

Cell Transport

Cell Membrane

Osmosis/Diffusion

Essay Entry: Cell Transport and Stability

"All living things maintain homeostasis."

Standard

Biology/Life Science

CELL BIOLOGY

1. Fundamental life processes of plants and animals depend on a variety of chemical reactions, that are carried out in specialized areas the organism's cells. As a basis for understanding this concept, students know:

Concept

- a. that cells are enclosed within semi-permeable membranes that regulate their interaction with their surroundings.

Standard

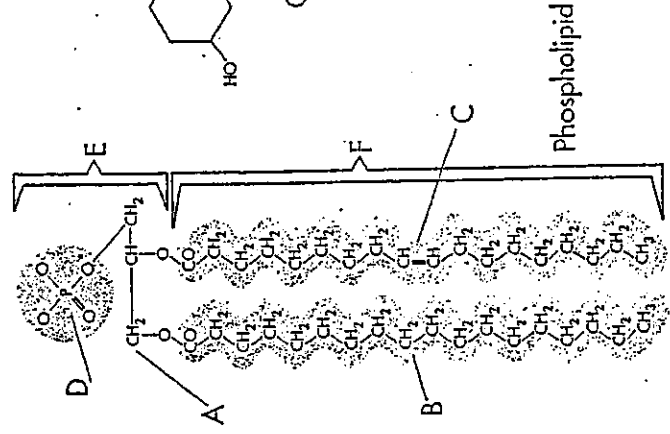
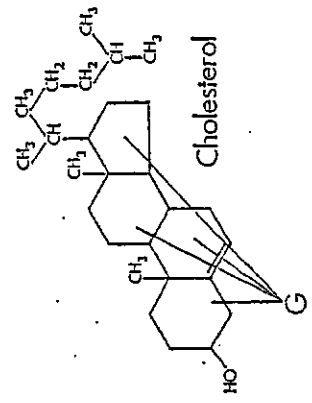
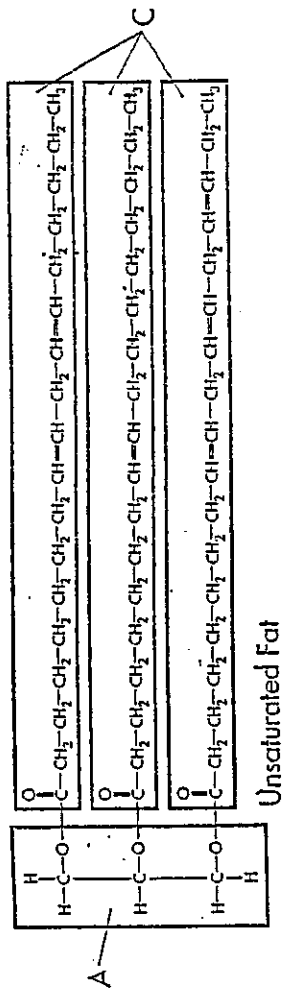
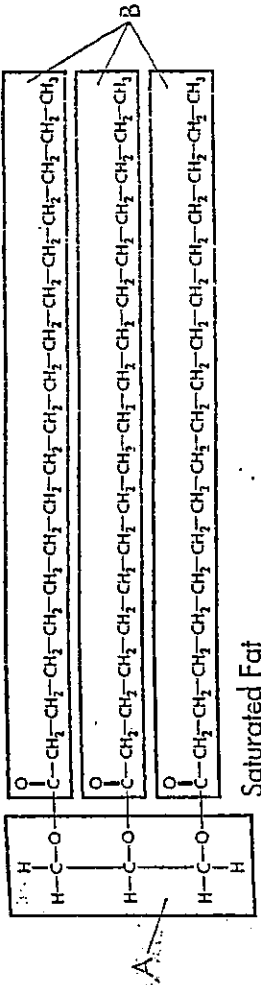
STRUCTURE AND FUNCTION IN LIVING SYSTEMS

9. As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic), despite changes in the outside environment, As a basis for understanding this concept, students know:

Concept

- g. *the homeostatic role of the kidneys in the removal of nitrogenous wastes, and of the liver in blood detoxification and glucose balance.

LIPIDS



- Lipids**
- Glycerol Molecule.....A
 - Saturated Fatty Acid Chains.....B
 - Unsaturated Fatty Acid Chains.....C
 - Phosphate Group.....D
 - Polar End.....E
 - Nonpolar End.....F
 - Sterol Ring.....G

Vocabulary: Osmosis & Diffusion

| Word Part | Meaning | Vocabulary Word |
|-----------|-------------------|-----------------|
| erythro | red | erythrocyte |
| hemo | blood | hemolysis |
| cyte | cell | cytology |
| hypo | below | hypotonic |
| hyper | above | hypertonic |
| tonus | tension, pressure | |
| iso | same | isotonic |
| homeo | same | homeostasis |
| stasis | state | |
| | | osmosis |
| | | diffusion |
| lysis | split | cytolysis |
| | | plasmolysis |
| endo | inside | endocytosis |
| exo | out of | exocytosis |

Format

| Word | Part of speech | Word parts/meanings |
|------------|----------------|---------------------|
| Definition | | |

| | | |
|--------------------|--|--|
| Erythrocyte | | |
| | | |
| Hemolysis | | |
| | | |
| Cytology | | |
| | | |
| Hypotonic | | |
| | | |

| | | |
|--------------------|--|--|
| Hypertonic | | |
| | | |
| Isotonic | | |
| | | |
| Homeostasis | | |
| | | |
| Osmosis | | |
| | | |
| Diffusion | | |
| | | |
| Cytolysis | | |
| | | |
| Plasmolysis | | |
| | | |
| Endocytosis | | |
| | | |
| Exocytosis | | |
| | | |

Cell Membrane

Cell Membrane functions:

- A. _____ the cell from its _____ environment.
- B. Gives _____ to the cell.
- C. _____ thus allowing some molecules to pass through while others do not. (semi-permeable barrier).

Cell Membrane Structure

- A. Composed of _____ layers of _____
Is also called a _____.
- B. Carboxyl - _____ "head" of the molecule forms the outside and the hydrocarbon _____ "tails" form the inside.
- C. _____ chunks embedded between _____ molecules.
 1. _____ act like passages through which only certain molecules can pass. **Example: Sodium/Potassium pump.**
 2. _____ transmit information into the cell by reacting to other molecules. **Example: insulin, glucose**
 3. _____ name tag cells giving all cells of the organism a unique identity **Example: Immune System.**

PHOSPHO-LIPID BILAYER

NON POLAR (HYDROPHOBIC) TAILS A

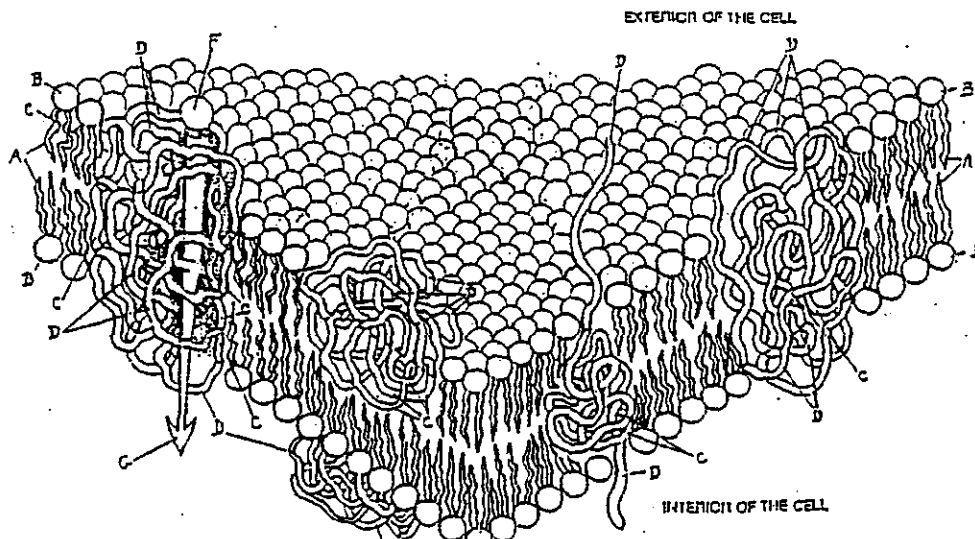
POLAR (HYDROPHOBIC) HEADS B

PROTEIN MOLECULE

HYDROPHOBIC PORTION C

HYDROPHILIC PORTION D

ION/SMALL POLAR MOLECULE F DIFFUSION G

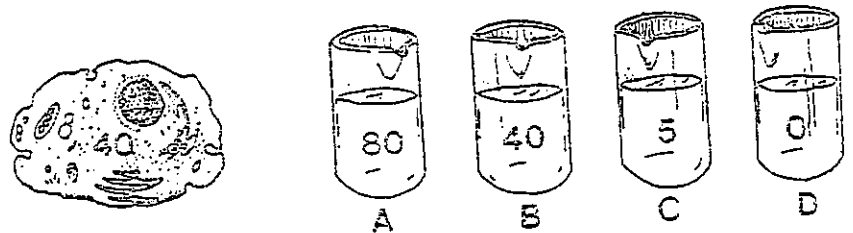


What determines the directions in which the water molecules diffuse across a cell membrane? The direction depends on the concentrations of water and solutes dissolved in the solution. Study the table below then answer the questions that follow.

| conditions | environment solution is | cell solution is | water will move |
|---|-------------------------|------------------|---------------------|
| If solute concentration in the environment is lower than in the cell | | HYPERTONIC | into the cell |
| If solute concentration in the environment is higher than in the cell | | HYPOTONIC | out of the cell |
| If solute concentration in the environment is equal to that in the cell | | ISOTONIC | water will not move |

If the concentration of solute molecules in the environment outside the cell is lower than that in the cell, the solution outside is **HYPOTONIC** relative to the cell environment. Water will move into the cell until equilibrium is established. When the concentration of solute molecules outside the cell is greater than that inside, the solution outside is considered **HYPERTONIC** to the cell. Water will diffuse out of the cell until equilibrium is established. When the concentration of solute is equal inside and outside the cell, the solution is **ISOTONIC** relative to the cell. Water will diffuse into and out of the cell at equal rates, establishing osmotic balance.

Concentration of Solute Molecules
in a Cell and Four Beakers



- Solution A is (hypertonic, hypotonic, isotonic) relative to the cell because _____
- Solution B is (hypertonic, hypotonic, isotonic) relative to the cell because _____
- Solution C is (hypertonic, hypotonic, isotonic) relative to the cell because _____
- Solution D is (hypertonic, hypotonic, isotonic) relative to the cell because _____
- Solute molecules from which solution would be most likely to diffuse into the cell?
Why? _____
- What would happen to the the cell if it was placed in solution C?
Why? _____
- Which solution best represents the fluid that surrounds the cells in our bodies?
Why? _____


PART I- Use the following words to fill in the blanks: plasmolysis, solute, ATP, motion, homeostasis, protein channels, cytolysis, hemodialysis, diffusion, cell membrane, facilitated diffusion, exocytosis, active transport, concentration gradient, osmosis, solution, endocytosis, contracting vacuole, filtration, ions,


1. A cell maintains a biological balance or _____ by controlling and regulating what gets into and out of itself.
2. Molecules are in constant _____.
3. Molecules move into and out of the cell through the semi-permeable _____.
4. _____ is the process by which molecules move from a region of high concentration to a region of low concentration.
5. The difference between the region of high concentration and the region of low concentration is called the _____.
6. _____ is the process by which *water* molecules move from an area of high concentration to an area of low concentration.
7. A dissolved substance is called a _____.
8. A mixture of a liquid and a dissolved substance is called a _____.
9. _____ has occurred when enough water has entered the cell causing it to burst.
10. _____ has occurred when enough water has left the cell causing it to shrink.
11. Some organisms, like a paramecium, have a _____ that helps pump out water and maintain equilibrium.
12. _____ aren't able to diffuse across the cell membrane due to their charge.
13. Large molecules and ions enter/ exit a cell through _____ in the cell membrane.
14. The process by which a paramecium ingests large food molecules is called _____.
15. The process by which a paramecium gets rid of its waste is called _____.
16. _____ is the movement of molecules from high to low through protein channels.
17. _____ is the movement of molecules from low to high concentration through protein channels using energy.
18. The energy used in active transport is _____.
19. The major function of the kidney is _____ of the blood.
20. _____ is the artificial filtering of the blood.

PART II- Complete the following chart.

| Conditions | Outside solution is... | Water will move... |
|--|------------------------|--------------------|
| Solute concentration outside is lower than in the cell. | | |
| Solute concentration outside is higher than in the cell. | | |
| Solute concentration outside is equal to that in the cell. | | |

PART III- Answer the following questions.

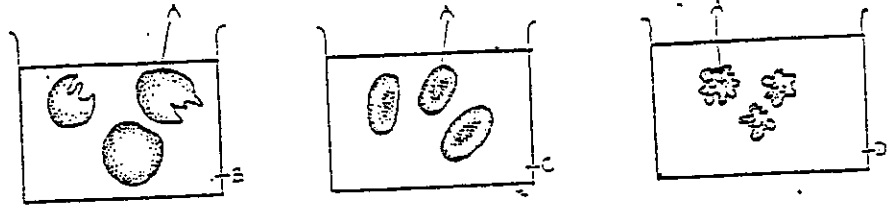
CELL A (1cm) 

CELL B (2 cm) 

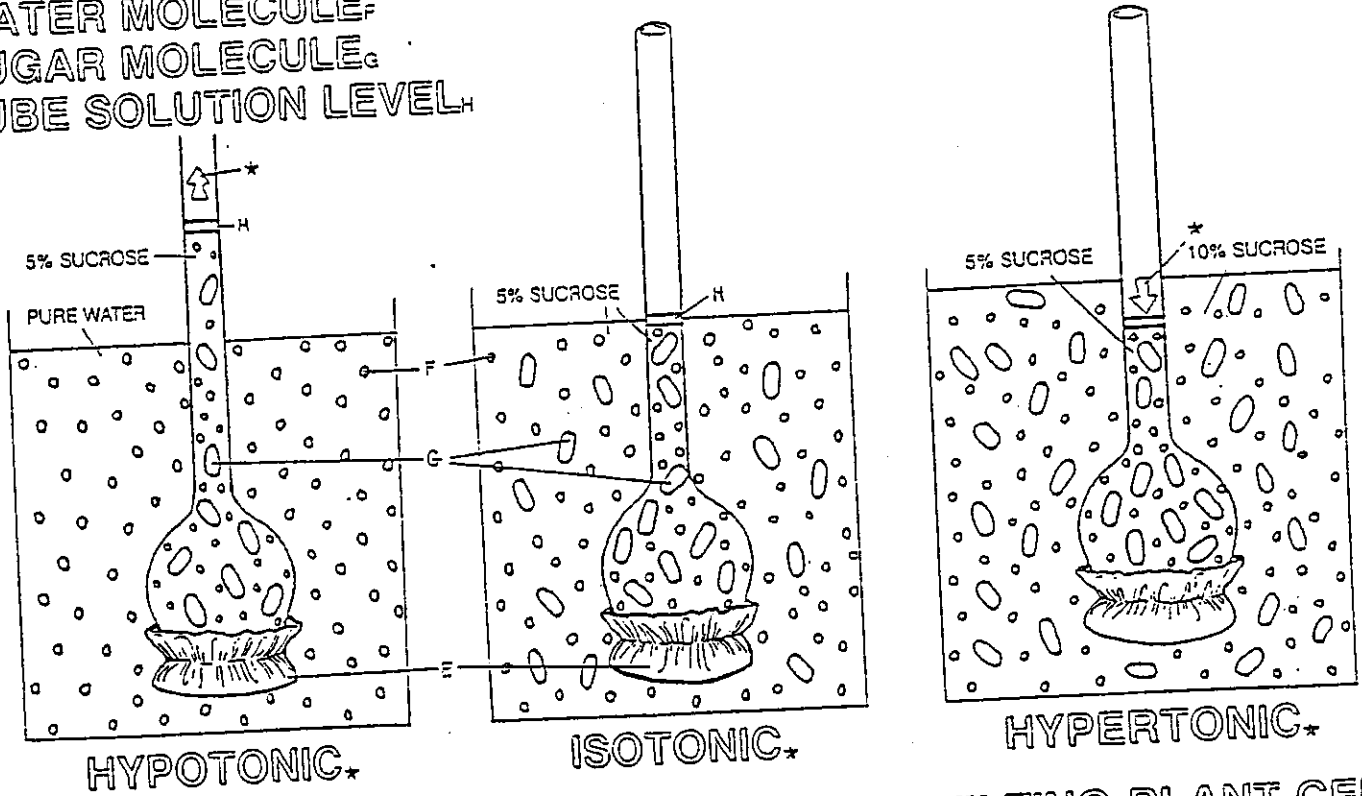
1. Which increases more rapidly as a cell increases in size, its surface area or its volume? _____
2. Does the SA/V ratio increase or decrease as cell size increases? _____
3. Which cell would be better suited to moving nutrients and wastes in and out of itself? _____

OSMOSIS.

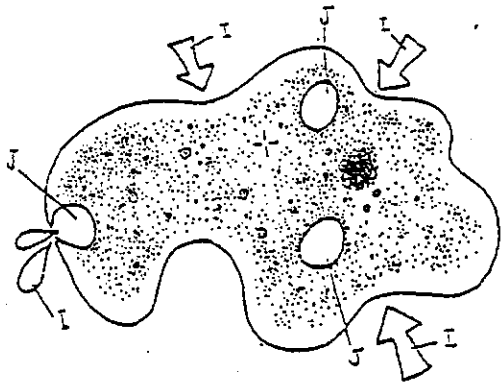
ERYTHROCYTE.
 PURE WATER:
 0.85% SALT SOLUTION:
 2% SALT SOLUTION.



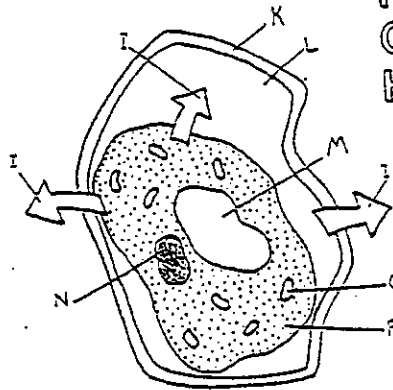
OSMOMETER.
 SELECTIVELY PERMEABLE
 MEMBRANE:
 WATER MOLECULE:
 SUGAR MOLECULE:
 TUBE SOLUTION LEVEL.



AMOEBA.
 WATER.
 CONTRACTILE VACUOLE.



WILTING PLANT CELL.
 CELL WALL.
 AIR SPACE.
 SHRUNKEN VACUOLE.
 NUCLEUS.
 CHLOROPLAST.
 HYALOPLASM.



OSMOSIS

The selective permeability of the cell membrane creates some unusual properties, which are readily illustrated by immersing human red blood cells in pure water and in two different solutions of common table salt (NaCl).

If you place some erythrocytes (red blood cells) in pure water, water will flow into the cells until the pressure is so great that the cells swell up and burst. This process is called hemolysis (Greek: hemo, "blood"; lysis, "loosening" or "breaking"). If you place erythrocytes in a 0.85 percent salt (NaCl) solution, a few water molecules will flow into the cells, but the same number will flow out, and the cells will retain their normal double-concave shape. In a 2 percent salt solution, water will flow out of the cells, and they will shrink and shrivel up in a process called crenation. All three of these situations involve a process called osmosis.

Osmosis is defined as the diffusion of solvent - water whenever we are dealing with living systems - through a selectively permeable membrane.

Osmosis can be demonstrated with a simple device called an osmometer, which will also indicate the resulting osmotic pressure. A membrane is stretched over the mouth of a thistle tube (a common laboratory item) and securely tied there. The membrane can be some tissue from an animal, such as intestine or bladder, or it can be something artificial, such as a cellophane dialysis membrane, as long as it allows water to pass through, but not larger molecules. Suppose that inside the thistle tube we place a 5 percent solution of sucrose and we immerse the end with the membrane so that the liquid inside the tube is at the same level as the liquid outside. Since the solution inside the thistle tube is 5% sucrose, it is therefore only 95 percent water. The pure water outside is 100 percent water. Since molecules always diffuse from regions where their concentration is higher to regions where their concentration is lower, the water molecules will diffuse through the membrane into the thistle tube. Some water molecules will also diffuse out, but not nearly as many as will diffuse in. The sugar molecules will tend to diffuse from inside, where their concentration is 5 percent, to outside, where their

concentration is 0 percent, but the membrane will not allow them to pass through. Since there is a net flow of water into the tube and no flow of sugar out of it, a pressure, called osmotic pressure, builds up in the tube, and the liquid level rises. The height of the liquid is a measure of the osmotic pressure. Because the osmotic pressure of the solution outside is less than that of the solution inside, the solution outside is said to be hypotonic (Greek: hypo, "below"; tonus, "tension" or "pressure"). In the experiment illustrated at the top of the plate, the pure water was hypotonic to the red blood cells.

If we put the same 5 percent sucrose solution outside the tube as we have inside it, there will be no net flow of water in either direction. Water molecules will diffuse out of the tube just as fast as they diffuse in, and the liquid level in the tube will remain the same. In this case, the solution outside the tube is said to be isotonic (Greek: isos, "same").

If we put a 10 percent solution outside the tube while we will have only 5 percent inside, we will have the reverse of the original hypotonic situation: there will now be a net diffusion of water molecules out of the tube, the level in the tube will drop, and the level in the beaker will rise. In this case the solution outside is said to be hypertonic (Greek: hyper, "above"). The 2 percent salt solution at the top of the plate was hypertonic to the red blood cells.

To survive the forces of osmosis, different living organisms have adopted various strategies. Single celled fresh water animals, such as amoeba, use active transport to pump excess incoming air into special contractile vacuoles, which collect that water and then contract to force it out of the cell through a tiny opening. Cells of plants, algae, and fungi have cell walls to resist being burst by osmotic pressure. Plants actually depend on osmotic pressure to keep them erect. If you let plant cells lose water (or make solution), they shrink away from their cell walls, and the plant wilts. That is why supermarkets spray their vegetables frequently and smart cooks keep vegetables damp in a humidifier drawer in their refrigerator.

Osmosis Questions

Directions: Read the passage, highlight important aspects, and then answer the following questions in complete, authentic sentences.

1. Fill in the chart

| Solutions | Pure Water | 0.85% salt solution | 2% salt solution |
|----------------------------|------------|---------------------|------------------|
| Which way will water flow? | | | |
| Name that process | | | |

2. Define or diagram osmosis in your own words.

3. What is osmotic pressure? Explain how it might affect a blood cell (erythrocyte)?

4. Define the following word parts:

hypo-

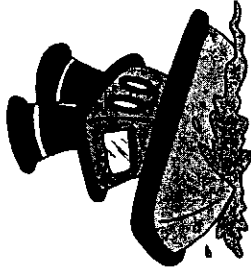
isos-

hyper-

5. How do these word parts relate to osmosis?

6. Describe two examples in which living things have adapted strategies of surviving the forces of osmosis.

Passive Transport Lab



Purpose: To observe passive transport in different solutions using eggs.

Background:

- Thoroughly describe the cell membrane and passive transport. Discuss how a concentration gradient can drive the movement of water, include the three types of environmental solutions (hypo-, etc).

Hypothesis:

- 1- If **FOOD COLORING** is added to the outside of a cell, then it _____ diffuse through the membrane.
- 2- If a cell is placed in **CORN SYRUP**, then it will _____.
- 3- If a cell is placed in **PURE H₂O**, then it will _____.

Procedure: refer to instructor and handout on pg. _____.

Data: (use a ruler)

| Day | Solution | Mass | Δ mass | H ₂ O moved | Type of solution |
|---------|----------|------|---------------|------------------------|------------------|
| Initial | | | | | |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |

Cell Diagram - diagram the cell on the day of the initial set-up



Data Analysis - use and refer your data as evidence to support your answers

- 1) In which direction did water move after the egg was placed in the vinegar? How do you know?
- 2) What type of solution is the vinegar?
- 3) Why did water move into/out of the egg?
- 4) In which direction did water move after the egg was placed in the syrup? How do you know?
- 5) What type of solution is the syrup?
- 6) Why did water move into/out of the egg?
- 7) In which direction did water move after the egg was placed in deionized water? How do you know?
- 8) What type of solution is deionized water?
- 9) Why did water move into/out of the egg?
- 10) Why are fresh fruits/vegetables sprinkled with water in the grocery store?

11) Why would you soak a swollen, sprained ankle in salt water?

Conclusion - Were your hypotheses supported? Explain.

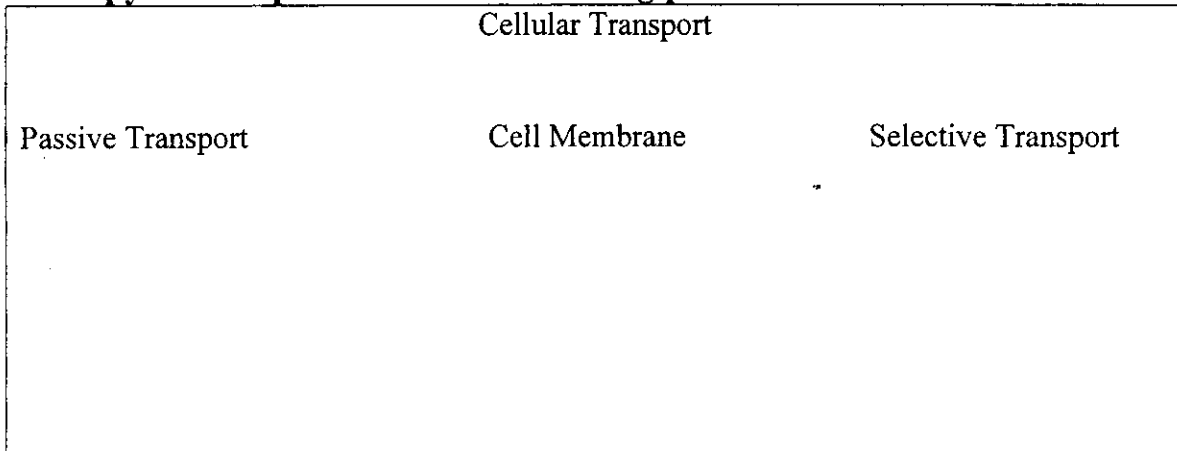
Hyp #1-

Hyp #2-

Hyp #3-

Cell Transport Concept Map

1. Copy the template below as a starting point.



2. Determine where the key words fit into template.

3. Add the following key words to template.

lipid bilayer

diffusion

equilibrium

exocytosis

marker protein

osmosis(isotonic, hypertonic, hypotonic)

transport(channel) protein

endocytosis

cytolysis

receptor protein

concentration gradient

ATP

selectively permeable

active transport

facilitated diffusion

4. Add information under the key words in bulleted form.

5. Add connections & diagrams where appropriate.

In your textbook, read about osmosis: diffusion of water.

Complete the table by checking the correct column for each statement.

| Statement | Isotonic Solution | Hypotonic Solution | Hypertonic Solution |
|---------------------------------------|-------------------|--------------------|---------------------|
| 1. Causes a cell to swell | | | |
| 2. Doesn't change the shape of a cell | | | |
| 3. Causes osmosis | | | |
| 4. Causes a cell to shrink | | | |

In your textbook, read about passive transport and active transport.

For each item in Column A, write the letter of the matching item in Column B.

Column A

Column B

- _____ 5. Transport protein that provides a tubelike opening in the plasma membrane through which particles can diffuse
- _____ 6. Is used during active transport but not passive transport
- _____ 7. Process by which a cell takes in material by forming a vacuole around it
- _____ 8. Particle movement from an area of higher concentration to an area of lower concentration
- _____ 9. Process by which a cell expels wastes from a vacuole
- _____ 10. A form of passive transport that uses transport proteins
- _____ 11. Particle movement from an area of lower concentration to an area of higher concentration
- _____ 12. Transport protein that changes shape when a particle binds with it

- a. energy
- b. facilitated diffusion
- c. endocytosis
- d. passive transport
- e. active transport
- f. exocytosis
- g. carrier protein
- h. channel protein

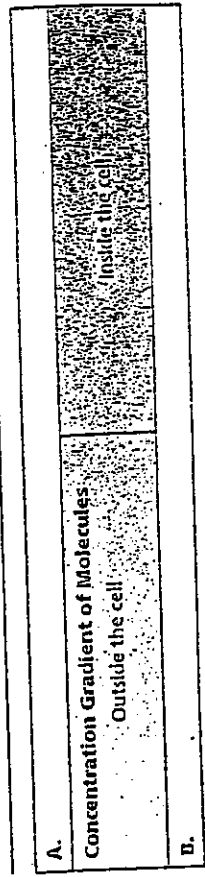


Active Versus Passive Transport

Use with Chapter 8, Section 8.1

1. Some people describe diffusion as the process by which "something moves from where it is to where it is not." Explain why this description is accurate and why it is not.

2. Explain what is meant by *concentration gradient*.



The model above represents a cell in a solution. Use it to answer questions 3 and 4.

- In space A, draw an arrow that shows the direction in which the molecules will move during passive transport.
- In space B, draw an arrow that shows the direction in which the molecules will move during active transport.
- What type of passive transport is shown in the transparency? Explain.

6. Why is passive transport called *passive*?

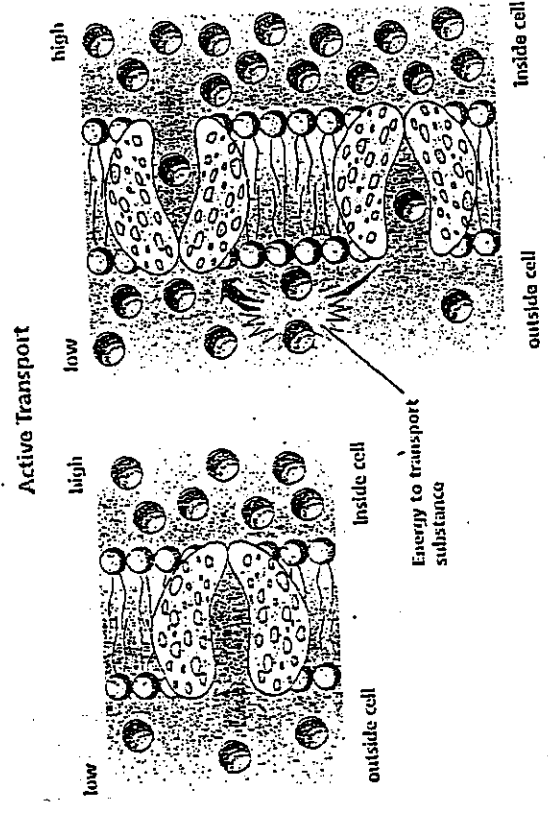
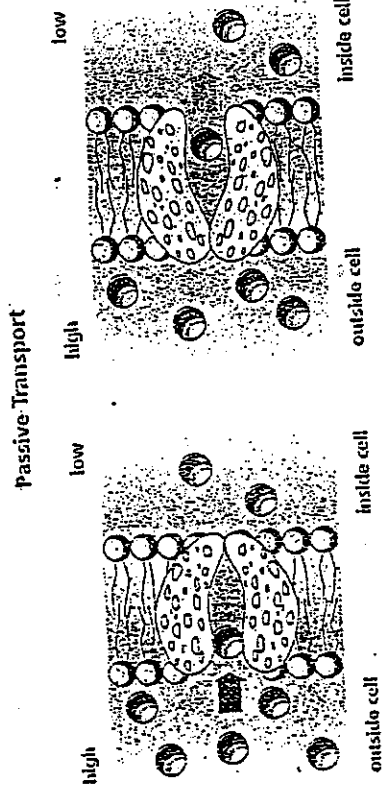
7. In the illustration of active transport, why is energy needed to move the particles across the plasma membrane?

8. Describe the role of carrier proteins during active transport.



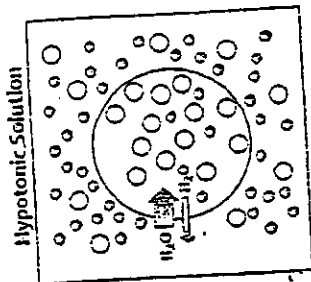
Active Versus Passive Transport

Use with Chapter 8, Section 8.1



12 Osmosis and Hypotonic, Hypertonic, and Isotonic Solutions

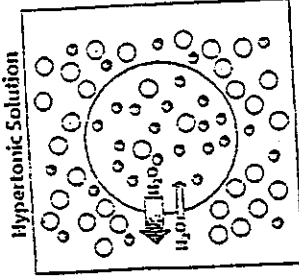
Use with Chapter 8, Section 8.7



Approximate ratio of water molecules to dissolved particles

Inside cell: _____ water molecules: _____ dissolved particles

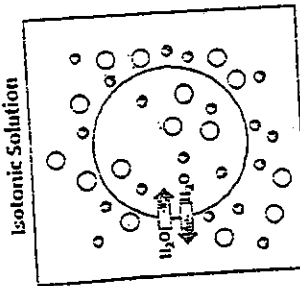
Outside cell: _____ water molecules: _____ dissolved particles



Approximate ratio of water molecules to dissolved particles

Inside cell: _____ water molecules: _____ dissolved particles

Outside cell: _____ water molecules: _____ dissolved particles



Approximate ratio of water molecules to dissolved particles

Inside cell: _____ water molecules: _____ dissolved particles

Outside cell: _____ water molecules: _____ dissolved particles

○ Water molecules
○ Dissolved particles

Count the water molecules and dissolved particles inside and outside each cell.

TRANSPARENCY MASTER 12 BIOLOGY: The Dynamics of Life

RETEACHING SKILLS

12 Osmosis and Hypotonic, Hypertonic, and Isotonic Solutions

Use with Chapter 8, Section 8.7

1. Define the following terms:

a. osmosis

b. hypotonic solution

c. hypertonic solution

d. isotonic solution

2. When a cell is in a hypotonic solution, how will water molecules move?

3. When a cell is in a hypertonic solution, how will water molecules move?

4. When a cell is in an isotonic solution, how will water molecules move?

5. Explain how hypotonic and hypertonic solutions can make a plant rigid and firm or make it wilt.

6. Osmosis is a form of passive transport. Explain how facilitated diffusion, which is another form of passive transport, is different from osmosis.

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RETEACHING SKILLS

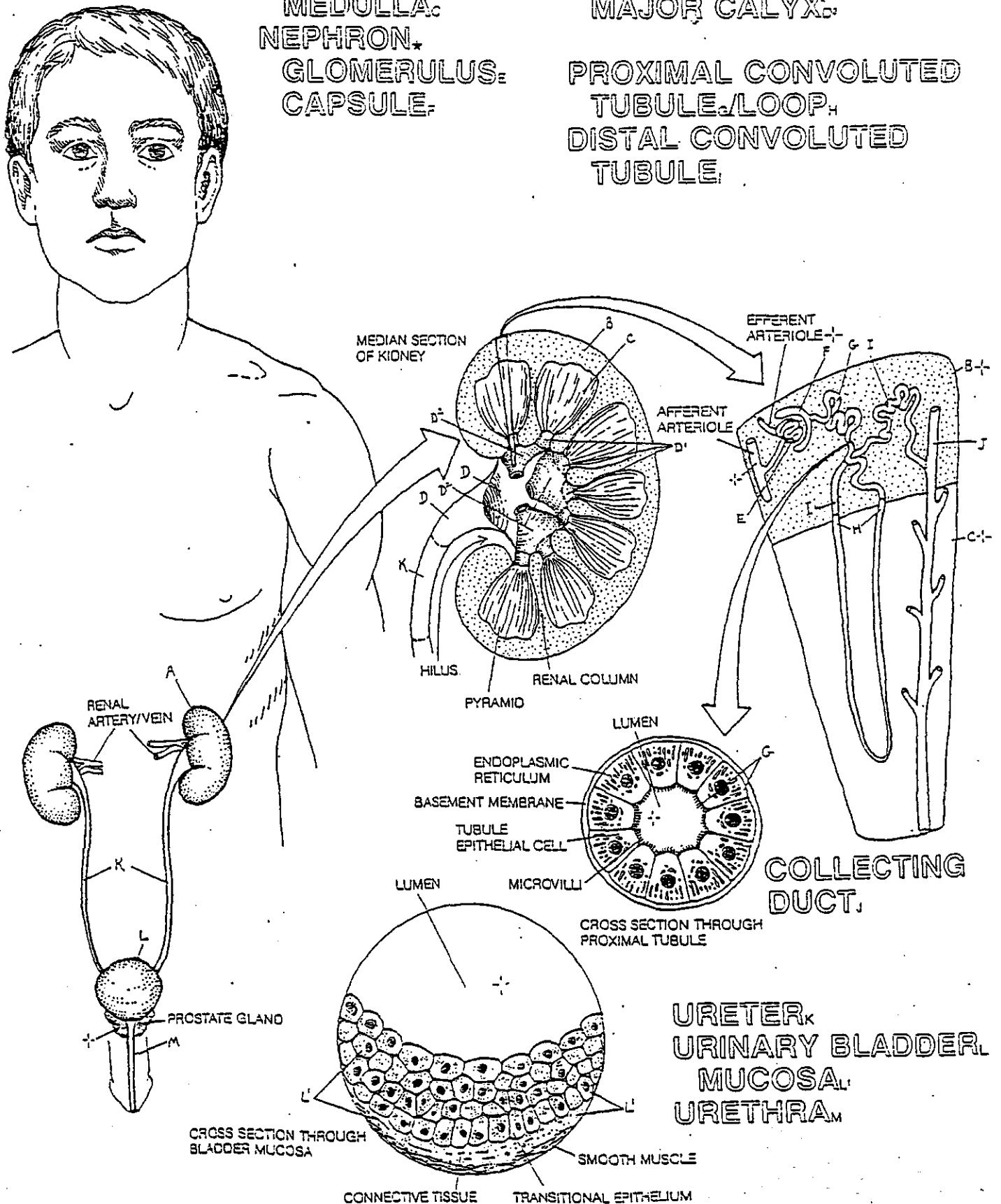
TRANSPARENCY WORKSHEET 12 BIOLOGY: The Dynamics of Life

URINARY SYSTEM.

KIDNEY.
CORTEX.
MEDULLA.
NEPHRON.
GLOMERULUS.
CAPSULE.

RENAL PELVIS.
MINOR CALYX.
MAJOR CALYX.

PROXIMAL CONVOLUTED
TUBULE./LOOP.
DISTAL CONVOLUTED
TUBULE.



Urinary System

The urinary system consists of a group of organs concerned with the conservation of body water and the acid-base balance of body fluids, as well as the excretion of undesired molecules. The principal organ of the urinary system is the kidney (Latin: *renes*; Greek: *nephras*). An individual normally has two kidneys, located on the posterior (back) wall of the abdominal cavity, partly protected by the curve of the 11th and 12th ribs. Many people have lived normal lives with only one kidney, but it is impossible to live without at least one unless supported by a blood filtration (dialysis) unit.

In this median section of the kidney you can see the four major divisions: the outer layer, the cortex (Greek: "bark"); a middle belt of conical pyramids, the medulla (Latin: "marrow"); an inner area containing the cuplike calyces (singular, calyx; Greek: kalix, "cup") with the renal pelvis (Greek: "basin"); and the concavity known as the hilus (Latin: "a trifle"), where the renal artery enters the kidney and where the ureter and renal vein exit.

The basic structural and functional unit of the kidney is the nephron. Each kidney has about one million nephrons. The nephron is a tubule, highly modified at the one end to filter blood. The filtration occurs in a globular cluster of highly specialized capillaries called a glomerulus, which is enclosed by a thin capsule. The capsule is comprised of a single layer of squamous epithelium and has the shape of a partly deflated ball pushed in on one side by the glomerulus so that the capsule largely surrounds the glomerulus. The interface between glomerulus and capsule is characterized by numerous pores in the capillary and slits in the epithelial capsule, enhancing filtration of blood plasma. Blood enters the glomerulus from the afferent arteriole, a sixth-order branch of the renal artery and large quantities of fluid filter out of the blood into the capsule, forming a glomerular filtrate. Only water, ions, and small molecules are normally found in the filtrate. Proteins and the various "formed elements" (cells) of the blood do not pass through the glomerular-capsular barrier except in disease states (one reason why urine tests are valuable in diagnosis).

Each capsule opens into a duct called the proximal convoluted tubule, and the filtrate passes into it. Both the capsule and the proximal tubule are located in the cortex. The proximal tubule enters the medulla as the descending segment of the loop of Henle. The ascending segment of the loop enters the cortex to become the distal convoluted tubule, which then empties into the collecting duct.

The efferent arteriole leaving the capsule divides into a network of peritubular capillaries (not shown), which pass around all the parts of the tubule before emptying into a vein that will take the blood out of the kidney. As the filtrate passes through the nephron, approximately 99 percent of it is reabsorbed by the cells in the tubule wall and passed on into the peritubular capillaries. At the same time, various substances are secreted into the filtrate, including hydrogen and ammonium ions to reduce blood acidity. These tubular reabsorptions and secretions are carefully regulated by osmotic and hormonal mechanisms to maintain body homeostasis.

The collecting duct does not function in tubular reabsorption or secretion. It passes through the medulla, joining with others to form a larger collecting duct, which opens at the base of a renal pyramid. Here the urine (no longer called filtrate) is caught by the minor calyces, ducted into the major calyces, through the renal pelvis, and into the ureter.

The ureters conduct urine into the urinary bladder. Their epithelial lining is similar to that of the urinary bladder (see below). Smooth muscle, along with fibrous tissue, is found in the walls of the ureters and contributes to the expulsion of urine by peristaltic contractions.

The urinary bladder is situated in the front part of the pelvis. It is a fibromuscular sac lined with transitional (stratified, cuboidal) epithelium and has the capacity to distend in response to increasing volumes of urine or to contract in response to decreasing volumes. A tube called the urethra, lined with transitional epithelia in the upper portion, stratified columnar epithelia in the lower portion, exits from the base of the bladder and conveys urine to the outside of the body. The urethra is about 4 centimeters long in females, but about 20 centimeters in males because of its convoluted course.

Urinary System Questions

Directions: Read the passage, highlight important aspects, and then answer the following questions in complete, *authentic* sentences.

1. What are the three goals of the urinary system?
2. What is the basic structural and functional unit of the kidney? What is the major purpose of this unit?
3. Name two things that can be found in the filtrate.
4. A test indicates that a patient has a large amount of proteins his urine. What is the specific cause of this?
5. List or diagram the path the urine follows after leaving the minor calyces. (The path should end with urine leaving the body)
6. How does the urethra differ in males and females?

Cell Transport Poster

Construct a poster that *describes* and *illustrates* each of the following processes.

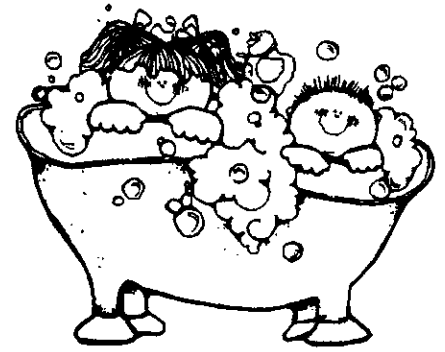
Passive Transport:

- Diffusion
- Osmosis (hypotonic, hypertonic, isotonic)
- Extra Credit: Cytolysis and Plasmolysis

Selective Transport:

- Facilitated Diffusion (include protein channel and concentration gradient)
- Active Transport: (include protein channel & energy)
- Endocytosis
- Exocytosis

- Diagram each: showing concentration of solutes/water (either by percentages or color codes), movement of molecules, & cell membrane
- Copy rubric on back part of poster



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Cell Transport Poster Rubric

| | 2 | 1 | 0 |
|-----------------------|--|---|--|
| Diffusion Diagram | Illustration neatly and clearly shows molecules diffusing and includes a title | Illustration show molecules diffusion | Illustration does not show molecules diffusing |
| Osmosis Diagrams | Illustrations neatly demonstrate hypotonic, hypertonic and isotonic solutions correctly + Title | Illustrations demonstrate hypotonic, hypertonic and isotonic solutions correctly | Illustrations of hypotonic, hypertonic and isotonic solutions are NOT present |
| Facilitated Transport | Illustration clearly shows cell membrane with protein channel + concentration gradient correctly + title | Illustration somewhat shows cell membrane with protein channel + concentration gradient | Illustration does not show cell membrane with protein channel + concentration gradient correctly |
| Active Transport | Illustration show exocytosis and endocytosis neatly and correctly + title | Illustration show exocytosis and endocytosis somewhat neatly and correctly | Illustration of endocytosis and exocytosis are not present or correct |
| Neatness | Poster depicts neatness, color and appropriate titles + rubric is glued on back | Poster is missing neatness or color or appropriate titles + rubric is glued on back | Poster is missing neatness, color, or appropriate titles and rubric is not glued on back |

Student names (First and Last) _____

Period: _____

Total = _____ x 2 = _____

