

TxCETP Course Component:

## **Natural Selection**

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Modified from “Marooned in the Galapagos” developed at Oklahoma State  
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## **TxCETP Course Component: Natural Selection**

This material is based on work supported by the National Science Foundation under Grant No. DUE 9987332.

### **I. Introduction**

#### **Overview of Course Component:**

This unit is designed to introduce students to the basic principles of natural selection.

#### **Objectives:**

After completing this unit, students will be able to:

1. List the “requirements” for natural selection to occur.
2. Explain the mechanism for natural selection.
3. Identify examples of natural selection and distinguish them from examples of Lamarckian thinking.

#### **Connections to TEKS:**

Biology

Scientific Processes 3(A), 3 (E)

Science Concepts 7 (B)

#### **Overall Time Frame:**

Varies. One class period (1hour) to a full week.

#### **Prior Knowledge:**

None.

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## **II. Activities**

### **Inquiry A: *The Crash***

Objective:

Students will identify minimal human survival requirements and relate those requirements to other organisms. Students will brainstorm on how to meet those requirements under prescribed conditions.

Time Frame for Activity:

About 30 minutes.

Materials:

1. Overheads or PowerPoint presentation of Galapagos Island landscape, flora, and fauna (brief). These should be separated into introductory material, which is quite brief, and explanatory materials which are more extensive and introduced to students as they ask for the information. In other words, information concerning climate (temperature, rainfall), plant and animal life, and minimal human survival requirements is introduced on a need-to-know basis. When they ask for the information, then they need to know.
2. “Suitcases” printed on slips of paper. It is best if they are folded in such a way that students cannot see the contents of the suitcases.

Suitcases:

1. Hand mirror, sunscreen, sneakers, romance novel, hooded sweatshirt, pair of tube socks, toothbrush.
2. Curling iron, water-resistant watch, playing cards, swim fins and snorkel, wet suit, diving knife, dental floss, toothbrush.
3. Tylenol in a small bottle, baseball cap, pocket knife, tank top, large beach towel, notebook and pencil, toothbrush.
4. Wrap-around cotton skirt, long-sleeved white shirt, bottle of shampoo, hair dryer, mesh bag, poncho, toothbrush.
5. Wool winter coat, insulated boots, chewing gum, insect repellent, fishing pole, toothbrush.
6. Quart thermos jug (plastic, filled with water), straw hat, harmonica, camera loaded with film, electric razor, box of matches, toothbrush.
7. 6 Snickers bars, water filterer, pocket knife, Leatherman, poncho, folding camp stool, denim shirt, 50 ft. of rope, toothbrush.

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#### Procedure:

1. Begin by asking students to imagine they knew they were going to be stranded on a desert island for a few weeks. What survival problems would they have to solve?
  - A. If they could pack a suitcase ahead of time with 6 items what would they take? You will need to set limits on the size of the suitcase. Have them list the items first individually, then as a small group of 3-4 students, and then brainstorm as an entire class. They should rather quickly come to an agreement as to what items they would like to have.
  - B. List the items and SPECIFICS as to what the items will be used for (e.g. a blanket for shelter, a desalinizer for water).
2. After they have made the list, introduce the crash on the island.
  - A. Narrative: Your private flight from Ecuador has been long and terrifying, the storm has shaken the plane continuously. As the plane approaches the islands, there is engine trouble and the plane descends rapidly. After the crash, you bob to the surface in heavy surf, clutching someone's suitcase, and fight for shore. You awaken on the beach, happy to be alive. You open the suitcase.....
3. At this point, allow each group of 3-4 students to draw a suitcase. There should be equal numbers of each suitcase even if that means that some will be left over. You will want to emphasize later the random chance element in who gets what suitcase.
4. Introduce the Problem.

#### Instructions for Student Groups:

Narrative: Student groups: Open your suitcase and read the list of items that you are carrying with you. Your group represents a person who has been washed ashore on the island pictured, the lone survivor of a plane crash at sea. You land on the island with only your suitcase and the vacation-style clothing (think Hawaiian shirt, denim shorts, and flip flops) that you were wearing on the plane. It is noon on a September day when you arrive. There are no trees on this island and no freshwater ponds or streams. [Each group represents ONE individual stranded on the island]

Question: Can you survive using only the contents of the suitcase? You may only use the objects for the purpose they were originally intended. For example, you can't disassemble anything. (Example for teachers: you can use the poncho to collect condensation, but you can't use electrical cords to build traps or strangle animals. Students have to be able to demonstrate that they can actually do what they say they can.) Be sure to address the survival needs that were identified earlier—How will you meet those needs?

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Later questions:

If you do not believe you will survive, what will be the limiting factor deciding this?  
If you survive—what suitcase items enabled you to do so? If you were unable to survive, why couldn't you just change your suitcase items to fit your needs?

**INSTRUCTORS:**

Give students a fairly free rein to work on this. As they ask questions, provide the necessary information. There are graphs in the images library that show temperature ranges and average rainfall for the islands during the year. There are other images of foliage and animal life. Most students are overly optimistic in their abilities to catch and eat native animals and in their ability to extract water from cacti.

