Lesson 2A: "How Can I Influence The Traits In A Population Through Selective Breeding?"

Overview:

Purpose:

The purpose of this activity is to 1) familiarize students with the process of selective breeding and its outcome (change in trait variations in a population and changes in the gene pool) and 2) Distinguish between three types of selection events:

- Intentional selection of which individuals to breed
- Intentional selection of which individuals to remove from a population
- Random selection of which allele is passed to an offspring from each parent

Prerequisite Knowledge:

LS2.A Interdependent Relationships in Ecosystems

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.
- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability .

LS1.A Structure and Function

- All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins.
- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions (alleles) for forming species' characteristics are carried in DNA. Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual.

LS3.A: Inheritance of Traits

- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.
- Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.

LS3.B: Variation of Traits

- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.

Performance Expectation

- Conduct an investigation to influence characteristics of virtual birds and the gene pool of their population by selective breeding them in a cooperative participatory computer simulation.

Scientific Principles (re)Discovered in this Activity

- Selective breeding has 3 mechanisms that influence its outcomes: 1) intentional selection of mates, 2) which alleles are randomly passed on via. meiosis, and 3) intentional removal of others from the population.

Description of the Lesson

Students identify variations of traits that people might selectively breed for in cats and dogs. They then work in a team of 4 students to selectively breed virtual birds in a computer simulation where they cooperate with each other and compete against other teams of students to see which team can most quickly develop a fancy breed of bird.

After analyzing the results of the simulation, the teacher facilitates a consensus building discussion through which the class identifies the mechanisms of selection in the model, including selection of which individuals will reproduce and which individuals will be removed from a population. They also identify how allele selection (via. Meiosis) for passing on genetic information to offspring is a random selection processes. And they describe how these mechanisms of selection influence the outcomes of the selective breeding.

In their out-of class reading they apply these experiences and understandings to describe how people have selectively bred corn, dogs, foxes, and cats for different trait combinations and how selective breeding in corn has changed the traits variation in these species over time.

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.
- Individual copy of Reading 2.1 - Selective Breeding (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 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 driving question and introduce today's lesson question– (2 min.)
- Review step 1.1 and previous scientific principles we know about inheritance (5 min.)
- Do step 1.2 together – intro. Litter, trait, variation, and complete this together (2 min.)
- Discuss purebred, gene pools and selecting individuals to mate and then do step 1.3 together – discuss (4 min)
- Demonstrating the interface using the Screencast (5 min.)

Explore

- Teacher assigns teams and students launch and join their team exploration (step 1.4) (2 min).
- Students breed birds (step 1.5) (10 min)
- Students record observations and follow-up question responses (step 1.6 through 1.7). Step 1.7 is recommended, but not required if time is short - (6 min)

Summarize

- Student's complete Follow-up questions and share this with a partner (step 1.8)– (5 min.)
- Consensus building discussion – (18 min.)

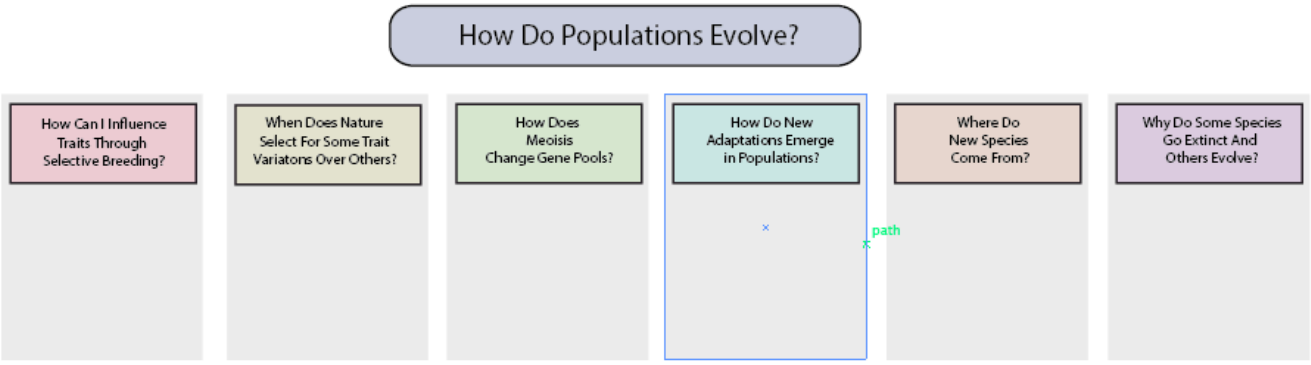
Lesson Enactment Details

Before the class starts:

Build the driving question board below before class starts. This is different than the case study board introduced in the last activity. Large pieces of butcher paper for each section are recommended. It is typically easiest to use the same driving question board for each class, so when you add your class discoveries to each section, it is recommended you temporarily tape those in. That will allow you to remove them before the next class.

