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Proteins, Fats and Carbs: Basics of Nutritional Biochemistry 101

Analysis by Dr. Joseph Mercola | May 30, 2024

STORY AT-A-GLANCE

- Macronutrients are the primary components of your diet that give you energy; they consist of proteins, fats and carbohydrates, each of which serves unique functions in your body
- Proteins are essential for building and repairing tissues, including muscles and organs; they also play crucial roles in the functioning of enzymes, hormones and immune system components
- Fats are a dense source of energy and play a role in hormone production and the regulation of body temperature, while acting as a key component of cells and tissues
- Carbohydrates, which include simple sugars and complex carbohydrates, are one of the primary sources of energy for your body
- Optimal health is an ongoing journey and you must listen to your body to determine the best macronutrient ratio for you

Macronutrients are the primary components of your diet that give you energy. They consist of proteins, fats and carbohydrates, each of which serves unique functions in your body. While you need each of these macronutrients in relatively large quantities — compared to micronutrients like vitamins and minerals — to function at your best and avoid disease, the exact breakdown for optimal health continues to be debated.

While I've long recommended high-fat and low-carb consumption, I've recently learned that most people would benefit from far higher amounts of carbohydrates in their diet. Further, it's likely that polymorphisms that affect your metabolic pathways alter your individual nutrient requirements, such that there's no one-size-fits-all diet program that's best for everyone.

There are certainly some nutritional tenets we can all adhere to, like getting your macronutrients from whole foods, not ultraprocessed ones. However, it's counterproductive to vilify fats, carbohydrates or any macronutrient your body needs. A better approach is to seek to understand each component on its own merits, and why it's essential for your overall health.

What Are Proteins?

Proteins are essential for building and repairing tissues, including muscles and organs. They also play crucial roles in the functioning of enzymes, hormones and immune system components. Proteins are made up of amino acids, some of which are essential because your body cannot produce them and must obtain them from food. Sources of protein include meat, fish, eggs, dairy products, legumes, nuts and seeds. As explained in the Osmosis video above:[1]

> *"Protein is an essential part of the human diet … Regardless of the source, the protein that we eat gets broken down and reformed into new proteins in our bodies. These proteins do everything from fighting infections to helping cells divide. You name it, they're doing it. At its simplest, a protein is a chain of amino acids bound to one another by peptide bonds like a string of beads.*
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> *These strings get twisted and folded into a final protein shape. When we eat protein, it gets broken down into its individual amino acids. Most amino acids have a central carbon atom bonded to one amino or nitrogen-containing group and one carboxylic acid group.*

That's why it's called an amino acid. The carbon also has one hydrogen atom and a sidechain, which is unique to each amino acid. The exception to this is prolene, which is a tiny little ring structure instead. Although there are hundreds of amino acids in nature, humans only use about 20 of them to make basically every type of protein."

Those 20 proteins include:

Alanine	Arginine	Asparagine	Aspartic acid
Cysteine	Glutamic acid	Glutamine	Glycine
Histidine	Isoleucine	Leucine	Lysine
Methionine	Phenylalanine	Prolene	Serine
Threonine	Tryptophan	Tyrosine	Valine

Five of these — alanine, asparagine, aspartic acid, glutamic acid and serine — are considered non-essential amino acids because your body can make them, although you can also get them from foods. Another six of these proteins — arginine, cysteine, glutamine, glycine, proline and tyrosine — are described as conditionally essential.

This is because, while your body can make them if you're healthy, during times of illness, stress or intense physical activity, your body's ability to produce these amino acids may not be sufficient to meet your needs, making it necessary to consume them through the diet.

There are also nine essential amino acids, which are those that we can only get from food. These include histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine.

