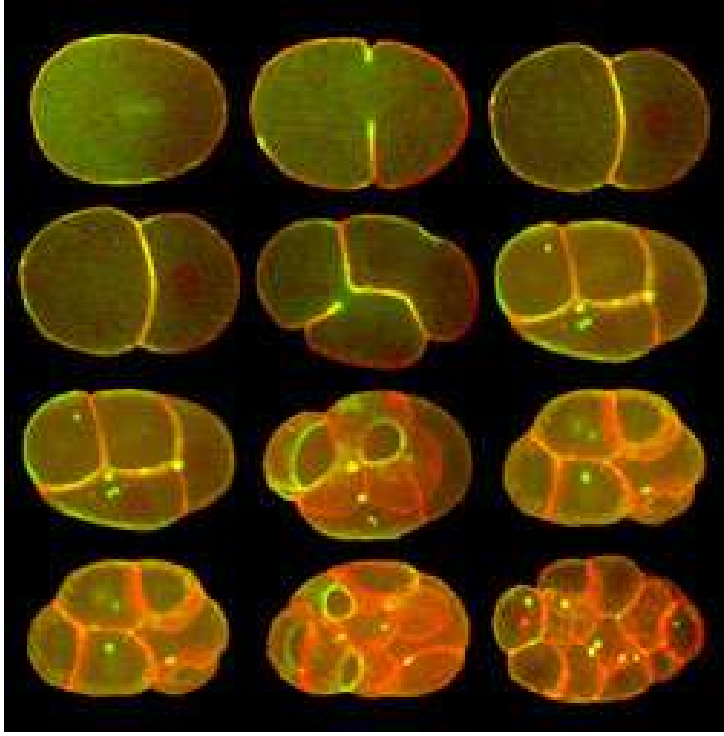
Cell Division—Mitosis Notes

Cell Division — process by which a cell divides into **2 new cells**

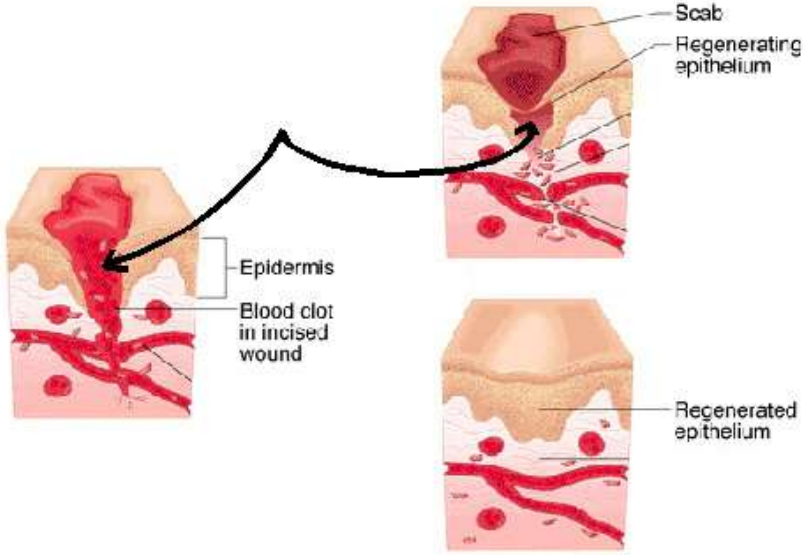


- Why do cells need to divide?

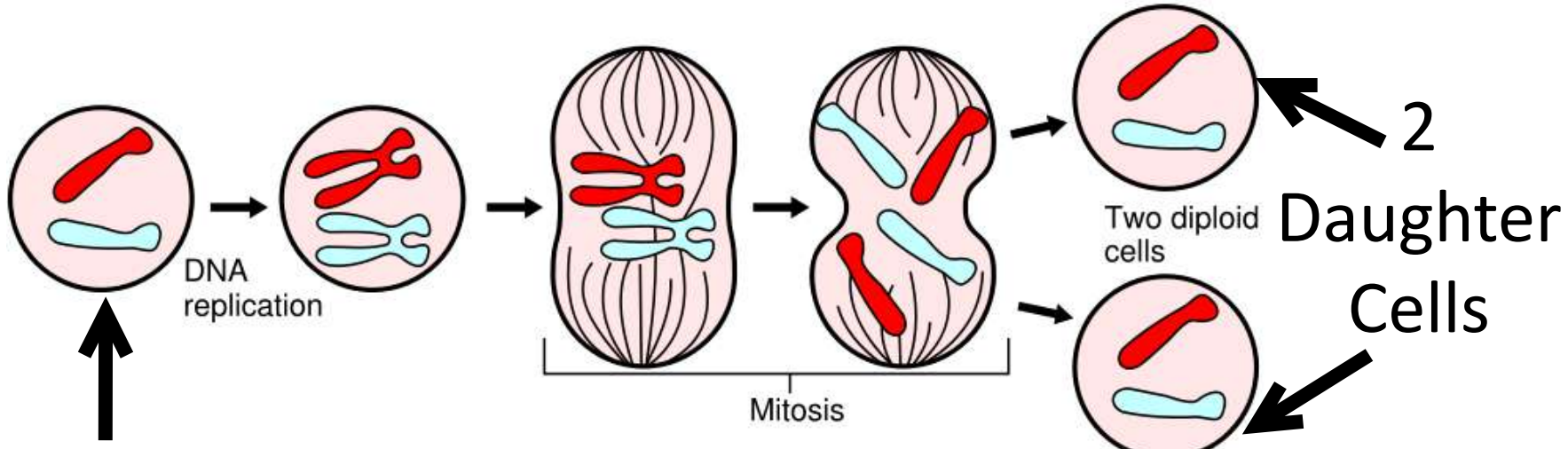
1. Living things **grow** by producing **more cells**, NOT because each cell increases in size

2. **Repair** of damaged tissue

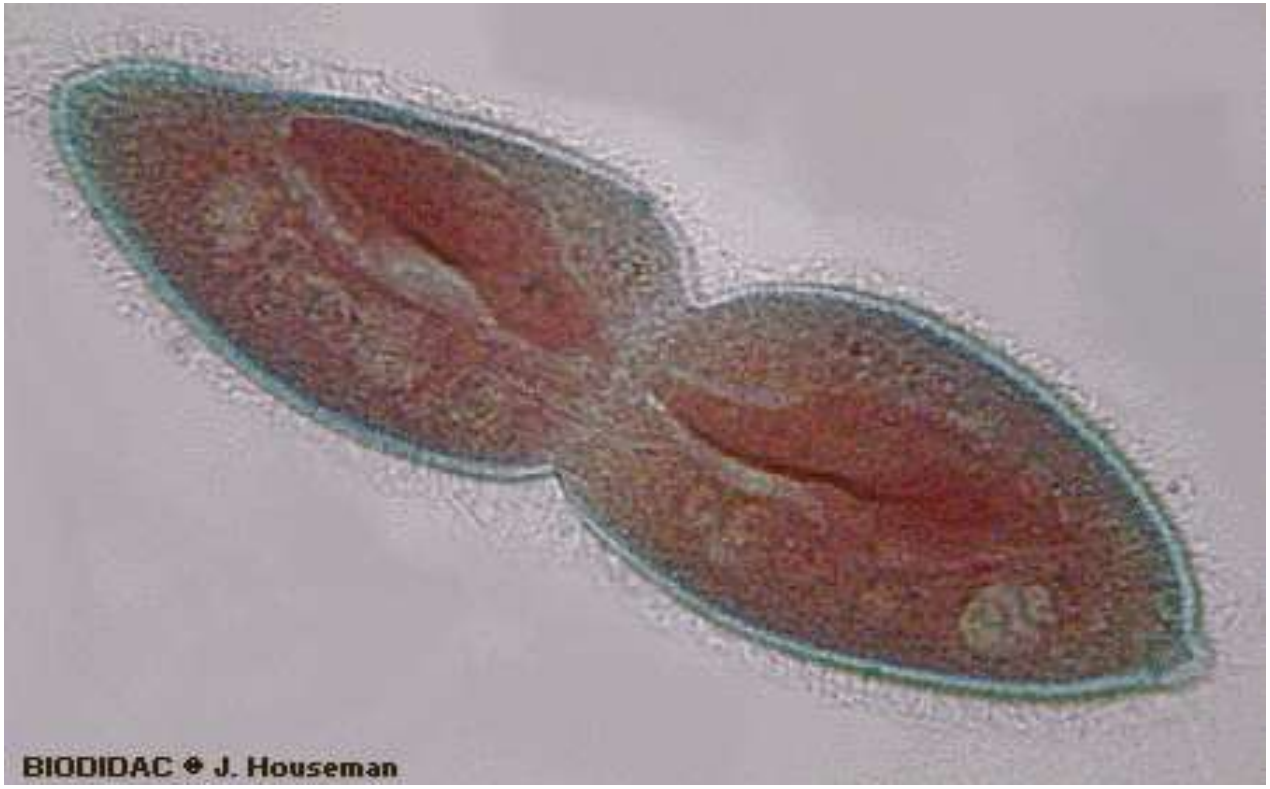
3. If cell gets too big, it **cannot** get enough **nutrients** into the cell and **wastes** out of the cell



- The **original** cell is called the **parent** cell; 2 **new** cells are called **daughter** cells
- Before cell division occurs , the cell **replicates** (copies) all of its **DNA**, so each daughter cell gets complete set of **genetic information** from parent cell
- Each daughter cell is **exactly** like the parent cell – **same** kind and number of **chromosomes** as the original cell



