21-1336

Baggie Cell Model

TEACHER'S MANUAL

CAROLINA

World-Class Support for Science & Math

Baggie Cell Model

Teacher's Manual

Photocopy Masters

This kit has been developed in collaboration with the Dolan DNA Learning Center, Cold Spring Harbor Laboratory. The activities have been tested by teachers and students participating in DNALC hands-on workshops.

Baggie Cell Model

Overview

The Baggie Cell Model kit provides teachers with the information, instructions, and materials needed to introduce middle school students to basic animal cell structure. Students will study and discuss the major organelles and features of animal cells. They will build a model animal cell using common materials to represent animal cell components. In addition, students will explore cell specialization and the concept that cellular "form fits function." Student instruction sheets, a worksheet, and follow-up activities are included, as is a glossary of important terms. Classroom options are also presented. This kit accommodates up to 32 students working in pairs.

Objectives

- To investigate the structure of an animal cell through model building
- To visualize the structure of an animal cell
- To understand the components of animal cells and their function
- To understand cell specialization and the concept of "form fits function"

Materials

Included in the kit:

16 plastic cups (10 oz)
16 plastic bags (6" × 9")
16 plastic plates
16 plastic measuring cups
16 plastic eggs
1 spool of green yarn
1 spool of white string
1 pack of pipe cleaners
8 packs of kidney beans
1 bag of Alaska peas (1/4 lb)
1 bag of colored beads
1 box of flat toothpicks
16 small binder clips
100 g sodium polyacrylate
1 measuring scoop

Needed, but not supplied:

scissors
water
clay or malleable dough (for optional activity)

Classroom Options

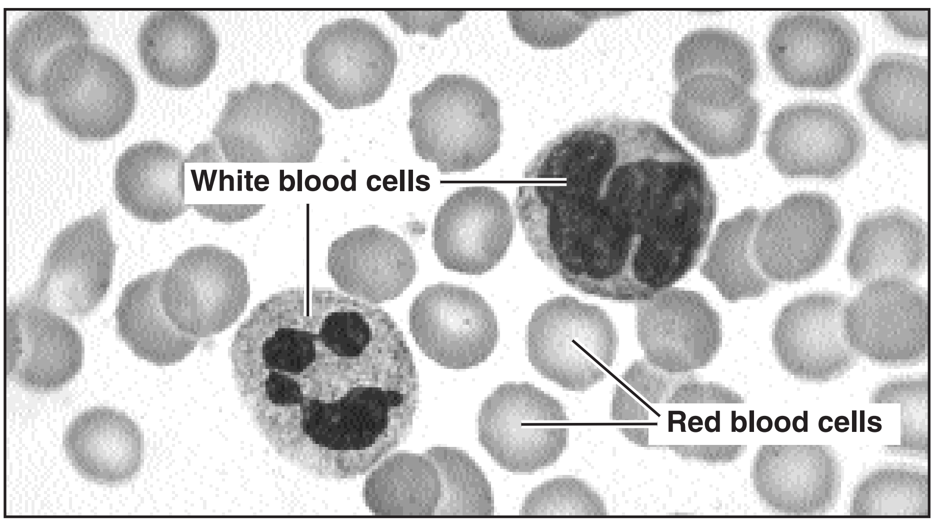
This Baggie Cell Model activity has been designed for a class of 32 students working in pairs. For smaller classes, students may work independently. For larger classes, students may work cooperatively in groups.

Background Information

The **cell** is the basic unit of life on earth. All living things are composed of cells. Living things might take the form of small, simple, unicellular organisms like bacteria, or the form of large, complex, multicellular organisms like pine trees and humans. Generally speaking, the cells of complex, multicellular organisms are specialized cells. Each cell has a specific job and this job is reflected in the shape and structures of the cell itself. Specialized cells are organized into tissues, tissues into organs, and organs into complex organisms. A discussion of several specialized cell types in humans will illuminate some of the ways in which cells are designed to perform certain specific functions.

Red Blood Cells

There are about 25 trillion red blood cells in the human body. Red blood cells are unique in that they do not contain genetic material; they discard their nuclei (singular, **nucleus**) soon after being created in bone marrow. Red blood cells contain a protein called hemoglobin that binds and carries oxygen to all of the other cells of the body. Red blood cells are made at a tremendous rate—120 million every minute—and live in the body for about four months. These small, round, flexible cells are designed for ease of movement, well suited to travel through the narrow veins and capillaries of the circulatory system.

