Fundamental Question: What is the function of the Integumentary System?

The Integumentary System continuously receives information about the external environment (temperature, humidity, etc.) and protects the body’s deeper tissues. It excretes waste, helps rid the body of heat and synthesizes vitamin D.

Organs of this system include:
skin (three layers: epidermis, dermis, hypodermis), hair, nails, sweat glands

Skin functions include excreting wastes, regulating temperature, and waterproofing and protecting deeper tissues. Skin also serves as the sensory receptor attachment site, so that the body can detect pain, sensation, pressure, and temperature. Additionally, it synthesizes vitamin D from sunlight, which aids in metabolizing calcium in the body.

The three layers of the skin are the epidermis, dermis, and hypodermis. The epidermis is the visible outer layer where new skin cells form. Finger nails function to protect the surrounding soft tissues of the fingers from injuries. The dermis contains oil and sweat glands. The sweat glands secrete sweat when the body is too warm, which cools the skin surface and body. Oil glands moisturize the skin and hair and add flexibility. The hypodermis helps the body stay warm and anchors the skin to all tissues beneath it. The hypodermis is mainly composed of fat, which also helps the body stay warm.

Fun facts about the Integumentary System:
• You lose about 30,000 to 40,000 dead skin cells every minute.
• The skin is the largest organ in the human body.

The sensory receptors on the dermis gather information about what is affecting the skin and send the information to the brain. If something is not right, the brain is alerted and the body takes action. There are two types of sensory receptors: touch receptors and pain receptors. Touch receptors are very sensitive and respond to the slightest contact. There are about 500,000 touch receptors in the human body, and they are found in areas such as the fingers, tongue, and lips. Pain receptors are not as sensitive. They do not react, unless there is a very strong stimulus or pain. There are 3 to 4 million pain receptors scattered all over the body. That tells you how important they are!
Part I: Love the Skin You’re In, continued

Which do you think are the most sensitive parts of your body?

Procedure:

1. Open a paperclip and separate into two points like so: Make sure the two points are very close together.

2. Place the palm of your hand up, lying relaxed on your desk.

3. Touch the tip of your index finger with the two points of the paper clip. Do you feel one point or two points of the paper clip pressing against your skin?

4. Open the paper clip up so the points have a little more space in between them.

5. Touch your index finger again in the same spot as in step 3. Do you feel one or two points?

6. Repeat the same procedure opening the paper clip to adjust the points’ distances. Touch your index finger skin until you feel two distinct points touching your skin. What is the smallest distance between the two points of the paper clip that you feel?

7. Once you discover the smallest distance between the two points of the paper clip to the extent you distinctly feel the two points, measure the distance in mm between the two points, and record it in Part I of your Student Journal.

8. Repeat the same procedure for your bottom of the wrist, upper arm, shoulder, upper lip, cheek, nose, back, calf, and foot.

9. Analyze your data. With one color of pencil or marker, mark the three most sensitive areas that were tested. With another color, mark the three least sensitive areas tested. Make sure to color the diagram key, as appropriate.

10. Discuss your results with classmates.

11. Finish this system activity by completing the sentence at the bottom of the page.
Part II: To Think or Not To Think

Fundamental Question: What is the function of the Muscular System?

The **Muscular System** allows the body to move when attached to bone and permits movement in internal organs, such as the heart and intestines. It also provides strength, posture, balance, and heat for body warmth.

**Organs of this system include:** muscles (three types: skeletal, smooth, and cardiac), ligaments, and tendons

There are approximately 639 skeletal muscles in the body, and they make up about 40% of body weight. Smooth muscles make up the walls of hollow organs, specifically utilized in the digestive, circulatory, respiratory, and reproductive systems. Cardiac muscle is the heart’s muscle tissue.

Ligaments and tendons are strong, fiber-like connectors assisting in efficient physical movement and stability. Ligaments connect bones to other bones, while tendons connect muscles to bones.