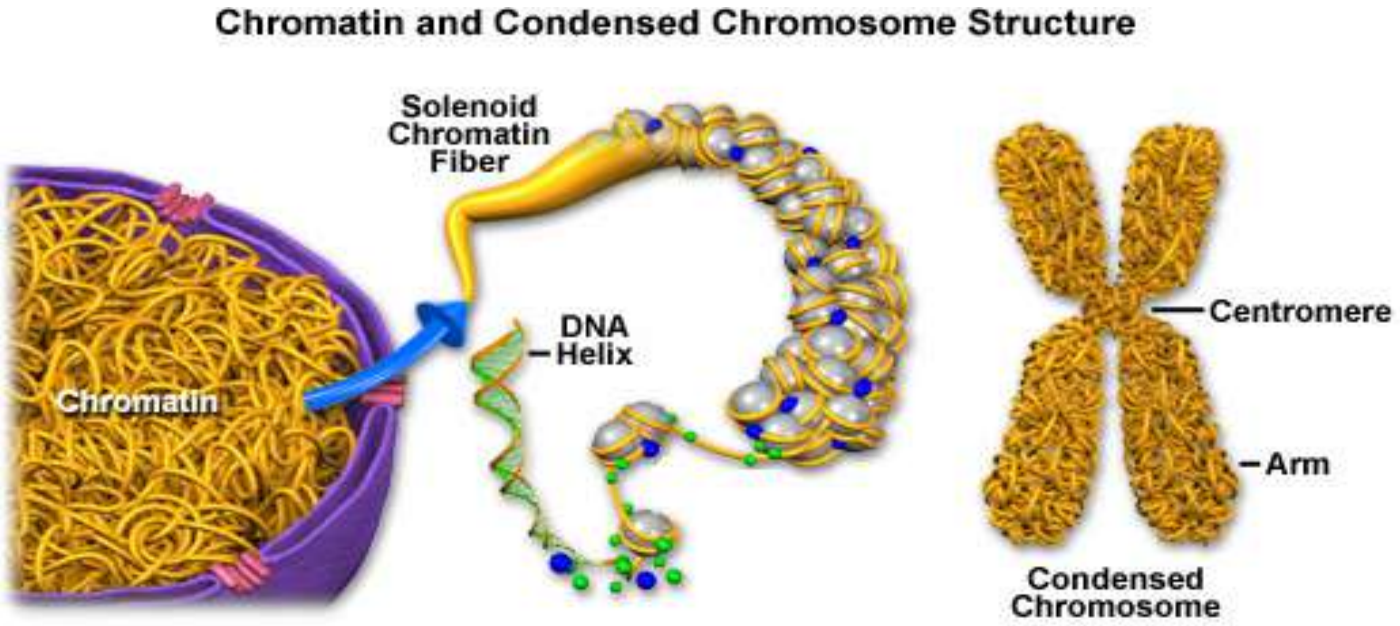
- Many organisms, especially **unicellular** organisms, reproduce by means of cell division – called **asexual reproduction** – Ex: bacteria



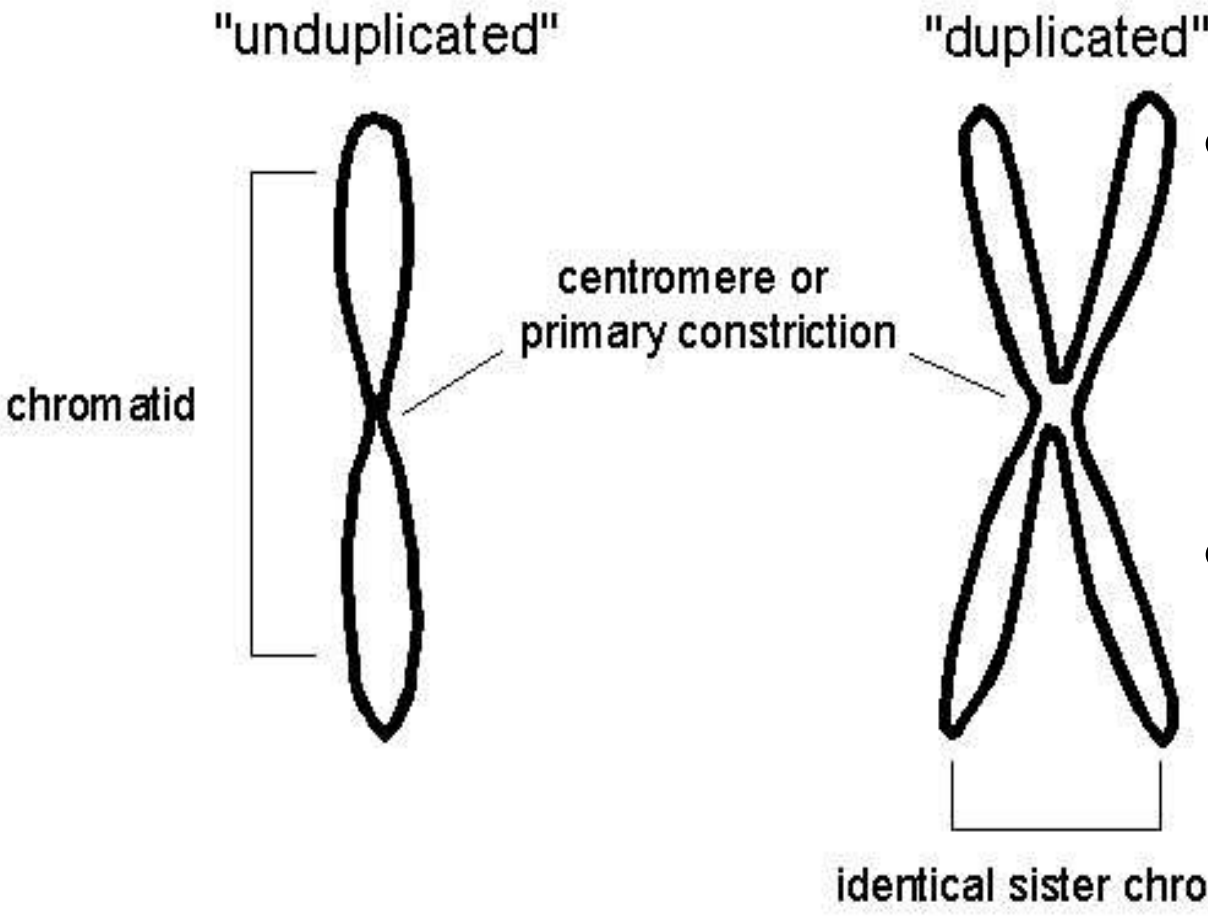
DNA

- DNA is located in the **nucleus** and controls all cell **activities** including cell division
- Long and **thread-like** DNA in a **non-dividing** cell is called **chromatin**
- **Doubled**, **coiled**, short DNA in a **dividing** cell is called **chromosome**

  Consists of 2 parts: **chromatid** and **centromere**

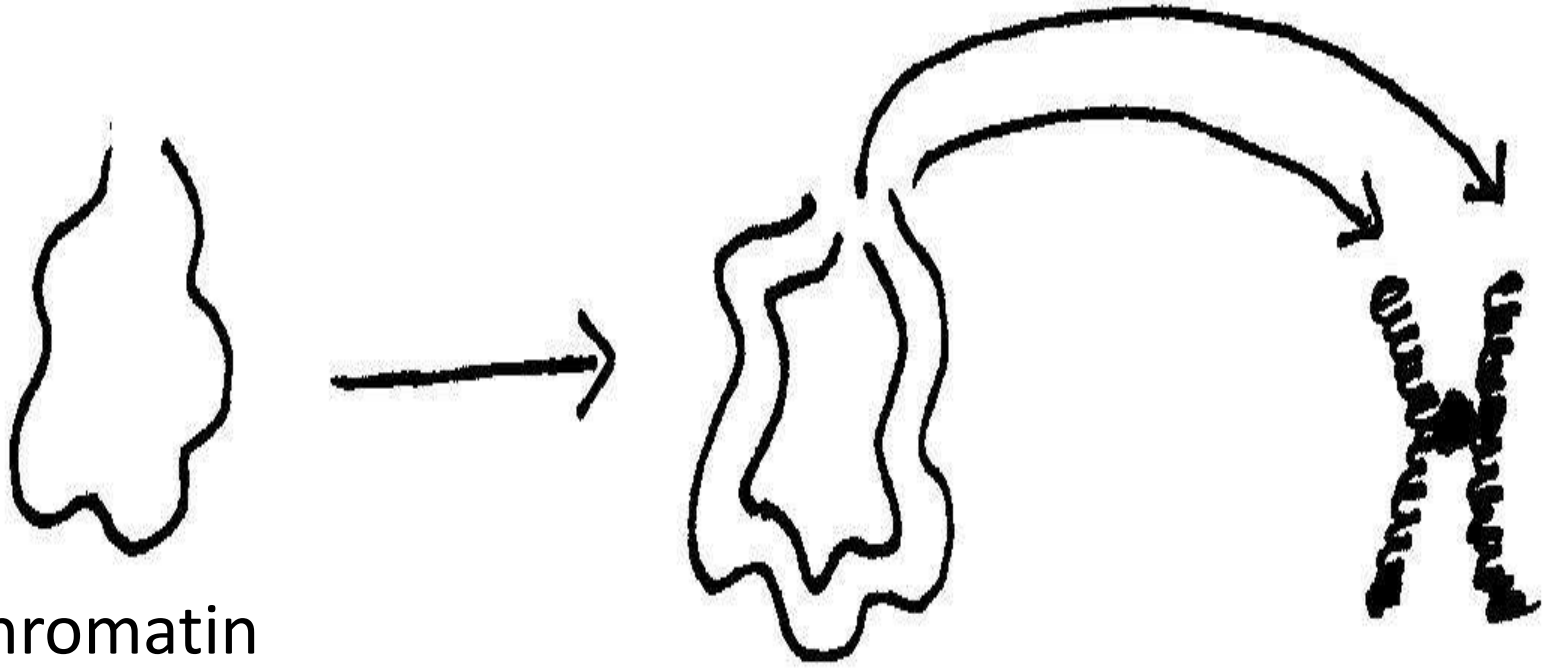


CHROMOSOME STRUCTURE



- 2 identical “sister” chromatids attached at an area in the middle called a **centromere**
- When cells divide, “sister” **chromatids** separate and 1 goes to each new cell

- Chromatin to chromosomes illustration:



Chromatin

Duplicates itself

Coils up into chromosomes

Why does DNA need to change from chromatin to chromosome?

