Lesson 3: "Why Do Some Variations Become More Common and Others Disappear?" (part 1)

Overview:

Purpose:

One purpose of this activity is to have students engage in simulated natural selection to discover how natural selection emerges from mechanisms: a) variation in heritable traits in a population and b) interactions in the environment give individuals with some variations a competitive advantage over other individuals. Another purpose is compare these mechanisms to those of intentional selection and random selection in selective breeding and describe the outcome of natural selection as an increase in the proportion of individuals with advantageous heritable trait variations in a population over multiple generations.

Prerequisite Knowledge:

Students need to be familiar with some examples of asexual reproduction in plants and animals (e.g. bacteria) and that cell division for reproduction creates exact genetic duplicates (clones) when new offspring are asexually reproduced from only one parent.

Connection to previous activities:

In the previous activity students discovered two important mechanisms in selective breeding that are also mechanisms in natural selection: 1) selection which individuals to remove from a population, and 2) selection of which individuals will breed. Students will learn how natural selection involves these two mechanisms, but unlike selective breeding, these selections occur unintentionally and naturally in ecosystems.

Performance Expectation

- **NGSS HS-LS4-3.** *Analyze data from a computer investigation* applying 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. [Emphasis is on analyzing shifts in numerical distribution of traits in a histogram and using these shifts as evidence to support explanations.].

Scientific Principles Discovered in this Activity

- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.
- As a result of natural selection, distribution of traits in a population can change when interactions in the ecosystem change.

Description of the Lesson

The teacher demonstrates the model rules for the computer model. Students use a computer model to assume the role of predator in a population of prey (bacteria). They hunt bacteria using two different predation strategies, each of which generates a different selective pressure and a different outcome from natural selection. They compare how the competitive advantage for different variations of speed in the prey changes based on these two types of interactions that occur with the predator.

At the end of class, the teacher develops a class consensus through discussion on the big ideas regarding the conditions necessary for natural selection and how these conditions leads to changes in the proportion of individuals that have advantageous characteristics will increase.

In their out-of-class reading, students describe how a population of prey and predators would change over

time due to natural selection, why bacteria have become more pesticide resistant over time, and what will eventually probably happen to populations of plants that pesticides are currently effective at killing off most of the individuals.

Lesson Details:

Time 60 min.

Materials

Per Student

- 1 computer with Java 7 and Firefox installed.
- A student WISE account for the class period was already created.
- One small post-it note and one large post-it note.
- An individual copy of Reading 3.1 – Natural Selection (to be assigned for completion outside of class)

For Teacher

- 1 computer with Java 7 and Firefox installed and projector or large display screen for the teacher to display the computer model.
- The case study board
- The new driving question board
- 1 piece of butcher paper or poster paper or space on the wall for students to stick the post it notes on.

Lesson Outline and Timing

Launch

- Introduce today's question and students complete step 2.1 (3 min.)
- Introduce and demonstrate the model (5 min.)
- Students complete step 2.2 (2 min.)

Explore: Exploration 1

- Chasing bacteria (step 2.3 through 2.7) (10 min).

Explore: Exploration 2

- Waiting for bacteria to come to you (step 2.8 through 2.9) (10 min).

Summarize

- Model rules questions and review (steps 2.10 through 2.11) (10 min)
- Class Consensus Building Discussion – (step 2.12 and time at the board) (10- min.)

Homework Assigned

- Assigning tonight's homework (2 min.)

Lesson Enactment Details

You will add new discoveries to the driving question board at the end of the lesson, under the section "How Does Nature Select For Some Trait Variations Over Others?" But, just like in the last lesson its recommended that you use pieces of butcher paper to write the discoveries on so they can be temporarily taped in. You can then move that class period's discoveries to the driving question board for that class. And then before the next class, you can remove the last class period's discoveries (or cover them up).

Launch:

Remind students of the discoveries they made related to their driving question pointing to and reviewing the ideas captured on the driving question board.

