ACTIVITY: LIMITS TO CELL SIZE

Background:

Why can't cells continue to grow larger and larger to become GIANT cells, like a blob? Why are most cells, whether from a horse or fly, microscopic in size? What happens when a cell grows larger, and what causes it to divide into two smaller cells rather than growing larger and larger? This investigation provides you with a "hands-on" activity that shows the changing relationship of Total Surface Area – to – Volume for a growing cell.

Modeling Limits to Cell Size

Cut out the three shapes and fold each to make a cube. The first cube should result in a model cell with each side being 2 units (cm). The second cube is 3 units (cm) and the third 4 units (cm). The models represent one cube-shaped cell at increasing stages of growth.

Comparing the models

1) Find the total surface area for each cube. Hint: find the area of one side of the cube and then multiple by 6 for each face of the cube. Area = Length x Width

   Cube 1 - $2 \times 2 = 4 \, cm2 \times 6 = 24 \, cm \, 2$

   Cube 2 –

   Cube 3 –

2) Now calculate the volume of each cube. Volume is LengthxWidthxHeight

   Cube 1 $2x2x2 = 8 \, cm3$

   Cube 2

   Cube 3

3) Finally determine the surface area-to-volume ratio for each cube. A ratio compares two numbers by dividing one number by the other.

Cube 1 24 cm2 divided by 8 cm3   24/8 = 3 so the Surface area to volume ratio is 3:1

Cube 2

Cube 3

Questions:

1) What patterns do you see as the surface area increases?

2) What would be the Surface area to volume ratio for a cube with a 1 cm side length?

3) Anything the cell takes in, like oxygen and food, or let's out, such as carbon dioxide, must go through the cell membrane. Which measurement of the cells best represents how much cell membrane the models have?

4) The cell contents, nucleus and cytoplasm, use the oxygen and food while producing waste. Which measurement best represents the cell content?

5) As the cell grows larger and gets more cell content, will it need more or less cell membrane to survive?

6) As the cell grows larger, does the total surface area-to-volume ratio get larger, smaller, or remain the same?

7) Why can't cells survive when the Total Surface Area-to-volume ratio becomes to small? (When the two numbers are too close to each other).

8) Which cell size has the greatest chance of survival? Why?

9) A Paramecium is a single-celled organism that is very flat. How does the organism's shape affect the cell's surface area-to-volume ratio?