CELL DIVISION

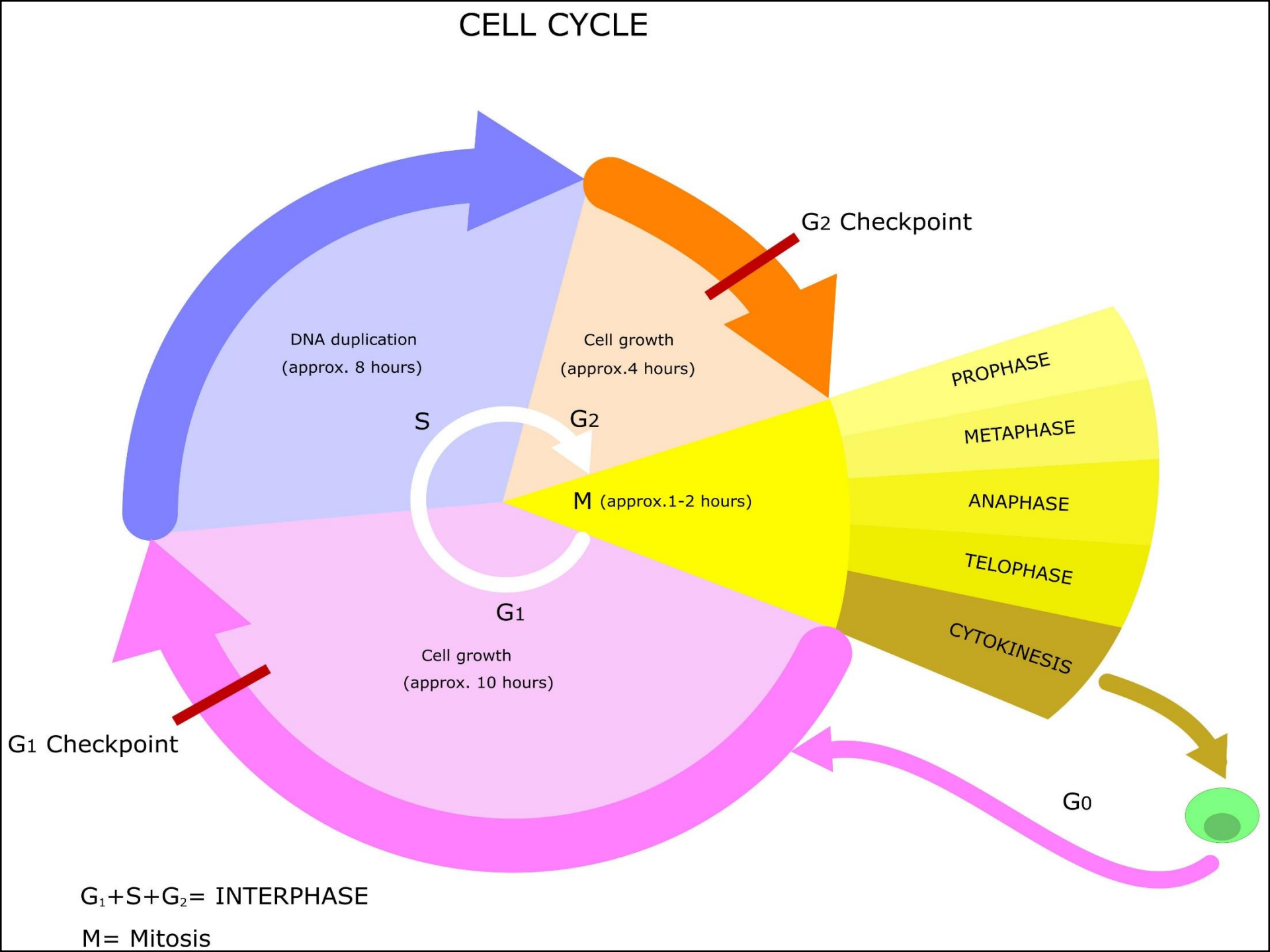
THE CELL CYCLE

- The cell cycle includes 2 phases:

1. **Interphase:**
   - **G1**, **S**, & **G2** phases

2. **Cell division – M (mitotic) Phase:**
   - Mitosis – division of the **nucleus** (**chromosomes**)
   - Cytokinesis - division of the **cytoplasm**

CELL CYCLE

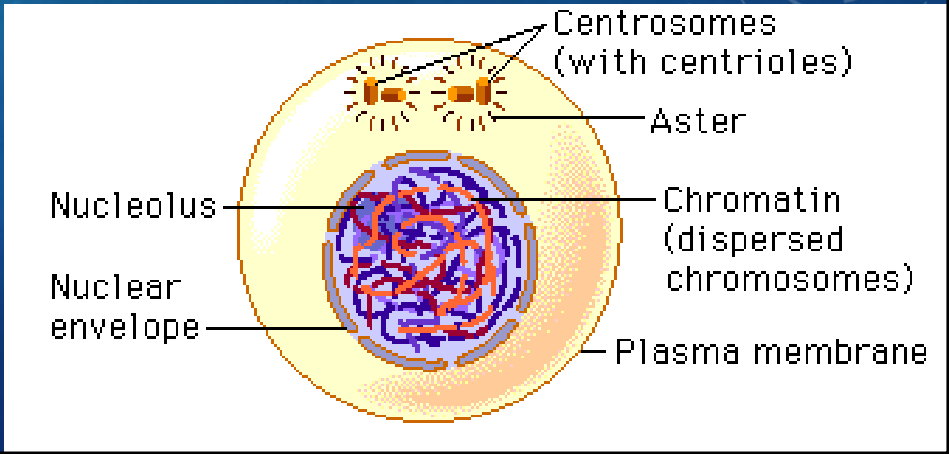


G_1+S+G_2= INTERPHASE

M= Mitosis

INTERPHASE

- **Interphase**
  - **Longest** part of a cell's life cycle
    - During this phase the cell isn't dividing
  - *Purpose*: cells **grow**, develop, & carry on all their normal metabolic **functions**
  - There are **3** parts



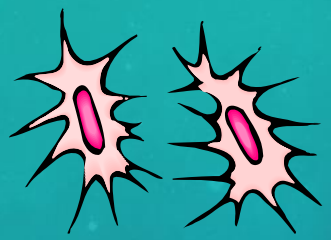
PHASES OF INTERPHASE

1. **G1** (1st *Growth* phase) of interphase
   - Cells mature & **increase** in size
   - *Normal* metabolic activities
   - The protein **cyclin** signals cell to continue cell cycle or not.
     - G0 is a resting phase when the cell has stopped dividing

2. **S** (***Synthesis*** Phase) of interphase
   - DNA is **replicated** (copied)
     - Before cell division occurs, a cell replicates it's DNA.
       - Cell must copy all of its genetic information **before** it divides. **WHY**?

3. **G2** (2nd *Growth* Phase) of interphase
   - Making more cell **organelles** (for 2 cells)

M PHASE



Bone Cell

Muscle cell

Red Blood Cell

M Phase/Mitotic Phase (Mitosis):

- Follows Interphase (G1, S, G2)
  - DNA has been replicated prior to mitosis in S or interphase
- **Mitosis** (cell division) the process in which the nucleus is divided into **2 nuclei** **(2 identical new cells)**
- **Occurs in our somatic (body cells)**
  - **Somatic (body) Cells:** contains both sets of homologous chromosomes (one from each parent)
    - Diploid (2n) "two sets- 2 chromosomes at each pair- 23 pairs = 46 chromosomes total"

Reasons for Cell Division

1. **Maintenance** & **repair** of tissues

- Different cells must be replaced at different rates due to their location & function

  - *Replacing cells*: **skin cells & lining of digestive tract** must be replaced frequently since they get rubbed off by friction

  - *Repairing cells*: **nerve** cells do NOT replace themselves and only **repair** themselves under very specific circumstances

Life Span of Cells

FIGURE 1.2 CELL LIFE SPAN	
CELL TYPE	**APPROXIMATE LIFE SPAN**
Skin cell	2 weeks
Red blood cell	4 months
Liver cell	300–500 days
Intestine—internal lining	4–5 days
Intestine—muscle and other tissues	16 years

REASONS FOR CELL DIVISION

2. **Growth** of organism
   - *In cell division*: cellular material is divided into **2 identical cells**
     - New cells are structurally and functionally **identical** to parent cell
     - They have the same number of **chromosomes**!!

