Lesson 5a: "Why Do Some Variations Become More Common and Others Disappear?" (part 3)

Overview:

Purpose:

The purpose of this activity is to describe how random fluctuations in gene frequency in a population are the result of the random sorting and recombination of genes in sexual reproduction (through meiosis and fertilization) and to explain why this drift in gene frequency can result in the loss of alleles from a gene pool. Students will extend this idea to help students 1) describe the relationship between population size and the rate of gene loss from a gene pool and 2) explain why barriers that cause reproductive isolation of a genetically diverse ancestor population would likely lead to offspring populations that have different gene pools from on another.

Performance Expectation

- *Design and conduct an experiment to* determine the effect of meiosis on fluctuations in the distribution of traits in a population and alleles in a gene pool. [Emphasis is on analyzing traits and alleles in the population through visualization of virtual karyotypes and related bivariate graphs]

Scientific Principles Discovered In This Activity:

- Some shifts in the distribution of traits in a population are the results of random selection events (such as meiosis and which gametes are fertilized).
- Alleles/genes can disappear from gene pools from random events; this also can lead to a population dominated by organisms that are different from other related populations,

Description

Students experiment with fish reproduction in a virtual fish tank, noting changes in allele frequency due to results of meiosis and fertilization events.

Students design experiments to investigate factors that affect loss of alleles from a population. They discover that the types of alleles that are lost from genetic drift are not predictable. They find that smaller populations and small gene pools lose alleles more quickly due to genetic drift than larger populations and larger gene pools.

At the end of the lesson, the teacher helps build consensus how genetic drift can lead to some trait variations becoming more common and others disappearing from a population.

In their homework students apply the mechanism of genetic drift to show how two descendant populations of organisms could appear very different from one another and they read about population bottle necks and founder effects in article about cheetahs.

Lesson Details:

Time: 60 minutes

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 5.1 – Random Events
- Optional: Reading 5.2 Population Bottlenecks and Founder Effects.

For Teacher

- 1 computer with Java 7 and Firefox installed and projector or large display screen for the teacher to display the computer model.
- 1 piece of butcher paper or poster paper or space on the wall for students to stick the post it notes on.
- Document camera or other display technology for student's to display their maps/models.

Lesson Outline and Timing

Day 1

Launch

- Review scientific principles about meiosis and chromosomes (steps 5.1 & 5.2) (8 min.)
- Show Screencast of Model (4 min).

Explore – Exploration 1

- (Un)predictable offspring (step 5.4-5.7) (10 min).

Explore – Exploration 2

- Design & conduct an investigation with a partner (step 5.8 through 5.11) (15-min).

Summarize

- Present results and respond to presentations of other students (step 5.12) (20- min.)
- Summarize a big idea from the investigation or presentations (10 min)

Lesson Enactment Details

Launch:

Ask students to name some traits that are primarily inherited in dogs and birds and plants as well.

Remind students that some traits have two variations and other have multiple variations. Remind students that populations that sexually reproduce can generate new combinations of trait variations in their offspring, through the recombination of genetic information passed on from each parent. Ask student to identify how this can occur.

Students should recall that:

Their traits are determined by a single piece of genetic information (a gene); each gene has two pieces of genetic information that can come in different forms (alleles). An individual can possess two copies of

genetic information either as identical alleles or as two different alleles, one on each chromosome of a chromosome pair.

Each parent passes on one of their alleles for every gene to an offspring; for each offspring there is a 50/50 chance as to which allele they will receive from each parent, since chromosomes are independent sorted when sex cells are crated through meiosis.

Also remind students that alleles are small sections of genetic information on a chromosome. This section of genetic information is like a catalyst or enzyme that helps cells produce a new substance that contributes to the new trait. Recessive alleles are often genetic information that gives no instructions about creating a new substance for a trait. Dominant alleles are genetic information that instructs cells to create a new substance for a trait. They discovered in the past when there are two different alleles for a single trait, sometimes one allele masks the presence of the other allele, since if one set of instructions says nothing about creating a substance for a trait, and another set of instructions says to create a new substance for a trait, the net result will still to be to create the substance for the trait. These alleles are said to assert a dominant expression over the other allele, so that the phenotype (or observable characteristics related to the trait) of the organism appears to be that of the single allele, which is the set of instructions for creating a substance. Give an example of genotypes vs. phenotypes for Mendelian genetics if needed.

