Name _____

Gene Switches—A Model

Some New Thinking—Gene Switches

All genes are tightly regulated. One major mechanism that plays a key role in this regulation is the genetic switch. These switches allow genes to be on, making a product in one tissue, while off in another. Recent discoveries have shown that much evolution takes place not through the creation of new genes but by changes in the way existing genes are used. Gene switches are the keys that enable old genes to be used in new ways.

What is the role of gene switch mutations in the evolution of a species?

✓ To help in your quest for an answer to this question, view the animation, ***Gene Switch.*** *

Step 1: Go to *Main Menu* on disc 1 of *Evolution: Constant Change and Common Threads.**

Step 2: Click on *Animations* located at the bottom of the *Main Menu* screen. After clicking on "Animations" click on *More* located in the lower right corner of the screen.

Step 3: View the animation with the title *Gene Switch*.

A Model Organism—Stickleback Fish

Stickleback fish exhibit a wide range of adaptations. For example, depending on the species, adult stickleback fish can vary in size from an average of 6 cm in length to a maximum of 18 cm. Sticklebacks are found in freshwater streams, ponds, and ditches, as well as in brackish and marine environments. They eat small crustaceans, fish larvae, and fish eggs.

All species possess strong dorsal spines. The number of spines varies from as few as two to as many as 16. All stickleback fish lack scales and are related to pipefish and seahorses.

Presently, sticklebacks are being used as a model organism by researchers at the Howard Hughes Medical Institute (HHMI) at Stanford University. Sticklebacks provide researchers with the chance to find out how many genetic changes it takes to evolve new traits. They also provide researchers with the opportunity to learn more about the role of genetic switches in variation and adaptation.

✓ To find out more about stickleback fish, watch the video, ***Stickleback Environment***. *

Step 1: Go to *Main Menu on* disc 1 of *Evolution: Constant Change and Common Threads*.

Step 2: Click on *Video Clips* and go to the second screen by clicking on *More*.

Step 3: View *Stickleback Environment*.

1. What environmental factor seems to have influenced whether groups of sticklebacks have kept or lost some of their armor?

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Some Old Fossils—Stickleback Fish

A quarry in Nevada carries the evolutionary history of a population of stickleback fish that resided there when it was a freshwater lake. Stickleback fish that reside in freshwater lakes tend to evolve a reduced pelvis and pelvic spines. About 10 million years ago, most of the stickleback fish inhabiting this lake possessed the characteristic reduced pelvis and pelvic spines. Then, possibly through an environmental change that temporarily connected the lake to the sea, a variety of stickleback with a complete pelvis and pelvic spines invaded the lake. The fish with the spines were at a selective advantage and rapidly replaced the reduced form. After that, in a short time span in evolutionary terms—about 10,000 years—the stickleback population underwent change. The pelvic spines became dramatically reduced. The fossil record of this transition is remarkably complete. The nearly year-by-year detail includes documentation of intermediate forms.

Could gene switch mutations account for the transition of the stickleback population from the complete form with pelvic spines to the reduced form?

✓ To learn more about the evolutionary history of sticklebacks in the Nevada lake, watch the video ***Fossil Record of Stickleback Evolution.****

Step 1: Load disc 1 of *Evolution: Constant Change and Common Threads*.

Step 2 Go to *Main Menu*, click on *Video Clips* and go to the second screen by clicking on *More*.

Step 3: View the clip *Fossil Record of Stickleback Evolution*.

✓ For additional information, watch the animation ***Pitx1 Expression***. *

Step 1: Return to *Main Menu*, click on *Animations* and go to the second screen by clicking on *More*.*

Step 2: View *Pitx1 Expression*.

✎ 2. How are gene switches involved in determining which sticklebacks possess armor and which do not? Does this cause a change in the protein coded for by the gene?

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✓ Next watch the animation ***Paintbrush Gene.****

Step 1: Click on *More* to go to the third screen of *Animations*.

Step 2: View *Paintbrush Gene*.

✎ 3. How are gene switches involved in the presence of spots on the wings of some fruit fly species and not on the wings of other species? How might the presence or absence of spots influence the evolution of these species?

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4. Based on the information you have gained from the video clips and animations; explain how gene switch mutations could lead to the evolution of a species.

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***Note:** You can also find the video clips and animations on HHMI's BioInteractive web site.

- *Fossil Record of Stickleback Evolution:* http://www.hhmi.org/biointeractive/evolution/animations.html
- *Gene Switch*: http://www.hhmi.org/biointeractive/evolution/animations.html.
- *Stickleback Environment:* http://www.hhmi.org/biointeractive/evolution/video.html
- *Pitx1 Expression*: http://www.hhmi.org/biointeractive/evolution/animations.html
- *Paintbrush Gene*: http://www.hhmi.org/biointeractive/evolution/animations.html

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Name _____

Title: **Constructing A Gene Switch Model**

Models take many different forms. Some are actual physical constructions that represent ideas. These can be replicas of individual objects or systems. One example is a 3-D structure that represents a molecule of DNA and can separate between the nitrogen base pairs to illustrate the process of replication. Some models may be no more than mental images that are developed to visualize something unseen, such as the arrangement of genes on a chromosome. Your task is to create a 3-D model that represents how a gene switch mutation could lead to variation within a species.

Using the materials provided or others of your choice; design and construct a model that makes it easier to understand the role a gene switch plays in the production of cell products. Your model should include representations of the following:

- noncoding and coding segments of DNA including a gene and its promoter
- one or more gene switches
- a regulatory molecule
- RNA polymerase
- mRNA

Scoring Guide for Gene Switch Model	Excellent	Good	Fair	Missing
Noncoding and coding segments of DNA including a gene and its promoter are represented.	10	8	4	0
One or more gene switches are included and placed correctly.	10	8	4	0
The role of the regulatory molecule is demonstrated.	10	8	4	0
The role of RNA polymerase is clearly represented.	10	8	4	0
The production of mRNA is shown.	10	8	4	0
An accurate and complete key is provided	10	8	4	0
Use of color and construction materials work together to create an accurate and clear model	10	8	4	0
Written description or demonstration utilizes appropriate scientific vocabulary and accurately represents how a gene switch mutation could lead to variations in a species.	20	15	8	0
			Total Points =	/90 =