Summer Work for Rising Sophomores

Dear Students, Parents, and Guardians,

This document contains the summer work for rising sophomores who will be taking Biology next year.

Our goal for Biology is to prepare for the Biology Keystone Exam that is required for high school graduation. Biology is traditionally a difficult subject because there is a lot of new vocabulary and concepts that students must learn. Further, with our format of classes on Monday/Wednesday/Friday or Tuesday/Thursday we have less time to reinforce these terms and concepts in the classroom. To be successful, scholars must take the initiative to spend time with Biology outside of the classroom.

To assist with our goals, I have assembled a packet of worksheets that cover the first two topics that we will cover in class in the fall. You are responsible for completing this material over the summer. Please print out and complete the worksheets, or write your answers on a separate piece of paper. You will hand in your answers on the second day of class. This will count towards your first marking period grade.

If you want to have an additional head start for the coming year, you could also spend time working on your Biology Keystone Vocabulary. Having a firm grasp of the vocabulary is key to scoring proficient or advanced on the Biology Keystone Exam. It will help you on both the multiple choice and the constructed response questions.

Head over to quizlet.com and search for Keystone Biology. For example you might find this set of vocabulary words:

https://quizlet.com/171279367/keystone-biology-flash-cards/

I look forward to being with you next year in Biology.

Michael P. King, Ph.D.

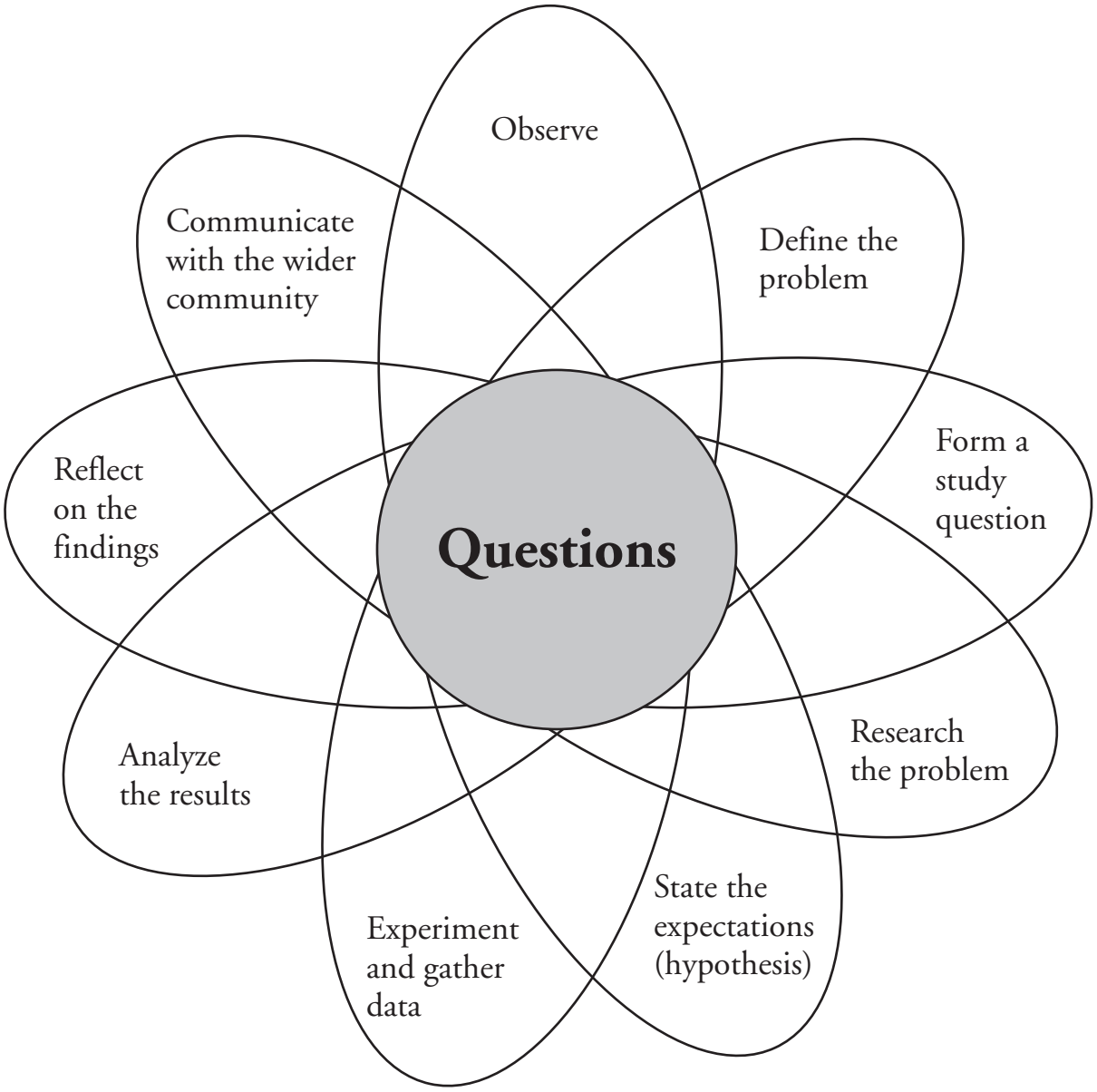
Scientific Inquiry

What do scientists do?

Why?

Science is a unique way of learning about the natural world. Scientists work hard to explain events, living organisms, and changes we see around us every day. Model 1 depicts typical activities or stages scientists engage in when conducting their work. The design of the model shows how various steps in scientific inquiry are connected to one another. None of the activities stands alone—they are all interdependent.

