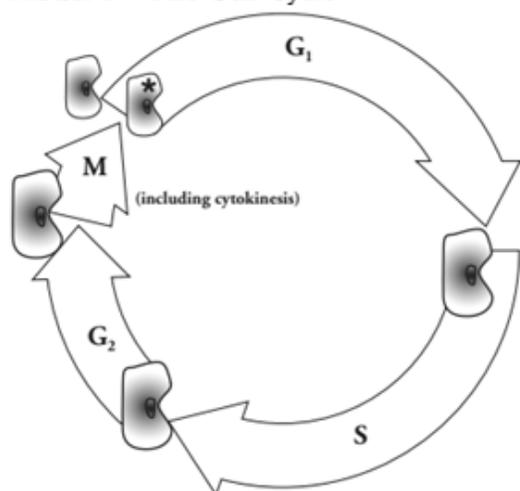


The Cell Cycle and its Control

For single celled organisms, cell division increases the number of individuals. In a multicellular organism, cell division functions to repair and renew cells that die or are lost. In order to achieve normal growth, development, and maintenance, the timing and rate of cell division in different parts of an animal or plant must be regulated. Any given cell monitors several signals, both inside and outside the cell, to determine whether it will divide or not.

Model 1 – The Cell Cycle



1. [SP1, SP2] a) During which phase does the size of the cell increase?

b) During which phase does the number of cells increase?

2. [SP1] Considering your answer to Question 1, identify two ways that the growth of an organism can be accomplished through the events of the cell cycle.

3. [SP1, SP2] a) Cancer, the uncontrolled growth of cells, often results in a tumor, or mass of abnormal cells. Some cancerous tumors consist of many cells that are much smaller than normal. According to Model 1, what part(s) of the cell cycle is/are most likely being affected?

b) In Model 1, if the length of the arrow represents time, then for those cancerous cells, what happens to the time that is necessary for the cell cycle? What implication might this have for doctors who are treating cancer patients?

Model 2 – Cell Cycle Data

Phase	Key Process	Time Interval (hours)	Sets of DNA present in each cell at end of phase	Number of organelles in each cell at end of phase
G ₁		11	1	560
S		8	2	570
G ₂	Protein and preparation for mitosis	4	2	600
M	Cell and nuclear splitting	1	1	300
	Total time:	24		

4. [SP4, SP6] The third column of Model 2 shows the time spent in each phase of the cell cycle. Imagine 100 cells were chosen randomly from a tissue sample containing dividing cells and examined under a microscope. In which phase of the cell cycle would you expect to find the largest number of cells? Justify your response.

5. [SP1, SP2] a) Fill in the “Key Process” column for G₁ and S phases in Model 2.

b) Look again at Model 2. Compare the amount of DNA at the beginning and end of synthesis. Why did the amount of DNA change?

c) Your friend wonders if cells have to make new organelles after they divide. Use data from Model 2 to provide an answer.

6. [SP1, SP2] Cytokinesis occurs as part of M phase and results in the production of two daughter cells. Identify the evidence from Model 2 that supports the idea that DNA is divided into the two daughter cells.

7. [SP6] If a starfish sustains damage to a limb, it often grows a new one. If a human adult sustains damage to his or her spinal cord, some degree of permanent paralysis is usually the result. If a gecko loses its tail, it may grow a new one.

a) Cells from which organism are least likely to go through the cell cycle to repair damage? Support your answer.

b) Explain why brain damage is nearly always permanent?

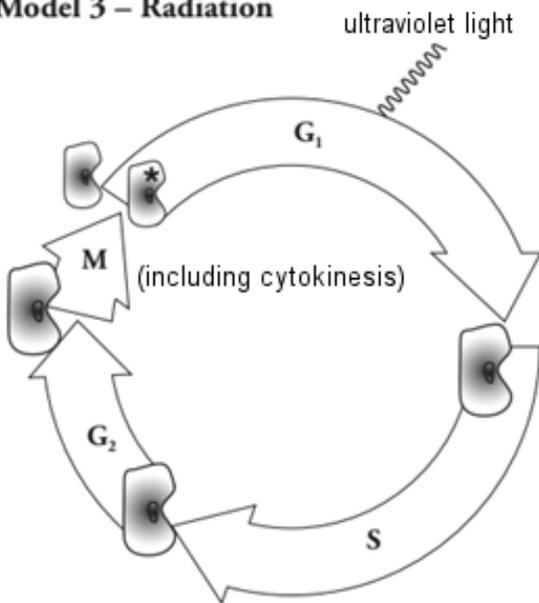
8. [SP1, SP2] Keeping in mind the events of each part of the cell cycle, mark with an arrow on Model 1 where those cells might (either temporarily or permanently) exit the cell cycle to G_0 . Label this as G_0 . Why did you choose this location for G_0 ? Hint: Think of a place in the cell cycle where the cell is functioning normally, but not preparing to divide.

9. [SP1, SP2, SP6] Consider a cell in G_0 . Use the information in both Models 1 and 2 to answer the following questions.

a) In order for this cell to divide normally, what would need to occur?

b) What if the requirement(s) you identified in part a of this question did not occur? What would be the outcome for the cell in that case?

Model 3 – Radiation



10. [SP2, SP6] Ultraviolet light may cause DNA damage, including mutation. Use Model 3 to propose a reason why the cell is especially susceptible to such damage during G_1 .

The cell cycle has a regular system of checks and balances that prevents damaged or mutated cells from proceeding to the next phase. One way an organism deals with the problems is to kill the damaged cell before it passes on the problem to its daughter cells. This is a normal process called apoptosis. (Some normal cells also go through this process.)

11. [SP6] a) What consequences might result if apoptosis did not occur in the cell with damaged DNA?

b) Sometimes, damaged cells enter G_0 rather than dividing. Why would this be beneficial?

c) Imagine a damaged cell that is supposed to die does not. What could happen, after several cell cycles, to an organism whose damaged cells did not go through apoptosis?

12. [SP1] Why are some types of cancer able to be treated with radiation?

13. [SP2, SP6] Plasmodial slime mold is an example of a multinucleated cell. It can be referred to as “one huge cytoplasmic mass with many nuclei.” What part of Model 1 is skipped in the formation of such a cell? Explain your answer.

14. [SP1, SP6] Chemotherapy utilizes chemicals that disrupt various parts of the cell cycle, targeting rapidly growing cells. Paclitaxel (Taxol) is one such drug that prevents the mitosis phase from taking place.

a) Explain how this drug is useful as a cancer treatment.

b) How might targeting rapidly growing cells explain common chemotherapy side effects such as hair loss and nausea?