NAME_____

Cell Size Lab: Instructions and Procedures

Introduction:
How are these five facts connected? (answer below)

- All cells are very small
- Flatworms have no blood, heart, or lungs. Yet they have no trouble getting oxygen to their cells.
- When you get cold, you hold your arms against your body.
- Elephants have big ears to help themselves stay cool.
- It takes hella long to bake a potato

How are these facts connected?

_____

_____

_____

_____

Supplies
1 razor blade
1 block of phenolthalein agar, in a beaker.
1 flask of 0.1 M NaOH
1 spoon
1 metric ruler.

Proceduce before soaking cubes.

A. (*note, you have to cut the cubes in correct order*).

1. Cut the largest cube: 3 cm by 3 cm by 3 cm.
2. Cut a 2 by 2 by 2 cm cube from what's left.
3. Cut a 1 by 1 by 1 cm cube.
4. Cut a 0.5 by 0.5 by 0.5 cm cube.
5. Put all four cubes in the beaker.
6. Pour the NaOH into the beaker so that it just covers all four cubes. Use the spoon to periodically turn the cubes.
7. Remove all cubes after 10 minutes. Place them on a paper towel and gently blot them.

B. Calculations (These can be performed **while** you're soaking the cubes).

- Formula for surface area of a cube: (length of side)^2 x 6 = SA
- Formula for volume of a cube: : (length of side)^3

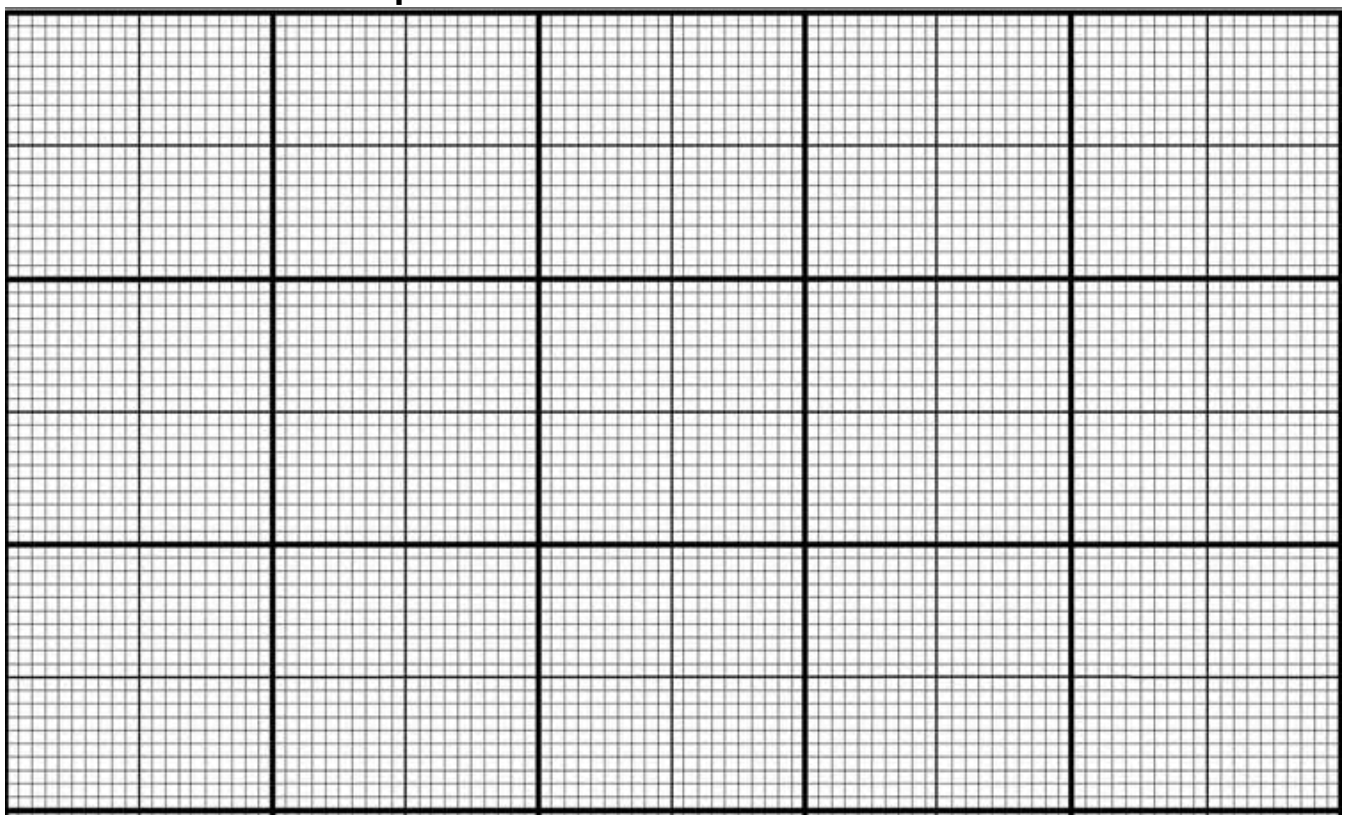
1. **Complete Table 1** showing the amount of surface area, the volume, and the ratio of surface area to volume for the four cubes. Also determine what this would be for cubes that are 10 cm on a side and 20 cm on a side.

