

# Human Metabolism

Real World Energy  
Backgrounder  
Grade Level: 9-12



## Metabolism

Our bodies are complex energy conversion machines. Every single living cell in our body is in the business of extracting chemical energy from glucose and using it for a wide range of life processes. To complicate things even further, no two human bodies are exactly the same. Each person is completely unique with respect to body chemistry, as well as diet, fitness, and lifestyle choices, and the hundreds of other factors that affect one's ability to process food and utilize energy.

To have energy for life processes, ALL animals need to eat. **Metabolism** is what happens to food energy after it enters the body. Metabolism refers to all of the chemical reactions that take place in a living organism. There are two basic types of metabolic reactions: anabolic (meaning to build up) and catabolic (meaning to break down).

## Anabolic Processes

**Anabolic Processes** may build molecules inside cells. To make these processes happen, cells must expend energy. In both animals and plants, new proteins are being made all the time to repair damaged or worn-out tissues and cells. As organisms grow, much of their food and energy are dedicated to growing new tissues. For example, human babies convert much of their food to growing bones, muscle, brain, and internal organs.

**Photosynthesis** is also an anabolic process. Like any other construction job in cells, energy must be

supplied to get the job done. In this case, the raw materials are water and carbon dioxide, and the energy comes from sunlight. The finished product is glucose.

## Catabolic Processes

If anabolic processes are all about building stuff, then **catabolic processes** are about taking stuff apart. A catabolic process is one where chemical bonds are broken or a substance is reduced to smaller particles. For example, one of the most important catabolic processes happens inside your stomach and intestines. Digestion relies on enzymes to break down complex materials such as proteins and starches into smaller molecules that can be absorbed into the bloodstream.

The most essential catabolic process we know of is **respiration**. During respiration, glucose is broken down into water and carbon dioxide, and the all-important chemical energy it contains is then available to power all the life processes in the cell.

## Reversible Processes

Some catabolic processes are reversible. For example, the body uses a catabolic process to break down body fat into fatty acids during heavy exercise or fasting. People on diets count on this process to help them lose weight! But the process is also reversible: if the person goes off the diet, an anabolic process kicks in right away, starts assembling new fat molecules, and the person can gain all the weight back again.

The muscles and liver store and release glucose in a similar way. Glucose molecules are packaged tightly into a kind of starch called **glycogen** by the liver and muscles. The production of glycogen is an anabolic process. But during exercise, the glycogen gets broken down by an enzyme, freeing up glucose for the energy-hungry muscle cells. The breakdown of the glycogen, therefore, is a catabolic process, as is the respiration of glucose.

### Did You Know? Anabolic Steroids

Anabolic steroids are substances that cause rapid growth in the human body. Your body makes its own steroid-based hormones that do this job naturally. Testosterone and human growth hormone are examples of this. But artificial versions of these substances have been made in labs and have found their way into a number of sports. Athletes may use them to develop "superhuman" bodies or to increase their strength or endurance. Steroids have a number of very serious and potentially fatal side effects, however. These include heart attacks and strokes, distorted facial features, damage to bones and joints, hair loss, acne, and the development of feminine features in men, and masculine features in women.

### Metabolism and Body Weight

Metabolism and body weight are connected and are both influenced by a very complex set of factors. We'll discuss some of the most important ones here:

#### Basal Metabolic Rate

Basal Metabolic Rate is defined as the rate at which glucose is consumed when the body is at rest. Some people have a naturally high metabolism and constantly burn off a lot of energy, even when they do not exercise. Others have a naturally low metabolism, which means their bodies make very efficient use of all the food energy they get. These people are often prone to being overweight.

#### Lifestyle Choices

Bodyweight also has a lot to do with diet, exercise, and other lifestyle choices. Food preferences and eating habits affect how much food energy is taken into the body. North American diets are very rich in

fats and carbohydrates, and low in fibre, and are linked to some of the highest rates of obesity in the world.

Fitness and exercise levels affect how much of that energy gets burned in the muscles. The difference between these two determines to some degree whether or not a person will tend to gain weight or not.

#### Age and Gender

As people get older, their activity levels and need for energy tapers off. People who were slim in their youth often begin to put on weight as they get older. This is jokingly called the "middle-aged spread," and is common in both men and women. On average, women show a higher tendency towards weight gain than men. This is related to the extra demands placed on a woman's body by pregnancy and breastfeeding.

#### Emotional State

Metabolism and body weight may also be affected by emotions. Intense emotions can produce startling effects on metabolism, either to increase it or decrease it. For example, the metabolism of a person playing an intense videogame can be two or three times higher than what it is at rest. Sexual arousal can do the same thing. You know the feeling: rapidly beating heart, faster breathing, blushing which are all signs of a racing metabolism!

#### The Role of Hormones

What is clear is that the topic of body weight and metabolism is complicated. But exactly how does the body change the rate of metabolism? The answer is through hormones. Hormones are chemical signals carried by the blood. Hormones that alter metabolism come from several glands throughout the body, including the thyroid gland, the brain, and the adrenal gland on the kidneys. These hormones act in various ways to increase the rate at which cells consume glucose. Other hormones, often produced by the same glands, have a calming effect, easing back on the body's metabolism.

The key to maintaining stable and healthy body weight is in finding a balance between your body's needs and the amount of food you eat. Most people who are successful in maintaining healthy body weight do it through a combination of both exercise and a healthy diet. It is possible to control your weight through dieting only, but the chance of long-term success is not nearly as good as exercise combined with diet.

### Did You Know? Fat Cells

Baby fat, chubby cheeks, cellulite, blubber...What exactly is fat? The tissue we call fat is actually made of masses of cells that often form layers under the skin, or in the spaces between our internal organs. A person stops developing new fat cells after the age of puberty. After this, any change in the amount of fat in the person's body is a result of fat cells getting larger or smaller. Fat cells absorb fatty acids from the blood and release fatty acids to the blood when needed. They grow if the intake of fatty foods is greater than the body's needs, and they shrink when the demand for energy is greater than the daily food intake. You can think of body fat as a kind of bank account to which the body makes deposits, or makes withdrawals, as needed. If the body spends less energy than it takes in, the bank account grows, and the body gains weight. We can blame the number of fat cells in your body on our parents: it is mostly an inherited trait. But the size of those fat cells is something we can, in most cases, control.

### Did You Know? Drugs and Metabolism

Most street drugs act directly on the brain and cause the metabolism to speed up or slow down. One of the best known is **methamphetamine** a powerful stimulant. "Meth" as it is often called, causes feelings of heightened alertness and euphoria. It causes the body to burn up all its reserves of stored energy, leaving the user drained and chronically tired. Meth users often "crash" after taking it. Methamphetamine is also powerfully addictive and difficult to kick. Other drugs have the opposite effect and are called depressants. The active ingredient in Marijuana is a depressant. Marijuana is an example of this, as is alcohol.