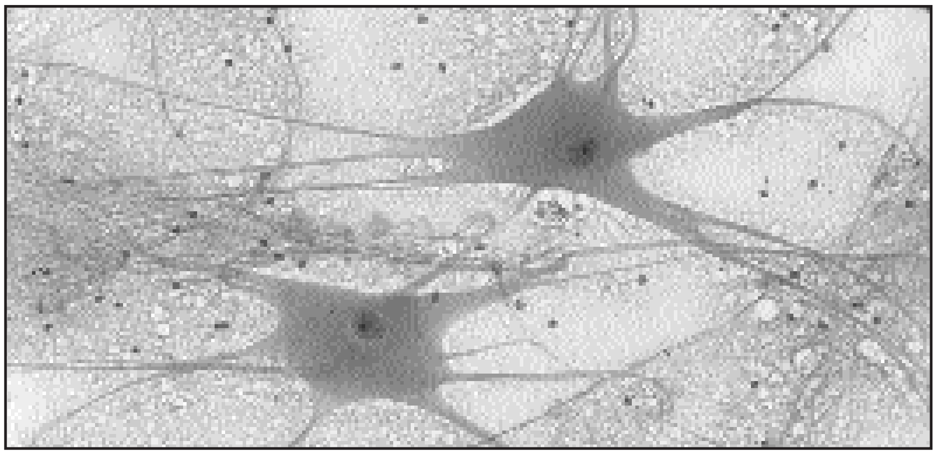


White Blood Cells

There are five major types of white blood cells in the human body. Each has a specific function but, in general, the job of white blood cells is to protect the body from infection by viruses and bacteria. Two important types of white blood cells are phagocytes and lymphocytes. Phagocytes eat bacteria that infect the body. Flexible **cell membranes** and specialized proteins make them good at detecting and destroying these invaders. Phagocytes also eat dead body cells. Lymphocytes, on the other hand, create antibodies. Antibodies are proteins that specifically tag invaders for destruction. Like red blood cells, white blood cells are made in bone marrow. There are 5,000 to 10,000 white blood cells in every drop of human blood. This number increases when viruses or bacteria infect the body.

Neurons

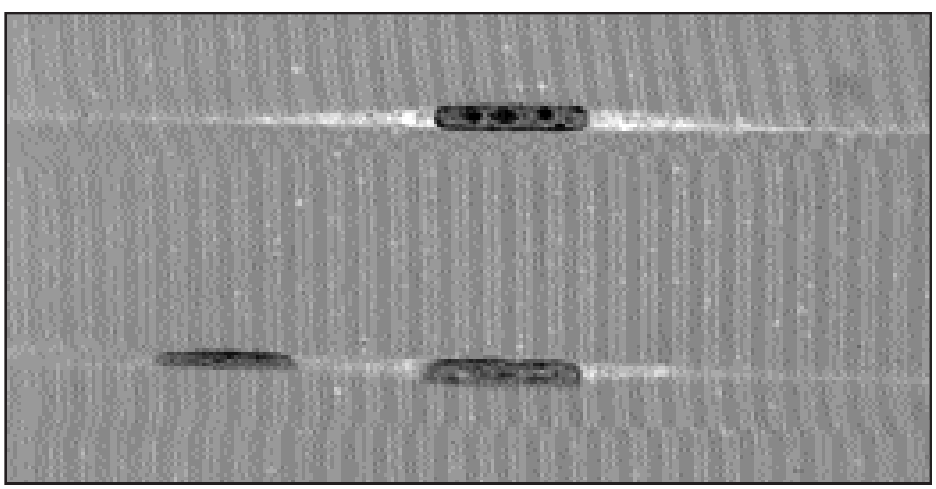
Neurons, nerve cells or brain cells, are the sensory cells that make up the nervous system. These highly specialized cells are characterized by long, branch-like extensions called axons. Axons have smaller branches called dendrites. These branches make it possible for neurons to send messages over long distances and receive messages from all over the body. Nerve cells carry messages around the body, from one nerve cell to another and also from nerve cells to muscle cells. Until recently, scientists believed that nerve cells could not regenerate; that is, if a nerve cell were destroyed, a new cell would not be made to replace it. However, there is recent evidence that some nerve cells are able make new cells.



