**3.1**

**Understandings**

1. Many human body systems work to create, process, and distribute the body’s main resources – food, water, and oxygen.

**Knowledge and Skills**

It is expected that students will:

* List and describe the human body systems that create, process, and distribute food, water, and oxygen.
* Recognize that factors unique to the person, such as age, weight, and overall health affect the body’s ability to utilize biological resources and maintain homeostasis.
* Recognize that factors in the environment, such as climate or temperature, affect the body’s ability to utilize biological resources and maintain homeostasis.
* Estimate how long the human body can last without food, without water, and without oxygen.

**Essential Questions**

1. What are the resources the human body needs to survive?
2. What role does food play in the human body?
3. What role does water play in the human body?
4. What role does oxygen play in the human body?
5. What human body systems work to create, process or distribute the body’s main power sources?
6. How do personal factors and environmental factors impact the body’s ability to survive without air, food or water?

**3.2**

**Understandings**

1. Enzymes are usually proteins and act as catalysts which speed up chemical reactions in the human body. (Optional)
2. The digestive system consists of the gastrointestinal tract and the accessory digestive organs which function together to chemically and mechanically digest food, absorb water and nutrients, and remove wastes.
3. Metabolism, the sum of all the chemical reactions that occur within the body, is required to maintain homeostasis.
4. When a process in the body requires energy, ATP is broken down to liberate energy stored in its chemical bonds.

**Knowledge and Skills**

It is expected that students will:

* Recognize that enzymes are designed to be highly specific, and the structure of the enzyme’s active site determines the substrate it acts upon. (Optional)
* Recognize that factors such as temperature, pH, and enzyme and substrate concentration affect the rate of an enzyme-catalyzed reaction.
* List specific enzymes that digest carbohydrates, fats, and proteins at sites along the digestive tract.
* Describe the structure and function of the organs in the digestive system.
* Explain how energy is stored in ATP.
* Model the interaction between enzymes and their corresponding substrates. (Optional)
* Outline what happens to a bite of food as it travels down the digestive tract.
* Design a laboratory experiment investigating the impact that environmental changes can have on enzyme function and analyze the results.
* Analyze energy inputs and outputs in the body to assess overall health.

**Essential Questions**

1. What are the functions of the digestive system?
2. How does the structure of each organ in the digestive system relate to its function?
3. How does the digestive system assist in maintaining the water balance in the body?
4. How do enzymes assist the process of digestion?
5. How do factors such as temperature, pH and concentration of enzyme or substrate affect the rate of enzyme-catalyzed reactions?
6. What are BMI and BMR?
7. How can BMI and BMR help assess healthy diet and weight?
8. What are the health risks associated with being overweight or underweight?
9. What body systems are affected when a person is overweight or underweight?
10. What is ATP?
11. How is energy released from ATP and used to do work in the body?
12. How do the air you breathe and the food you eat relate directly to the production of energy in the form of ATP?

**3.3**

**Understandings**

1. The structure of the lungs and the close association between the lungs and the vessels of the cardiovascular system facilitate the transport of oxygen to all cells in the body.
2. During normal breathing, a healthy individual is using only a small percentage of the total capacity of his or her lungs.
3. The amount of oxygen required by the cells in a body depends on the activity level of the cells.

**Knowledge and Skills**

It is expected that students will:

* Describe the structure of the respiratory system, especially the lungs, and the basic mechanics of breathing.
* Explain how the structure of the lungs facilitates the exchange of oxygen and carbon dioxide between air and the body.
* Recognize that during and after exercise the concentration of oxygen removed from the air is increased compared to when the individual is at rest.
* Use sensors to measure lung capacity and oxygen capture.
* Analyze data collected using a spirometer to determine tidal volume, vital capacity, and minute volume.
* Analyze data collected using an oxygen sensor to determine the change in oxygen concentration of inhaled air versus exhaled air.

**Essential Questions**

1. Why do we need oxygen?
2. How do we breathe?
3. How does the oxygen we inhale get to all of our cells?
4. How much air do we normally breathe in and out?
5. How much air can our lungs actually hold?
6. How do we measure lung capacity?
7. How efficient are our lungs at capturing oxygen from the air?
8. Why might some people be more efficient at capturing oxygen than others?
9. How do we measure oxygen capture?
10. What are examples of diseases or medical conditions that would affect breathing and/or oxygen capture?
11. How does a respiratory therapist assist patients with ventilation and utilization of oxygen?
12. What are the components of an effective resume?

