Review of the Cell and Its Organelles

Tips for most effective learning of this material:

Memorize the names and structures over several days. This will help you retain what you're learning. Cramming often leads to forgetting all the information before the test.

Learn the names and functions of all the organelles before trying to draw them. Once you know their functions, what the organelles look like and where they are in the cell can almost be guessed based on what you've learned.

Make sure that you understand the information in your text, rather than just memorizing specific phrases. Instructors often use different wording on tests to make sure students understand the material.

Prepare for tests by labelling organelles on many different diagrams. Some students get confused on tests when they're presented with a cell diagram that's different than the one they've been studying. Practice working with diagrams from several different textbooks.

Look for organelle characteristics that different diagrams have in common (e.g. ribosomes are small dark dots on the rough endoplasmic reticulum and in the cytosol), rather than memorizing something that might change with the artist (ribosomes are purple, next to the Golgi apparatus). Some of this identifying information is included in the descriptions below.

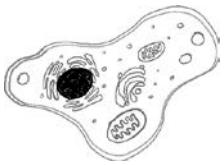
Organelles found in <u>both</u> animal and plant cells:

The **cell membrane** (or **plasma membrane**) is the 'skin' that surrounds the entire cell. This porous membrane is made of a double layer of phospholipids (phospholipid bilayer). The membrane allows the passage of nonpolar and small uncharged polar molecules via diffusion, while other larger polar molecules and ions are able to enter the cell through specialized pores that shuttle solutes through the bilayer. Organelles such as the endoplasmic reticulum and Golgi also have a membrane surrounding them.

Cytosol is the liquid inside the cell. Everything inside the cell that isn't an organelle or protein is cytosol.

Cytoplasm is everything inside the cell that isn't the nucleus. Both organelles and the cytosol make up the cytoplasm.

"Organelles" is the general name for the various structures inside the cytoplasm. Each type of organelle has a specific function.

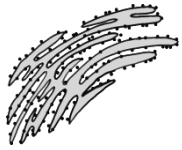


The **nucleus** is the control centre and source of genetic information for the cell. By using the the genetic information, proteins can be produced which controls the cell's functioning. The nucleus is almost always near the centre of the cell.

Chromatids are long sequences of genetic information in the form of DNA. In a resting cell, these long strings of information aren't visible in the nucleus. As the cell prepares to divide, the chromatids coil up to form **chromosomes**, which are visible with a microscope in a stained cell.

The **nucleolus** is the dark area in the centre of the nucleus. Among other functions, the nucleolus makes ribosomes.

The endoplasmic reticulum (ER) is attached to the nucleus by its membranes. The ER is divided into two parts: the **smooth endoplasmic reticulum** (smooth ER) and the **rough endoplasmic reticulum** (rough ER). The smooth ER releases lipids, such as hormones, that are used both in the cell and in neighbouring cells. The rough ER looks rough because it is studded with ribosomes, and functions in making proteins.

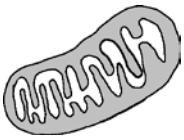


Ribosomes synthesize (make) proteins from amino acids. Ribosomes are comprised of two subunits: a large and a small subunit. Ribosomes are found on the rough ER, inside the nucleus, and also in the cytoplasm.

The **Golgi apparatus** modifies proteins by adding signalling sugars onto the surface of the proteins. This process is called post-translational modification. The Golgi is usually found next to the rough ER; however Golgi have their own membranes. (Note: The Golgi apparatus is always capitalized because it is named after a person.)

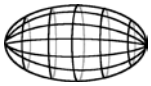
For a protein to be modified, it must get to the Golgi apparatus. The protein arrives at the Golgi inside a small vesicle called a **transport vesicle**. The transport vesicle fuses with the membrane of the Golgi and releases the unmodified protein into the Golgi. The protein then gets modified as it travels through the Golgi. Once the protein is modified, it leaves the Golgi. Part of the Golgi membrane pinches off with the modified protein inside. The contents of the vesicle are ready for use by other organelles within the cell,

or for export outside of the cell via exocytosis. **Exocytosis** is where a secretory vesicle fuses with the cell membrane and its contents are released outside of the cell.



