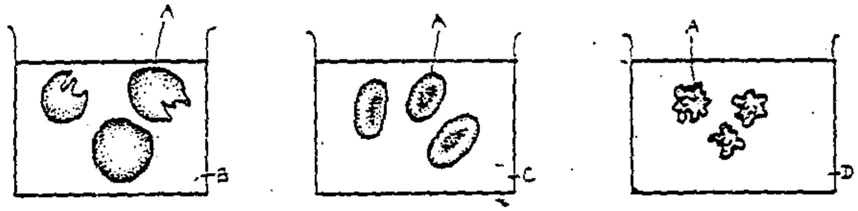
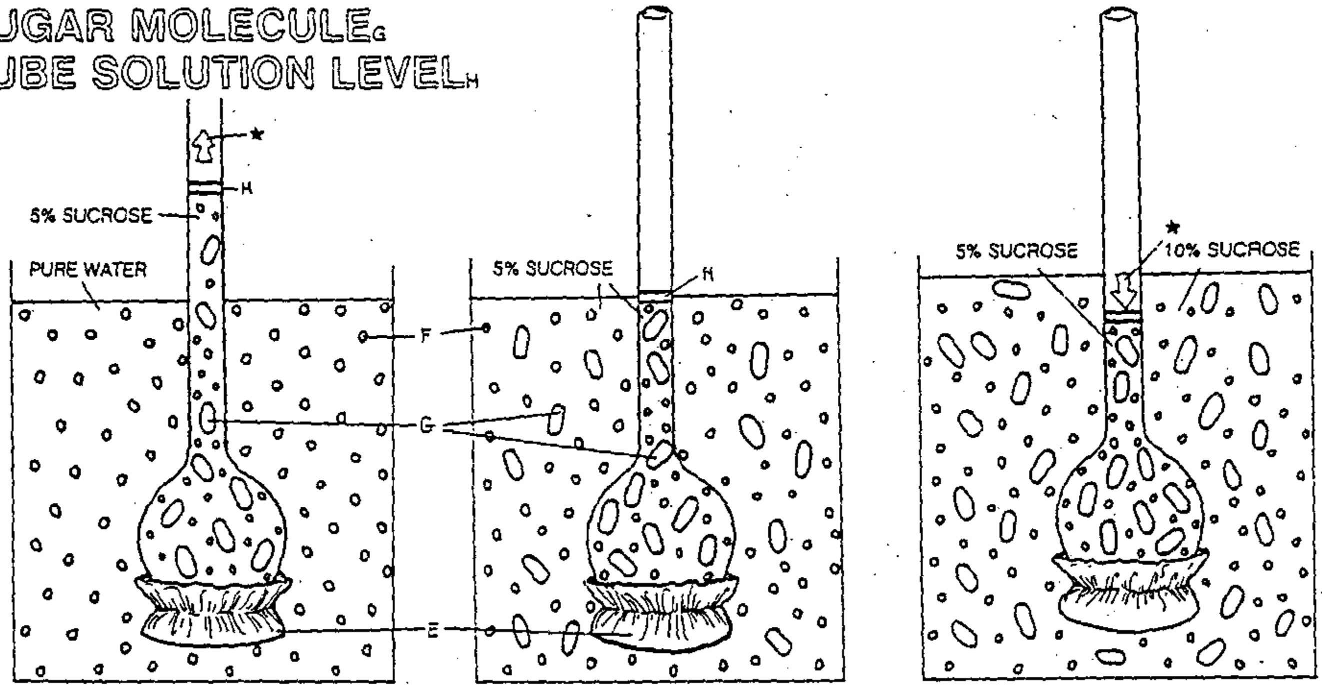
OSMOSIS.

ERYTHROCYTE A
PURE WATER B
0.85% SALT SOLUTION C
2% SALT SOLUTION D



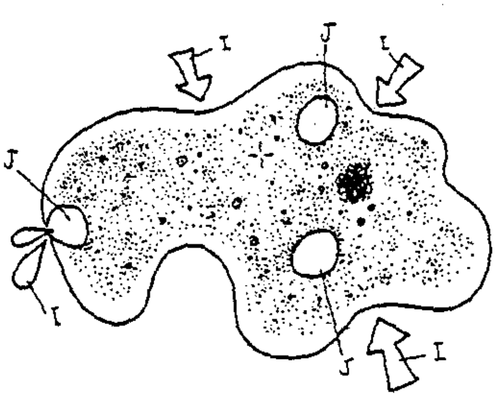
OSMOMETER *
SELECTIVELY PERMEABLE MEMBRANE E
WATER MOLECULE F
SUGAR MOLECULE G
TUBE SOLUTION LEVEL H

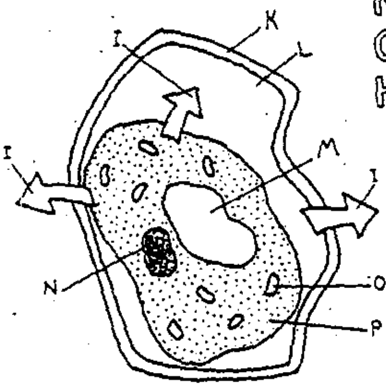


HYPOTONIC *   ISOTONIC *   HYPERTONIC *

AMOEBA *
WATER I
CONTRACTILE VACUOLE J

WILTING PLANT CELL *
CELL WALL K
AIR SPACE L
SHRUNKEN VACUOLE M
NUCLEUS N
CHLOROPLAST O
HYALOPLASM P





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. Thi s 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 go 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 tube 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 them lose water by placing them in a hypertonic solution), they shrink away from their cells 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?

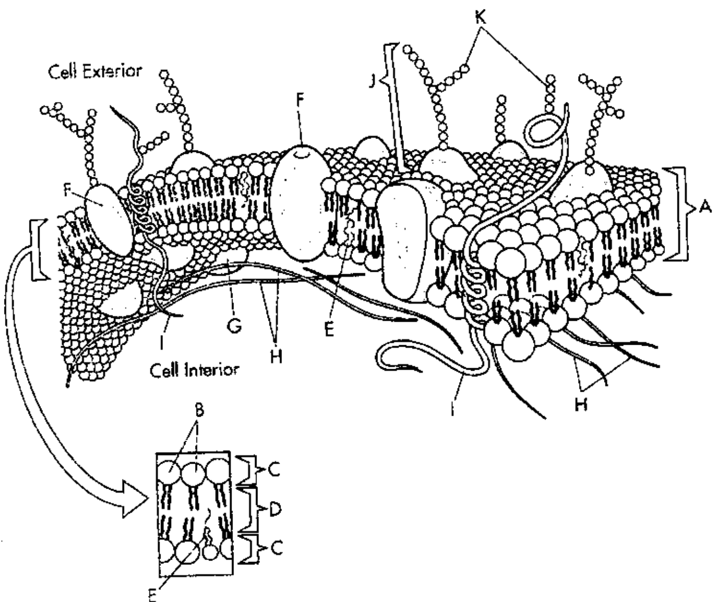
6. Describe two examples in which living things have adapted strategies of surviving the forces of osmosis.

NAME ______________________________ GROUP # ________

LAB: Diffusion Across A Cell Membrane

Pre-Lab:

1. Color the diagram of the cell membrane structure.

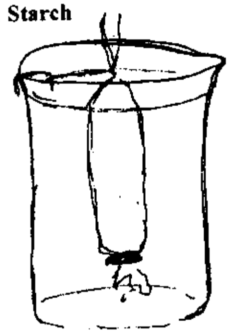


The Cell Membrane

- O Lipid Bilayer ....A
- O Phospholipids..........B
- O Hydrophilic Polar Head C
- O Hydrophobic Nonpolar Tail ....D
- O Cholesterol Molecule ..E
- O Integral Protein ......F
- O Peripheral Protein ....G
- O Cytoskeleton Filaments.............H
- O Alpha Helix Protein ..I
- O Glycoprotein ....J
- O Carbohydrate ....K

2 . Consider each of the four molecules we are testing as independent systems. Label each diagram showing the location and relative concentration of both the molecule and the water. Write a hypothesis predicting the direction of movement of each. .

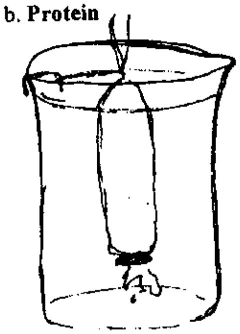
a. **Starch**



Hypothesis:

Conclusion:

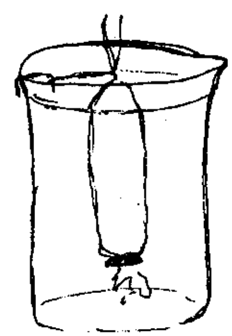
b. **Protein**



Hypothesis:

Conclusion:

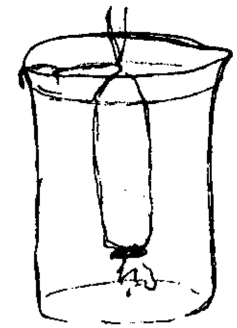
c. **Sodium Chloride**



Hypothesis:

Conclusion:

d. **Sugar (Glucose)**



Hypothesis:

Conclusion:

G3

DATA

Part I:

Organic Nutrient	Indicator	Observation
Starch		
Protein		
Sodium Chloride		
Sugar/Glucose		

Part II:

Organic Nutrient	15 minutes	25 minutes
Starch		
Protein		
Sodium Chloride		
Sugar/Glucose		

ANALYSIS QUESTIONS

1. Which nutrients diffused through the dialysis membrane? Which did not?

2. The chloride ion has a molecular weight of 35 while glucose is 180. Can you determine any comparison between the nutrients' weight and the time it took for diffusion to take place?

3. What must take place before proteins or starches can diffuse into cells?

4. Define osmosis and diffusion. Which principle is exhibited in this experiment?

CONCLUSION

1. Explain how the evidence supports or refutes each hypothesis in Q#3.

STARCH:

PROTEIN:

SODIUM CHLORIDE:

SUGAR:

2. Identify any experimental errors that may have affected your results.

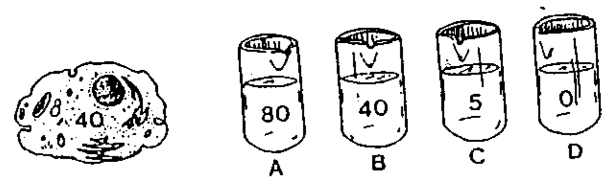
Direction of Osmosis

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	HYPOTONIC	HYPERTONIC	into the cell
If solute concentration in the environment is higher than in the cell	HYPERTONIC	HYPOTONIC	out of the cell
If solute concentration in the environment is equal to that in the cell	ISOTONIC	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



1. Solution A is (hypertonic, hypotonic, isotonic) relative to the cell because ____________________

2. Solution B is (hypertonic, hypotonic, isotonic) relative to the cell because ____________________

3. Solution C is (hypertonic, hypotonic, isotonic) relative to the cell because ____________________

Solution D is (hypertonic, hypotonic, isotonic) relative to the cell because ____________________

5. Solute molecules from which solution would be most likely to diffuse into the cell? __________

Why? ____________________

6. What would happen to the the cell if it was placed in solution C? __________ Why ?

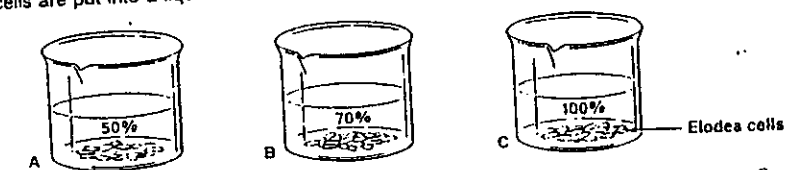
7. Which solution best represents the fluid that surrounds the cells in our bodies? __________

Why ? ____________________

Cell Processes

The cytoplasm of *Elodea* cells is composed of about 70 percent water molecules and 30 percent oth kinds of molecules.

Read the three examples given below.
A. *Elodea* cells are put into a liquid that is 50 percent water.
B. *Elodea* cells are put into a liquid that is 70 percent water.
C. *Elodea* cells are put into a liquid that is 100 percent water.



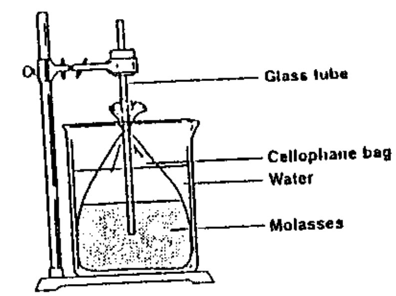
Study the predictions below and select the example above that matches the prediction. On the line ı *the left, write the letter of the example you select.*

_____ 1. The *Elodea* cells in the liquid will shrink.

_____ 2. The *Elodea* cells in the liquid will swell.

_____ 3. The *Elodea* cells will not change in size.

The diagram to the right shows a cellophane bag containing molasses. The bag is in a beaker of water. An open glass tube extends from the bag. The molasses comes up a short distance in the tube.



Use the diagram to answer the questions below.

_____ 1. Movement of water molecules across the membrane is the result of
(a) osmosis. (b) breathing. (c) the glass tube. (d) air pressure.

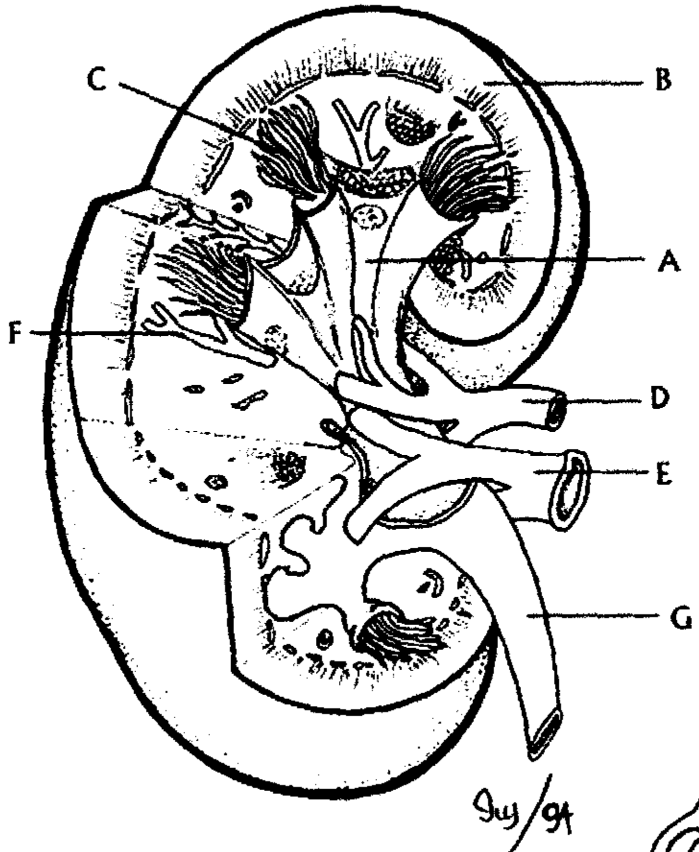
_____ 2. After 24 hours, the size of the cellophane bag will probably be
(a) smaller. (b) larger. (c) the same.

_____ 3. After 24 hours, the beaker will contain
(a) water only. (b) molasses only. (c) both water and molasses. (d) neither water nor molasses.

_____ 4. After 24 hours, the cellophane bag will contain
(a) water only. (b) molasses only. (c) both water and molasses. (d) neither water nor molasses.

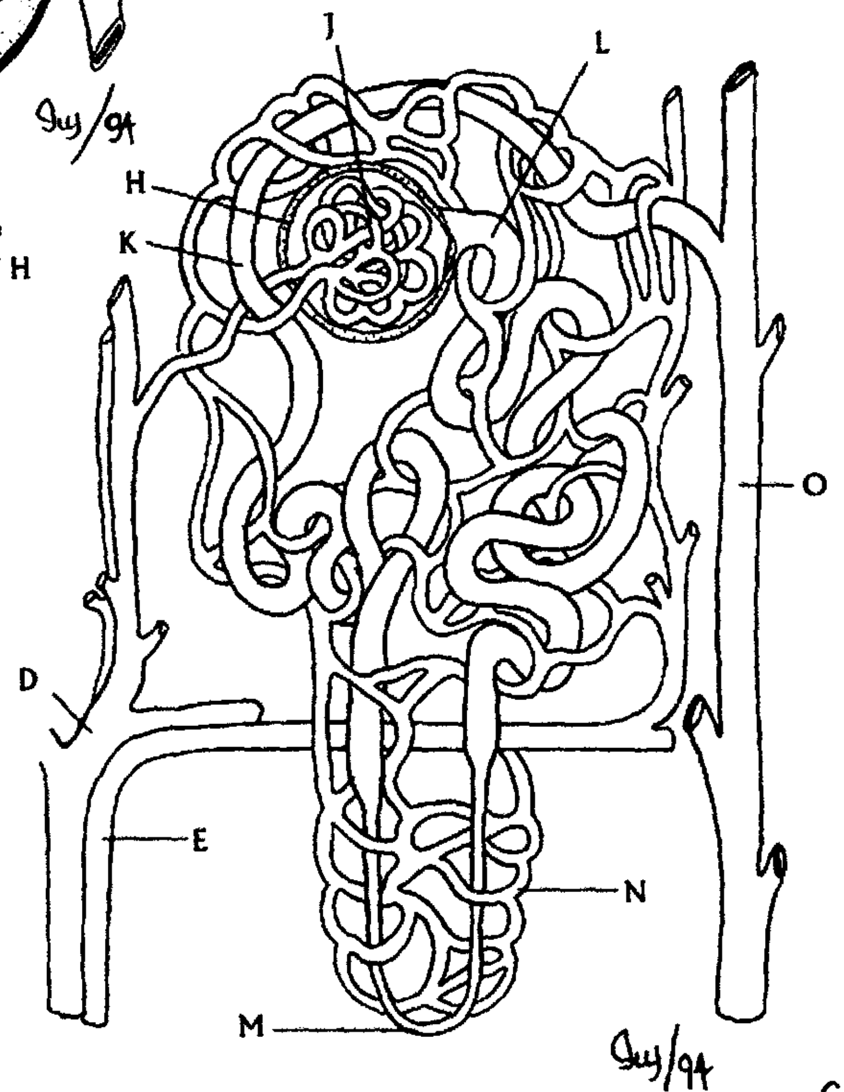
_____ 5. After 24 hours, the level of liquid in the glass tube
(a) will be lower. (b) will be higher. (c) will be the same.

STRUCTURE OF THE NEPHRON



RENAL PELVIS$_A$
CORTEX$_B$
MEDULLA$_C$
RENAL ARTERY$_D$
RENAL VEIN$_E$
NEPHRON$_F$
URETER$_G$

BOWMAN'S CAPSULE$_H$
GLOMERULUS$_J$
DISTAL TUBULE$_K$
PROXIMAL TUBULE$_L$
LOOP OF HENLE$_M$
CAPILLARIES$_N$
COLLECTING DUCT$_O$



How the Kidney Works

The basic structural and functional unit of the kidney is the nephron. Each kidney has about 1 million nephrons, all packed into an area of the kidney called the cortex. The nephron's primary function is to filter blood, but as you can see from the diagram, this is not a simple process. The nephron has three major parts: the glomerulus, the Bowman's Capsule, and the tubule (which is further divided into the promimal and distal tubule and the Loop of Henle).

Blood enters the kidney from the renal artery and moves into the glomerulus, where filtration occurs. Filtration is the process by which water and dissolved particles are pulled out of the blood. The resulting liquid, called filtrate contains water and many of the toxic substances that might have accumulated in the blood (like ammonia). The glomerulus is enclosed by the Bowman's capsule, small molecules and water can pass through this area, but larger molecules do not. The filtrate is then collected in the Bowman's capsule for transport through the nephron.

The nephron itself will restore vital nutrients and water back into the blood, while retaining the waster products the body needs to eliminate. Two processes accomplish this task: tubular reabsorption and tubular secretion. During tubular reabsorption, cells in the proximal tubule remove water and nutrients from the filtrate and pass them back into the blood, wastes such as urea are retained in the tubule. During tubular secretion, wastes that were not initially filtered out in the bowman's capsule are removed from the blood in the distal tubule. Ammonia and many drugs are removed from the blood during tubular secretion.

The concentrated filtrate moves into the proximal tubule. Notice the capillaries that wrap around the tubules. At the points of contact with the tubule and the capillaries, water and nutrients are reabsorbed into the blood. In addition, wastes remaining in the blood after filtration are passed to the tubule. The filtrate flows from the proximal tubule and into the Loop of Henle. The loop of henle concentrates the filtrate, by removing more water from it, and passes it to the distal tubule. From the distal tubule it travels to the collecting duct - now called urine. The collecting duct prepares the urine for transport out of the body, it is collected in the renal pelvis where it eventually enters the ureter. From there it goes to the bladder.

Meanwhile, the blood capillaries that are twisted around the nephron join back to the renal vein, from there the blood travels to the posterior vena cava, eventually reaching the heart where it is oxgenated, but that is a topic for the "Circulatory System".

Coloring Instructions

1. Color the renal artery red, and continue the flow of blood through the capillaries. It will remain red until it reaches the area of the Loop of Henle, then the blood is deoxygenated, and should be colored blue. The renal vein should be colored blue, tracing its path until the blue capillaries meet the red capillaries (near the loop of henle). You'll have to be careful when coloring the arteries and veins, as they are twisted about the entire nephron. Also note that the blood from the renal artery enters the glomerulus and then exits again, to twist around the distal tubule. The capillaries should be colored purple, to show the mixing of the blood (blue and red make purple)

2. Color the renal vein (blue) and the renal artery (red) on the kidney as well as the nephron.

3. Color the proximal tubule dark green, until it reaches the loop of henle. The loop of henle should be colored pink, and then when it changes into the distal tubule, color the distal tubule light green.

4. Color the Bowman's capsule brown, leave the glomerulus white, you should have already colored the arteries inside it red.

5. Color both the collecting duct and the ureter yellow.

6. Color the medulla (there are 3 pictured) light green. Color the cortex pink, and the renal pelvis yellow. The nephron pictured on the kidney should be colored orange.

Questions (answer on the back of the coloring sheet)

1. What is the function of the glomerulus and the bowman's capsule?
2. What is the function of the loop of henle?
3. Compare the processes of the distal tubule to the proximal tubule.
4. Trace the flow of blood through the nephron.
5. Trace the flow of filtrate through the nephron (beginning at the glomerulus).

Name Date Class

Activity 6 **Tech Prep Applications**

Inside the Artificial Kidney Machine

Use with Chapter 7: A View of the Cell

One of the most important organs in vertebrates is the kidney. Kidneys, which occur in pairs, help maintain homeostasis by regulating the concentrations of dissolved substances in the blood. Without this constant monitoring by the kidneys, the nitrogenous waste products of cellular activity can build to toxic concentrations. It is possible to live with only one kidney; however, if both kidneys fail, people must have their blood filtered by an artificial kidney machine in a process called hemodialysis. In this activity, you will investigate how artificial kidney machines duplicate the important functions of kidneys.

Part A: Nephron Structure and Function

Each kidney is composed of nearly one million tiny filtering units called nephrons (Figure 1). Through a complex process involving both active and passive transport of substances, nephrons filter out excess water, waste molecules, and excess ions from the blood, and ensure that critical nutrients such as glucose and proteins remain in the blood. The table in Figure 1 shows how the concentrations of substances dissolved in the blood change as they pass through the kidney. Study the table and diagram of the nephron in Figure 1, and then answer the following questions.

Dissolved Substances	Concentrations of Dissolved Substances (mg/100 mL of fluid) Arterial Blood (A)	Filtrate (B)	Urine (C)
Urea	30	30	2000
Uric Acid	2	2	30
Glucose	100	100	0
Salts	900	900	2300
Protein	8500	0	0

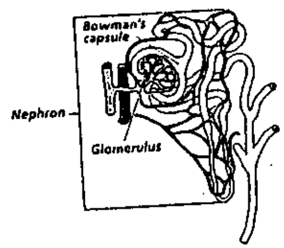


Figure 1

1. Bowman's capsule is a selectively permeable structure. According to the table, which substances pass through Bowman's capsule into the tubule to become filtrate?

2. Which parts of the nephron actually filter the blood?

3. Using your understanding of diffusion, how might you account for the increases in concentration of urea, uric acid, and salts in urine?

4. What happened to the glucose in the filtrate? What process was involved?

Name Date Class

Activity 6 **Tech Prep Applications**

Inside the Artificial Kidney Machine

Part B: How Do Artificial Kidney Machines Work?

Artificial kidney machines, like kidneys, work by the process of diffusion. During dialysis, blood is pumped from a person's artery through selectively permeable tubing that is bathed in a solution similar to actual blood plasma. As the blood circulates through the tubing, waste materials diffuse from the tubing into the surrounding solution and are washed away. The cleaned blood left behind is then returned to a vein.

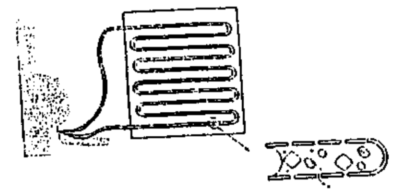


Figure 2

Study the diagram in Figure 2 and answer the following questions.

1. Using your knowledge of diffusion, explain what happens to the waste materials as the blood circulates through the machine.

2. Explain what would happen to the diffusion process if the solution surrounding the tubing were not regularly cleaned and discarded.

3. Which molecules would you expect to find in the tube leading back from the machine to the person's vein?

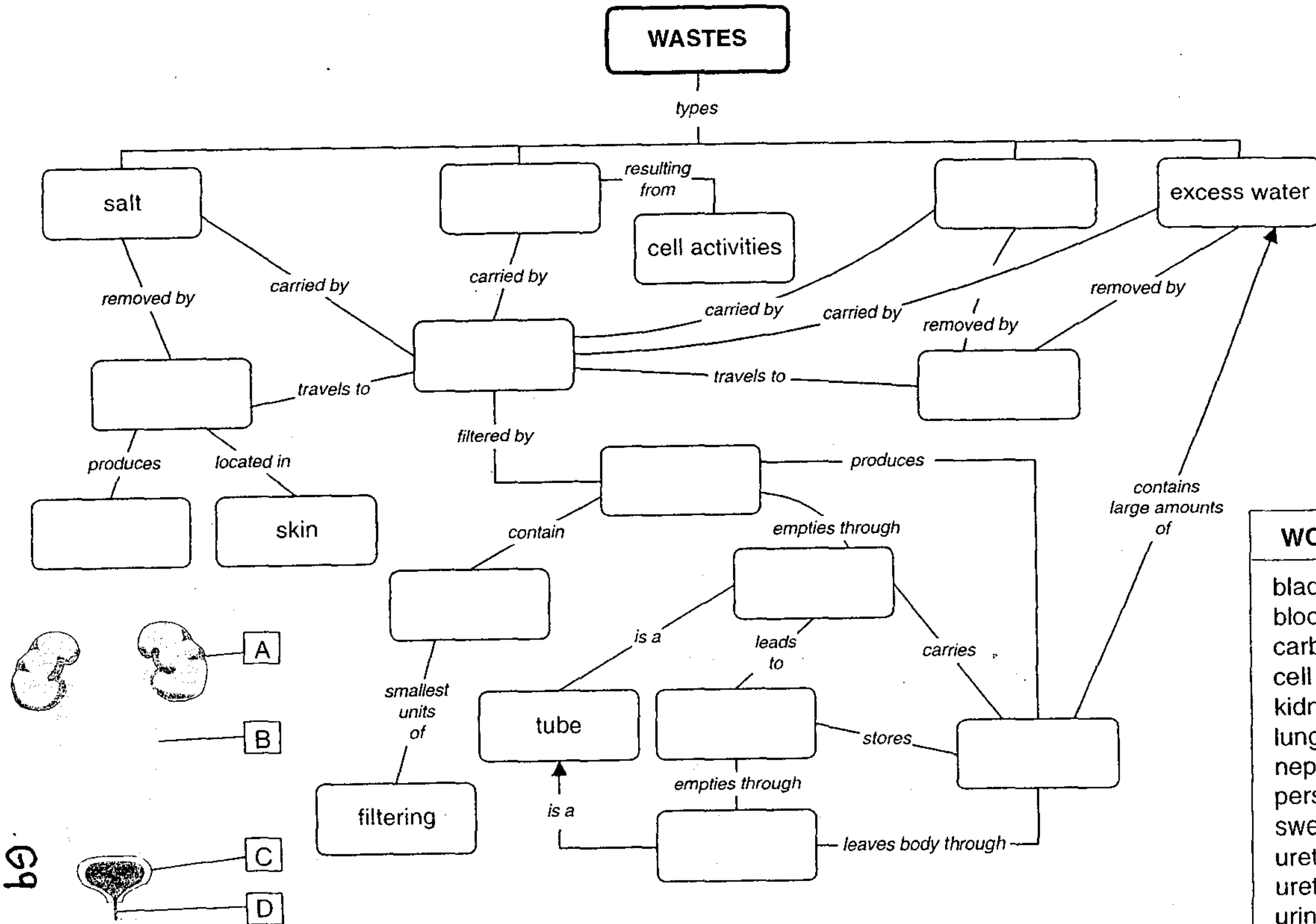
4. Explain why blood cells, glucose, protein, salts, and water don't leave the tubing.

Concept Map: Excretory System

Name ______________________

Date ________________ Period ____

Directions: Select words from the word list and fill in the blank map items. Use each word only once, and use all the words on the list. Write the letter of each label on the diagram in the box with its corresponding name.



WORD LIST

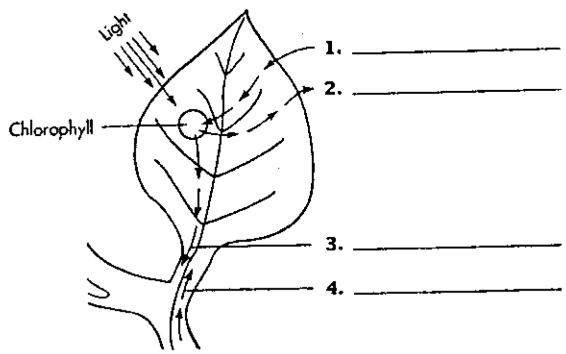
- bladder
- blood
- carbon dioxide
- cell wastes
- kidney
- lungs
- nephrons
- perspiration
- sweat glands
- ureter
- urethra
- urine

G9

Photosynthesis and Respiration

After it is labeled the diagram below will illustrate photosynthesis. Write each of the following terms on the correct numbered line. Then answer the questions that follow.

Carbon dioxide **Glucose** **Oxygen** **Water**



5. a. In photosynthesis, what comes in from the outside? ______________________

____

b. What are the end products of the process? ______________________

6. Write the overall equation for photosynthesis in the space below.

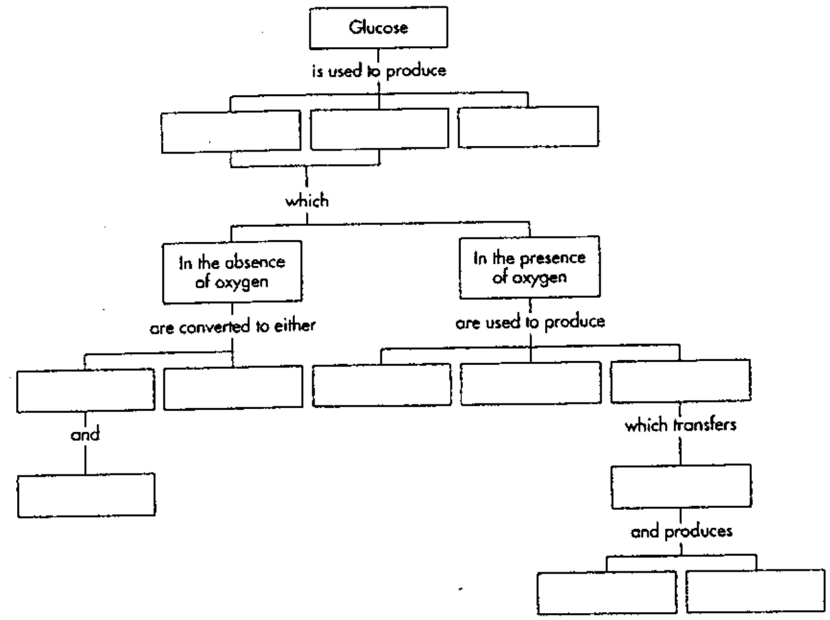
____

Answer the following questions relating to cellular respiration.

7. The purpose of cellular respiration is to store the energy of chemical bonds of glucose in molecules of ______________.

8. Write the formula that shows the release of energy by a molecule of ATP.

____



9. Place a star under each of the boxes that show stored energy.

10. Color the boxes in the concept map above. Use one color for the boxes that show glycolysis. Then use different colors for (a) the path taken during fermentation and (b) the path taken during oxidative reproduction.

11. a. In the process of cellular respiration, what substance comes in from the outside?

____

b. What are the end products of the process? ______________________

12. Write the overall equation for cellular respiration in the space below.

____

13. Compare the equation for oxidative respiration with the equation for photosynthesis.

____

____

WORD BANK:

ATP (3x)	Ethyl Alcohol	Electrons	Carbon Dioxide (2x)	Lactic Acid
Glucose	NADH (2x)	Pyruvate	Water	

G10

The Flow of Matter and Energy in the Living World: Photosynthesis and Cellular Respiration

Pre-test: Answer each questions TRUE or FALSE

_____1. All living things are able to capture the energy of sunlight and use it to power their life processes.

_____2. Many animals exhale carbon dioxide as a waste product, but plants need carbon dioxide to live.

_____3. The oxygen in our atmosphere comes from plants.

_____4. Matter and energy flow through food chains.

_____5. Chlorophyll is needed for cellular respiration.

Video Notes: Answer the following questions as directed by your teacher.

1. Write out the basic equation for photosynthesis and a paragraph describing what happens during photosynthesis.

2. Write out the basic equation for cellular respiration and a paragraph describing what happens during cellular respiration.

3. Define:
    a. Chlorophyll
    b. ATP
    c. Food chain
    d. Glucose
    e. Products
    f. Reactants

Video Quiz: Answer the following questions either True or False

1. TRUE OR FALSE? Elements are pure types of matter. _____
2. TRUE OR FALSE? Atoms are made from molecules. ______
3. TRUE OR FALSE? Chlorophyll is needed for cellular respiration. ______
4. TRUE OR FALSE? Matter and energy flow through food chains. _____
5. TRUE OR FALSE? Chemical compounds contain at least two types of atoms. ____

Diffusion and Cell Size

Background

The absorption of nutrients, excretion of cellular wastes, and the exchange of respiratory gases are life processes which depend upon the efficient transport of substances into, out of, and throughout living cells. Much like a drop of blue dye soon fills up a glass of water, many important substances move into and out of cells by diffusion. Diffusion is the movement of a substance through a concentration gradient from high to low concentration. It is an example of passive transport because it requires no energy on the part of the cell. For this reason, diffusion is one of the most common and efficient means by which substances are transported between cells and their environment.

The cell membrane is the selectively permeable barrier whose total surface area is important in regulating the substances that diffuse into or out of the cell. However, as a cell grows in size, its volume increases at a greater rate than its surface area. Consequently, the surface area of the growing cell soon becomes inefficient for effective diffusion throughout the cell. This relationship between surface area and the volume of a cell can be expressed as a ratio; and the need for an effectively large surface area to volume ratio is considered to be the most significant factor in triggering a cell to divide, and therefore, determining cell size.

Most human cells are .01 to .03mm. The following activity is designed to demonstrate that, while an increase in size and cell membrane surface area may increase the rate of diffusion, cells must remain small to maximize the efficiency of diffusion. Your group will make three model cells of different sizes and measure the extent and rate of diffusion into each cell. You will also calculate the surface area to volume ratio for each cell finding that the smallest cell with the greatest ratio demonstrates the most efficient diffusion.

Three model cells, a 3cm, 2cm, and 1 cm cube, will be cut from a block of agar. The agar has been conveniently prepared with phenolphthalein, an acid/base indicator, The agar will be soaked in a dilute base to produce a pink to red color. This color change provides a safe and easy way to measure the extent of diffusion into the "cell" after a given period of time.

Objective

To determine the extent and rate of diffusion into three agar cubes, and calculate the surface area to volume ratio for each cube to find the relationship between cell size and diffusion.

Materials Provided:

1 block of Phenolphthalein Agar
Metric Ruler
Plastic Cup
Fishing Line
Plastic Spoon
Ammonia

Procedure

SAFETY FIRST: ***Wear safety goggles and plastic gloves during this activity. Use caution when handling the agar and WARD'S Diffusion Medium; each contains chemicals which are irritating to skin and eyes.***

1. Obtain a 3cm x 3cm x 6cm agar block from your teacher. Using a plastic knife, trim this piece to a cube.3cm x 3cm x 3cm. Repeat this procedure to make two more cubes 2cm and 1 cm.

2. Place the three cubes carefully into a plastic cup. Add ammonia until the cubes are submerged. Using a plastic spoon, keep the cubes submerged for 10 minutes turning them frequently. Be careful not to scratch any surface of the cubes.

3. As the cubes soak, calculate the surface area, volume, and surface area to volume ratio for each cube. Record these values in Data Table 1. Use the following formulas:

surface area = length x width x number of sides

volume = length x width x height

Data Table 1: Agar Cubes

Cube Size	Surface Area (cm^2)	Volume (cm^3)	Surface Area/volume (smallest ratio)
3cm			
2cm			
1cm			

4. After 10 minutes, use the spoon to remove the agar cubes and carefully blot them dry on a paper towel. Then, cut the cubes in half, rinsing and drying the knife between each cut. Note the color change from red or pink to clear that indicates the diffusion ammonia into the "cube." Sketch the inner face of each of the agar cubes after the diffusion of the ammonia. Accurately label all the dimensions of both the area that reacted with the ammonia and the area that did not react with the ammonia.

5. Using a metric ruler, measure the distance in centimeters that the ammonia diffused into each cube. Record the data in Data Table 2. Next, record the total time of diffusion. Finally, calculate and record the rate of diffusion for each cube as centimeters per minute.

Data Table 2: Rate of Diffusion

Cube Size	Depth of Diffusion (cm)	Time (min)	Rate of Diffusion (cm/min.)
3 cm		10	
2 cm		10	
1 cm		10	

6. Calculate the volume of the portion of each cube which has not changed color. Record your results in Data Table 3.
7. Calculate the extent of diffusion into each cube as a percent of the total volume.

$$\frac{\text{Total Cube Volume} - \text{Volume of Cube which has NOT Changed Color}}{\text{Total Cube Volume}} \times 100 = \text{Percent of Cube Volume (Extent of Diffusion)}$$

Data Table 3: Extent of Diffusion

Total Volume of Cube (cm^3)	Volume of Cube which has NOT Changed Color	Percent Volume of Cube which has Changed Color (Extent of Diffusion)
27		
8		
1		

Questions

1. Explain why the diffusion of ammonia into the agar cube caused the observed color change.

2. According to Data Table 3, into which cube did the ammonia diffuse most- the largest or smallest?

3. If each cube represented a living cell and the ammonia a substance needed within the cell, what problem might exist for the largest cell?

4. Examine your data in Data Table 2 for a relationship between cube size and the rate of diffusion into the cube. Make a generalized statement about the relationship between cell size and the rate of diffusion.

5. Examine your data in Data Table 1. Describe what happens to the surface area, the volume, and their ratio as a cell grows larger.

6. According to the results of your investigation, describe the characteristics of cell size, surface area, and surface area to volume ration which best meets the diffusion needs of living cells.