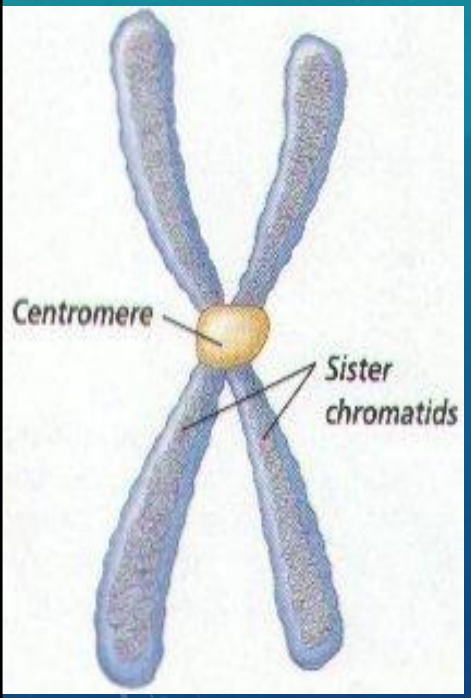
3. **Reproduction** of the species
   - ***Asexual Reproduction*** in prokaryotic cells:
     - **Binary fission** (splitting into 2) & **Budding** (star fish)
       - GENETICALLY IDENTIAL!!!
       - SAME AMOUNT OF CHROMOSOMES AS PARENT!

CHROMOSOMES & THEIR STRUCTURE

•During the process of mitosis (cell division) DNA is organized into structures called **chromosomes**

•*Purpose*: to keep genetic information organized during replication.

Chromosome



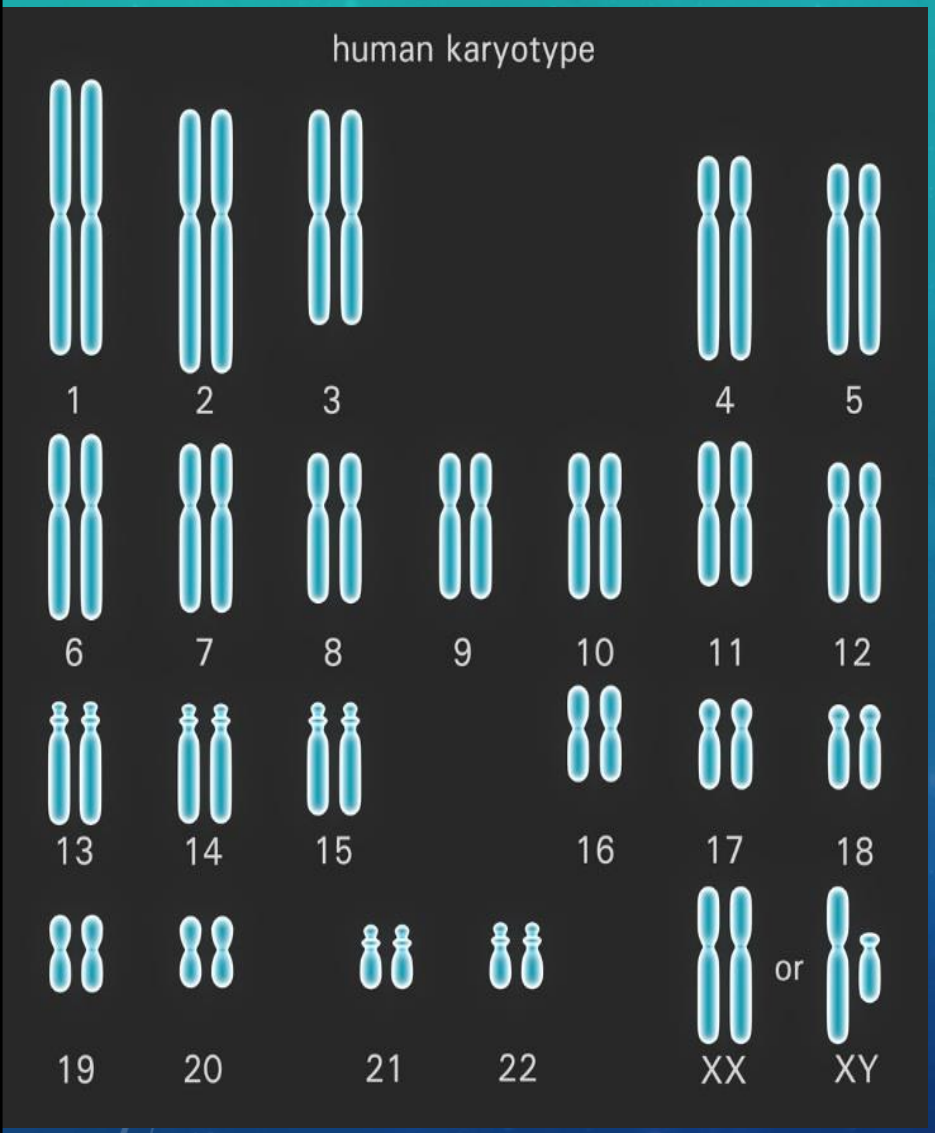
•Chromosomes are only visible

during mitosis **(cell division)** process.

•Sister **chromatid** = replicated chromosome

•Chromatids become **chromosomes** when they separate during mitosis

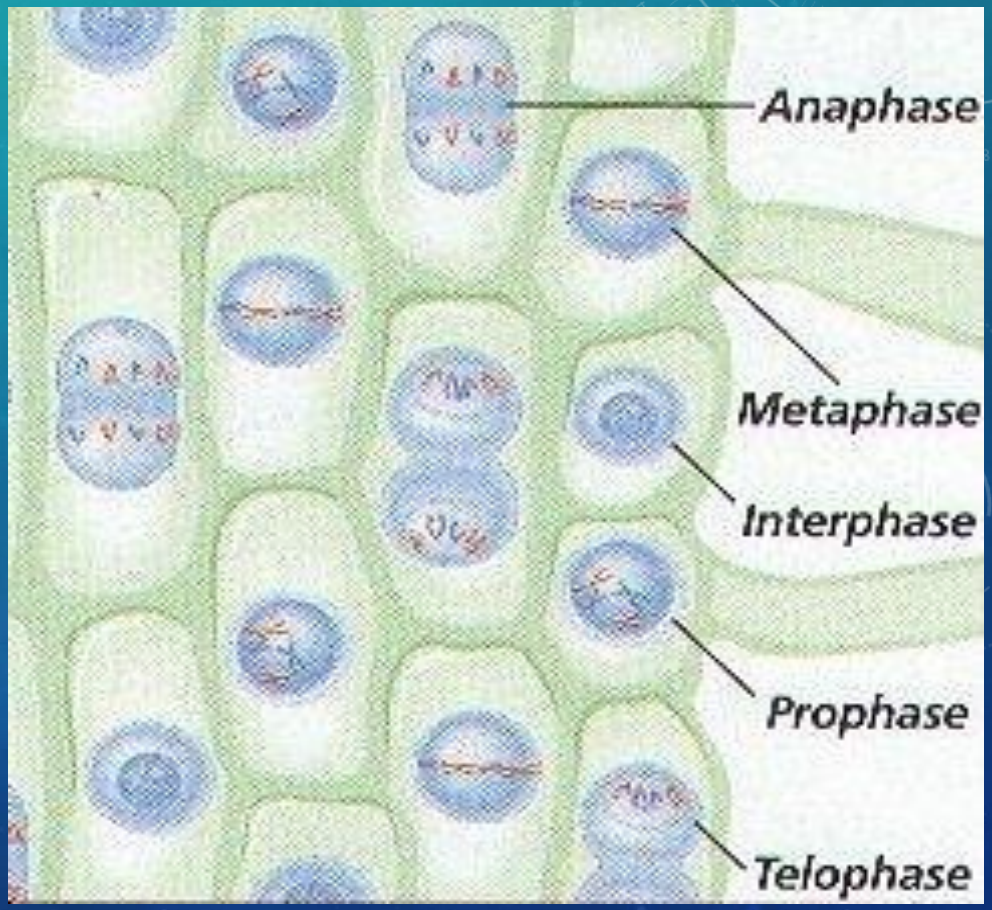
CHROMOSOME NUMBERS



- Each organism has a specific number of chromosomes
- Humans have **23** *pairs* of chromosomes
  - **46** chromosomes (23 from each parent)
    - Pairs 1-22= **autosomes** (everything but the sex chromosomes)
    - Pair 23= sex chromosomes
      - Male- XY
      - Female- XX