More **efficient** division

Chromosome number

- Every organism has its own **specific number** of chromosomes

Examples: Human = **46** chromosomes or **23 pairs**

Dog = **78** chromosomes or **39 pairs**

Goldfish = **94** chromosomes or **47 pairs**

Lettuce = **18** chromosomes or **9 pairs**

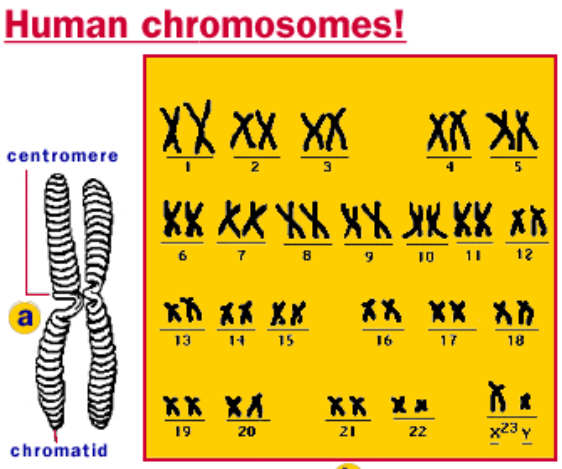
- All **somatic** (body) cells in an organism have the **same** kind and **number** of chromosomes

Examples: Human = **46** chromosomes

Human skin cell = **46** chromosomes

Human heart cell = **46** chromosomes

Human muscle cell = **46** chromosomes

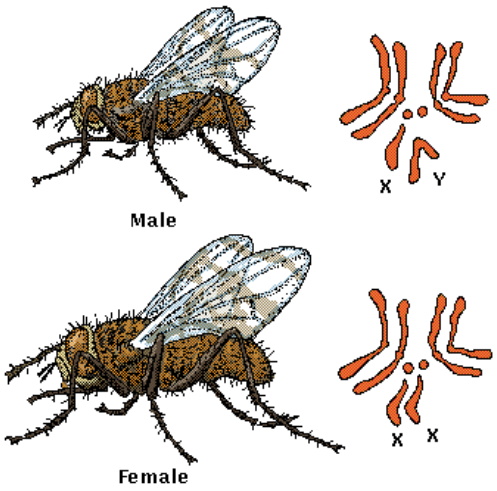


Fruit fly = 8 chromosomes

Fruit fly skin cell = **8** chromosomes

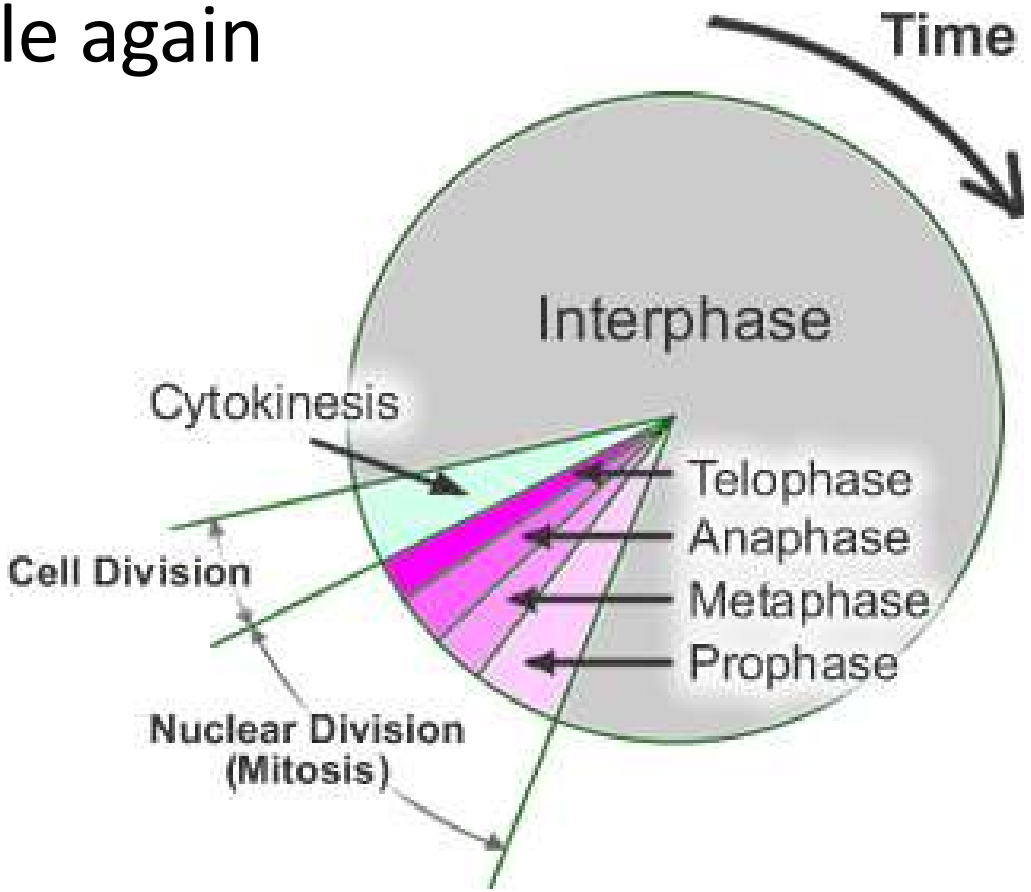
Fruit fly heart cell = **8** chromosomes

Fruit fly muscle cell = **8** chromosomes



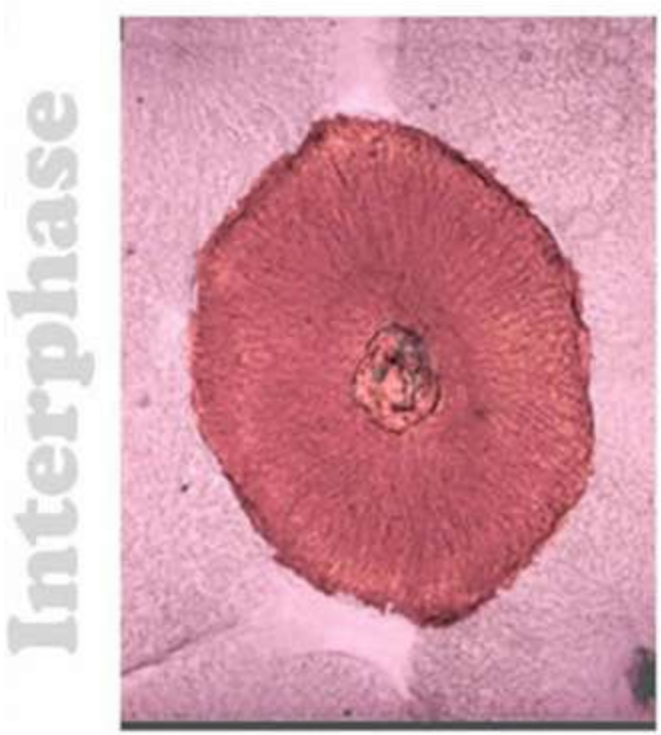
Cell Cycle -- series of events cells go through as they **grow** and **divide**

- Cell **grows**, prepares for division, then **divides** to form 2 **daughter** cells – each of which then begins the cycle again



Interphase—period of cell **growth** and **development**

- DNA **replication** (copying) occurs during Interphase
- During Interphase the cell also **grows**, carries out normal **cell activities**, replicates all other **organelles**
- The cell spends most of its life cycle in **Interphase**

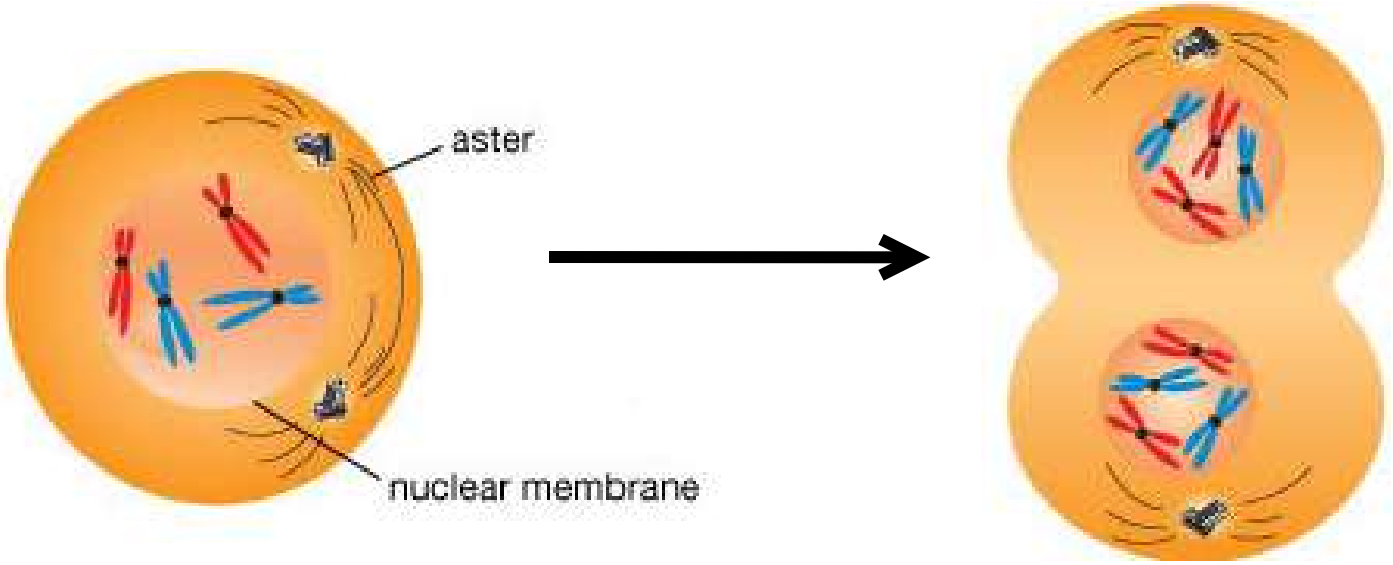


Mitosis – division of the **nucleus** into 2 nuclei, each with the same number of **chromosomes**

- Mitosis occurs in **all** the **somatic** (body) cells

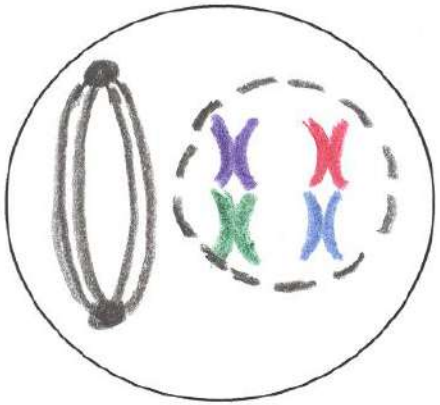
Why does mitosis occur?

