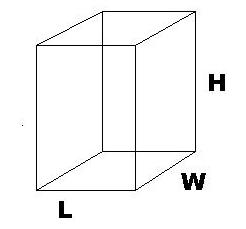
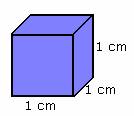
**Finding Surface Area and Volume** Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Surface area is the total area of the surface of a three dimensional object.*

How do YOU think we calculate the surface area?

1. How many sides does this box have?
2. How would you find the area of one side of this box?
3. If this box is a perfectly square cube with *L, W, and H* equaling 1 cm each, what would the area of one side of it be?
4. To find the TOTAL surface area, multiply the area of one side by what?
5. What would the total surface area be if *L, W, and H* all equaled 2cm?
6. What would the surface area be if L = 2cm, W = 3cm and H = 7cm?

*Volume is the amount of space an object takes up.*

How then do YOU think we calculate volume?

1. What is the volume of a cube with sides L = 1cm, W = 1cm, and H = 1cm?
2. What is the volume of a cube with sides L = 2 cm, W = 2cm, and H = 2cm?
3. What is the volume of a cube with sides L = 3cm, W = 2cm, and H = 7cm?
4. What is the volume of a cube with sides L = 4cm, W = 5cm, and H = 8cm?

**CELL SIZE COMPARISON**

INTRODUCTION:

Cells are limited in how large they can be. This is because the surface area and volume ratio does not stay the same as their size increases. The large the cell becomes, the less surface area it has compared with its volume. It is therefore less efficient for a large cell to pass materials in and out through the membrane, and to move materials throughout the cell.

In this lab, you will make cube shaped models to represent cells. The dimension along one side will be doubled with each model. You will then calculate the surface area, volume, and the ratio between the two.

MATERIALS:

Scissors

Paper cube patterns

Tape or glue

Metric ruler

PROCEDURE:

1. Construct three cell models: Cut out the three paper cube patterns. Fold and tape or glue each into a cube with the tabs to the inside. Record the dimensions in cm in the DATA TABLE.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **DATA TABLE: Cell Size Comparison** | | | | |
| **Cell** | **Dimensions**  **(cm)** | **Surface Area**  **(cm2)** | **Volume**  **(cm3)** | **Ratio**  **Surface Area to Volume** |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |

CALCULATIONS:

1. Calculate the total surface area for each cell model by the following formula:

Surface area of a cube = (length x width) x 6 sides

1. Calculate the volumes for each cell model by the following formula:

Volume = length x width x height

1. Screen shot 2012-06-28 at 12Calculate the surface area-to-volume ratio for each cell model by the following formula:

These ratios show how many times larger the surface area is as compared with the volume.

Notice that it becomes small very quickly.

1. Which cell has the greatest volume?
2. Which cell has the smallest volume?
3. Which cell has the greatest surface area?
4. Which cell has the smallest surface area?
5. Which cell has the greatest surface area to volume ratio?
6. How many small cubes do you think it would take to fill the medium cube?

***Why are cells so small?***

Think about this: even though a whale is much larger than a human and a human is much larger than a tulip, their cells are all roughly the same size. Whales donʼt have larger cells than humans, just more of them.

There is a very specific reason why cells are the size they are. Anytime this cell interacts with its environment, it does so at its membrane. The more membrane a cell has, the more exchange it can perform with its environment. (This exchange can include activities such as obtaining nutrients or getting rid of wastes.) We refer to the amount of surface that an object has as its surface area (SA).

Once materials get inside the cell, they move via diffusion. Diffusion is the random movement of particles that results in their dispersion in the cytoplasm. A drop of food coloring in a beaker of water will diffuse until the entire beaker is the same color. This type of movement occurs inside cells as a way of dispersing molecules. Diffusion works best over short distances. Imagine how long it would take food coloring molecules to diffuse in a water glass vs. in a swimming pool. Because the water glass has less volume (V), diffusion is more efficient.

Cells try to **maximize** their surface area (in order to improve exchange) and **minimize** their volume (to make diffusion more efficient). A basketball-sized cell would have lots of surface area (good), but also lots of volume (bad). Think about how long it would take molecules to diffuse from the outer portion of the ball to the center. A ping-pong ball or a marble would be better choices. When we discuss the interplay of these two quantities, we use the ratio of surface area to volume (abbreviated SA/V). **Ideal cells have large SA values, but small V values.**

**Instructions:**

First, look at the photos of the cells. These are very young embryos from sea urchins, marine organisms that you may have seen in nature documentaries or possibly along a rocky coastline. These photos were taken over a span of 105 minutes, beginning immediately after fertilization (Panel 1). The fertilized egg then divided once (Panel 3) to produce a two cell embryo (Panel 4), and then again (Panel 5) to produce a 4-cell embryo (Panel 6).

Eventually, hundreds of divisions would result in a tiny sea urchin larva that would settle to the sea bed and grow into a mature urchin (see photo to right).

Embryonic cells such as these are convenient to use as models for cell size because they are nearly perfect spheres.



1. To maintain life, and carry out cellular functions, materials must be able to move into and out of the cell. Also, material needs to be able to move within the cell. What might be the advantage of having a large surface area?

1. What might be the disadvantage of having a large volume?
2. Explain how a small change in cell size can have a huge impact on the cell and its normal functions.
3. So why are cells so small?