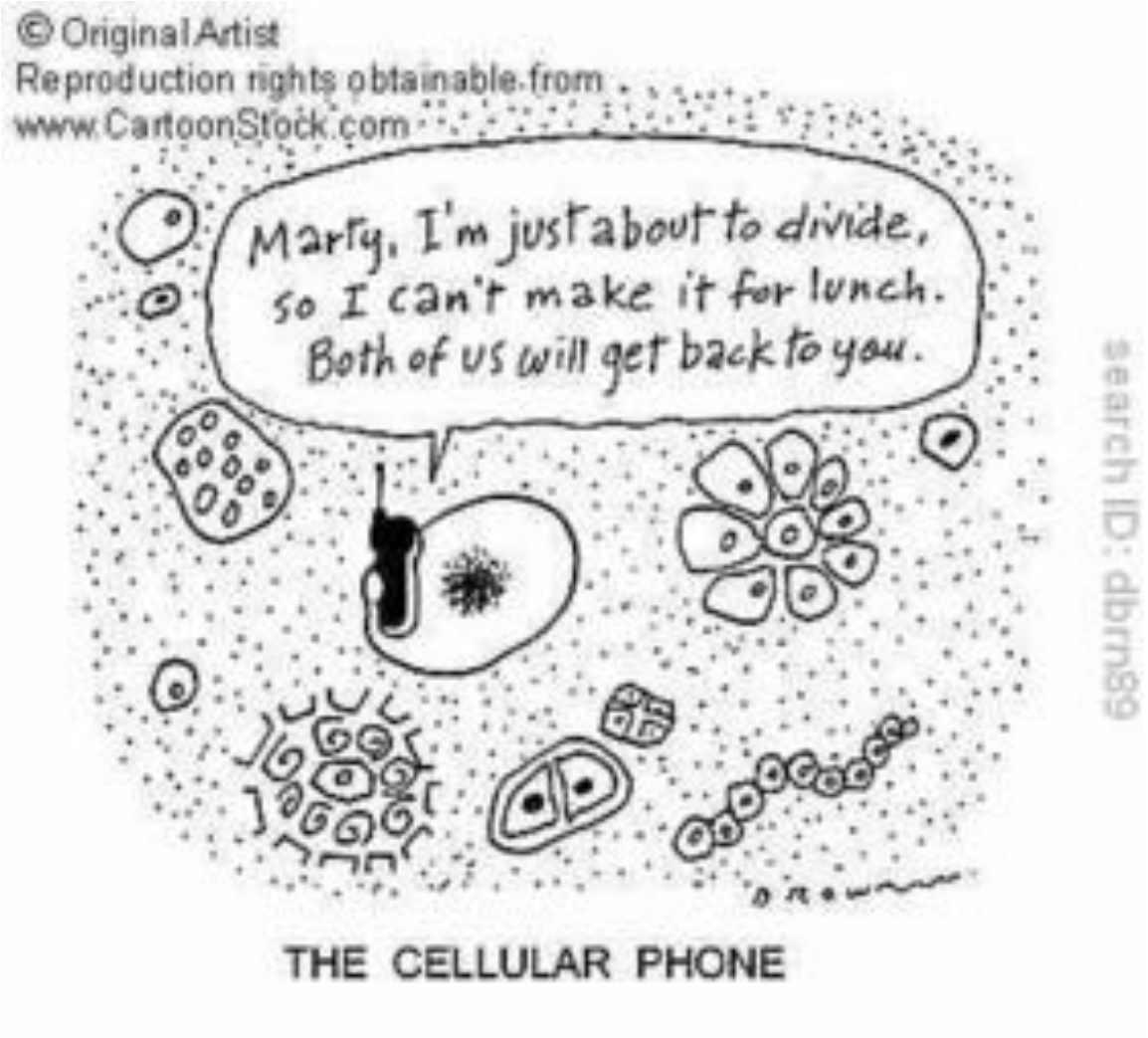
Mitosis!


© Original Artist
Reproduction rights obtainable from
www.CartoonStock.com
Marty, I'm just about to divide, so I can't make it for lunch. Both of us will get back to you.
search ID: dbrn89
THE CELLULAR PHONE

Learning Objectives

- Describe some of the difficulties a cell faces as it increases in size.
- Compare asexual and sexual reproduction.

Why are cells so small?
Surface-Area-to-Volume Ratio

Surface area = the amount of "covering" of the object

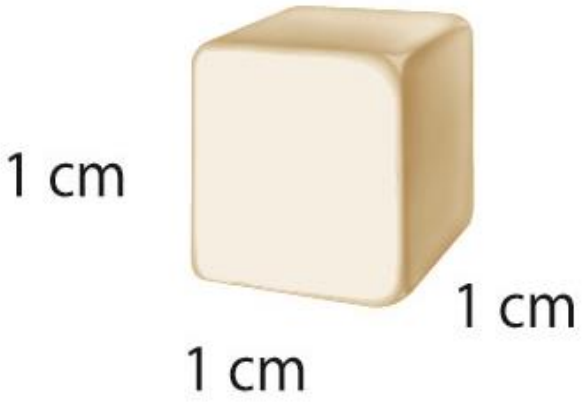
Volume = the amount of space inside the object; the amount of space the object takes up

$SA_{cube} = l \times w \times 6$

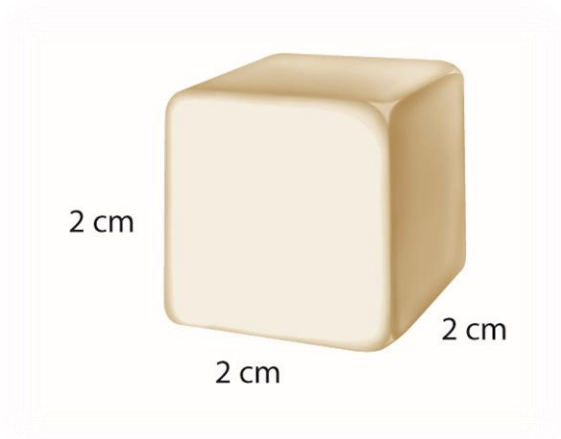
$1\ cm \times 1\ cm \times 6 = 6\ cm^2$

$V_{cube} = l \times w \times h$

$1\ cm \times 1\ cm \times 1\ cm = 1\ cm^3$



Surface Area to Volume in Growing Cells

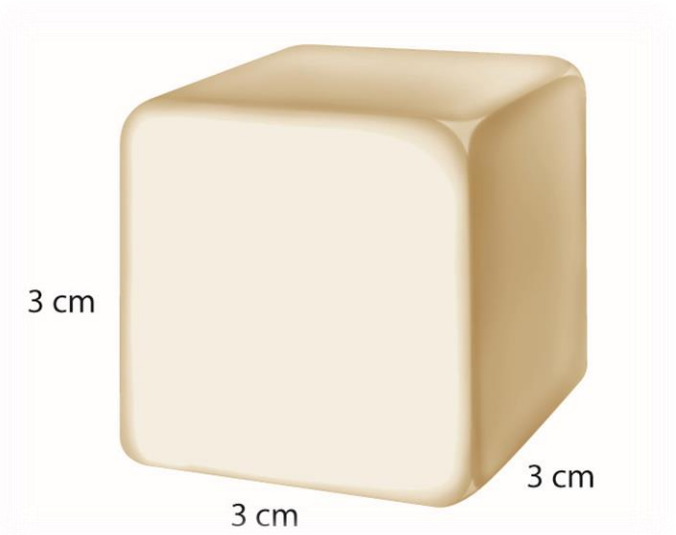


SA

$24\ cm^2$

V

$8\ cm^3$



SA

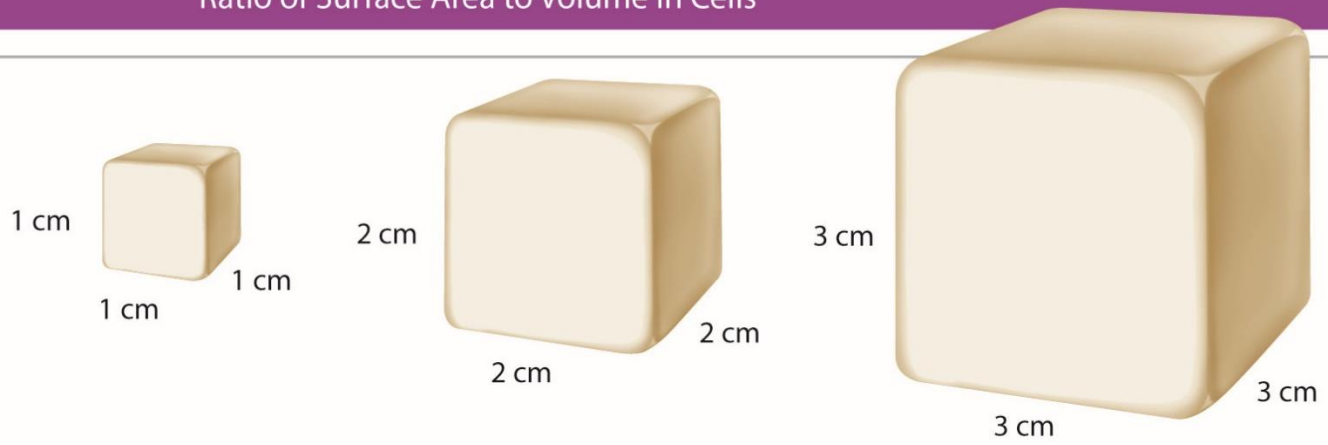
$54\ cm^2$

V

$27\ cm^3$

Ratio of Surface Area to Volume in Cells

Ratio of Surface Area to Volume in Cells



Surface Area (length x width) x 6 sides	1 cm x 1 cm x 6 = 6 cm^2	2 cm x 2 cm x 6 = 24 cm^2	3 cm x 3 cm x 6 = 54 cm^2
Volume (length x width x height)	1 cm x 1 cm x 1 cm = 1 cm^3	2 cm x 2 cm x 2 cm = 8 cm^3	3 cm x 3 cm x 3 cm = 27 cm^3
Ratio of Surface Area to Volume	6 / 1 = 6 : 1	24 / 8 = 3 : 1	54 / 27 = 2 : 1

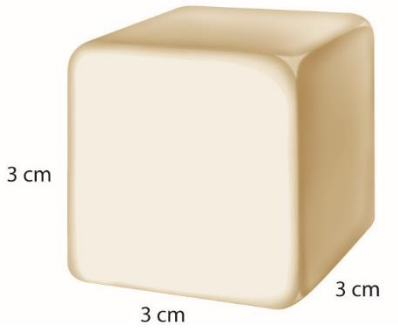
Largest ratio

Smallest ratio

Cell Growth Limitations

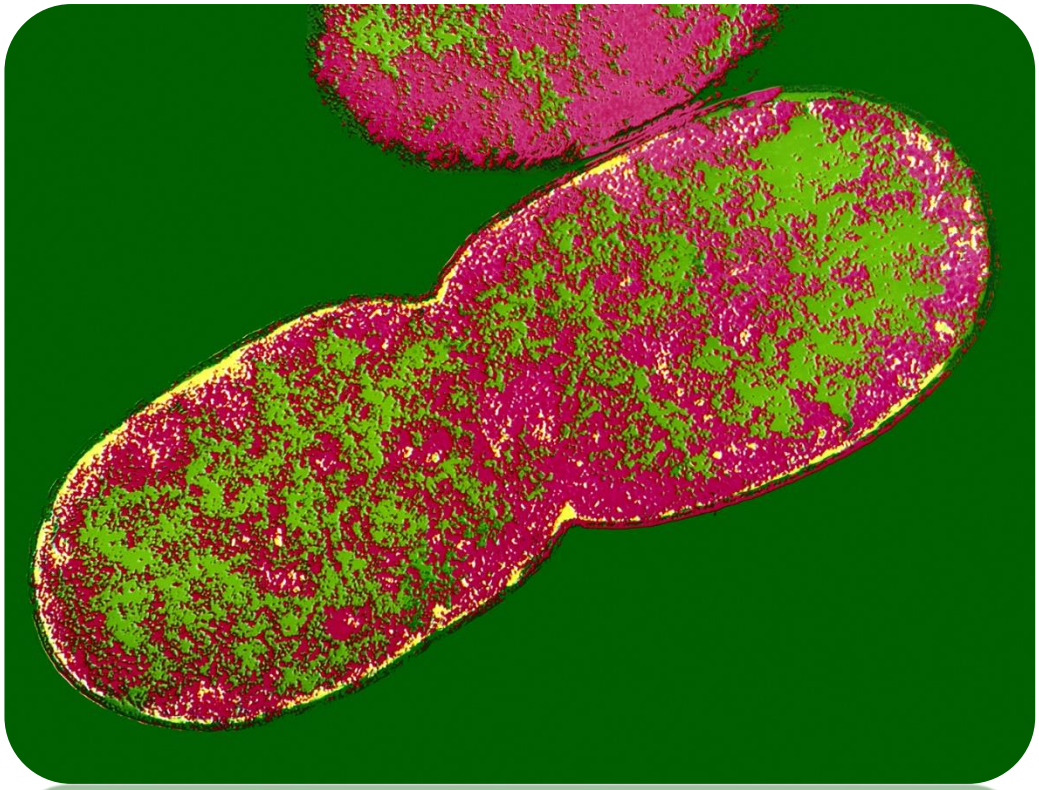
- **Information crisis**: too many demands placed on DNA

- **Traffic problems**: volume grows too fast relative to surface area, material exchange is insufficient



Cell Division

- Produces two daughter cells
- Cell must replicate DNA before cell division.
- Dividing to make more, smaller cells keeps surface area to volume ratio high.



Why do organisms need to make new cells?

How do little elephants grow up to be BIG elephants?

Why do animals shed their skin?

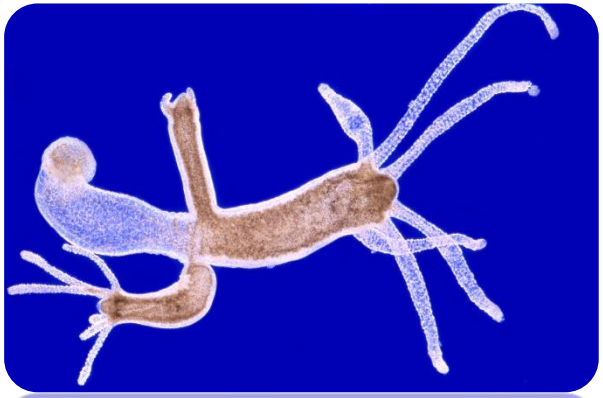
Three reasons why cells reproduce by asexual reproduction:

1. Growth
2. Repair
3. Replacement

Skin cancer - the abnormal growth of skin cells - most often develops on skin exposed to the sun.

Cell that reproduce by asexual reproduction reproduce constantly.