The **mitochondria** (sing., **mitochondrion**) are often called the powerhouses of the cell since they use the chemical energy from sugars, proteins, and fats to make the energy for the cell to do its various metabolic tasks. The main molecule that provides chemical energy is adenosine tri-phosphate (ATP).

Peroxisomes are special types of vesicles that contain oxidative enzymes which break down fatty acids, some amino acids, and toxic hydrogen peroxide. While peroxisomes look similar to lysosomes, they are generally bigger than lysosomes. Peroxisomes are found near mitochondria and chloroplasts, while lysosomes can be found anywhere in the cell.



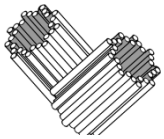
The **cytoskeleton** is the structure that gives a cell shape, holds organelles in place, and lets parts of the cell move. It is comprised of microfilaments, intermediate filaments, and microtubules.

Microfilaments (or actin filaments) allow the contraction and expansion of a cell, which allows cells to move in space. Microfilaments are the smallest and thinnest component of the cytoskeleton.

Intermediate filaments hold the organelles in place within the cytosol and anchor the nucleus in place. They are thicker than microfilaments, and thinner than microtubules.

Microtubules are the thickest structure in the cytoskeleton, and create a 3-D lattice within the cell that allows organelles to move within the cell.

Organelles found in <u>many</u> animal cells:



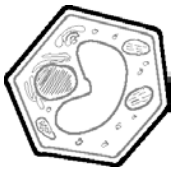
Centrioles organize the spindle during cell division. They consist of 9 groups of microtubules; each group has three microtubules. Therefore there are 27 microtubules in one centriole. Centrioles are always arranged perpendicular to each other.

Lysosomes are the recycling crew of the cell. They contain hydrolytic enzymes which break nutrient particles into smaller pieces so that other organelles can use these fragments as a source of energy. They destroy bacteria and organic debris that enter the cell from the extracellular fluid. Lysosomes also break down damaged organelles, freeing their components for re-use. Lysosomes can be found it some plant cells but this is rare because the central vacuole fulfill the recycling function in plant cells.

A **flagellum** is a bundle of microfilaments projecting out of the cell, creating a structure that looks like a tail. When this structure contracts, the cell is able to propel itself. Flagella are anchored to the cell at **basal bodies**.

Cilia are very similar in structure to the flagella, but they tend to be shorter, and are usually found in groups on the cell surface. In single-celled organisms, cilia can be used to move the cell. In the human body, cilia is used to move substances across the cell surface (e.g. Cilia can be found on cells lining the trachea. These cells help to move mucus and trapped particles away from the lungs).

Organelles found only in plant cells:



The **cell wall** surrounds the outside of a plant's cell membrane, and also attaches cells to their neighbours. The wall is made of cellulose, a glucose polymer that is quite rigid. The cell wall gives plant cells shape and structure – this is why plant cells tend to have straighter sides than animal cells. The cell wall prevents the cells from bursting when too much water is available (e.g. rainy seasons). This pressure that water puts on the cell wall is called turgor pressure.

Plants use **chloroplasts** to turn sunlight into CO_2 which is then used to create food (glucose) for themselves. Chloroplasts also give plants their green colour. They look like flat stacks of disks.

The **central vacuole** is always near the middle of the cell. Plants store water and other materials in these storage tanks, keeping them separate from the cytosol. Central vacuoles perform the same functions as a lysosome, breaking down nutrients and organelles into useable energy components.

Review Questions:

1. Match the cell parts in the first column with the descriptions in the second column. Each cell part and description should be used only once.

