

UNIT III STUDY GUIDE FOR BIO 156

For the third exam, 1) write out responses to all of the objectives and questions, 2) do the self-tests on the web for practice and extra credit points. Expect multiple choice, fill-ins, and short answer / essay questions on the lecture exam. PLEASE see me if you have any questions or problems. Study hard!

CHAPTER 4: A Tour of the Cell (introduction to cell structure and function)

For Exam III, you should be able to answer the following:

Objectives:

1. List the principles of Cell Theory.

Cells are the smallest living units, all living things have one or more cells, cells come from pre-existing cells

2. Name the 3 Domains of Life and briefly describe the types of organisms in each.

Domain Bacteria contains the bacteria. Domain Archaea contains the archaeans. Both of these Domains contain organisms with prokaryotic cells. Domain Eukarya contains the eukaryotes, including plants, animals, fungi, and protists (single-celled organisms with eukaryotic structures, such as nucleus and other membrane-bound organelles).

3. List the characteristics common to ALL cells, and describe the functions of these characteristics. Draw and label a picture of a cell that shows these characteristics.

Plasma membrane: made of phospholipids and proteins, provides a selectively permeable barrier that contains the cell's contents and serves as a barrier.

DNA: a nucleic acid that contains the genetic code for synthesizing all of the polypeptides and proteins of an organism. Structure and location differs between prokaryotes and eukaryotes.

Ribosomes: the smallest of organelles, although it is not a membrane-bound organelle. Functions as the site of polypeptide synthesis, either attached to Rough endoplasmic reticulum, or free in the cytosol.

Cytosol: the fluid portion of a cell in which water (the solvent) and various ions and organic molecules (the solutes) are found

4. List and describe the characteristics of prokaryotic cells. Draw a picture that shows these characteristics. List the major types (e.g., Domains) of organisms that have prokaryotic cells, respectively.

Prokaryotes do NOT have any membrane-bound organelles (such as nucleus, etc.). Their DNA "floats" freely in their cytosol, and is found in the nucleoid region. The DNA is circular, and does not have many proteins attached to it (so prokaryotes do not have chromatin). Bacteria have a cell wall made of peptidoglycan (different from the cell wall of some eukaryotic cells). Some have a slimy capsule for attachment to surfaces (capsule may contain toxins). Some bacteria have pilli for attachment. Some may have flagella for locomotion.

5. Describe what physical factors limit the size of a cell (lower and upper limits). What are the respective functions of volume and surface area of a cell?

Lower limit: Must have enough volume to fit DNA, ribosomes, cytosol, etc.

Upper limit: At some point, since volume increases faster than surface area for a specifically proportioned object, a cell reaches a maximum size because there is not enough surface area for materials to pass into and out of the cell fast enough.

6. Identify and describe the structure and function of the following organelles / structures of eukaryotic cells. Identify the following structures on a picture or drawing:

Plasma membrane

Cytoplasm

Cytosol

Nucleus

Nuclear envelope

Nucleolus

Chromatin

Chromosomes

Rough endoplasmic reticulum

Smooth Endoplasmic reticulum

Golgi complex

Cell wall (plants)

chloroplasts

peroxisomes

lysosomes

cytoskeleton

cilia

flagella

mitochondria

Ribosomes

Vacuoles and vesicles

Oh please! This is right out of your notes.

Plasma membrane: phospholipids and proteins. Selectively permeable, helps to regulate and contain cell's content.

Cytoplasm: All the cell's contents inside the plasma membrane, including cytosol and organelles.

Cytosol: The fluid portion of the cytosol.

Nucleus: Contains genetic code (DNA). DNA is combined with proteins in eukaryotes to form chromatin.

Nuclear envelope: The membrane surrounding the nucleus. Contains nuclear pores for relatively large molecules (proteins and RNA) to pass through.

Nucleolus: A region of densely packed chromatin in the nucleus where ribosomes are made

Chromatin: Combination of DNA and proteins in the nucleus. Forms separate, linear strands called chromosomes that are visible just before cell division.