Asexual Reproduction



- A single parent produces genetically identical offspring.

-Watch Amoeba Sisters: Asexual and Sexual Reproduction

-Create a Venn Diagram comparing sexual and asexual reproduction

Reproduction

Name _____

Write your own definition of reproduction:

2 types

_____ parents

Offspring will be _____ from parent

Requires _____ to produce sex cells

Sex cells include: _____ and _____

Requires _____ of egg by sperm

Advantages:

Disadvantages:

_____ parent

Offspring will be _____ to parent

Cell reproduction by _____is a type of asexual reproduction

Examples include: (describe)

Advantages:

Disadvantages:

Sexual Reproduction

- Sexual reproduction involves the fusion of two separate parent cells.

- Offspring inherit some genetic information from each parent.

Comparing Asexual and Sexual Reproduction

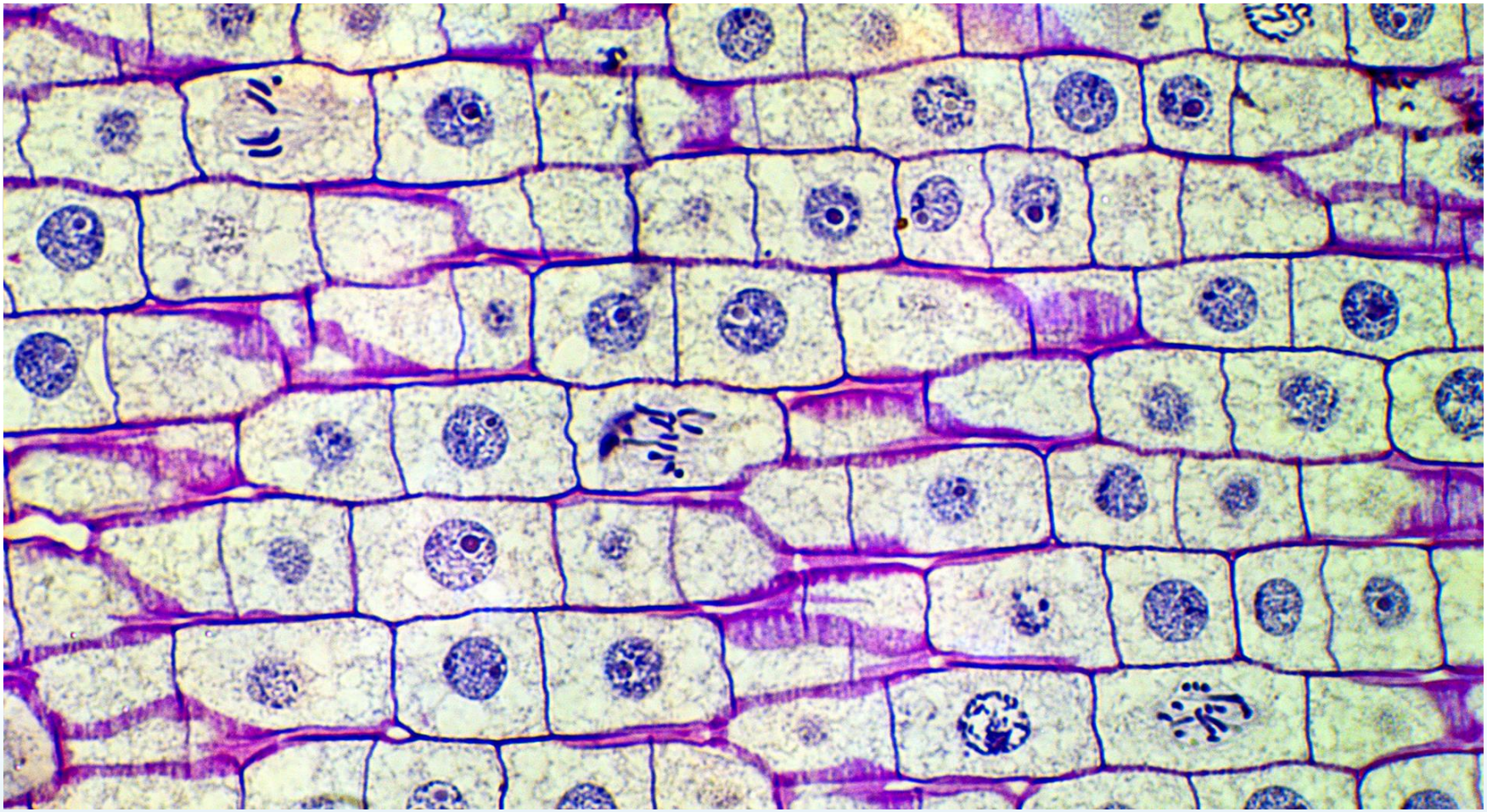
Asexual

- Produce many offspring in short period
- Don't need to find a mate
- In stable environments, genetically identical offspring thrive.
- If conditions change, offspring not well adapted.

Sexual

- Relatively fewer offspring; growth takes more time
- Need to find a mate
- In changing environments, genetic diversity can be beneficial.
- Offspring may be less well adapted to current conditions.

The Process of Cell Division
Why don't these cells look alike?

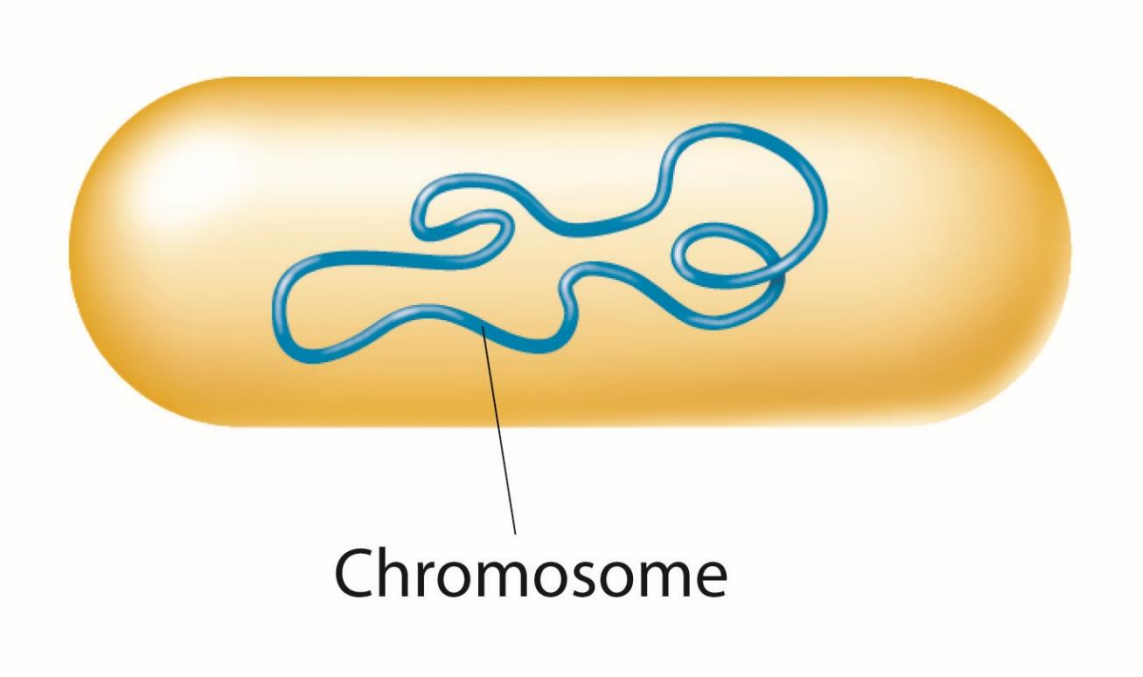


Learning Objectives

- Explain the role of chromosomes during cell division.
- Describe the main events of the cell cycle.
- Describe what happens during the phases of mitosis.
- Investigate how daughter cells split apart after mitosis.

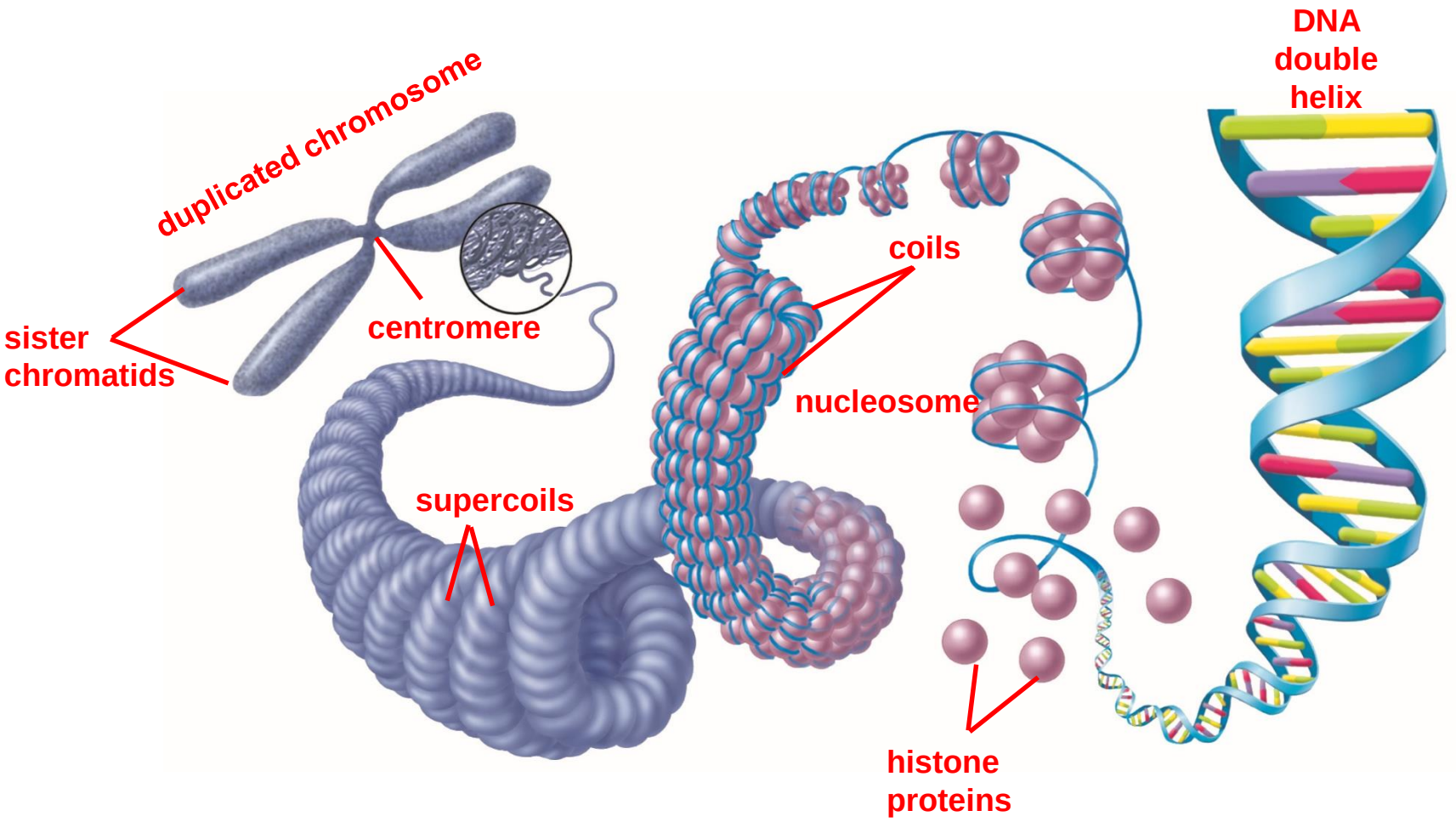
Chromosomes

In prokaryotic cells, DNA is packaged into a single, circular chromosome.



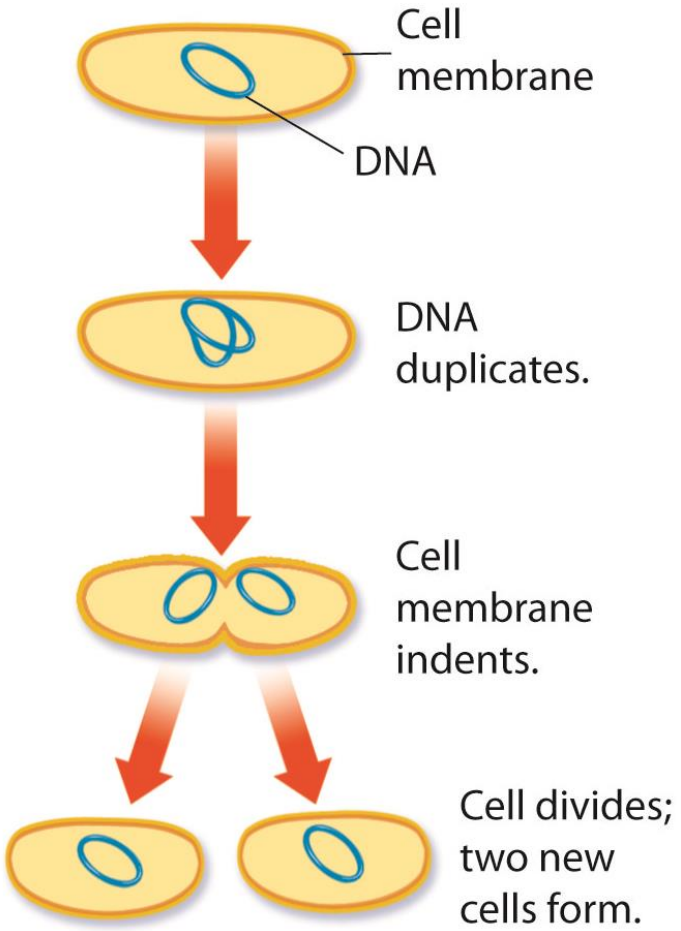
Chromosomes

In eukaryotic cells, DNA is packaged into multiple chromosomes.



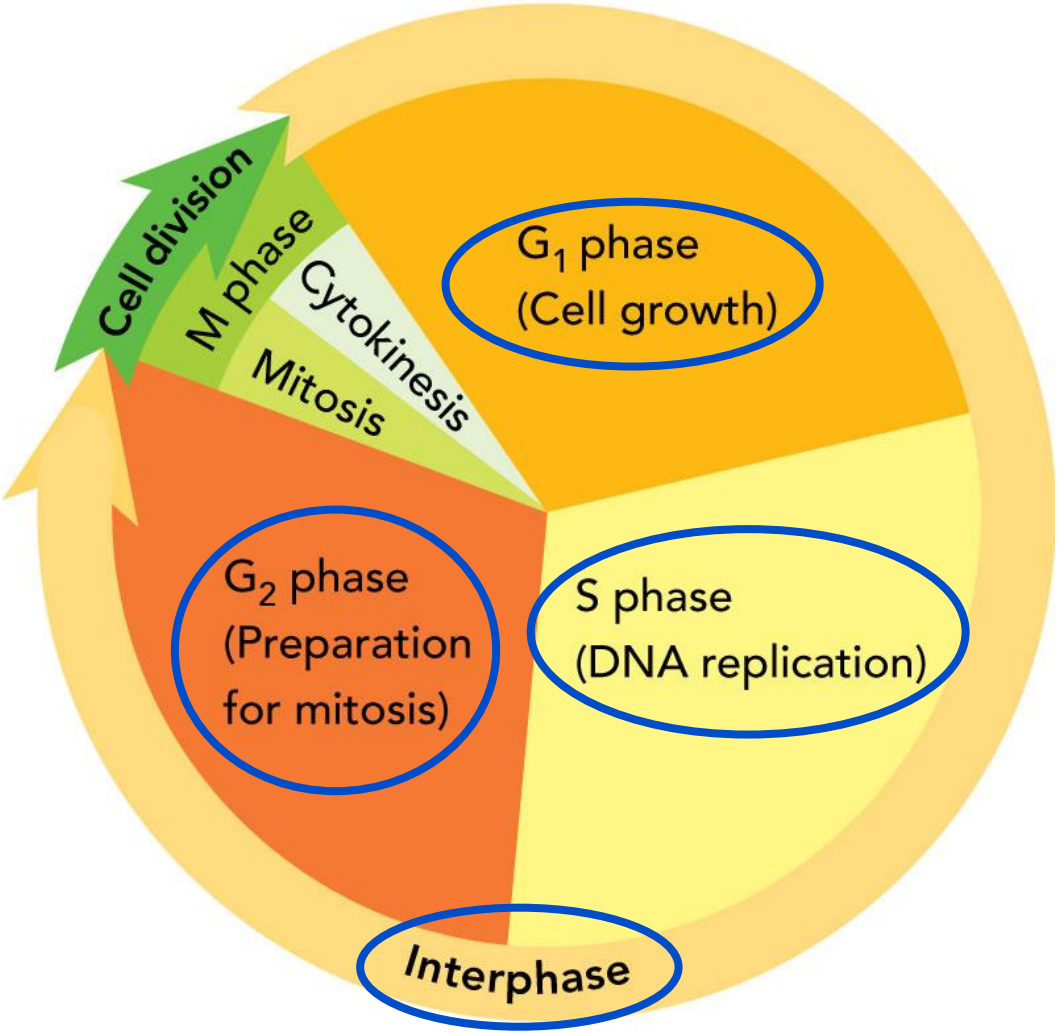
Prokaryotic Cell Cycle

Prokaryotes undergo binary fission.



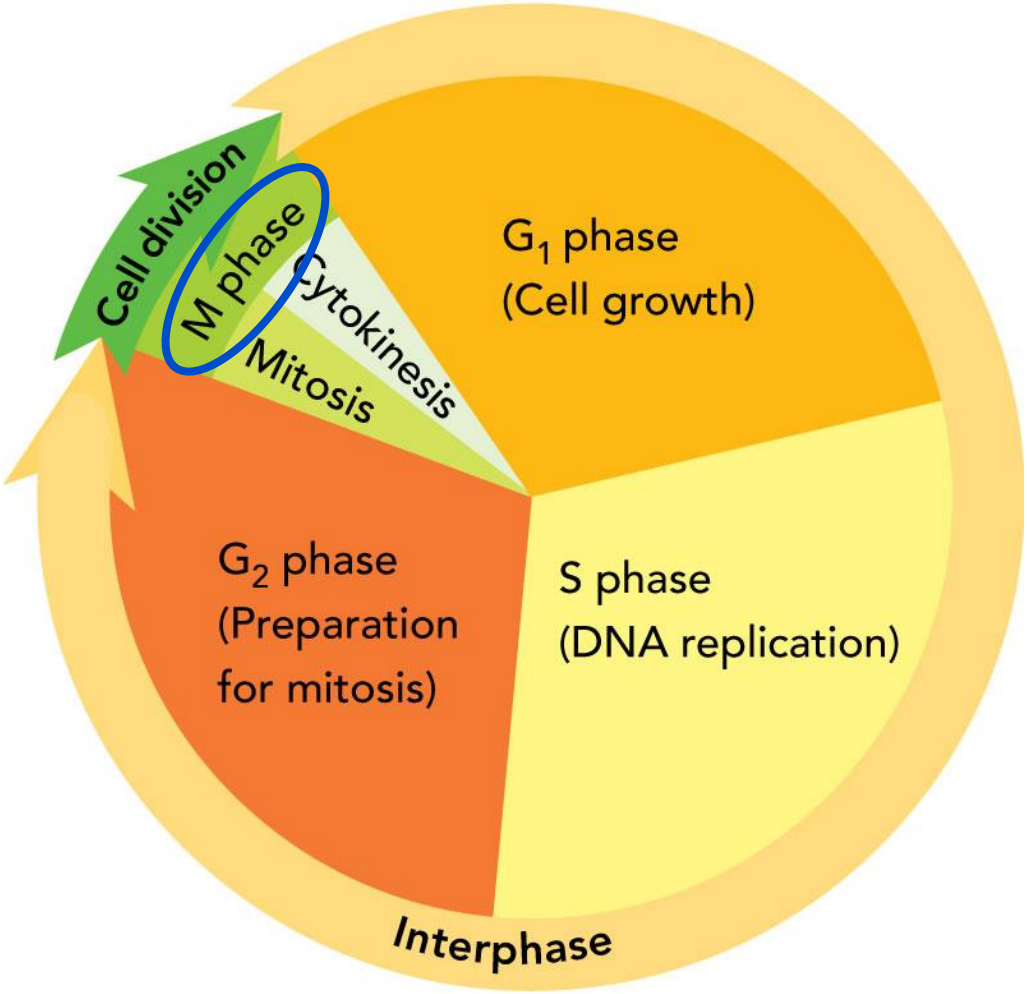
Eukaryotic Cell Cycle

Eukaryotic cells have a more complex cell cycle than prokaryotic cells.



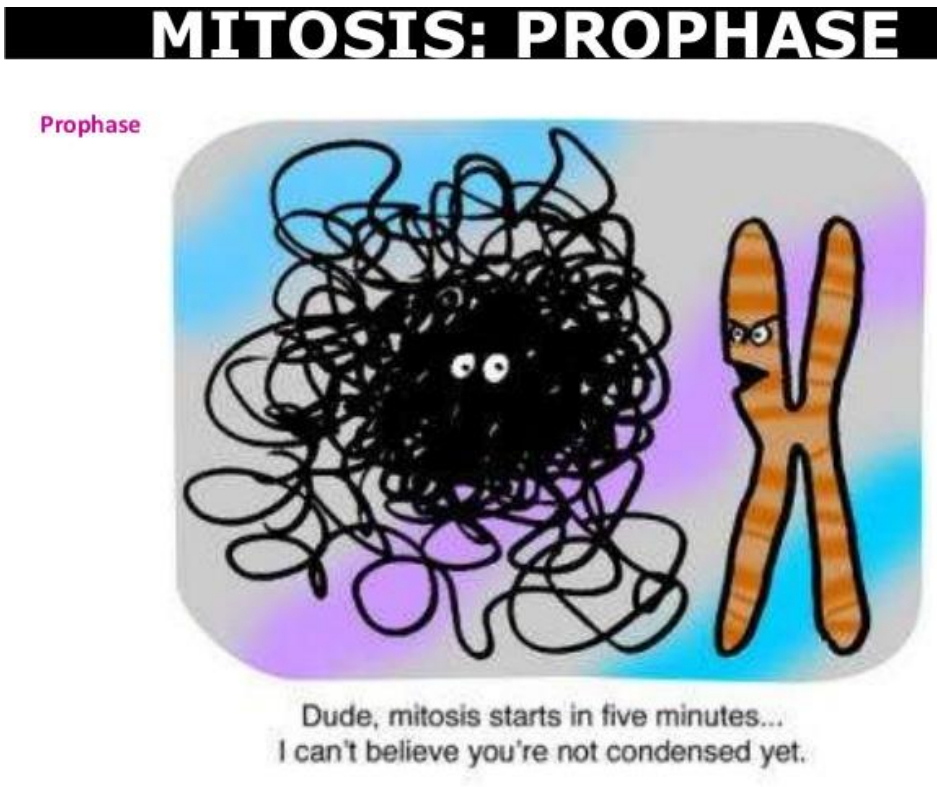
M Phase

Cell division occurs during M phase.

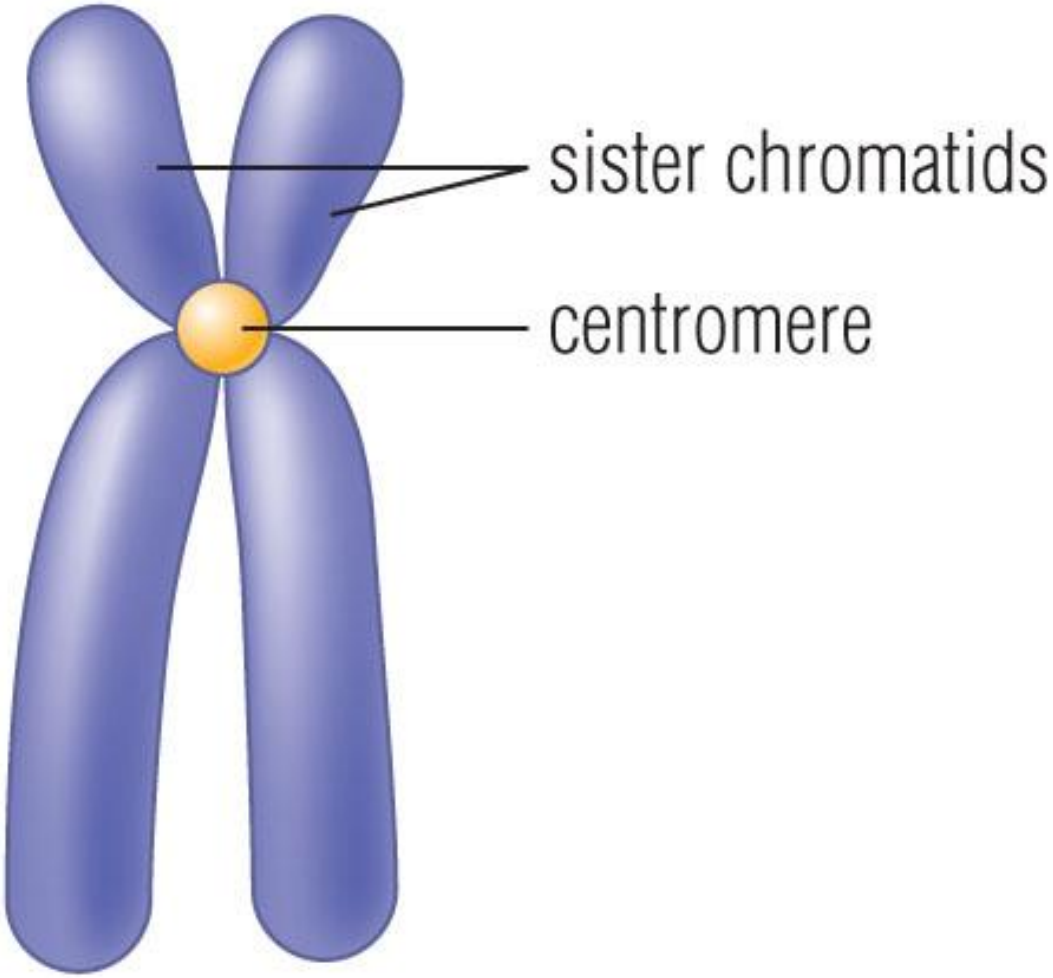


Temporary Cell Structures in Mitosis

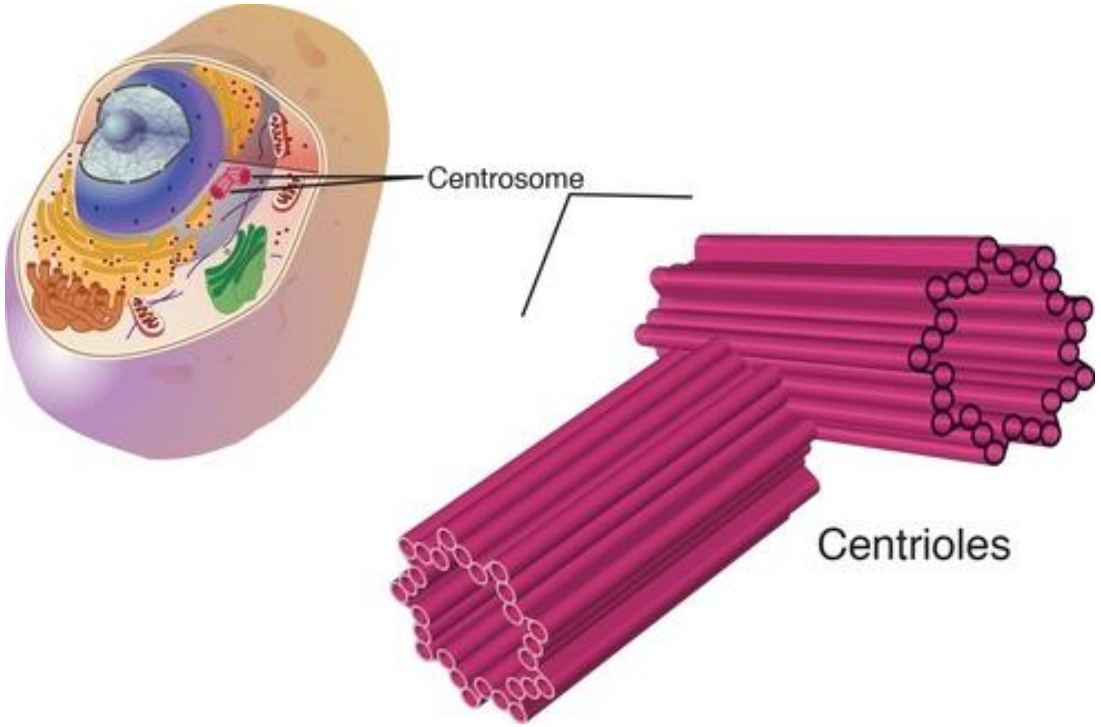
- are all temporary structures in the cell used for mitosis



Sister Chromatids



Centrioles



move to the opposite ends of the cell and attach to chromosomes by spindle fibers

