

CELLULAR DIVISION



Cell Division

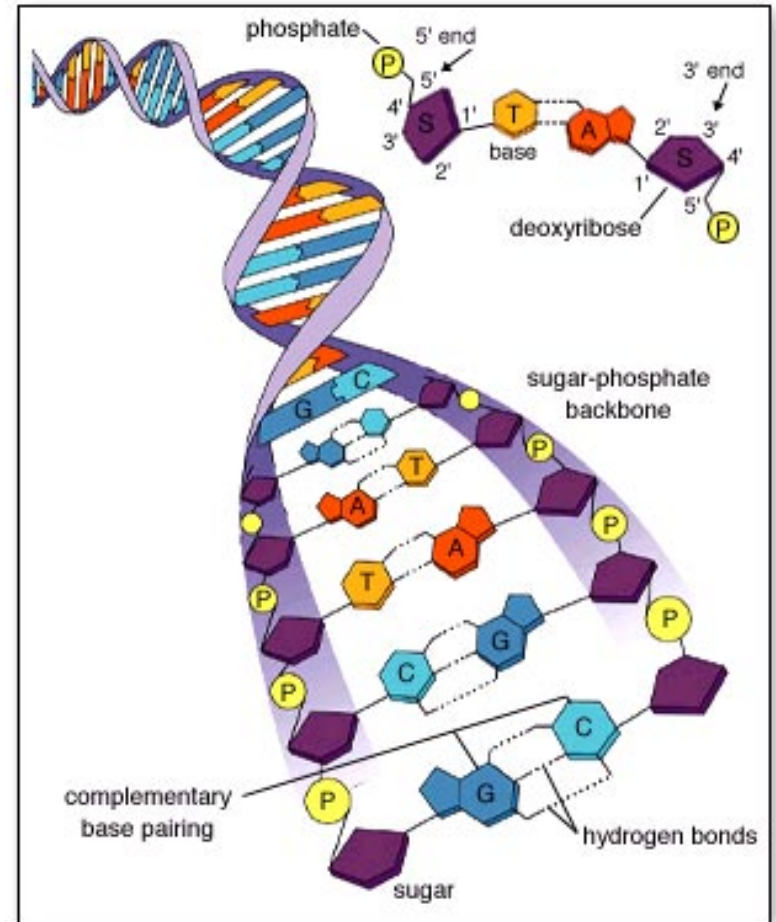
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- All cells are derived from pre-existing cells
- New cells are produced for growth and to replace damaged or old cells
- Differs in prokaryotes (bacteria) and eukaryotes (protists, fungi, plants, & animals)

Keeping Cells Identical

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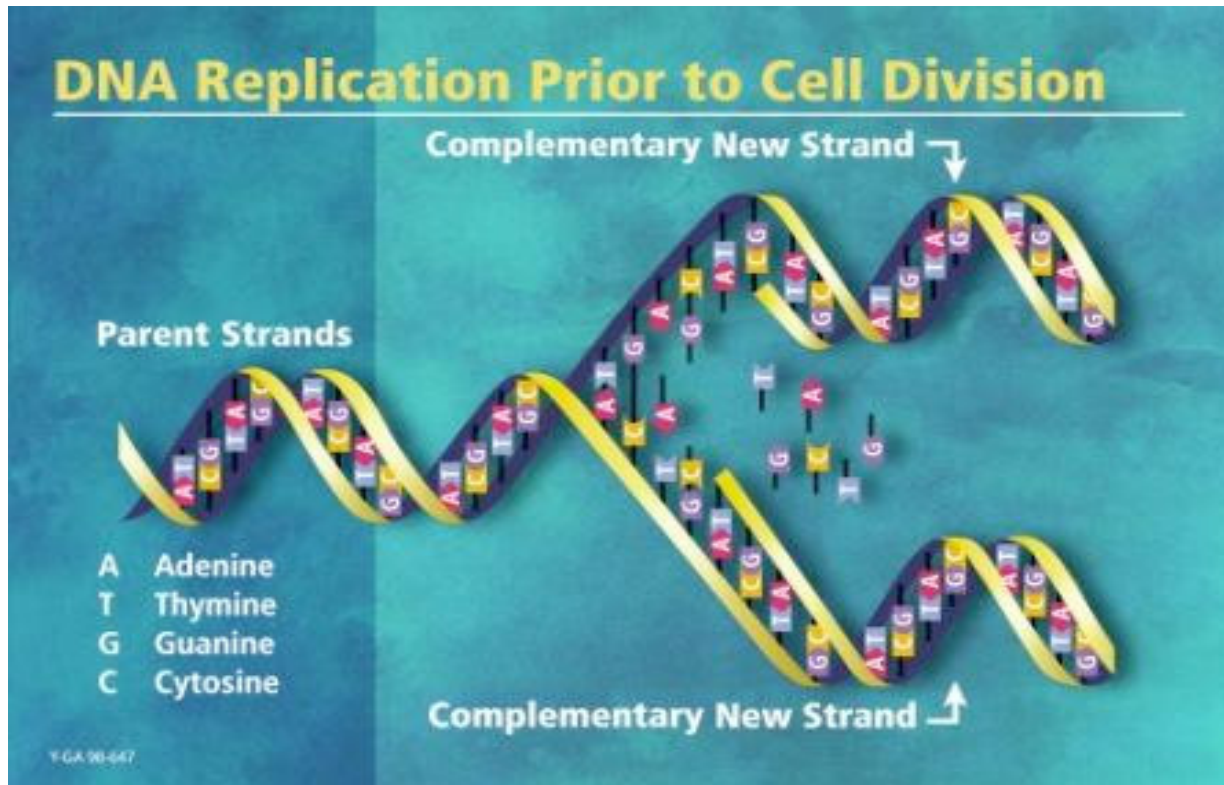
- The instructions for making cell parts are encoded in the DNA, so each new cell must get a complete set of the DNA molecules



DNA Replication

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- DNA must be copied or replicated before cell division
- Each new cell will then have an identical copy of the DNA

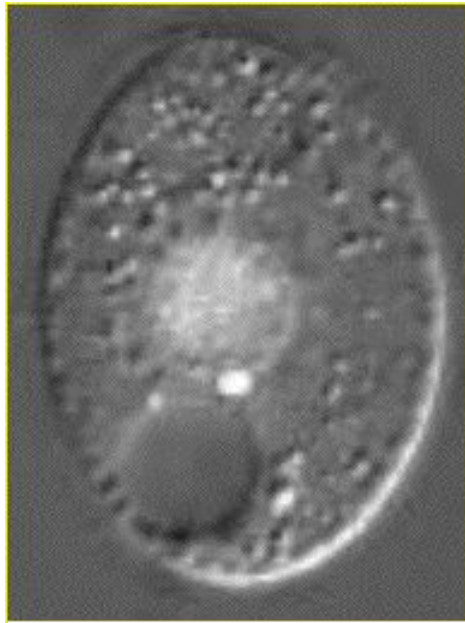


Original DNA strand

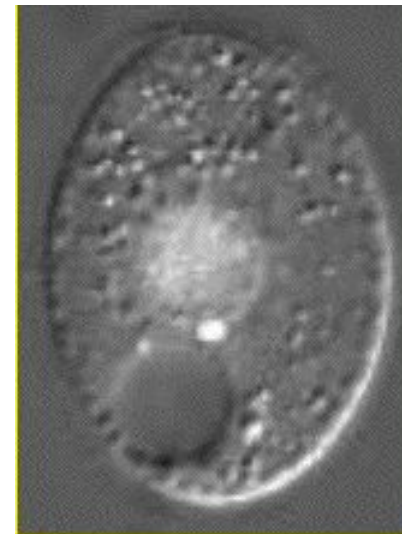
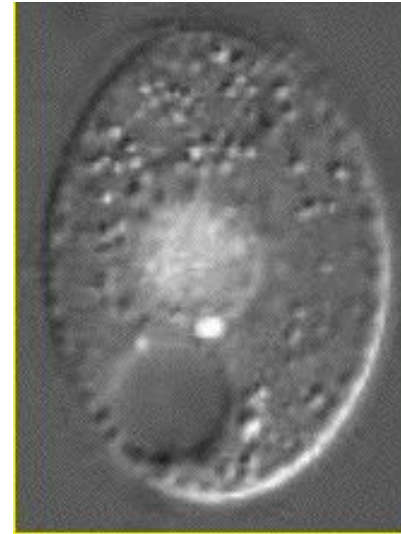
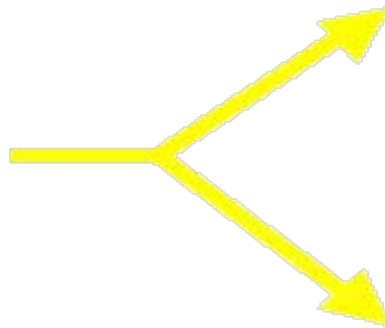
Two new, identical DNA strands