- **Have students log into WISE and resume work on the Evolution Unit**

- **Ask students to go to step 5.1** Identify that the picture shows a nucleus, and the 46 chromosomes found in the nucleus of humans. The chromosomes have been color coded to match up with another chromosome that is the same length. In this way we can see on the bottom left that there are clearly 23 pairs of chromosome. Ask students where an individual gets one of the chromosomes in pair 1 from? The other chromosome? Where do they get one of the chromosomes in pair 2 from? The other chromosome?

Reintroduce the idea of a **gene pool.** Remind students that they explored the idea of a gene pool in the selective breeding activity with the birds. Ask students to describe how the gene pool of the ending population was different than the gene pool of the initial population. And ask why every additional offspring that is born has an affect on the gene pool of the population.

For students who may not have done the selective breeding activity with the birds or as a review, you can (re)introduce the idea of gene pool with a short example related to sex chromosomes. Tell these students that a gene pool is all the chromosomes and their related alleles in a population. Provide an example of a family of a mom and dad and two children related to X and Y chromosomes. Draw the genotype for each member of a family that has two daughters (mom – XX, dad – XY, daughter 1 – XX, daughter 2 – XX), and ask the students which there is more alleles of in this gene pool X's or Y's? Then ask students to compare this family's gene pool to a 2nd family's gene pool. In the second family, there is a mom and dad and two sons. How would the proportion of X chromosomes in this family's gene pool compare to the first family? I*t would be lower (5 of the 8 chromosomes are now X instead of 7 out of 8)*. Ask how would the proportion of Y chromosomes in their gene pool compare to the first family? *It would be higher (3 of the 8 chromosomes are now Y instead of 1 out of 8).*

Summarize by pointing out that he proportion of alleles in the gene pool of one family might be very different than the proportion of alleles in another family and the same is true for different populations. For example, one population may have more dominant alleles in their gene pool than recessive, while another population might have only recessive alleles for a given trait in their gene pool.

Tell student that they will study how gene pools change over time by working with a model of a fish. In this model they will keep track of alleles for only 5 genes, and use only 5 pairs of chromosomes in the simulated body cells of these creatures to keep track of what alleles are in the gene pool of the population. Remind

students that even though they are only keeping track of 5 pairs of chromosomes in the model, many species of organisms in the real world have many more pairs of chromosomes.

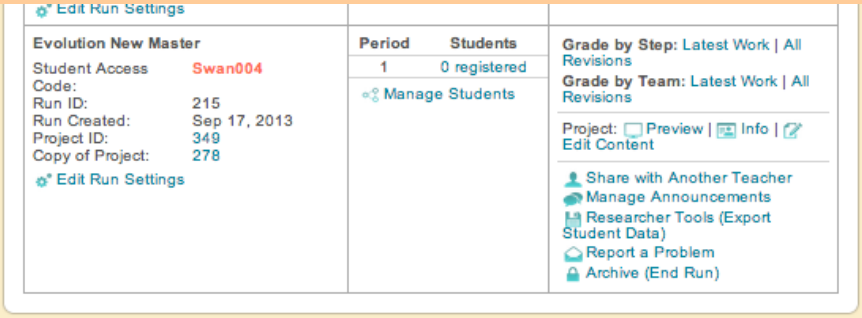
- **Have students complete step 5.2 now**

Next, demonstrate how this model works using the Screencast of the model.

Demonstrating the model via. Screencast

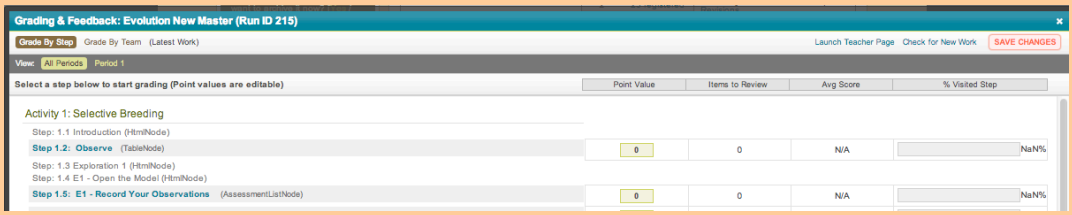
Model Demonstration Directions For the Teacher

