Cell Size and Transport Efficacy Lab; SB1a,d

Why are cells so small? Why do they stop growing after reaching a certain size? How does the size of a cell affect the transport of nutrients and waste across the membrane? What causes the cell to stop growing and then to divide into two smaller cells? The purpose of this lab is to learn about the relationship between the surface area of a cell, the volume of a cell, and the effect of cell size on the efficiency of transport. Remember our class motto to always "read before you proceed".

Materials:

- 2 plastic cups
- spatula
- plastic spoon
- ammonia, diluted 1:20
- plastic knife
- metric ruler
- paper towel
- green tray
- 2 gelatin cube cell models in **<u>each of 3 sizes</u>** ($1cm^3$, $2cm^3$, $2.5cm^3$) = 6 cubes total

Procedures:

1. Place 1 of each size block into each of the plastic cups. So each of the two cups will have a $1cm^3$, $2cm^3$, $2.5cm^3$ size cube. Have a timer ready. Carefully pour diluted ammonia into the two cups with blocks until the blocks are covered with fluid. Begin timing (you will be removing one set of three blocks after 5 minutes and the other set of three blocks after 20 minutes).

2. After 5 minutes, use a spoon to remove one block of each size from one of the cups and place them on the green tray. Cut each block in half with the knife or spatula. Measure the distance the color change has penetrated from the exterior toward the interior. Again, record your measurements in the appropriate table. Use this number to estimate the percentage of the block that the treatment liquid has penetrated.

3. While the other three cubes are still soaking in the treatment, you can fill out your data table. Calculate the surface area (SA) and volume (V) for each of cubes.

4. After 20 minutes total (15 minutes after you took out the first set), repeat the above procedures with the second set of blocks.

5. Clean up and return to homeostasis. Do not throw away cups and plastic utensils. Throw away used paper towels and cut up cubes in the trash receptacle. Discard used treatment liquid in the sink. Thoroughly rinse out cups and plastic utensils, return all cleaned out items to the front of the classroom.

Data Tables: **Time = 5 minutes**

Cube Dimensions	Surface area (SA) (cm^2)	Volume (V) (cm^3)	SA:V ratio	Depth of pink (cm)	V penetrated	% Penetrated
1 cm^3						
2 cm^3						
2.5 cm^3						

SA = number of sides x width x length of original gelatin cube
V = length x width x height of original gelatin cube
SA:V ratio = SA ÷ V (unit will be cm^{-1})

V penetrated = volume of original cube – volume of the clear portion of cube
% penetrated = (volume penetrated ÷ original volume) x 100

Data Tables: **Time = 20 minutes**

Cube Dimensions	Surface area (SA) (cm^2)	Volume (V) (cm^3)	SA:V ratio	Depth of pink (cm)	V penetrated	% Penetrated
1 cm^3						
2 cm^3						
2.5 cm^3						

Discussion Questions:

1. What do the gelatin blocks in this lab represent and why do they make realistic models?

2. Nutrients that a cell needs for survival and wastes that a cell needs to excrete must go through the membrane surrounding the cell. Which cell do you think will do the BEST job of moving materials into and out of the cell? Justify your response.

3. How do the depths of the pink portions of each cube compare?

4. Which cube size had the largest percentage of its volume penetrated? What does this imply about the efficacy of this size cube in receiving materials from the outside?

5. Looking at the surface area to volume ratio (SA:V) for each of your cells, explain efficiency of a cell in terms of the SA:V ratio. Which cube size had the highest SA:V ratio?

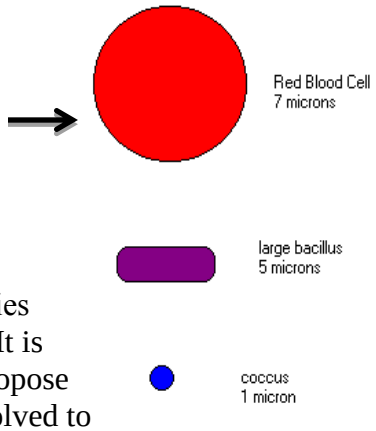
6. Given what you now know about the surface area to volume ratio, apply this to a real cell. How might cell size affect when a cell will divide into two?

7. Describe how phospholipid molecules are oriented in the plasma membrane? Draw a labeled sketch of a phospholipid molecule.

8. *SB1c Connection*: Identify the organic macromolecules that can be associated with the structure of the plasma membrane. Describe how each is associated.

9. Explain how the cell membrane is selectively permeable.

10. The diagram to the right shows a human red blood cell along with two types of bacteria. Formulate some reasons why you believe that the bacteria are so much smaller in size.



11. Read section 6.1 in your textbook. Write a synopsis for the history of cell theory and be sure to include the three components of cell theory.

12. *Valonia ventricosa*, also known as "bubble algae" and "sailors' eyeballs" is a species of algae found in oceans throughout the world in tropical and subtropical regions. It is one of the largest single-celled organisms. View the Smart Board for a picture. Propose an explanation for how these uni-cellular, photosynthetic eukaryotes may have evolved to have such a large cell size, and thus, an ostensibly low level of transport efficacy due to their small SA:V ratio.