2. **Graph these data in Graph 1**. Label the X axis as "length of cube side in cm" and the Y axis as "ratio of surface area to volume"

Table 1: The Surface Area: Volume ratio

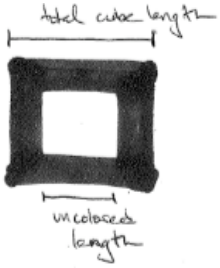
Length of one side of cube (cm)	Surface area in cm^2	Volume in cm^3	Ratio of surface area to volume
0.5			
1			
2			
3			
5			
10	100	1000	1 to 10
20			

Graph 1: The Surface Area: Volume ratio



C. Procedure after removing cubes.

1. Slice each cube in half
2. Measure the clear area (as shown at right)



3. In **diagram 1** in your lab entry handout, **draw a cross section of each cube**. Indicate the total length of the side of each cube, and the length of the clear section in the middle.

For each cube:

4. **Calculate** the volume of the uncolored area. Take the length of uncolored area and cube it (L^3)
5. Subtract this from the total volume of the cube (you calculated this earlier) to get the volume of the colored area.
6. Divide the volume of the colored area by the total volume and multiply by 100 to get the percentage of the cube reached by diffusion.

7. Record your results in the Table 2 and Graph 2 in your handout. Extrapolate your results for a cube that is 5 cm on a side, and a cube that is 10 cm on a side. In the graph, your independent variable is the Surface Area To Volume Ratio. The dependent variable is % of Volume Reached by Diffusion.

Diagram 1: Cross sections of cubes after _____ minutes. **THESE ARE DRAWINGS!**

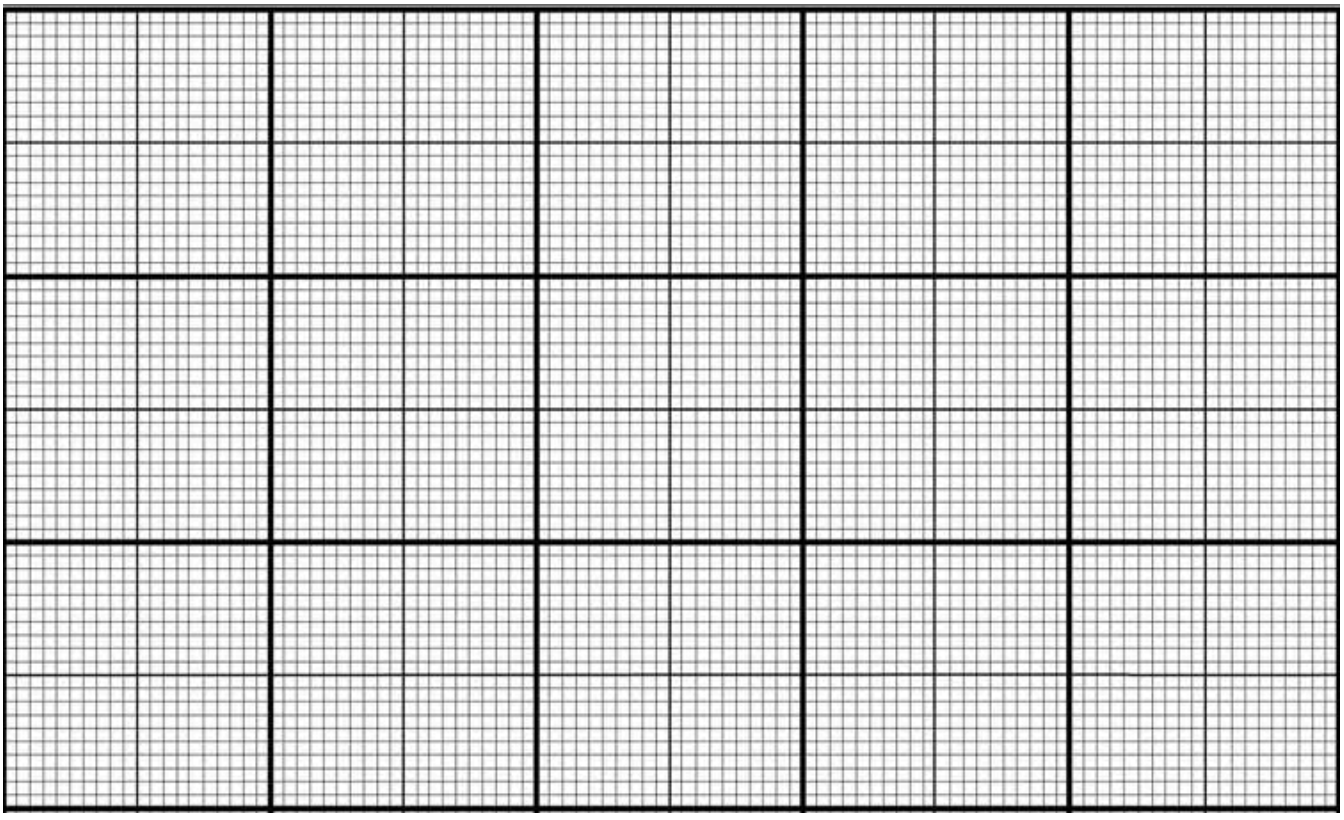
Cube 1 $(0.5\ cm)^3$	Cube 2 $(1\ cm)^3$	Cube 3 $(2\ cm)^3$	Cube 4 $(3\ cm)^3$

