Answer Key for Exam 2 Practice Problems

Cell Structure and Function Practice Questions

1. One of the relationships that exists between ribosomes and lysosomes is that
   a. ribosomes produce enzymes that could be stored in lysosomes.
   b. ribosomes produce lipids that could be stored in lysosomes.
   c. lysosomes are located near ribosomes on the surface of the endoplasmic reticulum.
   d. lysosomes are produced by ribosomes and therefore contain proteins that were synthesized at the ribosomes.

2. Alcohol consumption adversely affects the digestion of proteins within liver cells, which can eventually lead to liver damage. Given this information, which organelle in liver cells is most directly affected?
   a. nucleus
   b. Golgi apparatus
   c. rough ER
   d. lysosome

3. Small cells function more effectively, because as cells become larger their surface area to volume ratio
   a. increases.
   b. decreases.
   c. stays the same.
   d. is squared.
   e. is cubed.

4. The eukaryotic organelle that is modifies proteins that have been synthesized in the rough ER is called
   a. mitochondria.
   b. vacuole.
   c. cytoskeleton.
   d. Golgi apparatus
   e. nucleus.

5. In eukaryotes, mitochondria are the organelles primarily involved in
   a. the production of ATP
   b. phospholipid assembly.
   c. export of enzymes.
   d. lipid synthesis.
   e. protein synthesis.

6. Chromosomes can be condensed into compact structures, visible with the light microscope, but usually only
   a. after the cell is dead.
   b. during cell division. (chromosomes condense during prophase)
   c. while the DNA is being copied into RNA.
   d. while the proteins are being assembled.
   e. while the nuclear pores are open.

7. A cell biologist treats a cell so that oxygen cannot diffuse across the membrane. Which organelle will be directly affected?
   A. mitochondria (oxygen is needed for cellular respiration which occurs in the mitochondria)
   b. lysosome
   c. nucleus
   d. ribosome
   e. Golgi apparatus

8) Plant cells
A) lack mitochondria and chloroplasts.
B) have mitochondria and chloroplasts.
C) have mitochondria but do not have chloroplasts.
D) lack mitochondria but have chloroplasts.

Tay-Sachs disease
The following 8 Practice questions give you the opportunity to apply what you have learned about the 4 classes of biomolecules (carbohydrates, lipids, proteins, and nucleic acids), cell organelles, and Gaucher's disease to another genetic disease that we have not studied, Tay-Sachs disease. But since all genetic diseases involve many of the same principles, cell organelles, and biomolecules that you have studied so far, you should be able to apply that knowledge to this and many other genetic diseases. The true test of comprehension and understanding is the application of those concepts to new and unfamiliar situations.

Tay-Sachs disease is an inherited disorder in humans that affects one in 3600 births in Askenazic Jews, about 100 times greater than the incidence in non-Jews. As in Gaucher's disease, affected individuals have a single faulty enzyme. The defective enzyme, gangliosidase, is found in the brain cells of Tay-Sachs patients. As a consequence, the brain cells of an affected baby are unable to breakdown gangliosides, a type of lipid. This causes gangliosides to build up causing a gradual decrease in brain cell function that ultimately results in death within a few years. Symptoms are seen within a few months of birth and include seizures, blindness, and degeneration of motor and mental performance. There is no known cure.

1. Why do Tay-Sachs patients have the defective enzyme, gangliosidase? Be as specific as you can in answering this question.

   People with Tay-Sachs disease inherited a mutated version of the gangliosidase gene from each of their parents. The nucleotide sequence in a gene determines the amino acid sequence of the protein the gene codes for. Since the nucleotide sequence in the gangliosidase genes that they inherited is incorrect the order of amino acids in gangliosidase will be incorrect, resulting in an incorrect shape for gangliosidase, and hence the inability of the enzyme to break down gangliosides within their neurons.

2. Name the cell organelle in which you would expect gangliosides to be broken down in normal brain cells. Explain your reasoning.

   Gangliosides are broken down (digested) in lysosomes since this is the cell organelle responsible for digestion.

3. Name the cell organelle that you would expect to make gangliosides. Explain your reasoning.

   Smooth endoplasmic reticulum is the organelle that produces gangliosides. Why? Gangliosides are lipids and the smooth ER is the site of lipid synthesis.

4. Explain why gangliosidase is unable to break down gangliosides.

   Gangliosidase is a protein catalyst that normally breaks down gangliosides, but this enzyme is nonfunctional in people with Tay-Sachs because it has an incorrect order of amino acids. This causes the enzyme to have an incorrect shape, and therefore does not function properly.

5. Would you expect all brain cells that are capable of making gangliosidase to have the faulty enzyme? Explain your reasoning.

