CELLS BUILD TISSUES, ORGANS, AND BODY SYSTEMS

Overview:
Students gain an understanding that cells are the building blocks of the human body and how the cell nucleus directs the formation of different tissues, organs and systems.

Objectives:
The student will:
• build a simple model of an animal cell;
• determine that a cell has many parts, each with a different function;
• explain that cells are the building blocks of tissue, organs and systems; and
• name two kinds of tissue, two organs and one system of the body.

Targeted Alaska Grade Level Expectations:

Science
[6] SC2.3 The student demonstrates an understanding of the structure, function, behavior, development, life cycles, and diversity of living organisms by describing the levels of organization within a human body (i.e., cells, tissues, organs, systems).
[6] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating.

Vocabulary:
cell – the basic unit of living matter in all organisms, consisting of protoplasm enclosed within a cell membrane; all cells except bacterial cells have a distinct nucleus that contains the cell's DNA as well as other structures like mitochondria and the endoplasmic reticulum

cell division – the process by which a cell divides into two or more cells; cell division is the means of reproduction in organisms that reproduce asexually, as by fission or spore formation; in organisms that reproduce sexually, cell division is the source of all tissue growth and repair; the two main types of cell division are mitosis and meiosis

cell membrane – the thin membrane that forms the outer surface of the protoplasm of a cell and regulates the passage of material in and out of the cell; it is made up of proteins and lipids

chromosome – a structure in all living cells that carries the genes that determine heredity; in all cells except bacterial cells, the chromosomes are thread-like strands of DNA and protein that are contained in the nucleus

cytoplasm – the jelly-like material that makes up much of a cell inside the cell membrane, and in eukaryotic cells, surrounds the nucleus; the organelles of the cell, such as mitochondria, are contained in the cytoplasm; The cytoplasm of a cell together with the material inside the nucleus is called protoplasm.

endoplasmic reticulum – a network of membranes within the cytoplasm of many cells that is important in protein synthesis and involved in the transport of cellular material

mitochondria – a structure in the cytoplasm of all cells except bacteria in which food molecules are broken down in the presence of oxygen and converted to energy

nucleus – the structure in the cytoplasm of a living cell that contains the cell's DNA and controls its metabolism, growth, and reproduction; a nucleus surrounded by a membrane is found in almost all the cells of eukaryotes and thus sets them apart from the cells of prokaryotes, such as bacteria, which do not contain nuclei

organ – a distinct part of an organism that performs one or more particular function; examples of organs are the eyes, ears, lungs, and heart of an animal, and the roots, stems, and leaves of a plant

ribosome – a sphere-shaped structure within the cytoplasm of a cell that is composed of RNA and protein and is the site of protein synthesis; ribosomes are often attached to the membrane of the endoplasmic reticulum

skeleton – the internal structure of vertebrate animals, composed of bone or cartilage, that supports the body, serves as a framework for the attachments of muscles, and protects the vital organs and associated structures
tissue – a large collection of similar cells that together perform a specific function in an organism; the organs of the body and the parts of a plant are composed of many different kinds of tissues

vacuole – a space in a cell’s cytoplasm that is surrounded by a membrane and filled with a watery fluid; the fluid stores food prior to digestion or waste products prior to excretion

Whole Picture:

Scientist Robert Hooke first viewed cells, the building blocks of all living things, in 1665 when he used a microscope to examine cork. The small divisions he saw reminded him of the small rooms where monks lived called “cells.” Now powerful microscopes reveal myriad shapes, sizes and kinds of cells in all plants and animals.

The body of an average adult human contains 60- to 90-trillion cells. Each one has a specific role, determined by specific programming locked in the cell nucleus. Each cell is surrounded by a membrane that allows water and nutrients to come in and also allows the cell to get rid of waste. Cells are programmed to become different tissues. In turn, different tissues form the organs of the body. Organs working in concert form systems of the body.

Materials:

• White modeling clay (large handful per group)
• Blue and purple modeling clay (ping pong-size per group)
• Spaghetti noodles (5 strands, undercooked, per group)
• Pepper (1 pinch per group)
• Bubble wrap (2-inch square per group)
• Pencil shavings (1 pinch per group)
• Sharp knife
• Colored pencils
• TEACHER INFORMATION SHEET: “Guiding Student Lab - Building an Animal Cell”
• VISUAL AID: “Building Materials”
• VISUAL AID: “Basic Cell Structure”
• STUDENT LAB: “Building an Animal Cell”
• STUDENT WORKSHEET: “Cells Are Building Blocks”
• STUDENT INFORMATION SHEET: “Cells Build Your Whole Body”
• STUDENT WORKSHEET: “Piecing it All Together”

Activity Preparation:

1. Cook spaghetti noodles until they are flexible, but still somewhat firm (al dente!) then cool and store in an airtight container so they don’t dry out.