Note: If you have taught the Populations Biology unit in WISE already, then you will want to also put up the old driving question board (as it a related driving question,, "How do Populations Change?". In it, students have developed some important ideas related to interactions, resources, competition, stability, fluctuations, carrying capacity, predation, and trait variations in that unit that will be built upon in this unit).

For this new unit, the driving question is "How do Populations Evolve?" Under this write the space for the six lesson questions you will investigate. Leave space under each lesson question to make bulleted notes about what the class discovers related to each question. An example of this is shown here



Launch:

Tell students that you are going to study this driving question over the next two weeks of study, "How Do Populations Evolve?" And say that the answers to this question will help us explain the cases we introduced last time. This board is where we will keep track of our Discoveries and big ideas. In order to study this driving question, the class will look at a new lesson question each day. Tell students that one of the goals by the end of the lesson will be able to answer the lesson question, and the other will be to be able to develop ideas we can use to help answer the driving question.

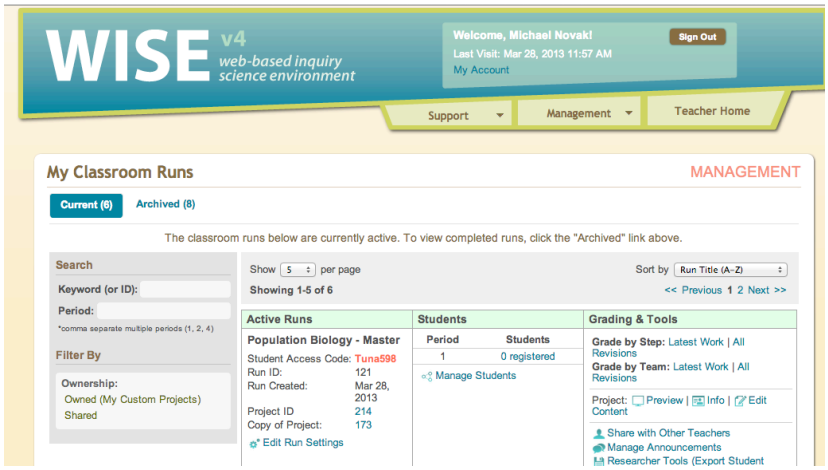
Point out the first question that they will investigate will be "How Can Selective Breeding Change Populations?"

Ask students if they have ever heard of people who people who breed dogs for a living? Some students will say yes. Ask students for some example of other organisms that they think people will breed for a living.

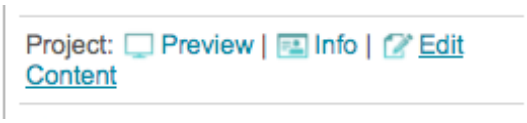
Tell students that they are going to use a computer system that will allow them to simulate breeding different organisms together.

- **Have students log into WISE and start the Evolution Unit.**

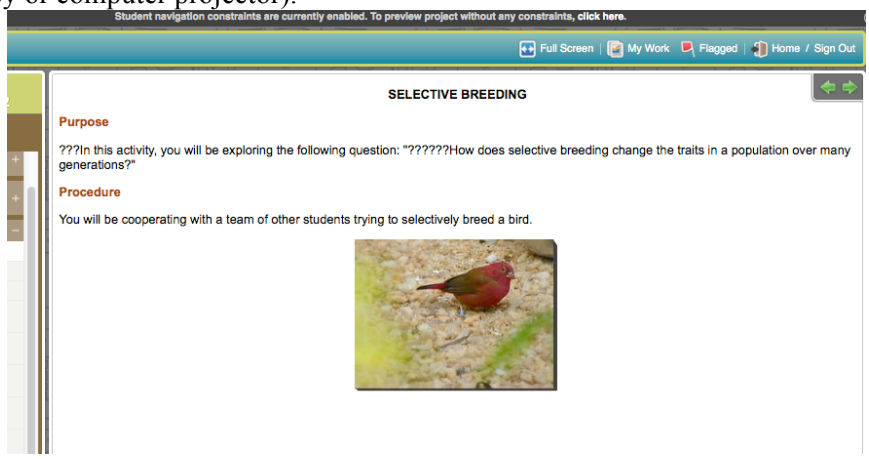
You too will want to log into WISE in teacher mode, but will be projecting some of the images from the student view. To do this click on the Teacher Home tab. You will see a list of all the active runs you have started for each class period. For the current class that you are teaching. In the example below, the first row show the Student Activity for this Teacher's Period 1 class



Look for the Grading & Tools Column to the right. Under that look for the Project: Preview link. Click on the link that says Preview.



