Chapter 1

Definition

- The word nutrition first appeared in 1551 and comes from the Latin word *nutrire*, meaning "to nourish." Today, we define **nutrition** as the sum of all processes involved in how organisms obtain nutrients, metabolize them, and use them to support all of life's processes.
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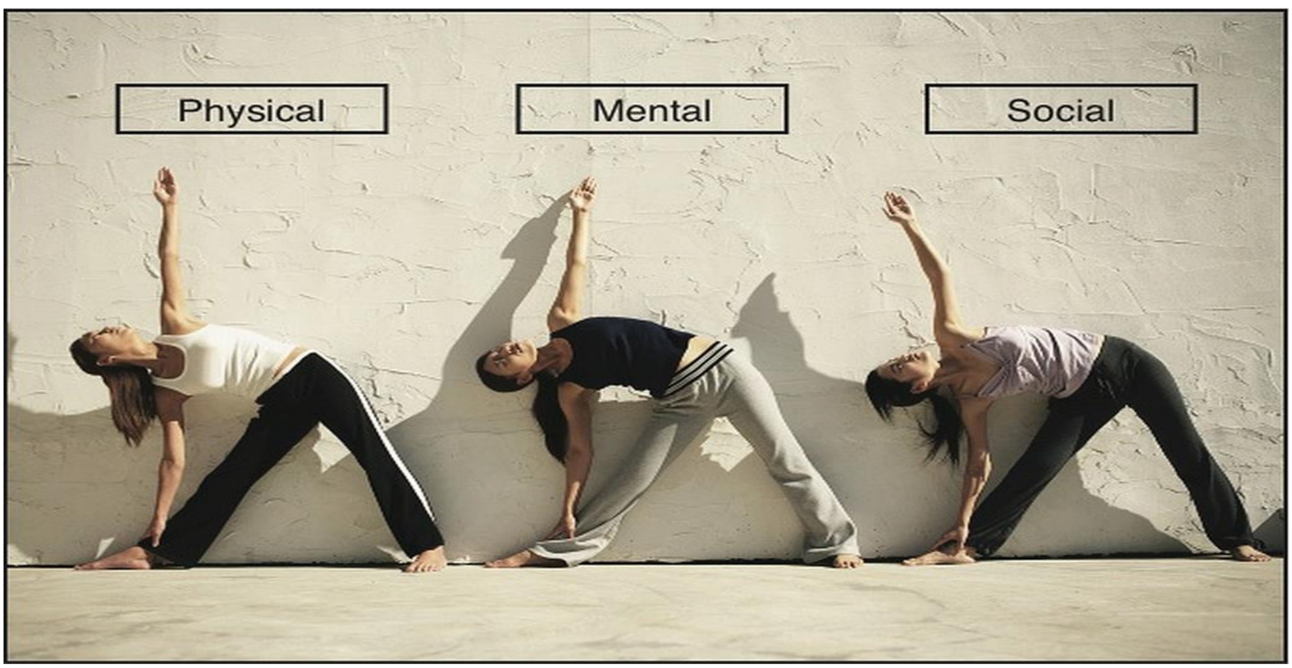
Nutrition and Health and Disease

- In 1946, the World Health Organization (WHO) defined **health** as "a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity."

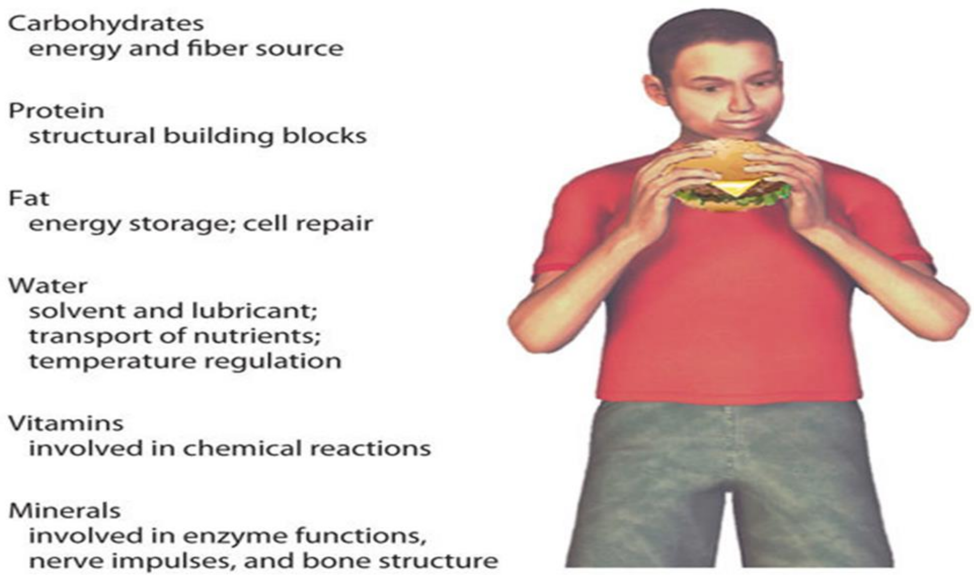


Nutrition and Health and Disease

- Disease: is defined as any abnormal condition affecting the health of an organism, and is characterized by specific signs and symptoms.
- Diseases are broadly categorized as resulting from pathogens (i.e., bacteria, viruses, fungi, and parasites), deficiencies, genetics, and physiological dysfunction. Diseases that

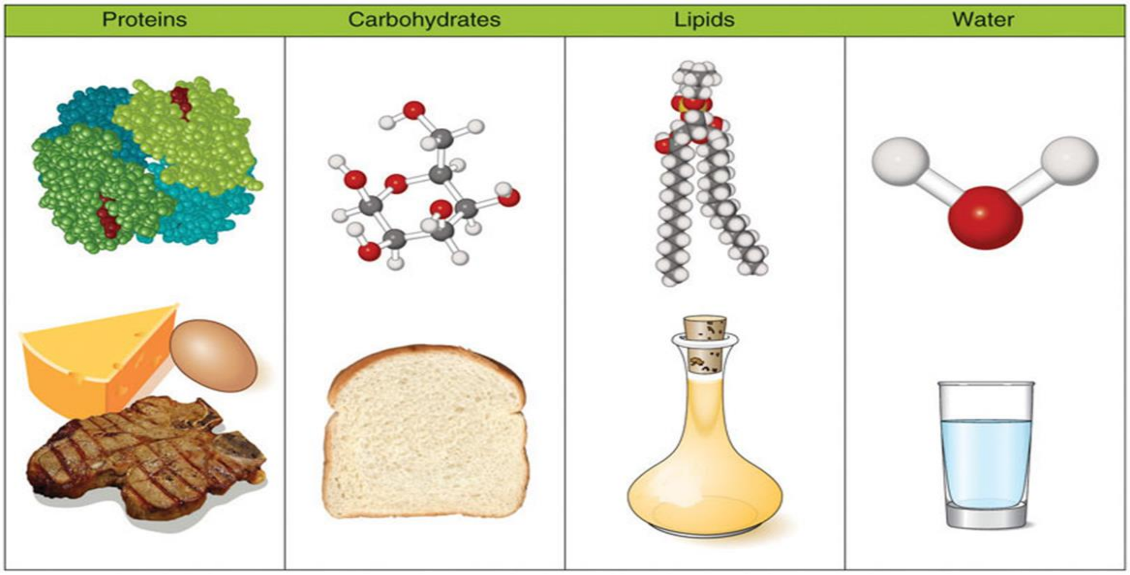
primarily affect physical health are those that impair body structure (as is the case with osteoporosis), or functioning (as is the case with cardiovascular disease). Mental illnesses primarily affect mental and social well-being.

What Are Nutrients?



Macronutrients

- Nutrients that are needed in large amounts are called **macronutrients.**
- There are three classes of macronutrients**: carbohydrates, lipids, and proteins.**
- These can be metabolically processed into cellular energy. The energy from macronutrients comes from their chemical bonds. This chemical energy is converted into cellular energy that is then utilized to perform work, allowing our bodies to conduct their basic functions.
- A unit of measurement of food energy is the calorie. On nutrition food labels the amount given for “calories” is actually equivalent to each calorie multiplied by one thousand. A kilocalorie



Carbohydrates

- Carbohydrates are molecules composed of carbon, hydrogen, and oxygen.
- The major food sources of carbohydrates are grains, milk, fruits, and starchy vegetables like potatoes. Non-starchy vegetables also contain carbohydrates, but in lesser quantities.
- Carbohydrates are broadly classified into two forms based on their chemical structure: fast-releasing carbohydrates, often called simple sugars, and slow-releasing carbohydrates.

- Fast-releasing carbohydrates consist of one or two basic units. Examples of simple sugars include sucrose, the type of sugar you would have in a bowl on the breakfast table, and glucose, the type of sugar that circulates in your blood.
- Slow-releasing carbohydrates are long chains of simple sugars that can be branched or unbranched.
- During digestion, the body breaks down all slow-releasing carbohydrates to simple sugars, mostly glucose.
- Glucose is then transported to all our cells where it is stored, used to make energy, or used to build macromolecules.
- Fiber is also a slow-releasing carbohydrate, but it cannot be broken down in the human body and passes through the digestive tract undigested unless the bacteria that inhabit the gut break it down.
- One gram of carbohydrates yields four kilocalories of energy for the cells in the body to perform work. In addition to providing energy and serving as building blocks for bigger macromolecules, carbohydrates are essential for proper functioning of the nervous system, heart, and kidneys.
- As mentioned, glucose can be stored in the body for future use. In humans, the storage molecule of carbohydrates is called glycogen and in plants it is known as starches. Glycogen and starches are slow-releasing carbohydrates.

Lipids

- Lipids are also a family of molecules composed of carbon, hydrogen, and oxygen, but unlike carbohydrates, they are insoluble in water.
- Lipids are found predominately in butter, oils, meats, dairy products, nuts, and seeds, and in many processed foods.
- The three main types of lipids are triglycerides (triacylglycerols), phospholipids, and sterols
- The main job of lipids is to store energy. Lipids provide more energy per gram than carbohydrates (nine kilocalories per gram of lipids versus four kilocalories per gram of carbohydrates). In addition to energy storage, lipids serve as cell membranes, surround and protect organs, aid in temperature regulation, and regulate many other functions in the body.

Proteins

- Proteins are macromolecules composed of chains of subunits called amino acids.
- Amino acids are simple subunits composed of carbon, oxygen, hydrogen, and nitrogen.

- The food sources of proteins are meats, dairy products, seafood, and a variety of different plant-based foods, most notably soy.
- The word protein comes from a Greek word meaning "of primary importance," which is an apt description of these macronutrients; they are also known colloquially as the "workhorses" of life.
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Water

- There is one other nutrient that we must have in large quantities: water.
- Water does not contain carbon, but is composed of two hydrogens and one oxygen per molecule of water. More than 60 percent of your total body weight is water.
- Without it, nothing could be transported in or out of the body, chemical reactions would not occur, organs would not be cushioned, and body temperature would fluctuate widely.
- On average, an adult consumes just over two liters of water per day from food and drink.
- According to the "rule of threes," a generalization supported by survival experts, a person can survive three minutes without oxygen, three days without water, and three weeks without food. Since water is so critical for life's basic processes.

Micronutrients

- Micronutrients are nutrients required by the body in lesser amounts, but are still essential for carrying out bodily functions. Micronutrients include all the essential minerals and vitamins.
- There are sixteen essential minerals and thirteen vitamins.
- In contrast to carbohydrates, lipids, and proteins, micronutrients are not directly used for making energy, but they assist in the process as being part of enzymes (i.e., coenzymes).

Minerals

- Minerals are solid inorganic substances that form crystals and are classified depending on how much of them we need. Trace minerals, such as molybdenum, selenium, zinc, iron, and iodine, are only required in a few milligrams or less and macrominerals, such as calcium, magnesium, potassium, sodium, and phosphorus, are required in hundreds of milligrams.
- Many minerals are critical for enzyme function, others are used to maintain fluid balance, build bone tissue, synthesize hormones, transmit nerve impulses, contract and relax muscles, and protect against harmful free radicals.

Minerals	Major Functions
Macro	
Sodium	Fluid balance, nerve transmission, muscle contraction
Chloride	Fluid balance, stomach acid production
Potassium	Fluid balance, nerve transmission, muscle contraction
Calcium	Bone and teeth health maintenance, nerve transmission, muscle contraction, blood clotting
Phosphorus	Bone and teeth health maintenance, acid-base balance
Magnesium	Protein production, nerve transmission, muscle contraction
Sulfur	Protein production
Trace	
Iron	Carries oxygen, assists in energy production
Zinc	Protein and DNA production, wound healing, growth, immune system function
Iodine	Thyroid hormone production, growth, metabolism
Selenium	Antioxidant
Copper	Coenzyme, iron metabolism
Manganese	Coenzyme

Vitamins

- The thirteen vitamins are categorized as either water-soluble or fat-soluble.
- The water-soluble vitamins are vitamin C and all the B vitamins, which include thiamine, riboflavin, niacin, pantothenic acid, pyroxidine, biotin, folate and cobalamin.
- The fat-soluble vitamins are A, D, E, and K. Vitamins are required to perform many functions in the body such as making red blood cells, synthesizing bone tissue, and playing a role in normal vision, nervous system function, and immune system function.
- Vitamin deficiencies can cause severe health problems. For example, a deficiency in niacin causes a disease called pellagra, which was common in the early twentieth century in some parts of America. The common signs and symptoms of pellagra are known as the "4D's—diarrhea, dermatitis, dementia, and death."
- Until scientists found out that better diets relieved the signs and symptoms of pellagra, many people with the disease ended up in insane asylums awaiting death Other vitamins were also found to prevent certain disorders and diseases such as scurvy (vitamin C), night blindness (vitamin A), and rickets (vitamin D).

Vitamins	Major Functions
Water-soluble	
B_1 (thiamine)	Coenzyme, energy metabolism assistance

Vitamins	Major Functions
B_2 (riboflavin)	Coenzyme, energy metabolism assistance
B_3 (niacin)	Coenzyme, energy metabolism assistance
B_5 (pantothenic acid)	Coenzyme, energy metabolism assistance
B_6 (pyroxidine)	Coenzyme, amino acid synthesis assistance
Biotin	Coenzyme
Folate	Coenzyme, essential for growth
B_{12} (cobalamin)	Coenzyme, red blood cell synthesis
C	Collagen synthesis, antioxidant
Fat-soluble	
A	Vision, reproduction, immune system function
D	Bone and teeth health maintenance, immune system function
E	Antioxidant, cell membrane protection
K	Bone and teeth health maintenance, blood clotting

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Food Quality

- One measurement of food quality is the amount of nutrients it contains relative to the amount of energy it provides.
- High-quality foods are nutrient dense, meaning they contain lots of the nutrients relative to the amount of calories they provide.
- Nutrient-dense foods are the opposite of "empty-calorie" foods such as carbonated sugary soft drinks, which provide many calories and very little, if any, other nutrients.
- Food quality is additionally associated with its taste, texture, appearance, microbial content, and how much consumers like it.

Food: A Better Source of Nutrients

- It is better to get all your micronutrients from the foods you eat as opposed to from supplements.
- Supplements contain only what is listed on the label, but foods contain many more macronutrients, micronutrients, and other chemicals, like antioxidants that benefit health.

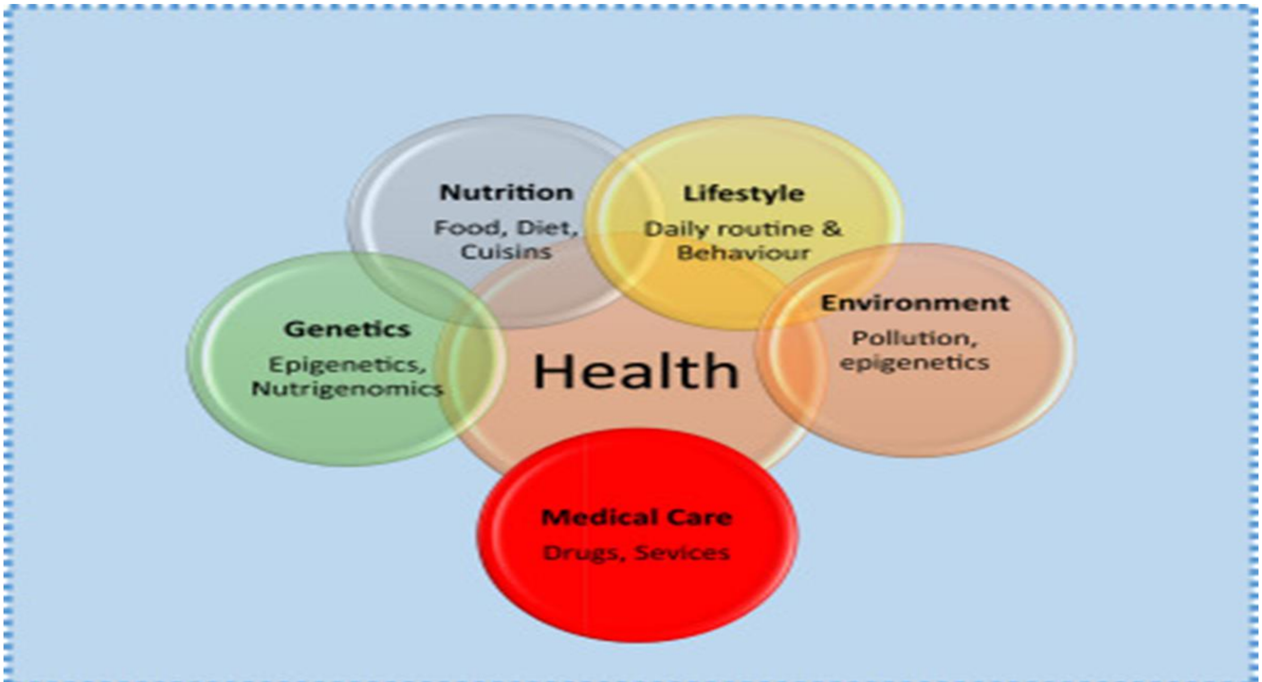
<u>Health Factors and Their Impact</u>

- In addition to nutrition, health is affected by genetics, the environment, life cycle, and lifestyle. These factors are referred to as "determinants" of health and they all interact with each other.
- For example, family income influences the food choices available and the quantity and quality of food that can be purchased, which of course affects nutrition.
- Except for nutrition and lifestyle, these factors can be difficult or impossible to change

<u>Genetics</u>

- Everyone starts out in life with the genes handed down to them from the families of their mother and father.
- Genes are responsible for your many traits as an individual and are defined as the sequences of DNA that code for all the proteins in your body.

- The expression of different genes can determine the color of your hair, skin, and eyes, and even if you are more likely to be fat or thin and if you have an increased risk for a certain disease.
- The sequence of DNA that makes up your genes determines your genetic makeup, also called your genome16, which is inherited from your mother and father.



- . In 2003, the Human Genome Project was completed and now the entire sequence of DNA in humans is known.
- It consists of about three billion individual units and contains between twenty-five and thirty thousand genes
- Now that we understand the map of the human genome, let's enter the fields of nutrigenomics and epigenetics.

<u>Nutrigenomics</u>

- is an emerging scientific discipline aimed at defining healthy genes and not-so healthy genes and how nutrients affect them.
- Currently, scientists cannot change a person's DNA sequence.
- But they have discovered that chemical reactions in the body can turn genes "on" and "off," causing changes in the amounts and types of proteins expressed.
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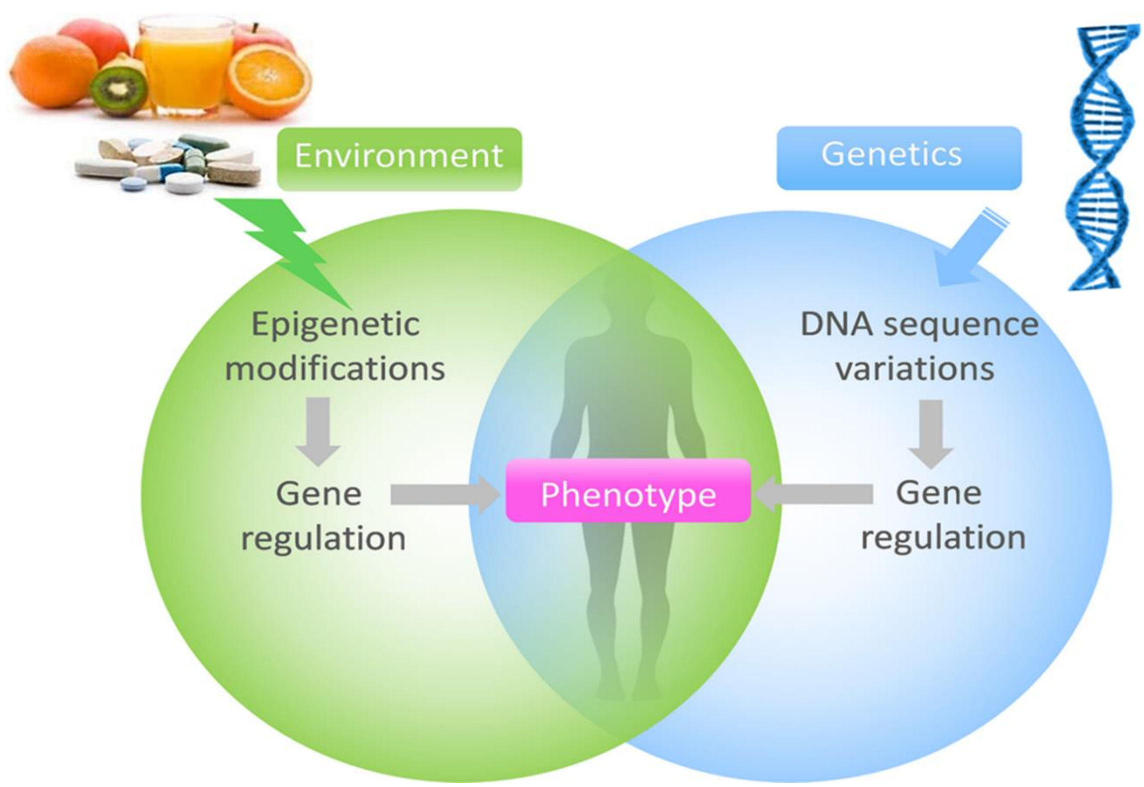

<u>The life cycle</u>

- The life cycle of human beings originates from a fertilized egg, which develops into a fetus that is eventually born as a baby. A baby develops into a child, transitions through the wonderful phase of adolescence, becomes an adult, and then advances into old age and eventually death.
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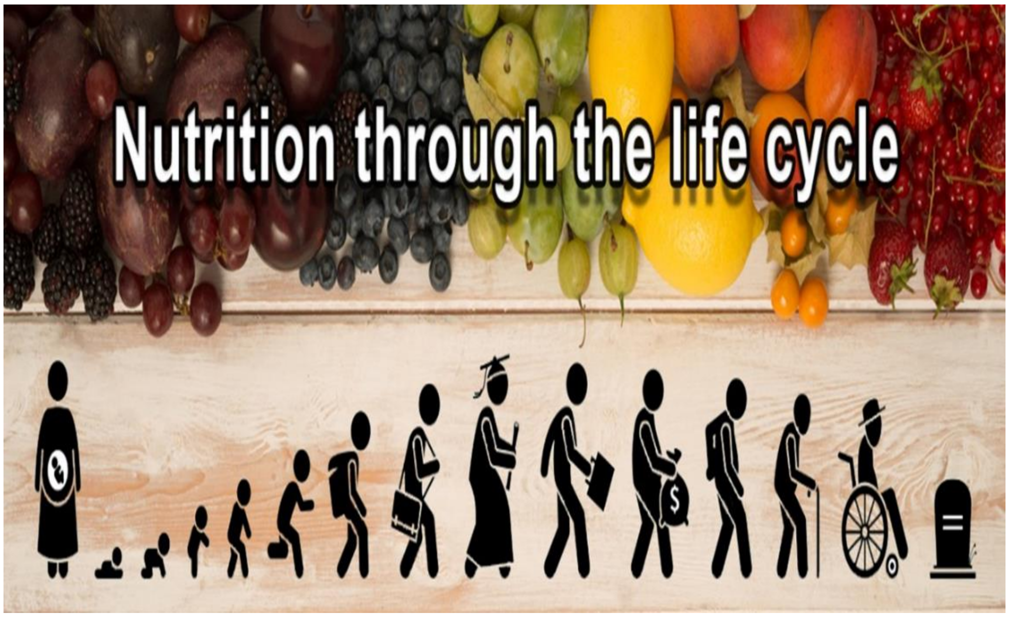


The Life Cycle

- A person's stage of life influences their health and nutritional requirements.
- For example, when you are **an adolescent**, your bones grow quickly. More calcium, a bone-building nutrient, is required in the diet during this life stage than at other ages.
- As you get older, the aging process affects how your body functions. One effect of aging, apparently earlier in women than in men, is the deterioration of bone tissue. As a result, women over age fifty-one need more calcium in their diet than younger adult women.
- Another life-cycle stage, pregnancy, requires several adjustments to nutrition compared to nonpregnant women.