Neurons

Muscles

Muscle cells are responsible for the body's movement. Muscle cells are long, thin, and flexible, and are organized into bundles. A bundle of muscle cells makes up a muscle. Muscle cells contain two important proteins, actin and myosin, which allow them to stretch. Unlike red blood cells, which do not have nuclei, muscle cells are multi-nucleated. They actually have more than one nucleus per cell.



Skeletal muscle

Form Fits Function

The shape of a cell is related to the job it performs. This is a concept in biology called "form fits function." For example, red blood cells are small, circular, and flexible, making it possible for them to fit through veins and capillaries. A red blood cell can twist to fit through a passage half the width of the cell itself. Problems arise when the cell's shape is altered. Sickle cell anemia is a disease that causes red blood cells to be shaped unusually, like a crescent moon or sickle. These cells tend to get stuck in narrow veins and block the flow of blood. These blockages can lead to strokes or blindness, and can cause damage to the lungs, kidneys, or heart. Sickle cell anemia is an excellent example of where a change in the shape of the cell interferes with the cell's ability to do its job.

Cell Parts

Although animal cells are specialized, they have the same basic components. Animal cells have cell membranes, a nucleus, and DNA that help them to do their specific jobs. An animal cell can also be compared to a factory. Like a factory, a cell consists of many individual parts that work together. Parts of an animal cell are described below.

Cell Membrane

The cell membrane provides the cell with its shape and structure. The cell membrane is made of lipids, or fats, which are stacked in two layers surrounding the cell. The cell membrane is a soft, flexible structure that protects the inside of the cell from the outside world. The cell membrane is semipermeable. The semipermeable membrane ensures that molecules needed within the cell (e.g., oxygen and food) can enter, waste can exit, and substances that might harm the cell are excluded. Anything that attacks the cell, such as viruses, has to get past the cell membrane.

Nucleus

The nucleus is the control center of the cell. It is the place where hereditary information—the DNA—is located. DNA does not leave the nucleus. Instead, it sends messages out from the nucleus to rest of the cell.

DNA

Deoxyribonucleic acid, or DNA, is the cell's hereditary material. It is arranged in a twisted ladder or "double helix" shape. A complete set of genetic instructions is present in the DNA of each cell. If the DNA in one human cell were stretched out to its full length, the DNA would measure 6 to 8 ft (about 2 m) long. To fit inside a tiny nucleus, DNA is tightly packaged into 46 chromosomes. Chromosomes are passed from parents to children. Each human parent contributes 23 chromosomes to its offspring, resulting in a total of 46 chromosomes.

Organelles

The word **organelle** means "little organ." As the name indicates, organelles are the microscopic, specialized organs of a cell, the individual "factory workers" that make it possible for the cell to conduct functions necessary for life. Note that organelles are also specialized; each organelle has a distinct structure that qualifies it for its specific role.

Mitochondria

The **mitochondria** are responsible for converting glucose (food brought to the cells by the bloodstream) into energy that cells can use. It is in the mitochondria that our food is "burned." For this reason, the mitochondria can be considered the "power plants" of the cell.

Ribosomes

Ribosomes make proteins. The DNA sends a messenger molecule, called RNA, to the ribosomes. The ribosome "reads" the RNA and attaches amino acids together in a chain. This chain folds to make a protein. Proteins play important roles in the human body. Many of the structural components of the body are proteins. Keratin, which makes up our hair, is a protein, and so is the melanin that gives our skin and hair its color. Ribosomes exist as both free organelles within the cell's **cytoplasm** (which gives the cell fluidity and shape) and as organelles associated with the endoplasmic reticulum.

Endoplasmic reticulum

The **endoplasmic reticulum**, or ER, acts as a passageway for molecules in the cell to travel through. For this reason, its shape is long and ribbon-like. There are two types of ER: rough and smooth. Rough ER is covered with ribosomes. Smooth ER is not.

Golgi apparatus

The role of the **Golgi apparatus** is to package molecules or proteins for secretion out of the cell. These secretions act as messages moving from one cell to another.

Lysosomes

Lysosomes break down molecules in the cell. In human cells, lysosomes break down organic material to be reused by the cell. For example, in a human liver cell, half of all the molecules in the cell are recycled every week.

Microtubules

Microtubules are rod-like structures that help the cell maintain its shape. Microtubules also act as a railway system that other molecules travel on to move through the cell.

