Name_______________________________

GLOSSARY

Active transport – movement of matter into, or out of, a cell which requires energy from the cell; usually this involves movement against the concentration gradient

Adenosine triphosphate (ATP) – the molecule used in cell processes as a supply of energy; it is produced by cells during cellular respiration

Alveoli – microscopic air sacs in the lungs; the site where most gas exchange occurs

Capillaries – microscopic blood vessels; most matter exchange between body cells and the blood occurs through the walls of the capillaries

Carrier protein – a molecule in the cell membrane that allows materials to pass through it

Cell membrane – the outer semipermeable covering of the cell; it is very thin and flexible

Cellular respiration – the process that converts the potential energy of food into other useful forms; its most important product is ATP

Concentration gradient – a difference in concentration of a particle at two points in a space

Diffusion – net movement of particles from an area of high concentration to an area of low concentration

Endocytosis – a process cells use to capture large particles; the cell membrane wraps around the particle and encloses it

Epidermis – an outer layer of cells covering plants and animals; its primary function is protection

Exocytosis – a process cells use to expel material; a vacuole connects to the cell membrane and opens so its content is now outside of the cell

Guard cells – the specialized plant cells which surround, and control the opening and closing of, the stoma

Lenticels – small pores visible on the stems of many plants; important for gas exchange

Metabolic rate – the rate at which an organism is converting energy

Osmosis – diffusion of water through a membrane

Passive transport – diffusion of materials across a membrane requiring no energy input

Root hairs – microscopic extensions from the surface cells of roots

Semipermeable membrane – a pliable tissue which allows some materials to pass, but stops others; cell membranes are semipermeable

Stomata (singular: stoma) – small openings on the surface of plant leaves which can open and close to control the movement of gases, particularly water vapor

Surface area to volume ratio – a value calculated by dividing the surface area of an object by the volume it contains; this ratio is large for cells efficient at exchanging materials with their surroundings

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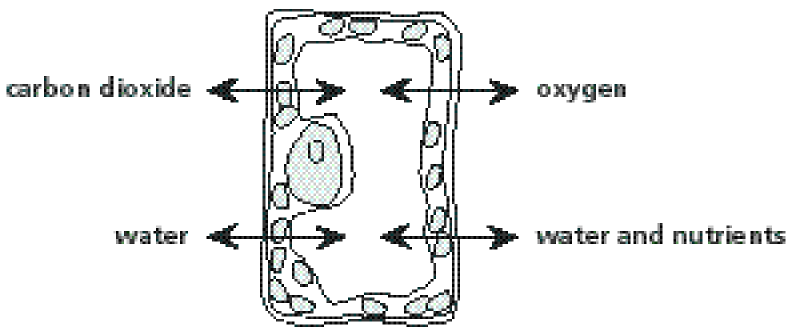
CELLULAR RESPIRATION

Write the balanced chemical equation for cellular respiration.

$C_6H_{12}O_{6(s)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)}$ + energy

Material constantly enters and leaves plant cells. Water, oxygen, carbon dioxide and nutrients pass through the cell membrane easily. Because some materials are able to pass through and some are stopped, the cell membrane is "semipermeable."



Check your understanding of this segment by completing the following. Use the back of the sheet if necessary.

1. Compare a single-celled organism, Amoeba, with a multicellular organism, a fish. Explain what special problems each must overcome to get the nutrients it requires.

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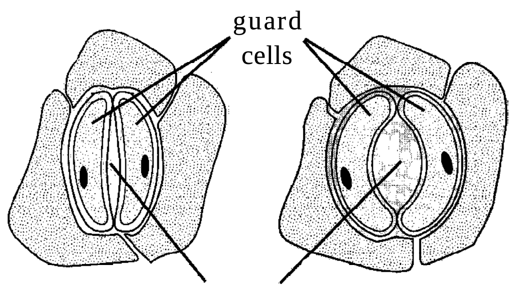
GAS EXCHANGE IN PLANTS

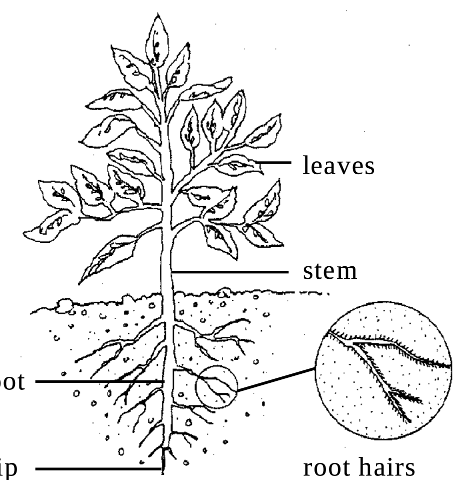
Plant leaves have a thick outer layer to protect them from the drying air. To allow gas exchange, there are small holes on the surface of the leaf. These holes are called stomata. They open when two bean-shaped cells (known as guard cells) around the stoma fill with water.



