

### Summary from Textbook

**ART CONNECTION**

Prophase	Prometaphase	Metaphase	Anaphase	Telophase	Cytokinesis
<ul style="list-style-type: none"> <li>Chromosomes condense and become visible.</li> <li>Spindle fibers emerge from the centrosomes.</li> <li>Nuclear envelope breaks down.</li> <li>Centrosomes move toward opposite poles.</li> </ul>	<ul style="list-style-type: none"> <li>Chromosomes continue to condense.</li> <li>Kinetochore appear at the centromeres.</li> <li>Mitotic spindle microtubules attach to kinetochores.</li> </ul>	<ul style="list-style-type: none"> <li>Chromosomes are lined up at the metaphase plate.</li> <li>Each sister chromatid is attached to a spindle fiber originating from opposite poles.</li> </ul>	<ul style="list-style-type: none"> <li>Centrosomes split in two.</li> <li>Sister chromatids (now called chromosomes) are pulled toward opposite poles.</li> <li>Certain spindle fibers begin to elongate the cell.</li> </ul>	<ul style="list-style-type: none"> <li>Chromosomes arrive at opposite poles and begin to decondense.</li> <li>Nuclear envelope material surrounds each set of chromosomes.</li> <li>The mitotic spindle breaks down.</li> <li>Spindle fibers continue to push poles apart.</li> </ul>	<ul style="list-style-type: none"> <li>Animal cells: a cleavage furrow separates the daughter cells.</li> <li>Plant cells: a cell plate, the precursor to a new cell wall, separates the daughter cells.</li> </ul>

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## Important Word Roots

ology	Phase	Inter	Pro	Meta	Ana	Tela
• Study of	Greek: Appearance	Between	First	After	Up/Against Or Back	Variant

<b>Mitos – Osis</b> • Wrapped Thread (greek) • Process/condition • Disease/Abnormal condition • Increase/Formation		<b>Homolog</b> • Homo = 1 • Logos = Proportional		
		<b>Onco</b>	<b>Carcin</b>	
		• Mass or tumor	• Cancer	<b>Genic</b> Creating/Causing

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Recap from Last Time:

Places Mutations get passed on:

Cell Reproduction:

- 2 types of cell reproduction:

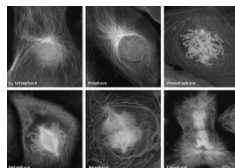
Focus of this Week:

### 1. Mitosis =

- growth, repair, asexual reproduction
- Photocopy machine
  - Growth/Repair
  - Passed on in the same body

### 2. Meiosis = sexual reproduction

- ½ of your genetics
- Gametes (egg and sperm)
- Passed on to offspring




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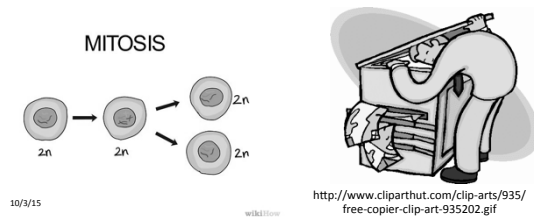
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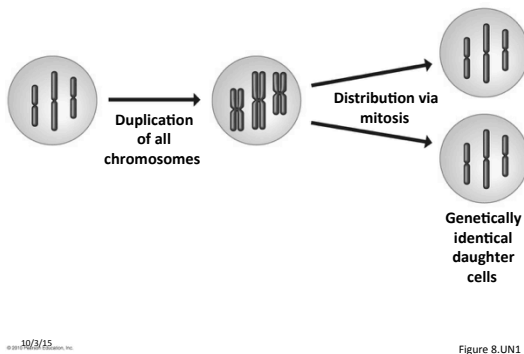
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## Functions of Mitosis

