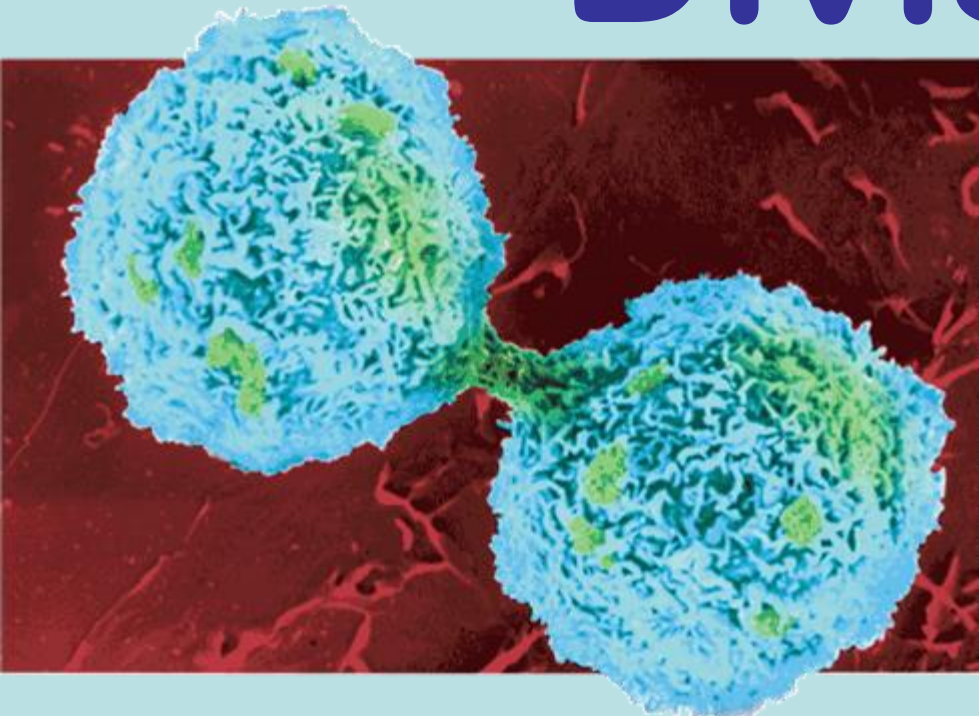


# Chapter 10

# Cell Growth & Division



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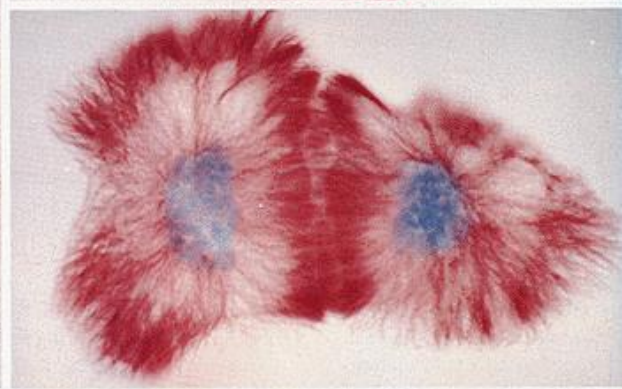
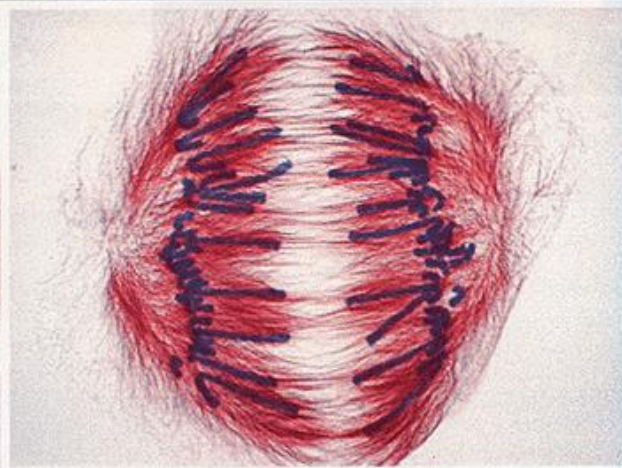
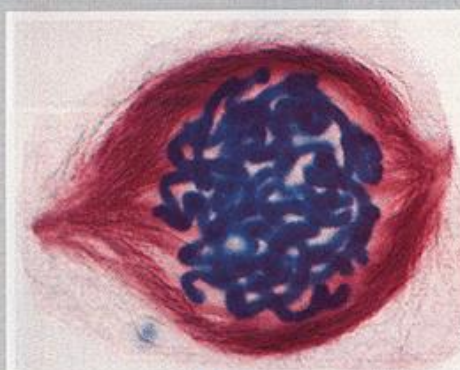
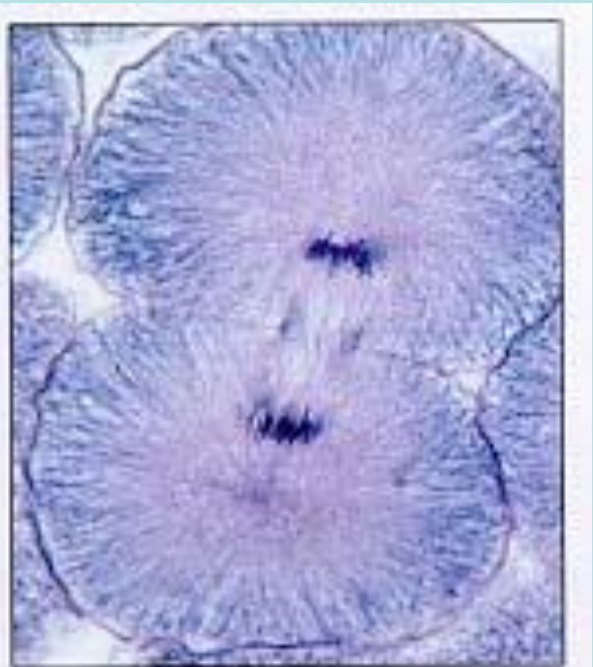
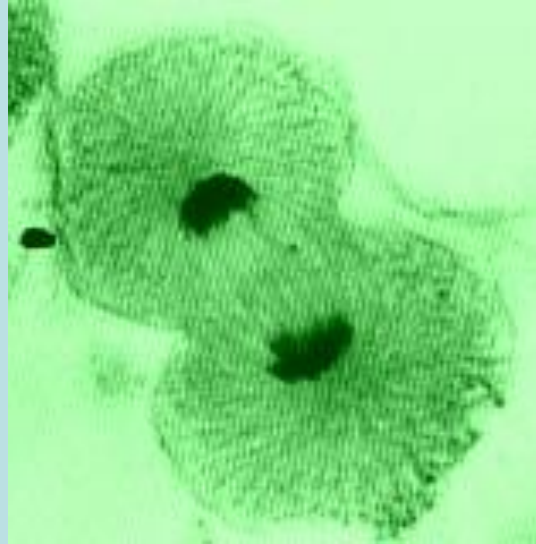
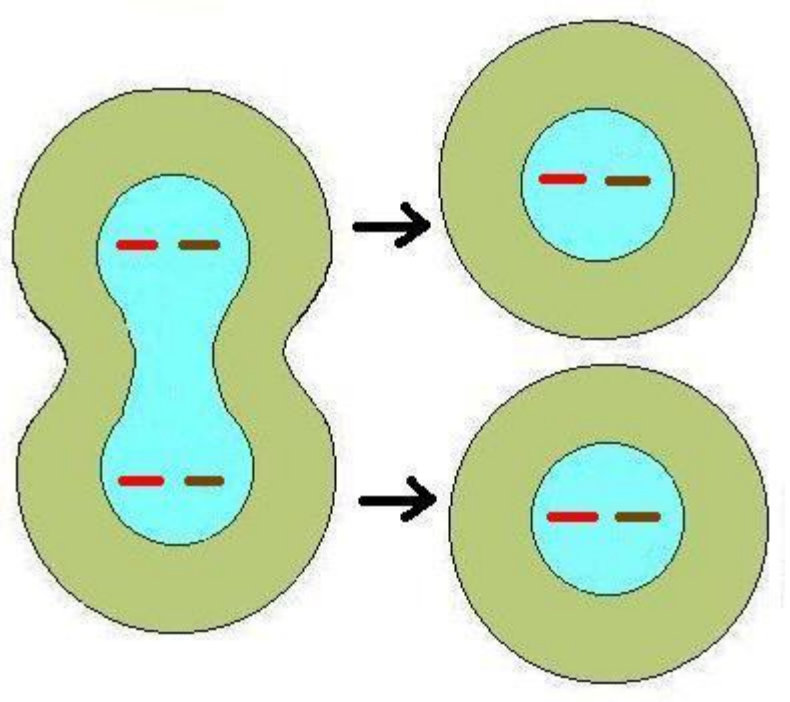
# 10 –1 Cell Growth