   Yes we should expect all brain cells to have the faulty enzyme. Why? All cells in the body contain the same genes; hence all brain cells would contain the faulty gangliosidase gene and would therefore produce the faulty enzyme.

6. Where would you expect the gangliosides to accumulate within the brain cells of babies affected by Tay-Sachs? Explain your reasoning.

   Gangliosides would be expected to accumulate within the Lysosomal membranes and plasma membranes of brain cells. Why? Gangliosides are lipids. Lipids are hydrophobic—therefore insoluble in water. Hence gangliosides will accumulate in the hydrophobic environment of the lipid bilayer of the plasma membrane and Lysosomal membrane.

7. Explain why enzyme therapy is not successful in treating Tay-Sachs disease. Hint: Think about where you need to get the enzyme.

   You would need to get the gangliosidase into virtually all brain cells for enzyme therapy to be effective. Since this is difficult to do, enzyme therapy would be ineffective.

8. Explain why gene therapy is not successful in treating Tay-Sachs disease. Hint: Think about where you need to get the enzyme.

   As in the previous question, you would need to get the gangliosidase gene into nearly all brain cells for gene therapy to be effective. This is tough to do—hence gene therapy is an ineffective therapy for this disease.

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9. Suppose that you are a biologist out for a stroll at Dash Point State Park on the Puget Sound and notice many fish have washed up dead on the beach. Upon examination you find small red lesions in their skin. You examine the lesions under a microscope and find a single celled organism that has a cell was, green organelles and a nucleus, but no mitochondria.
   a. Is this organism eukaryotic or prokaryotic? Explain your reasoning.

      It's a eukaryotic organism since the cells of eukaryotic organisms contain a nucleus. Prokaryotes do not have a nucleus.

   b. Which domains does this organism *not* belong to? Explain your reasoning.

      The critter can't belong to the domains bacteria and Archaea since these domains consist only of unicellular organisms with *prokaryotic* cells.

   c. To which biological domain does this organism belong? If the organism belongs to domain Eukarya, which kingdom does it belong to? Explain your reasoning.

      The critter belongs to the domains Eukarya since this domain consists of organisms with Eukaryotic cells. It belongs to the kingdom Protista since this kingdom consists of unicellular eukaryotic organisms, while kingdoms fungi, animalia and plantae contain eukaryotic Multicellular organisms.

10. a. Like the cutting of hair, when you trim your nails, you are removing dead cells that have accumulated to a huge amount one of the four classes of large biological molecules. Which one is it? Explain your reasoning.

       Hair and nails consist of structural protein (keratin).

    b. When you trim your nails, you are removing dead cells that have accumulated to a huge amount one of the cell organelles involved in giving shape and support to the cell. Which one is it? Explain your reasoning.

       The Cytoskeleton is the cell organelle responsible for providing shape and support to all cells. The cytoskeleton is made of protein.

    c. Which cell organelle is responsible for building this class of large biological molecules referred to in part a, above?

       The cell organelle responsible for making protein is the ribosome.

    d. Which class of large biological molecules determines if a cell will be capable of making this class of large biological molecules referred to in part a, above?

       Genes determine the kind of protein a cell is capable of making. Genes are made of DNA, a nucleic acid. Hence, the class of compound responsible for determining if a cell can make a protein such as keratin is nucleic acids.

    e. Almost all cells in the human body contain the exact same quantity and kind of molecules referred to in part d, above. Why then don't all cells in the body produce nails?

       Only certain genes are used or active in specific cells. Hence, what makes one tissue different from another is determined by which genes are active—e.g. Although all the cells found in muscle tissue and liver contain exactly the same genes, different genes are active in muscle cells than are active in liver tissue.

11. Beginning with the atom, list the hierarchy of organization of life of a Multicellular organism. Show your understanding of each level with a brief explanation.

Atoms → molecule → organelles → cells → tissues → organs → organ-systems → organism

Atoms combine together to form molecules. The four basic kinds of biomolecules (carbohydrates, proteins, lipids, and nucleic acids) combine to form cells. Cells contain genes, organelles and a plasma membrane surrounding the interior of the cell. The cell is the smallest unit of life. In multicellular life forms, cells of similar types are combined into tissues (e.g. nervous tissue) that perform a similar function. Various tissue types combine to make a structural unit called an organ (e.g. heart, brain, liver, etc.), several organs that collectively perform a similar function are called an organ system (digestive system, respiratory system, etc.). All organ systems functioning cooperatively make up an organism.

Biological Molecules Practice Questions

1. A general principle of large biological molecules is that monomers join to make polymers. On separate paper, make a table similar to that below, and list the four large groups of biological molecules, tell what the monomers are called, and list the major functions. Note: Lipids is one of polymers, but isn't really made of monomers. But you can still list the major molecules that make up lipids.