Cell Structure	Description
A. Ribosome	____ Anchors organelles, holds nucleus in place
B. Golgi apparatus	____ Released by the Golgi apparatus, travels to the surface
C. Nucleolus	of the cell to release its contents
D. Microtubules	____ Synthesizes proteins
E. Cell membrane	____ Where ribosomes are made
F. Rough ER	____ Controls cell function and site of DNA storage
G. Centriole	____ Allows movement of organelles within the cell
H. Transport vesicles	____ Shuttles proteins between organelles
I. Mitochondrion	____ Provides storage of water, chemicals, and wastes in
J. Flagella	plant cells
K. Nucleus	____ Controls passage of molecules in and out of the cell
L. Smooth ER	____ Where proteins are made
M. Cell wall	____ Organizes the spindle in cell division
N. Lysosome	____ Converts solar energy to useable cell energy
O. Microfilament	____ Allows contraction and movement of cells
P. Chloroplast	____ Allows the cell to move in space
Q. Central vacuole	____ Synthesizes and transports lipids
R. Chromosome	____ Shapes plant cells
S. Intermediate	____ Modifies and exports proteins
filaments	____ Converts the energy from nutrients into ATP
T. Organelle	____ Digests food vacuoles and damaged organelles
U. Secretory vesicles	____ Stores genetic information, located in nucleus
	____ General name for structures in the cytoplasm

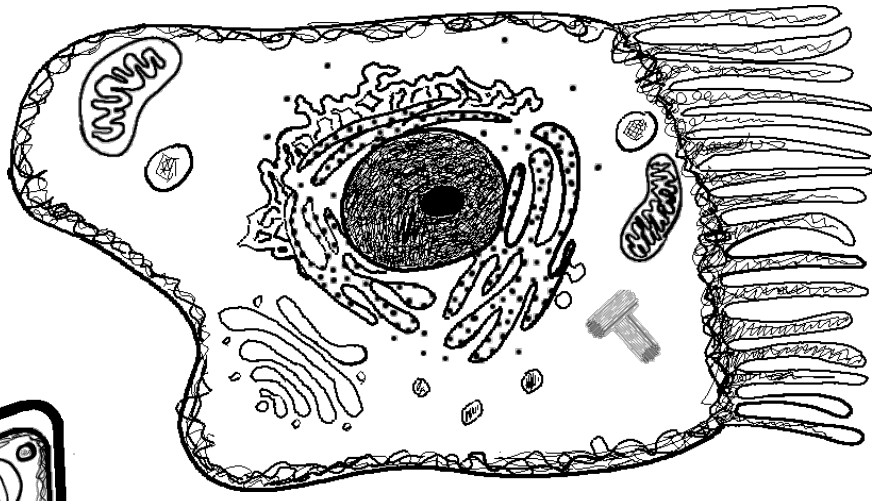
2. List seven differences between plant and animal cells.

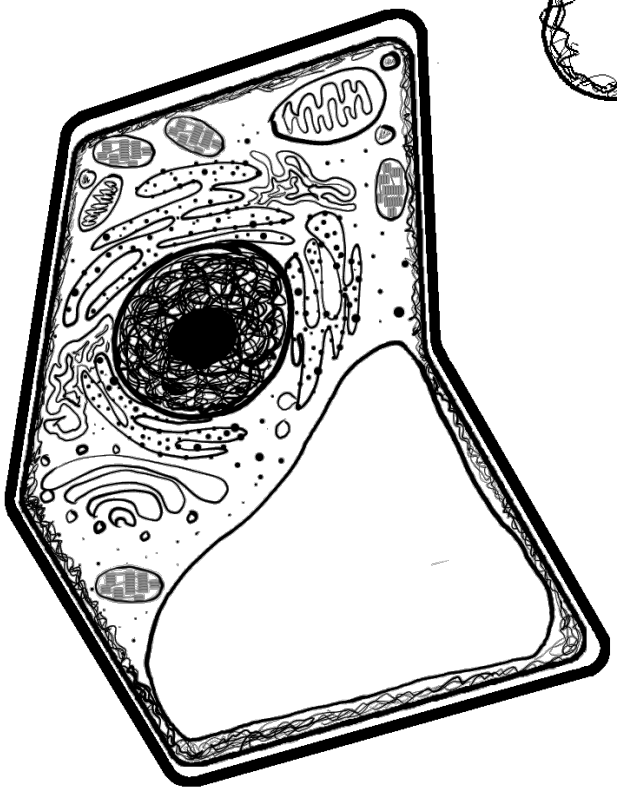
3. Describe the steps by which a protein is first synthesized, and then exported by a cell.