So **each** new **daughter** cell has **nucleus** with a complete set of **chromosomes**

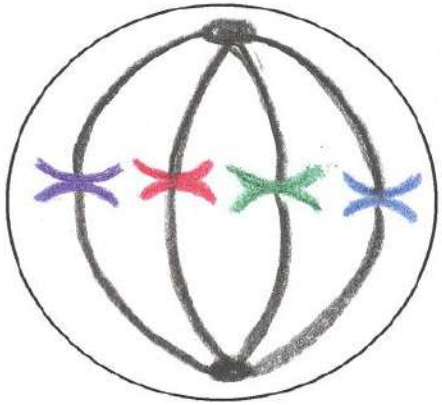


- 4 phases of nuclear division (mitosis), directed by the cell's DNA (**PMAT**)

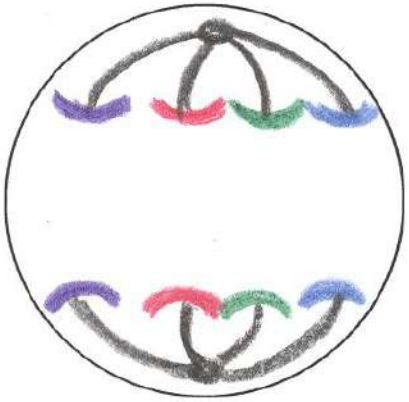
1. **Prophase**



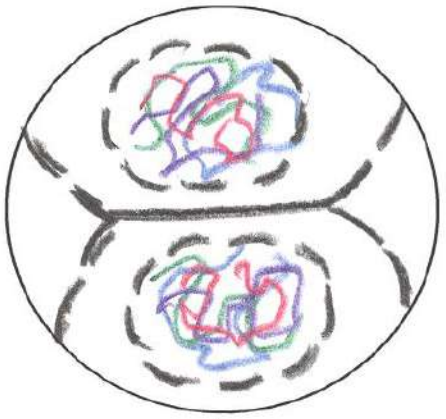
2. **Metaphase**—(Middle)



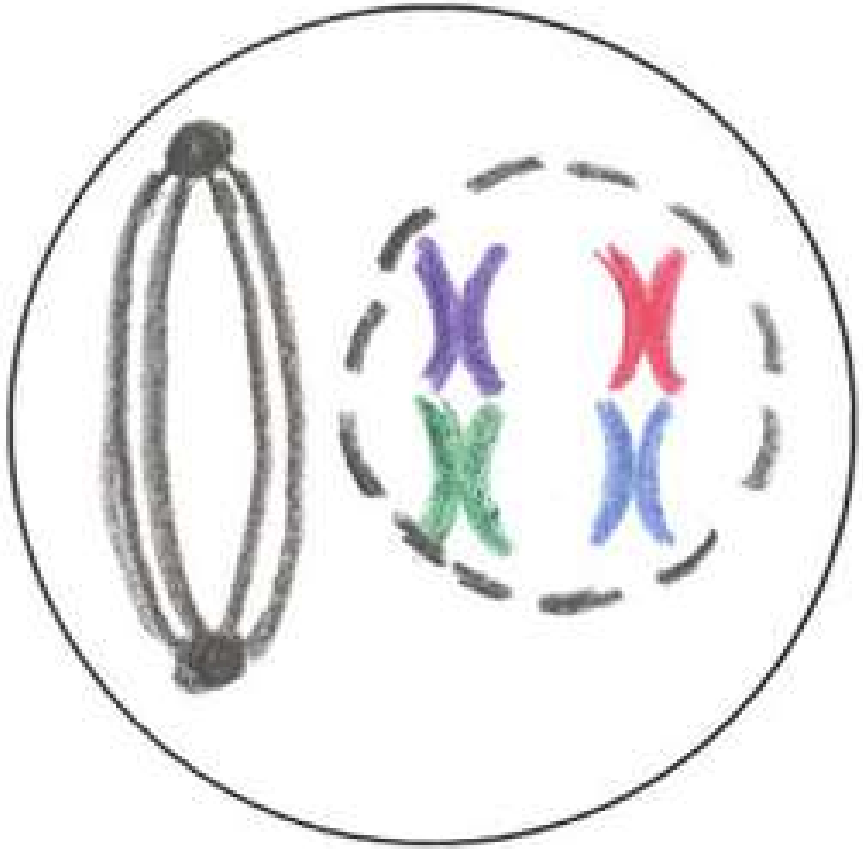
3. **Anaphase**—(Apart)



4. **Telophase**—(Two)

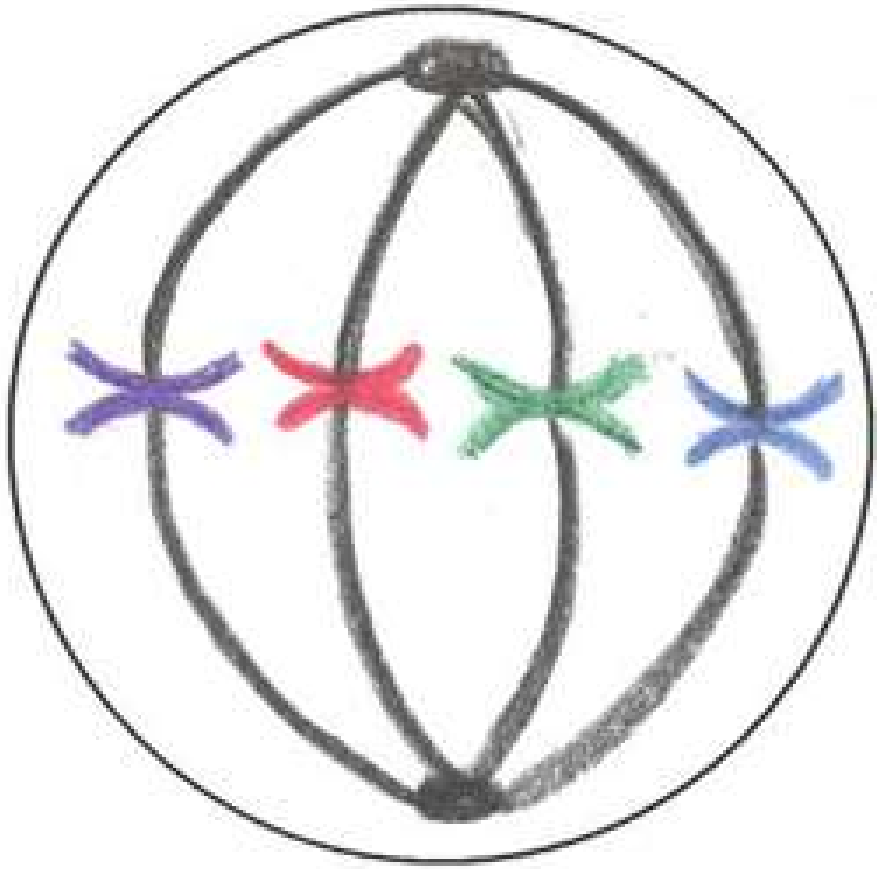


1. **Prophase**



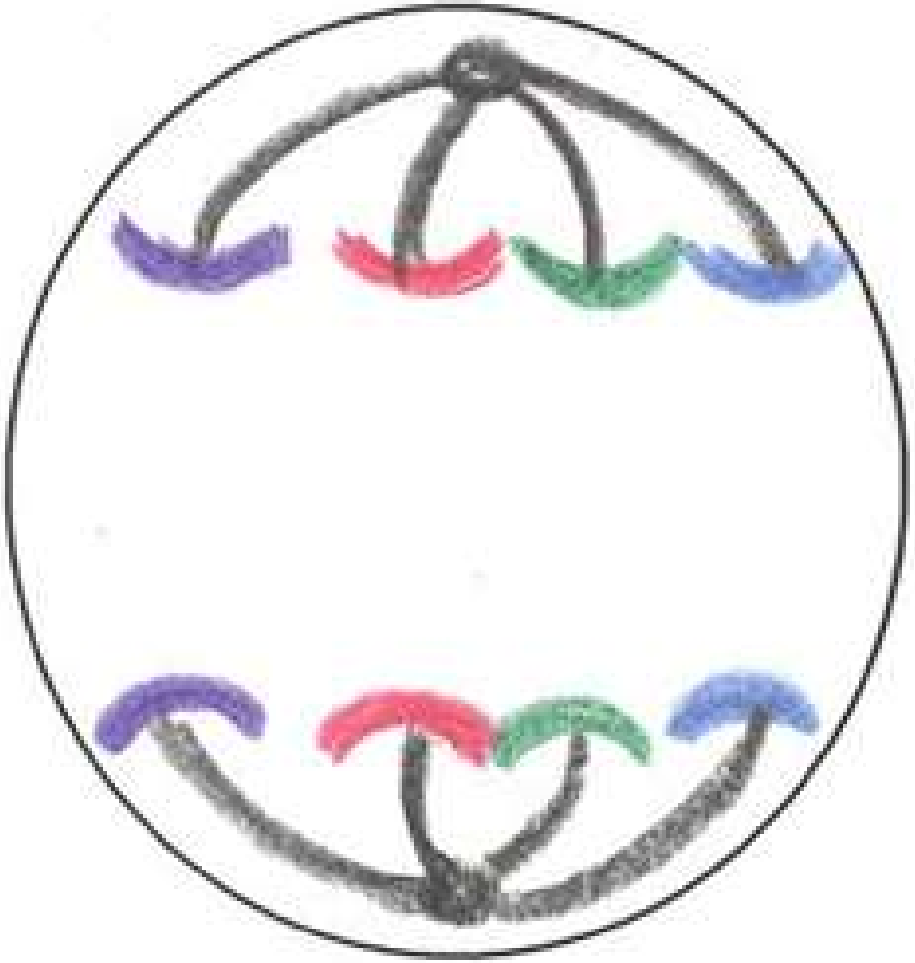
- Chromosomes **coil up**
- Nuclear envelope **disappears**
- **Spindle fibers** form