- Which has larger cells: an adult elephant or a baby elephant?
- Neither! They are the same size. The adult just has more cells.



# Two main reasons why cells divide rather than continuing to grow indefinitely:

- The larger a cell becomes, the more demands on its DNA. **DNA "Overload"**
  - A huge cell needs a lot of DNA, but it only has one set
- The large cell has more trouble moving enough nutrients and wastes across the cell membrane.
- Cells don't get bigger... Organisms do!!



# Cell Differentiation

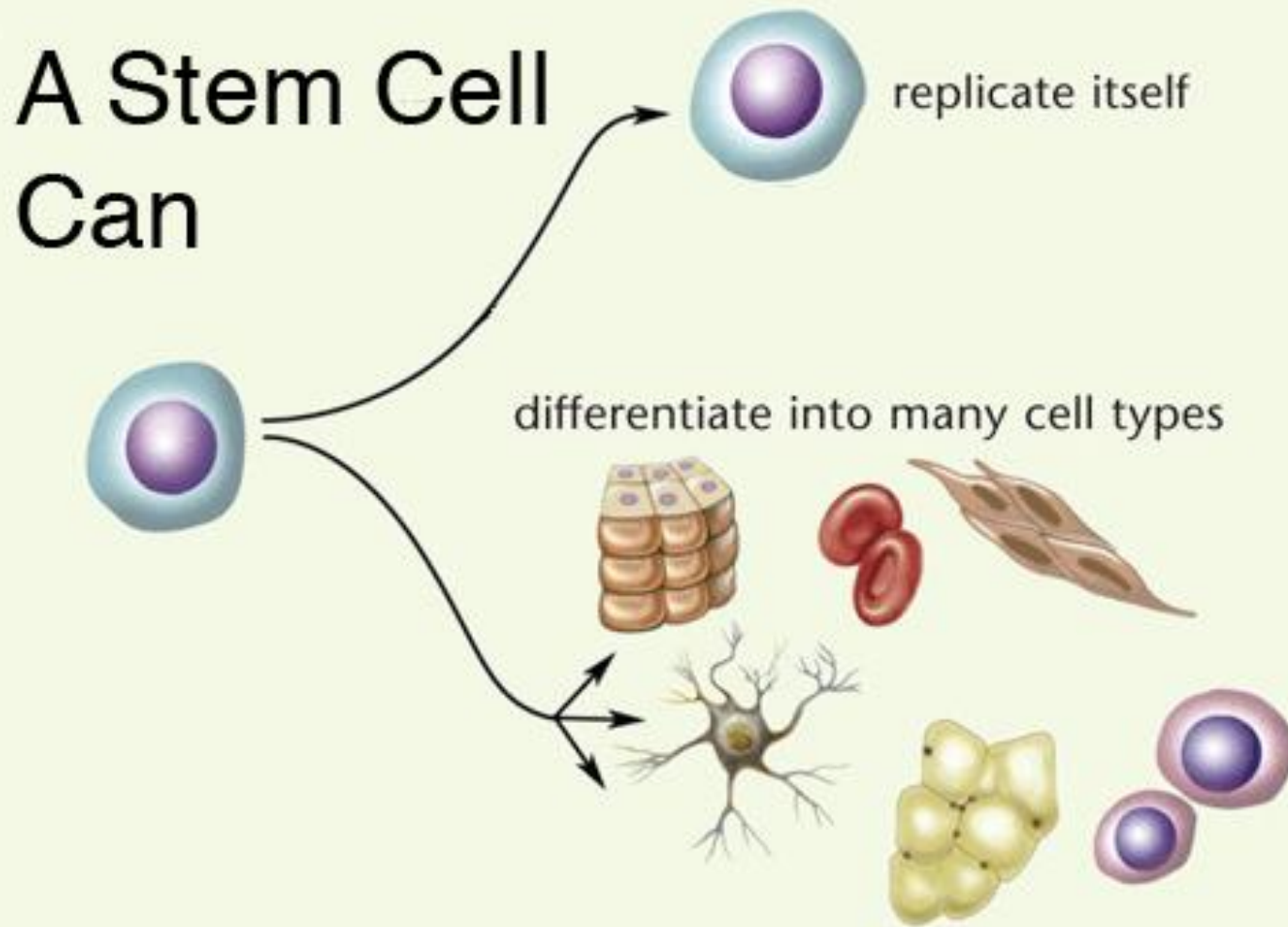


Image prepared by Catherine Twomey for the National Academies, *Understanding Stem Cells: An Overview of the Science and Issues* from the National Academies, [www.nationalacademies.org/stemcells](http://www.nationalacademies.org/stemcells).

# Cell Differentiation

Process of a less specialized cell changing into a more specialized cell.

Influenced by:

- How DNA is transcribed into RNA
  - Gene transcription factors
    - Protein that binds to a specific segment of DNA; controls how that segment is read (on or off)
- Environmental Factors
  - high temperatures, chemicals, nutrients, colored lights

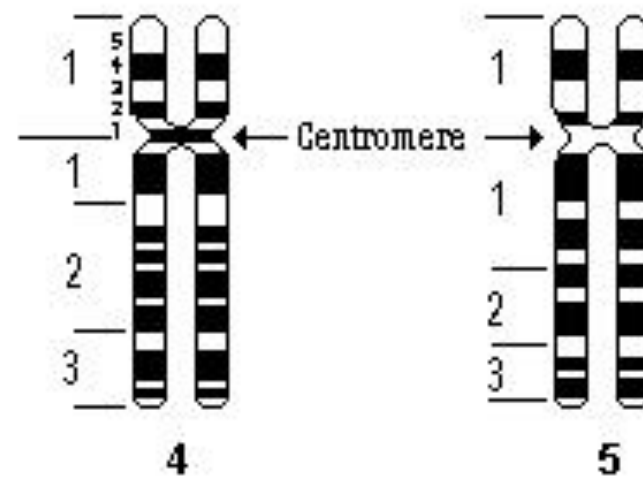
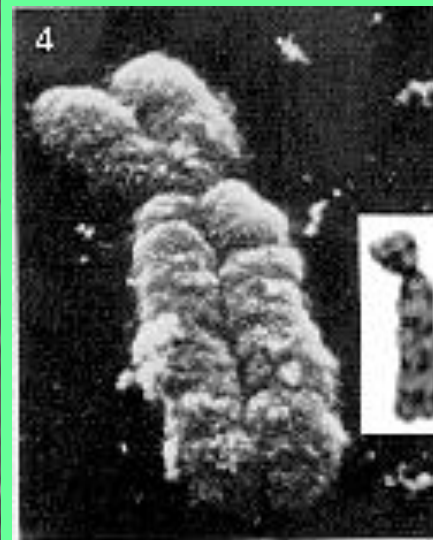
# Division of the Cell

- Cell divides into 2 new **daughter cells**.
- DNA duplication occurs before division (own genetic set)
- Each daughter cell has **increased surface area to volume**, which allows exchange of materials with the environment.