Model 1 – Scientific Inquiry



1. What is the central theme of all scientific inquiry as shown in Model 1?

2. What are the nine activities that scientists engage in as part of scientific inquiry?

3. Which of the activities would require a scientist to make some observations?

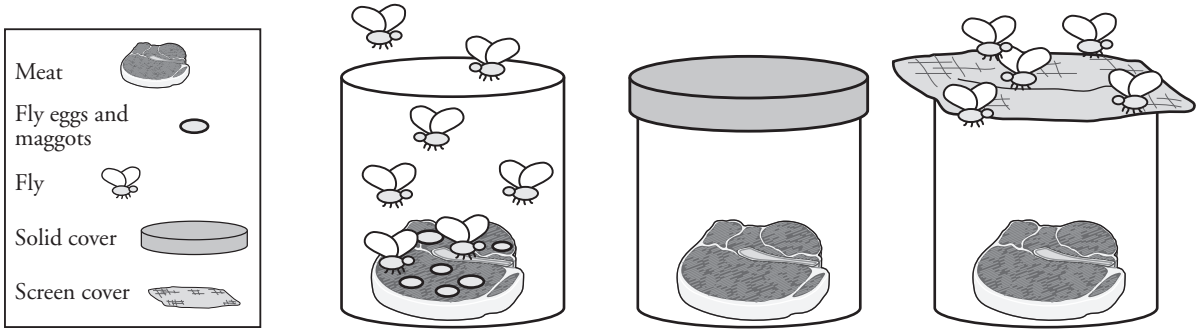
4. Which of the steps would require a scientist to gather data?

5. Considering the activity described as "communicating with the wider community," in what ways might a scientist communicate?

6. Remembering that scientists often work in teams, which activities would require a scientist to communicate with others?

7. Given your responses to Questions 1–6, do you think these activities must be carried out in a specific order or can multiple activities be carried out at the same time? Justify your response by giving examples to support your answer.

Model 2 – Redi's Experiment



Container 1 **Container 2** **Container 3**

The table below represents the ideas the Italian scientist Francesco Redi (1626–1698) might have had as he was carrying out his experiments. The questions that follow the table relate to the process Redi may have used.

Discovery of flies and maggots on a piece of meat.	**Scientific Inquiry**
Where did the flies and maggots come from?	
Are the maggots and flies "related"?	
Gather information about the origins of flies and maggots. The year is 1668 and no scientific studies are available, but the common belief is that living things such as flies can be generated from nonliving things, such as rotting meat. This belief is known as *spontaneous generation*.	
Does meat spontaneously generate flies and maggots?	
If I leave a container of meat open and seal another container, then both should create flies and maggots.	
Set up two containers with meat; one will be open and one will be covered. Leave them for several days.	
Flies and maggots are found in the jar with no cover (1) but not in the covered jar (2).	
Was the reason for no flies in the second jar due to the "bad air" being sealed in the jar, which stopped the flies and maggots from being generated by the meat?	
Run the experiment again adding a third jar with a fine mesh cover. Flies and maggots are only found in the open jar.	
Flies lay eggs on the meat, which hatch into maggots, which become flies.	
Flies lay eggs on the meat, which form maggots which become flies.	

8. What year did Redi carry out his experiment?

9. *a.* Describe the accepted theory during Redi's time explaining the origin of the flies.

   b. What was this theory called?

10. How many experiments/jars did Redi set up the first time?

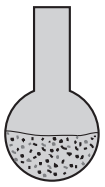
11. What was the purpose of having one jar left open and the other one sealed?

12. Why did Redi carry out another experiment with three jars?

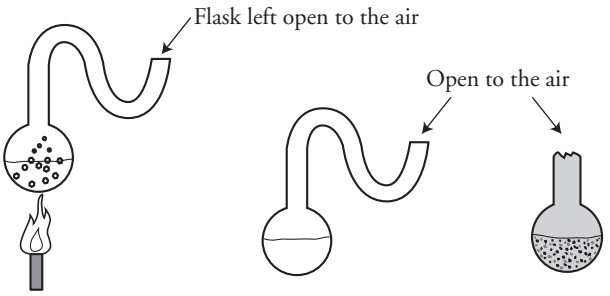
13. Using the nine activities from Model 1, complete the table in Model 2 for each of the processes Redi completed in his investigation.

Extension Questions

Model 3 – Pasteur's Experiment



Flask of nutrient broth left open to the air. After several days, bacteria are seen in the flask.



Part 1
Flask containing nutrient broth is boiled, killing any bacteria present. The goose neck shape allows air to enter but traps bacteria.

Part 2
After several days there is still no bacterial growth in the flask.

Part 3
The neck of the flask is broken and bacterial growth is observed in the broth after several days.

14. Study the diagrams above of another famous experiment by French chemist and microbiologist Louis Pasteur (1822–1895), which fully refuted the idea of spontaneous generation. Create a table similar to the one in Model 2 to outline the experimental processes that Pasteur carried out.

15. Had you been Louis Pasteur what would have been your reflections and conclusions based on this experiment?

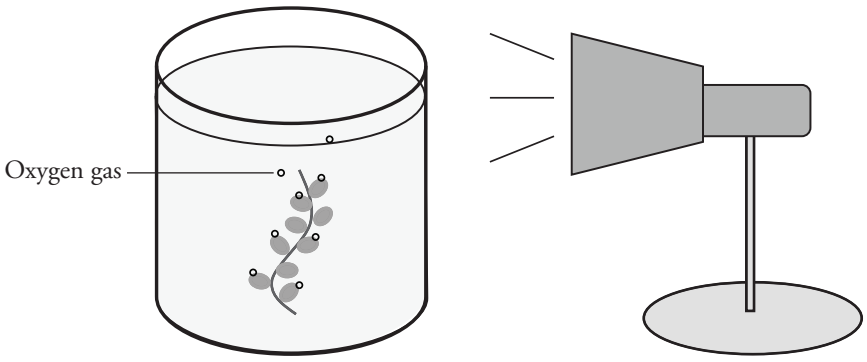
Experimental Variables

What is measured during a controlled experiment?

