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 a complete set of **genetic information** from the 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
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)

- Cleavage furrow
- Contractile ring of microfilaments
- Daughter cells

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

- Vesicles forming cell plate
- Wall of parent cell
- Cell plate
- New cell wall
- Daughter cells
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**)

![Diagram of a tumour forming with cancer cells dividing and normal cells]
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.

- Lung and bronchus: 1,335,000 (males) / 3,135,000 (females)
- Stomach: 1,400,000 (male) / 2,315,000 (female)
- Colon and rectum: 1,650,000 (male) / 3,010,000 (female)
- Liver: 650,000 (male) / 765,000 (female)
- Breast: 7,995,000 (female)
- Esophagus: 520,000 (male) / 615,000 (female)
- Mouth and pharynx: 805,000 (male) / 2,005,000 (female)
- Prostate: 1,280,000 (male) / 1,460,000 (female)
- Lymphoma and myeloma: 880,000 (male) / 685,000 (female)
- Leukemia: 485,000 (male) / 1,850,000 (female)
- Uterine cervix: 1,425,000 (female)
- Urinary bladder: 725,000 (male)
- Ovary: 535,000 (female)
- Kidney: 1,655,000 (male)
- Uterus: 385,000 (female)
- Melanoma: 530,000

The Immortal Life of Henrietta Lacks

http://www.youtube.com/watch?v=wRrNjHYxP_o
http://www.bbc.co.uk/blogs/adamcurtis/2010/06/the_undead_henrietta_lacks_and.html
<table>
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<th>Chromosome Appearance &amp; Location</th>
<th>Important Events</th>
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<td>Interphase</td>
<td>DNA copies itself; chromatin</td>
<td>DNA replication, cell grows and replicates organelles</td>
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<tr>
<td>Prophase</td>
<td>Chromosomes coil up</td>
<td>Nuclear envelope disappears, spindle fibers form</td>
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<td>Chromosome copies divide and move apart</td>
<td>Spindle fibers pull chromosome copies apart to opposite poles</td>
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<td>Telophase</td>
<td>Chromosomes uncoil back into chromatin</td>
<td>Nuclear envelopes reform, 2 new nuclei are formed, spindle fibers disappear</td>
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<tr>
<td>Cytokinesis</td>
<td>Chromatin</td>
<td>Division of the rest of the cell: cytoplasm and organelles</td>
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