The stem of a plant has openings called lenticels. You can often see them on new shoots in the spring, or at the base of spruce trees.

Roots also exchange gases. Finger-like projections called root hairs extend from the surface of the root. These increase the surface area enormously and speed up the exchange. The root hairs absorb gases dissolved in water in the soil.

Plant Root Systems



Check your understanding of this segment by completing the following. Use the back of the sheet if necessary.

2. The epidermis of a plant leaf is tough and waxy and makes gas exchange more difficult. What benefit does an epidermis have for the plant?

3. Most plants have many more stomata than lenticels. Why?

4. Why must roots be wet to function properly?

5. Would you expect carbon dioxide to diffuse into or out of stomata during the daylight hours? What about oxygen?

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GAS EXCHANGE IN ANIMALS

All of our cells require oxygen, which we absorb in our lungs. Predict how the oxygen gets from the lungs to all the cells of the body.

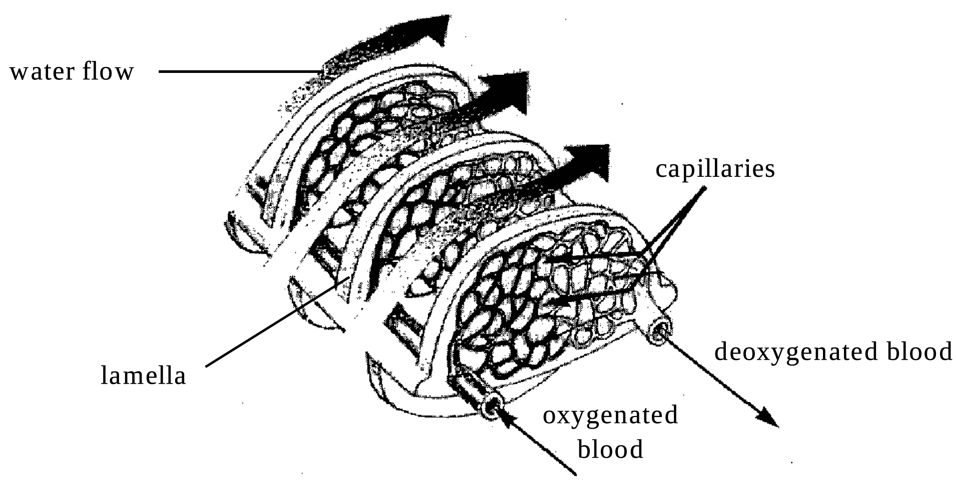
Gases and other nutrients are carried in the blood to all parts of the body.

Large organisms, like human beings, need to absorb gases. We also require a method of moving the absorbed gas around the body.

Lungs are structured to allow efficient gas exchanges. Lungs are not empty sacks, but tissues that are finely divided. This increases the surface area of the lung, allowing for speedy gas exchange. Once absorbed, gases must be transported to all parts of the body. For that reason the alveoli are surrounded by blood-carrying capillaries.

A fish's gills act in the same way. They are red because they are filled with blood-carrying capillaries. Gases exchange between the water and the blood by diffusing through the membranes of the gills.

Gill Filament



<u>Check your understanding of this segment by completing the following. Use the back of the sheet if necessary.</u>

6. Do fish and humans exchange the same gases with their environments?

7. Why would gills not function properly for land animals?

8. Why are gills and lungs both surrounded by capillaries?

9. Investigate the gas exchange system of a grasshopper.

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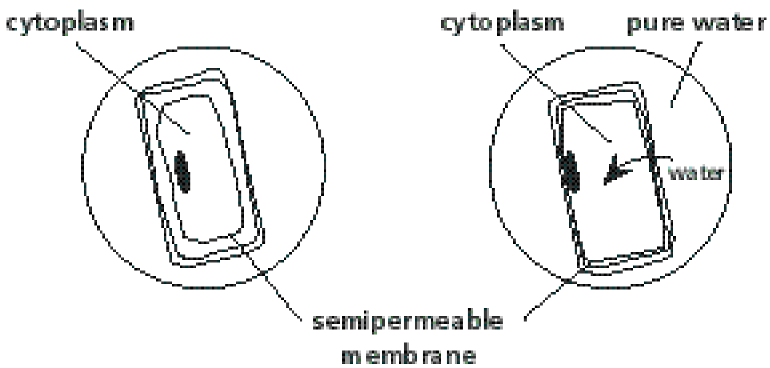
PASSIVE TRANSPORT

Pour a teaspoon full of vinegar onto a paper towel or cloth and put it into a plastic bag. Close the bag and wait about five minutes. Hold the bag at arm's length in a room without any breeze or draft. Slowly remove the cloth from the bag. Count how many breaths you can take before you smell the vinegar.

This gives you a rough idea of the speed of diffusion of vinegar molecules through air.

