

The Cell Cycle, Cancer, and the Synchrotron

Created by: Camille Hounjet, College of Education, University of Saskatchewan. A Lesson Plan for Grade 12 Biology, Genetics Unit

Pan-Canadian Objectives (Only Synchrotron Part - activity #3 & 4 and discussion)

Science Grade	Knowledge	Science, technology, society and the environment	Skills	ATTITUDES
10-12	315-6, 315-7	114-3, 116-2, 117-1, 117-10, 117-11	214-12, 215-3	436, 439, 440, 443
7-9	304-6, 305-1, 305-5	109-2, 109-3, 109-5, 109-7, 110-4, 111-all, 112-all, 113-1	210-16	422, 425, 426, 429

Factors of Scientific Literacy

A3-Holistic

A9-Human/Culture related

B11-Predictability

B14-Cycle

B15-Model

C2-Communicating

C10-Predicting

C14-Problem Solving

D1-Science and Technology

D3-Impact of Science and Technology

D5-Public Understanding Gap

D6-Resources for Science and Technology

D8-Limitations of Science and Technology

D9-Social Influence on Science and Technology

D10-Technology Controlled by Society

Common Essential Learnings

COM-To enable students to understand and use the vocabulary, structure and forms of expression which characterize the study of biology.

TL- To develop a contemporary view of technology.

TL- To develop an understanding that technology both shapes society and is shaped by society.

Materials

✿ Construction paper of different colors, cut into 4cmx6cm squares

✿ Pencils

✿ Tape

✿ Compound light microscopes Minimum of 6)

✿ Set of whitefish blastula slides

✿ Set of onion root tip slides

✿ Internet connection

- ✿ Biology textbooks
- ✿ Handouts
- ✿ Memory Game (prepared beforehand using accompanying words and definitions)
- ✿ Copies of online article “Diverse Strategies to Vanquish Cancer” by Kathleen Fackelmann (Science News, May 3, 1997, vol. 151, pp. 274-275) located at http://www.sciencenews.org/pages/sn_arc97/5_3_97/bob1.htm
- ✿ Information about, or a scheduled field trip to the Canadian Light Source on the University of Saskatchewan campus

Time

This lesson is estimated at approximately 3-4 hours long, depending on how long you allow for discussion.

Establishing Students’ Prior Knowledge: The following concepts/vocabulary should have already been taught in order to complete this lesson:

- | | |
|--------------------------|--|
| ✿ Gene | ✿ Structure of DNA |
| ✿ DNA molecule | ✿ Structure and Function of Nucleus |
| ✿ Chromosome | ✿ Structure and Function of Microtubules |
| ✿ Cell Division | ✿ How to use a compound light microscope |
| ✿ Chromatid | ✿ How to make basic microscopic drawings |
| ✿ Homologous Chromosomes | |
| ✿ Autosomes | |
| ✿ Sex Chromosomes | |
| ✿ Structure of Proteins | |

Motivational Set

Display either a model or a photograph of a human brain. Point out that once the brain is fully formed, most of the nerve cells do not divide again. These cells are arrested in a certain stage in the life of a cell (the G_1 phase).

Then display either a model or a photograph of a human bone. Point out that red blood cells are produced from cells in the marrow of long bones. An average red blood cell lives for an average of 120 days. Each second, about 2 million red blood cells are produced by cell division in the bone marrow. Cells in the marrow, unlike those in the brain, continue going through the life of a cell or the cell cycle, as long as a person lives.

Body of the Lesson:

Activity #1:

Students will:

1. Write the number 1-8 on paper pieces (one number per piece). Tape the pieces together in numerical order to model a chromosome with 8 genes.
2. Use the chromosome they made to model the four alterations in chromosome structure (deletion, duplication, inversion, and translocation). For example, remove the number 3 and reconnect the remaining chromosome pieces to represent a deletion.
3. Reconstruct the original chromosome before modeling a duplication, an inversion, and a translocation. Use the extra paper pieces to make the additional numbers they need. Make a drawing of each type of mutation in their notes.
4. Describe how a cell might be affected by each type of mutation if the cell were to receive a chromosome with that mutation. (ANSWERS: Deletion-cell would be missing a gene which could prove fatal; Duplication-cell would have an extra gene which could prove fatal or result in malfunctioning of the cell; Inversion-cell may not be able to use gene because it is located in a different area on the chromosome, which could prove fatal; Translocation-cell may not be able to use the gene because it is located on a different chromosome, which could prove fatal.)

Activity #2:

Teacher will:

1. Set up a variety of stations around the room. At each station put a folder containing specific instructions and enough copies of the activity for each student.
 - a. Station #1: Cell Cycle notes outline. Prepare an outline of notes corresponding to the Cell Cycle chapter in your students textbook. The students can then easily read along in their text while filling in the outline. Include Handout #1, or a version of it.
 - b. Station #2: Set up 6 or more microscopes and provide whitefish blastula and onion tip root slides for students to use. Include Handout #2, or a version of it.
 - c. Station #3: Prepare an outline of notes corresponding to the Control of the Cell Cycle. The students can easily read along in their text while filling in the outline. Include Handout #3, or a version of it.
 - d. Station #4: Make a memory game ahead of time. These are easy to make by cutting out the accompanying vocabulary words and putting them on construction or other coloured paper. Each game contains cards with vocabulary and definitions. Students will follow the instructions at this station (see Handout #4) and complete a vocabulary quiz to demonstrate that they know the Cell Cycle terms.

Students will:

Move around the room, completing the assignments at each station.

Activity #3:

Students will:

Read the article “Diverse Strategies to Vanquish Cancer” by Kathleen Fackelmann and write a report explaining the problems associated with using chemotherapy to kill tumour cells. They should also summarize three approaches that attempt to overcome these problems. They should also research the Canadian Light Source and its implications for cancer research.