2. After the lab is complete on day one cut each group’s cell in half using a very sharp knife.

Activity Procedure:

NOTE: This lesson can be divided into two days. For the first day, complete Activity Procedures 1 through 4. Complete the remaining lesson on day two.

1. Ask students to describe the kinds of building materials that go into making a house or a school. Ask, “Why do some buildings look different than others, when they seem to use the same materials?” Show students VISUAL AID: “Building Materials.” Explain a floor plan helps the builder know how to use tools to shape the materials into all kinds of different things. Tell students the human body works in a similar way, though more complicated, when building all the different parts of the whole.

2. Explain students will learn how basic building blocks, called cells, use similar material to form very different parts of the body. Show VISUAL AID: “Basic Cell Structure.” Cells are the building blocks of all living things. All
cells share basic parts, but the genes contained in the nucleus are a blueprint of the cell and direct it to form different tissues, organs and systems.

- Ask students to “flex” their muscle tissue.
- Ask students to point to their skin cells.
- Ask students to look at a classmate’s eyes. The eye looks much different than skin.
- Ask students to touch their arm with one finger. The touch sensation is picked up by nerve cells.

3. Explain before students learn about cells with different jobs (like muscle, skin, eye, and nerve) students will first learn some basic cell structure by building a simple model of a cell. Divide students into groups, then hand out STUDENT LAB: “Building an Animal Cell.”

4. Using TEACHER INFORMATION SHEET: “Guiding Student Lab - Building an Animal Cell” guide students through lab completion. Ask students to set their cell on top of their lab paper on a counter for storage until you are ready to continue. At an appropriate time, cut each student cell in half using a very sharp knife. (See Activity Preparation 2.)

5. Remind students they worked in groups to create a very simple cell. Ask groups to retrieve the cell, now cut in half. Cells are the basic building blocks of all tissues, organs and systems of the body.
   a. What is the jelly-like material that makes up much of the cell? (cytoplasm)
   b. What is the control center of the cell? (nucleus)
   c. How does a cell know what kind of tissue, organ or system of the body to become? (It is directed by genes, which are part of the chromosomes, located in the nucleus.)

6. Hand out STUDENT WORKSHEET: “Cells Are Building Blocks.” Review the directions, then allow students time to complete individual worksheets.

7. Hand out STUDENT INFORMATION SHEET: “Cells Build Your Whole Body.” Choose a reading strategy best suited for the class to review the information.

8. Hand out STUDENT WORKSHEET: “Piecing it All Together” and allow students time to complete.

**Extension Ideas:**

1. Allow students time to visit the website, Cells Alive! At www.cellsalive.com and view an interactive model of an animal cell.

2. Using an Internet search engine, find images for different kinds of cells. Use search terms such as human skin cells, red blood cells, muscle cells, lung cells, and brain cells.

3. Use a microscope to view cheek cells. Gently scrap the inside of the mouth with the flat side of a toothpick, place the cells on a flat slide and make a wet mount by adding a drop of water then placing a cover slip. Add stain, such as food coloring, iodine, malachite green or methylene blue, to the slide. To do so put a drop of stain next to the cover slip, then place a piece of paper towel against the other side of the cover slip. The paper towel will draw the water out and draw the stain under the cover slip. Look at the stained slide under a microscope.

**Answers:**

**STUDENT LAB: “Building an Animal Cell”**
Requires a visual check of cell model during construction and after being cut open with a sharp knife.

**STUDENT WORKSHEET: “Cells are Building Blocks”**
Answers will vary. Drawings dependent on student interpretation and ability.
STUDENT WORKSHEET: “Piecing it all Together”
1. true
2. true
3. false
4. true
5. true
6. cells
7. Any two of the following: epithelial, connective, muscle, or nerve.
8. Any two of the following: brain, ears, heart, liver, lungs, stomach, kidneys, small intestine or large intestine.
   Accept other examples of organs not on the information sheet if correct.
9. Any one of the following: skeletal, muscular, circulatory, nervous, respiratory, digestive, excretory,
   endocrine, reproductive, or immune.
10. Any one of the following: mouth, esophagus, stomach or intestines.
11. 