Identical Daughter Cells

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Parent Cell

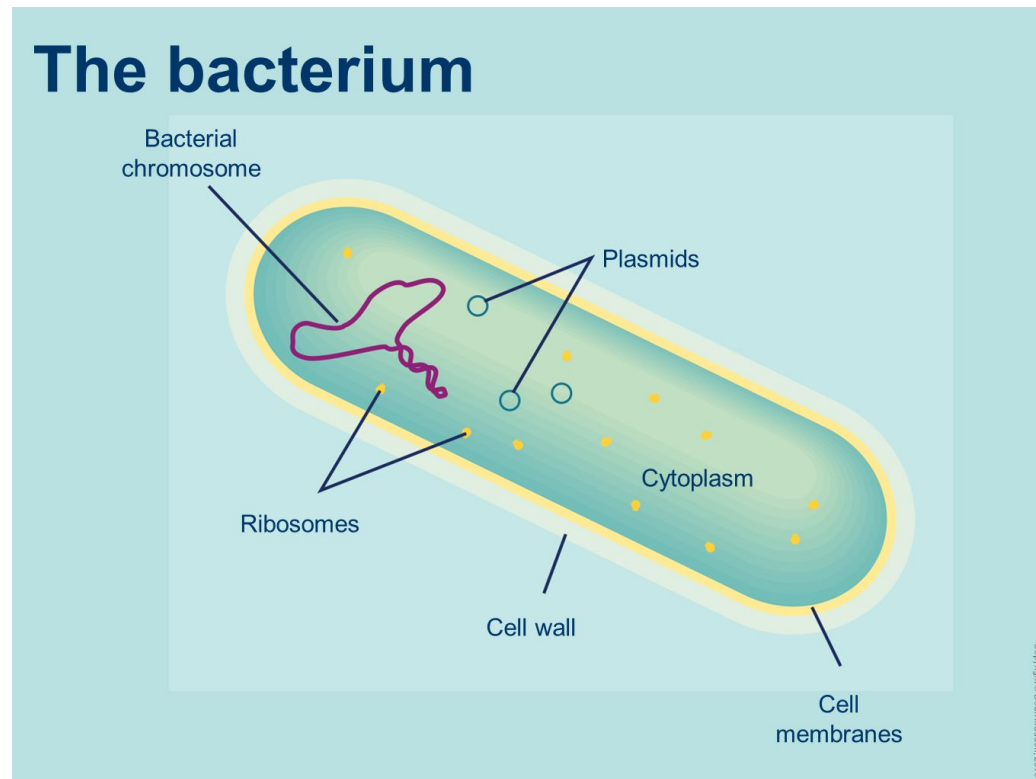


*Two
identical
daughter
cells*

Prokaryotic Chromosome

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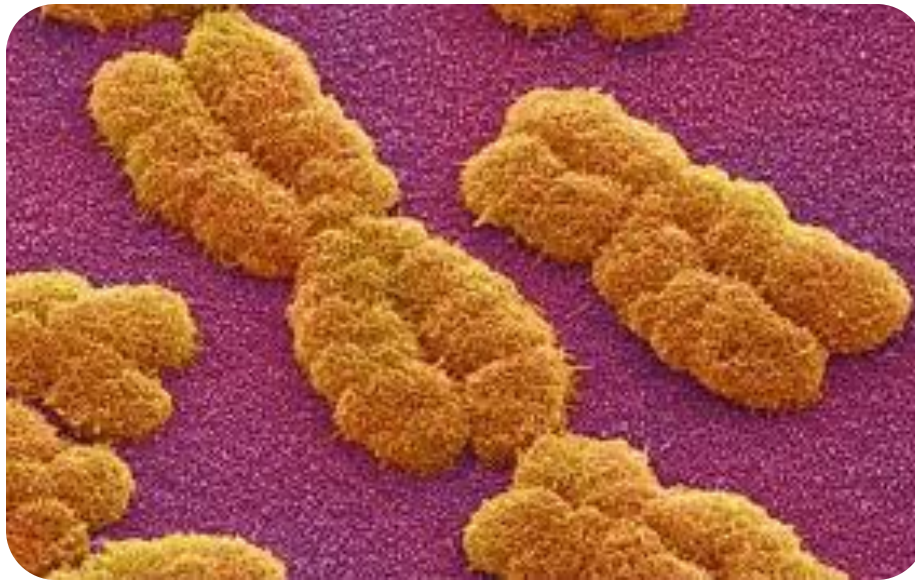
- The DNA of prokaryotes (bacteria) is one, circular chromosome attached to the inside of the cell membrane



Eukaryotic Chromosomes

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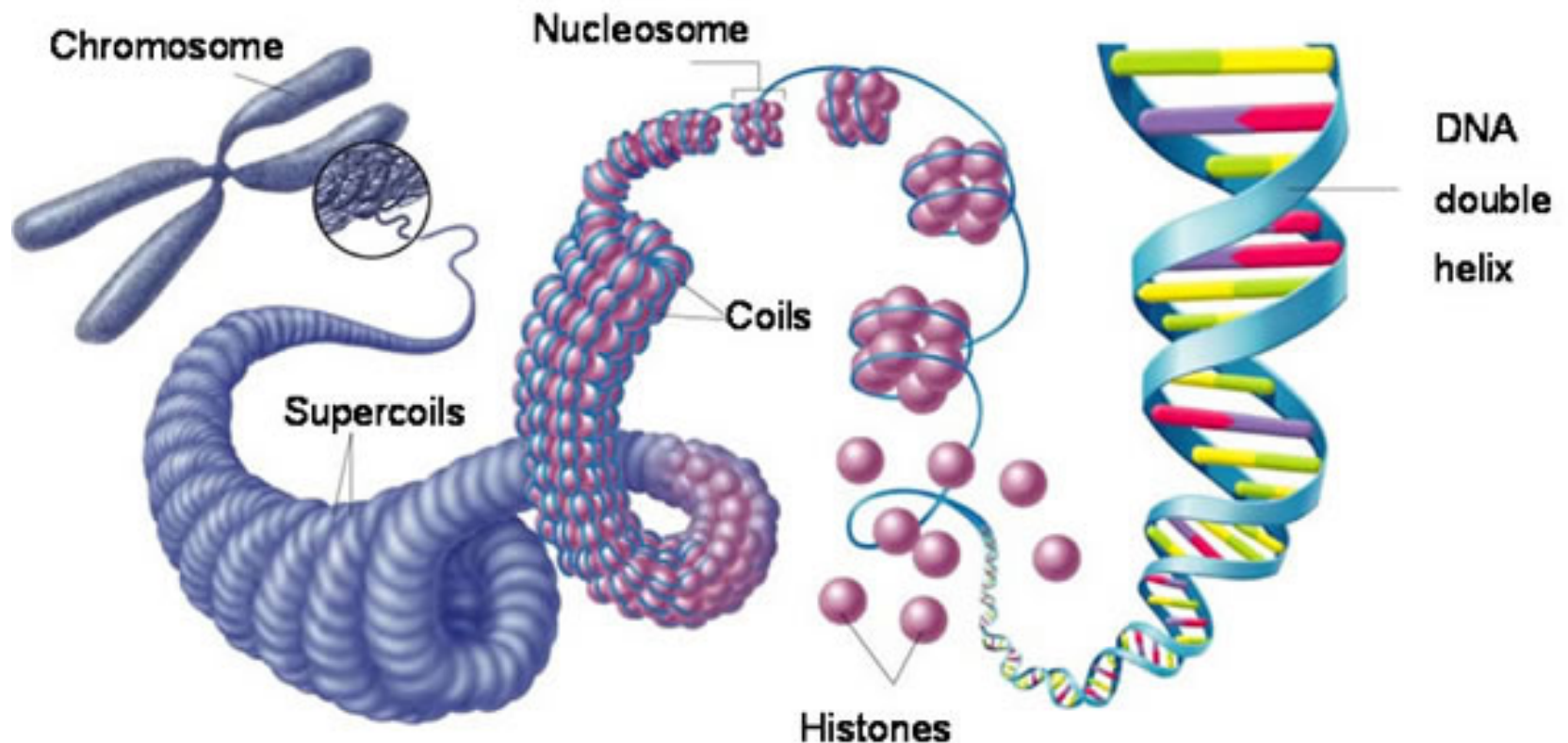
- All eukaryotic cells store genetic information in chromosomes
- Most eukaryotes have between 10 and 50 chromosomes in their body cells
- Human body cells have 46 chromosomes or 23 identical pairs