Introductory Discussions

Use the information in this section to facilitate class discussion and help students understand animal cell structure and the concept of specialization. You may wish to read aloud all or parts of the text, paraphrase the information, or ask questions aloud and invite student responses. Refer to the Background Information section as necessary. The goal of the discussions is to help students acquire an appreciation of the diversity of cell types and to learn how different parts of a cell help the cell do its job.

Specialization

What is one characteristic shared by all living things? Living things are composed of cells, also called "the building blocks of life." *Are all cells the same?* Yes and no. Cells have many of the same basic parts, but there are many different types of cells that do many different things and therefore have many different structures. The structure of a cell enables it to perform its function in the body. The idea that "form fits function" is called **specialization**.

Why is specialization important? Here is one example: because of its rounded shape, a red blood cell is specialized to carry oxygen to all of the other cells in the body. It is able to twist and move through very small passages in the body (arteries and veins). Red blood cells that are not shaped properly (such as sickle cells, which are shaped like a crescent moon) can get stuck in veins and arteries and can not carry out their function effectively. You may wish to reinforce this concept with the optional activity, *Specialization in Red Blood Cells*, below.

Optional Activity:
Specialization in Red Blood Cells

- Before the lesson, gather two equal portions of clay or malleable dough. Mold one portion to resemble a normal, round red blood cell. Mold the other portion to resemble an abnormal, crescent-shaped red blood cell (a sickle cell).
- Review with your students the concept of cell specialization.
- Show both of the cell models to your students. Have them observe and maneuver the cell models as if they were moving through small passages. Discuss with your students how the shape of each cell will affect its function. *Now that you understand the purpose of the shape of the cell, what about what is inside of a cell?* A cell consists of several parts: the nucleus, DNA, cell membrane, and the organelles.

Parts of an Animal Cell

Two animal cell diagram blackline masters are included with this manual. Page 14 of the Teacher's Manual is the labeled version and Page S-4 (Student Worksheet) is unlabeled. Use the labeled version as a class discussion handout and the unlabeled as an assessment, or have students label the unlabeled version during class activities. (Note that there are minor variations in cell parts between the *Animal Cell Diagram* and the *Baggie Cell Model Worksheet* and model.) Photocopy the reproducible *Animal Cell Diagram* of your choice and distribute one copy to each student. Have students refer to this diagram as you explain the parts of an animal cell and the functions of the organelles as discussed in the Background Information section. Continue to refer to the diagram as you discuss the parts of a cell in the following discussions and activities.

Cell Parts: Factory Metaphor

What is a factory? A factory is a place where something is made. *How is a cell like a factory?* Cells are like factories that make proteins. Each part of a cell can be compared to a part of a factory, and each part will be represented in the baggie cell model that students will create. To reinforce these comparisons, create a table on the board or overhead (or have students make a table in their notebooks) with the headings, "Factory Parts," "Cell Parts," and "Model Parts." Brainstorm or list parts of a factory (see the example below) and then have students name corresponding cell parts by form, function, or location. As a group, fill in the "Cell Parts" column of the table and then describe what object will represent the cell part in the model that students will make (see Table 1).*

Factory Parts	Cell Parts	Model Parts
factory walls	cell membrane	plastic bag
boss's office	nucleus	plastic egg
boss	DNA	white string
secretary's office	rough endoplasmic reticulum	pipe cleaner with colored beads
secretary	ribosomes	colored beads
support beams	microtubules	toothpicks
hallways	smooth endoplasmic reticulum	pipe cleaners
raw materials	nutrients/amino acids	sodium polyacrylate
power plant	mitochondria	kidney beans
shipping department	Golgi apparatus	green yarn
recycling area	lysosomes	Alaska peas
atmosphere	cytoplasm	gelled water

Table 1. Factory, Cell, and Model Parts Comparison

*These comparisons are intended as examples and are simplified and generalized for the purposes of this activity. You may wish to omit or change the comparisons or create your own metaphor, such as a school, a city, or a vehicle.

Lesson Instructions

Before the Lesson

- Cut the white string (DNA) into pieces approximately 6 to 8 feet long. Cut enough for each student pair to have one piece of string.
- Cut the green yarn (Golgi apparatus) into pieces approximately 6 inches long. Cut enough for each student pair to have three pieces of yarn.
- Create a measuring station where students can dispense 2 scoops of sodium polyacrylate and fill their measuring cup with 6 oz of water.
- Photocopy one set of the *Student Instructions* for each student.

