Unit 2 - Cell Structure and Function

amoeba, light micrograph
Cell Theory - Early Contributions

Cell Scientists

Hooke – first to see cells; named them

Leeuwenhoek – first to determine cells were alive
Cell Theory - Early Contributions

Schleiden – plants are made of cells

Schwann – animals are made of cells

Virchow – cells come from cells
The Cell Theory

1. All life is made of cells
2. The cell is the basic unit of life.
3. All cells arise from pre-existing cells.
4. Cells contain DNA and pass this DNA to offspring.
5. Cells are based on the same four classes of macromolecules.
6. Cells use energy.

Why is the Cell Theory called a Theory?
Cell Size Comparison (smallest to largest) -  
Atoms → DNA → Virus → PROKARYOTIC CELL (Bacteria) → Mitochondria → EUKARYOTIC CELL
Why must Cells be small?

- Cells are small because they must have a large surface area to volume RATIO in order to transport material efficiently.
  - Surface area is the area around the outside of the cell.
  - Volume is amount of space the cell takes up.
  - The higher the surface area AS COMPARED TO the volume, the better.
Figure 4.3

<table>
<thead>
<tr>
<th></th>
<th>One 4-cm cube</th>
<th>Eight 2-cm cubes</th>
<th>Sixty-four 1-cm cubes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total surface area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(height × width × number of sides × number of cubes)</td>
<td>96 cm²</td>
<td>192 cm²</td>
<td>384 cm²</td>
</tr>
<tr>
<td><strong>Total volume</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(height × width × length × number of cubes)</td>
<td>64 cm³</td>
<td>64 cm³</td>
<td>64 cm³</td>
</tr>
<tr>
<td><strong>Surface area: Volume per cube</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(surface area ÷ volume)</td>
<td>1.5:1</td>
<td>3:1</td>
<td>6:1</td>
</tr>
</tbody>
</table>
Single Cheek Cell - at different illuminations

**Bright-field.** Light passing through the specimen is brought directly into focus. Usually, the low level of contrast within the specimen interferes with viewing all but its largest components.

**Bright-field (stained).** Dyes are used to stain the specimen. Certain components take up the dye more than other components, and therefore contrast is enhanced.

**Differential interference contrast.** Optical methods are used to enhance density differences within the specimen so that certain regions appear brighter than others. This technique is used to view living cells, chromosomes, and organelle masses.

**Phase contrast.** Density differences in the specimen cause light rays to come out of "phase." The microscope enhances these phase differences so that some regions of the specimen appear brighter or darker than others. The technique is widely used to observe living cells and organelles.

**Dark-field.** Light is passed through the specimen at an oblique angle so that the objective lens receives only light diffracted and scattered by the object. This technique is used to view organelles, which appear quite bright against a dark field.
ALL CELLS HAVE:

1. Cell Membrane made of a Phospholipid Bilayer and embedded with proteins/carbohydrates
2. Genetic Material – DNA and RNA

3. Cytoplasm (cytosol) – aqueous jelly that fills the cell

Note: In Eukaryotes, organelles float within cytoplasm and perform specific functions.
Cell Type - Prokaryotic Cells

Example: Bacteria
(Copy definition for and add the following to your notes)

**Sex Pilus, Nucleoid, Glycocalyx**
Eukaryotes –
Examples: Plants, Protists, Fungi, Animals
Cell Evolution

Endosymbiotic theory: - Mitochondria & Chloroplasts have their own DNA, so they may have existed independently at one time; this is probably how eukaryotes evolved from prokaryote ancestors
i_am_vorticella, parameciuhwhut, euglinda, wutupstentor, foxyvolvoxy

phoebeamoebe Afternoon #cellifie, but couldn’t get all my pseudopods in the picture LOL! #ohwell #amoebaproblems

katie_the_beatrice  Aww, so cute!
Quick Recap......

