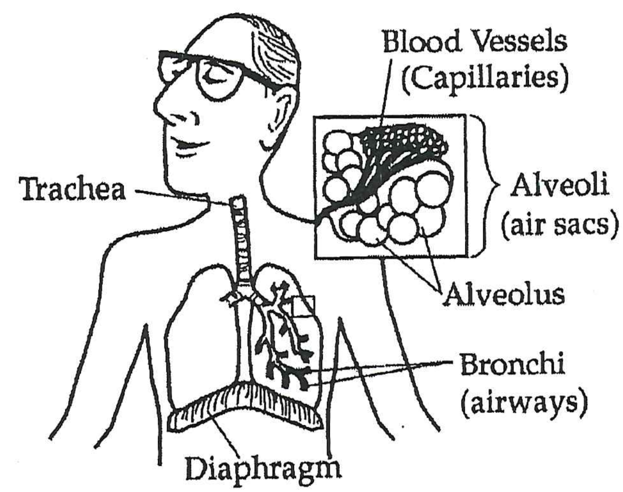
Reading for 3-1

How Your Body Uses Oxygen

Oxygen is a gas that your body uses for energy. It is needed by your body cells to keep them alive. Being able to move and think require your body to have oxygen. This handout will talk about how your body uses oxygen.

How do you get oxygen in your body?



Oxygen is found in the air around you, along with nitrogen and other gases. When you take a breath, air goes in through your nose and mouth. It passes through your **trachea or windpipe** and into airways called **bronchi** (BRAWN-ki) in your lungs. The airways branch off into smaller and smaller openings. At the end of the openings are **alveoli** (al-VEE-o-lie), or tiny air sacs. The air bounces around in these tiny air sacs and blood cells in the very small blood vessels around these air sacs pick up oxygen.

These very small blood vessels are called **capillaries** (KAP-e- ler-ees). Capillaries connect your arteries and veins. They are found all over your body. It is in these small blood vessels in your lungs that oxygen gets into your blood. This oxygen rich blood then goes back into the left side of your heart where it gets pumped out to all parts of your body through your arteries.

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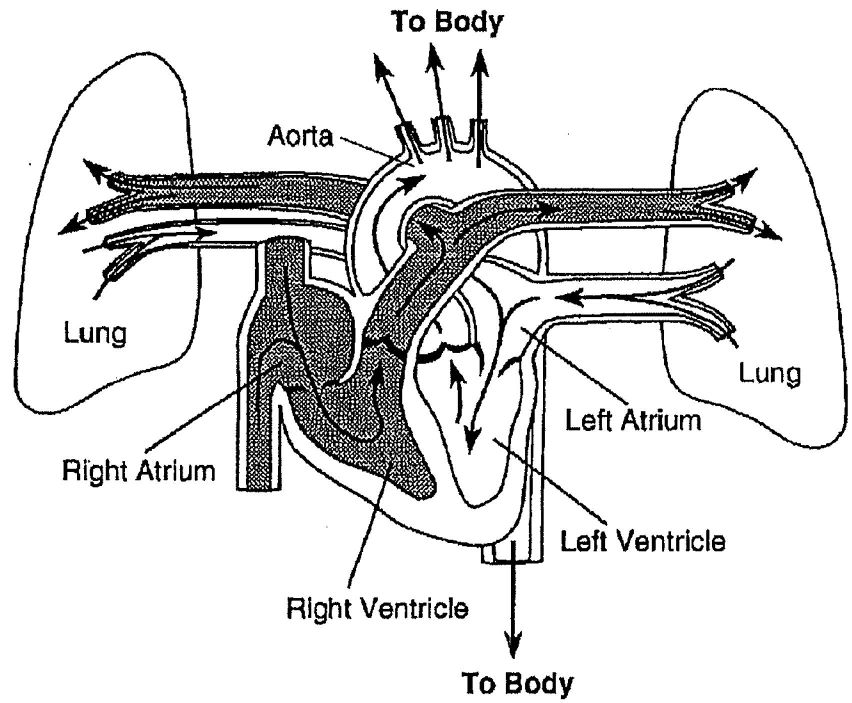
What happens when the oxygen is carried to the cells?