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

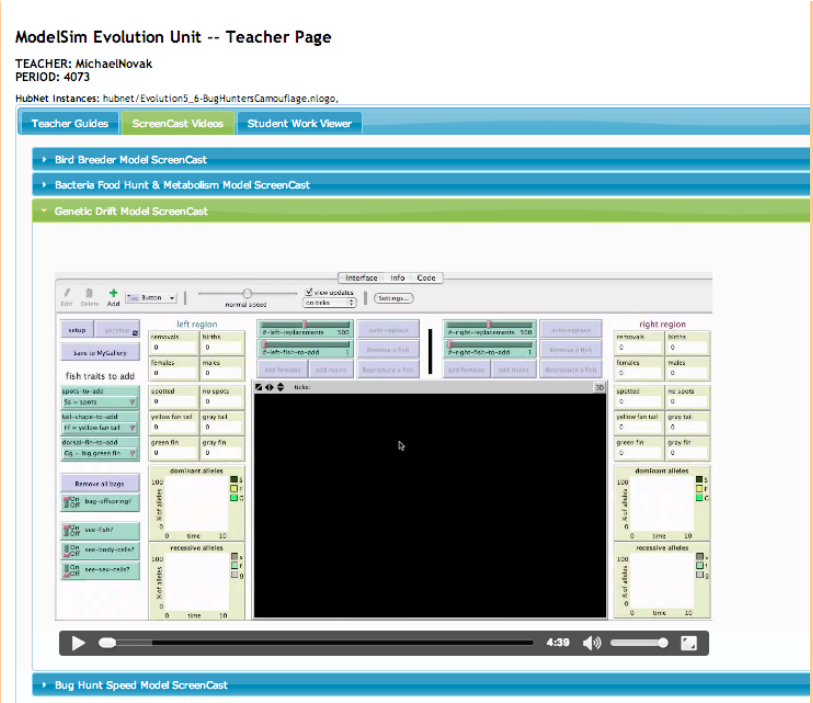


2. Look for the Grading & Tools Column to the right. Under that look for the Grade by Step heading and click on the Latest Work link.

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 Fish Tank Genetic Drift Link.



5. **Make sure students are on step 5.3** 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.

7. **Have students complete step 5.3 and 5.4 at the end of the Screencast.**

Explore:

- **Have students test their predictions in step 5.5 to 5.7 and have them plan their own investigation/experiment to conduct with a partner in steps 5.8 through 5.11**

Summarize:

Allow 20 minutes to have student volunteers from the partnership present their results in a short 2-3 min. summary from the class gallery (step 5.12), showing their results and explaining why they got the outcomes they did in the different regions. A

Ask audience members to volunteer these sorts of responses:

- Questions that would help clarify your understanding of the argument being.
- Similarities or differences between the evidence presented by different people.
- Insights into discoveries the class is making about the lesson question, "How do meiosis, reproduction and random death change gene pools?"

- **These comments can be posted on step 5.12 (optional) . But also having students share these verbally can help strengthen the discussion dynamics in a class**.
- **After volunteers have presented, have students bring a post it note or index card up to summarize a big idea discovered after they record it in step 5.13.**

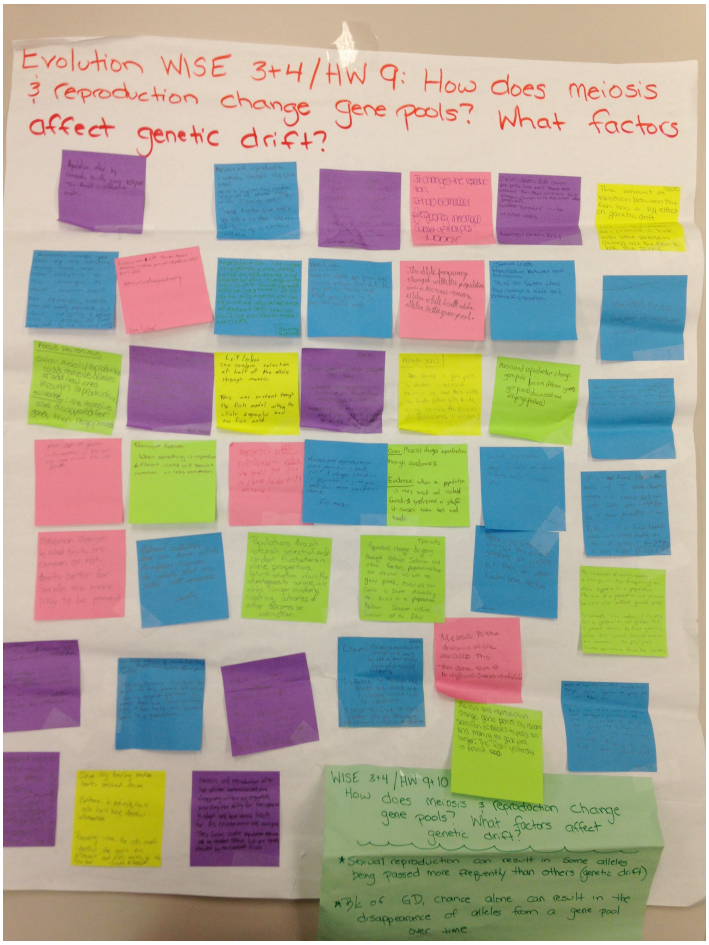
Have students bring the papers/post-its to a board so that it is displayed for the class to look at together.