Why?

When scientists set out to do an experiment, they first think about the variables that may affect the outcome of the experiment. A **variable** is any condition that may cause a change in the system being studied. Some variables are measured quantitatively, like temperature, mass or height. Other variables are recorded in a qualitative manner, like color, texture or species. The most important factor is that the scientist runs a **controlled experiment**. In a controlled experiment, only one variable is changed to ensure that the effect of only that one variable can be measured.

Model 1 – Photosynthesis in an Aquatic Plant



1. The diagram in Model 1 illustrates a clipping of an aquatic plant in water.
   a. What process is occurring in the plant's cells to produce the gas in the bubbles that appear?

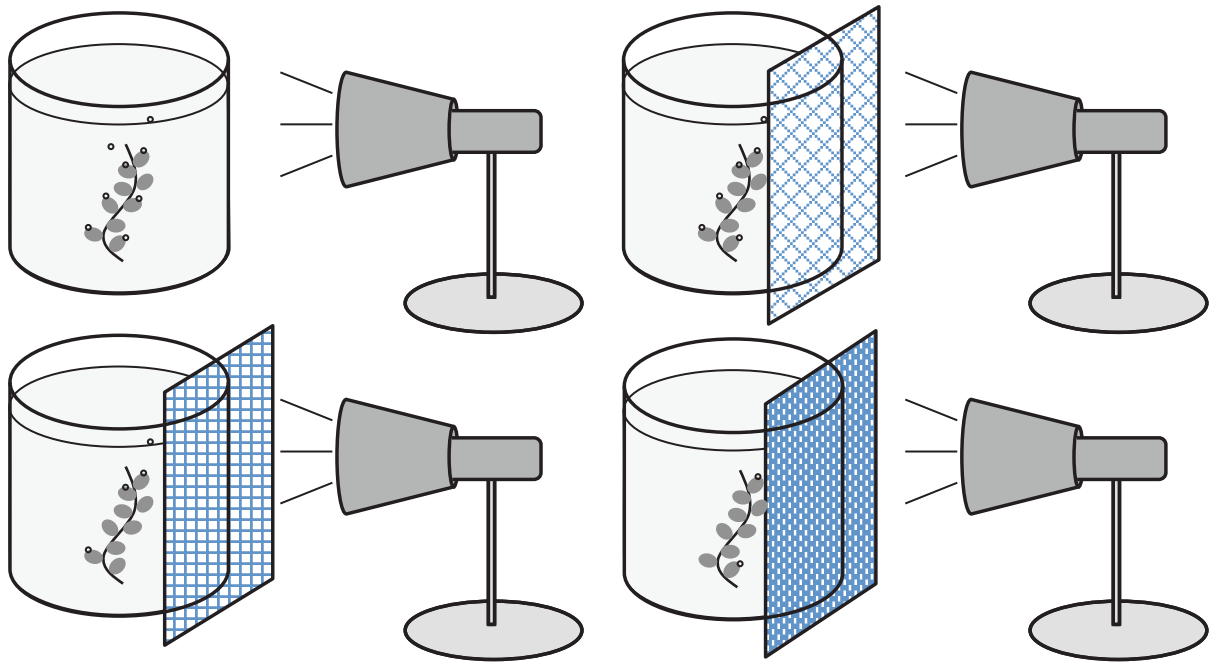
   b. What gas is the plant producing?

   c. What source of energy is the plant using to conduct the process recorded in part *a*?

2. Depending on the environment the plant is in, more or less gas may be produced. Suggest a method for measuring the rate of gas production from the aquatic plant in Model 1.

3. With your group, create a list of environmental factors that may affect the rate of gas production in the aquatic plant in Model 1. These factors could become variables in an experiment.

Model 2 – Aquatic Plant Experiment



4. Examine the four trials shown in Model 2. Identify several conditions in the experiment that are the same in each trial.

5. Describe the one condition that has been varied among the four trials in Model 2.

6. How does the condition described in Question 5 appear to affect the rate of gas production by the aquatic plant? Provide specific evidence from Model 2 to support your answer.

Model 3 – Aquatic Plant Data

	Length of clipping (cm)	Number of leaves on clipping	Lamp power (watts)	Percentage of light from lamp that reaches the plant	Number of oxygen bubbles formed in 10 minutes
A	12		40	100%	
B	12		40	75%	
C	12		40	50%	
D	12		40	25%	

7. Refer to the diagrams in Model 2 to complete the data table in Model 3.
8. The column headings in Model 3 each describe a variable in the experiment.
   a. What variable was purposefully changed in the experiment?

   b. What variable changed as a result of changing the variable listed in part *a*?

   c. What variable(s) in the Model 3 data table remained constant among all the trials?

Read This!

When designing an experiment, you need to consider three types of variables. The **independent variable** is changed by the experimenter in the design of the experiment. This variable is sometimes called the "manipulated variable." The **dependent variable** is what changes as a result of the change in the independent variable. This variable is sometimes called the "responding variable." In some cases more than one dependent variable is considered. The third category of variables is **controlled variables**. These are variables that you think may change the outcome of the experiment, but since they are not being studied, they need to be kept constant in each trial.

9. Identify the independent, dependent, and controlled variables for the experiment that produced the data in Model 3.

   Independent **Dependent** **Controlled**

Read This!

A well-written research question states the independent and dependent variables in the experiment. For example, a student investigated the effect of soil pH on the number of strawberries produced by a strawberry plant. Her research question was "How does the pH of soil affect the number of strawberries produced by a strawberry plant?"

