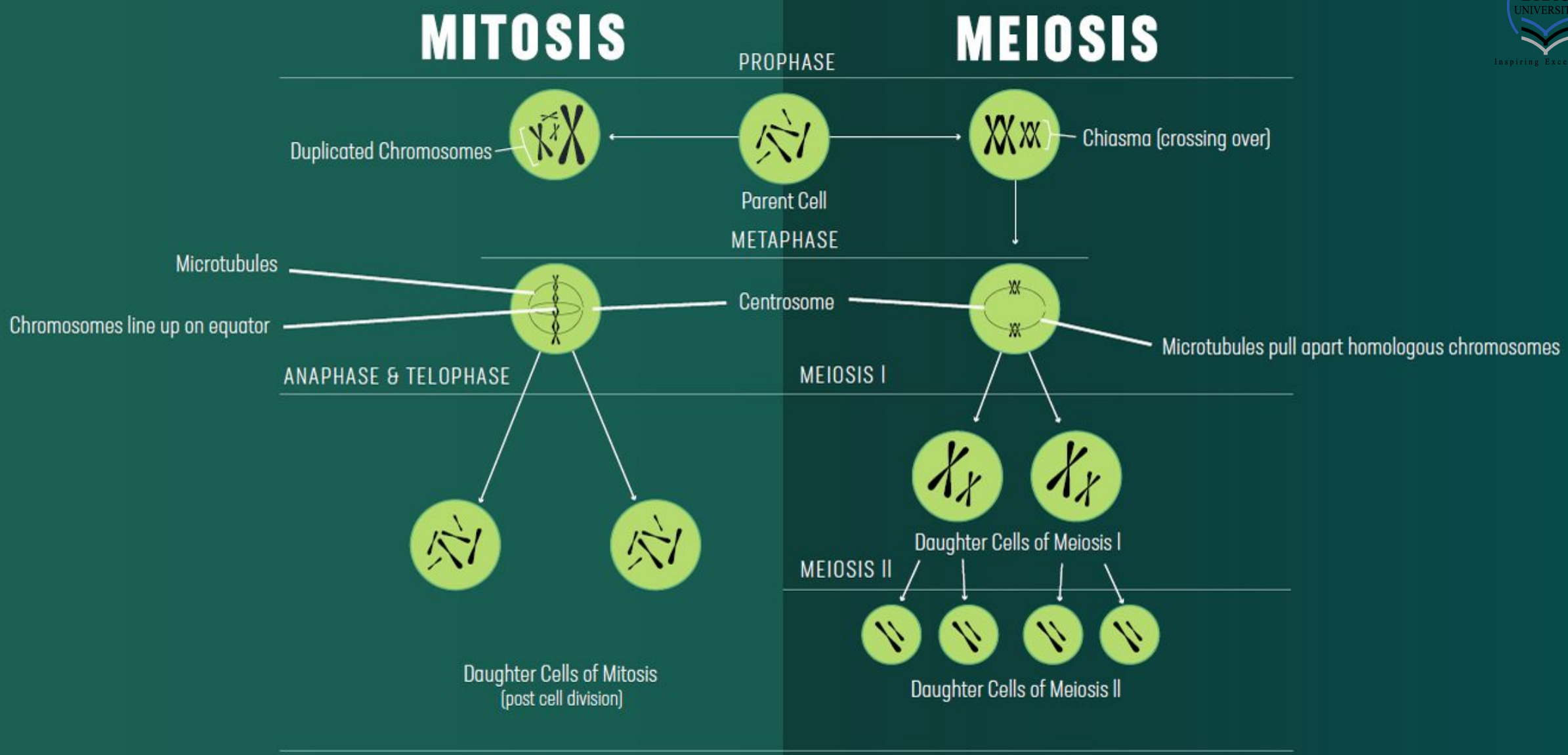
1. Meiosis gives rise to four haploid cells from the parent cell.

