unit 5. nutrition

ACTIVITY 5-1. NUTRIENTS

Living organisms require a constant supply of nutrients of various types. These nutrients must be obtained from certain types of foods.

**proteins**

Every type of organism synthesizes its own unique proteins. Proteins in food are a source of amino acids. The amino acids are then synthesized into the proteins of that organism. These include enzymes, hormones, pigments, etc. Good sources of protein are fish, lean meat, milk, cheese, eggs, and cereal.

**carbohydrates**

Carbohydrates, along with fats, supply the energy needs of the body. Carbohydrates are broken down to glucose by the digestive processes, and the glucose is used for energy. If the carbohydrates taken in in the diet are not needed for energy, they are stored in the body as glycogen or fat. Good sources of carbohydrates include bread, potatoes, and ice cream.

**fats**

Fats, like carbohydrates, supply the energy needs of the body. They are also structural components of cell and other membranes. Dietary fats not needed for energy are stored as glycogen or fat. Good sources of fats include butter and oils.

**vitamins**

Vitamins are organic compounds that are needed by an organism in very small quantities. A vitamin cannot be synthesized by the organism. It must be supplied in the diet. Many vitamins act as coenzymes, without which the enzymes involved cannot function properly. Good sources of vitamins are green and yellow vegetables, fruits, and meat.

**minerals**

Minerals are inorganic compounds that must be supplied by the diet. They include salts of calcium, phosphorus, magnesium, and iron, as well as iodine and sodium chloride. Good sources of minerals include milk, meat, and table salt.

**water**

Water makes up a large percentage of the body weight. It is the solvent in which many substances in the body are dissolved.

**Questions**

1. What are essential amino acids?

   Amino acids required in a person's diet. Humans can't make these amino acids.

2. Name three vitamin-deficiency diseases and give the vitamin involved in each.

<table>
<thead>
<tr>
<th>DISEASE</th>
<th>VITAMINS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin Disease</td>
<td>Lack Vitamin A</td>
</tr>
<tr>
<td>Hemophilia</td>
<td>Lack Vitamin K</td>
</tr>
<tr>
<td>Scurvy (rash)</td>
<td>Lack Vitamin C</td>
</tr>
<tr>
<td>Scurvy (bone breakdown)</td>
<td>Lack Vitamin D</td>
</tr>
</tbody>
</table>
3. Fill in the missing information in the chart below.

<table>
<thead>
<tr>
<th>TYPE OF NUTRIENT</th>
<th>USE</th>
<th>SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proteins</td>
<td>Repair of skin and muscles. Enzymes, pigments, hormones.</td>
<td>Eggs, lean meat, fish, milk, cheese, cereals</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>Source of energy</td>
<td>Whole grains, milk, fruit</td>
</tr>
<tr>
<td>Lipids</td>
<td>Use in energy storage and form of energy, insulation</td>
<td>Cheese, milk, butter, peanuts, oils, meats</td>
</tr>
<tr>
<td>Calcium and phosphorus</td>
<td>Proper formation of bones and teeth</td>
<td>Dairy product, milk, cheese, yogurt</td>
</tr>
<tr>
<td>Iron</td>
<td>Hemoglobin (Hem) in RBC</td>
<td>Liver, raisins, meats, eggs</td>
</tr>
<tr>
<td>Iodine</td>
<td>Used by thyroid gland in thyroxin</td>
<td>Seafood, Table salt, supplemented</td>
</tr>
<tr>
<td>Sodium</td>
<td>Balance water, nerve function</td>
<td>Table salt</td>
</tr>
<tr>
<td>Water</td>
<td>Major component of cell cytoplasm, solvent for chemical reactions</td>
<td>Tap water, Bottles, Indirectly from fruit, lettuce</td>
</tr>
<tr>
<td>Vitamins</td>
<td>Coenzymes, allow enzymes to function</td>
<td>Green and yellow vegetables, fruits, fish, milk, eggs, cereal</td>
</tr>
</tbody>
</table>

**Ingestion**

The nutritional process begins with *ingestion*—the taking of food into the body. Some protists and all animals must take in food from the environment to obtain the nutrients necessary for their life processes.