**Fun facts about the Muscular System:**
- More than 30 facial muscles create smiles and frowns, among other expressions.
- Scientists estimate the eye muscles move more than 100,000 times a day.
- The largest muscle in the body is the muscle in the buttocks, the gluteus maximus.

Some of the body’s muscles are “voluntary,” meaning the muscles work because you specifically tell them to. You control these muscles. Some of the body’s muscles are “involuntary,” meaning the muscles work automatically. Moving them does not involve any thought, and you do not have control over these muscles.
Part II: To Think or Not To Think, continued

Work with a partner in determining if specific actions are performed by voluntary or involuntary muscles. For each Action/Procedure, observe and record what muscles are being targeted for use in Part II of your Student Journal. Check the table column for either Voluntary or Involuntary, and then briefly explain why you concluded that for each action.

<table>
<thead>
<tr>
<th>Action</th>
<th>Procedure</th>
</tr>
</thead>
</table>
| Pupils of eyes with flashlight shining in them | **Partner 1:** Stare at a fixed point in the classroom.  
**Partner 2:** Shine the flashlight into Partner 1’s eye from the side of the face (not directly from the front). Next, turn the flashlight off. Observe Partner 1’s pupil. |
| Clapping hands                                 | **Partner 2:** Clap your hands three times.                                |
| Standing up                                     | **Partner 1:** Stand up out of your chair.                                 |
| Heart rate after jogging                       | **Partner 2:** Jog in place for 30 seconds.  
**Partner 1:** Check Partner 2’s heart rate by placing your index and middle finger on Partner 2’s wrist. The heart beats faster than when at rest. |
| Breathing rate after jogging                   | **Partner 1:** Jog in place for 30 seconds.  
**Partner 2:** Check Partner 1’s breathing rate. His/her breathing has sped up. |
| Knee jerk and leg raised                       | **Partner 2:** While sitting down, relax both legs.  
**Partner 1:** Make a fist and lightly hit just below Partner 2’s knee cap. Partner 2’s knee jerks and the leg raises up in response. |
| Raising arm                                     | **Partner 1:** Raise your arm high in the air.                            |
| Bicep curls with textbook                      | **Partner 2:** Hold the textbook in one hand and do five bicep curls.    |
| Resting heart rate                             | **Both partners:** You have been sitting there, and your hearts are beating at a resting rate. |
| Blinking eyes                                   | **Both partners:** You have been blinking your eyes throughout this investigation. |
Part III: Those Crazy Bones

Fundamental Question: What is the function of the Skeletal System?

The **Skeletal System** holds organs in place, provides a structural support for the body and its muscles, stores minerals, and contains resources to generate new blood cells.

**Organs of this system include:** bones and joints

**Bones** are hard, white, and mainly composed of a mineral compound called calcium phosphate. An important part of carrying out a wide range of functions depends on bone arrangement in the skeleton. These functions include supporting delicate and soft organs, anchoring muscles, and protecting the brain, lungs, and heart. Inside of the bones is bone marrow, the jelly-like substance where red and white blood cells form.

The function of various bones includes the following: The backbone provides structure, which enables you to stand up straight. The skull acts as a hard, safety helmet protecting the brain. The vertebrae surround your spinal cord. The rib cage protects the heart and lungs. The skeletal system also includes the flexible connections between bones, known as joints.

**Fun facts about the Skeletal System:**
- The human body’s longest bone is the femur, which is about 25% of your height.
- There are 230 joints in your body.
- 52 out of the 206 bones in the skeletal system are in both feet

**Procedure:**

1. Put gloves on and place the chicken leg on the dissection pan.
2. Observe and feel the texture of the skin.
3. Use the scissors to carefully cut the skin off the leg.
Part III: Those Crazy Bones, continued

Procedure, continued:

4. Observe the pink meat. The pink meat is muscle. The yellow, globular substance is fat. Feel the difference between muscle and fat.

5. At the end of either side of the leg, locate the ending of the bone. The white cap is cartilage. Cartilage protects the joint ensuring it won’t rub directly against another bone.