Animated Mitosis Cycle

http://www.cellsalive.com/mitosis.htm

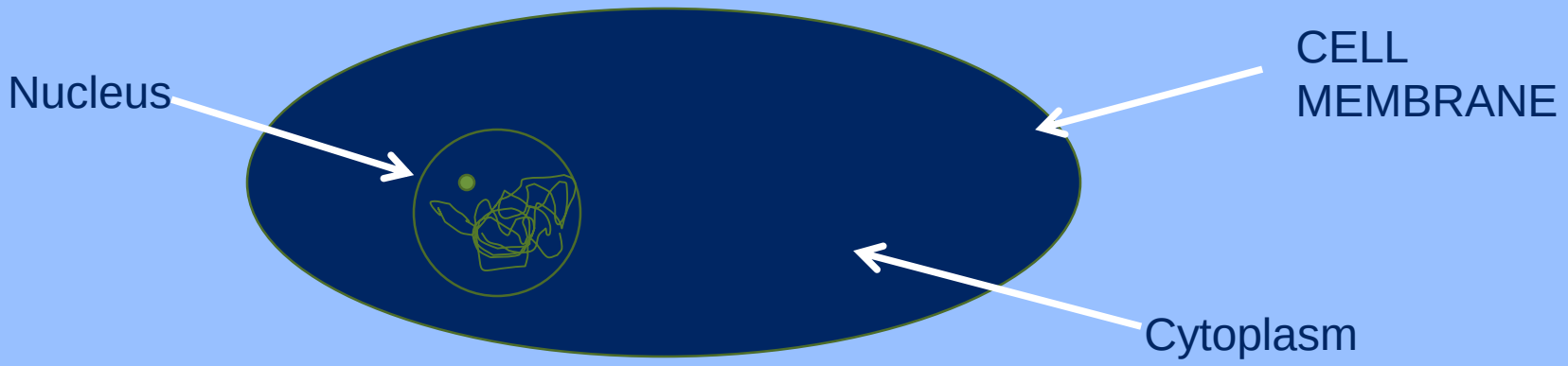
Cell Division occurs in a series of stages,
or phases

- Interphase
- Prophase
- Metaphase
- Anaphase
- Telophase & Cytokinesis

Interphase

occurs before mitosis begins

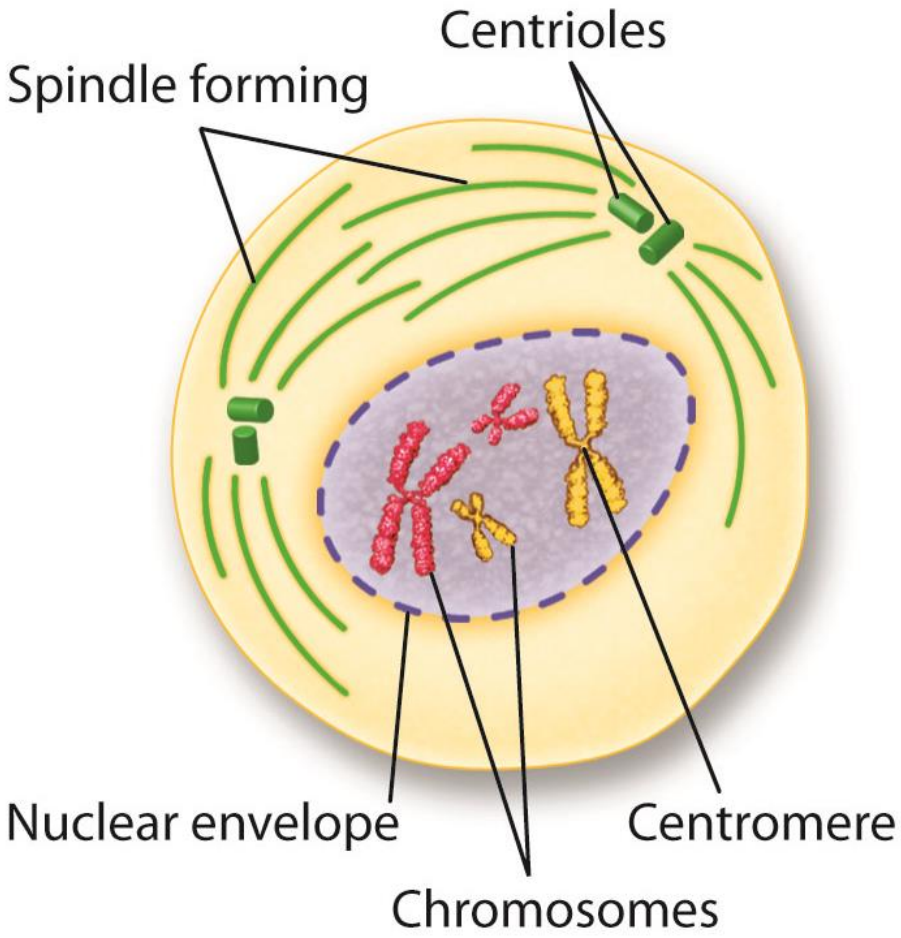
- Chromosomes are **copied** (# doubles)
- Chromosomes appear as threadlike coils (**chromatin**) at the start, but each chromosome and its copy(**sister** chromosome) change to sister chromatids at end of this phase



Centromere-holds together the sister chromatids

Prophase

The nucleus condenses and chromosomes become visible. The spindle begins to form.



Interphase

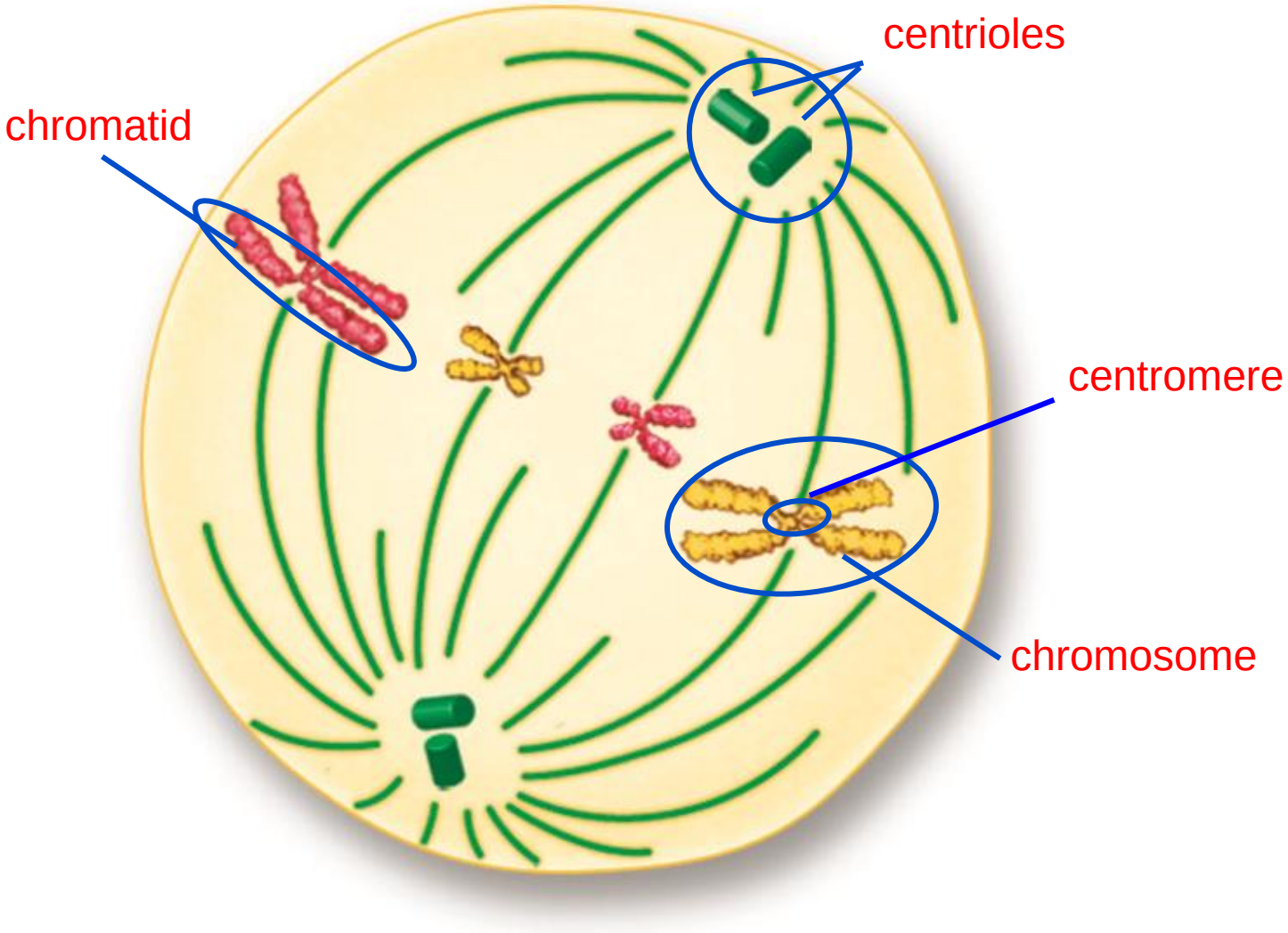
Animal Cell

Plant Cell

Photographs from: http://www.bioweb.uncc.edu/biol1110/Stages.htm

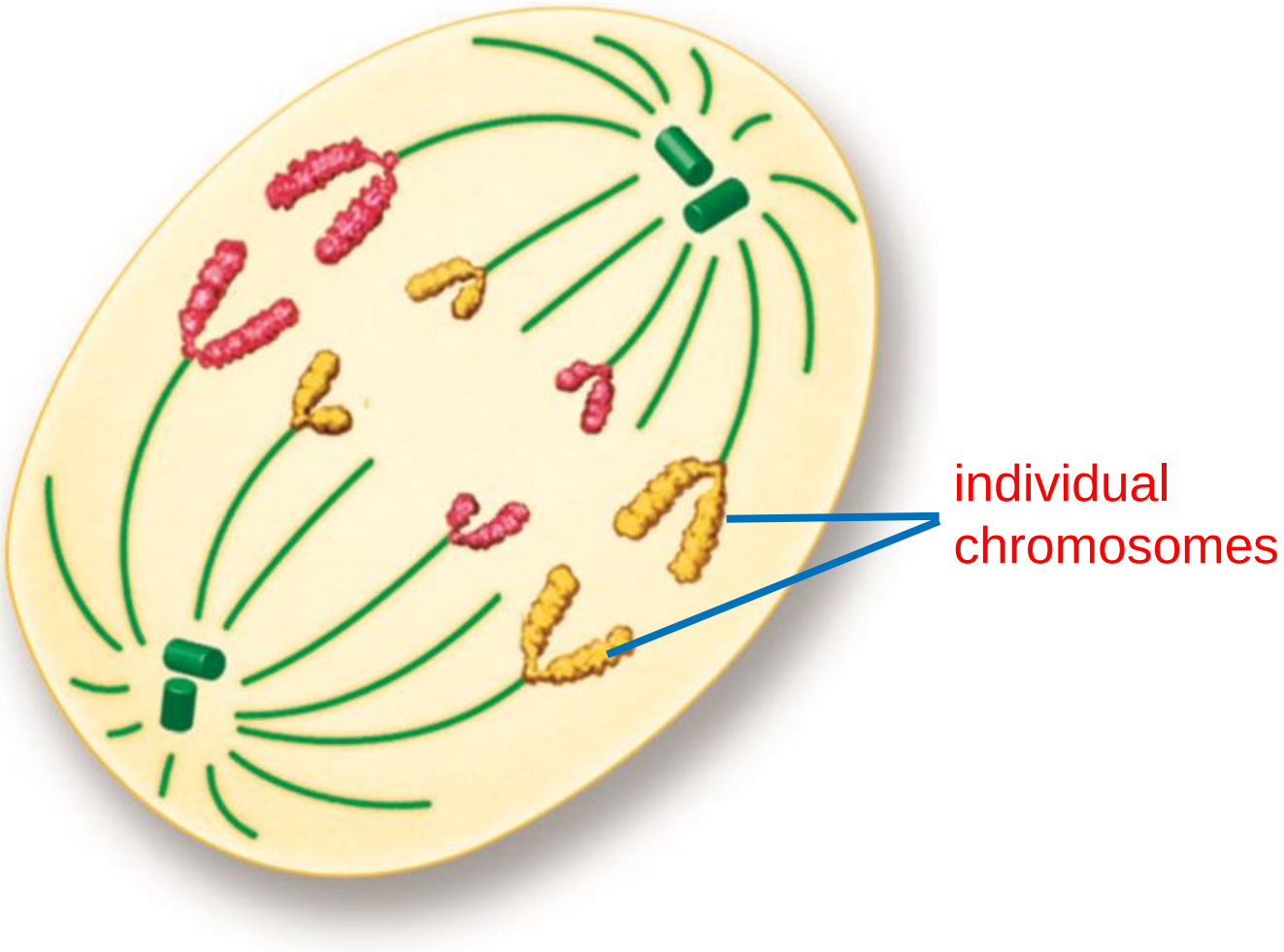
Metaphase

Chromosomes line up at the center of the cell.



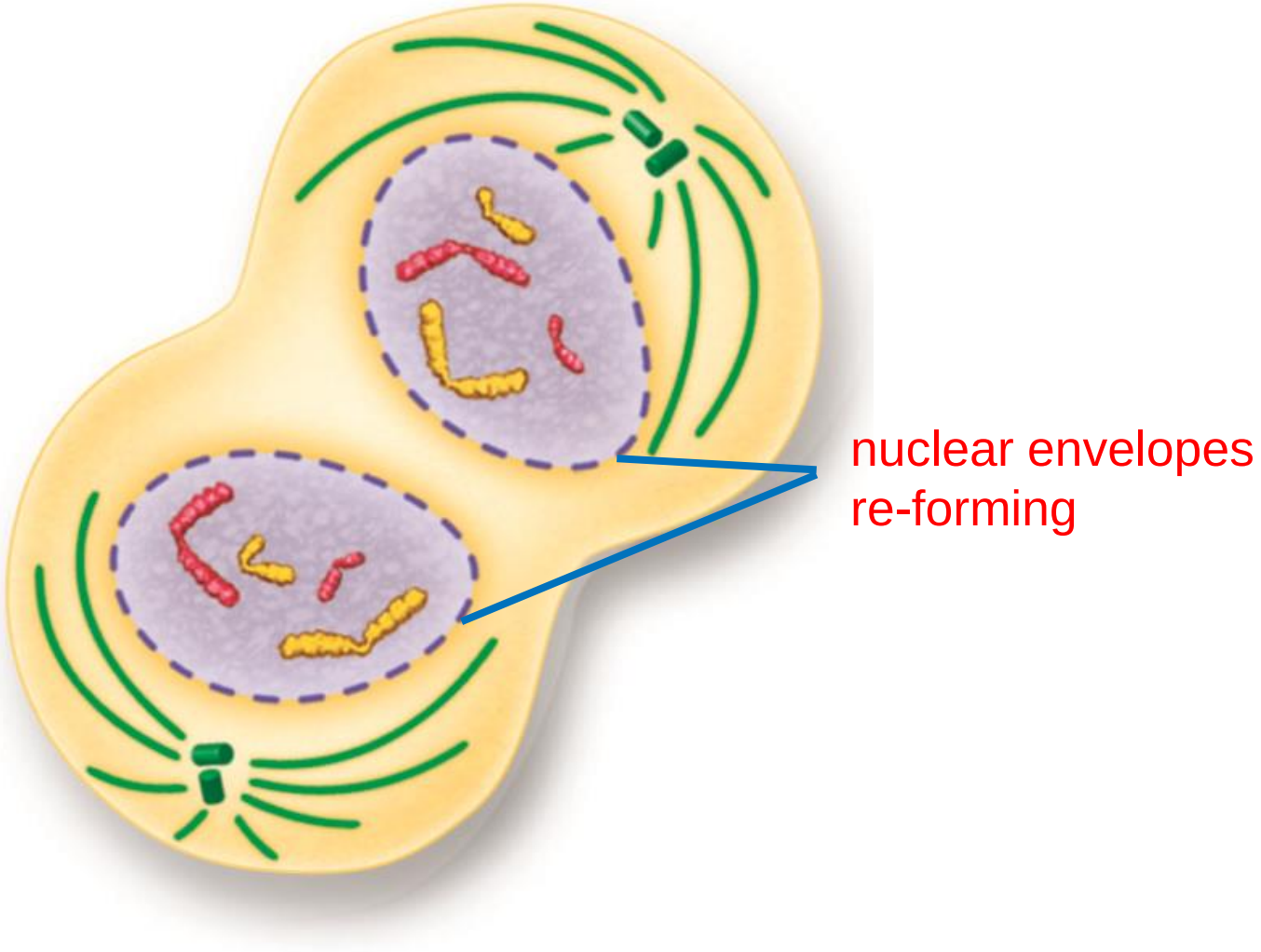
Anaphase

Chromosomes move toward opposite poles.