**Questions**

1. Why must heterotrophic organisms ingest food? *They can’t make their own food and must obtain nutrients necessary for their life processes.*

2. Green plants and other organisms that can synthesize their own food are called *Autotroph*.
**digestion**

Food entering the body is made up of large, complex molecules. Digestion is the process by which these large molecules are broken down into smaller, simpler molecules that can be absorbed and used by the cells of the body. Food is broken down first mechanically and then chemically. The mechanical breakdown is accomplished by chewing in the mouth and by the movements of the stomach. Chemical breakdown is accomplished by digestive enzymes, each of which acts on a specific type of nutrient.

**Questions**

1. What is accomplished by mechanical digestion?
   - Breakdown of food into simpler parts.

2. The three different types of teeth in humans are ____________, ____________, and ____________.

3. Why must food be digested?
   - Must be broken down into simpler molecules that can be absorbed.

4. How is the chemical breakdown of food accomplished?
   - Enzymes

5. What is assimilation?
   - To make molecules a part of the body.

To answer questions 6—9, refer to the following equation:

\[ C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{Maltase}} 2C_6H_{12}O_6 \]

6. The type of reaction shown in the equation is ____________.

7. The enzyme involved in the reaction is ____________.

8. The compound \( C_{12}H_{22}O_{11} \) is ____________.

9. The end product of the reaction is ____________.

**egestion**

Once food has been digested and the nutrients absorbed, the remaining material must be removed from the body. Bacteria in the digestive tract continue to break down those wastes from which they can extract nutrients. About one-third of the waste leaving the body is bacterial cells. The waste is called feces. The process by which feces leave the body is called egestion. Excretion, on the other hand, removes the wastes of metabolism and should not be confused with egestion.

**Question**

What is the difference between egestion and excretion?

- Eliminate solid waste
- Getting rid of metabolic waste
In amebas, paramecia, and other heterotrophic protozoa, food is taken into the organism and then broken down within the cell. Amebas feed on algae and on other protozoa. They capture their prey by engulfing it with pseudopods. The prey is incorporated into the ameba, where it is surrounded by a part of the cell membrane, forming a food vacuole. Digestive enzymes from the cytoplasm are secreted into the food vacuole and carry out the digestion of the prey.

In the paramecium, long cilia lining the oral groove sweep bacteria and other particles of food down the oral groove and into the gullet. Food vacuoles form at the bottom of the gullet. The food is digested within the food vacuoles.

Questions

1. On the diagram of the paramecium below, label the following structures: cilia, oral groove, gullet, food vacuole, cytoplasm, pellicle, micronucleus, and macronucleus.

2. What is the difference between intracellular and extracellular digestion?

3. Food particles are swept into the oral groove of the paramecium by the beating of

   cilia

4. In both the ameba and paramecium digestion takes place within the cell.

The body of the hydra is like a hollow sac with one opening—the mouth—at the top. Surrounding the mouth are tentacles that contain stinging cells (cnidoblasts). Poison on threads (nematocysts) shot from these cells paralyzes the prey, which is then drawn into the mouth of the hydra by the tentacles. Cells lining the digestive cavity secrete enzymes onto the food, breaking it down into small pieces. These particles enter the endoderm cells for further digestion. Waste materials are egested through the mouth.
Questions

1. Label the following structures on the diagrams below: mouth, digestive cavity, endoderm, mesoglea, ectoderm, tentacle, nematocyst, and bud.

2. The hydra paralyzes its prey with its nematocyst. The prey is drawn into the mouth by the mouth.

3. Is digestion in the hydra intracellular or extracellular? Explain your answer.

   Both, extracellular in the digestive cavity and intracellular within the cell.

   earthworm Earthworms feed on the organic matter in soil. Soil is taken in through the mouth. Contractions of the muscular pharynx push the food through the esophagus into the thin-walled crop, where it is stored temporarily. Material is gradually released into the gizzard, where it is ground into smaller particles. The food then passes into the intestine, where it is digested by enzymes and absorbed into the blood, which carries it to the cells of the animal. Wastes are egested through the anus. The earthworm has a tube-within-a-tube body plan in which the digestive tract is the inner tube.