How Your Body Breaks Down Proteins

When you eat proteins, a process known as proteolysis occurs to break them down. Osmosis explains:[2]

> *"Dietary protein provides the essential amino acids that are needed to make our own proteins, hormones and other important molecules — a circle of life of sorts — but to do so we need to break the dietary protein down first through a process called proteolysis. When we first eat a protein-containing food, proteolysis begins when the food reaches the stomach.*
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> *First, hydrochloric acid denatures the protein, unfolding it and making the amino acid chain more accessible to enzymatic action. Then, pepsin, which is itself made by gastric chief cells, enters the picture.*
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> *Pepsin cleaves any available protein into smaller oligopeptide chains, which move into the duodenum where a second set of digestive enzymes made by the pancreas further chopped the oligopeptides into tripeptides, dipeptides and individual amino acids.*
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> *These can all be taken up to the intestinal cells where di- and tripeptides are then converted into amino acids. Some amino acids remain in these cells and are used to synthesize intestinal enzymes and new cells. But most enter the bloodstream and are transported to other parts of the body in general."*

What Are Fats?

Fats are a dense source of energy and are important for absorbing vitamins, supporting cell growth and protecting organs. They also play a role in hormone production and the regulation of body temperature, while acting as a key component of cells and tissues.

Fats can also be converted into prostaglandins, which help cells communicate. The Osmosis video above further breaks down the makeup of the saturated and unsaturated fats in your diet:[3]

“Fats have a three-carbon backbone called glycerol, as well as fatty acid chains. The fatty acid chain is basically a string of carbon and hydrogen atoms. When an ‘OH’ from the glycerol molecule binds to an ‘H’ from the fatty acid, an ‘H_20’ — a water molecule — gets released, and the two molecules link up.

If this happens once, the result is a monoglyceride. If it happens twice, it’s a diglyceride and three times makes a triglyceride. Now, there are various types of fatty acid chains, and one way to categorize them is by their length, in other words, how many carbons they have.

Short-chain fatty acids have 2 to 5 carbons, medium chain fatty acids have 6 to 12 carbons and long chain fatty acids have 13 or more carbons. Fatty acid chains are also categorized by the bonds connecting the carbons in the chain. A single bond is just one bond between the carbon atoms, and when a fatty acid chain has only single bonds, it’s called a saturated fatty acid — because it has as many hydrogen atoms as possible — it’s saturated with them.

Triglycerides with saturated fatty acids are nice and straight so they pack together really well, and as a result they’re usually solid at room temperature. And the longer the saturated fatty acid chain, the more likely it will be solid at room temperature.

Carbons can also have double bonds between them, and when a fatty acid has one or more double bonds, it’s called an unsaturated fatty acid because it’s not saturated with hydrogen atoms — for every double bond there are two fewer hydrogen atoms.

Also, a double bond causes a kink in the molecule so the triglycerides don’t pack together as nicely as saturated fats. As a result, unsaturated fats are usually liquid at room temperature. Unsaturated fatty acids can be further classified according to the number of their double bonds. Monounsaturated fatty acids are fatty acids with only a single double bond. Polyunsaturated fatty acids have two or more double bonds.”

While I've long recommended a high-fat diet, I'm now convinced that having more healthy carbs than fat is a great choice to improve your metabolic health. To break down why very simply, when more than 30% to 35% of your calories are coming from fat, you are forcing your cells to burn fat and put glucose on the back burner, instead of being metabolized like it should be. I delve deeper into this topic in, "**Understanding the Randle Cycle**."

Further, as detailed in several previous articles, the evidence strongly suggests excessive amounts of the omega-6 fat **linoleic acid** is driving most modern diseases, including heart disease and cancer. Consuming over 5 grams of LA a day is likely to cause problems. I keep my intake below 2 grams a day.

What Are Carbohydrates?