10. Write a research question, using the format suggested in the *Read This!* box, for the experiment in Model 2.

11. A student wonders, "Does the moisture content in soil affect how far a worm can dig?" Identify the variables that are being considered in this experiment and the variables that need to be controlled.

Independent	**Dependent**	**Controlled**

Extension Questions

12. Scientists may design an experiment with a **control group**, which is a set of organisms or samples that do not receive the treatment (the independent variable) that is being tested. Scientists can then compare normal changes in organisms or samples with those that may have occurred because of the treatment. The idea of a control group is not the same as a controlled variable. Suppose a scientist is doing an experiment to determine the effect of an all-organic diet on the occurrence of cancer in rats.

    a. What variables should the scientist control in the experiment?

    b. Describe the control group for this experiment.

    c. Why is it important for a scientist to use a control group when working with organisms in an experiment?

Analyzing and Interpreting Scientific Data

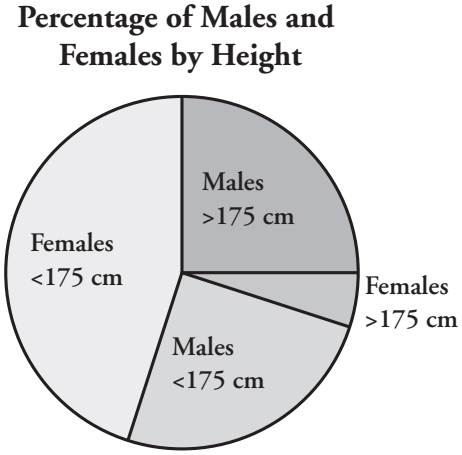
How can analyzing and interpreting scientific data allow scientists to make informed decisions?

Why?

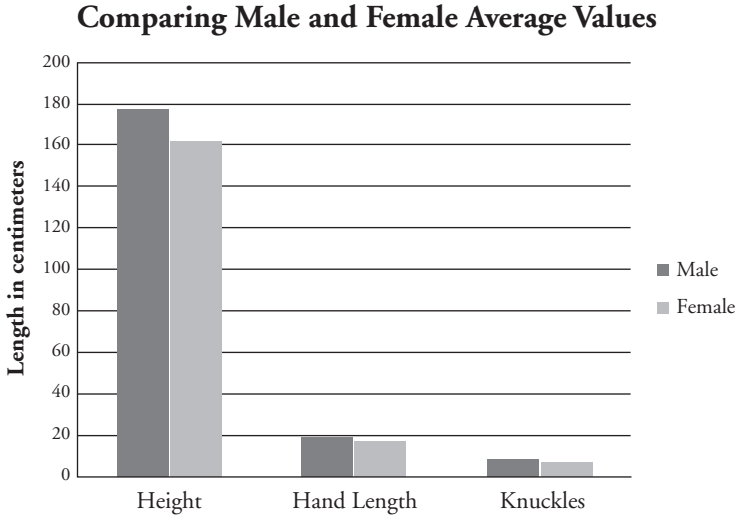
During scientific investigations, scientists gather data and present it in the form of charts, tables or graphs. The data must be properly collected, analyzed, and interpreted to allow scientists to make informed decisions regarding the validity of their study and any further work that may be necessary to achieve their objectives. The ability to present and use data charts, tables, and graphs correctly is essential for good scientific practice and also prevents unnecessary or inappropriate work and misinterpretation of the data.

Model 1 – Graphs and Charts of Classroom Measurement Data

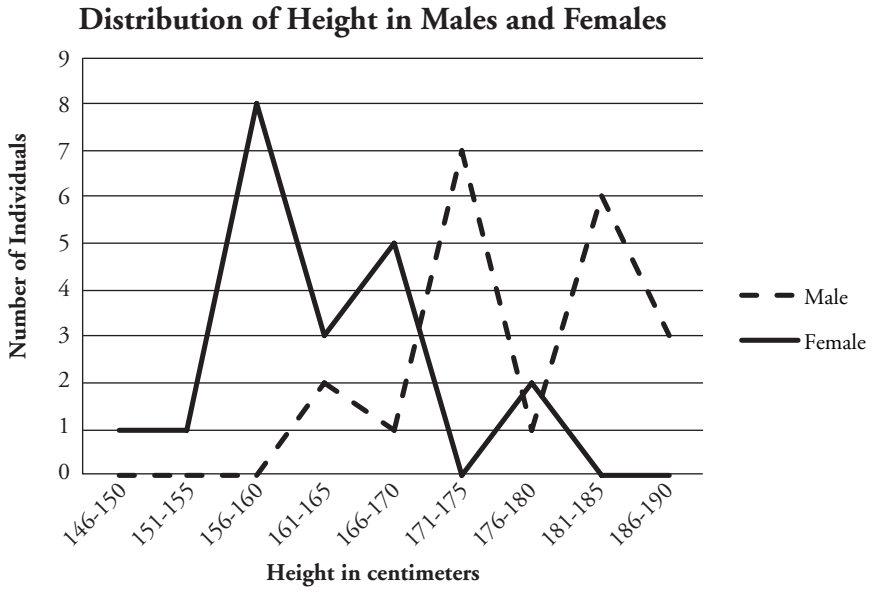
Pie Chart



Bar Graph



Line Graph



1. According to the data in Model 1, how many females fall within the range 146–155 cm tall?

2. According to the data in Model 1, how many males are 181 cm or above in height?

3. Using the graph(s) in Model 1, determine the approximate average height of males and of females.

4. Refer to the data in Model 1.
   a. How many males are taller than 175 cm and approximately what percentage of the total is that?

   b. Which graph(s)/chart(s) illustrate the answer to the previous question?