Questions

1. Label the parts indicated on the diagram of the earthworm below.
2. Is digestion in the earthworm intracellular or extracellular?

Extracellular digestion in the canal of the earthworm.

3. Fill in the functions of the digestive organs listed in the charts below.

<table>
<thead>
<tr>
<th>STRUCTURE</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth</td>
<td>take in food</td>
</tr>
<tr>
<td>Pharynx</td>
<td>push food into esophagus</td>
</tr>
<tr>
<td>Esophagus</td>
<td>tube leading to crop</td>
</tr>
<tr>
<td>Crop</td>
<td>stores food</td>
</tr>
<tr>
<td>Gizzard</td>
<td>grinds food</td>
</tr>
<tr>
<td>Intestine</td>
<td>digests food and absorbs food.</td>
</tr>
</tbody>
</table>

The grasshopper, like the earthworm, has a tube-within-a-tube body plan. Food is ingested and moistened in the mouth. It then passes through the esophagus to the crop, where it is stored temporarily. From the crop, it passes into the gizzard, where it is ground and shredded. Food next enters the stomach, where it is mixed with enzymes from the digestive glands. Digestion and absorption occur in the stomach. Water is reabsorbed in the intestines and rectum. Waste materials are temporarily stored in the rectum and then egested through the anus.

Questions

1. Label the parts indicated in the drawing below.

2. In the grasshopper, digestion and absorption occur in the ______________.
ACTIVITY 5-3. HUMAN DIGESTIVE SYSTEM

The human body plan is basically a tube-within-a-tube design, with the digestive tract formed by the inner tube. There are specialized organs along the length of the digestive tract that carry out the breakdown of food.

Food enters the digestive system through the mouth. In the mouth it is chewed and broken down by the teeth into smaller pieces. It is also mixed with saliva, which contains the enzyme ptyalin. Ptyalin digests some of the starch to maltose. The saliva also serves to moisten the food and make it easier to swallow.

From the mouth, food passes to the pharynx, or throat, and from there into the esophagus. The breakdown of starch that begins in the mouth continues in the pharynx and esophagus, but no other digestive changes occur in this portion of the digestive tract.

Questions
1. What mechanical changes in the food take place in the mouth?
   
   2. What chemical changes in food take place in the mouth?
   
   3. What structures produce saliva?
   
   4. What digestive enzyme is present in saliva and what is its function?
   
   5. Chew a piece of cracker or pretzel thoroughly and hold it in your mouth for a minute or two. What taste change occurs? Why?
   
   6. How is food moved down the esophagus?

From the esophagus, food passes into the stomach, a muscular sac with sphincter muscles at either end. The cardiac sphincter controls the passage of food between the esophagus and the stomach, and the pyloric sphincter controls the passage of food from the stomach into the small intestine.

The inner lining of the stomach contains tiny gastric glands, which secrete gastric juice. Gastric juice contains hydrochloric acid and the enzyme pepsin, which begins the digestion of protein. Contraction of the muscles of the stomach wall churn the food around and mix it with gastric juice. Food is retained in the stomach until it is completely liquefied. When it reaches this condition, it passes through the pyloric sphincter into the small intestine.
Questions

1. What structures control the passage of food into and out of the stomach?
   *Sphincter (muscle sac)*

2. What chemical changes in the food occur in the stomach?
   *Digestion of protein*

3. The enzyme secreted by the gastric glands is *pepsin*.

4. How does the hydrochloric acid of the stomach help protect the body against disease?
   *It kills bacteria in food.*

5. What condition arises when the gastric juice begins to digest the walls of the stomach itself?
   *Ulcer*

6. In what condition is the food mass when it leaves the stomach?
   *Liquified (chyme)*

**small intestine**
From the stomach, food passes into the *small intestine*, a tube 7 to 8 meters in length and about 2½ centimeters in diameter. It is in the small intestine that most digestion takes place, and the end products are absorbed into the circulatory system. The walls of the small intestine are in folds, and the lining is in the form of fingerlike projections called *villi*. Both the folding and the villi greatly increase the surface area for absorption.