- Growth
- Repair/Maintenance
- Asexual Reproduction

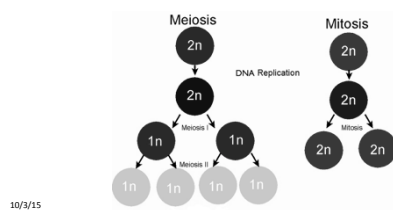


## Summary of Cell Division

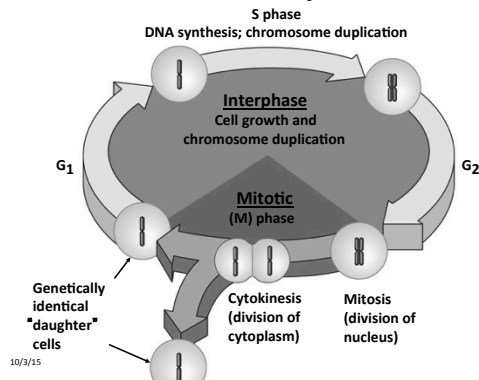


## Meiosis

- The division of the contents of the nucleus that divides the chromosomes among gametes.
  - → Makes gametes or sex cells (egg and sperm)
  - $2n \rightarrow n$  (diploid to haploid)



## The Cell Cycle




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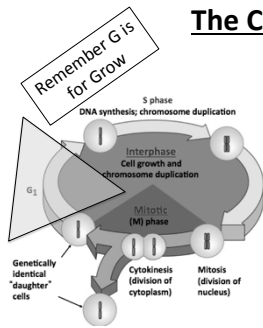
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## The Cell Cycle

### G<sub>1</sub> Phase



- **G<sub>1</sub> phase** = first gap
  - Little change is visible.
- The cell is accumulating the building blocks:
  - Chromosomal DNA
  - Associated proteins
  - Energy
- All to complete the task of replicating each chromosome in the nucleus.

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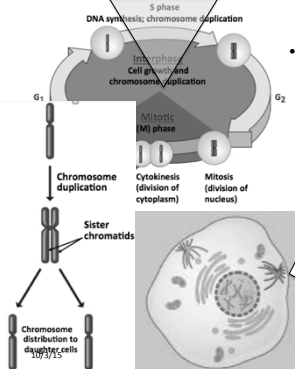
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## The Cell Cycle

### S Phase



- **S phase** = synthesis phase
  - DNA replication:
    - 2 identical copies of each chromosome—**sister chromatids**—that are firmly attached at the centromere region.
  - The centrosome is duplicated
  - The two centrosomes will give rise to the **mitotic spindle**, the apparatus that orchestrates the movement of chromosomes during mitosis.

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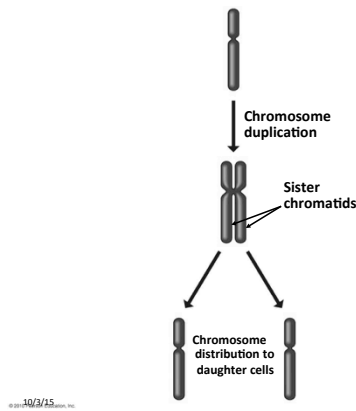
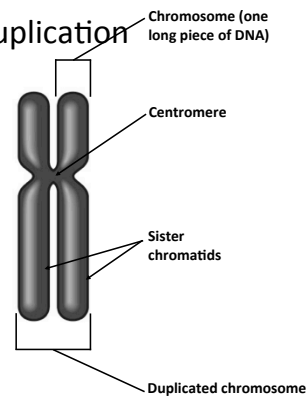


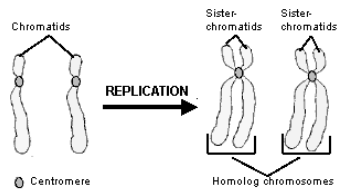
Figure 8.5

## Chromosome Duplication

- When a chromosome duplicates the result is two copies of the DNA molecule called **sister chromatids**.