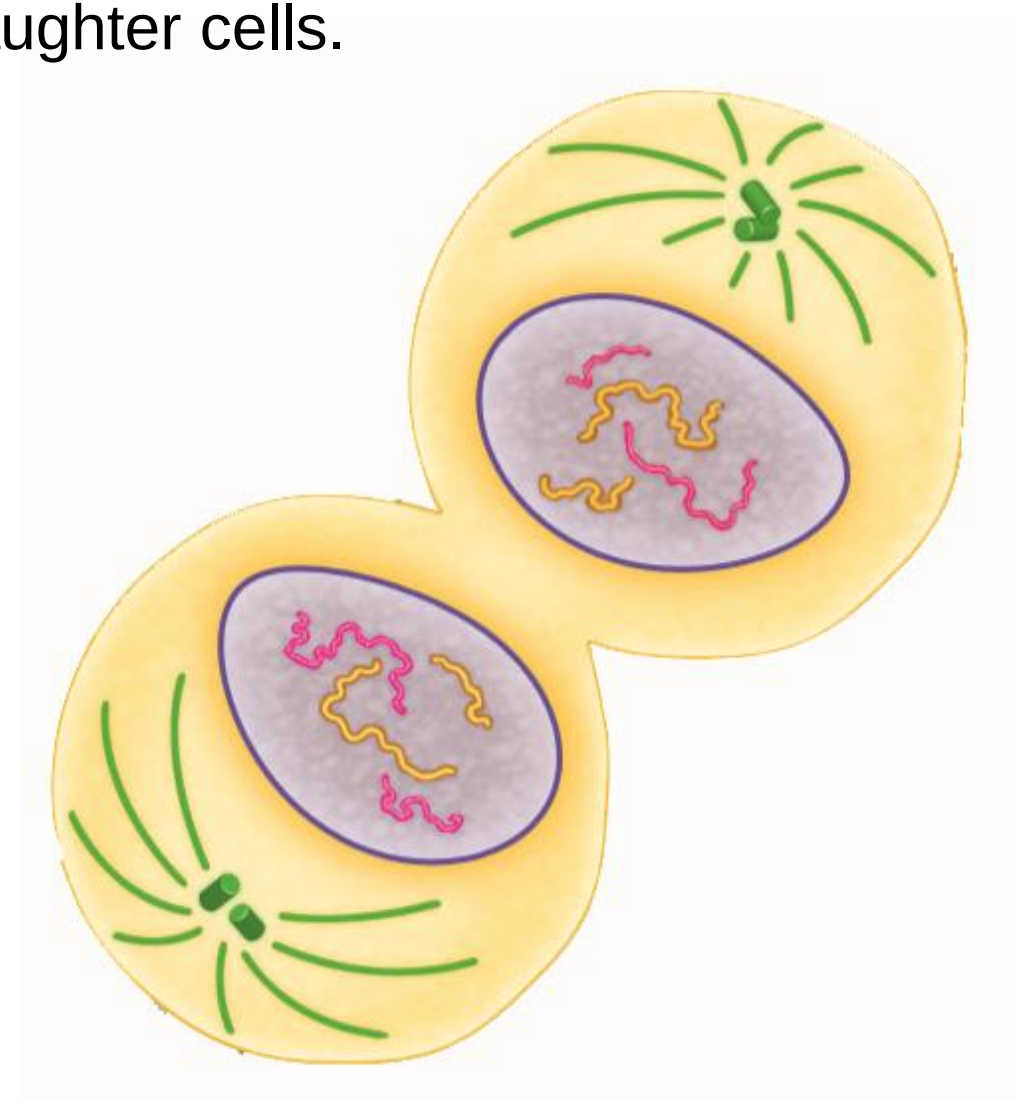
Telophase

The cell begins to divide into daughter cells.



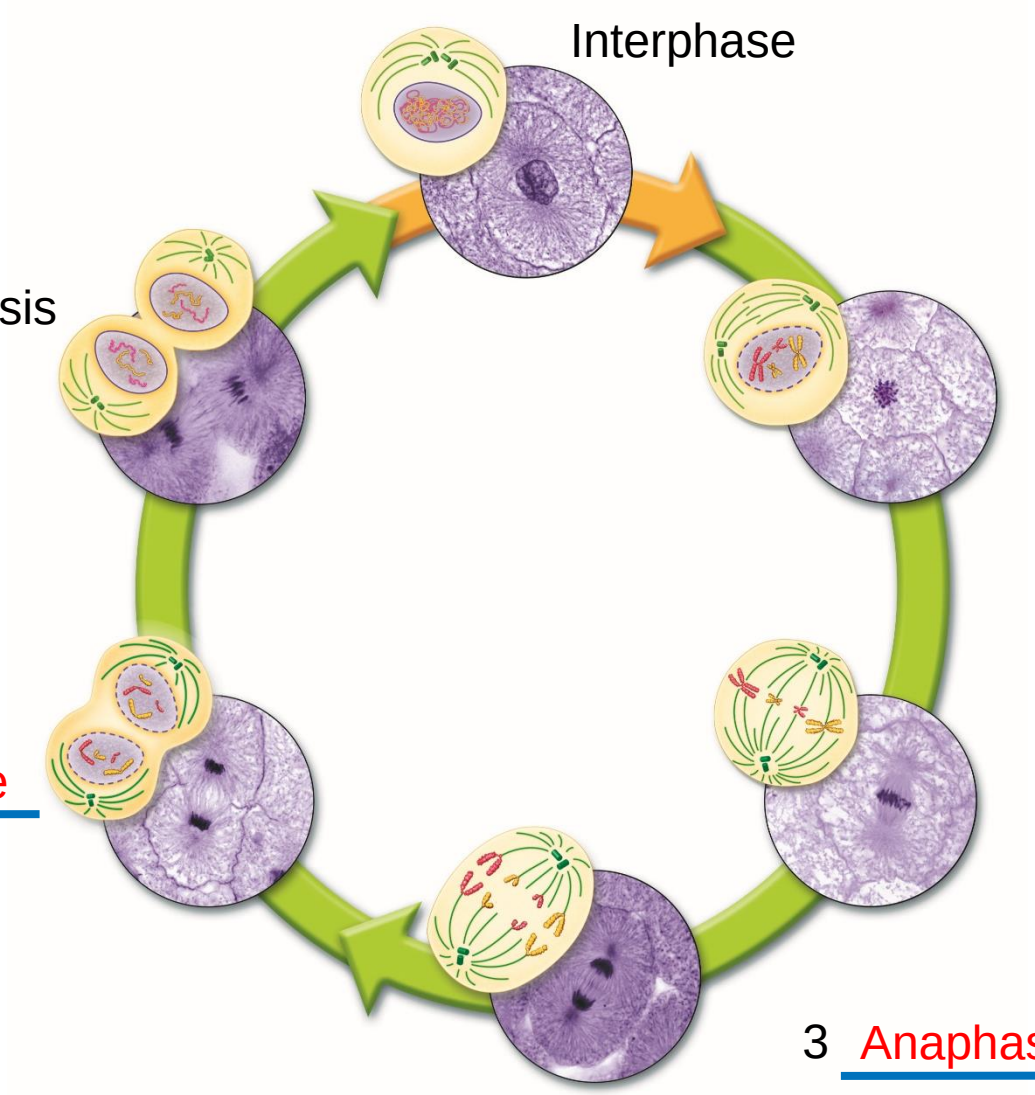
Cytokinesis

In animal cells, the cell membrane pinches in the center to form two daughter cells.



Mitosis Overview

List and describe the phases of mitosis.



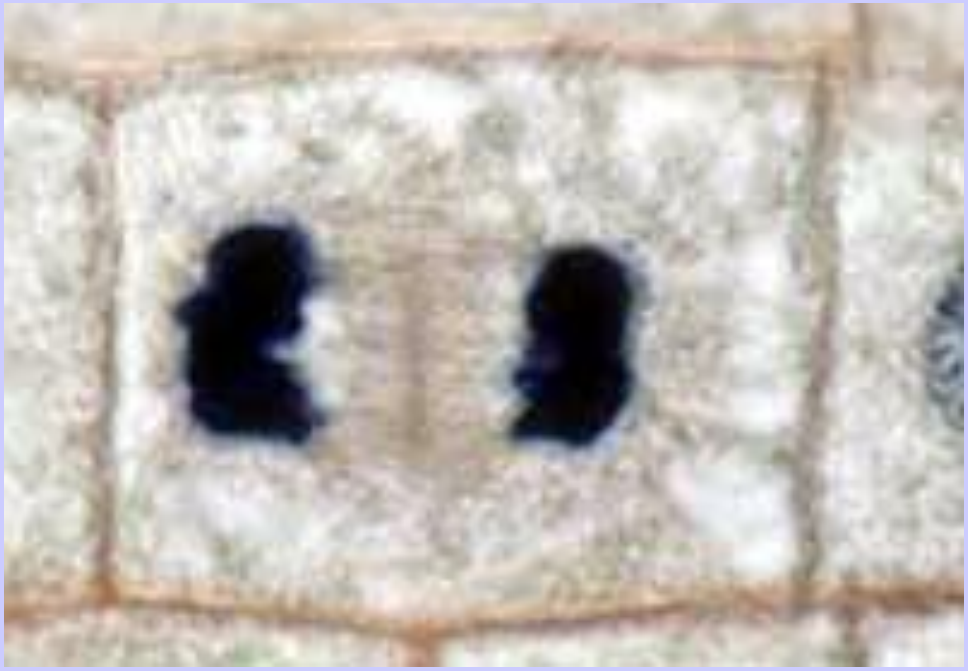
What phase is it?

What phase is it?

Anaphase

What phase is it?

Telophase

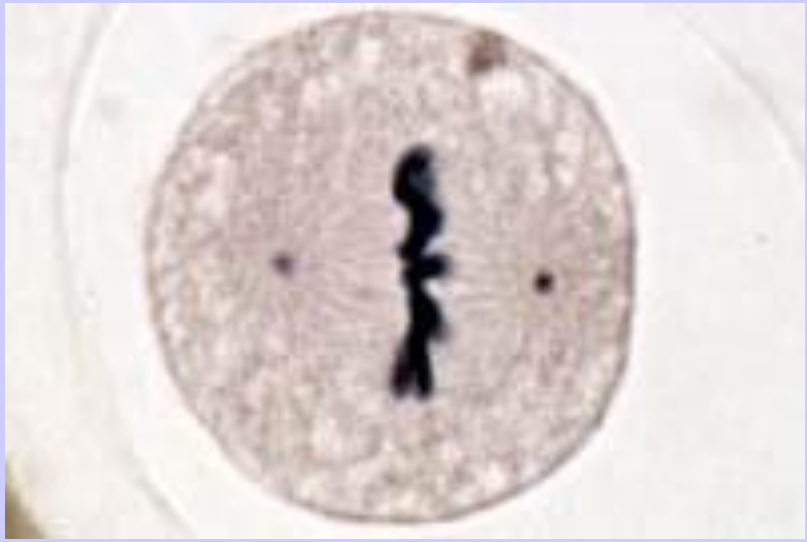


What phase is it?

Anaphase

What phase is it?

Metaphase



What phase is it?

Prophase

You can see chromosomes

What phase is it?

Interphase

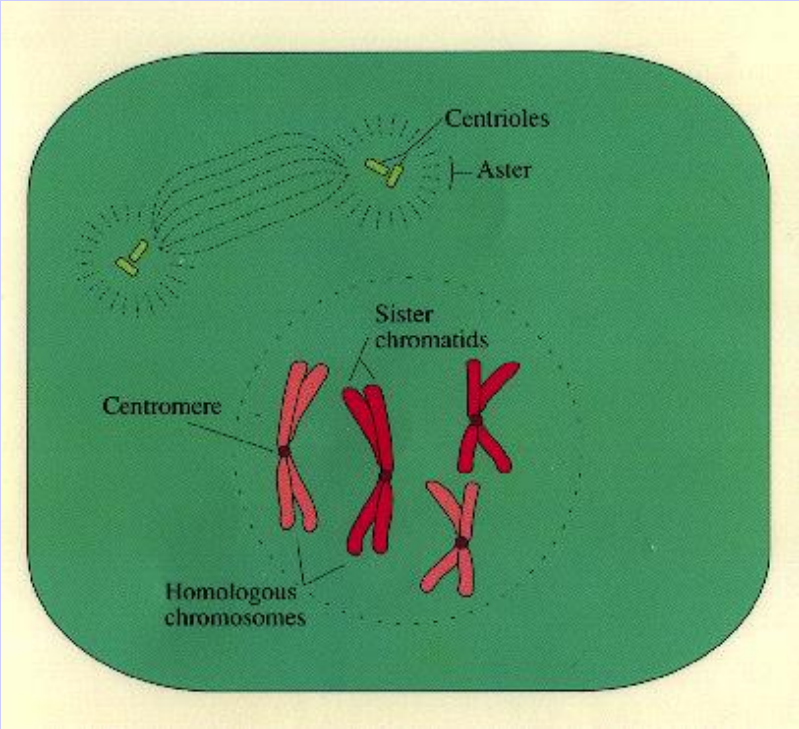
No chromosomes yet

What phase is it?