During the Lesson

In this activity, students will build a model animal cell, making a correlation between the materials of the model and specific cell parts and organelles. As each new piece of the model is added, review with students the shape and function of the represented cell part or organelle. The step-by-step instructions from the *Student Instructions* blackline master are reproduced below.

- Distribute one copy of the *Student Instructions* to each student.
- Distribute one plastic plate to each pair of students.
- Have students build a baggie cell model following the directions on the *Student Instructions* sheet.

1. Collect the following materials for your pair and place them on your plate:

   1 plastic cup
   1 plastic bag
   20–30 Alaska peas
   15–20 kidney beans
   20 colored beads
   5 toothpicks
   2 pipe cleaners of the same color
   3 strands of green yarn
   1 strand of white string
   1 measuring cup
   1 plastic egg
   1 binder clip

2. Place the plastic bag (cell membrane) inside the plastic cup. Fold the edges of the plastic bag over and around the lip of the cup, like a bag inside a garbage can.
3. Place the Alaska peas (lysosomes), kidney beans (mitochondria), toothpicks (microtubules), and green yarn (Golgi apparatus) inside the plastic bag in the cup.
4. Take 10 of the colored beads (ribosomes) and thread them onto 1 pipe cleaner (endoplasmic reticulum). Space the beads apart evenly. Bend the pipe cleaner to resemble the shape of endoplasmic reticulum by folding it back and forth. Place the bent pipe cleaner with colored beads (rough endoplasmic reticulum) inside the plastic bag in the cup.

5. Bend the remaining pipe cleaner to resemble the shape of endoplasmic reticulum. Place this bent pipe cleaners (smooth endoplasmic reticulum) inside the plastic bag in the cup.
6. Place the remaining colored beads (ribosomes) inside the plastic bag in the cup.
7. Bring your cup (with the plastic bag inside) to the measuring station. Using the measuring scoop, put two level scoops of sodium polyacrylate (nutrients/amino acids) inside the plastic bag in the cup.
8. Take the white string (DNA) and place it inside the plastic egg (nucleus). Close the plastic egg tightly and set it aside.
9. Fill your measuring cup with 6 oz of water. Carefully pour the water inside the plastic bag in the cup. The sodium polyacrylate you added in Step 7 will swell in the presence of water to give the water a gel-like consistency.
10. Place the plastic egg (nucleus containing DNA) inside the plastic bag in the cup. It will float on top of the water.
11. Carefully remove the plastic bag from the cup. Close the bag slowly, pushing all of the air out of the bag as you seal it.
12. *Gently* massage the bottom of the bag to aid in gelling the water. Be very careful not to puncture the bag with the toothpicks or pipe cleaners. The gelled water represents the cytoplasm of the cell.
13. Roll up the extra plastic at the top of the bag by folding it over repeatedly. Attach a binder clip to the folded portion of the plastic bag.
14. Now you have created a model of an animal cell! Examine your baggie cell and its components by moving it around in your hands.

Questions for Discussion

1. What materials could you use to substitute for those that you used to build this cell model?
2. Do you think this model accurately resembles what a cell would look like?
3. In addition to a factory, what other places or things could you compare a cell to? What could you compare different cell parts to?
4. Can you think of any people, animals, or machines that are specialized? What do they do well? What traits make them able to do a particular job well?

Follow-Up Activities

1. Follow a procedure similar to the one in this kit and have students create model plant cells. Afterward, have them compare the structural differences between plant and animal cells.
2. Have students come up with their own ideas for other ways to model a cell. Some suggestions:
   - Use edible gelatin and fruit or fruit cocktail to make an edible cell model.
   - Bake a "cell model" cake. Bake the cake and allow the students to decorate the top of the cake to resemble a cell.
   - Create a cell model out of a large sponge and common objects such as buttons, beads, marbles, cotton balls, and rubber bands.
3. Assign each student an organelle or a specialized human cell to learn more about. Have students provide illustrations and oral or written reports about the organelle or cell.
4. Have students observe animal and plant cells under a microscope.
5. Compare the functions of the body with the functions of the cell. For instance:

Human Body Part	Function	Cell Part
Lungs	Respiration	Mitochondria
Kidneys	Excretion	Cell membrane

Learning Assessment Questions

1. Have your students complete the reproducible handout on page S-3 of this booklet, the *Baggie Cell Model Worksheet*.
   This will demonstrate their knowledge of what they have learned in this exercise.
2. Have your students draw an animal cell and label the parts of the cell.
   Drawings will vary.
3. Name four specialized cell types, their shapes, and the functions that they perform.
   Red blood cells are rounded so that they can carry oxygen through the narrow circulatory system. White blood cells have sensitive cell membranes and proteins that protect the body from infection or produce infection fighting antibodies. Neurons have long branches so that they can send and receive messages throughout the body. Muscle cells are long and narrow and clustered so that muscle groups can expand and contract and allow the body to move.
4. What is specialization?
   Specialization means that each cell has a specific job and this job is reflected in the shape of the cell itself.