Polymer Name	Monomer(s) Name(s)	Specific Examples and their Functions
Lipids	**Fatty acids and glycerol** **(fat = 3 fatty acids connected to the glycerol, a three carbon compound)**	• **Fats (triglycerides): Energy storage, insulation** • **Steroids: hormones (chemical messengers such as testosterone and estrogen)**

Carbohydrates	**Monosaccharides**
	
	(e.g. glucose, fructose)
		• **Monosaccharides: source of energy (e.g. glucose)**
		• **Disaccharides: transport of sugars (e.g. sucrose, lactose)**
		• **Polysaccharides:**
		  ○ **storage of sugars: e.g. plants → starch; animals → glycogen**
		  ○ **Structural: cellulose → Cell wall (outermost structure of plants cells) are made of cellulose.**

Proteins	**Amino Acids**	• **Enzymes—protein catalysts that speed up chemical reactions in living things** • **Peptide hormones: e.g. Insulin controls blood levels of glucose in all mammals.** • **Transport: hemoglobin (O_2), HDL's and LDL's (cholesterol)** • **Structural: Hair, nails, cytoskeleton, tendons, cartilage, muscle fibers, etc.**
Nucleic acids	**Nucleotides**	• **DNA—the hereditary molecule—the substance that genes are made of. Genes control which proteins an organism can make. E.g. GCase gene, lactase gene, insulin gene, etc.** • **RNA—chemical messenger of DNA. Carries DNA's message from the nucleus to ribosomes in the cytoplasm or on the rough ER to direct the synthesis of protein.** • **ATP—nucleotide that is the major energy currency of all cells.**

2. Migratory birds expend vast amounts of energy during migration. Which type of biological molecule would be most suitable for energy storage? Explain.

Fat would be the biological molecule most suitable for migratory birds since gram for gram fats contain twice the energy (calories) as carbohydrates.

Estimating the size of an object viewed under the microscope.

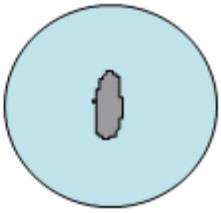
Problem 1

- Calculate the length and width of the following microscopic object in both millimeters and micrometers. **1 mm = 1000 µm**
- Base your calculations on the following field sizes:

Low power (40x): 4.5 mm

Medium power (100x): 1.8 mm

High power (400x): 0.45 mm



Object viewed at medium power (100x)

Length: ~ 1/3 field diameter
= (1/3)(1.8 mm)
= 0.6 mm = 600 µm

Width: ~ 1/6 field diameter
= (1/6)(1.8 mm)
= 0.3 mm = 300 µm

Remember: Field size decreases by the same factor as the magnification increases!

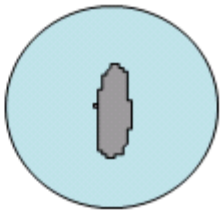
Problem 2

- Calculate the length and width of the following microscopic object in both millimeters and micrometers. **1 mm = 1000 µm**
- Base your calculations on the following *hypothetical* field sizes:

Low power (30x): 4.0 mm = **4000 µm**

Medium power (180x): **0.67 mm = 670 µm**

High power (300x): **0.4 mm = 400 µm**



Object viewed at high power (300x)

Length: ~ 1/2 field diameter
= (1/2)(0.4 mm)
= 0.2 mm = 200 µm

Width: ~ 1/5 field diameter
= (1/5)(0.4 mm)
= 0.08 mm = 80 µm

Diffusion, Osmosis and Active Transport Practice Questions

Multiple Choice Questions

1. Water-loving molecules such as glucose are:
   A. hydrophobic
   B. hydrophilic
   C. insoluble in water

2. The model of a cell membrane containing a bilayer of phospholipid molecules with interspersed protein molecules is the:
   A. fluid mosaic model
   B. induced fit model
   C. lock and key model

3. The cell membrane is differentially permeable. This means that:
   A. all molecules pass through the membrane at the same rate
   B. some molecules may pass through but not others
   C. only glucose passes through easily

4. The transport of mineral ions from soil to plant root requires energy-rich ATP. This is an example of:
   A. passive transport
   B. osmosis
   C. active transport

5. Diffusion is the movement of substances from:
   A. high to low concentrations
   B. low to high concentrations
   C. equal areas

6. The diffusion of water is called:
   A. hydrophobic
   B. osmosis
   C. concentration gradient

7. When a microscopic protozoan takes in a particle of food into itself, the process used is:
   A. endocytosis
   B. exocytosis
   C. osmosis

8. When milk is secreted by mammary glands, the process used is:
   A. endocytosis
   B. osmosis
   C. exocytosis

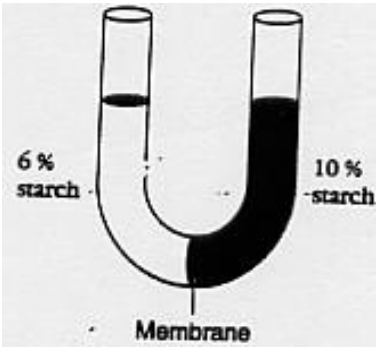
9. White blood cells engulfing foreign bacteria is an example of:
   A. phagocytosis
   B. exocytosis
   C. diffusion

10. Which of the following correctly describes the process of osmosis?
   A. The passive movement of water molecules from areas of low solute concentration to high solute concentration, through a selectively permeable membrane.
   B. The passive movement of water molecules from areas of high solute concentration to low solute concentration, through a selectively permeable membrane.
   C. The active movement of water molecules from areas of high solute concentration to low solute concentration, using a membrane pump protein.
   D. The passive movement of water molecules from areas of low solute concentration to high solute concentration, through a channel protein.

11. Inside one osmosis bag, A, is a 50% glucose solution and side bag B is a 20% glucose solution. Both bags are put into beakers containing 100% water.
   A) Bag A will gain weight.
   B) Bag B will gain weight.
   C) Both bags will gain weight.
   D) Both bags will lose weight.
   E) Both bags will remain the same.

12. A 0.9% NaCl solution is isotonic to red blood cells. Which of these describes the results if red blood cells are placed into a 9% solution of NaCl?
   A) They will burst.
   B) They will shrink.
   C) There will be no net change.
   D) They will expand but not burst.
   E) None of the above.

13. The U-shaped tube in the figure below is divided by a membrane that is impermeable to starch but permeable to water. Which of the following will occur?
   A) Water will move from the right to the left.
   B) Water will move from the left to the right.
   C) Starch will move from the right to the left.
   D) Starch will move from the left to the right.
   E) Nothing will happen. The membrane blocks the passage of all the molecules.



14. Red blood cells has a salt concentration of 0.9%. What will happen if it is placed into a 0.5% salt solution? The red blood cell will
    A) shrink if its membrane is permeable to both the salt and the water.
    B) shrink if its membrane is impermeable to the salt and permeable to the water.
    C) maintain its shape, ie nothing will happen.
    D) swell and probably burst because its membrane is impermeable to salt and permeable to water.
    E) swell and probably burst because its membrane is impermeable to water and permeable to salt.

15. The movement of materials through a transport protein without the use of energy is termed:
    A. active transport
    B. diffusion
    C. osmosis
    D. endocytosis
    E. facilitated diffusion

16. If the concentration of solutes outside a cell is equal to the concentration of solutes inside the cell, then the cell is _____ when compared to its surroundings?
    a.) hypertonic **b.) isotonic** c.) hypotonic d.) endocytic

17. The diffusion of water across a semipermeable membrane is:
    a. active transport of water **b. osmosis** c. exocytosis d. Endocytosis

18. The energy responsible for active transport is associated with which of the following?
    a. ATP b. ADP c. AMP d. kinetic energy of the diffusing particles

19. Which of the following is not true of an plasmolyzed plant cell when placed into distilled water?
    a. the cell is hypertonic to the water
    b. the water is hypotonic to the cell
    c. the cell will gain water
    d. the cell will lose water

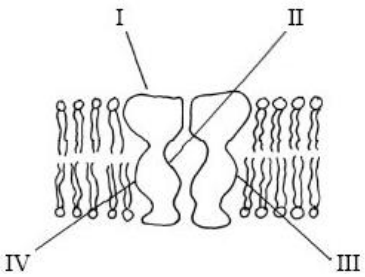
20. Red blood cells will lyse (burst) if they are in ___ solution.
    a. isotonic b. hypertonic **c. hypotonic**

21. Active transport moves materials from _____to _____concentration and requires an input of _____:
    a. low to high, water **b. low to high, energy** c. high to low, water d. high to low, energy

22. If a cell has a 10% solute concentration. What occurs to the cell in a 0% solute fluid?
    a. the cell neither gains nor loses water
    b. the cell will lose water
    c. the cell will gain water.
    d. none are correct

23. A substance moving through the membrane by facilitated diffusion moves through what part of the membrane?
    a. phosopholipid bilayer b. cytoskeleton **c. transport protein** d. Na/K pump portion

24. The diagram below shows a channel protein in a plasma membrane. Channel proteins allow polar molecules to pass through by facilitated diffusion. Which labeled parts of the channel proteins are likely to be polar?



    A. I and II only
    B. III and IV only
    C. I and III only
    D. All parts