SA:Vol Ratio

Introduction

In order to survive, cells must exchange materials with the environment to fuel essential metabolic processes. Diffusion is the passive movement of particles (gases and liquids) from an area of high concentration to an area of low concentration (down a concentration gradient). Diffusion is one of the main processes a cell undertakes to obtain vital substances (such as nutrients and oxygen) and remove cellular wastes (such as urea and carbon dioxide).

In this experiment, agar cubes will be used to represent a cell. A pH indicator (phenolphthalein) has been added to the cubes, causing them to turn pink. When phenolphthalein is exposed to acid, the indicator loses its colour and the cube will turn clear. Thus, when a cube is placed in an acid solution, the inside of the cube will gradually turn clear as the acid diffuses into the agar.

Aim

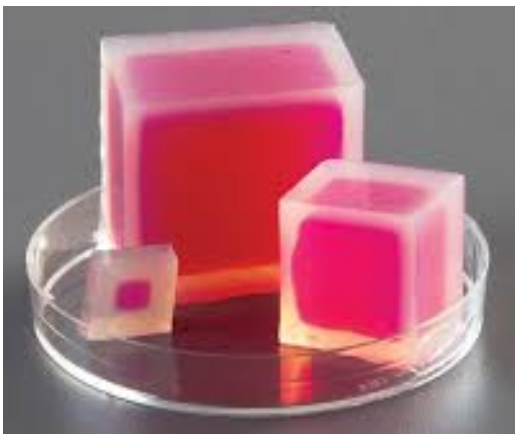
To investigate how the size of a cube affects the rate at which it turns clear when exposed to an acid solution for a period of 3 minutes (or until the smallest cube turns completely colourless).

Materials

- Block of agar / indicator
- 3 × 100 ml beakers
- Ruler (in millimetres)
- Cutting board and knife
- Stopwatch
- 200ml of 0.1M H_2SO_4 solution
- Paper towels
- Spoon / Tongs
- Measuring cylinder

Method

1. Cut the agar block into three cubes of the following dimensions: 3cm^3 cube, 2cm^3 cube and 1cm^3 cube
2. Pour 60ml of sulfuric acid solution into three beakers
3. Immerse one cube in each of the three beakers, start the stopwatch and leave for 3 minutes (180 seconds)
4. Periodically stir the solution – or turn the cubes over
5. After 3 minutes, remove the cubes from the beakers
6. Blot softly with paper towel to remove acid from cube
7. Cut each cube in half to measure the colour change
8. Record all measurements in the data table provided



Hypothesis

State a valid hypothesis for this experiment (including a justification that relates to the SA:Vol ratio)

Raw Data

Complete the following data table (calculations included below):

Side of cube (cm)	**A** Surface area (cm^2)	**B** Total Volume (cm^3)	**C** SA:Vol ratio [A ÷ B]	**D** Pink Volume (cm^3)	**E** Diffusion Volume [B – D]	**F** % Diffusion [(E ÷ B) × 100]
1						
2						
3						

Calculations:

a) Surface Area = Length × Width × Number of Sides (6)
b) Total Volume = Length × Width × Depth (of whole cube)
c) Surface Area : Volume Ratio = Surface Area ÷ Volume
d) Pink Volume = Length × Width × Depth (of pink region)
e) Total Volume Diffused = Total Volume – Pink Volume
f) Percentage Diffusion = Volume Diffused ÷ Total Volume

Processed Data

Draw a line graph to show the relationship between *total volume* (X axis) and *SA:Vol ratio* (Y axis)

Discussion

1. List the independent, dependent and control variables (at least two) for this investigation.

2. Identify one uncontrolled variable and explain how it could have an impact on the results.

3. Suggest how the accuracy and reliability could be improved (one suggestion each).

4. Describe the relationship between the volume of the cubes and the SA:Vol ratio (as per graph).

5. Explain how this relationship applies to the survival of living organisms (such as tiny microbes or large animals) who all rely on diffusion to exchange materials needed for metabolic activity.

Extension

Heat-sensitive putty is malleable and changes color when exposed to heat. Design an experiment to investigate the effect of differences in shape on the percentage of colour change in the putty.

- Include a hypothesis, variables (independent, dependent, control) and a brief methodology