Revised Lesson

**Quantitative Learning Goals**

Learning goals for General Biology 1 - Cell Structure and Function

Concept: Why are cells small?

(1) Knowledge and conceptual understanding

Students will be able to calculate the surface area and volume of hypothetical cells shaped like cubes.

(2) Thinking and other skills

Students will be able to graph the rate of change of the surface area and volume of the cells as they get bigger.

(3) Attitude and values

Students will develop their understanding of foundational biological concept by  interpreting graphical data generated by comparing the rate of change of surface area to that of volume. They will use their stated comparison to suggest an answer to the question of why cells are small. Students will then critique the answers generated as a means of assessing the validity of their answers.

Topic Goals

Students will describe two dimensions of cell: surface area and volume

Students will explain how each dimension is related to cell function

Students will apply  previously discussed content related to the functions of the cell membrane as it relates to movement of substances into and out of cells to the concept of cell dimension

Resources needed

Data table

Graph paper

Calculator

This exercise will be completed in the laboratory section in which we cover the structure and function of cells. Following the laboratory exercise in which the students both learn to identify cell structures and their functions. Emphasis, will be placed on the cell membrane and its role in regulating the internal environment of the cell. The above question of why cells are small will be posed, and students will be provided with a data table which they will use to input and calculate the data. The students will then be guided in the choice of axis for the values to be plotted in addition to the use of an appropriate scale, to plot the data.

The students will work in groups of four. Each group will generate a graph. Each group will have to write their analysis of the data in addition to explaining how this analysis helps them to answer the question of why cells are small?

In Class Exercise

**Lab 4                                                                                                 Part II**

In laboratory 3 & 4 you have learned about cell structure and function. You have observed the structural and functional relationship between three types of *Eukaryotic* cells, namely protists, plant cells and animal cells.

One of the observations that you have made is that most cells are microscopic. In this exercise you will be required to suggest why cells are microscopic, why are cells small?

How does being small help cells to function efficiently? Based on what you have learned in laboratory's 3 & 4 cells cannot be too small, because they must be big enough to carry the cell's nucleus and other organelles. However, you will not find an individual cell that is as big as a chicken egg. What determines the maximum size of a cell?

The answer to this question is determined by geometry. You will suggest an answer to this question by graphing the relationship between the length of  hypothetical cells of increasing size and their surface area and volume.

Complete the table below, by calculating the surface area and volume of the hypothetical cells of increasing lengths. Finally, calculate the surface to volume ratio. To make your calculations easier, the cells are shaped like cubes.

|  |  |  |
| --- | --- | --- |
| Length of cell in cm | Surface Area (LxW) x 6 | Volume (LxWxH)       SA/volume |
|      1 |  (1 x 1) x 6 = 6 cm2 | (1 x 1 x 1 ) = 1 cm3        6/1 = 6 |
|      2 |   |   |
|      3 |   |   |
|      4 |   |   |
|      5 |   |   |
|      6 |   |   |
|      7 |   |   |
|      8 |   |   |
|      9 |   |   |
|     10 |   |   |

Reminder: A cube has 6 equal sides. Therefore the surface area is equal to the area of one side (LXW)  x 6 sides. The volume is given by the length of a side multiplied by itself 3 times. After completing the table. Graph the results on the graph paper provided.

**Graphing**

**Step1:**  **Select your axis**

Identify the dependent variable and the independent variable. Remember, the independent variable is plotted on the x-axis and the dependent variable is plotted on the y-axis.

**Step 2:** **Determine your scale**

Choose a scale that gives an even distribution of points from smallest to largest on your graphing  paper.

**Step 3:** **Plot points of surface/volume ratios found in the last column (SA/V).**

Reminder: The bigger the top number compared to the bottom number, the larger the ratio. Meaning the surface area is bigger than the volume by that amount. If the ratio is less than one, the top number is smaller than bottom number.

**Step 4:** **Interpret graph**

Begin by answering the following questions.

(1) Think about the three types of cells you studied in laboratory 3, protists, plant and animal cells, of the three, the hypothetical cell would most closely resemble which type of cell.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Why\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(2) In the smaller cells, that is cells between 1 - 5 cm long, as the length increases how does the ratio of surface area to volume change. What does this tell us about the relationship between surface area to volume in smaller cells?

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(3) In the larger cells, that is cells between 7 - 10 cm long, as the length increases how does the ratio of surface area to volume change. What does this tell us about the relationship between surface area to volume in larger cells?

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Based on your answer to the question above, small cells have a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

surface to volume ratio than larger cells.

Briefly describe the function of the plasma membrane of the cell.

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Based on your observations of the effect of increasing cell size on surface area and volume and your description of the function of the plasma membrane suggest an explanation of why cells are small?

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Note: Your answer should be based on your observation. You will not be given credit for answers not based on your observations.