4. Is the plasma membrane the outer boundary of all cells?

5. How might it benefit an organism to have the nucleus near the centre of its cells?

6. Label all the major structures in each of the following diagrams. Can you determine which cell is the plant cell and which cell is an animal cell?





Answers:

1.

S	Anchors organelles, holds nucleus in place
U	Released by the Golgi apparatus, travels to the surface of the cell to release its contents
A	Synthesizes proteins
C	Where ribosomes are made
K	Controls cell function and site of DNA storage
D	Allows movement of organelles within the cell
H	Shuttles proteins between organelles
Q	Provides storage of water, chemicals, and wastes in plant cells
E	Controls passage of molecules in and out of the cell
F	Where proteins are made
G	Organizes the spindle in cell division
P	Converts solar energy to useable cell energy
O	Allows contraction and movement of cells
J	Allows the cell to move in space
L	Synthesizes and transports lipids
M	Shapes plant cells
B	Modifies and exports proteins
I	Converts the energy from nutrients into ATP
N	Digests food vacuoles and damaged organelles
R	Genetic information storage, located in nucleus
T	General name for structures in the cytoplasm

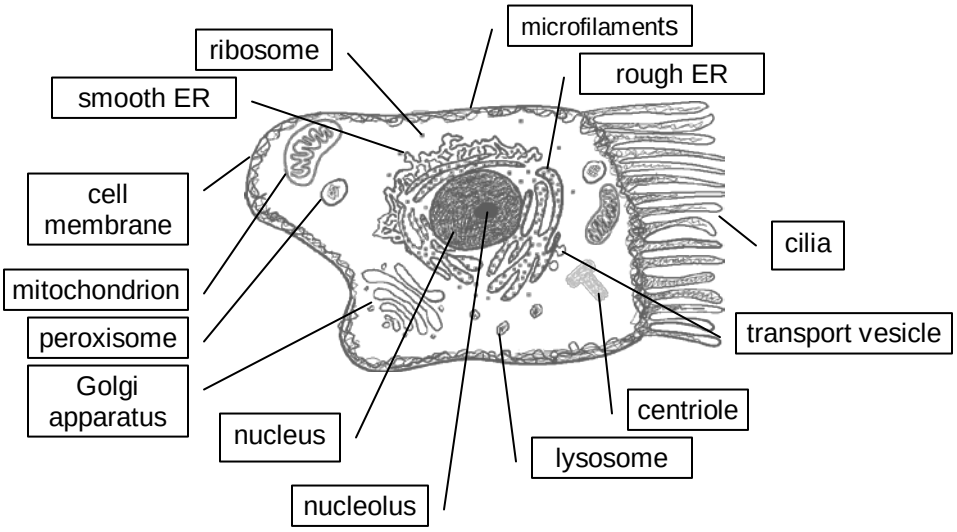
2. Plant cells have central vacuoles, chloroplasts, and cell walls, which animal cells do not. Animal cells have centrioles and lysosomes, and can have flagella and cilia, which plant cells do not.

3. Simplified process for protein synthesis:
   i. Ribosomes synthesize the protein in the nucleus and/or the rough ER.
   ii. As it is synthesized, the protein is directed through the membrane and into the rough ER.
   iii. The protein exits the rough ER in a transport vesicle.
   iv. The protein travels to the Golgi apparatus, enters, and gets further modified.
   v. The protein is released from the Golgi apparatus in a vesicle, and travels to other organelles for use, or to the cell membrane for exocytosis.

4. No – plant cells have a cell wall beyond the plasma membrane. Several other types of cells also have different structures beyond their cell walls.

5. By being in the centre of the cell, the nucleus is protected by the cell membrane and the space between the outside of the cell and the nucleus. The distance from the nucleus to other organelles in the cell is also minimized by having the nucleus in the centre.

6. Animal cell:



Plant cell: