Cell Size and Diffusion Name: _____

Introduction:

All living things depend on getting useful materials into their cells quickly – and getting waste materials out equally as quickly. Oxygen, foods, water, and other essential chemicals pass inwards continually. Carbon dioxide and other wastes pass the other way. Complex animals like humans have sophisticated systems(the lungs and circulatory system) to gather oxygen from the environment and deliver it to every part of the body. Simple animals such as spiders often rely on oxygen diffusing directly into the body across the whole surface of the animal. This is adequate for individual cells and very small organisms where the oxygen only has to travel a short distance. However, as organisms get larger and more complex they reach a limit at which simple diffusion will not supply their needs. (This is one of the reasons why the giant spiders and insects you see in horror films do not really exist – they could not get oxygen to all the tissues in their bodies quickly enough just by diffusion!). This is where mitosis is necessary. In this experiment, you will look at the effect of surface area to the volume of a cell, demonstrating the need for cellular division.

Materials:

Agar cube NaOH cutting tool ruler glass dish

Procedure:

1. Using a plastic knife, cut the agar block into three cubes sizes of: 1 cm, 2 cm, and 3 cm blocks.
2. Place the cubes in a dish and cover them with 0.1% NaOH. Record the time.

   Time: _____

   Use a plastic spoon to continuously cover the cubes with the NaOH for the next 10 minutes.
3. Calculate the Surface Area, Volume, and Surface Area : Volume Ratio in the table. The ratio should be expressed in its simplest form.
4. Wear gloves and use the plastic spoon to remove the agar cubes from the NaOH after 10 minutes. Place them on a paper towel -- DO NOT touch the NaOH with your hands! Blot the cubes dry with paper towels. Use the plastic knife to slice each cube in half. Measure the depth of diffusion of the NaOH in each of the cubes and record.

Results:

Comparison of Agar Cubes

Cube Dimensions	Surface Area (cm^2)	Volume (cm^3)	SA : Volume Ratio	Diffusion Depth
1 x 1 x 1				
2 x 2 x 2				
3 x 3 x 3				

Analysis:

1. What evidence is there that NaOH diffuses into an agar cube?

2. What evidence is there that the rate of diffusion is about the same for each cube? Explain.

3. List the agar cubes in order of size, from **largest to smallest**. List them in order of the ratios of surface area to volume from the **largest to the smallest** ratio. How do the lists compare?

4. Calculate the surface area to volume ratio for a cell model that is 0.01 cm on a side.

5. What conclusions can you draw from the relationship between surface area and volume for a cell?

6. Why is mitosis necessary for the survival of cells?

7. Imagine there are two perfectly cubical organisms both with a side length of 4 cm. The first organism has a single, cubical cell. The second organism is made up of a number of smaller cubical cells (side length 0.5 cm) packed neatly together. How many "cells" are there in the second organism?

8. What would be the total surface area of all of the "cells" in the second organism?

9. Explain why oxygen could reach every part of every cell in the second organism much more quickly than in the first. Use your experimental results in your explanation.