6. Demonstrate the movement of the joint by picking up the leg and bending it.

7. Use the scissors to cut some of the muscle open. Any white, stringy looking areas of the muscle are the tendons. What is the function of the tendons? Remember, tendons are part of the muscular system.

8. Use the scissors to cut out the muscle and fat to better see the bone and cartilage. Bend the leg again to show how the joint moves in one direction. This is a hinge joint, just like your knee.

9. Hold the leg on either side of the joint and carefully break the joint in half. Observe how the two bones fit together prior to splitting the bones apart.

10. Pick up the largest bone and carefully break it in half. Observe the inside of the bone. The red, jelly-like substance is the bone marrow. Feel the consistency of the bone marrow. Bone marrow makes new red and white blood cells. Red blood cells make certain the oxygen is distributed to all parts of your body, and white blood cells ensure you are able to fight germs and disease.

11. Record your observations in Part III of your Student Journal.

12. Thoroughly clean the equipment used at this station and properly dispose of the chicken leg as directed by your teacher.
Part IV: A Breath of Fresh Air

Fundamental Question: What is the function of the Respiratory System?

By breathing, the Respiratory System supplies oxygen to the blood, which transports this oxygen to all parts of the body. When we breathe, we inhale oxygen and exhale carbon dioxide.

Organs of this system include:
Airways (larynx, trachea, bronchial tubes), lungs, and alveoli

Respiration is achieved through the mouth, nose, trachea, lungs, and diaphragm. First, air enters the body through your nose or mouth, then travels through your larynx (or voice-box), down your trachea (or windpipe), and finally splits into two bronchial tubes entering your lungs.

Your lungs, located inside the chest cavity, carry oxygen into your body, and carbon dioxide out of your body. Within the lungs are thousands of thin bronchial branches with endings composed of millions of alveoli. This is where the exchange of oxygen and carbon dioxide occurs. Around the alveoli are microscopic capillaries transporting carbon dioxide from the heart via the pulmonary artery and delivering oxygen back to the heart via the pulmonary vein. Lastly, muscles near the lungs, including the diaphragm, help the lungs expand and contract. This allows breathing to occur.

Fun facts about the Respiratory System:
• There are approximately 1,500 miles of airways within the lungs.
• The fastest sneeze on record is 102 miles per hour.
Part IV: A Breath of Fresh Air, continued

Procedure:

1. First, read through this procedure to understand the experiment’s purpose.
2. Write your prediction in Part IV of your Student Journal before conducting the experiment. Use Part IV to record data.
3. Label one test tube A, a second test tube B, and the third test tube C.
4. Fill each test tube halfway with cabbage juice.
5. Fill the beaker with 300 ml of distilled water.
6. Using the eyedropper, add four drops of the distilled water to test tube A.
7. After 20 seconds, check to see if the distilled water has caused the cabbage water to change color.
8. Using the straw, blow gently for 20 seconds into the cabbage water in test tube B. You are to blow INTO the straw. Don’t suck from it! Check to see if the water has changed color.
9. Exercise for 1 minute, and then repeat step 2. However, this time use test tube C. Check to see if the water has changed color. Observe and compare test tube C to test tube B.
Fundamental Question: What is the function of the Circulatory System?

The Circulatory System circulates blood through the body, supplies cells with oxygen and nutrients, and removes waste products.

Organs of this system include: heart, arteries, and veins

Even though the heart is the size of a clenched fist, it is a powerful muscle. The heart pumps blood through its chambers to all parts of the body by cycles of contracting and relaxing. Blood is carried to and from the heart in tubes called arteries and veins. Arteries carry pumped blood under high pressure away from your heart through progressively smaller branched tubes called capillaries. Veins are tubes that most commonly carry deoxygenated blood from tissues and back into the heart, with less force.

With every breath, oxygen mixes with blood in the lungs and then is pumped to all cells in the body through the arteries. Oxygen-depleted blood then returns back to the heart and the process repeats.

