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CHAPTER 9 NUTRITION AND THE DIGESTIVE SYSTEM

9.1 WHY WE NEED TO EAT p. 396

Nutrients are chemical substances that must be obtained by an organism from its environment to survive; nutrients provide the raw material for growth and repair and may be a source of energy.

Metabolism is the set of chemical reactions that occur in living organisms that are necessary to maintain life.

Everyone's metabolic rate is different. It can depend on five factors:

- Body size: The larger the body, the more energy it requires
- Physical activity: Muscle burns more energy than fat, so physical activity requires more energy
- Sex: Males are typically larger in size and have a greater proportion of muscle mass than females of the same size, age, and fitness level
- Age: Metabolic rate decreases with age (in part due to decreased physical activity and the loss of muscle mass)
- Hereditary factors: Some individual have a naturally high metabolic rate. In these individuals, chemical energy from food is very quickly converted into other forms of energy

In discussing energy and food, Calories are used. One calorie is equal to 4160 J, or the amount of energy to raise the temperature of 1 g of water by 1 degree Celsius.

9.2 WHAT AND HOW MUCH WE NEED TO EAT p. 400

There are four major molecules in living organisms: carbohydrates, lipids, proteins, and nucleic acids. These are all very large molecules, or *polymers* that are composed of building blocks, or *monomers*.

CARBOHYDRATES

Carbohydrates are the main source of energy for the human body.

Minimum elements: carbon, hydrogen, and oxygen

Monomers: A molecule that can be bonded to other molecules to produce a chain of molecules called a polymer. For carbohydrates, the monomers are the monosaccharides, which are

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ring-shaped structures consisting of a single sugar molecule like glucose.

Two main functions in life: Provide energy and regulating blood glucose

Glycogen is a polysaccharide that is made and stored in animals

Why does the long branching structure make sense for this molecule?

Since glycogen is broken down from the ends of the molecule, more branches translate to more ends, and thus more glucose that can be released at once.

Why is cellulose important to human diet?

Cellulose provides fibre, a necessary part of a healthy diet.

Recall hydrogen-bonding. Highlight the partially positive atoms on the molecule of glucose to the right.

LIPID

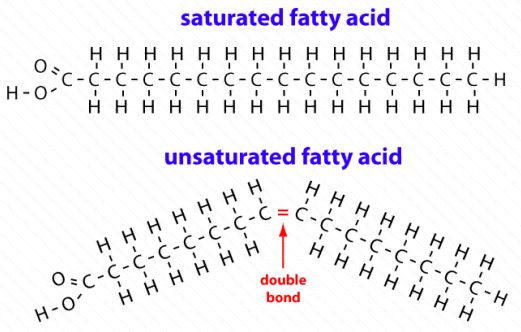
Functions:

- Provide a concentrated source of chemical energy
- Help in the absorption of vitamins
- A main component of cell membranes
- Insulation for the body

Triglyceride

A lipid composed of glycerol and three fatty acids that are bonded together

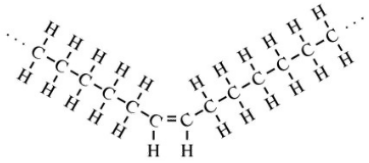
Lipids are classified as **saturated** or **unsaturated** based on the presence of single or double bonds. If a double bond is present in the fatty acid, it will not be *saturated* with hydrogen atoms. The presence of a double bond causes a kink in the molecule. The result is a lower melting point, thus are *liquid* at room temperature.