Through the rest of your body, these small blood vessels or capillaries are where oxygen is dropped off to your cells and waste products, like carbon dioxide are picked up. The waste products are then carried in your blood through your veins back to the right side of your heart.

When the blood gets back to your heart, there is very little oxygen left in it, and there are larger amounts of waste products. The blood goes into the right side of your heart and then gets pumped back into your lungs. The gray area in the picture shows this.



The waste gases, like carbon dioxide, are passed from the blood through the capillaries into the air sacs. They are then breathed out through your lungs while more oxygen is being picked up by your blood cells. This air exchange happens quickly and often.

There is a chemical in your blood called **hemoglobin** (HE-mo-glow-bin). This is what picks up and carries the oxygen in your blood. When there is oxygen, the hemoglobin turns bright red in color. As the oxygen is dropped off to the cells, the hemoglobin turns a darker red or purple color. This color change is what is used during a pulse oximeter reading to give your oxygen level.

All living things need food. Food supplies the energy needed for life activities (moving, breathing, sensing, growing, reproducing), and the materials needed for growth and repair.

Animals, including humans, have always relied on plant parts for food (see the K-4 unit, "Running on Energy.") Green plants are unique in being able to manufacture new food, by capturing energy from the sun and storing it in sugar molecules (glucose> made from carbon dioxide and water. These sugar molecules are built up into the various structures of plants (leaves, stems, roots, seeds, fruits, flowers, and so on), eventually becoming all of the different types of food that all living things use (see the 5 7 unit, "The Lives of Plants.")

Animals, then, spend most of their lives undoing the work of plants: Converting sugar molecules into carbon dioxide and water, releasing the energy stored in sugar to use in the conduct of their lives; and breaking apart the parts of plants in order to build up again the parts they need for their own bodies. How animals do this (especially how humans do this) is the subject of this unit.

It starts with digestion.

And it starts in the mouth. Food (which in general is made up of carbohydrates, fats, and proteins-see the product labeling on any food package-as well as small amounts of vitamins and minerals) is first physically broken into smaller pieces, and then mixed with saliva, which contains an enzyme that chemically changes some of the carbohydrates (mostly starches) into simple sugars (including glucose.>

Food then moves down the esophagus into the stomach where more enzymes mix with it as it is churned and turned. Some of those enzymes convert more carbohydrates into glucose; others begin to break down proteins into amino acids.

Finally, food moves into the small intestine, traveling through 30 feet of it (in adult humans) while the process of digestion is completed. Continuing the digestion of carbohydrates and proteins, new enzymes begin to react with fats, breaking them down into fatty acids and glycerol. The new molecules produced by digestion-simple sugars, fatty acids, and amino acids-are water soluble.

Then the circulatory system takes over.

Its function is to move these small, relatively simple molecules to all of the cells of the body.

The digested materials leave the small intestine and enter the circulatory system through tiny openings or holes in the walls of the intestine and bloodvessels. Since these substances are water soluble, they can be absorbed by the blood and can move with it all over the body. (Undigested non-soluble food particles which could not get out of the small intestine move into the large intestine and finally out of the body as feces.)

And constantly, all over the body, the digested substances leave the blood stream and enter the cells. It is in the cells where all the really important action takes place: releasing energy for life activities; building new materials for growth and repair.

All three substances-simple sugars, fatty acids, and amino acids-can be used to release energy, although it is primarily the simple sugars (which come from carbohydrates) that are used first. The fatty acids and amino acids (from fats and proteins) are the building blocks of new materials-the new materials that build longer bones, larger muscles, new skin, new blood as we grow and as we repair damaged and worn out body parts.

How do cells release the energy of simple sugars? The cells of ***all*** living things do this, from humans to mice to worms to amoebas, **and** not only animals, but all living things, **including** plants. Even plants use their own glucose as food, to release the energy they need for their life activities.