Fun facts about the Circulatory System:
• Your heart pumps about 4,000 gallons of blood each day.
• An average human’s heart beats 30 million times per year.
• The sound of a heartbeat is created by the valves in the heart closing as they push blood through its chambers.
Part V: Pump It Up, continued

Procedure:

1. Cut out the human forms from the following pages in this guide.

2. For the human forms numbered 1, 2, and 3, color the heart red. Next, color the simplified pathways going away from the heart also red to represent the oxygen and nutrients going to the body’s cells.

3. For the human forms numbered 4, 5, and 6, color the heart red, and color the pathways going away from the heart also red just to the mark. For the pathways going back to the heart color these pathways blue to represent the removal of waste products.

4. Staple your booklet together. Flip through the pages from 1 through 6 quickly. Notice the flow of blood through the body which takes from one to two minutes. Flip again sensing the blood flow. Flip again and imagine how your blood at this time is circulating in your body.

5. Touch the side of your neck and feel the flow of blood pumping up to your brain. Imagine again how all the blood is circulating through your body, bringing oxygen and nutrients to the cells and then eliminating the waste products, over and over again for almost 2 minutes per cycle.

6. In Part V of your Student Journal, write a story about the blood circulating through your body.
Part V: Pump It Up, continued
Part V: Pump It Up, continued
Part V: Pump It Up, continued
Part VI: Your Thinking Cap

Fundamental Question: What is the function of the Nervous System?

The **Nervous System** functions as a control center and coordinates all actions and reactions, sending immediate and specific information as electrical impulses.

**Organs of this system include:**
- **brain**, **spinal cord**, and **nerves**

The **brain** uses information received from the nerves to coordinate actions. Thin threads of nerve cells, called neurons, carry messages throughout the body. Sensory nerves carry these messages to the brain through the **spinal cord**, while motor nerves carry them from the brain to all of the various muscles and glands.

A tiny electrical pulse generates when a neuron is stimulated by heat, cold, touch, sound, or vibrations. Chemicals help carry the electrical pulse from the finger-like projection or dendrites of one neuron to the next cell.

**Fun facts about the Nervous System:**
- There are more nerve cells in the human brain than there are stars in the Milky Way.
- The left side of the human brain controls the right side of the body and vice-versa.
- As we get older, the brain loses a gram of brain mass per year.

**Procedure:**
1. Cut a large circle out of the grocery bag, so that it covers your head above the ears. This represents your “Thinking Cap.”
2. Divide the “thinking cap” into four sections to represent the four sections of the brain, as illustrated in the picture to the right.
   - Label the Frontal Lobe and color this section of the brain red. Also, write out the functions this section serves.
   - Label the Parietal Lobe and color this section blue. Write out its functions.
   - Label the Temporal Lobe and color this section yellow. Write out its functions.
   - Label the Occipital Lobe and color this section green. Write out its functions.
Part VI: Your Thinking Cap, continued

Procedure, continued:

3. Connect a piece of string to the Frontal Lobe by taping it to that section. The other end of the string needs to be long enough to end at your mouth. Loosely tape the string to your mouth. This represents how the Frontal Lobe controls speech. Connect another piece of string from the Frontal Lobe to one of your legs. This represents how the frontal lobe also controls movement.

4. Continue on to the Parietal Lobe. Connect a piece of string from this section of the brain to one of your fingers. This represents how the Parietal Lobe is in control of touch.

5. Keep connecting pieces of string to the part of the brain and the corresponding body part that it controls.

6. Once your Thinking Cap is ready, put the cap on your head, with the frontal lobe in front. Secure it in place with the yarn by tying it onto your head.

7. Perform five different actions of your choice. For example, walk across the classroom.

8. Determine which area of the brain is allowing you to perform the action. For instance, walking across the classroom is controlled by the Frontal Lobe of the brain because it directs movement.

9. Determine what other body systems assist the nervous system in performing the action.

10. Complete the table in Part VI of your Student Journal. Try to perform actions related to at least three different lobes.

