Carbohydrates

Carbohydrates are called carbohydrates because they are essentially hydrates of carbon (i.e. they are composed of carbon and water and have a composition of \((\text{CH}_2\text{O})_n\).

Carbohydrates:
Technically speaking, a carbohydrate is a compound made up of carbon, hydrogen, and oxygen.

Carbohydrates can be
1. simple sugars: include honey, jams, jellies, syrup, table sugar, candies, soft drinks, fruits, and fruit juices. Glucose (also called dextrose) is a common simple sugar found in fruits, honey, and vegetables. It is also the substance measured in blood. (In other words, blood sugar equals blood glucose.)
2. complex carbohydrates: When several of these simple sugars are linked together, they form more complicated molecules known complex carbohydrates or complex molecules containing multiple sugars. Complex carbohydrates that come from plants are called starch and are found in quality foods such as grains, vegetables, breads, seeds, legumes, and beans. Whether it's a handful of jelly beans or freshly sliced whole grain bread, it's all carbohydrate!

- The three main types of carbohydrates you need to know are monosaccharides, disaccharides, and polysaccharides.

A monosaccharide, or simple sugar, is the simplest form of a carbohydrate. The most important monosaccharide is glucose (\(\text{C}_6\text{H}_{12}\text{O}_6\)), which is used in cellular respiration to provide energy for cells. Monosaccharides with five carbons (\(\text{C}_5\text{H}_{10}\text{O}_5\)) are used in compounds such as genetic molecules (RNA) and high-energy molecules (ATP).

A disaccharide is a sugar consisting of two monosaccharides bound together. Common disaccharides include sucrose, maltose, and lactose. Sucrose, a major energy carbohydrate in plants, is a combination of fructose and glucose; maltose, a carbohydrate used in the creation of beer, is a combination of two glucose molecules; and lactose, found in dairy products, is a combination of galactose and glucose.

A polysaccharide is a carbohydrate containing three or more monosaccharide molecules. Polysaccharides, usually composed of hundreds or thousands of monosaccharides, act as a storage form of energy and as structural material in and around cells. The most important carbohydrates for storing energy are starch and glycogen. Starch, made solely of glucose molecules linked together, is the storage form of choice for plants. Animals store much of their energy in the form of glycogen, which is most often found in liver and muscle cells. Glycogen is formed by linking many glucose molecules together.

- The major nutritional role of carbohydrates is to provide energy and digestible carbohydrates provide 4 kilocalories per
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Kinds in food:
mainly from plants (fruits, vegetables, and grains)
simple sugars: mono & disaccharides (honey, fruits, lactose is from milk)
complex carbohydrates = polysaccharides: starches
and fiber from plants; glycogen from meats

Uses in body
1. Energy: are main energy source of all cells
2. ribose and deoxyribose to synthesize DNA and RNA
3. fiber enhances digestion :complex carbohydrates, the body cannot digest but required for digestion

Deficiencies:
1. if not enough carob's the body shifts to fats and proteins for energy but some cells cannot effectively do this and may become energy starved
2. tissue wasting
3. metabolic acidosis (from excessive fat breakdown)

Requirements
no essential carbohydrates the amount in diet is not critical for essential nutrition recommend 45 – 65% SN03 of diet is carbohydrates;
120-175 g/day minimum 100g/d to prevent shift to proteins and fat catabolism
a diet high in complex carbohydrates helps control
1. body weight
2. crowds out fat
3. reduces hunger
4. reduces “empty calorie” intake
5. enough fiber to promote digestion
recommended sugar intake ! 10% total energy intake
120 grams of glucose / day = 480 calories

- Eating 1 gram of carbohydrate provides your body with 4 Calories.
- Eating 1 gram of protein provides your body with 4 Calories.
- Eating 1 gram of fat provides your body with 9 Calories

- Starch: Provides 80% of dietary calories in humans worldwide
Lipids and Fat

Lipids are organic compounds used by cells as long-term energy stores or building blocks. Lipids are hydrophobic and insoluble in water because they contain a hydrocarbon tail of CH$_2$s that is nonpolar and repellant to water. The most important lipids are fats, oils, steroids, and phospholipids.

Fats, which are lipids made by combining glycerol and three fatty acids, are used as long-term energy stores in cells. They are not as easily metabolized as carbohydrates, yet they are a more effective means of storage; for instance, one gram of fat provides two times the energy of one gram of carbohydrate.

Fats can be saturated or unsaturated. Saturated fat molecules contain no double bonds. Unsaturated fats contain one (mono-) or more (poly-) double bonds, which means that they contain fewer hydrogen molecules per carbon than do saturated fats. Saturated fats are the bad guys and are associated with heart disease and atherosclerosis. Most of the fat found in animals is saturated, whereas plants tend to contain unsaturated fats. Fat is formed when three fatty acid molecules connect to the OH groups of the glycerol molecule. These connecting bonds are formed by dehydration synthesis reaction.

Lipids contain a lot of calories in a small space. Since Lipids are generally insoluble in polar substances such as water, they are stored in special ways in your body's cells. Lipids can also function as structural components in the cell. Phospholipids are the major building blocks of cell membranes. Lipids are also used as hormones that play roles in regulating our metabolism. Most lipids are composed of some sort of fatty acid arrangement. The fatty acids are composed of methylene (or Methyl) groups, and are not water soluble.