Glossary

Cell – an organism's basic unit of structure and function

Cell Membrane – the soft, flexible structure that acts as a selective barrier protecting the inside of the cell

Cytoplasm – all of the contents of the cell outside the nucleus but within the plasma membrane; it gives the cell fluidity and shape

Deoxyribonucleic Acid – DNA, the hereditary material of a cell; DNA carries the genetic information for making the cell's proteins

Endoplasmic Reticulum – the network of tubules and sacs through which cell molecules travel

Golgi Apparatus – the organelle that packages molecules and proteins for secretion out of the cell

Lysosome – a membrane-enclosed sac of enzymes used to digest reused organic materials

Microtubules – straight, hollow rods found in the cytoplasm of eukaryotic cells that shape and support the cell; microtubules also act as "tracks" for other molecules to travel on

Mitochondria – (singular, **mitochondrion**) organelles in eukaryotic cells responsible for converting glucose in the bloodstream into pure energy for use by the cell

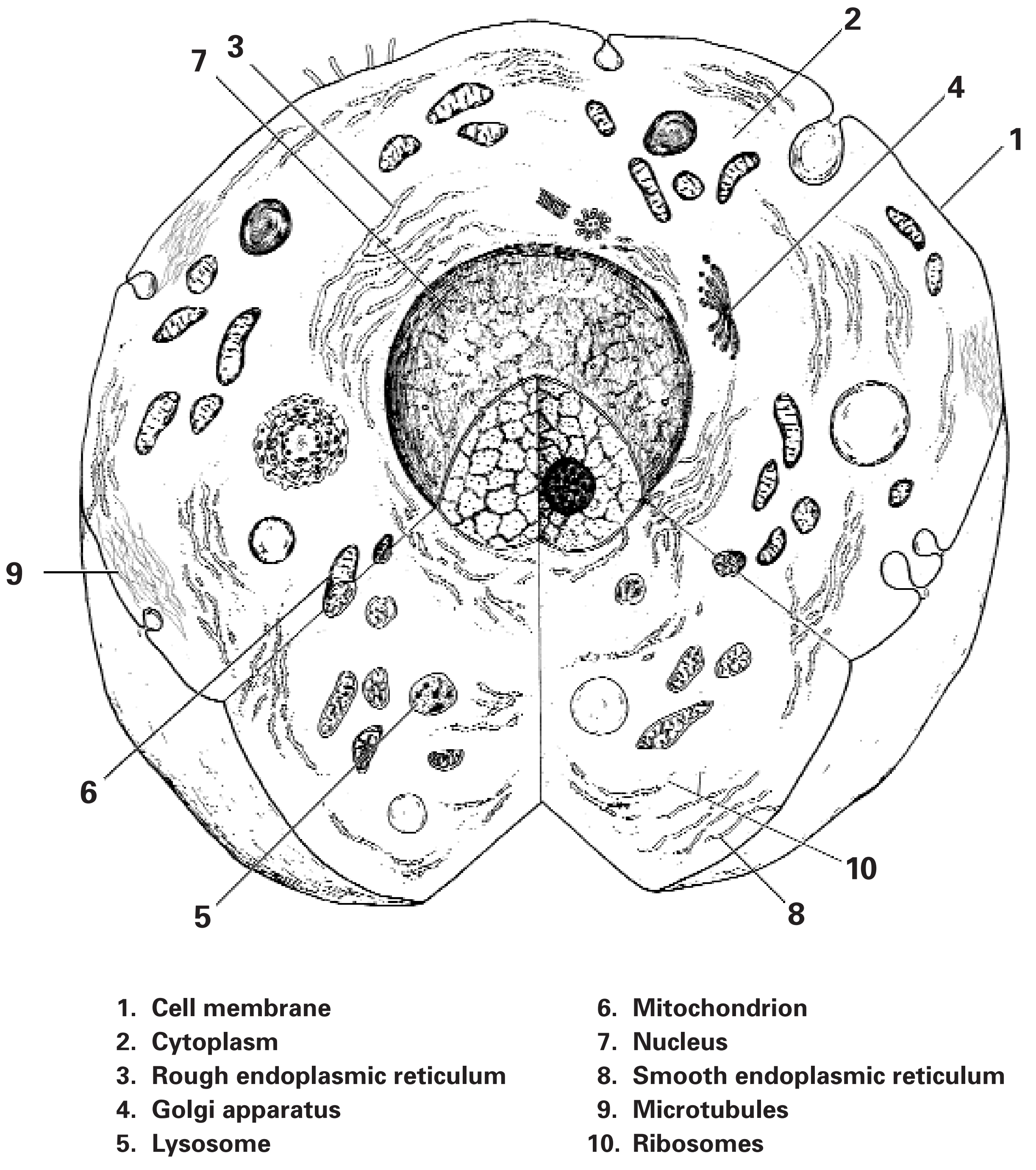
Nucleus – the control center of the cell; it contains the cell's DNA

