Lesson 7: How Do Adaptations Emerge in Populations? – Experimentation

Overview:

Purpose:
The purpose of this activity is to discover how the combination of mutations, natural selection, and environmental change generate progressively better-suited adaptations.

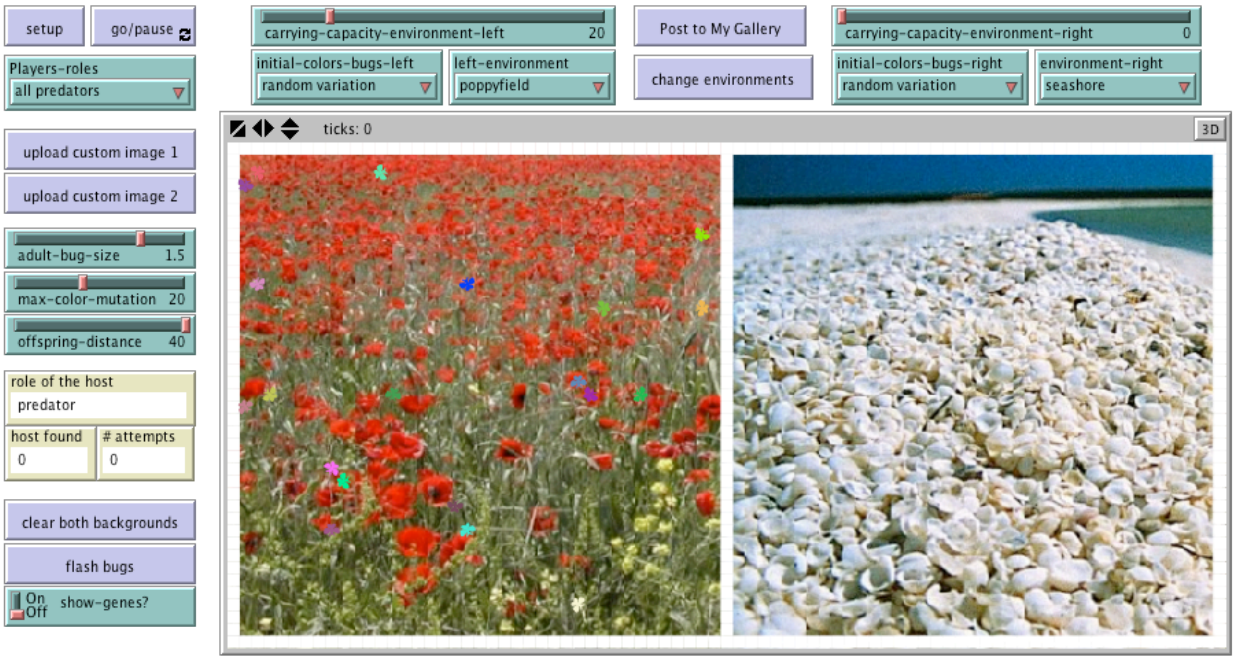
Prerequisite Knowledge:
Students need to have completed the previous activity, which orients them to the model they use for these experiments.

Students have the option to use photographs they have taken with the cameras on their cells phones from the environment in this experiment. This is not required, but if student's want to use these photos, they need to have access to a web based mail account and they should have already send the photos as attachments to an email to themselves. They will save these photos to their computer desktop in today's activities.

Learning Performances
- Design and conduct an experiment using a team-based participatory simulation to investigate how natural selection and mutation work together to generate populations that become progressively better adapted for survival and/or reproduction over time in different environments.

Scientific Principles Discovered In This Activity:
- A new trait might grant individual(s) a competitive advantage for survival and/or reproduction in an environment (an adaptation), or a competitive disadvantage, or neither.
- Advantageous traits tend to accumulate in populations over many generations yielding a population progressively better adapted to survive and reproduce in that environment over time

Description of the Lesson
Students design an experiment in natural selection, using digital images they captured of the natural world (from the homework the previous night) as "background data" to include in the experiment. In the experiment they choose which images (environment(s)) to use as a background. They choose whether the players on their team will be all mates, all predators, or a combination of both for a population of bugs. And they choose the initial variation in the colors of the bugs they will start with in each population.