- **Show Step 1.1 Ask students to go to step 1.1 and show this step to students** (project it as a transparency or computer projector).



Remind students of what they discovered in previous activities related to patterns of inheritance. Discuss some previously learned scientific principles learned about Patterns of Inheritance:

- Organisms that sexually reproduce can generate new combinations of trait variations in their offspring, since each parent contributes half of the genetic information for every trait to their offspring.
- When a parent has two alleles for a trait, there is a 50/50 chance that an offspring inherits either of

these alleles
- Sometimes genetic information for trait variations is hidden or masked by expression of the dominant alleles for the same trait.

If these principles are not already posted in the room, you may want to add them to the driving question board.

Introduce the idea of a **litter of offspring** as a number of siblings born all at once from two animals. Ask how many students have ever seen a litter of kittens, puppies, piglets, or rabbits?

- **Have students go to step 1.2 and complete it during the following discussion;**

Discuss what traits appear different in each of the kittens: What variations do students observe in kittens traits? Have students write down some of the variations they see in spottedness. *Students may say "spotted" and "non-spotted*. On their activity sheets have students write down variations they see in the color of fur on the paws. *Students may say "gray", "black", "tan", "white", and "black and white". Specific wording of the variations or the number of variations recorded is not important. The goal is to recognize the idea of the trait being the "name of the category for the attribute" and the variations being the possible "values" and that traits can have more than 1 variation is the key idea.*

Ask students if they suspect that either of the parents have the same variations in their traits as one of the kittens? *Accept all answers. Students may argue it's hard to know since parents don't always look exactly like their offspring.* Ask whether a kitten inherits alleles from only one parent or both? *Students should say both.*

And ask if all of these kittens were born from the same two parents why don't all the kittens look identical? *Students should say that different offspring might inherit a different half of genetic information from each parent for each trait.* This general idea should already be on the driving question board, but if not added it now.

Introduce the idea of a gene pool by first asking whether the offspring (the kittens) of the cats would likely have the same alleles (genetic information). *Students should provide reasons why not. Since there are 5 very different looking cats, and only two parents, the genetic information (alleles) must be in different combinations or frequencies in the offspring than in the parents.*

Say that scientists often think about what alleles are in a population as well as what traits they can observe in the population, since what they see on the outside (the traits or the phenotype) might be different from the genetic information on the inside (the genotype). Say that when scientists refer to the all of the alleles in a population, they call this the **gene pool** of the population. Tell students that they already have provided an argument for why the gene pool of the parent generation (the mom and dad cat) must be different than the gene pool of their offspring (the litter of five cats)

Ask students why the gene pool of the entire kitten family (mom, dad, and all their offspring) would change each time a new kitten is born. *Accept all answers.*

Ask students what else besides new births would change the gene pool of the kitten family. *Students may say if a kitten or a parent cat dies, or if it is permanently removed from the population (given away to another family)).*

Review with students these previously learned ideas, covered in earlier class instruction and connect them to the example of the litter of kittens.
- The variations in traits (color of fur, spottedness) is the result of genetic information from each parent
- Each offspring can inherit one of two different alleles for a gene that determines a trait. Some traits are influenced by more than one gene.

Introduce the idea of selective breeding**.** Tell students that some people breed animals for many reasons. Say that in general, all animal breeders purposely select which parent animals they arrange to mate together in an attempt to try to get desirable variations in the offspring. When a population of dogs has a set of similar characteristics that are genetically inherited over generations that are different than other populations of dogs, it is called a breed of dog. Ask students to name some different breeds of dogs. *Answers will vary*

- **Have students go to step 1.3 and complete it**

Ask students to think about different types of dogs that people might selectively breed for desirable characteristics or different trait variations. Show step 1.3. Ask student's, "If all of these dogs were female, which dog would you select to be mom if you were trying to get puppies with really long fur and a spotted coat? A small body size and pointy ears? *Answers will vary*

Ask, will it matter which dog you pick for a dad if you are trying to get puppies with really long fur and a spotted coat? *Answers will vary*

Tell students that one goal of selective breeding is to select dogs to produce offspring with desirable characteristics. To do this, sometimes breeders try to develop a line **purebred** offspring. A purebred offspring is an offspring that reliably passes on the genetic information for just one variation for each of many traits.

Purebred animals have two copies of the same allele for these traits. Offspring of two purebred dogs with the same trait variation will show all the same traits as its two parents. For example, when one purebred dog of a specific breed (e.g. poodle) is mated with another purebred dog of the same breed, the offspring will have all of the same traits as its parents that would qualify it as a poodle. Or in other words, a purebred dog with black fur mated with another purebred dog of the same breed with black fur will always have offspring with black fur.