Tell students that they will continue using models today explore and discover more ideas to help answer the driving question. Tell students that they are going to be investigating the 2nd lesson question today, "How Does Nature Select For Some Trait Variations Over Others?"

Tell students that they are going to compare forms of unintentional and intentional selection mechanisms in an asexually reproducing population that already has trait variations between individuals. Remind students of examples of asexually reproducing plants and animals and that offspring from each of these organisms is an exactly genetic duplicate of its one parent, and therefore has the same heritable traits as the parent. Examples of asexually reproducing organisms are shown in step 2.1

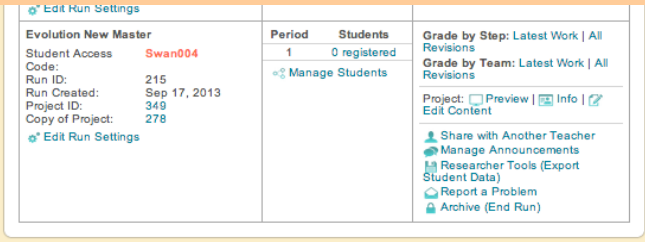
- **Have students log into WISE and resume work on the Evolution Unit**
- **Ask students to go to step 2.1 and complete the questions on that step.**

Next, demonstrate how intentional selection process works in the model and how asexual reproduction is modeled in the model using the Screencast. Tell students that you are going to show them how they are going to take the role of a predator (a multi-cellular organisms) that is predator of bacteria.

Demonstrating the model via. Screencast

Model Demonstration Directions For the Teacher

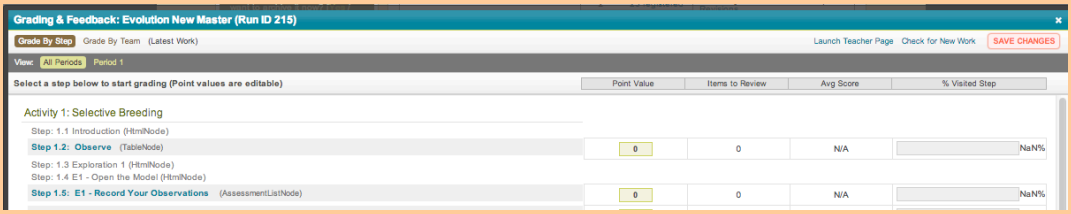
1. You too will want to log into WISE in teacher mode, but will launch the same model the students will be using in later steps. Click on the Teacher Home tab. You will see a list of all the active runs you have started for each class period. For the current class that you are teaching. In the example below, the first row show the Student Activity for this Teacher's Period 1 class



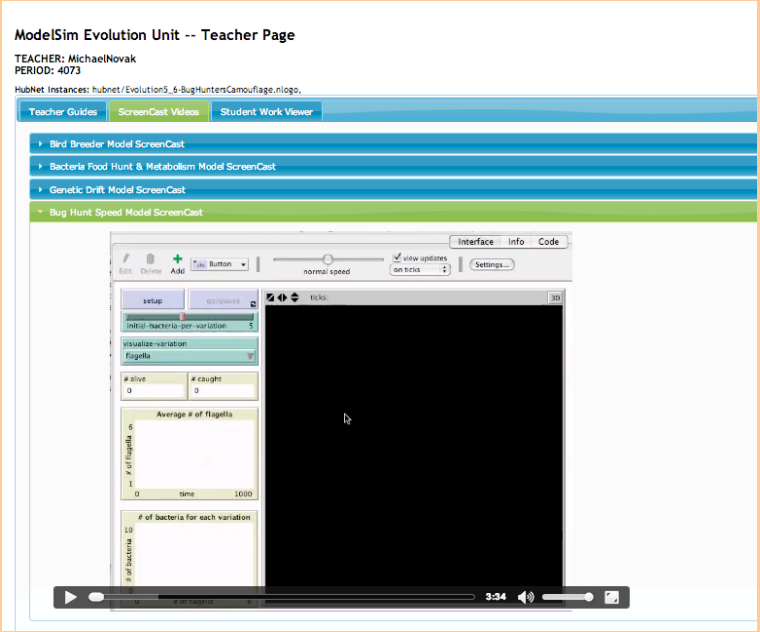
2. Look for the Grading & Tools Column to the right. Under that look for the Grade by Step

heading and click on the Latest Work link.