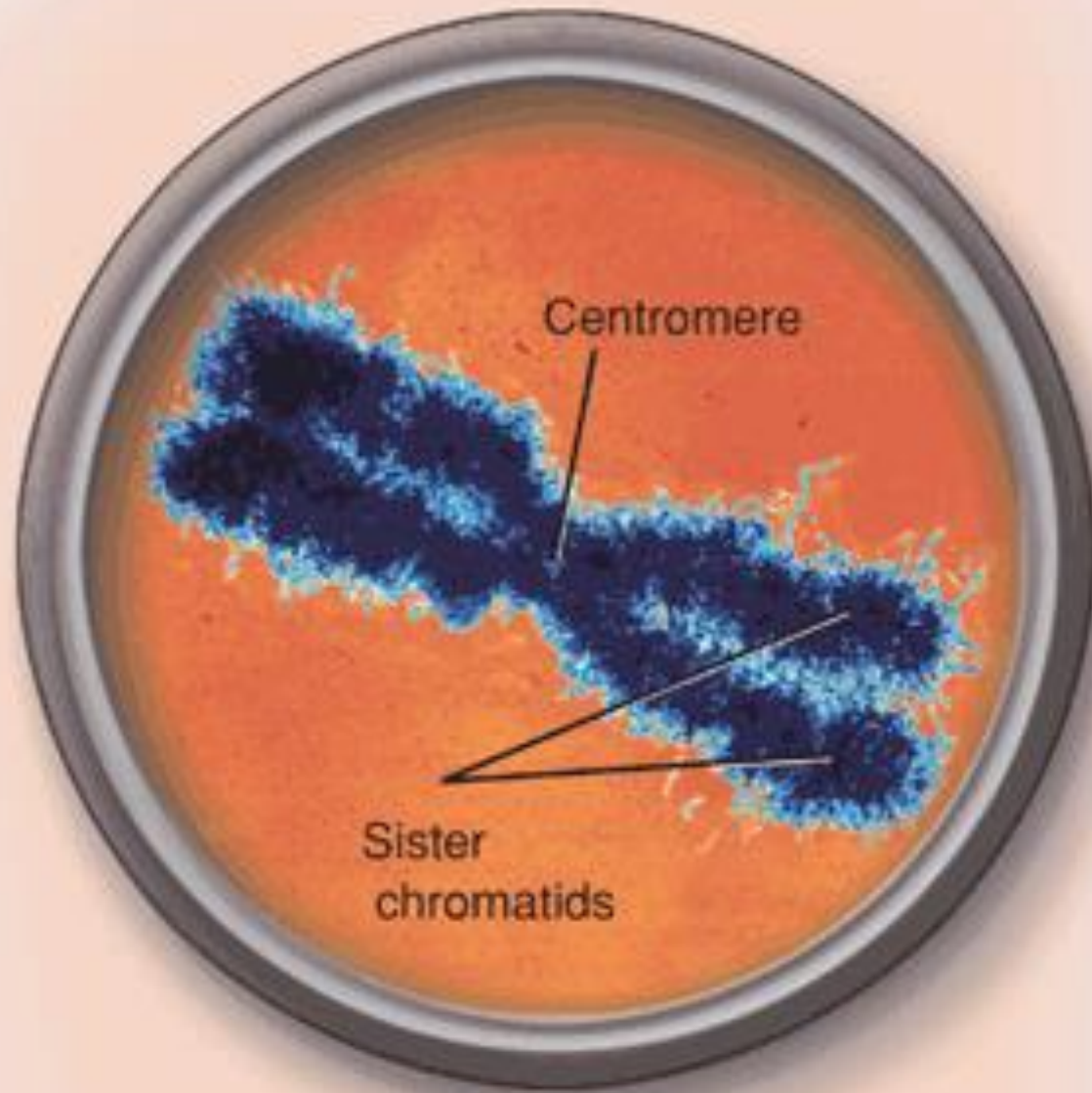
# Chromosomes

- Genetic information passed from one generation of cells to the next
- Made of DNA and proteins
- Most visible during cell division
- Every organism has a specific # of chromosomes
  - fruit flies = 8 chromosomes
  - humans = 46 chromosomes
  - carrot = 18 chromosomes
  - Chicken = 78 chromosomes



# Parts of the Chromosome

- **chromatids** – sister chromatids: each chromosome consists of 2 **identical** sister chromatids. (separated during cell division)
- **centromere** – spot where each pair of chromatids is attached (protein disk)
- entering cell division in humans = 46 chromosomes each with sister chromatids.



(magnification: 20,000 $\times$ )

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# The Cell Cycle

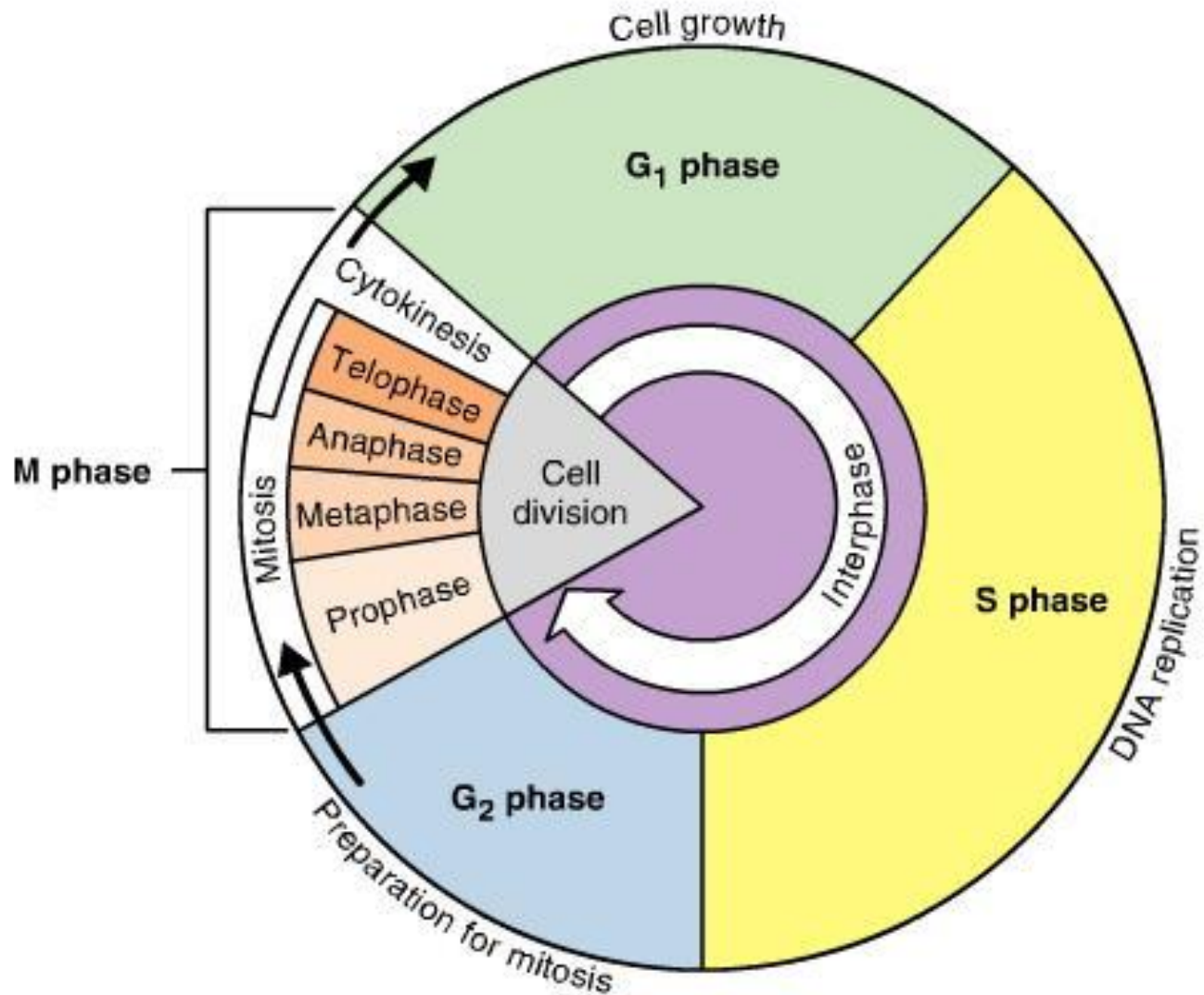
- Series of events that cells go through as they grow and divide
- During the cell cycle, a cell **grows**, **prepares** for **division**, and **divides** to form two daughter cells, each of which then **begins the cycle again.**