2. **Metaphase**—(Middle)



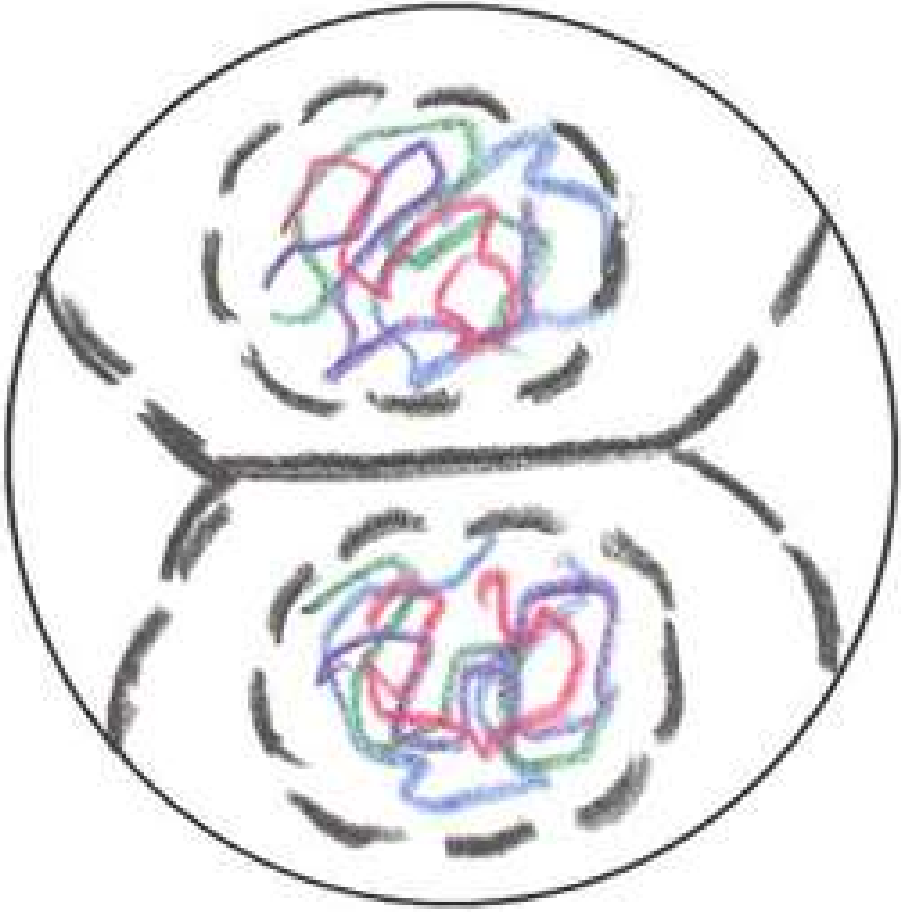
- Chromosomes line up in **middle** of cell
- Spindle fibers **connect** to chromosomes

3. **Anaphase**—(Apart)



- Chromosome copies **divide**
- Spindle fibers pull chromosomes to **opposite poles**

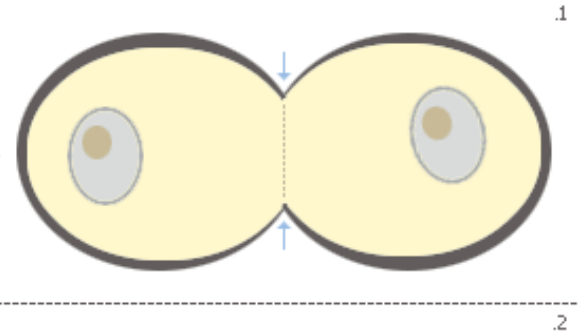
4. **Telophase**—(Two)



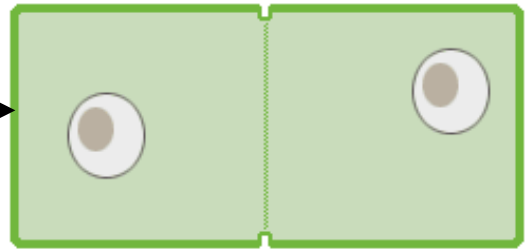
- Chromosomes **uncoil**
- Nuclear envelopes **form**
- **2 new nuclei** are formed
- Spindle fibers **disappear**

Cytokinesis — the **division** of the rest of the cell (**cytoplasm** and organelles) after the nucleus divides

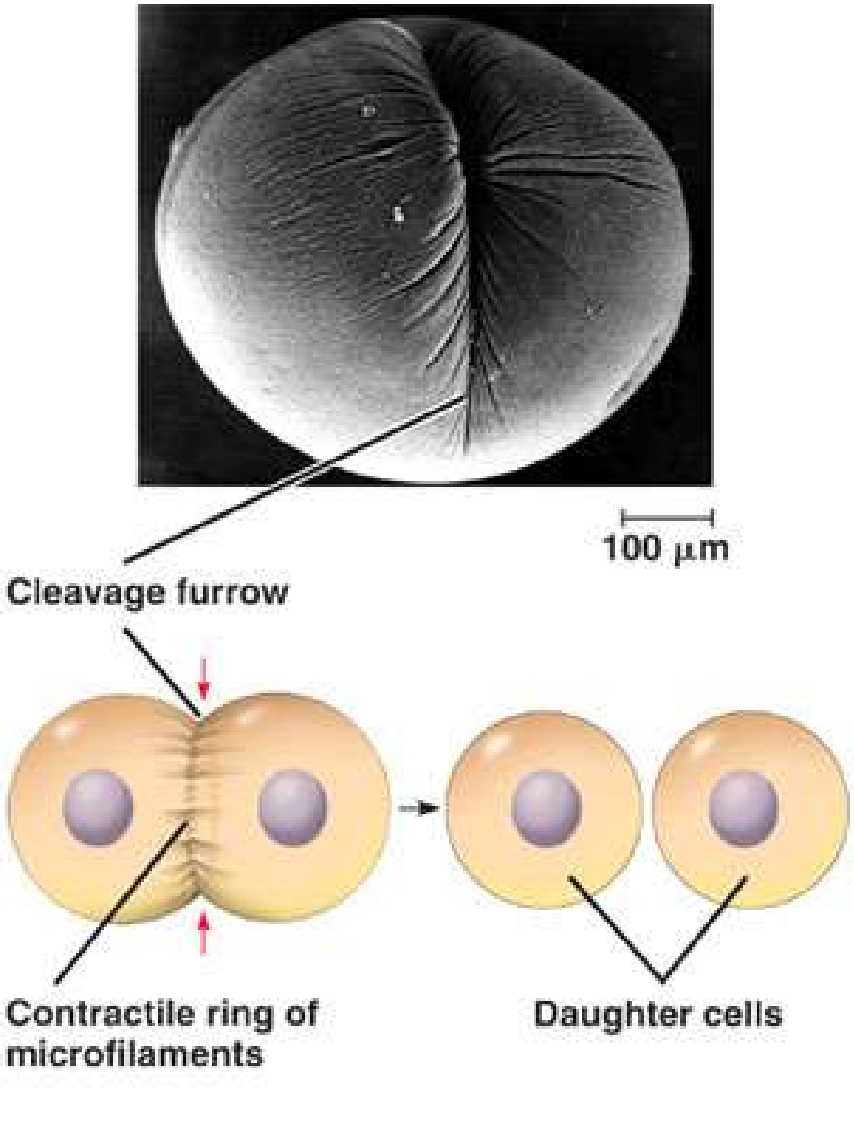
In **animal** cells the cytoplasm pinches in →



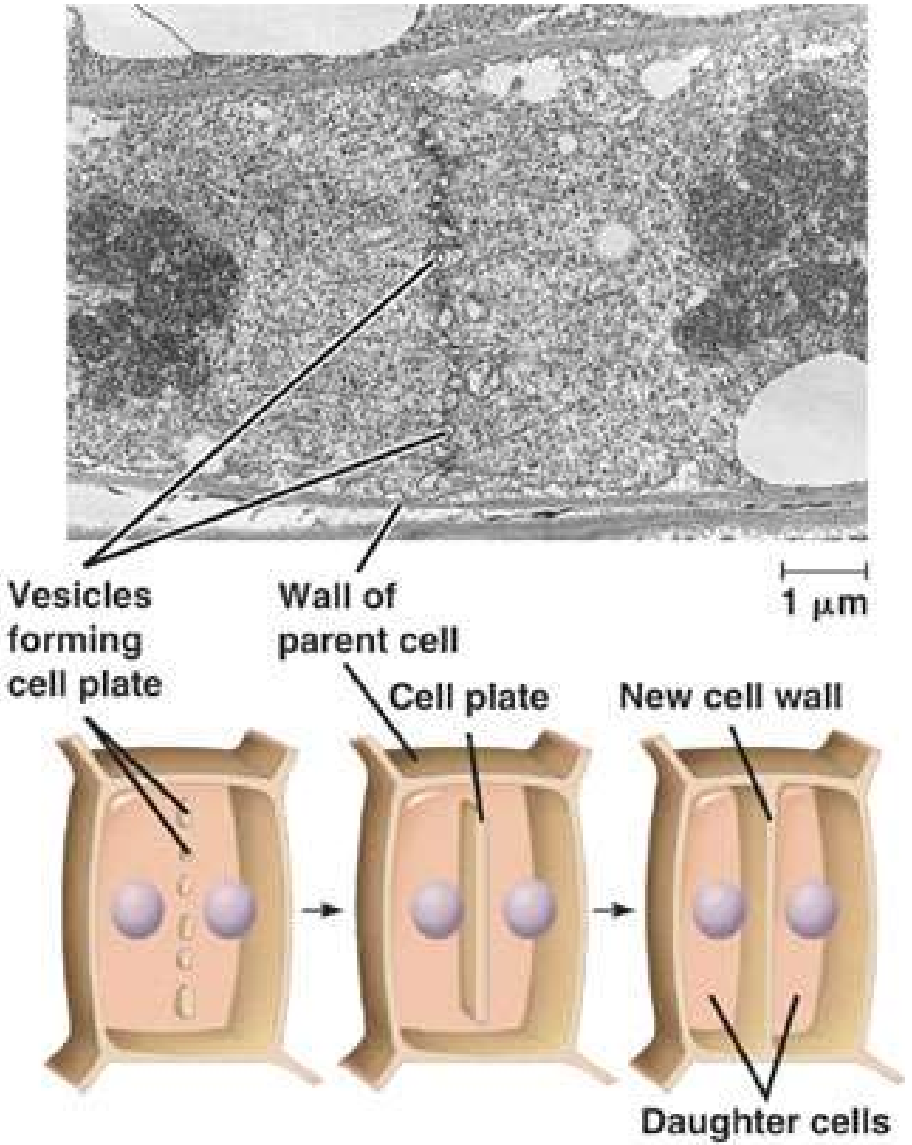
In **plant** cells a cell plate forms →



- After mitosis and cytokinesis, the cell returns to **Interphase** to continue to grow and perform regular cell activities