Secretions from the liver and from the pancreas act in the small intestine. *Bile* from the liver emulsifies fats into tiny globules, which present a larger surface area for enzyme action. *Pancreatic juice* from the pancreas contains a number of enzymes; some digest proteins, some starches, and some fats. Glands in the walls of the small intestine also produce protein-, starch-, and fat-digesting enzymes. The end products of digestion—fatty acids, amino acids, and simple sugars—are absorbed into the capillaries and *lacteals* (lymphatic vessels) of the villi and carried throughout the body. Wastes and water pass from the small intestine to the large intestine.

Questions

1. What are the three parts of the small intestine?
   *duodenum, jejunum, ileum*

2. What happens to proteins in the small intestine, and how are these changes brought about?
   *Broke down into amino acids*.
3. What happens to fats in the small intestine, and how are these changes brought about?

4. What happens to starches in the small intestine, and how are these changes brought about?

5. Where is bile produced, and how does it reach the small intestine?

6. How does bile aid in the digestion of fats?

7. The drawing below shows a cross section of a villus. Label the parts indicated.

8. What happens to simple sugars and amino acids after they are absorbed by the cells lining the small intestine?

large intestine, rectum, and anus

From the small intestine, food enters the large intestine, a tube about 2 meters long and 5 centimeters in diameter. No digestion occurs in the large intestine. However, most of the water present in the digestive wastes is reabsorbed in the large intestine. The wastes pass into the rectum, where they are stored temporarily. Eventually, they are egested through the anus.

Questions

1. What is the function of the large intestine?

2. What types of organisms are found in the large intestine, and what functions do they perform?
3. Label the parts indicated in the drawing of the human digestive system above.

**PUZZLE: UNIT 5**

The following twenty terms are hidden in the square below. Find them and circle them. The words may be forward, backward, vertical, horizontal, or diagonal.

appendix    large intestine   R N M E O L A X I D N E P P A B E C
bile        liver           D S A L T V Y B O A P D B C J H S F
carbohydrates   minerals   Q M P D O M I N E R A L S I M G O L
digestion   pancreas        R A S W I N V T O A C U Z N E S P K
egestion     salt           S L K N J G H T F I Y E B G X T H D
enzyme      small intestine E L O B I L E Q P V S R E E V A A E
esophagus    starch         T I M B L I A S T G E S B S C R G O
fats         stomach        A N B I N C E D T H T F I T G C U J

gallbladder  vitamin       R T K S T A F O L I P N Q I R H S S
ingestion    water         D E T W V U S M O X O Z Y O A C B A
                         Y S D G E F T N I H J N E N Z Y M E
                         H T K S M L O O N Q P X U V R T S R
                         O I V I T A M I N S T W Z E B Y C C
                         B N I A W G A L L B L A D D E R D N
                         R E O D X B C E W R A T Z L D E I A
                         A U M D X L H T X V Q E M P J V H P
                         C I B O T U Z C U F S R O N K I C P
                         L A R G E I N T E S T I N E A L G B
REVIEW EXERCISES: UNIT 5

A. Fill in the blanks in the statements below.

1. Proteins in food are a source of **amino acids** for the body.
2. Good sources of proteins are **meat**, **fish**, and **eggs**.
3. Most of the energy needs of the body are supplied by **carbohydrates** (e.g., **sugar**, **starch**).
4. Energy needs are also supplied by **protein** and **fat**.
5. Organic compounds that must be supplied by the diet are called **vitamins**. Many of these substances act as **cofactor**.
6. Inorganic compounds that must be supplied by the diet are **minerals**.
7. A large percentage of the body weight consists of **water**.
8. The taking of food into the body is **ingestion**.
9. The breakdown of complex food molecules into simpler molecules that can be absorbed and used by the cells is called **digestion**.
10. Sharp, pointed teeth used for tearing are called **cusps**.
11. Teeth with knife-like edges used for cutting and biting are called **incisors**.
12. Teeth with rough, broad surfaces for grinding are called **molars**.
13. The elimination of food wastes from the body is called **excretion**.
14. In the ameba, digestion occurs within a **cell**.
15. In the earthworm, enzymatic digestion and absorption take place in the **intestine**.
16. In the grasshopper, digestion and absorption take place in the **stomach**.
17. In humans, digestion begins in the **mouth**, where the enzyme **salivary amylase** acts on **carbohydrates**.
18. The digestion of protein begins in the **stomach**, with the action of the enzyme **pepsin**.
19. Most digestion and absorption take place in the **intestine**.
20. The pancreas produces **pancreatic enzymes**, which passes into the small intestine through the **pancreatic duct**.
21. Bile is produced in the **liver** and stored temporarily in the **gall bladder**. It is carried to the small intestine through the **bile duct**.
22. In the walls of the small intestine are **villi** and **glands**, which secrete enzymes that act in the digestion of **protein**, **carbohydrate**, and **lipid**.
23. From the small intestine, food passes into the **villi**, where reabsorption of **end products** occurs.
24. The end products of digestion are **carbohydrates**, **proteins**, and **lipids**.
25. Enzymes that digest proteins are called **protein-digesting**; enzymes that digest starch are called **carbohydrate-digesting**; enzymes that digest fats are called **fat-digesting**.
B. In the answer space for each question, write the letter of the choice that best completes the statement.

