Mechanisms of Change Mini-unit

**Overview:** This unit addresses the processes that cause evolutionary change. The central component to this change and to this unit is natural selection but the unit will also address gene flow and genetic drift. The unit also addresses artificial selection and its similarities and differences to natural selection. Preceding this mini-unit, students would have been introduced to the concept of evolution, Charles Darwin and the evidence for evolution.

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| **Lesson** | **Description** | **Mass State Framework** |
| Variation within a Population | * Students are asked to thing about the differences between individuals within a population.
* Students record data on a variety of characteristics in organism. (ex. Kidney Bean length, human ocular distance, femur length in grasshoppers, human hand width, or other…)
* Variations are graphed and patterns are observed as a class.
* Students hypothesize on the variations and what if any could be considered an advantage or a disadvantage in an environment.
* Ideas are collected as a class and discussed.
 | HS-LS4-2,Science and Engineering Practices4. Analyzing and interpreting data. 5. Using mathematics and computational thinking. 6. Constructing explanations (for science) and designing solutions (for engineering). 7. Engaging in argument from evidence |
| Mechanisms of Evolution – Simulations (variations on the bead bug simulation) | * In a think-pair-share discussion format students are asked to put the definition of evolution into their own words
* A class definition is constructed. It must include the concepts of population, time, change and heredity.
* Explain that we will explore how such a change could take place by doing a collection of simulations and data collection.
* Brief overview of simulations: Set-up the “environments” - Multiple large sections of multicolored and patterned fabric cover the lab tables (approximately 1.5 m2). At least 6 different “environments” –
* **Natural Selection**
1. Student groups of four (2 predators, 1 data collector, 1 time keeper.)
2. “Population” size of 30 bead bugs (prey) of 6 different colors equally mixed are randomly distributed on the fabrics.
3. Students rotate to next station (insures that kids to not ‘know’ where to look for bead bugs)
4. Student predators “prey” on the bead bugs bugs until the population is reduced by half. Timekeeper verbally cheers on the predators. (Predators “starve” if they do not complete their collection in 20 seconds or less. The goal here is to get the predators to move quickly and not search for specific bugs.)
5. Data recorders total the consumed bead bugs and calculate the distribution of the new population (bead bugs reproduce asexually).
6. New population is distributed onto the fabric environment.
7. Repeat steps 3-6 several times
8. Data is graphed for each of the environments.
9. Discussion on change over time, selection pressure, adaptation and variation.
10. Create class definition of natural selection.
* **Genetic Drift - Population bottle neck**
1. All 6 groups do the same thing and do not rotate.
2. Student groups of four (1 catastrophe cardholder, 2 bead bugs herders, 1 data collector)
3. Catastrophe cardholder, who is in position of an envelope titled random environmental event, averts their eyes. (or even better leaves room)
4. Bead bugs herders place a population of 30 bead bugs of 6 different colors equally mixed. Distribution is up to the bead bug herders but the beads must be somewhat equally distributed across the fabric environment.
5. Catastrophe cardholder returns and reads their card out loud. Cards refer to a collection of events that will severely reduce the population of the bead bugs. For example the card might read, “ You are the 100 year flood and you have covered approximately 75% of the bead bug habitat. Without regard to type you wipe of the face of the earth any bead bug in your path. Identify this area and remove any bead bug from that space.”
6. Data collector records the remaining population.
7. Populations of bugs in the next generation rebound back to 30. The new population is placed on the fabric environment.
8. Discussion on each of the outcomes at each station are graphed and discussed. Did evolution occur? How? Discussion of random events.
* **Genetic Drift – Founder effect.**
1. Full class demonstration to follow the bottleneck simulation.
2. Reveal a 7th fabric environment in an accessible corner of the room.
3. Ask one of the bead bug herders in one group to select 5 random bead bugs from their environment and to transfer them to the new environment.
4. Teacher calculates the distribution of bead bugs of this new population.
5. Discuss founder effect and random events. Did evolution occur? How? Segue to the next simulation.
* **Gene Flow**
1. Full class demonstration.
2. Ask a bead bug herder in one group to randomly select a 5 bead bugs from their population.
3. Add these bead bugs to the population of different groups.
4. Data collectors, calculate the new distribution of the populations.
5. Discussion of migration, brainstorm ideas of how this migration could occur, random events. Did evolution occur? How?
* **Mutation**
1. Full class demonstration.
2. Discuss the connection between genotype and phenotype (this discussion depends on if DNA has been covered or not).
3. Reveal a 7th color of bead bug. Explain that it randomly arose in one of the 6 populations in the class.
4. Data collectors calculate the new distribution of the population. Did evolution occur? How?
* Remind the students about the selective pressure of the predators from the first part of the simulation. Ask students to predict what would occur if predation started in their fabric environments again now that random events have transpired. What would be different this time? What would be the same?
 | HS-LS4-2HS-LS4-5Science and Engineering Practices2. Developing and using models.  4. Analyzing and interpreting data. 5. Using mathematics and computational thinking. 6. Constructing explanations (for science) 7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information |
| Learning about Selection through examples | * Students are asked to consider the aspects that are needed for natural selection to occur.
* Student read the essay, *Evolution by Natural Selection* from BSCS Biology: A Human Approach.
* In a jigsaw format…
* Example groups (6 students) watch or read a variety of real world scenarios of evolution due to selection. (Topics include 4 of the following: dog breeding, corn, Darwin’s finches, hummingbirds, antibiotic resistance, or other).
* Example groups identify the key variation in the population, the selection pressure and the differential survival and reproduction.
* Example groups identify the selection as natural or artificial.
* Example groups create a single slide presentation and each member is responsible for being able to explain their example.
* Example groups get reorganized into 6 presentation groups and each member takes turns explaining their example.
* Discussion on the differences and similarities between natural and artificial selection.
* Students asked to individually assess a 5th scenario. Asked to determine key variation in the population, the selection pressure and the differential survival and reproduction. And asked to identify the selection as natural or artificial.
 | HS-LS4-2.Science and Engineering Practices4. Analyzing and interpreting data.. 6. Constructing explanations (for science) and designing solutions (for engineering). 7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information |

Bishop, B. A., & Anderson, C. W. (1986). Evolution by Natural Selection: A Teaching Module. Occasional Paper No. 91. <http://files.eric.ed.gov/fulltext/ED272383.pdf>