5. Which type of graph or chart in Model 1 shows a side by side comparison of data?

6. Which type of graph or chart in Model 1 shows trends in data across an entire data set?

7. Describe two trends in male and female height using the line graph.

8. Use complete sentences to compare the presentation of height data in the three graphs. Discuss any information that is located on more than one graph, and any unique information that is available on each.

9. If you wanted to see if a correlation exists between the height of an individual and his/her hand length, what would be the best type of graph/chart to make? Explain your reasoning.

10. What conclusions can you draw comparing the height, hand length, and knuckle width of males and females? State your conclusions in complete sentences.

Model 2 – Foot Width in a High School Classroom

Female foot width (cm)	Male foot width (cm)
7.8	10
8	10.5
8	9
5	9.3
17	13
7.5	7.5
7.5	10
7	9.2
7.8	9
7	4.5

Mean = $\frac{\text{sum of all data values}}{\text{number of data values}}$

Median = Middle value of an ordered set of data.

Mode = Most frequently occurring value in a set of data.

11. Refer to the data in Model 2.
    a. What value for foot width is most frequent in males?

    b. What is this value called?

12. Determine the median value for foot width for males and for females. Describe in complete sentences the method you used to determine the median values.

13. Determine the mean for each data group, and describe in a complete sentence how you calculated them.

Read This!

Within a data set there may be individual values that seem uncharacteristic or do not fit the general trend. These data points may be referred to as **outliers** or **anomalous data**. In most samples, a small number of outliers is to be expected, due to the variation inherent in any naturally-occurring population. Outliers can also result from errors in measurement or in the recording of data. Normal variation can often be distinguished from error by repeating the measurements to see if the same range is obtained. Scientists also use statistical calculations to determine the expected range of data, so that judgments can be made about the authenticity of individual data points. Outliers should not be ignored, however, as many interesting scientific discoveries have resulted from the study of such unexpected findings.

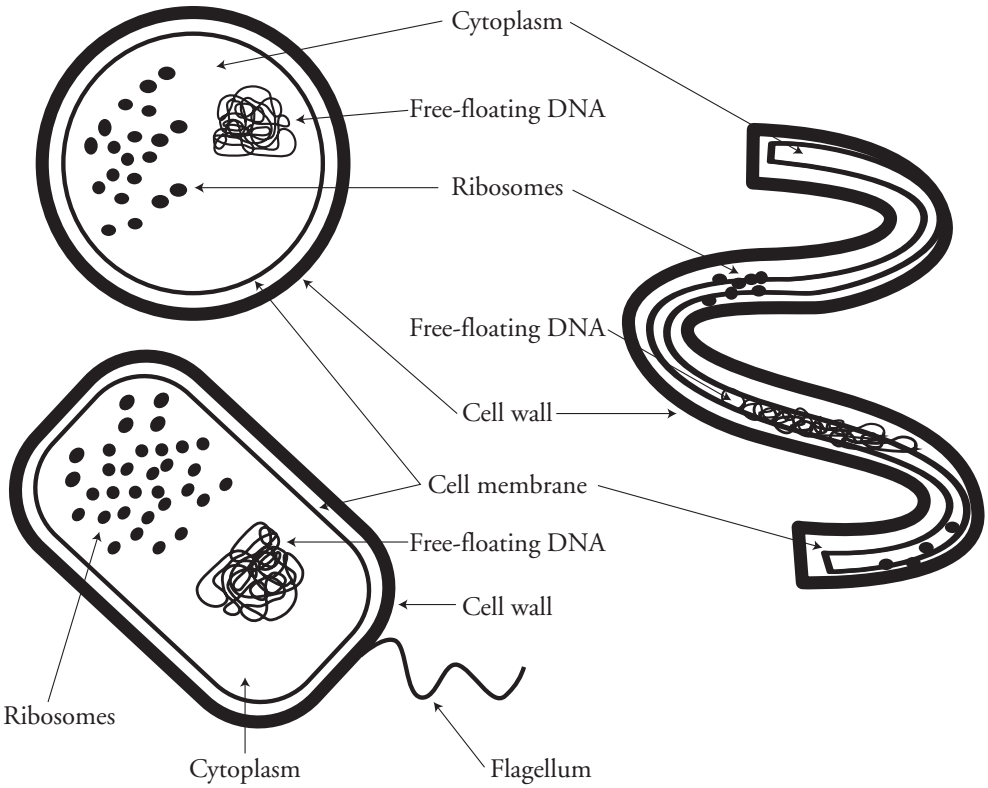
Prokaryotic and Eukaryotic Cells

Do all cells have the same structure?

Why?

An efficiency apartment is a one-room apartment. This one room is where you sleep, eat, shower, and entertain your guests. It all happens in one room. It is a simple way of living in a small space. A mansion is a large, complex living space with many separate rooms. There are rooms for cooking, eating, sleeping, bathing, reading, watching TV, entertaining guests, exercising, and storage. The rooms in a mansion are constructed for the specific things you would like to be able to do. You can live in simple efficiency or complexity. In this activity we will be looking at cells that are as simple as a one-room efficiency apartment or as complex as a mansion.

Model 1 – Three Types of Bacterial Cells



1. The three bacterial shapes in Model 1 are referred to as *coccus* (sphere), *spirillum,* and *bacillus* (rod). Label the diagrams in Model 1 with the correct descriptions.
2. What is represented by the small dots found in each of the bacteria cells?
3. What is the name of the outermost layer that forms a boundary around the outside of each cell?
4. How is the DNA described and what does this mean?