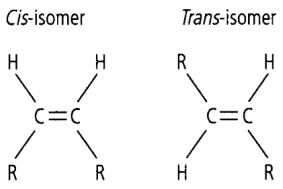


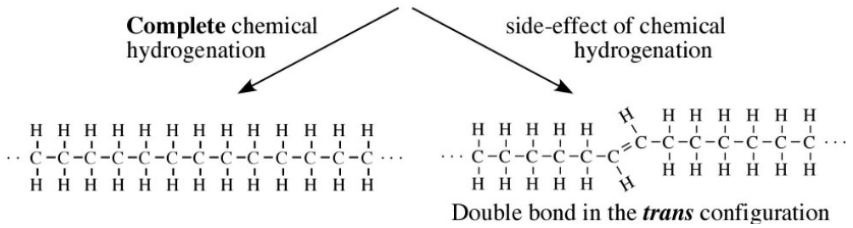
The cell membrane is composed mainly of phospholipids. What substances can diffuse through the membrane?

oxygen and carbon dioxide

Hydrogenation:







Double bond in the ***trans*** configuration

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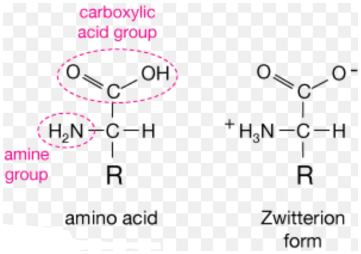
PROTEINS

Refer to table 1 to list the functions of proteins

Monomers: amino acids



WATER

Your body is made up of 55 - 60 % water. Water is necessary for all life.

VITAMINS AND MINERALS

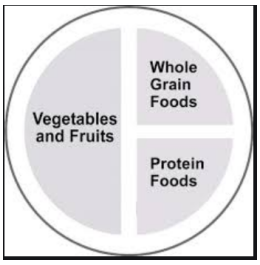
A vitamin is an organic molecule (molecule with C and H)

Differentiate between fat soluble and water soluble vitamins in terms of storage.

Fat-soluble vitamins: Will be stored in the body's fatty tissues for future use

Water-soluble vitamins: Cannot be stored in the body and excess quantities are readily excreted in urine

CANADA FOOD GUIDE FOR HEALTHY EATING



In 2019, Canada created a new guide based on the latest science to replace the guide of 2007. Instead of focusing on the portions, the 2019 guide has given way to the plate.

9.3 INTRODUCTIN DIGESTION p. 406

Four Steps in Digestion:

Ingestion: The taking in of nutrients

Digestion: The physical and chemical breakdown of complex food molecules into smaller molecules

Absorption: The transfer of digested nutrients from the digestive system to the bloodstream

Egestion: The removal of waste food materials from the body

Specialized Digestive Systems

Recall, the cnidarians have a gastrovascular cavity and lack *a second opening* (cnidarians use a single opening leading to their gastrovascular cavity). Such digestive systems with only one cavity are called *incomplete digestive systems.* Describe their digestive system.

These organisms have a digestive sac with a single opening into a gastrovascular cavity. This opening serves both as an entrance for food and as an exit for waste minerals. In some cases, the opening to the gastrovascular is taken directly into the gastrovascular cavity and is broken down by chemicals that are released into the cavity. The nutrients are then absorbed by the cells that line the gastrovascular cavity, and digestion continues inside the cells. Nutrients diffuse from these cells to all other cells of the body.

A *complete digestive system* has two openings - one for food intake and another for waste elimination. Humans have a complete digestive system.