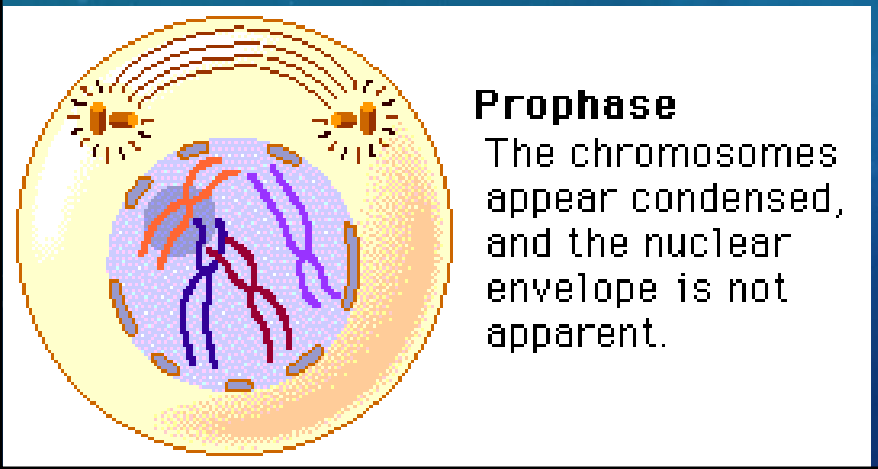
MITOSIS – M PHASE

- Division of the **Nucleus**
- 4 Phases: (In order – PMAT)
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase

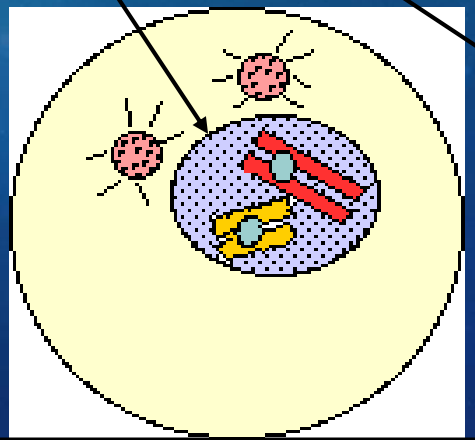


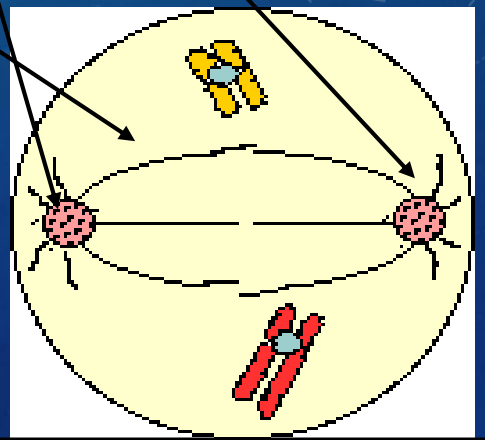
PHASES OF MITOSIS

- **Prophase**:
  1. ***Chromosomes become visible*** when they condense into sister chromatids
  2. *Centrioles* (animal cells) move to opposite ends of cell
  3. *Spindles* begin to form
  4. Nuclear envelope breaks down.



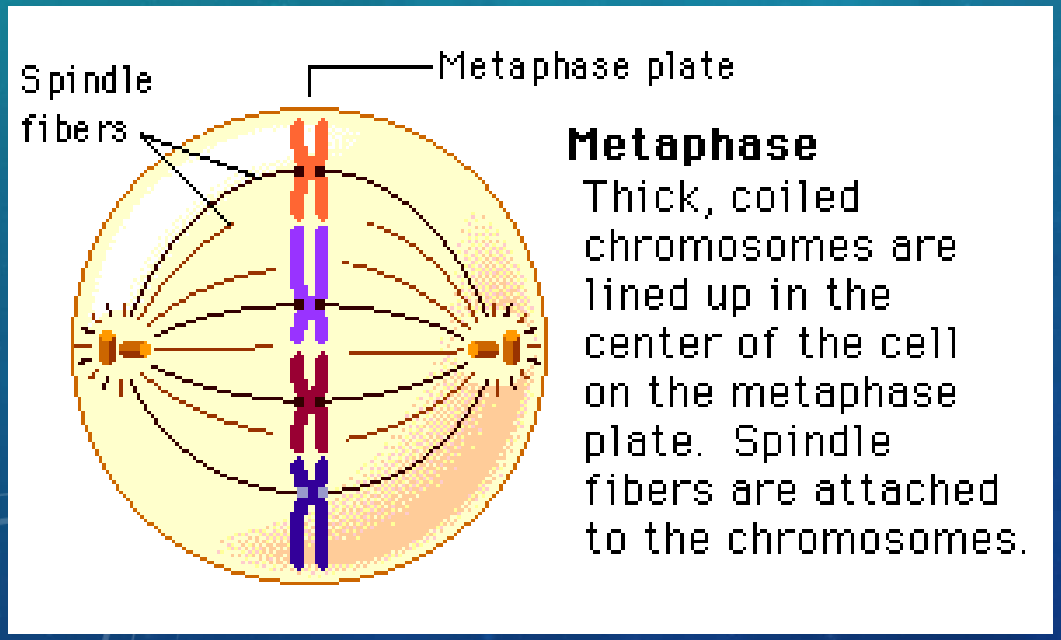
Prophase
The chromosomes appear condensed, and the nuclear envelope is not apparent.