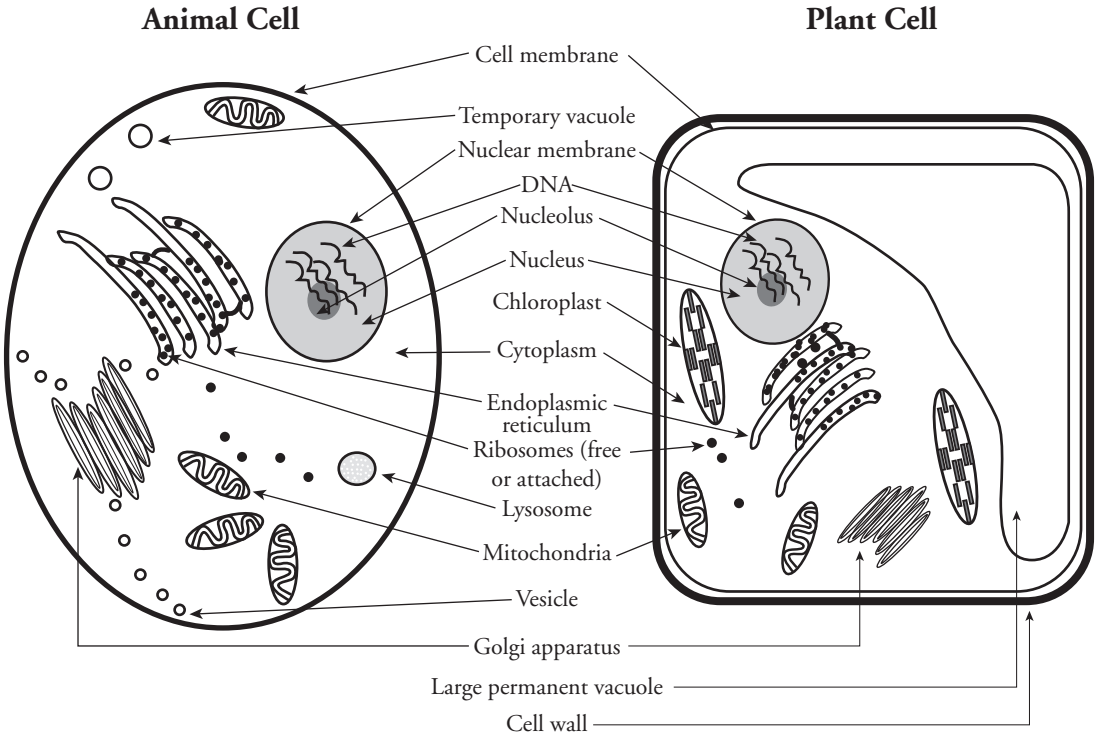
5. All the internal structures are suspended (floating) in what substance?

6. One of the bacteria in Model 1 has a tail-like structure.
   a. What is this structure called?

   b. What might be the purpose of this structure?

   c. Based on your answer to the previous question, what might you infer about the absence of this structure in the other two bacteria cells?

Model 2 – Animal and Plant Cells



7. Looking at Model 2, list at least three structural differences (other than shape) between an animal and a plant cell.

8. Where do you find the DNA in each cell in Model 2?

9. Do both cells in Model 2 have a nucleus?

10. List the structure(s) that form the boundary between the inside and the outside of each cell in Model 2.

11. What is different about the outermost boundary in a plant cell compared to an animal cell?

12. Decide as a group whether the cells in Model 1 or 2 are more complex and list at least three supporting reasons for your choice.

Model 3 – Structural Comparisons

Word Part	Meaning
pro	before
karyon	nucleus or kernel
eu	true

13. Use the chart in Model 3 to determine the meaning of the word prokaryote.

14. What does the word eukaryote mean?

15. Based on the above word definitions, label the cells in Model 1 and Model 2 as prokaryotic or eukaryotic.

16. By comparing Model 1 and Model 2, what structures are the same in both prokaryotic and eukaryotic cells?

17. What differences are there between a prokaryotic and eukaryotic cell?

18. Refer to Models 1 and 2 to complete the chart below. Write yes or no in the box for each cell.

	Bacterial Cell	**Animal Cell**	**Plant Cell**	**All Cells**
Cell Membrane				
Ribosome				
Cytoplasm				
Mitochondria				
Nucleolus				
Nucleus				
DNA				
Cell Wall				
Prokaryotic				
Eukaryotic				

19. As a group, write a definition for a prokaryotic cell.

20. As a group, write a definition for a eukaryotic cell.

21. Complete the phrase below. Each member must contribute one complete sentence. The words prokaryotic and eukaryotic must be used:

    All cells are not the same because…

22. As a group, discuss the opening analogy of an efficiency apartment and a mansion as it relates to cells. Record your final consensus of how this analogy applies to cell structure.

Extension Questions

23. What effect do you expect the structural differences between prokaryotes and eukaryotes to have on their functions? Explain in detail.

24. With as much detail as possible, give another example of an analogy for describing the difference between prokaryotic cells and eukaryotic cells.

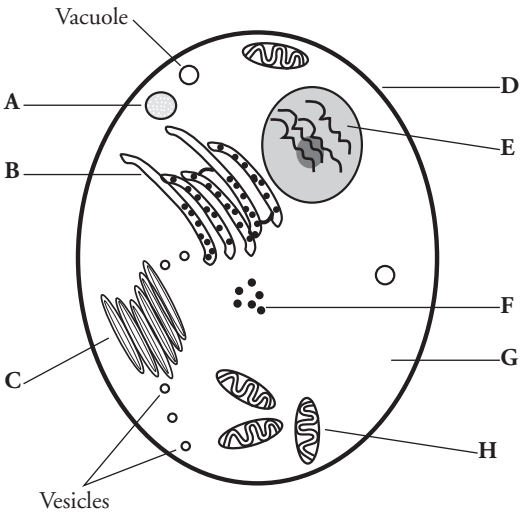
Organelles in Eukaryotic Cells

What are the functions of different organelles in a cell?

Why?