# Events of the Cell Cycle

$G_1 \rightarrow S \rightarrow G_2 \rightarrow M$

- $G_1$  = cells do most of their growing.
  - cells **increase in size** and synthesize new proteins and organelles
- $S$  = *DNA* is replicated
  - **synthesis of DNA** molecules
  - Key proteins associated w/the chromosomes also synthesized
- $G_2$  = shortest phase of interphase
  - **organelles** and proteins required for cell division are produced
- $M$  = Mitosis and Cytokinesis

# The Cell Cycle



# The Cell Cycle Animation

- [http://www.cellsalive.com/cell\\_cycle.htm](http://www.cellsalive.com/cell_cycle.htm)

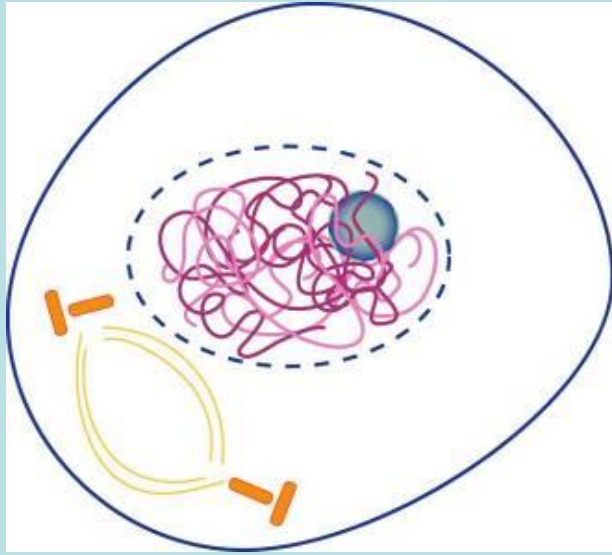


# Mitosis

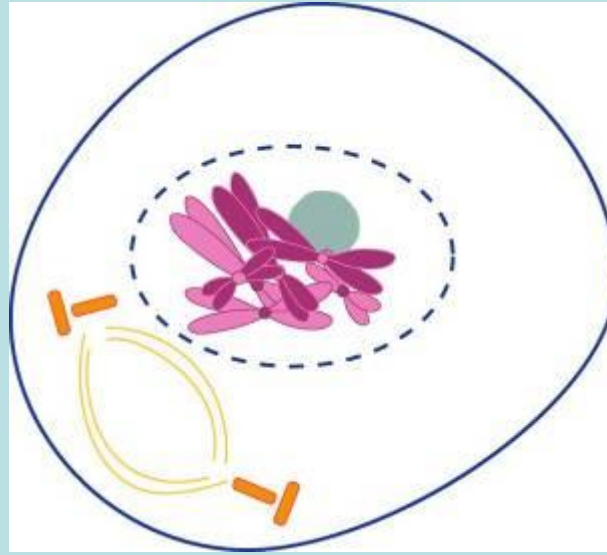
- 4 phases: [**P M A T**]
  - **P**rophase
  - **M**etaphase
  - **A**naphase
  - **T**elophase/Cytokinesis
- Lasts from a few minutes to several days

# Prophase

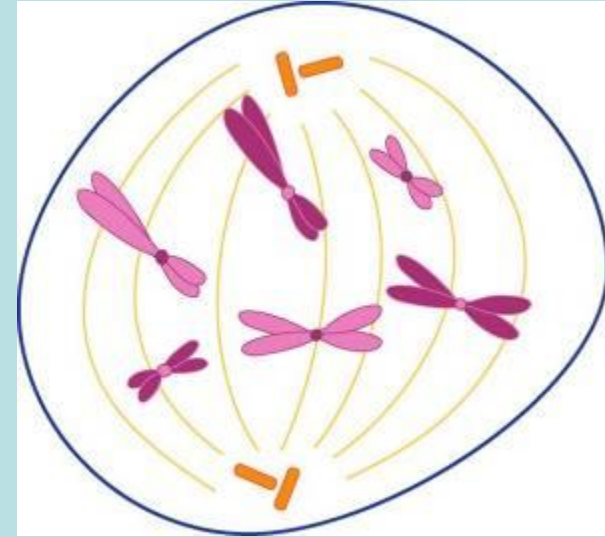
Early prophase



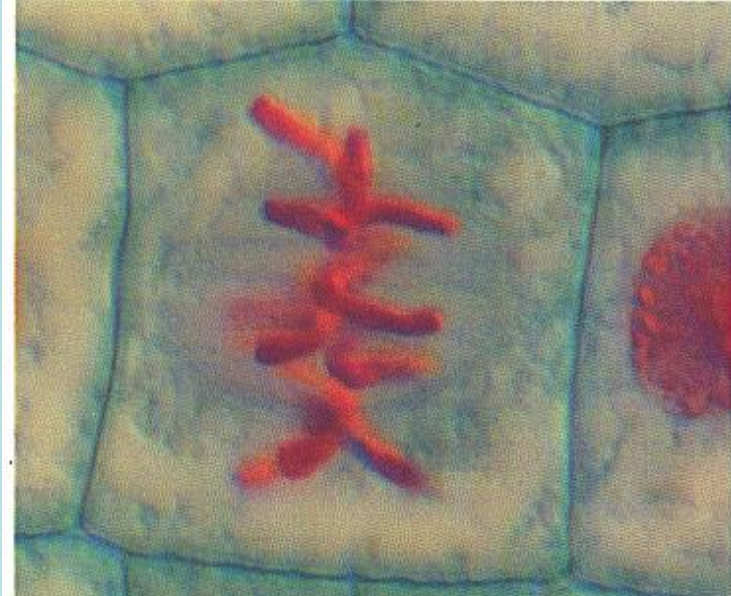
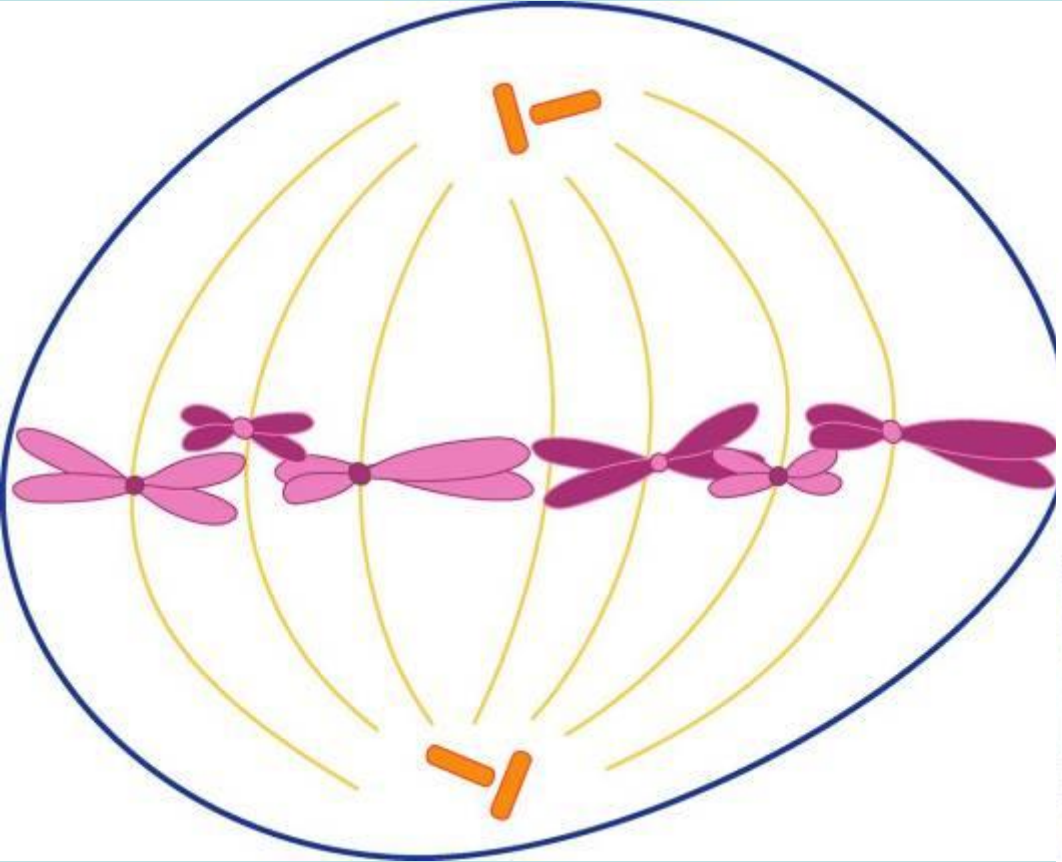
Mid prophase