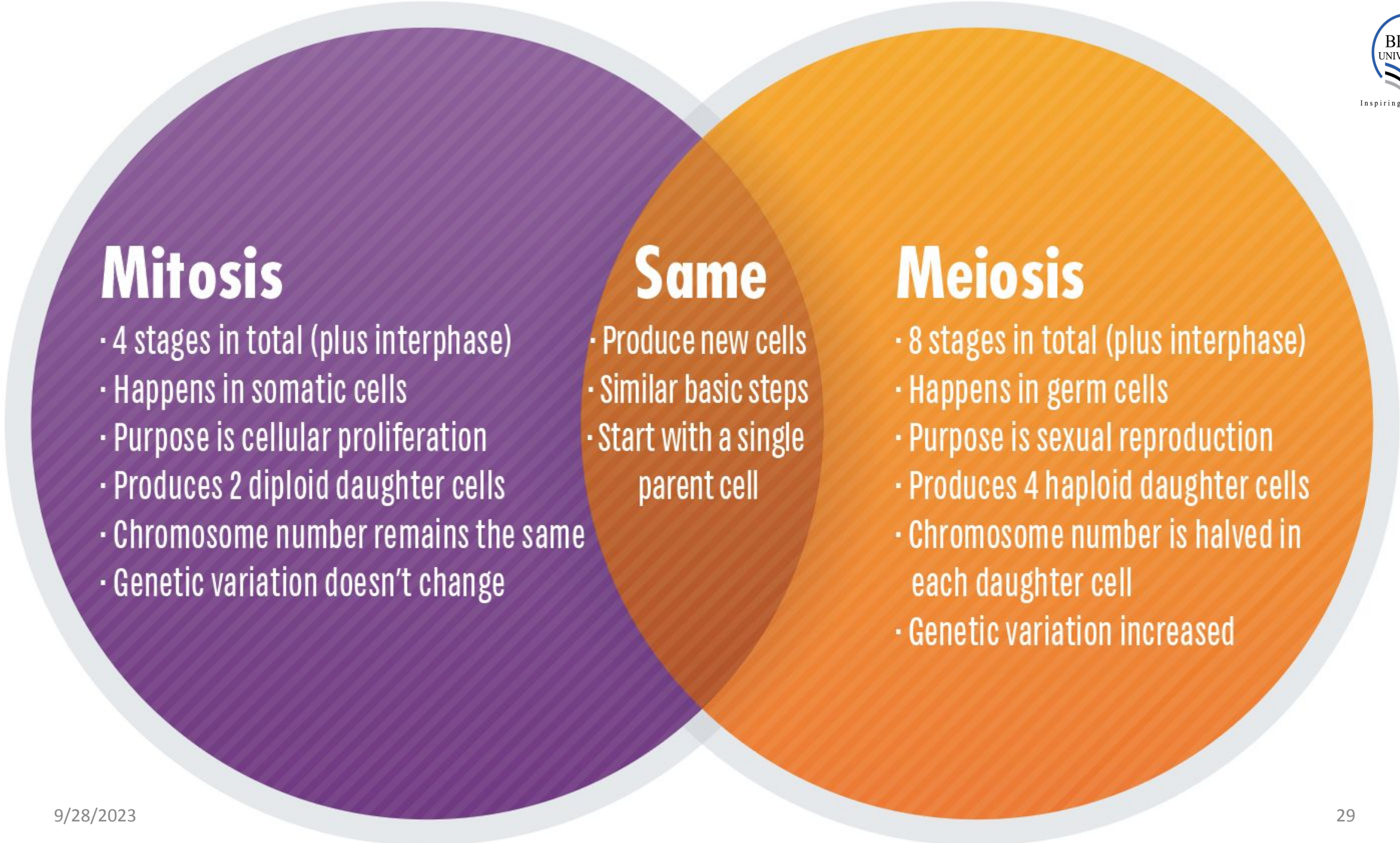
2. Meiosis is responsible for the formation of sex cells or gametes which might be responsible for sexual reproduction.

3. Due to recombinations in parental characters, variations occur, which are necessary for the evolution process.

4. The number of chromosomes is halved during meiosis; this allows gametes to fuse to form a zygote containing a mixture of paternal and maternal chromosomes.