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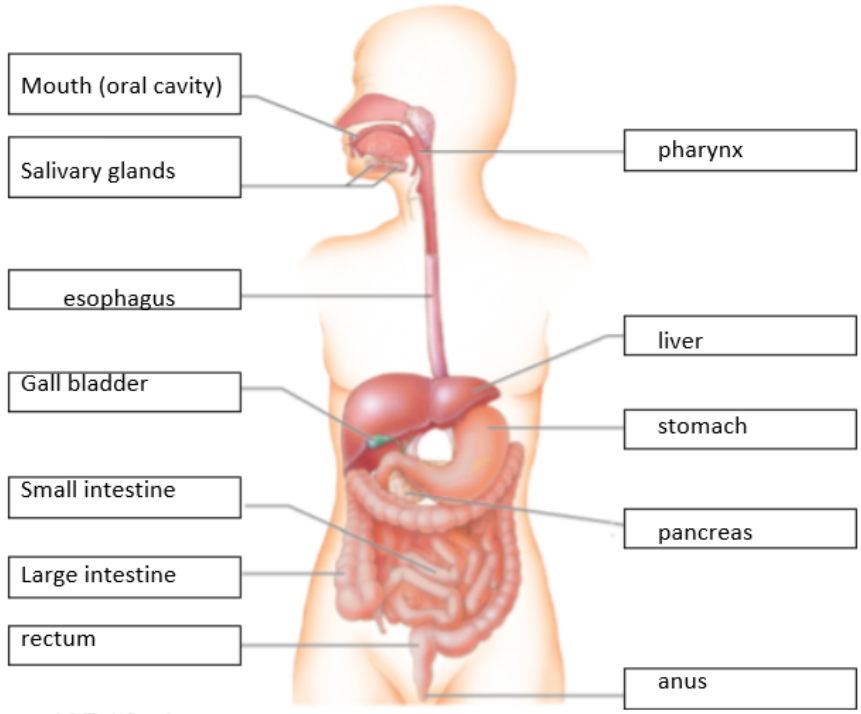

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3. A complete digestive system can hold significantly more food
4. The circulatory system also carries chemical signals from your endocrine system to control the speed of digestion

9.4 DIGESTION IN THE MOUTH AND STOMACH p. 408

Physical and Chemical Digestion in the Mouth

Differentiate between physical and chemical digestion and explain the importance of the two.

Physical digestion is how food is physically broken down into smaller pieces by the teeth or the muscles in your stomach. Chemical digestion is how certain compounds like starch or complex carbohydrates, are broken down into smaller disaccharides.

9.5 DIGESTION IN THE SMALL AND LARGE INTESTINES p. 412

Structure and Function of the Small Intestine

The function of the small intestine is to digest and absorb most of the nutrients in your food.

It is considered small due to its diameter of 2.5cm compared to the diameter of the large intestine at 7.6cm. The length of the small intestine is much larger, 7m compared to 1.5m. The small intestine is divided into three regions moving from the stomach: the duodenum, the jejunum, and the ilium. The duodenum's job is to add most enzymes and begin the digestion, and the ilium is mainly to absorb the majority of nutrients.

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In the absorption of nutrients, diffusion occurs. There are three ways to increase the rate of diffusion:

1. increase surface area,
2. decrease the distance necessary for diffusion, and
3. increase the concentration gradient for the molecules that are diffusing.

Discuss how these three are achieved in the design of the small intestine.

1.Villi, small, thin hairs from which nutrients can be absorbed increases the available surface area. Furthermore, there are even smaller, microscopic projections of the cell membrane called microvilli.

2.The small intestine's small diameter (2.5cm) decreases the distance necessary for diffusion

3. The mucosa of the small intestine produces an electrochemical gradient of sodium.

Connective tissue, mesentry keeps the intestines in place and not knotting, and it carries the blood vessels and nerves to the digestive tract.

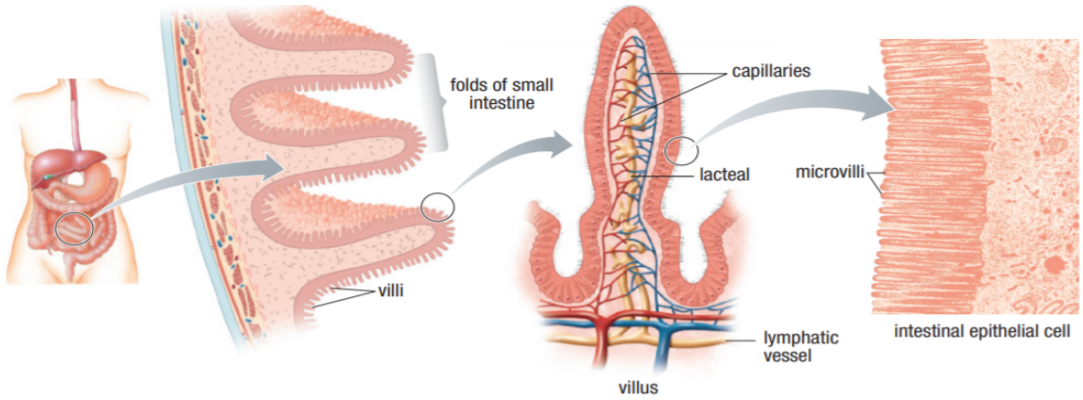

Figure 3 The villi and microvilli greatly increase the surface area available for absorption of nutrients.