Areas of the Brain and Their General Functions

FRONTAL LOBE: Manages reasoning, planning, parts of speech, problem solving, and movement.

PARIETAL LOBE: Focuses on touch, pressure, temperature, and pain.

TEMPORAL LOBE: Handles perception and recognition of hearing and memory.

OCCIPITAL LOBE: Covers many aspects of vision.
Part VII: What’s Your Rush?

Fundamental Question: What is the function of the Endocrine System?

The Endocrine System regulates the body by secreting different types of hormones into the bloodstream. The endocrine system controls growth, reproduction, and metabolism.

**Organs of this system include:**

- **glands** (two types: pituitary and adrenal), **hormones**

Hormones are chemical messengers released from glands, enabling communication between cells to occur by attaching to tissues. There are over 30 hormones secreted by the endocrine system helping regulate body functions, such as mood, growth, development, tissue functions, and metabolism. When a person is frightened or anxious, a hormone called adrenaline releases into the bloodstream. This hormone speeds the breathing and heart rate, transporting more oxygen to the muscles. As a result, the body creates what is known as a “fight or flight” response. The “fight” response is exactly as it sounds. Your body tells you to stay and fight with whatever is causing the scary moment. “Flight” occurs when the body tells you to walk away from the scary scenario.

These hormones also regulate body temperature, sleep, and stress.

**Fun facts about the Endocrine System:**

- Without glands, there would be no sweat, mucus, and chemicals juices in your body.
- For girls, puberty generally begins sometime between ages 9-13. For boys, puberty generally begins between ages 10-15.
Part VII: What’s Your Rush?, continued

Procedure:

1. View the nine pictures below. Imagine yourself encountering or experiencing what is shown in the pictures.
2. Discuss with a partner and share your feelings and emotions about each picture.
3. Discuss how your body responds during encounters or experiences exhibited in each picture.
4. Complete the table in Part VII of your Student Journal based on your discussion.

1

2

3

4

5

6

7

8

9
Part VIII: Cracker Breakdown

Fundamental Question: What is the function of the Digestive System?

The Digestive System is designed to break down food into smaller parts through mechanical and chemical means, which aids in absorption into the blood stream.

Organs of this system include: teeth, esophagus, stomach, small intestine, large intestine, and anus.

Teeth mechanically chew food entering the mouth. Salivary glands produce saliva teaming up with teeth to further break down food into smaller components. Esophagus muscles push the smaller food particles into the stomach. The stomach is where hydrochloric acid chemically breaks down food and destroys most microorganisms.

After an hour or two of digestion in the stomach, a thick liquid called chyme is formed. Chyme then passes through the small intestine. Here up to 95% of nutrients are absorbed. Finally, it passes through the large intestine, where it excretes from the body through the rectum and anus.

Fun Facts about the Digestive System:
- Together, your large and small intestines measure about 25 feet long.
- It takes about three hours for food to move through the intestines.
- The large intestine sometimes holds food for up to two days.
- The average human’s digestive system processes about 50 tons of food in a lifetime.
Part VIII: Cracker Breakdown, continued

Procedure:

**Step 1: Mouth Attack**
1. Put one cracker into your mouth. Hold it in your mouth for 10 seconds. Start recording your observations in Part VIII of your Student Journal.
2. Start to slowly chew the cracker.
3. Swallow the cracker.

**Step 2: Stomach Acid Machine**
1. Place 10 crackers into a sealable bag.
2. Pour in 300 ml of cola into the bag and zip the bag closed.
3. Observe the crackers. Record any changes.
4. “Pump” the bag for three minutes.
5. Observe and record what happens to the crackers inside of the bag.

**Step 3: Show Me What You Gut**
1. Place filter paper on top of the beaker. Use the rubber band to keep the filter paper in place.
2. Using the spoon, slowly pour out the cola and cracker mixture from the bag and into the filter paper.
3. Use the spoon to transfer the filtered crackers into one end of the pantyhose.
4. Squeeze the crackers from one end of the hose to the other end. Record your observations.