## Sister Chromatids



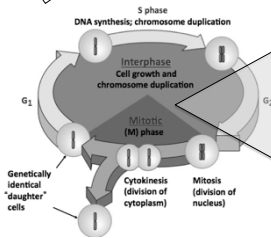
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Remember G is for Grow

## The Cell Cycle

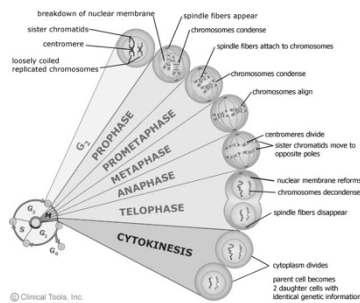
### G<sub>2</sub> Phase

- G<sub>2</sub> phase = 2<sup>nd</sup> Gap
  - The cell **replenishes** its energy stores and synthesizes the proteins
  - Some cell organelles are duplicated
  - Lots of **Growth** during G<sub>2</sub>.



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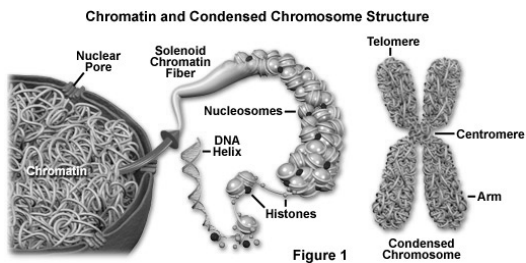
## Mitosis



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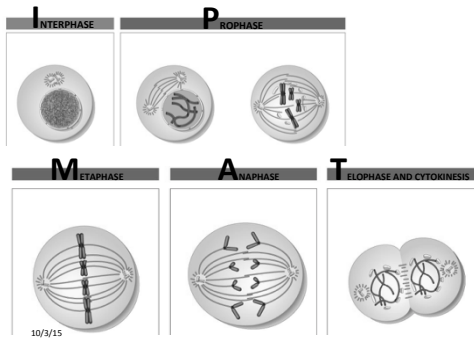
## Chromatin to Chromosome

\* condensing occurs during Prophase



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# Mitosis *I Pee on the MAT*




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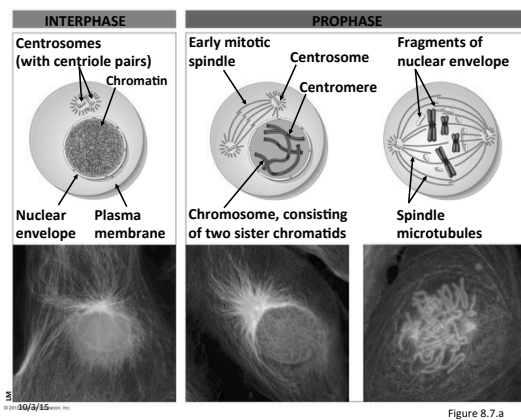
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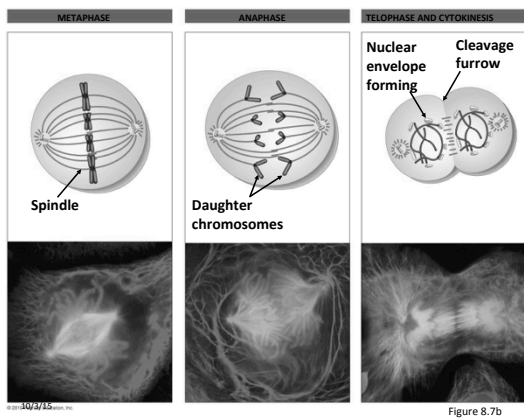
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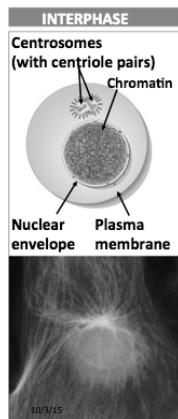
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## I Pee on the MAT Interphase

### Interphase:

- The cell undergoes **normal processes** while also **preparing for cell division**.
  - For a cell to move from interphase to the mitotic phase, many internal and external conditions must be met.
  - The three stages of interphase are called G<sub>1</sub>, S, and G<sub>2</sub>.