Environment

- Your environment has a large influence on your health, genetics, life cycle, and lifestyle.
- Scientists say that the majority of your expressed traits are a product of your genes and environment, of which nutrition is a component.

Socioeconomic Status

- Socioeconomic status is a measurement made up of three variables: income, occupation, and education.

- Socioeconomic status affects nutrition by influencing what foods you can afford and consequently, food choice and food quality.
- Nutrition and health are generally better in populations that have higher incomes, better jobs, and more education.
- On the other hand, the burden of disease is highest in the most disadvantaged populations.

Lifestyle

- Dietary habits include what a person eats, how much a person eats during a meal, how frequently meals are consumed, and how often a person eats out at restaurants.
- Other aspects of lifestyle21 include physical activity level, recreational drug use, and sleeping patterns, all of which play a role in health and impact nutrition. Following a healthy lifestyle improves your overall health

Sleeping pattern

- The neurotransmitters ghrelin and leptin are thought to be central to appetite.
- Ghrelin promotes hunger, and leptin contributes to feeling full. The body naturally increases and decreases the levels of these neurotransmitters throughout the day, signaling the need to consume calories.
- A lack of sleep may affect the body's regulation of these neurotransmitters.
- In one study, men who got 4 hours of sleep had increased ghrelin and decreased leptin compared to those who got 10 hours of sleep.
- This dysregulation of ghrelin and leptin may lead to increased appetite and diminished feelings of fullness in people who are sleep deprived.

Factors that Drive Food Choices

<u>Taste, texture, and appearance.</u>

- Individuals have a wide range of tastes which influence their food choices, leading some to dislike milk and others to hate raw vegetables.
- Some foods that are very healthy, such as tofu, may be unappealing at first to many people. However, creative cooks can adapt healthy foods to meet most peoples' taste.

<u>Economics.</u>

- Access to fresh fruits and vegetables may be scant, particularly for those who live in economically disadvantaged or remote areas, where cheaper food options are limited to convenience stores and fast food.

Early food experiences.

- People who were not exposed to different foods as children, or who were forced to swallow •

<u>Habits.</u>

- It's common to establish eating routines, which can work both for and against optimal health. Habitually grabbing a fast food sandwich for breakfast can seem convenient, but might not offer.
- every last bite of overcooked vegetables, may make limited food choices as adults.

Culture. The culture in which one grows up affects how one sees food in daily life and on special occasions.

• **Geography.** Where a person lives influences food choices. For instance, people who live in Midwestern US states have less access to seafood than those living along the coasts.

• **Advertising.** The media greatly influences food choice by persuading consumers to eat certain foods

• Social factors.

Any school lunchroom observer can testify to the impact of peer pressure on eating habits, and this influence lasts through adulthood. People make food choices based on how they see others and want others to see them. For example, individuals can purchase cheap and fast pizzas or opt for high-end versions at fancy restaurants.

Health concerns.

- Some people have significant food allergies, to lactose or peanuts for example, and need to avoid those foods.
- Others may have developed health issues, which require them to follow a low salt diet.
- In addition, people who have never worried about their weight have a very different approach to eating than those who have long struggled with excess pounds.
- **Emotions.**
- There is a wide range in how emotional issues affect eating habits. When faced with a great deal of stress, some people tend to overeat, while others find it hard to eat at all

Chapter II

The gastrointestinal (GI) system

The gastrointestinal (GI) system includes the gastrointestinal tract (mouth, pharynx, esophagus, stomach, small intestine, and large intestine) plus the accessory organs (salivary glands, liver, gallbladder, and pancreas) that are not part of the tract but secrete substances into it via connecting ducts. The overall function of the gastrointestinal system is to process ingested foods into molecular forms that are then transferred, along with salts and water to the body's internal environment, where they can be distributed to cells by the circulatory system.

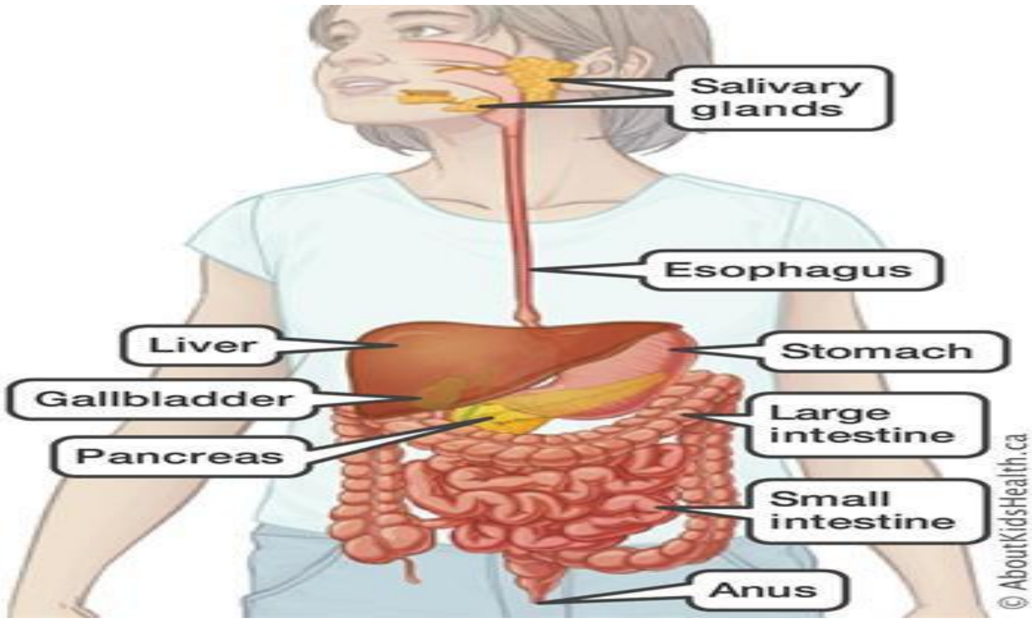
The adult gastrointestinal tract is a tube approximately 15 ft long, running through the body from mouth to anus. The lumen of the tract is continuous with the external environment, which means that its contents are technically outside the body. This fact is relevant to understanding some of the tract's properties. For example, the large intestine is inhabited by billions of bacteria, most of which are harmless and even beneficial in this location. However, if the same bacteria enter the internal environment, as may happen, for example, in the case of a ruptured appendix, they may cause a severe infection.

Most food enters the gastrointestinal tract as large particles containing macromolecules, such as proteins and polysaccharides, which are unable to cross the intestinal epithelium. Before ingested food can be absorbed, therefore, it must be dissolved and broken down into small molecules. This dissolving and breaking-down process—digestion—is accomplished by the action of hydrochloric acid in the stomach, bile from the liver, and a variety of digestive enzymes that are released by the system's exocrine glands. Each of these substances is released into the lumen of the GI tract by the process of secretion.

The molecules produced by digestion then move from the lumen of the gastrointestinal tract across a layer of epithelial cells and enter the blood or lymph. This process is called absorption. While digestion, secretion, and absorption are taking place, contractions of smooth muscles in the gastrointestinal tract wall serve two functions; they mix the luminal contents with the various secretions, and they move the contents through the tract from mouth to anus. These contractions are referred to as the motility of the gastrointestinal tract.

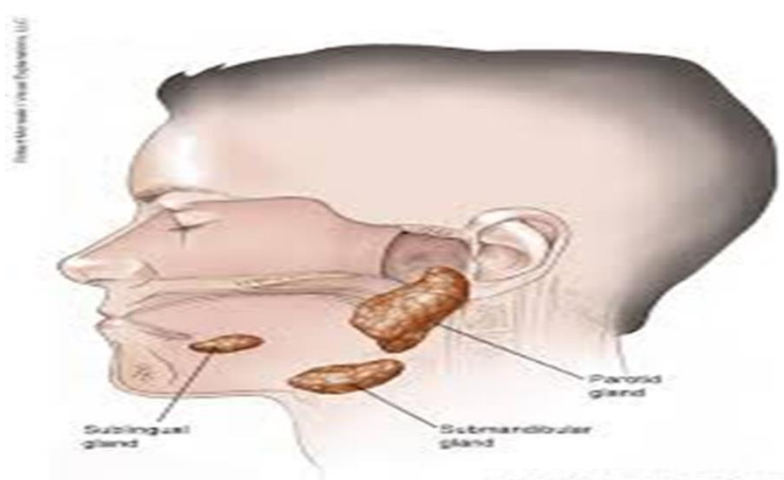
The functions of the gastrointestinal system can be described in terms of these four processes—digestion, secretion, absorption, and motility and the mechanisms controlling them. The gastrointestinal system is designed to maximize absorption, and within fairly wide limits it will absorb as much of any particular substance as is ingested. With a few important exceptions the gastrointestinal system does *not regulate* the amount of nutrients absorbed or their concentrations in the internal environment. The regulation of the plasma concentration of the absorbed nutrients is primarily the function of the kidneys and a number of endocrine glands.

Small amounts of certain metabolic end products are excreted via the gastrointestinal tract, primarily by way of the bile, but the elimination of most of the body's waste products is achieved by the lungs and kidneys. The material—feces— leaving the system at the end of the gastrointestinal tract consists almost entirely of bacteria and ingested material that was neither digested nor absorbed—that is, material that was never actually part of the internal environment.



<u>Functions of the Gastrointestinal Organs:-</u>

The gastrointestinal tract begins with the **mouth,** and digestion starts there with chewing, which breaks up large pieces of food into smaller particles that can be swallowed. **Saliva,** secreted by three pairs of **salivary glands** located in the head, drains into the mouth through a series of short ducts. Saliva, which contains mucus, moistens and lubricates the food particles before swallowing. It also contains the enzyme **amylase,** which partially digests polysaccharides. A third function of saliva is to dissolve some of the food molecules. Only in the dissolved state can these molecules react with chemoreceptors in the mouth, giving rise to the sensation of taste.



The next segments of the tract, the **pharynx** and **esophagus,** contribute nothing to digestion but provide the pathway by which ingested materials reach the stomach. The muscles in the walls of these segments control swallowing.

The **stomach** is a saclike organ, located between the esophagus and the small intestine. Its functions are to store, dissolve, and partially digest the macromolecules in food and to regulate the rate at which the stomach's contents empty into the small intestine. The glands lining the stomach wall secrete a strong acid, **hydrochloric acid,** and several protein-digesting enzymes collectively known as **pepsin** (actually a precursor of pepsin known as pepsinogen is secreted and converted to pepsin in the lumen of the stomach).

The primary function of hydrochloric acid is to dissolve the particulate matter in food. The acid environment in the **gastric** (adjective for "stomach") lumen alters the ionization of polar molecules, especially proteins, disrupting the extracellular network of connective tissue proteins that form the structural framework of the tissues in food. The proteins and polysaccharides released by hydrochloric acid's dissolving action are partially digested in the stomach by pepsin and amylase, the latter contributed by the salivary glands. A major food component that is not dissolved by acid is fat.

Hydrochloric acid also kills most of the bacteria that enter along with food. This process is not 100 percent effective, and some bacteria survive to take up residence and multiply in the gastrointestinal tract, particularly the large intestine.

The digestive actions of the stomach reduce food particles to a solution known as **chyme,** which contains molecular fragments of proteins and polysaccharides, droplets of fat, and salt, water, and various other small molecules ingested in the food. Virtually none of these molecules, except water, can cross the epithelium of the gastric wall, and thus little absorption of organic nutrients occurs in the stomach.

Digestion's final stages and most absorption occur in the next section of the tract, the **small intestine,** a tube about 1.5 inches in diameter and 9 ft in length that leads from the stomach to the large intestine. Here molecules of intact or partially digested carbohydrates, fats, and proteins are broken down by hydrolytic enzymes into monosaccharides, fatty acids, and amino acids. Some of these enzymes are on the luminal surface of the intestinal lining cells, while others are secreted by the pancreas and enter the intestinal lumen. The products of digestion are absorbed across the epithelial cells and enter the blood and/or lymph. Vitamins, minerals, and water, which do not require enzymatic digestion, are also absorbed in the small intestine.

The small intestine is divided into three segments: An initial short segment, the **duodenum,** is followed by the **jejunum** and then by the longest segment, the **ileum.** Normally, most of the chyme entering from the stomach is digested and absorbed in the first quarter of the small intestine, in the duodenum and jejunum. Two major glands—the pancreas and liver—secrete substances that flow via ducts into the duodenum.

The **pancreas,** an elongated gland located behind the stomach, has both endocrine (Chapter 18) and exocrine functions, but only the latter are directly involved in gastrointestinal function and are described in this chapter. The exocrine portion of the pancreas secretes (1) digestive enzymes and (2) a fluid rich in bicarbonate ions. The high acidity of the chyme coming from the stomach would inactivate the pancreatic enzymes in the small intestine if the acid were not neutralized by the bicarbonate ions in the pancreatic fluid.

The **liver,** a large gland located in the upper right portion of the abdomen, has a variety of functions, which are described in various chapters. Bile contains bicarbonate ions, cholesterol, phospholipids, bile pigments, a number of organic wastes and—most important—a group of substances collectively termed **bile salts.** The bicarbonate ions, like those from the pancreas, help neutralize acid from the stomach, while the bile salts, as we shall see, solubilize dietary fat. These fats would otherwise be insoluble in water, and their solubilization increases the rates at which they are digested and absorbed.

Bile is secreted by the liver into small ducts that join to form a single duct called the common hepatic duct. Between meals, secreted bile is stored in the **gallbladder,** a small sac underneath the liver that branches from the common hepatic duct. The gallbladder concentrates the organic molecules in bile by absorbing salts and water. During a meal, the smooth muscles in the gallbladder wall contract, causing a concentrated bile solution to be injected into the duodenum via the **common bile duct** (Figure 17–4), an extension of the common hepatic duct. The gallbladder can be surgically removed without impairing bile secretion by the liver or its flow into the intestinal tract. In fact, many animals that secrete bile do not have a gallbladder.

In the small intestine, monosaccharides and amino acids are absorbed by specific transporter-mediated processes in the plasma membranes of the intestinal epithelial cells, whereas fatty acids enter these cells by diffusion. Most mineral ions are actively absorbed by transporters, and water diffuses passively down osmotic gradients.

The motility of the small intestine, brought about by the smooth muscles in its walls, (1) mixes the luminal contents with the various secretions, (2) brings the contents into contact with the epithelial surface where absorption takes place, and (3) slowly advances the luminal material toward the large intestine. Since most substances are absorbed in the small intestine, only a small volume of water, salts, and undigested material is passed on to the **large intestine.** The large intestine temporarily stores the undigested material (some of which is metabolized by bacteria) and concentrates it by absorbing salts and water. Contractions of the **rectum,** the final segment of the large intestine, and relaxation of associated sphincter muscles expel the feces—**defecation.**

The average adult consumes about 800 g of food and 1200 ml of water per day, but this is only a fraction of the material entering the lumen of the gastrointestinal tract. An additional 7000 ml of fluid from salivary glands, gastric glands, pancreas, liver, and intestinal glands is secreted into the tract each day (Figure 17–5). Of the 8 L of fluid entering the tract, 99 percent is absorbed; only about 100 ml is normally lost in the feces. This small amount of fluid loss represents only 4 percent of the total fluids lost by the body each day (most fluid loss is via the kidneys and respiratory system). Almost all the salts in the secreted fluids are also reabsorbed into the blood.

Moreover, the secreted digestive enzymes are themselves digested, and the resulting amino acids are absorbed into the blood

	Organ	Exocrine Secretions	Functions
	Mouth and Pharynx		Chewing begins; initiation of swallowing reflex.
	Salivary glands	Salt and water Mucus Amylase	Moisten food Lubrication Polysaccharide-digesting enzyme
	Esophagus	Mucus	Move food to stomach by peristaltic waves. Lubrication
	Stomach		Store, mix, dissolve, and continue digestion of food; regulate emptying of dissolvedfood into small intestine.
		HCl Pepsin Mucus	Solubilization of food particles; kill microbes Protein-digesting enzyme Lubricate and protect epithelial surface
	Pancreas	Enzymes	Secretion of enzymes and bicarbonate; also has nondigestive endocrine functions

		Bicarbonate	Digest carbohydrates, fats, proteins, and nucleic acids Neutralize HCl entering small intestine from stomach
	Liver	Bile salts Bicarbonate Organic waste products and trace metals	Secretion of bile; many other nondigestive Functions. Solubilize water-insoluble fats Neutralize HCl entering small intestine from stomach Elimination in feces
	Small intestine	Enzymes Salt and water Mucus	Digestion and absorption of most substances; mixing and propulsion of contents Food digestion Maintain fluidity of luminal contents Lubrication
	Large intestine	Mucus	Storage and concentration of undigested matter; absorption of salt and water; mixing and propulsion of contents; defecation Lubrication

Digestion and Absorption

Carbohydrate

Carbohydrate intake per day ranges from about 250 to 800 g in a typical American diet. About two-thirds of this carbohydrate is the plant polysaccharide starch, and most of the remainder consists of the disaccharides sucrose and lactose (milk sugar). Only small amounts of monosaccharides are normally present in the diet. Cellulose and certain other complex polysaccharides found in vegetable matter—referred to as **fiber**—cannot be broken down by the enzymes in the small intestine and are passed on to the large intestine, where they are partially metabolized by bacteria.

Starch digestion by salivary amylase **begins in the mouth** and continues in the upper part of the stomach before the amylase is destroyed by gastric acid. Starch digestion is completed in the small intestine by pancreatic amylase. The products produced by both amylases are the disaccharide maltose and a mixture of short, branched chains of glucose molecules. These products, along with ingested sucrose and lactose, are broken down into monosaccharides—glucose, galactose, and fructose—by enzymes located on the luminal membranes of the small-intestine epithelial cells.

These monosaccharides are then transported across the intestinal epithelium into the blood. Fructose enters the epithelial cells by facilitated diffusion, while glucose and galactose undergo secondary active transport coupled to sodium. These monosaccharides then leave the epithelial cells and enter the blood by way of facilitated diffusion transporters in the basolateral membranes of the epithelial cells. Most ingested carbohydrate is digested and absorbed within the first 20 percent of the small intestine.

Protein

Only 40 to 50 g of protein per day is required by a normal adult to supply essential amino acids and replace the amino acid nitrogen converted to urea. A typical American diet contains about 125 g of protein per day.

In addition, a large amount of protein, in the form of enzymes and mucus, is secreted into the gastrointestinal tract or enters it via the disintegration of epithelial cells. Regardless of source, most of the protein in the lumen is broken down into amino acids and absorbed by the small intestine.

Proteins are broken down to peptide fragments in the stomach by pepsin, and in the small intestine by **trypsin** and **chymotrypsin,** the major proteases secreted by the pancreas. These fragments are further digested to free amino acids by **carboxypeptidase** from the pancreas and **aminopeptidase,** located on the luminal membranes of the small-intestine epithelial cells.

These last two enzymes split off amino acids from the carboxyl and amino ends of peptide chains, respectively. At least 20 different peptidases are located on the luminal membrane of the epithelial cells, with various specificities for the peptide bonds they attack.

The free amino acids then enter the epithelial cells by secondary active transport coupled to sodium.

There are multiple transporters with different specificities for the 20 types of amino acids. Short chains of two or three amino acids are also absorbed by a secondary active transport that is coupled to the hydrogenion gradient. (This is in contrast to carbohydrate absorption, in which molecules larger than monosaccharides are not absorbed.) Within the epithelial cell, these di- and tripeptides are hydrolyzed to amino acids, which then leave the cell and enter the blood through a facilitated diffusion carrier in the basolateral membranes. As with carbohydrates, protein digestion and absorption are largely completed in the upper portion of the small intestine.

Very small amounts of intact proteins are able to cross the intestinal epithelium and gain access to the interstitial fluid. They do so by a combination of endocytosis and exocytosis. The absorptive capacity for intact proteins is much greater in infants than in adults, and antibodies (proteins involved in the immunological defense system of the body) secreted into the mother's milk can be absorbed by the infant, providing some immunity until the infant begins to produce its own antibodies.

Fat

Fat intake ranges from about 25 to 160 g/day in a typical American diet; most is in the form of triacylglycerols. Fat digestion occurs almost entirely in the small intestine. The major digestive enzyme in this process is pancreatic **lipase,** which catalyzes the splitting of bonds linking fatty acids to the first and third carbon atoms of glycerol, producing two free fatty acids and a monoglyceride as products:

Triacylglycerol $^{\text{lipas}}\rightarrow$Monoglyceride +2 Fatty acids

The fats in the ingested foods are insoluble in water and aggregate into large lipid droplets in the upper portion of the stomach. Since pancreatic lipase is a water-soluble enzyme, its digestive action in the small intestine can take place only at the *surface* of a lipid droplet. Therefore, if most of the ingested fat remained in large lipid droplets, the rate of lipid digestion would be very slow. The rate of digestion is, however, substantially increased by division of the large lipid droplets into a number of much smaller droplets, each about 1 mm in diameter, thereby increasing their surface area and accessibility to lipase action. This process is known as **emulsification,** and the resulting suspension of small lipid droplets is an emulsion.

The emulsification of fat requires (1) mechanical disruption of the large fat droplets into smaller droplets, and (2) an emulsifying agent, which acts to prevent the smaller droplets from reaggregating back into large droplets. The mechanical disruption is provided by contractile activity, occurring in the lower portion of the stomach and in the small intestine, which acts to grind and mix the luminal contents.

Phospholipids in food and phospholipids and bile salts secreted in the bile provide the emulsifying agents, whose action is as follows.

Phospholipids are amphipathic molecules consisting of two nonpolar fatty acid chains attached to glycerol, with a charged phosphate group located on glycerol's third carbon. Bile salts are formed from cholesterol in the liver and are also amphipathic (Figure 17–9). The nonpolar portions of the phospholipids and bile salts associate with the nonpolar interior of the lipid droplets, leaving the polar portions exposed at the water surface. There they repel other lipid droplets that are similarly coated with these emulsifying agents, thereby preventing their reaggregation into larger fat droplets (Figure 17–10).

The coating of the lipid droplets with these emulsifying agents, however, impairs the accessibility of the water-soluble lipase to its lipid substrate. To overcome this problem, the pancreas secretes a protein known as **colipase,** which is amphipathic and lodges on the lipid droplet surface. Colipase binds the lipase enzyme, holding it on the surface of the lipid droplet
Although digestion is speeded up by emulsification, absorption of the water-insoluble products

of the lipase reaction would still be very slow if it were not for a second action of the bile salts, the formation of **micelles,** which are similar in structure to emulsion droplets but are much smaller—4 to 7 nm in diameter. Micelles consist of bile salts, fatty acids, monoglycerides, and phospholipids all clustered together with the polar ends of each molecule oriented toward the micelle's surface and the nonpolar portions forming the micelle's core (Figure 17–11). Also included in the core of the micelle are small amounts of fat soluble vitamins and cholesterol.

How do micelles increase absorption?