What goes on in cells is a series of complex chemical reactions that use oxygen (this is why we breathe!) to break down glucose into carbon dioxide and water, releasing the energy (originally from the sun) stored in the glucose (by plants.) Carbon dioxide and water are waste products that are removed from the cell and carried away by the circulatory system to the lungs-where the carbon dioxide and some water vapor are breathed out-and to the kidneys-where water is discarded in the urine.

To illustrate this process of cellular respiration a bit more: During vigorous physical activity, the need for glucose and oxygen increases with the increased need for energy. When you're exercising vigorously, you know that you have to breathe faster (to take in more oxygen), and-ifyou control how much you eat-the extra glucose you need will be converted from the fat your body normally stores from excess food.

Also during exercise, the production of water and carbon dioxide increases. The increased heart and breathing rate is the body's way of delivering and removing these extra materials to and from the cells during this increased activity.

Some of the energy released in cells is heat energy, which maintains your body temperature or heats you up when you exercise. But most of it (about 60%) remains as chemical energy, transferred to many special molecules (called ATP) in the cell, each of which can store the energy in very small usable quantities. These energy-rich ATP molecules move around the cell, supplying the energy needed by cells for life processes. The chemical energy in ATP molecules can be changed to motion in muscle cells, to light in the light-producing cells of the firefly, or to electrical signals in brain cells. It is used to move blood, repair wounds, move the lungs to breathe, and make new cells.

Now the next question is, what happens with food to help people grow and repair damaged tissues? Again, this happens at the cell level.

We grow by adding new cells to our bodies, new muscle cells, new skin cells, new heart cells, new blood cells, new blood vessel cells, etc. etc. Where do these new cells come from? They are made out of the materials in food: the building blocks of fatty acids and amino acids.

Fatty acids are the building blocks for new fats and oils, which primarily make up cell membranes. Amino acids (along with nitrates and other minerals) are used for making specific new proteins, different from the ones in the plant and animal materials we eat. Some of these proteins are used for the inside components of new cells-the structures that allow nerve cells, for example, to pass electrical signals, or that allow muscle cells to contract. Some are exported out of certain cells to play important roles in fighting off disease (antibodies), or to regulate the action of organs (hormones) by acting as messengers or message receptors between cells. Some are used for the material that makes up hair, nails and teeth. Also, perhaps most importantly, protein is used to make enzymes. Enzymes are all over the body, not just in the digestive tract. They are needed to make many chemical reactions occur in cells.

The process of building new molecules is a critical function of cells. It uses the building blocks supplied by food, it requires energy from cellular respiration, and it is directed by instructions coded in the DNA. Our bodies are alive with internal activity, even when we sleep!

So in order to grow and maintain a healthy body, humans must eat sufficient quantities of carbohydrates, proteins and fats (along with vitamins and minerals) to supply all of the materials needed for growth and repair as well as all of the body's energy needs. This is why parents have always been concerned about their children's diets, and why world health organizations are concerned about food supplies in developing countries.

Nutritionists tell us that we don't need as much protein as we once thought, but the types of protein we eat are important; that we need complex carbohydrates for long-lasting energy supplies; and that we need very little fat in our diets.

In general, American diets include too many calories and too much fat (especially saturated fat), cholesterol, and salt, and too few complex carbohydrates and fiber. These diets are generally believed to be one reason for the large numbers of cases ofobesity, heart disease, stroke and cancer in Americans. However, the exact role of the diet in preventing some of these diseases is not well understood.

While many Americans are replacing the traditional diet represented by hamburgers, french fries, and shakes, many diverse cultures both within the U.S. and around the world have traditionally had much more healthy diets.

There are almost as many ways of meeting nutritional needs as there are cultures in the world. In most places, the food people eat is that which comes from their natural environment, rather than that which they import. This includes harvests from the land and the surrounding sea. Cultures all over the world, including those of which many students in the United States are decendents, have developed ingeneous ways of meeting their nutritional needs, including the need for sufficient carbohydrates for energy and sufficient and complementary proteins for the numerous amino acids needed for protein synthesis.