Does Size Matter?

Introductory Lab

Grade Level	9-10
Subjects	Biology, Environmental Science, General Science, Physical Science
Objective	Students will consider that the identity of chemical substances making up an object may not be sufficient to explain all of their chemical/physical properties. This activity will clearly demonstrate that different-sized particles of the same exact substance can and do exhibit different properties because of their different particle sizes.
Time	One class period
Engagement	Ask students why cells divide and stay very small instead of simply growing to a larger and larger size.
Background	The size of objects greatly influences the relative amounts of objects that are physically located at their own surfaces.

In biology the surface area to volume ratio of a cell places an upper limit on its potential size due to respiration requirements. All nutrients and waste products must be transported across a cell's surface in a timely manner if it is to live. The larger the volume of a cell is, the smaller its relative surface area. Low surface area to volume ratios impair a cell's ability to live by dangerously decreasing metabolic efficiency.

The importance of size and proportional surface area is not limited to cellular respiration. Many other natural processes occur largely as surface phenomena. Examples include: adhesion, boiling, capillarity, catalyzation, cohesion, condensation, corrosion, crystallization, dissolving, electroplating, erosion, evaporation, oxidation, photo-dissociation, reflection, transpiration, etc.

Because nanotechnology, by definition, deals with very small particles, to be able to appreciate, understand and fully participate in nanotechnology students will need to comprehend how size can affect properties of objects and substances.

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Materials (per small group)**:**

1 Pen or Pencil

1 Large Apple

1 Metric Ruler

1 Sharp Knife (not a switchblade)

1 sealable plastic baggie

1 Graduated Cylinder

40 cc diluted Food Coloring (3 parts very hot water / 1 part FC)

1 Styrofoam (or paper or plastic) Cup

2 Pages of Paper (cm^2 graph paper if available)

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Name_____ **Does Size Matter?** Block or Period #_____

Guided Inquiry Lab Date_____

QUESTION: Does the size of a cell (**or a piece of apple "pseudo-cell"**) relate to its' effectiveness at quickly and thoroughly absorbing substances from its environment? If so, in what way does it relate, directly or inversely?
PREDICTION:_____

PROCEDURE:

1 – In your lab group, read this entire procedure out loud.

2 – Discuss the question, come to a consensus, and record your prediction above.

3 – From your apple, cut three cubes: 1x1x1cm, 2x2x2 cm and 3x3x3cm.

4 – Calculate and record the surface areas of all 3 cubes on a data chart.

5 - Calculate and record the volumes of all 3 cubes on your data chart.

6 – Predict, and record on your data chart, the percentage of your apple cube volumes that will absorb the food coloring in 30 minutes.

7 – Place the 3 apple cubes inside the unsealed baggie.

8 – Measure enough food coloring to equal the combined volumes of all of 3 apple cubes. Pour food coloring in the baggie and seal it with very little air inside.

9 – Put the sealed baggie in the cup. Note and record the time on your data sheet.

10 – Determine the procedure that you will use to measure/estimate/calculate the percentage of cube volume that will have absorbed food coloring in 30 minutes.

11 – Calculate (record on your data chart) the surface area/volume ratios of your 3 cubes.

12 – What dimensions would a cube with a 1 to 1 surface area to volume ratio have?

_____ x _____ x _____ cm. Why? _____

13 – Have each group member draw a different gas exchange breathing organ (e.g. book lung of spider, gill of fish, lung of human, trachea of insect). Discuss and come to a consensus how the forms (shapes) of these organs are well suited to their function (gas exchange by diffusion). Consensus: _____

14 – Remove all 3 apple cubes after 30 minutes.

15 – Perform (and record on your data chart) the results of your #10 procedure.

16 – How did your results compare with your prediction, and what do you infer?

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