

Keeping it All in Check: The Life of a Cell in the Cell Cycle

4

Vocabulary:

Oncogene: is a gene that has the potential to cause cancer. In tumor cells, they are often mutated or expressed at high levels.

Proto-oncogene: a normal gene that can become an oncogene due to mutations or increased expression

Mutation: a permanent change in the DNA sequence of a gene. Mutations in a gene's DNA sequence can alter the amino acid sequence of the protein encoded by the gene.

Tumor Suppressor Gene: a gene that reduces the probability that a cell in

a multicellular organism will turn into a tumor cell. A mutation or deletion of such a gene will increase the probability of the formation of a tumor.

Lesson Summary:

Students will use knowledge of the cell cycle, checkpoints and the types of genes controlling the checkpoints from Lesson Three to predict how mutations in both proto-oncogenes and tumor suppressor genes affect the cell cycle and cellular division to determine when cancer could develop. Students will complete a formative activity in which they randomly draw mutation types as a "cause" of cancer and determine the effect on the individual.

Student Learning Objectives:

The student will be able to...

1. Apply the concepts of the control of the cell cycle, gene mutation and cancer development.
2. Recognize that the development of cancer is a varied, multi-step process.

Standards:

SC.912.L.16.3

SC.912.L.16.8

SC.912.L.16.14

Materials:

- Completed Group Cell Cycle Diagram and/or completed student handout from Lesson Three
- Student Page: What Happens When Genes Lose Control?
- Cell Cycle & Cancer Cause and Effect Cards
- Paper bags for the Cause Cards (two for each group)
- Student Page: Development of Cancer Concept Map
- Computers with internet access

? KEY QUESTION(S):

- When mutations arise in proto-oncogenes and/or tumor suppressor genes what changes occur in the cell cycle?
- Why is cancer development a multi-step process?

🕒 TIME ESTIMATE:

- Advanced Preparation: ~30 minutes
- Student Procedure: 1 class period, ~45 minutes each

🎯 LEARNING STYLES:

- Visual, auditory and kinesthetic



Background Information:

Read the article “Cell Cycle Control by Oncogenes and Tumor Suppressors: Driving the Transformation of Normal Cells into Cancerous Cells” from Scitable by Nature. <http://www.nature.com/scitable/topicpage/cell-cycle-control-by-oncogenes-and-tumor-14191459>

Read the literature on “Oncogenes, Tumor Suppressor Genes, and Cancer” by the American Cancer Society, found here: <http://www.cancer.org/acs/groups/cid/documents/webcontent/002550-pdf.pdf>

Advance Preparation:

- Print Student Page: What Happens When Genes Lose Control? (one per student)
- Print Student Page: Development of Cancer Concept Map (one per student)
- Prepare Cancer Cause and Effect cards by printing them on colored paper (three different colors for the three different categories are suggested) and possibly laminating for future use. (Each set per group will consist of the following: bag one containing the proto-oncogene cards, bag two containing the tumor suppressor gene cards, the set of three effect cards)

Procedure and Discussion Questions With Time Estimates:

1. **(4 min)** Show the 1:09 minute video clip on the relationship between oncogenes and tumor suppressor genes adapted from the National Institutes of Health “Cell Biology and Cancer” curriculum Student Activities 2 – Cancer and the Cell Cycle and available on YouTube: http://www.youtube.com/watch?v=eoWRZbtqB_s
 - a. Briefly ask students to summarize the video as a review from Lesson Three and address any questions/misconceptions.
2. **(6-8 min)** Pass back group Cell Cycle Diagrams from Lesson 3 and copies of the student page What Happens When Genes Lose Control?
 - a. Pass out the complete set of three effect cards to each group.
 - b. Randomly pass out one of the cause gene cards to each group (from either the proto-oncogene set or the tumor suppressor gene set- if possible it would be best if each group had a different card)
 - c. Students will record the change from the cause gene card under the **cause** column on their What Happens When Genes Lose Control? student page and then write what the possible outcome of that change is under the **effect** column; choosing from the three effect cards. This is round one.
3. **(5-7 min)** Ask each group to share what was on their gene card (the cause) and what effect they think it had on the cell cycle.
 - a. Ideally the process of sharing out with the whole group should cause some debate, as students may not agree with other groups chosen effect, and this will cause friendly debate between the groups.
 - b. After all the groups have shared and the informal debate wanes inform the students that NONE of their groups should “have cancer” yet because the development of cancer is a multi-step process involving the mutation of multiple genes.
4. **(10 min)** Pass out the Student Page: Development of Cancer Concept Map as well as project a copy onto the screen.
 - a. Using the Teacher Page as a guide, ask the students leading questions to complete the empty portions of their concept map.
 - i. Remember the emphasis of this lesson is that **both** the tumor suppressor gene must be inactivated **and** the oncogene must be activated before cancer development is possible.



EXTENSION

- Have students play the “What’s Your Risk” game, included in this curriculum unit.

5. **(20-25 min)** Instruct students to return to the Student Page: What Happens When Genes Lose Control.

For the remaining rounds 2-4, students will draw one card from the proto-oncogene bag and one card from the tumor suppressor gene bag and using their knowledge of mutations in these genes choose the correct effect card. They should record their results on their Student Page. *TEACHER NOTE: It is suggested that students leave out the Development of Cancer Concept Map on their desk as a reference as they complete this activity.*

Assessment Suggestions:

- Collect Student Page: What Happens When Genes Lose Control?

Resources/References:

- http://www.nobelprize.org/nobel_prizes/medicine/laureates/2002/
- Croce, C. M. “Oncogenes and Cancer.” *New England Journal of Medicine* 358.5 (2008): 502-11. Print.



What Happens When Genes Lose Control?

Use your completed Cell Cycle Diagram from Lesson Three to predict the possible outcome of the cell (the effect) based on the event on your gene scenario card (the cause).

Proto-Oncogene "Cause" Cards:

No mutations are present in Scr

Mutation is present in one copy of Scr

Mutation is present in both copies of Scr

No mutations are present in Ras

Mutation is present in one copy of Ras

Mutation is present in both copies of Ras



What Happens When Genes Lose Control?

Tumor Suppressor Gene "Cause" Cards:

No mutations are present in p53

Mutation is present in one copy of p53

Mutation is present in both copies of p53

No mutations are present in BRAC-1

Mutation is present in one copy of BRAC-1

Mutation is present in



What Happens When Genes Lose Control?

Effect Cards:

Apoptosis occurs at a checkpoint.

The individual does not develop cancer.

Apoptosis does not occur at the checkpoint.

Cancerous cell continues through the cell cycle and divides producing numerous cancer cells; the individual develops cancer.

No mutations are present.

The cell cycle continues as normal; the individual does not develop cancer.