Cells → Tissue → Organs → Body Systems
Students will build a simple model of an animal cell. The vocabulary associated with cell parts is difficult. Discuss the vocabulary as students build the cell. Use the words, as well as the description of function, often when giving directions. Follow the steps below to help guide students.

**NOTE:** Since this is a visual demonstration, it is very important to help students make connections between structure and function. Example: Why is there so many ribosomes sprinkled all over the cell? (Because they are used to make proteins, and proteins must be made for the cell to perform its functions.)

**STEP 1:** Roll out the cytoplasm (white modeling clay) into a pancake. Do not make it too thin. Cytoplasm is the jelly-like material that makes up much of a cell. The other parts of the cell are all found in the cytoplasm. Say cytoplasm! Cyto means “cell” and plasm means “watery fluid.”

**STEP 2:** Pick up the nucleus (blue modeling clay). Remember, the nucleus of the cell is the control center of the cell. It contains the directions for how that cell is supposed to function. It tells the cell what kind of cell to grow into. Those directions are called genes, which are part of a bigger set of directions called chromosomes. Sprinkle some chromosomes (pencil shavings) on the nucleus then lightly knead them in. Roll the nucleus into a ball and place it on the cytoplasm.

Now that you’ve added the control center, the cell is going to need some more things to help it function. There are many parts to cells, and some are specialized to help them do their specific job in the body. We’ll cover some basics of most cells.

**STEP 3:** Add the vacuoles (bubble wrap). Vacuoles are a space in a cell’s cytoplasm that is surrounded by a membrane and filled with a watery fluid. It acts as a storage space for the cell. It stores food coming in. It also stores waste that needs to go out.

**STEP 4:** Now it is time to add the mitochondrion. Take the mitochondrion material (purple modeling clay) and roll it into a ribbon. Take that ribbon and fold it back and forth onto itself to form the mitochondrion. (Demonstrate if necessary.) The job of the mitochondrion is to convert sugar into usable energy for the cell. If the mitochondrion breaks down the food it should be near the food storage area. Who remembers what the food storage area is called? Add your mitochondrion to the cell.

**STEP 5:** Now it’s time for the endoplasmic reticulum! Grab your endoplasmic reticulum (spaghetti) and place it next to the nucleus. The job of the endoplasmic reticulum is to transport materials around the cell. It’s attached to the nuclear membrane. Endo means “in,” so endoplasmic means “in the cytoplasm.” Reticulum means “little net.”

**STEP 6:** Let’s add the ribosomes (pepper). Go ahead and carefully sprinkle ribosomes around the cell. Ribosomes are tiny particles found in the cytoplasm. Ribosomes take amino acids and make them into proteins. Proteins are important in every part of cell function.

**STEP 7:** Cells are not usually flat. They are closed within a membrane that holds everything in. Carefully gather the edges of the cytoplasm around all the cell contents and seal the edges together to form a ball. You now have a simple cell.
A builder knows how to turn raw materials into many different parts of a house.

The directions for building a house are called a floor plan. What it looks like in the end depends on that plan.
The nucleus is the control panel in each cell. It contains the directions, called genes, for that cell’s job in the body. Some genes may be turned off or on. That is how a cell knows if it is a muscle cell, a liver cell, a blood cell, or a skin cell. Different combinations mean different jobs for that cell.
BUILDING AN ANIMAL CELL

Part 1:
Choose group members to gather the following materials:

Chromosomes: ____________________________
Cytoplasm: ______________________________
Endoplasmic reticulum: ____________________
Mitochondria: ____________________________
Nucleus: _________________________________
Ribosomes: ______________________________
Vacuole: ________________________________

Part 2:
Follow along as the teacher leads the following steps to building a simple animal cell.

STEP 1: Roll out the cytoplasm into a pancake. Do not make it too thin.

STEP 2: Pick up the nucleus then sprinkle some chromosomes on it and gently knead them in. Roll the nucleus into a ball and place it on the cytoplasm.

STEP 3: Add the vacuoles.

STEP 4: Roll the mitochondrion material into a ribbon then fold it back and forth onto itself to form the mitochondrion shape. Add the mitochondrion to the cell.