Bug Hunters Camouflage Model

It's likely that different groups will design different experiments. Group will present their results to the rest of the class. These results will motivate the revision/development of some of the scientific principles listed above.

In the homework, students will read about examples of sexual selection (for mates). And they will compare examples of traits for attention seeking behavior/traits that is displayed only for a limited time (e.g. during a mating season, or only when other mates are detected nearby) or in only one of the two sexes.

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.
- One individual copy of Reading 7.1 – Adaptation and Survival

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

- Students open web mail and save background images to desktop (5 min.)
- Students log into WISE and complete steps 7.1 through 7.2 (5 min.)
- Teacher and students read through directions on step 7.3 together (3 min)

Explore – Experimental Design

- Students work in team on step complete step 7.4 (2 min).
- Students individually advise on one another's experimental designs in step 7.5 (3-5 min)
- Student teams complete steps 7.6 through 7.8 (13 min).

Present & Summarize

- Students present evidence from Gallery (15-18 min.)
- Class Consensus Building Discussion (10 min.)

Homework Assigned:

- Assign tonight's homework (2 min.)

Lesson Enactment Details

Launch:

- Remind students that they will be designing their own experiment today in adaptation. Have Students open their web mail and save background images they sent themselves to the desktop of the one member of the group who will be the group leader.

- **Have students log into WISE and complete steps 6.1 through 6.2**

- **Read through step 6.3 together as a class.**

Explore:

- **Have students work in team on a single computer (the teacher leader's) on step 7.4**
- After this, students need to return to the individual computers for the next steps.
- **Have students individually advise on one another's experimental designs in step 7.5 and then connect to their team leaders computer following step 7.6. Students should complete steps 7.7 through 7.8 at the end of their experiment.**
- **Students can also use step 7.10 to upload any images you saved to the Experiment Gallery.**

Summarize:

Post these questions on the board, asking students to talk with their group to determine if their model run provides evidence to help answer these questions. Which of these other questions can your experimental results help answer?

- Can adaptation occur even when a population starts with no initial trait variation?
- Is the outcome of adaptation in the same environment identical every time?
- Does selection for mates lead to the same kind of adaptations as selection by predators?

After a minute of conferring with their group, ask for volunteers to present their model and an explanation of which question their results help provide evidence for answering and why.

Have students volunteers use step 7.9 to present their results from the gallery on the computer with the projector.