Prophase

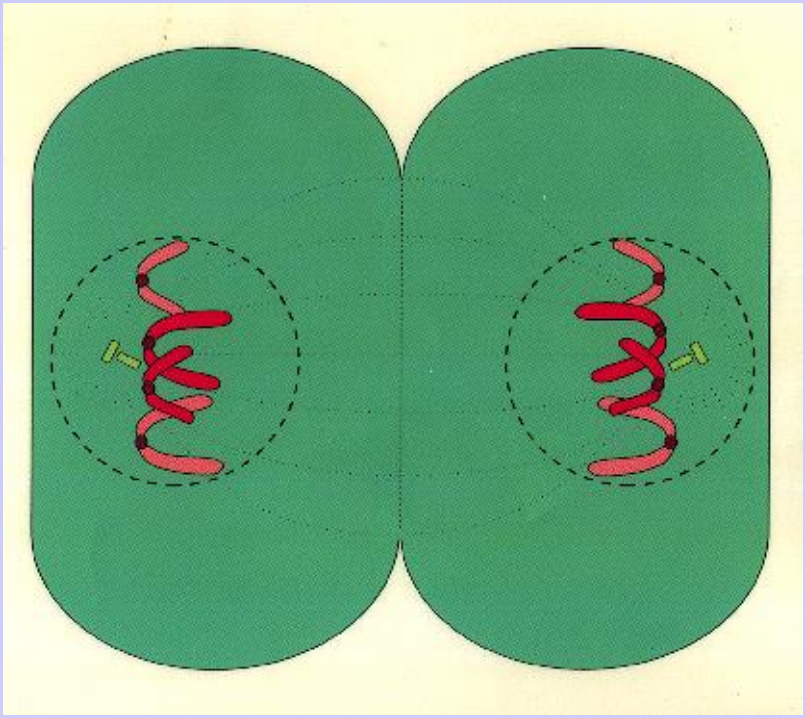
What phase is it?

prophase



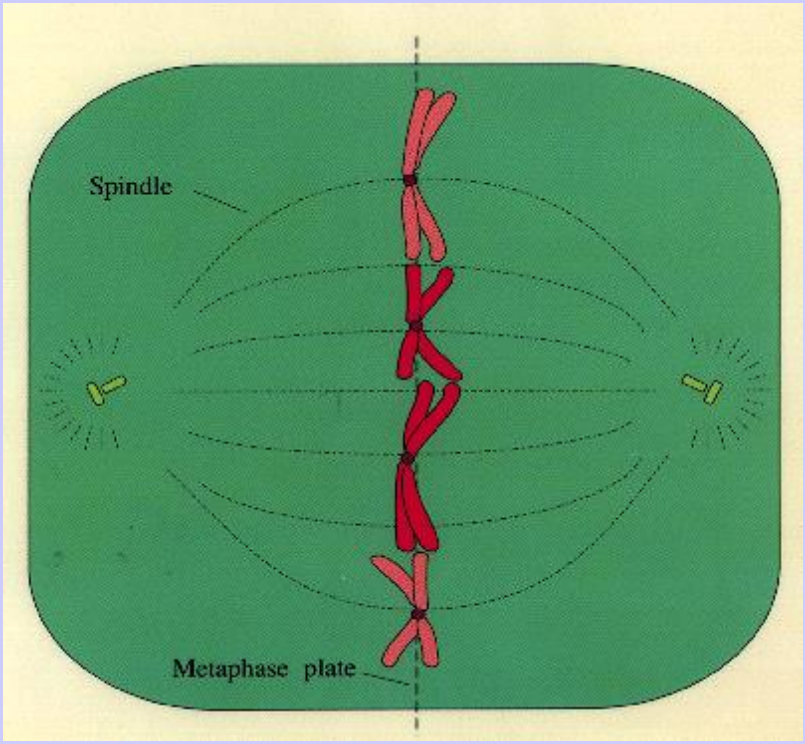
What phase is it?

Telophase



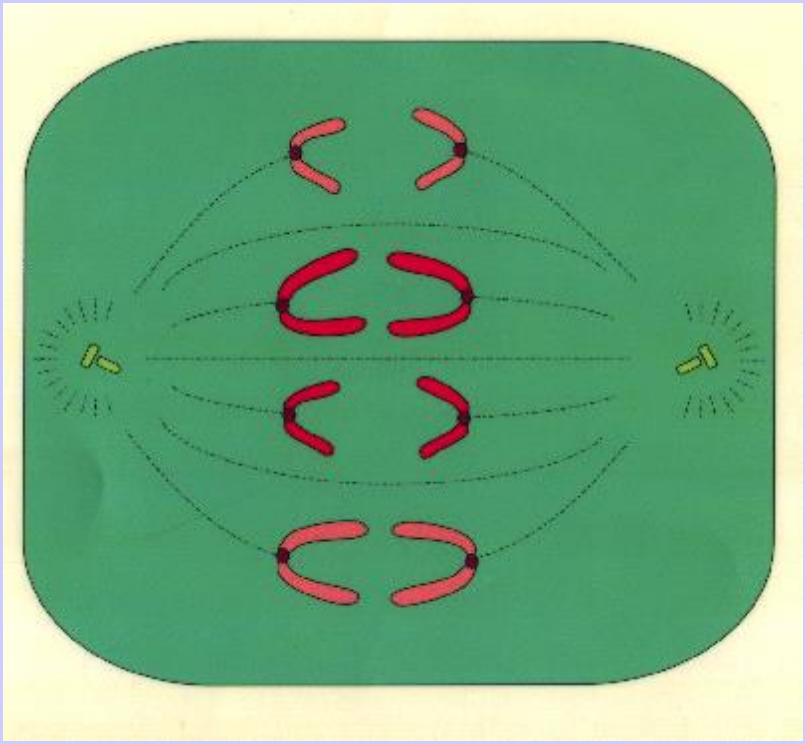
What phase is it?

Metaphase



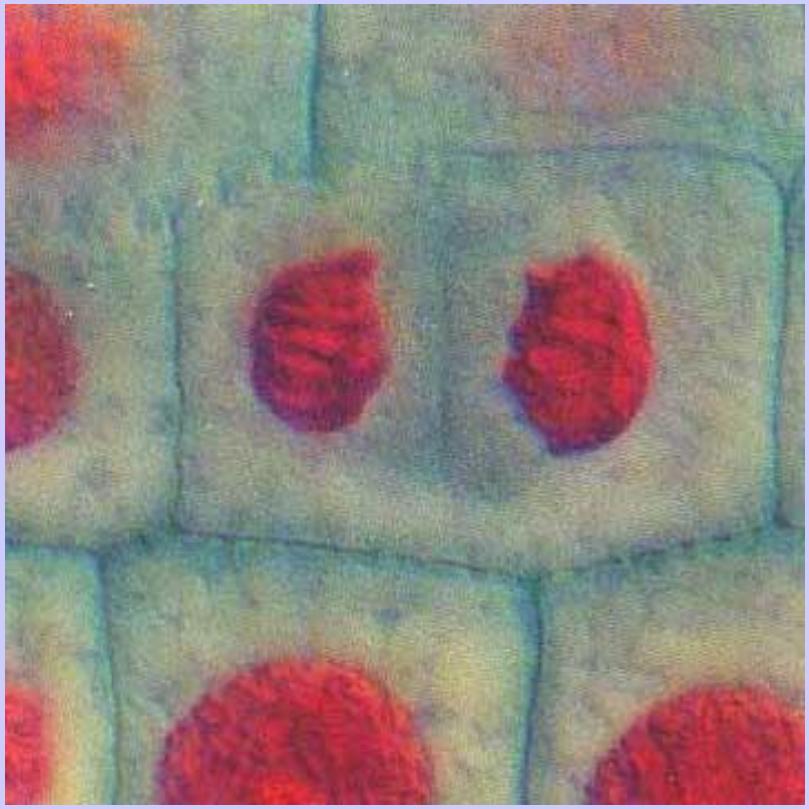
What phase is it?

Anaphase



What phase is it?

Telophase

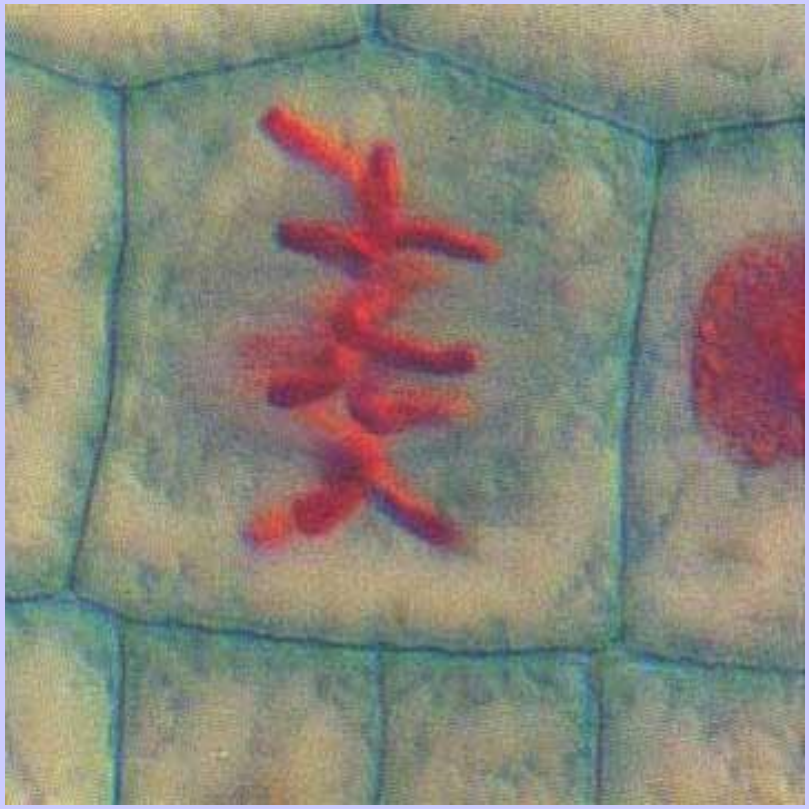


What phase is it?

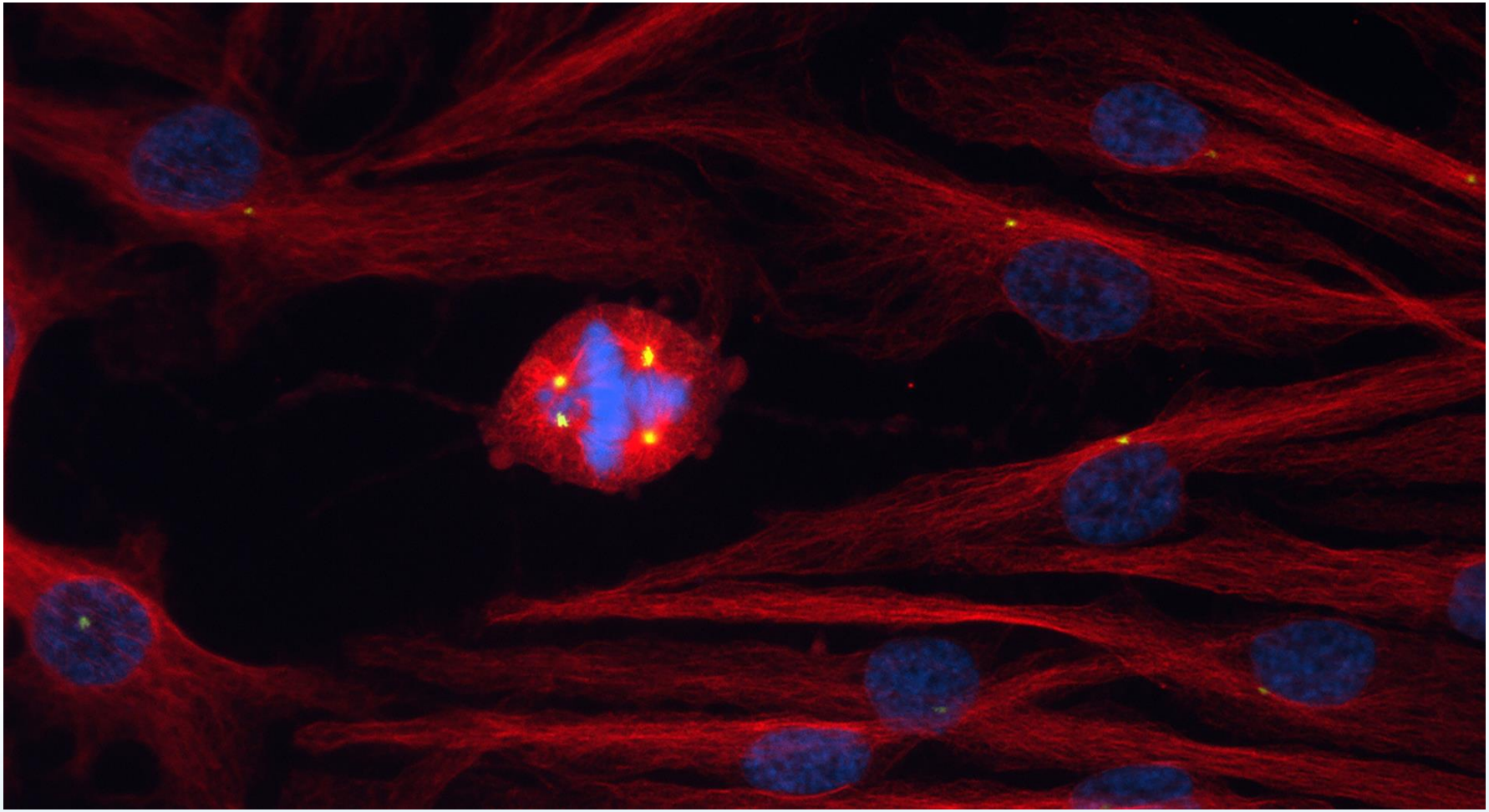
Anaphase

What phase is it?

Metaphase



Regulating the Cell Cycle



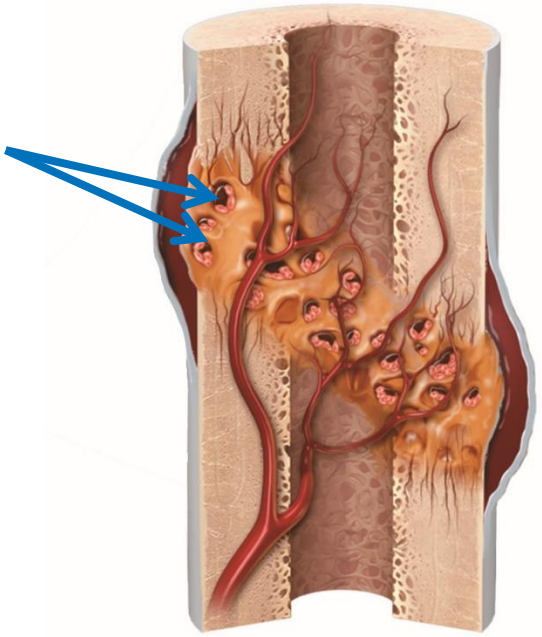
Learning Objectives

- Investigate how the cell cycle is regulated.
- Compare cancer cells with other cells.