3. The teacher Grading & Feedback page will come up. Click on Launch Teacher Page on the top right of the page.



4. Click on the Screencast Videos tab. Click on the Bacteria Hunt Speeds Link.



5. **Make sure students are on step 3.2** and tell them that when you play the video you will need them to record some information about how the model works and make a prediction.

6. Press the play button. Audio narration is provided.

- **Have students complete step 3.2 and 3.3 at the end of the Screencast.**

Explore

- **Tell students that they will work in partners now by taking turns running and watching one of the models on one of the two partner's computer. Have student partners do steps 3.4 to 3.7 on a single computer.**

Summarize:

Then have students talk with a partner and select one idea they discovered today. Have students write this idea on a large piece of paper or a large post it note in dark pen/marker. Have one student from each pair of students bring their papers/post-its to the front of the room and stick them up on the board.

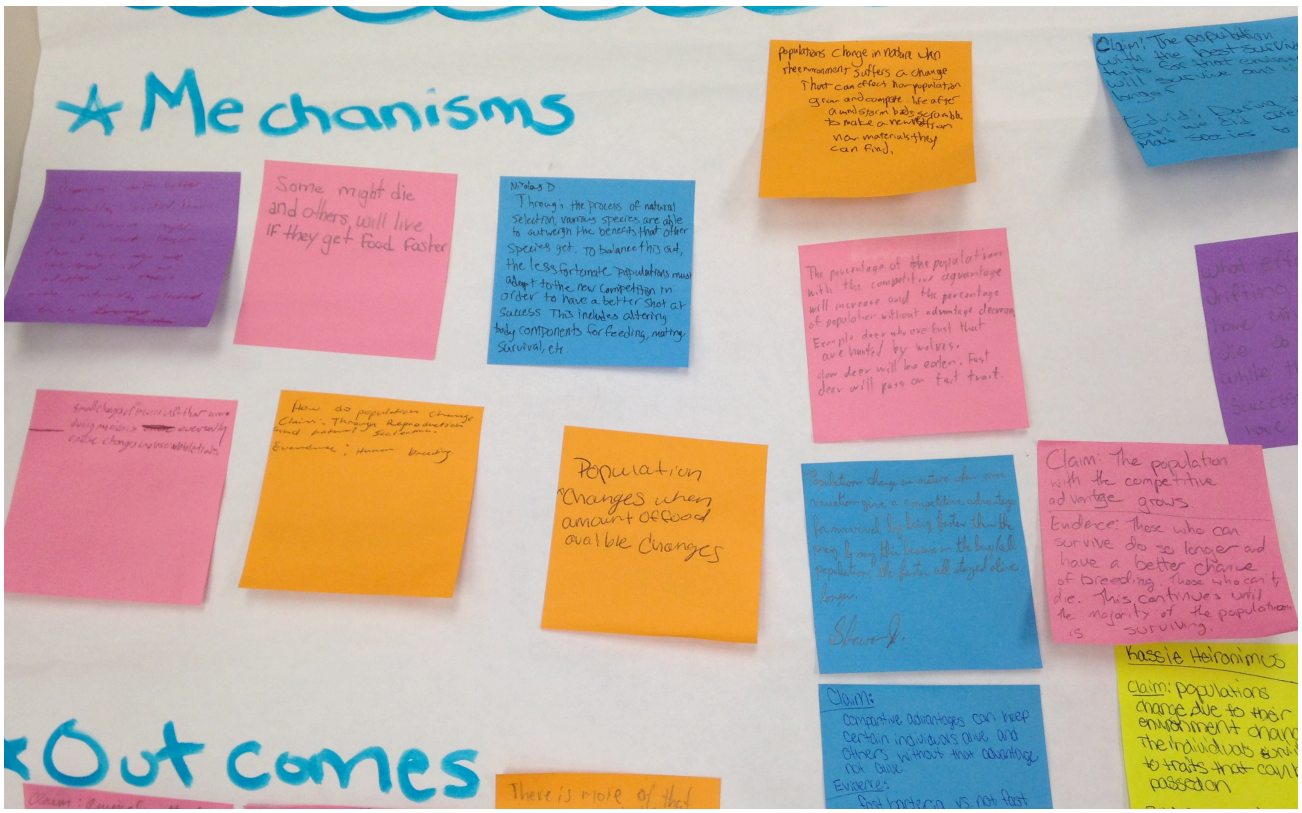
Ask students to share reasons for why slower bacteria have a competitive advantage when students waited for all the bacteria to run into their cursor to catch them? *students should say faster bacteria run into the predator more often and are removed more often than slower. So slower bacteria run less risk of encountering a predator. A bacterium that didn't move at all would never run into this type of predator.*