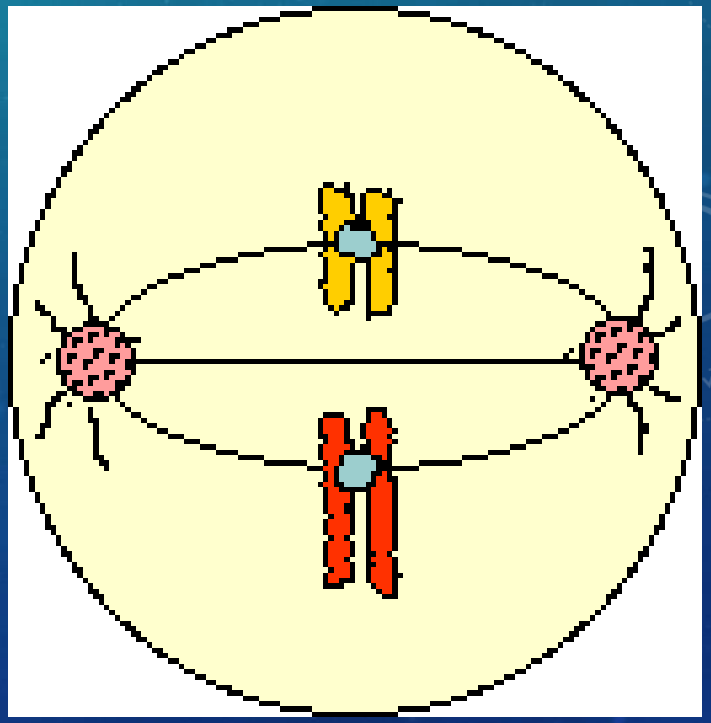




PHASES OF MITOSIS

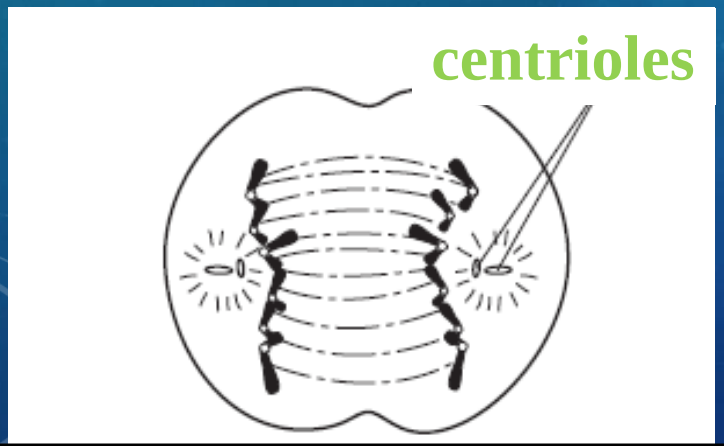
- **Metaphase**:
  - *Chromosomes line up* in **center/middle** or equator of the cell moved by the spindle.

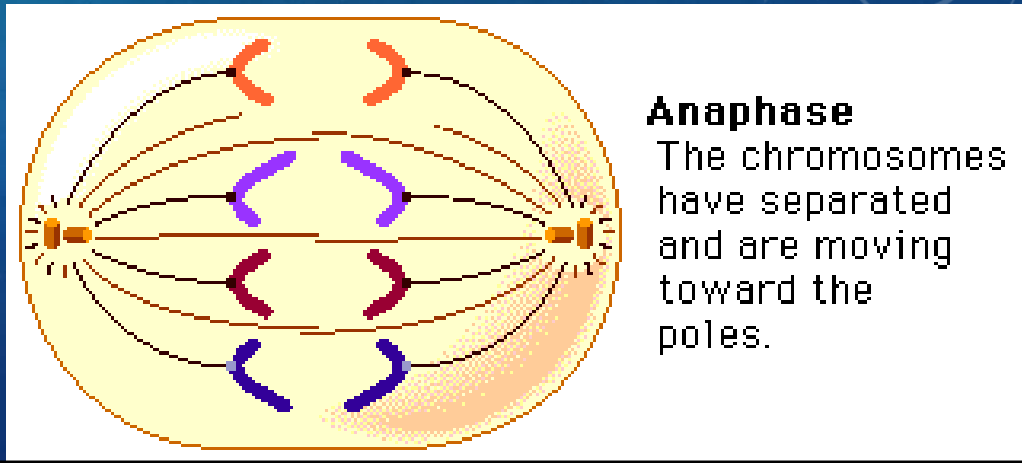




PHASES OF MITOSIS

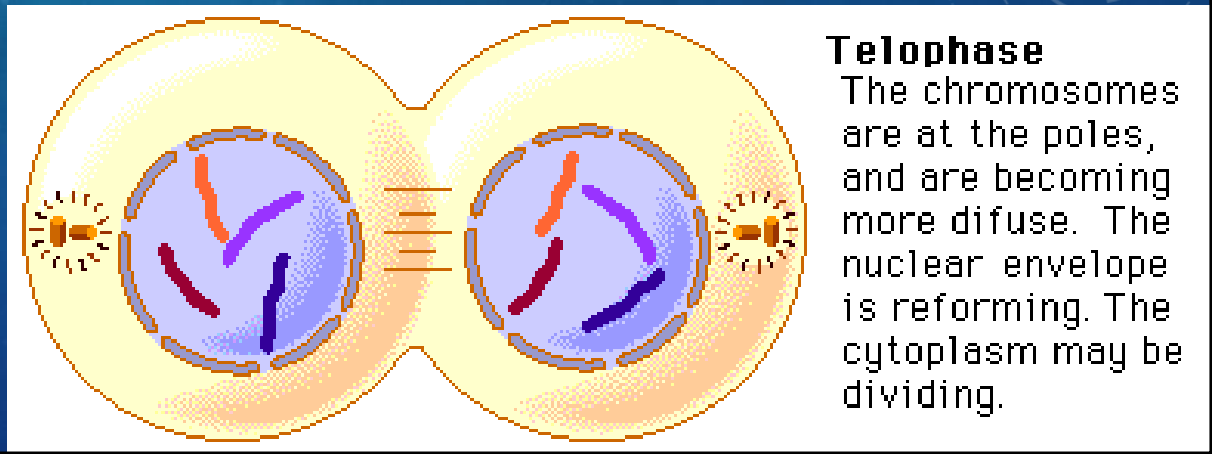
- **<u>Anaphase</u>**:
  1. Spindle fibers attached to the centromere *pull the sister chromatids* ***apart***, microtubules shorten
     - This ensures that daughter each cell has the SAME number of chromosomes in each cell as the parent cell
  2. Chromosomes *move toward opposite* ends of cell



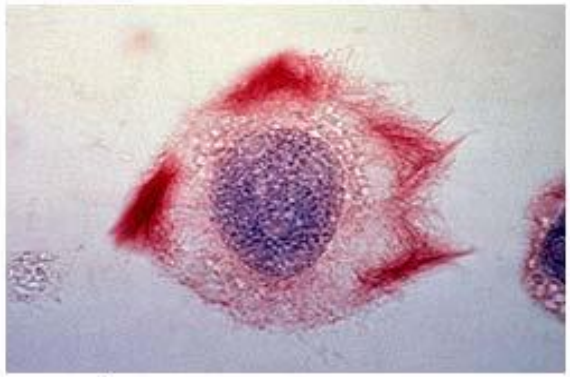


PHASES OF MITOSIS

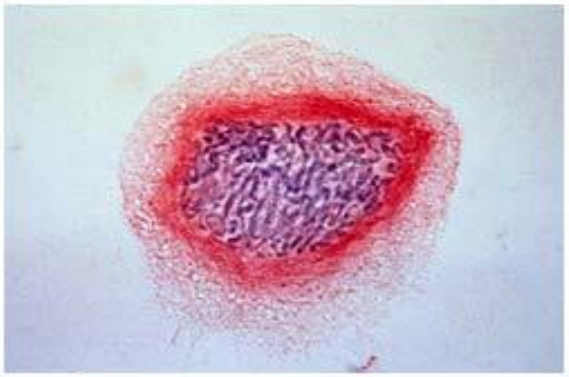
- **Telophase**:
  1. Nuclear membrane forms at each end of the cell around the chromosomes
  2. Nucleolus reform
  3. Chromosomes become less tightly coiled & appear as chromatin again
  4. Signifies **completion** of nuclear division