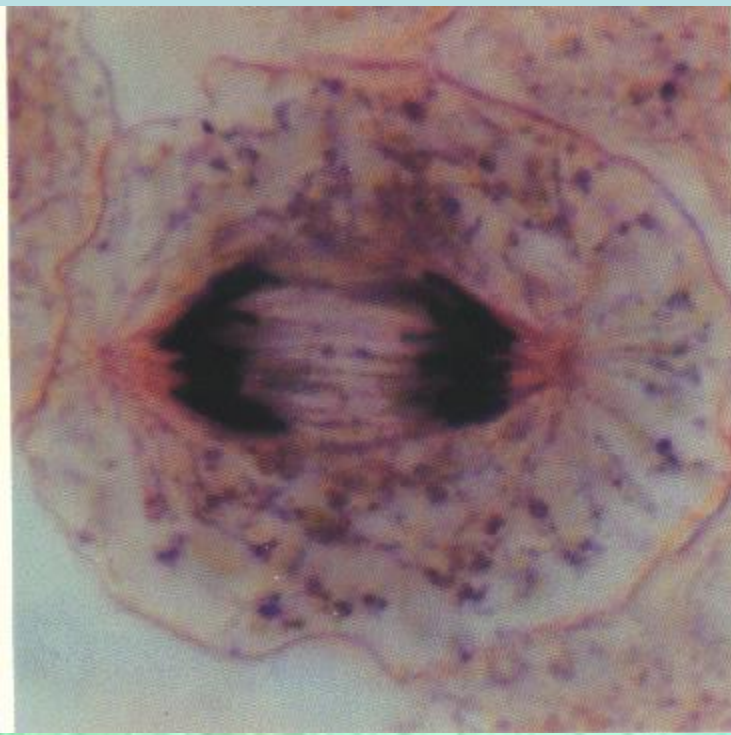
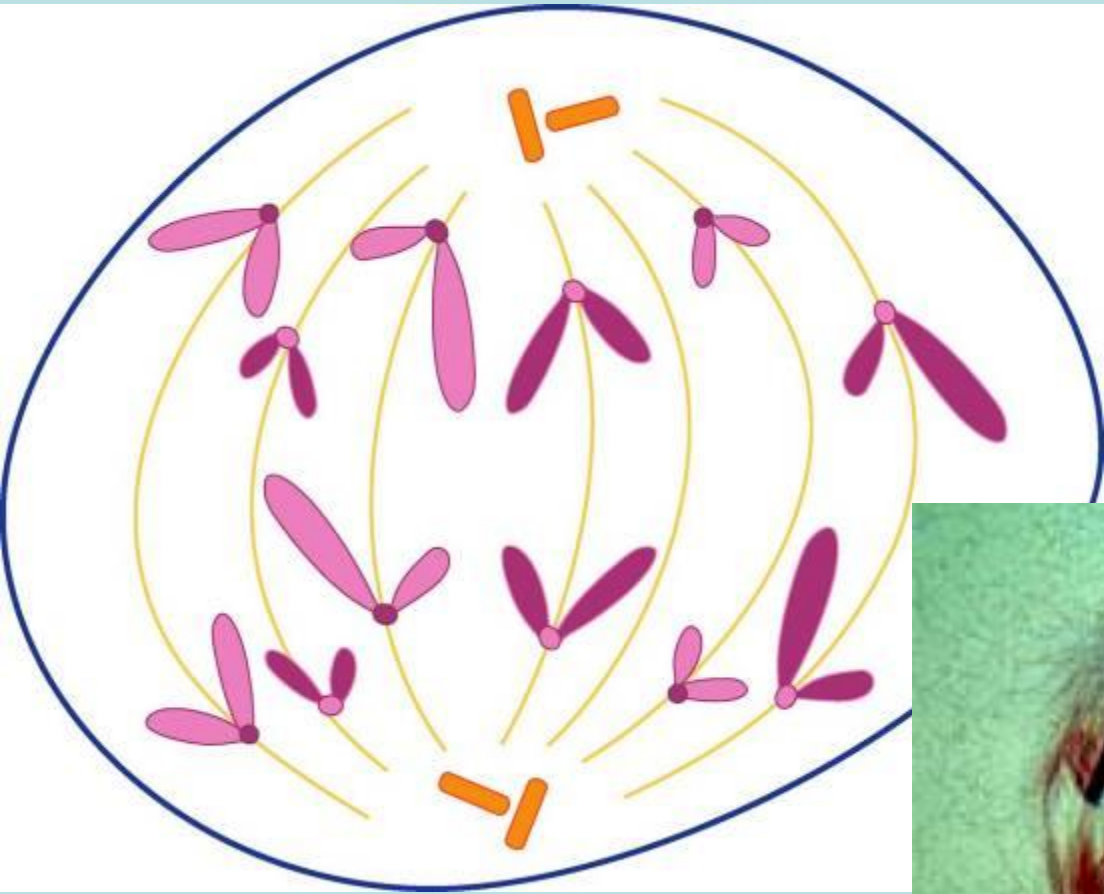
Late prophase



