Part 3: Loss of Cell Cycle Control in Cancer

Many of us have family members who have or have had cancer. Cancer can occur when cells lose control of their cell cycle and divide abnormally. This happens when tumor suppressor genes, such as p53 or Rb (retinoblastoma), are mutated. There are many questions you should consider before beginning your investigation.

Review from Part 1

- How is the cell cycle controlled in normal cells?
- What are cyclins and cyclin-dependent kinases? What do these proteins do in a cell?

Prelab Questions for Part 3

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 that the chromosomes might be different between normal and cancer cells?

The last question is the focus of this part of the lab. Write a one-sentence hypothesis as to how the chromosomes of a cancer cell might appear in comparison to a normal cell and how those differences are related to the behavior of the cancer cell.

For each of the following cases, look at pictures of the chromosomes (karyotype) from normal human cells. Compare them to pictures of the chromosomes from cancer cells. Use a Google image search (suggestion “cancer cell karyotype” is a good starting point).

For each case, count the number of chromosomes in each type of cell, and discuss their appearance. Then answer the following questions.

7) Do your observations support your hypothesis?
8) If not, what type of information might you need to know in order to understand your observations?
9) If yes, what type of information can you find that would validate your conclusions?

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. Lacks’s cancer cells contain remnants of human papillomavirus (HPV), which we now know increases the risk of cervical cancer.

Your teacher may ask you to read The Immortal Life of Henrietta Lacks by Rebecca Skloot. Alternatively, check out her Wikipedia page. Then look at these links:


Henrietta Lacks Article
Henrietta Lacks Video

HeLa Karyotype

Answer the following:

1) From your observations, what went wrong in Henrietta Lacks’s cervical cells that made them cancerous?
2) How does infection with human papillomavirus virus (HPV) increase the risk of cervical cancer?
3) Your take: Should tissue be removed from a patient without his or her consent for research? Why?
4) How was the HeLa cell line cultured?
5) What virus infected Henrietta Lacks and may have caused her cervical cancer? What cellular process is affected by this virus?
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’s 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?
10) What other legal and ethical questions are raised by this case?

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.

Philadelphia Cell Karyotype
http://2.bp.blogspot.com/_4co61v90rNA/R8BtX470mUI/AAAAAAAADY/Tuj0im1IFzc/s320/philadelphia_karyotype.jpg

Answer the following questions:

1) What happens in a normal cell if the DNA has mutations?
2) What would happen if cells with mutated DNA replicated?
3) How do cells monitor DNA integrity?
4) How are the chromosomes different in the cancer cells compared to normal cells?
5) How could these differences lead to cancer?
Figure 5. Karyotype of a Patient with Chronic Myelogenous Leukemia Indicating Chromosomal Deformity