(This assumes no mutation in genetic information of the offspring from the parent. Do not bring this idea up at this time, but if students suggest the idea, then say that we will study that mechanism in future explorations, but that mechanism is not included in this model yet).

Tell students that they are going to work in a team of 4 to selectively breed birds and that you are going to demo how the model works now. Don't have students go onto to step 1.5.

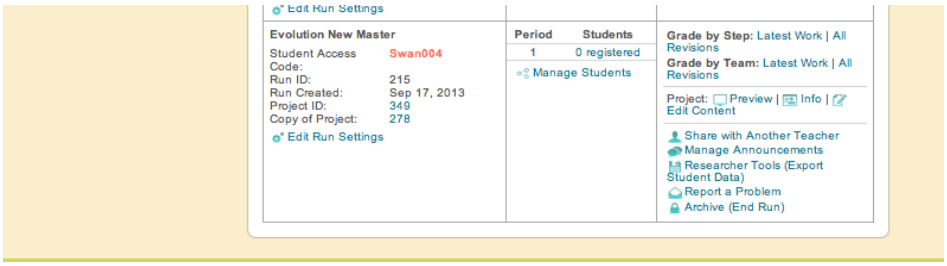
Directions for teacher: Model Introduction & Exploration #1

You have two choices as a teacher for this model introduction. You may either 1) play the screencast from the WISE teacher web page or 2) you may demo the model live.

If you do the first, you may chose to keep the audio of the screencast on or mute it and narrate the directions yourself.

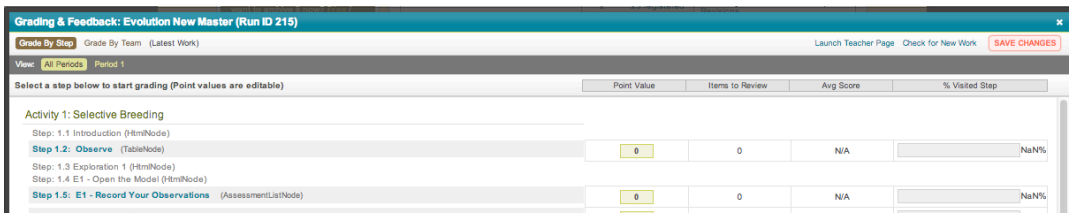
Option 1: Model Demonstration Directions For the Teacher Using A ScreenCast

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. Press the play button. Audio narration is provided.

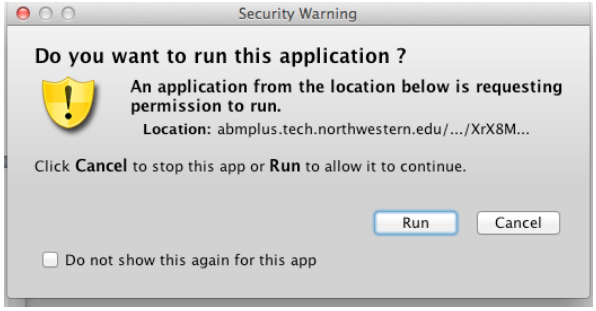
Option 2: Live Model Demonstration Directions For the Teacher

Remember to have Java 7 downloaded and log into WISE using a 64-bit browser (Safari or Firefox). You will not be able to run Java content in Chrome. Do the following steps to launch the model before class starts.

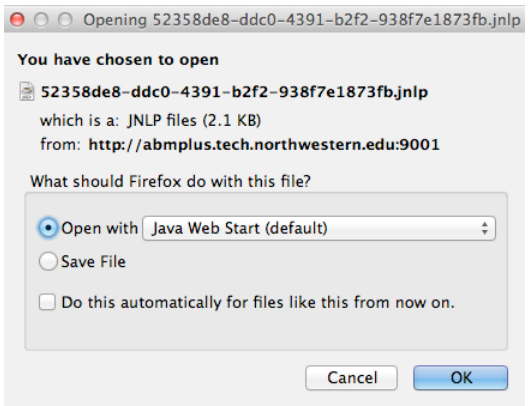
1. Go to step 1.4 Click on the link that says how to join as the Host …..