Organelles – microscopic organs of a cell, each having a specialized function or functions

Ribosomes – organelles where proteins are made

Specialization – in biology, the concept of "form fits function," that each cell has a specific job and that this job is reflected in the shape of the cell itself

Animal Cell Diagram



1. Cell membrane
2. Cytoplasm
3. Rough endoplasmic reticulum
4. Golgi apparatus
5. Lysosome
6. Mitochondrion
7. Nucleus
8. Smooth endoplasmic reticulum
9. Microtubules
10. Ribosomes

Name ______________________

Date ______________________

Baggie Cell Model

1. Collect the following materials for your pair and place them on your plate:

   1 plastic cup
   1 plastic bag
   20–30 Alaska peas
   15–20 kidney beans
   20 colored beads
   5 toothpicks
   2 pipe cleaners of the same color
   3 strands of green yarn
   1 strand of white string
   1 measuring cup
   1 plastic egg
   1 binder clip

2. Place the plastic bag (cell membrane) inside the plastic cup. Fold the edges of the plastic bag over and around the lip of the cup, like a bag inside a garbage can.
3. Place the Alaska peas (lysosomes), kidney beans (mitochondria), toothpicks (microtubules), and green yarn (Golgi apparatus) inside the plastic bag in the cup.
4. Take 10 of the colored beads (ribosomes) and thread them onto 1 pipe cleaner (endoplasmic reticulum). Space the beads apart evenly. Bend the pipe cleaner to resemble the shape of endoplasmic reticulum by folding it back and forth. Place the bent pipe cleaner with colored beads (rough endoplasmic reticulum) inside the plastic bag in the cup.
5. Bend the remaining pipe cleaner to resemble the shape of endoplasmic reticulum. Place this bent pipe cleaners (smooth endoplasmic reticulum) inside the plastic bag in the cup.
6. Place the remaining colored beads (ribosomes) inside the plastic bag in the cup.
7. Bring your cup (with the plastic bag inside) to the measuring station. Using the measuring scoop, put two level scoops of sodium polyacrylate (nutrients/amino acids) inside the plastic bag in the cup.
8. Take the white string (DNA) and place it inside the plastic egg (nucleus). Close the plastic egg tightly and set it aside.
9. Fill your measuring cup with 6 oz of water. Carefully pour the water inside the plastic bag in the cup. The sodium polyacrylate you added in Step 7 will swell in the presence of water to give the water a gel-like consistency.

10. Place the plastic egg (nucleus containing DNA) inside the plastic bag in the cup. It will float on top of the water.
11. Carefully remove the plastic bag from the cup. Close the bag slowly, pushing all of the air out of the bag as you seal it.
12. *Gently* massage the bottom of the bag to aid in gelling the water. Be very careful not to puncture the bag with the toothpicks or pipe cleaners. The gelled water represents the cytoplasm of the cell.
13. Roll up the extra plastic at the top of the bag by folding it over repeatedly. Attach a binder clip to the folded portion of the plastic bag.
14. Now you have created a model of an animal cell! Examine your baggie cell and its components by moving it around in your hands.

Student Worksheet

21-1336

Name ______________________

Date ______________________

Baggie Cell Model

Look at your baggie cell model. Identify the animal cell parts listed and complete the table below. Write down what material was used in the model to represent each cell part, then write down the specialized function of each cell part.