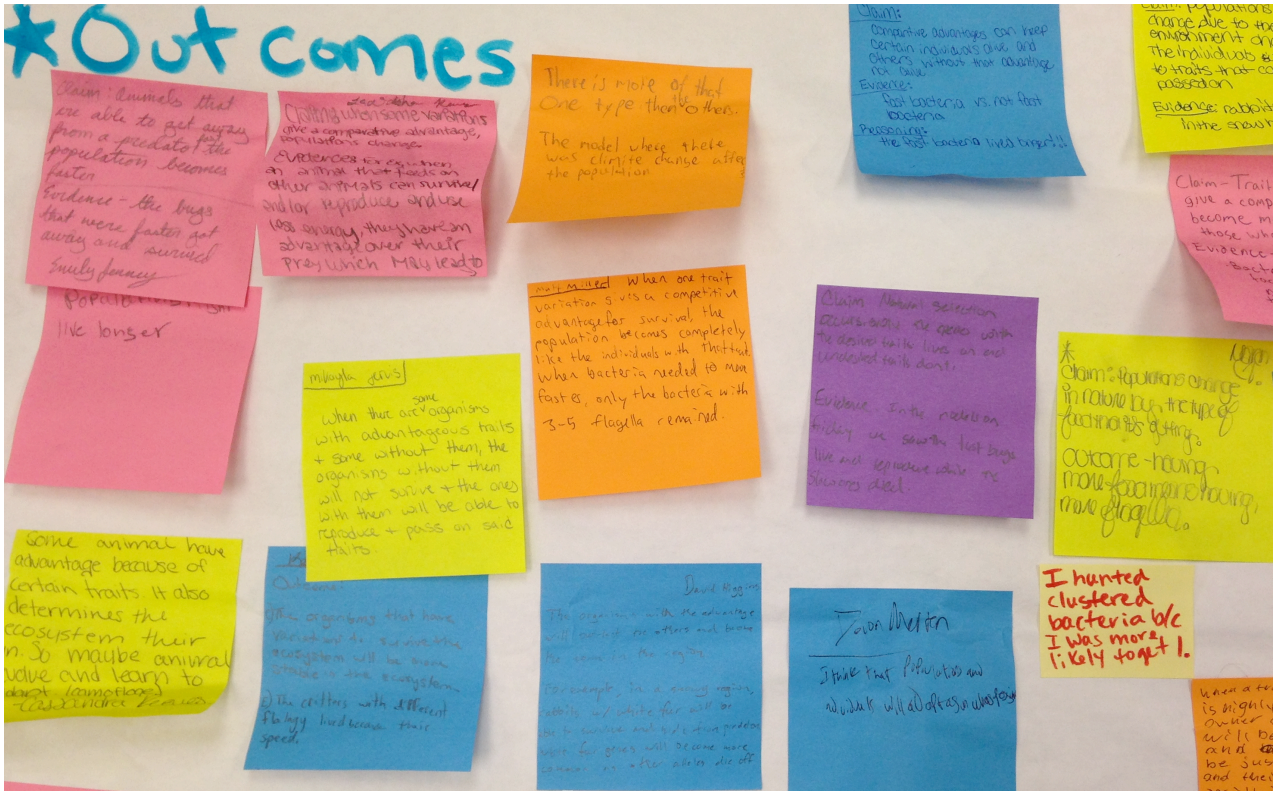
Ask students to share reasons why faster bacteria have a competitive advantage for survival when you were chasing all the bacteria around to try to catch some? *Students should say that faster bacteria are harder to catch. Just when you seem to have them lined up under your cursor, they tend to move out from under it before you can press the button. Because of this, sometimes you miss catching the fast ones slower bacteria are easier to catch. So, more of the time you try to click on them you actually succeed. A bacterium that didn't move at all would be the easiest one to catch and you probably could successful catch (with one click) every stationary bacterium (if there were any).*