Although fatty acids and monoglycerides have an extremely low solubility in water, a few molecules do exist in solution and are free to diffuse across the lipid portion of the luminal plasma membranes of the epithelial cells lining the small intestine. Micelles, containing the products of fat digestion, are in equilibrium with the small concentration of fat digestion products that are free in solution. Thus, micelles are continuously breaking down and reforming. When a micelle breaks down, its contents are released into the solution and become available to diffuse across the intestinal lining. As the concentrations of free lipids fall, because of their diffusion into epithelial cells, more lipids are released into the free phase as micelles break down (Figure 17–11). Thus, the micelles provide a means of keeping most of the insoluble fat digestion products in small soluble aggregates, while at the same time replenishing the small amount of products that are free in solution and are able to diffuse into the intestinal epithelium. Note that it is not the micelle that is absorbed but rather the individual lipid molecules that are released from the micelle.

Although fatty acids and monoglycerides enter epithelial cells from the intestinal lumen, it is triacylglycerol that is released on the other side of the cell into the interstitial fluid. In other words, during their passage through the epithelial cells, fatty acids and monoglycerides are resynthesized into triacylglycerols. This occurs in the agranular (smooth) endoplasmic reticulum, where the enzymes for triacylglycerol synthesis are located. This process lowers the concentration of cytosolic free fatty acids and monoglycerides and thus maintains a diffusion gradient for these molecules into the cell. Within this organelle, the resynthesized fat aggregates into small droplets coated with amphipathic proteins that perform an emulsifying function similar to that of bile salts.

The exit of these fat droplets from the cell follows the same pathway as a secreted protein. Vesicles containing the droplet pinch off the endoplasmic reticulum, are processed through the Golgi apparatus, and eventually fuse with the plasma membrane, releasing the fat droplet into the interstitial fluid. These one micron- diameters, extracellular fat droplets are known as **chylomicrons.** Chylomicrons contain not only triacylglycerols but other lipids (including phospholipids, cholesterol, and fat-soluble vitamins) that have been absorbed by the same process that led to fatty acid and monoglyceride movement into the epithelial cells of the small intestine.

Chapter III

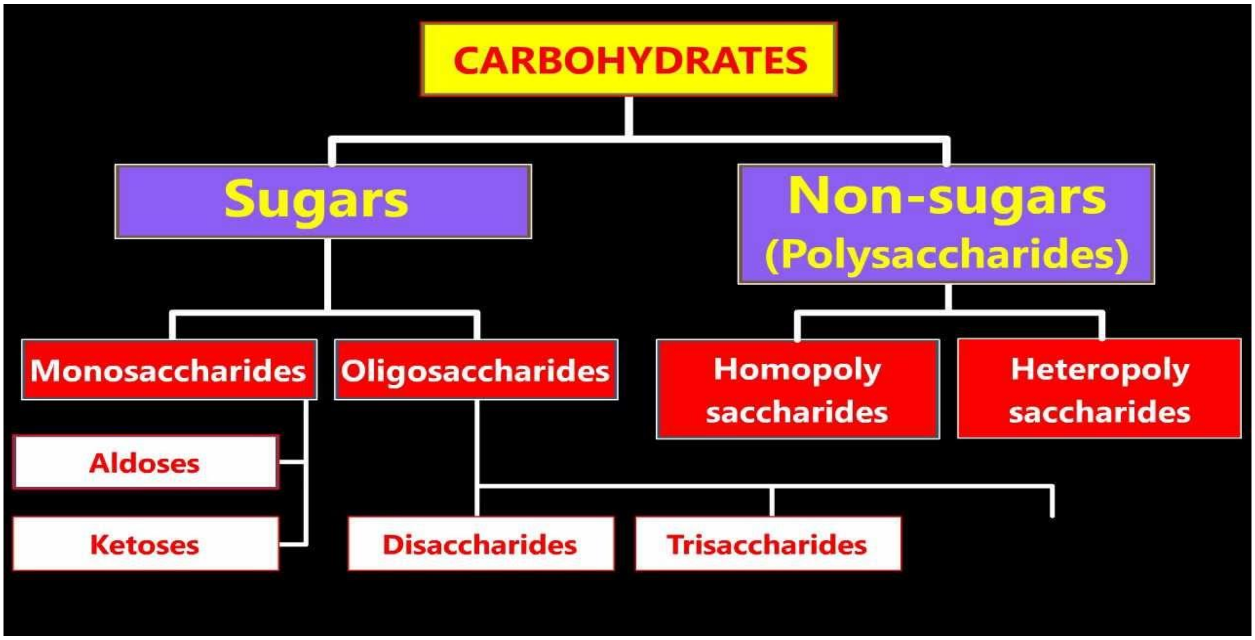
Carbohydrates

What Exactly Are Carbohydrates and How Many Types Are There?

- Carbohydrates are the perfect nutrient to meet your body's nutritional needs.
- They nourish your brain and nervous system, provide energy to all your cells (within proper caloric limits), and help keep your body fit and lean.
- Specifically, **digestible carbohydrates** provide bulk in foods, vitamins, and minerals, while indigestible carbohydrates provide good fiber and other health benefits.

What Exactly Are Carbohydrates and How Many Types Are There?

- Carbohydrates are a group of organic compounds containing a ratio of one carbon atom to two hydrogen atoms to one oxygen atom.
- Basically, they are hydrated carbons. The word "carbo" means carbon and "hydrate" means water. Glucose1 , the most abundant carbohydrate in the human body, has six carbon atoms, twelve hydrogen atoms, and six oxygen atoms.
- The chemical formula for glucose is written as $C_6H_{12}O_6$.
- Synonymous with the term carbohydrate is the Greek word "saccharide," which means sugar. The simplest unit of a carbohydrate is a monosaccharide.
- Carbohydrates are broadly classified into two subgroups, "fast releasing" and "slow-releasing." Fast-releasing carbohydrates are further grouped into the monosaccharides and dissacharides. Slow-releasing carbohydrates are long chains of monosaccharides.



What Exactly Are Carbohydrates and How Many Types Are There?

Fast-Releasing Carbohydrates

- Fast-releasing carbohydrates are also known more simply as "sugars."
- Fast-releasing carbohydrates are grouped as either monosaccharides or dissacharides.
- Monosaccharides include glucose, fructose, and galactose, and the dissacharides include, lactose, maltose, and sucrose

Monosaccharides

- For all organisms from bacteria to plants to animals, **glucose** is the preferred fuel source. The brain is completely dependent on glucose as its energy source.
- The monosaccharide **galactose** differs from glucose only in that a hydroxyl (−OH) group faces in a different direction on the number four carbon. This small structural alteration causes galactose to be less stable than glucose. As a result, the liver rapidly converts it to glucose. Most absorbed galactose is utilized for energy production in cells after its conversion to glucose.
- (Galactose is one of two simple sugars that are bound together to make up the sugar found in milk. It is later freed during the digestion process.)
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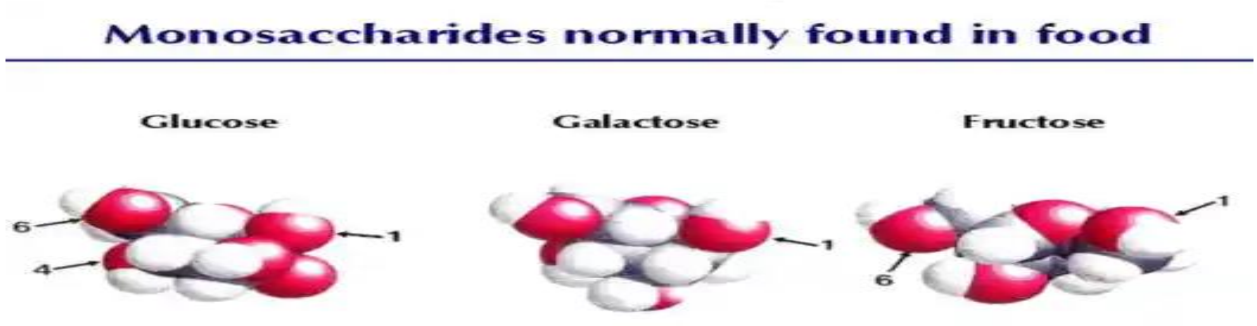


- Less common monosaccharides are the pentoses, which have only five carbons and not six. The pentoses are abundant in the nucleic acids RNA and DNA, and also as components of fiber.
- Lastly, there are the sugar alcohols, which are industrially synthesized derivatives of monosaccharides. Some examples of sugar alcohols are sorbitol, xylitol, and glycerol.
- Interestingly, the sensation of "coolness" that occurs when chewing gum that contains sugar alcohols comes from them dissolving in the mouth, a chemical reaction that requires heat from the inside of the mouth.

Disaccharides

- Disaccharides are composed of pairs of two monosaccharides linked together.
- Disaccharides include sucrose, lactose, and maltose.
- All of the disaccharides contain at least one glucose molecule.
- Sucrose, which contains both glucose and fructose molecules, is otherwise known as table sugar.
- Sucrose is also found in many fruits and vegetables, and at high concentrations in sugar beets and sugar cane, which are used to make table sugar.
- Lactose, which is commonly known as milk sugar, is composed of one glucose unit and one galactose unit.
- Lactose is prevalent in dairy products such as milk, yogurt, and cheese. Maltose consists of two glucose molecules bonded together.
- It is a common breakdown product of plant starches and is rarely found in foods as a disaccharide.

Slow-Releasing Carbohydrates

- Slow-releasing carbohydrates are **polysaccharides ,** long chains of monosaccharides that may be branched or not branched. There are two main groups of polysaccharides: starches and fibers

Starch

- Starch molecules are found in abundance in grains, legumes, and root vegetables, such as potatoes.
- Amylose, a plant starch, is a linear chain containing hundreds of glucose units.
- Amylopectin, another plant starch, is a branched chain containing thousands of glucose units.
- These large starch molecules form crystals and are the energy-storing molecules of plants.
- Eating raw foods containing starches provides very little energy as the digestive system has a hard time breaking them down.
- Cooking breaks down the crystal structure of starches, making them much easier to break down in the human body.
- The starches that remain intact throughout digestion are called resistant starches.
- Bacteria in the gut can break some of these down and may benefit gastrointestinal health.
- Isolated and modified starches are used widely in the food industry and during cooking as food thickeners

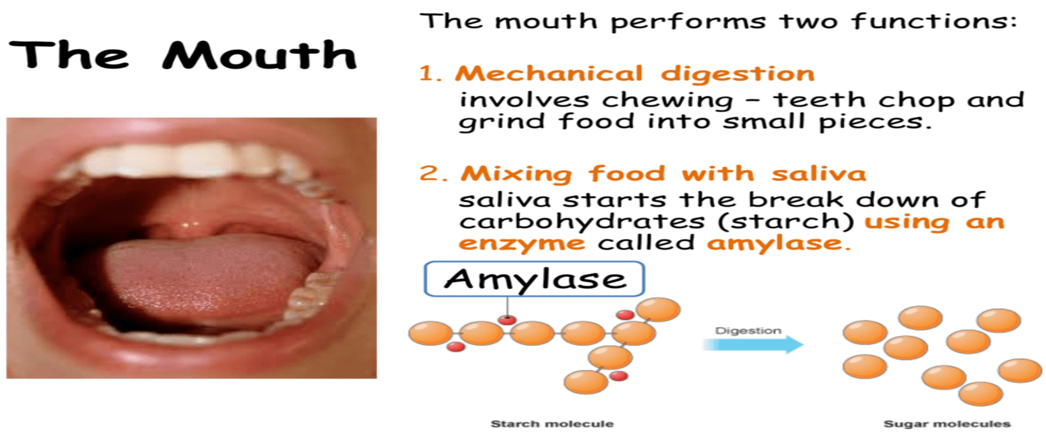
Dietary Fibers

- Dietary fibers are polysaccharides that are highly branched and cross-linked.
- Some dietary fibers are pectin, gums, cellulose, and lignin.
- Humans do not produce the enzymes that can break down dietary fiber; however, bacteria in the large intestine (colon) do.
- Dietary fibers are very beneficial to our health.
- The Dietary Guidelines Advisory Committee states that there is enough scientific evidence to support that diets high in fiber reduce the risk for obesity and diabetes, which are primary risk factors for cardiovascular disease.

From the Mouth to the Stomach

- The mechanical and chemical digestion of carbohydrates begins in the mouth.
- Chewing, also known as mastication, crumbles the carbohydrate foods into smaller and smaller pieces.

- The salivary glands in the oral cavity secrete saliva that coats the food particles.
- Saliva contains the enzyme, salivary amylase.
- This enzyme breaks the bonds between the monomeric sugar units of disaccharides, oligosaccharides , and starches.
- The salivary amylase breaks down amylose and amylopectin into smaller chains of glucose, called dextrins and maltose.



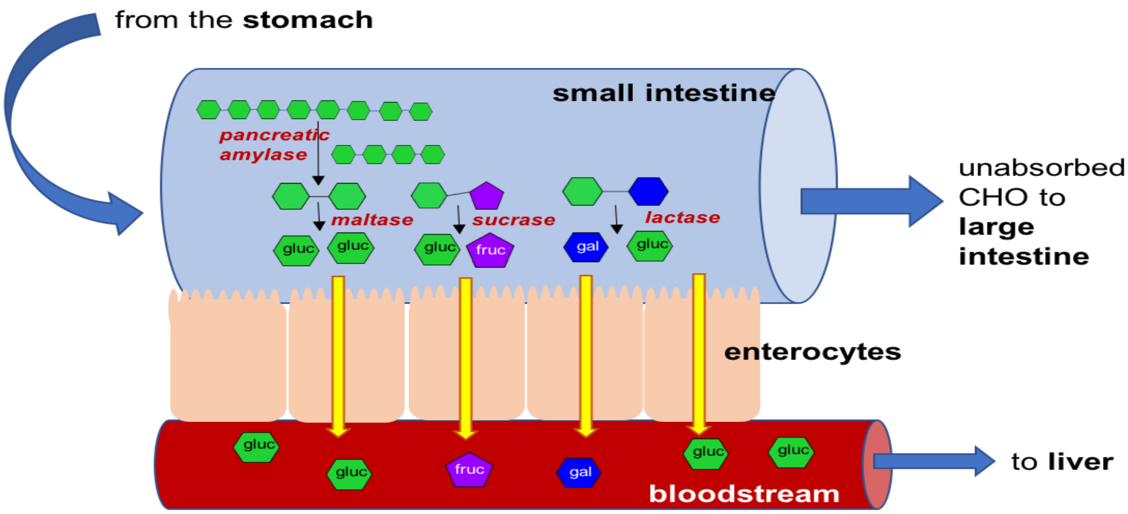
From the Mouth to the Stomach

- The increased concentration of maltose in the mouth that results from the mechanical and chemical breakdown of starches in whole grains is what enhances their sweetness.
- Only about five percent of starches are broken down in the mouth. (This is a good thing as more glucose in the mouth would lead to more tooth decay.)
- When carbohydrates reach the stomach no further chemical breakdown occurs because the amylase enzyme does not function in the acidic conditions of the stomach.
- But mechanical breakdown is ongoing—the strong peristaltic contractions of the stomach mix the carbohydrates into the more uniform mixture of chyme.

From the Stomach to the Small Intestine

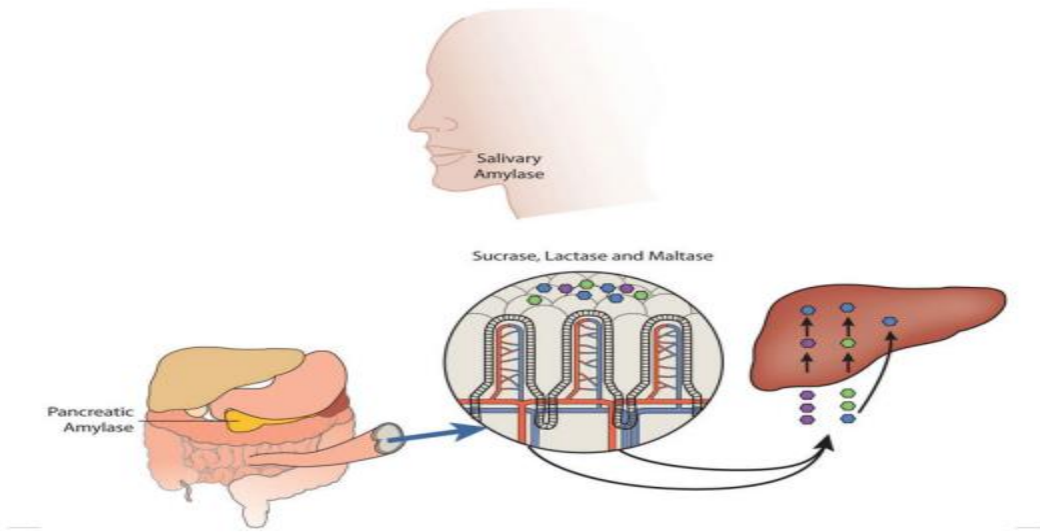
- The chyme is gradually expelled into the upper part of the small intestine.
- Upon entry of the chyme into the small intestine, the pancreas releases pancreatic juice through a duct.
- This pancreatic juice contains the enzyme, pancreatic amylase , which starts again the breakdown of dextrins into shorter and shorter carbohydrate chains.
- Additionally, enzymes are secreted by the intestinal cells that line the villi.
- These enzymes, known collectively as disaccharides, are sucrase, maltase, and lactase.

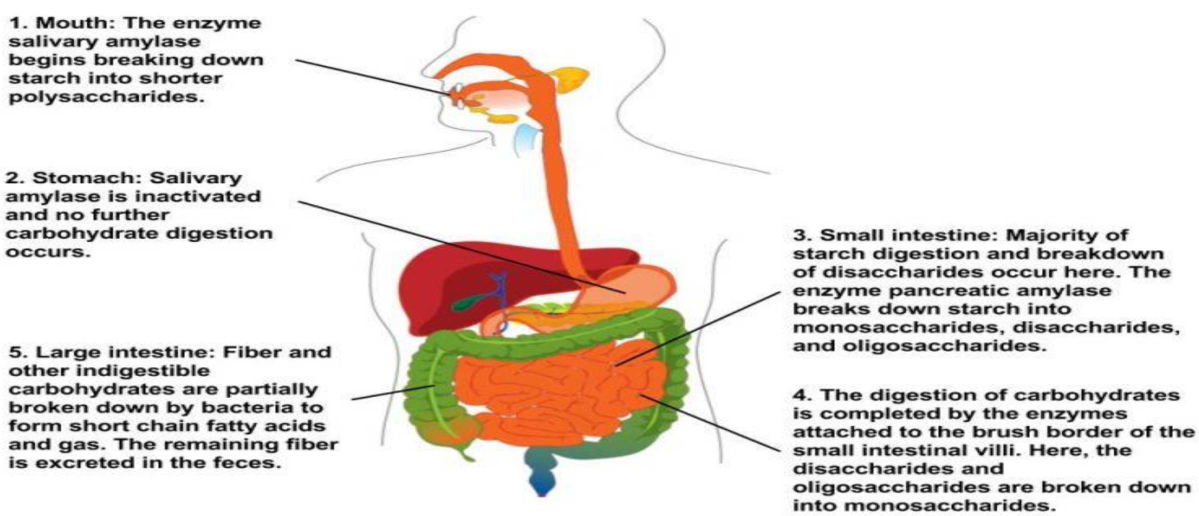
- Sucrase breaks sucrose into glucose and fructose molecules.
- Maltase breaks the bond between the two glucose units of maltose, and lactase breaks the bond between galactose and glucose.
- Once carbohydrates are chemically broken down into single sugar units they are then transported into the inside of intestinal cells.



Absorption:

- Going to the Blood Stream The cells in the small intestine have membranes that contain many transport proteins in order to get the monosaccharides and other nutrients into the blood where they can be distributed to the rest of the body.
- The first organ to receive glucose, fructose, and galactose is the liver.
- The liver takes them up and converts galactose to glucose, breaks fructose into even smaller carbon-containing units, and either stores glucose as glycogen or exports it back to the blood.
- How much glucose the liver exports to the blood is under hormonal control and you will soon discover that even the glucose itself regulates its concentrations in the blood.





<u>Maintaining Blood Glucose Levels: The Pancreas and Liver</u>

- Glucose levels in the blood are tightly controlled, as having either too much or too little glucose in the blood can have health consequences.
- Glucose regulates its levels in the blood via a process called negative feedback.
- Insulin-secreting cells in the pancreas sense the increase in blood glucose and release the hormonal message, insulin, into the blood.
- Insulin sends a signal to the body's cells to remove glucose from the blood by transporting to the insides of cells and to use it to make energy or for building macromolecules.

Maintaining Blood Glucose Levels: The Pancreas and Liver

- In the case of muscle tissue and the liver, insulin sends the biological message to store glucose away as glycogen.
- The presence of insulin in the blood signifies to the body that it has just been fed and to use the fuel.
- Insulin has an opposing hormone called glucagon. As the time after a meal increases, glucose levels decrease in the blood.
- Glucagon secreting cells in the pancreas sense the drop in glucose and, in response, release glucagon into the blood.
- Glucagon communicates to the cells in the body to stop using all the glucose.
- More specifically, it signals the liver to break down glycogen and release the stored glucose into the blood, so that glucose levels stay within the target range and all cells get the needed fuel to function properly.

Glycemic Index

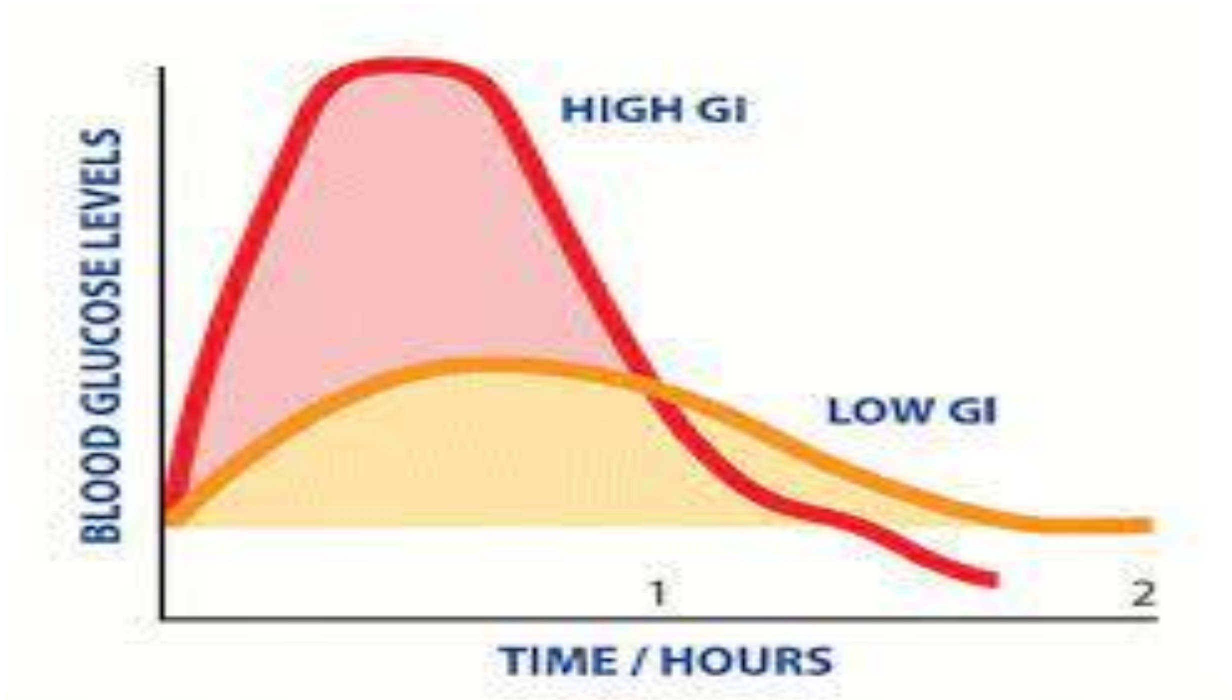
- The glycemic responses of various foods have been measured and then ranked in comparison to a reference food, usually a slice of white bread or just straight glucose, to create a numeric value called the glycemic index (GI).
- Foods that have a low GI do not raise blood-glucose levels neither as much nor as fast as foods that have a higher GI.
- A diet of low-GI foods has been shown in epidemiological and clinical trial studies to increase weight loss and reduce the risk of obesity, Type 2 diabetes, and cardiovascular disease.

