# Hard Drive:Users:eschultheis:Desktop:KBS Logo.png

# K-12 Partnership Lesson Plan

# Amanda Charbonneau, Sarah Jones

# *Pig Bang Theory*

# *The implications for ignoring evolution*

## Overview

What do pest-resistant corn, antibiotic resistance and pig farm explosions have in common?

Sometimes nature fights back against our attempts at environmental engineering, and we must change tactics accordingly.  Humans spend huge amounts of money and time to improve crops or domestic animals, and increasingly, we are finding that evolution can creatively side-step our intended goals. For instance, pest-resistant crops have resulted in new breeds of insects that are immune to our poisons. Modern farmers must find ways to prevent not only damage to their current crops, but evolution in pest populations that will eat their future fields. This lesson will focus on how evolution can hamper our efforts, and have explosive consequences. Students will learn how evolution happens in pest populations and have an opportunity to think critically about a current problem in agriculture using claims, evidence, and reasoning.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Describe how variation can be maintained in a population
* Explain how evolution by natural selection primarily results from 4 factors: potential of a population to increase in number, heritable genetic variation, competition, differential survival/reproduction
* Use CER (claims, evidence, reasoning) to think about a scientific question
* Describe ways that humans have changed the environment
* How changes in the environment can cause changes in species composition
* Brainstorm and critique solutions to problems caused by changes in species composition

**Length of Lesson**

Can be completed in 60 minutes, but would be more comprehensive in 90 minutes

**Grade Levels**

9-12

**Standards covered**

Disciplinary Core Ideas:

* **HS-LS4-2**: construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to live and reproduce in the environment
* (with extension) **HS**-**LS4-3:** apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait
* **HS-LS4-5**: evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

Cross Cutting Concepts:

* Patterns
* Stability and change of systems

Science and Engineering Practices

* Engaging in argument from evidence

**Materials**

* Playing cards
* Small tokens in two colors (eg. brown and white beans)
* Dice
* Game rules (provided)
* Powerpoint (provided)
* Pig farm explosion reading (provided)
* Pig farm CER (provided)

**Background**

Humans make large changes to the environment around them, which have far reaching effects. For instance, agriculture covers more than 40% of the land surface of our planet, which both provides food for us, and reduces the amount of land available for other life. There are also un-intended consequences of agriculture. Many of our farming practices have resulted in increased antibiotic resistance, and pest severity.

### Activities of the session

1. Read “The Curious Case of the Exploding Pig Farms”. This story has been slightly adapted with extra background and information not available in the original text. The original can be found online at <http://nautil.us/blog/the-curious-case-of-the-exploding-pig-farms> and may be more appropriate for higher lever courses.
2. Have the students work in pairs to complete the CER sheet about the reading. They should choose a question from the story “Why are pig farms exploding” is a good one. Then make a claim (answer) for that question, and support it with facts from the text. They should provide reasoning, in their own words, for why that text supports the claim. Finally, they should give a possible experiment, or the next thing they want to check.
3. Ask the students what they learned from the reading, and what things they would like to look at. This should lead directly to a discussion of antibiotics, as most students will recognize that one unintended consequence of the current explosion solution is antibiotic resistance.
4. Go through slides about antibiotic resistance. (Notes are provided in slides)
5. This will lead into a discussion about other types of resistance, and a game to demonstrate how the evolution of resistance works.
6. Play BT corn resistance game, have everyone compete to grow the most corn.
7. Go through slides about BT corn resistance (Notes are provided in slides)

**Resources**

Resources for BT corn:

<http://www.nature.com/scitable/knowledge/library/use-and-impact-of-bt-maize-46975413>

<http://www2.ca.uky.edu/entomology/entfacts/ef130.asp>

<http://www.wired.com/2014/03/rootworm-resistance-bt-corn/>

<http://www.sciencedaily.com/articles/a/antibiotic_resistance.htm>

Resources for antibiotic resistance (more in Powerpoint notes) http://www.scientificamerican.com/report/antibiotic-resistance-bacteria-in-depth/

http://www.cdc.gov/features/antibioticresistance/charts.html (Graphs/statistics)

http://www.pbs.org/wgbh/pages/frontline/health-science-technology/hunting-the-nightmare-bacteria/dr-arjun-srinivasan-weve-reached-the-end-of-antibiotics-period/

**Extensions and Modifications**

Have students provide written responses to final slide:

“What do you think we should do about the unintended consequences of evolution?”

“What are other areas where we have to worry about evolution?”

Examples: Domesticated animals with defects (like hip dysplasia in German Shepherds. Pesticide resistance in plants. Crop mimicry due to hand weeding.

Have students write an experimental protocol for their proposed extension in the CER

Have students graph numbers of resistant and non-resistant worms of the game each round to visualize changes (would cover HS-LS4-3)

**Assessment**

Have students provide written responses to final slide:

“What do you think we should do about the unintended consequences of evolution?”

“What are other areas where we have to worry about evolution?”

Examples: Domesticated animals with defects (like hip dysplasia in German Shepherds. Pesticide resistance in plants. Crop mimicry due to hand weeding.

Ask students to list the steps involved in the evolution of antibiotic/pest resistance