Build class consensus on the following ideas – in exploration 1, the selection was more similar to selective breeding than explorations 2 and 3, because you were focused on intentionally trying to change the traits of the populations, explorations 2 and 3, the same result occurred, but it was unintentional on your partner. In all the explorations, selection is occurring, but the manner of selection is different. When humans engage in the selection (like in selective breeding) it is also sometimes called **artificial selection**. When other organisms, objects or events in nature are unintentionally selecting what individuals survive and reproduce and causing the distribution of inherited traits variations in the population to change it is called **natural selection**. It is called natural selection, because it is also a process in which any individual does not necessarily intentionally choose "favorability". Instead, interactions in nature are doing the selecting. Bacteria, birds, plants, and any other organisms, and even non-living interactions from the environment (such as sunlight, weather, geography, etc..) all can cause natural selection to occur, without intending to.

With the papers/post-its displayed for the class to look at together, lead a consensus building discussion. Facilitate the movement and reorganization/clustering of the ideas students brought up, under the headings listed below. This consensus building discussion and reorganization of the student descriptions of their discoveries will help students condense and summarize the big ideas from the day's lesson. If an idea that students suggest doesn't fit under these areas, don't leave it out. Rather, emphasize that the idea shared is another interesting discovery and that the main ideas that the students are responsible for knowing and reusing in future explorations are the ones organized under the areas listed. Try to write the categories in the student's own words, and using their own papers if possible. You may want to consider posting these big ideas in class, having students summarize these ideas now (or later) in their notes. Either way, try to use the students own words and the way the class expresses the ideas listed below, without feeling it is necessary to use this exact wording. Examples of possible student responses they might contribute on their sheet or post it note are shown in italics. Ask students whether they agree or disagree with how the ideas or organized and whether this summary helps pull out the main points they discovered.

Here are example student post-its from 9th grade regular biology classroom
(special thanks to the first pilot teacher: Katahdin Cook Whitt in Dayton in Dayton, OH):





The underlined statement is the suggested category. The non-bold italics statements are possible student ideas.

The bold italics statement can serve as another way to summarize what is common amongst the student ideas and each underlined category.

Conclusions & Big Ideas: "Why Do Some Variations Become More Common and Others Disappear?"

When these conditions or mechanisms exist:

- **There is variation in heritable traits.** *(in every species such variation exists).*
- **Some variations give a competitive advantage for survival**
- **The individuals with variations that do not grant a survival advantage die more frequently.** *The interactions between the environment and the population unintentionally select individuals with a variation(s) of the trait that gives a competitive disadvantage for survival to die more often or more quickly than the other individuals.*
- **The surviving individuals reproduce.** *As a result the surviving individuals are more likely to reproduce (either asexually or sexually), and create more offspring.*

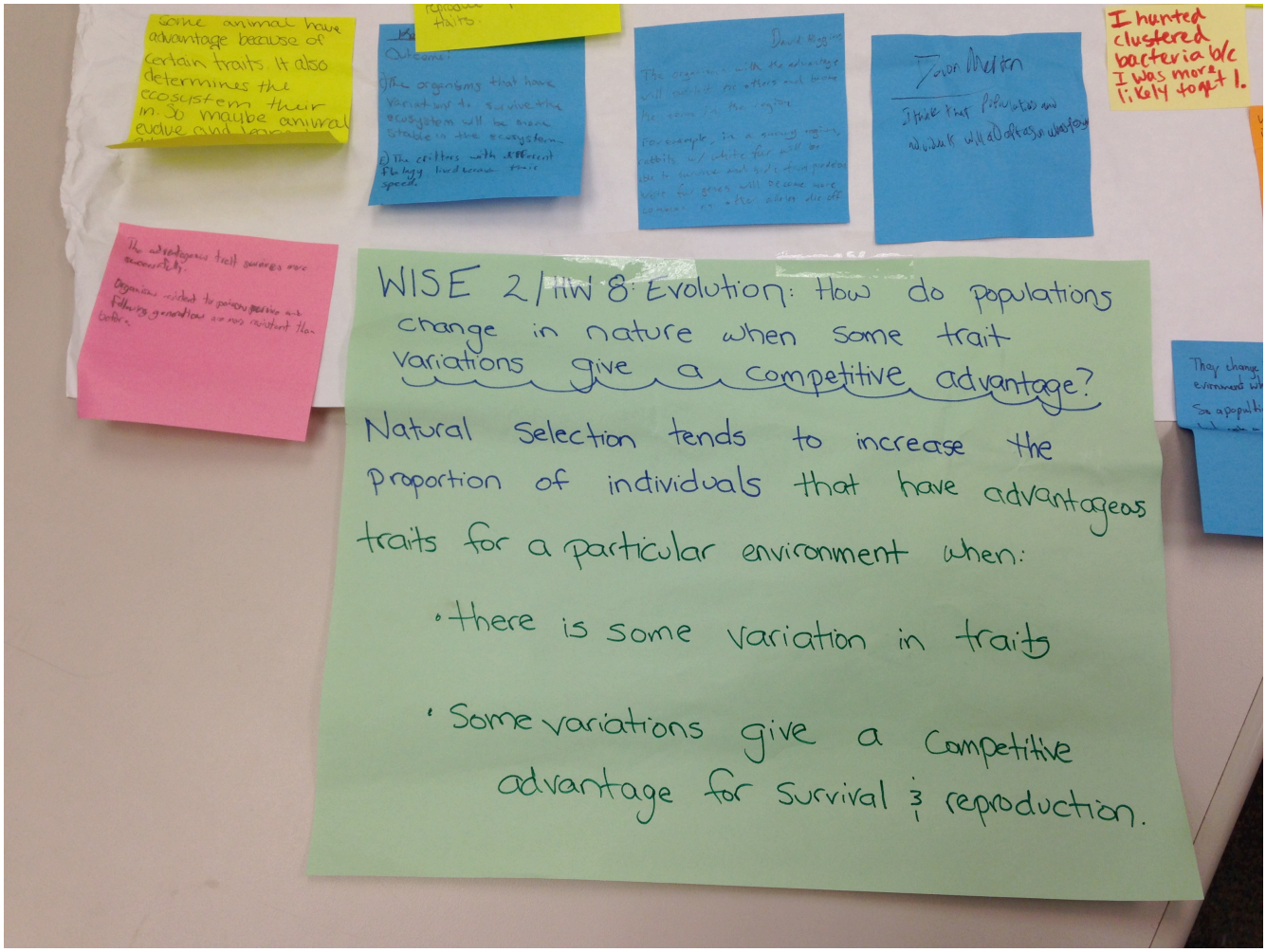
The outcomes of natural selection:

- **When environments change (including other organisms that inhabit it change), the survival value of inherited characteristics may change.** *(e.g. in one environment when you were a predator chasing bacteria, faster bacteria had a competitive advantage for survival, and for a different environment when you waited for bacteria to come to you, slower bacteria had a competitive) advantage for survival)*
- **As a result of natural selection, the proportions of individuals in a population that have advantageous traits tend to increase over time after an environmental change and those that don't decrease over time.**

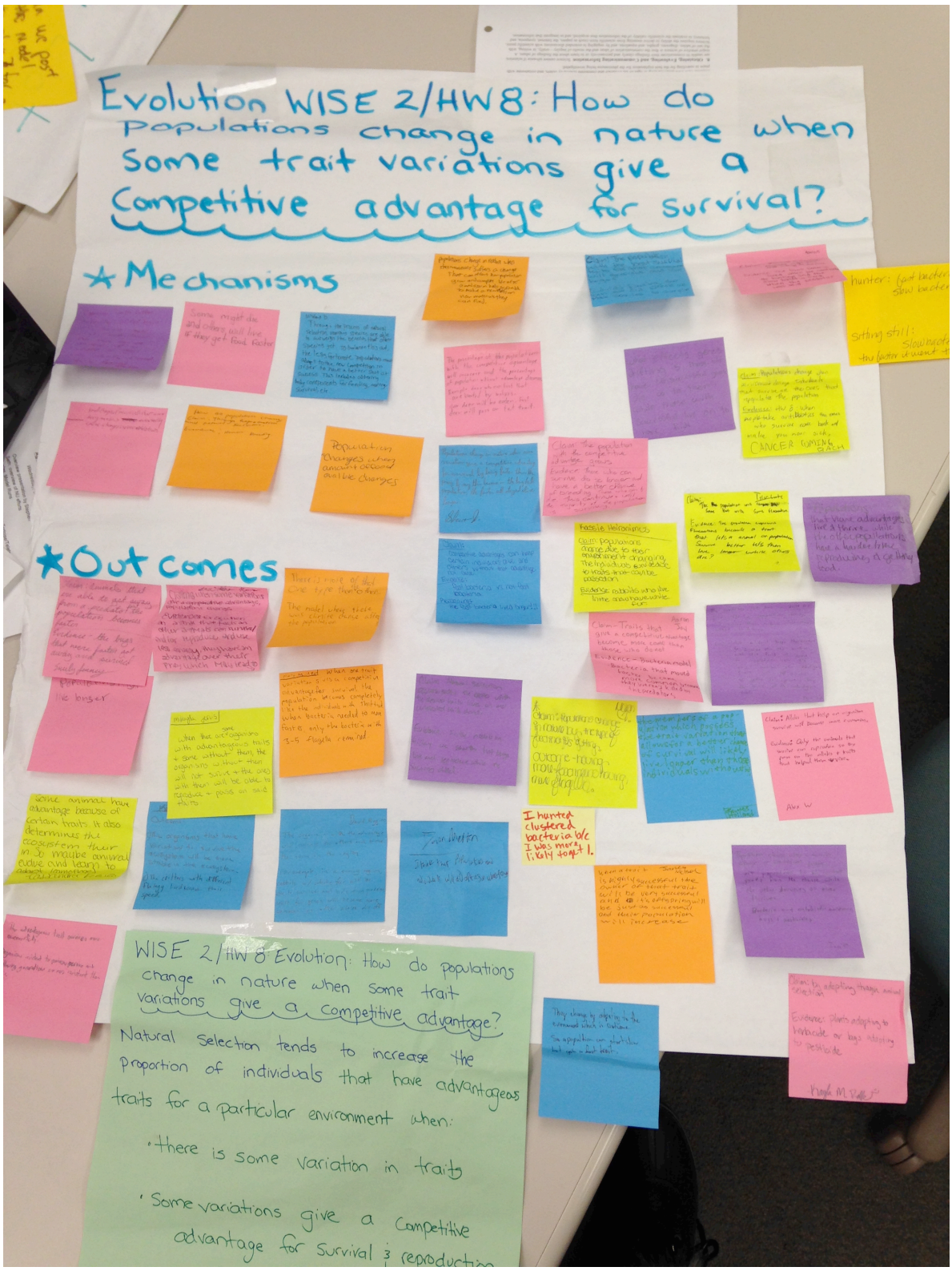
Add only these two scientific principles to the driving question board:

- Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.
- As a result of natural selection, distribution of traits in a population can change when interactions in the ecosystem change.

Once these ideas in the bold have been agreed upon by the class make sure they have been added to the orange section of your driving question board. Add them either in the abbreviated form or the fuller form of the idea. One easy way to do this is to move the butcher paper or poster paper that you had been using to keep track of the ideas and tape it under the lesson question for today. An example of this is shown below:



Notice that the big ideas on the green sheet can take a very different syntax and focus than the ones suggested in the teacher manual. This teacher used her own student's ideas and language to craft summaries of their ideas. An example of the full poster for this lesson from a 9th grade regular biology classroom :


Evolution WISE 2/HW8: How do populations change in nature when some trait variations give a competitive advantage for survival?
★ Mechanisms
★ Out comes
WISE 2/HW 8 Evolution: How do populations change in nature when some trait variations give a competitive advantage?
Natural selection tends to increase the proportion of individuals that have advantageous traits for a particular environment when:
• there is some variation in traits
• Some variations give a competitive advantage for survival & reproduction

Homework Assigned:

Assign Reading 3.1 – Natural Selection for students to complete before the next activity. Tell students that tonight they will also read about other factors in the environment that can cause natural selection besides predators in order to be able to more fully understand "How Does Nature Select For Some Trait Variations Over Others?" PDFs of the homework are available on the teacher resource page for the unit. Simply click on the blue link for each activity under the student assignments section to download the pdf of the homework.

ModelSim Evolution Unit -- Teacher Page

TEACHER: MichaelNovak
PERIOD: 4073

HubNet Instances: hubnet/Evolution5_6-BugHuntersCamouflage.nlogo,

Teacher Guides | ScreenCast Videos | Student Work Viewer | Student Assignments

Student Assignments for the ModelSim Evolution Unit

In-class Activity	In-class Steps or handout	Estimated Time	Out of class assignment based on this activity
1: Introduction to the Case Studies Board	Case Study Board Introduction	Option 1: 40-60 min. Option 2: 10-15 min.	Reading 1.1 – Interactions In Ecosystems
2: Selective Breeding	2.1 to 2.8 Case Study #1	60 min.	Reading 2.1 – Selective Breeding Complete Case Study #1
3: Natural Selection: Predation	Case Study #1 3.1 to 3.7	60 min. 1st part of lesson is not on the computer, the 2nd part is.	Reading 3.1 – Natural Selection
4: Natural Selection: Food & Metabolism	4.1 to 4.9	60 min.	
5: Genetic Drift and Case Study #2	5.1 to 5.13 Case Study #2 (printed in color for each student)	120 min. 1st part of lesson is on the computer, the 2nd part is not.	Reading 5.1 – Random Events Reading 5.2 – Genetic Drift Population Size
6: Adaptation Explorations	6.1 to 6.10	60 min.	Reading 6.1 – Adaptation and Survival
7: Adaptation Experimentation	7.1 to 7.11	60 min.	Take of digital photo of an environment and send it to web based email to access tomorrow at school Reading 7.1 – Adaptation for Sexual Selection
8: Speciation	8.1 to 8.13	60 min.	Reading 8.1 – Speciation Reading 8.2 – Adaptive Radiation
Final Case Study	Case Study #3		To be completed in class or out of class