Foods	GI Value
Low GI Foods (< 55)	
Apple	44
Pear	38
Banana (under-ripe)	51
Grapefruit	25
Barley	25
Navy beans	38
Green peas	48
Oat bran (Quaker Oats)	50
Spaghetti (whole wheat)	37
Mashed sweet potatoes	54
Baked beans	48
Butter beans	44
Banana bread	47
Bread (sourdough)	52
Soy milk	31
Skim milk	32
Whole milk	27
Yogurt (sweetened)	33
Yogurt (plain, artificial sweetener)	14

High GI Foods (70 and higher)	
Dates	103
Banana (over-ripe)	82
Parsnips	97
Corn chips	72
Pretzels	83
White bread	70
White rice	72
Spaghetti (durum flour)	78
White rice (instant)	87
French baguette	95
Bagel	72
Bread stuffing	74
Cheerios	74
Cream of wheat	71
Raisin Bran	73
Fruit roll-up	99
Gatorade	78

Medium GI Foods (56-69)	
Apricots	57
Cantaloupe	65
Mashed potatoes	70
Whole-wheat pita bread	57
Whole-wheat bread	69
Couscous	65

Foods	GI Value
Brown rice	55
Cheese pizza	60
Rye bread	65
Hamburger bun	61
Black bean soup	64
Macaroni and cheese	64
Coca-Cola	63



The Functions of Carbohydrates in the Body

Energy Production

- The primary role of carbohydrates is to supply energy to all cells in the body. Many cells prefer glucose as a source of energy versus other compounds like fatty acids.
- Some cells, such as red blood cells, are only able to produce cellular energy from glucose.
- The brain is also highly sensitive to low blood-glucose levels because it uses only glucose to produce energy and function (unless under extreme starvation conditions).
- About 70 percent of the glucose entering the body from digestion is redistributed (by the liver) back into the blood for use by other tissues.
- Cells that require energy remove the glucose from the blood with a transport protein in their membranes.

Building Macromolecules

- Although most absorbed glucose is used to make energy, some glucose is converted to ribose and deoxyribose, which are essential building blocks of important macromolecules, such as RNA, DNA, and ATP (Figure 4.6).

- Glucose is additionally utilized to make the molecule NADPH, which is important for protection against oxidative stress and is used in many other chemical reactions in the body.

<u>Sparing Protein</u>

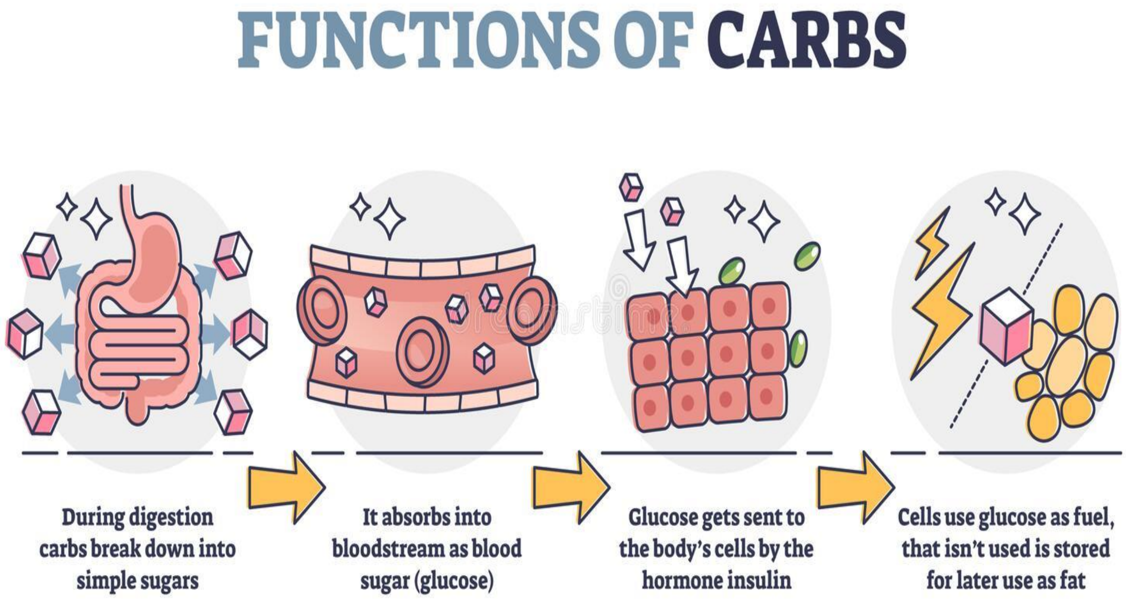
- In a situation where there is not enough glucose to meet the body's needs, glucose is synthesized from amino acids.
- Because there is no storage molecule of amino acids, this process requires the destruction of proteins, primarily from muscle tissue.
- The presence of adequate glucose basically spares the breakdown of proteins from being used to make glucose needed by the body.

<u>Lipid Metabolism (fat sparing)</u>

- As blood-glucose levels rise, the use of lipids as an energy source is inhibited. Thus, glucose additionally has a "fat-sparing" effect.

How Many Carbohydrates Does a Person Need?

- The Food and Nutrition Board of IOM has set the Recommended Dietary Allowance (RDA) of carbohydrates for children and adults at 130 grams per day.
- This is the average minimum amount the brain requires to function properly.
- The Acceptable Macronutrient Distribution Range (AMDR) for carbohydrates is between 45 and 65 percent.
- This means that on a 2,000 kilocalorie diet, a person should consume between 225 and 325 grams of carbohydrate each day.
- According to the IOM not more than 25 percent of total calories consumed should come from added sugars.
- The World Health Organization and the AHA recommend much lower intakes of added sugars—10 percent or less of total calories consumed.
- The IOM has also set Adequate Intakes for dietary fiber, which are 38 and 25 grams for men and women, respectively.
- The recommendations for dietary fiber are based upon the intake levels known to prevent against heart disease.



Dietary Sources of Carbohydrates

- Carbohydrates are contained in all five food groups: grains, fruits, vegetables, meats, and beans (only in some processed meats and beans), and dairy products.
- Fast-releasing carbohydrates are more prevalent in fruits, fruit juices, and dairy products, while slow-releasing carbohydrates are more plentiful in starchy vegetables, beans, and whole grains.
- Fast-releasing carbohydrates are also found in large amounts in processed foods, soft drinks, and sweets.
- On average, a serving of fruits, whole grains, or starches contains 15 grams of carbohydrates.
- A serving of dairy contains about 12 grams of carbohydrates, and a serving of vegetables contains about 5 grams of carbohydrates.

Personal Choices

- Get more daily carbohydrate servings from whole grains by eating whole-grain cereal for breakfast, using whole-grain bread to make a sandwich for lunch, and eating a serving of beans and/or nuts with dinner.
- Make sure to get at least three servings (or more) of all the grains you eat as whole grains every day. A serving of whole grains is equal to one slice of whole-wheat bread, one

ounce of whole-grain cereal, and one half cup of cooked cereal, brown rice, or whole-wheat pasta.

- Food products made with cornmeal use the whole grain so choose tortillas, corn cereals, and corn breads with cornmeal listed as the first ingredient.
- When baking, substitute whole-wheat flour or other whole-grain flour for some of the refined white flour.
- If you like bread at dinner, choose a whole-grain muffin over a Kaiser roll or baguette.
- Add beans, nuts, or seeds to salad—they add texture and taste.
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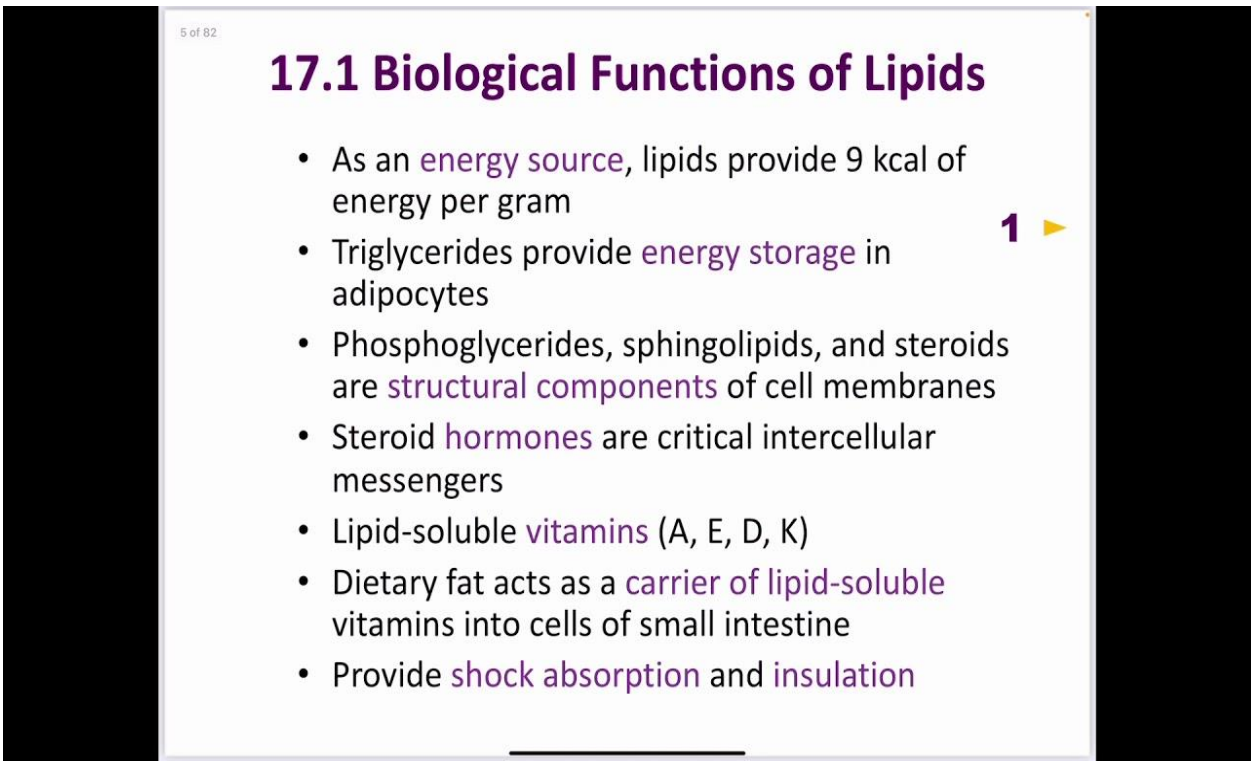
Chapter IV

Lipids

What are lipids?

- lipids are important fats that serve different roles in the human body.
- Lipids are a family of organic compounds that are mostly insoluble in water.
- Composed of fats and oils, lipids are molecules that yield high energy and have a chemical composition mainly of carbon, hydrogen, and oxygen.
- Lipids perform three primary biological functions within the body: they serve as structural components of cell membranes, function as energy storehouses, and function as important signaling molecules.



Types of lipids:

- triacylglycerols
- phospholipids
- and sterols.

Triacylglycerols

- Triacylglycerols (also known as triglycerides) make up more than 95 percent of lipids in the diet and are commonly found in fried foods, vegetable oil, butter, whole milk, cheese, cream cheese, and some meats. Naturally occurring triacylglycerols are found in many foods, including avocados, olives, corn, and nuts.

- We commonly call the triacylglycerols in our food “fats” and “oils.”
- Fats are lipids that are solid at room temperature, whereas oils are liquid.
- As with most fats, triacylglycerols do not dissolve in water.
- The terms fats, oils, and triacylglycerols are discretionary and can be used interchangeably.

Phospholipid

- **Phospholipids** make up only about 2 percent of dietary lipids.
- They are water soluble and are found in both plants and animals.
- Phospholipids are crucial for building the protective barrier, or membrane, around your body’s cells.
- In fact, phospholipids are synthesized in the body to form cell and organelle membranes.
- In blood and body fluids, phospholipids form structures in which fat is enclosed and transported throughout the bloodstream.

Sterols

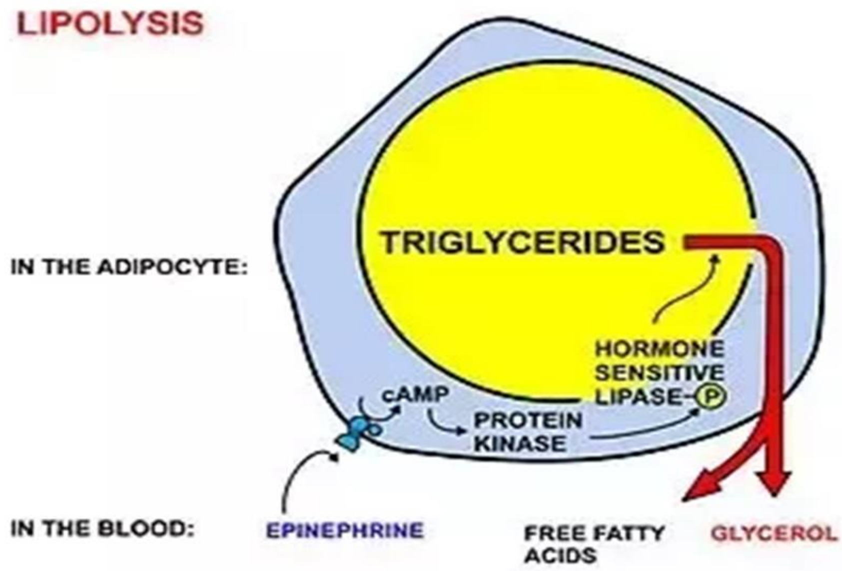
- Sterols are the least common type of lipid.
- Cholesterol is perhaps the best well known sterol.
- Though cholesterol has a notorious reputation, the body gets only a small amount of its cholesterol through food the body produces most of it.
- Cholesterol is an important component of the cell membrane and is required for the synthesis of sex hormones, vitamin D, and bile salts

The Functions of Lipids in the Body

<u>1-Storing Energy</u>

- The excess energy from the food we eat is digested and incorporated into **adipose tissue**, or fatty tissue. Most of the energy required by the human body is provided by carbohydrates and lipids.
- glucose is stored in the body as glycogen. While glycogen provides a ready source of energy, lipids primarily function as an energy reserve.
- As you may recall, glycogen is quite bulky with heavy water content, thus the body cannot store too much for long.

- Alternatively, fats are packed together tightly without water and store far greater amounts of energy in a reduced space. A fat gram is densely concentrated with energy—it contains more than double the amount of energy than a gram of carbohydrate.
- Energy is needed to power the muscles for all the physical work and play an average person or child engages in.
- For instance, the stored energy in muscles propels an athlete down the track, spurs a dancer's legs to showcase the latest fancy steps, and keeps all the moving parts of the body functioning smoothly.



2-Regulating and Signaling

- Triacylglycerols control the body's internal climate, maintaining constant temperature.
- Those who don't have enough fat in their bodies tend to feel cold sooner, are often fatigued, and have pressure sores on their skin from fatty acid deficiency.
- Triacylglycerols also help the body produce and regulate hormones.
- For example, adipose tissue secretes the hormone leptin, which regulates appetite.
- In the reproductive system, fatty acids are required for proper reproductive health; women who lack proper amounts may stop menstruating and become infertile
- Omega-3 and omega-6 essential fatty acids help regulate cholesterol and blood clotting and control inflammation in the joints, tissues, and bloodstream.
- Fats also play important functional roles in sustaining nerve impulse transmission, memory storage, and tissue structure.

- More specifically in the brain, lipids are focal to brain activity in structure and in function. They help form nerve cell membranes, insulate neurons, and facilitate the signaling of electrical impulses throughout the brain.

3- Insulating and Protecting

- Did you know that up to 30 percent of body weight is comprised of fat tissue? Some of this is made up of visceral fat or adipose tissue surrounding delicate organs.
- Vital organs such as the heart, kidneys, and liver are protected by visceral fat.
- The composition of the brain is outstandingly 60 percent fat, demonstrating the major structural role that fat serves within the body.
- You may be most familiar with subcutaneous fat, or fat underneath the skin. This blanket layer of tissue insulates the body from extreme temperatures and helps keep the internal climate under control.
- It pads our hands and buttocks and prevents friction, as these areas frequently come in contact with hard surfaces. It also gives the body the extra padding required when engaging in physically demanding activities such as ice- or roller skating, horseback riding, or snowboarding.

4- Aiding Digestion and Increasing Bioavailability

- The dietary fats in the foods we eat break down in our digestive systems and begin the transport of precious micronutrients. By carrying fat-soluble nutrients through the digestive process, intestinal absorption is improved.
- This improved absorption is also known as increased **bioavailability**.
- Fat-soluble nutrients are especially important for good health and exhibit a variety of functions. Vitamins A, D, E, and K—the fat-soluble vitamins—are mainly found in foods containing fat.
- Some fat soluble vitamins (such as vitamin A) are also found in naturally fat-free foods such as green leafy vegetables, carrots, and broccoli.
- These vitamins are best absorbed when combined with foods containing fat. Fats also increase the bioavailability of compounds known as **phytochemicals**, which are plant constituents such as lycopene (found in tomatoes) and beta-carotene (found in carrots).
- Phytochemicals are believed to promote health and well-being. As a result, eating tomatoes with olive oil or salad dressing will facilitate lycopene absorption. Other essential nutrients, such as essential fatty acids, are constituents of the fats themselves and serve as building blocks of a cell.

Digestion and Absorption of Lipids

From the Mouth to the Stomach

- The first step in the digestion of triacylglycerols and phospholipids begins in the mouth as lipids encounter saliva.
- Next, the physical action of chewing coupled with the action of emulsifiers enables the digestive enzymes to do their tasks.
- The enzyme lingual **lipase**, along with a small amount of phospholipid as an emulsifier, initiates the process of digestion.
- These actions cause the fats to become more accessible to the digestive enzymes. As a result, the fats become tiny droplets and separate from the watery components.
- In the stomach, gastric lipase starts to break down triacylglycerols into **diglycerides** and fatty acids.
- Within two to four hours after eating a meal, roughly 30 percent of the triacylglycerols are converted to diglycerides and fatty acids.
- The stomach's churning and contractions help to disperse the fat molecules, while the diglycerides derived in this process act as further emulsifiers. However, even amid all of this activity, very little fat digestion occurs in the stomach.

Going to the Bloodstream

- As stomach contents enter the small intestine, the digestive system sets out to manage a small hurdle, namely, to combine the separated fats with its own watery fluids.
- The solution to this hurdle is **bile**. Bile contains bile salts, lecithin, and substances derived from cholesterol so it acts as an emulsifier.
- It attracts and holds on to fat while it is simultaneously attracted to and held on to by water.
- Emulsification increases the surface area of lipids over a thousand-fold, making them more accessible to the digestive enzymes.
- As pancreatic lipase enters the small intestine, it breaks down the fats into free fatty acids and **monoglycerides**.
- Yet again, another hurdle presents itself.
- How will the fats pass through the watery layer of mucous that coats the absorptive lining of the digestive tract? As before, the answer is bile.
- Bile salts envelop the fatty acids and monoglycerides to form micelles.
- Micelles have a fatty acid core with a water-soluble exterior.
- This allows efficient transportation to the intestinal microvillus.

- Here, the fat components are released and disseminated into the cells of the digestive tract lining.
- Just as lipids require special handling in the digestive tract to move within a water based environment, they require similar handling to travel in the bloodstream.
- Inside the intestinal cells, the monoglycerides and fatty acids reassemble themselves into triacylglycerols.
- Triacylglycerols, cholesterol, and phospholipids form **lipoproteins** when joined with a protein carrier.
- Lipoproteins have an inner core that is primarily made up of triacylglycerols and cholesterol esters (a cholesterol ester is a cholesterol linked to a fatty acid). The outer envelope is made of phospholipids interspersed with proteins and cholesterol.
- Together they form a **chylomicron**, which is a large lipoprotein that now enters the lymphatic system and will soon be released into the bloodstream via the jugular vein in the neck.
- Chylomicrons transport food fats perfectly through the body's water-based environment to specific destinations such as the liver and other body tissues.
- Cholesterols are poorly absorbed when compared to phospholipids and triacylglycerols.
- Cholesterol absorption is aided by an increase in dietary fat components and is hindered by high fiber content.
- This is the reason that a high intake of fiber is recommended to decrease blood cholesterol.
- Foods high in fiber such as fresh fruits, vegetables, and oats can bind bile salts and cholesterol, preventing their absorption and carrying them out of the colon.

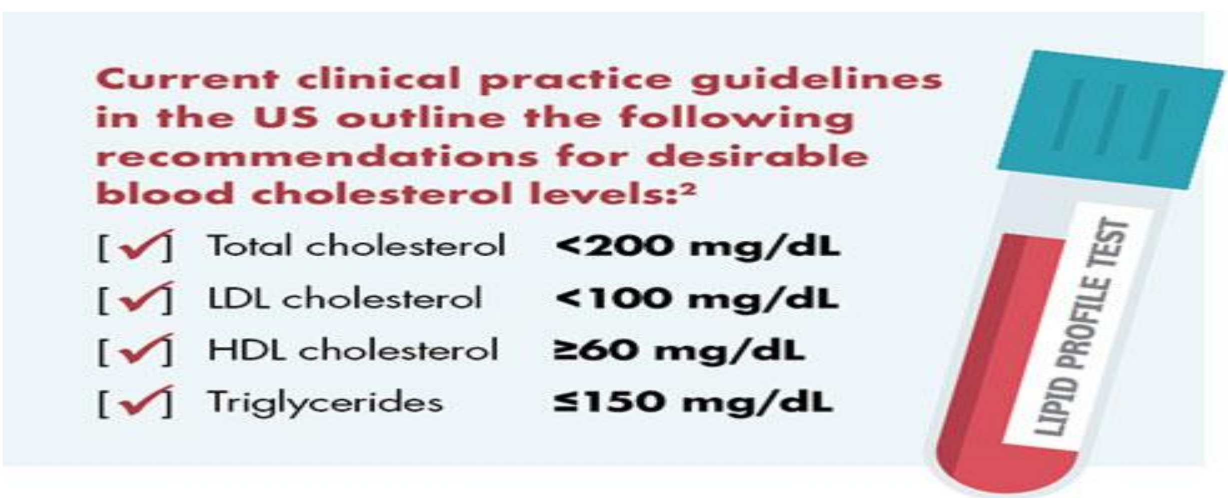
Blood Cholesterol

- You may have heard of the abbreviations LDL and HDL with respect to heart health.
- These abbreviations refer to low-density lipoprotein (LDL) and high-density lipoprotein (HDL), respectively.
- Lipoproteins are characterized by size, density, and composition.
- As the size of the lipoprotein increases, the density decreases. This means that HDL is smaller than LDL.
- Why are they referred to as "good" and "bad" cholesterol? What should you know about these lipoproteins?

<u>Major Lipoproteins</u>

- Recall that chylomicrons are transporters of fats throughout the watery environment within the body.
- After about ten hours of circulating throughout the body, chylomicrons gradually release their triacylglycerols until all that is left of their composition is cholesterol-rich remnants.
- These remnants are used as raw materials by the liver to formulate specific lipoproteins.
- **VLDLs.** Very low-density lipoproteins are made in the liver from remnants of chylomicrons and transport triacylglycerols from the liver to various tissues in the body. As the VLDLs travel through the circulatory system, the lipoprotein lipase strips the VLDL of triacylglycerols. As triacylglycerol removal persists, the VLDLs become intermediate-density lipoproteins.
- **IDLs.** Intermediate-density lipoproteins transport a variety of fats and cholesterol in the bloodstream and are a little under half triacylglycerol in composition. While travelling in the bloodstream, cholesterol is gained from other lipoproteins while circulating enzymes strip its phospholipid component. When IDLs return to the liver, they are transformed into low-density lipoprotein.
- **LDLs.** As low-density lipoproteins are commonly known as the "bad cholesterol" it is imperative that we understand their function in the body so as to make healthy dietary and lifestyle choices. LDLs carry cholesterol and other lipids from the liver to tissue throughout the body.
- **HDLs.** High-density lipoproteins are responsible for carrying cholesterol out of the bloodstream and into the liver, where it is either reused or removed from the body with bile. HDLs have a very large protein composition coupled with low cholesterol content (20 to 30 percent) compared to the other lipoproteins. Hence, these high-density lipoproteins are commonly called "good cholesterol."