Accessory Organs – food does not enter these organs but they play a role in the digestive system

Pancreas:

A long, flat gland nestled between the stomach and the duodenum.

What triggers the release of the hormone, CCK?

Special cells in the mucosa of the duodenum

Why is CCK a hormone?

Hormones are regulatory substances that are transported in tissue fluids to stimulate specific cells or tissues into action. CCK signals the pancreas to secrete a variety of substances, including ones that control the pH of the intestine and enzymes that are needed for lipid, carbohydrate, and protein digestion,

Discuss the role of the hormone, secretin

Secretin stimulates the pancreas to release bicarbonate ions to neutralize the acidic chyme and raise the the pH from about pH 2.5 to pH 9.0. It also stimulates the liver to make more bile and encourages the pancreas to secrete lipid and protein enzymes.

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The pancreas releases enzymes to digest carbohydrates (carbohydrases), lipids (lipases), proteins (proteases) and nucleic acids (nucleases).

Liver:

The liver is the largest internal organ of the body, located directly underneath the diaphragm. The liver performs a variety of important functions, specifically to produce and secrete bile.

<u>Transportation into the Cell</u>

What types of molecule can pass through the cell membrane?

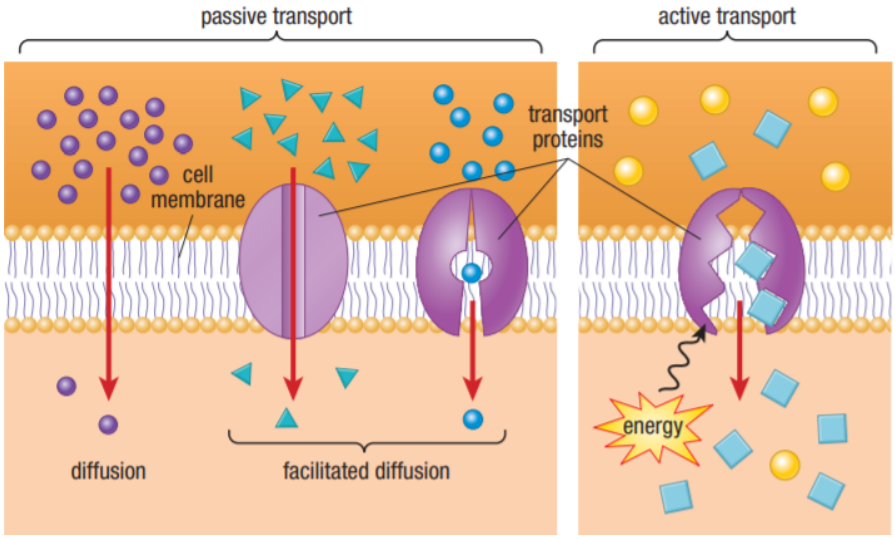
Small amino acids, water molecules,

These molecules can passively cross the membrane, meaning

they can move across the membrane without the use of energy from the cell. This includes diffusion, osmosis, and facilitated diffusion.

Facilitative transport is the diffusion of molecules across a membrane through transport proteins.

Transport proteins, like enzymes are specific to certain substances, and they bind these substances, causing a change in the concentration gradient that results in the movement of substances across the cell membrane.



Active transport is the process by which materials are moved across a cell membrane, from an area of lower concentration of an area of a higher concentration, using energy provided by the cell.