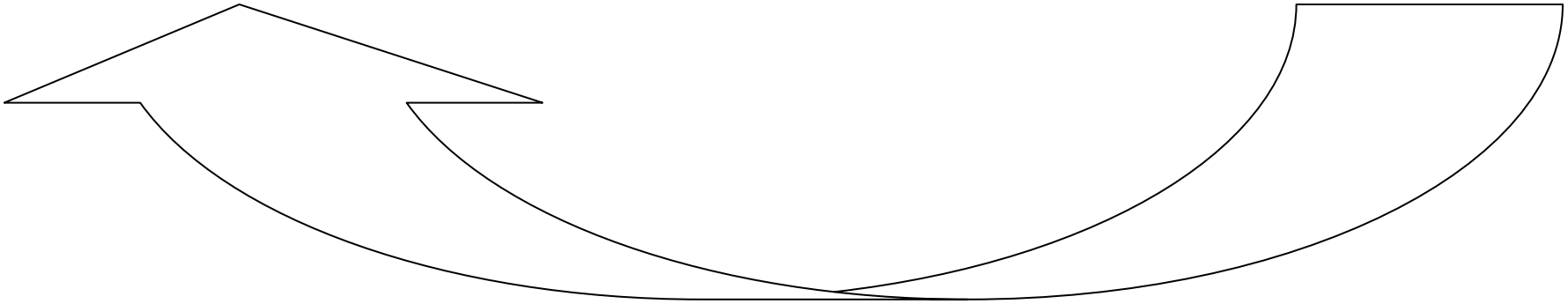
(a) Cleavage of an animal cell (SEM)



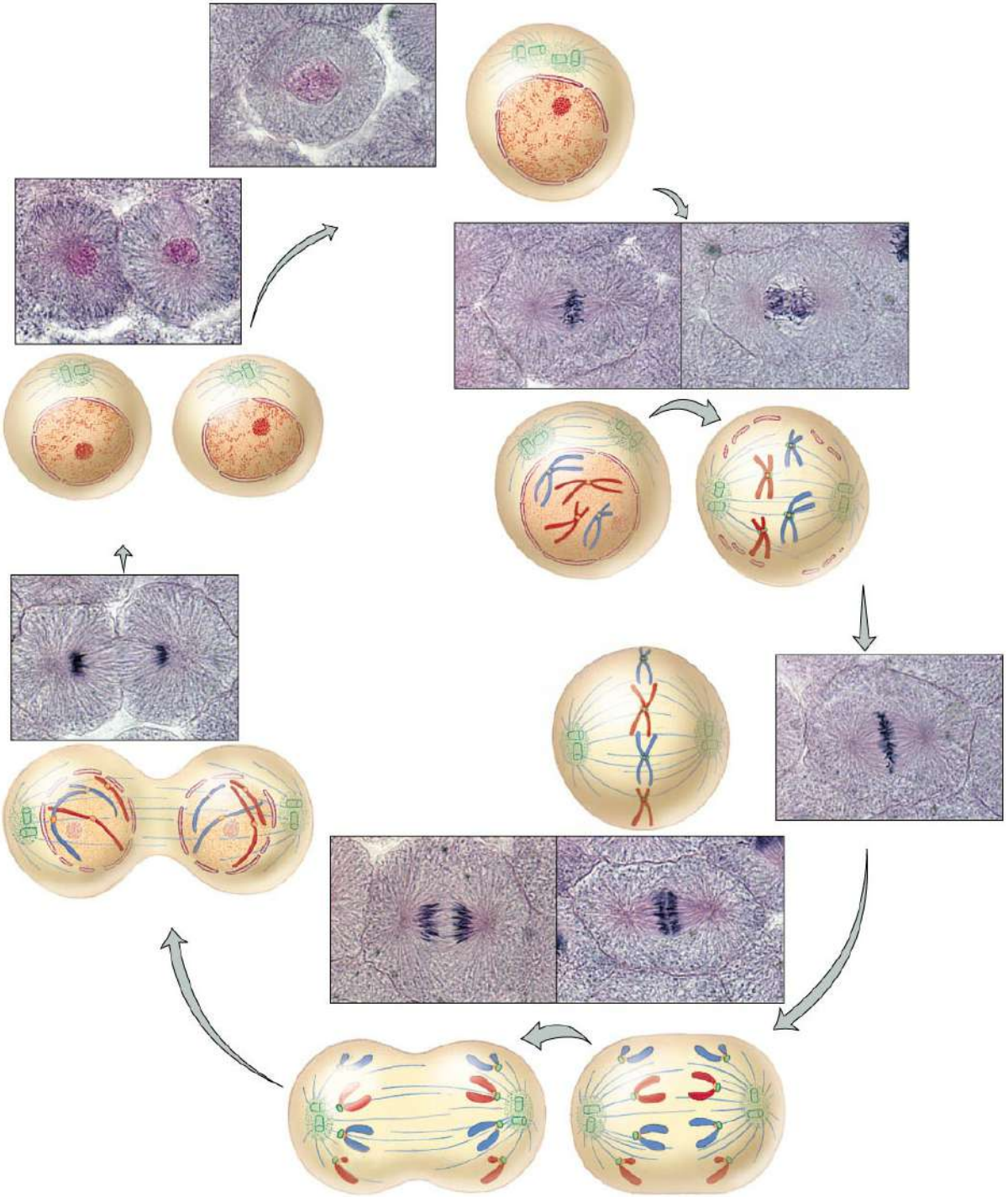
(b) Cell plate formation in a plant cell (TEM)

Summary: Cell Cycle

Interphase → Mitosis (PMAT) → Cytokinesis

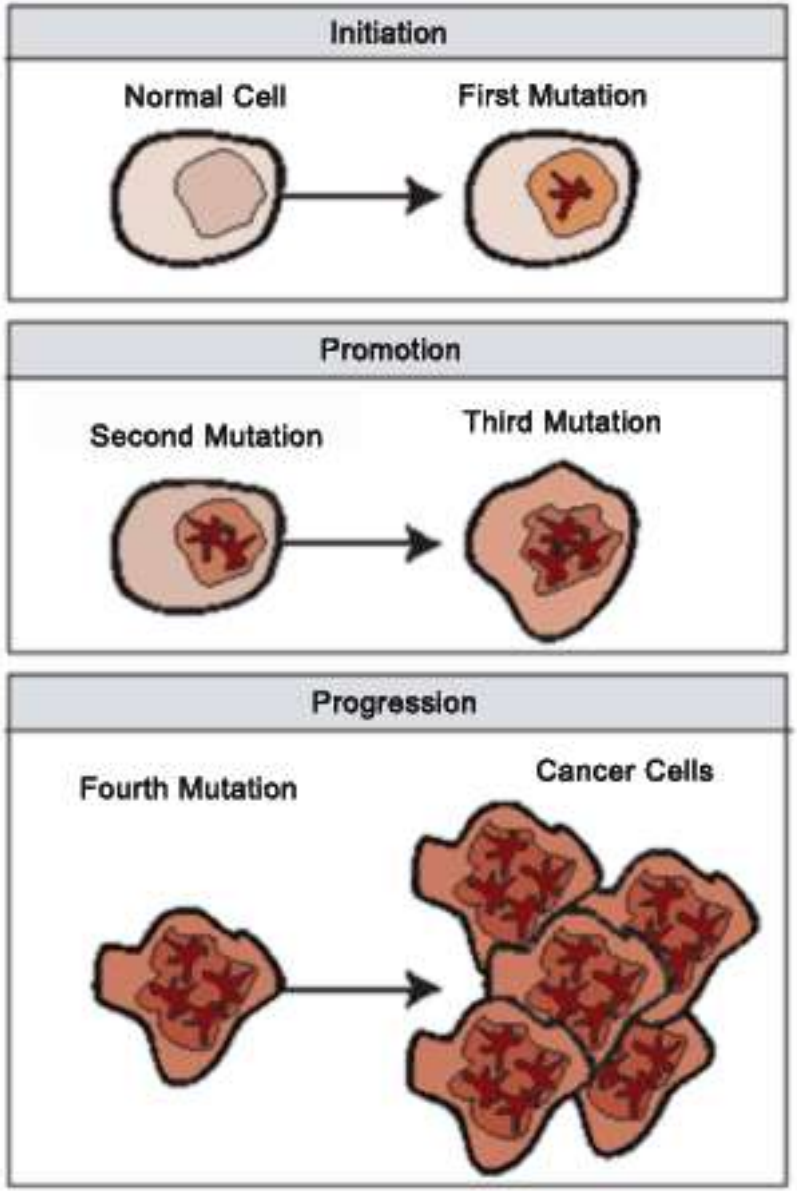


- When cells become old or damaged, they **die** and are replaced with **new** cells