Structure	Material Used in Model	Function
Cell Membrane		
Nucleus		
DNA		
Mitochondrion		
Ribosomes		
Smooth and Rough Endoplasmic Reticulum		
Golgi Apparatus		
Lysosomes		
Microtubules		
Nutrients/Amino Acids		
Cytoplasm		

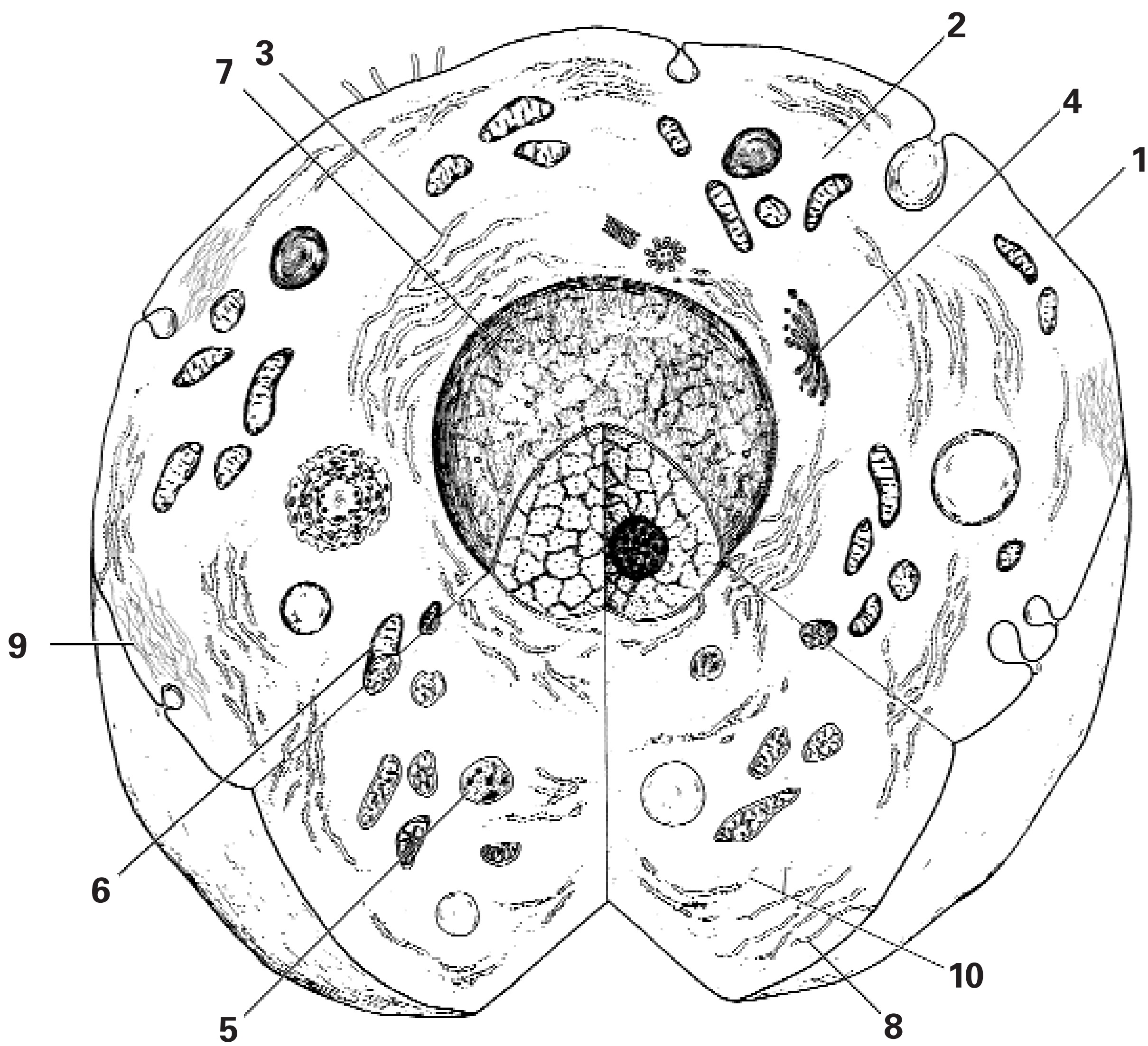
Student Worksheet

21-1336

Name ______________________

Date ______________________

Animal Cell Diagram



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