Compacting DNA into Chromosomes

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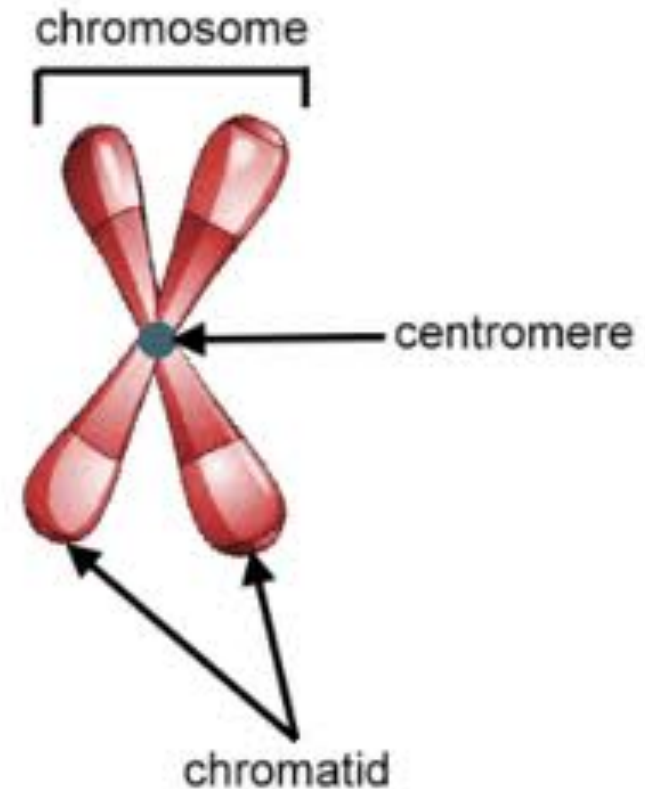
- DNA is tightly coiled around proteins called histones



Chromosomes in Dividing Cells

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- Duplicated chromosomes are called chromatids & are held together by the centromere

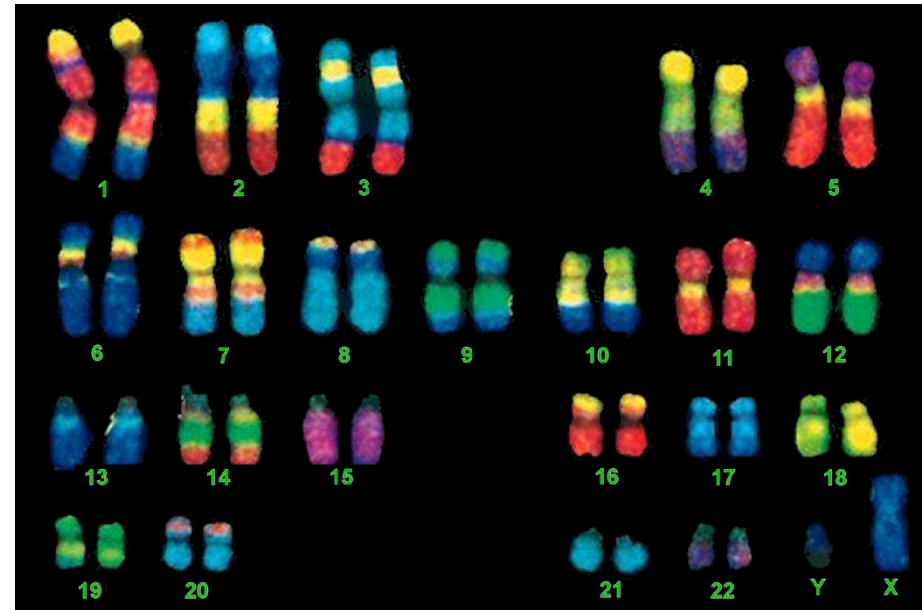


Called Sister Chromatids

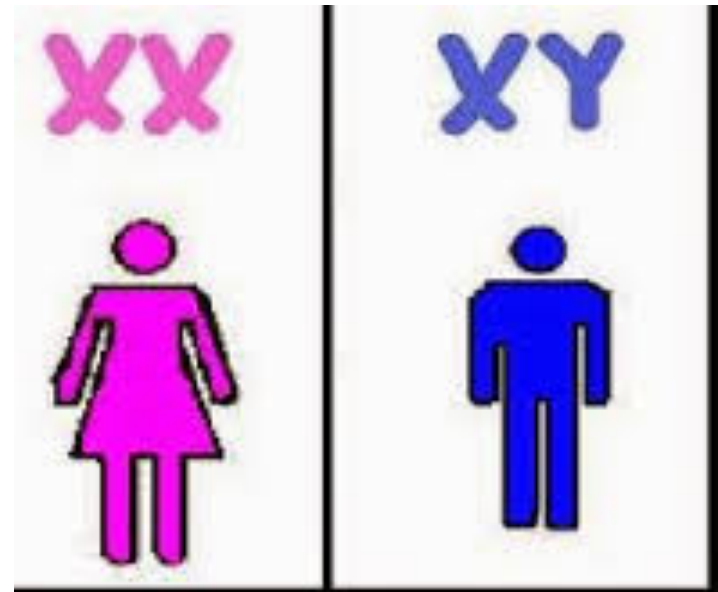
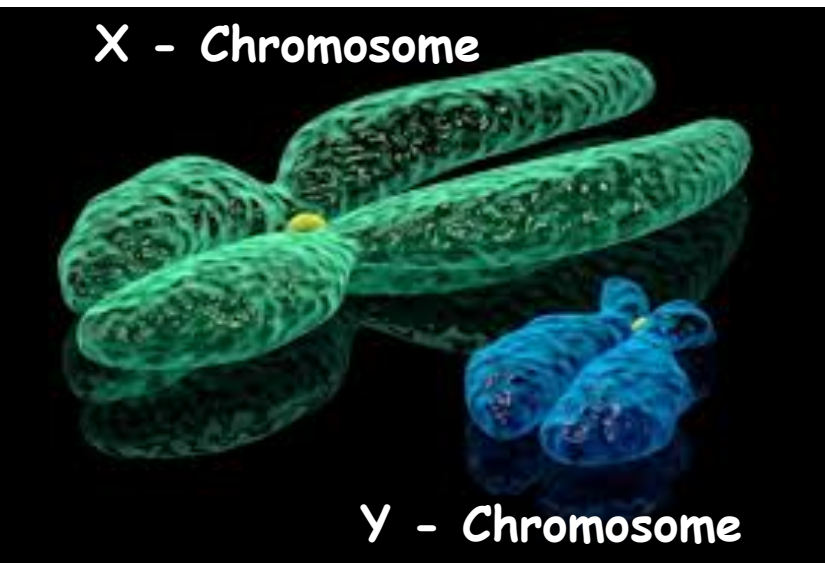
Karyotype

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- A picture of the chromosomes from a human cell arranged in pairs by size
- First 22 pairs are called autosomes
- Last pair are the sex chromosomes
- XX female or XY male



Boy or Girl?