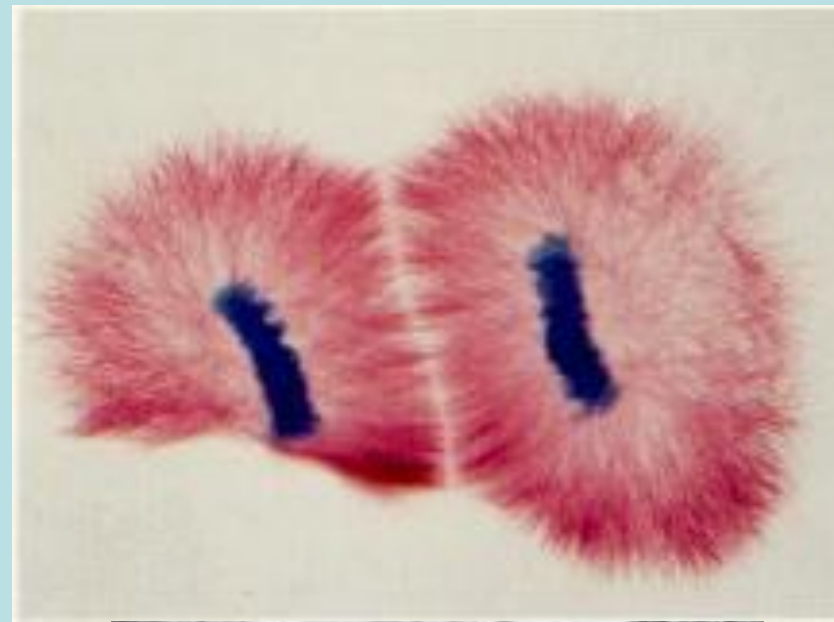
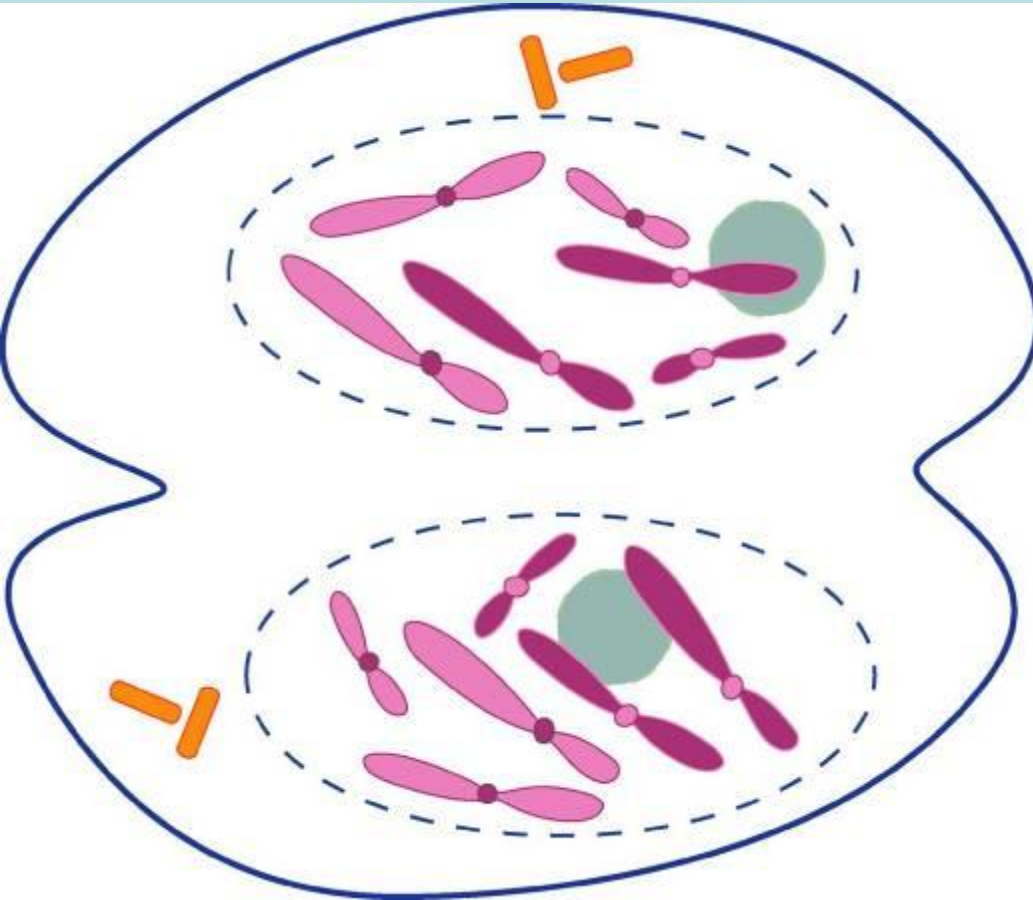
# Metaphase



# Anaphase



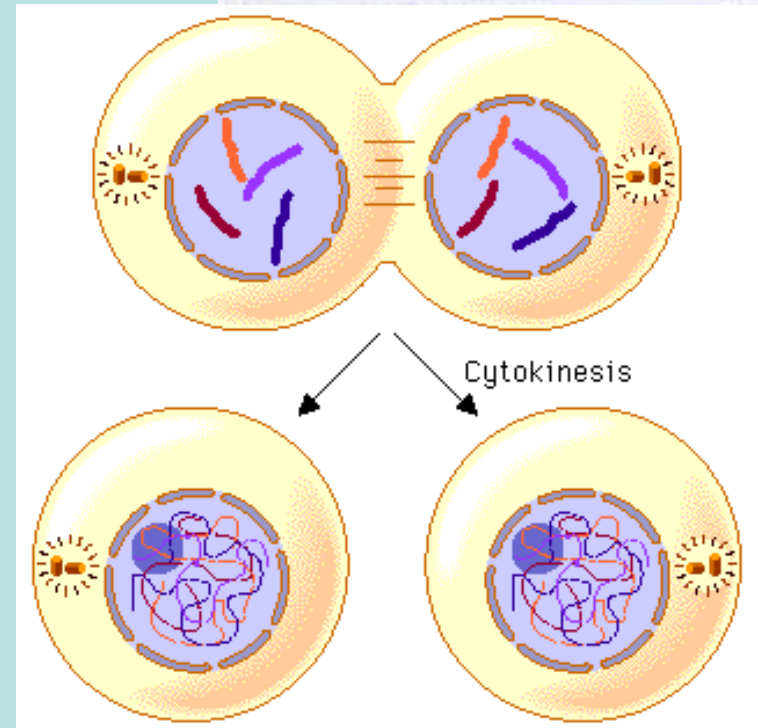
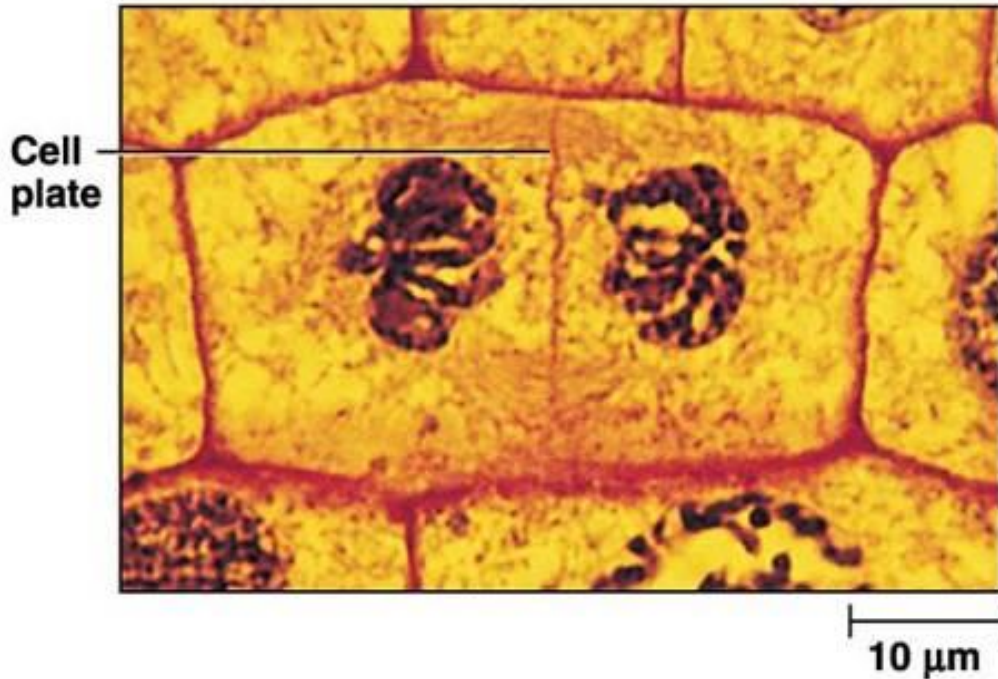
# Telophase



