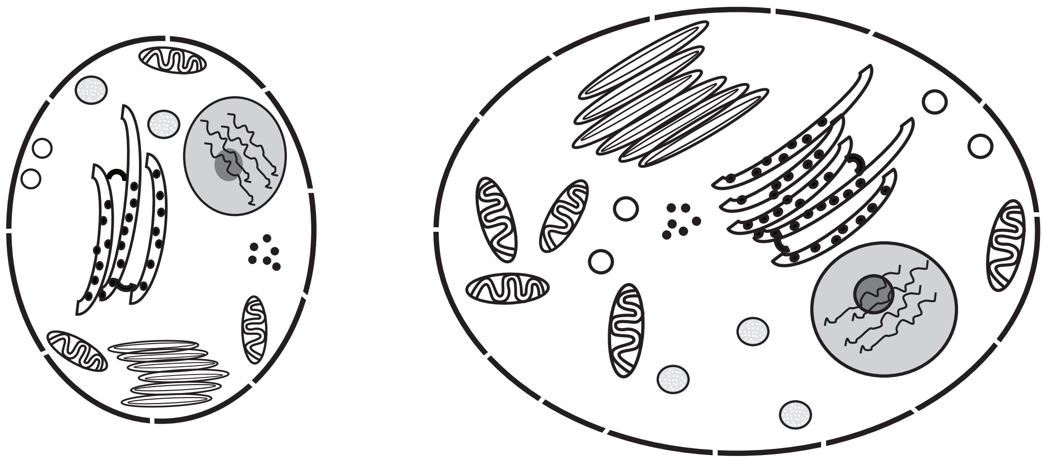
Cell Size

What determines the size of a cell?

Why?

Sometimes bigger is better—tall basketball players, more closet space, and savings accounts may come to mind. What about cells? Does having big cells make an organism bigger or better? Would having larger cells be an advantage to an organism? If so, why do cells divide rather than continue growing? Maybe there is an advantage to being small.

Model 1 – Investigating Cell Size



Cell A **Cell B**

1. Are the cells shown in Model 1 plant or animal cells? Explain your answer.

2. Label Cell B in Model 1 with the following structures.

cell membrane	cytoplasm	nucleus
ribosomes	vacuole	mitochondria

3. Compare the smaller cell in Model 1 to the larger cell in Model 1.

   a. Which cell has a larger surface area (more cell membrane surface)?

   b. Which cell has more channels in its cell membrane that can transport molecules (nutrients, oxygen, and waste products) in and out of the cell?

4. Compare the smaller cell to the larger cell in Model 1.

   a. Which cell has more mitochondria?

   b. Propose an explanation for why the cell in part *a* would need more mitochondria for proper functioning of the cell.

5. What would be the consequences for a cell if the cell membrane was not large enough to have adequate channels for bringing in nutrients and removing waste?

6. Compare the smaller cell to the larger cell in Model 1.

   a. Which cell has a larger volume?

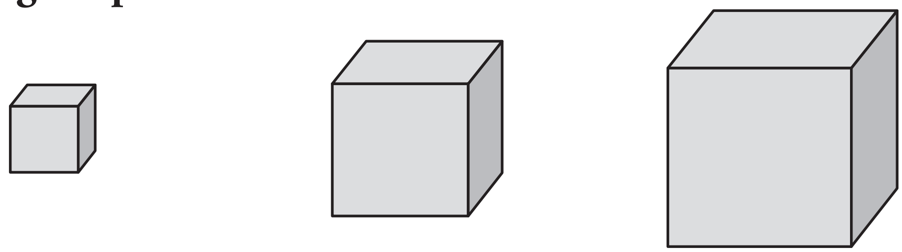
   b. Imagine a glucose molecule entering the cell membrane. Would that molecule be able to reach the mitochondria faster if the cell had a smaller volume or a larger volume? Explain.

   c. As the mitochondria metabolize the glucose, they produce carbon dioxide waste. Would the CO_2 molecules be able to leave the cell faster if the cell had a smaller volume or larger volume? Explain.