Human Survival requirements are 500 grams/per day for long term minimal survival, but you can go about 3 weeks without food. You need 2-3 cups (590 ml) of water/per day for long term survival. You can only go 3 days without water.

Students should be writing down their ideas about how they will survive. Encourage them to be as specific as possible in how they will solve their survival problems with the items in their suitcase.

5. Review their answers

Ask each group with the same suitcase to explain their answer—will they survive? If so, how? If not, why not? You will want to show the other groups the contents of each suitcase. Ask the other groups if they agree with the assessments made as to whether or not those groups with that suitcase will survive.

6. Once you have gone through all the groups, lead a whole class discussion of the following questions:

- A. What is an adaptation? Allow them to brainstorm until a consensus is reached.
- B. Which of the groups had the “adaptations” needed to survive? Allow them to brainstorm until a consensus is reached.
- C. What do you think the items in the suitcase represent? (Hint—Other organisms stranded on the island don't have suitcases—what determines if they will survive or not?)
- D. Why couldn't those who would not survive just “adapt” because they needed to? This should lead to a discussion of Lamarckian evolution.
- E. If permanently stranded on the island—(and assuming others of the same species are also

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eventually stranded) which of the groups will be represented in the next generation? (In other words, who gets to reproduce? Those who survive.)

- F. To be represented in the next generation, what must be true concerning various adaptations? (They must be heritable or they are useless from an evolutionary perspective)
  - G. If you assume that all the adaptations (both successful and unsuccessful) are heritable, which will be more prevalent in the next generation? (Successful ones)
7. Summarize their answers to match the criteria for Natural Selection—you will probably have to lead them a lot on this –most students are fairly resistant to coming to these conclusions on their own.

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#### Natural Selection Criteria:

1. More offspring are produced than survive.
2. There is variation among members of populations for many adaptations (and these are randomly distributed—no organism “knows” what adaptations they will “need” to survive. Just as the students did not get to choose the contents of their suitcases, organisms do not get to choose the contents of their genetic suitcases—what genes they end up with is due to random chance).
3. Variation is largely heritable.
4. Some adaptations are more successful than others in allowing survival (and thus reproduction of the adaptations) in the individuals that carry them.
5. Over time, individuals with successful adaptations will be more successful in reproducing and passing on those adaptations than those without them. The population in later generations will have a different genetic make up than previous generations—this is in effect evolution (change in gene frequencies over time).
6. Natural Selection (differential survival and reproduction of individuals with successful traits) acts on INDIVIDUALS. Evolution occurs in populations or species—no individual ever evolved!!

#### Myths about Evolution by Natural Selection:

Myth: A species can evolve new adaptations based on a perception or anticipation of its needs for those adaptations.

Fact: Species can use only existing adaptations. Those that, by chance, have the most successful adaptations (got the right suitcase for the occasion), will survive and reproduce more than those without them.

Myth: Species can induce their own mutations when necessary.

Fact: Mutations are random events that occur without direction. While mutations do have causes—they are not caused by the need to adapt to a certain environment or survival need.

Myth: Natural selection is moving species toward perfection (more complex is better).

Fact: The natural selection process is highly location specific—what works in one situation may not work in another—and recreating specific conditions may or may not produce the same results. Natural selection is a mechanism for evolution that sorts out the individuals best suited for the current environment. Changes in the environment may well favor a new set of adaptations.

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**III. Assessment & Evaluation**

Formative Assessment:

1. Prior to beginning the lesson, ask students to define the following terms:

Adaptation  
Natural Selection  
Evolution

After completing the lesson, have them repeat the exercise and compare their answers.

2. Prior to beginning the lesson, ask students to answer the following questions. Repeat the exercise after completing the lesson
  1. How confident are you that you can accurately explain how a population adapts to a change in environment?
    - A. TOTALLY CONFIDENT
    - B. VERY CONFIDENT
    - C. FAIRLY CONFIDENT
    - D. ONLY A LITTLE CONFIDENT
    - E. NOT AT ALL CONFIDENT

Use the following information to answer the next 2 questions.

A population of butterflies is blown to an island by a storm. It is too far for them to fly back to the mainland without help from another storm. The island they are stranded on only has a few flowering plants for the butterflies to feed on and all of them produce toxins that some butterflies are affected by but others are not.

2. Which of the following concerning the next generation of butterflies would you correctly predict to be TRUE?
  - A. the next generation will be exactly like this generation in number of individuals affected by the toxin
  - B. butterflies unaffected by the toxins will be less prevalent in the next generation
  - C. butterflies unaffected by the toxins will be more prevalent in the next generation
3. Which of the following concerning the butterflies would you correctly predict to be TRUE?
  - A. all of the butterflies are equally likely to survive on the island
  - B. butterflies unaffected by the toxins will survive and reproduce better than those affected
  - C. butterflies affected by the toxins will become unaffected and pass the adaptation on to their offspring
  - D. all of the above are accurate predictions
  - E. only A and C are accurate predictions