Primary System Parts

The **esophagus** is a long tube carrying food, liquids, and saliva from your mouth to the stomach.

The **stomach** is a sac-shaped muscle where acid and enzymes digest food. Ridges of muscle tissue line the stomach. Stomach muscles contract and promote digestion.

The **small intestine** connects from the bottom of the stomach absorbing most of the nutrients from what we eat and drink.

The **large intestine** connects to the small intestine absorbing water from wastes, creating stool.
Part IX: Flush Those Toxins

Fundamental Question: What is the function of the Excretory System?

The Excretory System filters excess fluids, chemicals, vitamins, minerals, salts, and other wastes from the bloodstream into the kidneys. The kidneys filter these excess fluids a hundred times per day to ensure your body has optimum blood. The kidneys factor in consistency, salt concentrations, and wastes.

Organs of this system include: kidneys and bladder

Waste collects in the center of the kidneys, where it is processed into urine and forced down through tubes into a stretchy pouch called the bladder.

When the bladder becomes full, it sends a signal through the nervous system to your brain. The bladder then signals your body to release the urine through the urethral opening.

Fun facts about the Excretory System:

- Inside the kidneys, millions of tiny structures that filter out liquids and wastes.
- About 440 gallons of blood flow in and out of the kidneys every day.
- Your bladder can hold about one pint of urine.

Procedure:

Trial #1
1. Measure 200 ml of sand using one of the beakers. Leave the sand in the beaker.
2. Add 100 ml of water to the beaker.
3. Add 20 drops of yellow food coloring into the beaker and stir.
4. Fill the second beaker halfway full with water.
5. Place the filter paper over the beaker, and secure it in place with a rubber band.
6. Place five spoonfuls of the yellow mixture from the first beaker directly on top of the filter paper.
7. Observe and record in Part IX of your Student Journal what happens to the color of the water in the second beaker.
8. Carefully remove the filter paper, keeping the sand on top of it (you use it again). Pour the water in the second beaker down the drain.
Part IX: Flush Those Toxins, continued

Trial #2

1. Refill the beaker again halfway full with water.
2. Place the filter paper with the same sand and water mixture you just used onto the top of the beaker again. Secure it with the rubber band.
3. Using the graduated cylinder, pour 10 ml of water over the sand and water mixture. Record your observations.

Part X: Unseen Foes

Fundamental Question: What is the function of the Immune System?

The Immune System protects the body by fighting off sickness and defending it against foreign invaders, such as bacteria, microorganisms, viruses, toxins, and parasites. The immune system organs guard the body against disease and are located throughout the body.

Organs of this system include: lymph nodes, tonsils, and spleen

The tonsils are located on either side of the throat and catch ingested or inhaled foreign pathogens. Lymph nodes are small, ball-shaped organs that spread throughout the body and trap and filter foreign particles. Enlarged lymph nodes signal infection.

The spleen, located in the upper left corner of the abdomen protected by your ribcage, filters blood and helps fight infection. White blood cells, located in the spleen and other places in the body, attack foreign and diseased cells. There are two types of white blood cells: phagocytes, which destroy germs; and lymphocytes, which remember and reorganize germs to assist the body in fighting future infections.

Fun Facts about the Immune System:
- The body has over 50 million white blood cells working as part of its defense system.
- When you laugh, a proactive immune response occurs, which contributes to a healthy body. So, laugh all you can!
Part X: Unseen Foes, continued

Procedure:

1. Think of a surface in the school or classroom that has the most bacteria on it. You can only choose one spot, so think of a good one!

2. Put gloves on.

3. Rub the cotton swab on the bacteria-rich spot.

4. Gently rub the cotton swab onto the agar inside of the Petri dish.

5. Discard the cotton swab into the trash.

6. Cover the Petri dish with its the lid.

7. Label the dish with the location your group chose.

8. In Part X of your Student Journal, draw a picture and describe the location.

9. Allow the Petri dish to sit undisturbed in a warm and damp place for three days, and then record your observations in Part X of your Student Journal.