Chromosomes: See above.

Rough endoplasmic reticulum: System of membranous pouches, connected to the nucleus and the smooth ER. Ribosomes are attached. Involved with the synthesis of glycoproteins, which are transported to the Golgi.

Smooth ER: System of interconnected tubes. Synthesis of lipids and polysaccharides. Also detoxifies certain molecules dangerous to the cell.

Golgi: Stacks of membranous pouches. Receives transport vesicles from ER. Refines and modifies the products, preparing them to be shipped to their final destinations.

Cell wall (plants): Contains cellulose. Provides support and shape to plant cells. NOT selectively permeable.

Chloroplasts: Organelle unique to plants and algae. Used for photosynthesis to synthesize energy-rich organic molecules (e.g., sugars).

Lysosomes: Organelle produced by the Golgi. Contains hydrolytic enzymes that only function at pH 5.0. Hydrolyzes food particles brought into cell by food vacuoles, or run-down organelles to recycle materials.

Cytoskeleton: System of protein filaments, including microtubules, microfilaments, and intermediate filaments, within the cytoplasm of a cell. Variety of functions, depending upon the type of filament.

Cilia and flagella: Hair-like structures (short and long, respectively) extending outward from a cell. Each is surrounded by plasma membrane, and contains microtubules that slide past each other, causing the cilium or flagellum to move back and forth. Used for locomotion, or for “pushing” particles.

Mitochondria: Double membrane, internal membrane highly folded into cristae to maximize surface area. Factories for synthesizing ATP, the common energy molecule used by all cells. Food molecules (e.g., monosachharides) are oxidized here to release energy, energy used to make ATP.

Ribosomes: Possessed by all cells. Sites of polypeptide synthesis. Some are attached to RER, others are free in the cytosol.

Vacuoles: Large vessels used to transport bulk materials (e.g., food vacuoles, or contractile vacuoles). Plants have central vacuole for storing water, pigments, etc. Form either from plasma membrane (food vacuole) or from many vesicles combining together.

7. Describe the structural and functional differences between plant and animal cells. What characteristics are unique to plant cells, and what is the function / job of each characteristic?

Plants have cell walls made of cellulose. Cell walls help to give structure and shape to the plant. Central vacuoles store water and pigments. Chloroplasts are the sites of photosynthesis. Plant cells usually do NOT have lysosomes, but animal cells do (for digestion, etc.). Animal cells may form food vacuoles, plants don't. Some animal cells have cilia or flagella, but plant cells do not (except sperm cells).

8. Beginning with protein synthesis at the ribosome, describe the pathways that proteins may take as they are synthesized, packaged, modified, and transported. Explain what happens to proteins along each step of the way (name the organelles involved with the process, and what each organelle does).

Polypeptide synthesized at ribosome using genetic code from the nucleus. Polypeptides are inserted into the RER where oligosaccharides are attached to the proteins, making them glycoproteins. The sugar molecules function as I.D. tags to identify the type of protein. Glycoproteins are inserted into transport vesicles, that form from pieces of RER membrane. Transport vesicles move along microtubules to the Golgi, where the molecules are refined, sorted, and packaged into new vesicles. Finally, the vesicles are sent to their final destination (e.g., other organelles, plasma membrane, etc.).

9. Describe the functions of the cytoskeleton. List the 3 major types of protein fibers found in the cytoskeleton, and briefly describe their structure. List some of the functions for each fiber type. Describe cellular motility (movement) involving microtubules and microfilaments.

(1) Structure and shape (2) cell motility(movement). Microtubules: hollow, relatively large diameter. Prevents cellular compression. Components of cilia and flagella; microtubules slide past each other, causing cilium or flagellum to move back-and-forth. Helps move chromosomes before cell division. Assists with movements of organelles (e.g., transport vesicles). Microfilaments: double, twisted chains. Prevents tension (twisting) stresses. Constricts animal cells to divide them into two cells. Actin filaments slide past each other during muscle contractions. Intermediate filaments; twisted fibers that form strong “cables”. Prevents tension stresses. Helps hold and support organelles (e.g., nucleus) in place.