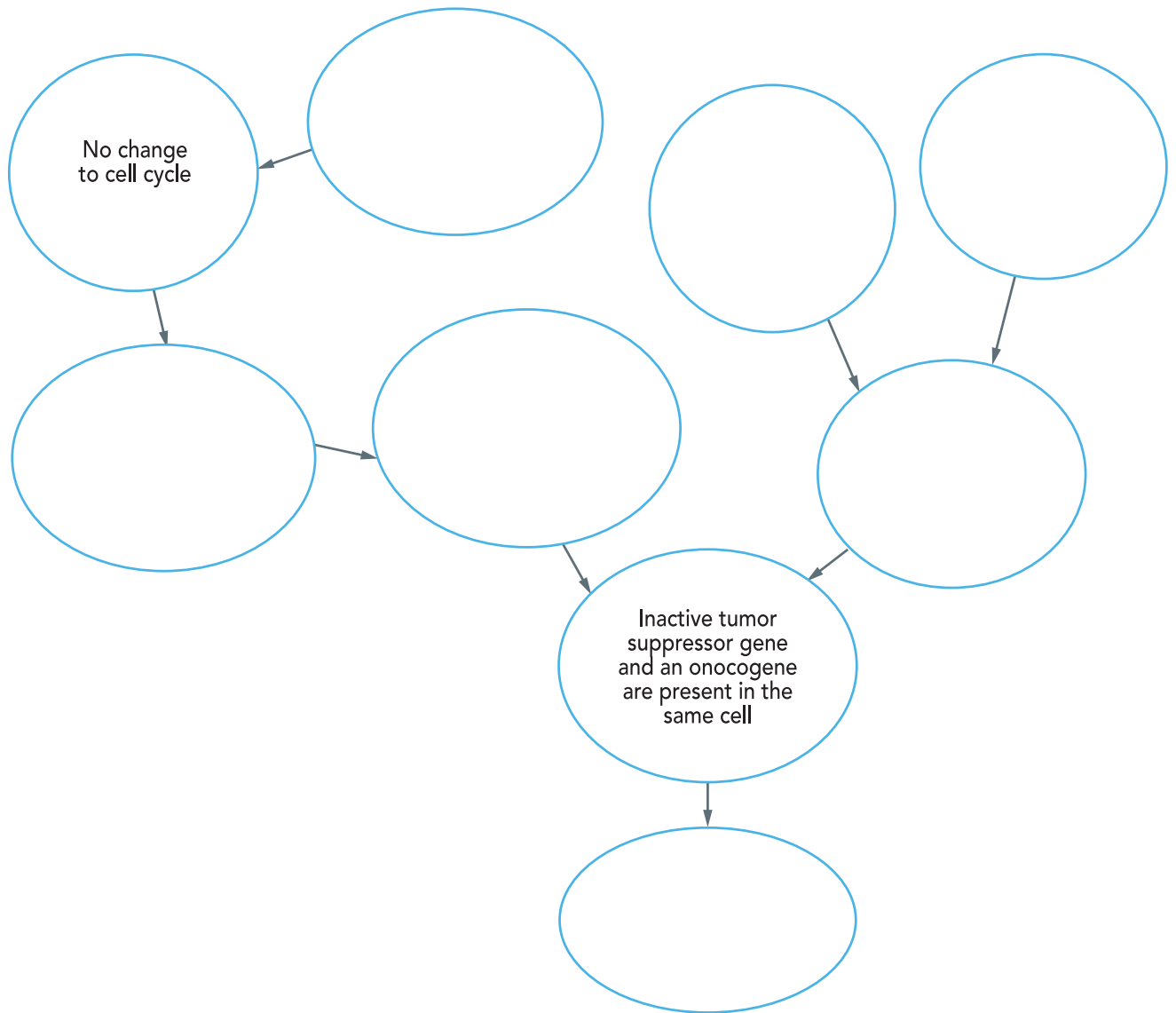
What Happens When Genes Lose Control?

Use your completed Cell Cycle Diagram from Lesson Three to predict the possible outcome of the cell (the effect) based on the event on your gene scenario card (the cause).

	CAUSE	EFFECT
Round 1		
	CAUSE	EFFECT
Round 2		
	CAUSE	EFFECT
Round 3		
	CAUSE	EFFECT
Round 4		