Aging

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All cells die after a certain number of divisions (programmed cell death-“apoptosis”). At any given time some cells are dividing and some cells are dying

Childhood Cell division $>$ cell death

Adulthood Cell division = cell death

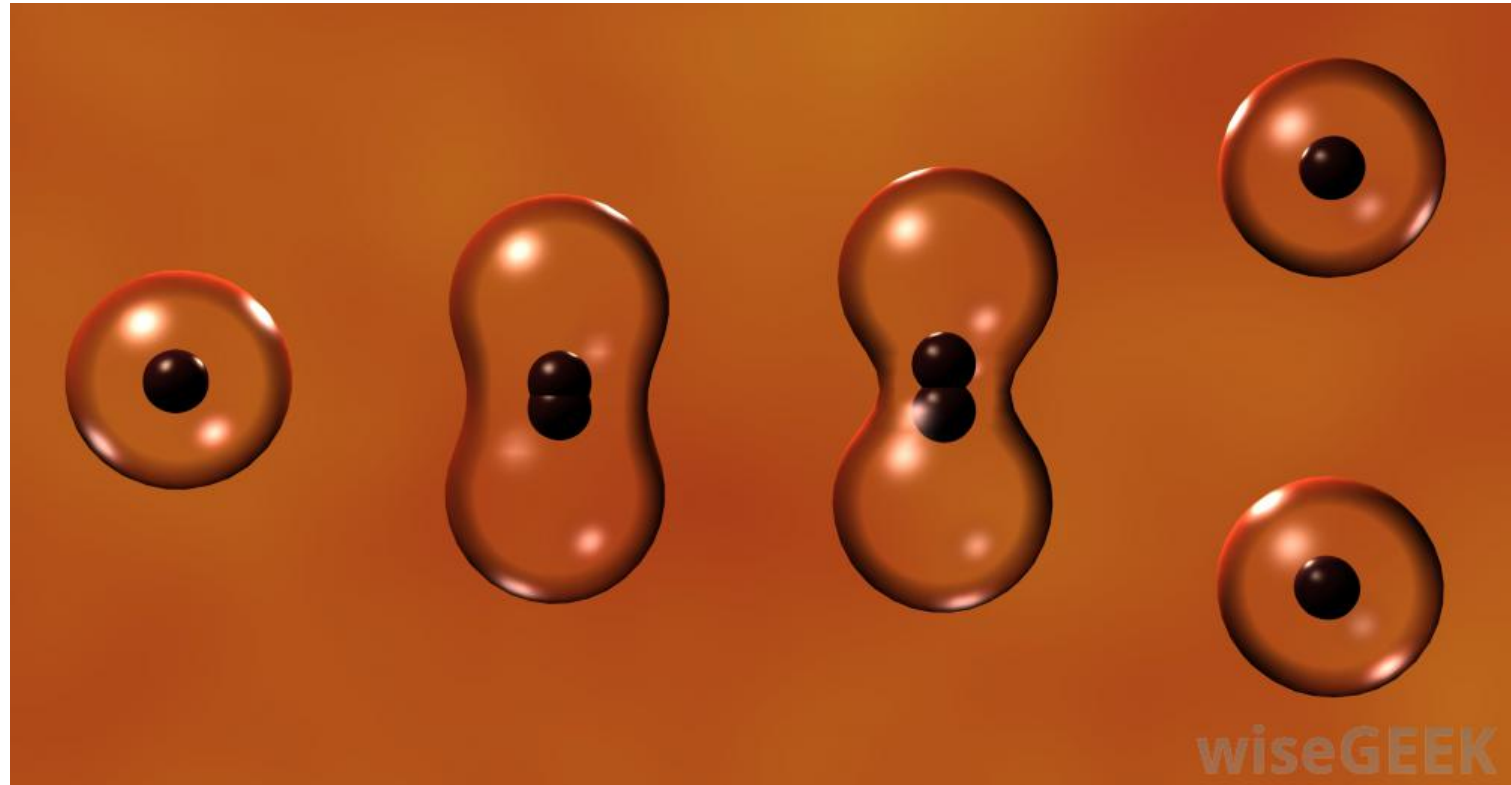
Aging Cell division $<$ cell death

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Cell Reproduction

Cell Division in Prokaryotes

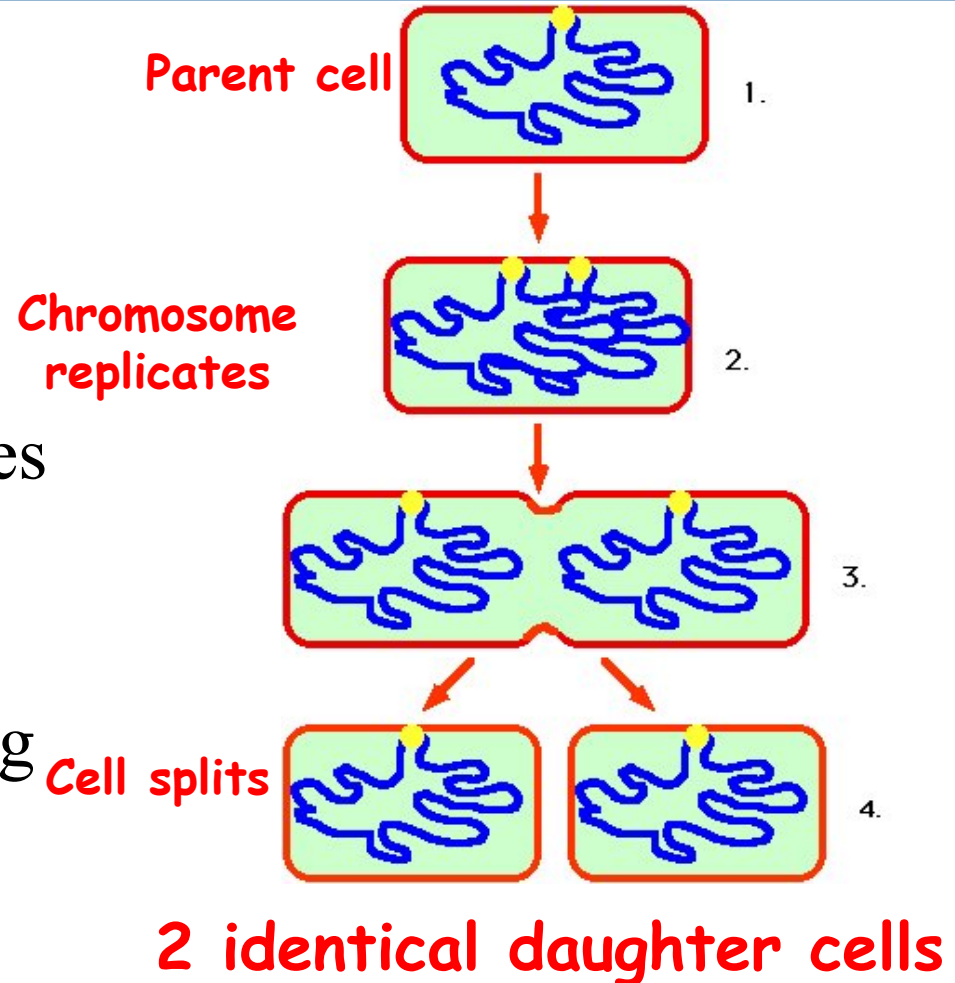
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Cell Division in Prokaryotes

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- Prokaryotes such as bacteria divide into 2 identical cells by the process of binary fission
- Single chromosome makes a copy of itself
- Cell wall forms between the chromosomes dividing the cell



Prokaryotic Cell Undergoing Binary Fission

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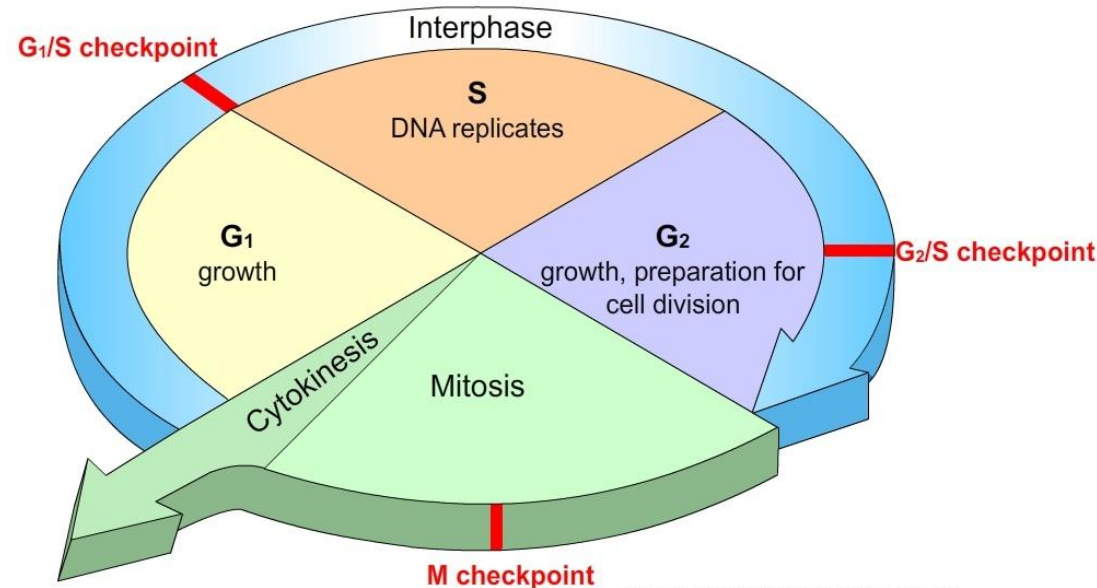
THE CELL CYCLE

Five Phases of the Cell Cycle

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- G1 - primary growth phase
- S – synthesis; DNA replicated
- G2 - secondary growth phase
 - collectively these 3 stages are called interphase
- M - mitosis
- C - cytokinesis

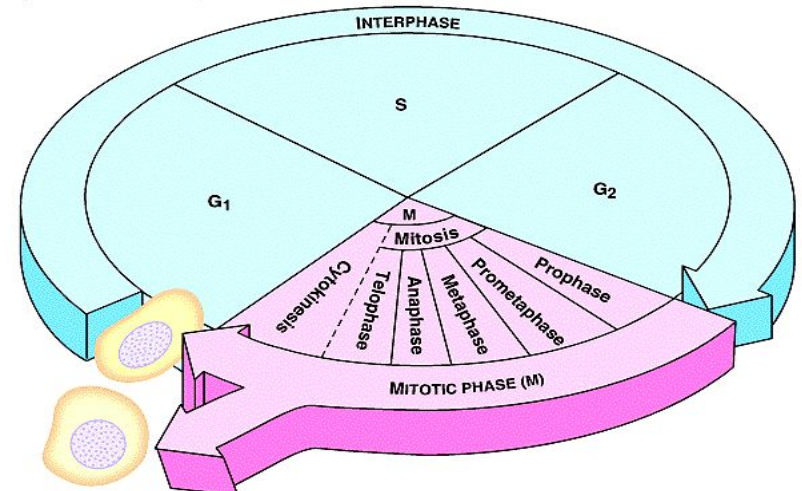
Interphase ~ 90% of the time.



Mitosis

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- ❑ Division of somatic cells (body cells)
 - ❑ (non reproductive cells) in eukaryotic organisms
 - ❑ A single cell divides into two identical daughter cells (cellular reproduction)
 - ❑ Maintains chromosome ploidy of cell
- ❑ Ploidy - refers to the number of pairs of chromosomes in cells
 - Haploid - one copy of each chromosome - designated as "n"
 - Diploid - two copies (pair) of each chromosome - designated as "2n"



Mitosis

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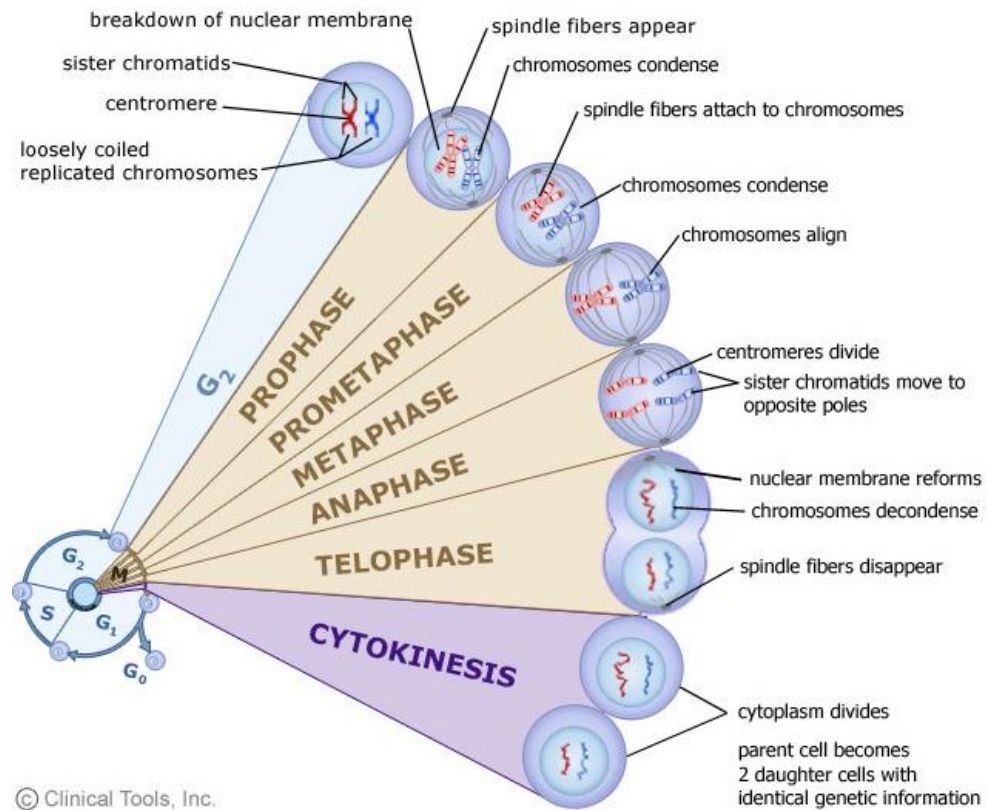
- Division of the nucleus
- Also called karyokinesis
- Only occurs in eukaryotes
- Has four stages
- Doesn't occur in some cells such as brain cells



Four Mitotic Stages

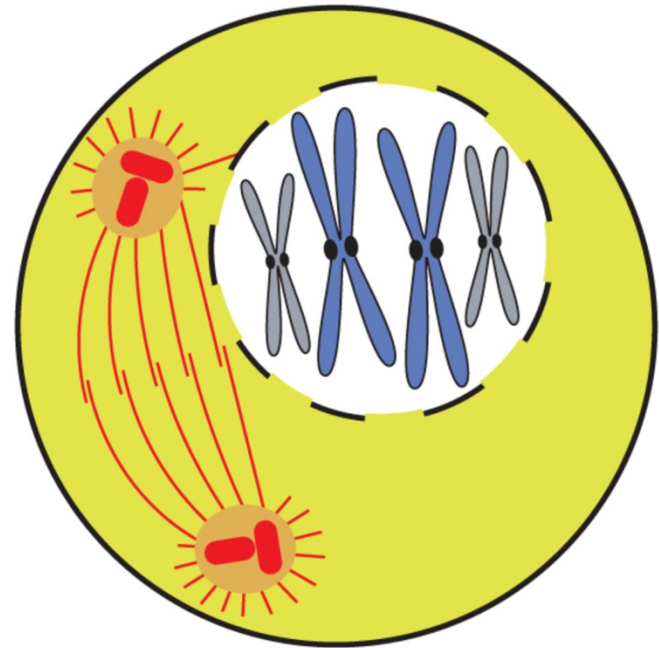
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- Prophase
- Metaphase
- Anaphase
- Telophase



Prophase

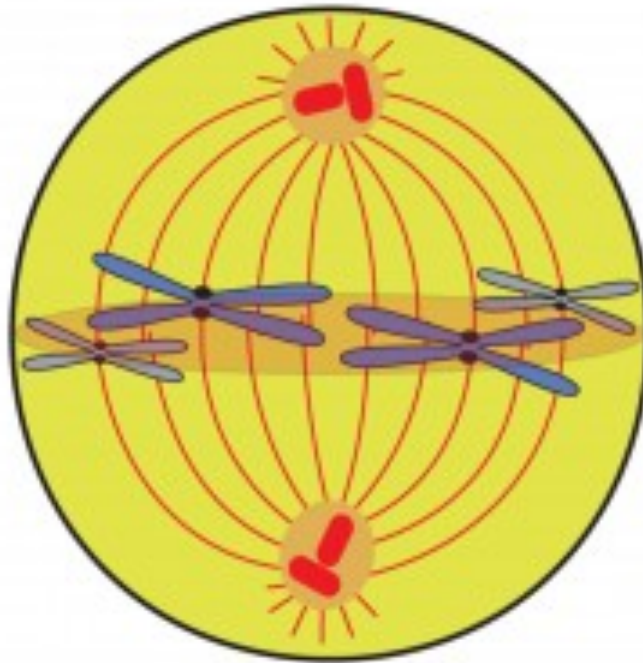
- ❑ Chromatin condenses (coils) into chromosomes.
- ❑ Sister chromatids joined by centromere.
- ❑ Nuclear membrane dissolves.
- ❑ Centrioles divide and move to opposite poles forming spindle between them.



Metaphase...

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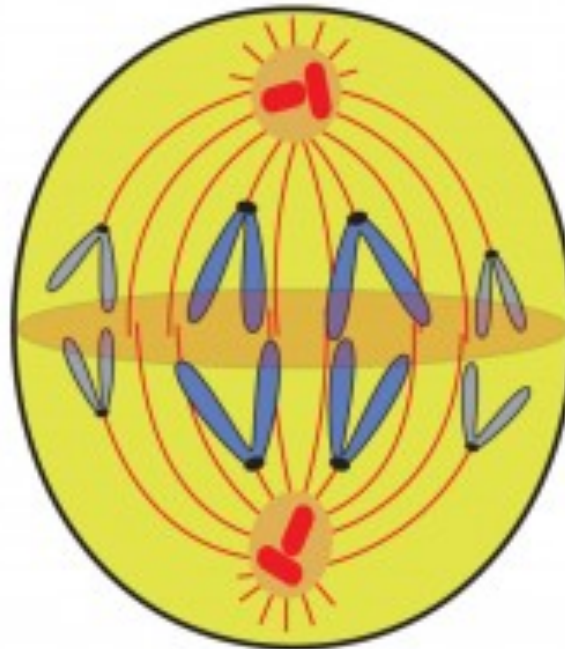
- ❑ Sister chromatids line up on metaphase plate.
- ❑ Centromeres lock on to spindle fibre



Anaphase...

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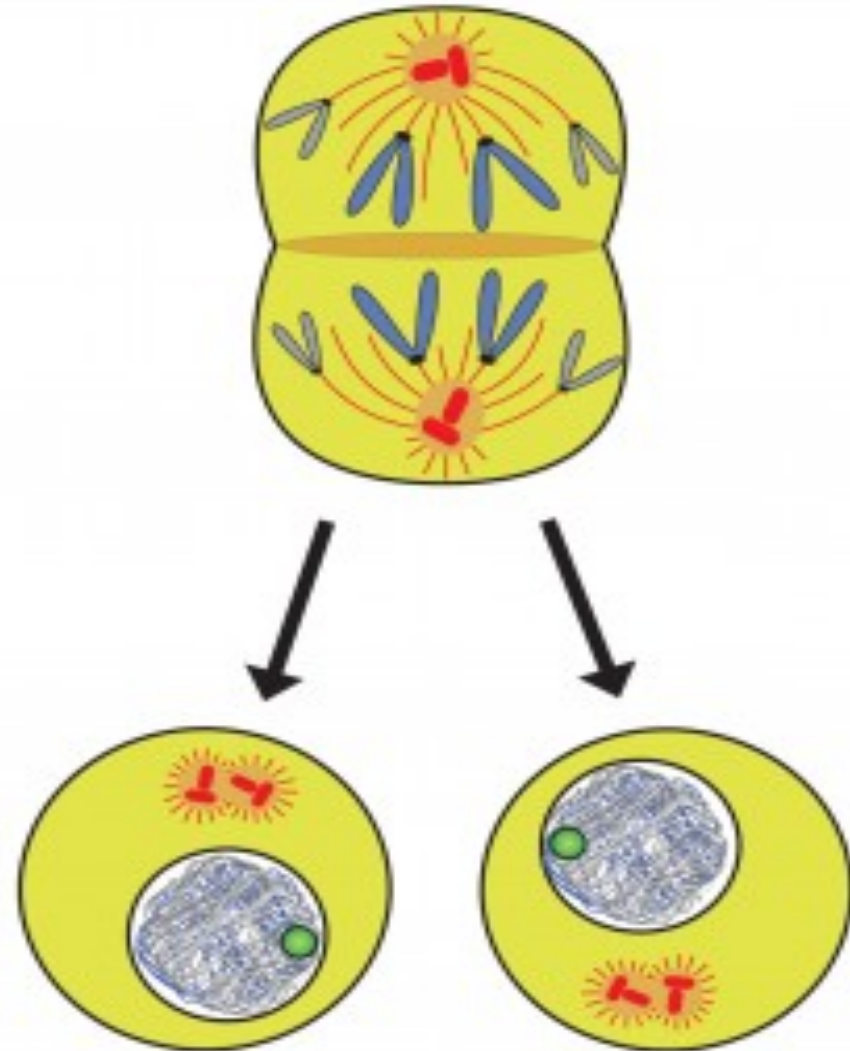
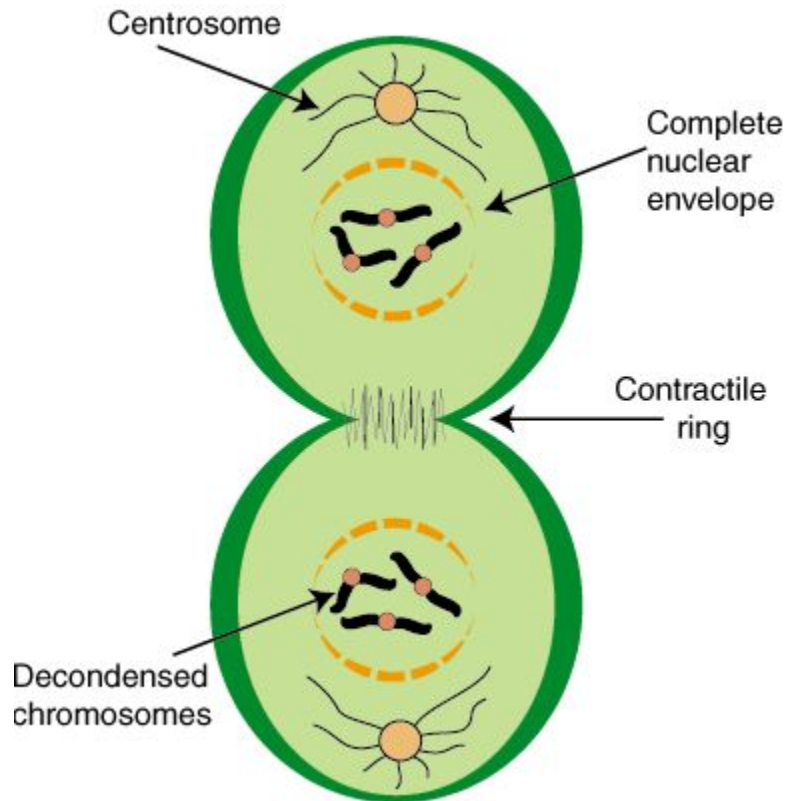
- ☐ Centromeres divide.
- ☐ Spindle fibres contract pulling sister chromatids apart to poles



Telophase...

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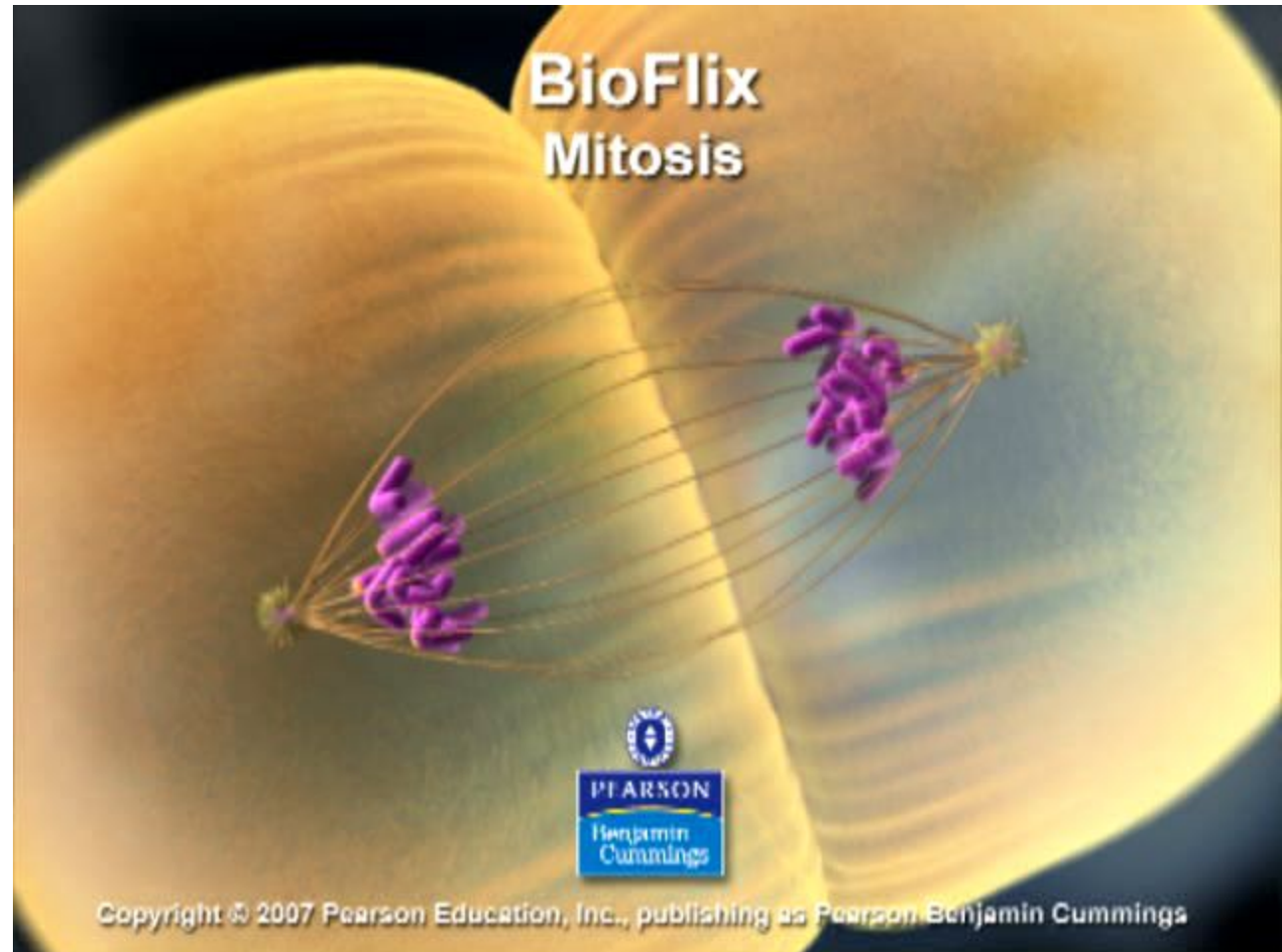
- ❑ New nuclear membranes form around new nuclei