10. Describe the four functional categories of eukaryotic cells. For each category, list and briefly describe the specific organelles and their function(s) (see Section 4.20).

See chart on page 67 of your textbook

11. List several functions of the extracellular matrix of animal cells. List and briefly describe the types of intercellular junctions in plants and animals.

ECM helps adhere or stick adjacent cells together, as the glycoproteins are “sticky”. Some ECM proteins also help to communicate information between cells. PLEASE SEE SECTION 4.19 FOR OVERVIEW OF CELLULAR JUNCTIONS BETWEEN ANIMAL CELLS.

12. Identify and describe the structure and function of the following structures of viruses: capsid, envelope, genetic material

Capsid made of proteins; functions as the outer coat of a virus. Some viruses have a membranous envelope with glycoproteins that helps the virus to enter and leave a cell. Viruses have either DNA or RNA as their genetic material.

NOTE: PLEASE UNDERSTAND WHY VIRUSES ARE THOUGHT BY MANY TO NOT BE “ALIVE”. COMPARE CHARACTERISTICS OF CELLS WITH VIRUSES.

13. List and describe the generalized stages of a virus’ infective cycle.

Attachment: virus attaches to the external surface of a prokaryotic or eukaryotic host cell.

Injection: Virus injects its DNA or RNA into the host cell.

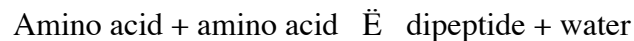
Biosynthesis: Virus uses the host cell’s ribosomes and materials to synthesize new capsids, envelopes, and DNA or RNA. The genetic code of the virus is used to synthesize these things.

Maturation: The various parts of the virus come together to form new viruses.

Release: Newly formed viruses leave the cell, either damaging or killing the cell.

Questions:

1. Where in the cell would you expect this dehydration synthesis reaction to take place?



Ribosomes!

2. Name ONE organelle in the cell where you would expect ALL of the following reactions to take place: hydrolysis of triglycerides, hydrolysis of proteins, hydrolysis of carbohydrates.

Lysosomes

3. Bacterial cells are 0.1 to 10 μm in size, and eukaryotic cells can reach 100 μm in size. What allows eukaryotic cells to be larger than the upper limit imposed on prokaryotic cells?

Membrane bound organelles help to separate cellular functions into separate compartments. This makes physiology of eukaryotic cells more organized, and in some senses, efficient.

4. Many unfertilized eggs are larger than the usual 100 μm upper size limit on cell size. What allows unfertilized eggs to exceed the upper limit? (Think about this!! You probably will not find the answer in your textbook; think about the surface area:volume problem, and apply this to an egg cell).

Eggs aren't really doing anything; they are simply "waiting" for a sperm cell. They are not growing, dividing, developing. So they don't need as much materials and energy, and so the surface area:volume limitations are relaxed; egg cells can be bigger.

5. Where would you expect the following to take place in a eukaryotic cell:

- A) Production of ATP using energy from small organic molecules?

Mitochondria

- B) Synthesis of a polypeptide by bonding together amino acids?

Ribosomes

- C) Modification, packaging, and distribution of macromolecules produced by the cell?

Golgi

- D) In a plant, the storage of water, sugars, pigments, and perhaps toxins?

Central vacuole

- E) Synthesis of sugars (food) using energy from the sun?

Chloroplasts

- F) Synthesis of carbohydrates and lipids?

Smooth endoplasmic reticulum

6. Fill in the following table, indicating whether the indicated organelle is present or absent in Bacteria, Plants, or Animals. In addition, highlight the function(s) of each organelle.

