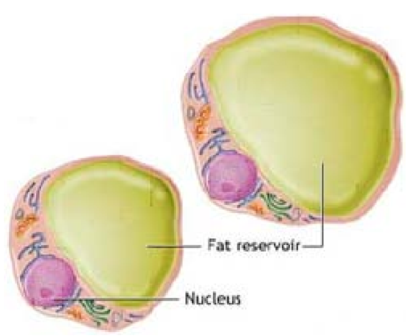
You Are What You Eat

Lipids and carbohydrates are the scientific names for fats and sugars. These natural substances do a lot to keep us healthy. Along with giving us energy, they help cells move around the body and communicate.

Fats

Eating healthy means that you need to be careful about the amount of fat in your diet. But a certain amount of fat is really necessary: All humans need lipids, called essential fatty acids, from food because our bodies can't make them from scratch. Some body fat is also necessary as insulation to prevent heat loss and to protect vital organs from the strain of routine activities.



The body stores excess fat in fat cells, or lipocytes, which expand in size until the fat is used for fuel.

Lipids in adipose tissue (fat cells) are a major form of energy storage in animals and people. The "fat-soluble" vitamins (A, D, E and K) are essential nutrients stored in the liver and in fatty tissues. Triglycerides, another type of lipid, are especially suited for stockpiling energy because of their high caloric content. When we need energy, our bodies use enzymes called lipases to break down stored triglycerides into smaller pieces that participate directly in metabolism.

The mitochondria in our cells ultimately create energy from these reactions by generating adenosine triphosphate, or ATP, the main currency of metabolism.

In addition to providing and storing energy, lipids do many other things. They act as messengers, helping proteins come together in a lock-and-key fashion. They also start chemical reactions that help control growth, immune function, reproduction and other aspects of basic metabolism.

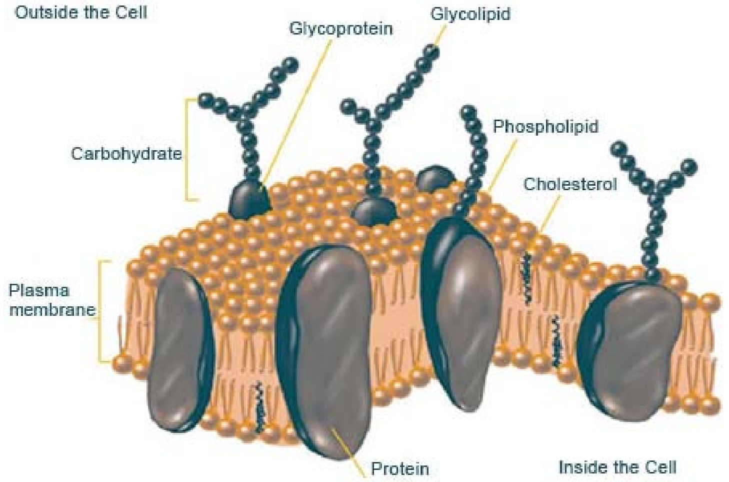
The lipid molecule cholesterol is a key part of the plasma membrane, a coating that wraps around every cell in the human body.

Although it does act as a protective barrier, the plasma membrane is less like a rigid wall and more like a pliable blanket. In addition to lipids, the plasma membrane contains sugars that stick out from its surface and proteins that thread through it.

It is an orderly arrangement of ball-and-stick molecules called glycolipids (lipid chains with sugars attached) and phospholipids (lipids marked with cellular tags called phosphates). When aligned "tail-to-tail," these fat-containing molecular assemblies resemble a double array of matchsticks lined up perfectly end-to-end.

The membrane forms more or less automatically when the lipid end of each glycolipid or phospholipid matchstick is attracted to oily substances: other lipids. The other matchstick end, containing a sugar or phosphate molecule, drifts naturally toward the watery environment typical of the areas inside or between cells.

Membranes are a hallmark of how organisms evolved the ability to multitask. Membranes allow cells to keep proteins and other molecules in different compartments so that more than one set of reactions can occur at the same time.



The plasma membrane is a perfect example of the rule that oil and water don't mix.

In addition to the plasma membranes around cells, organelles inside cells are wrapped by similar, lipid-containing membranes that encase specialized contents.

Sugars

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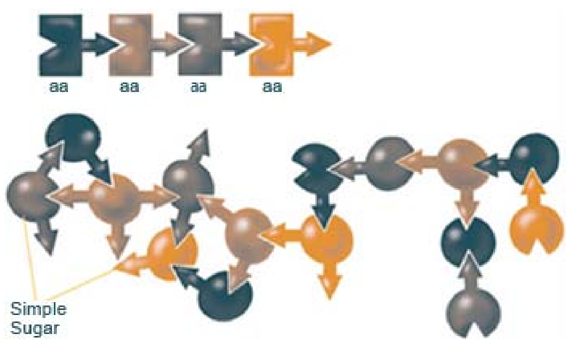
In chemistry, a polymer is a substance that contains repeating units: Polyester and many plastics are examples of synthetic polymers. Proteins, nucleic acids and carbohydrates are natural "biopolymers" that consist of chains of amino acids, DNA, RNA or sugar molecules.

How do our bodies make biopolymers? You guessed it: enzymes. Scientists can also make some biopolymers in the lab. DNA, RNA and proteins are fairly simple to construct—so simple that scientists today routinely synthesize thousands of different versions at once on wafer-like chips similar in size to those used in computers.



Amino acids link head-to-tail to make proteins (top). Simple sugars link in many orientations to make oligosaccharides (bottom).

But complex carbohydrates—chains of sugars—are a different story.

Why is making sugar chains so hard? The answer lies in their fundamental structure.

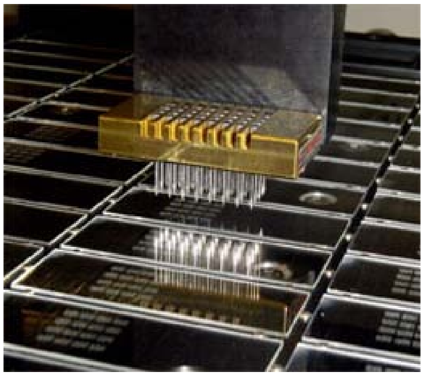
Proteins are strings of amino acids that can only fit together one way, head-to-tail. In contrast, long, branched chains of sugars called oligosaccharides can fit together in dozens of different ways. Chemists have a tough time forcing them to connect one way instead of another.

One reason chemists want to make sugars from scratch is to design vaccines that target the surfaces of bacteria and viruses.

Sugars attached to proteins, called glycoproteins, are an important part of cell membranes. Jutting out from the surface of nearly all cells, these sugary signposts are a cell's identification. They are sort of like cellular address labels.

Also called glycans, these branched molecules serve as specialized receptors that act as docking stations for proteins on other cells. Each organ and tissue has its own special glycans, which grant access only to those molecules that know the proper molecular "code."

Every type of virus we encounter can only grip the glycans that have the right connections at their tips. In this manner, the types of glycans that a virus latches onto can determine how it will make you sick. Some viruses prefer glycans in the lungs, some like the intestines or the throat, and so on.



Glycan "arrays" enable scientists to test which proteins attach to thousands of different human glycans. Credit: Ola Blixt

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