

Investigation 7: Cell Division

Getting Started

These questions are designed to see how well you understand and can explain the key concepts related to cell division before you begin your investigations.

1. **How did you develop from a single-celled zygote to an organism with trillions of cells? How many mitotic cell divisions would it take for one zygote to grow into an organism with 100 trillion cells?**
2. **How is cell division important to a single-celled organism?**
3. **How do chromosomes move inside a cell during cell division?**
4. **Why is it important for DNA to be replicated prior to cell division?**
5. **What must happen to ensure successful cell division? What are cyclins and cyclin-dependent kinases? What do these proteins do in a cell? What would happen if the control were defective?**
6. **How does the genetic information in one of your body (somatic) cells compare to that found in other body (somatic) cells?**

Bead Mitosis: Summary questions for bead activity in class (individual)

1. **If a cell contains a set of duplicated chromosomes, does it contain any more genetic information than the cell before the chromosomes were duplicated?**
2. **What is the significance of the fact that chromosomes condense before they are moved?**
3. **How are the chromosome copies, called sister chromatids, separated from each other?**

Effects of the Environment on Mitosis

Scientists reported that a fungal pathogen, may negatively affect the growth of soybeans (*Glycine max*). Soybean growth decreased during three years of high rainfall, and the soybean roots were poorly developed. Close relatives of *R. anaerobis* are plant pathogens and grow in the soil. A lectin-like protein was found in the soil around the soybean roots. This protein may have been secreted by the fungus. Lectins induce mitosis in some root apical meristem tissue (primary growing tissue at the tips of roots and stems). In many instances, rapid cell divisions weaken plant tissues.

You have been asked to investigate whether the fungal pathogen lectin affects the number of cells undergoing mitosis in a different plant, using onion root tips. Onion root tip cells can easily be seen under a microscope to visualize cells in different phases of the cell cycle.

1. **What is your experimental hypothesis?**
2. **How would you design an experiment with onion bulbs to test whether lectins increase the number of cells in mitosis?**
3. **What would you measure, and how would you measure it?**
4. **What would be an appropriate control for your experiment? What is a control?**
5. **How could a Chi-square test be used to analyze your results?**
 - Assume the observed values are the number of treated cells in the phases of the cell cycle
 - Assume the expected values are the percentage of cells in the different phases in the control group multiplied by the total number of cells in the treated group
6. **Does an increased number of cells in mitosis mean that the cells are dividing faster than the cells in the roots with a lower number of cells in mitosis?**

Loss of Cell Cycle Control in Cancer

Getting Started

1. **How are normal cells and cancer cells different from each other?**
2. **What are the main causes of cancer?**
3. **What goes wrong during the cell cycle in cancer cells?**
4. **What makes some genes responsible for an increased risk of certain cancers?**
5. **Do you think the chromosomes might be different between normal and cancer cells?**

Case Studies

Research karyotype pictures for each of the following cases and compare it to a karyotype from a normal human cell with no defects or genetic disorders. Search HeLa cell karyotype and Philadelphia chromosome karyotype. For each case, get a rough count of the number of chromosomes in each type of cell, then answer the following questions.

1. **What is a karyotype?**
2. **Do your observations support your hypothesis from question #5 above?**
 - a. **If not, what type of information might you need to know in order to understand your observations?**
 - b. **If yes, how do you think the difference in appearance and/or number of chromosomes affects the functioning of the cell?**

Case 1: HeLa Cells

HeLa cells are cervical cancer cells isolated from a woman named Henrietta Lacks. Her cells have been cultured since 1951 and used in numerous scientific experiments. Henrietta Lacks died from her cancer not long after her cells were isolated. Lack's cancer cells contain remnants of human papillomavirus (HPV), which we now know increases the risk of cervical cancer. Research HeLa cells to be able to provide answers for the questions below.

1. **From your observations, what went wrong in Henrietta Lack's cervical cells that made them cancerous?**
2. **What is HPV? How does infection with human papillomavirus (HPV) increase the risk of cervical cancer?**
3. **What cellular process is affected by the human papillomavirus (HPV)?**
4. **How was the HeLa cell line cultured?**

Discussion Questions

5. **Should tissue be removed from a patient without his or her consent for research?**
6. **Was there bias in the way Henrietta Lacks was treated at Johns Hopkins?**
7. **Put the use of HeLa cells on trial. Debate what is more important: an individual's rights to his/her own body tissues or the medical knowledge gained by studying a patient's tissues?**
8. **Should Henrietta Lacks' family be compensated for the discoveries made using her cells?**
9. **Do companies or universities have the right to patent discoveries made using a patient's tissues or genes without consulting the patient?**

Case 2: Philadelphia Chromosomes

In normal cells, mitosis usually is blocked if there is DNA damage. Sometimes, though, DNA damage makes cells divide more often. Certain forms of leukemia have a unique feature called a Philadelphia chromosome. Find a karyotype of chronic myelogenous leukemia cells with a Philadelphia chromosome, and answer the following questions.

1. What happens in a normal cell if the DNA has mutations?
2. What type of mutation causes Philadelphia chromosomes?
3. What would happen if cells with mutated DNA replicated?
4. How do cells monitor DNA integrity?
5. How are chromosomes different in the leukemia cancer cells compared to normal cells?
6. How could these differences lead to cancer?

Where Can You Go From Here? Pick one to research

1. Investigate how growth factors affect the cell cycle. Include a discussion of cell communication.
2. Research what tumor suppressors do in the cell cycle and which types of cancers may be caused by mutations in tumor suppressor genes. Specific examples include human papillomavirus (HPV), retinoblastoma protein (Rb), BRCA 1 and BRCA 2, and p53.

Grading Rubric

	Points Possible	Points Earned
Getting Started ?s - Questions answered thoroughly and completely	12	
Bead Mitosis ?s - Questions answered thoroughly and completely	8	
Effects of the Environment on Mitosis - Supply a thorough explanation of the lab set and analysis questions	18	
Loss of Cell Cycle Control in Cancer - Answer questions thoroughly and completely	10	
Case Studies - Answer the questions and be prepared for a class discussion of HeLa cells	30	
Where can you go from here? - At least a 300 word summary of the main points of your research	22	

Total = 100