Mitosis

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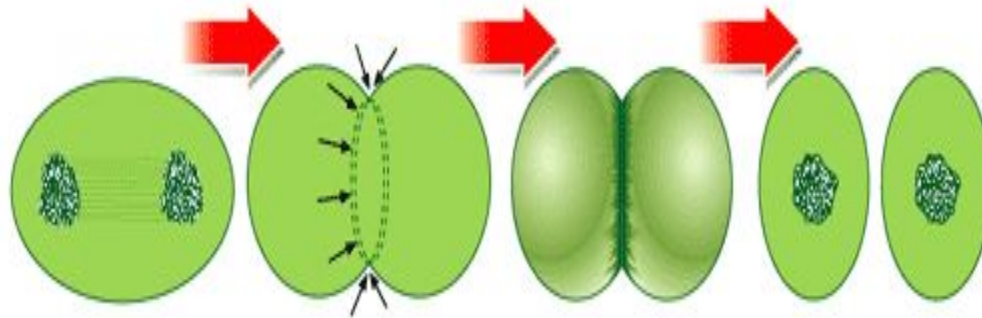
1. Prophase
2. Metaphase
3. Anaphase
4. Telophase



CYTO KINESIS – Cytoplasm splits into 2 cells.

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-Animal cells: *Cleavage furrow* forms from outside in.



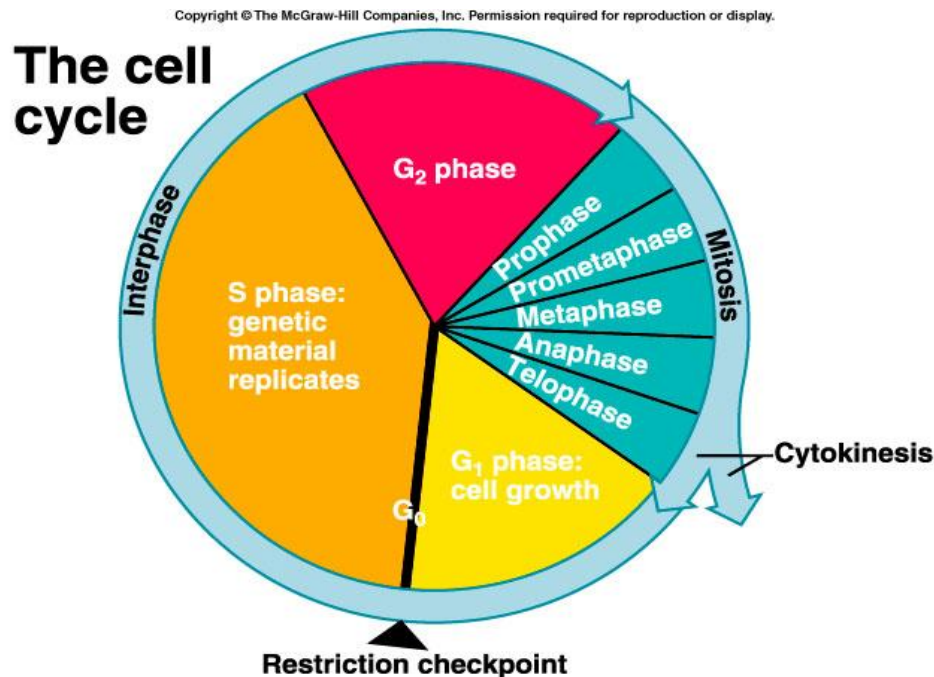
Cell cycle

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Cell now returns to interphase .

The chromosomes uncoil back into chromatin.

The whole cell cycle starts over again....



Daughter Cells of Mitosis

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- Have the same number of chromosomes as each other and as the parent cell from which they were formed
- Identical to each other, but smaller than parent cell
- Must grow in size to become mature cells (G1 of Interphase)

Animation on cell cycle and mitosis

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- <https://www.youtube.com/watch?v=woD6zvp-4E8>

Meiosis

Formation of Gametes
(Eggs & Sperm)

Facts About Meiosis

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- Preceded by interphase which includes chromosome replication
- Two meiotic divisions --- Meiosis I and Meiosis II
- Called Reduction- division
- Original cell is diploid ($2n$)
- Four daughter cells produced that are monoploid ($1n$)

Facts About Meiosis

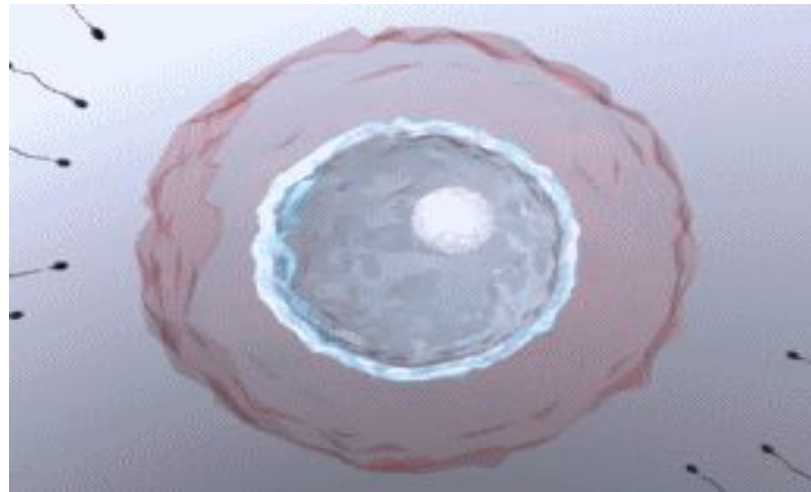
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- Daughter cells contain half the number of chromosomes as the original cell
- Produces gametes (eggs & sperm)
- Occurs in the testes in males (Spermatogenesis)
- Occurs in the ovaries in females (Oogenesis)

Why Do we Need Meiosis?