   If you are going to join as the Host (only one student can be Host!), click: Launch HubNet HOST App

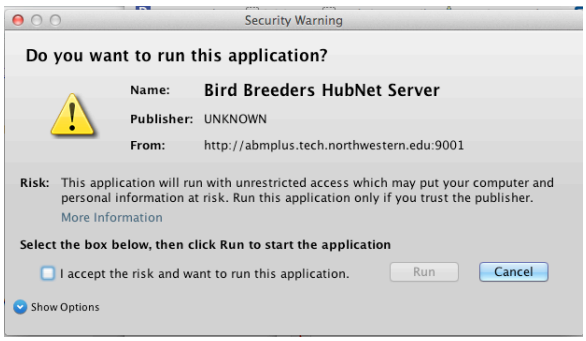
2. You will see a Security Warning dialog box appear. Click on Run to run the program



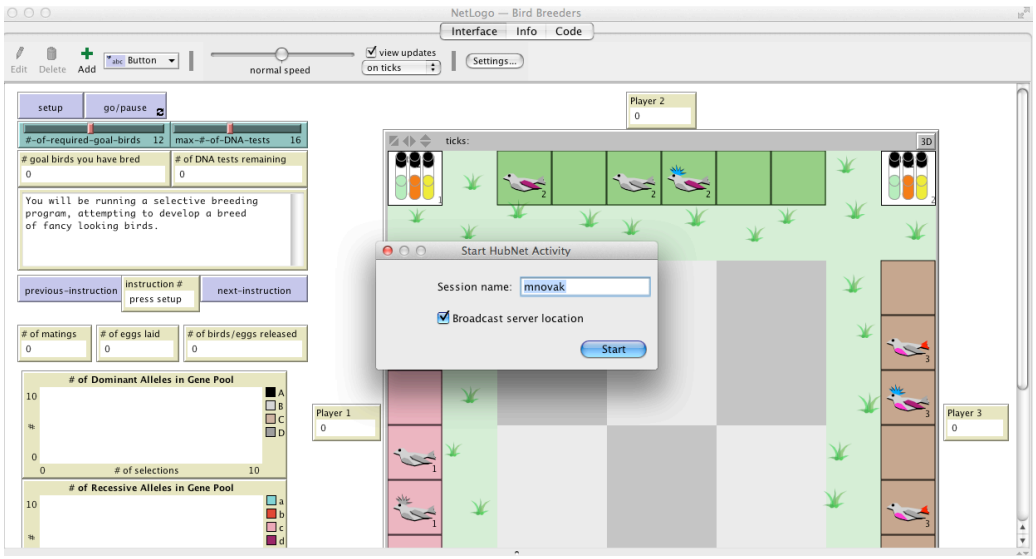
3. A Java Web Start file dialog box will now open. Press the **OK** button.



4. A 2nd Security Warning dialog window will open. Select the box that says **I accept the risk and want to run this application,** then click **Run** to start the supplication.



5. A NetLogo – Bird Breeders Window will now open. When it does press the **Start** button on the Start HubNet Activity dialog box.



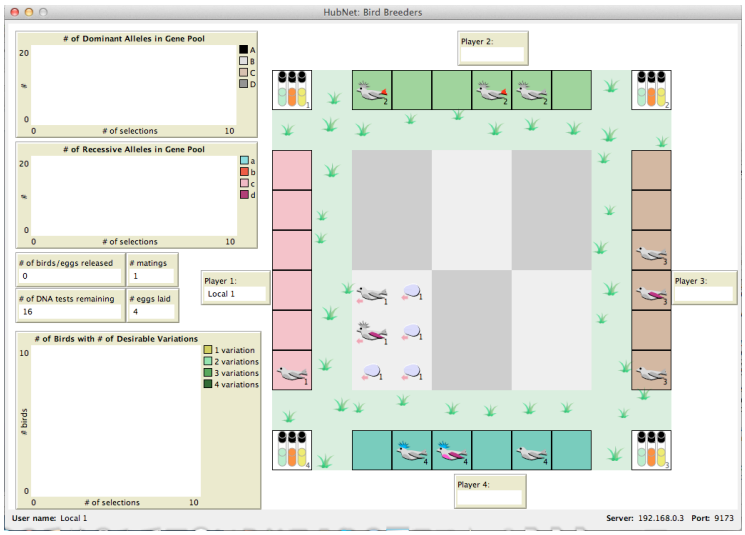
6. A HubNet Control Center window will now open. Check both the **Mirror 2D view on clients** box and check the **Mirror plots on clients (experimental)** box too.

7. Tell students that they must check these two boxes in order for the display to appear on the computers of the students who join the team. And say that this box is what the team leader will use to check and make sure that all the players have joined. If hen players are joining, the hosts name doesn't automatically appear for them, they can connect by typing in the

Server address number shown in the screen too.