Blood Cholesterol Recommendations:



Balancing Your Diet with Lipids

Recommended Fat Intake

- Fat calories should be limited to 20–35 percent of total calories with most fats coming from polyunsaturated and monounsaturated fats, such as those found in fish, nuts, and vegetable oils.
- Consume fewer than 10 percent of calories from saturated fats.
- Some studies suggest that lowering the saturated fat content to less than 7 percent can further reduce the risk of heart disease.
- Keep the consumption of trans fats (any food label that reads hydrogenated or partially hydrogenated oil) to a minimum, less than1 percent of calories.
- Think lean and low-fat when selecting meat, poultry, milk, and milk products.

Identifying Sources of Fat

Monounsaturated fat.

- This type of fat is found in plant oils. Common sources are nuts (almonds, cashews, pecans, peanuts, and walnuts) and nut products, avocados, extra virgin olive oil, sesame oil, high oleic safflower oil, sunflower oil, and canola oil.

Polyunsaturated fat.

- This type of fat is found mainly in plant-based foods, oils, and fish. Common sources are nuts (walnuts, hazel nuts, pecans, almonds, and peanuts), soybean oil, corn oil, safflower oil, flaxseed oil, canola oil, and fish (trout, herring, and salmon).

Saturated fat.

- This fat is found in animal products, dairy products, palm and coconut oils, and cocoa butter. Limit these products to less than 10 percent of your overall dietary fat consumption.

Trans fatty acids.

- Stick margarines, fast foods, commercial baked goods, and some snack foods contain trans fats.
- Limit your consumption of these products to keep trans fats to less than 1 percent of your fat consumption.

Omega-3 fatty acids (linolenic acid).

- Good sources of these are canola oil, flaxseed oil, soybean oil, olive oil, nuts, seeds, whole grains, legumes, and green leafy vegetables.

DHA and EPA.

- Good sources of these are cod liver oil and fish such as tuna, herring, mackerel, salmon, and trout.

Omega-6 fatty acids (linoleic acid).

- Eggs, poultry, most vegetable oils, wheat germ oil, whole grains, baked goods, and cereals contain these fatty acids. Omega-6 fatty acids are present abundantly in nuts and seeds such as flaxseeds, sunflower seeds, sesame seeds, and watermelon seeds.

- **Assignment**

Lipids and diseases

Chapter V

Protein

Definitions:-

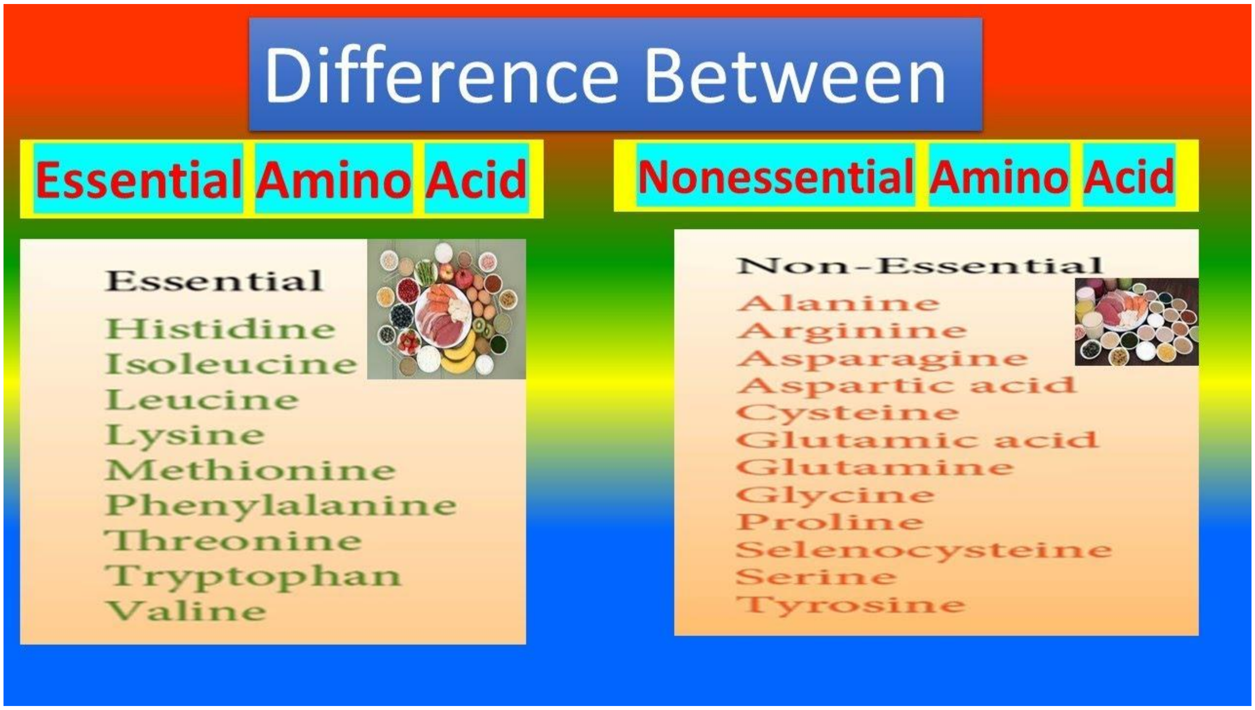
- Protein makes up approximately 20 percent of the human body and is present in every single cell.
- The word protein is a Greek word, meaning "of utmost importance."
- Proteins are called the workhorses of life as they provide the body with structure and perform a vast array of functions.
- You can stand, walk, run, skate, swim, and more because of your protein-rich muscles.
- Protein is necessary for proper immune system function, digestion, and hair and nail growth, and is involved in numerous other body functions.
- In fact, it is estimated that more than one hundred thousand different proteins exist within the human body.

What Is Protein?

- Proteins, simply, are macromolecules composed of amino acids.
- Amino acids are commonly called **protein's building blocks**.
- Proteins are crucial for the nourishment, renewal, and continuance of life.
- Proteins contain the elements carbon, hydrogen, and oxygen just as carbohydrates and lipids do, but proteins are the only macronutrient that contains nitrogen.

Types of amino acids

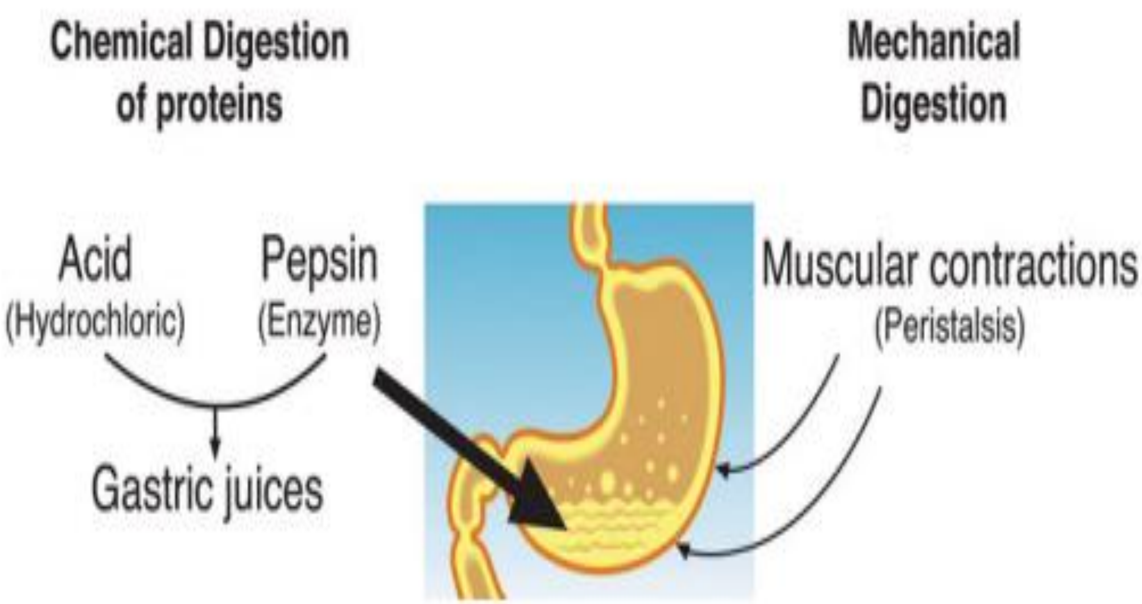
- Amino acids are further classified based on nutritional aspects. Recall that there are twenty different amino acids, and we require all of them to make the many different proteins found throughout the body.
- Eleven of these are called nonessential amino acids because the body can synthesize them.
- However, nine of the amino acids are called essential amino acids because we cannot synthesize them either at all or in sufficient amounts. These must be obtained from the diet.
- Sometimes during infancy, growth, and in diseased states the body cannot synthesize enough of some of the nonessential amino acids and more of them are required in the diet. These types of amino acids are called conditionally essential amino acids .



Protein Digestion and Absorption

- From the Mouth to the Stomach Unless you are eating it raw, the first step in protein digestion (or any other protein food) involves chewing.
- The teeth begin the mechanical breakdown of the large protein pieces into smaller pieces that can be swallowed.
- The salivary glands provide some saliva to aid swallowing and the passage of the partially mashed protein through the esophagus.
- The mashed egg pieces enter the stomach through the esophageal sphincter.
- The stomach releases gastric juices containing hydrochloric acid and the enzyme, pepsin, which initiate the breakdown of the protein.
- The acidity of the stomach facilitates the unfolding of the proteins that still retain part of their three-dimensional structure after cooking and helps break down the protein aggregates formed during cooking.
- Pepsin, which is secreted by the cells that line the stomach, dismantles the protein chains into smaller and smaller fragments.
- Egg proteins are large globular molecules and their chemical breakdown requires time and mixing.

- The powerful mechanical stomach contractions churn the partially digested protein into a more uniform mixture, which, is called chyme.
- Protein digestion in the stomach takes a longer time than carbohydrate digestion, but a shorter time that fat digestion.
- Eating a high-protein meal increases the amount of time required to sufficiently break down the meal in the stomach.
- Food remains in the stomach longer, making you feel full longer.



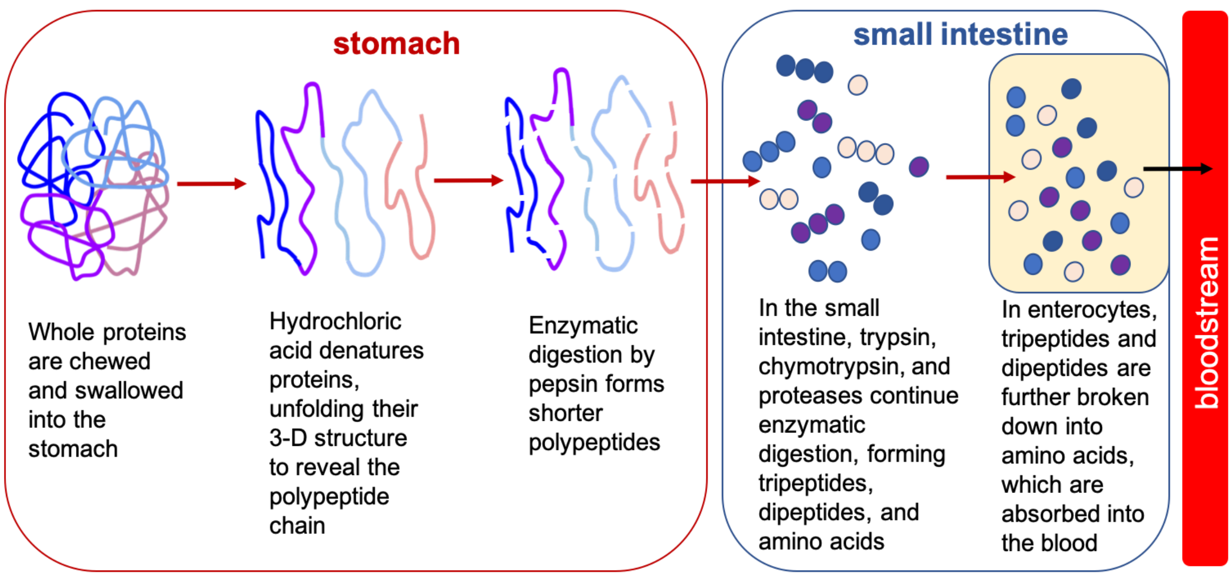
<u>From the Stomach to the Small Intestine</u>

- The stomach empties the chyme containing the broken-down egg pieces into the small intestine, where the majority of protein digestion occurs.
- The pancreas secretes digestive juice that contains more enzymes that further break down the protein fragments.
- The two major pancreatic enzymes that digest proteins are chymotrypsin and trypsin.
- The cells that line the small intestine release additional enzymes that finally break apart the smaller protein fragments into individual amino acids.
- The muscle contractions of the small intestine mix and propel the digested proteins to the absorption sites.
- In the lower parts of the small intestine, the amino acids are transported from the intestinal lumen through the intestinal cells to the blood.

- This movement of individual amino acids requires special transport proteins and the cellular energy molecule, adenosine triphosphate (ATP).

From the Stomach to the Small Intestine

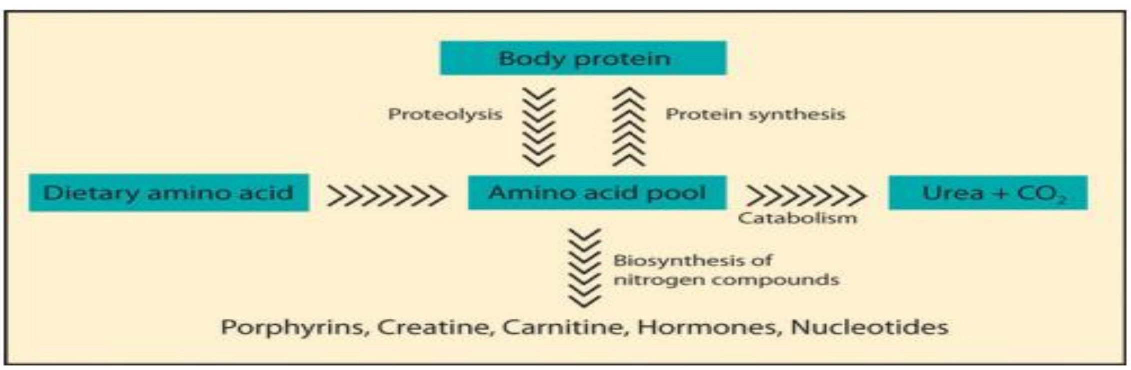
- Once the amino acids are in the blood, they are transported to the liver.
- As with other macronutrients, the liver is the checkpoint for amino acid distribution and any further breakdown of amino acids, which is very minimal.
- Recall that amino acids contain nitrogen, so further catabolism of amino acids releases nitrogen containing ammonia.
- Because ammonia is toxic, the liver transforms it into urea, which is then transported to the kidney and excreted in the urine.
- Urea is a molecule that contains two nitrogens and is highly soluble in water.
- This makes it a good choice for transporting excess nitrogen out of the body.
- Because amino acids are building blocks that the body reserves in order to synthesize other proteins, more than 90 percent of the protein ingested does not get broken down further than the amino acid monomers.



<u>**Amino Acids Are Recycled**</u>

- Just as some plastics can be recycled to make new products, amino acids are recycled to make new proteins.
- All cells in the body continually break down proteins and build new ones, a process referred to as protein turnover.
- Every day over 250 grams of protein in your body are dismantled and 250 grams of new protein are built.

- To form these new proteins, amino acids from food and those from protein destruction are placed into a "pool."
- Though it is not a literal pool, when an amino acid is required to build another protein it can be acquired from the additional amino acids that exist within the body.
- Amino acids are used not only to build proteins, but also to build other biological molecules containing nitrogen, such as DNA and RNA, and to some extent to produce energy.
- It is critical to maintain amino acid levels within this cellular pool by consuming high-quality proteins in the diet, or the amino acids needed for building new proteins will be obtained by increasing protein destruction from other tissues within the body, especially muscle.
- This amino acid pool is less than one percent of total body protein content. Thus, the body does not store protein as it does with carbohydrates (as glycogen in the muscles and liver) and lipids (as triglycerides in adipose tissue).



<u>Protein's Functions in the Body</u>

<u>1-Structure and Motion</u>

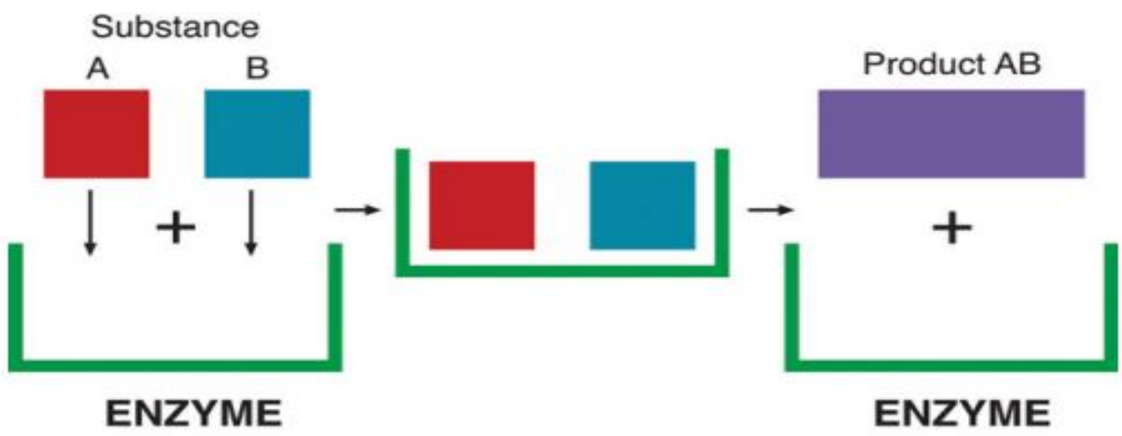
- More than one hundred different structural proteins have been discovered in the human body, but the most abundant by far is collagen, which makes up about 6 percent of total body weight.
- Collagen makes up 30 percent of bone tissue and comprises large amounts of tendons, ligaments, cartilage, skin, and muscle.
- Collagen is a strong, fibrous protein made up of mostly glycine and proline amino acids.
- Within its quaternary structure three protein strands twist around each other like a rope and then these collagen ropes overlap with others. This highly ordered structure is even stronger than steel fibers of the same size.

- Collagen makes bones strong, but flexible.
- Collagen fibers in the skin's dermis provide it with structure, and the accompanying elastin protein fibrils make it flexible. Pinch the skin on your hand and then let go; the collagen and elastin proteins in skin allow it to go back to its original shape.
- Smooth-muscle cells that secrete collagen and elastin proteins surround blood vessels, providing the vessels with structure and the ability to stretch back after blood is pumped through them.
- Another strong, fibrous protein is keratin20 , which is what skin, hair, and nails are made of.
- The closely packed collagen fibrils in tendons and ligaments allow for synchronous mechanical movements of bones and muscle and the ability of these tissues to spring back after a movement is complete.
- Move your fingers and watch the synchrony of your knuckle movements.
- In order to move, muscles must contract. The contractile parts of muscles are the proteins actin and myosin.
- When these proteins are stimulated by a nerve impulse they slide across each other, causing a shortening of the muscle cell.
- Upon stimulation, multiple muscle cells shorten at the same time, resulting in muscle contraction.

2-Enzymes

- Although proteins are found in the greatest amounts in connective tissues such as bone, their most extraordinary function is as enzymes.
- Enzymes are proteins that conduct specific chemical reactions.
- An enzyme's job is to provide a site for a chemical reaction and to lower the amount of energy and time it takes for that chemical reaction to happen (this is known as "catalysis").
- On average, more than one hundred chemical reactions occur in cells every single second and most of them require enzymes.
- The liver alone contains over one thousand enzyme systems.
- Enzymes are specific and will use only particular substrates that fit into their active site, similar to the way a lock can be opened only with a specific key.
- Nearly every chemical reaction requires a specific enzyme.
- Fortunately, an enzyme can fulfill its role as a catalyst over and over again, although eventually it is destroyed and rebuilt.

- All bodily functions, including the breakdown of nutrients in the stomach and small intestine, the transformation of nutrients into molecules a cell can use, and building all macromolecules, including protein itself, involve enzymes.



<u>3-Hormones</u>

- Proteins are responsible for hormone synthesis.
- hormones are the chemical messages produced by the endocrine glands.
- When an endocrine gland is stimulated, it releases a hormone.
- The hormone is then transported in the blood to its target cell, where it communicates a message to initiate a specific reaction or cellular process.
- For instance, after you eat a meal, your blood glucose levels rise. In response to the increased blood glucose, the pancreas releases the hormone insulin. Insulin tells the cells of the body that glucose is available and to take it up from the blood and store it or use it for making energy or building macromolecules.
- A major function of hormones is to turn enzymes on and off, so some proteins can even regulate the actions of other proteins. While not all hormones are made from proteins, many of them are.

4-Fluid and Acid-Base

- Balance Proper protein intake enables the basic biological processes of the body to maintain its status in a changing environment.
- Fluid balance refers to maintaining the distribution of water in the body.
- If too much water in the blood suddenly moves into a tissue, the results are swelling and, potentially, cell death.

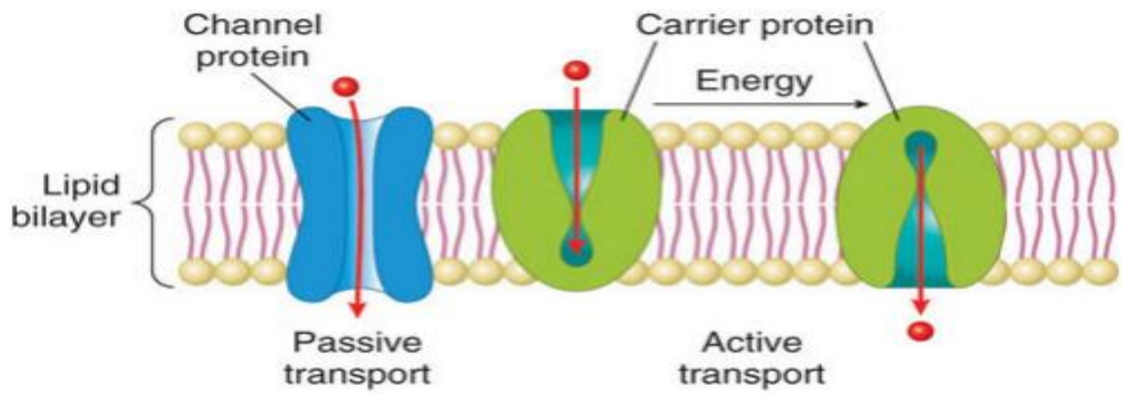
- Water always flows from an area of high concentration to one of a low concentration. As a result, water moves toward areas that have higher concentrations of other solutes, such as proteins and glucose.
- To keep the water evenly distributed between blood and cells, proteins continuously circulate at high concentrations in the blood.
- The most abundant protein in blood is the butterfly-shaped protein known as albumin.
- Albumin's presence in the blood makes the protein concentration in the blood similar to that in cells. Therefore, fluid exchange between the blood and cells is not in extreme, but rather is minimized to preserve the status quo.
- Protein is also essential in maintaining proper pH balance (the measure of how acidic or basic a substance is) in the blood.
- Blood pH is maintained between 7.35 and 7.45, which is slightly basic.
- Even a slight change in blood pH can affect body functions.
- Recall that acidic conditions can cause protein denaturation, which stops proteins from functioning.
- The body has several systems that hold the blood pH within the normal range to prevent this from happening.
- One of these is the circulating albumin. Albumin is slightly acidic, and because it is negatively charged it balances the many positively charged molecules, such as hydrogen protons (H^+), calcium, potassium, and magnesium which are also circulating in the blood.
- Albumin acts as a buffer against abrupt changes in the concentrations of these molecules, thereby balancing blood pH and maintaining the status quo. The protein hemoglobin also participates in acid-base balance by binding hydrogen protons.