ANIMAL CELL MITOSIS



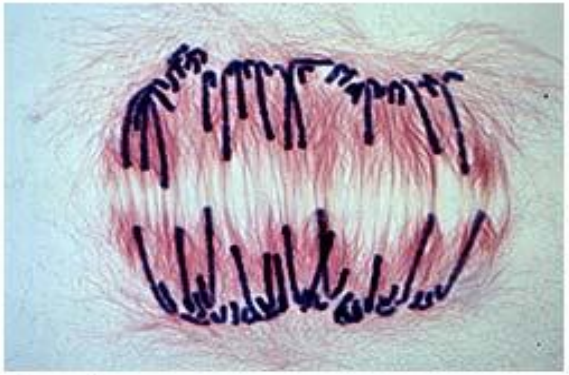
Interphase



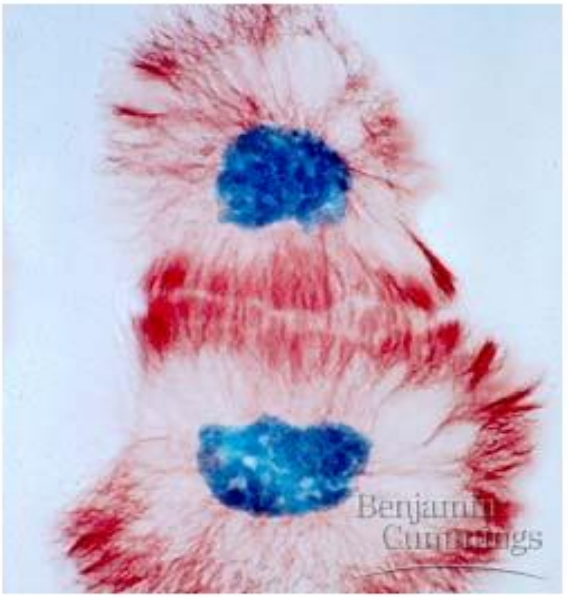
Prophase

Prometaphase

Metaphase

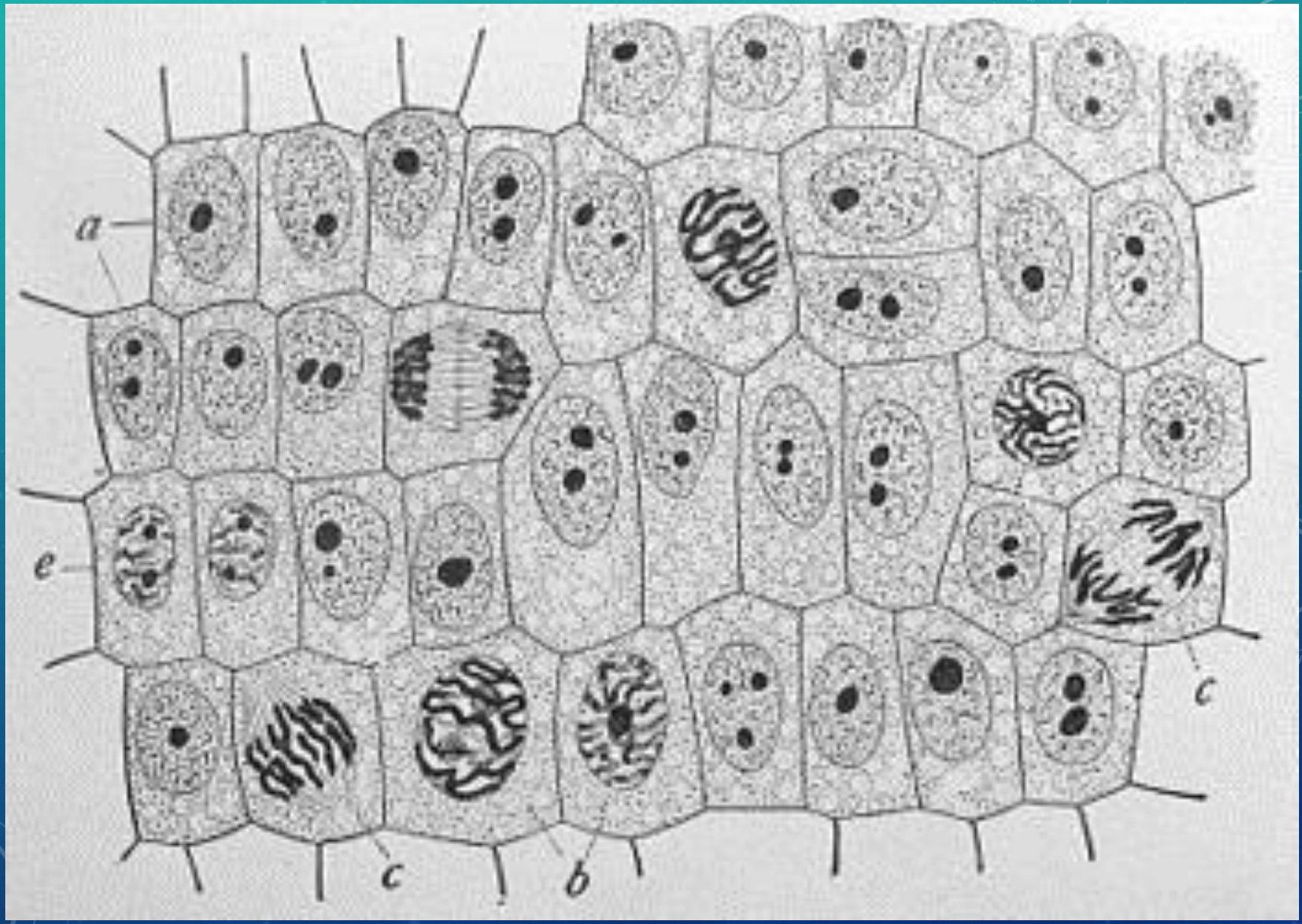


Anaphase



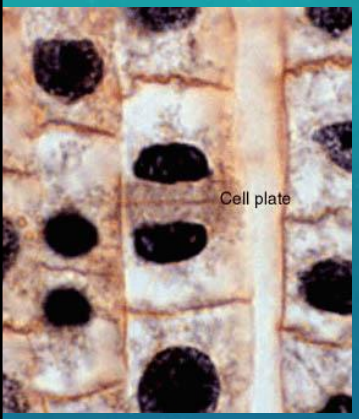
Telophase

PLANT CELL MITOSIS



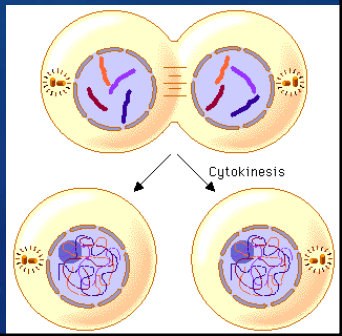
CYTOKINESIS - DIVISION OF CYTOPLASM

- **Cytokinesis**: division of the **cytoplasm**
- Cytoplasm of the cell and its organelles separate into **2** new IDENTICAL **daughter cells**



- A groove (**cleavage furrow**) forms from outside to inside pinching the parent cell in two – in animal cells
- In plants, a **cell plate** is formed (this turns into the cell wall)

- The cleavage furrow and cell plate begin forming in telophase and are completely formed in cytokinesis, therefore some scientists dispute if they are formed in telophase or cytokinesis… therefore we say either phase!



PRACTICE!

- If an organism has **12** chromosomes and its cell undergoes mitosis, how many chromosomes will the daughter cells have?