Cell Division and Repair

Healing a Bone

new bone cells



- Cells at the edge of an injury are stimulated to divide rapidly.
- As an injury heals, the rate of cell division slows.

How do cells know when to divide? What kind of signal do they need?

When will the cells stop dividing?

The Discovery of Cyclins

- Scientists found a protein in a cell undergoing mitosis.
- They injected the protein into a non-dividing cell.
- A mitotic spindle started to form. What is the function of the spindle fibers?
- **Cyclins**: proteins that regulate the cell cycle

Regulatory Proteins

Internal regulators:

- respond to events inside the cell
- let cell cycle proceed only when certain steps have already happened

External regulators:

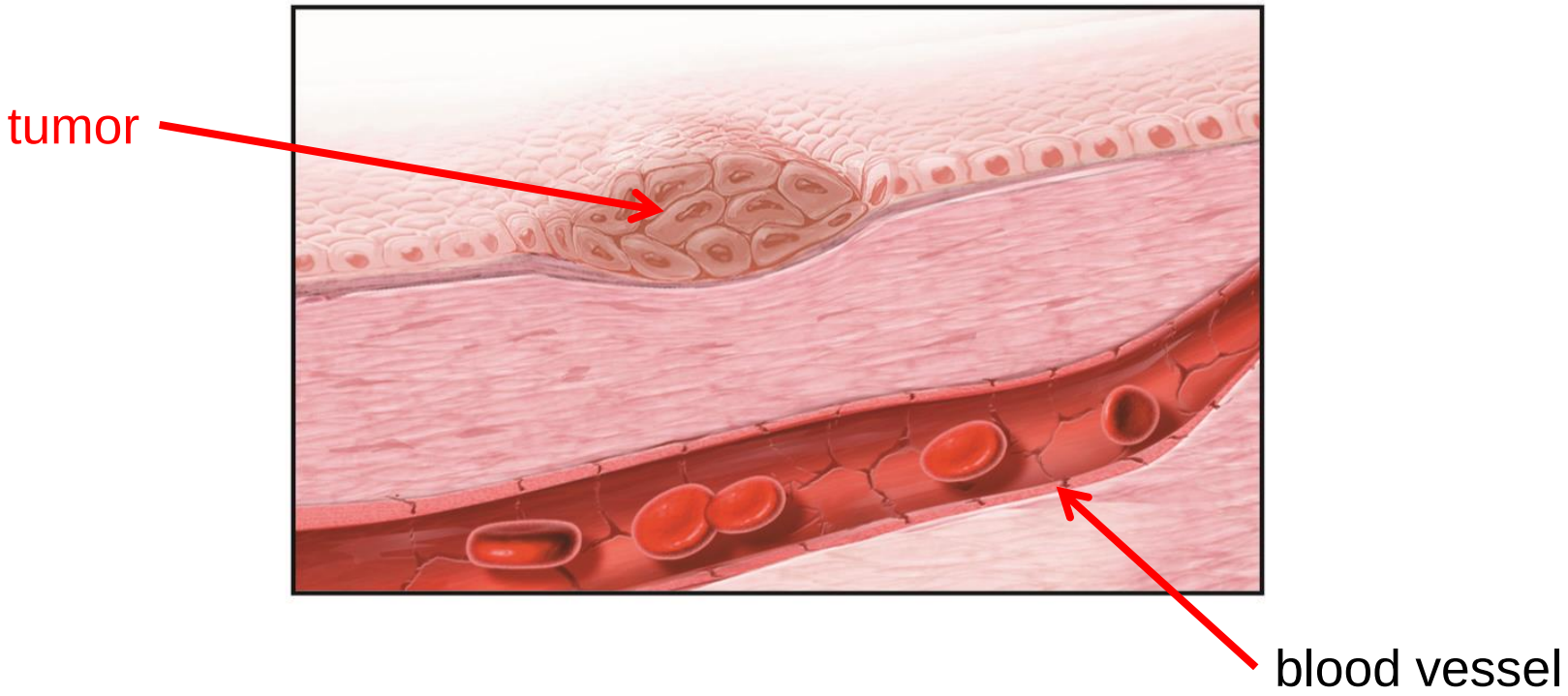
- respond to events outside the cell
- direct cells to speed up or slow down the cell cycle
- **growth factors**: wound healing and embryonic development

Apoptosis

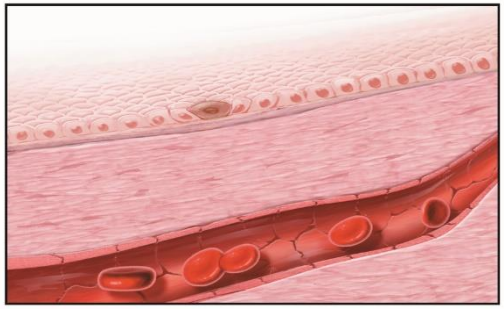
- A process of programmed cell death
- Important role in structuring tissues during growth and development
- Cell undergoes a series of controlled steps for self-destruction.

Cancer: Uncontrolled Cell Growth

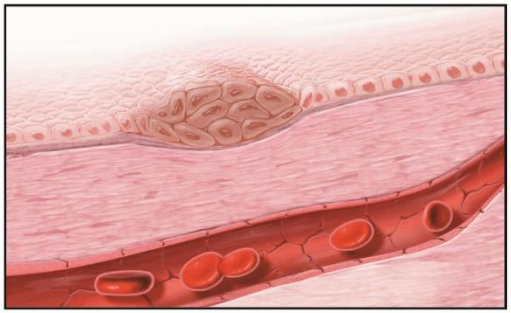
- Cancer cells don’t respond to normal regulatory signals.
- Cell cycle is disrupted.
- Cells grow and divide uncontrollably.



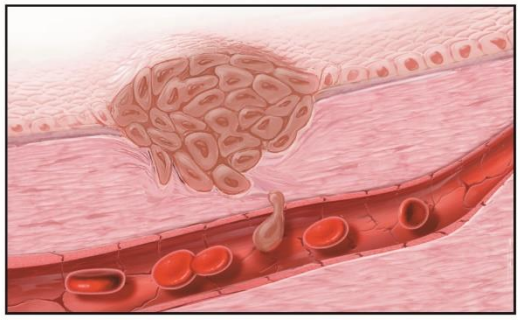
Cancer Formation: A Closer Look



1. A cell begins to divide abnormally.



2. Cells produce a tumor and start to displace normal cells and tissues.

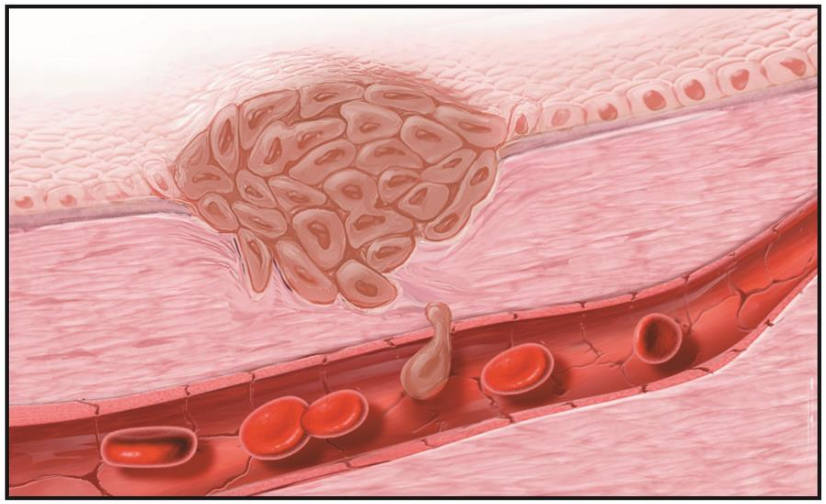


3. Cancer cells move to other parts of the body.

What Causes Cancer?

In all cancers, control over the cell cycle has broken down.

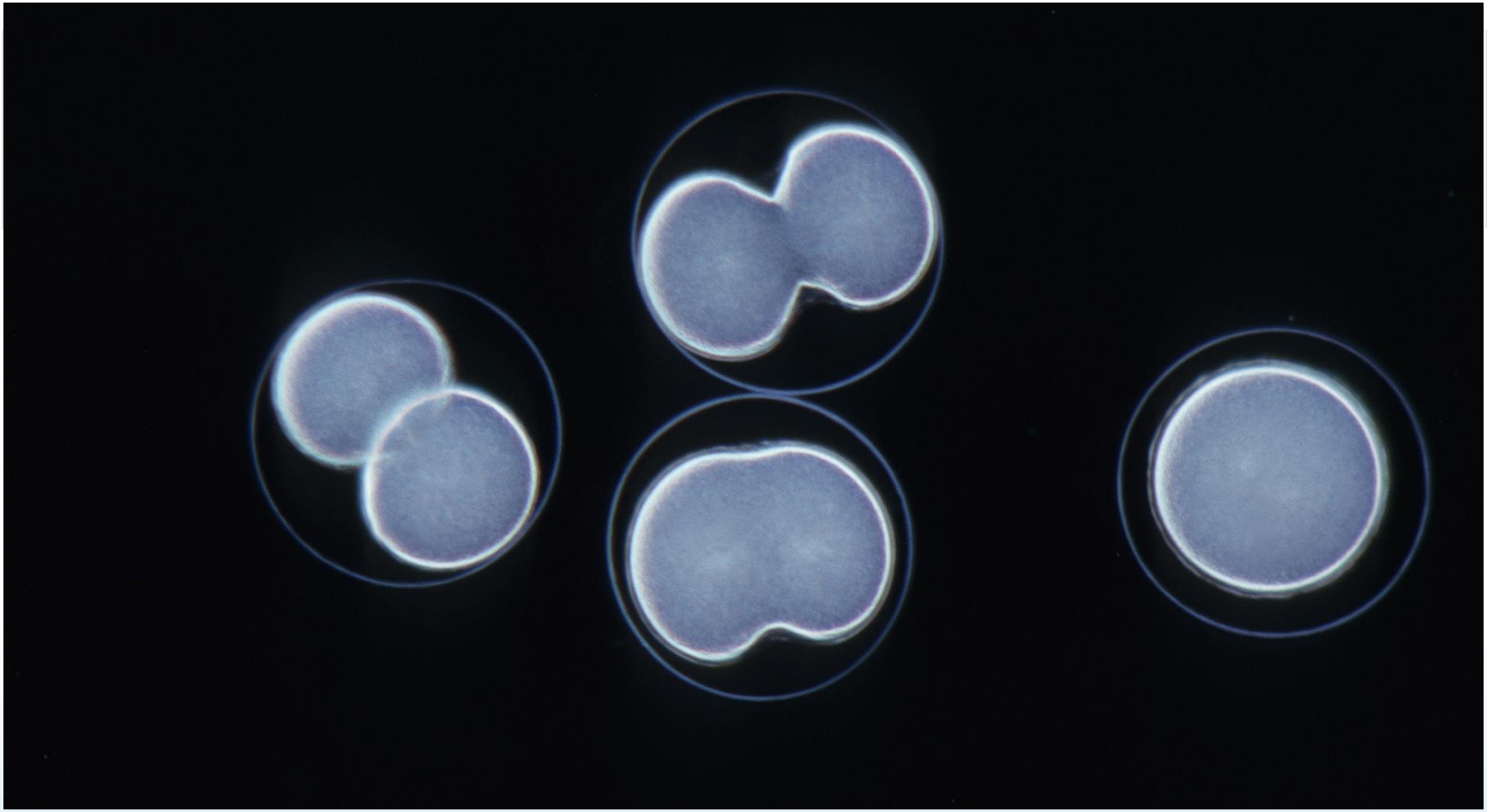
Cancer results from a **defect in genes** that control cell growth and division.



Treatments for Cancer

- Surgery to remove localized tumor
- Radiation to destroy cancer cell DNA
- Chemotherapy to kill cancer cells or slow their growth