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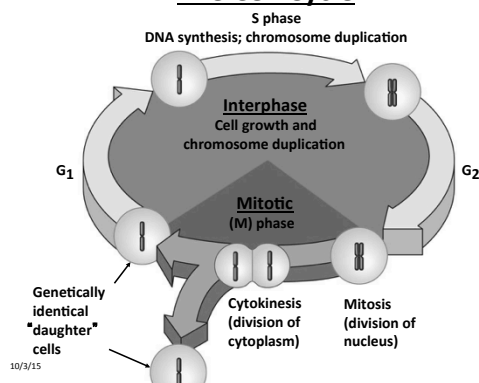
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## The Cell Cycle




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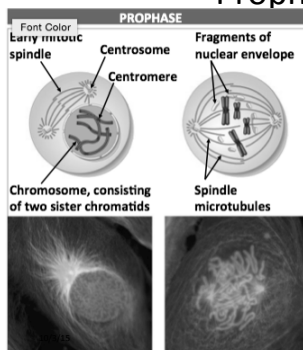
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## I Pee on the MAT Prophase



**Goal:** Gain access to the chromosomes in the nucleus.

- The nuclear envelope starts to break
- The centrosomes begin to move to opposite poles of the cell.
- The mitotic spindle extend between the centrosomes, pushing them farther apart
- The sister chromatids begin to coil more tightly and become visible under a light microscope.

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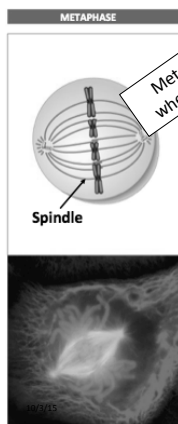
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Metaphase is where the Meet

## I Pee on the MAT Metaphase

### Prometaphase

- The remnants of the nuclear envelope disappear.
- The mitotic spindle continues to develop as more microtubules assemble and stretch across the length of the former nuclear area.
- Chromosomes become more condensed and visually discrete.
- Each sister chromatid attaches to spindle microtubules at the centromere

### Metaphase

- Chromosomes align in a plane called the **metaphase plate**, midway between the two poles of the cell.
- The sister chromatids are still tightly attached to each other.

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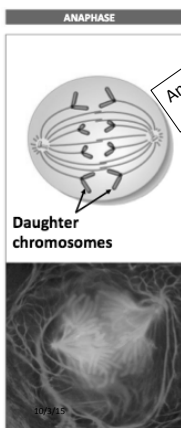
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Anaphase is where they move Apart

## I Pee on MAT Anaphase

### Anaphase

- Sister chromatids at the equatorial plane are split apart at the centromere.
- Each chromatid, now called a chromosome, is pulled rapidly toward the centrosome to which its microtubule was attached.
- The cell becomes visibly elongated as the non-kinetochore microtubules slide against each other at the metaphase plate where they overlap.

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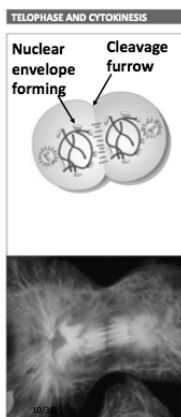
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## I Pee on the MAT Telophase

### Telophase:

- All of the events that set up the duplicated chromosomes for mitosis during the first three phases are reversed.
  - The chromosomes reach the opposite decondense (unravel).
  - The mitotic spindles are broken down into monomers
  - Nuclear envelopes form around chromosomes.

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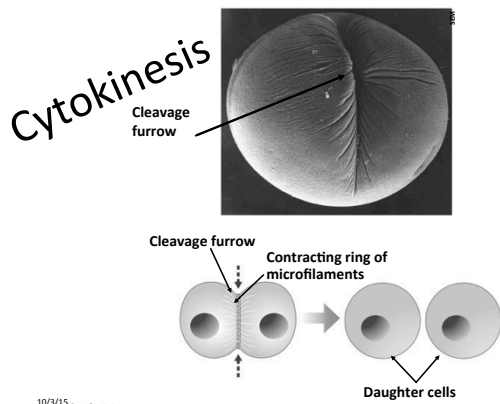