MEIOSIS

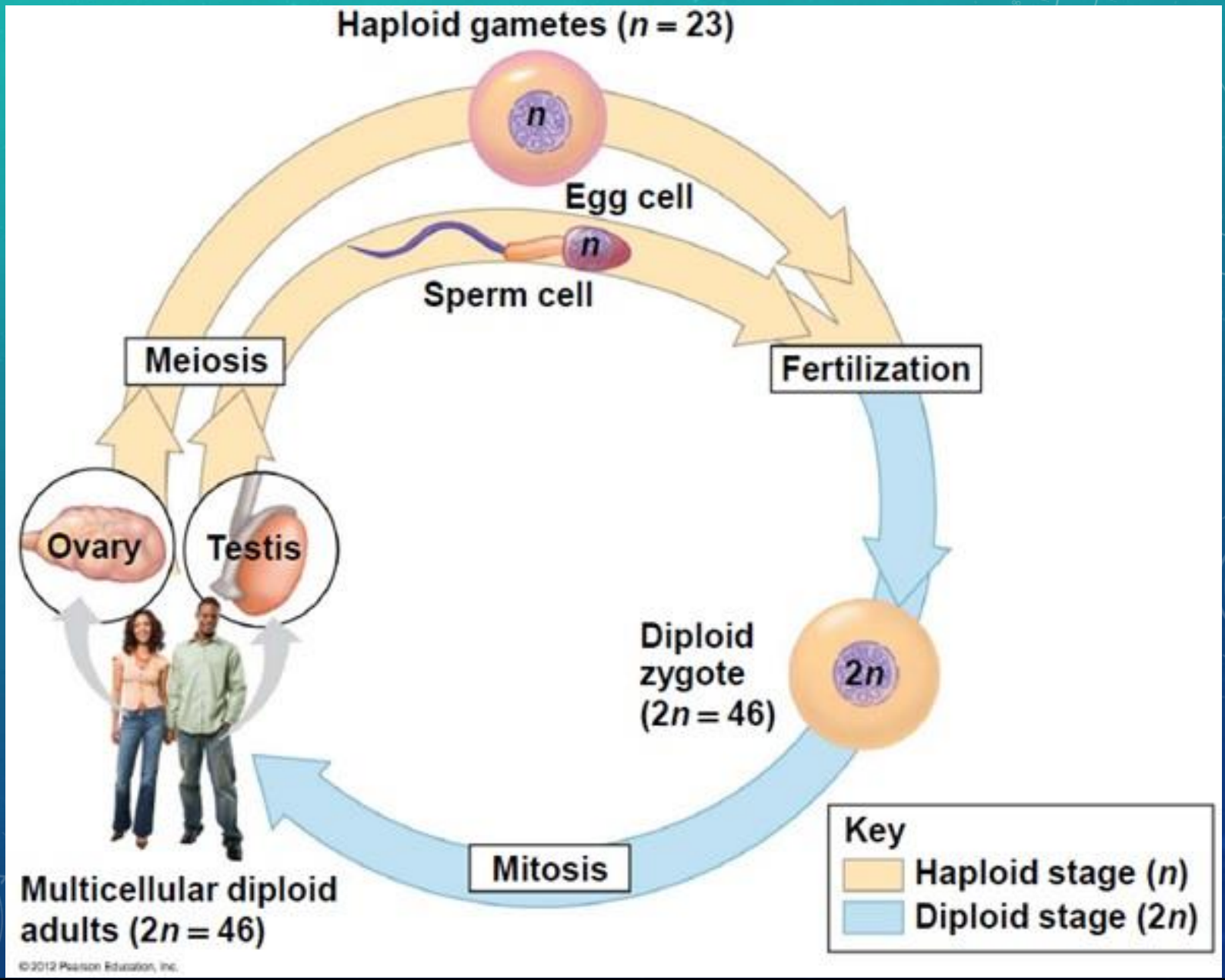
THE CREATION OF SEX CELLS!!!=SPERM OR EGG

- Our **gametes** (sex cells- either egg, or sperm) = **haploid** (1n)
  - Which means "one set" of chromosomes.

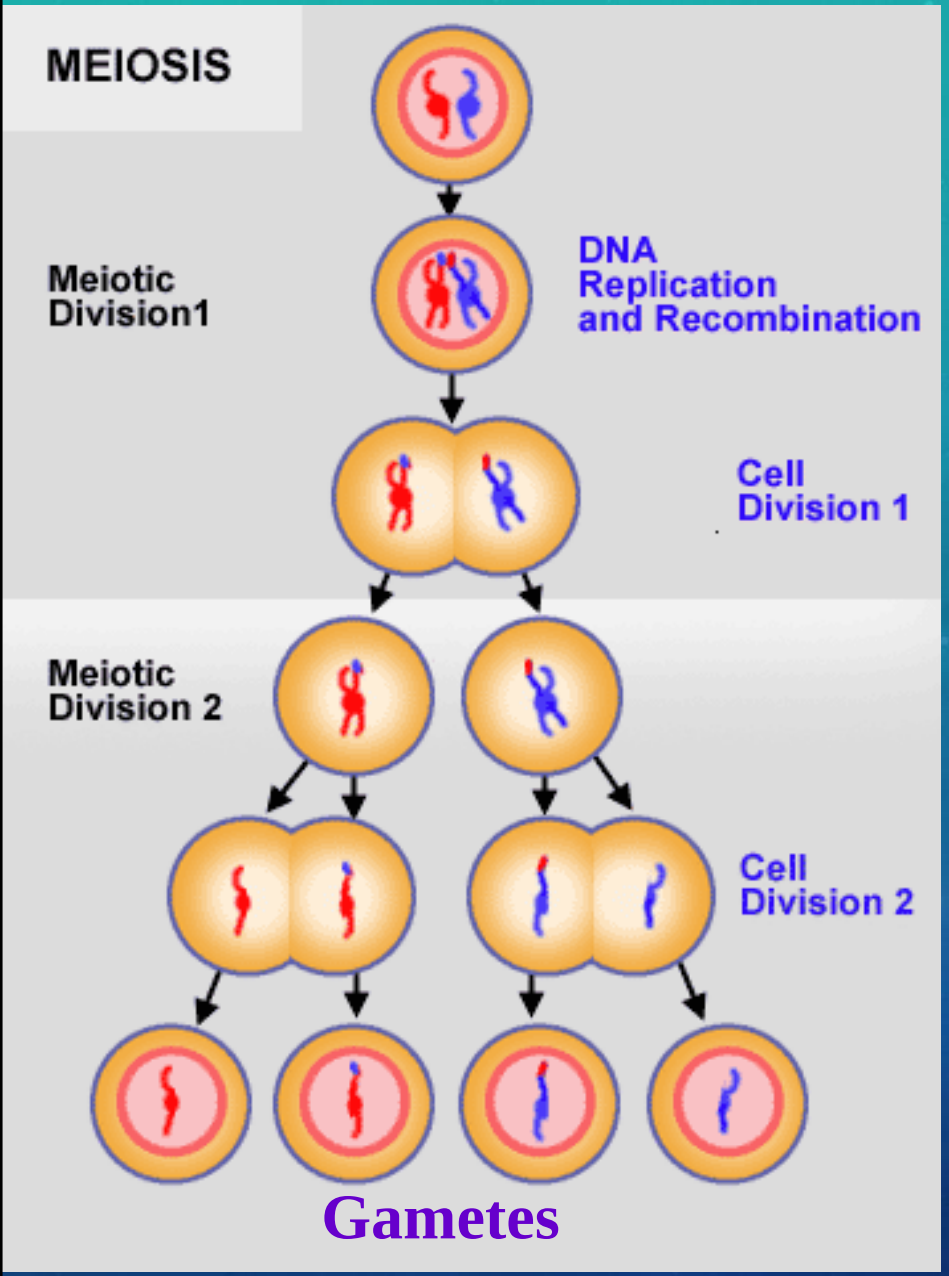
- Eggs and sperm have only 1 chromosome of each pair per cell for a total of 23.

  - Egg & sperm come together to form a **zygote** (fertilized egg)
    - -it will inherit one chromosome from each parent in **all** cells to make them **diploid**.