Activity #4:

As a class:

Tour the CLS if possible. If not, have students read and work through the following materials, located at <http://www.lightsource.ca/education/pdf/Cancer.pdf>.

Debrief

As a class:

- ✿ Debrief the Cell Cycle with students. Include the order of the 5 phases (G1, S, G2, Mitosis, and Cytokinesis), and describe what happens at each phase. Review what happens to a cell when a mutation has occurred. Discuss how normal cells can become cancer cells.
- ✿ Discuss the Canadian Light Source and its relevancy to cancer and cancer research. The poster located at <http://www.lightsource.ca/education/pdf/Cancer.pdf> will be very helpful in showing students examples of the application of the CLS in researching cancer. This discussion can lead to topics such as technological advancement, research and funding, and current issues in medicine, among others.

Evaluation

Students should turn in their filled in worksheets. The vocabulary quiz could be graded. The essay should be graded. A quiz after this lesson might be helpful in having students recall what they have learned. This material should also be tested on a unit exam.

References

<http://www.lightsource.ca/education/>

<http://www.lightsource.ca/education/resource.php>

<http://www.lightsource.ca/education/poster.php>

http://www.powertolearn.com/teachers/lesson_activities/science/

“Biology: Principles and Explorations” by Johnson, G. and Raven, P. Copyright 2001 by Holt, Rinehart, and Winston

Station #1: Cell Cycle Outline

Use the following outline to make notes on the “Five Phases of the Cell Cycle”.

Definitions:

Cell Cycle:

Interphase:

First Growth (G_1) phase: Brief Description (What’s happening?)

Synthesis (S) phase: Brief Description (What’s happening?)

Second Growth (G_2) phase: Brief Description (What’s happening?)

Mitosis: Brief Description (What’s happening?)

Cytokinesis: Brief Description (What’s happening?)

The Cell Cycle (diagram):

Additional Questions:

1. During which phase(s) of the Cell Cycle does the cytoplasm divide?
2. During which phase(s) of the Cell Cycle would one expect to find a rapidly growing cell?

Station #2: Observing the Cell Cycle in Plant and Animal Cells

At this station you will observe the different phases of the cell cycle on onion root tips and whitefish blastula cells. You should view AT LEAST five different phases of the cell cycle and make sketches in the space provided below. Please include a few animal and plant cells in your collection of sketches!

- Neatly label the following structures (if they are visible):
Chromosomes Cell wall Spindle fibers
Nuclear membrane Cleavage Furrow
- In the blanks provided, please indicate the phase of the cell cycle the cell is undergoing.
- Identify whether the slide represents an animal or a plant cell.

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A

B

C

Phase: _____ Phase: _____ Phase: _____
Type of cell: _____ Type of cell: _____ Type of cell: _____

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D

E

Phase: _____ Phase: _____
Type of cell: _____ Type of cell: _____

Additional Questions: Answer the questions below on the back of this worksheet.

1. What is the importance of mitosis to unicellular organisms?
2. What is the importance of mitosis to multi-cellular organisms?
3. Why are onion root tip cells and whitefish blastula cells often used to view cell division?

Station #3: Control of the Cell Cycle and its Relation to Cancer

Use the following outline to make notes on the “Control of the Cell Cycle and its Relation to Cancer”

Cell Growth (G1) checkpoint: Brief Description (What’s happening?)

DNA Synthesis (G2) checkpoint: Brief Description (What’s happening?)

Mitosis checkpoint: Brief Description (What’s happening?)

Definitions:

Cancer:

Benign tumours:

Malignant tumours:

Metastasis:

Chemotherapy:

Proto-oncogenes:

Tumour-suppressor genes:

Relate cancer to immunity:

Relate cancer to mutations:

Additional Questions:

1. Differentiate between the G1, G2, and S phases of the Cell Cycle.
2. Relate the onset of cancer to three major checkpoints at which the Cell Cycle is controlled.
3. Identify the type of environmental factors that can cause mutations that may lead to cancer.

Station #4: The Memory Game

1. Place all of the cards face down.
2. Flip over two cards.
3. If you have a match (a vocabulary term with the correct definition), you may remove both cards from the board.
4. If you do not have a match, it is the other person's turn, but you should remember where the cards are so that later in the game you can make a match.
5. Repeat steps 2-4 until all matches have been made.
6. The winner is the person with the most matches.

Vocabulary for Memory Game

Cancer	S phase
Cell cycle	Chemotherapy
Benign tumor	Proto-oncogenes
G1 phase	Tumour-suppressor genes
Malignant tumor	Mitosis
G2 phase	Cytokinesis
Metastasis	Interphase

Definitions for Memory Game

A disease characterized by abnormal cell growth.	A mass of cancer cells which remain at the original site of the tumour formation.
A mass of cancer cells which spread to neighbouring tissues and organs.	The spread of cancer cells beyond their original site.
Poisonous chemicals that are harmful to actively dividing cells (both cancerous and non-cancerous).	Genes that stimulate normal cell growth and cell division.
Genes that inhibit cell growth and cell division to prevent uncontrolled cell growth.	The process during cell division in which the nucleus of a cell divides into 2 nuclei, each with the same # and kind of chromosomes.
The division of the cytoplasm to form 2 different cells.	The period between 2 divisions of a eukaryotic cell during which the cell carries out routine functioning, copies its DNA, and prepares to divide.
The repeating 5 phase sequence of eukaryotic cell growth and division.	The stage in which the cell grows rapidly and carries out normal functions.
The stage in which microtubules form to move the chromosomes during mitosis.	The stage in which the cell's DNA is copied.