Table 2: The % of Cube Reached by Diffusion

a	b	c	d	e	f
Length of side (cm)	S.A.: vol. ratio	Total Volume (cm^3)	Volume of uncolored area (cm^3)	Volume of colored area (c – d) (cm^3)	% of cube reached by diffusion (e/c)
0.5					
1					
2					
3					
5*					

*extrapolation

Graph 2: % of Cube Reached by Diffusion



Analysis

1. Reviewing the Math

a. As a cube gets bigger, its ratio of surface area to volume _____.

b. As a cube gets smaller, its ratio of surface area to volume _____.

c. As objects get bigger, why does volume increase so much more rapidly than surface area?

_____

_____

_____

2. Concepts from the Lab

a. The movement of a substance from where it is more concentrated to where it is less concentrated is called _____.

b. The NaOH (sodium hydroxide) entered the agar cubes through the process called _____.

c. For the NaOH to enter into the cubes, it had to go through the cube's surface!

d. Because the 3 cm cube had only _____ units of surface area for every 1 unit of volume, the NaOH was only able to diffuse into _____ percent of the cube's volume.

e. Because the 1 cm cube had _____ units of surface area for every 1 unit of volume, the NaOH was able to reach into _____ percent of the cube's volume.

3. Applying concepts

a. Pretend that the large cube was a cell, and the NaOH was food. In this analogy, the surface of the cube would be the _____ of the cell, and the inside of the cube would be the _____. The part of the "cell" that remained whitish would be _____ because little or no food would have been able to _____ into it.

b. Cells are small because compared to their _____, small objects have a lot of _____ _____ . This makes it easy for things to _____ in and out.

c. Cells in your intestine are very wavy on top. This shape gives them a high _____ _____ to _____ ratio, making it easy for food to _____ into them.

d. Gills in fish consist of lots of thin flaps of tissue. These thin flaps provide lots of _____ _____ for absorbing _____ from the water.

e. Heat also diffuses in and out through an animal's surface. Because they're so big, whales have a very _____ _____ _____ to _____ ratio. This makes it _____ for heat to escape from their bodies, which helps them survive in cold water.

f. Elephants are the largest land animals. Like whales, they have a relatively _____ surface area to volume ratio. But, because they live in a hot climate, they need to be able to let heat escape from their bodies. Their huge _____ give them a lot of additional _____. Their ears, in other words, act like a car's _____.

4. **On a separate sheet**, answer the following questions based on the data you collected in this lab. In your own words, explain what you learned in the lab. Label each answer, then staple it to this paper. Turn it in when you are finished.

a) The relationship between the size of an object and its surface area to volume ratio.

b) The relationship between the surface area to volume ratio of something and the ability of substances (or heat) to diffuse into and out of that thing, and how we proved that in the lab (briefly recap the procedure so that, for example, one of your parents would have a good idea of how this lab worked).

b) The reason why cells are small.

c) The reason why lungs are made of lots of bubbles of tissue instead of two large sacs; the reason why we have the instinct to fold our arms against our chest when it's cold; the reason why one cup of ice chips melts faster than a one-cup block of ice; the reason why jackrabbits have big ears; the reason why there's so much membrane (ER, Golgi) inside a eukaryotic cell, and at least two other examples you can think of independently.