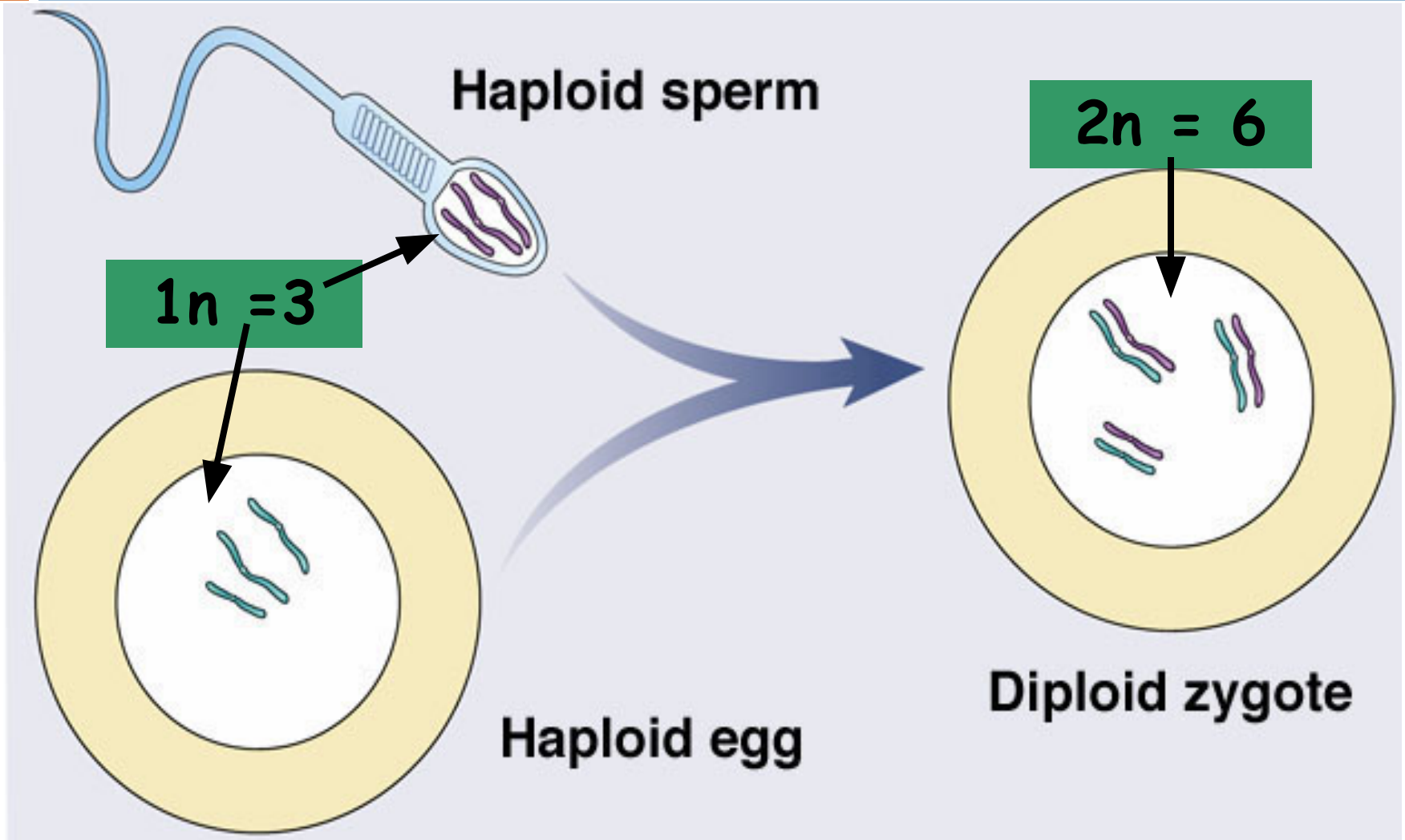
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- It is the fundamental basis of sexual reproduction
- Two haploid ($1n$) gametes are brought together through fertilization to form a diploid ($2n$) zygote



Fertilization – “Putting it all together”

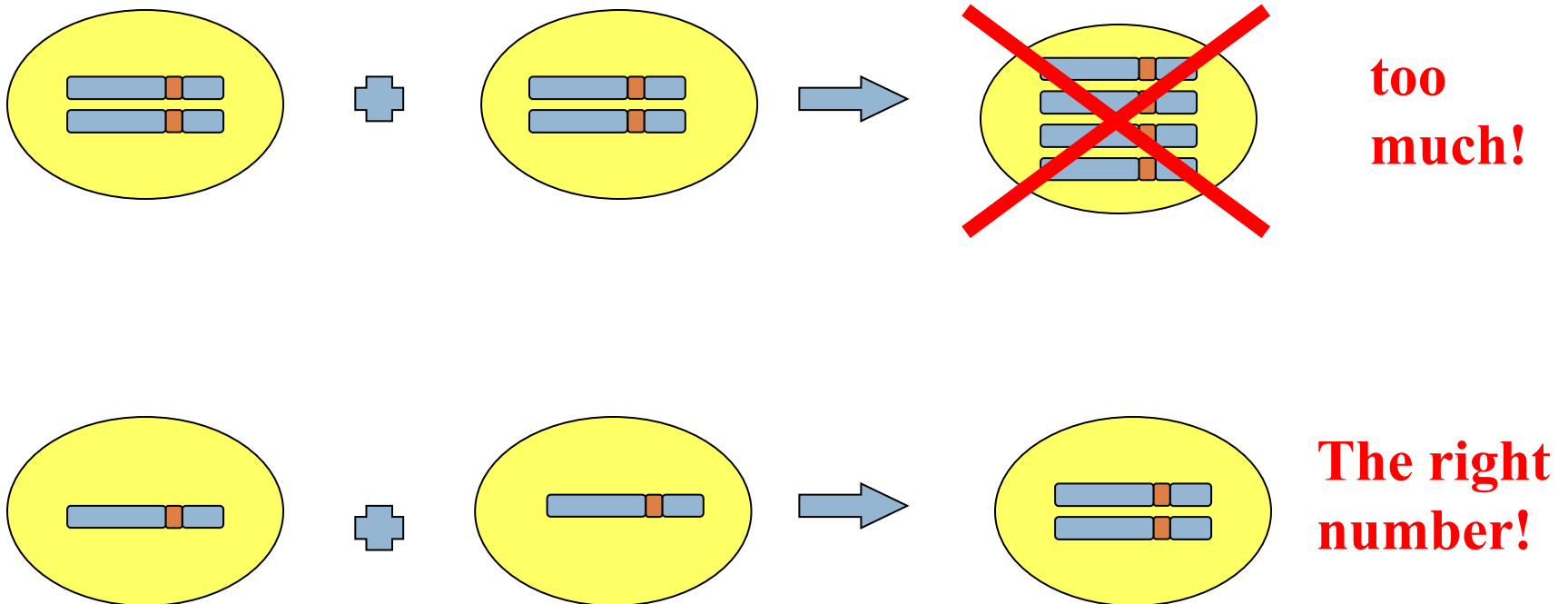
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Meiosis Forms Haploid Gametes

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- ✓ Meiosis must reduce the chromosome number by half
- ✓ Fertilization then restores the $2n$ number



Process of Meiosis

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- Meiosis animation

Comparing Mitosis and Meiosis

Comparison of Divisions

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	Mitosis	Meiosis
Number of divisions	1	2
Number of daughter cells	2	4
Genetically identical?	Yes	No
Chromosome #	Same as parent	Half of parent
Where	Somatic cells	Germ cells
When	Throughout life	At sexual maturity
Role	Growth and repair	Sexual reproduction

Types of Cell Reproduction

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Asexual reproduction:

Involves a single cell dividing to make 2 new, identical daughter cells

- Binary fission and budding are examples of asexual reproduction

Sexual reproduction

Involves two cells (egg & sperm) joining to make a new cell (zygote) that is NOT identical to the original cells.

- Meiosis is an example

Asexual reproduction:

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Binary Fission:

- Binary fission is the simplest form and involves the division of a single organism into two complete organisms, each identical to the other and to the parent.
- Fission is common among unicellular organisms such as bacteria, many protists, some algae such as *Spirogyra* and *Euglena*, as well as a few higher organisms such as flatworms and certain species of polychaete worms.

Asexual reproduction:

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Regeneration:

- A similar form of asexual reproduction is regeneration, in which an entire organism may be generated from a part of its parent.
- The term regeneration normally refers to **re-growth** of missing, or damaged body parts in higher organisms, but whole body regeneration occurs in Hydra, starfish, and many plants.

Asexual reproduction:

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Asexual Spore:

- Spores are another form of asexual reproduction and are common among bacteria, protists, and fungi.
- Spores are DNA-containing capsules capable of sprouting into new organisms; unlike most seeds, spores are produced without sexual union of gametes, that is, reproductive cells.

Asexual reproduction:

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Budding:

- Budding is another method of asexual reproduction in which a group of self-supportive cells sprouts from and then detaches from the parent organism.
- Unlike eggs or spores, buds are multicellular and usually contain more than one cell layer.
- Hydra and sea squirts reproduce by budding.

Asexual reproduction:

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Vegetative Reproduction:

- Vegetative reproduction is common among plants and consists of certain parts that grow out from a main parent plant and eventually root and sprout to form new, independent plants.
- Examples are the runners of strawberries, the tubers of potatoes, and the bulbs of onions.

Parthenogenesis:

- Parthenogenesis is an important means of asexual reproduction in which new individuals are formed from unfertilized eggs.
- It occurs in some insects, amphibians, reptiles, and birds and in some species of plants.