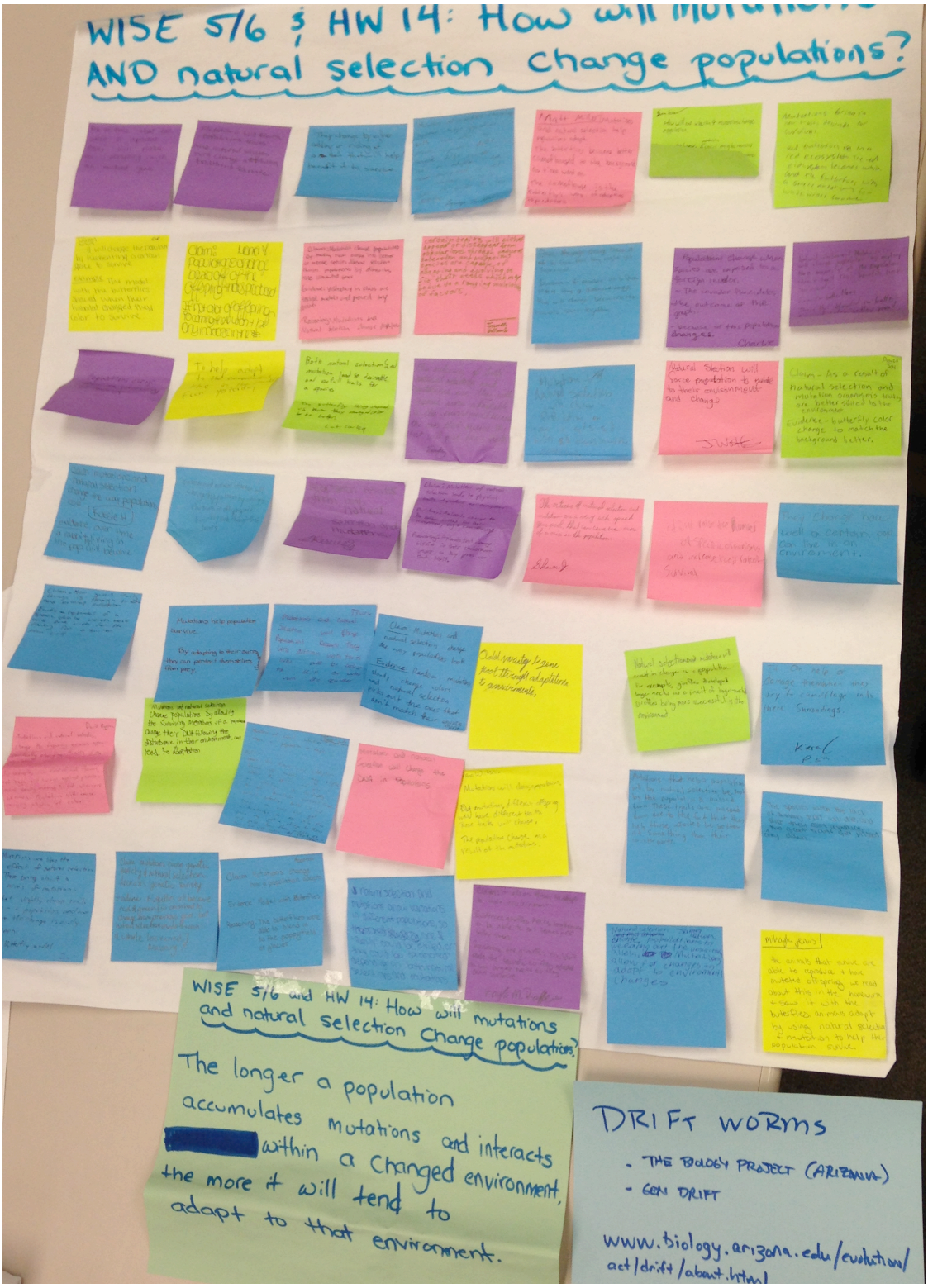
Ask audience members to volunteer these sort of responses:

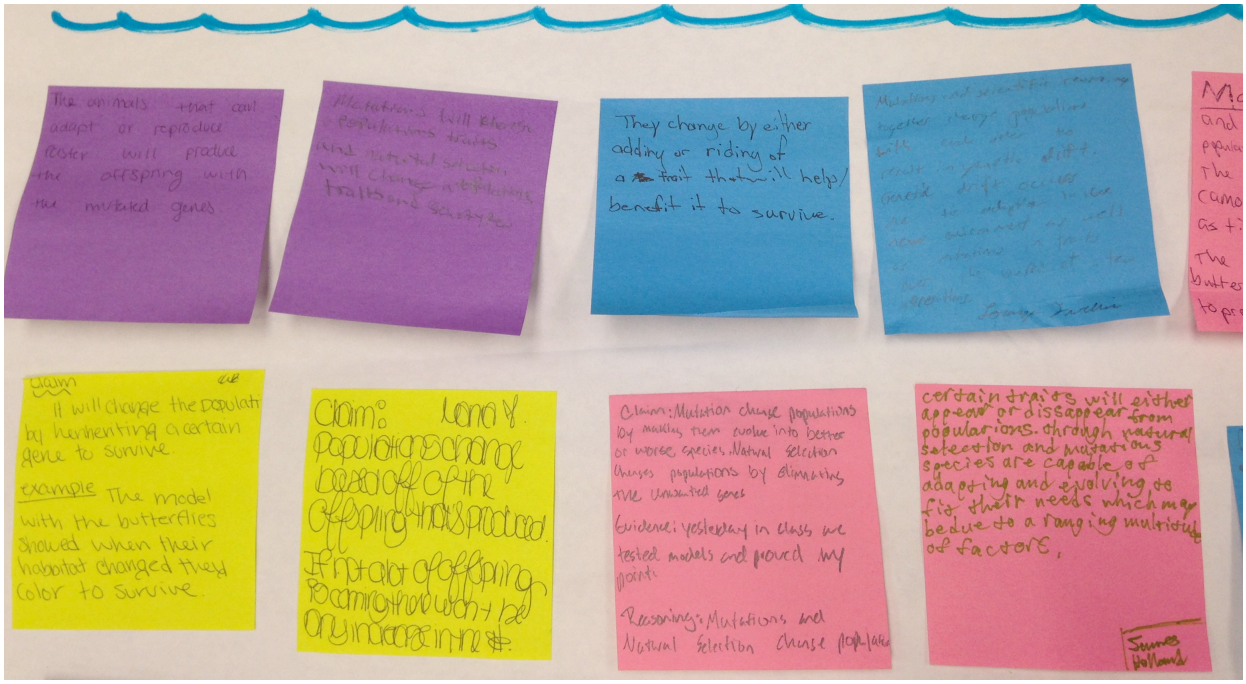
- Questions that would help clarify your understanding of the argument being.
- Similarities or differences between the evidence presented by different people.
- Insights into discoveries the class is making about the lesson question, "How do adaptations emerge in populations?"