STEP 5: Place the endoplasmic reticulum next to the nucleus.

STEP 6: Sprinkle the ribosomes around the cell.

STEP 7: Carefully gather the edges of the cytoplasm around all the cell contents and seal the edges together, to form a ball.

Lab Materials Needed:
Chromosomes: pencil shavings, a pinch
Cytoplasm: white modeling clay, a large handful
Endoplasmic reticulum: 5 spaghetti noodles
Mitochondrion: purple modeling clay, a small, ping pong-sized ball
Nucleus: blue modeling clay, a small, ping pong-sized ball
Ribosomes: pepper, a pinch
Vacuole: bubble wrap, 2-inch
Directions: Draw a picture of the cut-away view of the simple cell constructed from STUDENT LAB: “Building an Animal Cell.” Draw a line from the vocabulary word on the right to the matching part of the cell.

All living things are made up of cells. The nucleus of the cell contains the instructions about what kind of cell will form. Each kind of cell has a very special job. Think about all the different parts that make up a human body!

Directions: Look at the different kinds of cells below then draw your own. Be sure to label them.
Cells join together to make tissue, organs and body systems.

**Tissue** is a group of cells that work together to carry out a specific function. There are four main types of tissue:
- **epithelial tissue** – the outer layer of skin, the inside of the mouth and the membranes surrounding the body’s organs
- **connective tissue** – tendons, ligaments, cartilage, bone and fat
- **muscle tissue** – specialized tissue that can contract
- **nerve tissue** – conduct electrical signals in the body and down the spinal cord

Organs are formed when at least two types of tissue work together for a common purpose. For example, epithelial tissue and connective tissue form the skin, which is the body’s largest organ. Below is a diagram of some of the organs found in the human body.
A body system means two or more different organs that work together to do the same job. There are 10 major organ systems in the human body.

- **Skeletal System** – provides support for the whole body and protects delicate organs; the major organs in the system are bones, cartilage, tendons and ligaments
- **Muscular System** – provides movement of the body, and movement of materials through some organs, like the stomach and intestine; the major organs in the system are skeletal muscles and smooth muscles
- **Circulatory System** – transports blood throughout the body; the major organs in the system are the heart, blood vessels and blood
- **Nervous System** – directs behavior and movement with electrical signals to and from the brain; the major organs in the system are the brain, spinal cord and nerves
- **Respiratory System** – takes in oxygen and lets out carbon dioxide through breathing; the major organs in the system are the nose, trachea (throat) and lungs
- **Digestive System** – breaks down and absorbs food need to maintain the body; the major organs of the system are the mouth, esophagus, stomach and intestines
- **Excretory System** – gets rid of unusable food and other waste; the major organs of the system are the kidneys and bladder
- **Endocrine System** – works with the nervous system and sends chemical messages through the body to control digestion and growth; the organs involved are the glands of the body
- **Reproductive System** – allows humans to produce offspring; some major organs in the system include the uterus and the mammary glands
- **Immune System** – destroys things that try to invade the body, such as viruses and bacteria; the organs involved are lymph nodes and spleen

**Did you know…**

- there are 206 bones in the human body.
- there are 600 muscles in the human body.
- the circulatory system, made of arteries, veins and capillaries, is about 60,000 miles long.
- in every square inch of the human body there are about 19 million skin cells.
- 1 billion cells in the human body must be replaced every hour.
Directions: Using STUDENT INFORMATION SHEET: “Cells Build Your Whole Body,” complete the following.

Write True or False:

1. ________ The many parts of a cell each have a different function.
2. ________ The nucleus contains the directions for what tissue the cell will become.
3. ________ An organ has only one kind of tissue.
4. ________ The liver, kidneys and lungs are examples of organs.
5. ________ The skeleton is a body system.

Fill in the blanks:

6. The basic building blocks for tissue, organs and body systems are called ____________.
7. There are four main types of tissue in the human body. Two of those are tissue types are ________________ and ____________________.
8. Two of the many organs in the human body are the ____________________ and the ____________________.
9. When two or more organs work together to do a certain job in the body it is called a system. One system in the human body is the ____________________ system.
10. One organ in the digestive system is the ____________________.

Complete the following flow chart.

11. Use the following words to complete the flow chart showing how process of building the human body: body systems, organs, cells and tissues.

   builds → builds → builds → builds