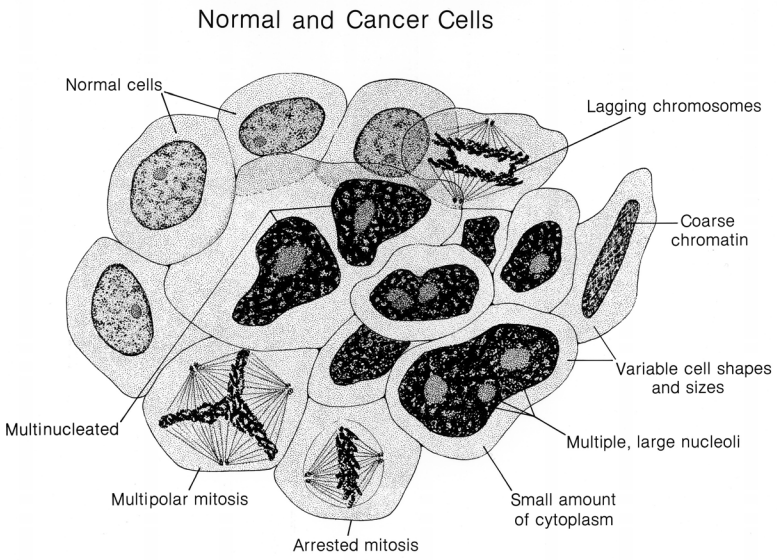
Lab 4. Normal and Abnormal Cell Division: Which of These Patients Could Have Cancer?

Introduction

Hundreds of genes control the process of cell division in normal cells. Normal cell growth requires a balance between the activity of those genes that promote cell division and those that suppress it. It also relies on the activities of genes that signal when damaged cells should undergo apoptosis (programmed cell death). Cells become cancerous after mutations accumulate in the various genes that control cell division. Some mutations occur in genes that stimulate cell division, which triggers these cells to start dividing. Other cancer-related mutations inactivate the genes that suppress cell division or those that signal the need for apoptosis. Gene mutations accumulate over time as a result of independent events.

The figure below provides an illustration of normal and cancerous cells. A normal cell often has a great deal of cytoplasm and one nucleus, and it is about the same size and shape as the cells that it borders. A cancerous cell, in contrast, often has a small amount of cytoplasm, more than one nucleus, and an abnormal shape. Cancerous cells also divide faster than normal cells do, so there is a greater chance that these cells will be in one of the stages of mitosis. The stages of mitosis in a cancerous cell, however, will often look different than they do in a normal cell. For example, the chromosomes may be pulled toward three or more centrioles (instead of two), and some chromosomes may lag behind others during anaphase. These types of abnormalities are often present because the genes in the cells that trigger apoptosis are no longer functional.

Normal and cancer cells side by side, with normal and cancerous characteristics identified



As a mass of cancerous cells grows, it develops into a tumor. Tumors often remain confined within the normal boundaries of a tissue during the early stages of cancer. As time passes, however, tumors will often break through the boundaries of a tissue and invade adjoining tissues. These tumors are described as malignant. Sometimes individual cancer cells will break off from a malignant tumor and travel to other parts of the body, leading to the formation of new tumors at those sites. This process is called metastasis, and it occurs during the terminal stages of cancer. Tumors that are not capable of invading adjoining tissue are described as benign.

A medical doctor will often order a procedure called a biopsy if he or she suspects that a patient has a tumor. As part of a biopsy, the doctor or other medical professional will remove a piece of tissue or a sample of cells from a patient's body so that it can be examined in a laboratory by a pathologist. The pathologist will prepare several histological slides of the tissue and use a microscope to look for the presence of cancerous cells. The pathologist will then prepare a pathology report for the medical doctor. The pathology report describes the results of the analysis and the opinion of the pathologist.

Your Task

You will be provided with images of histological slides from four different individuals. Examine these images and use what you know about the appearance of cells and what proportion of time cells tend to spend in each stage of mitosis to determine if any of the individuals have cancer.

The guiding question of this investigation is, **Which of these patients could have cancer**?

Materials

You may use any of the following materials during your investigation:

- Histological slide from stomach (thin section, H&E)
- Histological slide from pancreas (thin section, H&E)
- Images of histological slides from patients 1, 2, 3, and 4
- Microscope

Safety Precautions

1. Glass slides can have sharp edges—handle with care to prevent cutting of skin.
2. Use caution when working with electrical equipment. Keep away from water sources in that they can cause shorts, fires, and shock hazards. Use only GFI-protected circuits.
3. Wash hands with soap and water after completing this lab.
4. Follow all normal lab safety rules.

Getting Started

To answer the guiding question, you will need to design and conduct an investigation to examine the characteristics of typical cells found within the stomach and pancreas. You will then compare these cells with the cells taken from four fictitious patients. To accomplish this task, you must determine what type of data you will need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you will need to collect,* think about the following questions:

- What type of measurements or observations will you need to record during your investigation? (Hint: What are the characteristics of cancerous cells?).
- Will you collect one type of data (appearance of cells only) or multiple types of data (appearance of cells and proportion of time spent in various stages of the cell cycle)?

To determine *how you will collect your data,* think about the following questions:

- What will serve as a control (or comparison) condition?
- How will you collect data? (Hint: Higher magnifications make counting cells and comparing easier.)
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect and how will you organize the data?

To determine *how you will analyze your data,* think about the following questions:

- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

Investigation Proposal Required? ☐ Yes ☐ No

Connections to Crosscutting Concepts and to the Nature of Science and the Nature of Scientific Inquiry

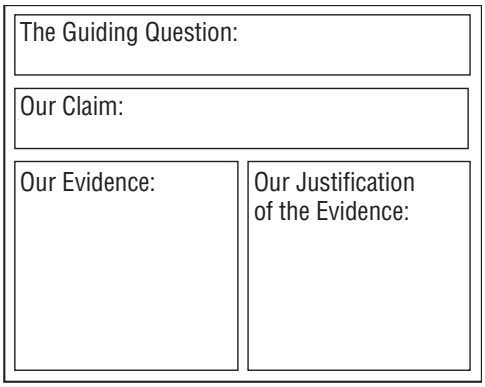
As you work through your investigation, be sure to think about

- the importance of identifying patterns,
- what is and is not important at different scales or time periods,
- how structure is related to function in living things,
- the difference between observations and inferences in science, and
- the nature of scientific knowledge.

Argumentation Session

Once your group has finished collecting and analyzing your data, prepare a whiteboard that you can use to share your initial argument. Your whiteboard should include all the information shown in the figure to the right.

Argument presentation on a whiteboard



To share your argument with others, we will be using a round-robin format. This means that one member of your group will stay at your lab station to share your group's argument while the other members of your group go to the other lab stations one at a time to listen to and critique the arguments developed by your classmates.

The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. In order to critique an argument, you will need more information than what is included on the whiteboard. You might, therefore, need to ask the presenter one or more follow-up questions, such as:

- Why did you decide to focus on those data?
- What did you do to analyze your data? Why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your analysis? How do you know that your interpretation of your analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those alternative ideas?
- How confident are you that your claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. This report must be typed, and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!