5-Transport

- Albumin and hemoglobin also play a role in molecular transport.
- Albumin chemically binds to hormones, fatty acids, some vitamins, essential minerals, and drugs, and transports them throughout the circulatory system.
- Each red blood cell contains millions of hemoglobin molecules that bind oxygen in the lungs and transport it to all the tissues in the body.
- A cell's plasma membrane is usually not permeable to large polar molecules, so to get the required nutrients and molecules into the cell many transport proteins exist in the cell membrane.

➡ Some of these proteins are channels that allow particular molecules to move in and out of cells. Others act as one-way taxis and require energy to function.

Figure 6.6



Molecules move in and out of cells through transport proteins, which are either channels or carriers.

6-Protection

➡ Earlier we discussed that the strong collagen fibers in skin provide it with structure and support.

➡ The skin's dense network of collagen fibers also serves as a barricade against harmful substances.

➡ The immune system's attack and destroy functions are dependent on enzymes and antibodies, which are also proteins.

➡ An enzyme called lysozyme is secreted in the saliva and attacks the walls of bacteria, causing them to rupture.

➡ Certain proteins circulating in the blood can be directed to build a molecular knife.

➡ that stabs the cellular membranes of foreign invaders.

➡ The antibodies secreted by the white blood cells survey the entire circulatory system looking for harmful bacteria and viruses to surround and destroy.

➡ Antibodies also trigger other factors in the immune system to seek and destroy unwanted intruders

7-Wound Healing and Tissue Regeneration

➡ Proteins are involved in all aspects of wound healing, a process that takes place in three phases: inflammatory, proliferative, and remodeling.

- For example, if you were sewing and pricked your finger with a needle, your flesh would turn red and become inflamed.
- Within a few seconds bleeding would stop. The healing process begins with proteins such as bradykinin, which dilate blood vessels at the site of injury.
- An additional protein called fibrin helps to secure platelets that form a clot to stop the bleeding.
- Next, in the proliferative phase, cells move in and mend the injured tissue by installing newly made collagen fibers.
- The collagen fibers help pull the wound edges together. In the remodeling phase, more collagen is deposited, forming a scar.
- Scar tissue is only about 80 percent as functional as normal uninjured tissue.
- If a diet is insufficient in protein, the process of wound healing is markedly slowed.

8-Energy Production

- Some of the amino acids in proteins can be disassembled and used to make energy.
- Only about 10 percent of dietary proteins are catabolized each day to make cellular energy.
- The liver is able to break down amino acids to the carbon skeleton, which can then be fed into the citric acid cycle.
- This is similar to the way that glucose is used to make ATP.
- If a person's diet does not contain enough carbohydrates and fats their body will use more amino acids to make energy, which compromises the synthesis of new proteins and destroys muscle proteins.
- Alternatively, if a person's diet contains more protein than the body needs, the extra amino acids will be broken down and transformed into fat.

Health Consequences of Protein Deficiency

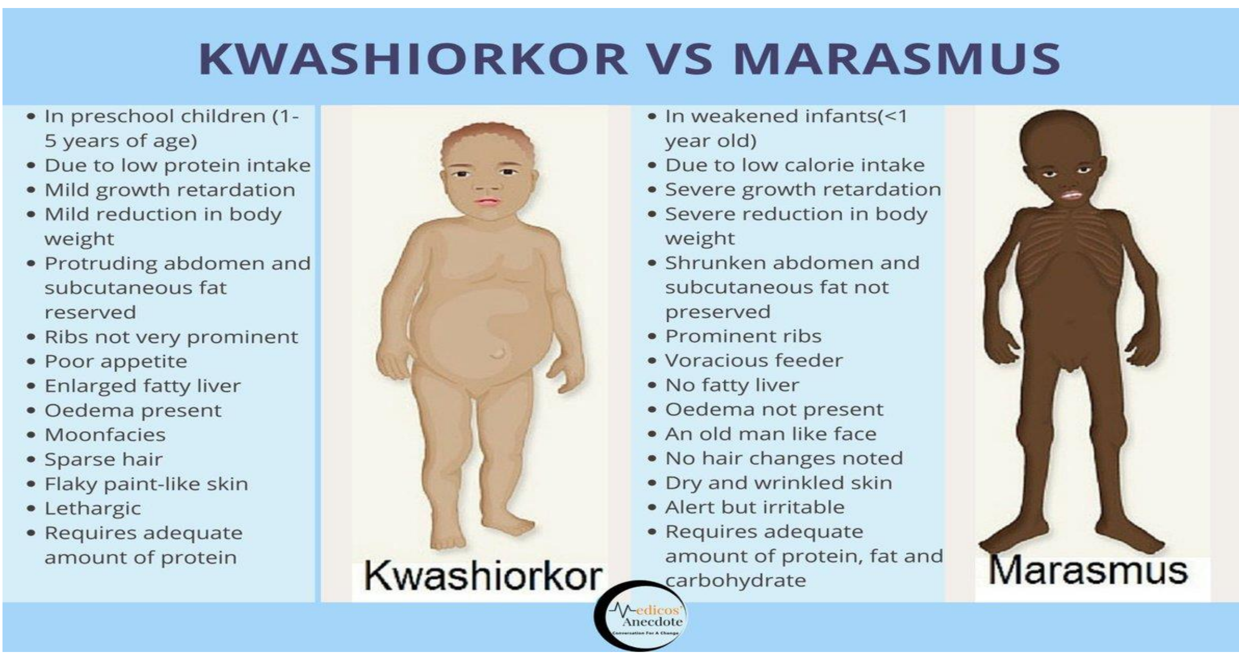
Kwashiorkor

- Kwashiorkor affects millions of children worldwide.
- When it was first described in 1935, more than 90 percent of children with Kwashiorkor died.
- Although the associated mortality is slightly lower now, most children still die after the initiation of treatment.
- The name Kwashiorkor comes from a language in Ghana and means, "rejected one."

- Kwashiorkor is characterized by swelling (edema) of the feet and abdomen, poor skin health, growth retardation, low muscle mass, and liver malfunction. Recall that one of protein's functional roles in the body is fluid balance.

marasmus

- children and adults with marasmus neither have enough protein in their diets nor do they take in enough calories.
- Marasmus affects mostly children below the age of one in poor countries. Body weights of children with Marasmus may be up to 80 percent less than that of a normal child of the same age.
- Marasmus is a Greek word, meaning "starvation."
- The syndrome affects more than fifty million children under age five worldwide.
- It is characterized by an extreme emaciated appearance, poor skin health, and growth retardation.
- The symptoms are acute fatigue, hunger, and diarrhea.



Age Group	RDA (g/day)	AMDR (% calories)
Infants (0–6 mo)	9.1*	Not determined
Infants (7–12 mo)	11.0	Not determined
Children (1–3)	13.0	5–20
Children (4–8)	19.0	10–30
Children (9–13)	34.0	10–30
Males (14–18)	52.0	10–30
Females (14–18)	46.0	10–30
* Denotes Adequate Intake		

Age Group	RDA (g/day)	AMDR (% calories)
Adult Males (19+)	56.0	10–35
Adult Females (19+)	46.0	10–35
* Denotes Adequate Intake		

Proteins, Diet, and Personal Choices

Protein Input = Protein Used by the Body + Protein Excreted

- The appropriate amount of protein in a person's diet is that which maintains a balance between what is taken in and what is used.
- he RDAs for protein were determined by assessing nitrogen balance.
- Nitrogen is one of the four basic elements contained in all amino acids.
- When proteins are broken down and amino acids are catabolized, nitrogen is released.
- Remember that when the liver breaks down amino acids, it produces ammonia, which is rapidly converted to nontoxic, nitrogen-containing urea, which is then transported to the kidneys for excretion. Most nitrogen is lost as urea in the urine, but urea is also excreted in the feces. Proteins are also lost in sweat and as hair and nails grow.
- The RDA, therefore, is the amount of protein a person should consume in their diet to balance the amount of protein used up and lost from the body.
- For healthy adults, this amount of protein was determined to be 0.8 grams of protein per kilogram of body weight
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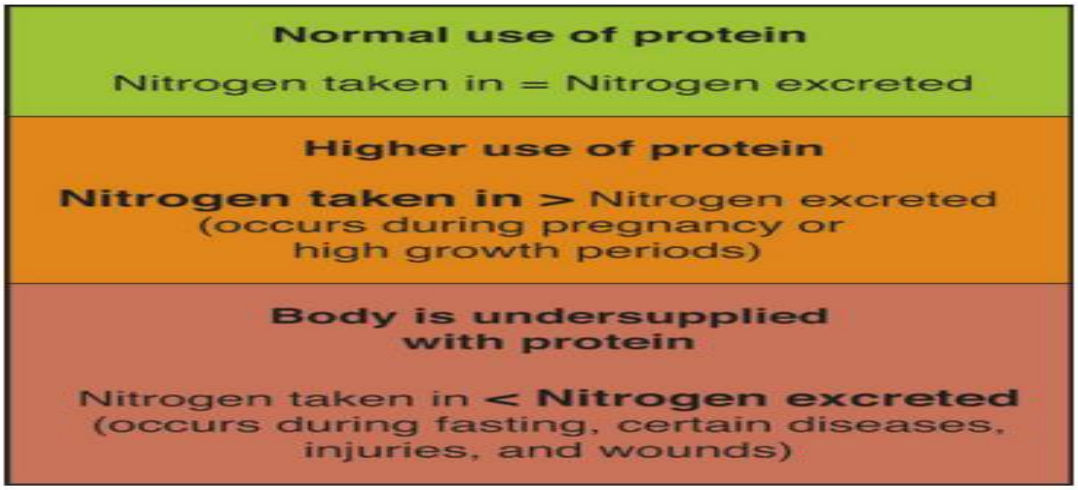


Dietary Sources of Protein

- The protein food group consists of foods made from meat, seafood, poultry, eggs, soy, beans, peas, and seeds.
- According to the Harvard School of Public Health, “animal protein and vegetable protein probably have the same effects on health.
- Simply put, different protein sources differ in their additional components, so it is necessary to pay attention to the whole nutrient “package.”
- Protein-rich animal-based foods commonly have high amounts of B vitamins, vitamin E, iron, magnesium, and zinc.
- Seafood often contains healthy fats.
- plant sources of protein contain a high amount of fiber.
- Some animal-based protein-rich foods have an unhealthy amount of saturated fat and cholesterol.

Food	Protein Content (g)	Saturated Fat (g)	Cholesterol (mg)	Calories
Hamburger patty 3 oz. (80% lean)	22.0	5.7	77	230
Hamburger patty 3 oz. (95% lean)	22.0	2.3	60	139
Top sirloin 3 oz.	25.8	2.0	76	158
Beef chuck 3 oz. (lean, trimmed)	22.2	1.8	51	135
Pork loin 3 oz.	24.3	3.0	69	178
Pork ribs (country style, 1 piece)	56.4	22.2	222	790
Chicken breast (roasted, 1 c.)	43.4	1.4	119	231
Chicken thigh (roasted, 1 thigh)	13.5	1.6	49	109
Chicken leg (roasted, 1 leg)	29.6	4.2	105	264
Salmon 3 oz.	18.8	2.1	54	175
Tilapia 3 oz.	22.2	0.8	48	109
Halibut 3 oz.	22.7	0.4	35	119
Shrimp 3 oz.	17.8	0.2	166	84

Protein Quality

- The amino acid profile of different foods is therefore one component of protein quality.
- Foods that contain some of the essential amino acids are called incomplete protein sources, while those that contain all nine essential amino acids are called complete protein sources, or high-quality protein sources.
- Foods that are complete protein sources include animal foods such as milk, cheese, eggs, fish, poultry, and meat, and a few plant foods, such as soy and quinoa.
- The only animal-based protein that is not complete is gelatin, which consists of the protein, collagen.
- Most plant-based foods are deficient in at least one essential amino acid and therefore are incomplete protein sources.
- For example, grains are usually deficient in the amino acid lysine, and legumes do not contain methionine or tryptophan.

Activity

Protein Supplements

With or against and

Why?

Chapter VI

Obesity

- Obesity is a major public health and economic problem of global significance. Prevalence rates are increasing in all parts of the world, both in affluent Western countries and in poorer nations. Men, women and children are affected.
- Obesity is increase in the number or size of fat cells. Increase in the number occurs in the gestional months and during the 1 st years of life and continues at reduced rate throughout puberty.

WHAT IS OBESITY AND HOW IS IT MEASURED?

At the physiological level, obesity can be defined as a condition of abnormal or excessive fat accumulation in adipose tissue to the extent that health may be impaired. However, it is difficult to measure body fat directly and so surrogate measures such as the body mass index (BMI) are commonly used to indicate overweight and obesity in adults. Additional tools are available for identification of individuals with increased health risks due to 'central' fat distribution, and for the more detailed characterization of excess fat in special clinical situations and research.

Causes of obesity:

1- Bad eating habits:

- *Fast food*
- *Sugar sweetened drinks.*
- *More snack between meals.*
- *Eat breakfast less often.*
- *Consume more calorie-dense foods at restaurants more often.*

2-Sedentary life style:

- *2-17 years spend an average 4.7 hours in screen time (watching TV, videos, DVDs, movies, computer games, email, etc).*
- *Obesity rates are more 4X higher among those who watch 21+ hrs TV per week than those who watch less than 7 hrs per week.*
- *Obesity prevention program: reducing screen time by 10 hours a week led to 0.45 reduction BMI.*
- Displace time spent in physical activities.
- Lowers their metabolic rate.

- Contributes to increased calorie intake (excess snacking, meals in front of TV).
- ***3- pathological:***

Endocrine disorders	• Cushing syndrome • Hypothyroidism • Pseudohypoparathyrodism • Type 2 diabetes
Genetic syndromes	• Prader-willi syndrome • Bardet-biedel syndrome • Cohen syndrome • Beckwith-weidemann syndrome • Alstrom syndrome
CNS	• Hypothalamic tumor • Trauma • Inflammation

Assessment:-

A-nutrional assessment:-

1- 24 h recall

2-food frequency

- ***B- Arthrometric assessment:-***

1-body mass index

The BMI provides the most useful and practical population-level indicator of overweight and obesity in adults. It is calculated by dividing bodyweight in kilograms by height in metres squared (BMI_kg/m_). Both height and weight are routinely collected in clinical and population health surveys. In the new graded classification system developed by the World Health Organization (WHO), a

BMI of 30 kg/m_ or above denotes obesity (Table 1.1). There is a high likelihood that individuals with a BMI at or above this level will have excessive body fat. However, the health risks associated with overweight and obesity appear to rise progressively with increasing BMI from a value below 25 kg/m_, and it has been demonstrated that there are benefits to having a measurement nearer 20—22 kg/m_, at least within industrialized countries. To highlight the health risks that can exist at BMI values below the level of obesity, and to raise awareness of the need to prevent further weight gain beyond this level, the first category of overweight included in the new WHO classification system is termed 'preobese' (BMI 25—29.9 kg/m_).

Classification	**BMI (kg/m_)**
Underweight	<18.5
Normal range	18.5—24.9
Overweight Pre-obese Obese class I Obese class II Obese class III	>25 25.0—29.9 30.0—34.9 35—39.9 _>40

2- *Waist circumference*

For a comprehensive estimate of weight-related health risk it is also desirable to assess the extent of intra-abdominal or 'central' fat accumulation. This can be done by simple and convenient measures such as the waist circumference or waist-to-hip ratio. Changes in these measures tend to reflect changes in risk factors for cardiovascular disease and other forms of chronic illness. Some experts believe that a health risk classification based on waist circumference alone is more suitable as a health promotion tool than either BMI or waist-to hip ratio, alone or in combination (4). Recent work from the Netherlands has indicated that a waist circumference greater than 102 cm in men, and greater than 88 cm in women, is associated with a substantially increased risk of obesity-related metabolic complications (Table 1.2). The level of health risk associated with a particular waist circumference or waist-to-hip ratio may vary across populations.

	Risk of metabolic Complications	Male circumference	Female circumference
Alerting zone	Increased	94	80
Action zone	Substantially increased	102	88

3- waist/hip ratio:

Men	Women	Health risk
0.95 or less	0.80 or less	Low risk
0.96 -1	0.81- 0.85	Elevated risk
1 or higher	0.85 or higher	High risk

c- Lab assessment:

1- lipid profile:

	Acceptable	Border line	abnormal
TC	<170	170-199	≥200
LDL-C	<110	110-129	≥130
TG	0-9y: < 75 10-19y:<90	75-99 90-129	≥100 ≥130
HDL	>45	40-45	<40

2-hypertension:

- Prehypertension: 120-139 mmHg systolic or 80-89 mmHg diastolic.
- Statge1 HT: 140-159 mmHg systolic or 90-99 MMhg diastolic.
- Stage 2 HT: >160 mmHg systolic or >100 mmHg diastolic
- Normal BP <130 systolic & <85 diastolic.
- Optimal BP: 120/80

3- diabetes:-

Dyslipidemia:

	Fasting	Pp	A1C
Normal	80-100	120-140	5
pre diabetic	101-125	140-199	5.7 – 6.4
diabetic	126 +	200+	6.5 or above

- It is disorder of lipoprotein metabolism.

- ***Manifestation:-***
- 1-elevation of TC
- 2-elevation of LDL
- 3-elevation TG
- 4-decreasing of HDL

Metabolic syndrome:

- It occur in presence of central obesity plus tow from the following
- 1- TG>150
- 2-HDL<40
- 3-blood pressure ≥130/85
- 4-diabetes FBG ≥100 mg/dl

FOOD EXCHANGE LIST

Foods separated into these seven groups:-

- Starches
- Fruits and Fruit Juices
- Milk, Yogurt, and Dairy-like foods
- Non-Starchy Vegetables
- Sweets, Desserts, and Other Carbohydrates
- Meats and Meat Substitutes
- Fats

At the top of each section you will find the amount of carbohydrate, protein and fat and calories in each section:

- counting carbohydrates
- counting calories
- counting grams of fat
- counting grams of protein

Starch

Breads and Flours

Each serving=15 g carb, 3 g protein , 0 fat , 80 calories

Bagel	1/4 (1 oz)	Naan Indian Bread	1/4 (8 inches by 2 inches)
Biscuit	1 (2 1/2 inches across)	Pancake, 1/4 inch thick	1 (4 inches across)

Cereals,

Bread Reduced-calorie White, whole-grain, pumpernickel, rye, unfrosted raisin	2 slices (1 1/2 oz) 1 slice (1 oz)	Pita bread	1/2 pocket (6 inches across)
Bun (hotdog or hamburger)	1/2 bun (1 oz)	Roll, plain, small	1 (1 oz)
Chapatti, small	1 (6 inches across)	Stuffing, bread	1/3 cup
Cornbread	1 (1 3/4 inch cube or 1 1/2 oz)	Taco shell or tostada shell	2 crisp shells (5 inches across)
English muffin	1/2	Tortilla Corn or flour, 6 inches across Flour, 10 inches across	1 1/3
Flour, corn meal, wheat germ	3 Tbsp dry	Waffle	1 (4-inch square, or 4 inches across)

Grains and Pasta
Each Serving = 15 g carbohydrate, 3 g protein, 0-1 g fat, 80 calories

Barley, cooked	1/3 cup	Millet, cooked	1/3 cup
Bran, dry Oat bran Wheat bran	1/4 cup 1/2 cup	Muesli	1/4 cup
Bulgur, cooked	1/2 cup	Pasta, cooked	1/3 cup
Cereals Bran Oats, oatmeal, cooked Puffed Shredded wheat, plain Sugar-coated cereals Unsweetened, ready-to-eat cereals	 1/2 cup 1/2 cup 1 1/2 cups 1/2 cup 1/2 cup 3/4 cup	Polenta, cooked	1/3 cup
Couscous, cooked	1/3 cup	Quinoa, cooked	1/3 cup

Granola, regular or low-fat	1/4 cup	Rice, white or brown, cooked	1/3 cup
Grits, cooked	1/2 cup	Tabbouleh, prepared	1/2 cup
Kasha	1/2 cup	Wild rice, cooked	1/2 cup

Starchy Vegetables
Each Serving = 15 g carbohydrate, 3 g protein, 0-1 g fat, 80 calories

Cassava	1/3 cup	Pumpkin, canned, no sugar added	1 cup
Corn	1/2 cup	Squash, winter (acorn, butternut)	1 cup
Corn on cob, large	1/2 cup	Succotash	1/2 cup
Hominy, canned	3/4 cup	Yam, sweet potato	1/2 cup
Parsnips	1/2 cup	Potato Baked with skin Boiled, all kinds Mashed, with milk French fried (oven baked)	 1/4 large (3 oz) 1/2 cup 1/2 cup 1 cup (2 oz)
Peas, green	1/2 cup	Plantain, ripe	1/3 cup

Beans, Peas and Lentils (Cooked)
(also found under Meat and Meat Substitutes)
Each Serving = 15 g carbohydrate, 7 g protein, 0-3 g fat, 125 calories

Baked beans	1/3 cup
Beans (black, garbanzo, kidney, lima, navy, pinto, white)	1/2 cup
Lentils (brown, green, yellow)	1/2 cup
Peas (black-eyed, split)	1/2 cup
Refried beans, canned	1/2 cup

Fruit and Fruit Juices
Each Serving = 15 g carbohydrate, 0 g protein, 0 g fat, 60 calories
Note: the weights in parenthesis include the peel, skin, rind, and seeds

Apple, unpeeled, small	1 (4 oz)	Cherries Sweet, canned Sweet, fresh	 1/2 cup 12 (3 oz)
Apples, dried	4 rings	Dates	3
Applesauce, unsweetened	1/2 cup	Dried fruits	2 Tbsp

Apricots, fresh	4 whole (5 1/2 oz)	Figs	2 medium (3 1/2 oz)

Banana	1/2 large or 1 baby banana (4 oz)	Fruit cocktail	1/2 cup
Blackberries	3/4 cup	Grapefruit Large Sections, canned	1/2 (11 oz) 3/4 cup
Blueberries	3/4 cup	Grapes, small	17 (3 oz)
Cantaloupe	1 cup cubed (11 oz)	Honeydew	1 slice or 1 cup cubed (10 oz)

Kiwi	1 (3 1/2 oz)	Papaya	1 cup cubed (8 oz)
Mandarin oranges, canned	3/4 cup	Peach Canned Fresh, medium	1/2 cup 1 (6 oz)
Mango	1/2 cup or 1/2 small (5 1/2 oz)	Pear Canned Fresh, large	1/2 cup 1/2 (4 oz
Nectarine, small	1 (5 oz)	Pineapple Canned Fresh	1/2 cup 3/4 cup
Orange, small	1 (6 1/2 oz)		

Plums Canned Fresh, small	1/2 cup 2 (5 oz)	Strawberries	1 1/4 cup whole berries
Prunes	3	Tangerines, small	2 (8 oz)
Raisins	2 Tbsp	Watermelon	1 1/4 cup cubes (13 1/2 oz)
Raspberries	1 cup		

Apple juice and apple cider	1/2 cup	Orange juice	1/2 cup
Fruit juice blends, 100% juice	1/3 cup	Pineapple juice	1/2 cup
Grape juice	1/3 cup	Prune juice	1/3 cup
Grapefruit juice	1/2 cup		

Milk and Yogurt
Fat-free (skim) and Low-fat (1%) Selections
(Best choice)
Each Serving = 15 g carbohydrate, 8 g protein, 0-3 g fat, 100 calories

Fat-free and low-fat buttermilk	1 cup	Evaporated fat-free milk	1/2 cup
Fat-free milk	1 cup	Fat-free dry milk powder	1/3 cup dry
Low-fat, 1 % milk	1cup	Yogurt, - Fat-free, flavored with artificial sweetener -Plain, fat-free	2/3 cup (6 oz) 2/3 cup (6 oz)