The cell is the basic unit and building block of all living things. Organisms rely on their cells to perform all necessary functions of life. Certain functions are carried out within different structures of the cell. These structures are called **organelles**.

Model 1 – How Is a Cell Like a Factory?



Part of factory	Cell organelle	Function
Control room (E)	Nucleus	Contains and protects genetic material (DNA)
Factory manager	DNA/chromo-somes	Information for making proteins
Assembly workers (F)	Ribosomes	Make proteins
Production line (B)	Endoplasmic reticulum (ER)	Transports and finishes proteins and other biologi-cal molecules
Custodians (A)	Lysosomes	
Power generators (H)	Mitochondria	
Shipping department (C)	Golgi apparatus	
Factory interior (G)	Cytoplasm	Space for work to be done
Items to be shipped	Vesicles	Cellular pack-age containing products such as protein
Warehouse for storage of products	Vacuole	
Loading dock	Pores/gated channels	Points of entry and exit for materials
Security fence (D)	Cell membrane	

1. Using the letters from the table in Model 1, label the cell diagram with the organelle names.
2. According to the table,
   a. what substance is analogous to a factory manager?

   b. in what organelle would this substance be found?

3. Using the information in Question 2, which cell organelle controls the activities of the entire cell?

4. Which organelle generates energy to power cellular activities?

5. Which organelle is responsible for assembling proteins?

6. Once proteins have been assembled, to which organelle would they go next?

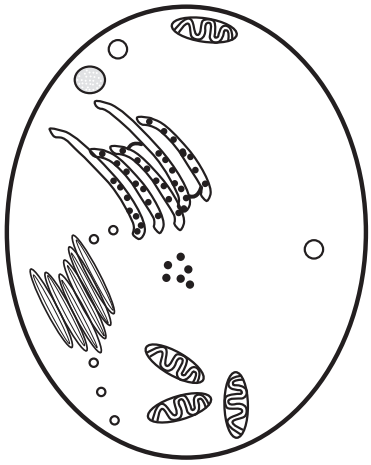
7. Into what organelle might the cellular products be placed?

8. Fill in the missing functions of cellular organelles in the table in Model 1.

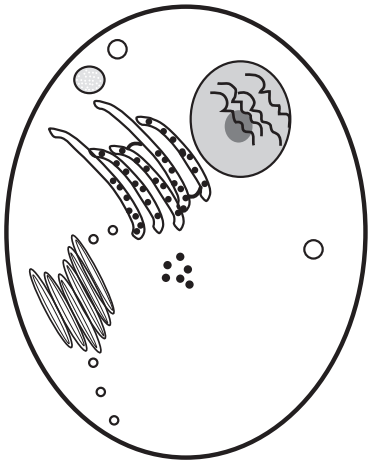
9. Starting with instructions from the factory manager (DNA/chromosomes), create a flow chart to show how a protein is produced and shipped from a cell.

