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| **Diffusion and surface area to volume** |  |

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**Aim**  
To determine how surface area and volume relate to one another and how the rate of diffusion varies with the ratio of surface area to volume.

**Materials**  
Three cubes of agar-phenolphthalein (1 cm, 2 cm, and 3 cm sides), dilute sulphuric acid solution (H2SO4), a ruler, a razor blade, a plastic spoon, a paper towel, beaker.

**Overview**  
The phenolphthalein in the agar cubes reacts with the sulphuric acid, changing the colour of the cube from pink to clear. After the cubes are exposed to sulphuric acid, you will be able to see how far the sulphuric acid has diffused, based upon the change in colour which it caused. This will allow you to determine the relationship between diffusion and the surface area to volume ratio of the cubes. You should assume that the sulphuric acid represents some vital requirement of a living cell, such as oxygen

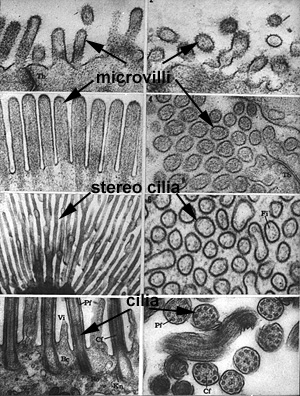
**Procedure**

1. Cut out three agar cubes of side length 1 cm, 2 cm and 3 cm from the block of jelly.
2. Calculate the surface area and volume of each of these cubes and record these values in the table below.
3. Carefully fill a beaker with sulphuric acid so that the cubes will be completely submerged when placed in the beaker.
4. Place the three agar cubes in the beaker. After 15 minutes (or as directed by your teacher), remove them and place them on a paper towel.
5. Using the paper towel, blot the cubes dry.
6. Use the razor blade to carefully cut each cube in half.
7. Measure the length of the part of each cube that did not change colour i.e. (remained red).
8. Calculate the volume of this part of each cube and record these values in the table below.
9. From the answer in the previous step, calculate the volume of each cube that became uncoloured.

**Observations**  
Record the data you gathered in the table below.

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| **Diffusion into the agar cubes** | | | | | | |
| *Cube size*  *(cm)* | *Surface area*  *(cm2)* | *Volume*  *(cm3)* | *Surface area/volume ratio*  *(cm-1)* | *Length of cube that remained coloured*  *(cm)* | *Volume of cube that remained coloured*  *(cm3)* | *Volume of cube that became uncoloured*  *(cm3)* |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |

**Questions**

1. If the length of the side of a cube is increased, the surface area to volume ratio of the cube......    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. The effective rate of diffusion into the cubes is the volume of the uncoloured area of the cube divided by the volume of the coloured area. Calculate the effective rate of diffusion for each of the three cube sizes.  
     
   Cube of sides of 1cm: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Cube of sides of 2 cm: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Cube of sides of 3 cm: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. In which of the three cubes was the rate of diffusion the most effective?

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**Conclusions**  
I the space below, write down any conclusions you can draw from this experiment. For example, you may wish to address the question as to why cells are so small (hint: a large cell would have a large surface area for diffusion, but what about its volume?). You can also discuss why many cell organelles have folded membranes as opposed to straight membranes. You may also like to discuss why individual animals of the same species (give examples) tend to be larger in colder climates.

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**Sources of Error**  
Identify any possible sources of error which may have affected the results of this experiment.

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