Reduced-Fat Selections
Each Serving = 15 g carbohydrate, 8 g protein, 5 g fat, 120 calories

Milk, 2%	1 cup
Kefir	1 cup
Yogurt, plain low-fat	2/3 cup (6 oz)
Sweet acidophilus milk	1 cup

Whole Milk Selections
(Limit use - high in saturated fat)
Each Serving = 15 g carbohydrate, 8 g protein, 8 g fat, 160 calories

Milk, whole	1 cup
Evaporated whole milk	1/2 cup
Yogurt, plain (made from whole milk)	8 oz
Goat's milk	1 cup

Dairy-like Foods
Food composition varies – See right-hand column

Chocolate milk Fat-free Whole	1 cup 1 cup	30 g carb, 8 g protein, 0 g fat 30 g carb, 8 g protein, 8 g fat
Eggnog, whole milk	1/2 cup	15 g carb, 10 g fat
Rice milk Flavored, low-fat Plain, fat-free	1 cup 1 cup	30 g carb 15 g carb
Smoothies, flavored	10 oz	45 g carb, 8 g protein, 0-3 g fat
Soy milk Light Regular, plain	1 cup 1 cup	15 g carb, 4 g protein, 3 g fat 15 g carb, 8 g protein, 5 g fat

Yogurt And juice blends Low carbohydrate	1 cup 2/3 cup (6 oz)	30 g carb, 8 g protein, 0 g fat 6 g carb, 4 g protein, 0 g fat

Beverages, Soda, Energy and Sports Drinks
See right-hand column for composition of each food item

Cranberry juice cocktail	1/2 cup	15 g carb
Energy drink	1 can (8.3 oz)	30 g carb
Fruit drink or lemonade	1 cup (8 oz)	30 g carb
Hot chocolate Regular Sugar-free or light	1 envelope (added to 8 oz water)	22 g carb, 5 g fat 15 g carb
Soft drink (soda), regular	1 can (12 oz)	38 g carb
Sports drink	1 cup (8 oz)	15 g carb

Brownies, Cake, Cookies, Gelatin, Pie, and Pudding
See right-hand column for composition of each food item

Brownie, small, unfrosted	1 1/4 inch square, 7/8 inch high (1 oz)	15 g carb, 5 g fat
Cake • Angel food, unfrosted • Frosted • Unfrosted	 1/12 of cake (2 oz) 2 inch square (2 oz) 2 inch square (2 oz)	 30 g carb 30 g carb, 5 g fat 15 g carb, 5 g fat
Cookie • Chocolate chip • Gingersnap • Sandwich with crème filling • Sugar-free • Vanilla wafer	 2 small (2 1/4 inches) 3 cookies 2 small (2/3 oz) 3 small (3/4-1 oz) 5 cookies	 15 g carb, 10 g fat 15 g carb 15 g carb, 5 g fat 15 g carb, 5-10 g fat 15 g carb, 5 g fat

Candy, Spreads, Sweets, Sweeteners, Syrups, and Toppings
See right-hand column for composition of each food item

Candy bar, chocolate and peanuts	2 "fun size" bars (1 oz)	22 g carb, 8 g fat
Candy, hard	3 pieces	15 g carb
Chocolate "kisses"	5 pieces	15 g carb, 5 g fat
Coffee creamer Dry, flavored Liquid, flavored	4 tsp 2 Tbsp	8 g carb, 3 g fat 15 g carb
Fruit snacks, chewy	1 roll (3/4 oz)	15 g carb
Fruit spread, 100% fruit	1 1/2 Tbsp	15 g carb
Honey	1 Tbsp	15 g carb

Barbeque sauce	3 Tbsp	15 g carb
Cranberry sauce, jellied	1/4 cup	22 g carb
Gravy, canned or bottled	1/2 cup	8 g carb, 3 g fat
Salad dressing, fat-free	3 Tbsp	15 g carb
Sweet and sour sauce	3 Tbsp	15 g carb
Jam or jelly, regular	1 Tbsp	15 g carb
Sugar	1 Tbsp	15 g carb
Syrup • Chocolate • Light (pancake type) • Regular (pancake type)	 2 Tbsp 2 Tbsp 1 Tbsp	 30 g carb 15 g carb 15 g carb

Doughnuts, Muffins, Pastries, and Sweet Breads
See right-hand column for co

mposition of each food item

Banana nut bread	*1-inch wide slice (1 oz)*	*30 g carb, 5 g fat*
Doughnut • *Cake, plain* • *Yeast-type, glazed*	*1 medium (1 1/2 oz)* *3/4 inches (2 oz)*	*22 g carb, 10 g fat* *30 g carb, 10 g fat*
Muffin	***1/4 muffin (1 oz)***	***15 g carb, 3 g fat***
Sweet roll or Danish	***1 (2 1/2 oz)***	***38 g carb, 10 g fat***

Frozen Bars, Frozen Desserts, Frozen Yogurt, and Ice Cream
See right-hand column for composition of each food item

Frozen pops	**1**	8 g carb
Fruit juice bars, frozen, 100% juice	1 bar (3 oz)	15 g carb

Frozen yogurt Fat-free Regular	1/3 cup 1/2 cup	15 g carb 15 g carb, 0-5 g fat
Ice cream Fat-free Light No sugar added Regular	1/2 cup 1/2 cup 1/2 cup 1/2 cup	22 g carb 15 g carb, 5 g fat 15 g carb, 5 g fat 15 g carb, 10 g fat
Sherbet, sorbet	1/2 cup	30 g carb

Granola Bars, Meal Replacement Bars or Shakes, and Trail Mix
See right-hand column for composition of each food item

Granola or snack bar	1 bar	22 g carb, 0-5 g fat
Meal replacement bar	1 bar	30 g carb, 5 g fat
Meal replacement shake, reduced calorie	1 can	22 g carb, 0-5 g fat
Trail mix Candy and nut-based Dried fruit-base	 1 oz 1 oz	 15 g carb, 10 g fat 15 g carb, 5 g fat

Non-Starchy Vegetables

- Serving size = 1/2 cup cooked
- 1 cup raw
- 1/2 cup vegetable juice

Each Serving = 5 g carbohydrate, 2 g protein, 0 g fat, 25 calories

- Amaranth or Chinese spinach
- Artichoke and Artichoke hearts
- Asparagus
- Baby corn
- Bamboo shoots
- Beans (green, wax, Italian)
- Bean sprouts
- Beets
- Bok choy
- Borscht
- Broccoli
- Brussels sprouts
- Cabbage - all types
- Carrots
- Cauliflower
- Celery

Okra
Onions
Oriental radish or daikon
Pea pods (snow peas)
Peppers (all varieties)
Radishes
Rutabaga
Sauerkraut
Soybean sprouts
Spinach
Summer squash
Sugar snap peas
Swiss chard
Tomato (fresh or canned)
Tomato sauce
Tomato/vegetable juice

- Chayote
- Coleslaw, no dressing
- Cucumber
- Eggplant
- Gourds (bitter, bottle, luffa)
- Greens (collard, kale, mustard, turnip)
- Green onions or scallions
- Hearts of palm
- Jicama
- Kohlrabi
- Leeks
- Mixed vegetables (without corn or peas)
- Mung bean sprouts
- Mushrooms
- Turnips
- Water chestnuts
- Yard-long beans
- Zucchini

Meats and Meat Substitutes

- Lean Selections (Good Choice)
- Each Serving = 0 g carbohydrate, 7 g protein, 0-3 g fat, 45 calories

Beef (Select or Choice grades): ground round, roast (chuck, rib, rump), sirloin, steak (flank, porterhouse, T-bone), tenderloin	1 oz
Beef jerky	1 oz
Cheeses (0-3 g fat per oz)	1 oz
Cottage cheese	1/4 cup
Egg substitute, plain	1/4 cup
Egg whites	2
Fish: catfish, cod, flounder, haddock, halibut, orange roughy, salmon, tilapia, trout, tuna	1 oz
Fish, smoked: herring or salmon (lox)	1 oz
Game: buffalo, ostrich, rabbit, venison	1 oz
Hot dog with 0-3 g fat per oz	1 oz
Lamb: chop, leg, roast	1 oz
Organ meats: heart, kidney, liver (high cholesterol)	1 oz
Oysters, fresh or frozen	6 medium
Pork, lean: ham, pork tenderloin, Canadian bacon, rib or loin chop	1 oz
Poultry, skinless: Cornish hen, chicken, domestic duck or goose (well-drained of fat, turkey)	1 oz

Processed sandwich meats with 0-3 g fat per oz: chipped beef, deli thin-sliced meats, turkey ham, turkey kielbasa, turkey pastrami	1 oz
Salmon, canned	1 oz
Sardines, canned	2 medium
Sausage with 0-3 g fat per oz	1 oz
Shellfish: clams, crab, imitation shellfish, lobster, scallops	1 oz
Shrimp and squid (high cholesterol)	1 oz

Medium Fat Selections

Each Serving = 0 g carbohydrate, 7 g protein, 4-7 g fat, 75 calories

Cheese, reduced-fat cheeses	1 oz	Pork: cutlet, shoulder roast	1 oz
Ricotta cheese	1/4 cup, 2 oz	Poultry: chicken with skin, dove, pheasant, wild duck, wild goose, fried chicken, ground turkey	1 oz
Mozzarella	1 oz	Ricotta cheese	1/4 cup. 2 oz
Feta cheese	1 oz	Sausage, 4-7 grams of fat per oz	1 oz
Beef: corned beef, ground beef, meatloaf, Prime grades trimmed of fat (prime rib), short ribs, tongue	1 oz	Veal, cutlet (no breading)	1 oz

High Fat Selections (Limit use)

Each Serving = 0 g carbohydrate, 7 g protein, 8 or more g fat, 100 calories

Bacon Pork Turkey	2 slices (1 oz each before cooking) 3 slices (1/2 oz each before cooking)
Cheese, regular: American, bleu, brie, cheddar, Colby, hard goat, Monterey jack, queso, Swiss	1 oz

Hot dog: beef, pork, turkey, chicken or combination (10 per pound sized package)	1 oz
Pork: ground, sausage, spareribs	1 oz
Processed meats with 8 or more g fat per oz: bologna, pastrami, hard salami	1 oz
Sausage with 8 or more g of fat or more per oz: bratwurst, chorizo, Italian, knockwurst, Polish, smoked, summer	1 oz

<u>Plant- Based Proteins</u>

<u>See right-hand column for composition of each food item</u>

"Bacon" strips, soy-based	3 strips	7 g protein, 4-7 g fat
Baked beans	1/3 cup	15 g carb, 7 g protein, 0-3 g fat
Beans, cooked: black, garbanzo, kidney, lima, navy, pinto, white	1/2 cup	15 g carb, 7 g protein, 0-3 g fat
Beef" or "sausage" crumbles, soy-based	2 oz	8 g carb, 7 g protein, 0-3 g fat
Chicken" nuggets, soy-based	2 nuggets (1 1/2 oz)	8 g carb, 7 g protein, 4-7 g fat
Edamame	1/2 cup	8 g carb, 7 g protein, 0-3 g fat
Falafel (spiced chickpea and wheat patties)	3 patties	15 g carb, 7 g protein, 8 g fat
Hot dog, soy-based	1 (1 1/2 oz)	8 g carb, 7 g protein, 0-3 g fat
Hummus	1/3 cup	15 g carb, 7 g protein, 8 g fat
Lentils, brown, green, or yellow	1/2 cup	15 g carb, 7 g protein, 0-3 g fat
Meatless burger, soy-based	3 oz	8 g carb, 14 g protein, 0-3 g fat
Nut spreads: almond butter, cashew butter, peanut butter, soy nut butter	1 Tbsp	7 g protein, 8 or more g fat
Peas, cooked: black-eyed and split peas	1/2 cup	15 g carb, 7 g protein, 0-3 g fat
Refried beans, canned	1/2 cup	15 g carb, 7 g protein, 0-3 g fat
Sausage" patties, soy-based	1 (1 1/2 oz)	7 g protein, 4-7 g fat

Soy nuts, unsalted	3/4 oz	8 g carb, 7 g protein, 4-7 g fat
Tempeh	1/4 cup	7 g protein, 4-7 g fat
Tofu	4 oz (1/2 cup)	7 g protein, 4-7 g fat
Tofu, light	4 oz (1/2 cup)	7 g protein, 0-3 g fat

Fats

- ***Monounsaturated Fats Each Serving = 0 g carbohydrate, 0 g protein, 5 g fat, 45 calories***

Avocado	2 Tbsp (1 oz)
Nut butters (trans fat-free): almond butter, cashew butter, peanut butter	1 1/2 tsp
Nuts: Almonds Brazil Cashews Filberts (hazelnuts) Macadamia Mixed (50% peanuts) Peanuts Pecans Pistachios	6 nuts 2 nuts 6 nuts 5 nuts 3 nuts 6 nuts 10 nuts 4 halves 16 nuts
Oils: olive oil, canola oil, peanut oil	1 tsp
Olives Black (ripe) Green, stuffed	 8 large 10 large

Polyunsaturated Fats

Each Serving = 0 g carbohydrate, 0 g protein, 5 g fat, 45 calories

Margarine, reduced-fat (30-50% vegetable oil, *trans* fat-free)	1 Tbsp
Margarine: stick tub, or squeeze (*trans* fat-free)	1 tsp
Mayonnaise: Reduced-fat Regular	 1 Tbsp 1 tsp
Mayonnaise-style salad dressing Reduced-fat Regular	 1 Tbsp 2 tsp
Nuts Pignolia (pine nuts) Walnuts	 1 Tbsp 4 halves
Oils: corn, cottonseed, flaxseed, grape seed, safflower, soybean, sunflower	1 tsp
Margarines with plant stanol esters Light Regular	 1 Tbsp 2 tsp
Cream cheese Reduced-fat Regular	 1 1/2 Tbsp (3/4 oz) 1 Tbsp (1/2 oz)
Lard	1 tsp
Oil: coconut, palm, palm kernel	1 tsp
Salt pork	1/4 oz
Shortening, solid	1 tsp

Summary of food exchange table

	carb	Protein	fat	Calories
Starch	15 g	3 g	0	80 kcal
Beans	15 g	7 g	1-3 g	125 kcal
Milk				
skim	15 g	8 g	3 g	100 kcal
reduced	15 g	8 g	5 g	120 kcal
whole	15 g	8 g	8g	160 kcal
Fruits	15 g	0 g	0 g	60 kcal
Vegetables	5 g	2 g	0 g	25 kcal
Meat				
Lean	0 g	7 g	3 g	55 kcal
med	0 g	7 g	5 g	75 kcal
high fat	0 g	7 g	8 g	100 kcal
Fat	0 g	0 g	5 g	45 kcal

Diet planning

- **Ideal body weight (IBW) = height – 100**
- **Adjusted body weight (ABW) = IBW+0.4(body weight- IBW)**
- **Total calories = ABW * 24*1.3 or 1.4 or 1.5**
- **Protein demand = 1.6 g* body weight**
- **Cho = total calories *55/100**
- **SFA= total calories *5/100**
- **PUFA = total calories *10/100**
- **MUFA =total calories *14/100**

Chapter VII

Nutrition and Underweight

Definition

Underweight status represents depleted body fat and/or lean tissue stores.

Classification according BMI:

Mild under weight	BMI=17- 18.5Kg/m2
moderate under weight	BMI=16- 17Kg/m2
sever under weight	BMI <16 Kg/m2

Magnitude of the problem:-

- **In the world:** About 8-9 %.
- **In Egypt:** 2.4 %.

Significance:-

- Higher rates of hospitalizations and mortality in underweight adults, compared to those with weights within normal ranges.
- Higher rates of asthma, scoliosis, intestinal problems and emotional disorders were found in underweight 17 year olds.
- Abnormal menses and subfertility has been demonstrated in underweight females.
- Amenorrhea may also occur, as a result of low leptin levels, decreased body fat, emotional stress or anxiety.
- Underweight adolescents who become pregnant may be at increased risk for pregnancy complications and poor fetal outcomes, including prematurity and low birth weight.
- The onset of puberty may be delayed in male and female adolescents with a low BMI.
- The risk for osteoporosis may be increased in youth who remain lean as adults.
- Underweight adolescents may have a negative body image, particularly males who may desire a muscular physique.
- Fatigue, lack of energy and increased susceptibility to infection may be experienced in youth with a low BMI.

Etiology:-

A- simple under weight:-

People who are thinner than average all their lives and seems perfectly healthy.

1- Genetic tendency toward leanness:

- An efficient metabolism and low propensity to store body fat.

- Percentage of body fat may be low, lean tissue is usually within normal ranges and they are proportionately small.

2- Inadequate eating patterns:-

- Limited food resources.
- Lifestyle habit

B- Secondary underweight:

People get thinner than average at certain period of their lives and are not perfectly healthy.

- ***Problems affecting eating:***

- Problems of the GIT (mouth, esophagus, stomach, small intestine, large intestine)
- General causes affecting the desire to eat (certain types of cancers, chemotherapy, radiotherapy, certain types of drug intake, psychological upset, chronic inflammatory process and diabetes.

Geographic tongue:

- Geographic tongue is an inflammatory but harmless condition affecting the surface of your tongue. The tongue is normally covered with tiny, pinkish-white bumps (papillae), which are actually short, fine, hairlike projections. With geographic tongue, patches on the surface of the tongue are missing papillae and appear as smooth, red "islands," often with slightly raised borders.
- These patches (lesions) give the tongue a maplike, or geographic, appearance. The lesions often heal in one area and then move (migrate) to a different part of your tongue. Geographic tongue is also known as benign migratory glossitis.

Symptoms:-

Signs and symptoms of geographic tongue may include:

- Smooth, red, irregularly shaped patches (lesions) on the top or side of your tongue
- Frequent changes in the location, size and shape of lesions
- Discomfort, pain or burning sensation in some cases, most often related to eating spicy or acidic foods.

Causes:-

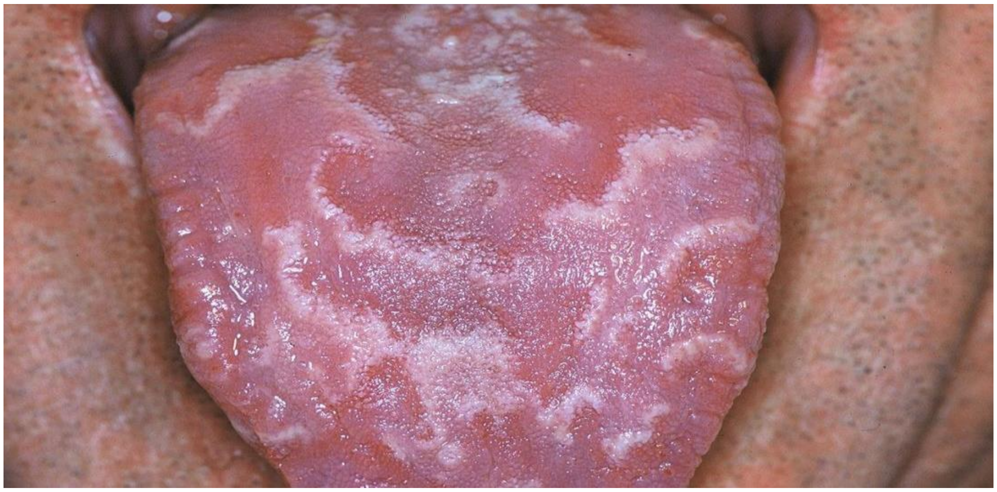
- The cause of geographic tongue is unknown, and there's no way to prevent the condition. There may be a link between geographic tongue and psoriasis and between geographic tongue and lichen planus. But more research is needed to better understand possible connections.

Risk factors

Studies of factors that may be associated with an increased risk of geographic tongue have produced mixed results. Factors that are likely associated with an increased risk include:

- **Family history.** Some people with geographic tongue have a family history of the disorder, so inherited genetic factors may increase risk.

- **Fissured tongue.** People with geographic tongue often have another disorder called fissured tongue, which has the appearance of deep grooves (fissures) on the surface of the tongue



Nutrients affecting the tongue:-

- ***Iron deficiency***: sore, burning tongue, atrophy.
- ***Vit C***: sore burning mouth.
- ***Vit A***: xerostomia.
- ***Vit B2(riboflavin):*** atrophy of filliform papillae.
- ***Vit B3 (niacin):*** glossitis
- ***Vit B6 (pyridoxine):*** sore or burning mouth
- ***Zinc deficiency***
- ***Folic acid deficiency***: loss or distortion of taste & smell acuity loss of tongue sensation.

Stomach, small intestine, large intestine:-

- Heart burn (ulcers).
- Bloating(maldigestion, malabsorption)
- Flatulations (giardia, maldigestion)
- Pain.

Food allergy:-

- Food allergy is an abnormal response to a food triggered by the body's immune system.
- Antibodies are produced specifically to reject the food called sensitization.
- Inflammatory mediators are released to defend the body.
- Mediators act on body tissue to cause the symptoms of allergy.

Allergenic foods:

1-milk

2- Eggs

3-peanuts

4- Tree nuts

5- Soy

6- Wheat

7- Fish

8- Crustacean shellfish

Symptoms:-

- GIT: swelling or itching of the lips, mouth and/or throat nausea, vomitting, cramping and/or diarrhea.
- Skin: itching, swelling, hives, eczema and/or redness.
- Respiratory tract: congested, runny and/or itchy nose, sneezing, raspy cough and/or wheezing.
- Anaphylaxis: Anaphylaxis caused by an allergic reaction to a certain food is highly unpredictable. The severity of a given attack does not predict the severity of subsequent attacks.

Diagnosis:-

Detailed History

- Your healthcare professional will begin by taking a detailed medical history to find out whether your symptoms are caused by an allergy to specific foods, a food intolerance, or other health problems.
- A detailed history is the most valuable tool for diagnosing food allergy. Your healthcare professional will ask you several questions and listen to your history of food reactions to decide whether the facts fit a diagnosis of food allergy.
- ***Skin prick test:-***

If your history, diet diary, or elimination diet suggests a specific food allergy is likely, then your healthcare professional will use the skin prick test to confirm the diagnosis.

With a skin prick test, your healthcare professional uses a needle to place a tiny amount of food **extract** just below the surface of the skin on your lower arm or back. If you are allergic, there will be swelling or redness at the test site. This is a positive result. It means that there are IgE molecules on the skin's mast cells that are specific to the food being tested.

The skin prick test is simple and relatively safe, and results are ready in minutes.
You can have a positive skin prick test to a food, however, without having an allergic reaction to that food. A healthcare professional often makes a diagnosis of food allergy when someone has *both* a positive skin prick test to a specific food *and* a history of reactions that suggests an allergy to the same food.

- ***<u>Blood test:-</u>***

  Instead of the skin prick test, your healthcare professional can take a blood sample to measure the levels of food-specific IgE antibodies.

As with skin prick testing, positive blood tests do not necessarily mean that you have a food allergy. Your healthcare professional must combine these test results with information about your history of reactions to food to make an accurate diagnosis of food allergy.

- ***<u>Oral Food Challenge :-</u>***

Caution: Because oral food challenges can cause a severe allergic reaction, they should always be conducted by a healthcare professional who has experience performing them.

An oral food challenge is the final method healthcare professionals use to diagnose food allergy. This method includes the following steps:

• Your healthcare professional gives you individual doses of various foods (masked so you do not know what food is present), some of which are suspected of starting an allergic reaction.

• Initially, the dose of food is very small, but the amount is gradually increased during the challenge.

• You swallow the individual dose.

• Your healthcare professional watches you to see whether a reaction occurs.

To prevent bias, oral food challenges are often done double blinded. In a true double-blind challenge, neither you nor your healthcare professional knows whether the substance you eat contains the likely allergen. Another medical professional has made up the individual doses. In a single-blind challenge, your healthcare professional knows what you are eating but you do not.