Organelle	Bacteria	Plants	Animals	Function(s)
Nucleus		Yes	Yes	See earlier summary in the study guide
Endoplasmic Reticulum		Yes	Yes	
Golgi Apparatus		Yes	Yes	
Ribosomes	Yes	Yes	Yes	
Lysosomes	Usually No	Yes	Yes	
Mitochondria		Yes	Yes	
Chloroplasts		Yes		
Peroxisomes		Yes	Yes	
Central Vacuole		Yes		
Flagella	Yes, but different structure	Yes, in sperm	Yes, mostly sperm	
Cell Wall	Yes. Peptidogly can	Yes. Cellulos e		

7. Label the following structures in the animal cell shown below: *plasma membrane, nucleus, chromatin, nucleolus, nuclear envelope, cytoplasm, cytosol, rough endoplasmic reticulum (RER), ribosomes, smooth endoplasmic reticulum (SER), mitochondria, Golgi complex, lysosome, flagellum, vesicle, ribosome, cytoskeleton.*

*I am not posting a key for this picture. Ask me if you have questions.
I will tell you not to worry about “peroxisomes”.
Ribosomes are labeled in two places.*

CHAPTER 5 (Section 5.10 through pg. 87): MEMBRANE STRUCTURE AND FUNCTION

Objective (you should be able to):

1. Describe the structure of cell (=plasma) membranes, and explain why the membrane is semi (or selectively) permeable. In your answer, explain why cell membranes are referred to as a “fluid mosaic”.

Proteins and phospholipids, some cholesterol. Connected to cytoskeleton filaments and proteins of ECM. Chemical nature of phospholipids, having hydrophilic heads and hydrophobic tails, prevents most types of molecules and ions from passing through. Only very small, uncharged molecules (such as oxygen, carbon dioxide, etc.) can pass between the phospholipids. Ions, being strongly charged, cannot pass through the phospholipids. Instead, a diversity of protein molecules allow specific types of monomers and ions to selectively pass through membranes.

2. Describe the functions of the cell membrane, and list and describe the types of molecules (and their chemical characteristics) that can or cannot pass through the phospholipid bilayer. Explain how most types of molecules and ions generally pass through membranes.

Membranes help to contain contents and regulate the passage of substances in and out of a cell, organelle, etc. See #1 for other details to this question.

3. Describe the functions of transport, signal transduction, recognition, and enzymatic proteins in cell membranes.

Transport: help move substances (monomers, ions, inorganic molecules such as oxygen) into and out of cells, through cells, or through the body (such as red blood cells in our circulatory system carrying oxygen).

Signal transduction: sends signals or communications from outside to inside of cell. Usually, a molecule attaches to a receptor on a protein, then a chemical signal is sent across.

Recognition: Glycoproteins have receptors or identification tags on them to identify the particular type of cell.

Enzymatic: proteins that speed up chemical reactions far beyond their normal levels.

4. Compare and contrast: simple diffusion and facilitated diffusion. How are the two processes similar? How are they different?

Simple diffusion does not require any molecules, such as proteins, for molecules to pass through a membrane. Facilitated diffusion requires a protein to assist in moving or

transporting the substance across the membrane. Both types of diffusion do not require any “extra” energy, as the particles are simply moving “down” their concentration gradients.

5. Define osmosis. Determine which direction water will move given the solute concentration on either side of a semipermeable membrane.

Diffusion of water across a selectively permeable membrane. Water always will diffuse from a hypotonic into a hypertonic solution, since the hypotonic solution has a lower concentration of solutes, and hence a higher concentration of water.

6. Identify hypertonic, hypotonic, and isotonic conditions relative to a cell with defined solute concentrations.

Hypertonic: has higher concentration of solutes compared to the other solution (other solution is hypotonic). Be able to think through problems that I might give you regarding solute concentrations and the diffusion of water.

7. Describe ways in which plant cells, animal cells, and protozoans respond to hypotonic or hypertonic solution conditions (e.g., which way water will diffuse, and whether a cell will experience turgor, lysis, etc.).

