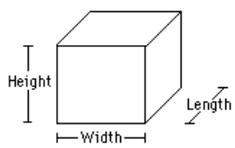
Biology 2201 - Limits to Cell Size - Why are Cells so Small?

Why are cells so small? The answer to this question has as much to do with mathematics as biology. Imagine that a cell is shaped like a cube. As cell size increases, its surface area to volume ratio changes. The surface area and volume are calculated as shown in the figure below:

Area of side = Length x Width

Area of Cube = Length x Width x 6
Volume of Cube = Length x Width x Height



Questions:

1. List some of the things that cross a cell's membrane:

i. _____ ii. _____ iii. _____

2. Why is it important that a cell have a large surface area relative to its volume? (In other words, a high surface area to volume ratio?)

3. Imagine that a cell's side could be any size that you wanted. Determine what would happen to the surface area to volume ratio as the cell grows. Since we are assuming the cell to be cube shaped, all sides are equal (X=Length=Width=Height). The units here could be anything, since we're just hypothesizing.

Cell Size	**Side Length** **X**	**Surface Area** **$6X^2$**	**Volume** **X^3**	**SA:Vol Ratio** **$6X^2 \div X^3$**
Small Cell	**0.5**	$6\ (\mathbf{0.5})^2 = 1.5$	$(\mathbf{0.5})^3 = 0.125$	$1.5 \div 0.125 = 12{:}1$
	1	$6\ (\mathbf{1})^2 = 6$	$(\mathbf{1})^3 = 1$	$6 \div 1 = 6{:}1$
	2			
	3			
	4			
	5			
Large Cell	10			

4a. What is happening to the ***surface area to volume*** ratio as cell size increases?

As cells get larger, the surface area to volume ratio _____

4b. Since transport of materials in and out of the cell can only happen at the cell's surface, what problem does this pose for larger cells??

5. Do larger organisms have larger cells than smaller organisms, or more cells than smaller organisms? Explain.

6. What is the advantage of having folded membranes surrounding the cell(plasma membrane), or within the cytoplasm (endoplasmic reticulum) or within organelles (eg. chloroplasts) ?