1. What are the two main types of cells?

2. Which one is larger?

3. Which one does not have a membrane bound nucleus?

4. What are the three main parts of the cell (that all cells have)?

5. What are the 6 components of the cell theory?

6. What theory explains how eukaryotes evolved?
The Parts of the Cell

- **Nucleus**
  - nuclear pore
  - chromatin (DNA)
  - nucleolus
  - nuclear envelope
- **Flagellum**
- **Centriole**
- **Intermediate filaments**
- **Plasma membrane**
- **Golgi complex**
- **Vesicle**
- **Rough endoplasmic reticulum**
- **Ribosome**
- **Lysosome**
- **Microtubules**
- **Smooth endoplasmic reticulum**
- **Free ribosome**
- **Mitochondrion**
- **Cytoplasm**
The Nucleus

-- nuclear envelope (2)
-- chromatin (A)
-- nucleolus (1)
I am a reticulated python. Ask me what I have to do with the endoplasmic reticulum.
Endoplasmic Reticulum - In Cell Transport and Protein (rough) and lipid (smooth) assembly
Golgi Apparatus (8)
- out of cell delivery system

Cisternae (folds) (11)

Vesicles - package to be delivered (12); made of the same phospholipid bilayer as the membrane, so they smoothly combine to release materials outside of cell (exocytosis)
Ribosomes - Sites of Protein Synthesis

Each ribosome has a large and small subunit

Messenger RNA is threaded through the ribosomes

Transfer RNA builds a polypeptide chain (protein primary structure) based on the code of the mRNA
Lysosomes - Intracellular Digestion Centers
- New function for AP: “suicide sacs” - apoptosis

**TAY-SACHS disease** – What do lysosomes have to do with this deadly disease? (Answer is on the next slide)
Inside a nerve cell

Cells in healthy children
In a healthy child, a lipid, or fat, called GM2 ganglioside enters the nerve cell as a source of food. Among the components of the cell are lysosomes, which might be thought of as the “stomachs” of the cell. They contain an enzyme called Hexosaminidase A, or Hex-A, that digests the GM2.

GM2 enters the lysosome ... ... where it is engulfed ... ... and digested by the Hex-A.

Cells in children with Tay-Sachs disease
Children with Tay-Sachs lack Hex-A, so the GM2 proliferates to such a degree that it eventually kills the cell, gradually shutting down the central nervous system. If Hex-A enzyme is not present ... ... GM2 accumulates ... ... and in time choking the cells.

Diagrams not to scale

SOURCES: University Hospitals; The National Tay-Sachs & Allied Diseases Association; healthnine.com; howstuffworks.com

REID BROWN | THE PLAIN DEALER
Other Organelles

-- **Peroxisomes** – break down hydrogen peroxide by the enzyme catalase
-- **Vacuole** -- mainly storage or specific functions (New for AP: contractile vacuole in small aquatic single-celled organisms to control excess water; large central vacuole in plants)
-- Plant cells have a **CENTRAL VACUOLE** - used for storage and help to maintain hydrostatic pressure (prevent wilting)
Energy Related Organelles

Mitochondria - The Cell's energy factories, produce ATP through respiration and the break down of carbohydrates (Plants and Animals)

Chloroplasts - Where Photosynthesis takes place to create carbohydrates (Plants only)

What do these organelles have in common? (lots of internal membranes, similar size/shape, their own DNA- endosymbionts)
What happens if your mitochondria don’t work?

How would mitochondrial disease affect you?

Consider the mitochondria have their own DNA separate from the parental DNA. How could you cure this disease?
Cytoskeleton

How do cells maintain their shape?

Microfilaments (actin filaments)
Microtubules - form the spindle during cell division
Centrioles – used during cell division to move and separate chromosomes, only found in animal cell

Cellular Movement

- pseudopod – cytoplasm extensions; “fake feet”
- cilia
- flagella
Mini Quiz

1. What part of the cell produces vesicles for export?

2. What part of the cell makes proteins?

3. What part of the cell produces ATP?

4. What part of the cell transports materials throughout the cytoplasm, but not out of the cell?
Can you describe this process in 10 words or less?