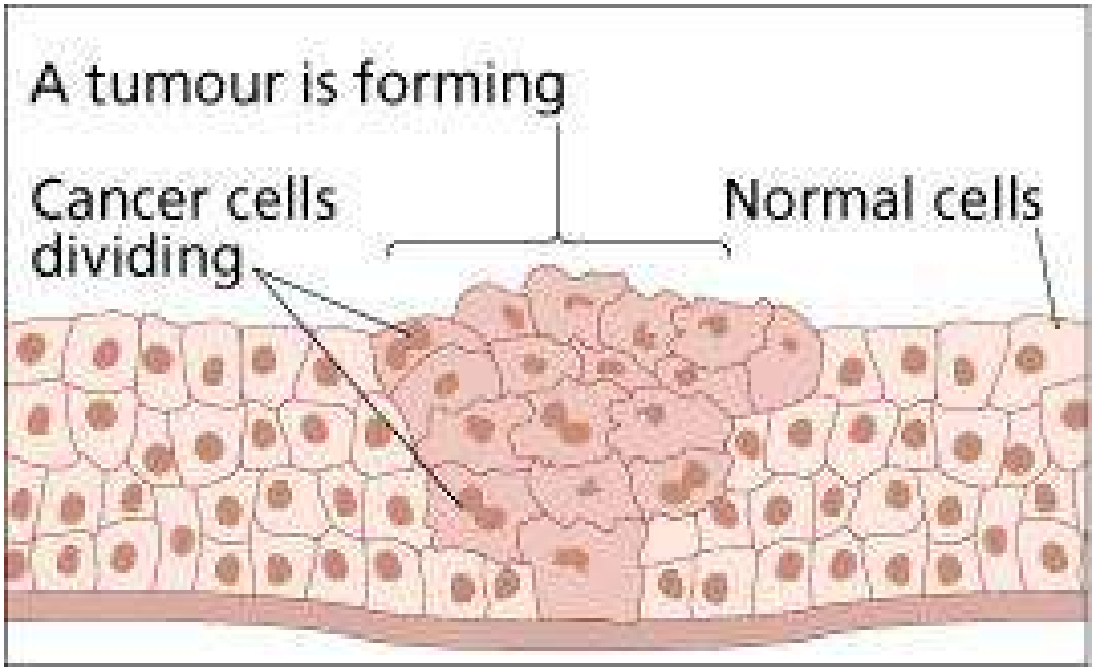


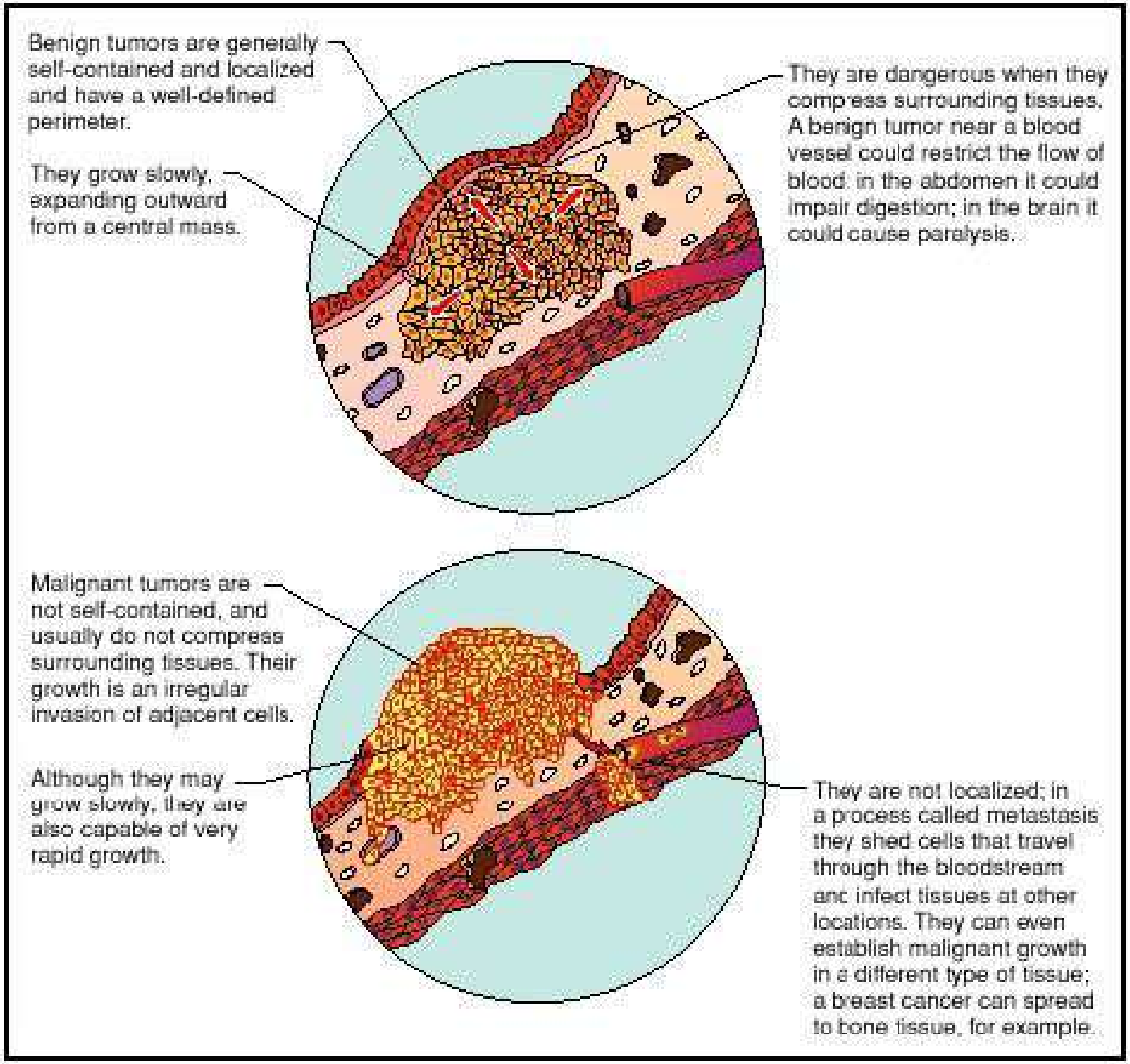
Cell Division Control

- **DNA** controls **all** cell activities including cell **division**
- Some cells **lose** their ability to **control** their **rate of cell division** – the DNA of these cells has become **damaged** or changed (**mutated**)
- These **super-dividing** cells form masses called **tumors**

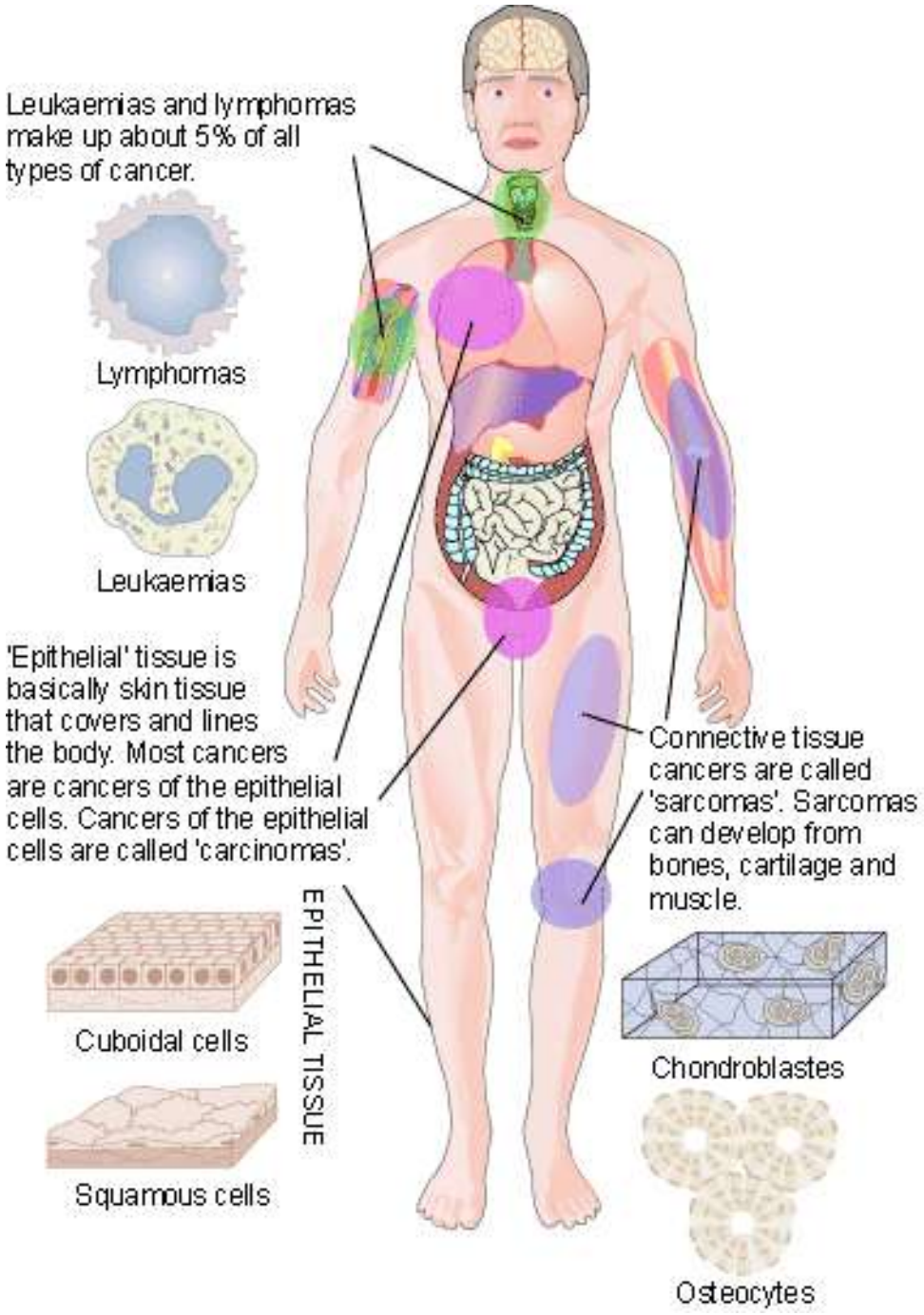


- **Benign** tumors are **not cancerous** – these cells **do not spread** to other parts of the body
- **Malignant** tumors are **cancerous** – these cells break loose and can invade and **destroy healthy tissue** in other parts of the body (called **metastasis**)