8. Press SETUP.

9. Then press GO/PAUSE In both windows, you will see one of the Player monitors show the name "Host".

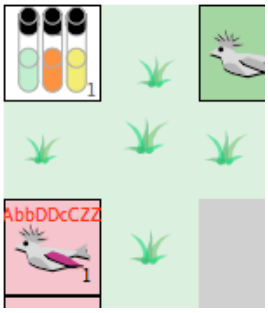


10. Click on any bird in one of the cages on that side of screen. A rotating ring will appear on it. Then click where you want it to travel to. In this first case click on one of the gray rectangles in the middle of the screen. A destination target will appear on the location and the bird will move to that spot:

11. Tell students that they need to move both a male and female to a breeding site in order to produce offspring. Tell students that the males have head feathers, but females do not. When a male or female is ready to mate a heart will appear. After it produces offspring the heart will disappear and arrows will appear showing that it must be returned to the owners cage before it can breed again:

12. Tell students that they must drag an egg back to the cages that they own before they can see the trait variations of that individual (before the egg will hatch). Show them this action. Also tell students that they can drag individuals to the DNA sequencer in the corners of the board that correspond to their player number to see information about the individual's genotype. Tell students that they may have to then drag the individual back to a cage or breeding site to

clearly read the genotype. Example shown below:



13. Show students how to release eggs or birds to the wild by dragging a bird to the grassy area. It will disappear.

14. Tell students that their team of 4 people has only 20 DNA sequencing events available for the entire team, so use them wisely. Tell students what type of bird they are trying to breed and write this goal on the board:

Goal: Breed 4 birds that each have:
- Blue head feathers
- Red chest feathers
- Purple wings
- Red tails

15. Tell students to that the following rules are built into the model:
- *The desirable traits only appear if the bird has matching alleles (homozygote) for that trait.*
- *The desired traits are due to recessive alleles.*
- *Birds can carry an allele for the recessive allele and not show it, simulating the patterns of inheritance for Mendel's rules of genetics seen in other organisms and traits.*
- *There is a 50/50 chance as to which allele will be passed on for each gene. The gene for each trait is modeled as being on a separate chromosome, so each allele for one gene is independently sorted from the alleles for others genes.*
- *Every group starts with a gene pool that has at least one copy of each of the alleles they need to breed the desired fancy bird.*

Now that the model has been introduced (either through a screen cast or a live demo), move on to the exploration phase of the lesson:

Explore:

- **Assign students to groups of 4 and have them complete steps 1.4 and 1.5.** After 15 min. have students stop the simulation, but continue in wise.

- **Have students record their observations (step 1.6 – 1.9)** (give about 5 min).

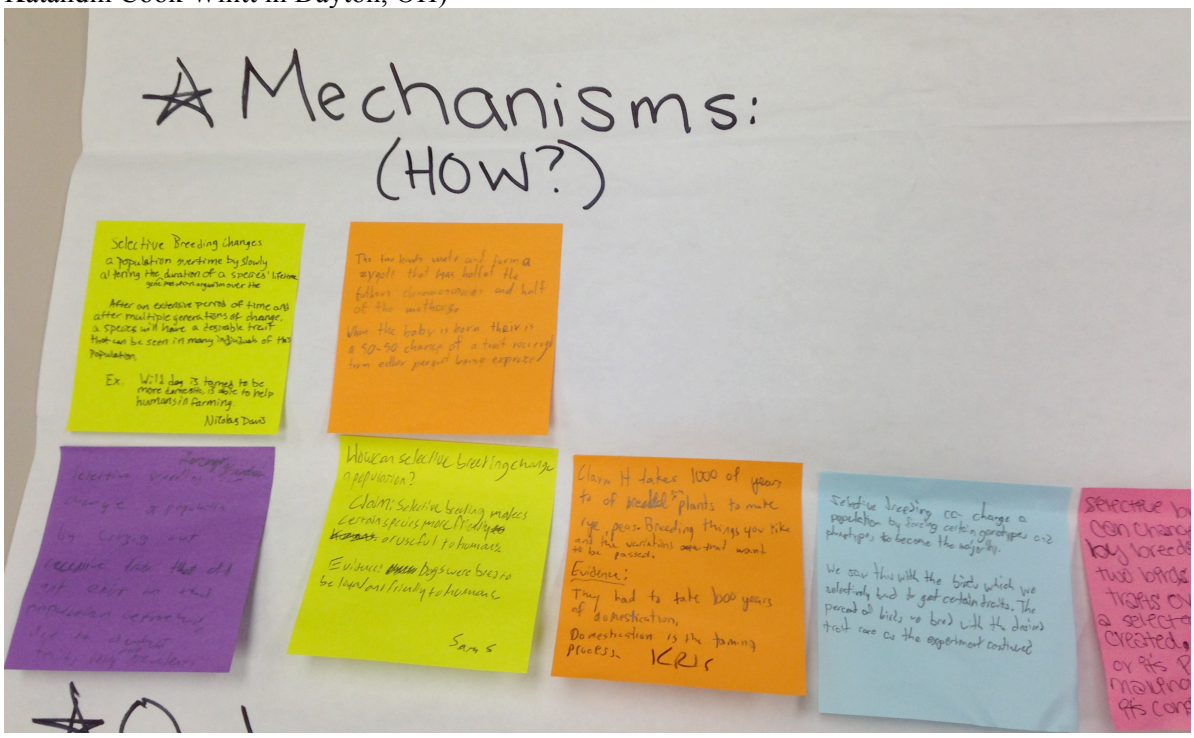
Summarize:

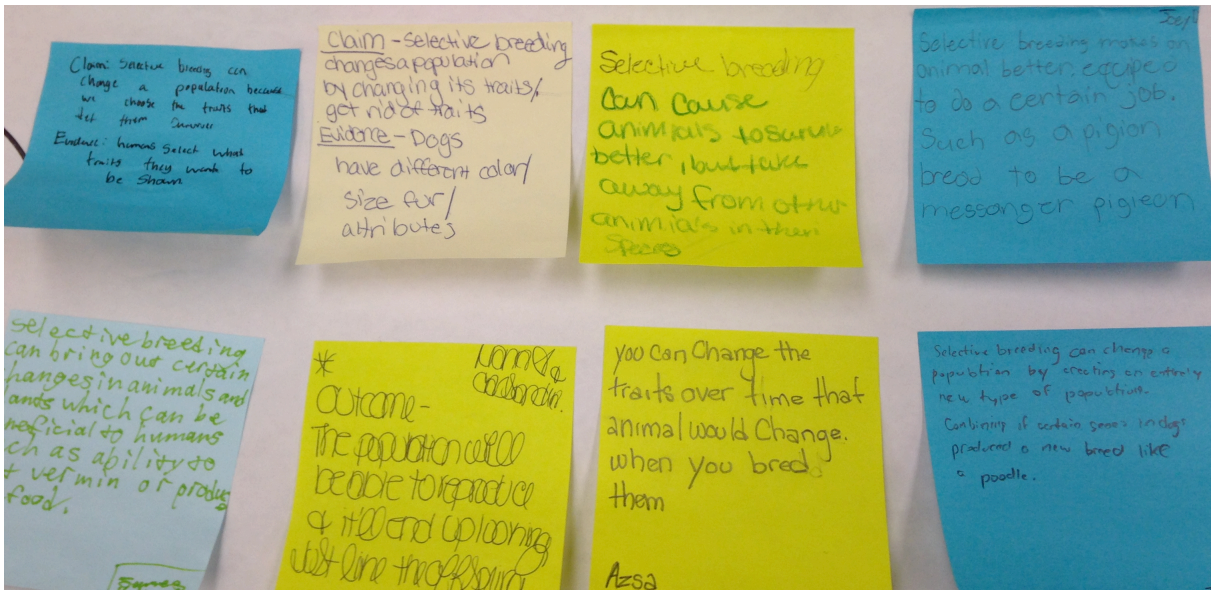
- **Have students answer the DISCOVERIES AND INSIGHTS (step 1.10)**

Then have students talk with a partner and select one idea they discovered today that they wrote in step 1.12.. 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.