# Cytokinesis

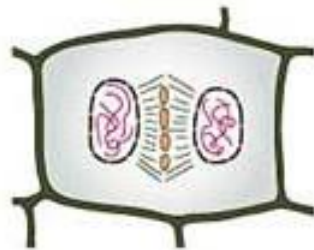
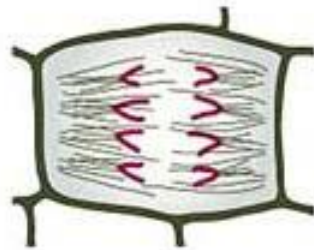
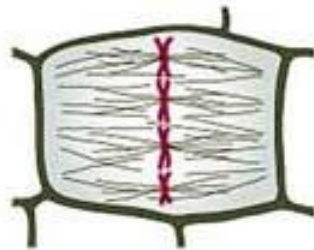
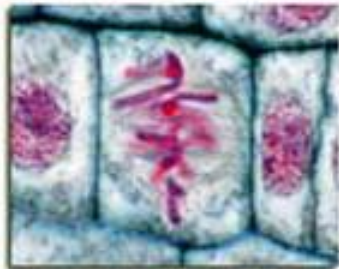
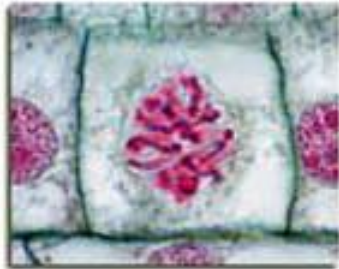
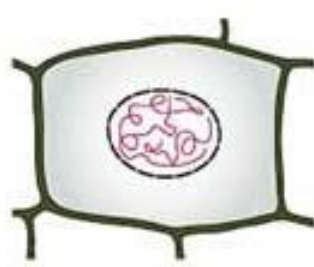
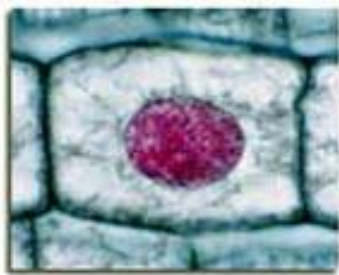
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## Cytokinesis in plant cells

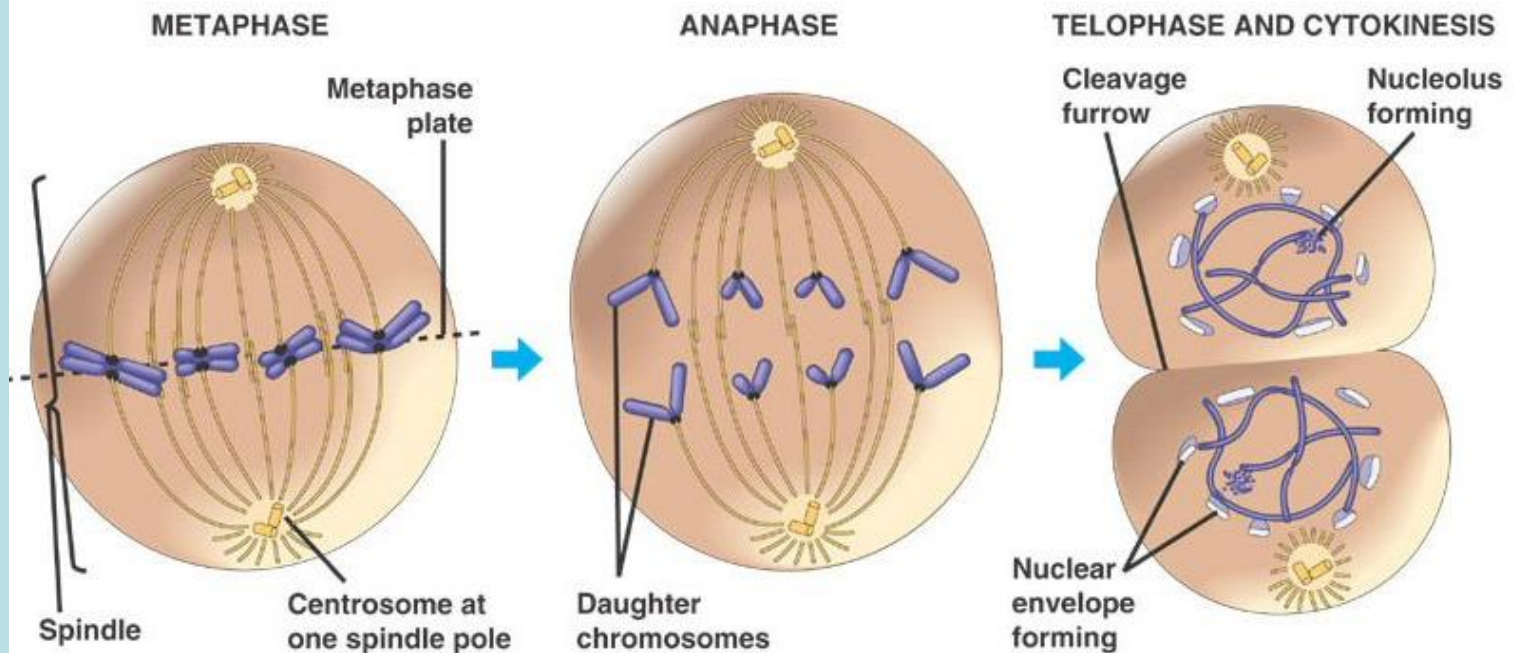
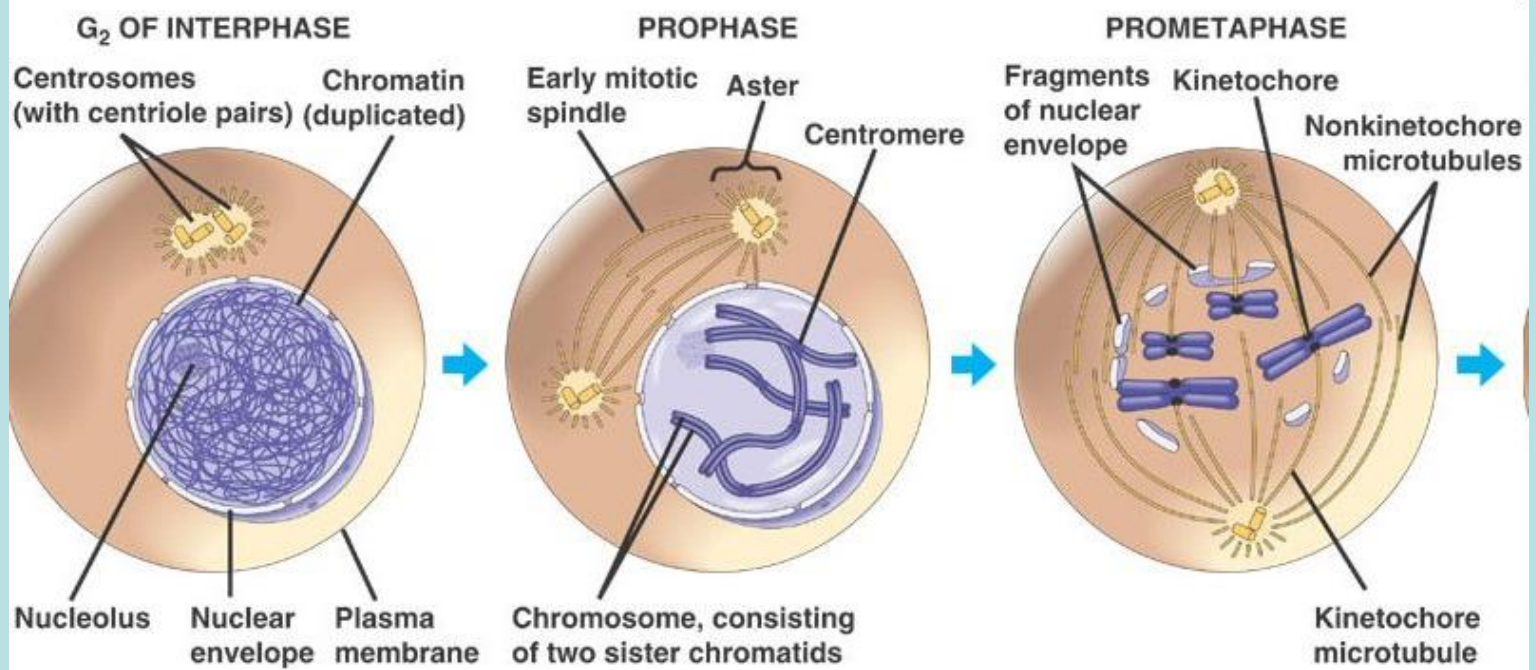