Figure 8.8a

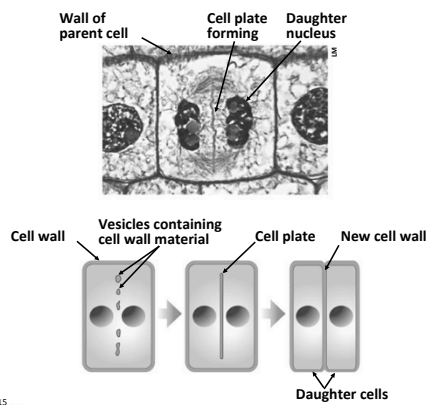


Figure 8.8b

## Section #2: Cancer

# Cancer

## What Is Cancer?

- Cancer is a disease of the cell cycle.
  - Uncontrolled cell division
- Cancer cells do not respond normally to the cell cycle control system.
  - MUTATIONS in genes for proteins that regulate cell division

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## Two types of mutations:

1. Oncogenes or (gas pedal stuck down)
2. Tumor suppressor genes (breaks don't work)

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## Oncogenes (gas pedal stuck down)

- Most **oncogenes** are **mutations of** certain normal genes called **proto-oncogenes**.
- Proto-oncogenes are the "good" genes that normally control what kind of cell it is and how often it divides.
  - When a proto-oncogene mutates into an oncogene, it can become permanently turned on or activated when it is not supposed to be.
- *Most of these mutations are acquired, a few are inherited.*

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## Tumor Suppressor Genes (breaks don't work)

- Tumor suppressor genes:
  1. Slow down cell division
  2. Repair DNA mistakes
  3. Tell cells when to die (a process known as *apoptosis*).
- The "breast cancer genes" (*BRCA1*, *BRCA2*, ) are examples of this kind of mutation
- *Most of these mutations are acquired, a few are inherited.*

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## Tumors

- Cancer cells can form **tumors**, abnormally growing mass of cells.
- **Malignant tumors** can:
  - Spread to other parts of the body
  - Interrupt normal body functions
  - Take a lots of nutrients and blood supply
- A person with a malignant tumor is said to have **cancer**.

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### Largest Tumor in the World

With a 186-pound growth, Hai is believed to have the largest tumor in Vietnam - and he's too poor to afford an operation to stop the growth.

- What is the main issue with this tumor?
  - Benign (Non-Malignant)

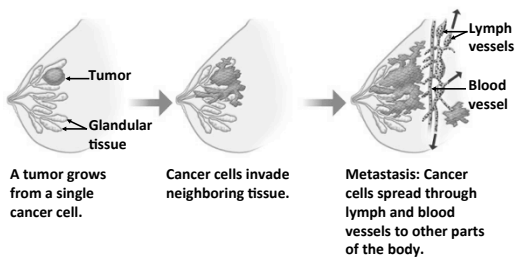
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Figure 8.9

Her condition is rare. Mutations in *BRCA1* and another gene called *BRCA2* are estimated to cause only 5 percent to 10 percent of breast cancers and 10 percent to 15 percent of ovarian cancers among white women in the United States. The mutations are found in other racial and ethnic groups as well, but it is not known how common they are.



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<http://www.nytimes.com/2013/05/15/health/angelina-jolies-disclosure-highlights-a-breast-cancer-dilemma.html?ref=opinion>

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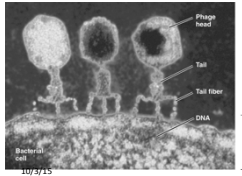
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## Viruses and Cancer

- Viruses inject their genetic material into cells
- If that material damages the regulation of cell division, it causes
  - Pap smears for HPV (human papilloma virus)
    - Causes cervical cancer
    - Most women with HPV don't get cancer
  - Great resource: <http://www.cancer.org/acs/groups/content/@editorial/documents/document/acspc-043803.pdf>



### What is cervical cancer?

Cervical cancer starts in the cells of the cervix, the part of the womb (or uterus) that opens to the vagina.




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## Cancer Treatment

- Cancer treatment can involve:
  - **Radiation therapy**, which damages DNA and disrupts cell division
  - **Chemotherapy**, which uses drugs that disrupt cell division
  - **Tumor removal:**
    - Easier with fluorescent proteins

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