At this point, you may need to post-pone the consensus building discussion until the following day

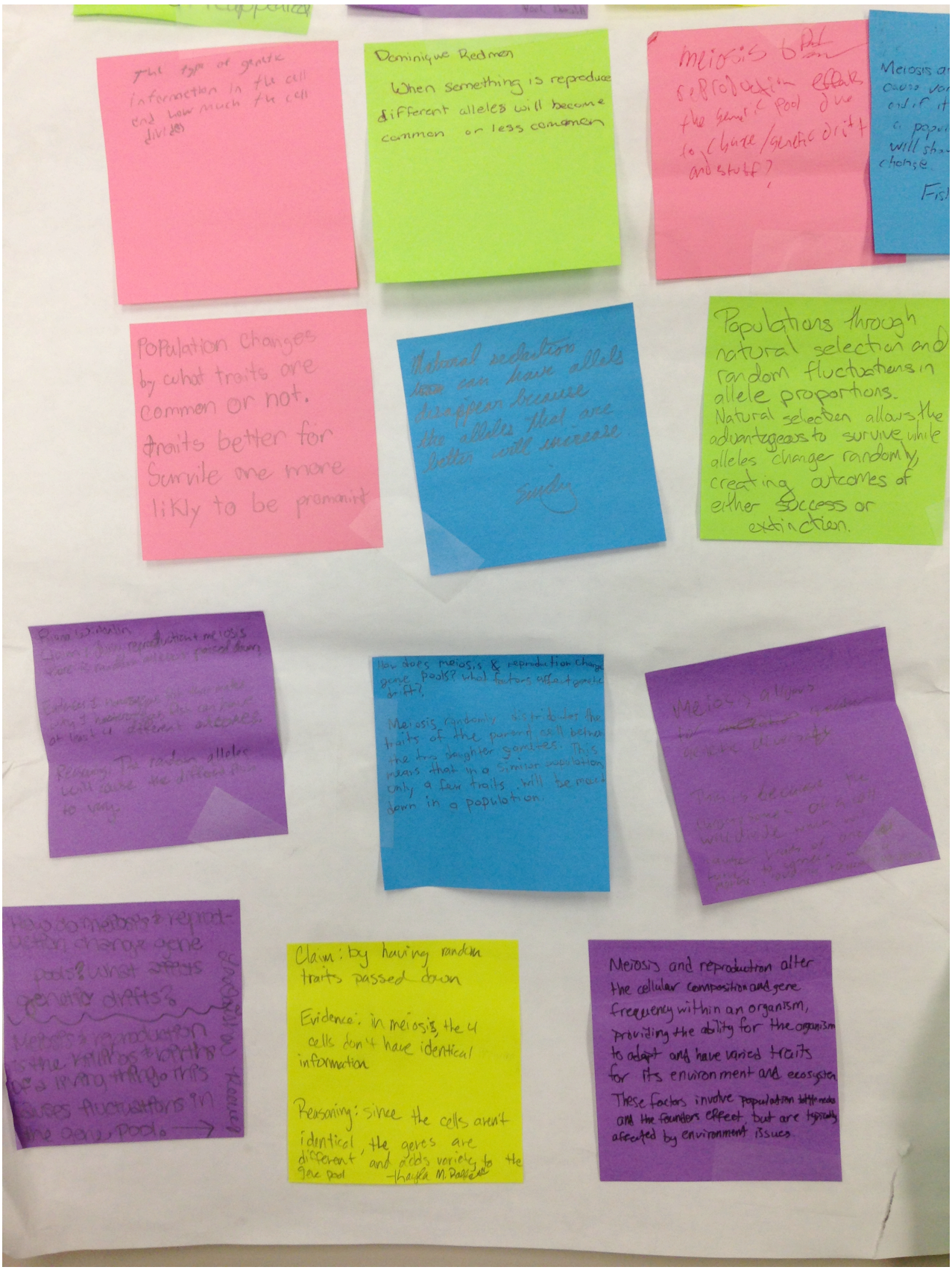
Summarize continued:

Lead a consensus building discussion around that board. 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, OH):




HW 9: How does meiosis
gene pools? What factors
?
It changes the reproduction.
It has a smaller frequency in a small subset of the population!
-Ivanor
Claim: Genetic Drift changes gene pools. Some traits become more prevalent than others while some traits disappear. Changes to the ecosystem affect genetic drift.
Evidence: Yesterday in class we tested models
Reasoning: Genetic Drift
The amount of variation between the fish has a big effect on genetic drift.
Joshua Watts
Reproduction between small populations.
So of the factors where how common a allele and bottleneck population.
The allele frequency changed with the population since a decrease removes alleles while diversity adds alleles to the gene pool.
Meiosis and reproduction change gene pools because different genes get passed down each time offsprings produced
Claim: Meiosis changes reproduction through randomness
Evidence: when a population is very small and isolated founders syndrome n stuff it causes extra toes and hands
If a Female Cheetah mates w/ 3 male cheetahs there is a chance that the cubs will been susceptible to a new pathogen is low.
Rather if a Female Cheetah mates with 1 male cheetah the chance of getting a new pathogen


the type of genetic information in the cell and how much the cell divides
Dominique Redmon
When something is reproduce different alleles will become common or less comonon
meiosis & reproduction effects the genetic pool due to change/genetic drift and stuff?
Population changes by what traits are common or not. traits better for survite are more likly to be promanint
Natural selection can have alleles disappear because the alleles that are better will increase
Populations through natural selection and random fluctuations in allele proportions. Natural selection allows the advantageous to survive while alleles change randomly, creating outcomes of either success or extinction.
How does meiosis & reproduction change gene pools? what factors affect genetic drift?
Meiosis randomly distributes the traits of the parent cell betwe the two daughter gametes. This means that in a similar population only a few traits will be passed down in a population.
Claim: by having random traits passed down
Evidence: in meiosis, the 4 cells don't have identical information
Reasoning: since the cells aren't identical, the genes are different and adds variety to the gene pool
Meiosis and reproduction alter the cellular composition and gene frequency within an organism, providing the ability for the organism to adapt and have varied traits for its environment and ecosystem. These factors involve population bottlenecks and the founders effect but are typically affected by environment issues.

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?

Randomness in sexual reproduction

- *Example student idea: Which egg / sperm fertilize each other is kind of random*
- *Example student idea: Which allele ends up in a sex cell is random*
- *Example student idea: Recessive alleles can be hidden and then reappear as a trait in future generations.*
- ***Summarize with this idea:*** **There is a 50/50 chance which allele from a parent ends up in a gamete and which gametes get fertilized can also be kind of random.**

Randomness related to deaths

- *Example student idea: When individuals die, their alleles disappear from the gene pool.*
- *Example student idea: Who dies aren't always due to natural selection, sometimes it's just due to poor luck (being at the wrong place at the wrong time).*
- ***Summarize with this idea:*** **Some alleles become more or less common in the gene pool from these random events (genetic drift). Some alleles or genes can disappear completely from the gene pool because of genetic drift.**

Factors that affect the outcomes of genetic drift
(these are optional big ideas, depending on the findings of the students experiments)

Population size affects genetic drift

- *Example student idea: The larger the population size the longer it takes to lose a type of allele from the gene pool.*
- *Example student idea: The odds of losing an allele goes up the smaller the population is.*
- ***Summarize with this idea: Genetic drift typically causes smaller populations lose diversity from their gene pool more quickly than larger populations.***

Post these two principles (**bold** is newly added):

- Some shifts in the distribution of traits in a population are the results of random selection events (such as meiosis and which gametes are fertilized).
- Alleles/genes can disappear from gene pools from random events; this also can lead to a population dominated by organisms that are different from other related populations,

Once these ideas in the bold have been agreed upon by the class make sure they have been added to the pink section of your driving question board. 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:

Homework Assigned:

Pass out Reading 5.1 – Random Selection Events . Reading 5.2 – Population Bottlenecks and Founder effects is an optional reading. It deals with topics beyond the assessment boundaries of NGSS, but potentially useful for explaining the next case study. 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/Evolution3_6-BugHuntenCamouflage.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