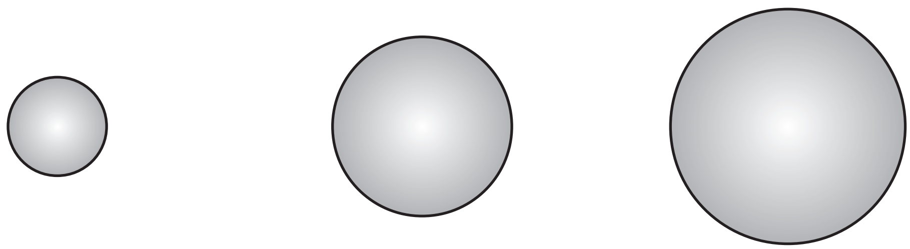
7. Consider your answers to the previous questions. Is bigger always better for a cell? Explain.

STOP

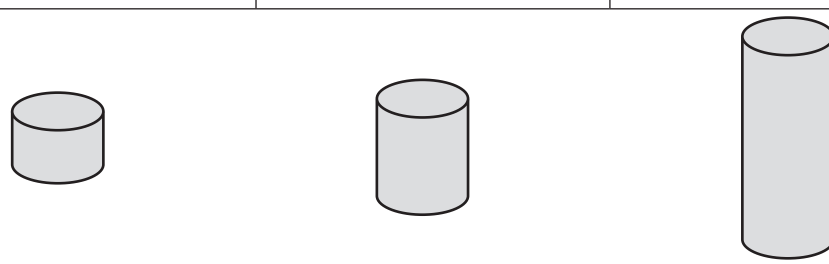
Model 2 – Comparing Shapes



Side	1 cm	2 cm	4 cm
Surface area	6 cm^2	24 cm^2	96 cm^2
Volume	1 cm^3	8 cm^3	64 cm^3
Surface Area-to-Volume Ratio			96:64 = 1.5:1



Diameter	1 cm	2 cm	4 cm
Surface area	3 cm^2	13 cm^2	50 cm^2
Volume	0.5 cm^3	4.2 cm^3	34 cm^3
Surface Area-to-Volume Ratio			



Diameter × Height	1 cm × 1 cm	1 cm × 2 cm	1 cm × 4 cm
Surface area	4.7 cm^2	7.9 cm^2	14 cm^2
Volume	0.8 cm^3	0.6 cm^3	3.1 cm^3
Surface Area-to-Volume Ratio			

8. Label the sets of shapes in Model 2 with each of the following: cubes, spheres, cylinders.
9. Calculate the surface area and volume values that are missing in Model 2. Divide the work among the members of your group and check each other's work.

10. Consider the data in Model 2.
    a. Describe the change in the surface area of the cube when the length of the side doubles.

    b. Describe the change in the volume of the cube when the length of the side doubles.

    c. When a shape gets larger, which increases at a faster rate, surface area or volume?

12. Calculate the surface area-to-volume ratio for each shape in Model 2. One example is given in Model 1 for this calculation.
13. For all three of the shape sets, describe the change in the surface area-to-volume ratio as the size of the shape increases.

14. Considering your answer to Question 7, is it more desirable for a cell to have a small surface area-to-volume ratio or a large surface area-to-volume ratio? Explain your answer in terms of the functions of a cell.

15. Circle two figures in Model 2 that have a similar surface area (within 1 cm^2 of each other).
    a. Do the two figures have the same volume?

    b. Which shape has a more desirable surface area-to-volume ratio?

16. In multicellular organisms some cells need to be large because of the functions they perform (*i.e.* nerve cells, muscle cells). What shape would be most desirable for these larger cells?

Extension Questions

17. Propose, by means of a sketch, geometrical shapes of cells that would allow a balance of function and materials movement for each of the following situations. (*Hint:* Think about which aspect of shape would help the cell best carry out its given function.)

    a. Long-distance communication.

    b. Stretching.

    c. Storage.

    d. Covering and protecting.

    e. Importing large quantities of material for transfer to other cells.

18. Among unicellular eukaryotes, cell sizes differ greatly. *Amoeba* and *Paramecium* organisms are animal-like protists that are heterotrophic, have no cell wall, and are several times larger than most human cells. What might be some reasons why these unicellular organisms have larger cells than cells with similar traits (heterotrophic, lacking cell walls) that are found in multicellular organisms?