Why Food?

Food gives us the matter to make more of us – to grow and repair, to replace worn-out cells, to reproduce when it's time. It also provides us with the energy necessary to stay alive – to move, to respond to the environment, to keep our bodies free of disease, and to keep out cells, tissues, organs, organ systems – all of us – organized and in balance.

When we eat food, we need to break it down. Physically, we take small bites, grind and mash it with our teeth, and squish it into a pulp with our stomachs. Breaking it into smaller and smaller pieces isn't good enough, though. We need to take huge macromolecules and chemically turn them into their smaller monomers. We then either chemically turn those small pieces into huge macromolecules we need, we convert them to fat or glycogen for energy storage, or we burn the small pieces in another chemical reaction to get the energy that is stored there.

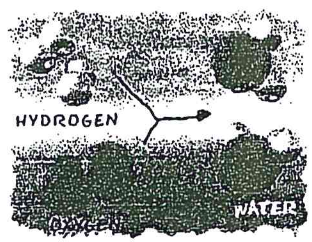
Ex: We eat a burger (cow muscle protein). We use chemistry to break that protein into a bunch of amino acids. We use those amino acids to build our own proteins: like skin proteins to heal a cut, for example.

Ex: We eat a potato. We use chemistry to break down the starch into simple sugars. We use chemistry to turn the sugars into glycogen to store energy in our muscles and liver. Later we will do more chemistry: turn the glycogen to sugar and then burn the sugar in the presence of oxygen to get energy.

Either way, chemical change is all about. Chemical reactions rule our cells. Matter can't be created or destroyed. But matter can be rearranged in chemical reactions.

Chemical Reactions

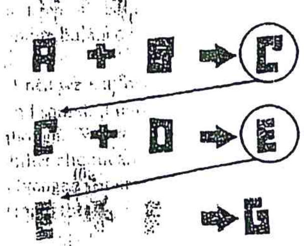
Let's start with the idea of a reaction. In chemistry, a reaction happens when two or more molecules interact and something happens. That's it. What molecules are they? How do they interact? What happens? Those are all the possibilities in reactions. The possibilities are infinite. There are a few key points you should know about chemical reactions.



HYDROGEN AND OXYGEN MOLECULES COMBINE TO FORM WATER.

Key Points A chemical change must occur. You start with one compound and turn it into another. That's an example of a chemical change. A steel garbage can rusting is a chemical reaction. That rusting happens because the iron (Fe) in the metal combines with oxygen (O_2) in the atmosphere. When a refrigerator or air conditioner cools the air, there is no reaction. That change in temperature is a physical change. Nevertheless, a chemical reaction can happen inside of the air conditioner.

2. A reaction could include ions, molecules, or pure atoms. We said molecules in the previous paragraph, but a reaction can happen with anything, just as long as a chemical change occurs (not a physical one). If you put pure hydrogen gas (H_2) and pure oxygen gas in a room, they can be involved in a reaction. The slow rate of reaction will have the atoms bonding to form water very slowly. If you were to add a spark, those gases would create a reaction that would result in a huge explosion. Chemists would call that spark a catalyst.

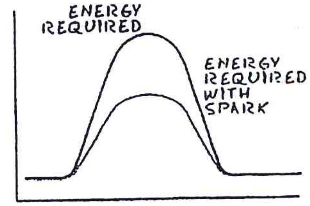


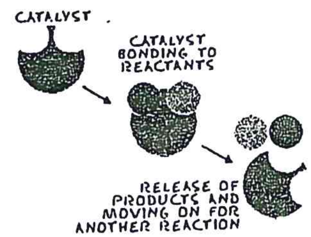
3. Single reactions often happen as part of a larger series of reactions.

Take something as simple as moving your arm. The contraction of that muscle requires sugars for energy. Those sugars need to be metabolized. You'll find that proteins need to move in a certain way to make the muscle contract. A whole series (hundreds actually) of different reactions are needed to make that simple movement happen.

1. CATALYSTS SPEED IT UP

A catalyst is like adding a bit of magic to a reaction. Reactions need a certain amount of energy to happen. If they don't have it, oh well, the reaction probably can't happen. A catalyst lowers the amount of energy needed so that a reaction can happen easier. A catalyst is about energy; it doesn't have to be another molecule. If you fill a room with hydrogen gas and oxygen gas, very little will happen. If you light a match in that room (or just a spark), all of the hydrogen and oxygen will combine to create water molecules. It is an explosive reaction.



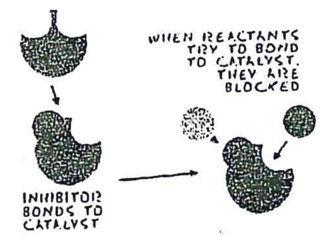


The energy needed to make a reaction happen is called the **activation energy**. As everything moves around, energy is needed. The energy a reaction needs is usually in the form of heat. When a catalyst is added, something special happens. Maybe a molecule shifts it's structure. Maybe that catalyst makes two molecules combine and they release a ton of energy. That extra energy might help another reaction to occur. In our earlier example, the spark added the activation energy.

Catalysts are also used in the human body, not to cause explosions but to make very difficult reactions happen. They help very large molecules combine. There is another interesting fact about catalysts. Catalysts lower the activation energy required for a reaction to occur. With the activation energy lower, the products can also combine more easily. Therefore, the forward and reverse reactions are both accelerated. It helps both reactions.

INHIBITORS SLOW IT DOWN

There is also something called an inhibitor that works exactly the opposite of catalysts. Inhibitors slow the rate of reaction. Sometimes they even stop the reaction completely. You might be asking, "Why would anyone need those?" You could use an inhibitor to make the reaction slower and more controllable. Without them, some reactions could keep going and going and going. If they did, all of the molecules would be used up. That would be bad, especially in your body.



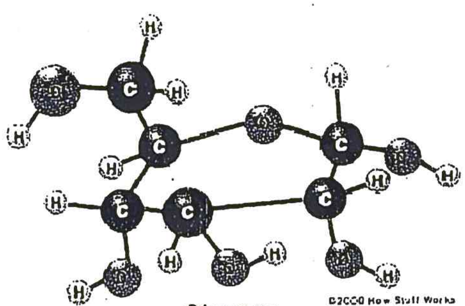
Enzymes

At any given moment, all of the work being done inside any cell is being done by **enzymes**. If you understand enzymes, you understand cells. A bacterium like E. coli has about 1,000 different types of enzymes floating around in the cytoplasm at any given time.

Enzymes have extremely interesting properties that make them little chemical-reaction machines. The purpose of an enzyme in a cell is to allow the cell to carry out chemical reactions very quickly. These reactions allow the cell to build things or take things apart as needed. This is how a cell grows and reproduces. At the most basic level, a cell is really a little bag full of chemical reactions that are made possible by enzymes!

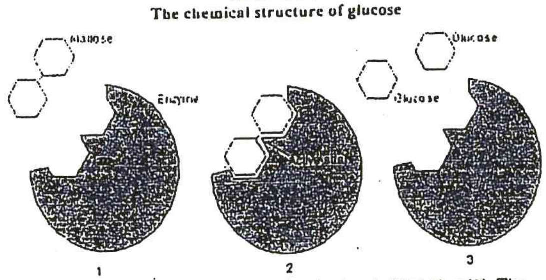
Enzymes are made from amino acids, and they are proteins. When an enzyme is formed, it is made by stringing together between 100 and 1,000 amino acids in a very specific and unique order. The chain of amino acids then folds into a unique shape. That shape allows the enzyme to carry out specific chemical reactions -- an enzyme acts as a very efficient catalyst for a specific chemical reaction. The enzyme speeds that reaction up tremendously.

For example, the sugar maltose is made from two glucose molecules bonded together. The enzyme **maltase** is shaped in such a way that it can break the bond and free the two glucose pieces. The only thing maltase can do is break maltose molecules, but it can do that very rapidly and efficiently. Other types of enzymes can put atoms and molecules together. Breaking molecules apart and putting molecules together is what enzymes do, and there is a specific enzyme for each chemical reaction needed to make the cell work properly.



Glucose

The chemical structure of glucose



Maltose is made of two glucose molecules bonded together (1). The maltase enzyme is a protein that is perfectly shaped to accept a maltose molecule and break the bond (2). The two glucose molecules are released (3). A single maltase enzyme can break in excess of 1,000 maltose bonds per second, and will only accept maltose molecules.

You can see in the diagram above the basic action of an enzyme. A maltose molecule floats near and is captured at a specific site on the maltase enzyme. The active site on the enzyme breaks the bond, and then the two glucose molecules float away.

You may have heard of people who are **lactose intolerant**, or you may suffer from this problem yourself. The problem arises because the sugar in milk -- lactose -- does not get broken into its glucose components. Therefore, it cannot be digested. The intestinal cells of lactose-intolerant people do not produce lactase, the enzyme needed to break down lactose. This problem shows how the lack of just one enzyme in the human bo can lead to problems. A person who is lactose intolerant can swallow a drop of lactase prior to drinking milk and the problem is solved. Many enzyme deficiencies are not nearly so easy to fix.

Inside a bacterium there are about 1,000 types of enzymes (lactase being one of them). All of the enzymes flo freely in the cytoplasm waiting for the chemical they recognize to float by. There are hundreds or millions of copies of each different type of enzyme, depending on how important a reaction is to a cell and how often the reaction is needed. These enzymes do everything from breaking glucose down for energy to building cell wal constructing new enzymes and allowing the cell to reproduce. Enzymes do all of the work inside cells.

http://science.howstuffworks.com/environmental/life/cellular-microscopic/cell2.htm

http://www.chem4kids.com/files/react_intro.html