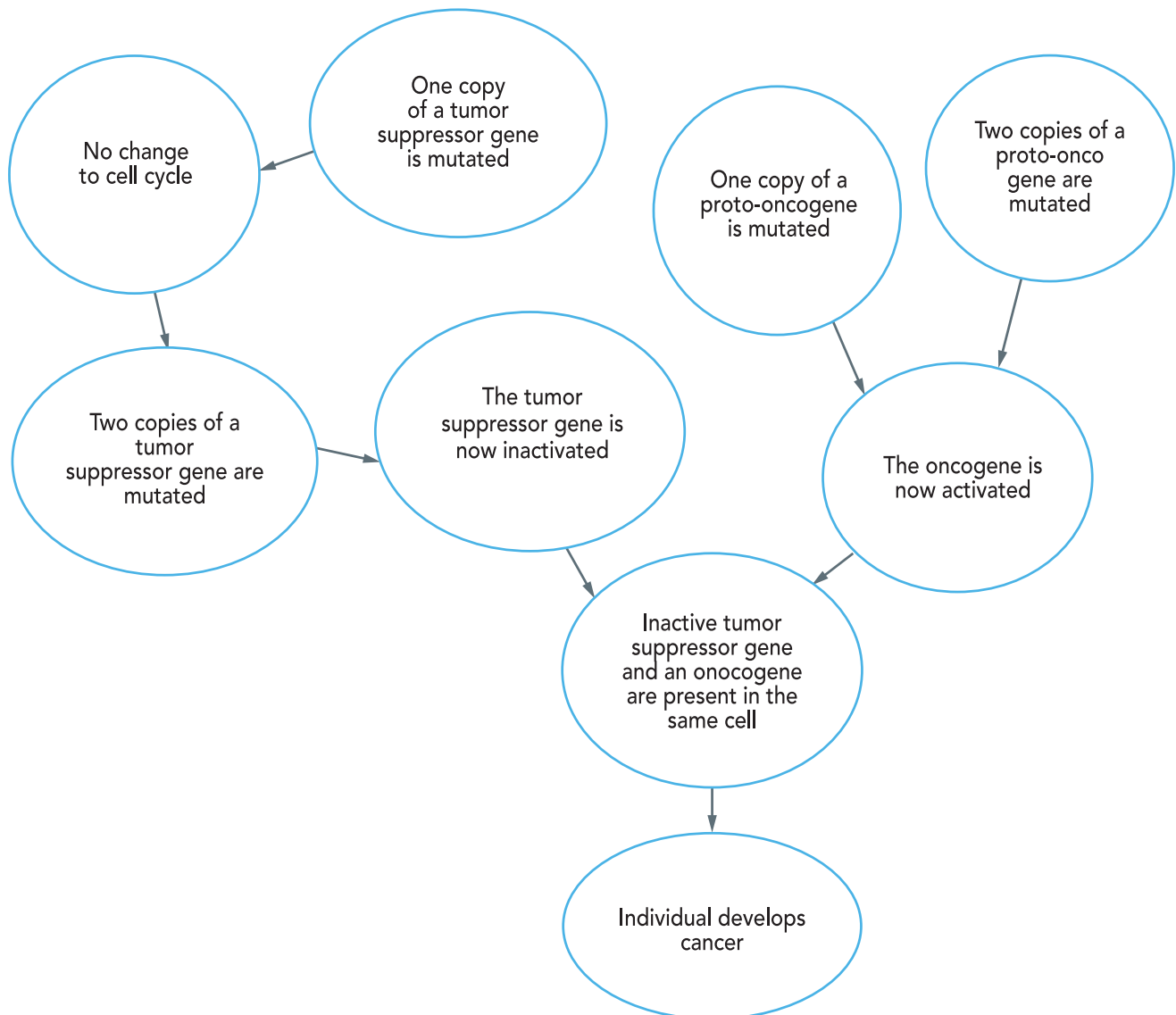
Development of Cancer Concept Map



- Concept Map Key Words and Phrases:**
- a. the tumor suppressor gene is now inactivated
 - b. individual develops cancer
 - c. one copy of a tumor suppressor gene is mutated
 - d. one copy of a proto-oncogene is mutated
 - e. two copies of a tumor suppressor gene are mutated
 - f. two copies of a proto-oncogene are mutated
 - g. the oncogene is now activated



Development of Cancer Concept Map





Notes:
