BLOSSOMS NGSS LESSON

Target Grade: High School	**Lesson Title: Variation is Essential** **Developed by: David Upegui** **Central Falls High School** **Central Falls, Rhode Island**
Topic: Biology - Evolution: general definition of biological evolution, tenets of evolution, natural vs. artificial selection, selective pressure.	
State Standard – NGSS Performance Expectation(s) **HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.** [Clarification Statement: Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.]	
Lesson Performance Expectations Students will • Use a **model** (kidney beans) to explore the natural variations within a population. • **Measure differences** between individuals in a population (population of beans). • **Explain** how genetic/phenotypic variation is a key part of biological evolution because it is a prerequisite for natural selection	
Lesson Length *- Two - 45 to 55-minute class periods, Lesson can be modified accordingly*	
Materials • Bag of 50 dried kidney beans* (or any other kind of beans) beans (NOTE: teacher should "pre-make" these bags) • metric rulers • graphing paper • Table 1 - Variation is Essential Organizer • Table 2 - Bean Size Summary Sheet • Group Questions (cut into strips)	

***Safety**: *Warning: these uncooked kidney beans are NOT to be consumed. Eating raw beans can cause severe nausea, vomiting and diarrhea due to high concentration of a chemical called phytohemagglutinin (which is destroyed when properly cooked).*

BLOSSOMS NGSS LESSON

Investigative Phenomenon Variation in a population is an important factor for the survival of a species.

Engage Phase	
What Is the Teacher Doing? (lesson fits into 50 min but could be adapted accordingly to extend into two class periods.) This lesson centers around the concept of variation. Students should have prior understanding of what variation is prior to the lesson. This may be accomplished by providing the students with the definition: *any difference between cells, individual organisms, or groups of organisms of any species caused either by genetic differences (genotypic **variation**) or by the effect of environmental factors on the expression of the genetic potentials (phenotypic **variation**)* or by having the students **obtain this information** by researching the internet, their text, or other materials in advance of the lesson.	**What are the Students (Ss) Doing?** *Though students may have the working definition of variation they, most* likely, will need to make sense of this concept. Variation is a key concept that leads to a deeper understanding of Biodiversity. The Framework for K-12 Science Education states "variation of genetically determined traits in a population may give some members a reproductive advantage in a given environment. (NRC, 2012 p. 141). The goal of this BLOSSOMS lesson is for students to "figure out" the importance of variation and its role in determining biodiversity

In the Classroom: The teacher shows a video as a way to bring up variations within a population to light with students. Some prompts which can be used to focus the students when introducing the video: ● What did you notice in the video? What **patterns** emerged? ● What variation did you notice? Why does this variation exist? ● Why is variation within a population important? Why? The teacher then plays the BLOSSOMS video, Variation is Essential from **0:00 to 3:21**. At the **3:21** mark pause the video to allow the students to discuss the questions on the screen (see What the Students are Doing on the right). *Teacher should "look for" evidence of the following when Ss are engaged in the practice of **Asking Questions**:* ***Evidence Bullets (Look fors)*** ● *Formulate questions which seek evidence that will lead to a testable hypothesis.* ● *Ask relevant questions to increase the understanding of others* ● *Ask questions that arise from the observed phenomenon.*	**In the Classroom:** ● In groups of 4, students watch the Ted Talks Humanae Video: http://www.angelicadass.com/humanae-project/ (TEACHER: To shorten the time you may consider only playing from 4:00 to 7:16) OR show photographs from the humanae project ● Ss **ask questions** (see evidence bullets in the teacher column) pertaining to the video and/or photos. ● Once the students have discussed the Humanae Video the students observe the first segment of the BLOSSOMS video, Variation is Essential, from **0:00 to 3:21**. ● At the **3:21** timestamp of the video the students are asked to: ○ Discuss how they can identify patterns of variability within a population? In other words, how can they identify different physical characteristics that are measurable and that vary over the population?
Explore Phase	

In the Classroom:
The teacher then plays the BLOSSOMS video. At the 3:21 mark pause the video to allow the students to discuss the questions on the screen (see What the Students are Doing on the right). NOTE: When asked to describe the contents of the bag students may respond in a number of ways (i.e. a bag of beans, a food product, a population, materials, etc.). Teachers should use the prompting questions found at the **3:34** mark of the video to help the students focus on **patterns**:

- *What **patterns** do you notice when observing the beans?*
- *How are these **patterns** different?*
- *How are these **patterns** similar?*
- *What might have caused these **patterns**?*

*Teacher should "look for" evidence of the following when students are engaged in the practice of **Planning and Carrying Out Investigations**:*
Evidence Bullets (Look fors)

- *Make careful observations to generate evidence.*
- *Recognize patterns in observations and data.*
- *Discuss and compare observations with others.*
- *Share science findings in graphic presentations to others.*
- *Use models to represent and explain phenomena to others.*

NOTE: Some of the common responses that students share in the organizer are:

- *Examples for step 2 of the organizer (ways to separate beans): (e.g. shape, color, length, mass, thickness of coat, percent water, etc.)*

- *Examples for step 4 of the organizer (overlapping characteristics):*

In the Classroom:

- In groups of four the students will use the questions (see below) posted at the break in the video beginning at the **3:34** mark of the BLOSSOMS video as they go through their investigation.
  - *What **patterns** do you notice when observing the beans?*
  - *How are these **patterns** different?*
  - *How are these **patterns** similar?*
  - *What might have caused these **patterns**?*

- Students will be using the Variation Within a Population Organizer. Following the guidance on the organizer, students will **carry out an investigation** (see evidence bullets in the teacher column) of variation.
  - Students are provided a bag of dried red kidney beans (with at least 50 beans) and are asked to **describe the bag of beans and record their observations.** (Step 1 of organizer)

  - Students then shift their **observations** to how the individual beans from a bag may be **different from one another** and discuss ways in which individual beans from a bag may be different from one another and **record their observations.** (Step 2 of organizer)

  - Students will then **observe the individual beans** and will look for patterns within the beans to select two separate characteristics to separate the beans into two distinct groups. (Step 3 of organizer)

  - Once students have separated beans into two groups, they will **observe** the beans within each group to identify any overlapping categories. (Step 4 of organizer)

Explain Phase

In the Classroom:

Teacher should "look for" evidence of the following when students are engaged in the practice of ***Using Mathematical and Computational Thinking*** *such as:*

- *Make and use measurements as evidence.*
- *Compare evidence from measurements.*
- *Organize and analyze simple data sets for patterns that suggest relationships.*
- *Use graphs to find patterns and/or relationships in data.*

Teacher should "look for" evidence of the following when students are engaged in the practice of ***Analyzing and Interpreting Data*** *such as:*

- *Compare data to make sense of and explain phenomena.*
- *Compare data and use comparisons as evidence.*
- *Use graphical displays to analyze data in order to identify linear and nonlinear relationships.*

Teacher should "look for" evidence of the following when students are engaged in the practice of ***Engaging in Argument from Evidence*** *such as:*

- *Use evidence to support or generate explanations.*
- *Use evidence to support arguments about scientific explanations for phenomena.*
- *respectfully provide and receive critique on scientific arguments.*
- *Listen and make sense of other's explanations.*
- *Debate the merits of competing arguments.*
- *Evaluate and share weaknesses in one's own arguments and collaborate to seek better evidence.*

In the Classroom:

The students observe the second segment of the BLOSSOMS video from **3:55 to 5:03**.

- Students **measure** (see evidence bullets in the teacher column) each bean to the nearest millimeter and record their data in Column 1 of **Table 1** (Step 5 of organizer).

The students observe the third segment of the BLOSSOMS video from **5:04 to 6:49.**

- Once all beans are measured students **will organize their data** in Table 2 by length. (Step 6 of organizer)

- Students create a bar **graph** using the graph paper. Once completed, students will **analyze their graphs** to determine any **patterns** and **interpret** what these **patterns** may represent. (see evidence bullets in the teacher column) to identify relationships.

- Students groups then share their graphed data with the rest of the class and **use their evidence to argue** in support or to refute the question "are the differences seen in the beans enough to separate them into discrete categories." (see evidence bullets in the teacher column)

Teacher uses the following Crosscutting Concept Prompts with the students: ● *Which measurement size had the greatest **quantity** of beans?* ● *Which measurement size had the fewest **quantity** of beans?* ● *Are the **differences** observed in the beans enough to separate them into discrete categories?* ● *How does your mean (average) **compare** to the mean other groups determined?* ● *What would **cause** the size of each bean to vary? (Ss should think about where the plants may have come from).* ● *Given ideal environmental conditions, can individual beans change their size?*	
Elaborate Phase	

In the Classroom:
This segment contains key information that the Video Teacher shares to scaffold the students to their next task. Evolution is defined and the key components of the definition are further broken down for the students' understanding. Additionally, the Video Teacher provides Darwin's three conditions required for natural selection to occur. The Classroom Teacher should pause the video during this portion so that students can take notes.

Definitions:

- **Evolution** - change in genetic frequency in a population over time. Each part of this definition will be explored in detail.
- **Change** - for its own sake, without regard to any direction for evolution.
- **Genetic Frequency** - the frequency of genes must change.
- **Population -** evolution creates a change in population, not individuals.
- **Over time** - it takes time for these changes to take place, mainly in future generations

Darwin's Conditions for Natural Selection:

- There is variation among individuals within a population in some trait.
- This variation is heritable (i.e., there is a genetic basis to the variation, such that offspring tend to resemble their parents in this trait).
- Variation in this trait is associated with variation in fitness (the average net reproduction of individuals with a given genotype relative to that of individuals with other genotypes).

In the Classroom:

- The students observe the fourth segment of the BLOSSOMS video from **6:49 to 10:07**. From the video the following key definitions are shared:
  a. **Evolution** - change in genetic frequency in a population over time. Each part of this definition will be explored in detail.
  b. **Change** - for its own sake, without regard to any direction for evolution.
  c. **Genetic Frequency** - the frequency of genes must change.
  d. **Population -** evolution creates a change in population, not individuals.
  e. **Over time** - it takes time for these changes to take place, mainly in future generations.
- Additionally, this video segment describes the conditions that Charles Darwin argued in "On the Origin of Species", in order for natural selection to occur:
  f. There is variation among individuals within a population in some trait.
  g. This variation is heritable (i.e., there is a genetic basis to the variation, such that offspring tend to resemble their parents in this trait).
  h. Variation in this trait is associated with variation in fitness (the average net reproduction of individuals with a given genotype relative to that of individuals with other genotypes).

- Beginning at **9:55** of the video segment student groups will respond to the prompt in the video stated below:
  *i. You will write a sentence **explaining** why variation within a population is essential for evolution and create a **model** of a scenario where there is variation in a population and how it is*

Evaluate Phase	
In the Classroom: Activity 5 (**11:57**) instructs the students to respond to a set of questions found here. Cut the questions into strips and distribute to the groups. Once completed, students should share with the entire class and use evidence from their models and their investigations to support their claims. The responses to these questions can be used to formatively assess student understanding of the lesson.	**In the Classroom:** ● At **11:57** students will see the following instructions: ● In groups: a. Carefully read the question on the strip of paper prepared by your teacher. b. Use evidence from your investigations to write your best response to the question. c. Come to a consensus for your response to your group's question and prepare to share with the entire class.

The 5E Instructional Model (Bybee, 2015)

Engage	The teacher or a curriculum task assesses the learners' prior knowledge and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.
Explore	Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions and possibilities, and design and conduct a preliminary investigation.

Explain	The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.
Elaborate	Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.
Evaluate	The evaluation phase encourages students to assess their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

Bybee, R. (2015). *The BSCS 5E Instructional Model: Creating Teachable Moments.* Washington, DC: NSTA Press

Websites/articles used for ideas:

https://courses.lumenlearning.com/boundless-biology/chapter/population-genetics/
http://blogs.discovermagazine.com/gnxp/2013/01/why-the-future-wont-be-genetically-homogeneous/#.XCa3h2hKi00
https://www.nature.com/scitable/knowledge/library/natural-selection-genetic-drift-and-gene-flow-15186648