5. Depending on the species, meiosis can create spores or gametes.


MITOSIS
MEIOSIS
PROPHASE
Duplicated Chromosomes
Chiasma (crossing over)
Parent Cell
METAPHASE
Microtubules
Chromosomes line up on equator
Centrosome
Microtubules pull apart homologous chromosomes
ANAPHASE & TELOPHASE
MEIOSIS I
Daughter Cells of Meiosis I
MEIOSIS II
Daughter Cells of Mitosis
(post cell division)
Daughter Cells of Meiosis II


Mitosis
· 4 stages in total (plus interphase)
· Happens in somatic cells
· Purpose is cellular proliferation
· Produces 2 diploid daughter cells
· Chromosome number remains the same
· Genetic variation doesn't change
Same
· Produce new cells
· Similar basic steps
· Start with a single parent cell
Meiosis
· 8 stages in total (plus interphase)
· Happens in germ cells
· Purpose is sexual reproduction
· Produces 4 haploid daughter cells
· Chromosome number is halved in each daughter cell
· Genetic variation increased

SIGNIFICANCE

Hereditary material is equally distributed in the daughter cell

No crossing over and genetic information remains unchanged generation after generation

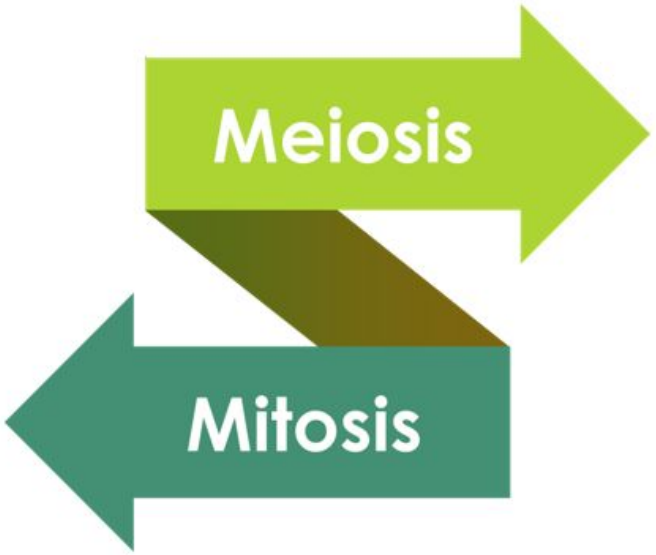
Some organisms undergo asexual reproduction by mitosis

Involved in regeneration, healing of the wound, and replacement of older cells

The development and growth of multicellular organisms require mitosis

Involved in tissue culture and cloning

Malfunction in mitosis leads to unwanted tumors or cancer



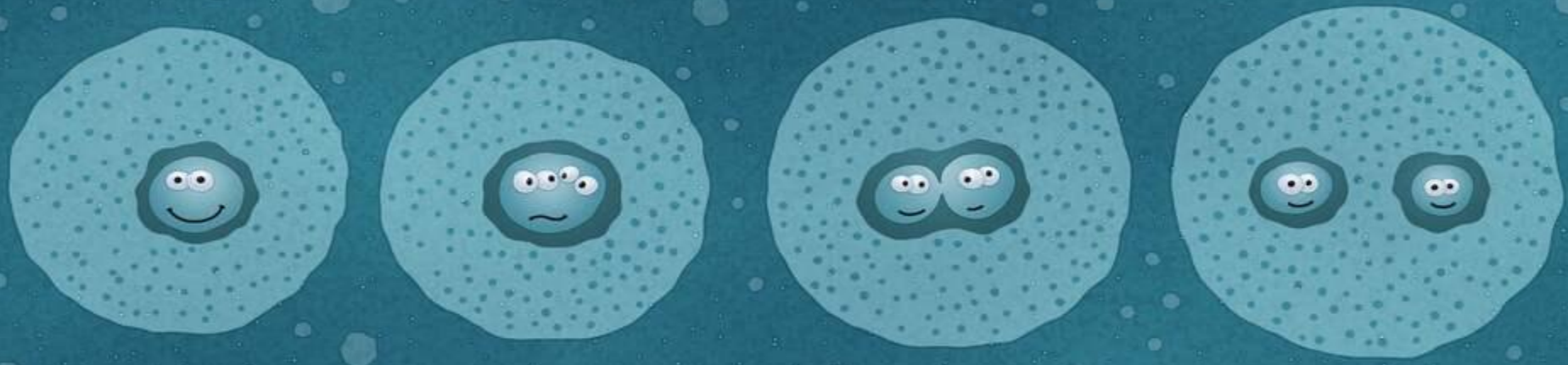
Crossing over and a random assortment of chromosomes

New genetic combinations in the next generation

Reduction division to maintain chromosome numbers of species

Involved in gametes formation

Malfunction may lead to genetic disorders



THANK YOU