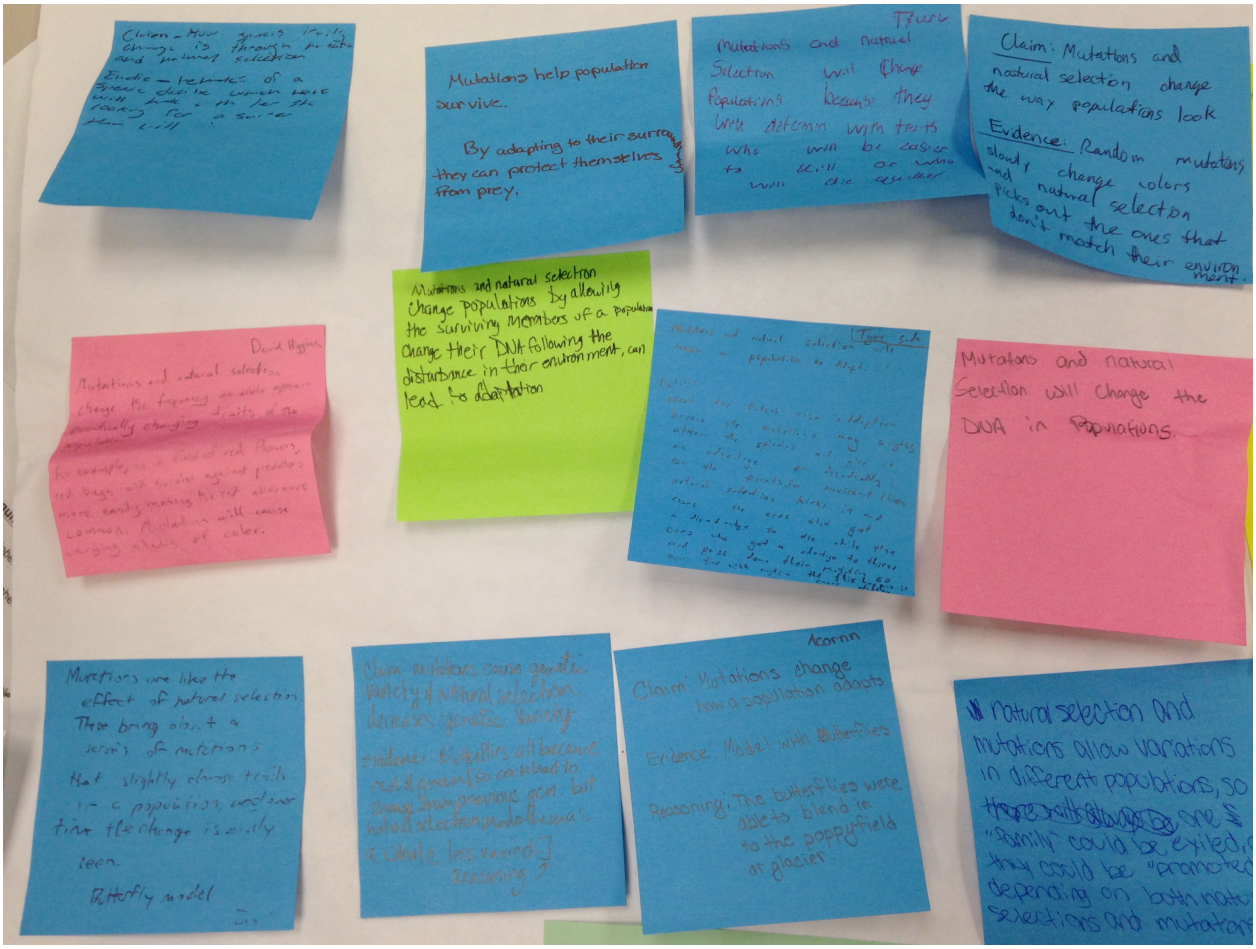
These comments can be posted on step 7.9 or 7.10 (optional) . But also having students share these verbally can help strengthen the discussion dynamics in a class.