Cell Differentiation

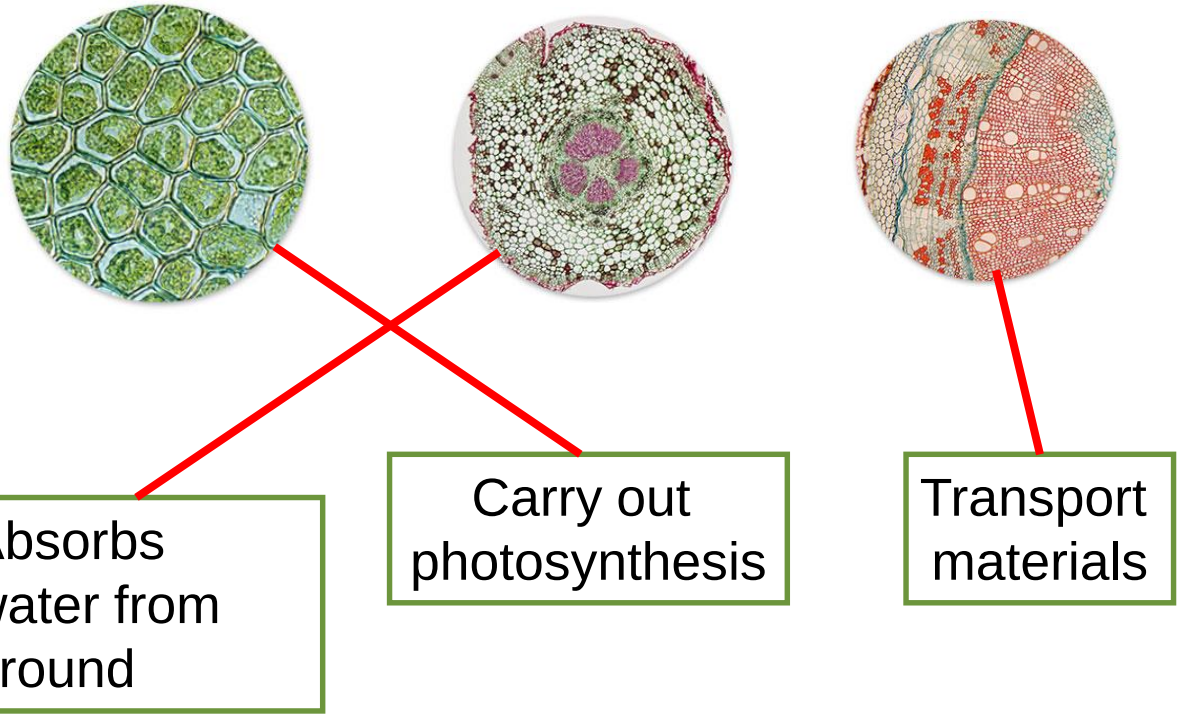


Learning Objectives

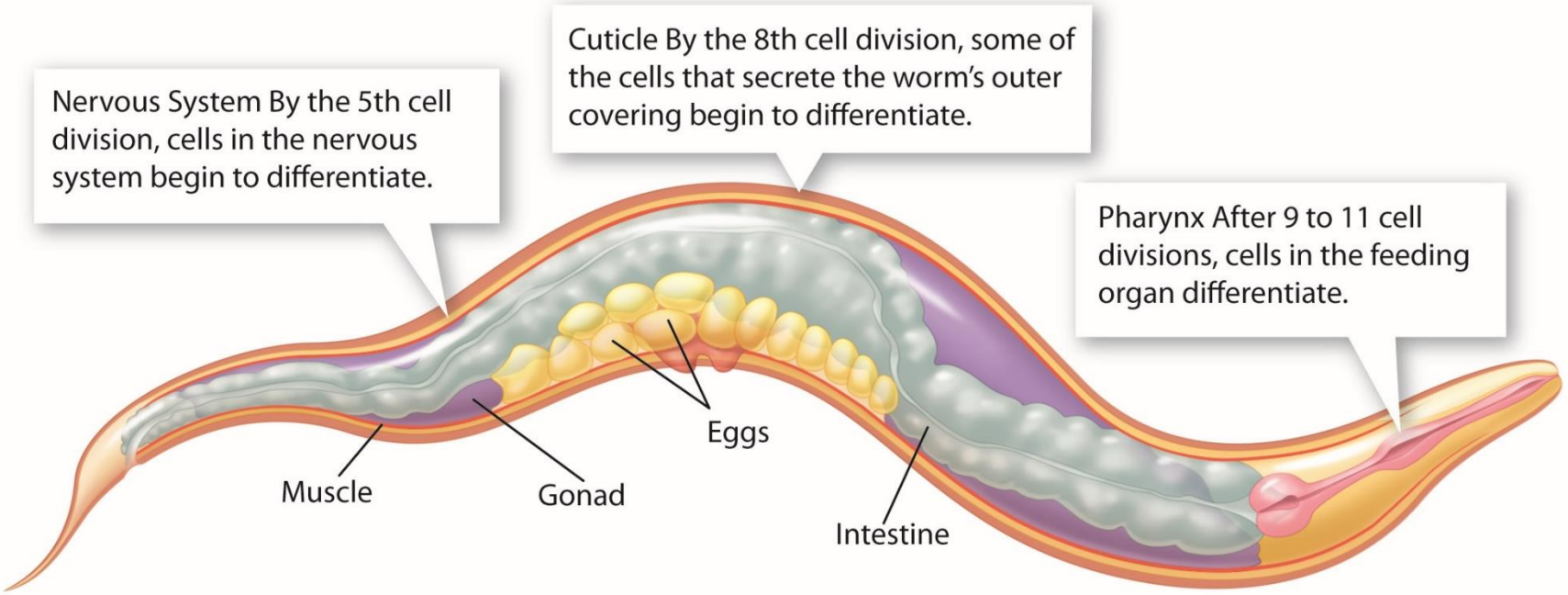
- Investigate how cells become specialized for different functions.
- Explain what stem cells are.
- Evaluate some possible benefits and issues associated with stem cell research.

From One Cell to Many

During the development of an organism, cells differentiate to become specialized.



Mapping Differentiation



2^5 = 32

2^8 = 256

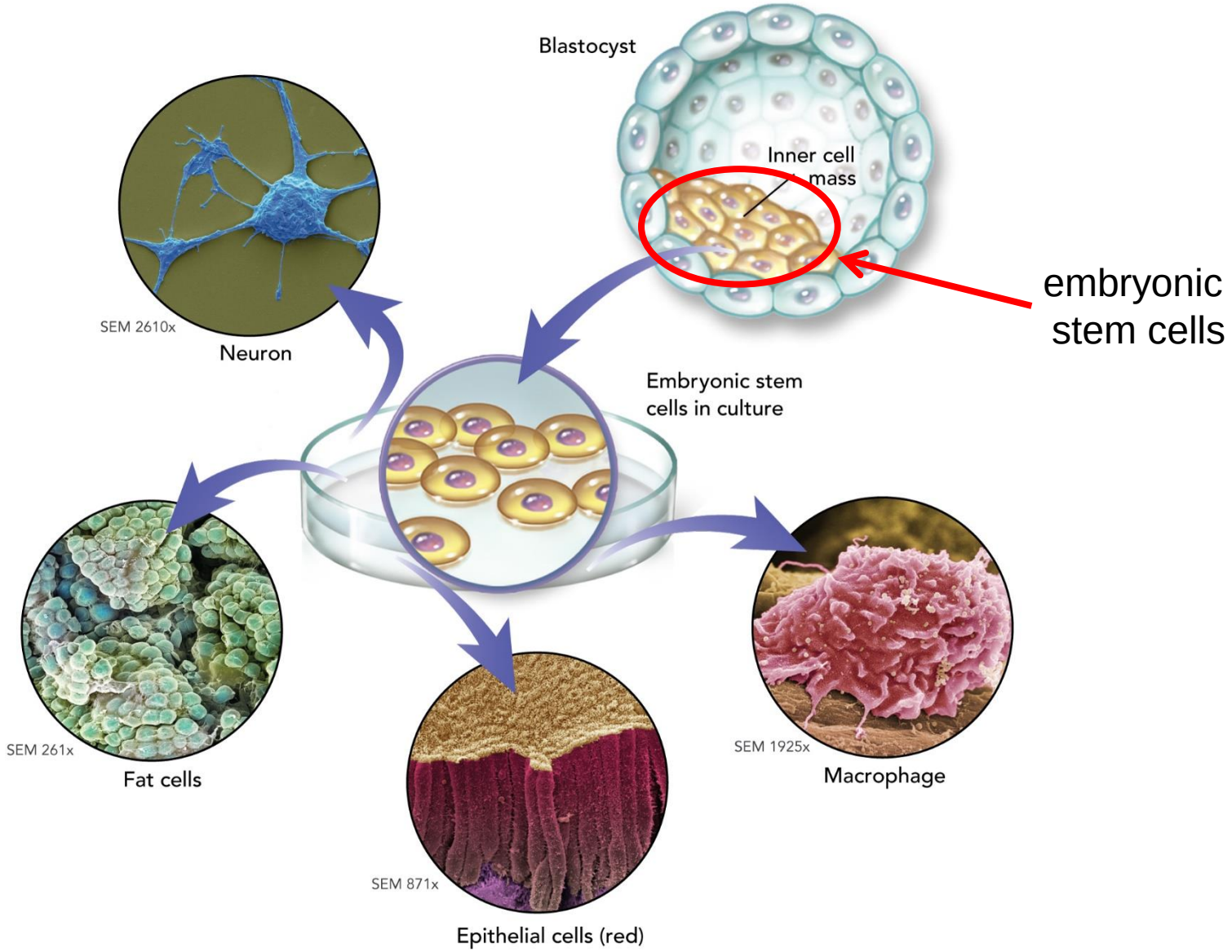
Stem Cells and Development

Stem cells are the unspecialized cells from which differentiated cells develop.

Totipotent: can develop into any type of cell in the body (including the cells that make up the extraembryonic membranes and placenta)

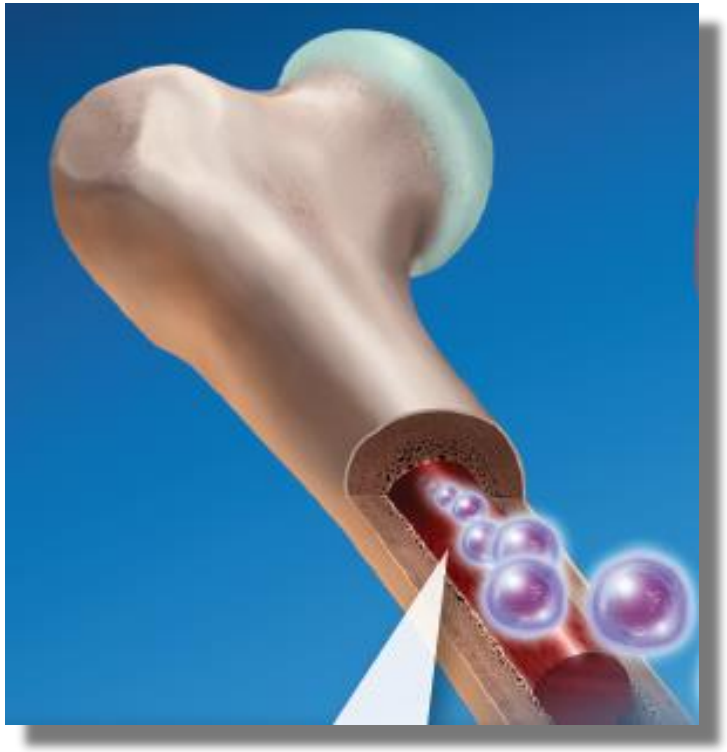
Pluripotent: cells that are capable of developing into most, but not all, of the body's cell types

Embryonic Stem Cells

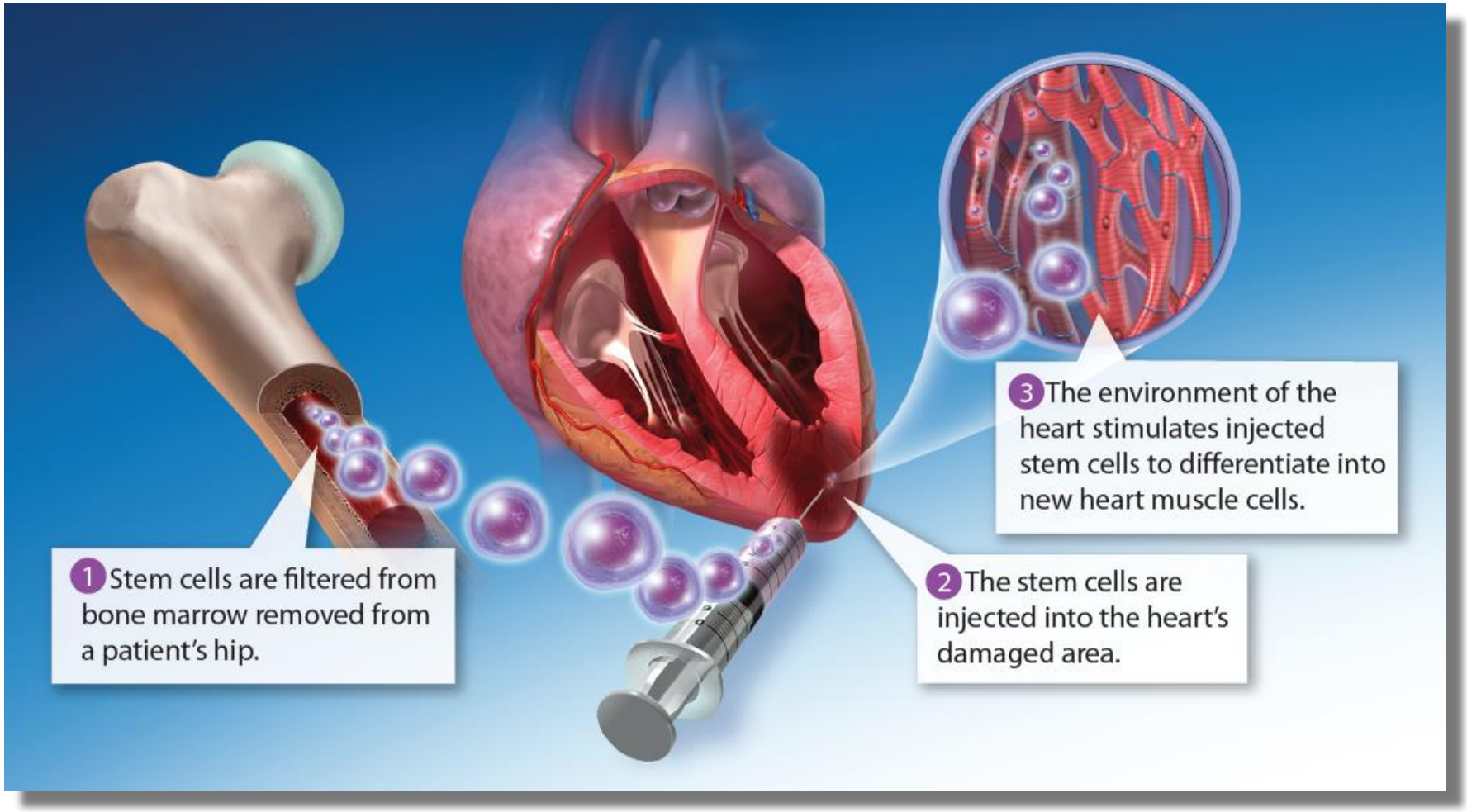


Adult Stem Cells

- **Multipotent:** limited potential to develop into many different types of differentiated cells
- Mainly found in bone marrow, hair follicles
- Also some in brain, heart, and skeletal muscle



Regenerative Medicine

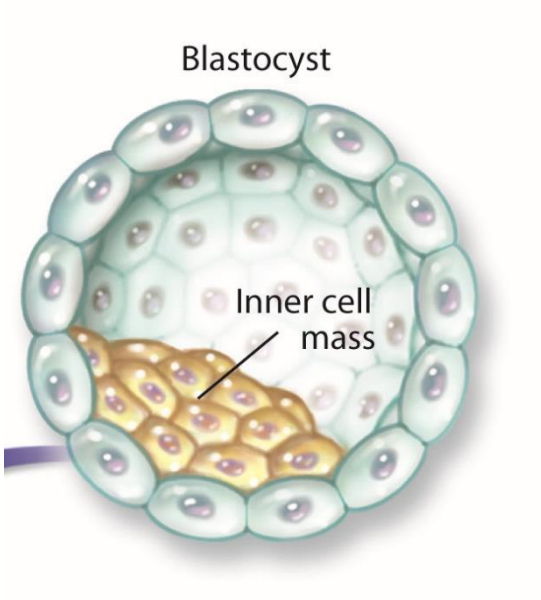


Undifferentiated cells are used to repair or replace damaged cells and tissues.

Ethical Issues

- Human **adult** stem cell research is rarely controversial because of willing donors.

- Human **embryonic** stem cell research is controversial because arguments for and against involve ethical issues of life and death.



Induced Pluripotent Stem Cells