DIPLOID VS. HAPLOID STAGES



MEIOSIS – SEXUAL REPRODUCTION



1. DNA replication prior

2. Meiosis I:

- Prophase I: Crossing over!!!
- Metaphase I
- Anaphase I
- Telophase I

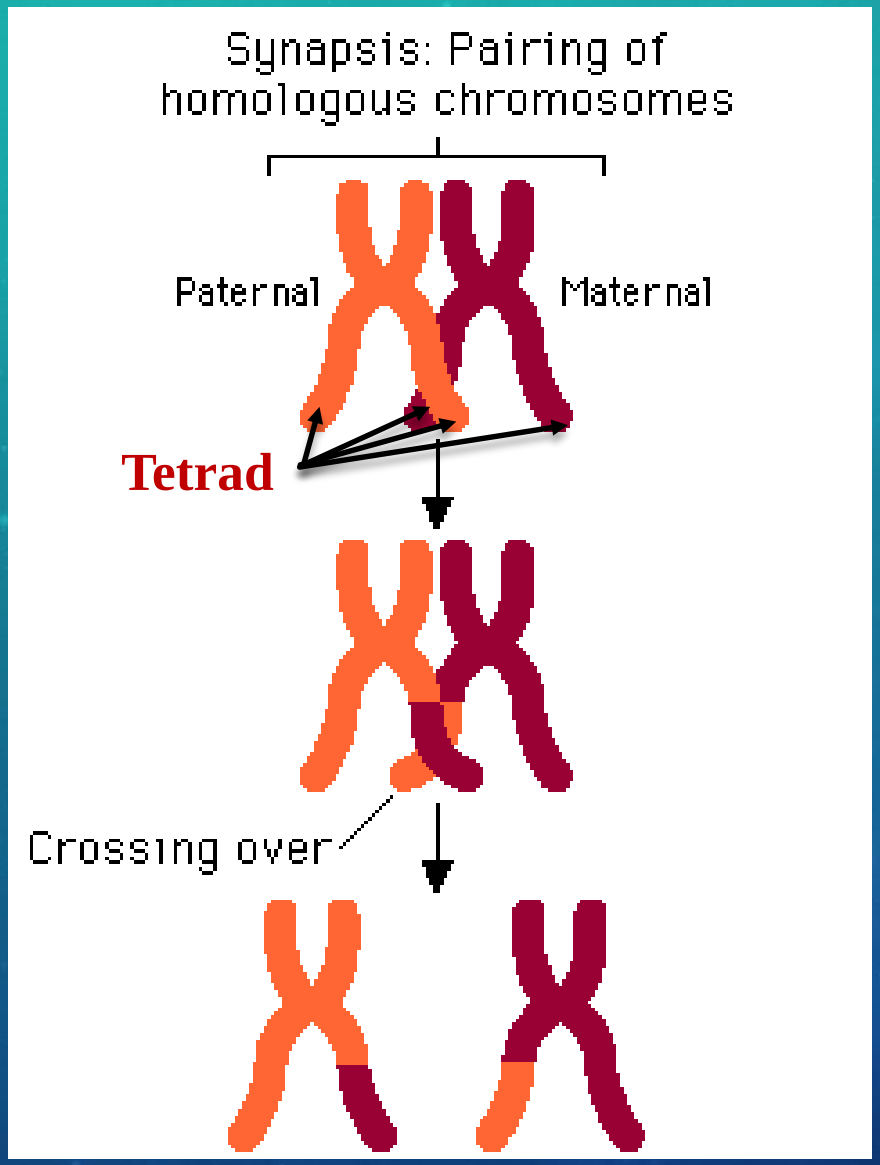
3. Replication **does not occur** between phases 1 & 2

4.Meiosis II steps similar to Mitosis

** Chromosome number is reduced by half**

- Prophase II
- Metaphase II
- Anaphase II
- Telophase II

CROSSING OVER IN MEIOSIS



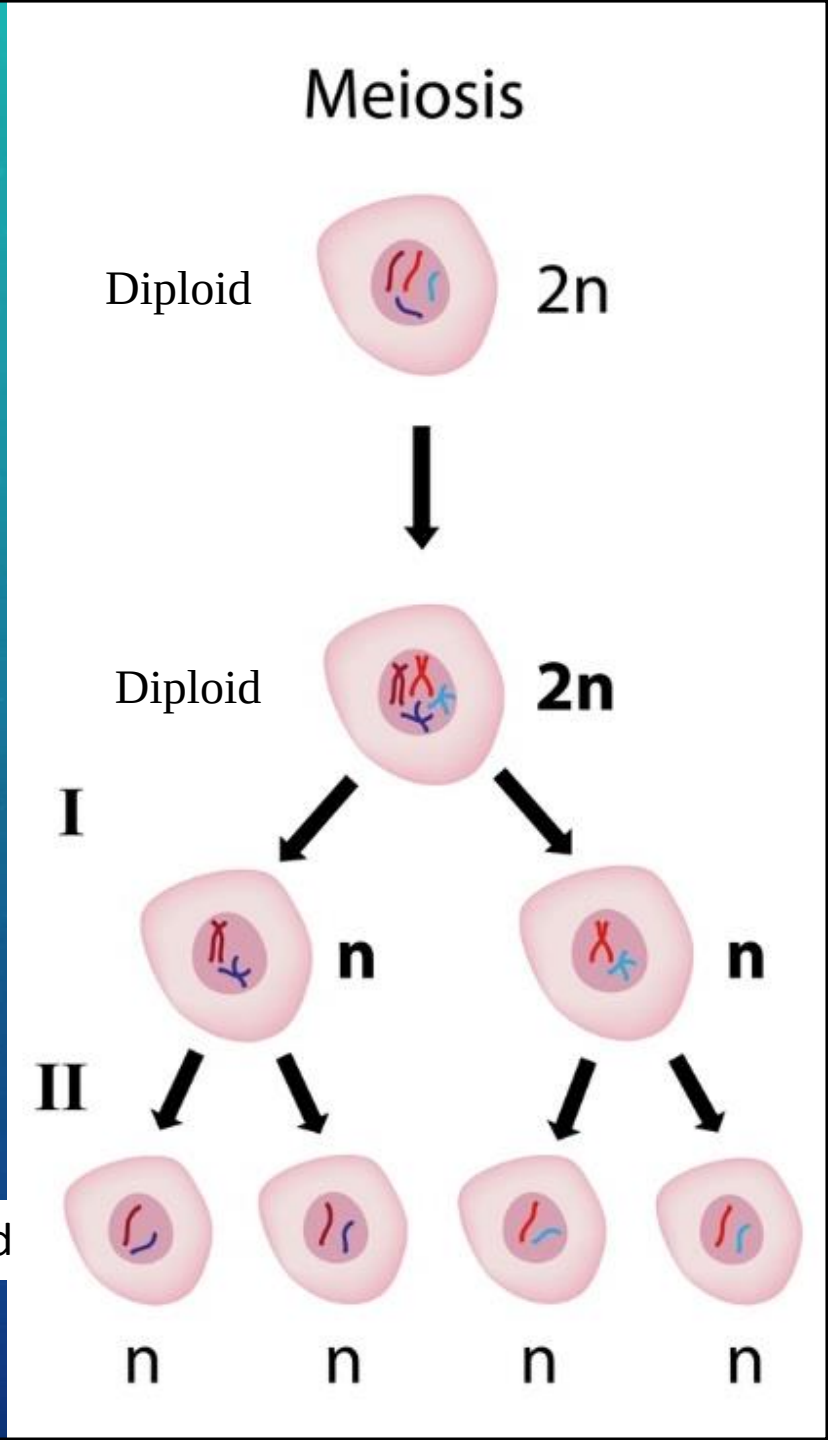
- Provides **genetic** diversity in offspring

- In **prophase I** homologous chromosomes pair up and undergo crossing-over.

- Crossing-over: the reason that genetically related people do not look or act exactly the same.

MEIOSIS

- 4 haploid cells are formed which are **genetically different** from each other
  - Haploid cell = half the # of chromosomes
  - **gamete** = sex cell