Carbohydrates, which include simple sugars and complex carbohydrates, are one of the primary sources of energy for your body. But in terms of your health, not all carbohydrates are created equal. Osmosis describes some of the key differences among the most common dietary carbs:[4]

> *"Sugar actually refers to a family of molecules called saccharides — monosaccharides where 'mono' means one, so one sugar molecule, disaccharides where 'di' means two, so two sugar molecules linked together, oligosaccharides where 'oligo' means a few, so it's three to nine sugar molecules linked together, and polysaccharides where 'poly' means many, so it's 10 or more sugar molecules linked together.*
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> *Glucose is the most important member of the sugar family and it's a monosaccharide. It's one of the main sources of calories for the body, and is able to cross the blood-brain barrier and nourish the brain. Another monosaccharide is fructose, which is commonly found in honey, fruits and root vegetables. Finally, there's the monosaccharide galactose, known as milk sugar.*

It's known as milk sugar because it's only found in nature when it links with glucose to form lactose, a disaccharide found in the milk of mammals, which includes cow and human breast milk. Sucrose, or table sugar, is another disaccharide and it's formed when fructose links up with glucose.

Sucrose is found in various fruits and vegetables, with sugarcane and sugar beets having the highest quantities. Maltose is another disaccharide — and this one is two glucose molecules linked together, and it's found in molasses, which can be used as a substrate to ferment beer."

Complex carbohydrates, meanwhile, can be oligosaccharides or polysaccharides, which are the most abundant type of carbohydrates found in food. Among complex carbs, there are also starches and fibers:[5]

"Starches are polysaccharides with molecular bonds between sugar molecules that human intestinal enzymes can break down. Starches are an important source of calories, and can be found in foods like rice, potatoes, wheat and maize. Starches don't taste sweet like simple sugars because they don't activate taste buds in the same way.

And there also dietary fibers, which are carbohydrates that intestinal enzymes can't break down, and so the body cannot digest them. Now there are many different types of dietary fibers, and they're not all the same when it comes to their structure or impact on health.

Fibers have molecular bonds that are resistant to human intestinal enzymes, so they pass through the small intestine undigested, get broken down a bit by bacteria in the large intestine, and ultimately end up as bulk matter in the stool.

Fiber is critical because it can slow down the rate of absorption of simple sugars like glucose in the small intestine, which can help maintain healthy blood glucose levels. They also increase stool weight, which helps prevent constipation, and fibers like beta-glucan are also good for heart health."

Refined Sugars vs. Healthy Carbs

Refined carbohydrates or sugars, which are also sometimes referred to as free sugars, include those that are added to ultraprocessed foods and drinks. High-fructose corn syrup is an example of a refined sugar. These sugars are linked to health problems such as dental decay and heart disease, as well as cancer.[6]

Intrinsic sugars, also known as naturally occurring sugars, are those found within the cellular structure of foods, including whole fruits and vegetables. These sugars are part of the food's natural composition, not added during processing, and come with the beneficial nutrients and fiber found in whole foods, which can slow down sugar absorption and mitigate its impact on blood sugar levels.

One of the primary differences between these two types of sugars is that refined sugars, as well as many starches, are a common cause of endotoxin production in your gut, which destroys mitochondrial function and results in cancer metabolism.

The fructose present in whole foods does not typically result in the production of endotoxin. This is one of the primary differences between refined sugar and fructose from ripe fruit and helps explain **why refined sugars fuel cancer**. However, adding healthy carbs to your diet can be beneficial.

In the past, I followed a ketogenic diet that was below 50 grams of carbs a day up to about 100 grams a day. However, I've recently increased that to 500 grams of carbs per day, mostly in the form of rice and ripe fruit.

The key to remember is that optimal health is an ongoing journey and you must listen to your body to determine the best macronutrient ratio for you. You'll also get a dramatically different outcome if your macronutrients come from highly processed fake foods — like processed foods high in LA — compared to those from healthy whole foods.

The easiest way to keep track of your nutrient intake is to use an online nutritional calculator such as **Cronometer**. To get the most accurate data, carefully weigh your food with a digital kitchen scale so you can enter the weight of your food to the nearest gram.

Sources and References

- [1, 2] YouTube, Osmosis from Elsevier, Proteins February 27, 2019
- [3] YouTube, Osmosis from Elsevier, Fats – biochemistry February 14, 2018
- [4, 5] YouTube, Osmosis from Elsevier, Carbohydrates & sugars – biochemistry April 4, 2018
- [6] PLOS ONE 2014; 9(6): e99816