There are three different functions for lipids in our bodies:

1. Energy storage: A good source of energy because each gram of fat provides 9 calories, while carbohydrates gives only 4 calories.
2. Forming the membranes around our cells.
3. make Hormones: cholesterol, a key material in the production of sex hormones
4. normal brain development: food poverty of fatty acids leads to growth retardation and lack of integrity of the skin and nails.
5. immune response
6. fat soluble vitamins are usually dissolved in fats & oils: It carrier for vitamins A, D, K, and ADEK These vitamins are important for human health.
7. A good source of energy because each gram of fat provides 9 calories, while carbohydrates gives only 4 calories.
8. food containing saturated fat it needs to for a long time to digest.
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9. Protect the internal organs, such as: kidney and liver effects and external shocks
10. to maintain body temperature, and that the composition of the insulating layer under the skin

- The two main dietary lipids are fats/oils and cholesterol. Most cells use a fuel mix of fat and glucose when oxygen is available. Without adequate glucose, fat is incompletely metabolized and forms molecules called ketones, which are mostly excreted.
- Certain fats known as omega-3 and omega-6 are used to synthesize regulatory hormone like chemicals. A certain amount of body fat is needed for energy reserves and protection of internal organs.
- Cholesterol does not supply calories, but it is a building block of very important chemicals such as vitamin D. Lipids are also the major component of cell membranes.

Digestion and fat absorption

The basis of the composition of fatty substances produced when digested

Fatty acids and glycerol

In the mouth: No effect on fat. In the small intestine: fatty substances turn to fatty acids and glycerol. Is absorption into the blood vessels to reach the liver.

Requirements
- 80-100g/d; 25 - 35%SN03 of calories should be from fats unsaturated better than saturated fats "3% required Fatty Acids (1-1.5 g/day) <250 mg/d cholesterol
- The child from six months to three years needs to be 40 grams fat

Deficiencies:
mainly due to inadequate amounts of essential fatty acids mainly seen in infants and young children fed nonfat milk and low-fat diets
  1. retarded growth
  2. reproductive failure
  3. skin lesions
  4. kidney and liver disorders
  5. neurological and visual problems
  6. The severe shortage and constant may lead to general weakness and wasting
  7. The shortage of primary fatty acid (linolenic acid) cause eczema

Excesses:
1. total fats
of all nutrients, excess fat is most often linked to chronic diseases:
  1. obesity
  2. cardiovascular disease :(esp. high cholesterol & high LDL)
  3. some cancers (total fat intake)
Proteins

A **protein** is a compound composed of chains of amino acids. Proteins have many functions in the body—they serve as structural components, transport aids, enzymes, and cell signals, to name only a few. You should be able to identify a protein or an amino acid by sight if asked to do so on the test.

**Protein** is composed of molecular units called amino acids. It is the only macronutrient that contains nitrogen.

**Its primary function is to**

1. build and maintain body structures, such as muscle, bones and internal organs
2. to synthesize important molecules such as antibodies, enzymes, neurotransmitters and various blood proteins
3. Protein can be used for energy, but that is not the body’s preference.
4. enzymes hormones regulators
5. transport antibodies actin/myosin
6. fiber(collagen) buffers complement
7. active transport hemoglobin clotting
8. salt/water balance

An amino acid consists of a carbon center surrounded by an amino group, a carboxyl group, a hydrogen, and an R group. Remember that the R stands for "rest" of the compound, which provides an amino acids unique personal characteristics. For instance, acidic amino acids have acidic R groups, basic amino acids have basic R groups, and so forth.

![Amino Acid Structure](image)

**Figure 5.7 Structure of an amino acid.**

Many foods contain protein, but the best sources are beef, poultry, fish, eggs, dairy products, nuts, seeds, and legumes like black beans and lentils. Protein builds up, maintains, and replaces the tissues in your body. We mean the stuff your body's made up of. Your muscles, your organs, and your immune system are made up mostly of protein.

**Different Kinds of Protein**

Protein from animal sources, such as meat and milk, is called complete, because it contains all nine of the essential amino acids. Most vegetable protein is considered
incomplete because it lacks one or more of the essential amino acids. This can be a concern for someone who doesn't eat meat or milk products. But people who eat a vegetarian diet can still get all their essential amino acids by eating a wide variety of protein-rich vegetable foods.

**Kinds in food:**
animal proteins: meats, fish, poultry, cheese, milk, eggs
plant proteins: nuts, cereals & grains, legumes

**Requirements**
~half of 20 amino acids are essential, must be gotten in diet
10 essential in children
8 essential in adults
(body can't make proteins if any one of the Amino Acids are in short supply)
   1. **complete protein** (generally animal protein)
      = all essential amino acids
      (meats, fish, cheese, milk, eggs)
   2. **incomplete protein** (most plant protein)
      = missing 1 or more essential amino acids
      (nuts, cereals, legumes)

**Deficiencies:**
3. Protein-Energy Malnutrition (*Marasmus & Kwashiorkor*)
4. impaired brain and learning development
5. GI tract fails
6. anemia
7. edema due to deficits of plasma proteins
8. during pregnancy – miscarriage or premature birth

**Excesses:**
1. may be risk factor in heart disease
2. some cancers (colon, breast, pancreas, prostate, kidney)
3. adult bone loss and calcium loss increases with
4. excessive animal (not plant) proteins in diet
5. obesity (protein rich foods are usually fat rich foods)