8. Compare Cell #1 to Cell #4. It is obvious that #4's volume and cell membrane are much larger than #1's.

   a. How many times larger is #4's volume compared to #1? ______________
   b. Approximately how much more food and O_2 would #4 need? ______________
   c. Approximately how much more waste would #4 produce? ______________
   d. How many times larger is #4's surface area or cell membrane? ______________
   e. Is #4's cell membrane 64 times larger than #1's? ______________

9. As cells become larger and larger, their *volumes increase faster than their surface areas*. **The surface area-to-volume ratio for Cell #1 is 6 to 1 (6/1)**.

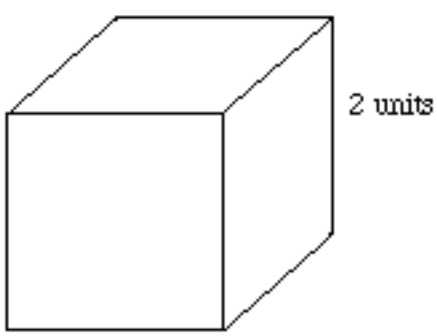
   a. For Cell #3, this ratio is _______ to 1, and for Cell #4, the ratio is ______ to 1.
   b. For a cell that is 10 x 10 x 10, the ratio is only ______ to 1.

10. **As our cubic cells gets larger, the surface area-to-volume ratios get smaller.** Explain why there are very few cells larger than a paramecium and that there are absolutely no cells large enough to eat your town. (Note: Think about supply and demand balance and "feeding" the entire cell.)

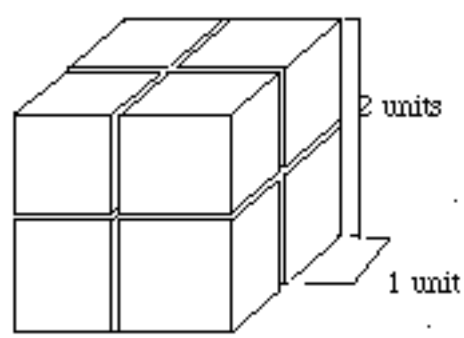
Summary:
The idea that a cell can get extremely large is physically impossible unless the surface area increases at the same rate. Basically, the large cells do no have enough surface area to supply them with the necessary materials to maintain homeostasis. In addition, the cell membrane is not large enough to eliminate waste products. Again, homeostasis cannot be maintained.

The Next Concept!!!

Single Cellular vs. Multicellular: Which is best for cell survival???



Cell A



Cell B

11. Examine the two cubic "animals" diagrammed above. Organism "A" is surrounded by a single semipermeable membrane and therefore can be considered **unicellular or single cellular.**

    Organism "B" consists of eight cells, each surrounded by a separate semipermeable membrane. *Fluid carrying food and oxygen can flow between the cells*. Organism "B" is considered **multicellular**.

a. What is the total volume of "A"? ____________________

b. What is the total volume of "B"? ____________________

c. Calculate the total surface area of "A." ____________________

d. Calculate the surface area of one cell of "B." ____________________

e. What is the total surface area of "B"? ____________________

f. Calculate the surface area-to-volume ratios for each cell. (SA/V)

"Animal" A	**"Animal" B**
Total Surface Area of "A" = _____ Volume ______________________ = ______	Total Surface Area of "B" = _____ Volume ______________________ = ______

12. Briefly explain why "A" and "B" need about the same amount of food, water, oxygen, etc.

13. Briefly explain why "A" and "B" need to eliminate approximately the same amount of solid, liquid, or gaseous wastes?

14. Can cell "A" eliminate the same amount of wastes or obtain the same amount of food or oxygen through its outer membrane? **Explain!!**

15. What possible explanation can be given to account for the fact that large organisms are multicellular?

OK, we have struggled with the concepts. Now let's look at a model that will illustrate these concepts.

When cells reach a certain size, their rate of growth slows down. Then they stop growing. Each of these cells divides into two smaller cells, which begin to grow. What causes this? An easy way to investigate such questions is to build a model. A model is often thought of as a small copy of something large. Here we will reverse the process and build a large model of something small.

Materials (per team):

Block of phenolphthalein agar
100 ml 4% sodium hydroxide
Beaker
Millimeter ruler
Razor blade
Plastic spoon
Plastic table knife
Paper towel

Procedure:

1. Place a block of agar on a paper towel and cut the block of agar into cubes with a razor blade. The **first** cube should be 3 cm on each side; the **second**, 2 cm on each side; and the **third**, 1 cm on each side.
2. Measure carefully and trim away waste. (Save the larger waste pieces.)
3. Place the three cubes in the beaker at the same time.
4. Pour in enough sodium hydroxide solution to cover them.
5. **Record your starting time.** Use the plastic spoon to turn the cubes often for the next 10 minutes. Be careful not to cut or scratch the surface of the cubes.

Continue with the following while waiting for ten minutes:

1. Examine the cubes. Think of them as giant models of tiny cells.
   Make a hypothesis: Which of your three different-sized "model cells" do you think would be most likely to survive? _______________

   Food for Thought: (HINTS)
   Materials used during cellular activity and growth must enter the cell from the outside. Waste products made in the cell go through the cell surface to the outside. That is obviously the only way materials get in or out of the cell. Don't forget that the membrane can only do so much— there is a limit to how much can go through a membrane at any one time. A cell that survives best gets "fed" completely.

2. Do you think the cell with the greatest *total surface area* will survive the best? Why or why not?

   ____

   ____

3. Refer to the **total surface area** of each of your three models as calculated on page three of this lab activity. Which cell model has the greatest surface area?

   3 cm cube   2 cm cube   1 cm cube

   The cells have different surface areas, and they have different volumes (amount of material inside.) **Refer to the volume calculations on page 3.** Think about the prediction you made in question 1. Do these calculations change any of your earlier ideas? Why or why not?

   ____

   ____

OK, enough theory. Let's finish this experiment.

- Blot the cubes dry with a paper towel. Allow them to dry completely.
- Rinse the plastic knife with water and slice each cube in half.
- Measure the outer colored zones with the millimeter ruler.

What similarities do you notice?

Cell Size	**Depth of Colored Zone - mm**
1 cm^3	
2 cm^3	
3 cm^3	

Similarities: ____

In which cell did the color seep closest to the middle? ________

Which cell was apparently **most efficient** in bringing materials into the cell? _______

Which cell was apparently **least efficient? _______**

If the colored area represented food or oxygen seeping in and getting to all parts of the cell, which cell will have fed (or oxygenated) itself the best? _____________

Recall your individual calculations of the surface area and volume. Does either calculation explain what you have observed in your cell models? ________________

Recall your calculations of the *ratios* of surface area to volume.
Relate these ratios to what you observed with the cell models. As a general rule, the greater the surface area/volume ratio, the better it is to move things in and out of cells—the better the cell is "fed."

Which of the above cells had the best ratio? ____________

It is true that cells are usually very small. How do your observations and your calculations help you understand this fact?

____

____

____

____