<u>Management of food allergy:-</u>

- Avoid the allergen-containing food.
- Develop a food allergy action plan inform and involve family, friends, and caretakers.
- Early symptoms recognition.
- Emergency therapy: epinephrine.
- Medical identification necklaces/bracelets.
- ***<u>Food intolerance</u>***

When people complain of symptoms such as headaches, bloating or mouth ulcers after eating, they are describing food intolerance, rather than food allergy. During an allergic reaction to food, many irritant chemicals (such as histamine) are released into the tissues. This can result in itchy rashes, stomach upset, cough and wheeze and the more severe allergic symptoms (anaphylaxis). These reactions are due to allergy, which is an immune system reaction to foods**.**

<u>What is food intolerance?</u>

Food allergy and food intolerance are commonly confused as the symptoms of food intolerance occasionally resemble those of food allergy. However, there is a difference. **Food**

intolerance does not involve the immune system. It does not cause severe allergic reactions (known as anaphylaxis) and does not show on allergy testing.

Food intolerance can be a difficult concept to understand. Sometimes substances within foods can increase the frequency and severity of migraine headaches, rashes (such as hives) or the stomach upset of irritable bowel. Coincidence can often confuse the issue, as we spend many of our waking hours eating or drinking.

<u>Causes of food intolerance:</u>

- **Monosodium glutamate** (MSG, additive numbers 620 and 621) was originally isolated from seaweed in 1908 by a Japanese chemist. Glutamates also occur naturally in such foods as camembert cheese, Parmesan cheese, tomatoes, soy sauce and mushrooms. MSG stimulates nerve endings, perhaps accounting for its function as a flavour enhancer when it is added to food.

- **Vasoactive amines** such as tyramine, serotonin and histamine are well known triggers of migraines in some patients and are present naturally in pineapples, bananas, baked meat, vegetables, red wine, wood-matured white wine, avocados, chocolate, citrus fruits and mature cheese. Amines can act directly on small blood vessels to expand their capacity, perhaps accounting for their effect on flushing, migraines and nasal congestion in some patients.

- **Salicylates** are natural aspirin like compounds (aspirin was originally isolated from willow tree bark) present in a wide variety of herbs, spices as well as fruit and vegetables. Reactions to these may be even more common than reactions to artificial colours and preservatives. Aspirin can trigger hives (urticaria) by acting directly on skin mast cells. Natural and structurally similar salicylates can also worsen hives in some patients.
- **Toxins.** Other than contamination of food with micro-organisms or their products (spoilage, food poisoning), some foods contain toxins than can cause severe symptoms. For example, if some types of fish are stored poorly, their gut bacteria can convert histidine to histamine, resulting in allergy-like symptoms.
- **Irritants**. Caffeine and curry are gut irritants and can trigger indigestion in some people.
- **Enzyme deficiencies**. Some people are born with, or develop, insufficient enzymes to digest, absorb or deal with some foods. For example, a deficiency of the enzyme lactase results in lactose intolerance. The inability to digest lactose can result in bloating, wind, nausea and diarrhoea after having dairy products. Similarly, people with low levels of alcohol dehydrogenase will experience flushing and severe nausea because they are unable to metabolise toxic breakdown products of alcohol.
- **Histamine in food:** (fish that are not fresh and have not been stored properly).
- **Pharmacological (caffeine or amines)**

<u>Food intolerance circumstances:</u>

1- Lifestyle with erratic food intakes.

2- Poor nutritional intake.
3- High intakes of refined foods.
4- Poor intakes of dietary fiber.
5- High fat diets.

<u>How is food intolerance recognized?</u>

- The pattern and type of symptoms.
- No reliable and/or validated tests to identify food intolerance.
- Exclusion diet (also called a diagnostic diet).
- Symptoms are not immediate (abdominal pains, acid reflux, asthma)

<u>Management of underweight:-</u>

- ***<u>Medications:</u>***
  a- Appetite stimulants (vitamins and zinc)
  b- Digestive enzyme replacement.
  c- Amino acids supplementation.
- ***<u>General guidelines:</u>***

-The 24 h recall will help you to know the average intake of your underweight client.
-add 500 calories for each couple of week.
-stop smoking because it leads to decrease of appetite.
-choose foods with concentrated calories.
-focus on nutrient-rich foods & beverages, such as juice & milk rather than coffee, tea and water.
-Drink fluids 30 minutes before and after meals not with meals.
-enjoy a snack before bedtime.
- eat meals with friends.
-Make mealtimes pleasant. A relaxed and attractive setting with soft music or flowers on the table may increase the appetite.
-stay away from unpleasant or unstelling topics of conversation at mealtimes.
-eliminate from diet coffee, tea, and anything else that contains caffeine.
-stay physically active, as exercise encourages weight gain as lean body mass rather than fat.
-investigate the possibility of food senstiviy.
-Eat at least five small meals and snacks each day.
-Drink healthy beverages that add calories. For example, have juice, milk, or shakes.
- Drink nutritional supplements.
-Try high-calorie, high-protein recipes.
-Sweeten foods and beverages with sugar, jam, jelly, or honey.
-Choose higher-calorie starchy vegetables, like potatoes, corn, and peas. Add cream, butter, margarine, cheese sauce, olive oil, or salad dressing to get more calories.
-Eat fruit canned in heavy syrup.
-Choose foods high in protein. These include milk, eggs, cheese, meat, fish, poultry, and beans. You may also use protein powders, and meal replacement shakes and bars.
-Add high-fat foods to meals and snacks:

1-Choices include butter, regular margarine, vegetable oils, peanut butter, and mayonnaise.

2- Whole milk, half-and-half, and cream have more calories than skim or low-fat milk.

3- Higher-fat meats and whole-milk cheeses provide more calories than lean or low-fat types.

- ***Hormonal supplements:***

1- Cortisone:

It may lead to

- Oedema.
- Hyperglycemia with glucosurea.
- Osteoporosis.
- Psychiatric disturbances.
- Weakness of muscles.
- Iatrogenic cushing syndrome.
- Thromboembolic complications
- Cataract.

2- Muscle building steroids:

- They are synthesized to act like testosterone
- Steroids can help build bigger muscles and do not ensure physical performance.

In men It may cause:

- Acne.
- Testicular damage.
- Enlarged breast
- Lower sperm count

In women it may cause:

- Change in voice.
- Facial hair
- Smaller
- Loss of menstrual cycle.

Chapter VIII

Sport nutrition

Carbohydrate: the fuel of champions

Carbohydrate is stored as glycogen in muscles and liver. Glycogen is the "quick energy" for muscle activity. Do you get enough carbohydrate?

How much carbohydrate do I need?

Carbohydrate is found in a variety of foods in every food group.

More active individuals need more carbohydrate. Use the table below to help you get enough carbohydrate and meet all your other nutrient needs.

FOOD GROUP	AESTHETIC SPORT S	MOST AT HLETES	ENDURANCE SPORTS
Vegetables & Fruit	Minimum 6–7	8–14+	15+
Grain Products	Minimum 6–7	8–14+	15+
Milk & Alternatives	Minimum 3	3–4	4–6
Meat & Alternatives	Minimum 2–3	2–3	3–4

How can I maximize muscle glycogen—the quick energy for muscle activity?

In addition to eating a high carbohydrate diet regularly, athletes involved in longer duration and/or intense activity can take the steps outlined below.

- Eat or drink high carbohydrate foods (i.e. fruit/fruit juice, fruit yogurt, crackers, chocolate/flavoured milk, bagels, cereal, low fat granola bars), ideally within the first 15–30 minutes of finishing activity.
- Consume several high carbohydrate snacks in the 2–4 hours after exercise. Be sure to follow up your snacks with a high carbohydrate meal.
- Include rest days after hard training or prior to competition (along with adequate carbohydrate intake), to ensure maximum filling of muscle energy stores. Remember, muscle glycogen stores take 24–48 hours to refill completely.
- Recent research has shown that chocolate milk is as effective (or better!) than commercial products designed for recovery from a rigorous workout. In addition to helping replace lost fluids, the amount of carbohydrate and protein in chocolate milk is ideal for exhausted muscles.

Why are carbohydrate foods so important?

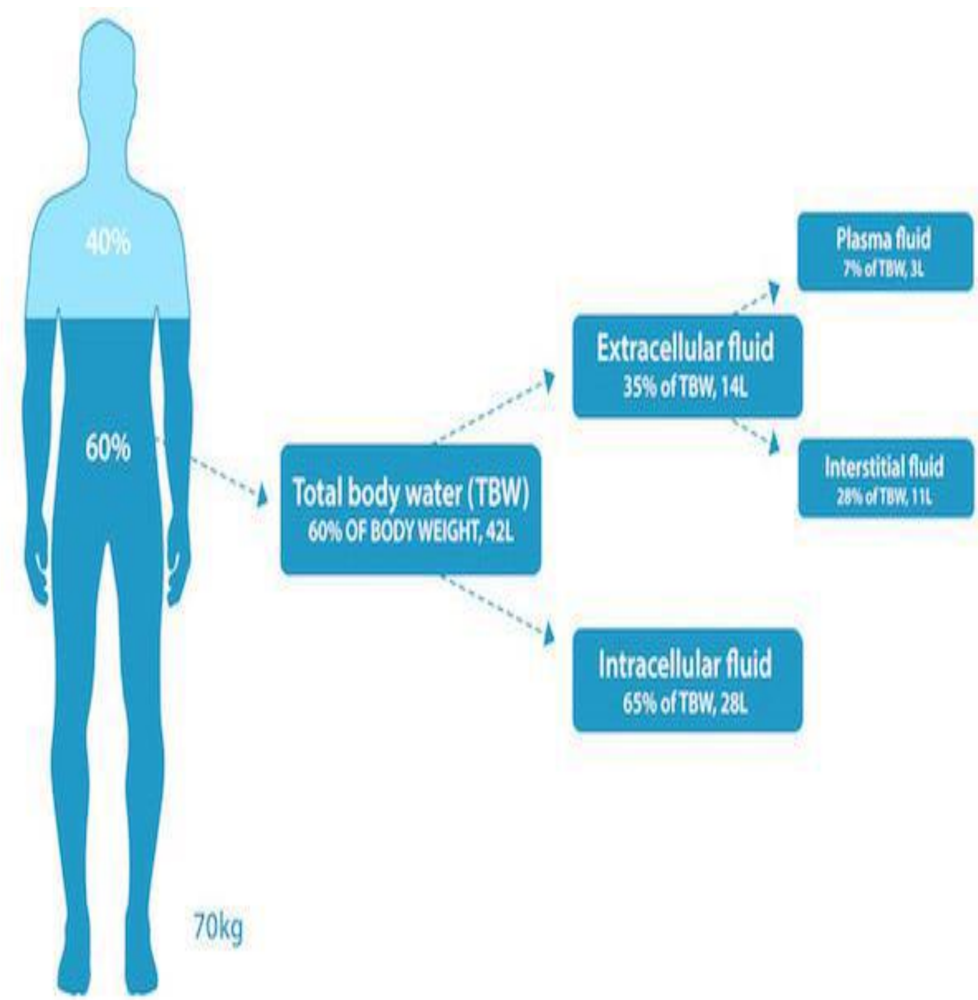
Muscle glycogen depletion can occur during long, steady, intense activity (e.g. marathon running, cycling, cross-country skiing) and strenuous, intermittent bouts of exercise (e.g. hockey, volleyball, basketball, soccer).

Depletion can also occur over several days during training camps, tournaments, or repeated endurance training sessions without consuming enough dietary carbohydrate.

• Depleted glycogen stores lead to reduced endurance, fatigue and exhaustion.
• Eating carbohydrate foods is the only way to maintain and refill muscle glycogen stores.
• Carbohydrate needs vary from person to person (even within a specific sport).

Hydration:

Water accounts for approximately 60% of the average person's body weight.



Fluid recommendations:-

RECOMMENDED DAILY FLUID INTAKE FROM BEVERAGES			
TEENS		ADULT S	
female	male	female	male
1.8L (8 CUPS)	2.6L (11 CUPS)	2.2L (9 CUPS)	3L (13 CUPS)

How to monitor hydration status?

There are a few simple ways to determine if someone is hydrated. The most common methods of determining one's hydration status are:

- **Body weight**
- **Sweat rate**
- **Urine color**
- **Urine specific gravity**

Body Weight:

One of the easiest ways an athlete can prevent dehydration is by weighing before and after exercising (See Figure 1). By determining the percentage of body mass lost, an athlete can determine how dehydrated he/she is. The first step is to determine an athlete's euhydrated (or hydrated) body mass. This is achieved by having an average of the athlete's body weight across several days, since a person's body weight may fluctuate due to various factors, such as the time of day, time of meals, etc. Once athletes know their baseline body mass, they can use their pre- and post-exercise body mass to determine two factors: (1) how much they need to drink before the next practice or competition, and (2) whether they need to change their rehydration behaviors during future practices. Most body mass lost during exercise is a result of fluid lost through sweating; therefore, weigh-ins can tell the athlete how well they replaced the lost fluid or how much they need to replace after exercising. Dehydration of one to two percent of body mass can result in decreased athletic performance as well as decreased physiologic functioning (Casa, 2000). Furthermore, body mass losses of three percent of greater can further decrease athletic performance and possibly lead to heat illness (Casa, 2000). Therefore, when athletes calculate their percentage of body mass lost, they can match their fluid losses with their fluid intake. This is performed by having your athletes determine what a three-percent body mass loss means to them in pounds or kilograms so that they know what to look for when they step on the scale. For instance, three-percent body mass of an athlete weighing 145 pounds is 4.35 pounds. If this athlete is weighing 141 pounds after practice, she can determine that she needs to 1) drink fluids to replace that loss and 2) do a better job of replacing fluids during exercise in future practices.

Sweat Rate

Along with pre- and post-exercise weigh-ins, knowing an athlete's sweat rate can provide a good indication of how to keep athletes hydrated. Although there are average sweat rates for various types of athletes (between 0.5 liters/hour to more than 2.5 liters/hour) (Casa, 2000), not all athletes have the same sweat rate. As a coach, you have probably noticed some athletes who are sweating profusely five minutes into practice, while others are barely sweating after 30 minutes. Because athletes' fluid losses vary, determining their sweat rates is another tool in determining how much an athlete should be drinking (See Table 1). Once you have each individual athlete's sweat rate, you can determine what each athlete's fluid needs are and provide fluids accordingly.

Table 1a: Sample Sweat Calculations

Example 1* Example 2 Example 3 Soccer (F) Cross Country (M) Football (M) Pre-exercise

	Example 1 Soccer (F)	Example 2 Cross Country (	Example 3 Football (M)
Pre-exercise Body Weight	125 lb (56.8 kg) 1	132 lb (60 kg)	190 lb (86.4 kg)
Post-exercise Body Weight	124 lb (56.4 kg)	129 lb (58.6 kg)	186 lb (84.5 kg)
Fluid Consumed)	24 oz (710 mL)	) 16 oz (473 mL)	40 oz (1183 mL)
Sweat rate/per H	1110 mL	1873 mL	3083 mL

Sweat rate can be determined by calculating the difference in pre- and post-exercise body weight, while incorporating fluid intake and urine volume (See Figure 2). The easiest way to determine your athletes' sweat rate is to set aside a one-hour practice session where you do not allow rehydration or urination. The difference between the pre-and post-exercise body weight is their sweat rate per hour of exercise. You can also give each athlete his or her designated water bottle and measure how much fluid the athlete drank during the session, and then incorporate the amount of fluid consumed into the equation (See Table 1 a & b). Having a calculated sweat rate helps athletes understand that if they sweat more than their teammates, they should be consuming more fluids. It also helps the coaches understand the importance for athletes to be able to consume fluids throughout exercise sessions when needed.

<u>Sweat Rate Formula</u>

SR = [(pre BW - Post BW) + Fluid Consumed – Urine Volume] / Exercise Time (Hours)

SR = Sweat Rate **Pre BW** - Pre-exercise body weight **Post BW** - Post-exercise body weight

<u>Urine Color:-</u>

Another simple way for coaches to educate athletes about hydration is through urine color. The lighter someone's urine color, the more hydrated they are; conversely, the darker someone's urine, the less hydrated, or dehydrated, they are. By educating your athletes to check their urine color, they will be able to tell if they are replacing lost fluids adequately. The key is for athletes to monitor their urine color to ensure it remains a pale yellow (like lemonade), even after exercising. If it's a little on the dark side (like apple juice), then they know they probably didn't replace enough fluids and need to make sure they do before exercising again. One of the best guides for your athletes would be to post a urine color chart (Armstrong, 2000) in the locker room so that they can use their urine color to determine how well they are hydrated. The urine color chart also uses numbers, whereby urine colors 1, 2 and 3 represent someone who is adequately hydrated, and 6, 7 and 8 represent someone who is dehydrated (Armstrong, 2000). Be sure to inform your athletes that taking a multi-vitamin may cause their urine to be darker; if this is the case, you should still be able to see differences in urine color before and after exercise, but you should incorporate other methods of determining hydration status. The urine color chart can be found on the back cover of Armstrong's Performing in Extreme Environments (Armstrong, 2000).

Urine-specific Gravity:

Urine-specific gravity is another means of determining a person's hydration status. Urine-specific gravity is a measure of urine concentration and can be measured using a clinical refractometer. This device costs between $60 and $400; however, one of the inexpensive ones will do just fine. If your athletic trainer is comfortable measuring urine-specific gravity, taking pre- and post-exercise measures would be another means of determining your athletes' hydration status. A hydrated athlete's urine-specific gravity would be less than 1.015; and athlete whose urine specific gravity is more than 1.025 is considered dehydrated. Urine-specific gravity is a good means of confirming whether the pre-exercise weight is a hydrated body weight in athletes who may be showing up to practice already dehydrated.

After Exercise:

Quenching thirst may not satisfy the body's need for fluid. Follow these guidelines to ensure adequate rehydration:

• Drink 1.5 litres of fluid for each kg of weight loss during exercise (or 3 cups of fluid for each pound).

• Monitor urine colour and amount. A small amount of dark urine is a sign of dehydration. Plenty of pale urine during the day is a sign of sufficient fluid intake.

Sport drinks:-

During activity:

• Plain, cool water is sufficient for events or workouts lasting one hour or less. Consume plenty of plain, cool water before, during and after exercise.

• Beverages containing about 4–8% carbohydrate are beneficial when intense physical activity lasts longer than one hour, as the carbohydrate they contain helps to maintain blood glucose levels. Check the labels of purchased sport drinks; look for approximately 40–80 g of carbohydrate (glucose, glucose polymer, maltodextrin and/or sucrose) per 1 litre of prepared beverage.

• If you plan to use a commercial sport drink during an event, try it first in training.

• Make your own sport drink: mix equal volumes of fruit juice and water, and add a small "pinch" of salt.

After activity:

• The carbohydrate-to-protein ratio and fluid in chocolate milk make it a great recovery beverage. It provides carbohydrate to refuel muscles, protein to help muscle repair and fluid & electrolytes for rehydration.

Eating at competition time

The Pre-Event Meal: It's important that meals eaten before competition are high in carbohydrate, low in fat and consumed 2–3 hours before the event. Fat takes longer to digest and may lead to discomfort if eaten close to strenuous activity. Consume fluid with the meal. Avoid gas forming or unfamiliar foods and alcohol. Fiber may also need to be limited since it takes longer to digest or moves too quickly through the digestive tract if you are nervous before an event. Both situations may lead to discomfort during an event.

Examples of pre-event meals:

• Cereal, milk, fruit, toast
• Yogurt, bagel, fruit
• Soup, sandwich with lean meat, milk
• Small portion of pasta with tomato sauce
• Toast, egg, milk

Choose smaller amounts of similar foods if there is less than 2–3 hours before the event.

Maintaining Your Training Diet Away From Home

• If travel time is longer than a few hours, pack snacks (sandwiches, bagels, milk, chocolate milk, yogurt, juice, fruit, cereal bars, cheese, crackers, peanut butter) rather than having to purchase whatever is available at gas stops.

Carry a full bottle of water.

• If meals are consumed en route, plan stops in advance to ensure that good food choices are made (choose a restaurant that serves pasta or thick crust pizza instead of fries & burgers). Do not consume alcohol prior to competing.

• If travelling by plane, drink plenty of water during the flight. Even a few hours in the air can cause significant dehydration. Take your own water bottle and pack your own snacks.

• Eat a good dinner the night before competition begins, or a substantial lunch if the first event is in the evening. A meal high in carbohydrates is ideal for energy (pasta's great). Consume lots of fluids.

• At restaurants, to ensure a balanced, high carbohydrate, lower fat meal, order extra rolls, rice, pasta, or baked potato (instead of fries), milk or juice, salad dressing on the side or toast lightly buttered. Go easy on the sauces or mayonnaise when ordering sandwiches or burgers. Avoid battered, deep-fried meat and fish.

• If competition or games take place throughout the day, athletes may not have the time or inclination to eat normal "meals." In this case, schedule snacks around events to maintain energy levels. Find out in advance what the canteen will sell or if stores and restaurants nearby will be open. If available food is not satisfactory, you may wish to take your own. Non-perishable items like juice, fruit, crackers, bagels, cheese even a jar of peanut butter and a loaf of bread help ensure the energy consumed also supplies the nutrients so important to good performance. Pack a cooler with milk, yogurt, and juice.

• Keep a large jug of water or sport drink with cups on hand for drinks during and between events. Consume water regularly during the day in addition to soups, milk, juice and other fluids.

• Eat supper after a full day of competition, even if tired. This helps ensure the body is well-fuelled for the next day of competition. Include carbohydrate foods and fluids.

• Athletes too nervous or upset to eat much during competition should know what they are able to tolerate (even if it's just soup, milk, sport drinks or juice). Be sure these choices are available. Meal replacement beverages (e.g. Boost™, Ensure™) may be useful.

The "formula" for a peak performance diet is no secret. Canada's Food Guide is the starting point to plan food choices.

• Choose at least the recommended number of Food Guide Servings suggested in each food group every day for basic healthy eating (see table below).
• Choose more servings of VEGETA BLES & FRUIT and GRAIN PRODUCTS to meet the higher energy needs associated with strenuous activity. These food groups provide the carbohydrate for muscle fuel.
• Choose a variety of foods from each group every day as no single food or food group supplies all the nutrients athletes and active individuals need. Remember that pills, powders or nutritional

RECOMMENDED NUMBER OF FOOD GUIDE SERVINGS PER DAY						
FOOD GROUP	**TEENS**		**adults**			
	female	**Male**	**female**	**male**	**female**	**male**
Vegetables & Fruit	7	8	7-8	8-10	7	7
Grain Products	6	7	6-7	8	6	7
Milk & Alternatives	3-4	3-4	2	2	3	3
Meat & Alternatives	2	3	2	3	2	3

<u>Summary</u>

Pre-exercise fuel

•3-4 hours before
•200-300 g of carbohydrates (Low glycaemic index type)
•Moderate in protein
•Lowin fibre and fat

More example meals:

- •Porridge/Weetabix with low fat milk and fruit juice or a piece of fruit
- •Pasta, chicken and veg
- •Granary/wholegrain bread with baked beans
- •Bagel with cream cheese/ pancake with honey and banana
- •Basmati rice and chicken
- •Fruit salads or a piece of fruit e.g. apple, banana with milk/yoghurt

Pre-exercise fuel

- 30-60minutes before exercise
- High carbohydrate (high GI food): 50 –100 grams
- Moderate protein
- Low fat and fiber

Examples:

Cereal bar, wholemeal bread/pitta and banana
Yogurt and berries/ 2 small oranges
Dried fruit
Wholemeal pitta, low fat cheese stick and small piece of fruit
Isotonic carbohydrate drink
Be sure to includewater** *with snacks*

Post- exercise glycogen recovery

- Rate of glycogen synthesis is greatest in the first hour after exercise.
- Complete refuelling of glycogen stores may take up to 20 hours post exercise
- Consume 1.2g carbohydrate / kg / hour for first 4 hours
- CHO intake after exhaustive exercise should average 50g / 2 hours

Post game recovery snack:

- Small snack of 4:1 ratio (CHO/protein)
- E.g. chocolate milk, Gre