# Mitosis Animation

- <http://www.cellsalive.com/mitosis.htm>



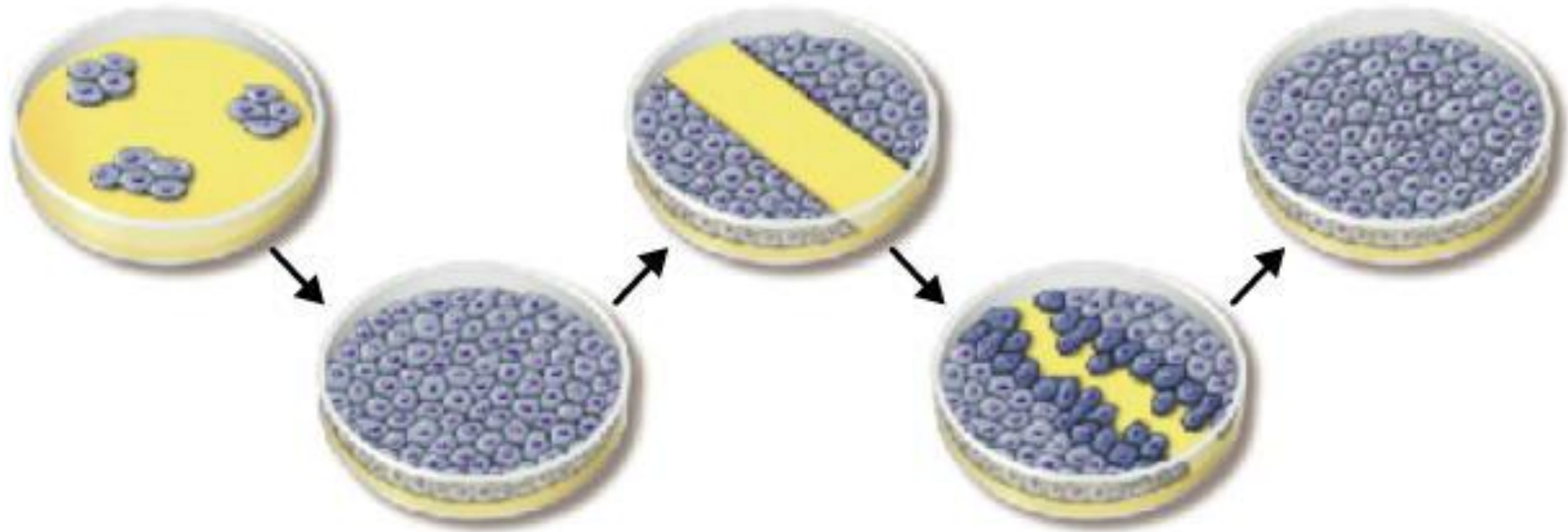




# 10-3 Regulating the Cell Cycle

- Controls on Cell Division
  - When cells come into contact with each other, cells respond by stopping growth
  - when space is put between cells, cells begin growing once again.
  - controls on cell growth can be turned on and off

# Contact Inhibition



# Cell Cycle Regulators

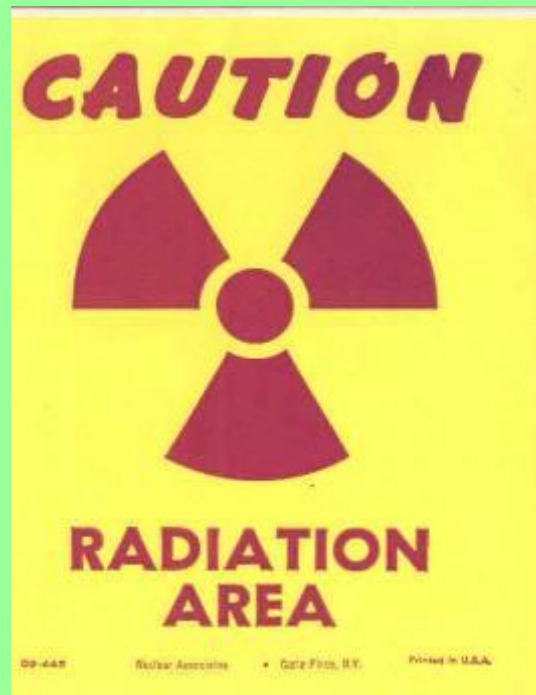
- Cyclins (proteins) regulate the timing of the cell cycle in eukaryotic cells.
- 2 types of regulatory proteins:
  - those that occur **inside** the cell (internal)
  - those that occur **outside** the cell (external)

# Uncontrolled Cell Growth

- **Tumors** - Cells that divide uncontrollably and form masses
- **Cancer cells** do not respond to the signals that regulate the growth of most cells and may break loose from tumors and spread throughout the body (cancer)
- Metastasis - spread of cancer from its primary site to other places in the body

# Causes of cancer

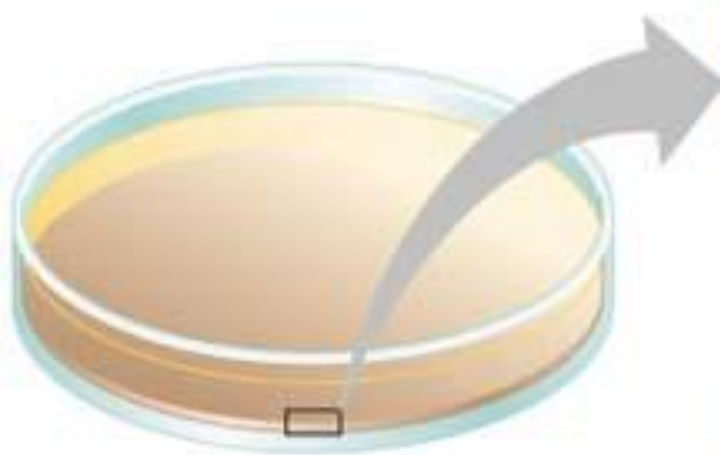
- smoking tobacco
- radiation exposure
- even viral infection



# Why does cancer occur?

- Many (but not all) cancers: defect in **p53** gene
- Normally halts cell cycle until all chromosomes have been properly replicated
- Damaged or defective p53 = uncontrolled growth

# Contact inhibition



**Cells form single layer in culture.**

**A**



**Cells removed.**

**B**



**Cells replace removed cells; division stops when single layer is repaired.**

**C**



**Cancer cells in culture will continue to divide and pile up haphazardly.**

**D**



## Life Spans of Various Human Cells

Cell Type	Life Span	Cell Division
Lining of esophagus	2–3 days	Can divide
Lining of small intestine	1–2 days	Can divide
Lining of large intestine	6 days	Can divide
Red blood cells	Less than 120 days	Cannot divide
White blood cells	10 hours to decades	Many do not divide
Smooth muscle	Long-lived	Can divide
Cardiac (heart) muscle	Long-lived	Cannot divide
Skeletal muscle	Long-lived	Cannot divide
Neuron (nerve cell)	Long-lived	Most do not divide