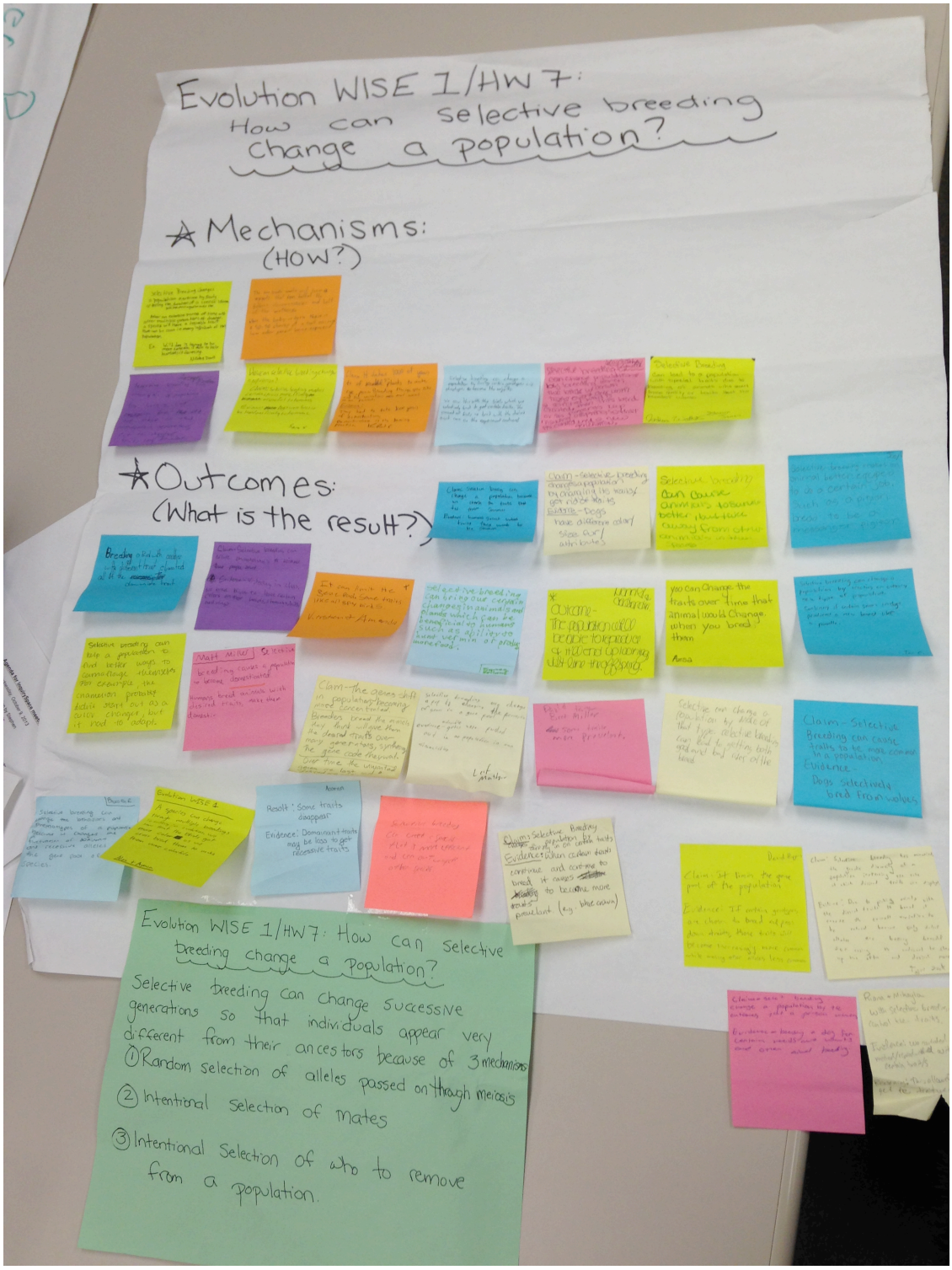
With the papers/post-its displayed for the class to look at together, lead a consensus building discussion. Facilitate the movement and reorganization/clustering of the ideas students brought up, under the headings listed below. The two main heading should be "mechanisms that change the population (through selective breeding)" and "the outcomes (of selective breeding)" 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 (thanks to the first pilot teacher: Katahdin Cook Whitt in Dayton, OH)





ere is an example of the entire poster for this lesson:



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: " How Can I Influence The Traits in A Population Through Selective Breeding?"

Mechanisms

Intentional selection of mates

- *Example student idea: The breeders are selecting some birds to breed together and not others.*
- *Example student idea: If a breeder needs an offspring to have a certain variation, they may pick a parent that produced offspring with that variation before.*
- *Example student idea: Knowing the genotype of the parents help you pick which ones will breed true for certain traits.*
  - ***Summarize with this idea:*** **Breeders intentionally select which individuals to mate together in an attempt to get the desirable traits or alleles in the offspring.**

Intentional selection of individuals to remove.

- *Example student idea: The breeders don't keep all the individuals. .*
- *Example student idea: There is limited space, so sometimes you have to get rid of the birds that aren't useful.*
  - ***Summarize with this idea:*** **Breeders intentionally select which individuals to remove from their stock** (population)**.**

Random selection of which of the two alleles for each gene are passed on to offspring

- *Example student idea: Different offspring result from the same parents.*
- *Example student idea: There is something random about what the offspring end up with.*
  - ***Summarize with this idea:*** **Meiosis contribute randomness to the traits in an offspring, since there is a 50/50 chance as to which of the two alleles per gene from each adult is sorted/separated into which sex cell that is passed on to an offspring.**

Outcomes

The frequency of alleles in gene pools and distribution of variations in the population changes over time.

- *Example student idea: There are more individuals with the alleles you want as you keep breeding them over and over again.*
- *Example student idea: Every time and individual is born or removed, the gene pool changes*
  - ***Summarize with this idea: Selective breeding*** **changes gene pools, making some alleles *more common and others become less common in the population.***

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

- Selective breeding has 3 mechanisms that influence its outcomes: 1) intentional selection of mates, 2) which alleles are randomly passed on via. meiosis, and 3) intentional removal of others from the population.
- Selective breeding can result in individuals with new combinations of traits and populations with different gene pools.

Homework Assigned:

Then tell students that they will read about other organisms that have been selectively bred tonight in Reading 2.1-Selective Breeding. These resources 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 or case study.

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