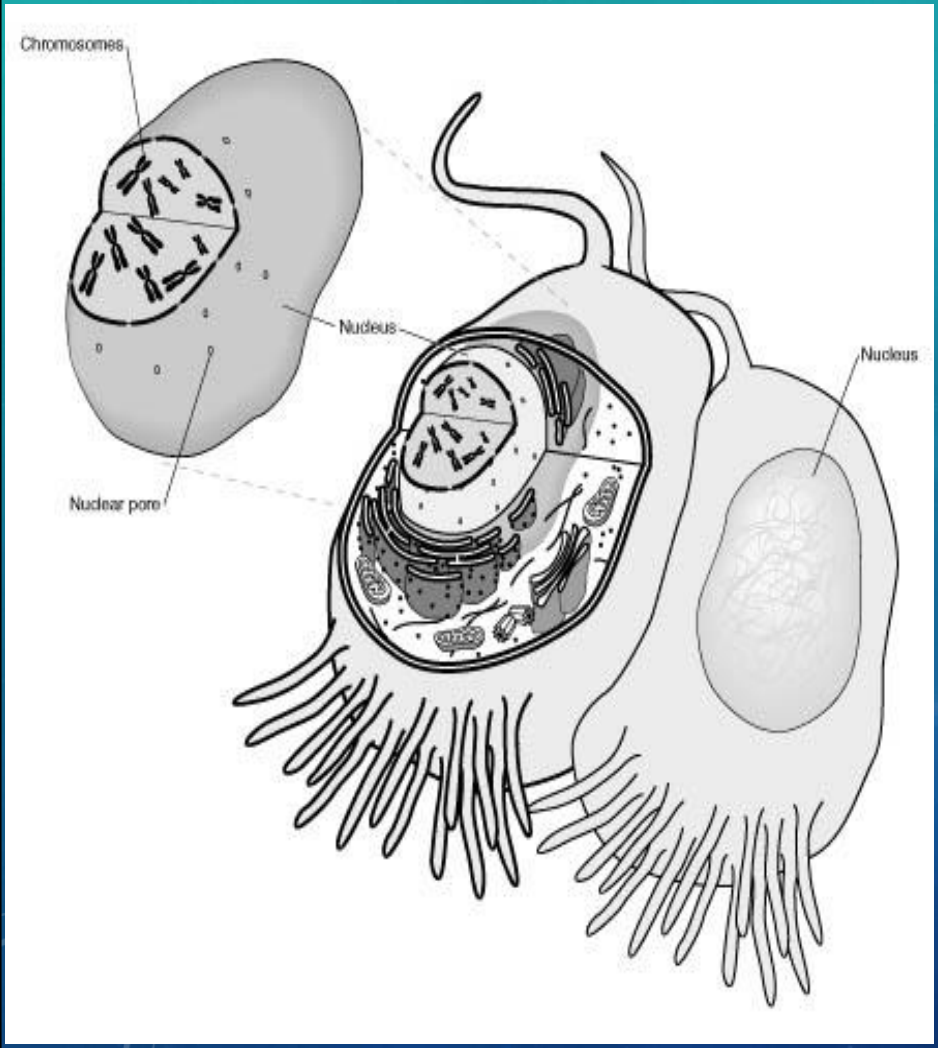


COMPARING MITOSIS & MEIOSIS & MUTATIONS

- Mitosis = makes 2 genetically **identical** DIPLOID **body (somatic)** cells (Asexual Reproduction)
  - Mutations occurring in these cells are NOT passed down to offspring
  - After these **mutated** cells undergo mitosis, the **function** of the future cells that are made may **change**

- Meiosis = makes 4 genetically **different** HAPLOID **sex (gametes)** cells (Sexual Reproduction)
  - Mutations occurring in these cells ARE passed down to offspring

CELL DIVISION/DIFFERENTIATION



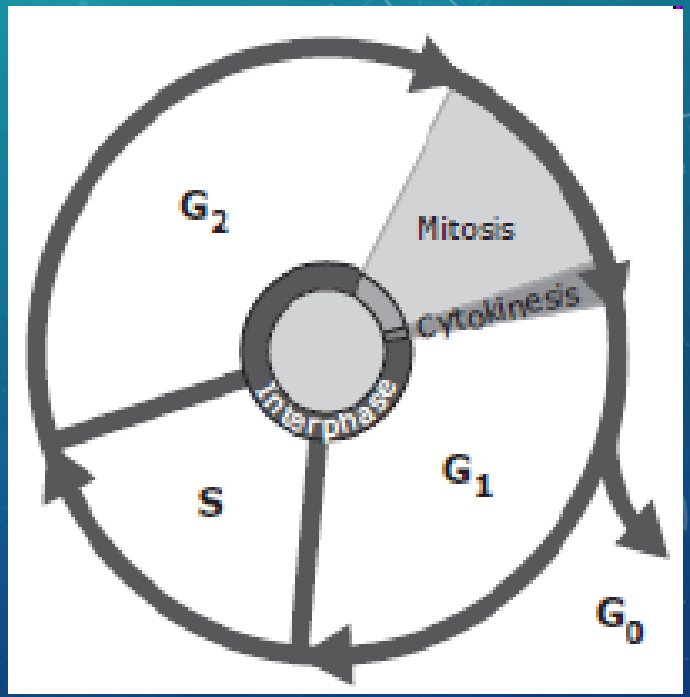
- Every cell in your body has the **SAME** DNA
  - How then, is a cell in your liver different from the cell in your heart?
    - **cells can turn genes on or off**

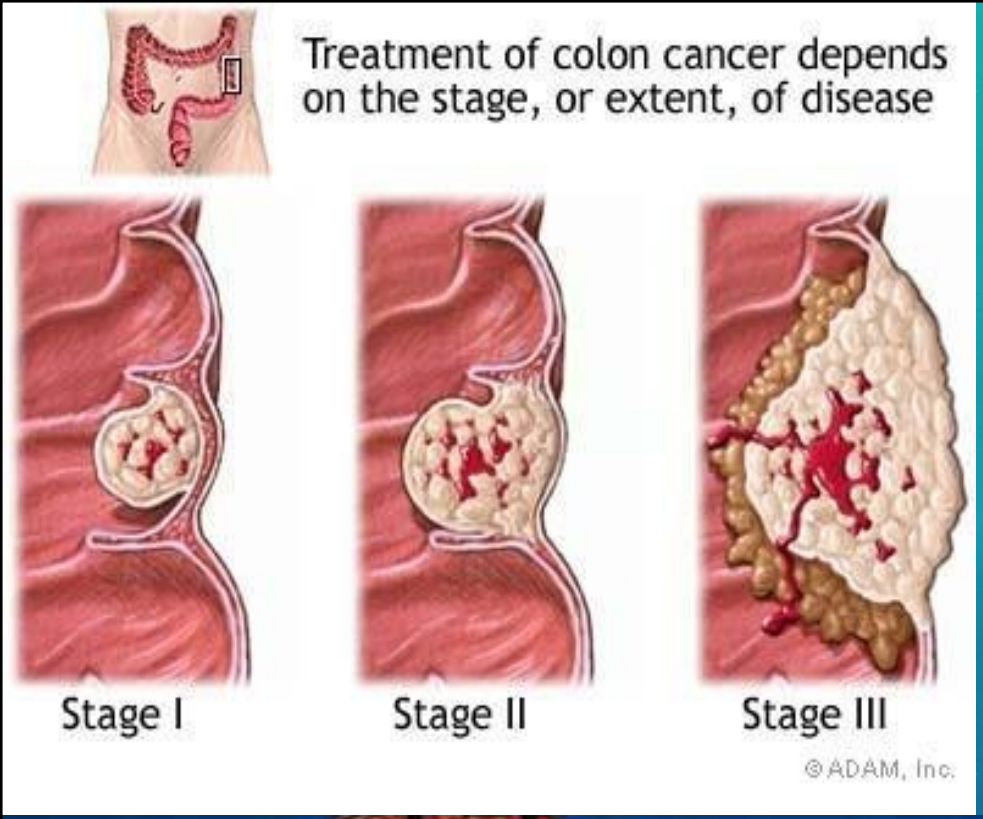
CELL DIVISION/CELL GROWTH

- Cells divide according to your body's need for those cells
- As cells **grow** & reach a certain size, they have instructions to undergo **mitosis** (cell division)
  - This ensures that the cell's **volume** and surface area are in proper proportion
    - surface area is critical for passage of food, oxygen, and water entering and leaving the cell
    - to solve the problem of getting too large, the cell **divides**

REGULATION OF THE CELL CYCLE

- When cells leave the cell cycle, they enter **G_0** phase, a **resting** period.
- Normal cells can leave G_0 and re-enter the cell cycle at G_1 phase
- **Cancer** cells are different because they **cannot** enter G_0 phase
  - this causes the cell to **repeat** the cell cycle continuously instead of "resting" in G_0





CANCER

- Cancer is uncontrolled **cell growth**
  - Cancer cells do not stop dividing when they come in contact with other cells like normal cells do
- Cancer cells do not respond to signals that regulate the cell cycle.
  - What protein regulates the cell cycle? **cyclin**
- Cancer cells form masses called **tumors**

Liver cancer at Left (metastasized)

CAUSES OF CANCER

- **Radiation** (UV) – exposure to sunlight
- Chemicals
- Carcinogens
  - Tobacco smoke
  - Air pollutants

Quick Question: How can epigenetics cause diseases like cancer?