Animal cells will lyse (experience lysis) when placed in a hypotonic solution, will shrivel when placed in a hypertonic solution, and will remain “normal” when placed in an isotonic solution. Most animal (human) cells function best when isotonic.

Plant cells experience turgor pressure when placed in a hypotonic solution, plasmolysis when placed in a hypertonic solution. Plant cells do best in hypotonic solutions.

8. Compare and contrast: facilitated diffusion and active transport. What do they have in common? Under what conditions does each of these types of transport operate? Explain how each of these processes works.

Both facilitated diffusion and active transport require proteins to move substances across membranes. But active transport requires an input of energy, usually from ATP, to transport substances from low to high concentration (this is done for muscle contractions, nerve signals, etc.)

9. Compare and contrast: exocytosis and endocytosis. What do these processes have in common? How are they different? Also, explain how phagocytosis, pinocytosis, and receptor mediated endocytosis work.

Both processes involve pieces of plasma membrane forming vesicles and vacuoles, or vesicles and vacuoles combining with the plasma membrane.

In exocytosis, a membrane or vacuole within the cell attaches to and combines with the membrane, releasing contents (wastes, water, hormones, etc.) outside of the cell. In endocytosis, pockets of membrane form inside the cell, they pinch off to form vesicles or vacuoles, bringing substances inside.

Receptor mediated endocytosis involves specific particles (molecules) attaching to receptor molecules in coated pits of plasma membranes. The pits then pinch off inside the cells, forming vesicles that now contain very specific types of particles. This strategy works well for bringing in specific types of molecules in relatively low concentration. Phagocytosis involves forming food

vacuoles. Pinocytosis involves forming tiny pouches in the plasma membrane to take in extracellular fluids with whatever the fluid contains.

Important terms (be able to recognize, define, and use: phospholipid bilayer, selectively permeable membrane, glycoprotein, diffusion, osmosis, concentration gradient, hypertonic, hypotonic, isotonic, lysis, turgor pressure, osmoregulation, facilitated diffusion, active transport, exocytosis, endocytosis, phagocytosis, pinocytosis, receptor mediated endocytosis

Additional Questions:

1. If you placed a cell containing 1% solutes in a solution of 5% dissolved solutes, in which direction would you expect the water to move (into or out of the cell)?

Out of the cell. Cell has 99% water, external solution has 95% water.

Is the cell hypertonic, isotonic, or hypotonic compared to the surrounding solution?

Cell is hypotonic, because it has a lower solute concentration compared to the external solution.

What would be the RELATIVE solute concentration of a solution that is hypertonic to this cell? Isotonic to this cell? Hypotonic to this cell?

- *If a solution is hypertonic to the cell, then the solution would have a HIGHER concentration of solutes, compared to the cell.*
- *If isotonic, the two solutions (inside and outside of the cell) would have EQUAL solute concentrations.*
- *If hypotonic, the outside solution has a LOWER concentration of solutes.*

2. You fill a dialysis bag with a solution containing 1% starch and place it into a beaker containing a solution of 5% albumin, 10% sucrose, 15% sodium chloride. The dialysis membrane is impermeable to starch and albumin and permeable to all the other molecules.

Which molecules would cross the membrane, and which direction would they move (into or out of the bag)?

Sucrose, ions, and water would cross the membrane. Sucrose would move into the bag, sodium and chloride ions would move into the bag. All particles move down their concentration gradients (from high to low concentrations).

Which direction (into or out of the bag) would water move? Why?

Water would move out of the bag, from high to low concentration.

3. Glucose is a relatively large polar molecule. Suppose you place a cell containing 1% glucose in a solution of 5% glucose. By what process would glucose be transported INTO this cell? What must be present (as a source of energy) in order for this process to occur?

Glucose would move into the cell by facilitated diffusion (a specific type of protein would assist glucose in crossing the membrane). NO energy is required, as the glucose is moving from a high to low concentration.