Inside and outside cells, water will diffuse from higher to lower concentration until it reaches equilibrium. This is called osmosis.

The cytoplasm of a cell has many materials dissolved in it. When the cell is placed in pure water, the net flow of water by osmosis is into the cell.



Check your understanding of this segment by completing the following. Use the back of the sheet if necessary.

10. Compare and contrast diffusion and osmosis.

11. Food can be preserved by salting it. What would happen to the water inside bacteria when they are in an extremely salty environment?

12. The contractile vacuole of a Paramecium constantly pumps water out of the cell. Why would a Paramecium need to remove water?

13. After a long bath your finger tips look all wrinkled. Why?

14. "Reverse osmosis" is a method of purifying water. Considering the meaning of osmosis, explain how reverse osmosis would make water more pure.

15. Some people claim to "learn by osmosis" – does this make sense?

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ACTIVE TRANSPORT

If a microscope is available, mix household yeast with water and a drop of food colouring. Prepare a wet mount slide and observe the yeast cells.

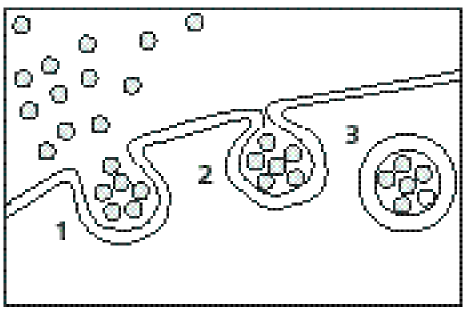
Now boil the yeast and water (a microwave oven will work).

Observe the yeast under the microscope once again.

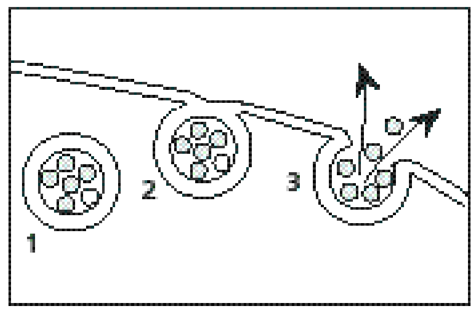
Compare the yeast cells before and after boiling.

The living yeast cells use active transport to remove dye molecules. Because of this, they do not become coloured. Once killed by boiling, the cells are no longer able to do active transport and will pick up the colour of the dye.

Cells use endocytosis and ectocytosis to acquire and remove large particles which cannot be accommodated by diffusion.



Endocytosis



Ectocytosis

<u>Check your understanding of this segment by completing the following. Use the back of the sheet if necessary.</u>

16. Explain the difference between endocytosis and exocytosis.

17. What two organelles are involved in endocytosis?

18. What is the role of adenosine triphosphate (ATP) in active transport?

19. A Paramecium’s contractile vacuole pumps water out of the cell. Is this active or passive transport?

20. Describe the role of carrier proteins in active transport.

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CELL SIZE

Place your hand, with your fingers together, flat on a blank page and trace it with a pencil. Measure the length of the line you drew. (Use a piece of string!)

Now do the same thing again, except spread out your fingers.

Compare the length of the two lines.

Describe how this activity demonstrates the ideas of surface area and volume.

The length of the line corresponds to the surface area. The space your hand occupies corresponds to the volume. By spreading your fingers you increased the surface area, but the volume of your hand remained unchanged. This shows that dividing objects into smaller pieces increases the surface area to volume ratio.

Calculating surface area to volume ratio of a cube.

1. Find the surface area to volume ratio of a sugar cube with sides 1.0 cm in length.

$$\frac{\text{surface area}}{\text{volume}} = \frac{\text{number of sides} \times \text{area of one side}}{\text{volume}}$$

$$= \frac{n(l \cdot w)}{l \cdot w \cdot h}$$

$$= \frac{6(1.0\ \text{cm})(1.0\ \text{cm})}{(1.0\ \text{cm})(1.0\ \text{cm})(1.0\ \text{cm})}$$

$$= \frac{6.0\ \text{cm}^2}{1.0\ \text{cm}^3}$$

$$= 6.0^*$$

* Note that surface area to volume ratios are reported without units.

Check your understanding of this segment by completing the following. Use the back of the sheet if necessary.

21. Find the surface area to volume ratio for a cube with sides 0.20 cm long.

22. Does the surface area to volume ratio increase or decrease as a cell gets larger?

23. What is more efficient for exchange of materials with the surroundings, a large or a small surface area to volume ratio?

24. Sketch a scale diagram of two cells with a volume of 12 cm^3: one with dimensions of 3 cm x 2 cm x 2 cm, the second with dimensions 12 cm x 1 cm x 1 cm.

25. Which of the two cells you sketched has the greater surface area to volume ratio? Which cell would be more efficient at exchanging materials with the environment?