Model 2 – Animal Cells with Organelle(s) Removed

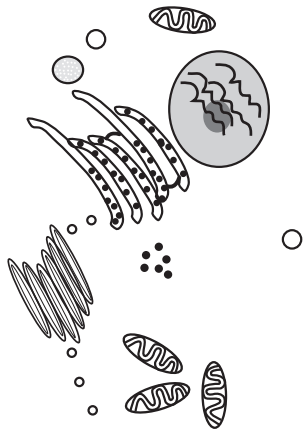
Cell 1



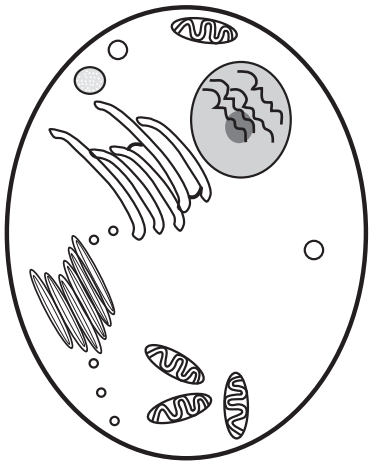
Cell 2



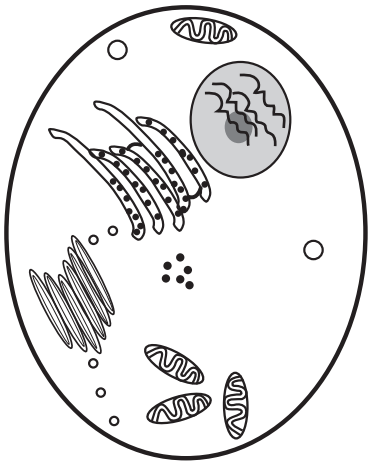
Cell 3



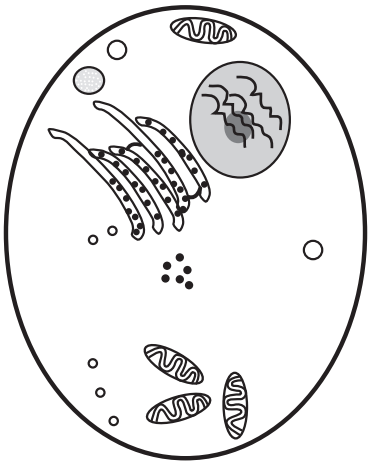
Cell 4



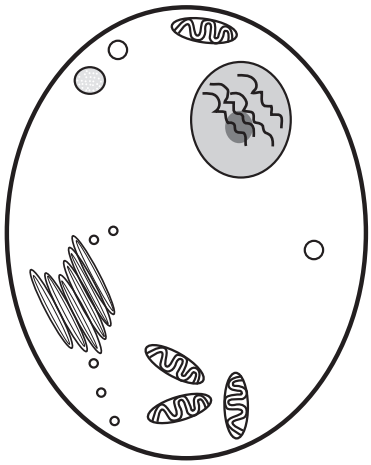
Cell 5



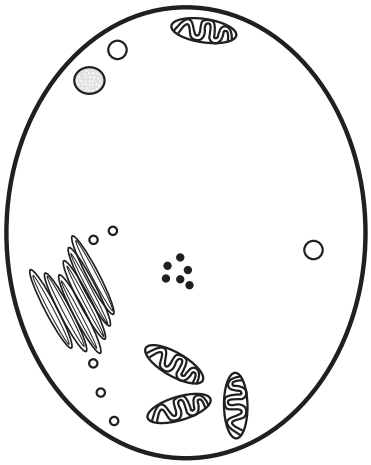
Cell 6



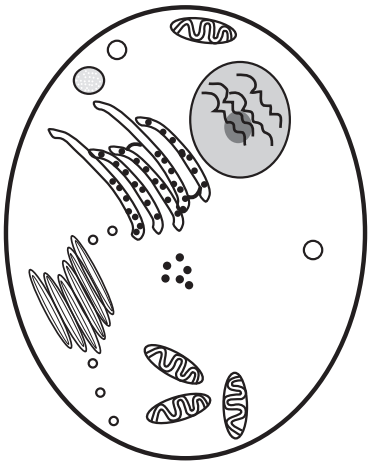
Cell 7



Cell 8



Cell 9



10. Study the cells in Model 2. Which cell is not missing any organelles compared to Model 1?

11. Look carefully at Cell 2 in Model 2. Compared to Model 1, what kind of organelle is missing?

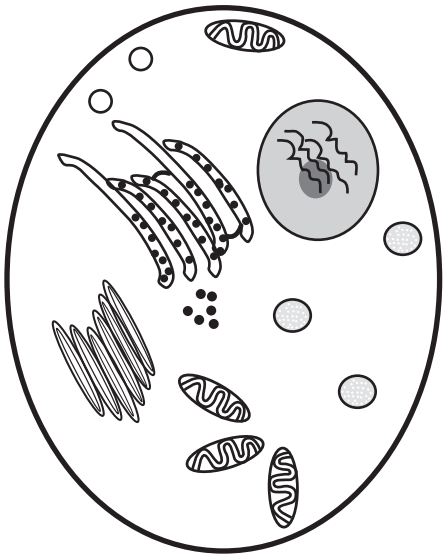
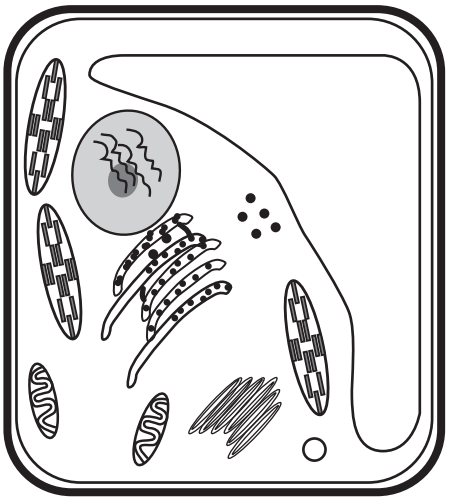
12. Using grammatically correct sentences, describe why Cell 2 would not function normally.

13. Which two cells in Model 2 will have difficulty containing and getting rid of wastes within the cell? Why?

14. Cell 1 is missing one organelle. List as many reasons as possible why Cell 1 will not survive.

15. Cell 4 and Cell 7 will not be able to synthesize a major biological molecule. What molecule is this?

Model 3 – Animal Cell vs. Plant Cell

Animal Cell	Plant Cell
	

16. Do both cells in Model 3 have a nucleus?

17. Do both cells in Model 3 have mitochondria?

18. Describe at least three differences between the animal and plant cells shown in Model 3.

Read This!

Plant cells have three organelles not found in animal cells. They include the cell wall, large central vacuole, and plastids (including chloroplasts).

19. Complete the table below using the three plant organelles mentioned in the *Read This!* box.

Organelle	Function
	Fluid-filled organelle stores water, enzymes, and waste products. Size of this organelle can change.
	Supports and protects the cell.
	Some store food or pigments; some convert light energy to chemical energy in the form of organic compounds.

20. Label each of these three organelles on the plant cell diagram in Model 3.

21. Individually, in one grammatically correct sentence, describe why it is necessary for plants to have chloroplasts.

22. As a group, reach a consensus on the answer to Question 21. Record the answer below.

23. The central vacuole stores water. What would happen to the size of the central vacuole if a plant does not have enough water?

24. Describe the appearance of the vacuole in a well-watered plant. What effect would this have on the cell wall of the plant?

25. Using your response to Question 24, construct an explanation for why a plant has both a rigid cell wall and a cellular membrane.

Extension Questions

Read This!

All cells undergo cellular respiration for the production of energy. Energy is necessary for all metabolic activity within the cell.

The formula for cellular respiration is

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{energy/ATP}$$

Plants carry out photosynthesis for the production of glucose. The glucose then becomes the energy source for cellular respiration.

The formula for photosynthesis is

$$6CO_2 + 6H_2O \xrightarrow{\text{Sun's energy}} C_6H_{12}O_6 + 6O_2$$

26. Study the information given in the *Read This!* box.

    a. In what organelle does cellular respiration occur?

    b. Do plant and animal cells both have this structure?

27. In what organelle does photosynthesis occur? Do plant and animal cells both have this structure?

28. Using the equations above, explain the relationship between mitochondria and chloroplasts.

29. Plants have both mitochondria and chloroplasts; they can produce their own glucose to fuel cellular respiration. Animal cells, on the other hand, have only mitochondria. If an animal eats only meat what would be its source of glucose?

30. Where in the human body would you find cells with a large number of mitochondria? Why?