1. Which of the following nutrients cannot be used as a source of energy for the cell?
   (a) proteins  (b) carbohydrates  (c) fats  (d) water

2. Many vitamins act as (a) enzymes  (b) coenzymes  (c) nucleic acids  (d) energy sources

3. Nutrients not needed for energy may be stored in the body in the form of fat and
   (a) glycogen  (b) starch  (c) cellulose  (d) maltose

4. An ameba ingests its prey by (a) cyclosis  (b) pinocytosis  (c) osmosis  (d) phagocytosis

5. Liquefied food that passes from the stomach into the small intestine is called
   (a) gastric juice  (b) intestinal juice  (c) chyme  (d) hydrochloric acid

6. The passage of food from the stomach into the small intestine is controlled by the
   (a) cardiac sphincter  (b) diaphragm  (c) pyloric sphincter  (d) esophagus

7. The fingerlike projections of the lining of the small intestine are called (a) capillaries
   (b) lacteals  (c) villi  (d) lymphatic vessels

8. In the small intestine fatty acids are absorbed into (a) arteries  (b) veins  (c) capillaries
   (d) lacteals

9. In the small intestine simple sugars and amino acids are absorbed into (a) arteries
   (b) veins  (c) capillaries  (d) lacteals

10. Simple sugars and amino acids absorbed in the small intestine pass directly to the
    (a) heart  (b) liver  (c) kidneys  (d) pancreas

C. Fill in the blanks in the following table.

<table>
<thead>
<tr>
<th>SECRERATION</th>
<th>PRODUCED BY</th>
<th>ENZYMES</th>
<th>ACTS ON</th>
<th>BREAKDOWN PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saliva</td>
<td>salivary glands</td>
<td>Ptyalin</td>
<td>starch</td>
<td>maltose</td>
</tr>
<tr>
<td>Gastric juice</td>
<td>gastric glands</td>
<td>Pepsin</td>
<td>protein</td>
<td>peptides</td>
</tr>
<tr>
<td>Hydrochloric acid</td>
<td>gastric glands</td>
<td>(none)</td>
<td>enzyme</td>
<td>peptides</td>
</tr>
<tr>
<td>Bile</td>
<td>liver</td>
<td>(none)</td>
<td>fat</td>
<td>fat droplets</td>
</tr>
<tr>
<td>Pancreatic juice</td>
<td>pancreas</td>
<td>Trypsin</td>
<td>starch</td>
<td>maltose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Amylase</td>
<td>peptides</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lipase</td>
<td>fat</td>
<td>glycerol + fatty acids</td>
</tr>
<tr>
<td>Intestinal juice</td>
<td>intestine</td>
<td>Peptidase</td>
<td>dipeptides</td>
<td>amino acids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lactase</td>
<td>lactose</td>
<td>glucose + galactose</td>
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<td>Maltase</td>
<td>maltose</td>
<td>glucose + glucose</td>
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<tr>
<td></td>
<td></td>
<td>Sucrase</td>
<td>sucrose</td>
<td>glucose + fructose</td>
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