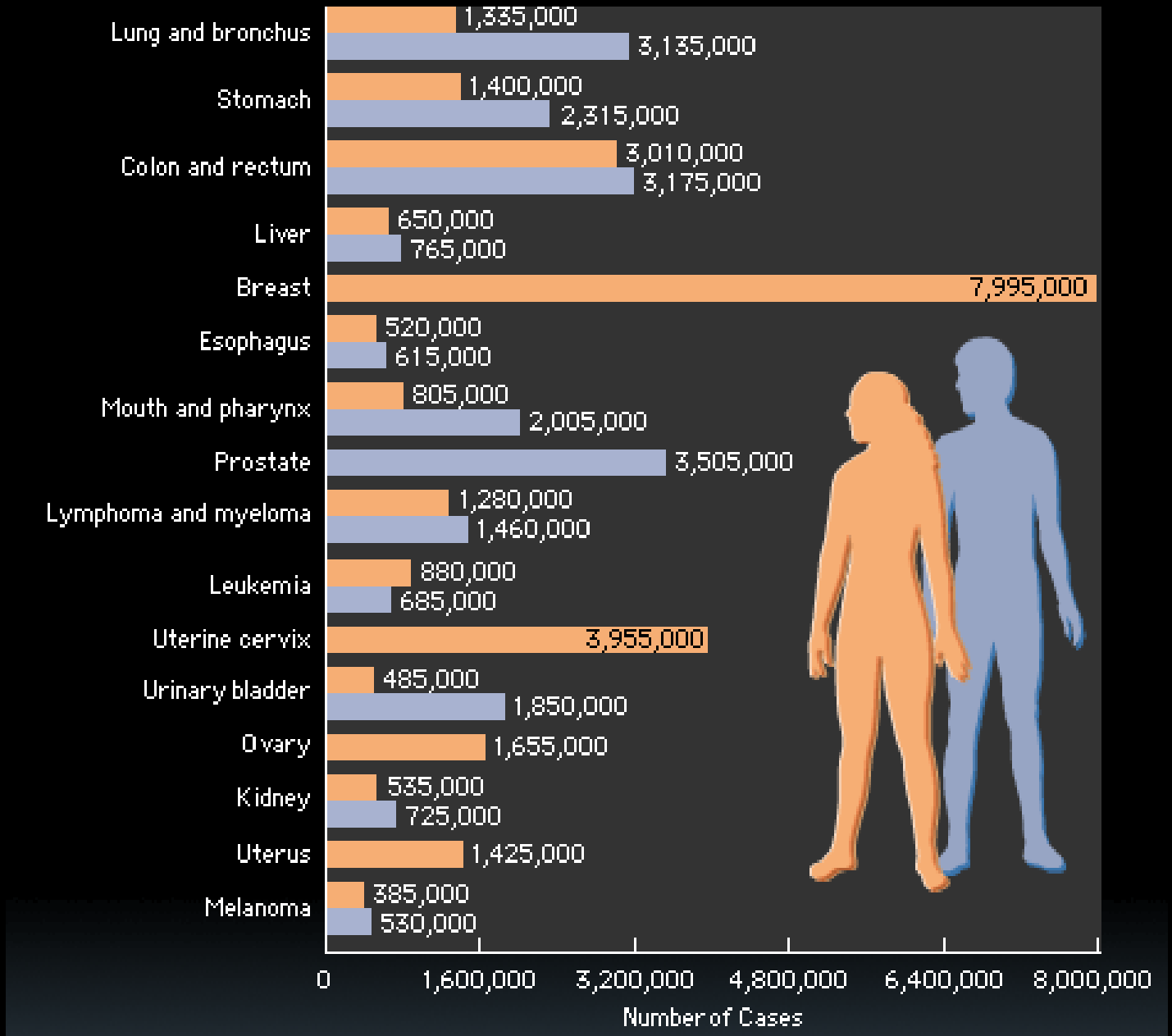



Benign tumors are generally self-contained and localized and have a well-defined perimeter.
They grow slowly, expanding outward from a central mass.
They are dangerous when they compress surrounding tissues. A benign tumor near a blood vessel could restrict the flow of blood; in the abdomen it could impair digestion; in the brain it could cause paralysis.
Malignant tumors are not self-contained, and usually do not compress surrounding tissues. Their growth is an irregular invasion of adjacent cells.
Although they may grow slowly, they are also capable of very rapid growth.
They are not localized; in a process called metastasis they shed cells that travel through the bloodstream and infect tissues at other locations. They can even establish malignant growth in a different type of tissue; a breast cancer can spread to bone tissue, for example.

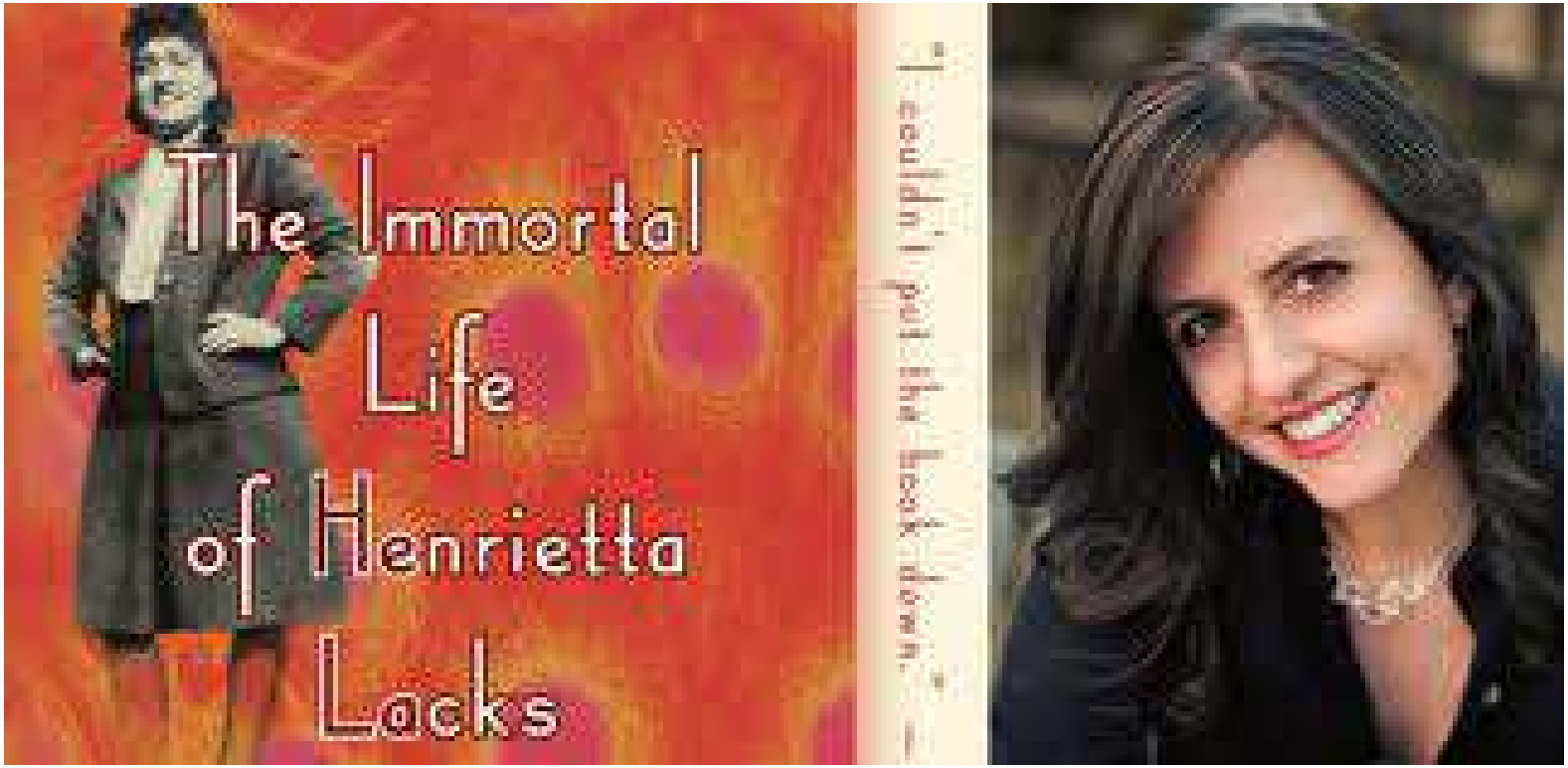
- Cancer is not just one disease, but **many diseases** – over **100 different** types of cancers



Prevalence of Cancer Worldwide* (1997)



*Source: *The World Health Report*, World Health Organization.



http://www.youtube.com/watch?v=wRrNjHYxP_o

http://www.bbc.co.uk/blogs/adamcurtis/2010/06/the_undead_henrietta_lacks_and.html

Phase	Chromosome Appearance & Location	Important Events
Interphase	DNA copies itself; chromatin	DNA replication, cell grows and replicates organelles
Prophase	Chromosomes coil up	Nuclear envelope disappears, spindle fibers form
Metaphase	Chromosomes line up in the middle	Spindle fibers connect to chromosomes
Anaphase	Chromosome copies divide and move apart	Spindle fibers pull chromosome copies apart to opposite poles
Telophase	Chromosomes uncoil back into chromatin	Nuclear envelopes reform, 2 new nuclei are formed, spindle fibers disappear
Cytokinesis	Chromatin	Division of the rest of the cell: cytoplasm and organelles