**3.4**

**Understandings**

1. The urinary system helps maintain homeostasis in the body by filtering the blood, regulating water and electrolyte concentration, maintaining the pH balance of the blood, and ridding the body of liquid waste called urine.
2. Through filtration, reabsorption, and secretion, the nephron assists in maintaining normal values of water, electrolytes, pH, and blood pressure in the body.
3. The hormones aldosterone and antidiuretic hormone (ADH) both help regulate the amount of water in the body.
4. Malfunctions in the body can be identified through noticeable changes in the composition of urine, and these changes can be detected through urinalysis.

**Knowledge and Skills**

It is expected that students will:

* Describe the structure and function of the human urinary system.
* Describe how the structure of the kidney relates to its function in the body.
* Recognize that the nephron is the structural and functional unit of the kidney.
* Describe the connections between urine and blood and the exchange of ions and fluids that occurs across the nephron.
* Illustrate the path of urine formation through the kidney.
* Estimate the filtration rate of the glomerulus and relate mathematical estimates to the function of the human kidney.
* Analyze urinalysis results to diagnose disease and dysfunction in human body systems.

**Essential Questions**

1. What are the functions of the urinary system?
2. What are the major organs of the urinary system?
3. What is the general structure of the kidney and how does this structure relate to kidney function?
4. How does the kidney form urine?
5. What is the relationship between blood and urine?
6. What is the function of the nephron?
7. How do filtration, secretion and reabsorption in the nephron help maintain a fluid and electrolyte balance in the body?
8. How do the hormones ADH and aldosterone affect the nephron and the body’s overall water balance?
9. What is urinalysis?
10. How can the composition of urine provide clues about problems in other human body systems?

Key Terms:

|  |  |
| --- | --- |
| **Abdominal cavity** | The body cavity in mammals that primarily houses parts of the digestive, excretory, and reproductive systems. It is separated from the thoracic cavity by the diaphragm. |
| **Adenosine triphosphate (ATP)** | An adenine-containing nucleoside triphosphate that releases free energy when its phosphate bonds are hydrolyzed. This energy is used to drive endergonic reactions in the cell. |
| **Adrenal glands** | Hormone-producing glands located superior to the kidneys; each consists of a medulla and a cortex. |
| **Aldosterone** | A mineralcortocoid produced by the adrenal cortex that promotes sodium and water reabsorption by the kidneys and potassium excretion in urine. |
| **Alveoli** | Terminal air sacs that constitute the gas exchange surface of the lungs. |
| **Anabolism** | Synthetic, energy-requiring reactions whereby small molecules are built up into larger ones. |
| **Antidiuretic Hormone (ADH)** | Hormone produced by the neurosecretory cells in the hypothalamus that stimulates water reabsorption from kidney tubule cells into the blood and vasoconstriction of arterioles. |
| **Basal metabolic rate (BMR)** | The rate at which heat is given off by an organism at complete rest. |
| **Body mass index (BMI)** | A measure of body fat that is the ratio of the weight of the body in kilograms to the square of its height in meters. |
| **Bolus** | A soft mass of chewed food. |
| **Bronchi** | Pair of breathing tubes that branch from the trachea into the lungs. |
| **Calorie** | The amount of heat energy required to raise the temperature of 1 g of water by 1°C. The Calorie (with a capital C), usually used to indicate the energy content of food, is a kilocalorie. |
| **Catabolism** | Chemical reactions that break down complex organic compounds into simple ones, with the net release of energy. |
| **Catalyst** | A substance that enables a chemical reaction to proceed under different conditions (as at a lower temperature) than otherwise possible. |
| **Diaphragm** | A sheet of muscle that forms the bottom wall of the thoracic cavity in mammals; active in ventilating the lungs. |
| **Digestion** | The process of making food absorbable by mechanically and enzymatically breaking it down into simpler chemical compounds in the alimentary canal. |
| **Digestive system** | The bodily system concerned with the ingestion, digestion, and absorption of food. |
| **Enzyme** | A protein serving as a catalyst, a chemical agent that changes the rate of reaction without being consumed by the reaction. |
| **Esophagus** | A muscular tube that in adult humans is about nine inches (23 centimeters) long and passes from the pharynx down the neck between the trachea and the spinal column and behind the left bronchus where it pierces the diaphragm slightly to the left of the middle line and joins the cardiac end of the stomach. |
| **Excretion** | The disposal of nitrogen-containing waste products of metabolism. |
| **Filtration** | In the vertebrate kidney, the extraction of water and small solutes, including metabolic wastes, from the blood by the nephrons. |
| **Gallbladder** | A membranous muscular sac in which bile from the liver is stored. |
| **Gastrointestinal tract** | The stomach and intestine as a functional unit. |
| **Glomerular Filtration** | The first step in urine formation in which substances in blood pass through the filtration membrane and the filtrate enters the proximal convoluted tubule of the nephron. |
| **Glomerulus** | A ball of capillaries surrounded by Bowman’s capsule in the nephron and serving as the site of filtration in the vertebrate kidney. |
| **Homeostasis** | The maintenance of relatively stable internal physiological conditions (as body temperature or the pH of blood) in higher animals under fluctuating environmental conditions. |
| **Intercostal muscle** | Muscle located between the ribs. |
| **Kidney** | One of a pair of vertebrate organs situated in the body cavity near the spinal column that excrete waste products of metabolism, in humans are bean-shaped organs about 4½ inches (11½ centimeters) long lying behind the peritoneum in a mass of fatty tissue, and consist chiefly of nephrons by which urine is secreted, collected, and discharged into the pelvis of the kidney whence it is conveyed by the ureter to the bladder. |
| **Large intestine** | The more terminal division of the vertebrate intestine that is wider and shorter than the small intestine, typically divided into cecum, colon, and rectum, and concerned especially with the resorption of water and the formation of feces. |
| **Liver** | The largest internal organ in the vertebrate body; performs diverse functions such as producing bile, preparing nitrogenous wastes for disposal, and detoxifying poisonous chemicals in the blood. |
| **Macromolecule** | A very large molecule (as of a protein, nucleic acid, or carbohydrate) built up from smaller chemical structures. |
| **Metabolism** | The totality of an organism’s chemical reactions, consisting of catabolic and anabolic pathways. |
| **Minute Volume** | The volume of air breathed in one minute without conscious effort. Minute volume = Tidal Volume x (breaths/minute) |
| **Monomer** | A molecule that can combine with others to form a polymer. |
| **Nephron** | The tubular excretory unit of the vertebrate kidney. |
| **Oral cavity** | The part of the mouth behind the gums and teeth that is bounded above by the hard and soft palates and below by the tongue and by the mucous membrane connecting it with the inner part of the mandible. |
| **Pancreas** | A gland with dual functions: The nonendocrine portion secretes digestive enzymes and an alkaline solution into the small intestine via a duct; the endocrine portion secretes the hormones insulin and glucagon into the blood. |
| **Peristalsis** | Successive muscular contractions along the wall of a hollow muscular structure. |
| **Pharynx** | An area in the vertebrate throat where air and food passages cross. |
| **Polymer** | A large molecule composed of repeating structural units or monomers. |
| **Residual Volume** | The volume of air remaining in lungs after maximum exhalation. |
| **Resource** | A natural feature or phenomenon that enhances the quality of human life. |
| **Résumé** | A brief written account of personal, educational, and professional qualifications and experience, as that prepared by an applicant for a job. |
| **Salivary amylase** | A salivary gland enzyme that hydrolyzes starch. |
| **Salivary glands** | Exocrine glands associated with the oral cavity. The secretions of salivary glands contain substances to lubricate food, adhere together chewed pieces into a bolus, and begin the process of chemical digestion. |
| **Small intestine** | The part of the intestine that lies between the stomach and colon, consists of duodenum, jejunum, and ileum, secretes digestive enzymes, and is the chief site of the absorption of digested nutrients. |
| **Spirometer** | An instrument for measuring the air entering and leaving the lungs. |
| **Stomach** | A saclike expansion of the alimentary canal of a vertebrate communicating anteriorly with the esophagus and posteriorly with the duodenum and being typically a simple often curved sac with an outer serous coat, a strong complex muscular wall that contracts rhythmically, and a mucous lining membrane that contains gastric glands. |
| **Substrate** | A substance acted upon by an enzyme. |
| **Thoracic cavity** | The body cavity in mammals that houses the lungs and heart. It is surrounded in part by ribs and separated from the lower abdominal cavity by the diaphragm. |
| **Tidal Volume** | The volume of air breathed in and out without conscious effort. |
| **Ureter** | A duct leading from the kidney to the urinary bladder. |
| **Urethra** | A tube that releases urine from the body near the vagina in females or through the penis in males; also serves in males as the exit tube for the reproductive system. |
| **Urinalysis** | Chemical analysis of urine. |
| **Urinary bladder** | The pouch where urine is stored prior to elimination. |
| **Urinary system** | The organs of the urinary tract comprising the kidneys, ureters, urinary bladder, and urethra. |
| **Urine** | Waste material that is secreted by the kidney, is rich in end products (as urea, uric acid, and creatinine) of protein metabolism together with salts and pigments, and forms a clear amber and usually slightly acid fluid. |
| **Vital Capacity** | The total volume of air that can be exhaled after maximal inhalation. |