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 7.11

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):




The animals that can adapt or reproduce faster will produce the offspring with the mutated genes.
They change by either adding or riding of a trait that will help/ benefit it to survive.
Claim
It will change the populati by hermenting a certain gene to survive.
example The model with the butterflies showed when their habitat changed they color to survive.
Claim: Long Y. Populations change based off of the offspring that is produced. If not alot of offspring is coming out with it it only increase in the #.
Claim: Mutation cause populations by making them evolve into better or worse species. Natural selection changes populations by eliminating the unwanted genes
Evidence: yesterday in class we tested models and proved my point.
Reasoning: Mutations and Natural Selection cause populati
certain traits will either appear or dissappear from populations. through natural selection and mutations species are capable of adapting and evolving to fit their needs which may be due to a ranging multitude of factors.
James Holland


Mutations help population survive.
By adapting to their surroundings they can protect themselves from prey.
Mutations and natural Selection will change Populations because they will determine with traits who will be easier to kill or who will die easier
Claim: Mutations and natural selection change the way populations look
Evidence: Random mutations slowly change colors and natural selection picks out the ones that don't match their environment.
Mutations and natural selection change populations by allowing the surviving members of a population change their DNA following the disturbance in their environment, can lead to adaptation
David Higgins
Mutations and natural selection change the frequency in which appear individually changing traits of the population
Mutations and natural Selection will change the DNA in Populations.
Mutations are like the effect of natural selection These bring about a series of mutations that slightly change traits in a population, and over time the change is easily seen.
Butterfly model
Claim: mutations cause genetic variety & Natural selection decreases genetic variety.
Evidence: Butterflies all became red & green & so each had to change from previous gen. but natural selection made them a stable, less varied
Reasoning
Acornn
Claim: Mutations change how a population adapts
Evidence: Model with butterflies
Reasoning: The butterflies were able to blend in to the poppyfield or glacier.
natural selection and mutations allow variations in different populations, so some "family" could be exiled, or they could be "promoted" depending on both natural selections and mutations

Examples of possible student responses they might contribute are shown in italics below. 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.

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 Do Adaptations Emerge in Populations?"

Groups that started with all gray bugs or black / white bugs

- *Example result: a color similar to part of the background became common in population when predators hunted them.*
- *Example result: a color dissimilar to part of the background became common in population when mates hunted them.*
- ***Summarize with these idea:*** **Adaptations can emerge even when a population starts with no initial trait variation or diversity in its gene pool.**

Groups that tested the same environment side by side.

- *Example result: though camouflaging emerges in environments where only predators are selecting and garish colors emerge in environments where only mates are selecting, the specific hue, saturation, brightness, etc.… are different in each environment, in spite of the same background.*
- ***Summarize with this idea:*** **Adaptations are not wholly predictable (even in the same environment and starting with the same initial population), but over time they tend to make the next generation progressively better "fit" for their environment.**

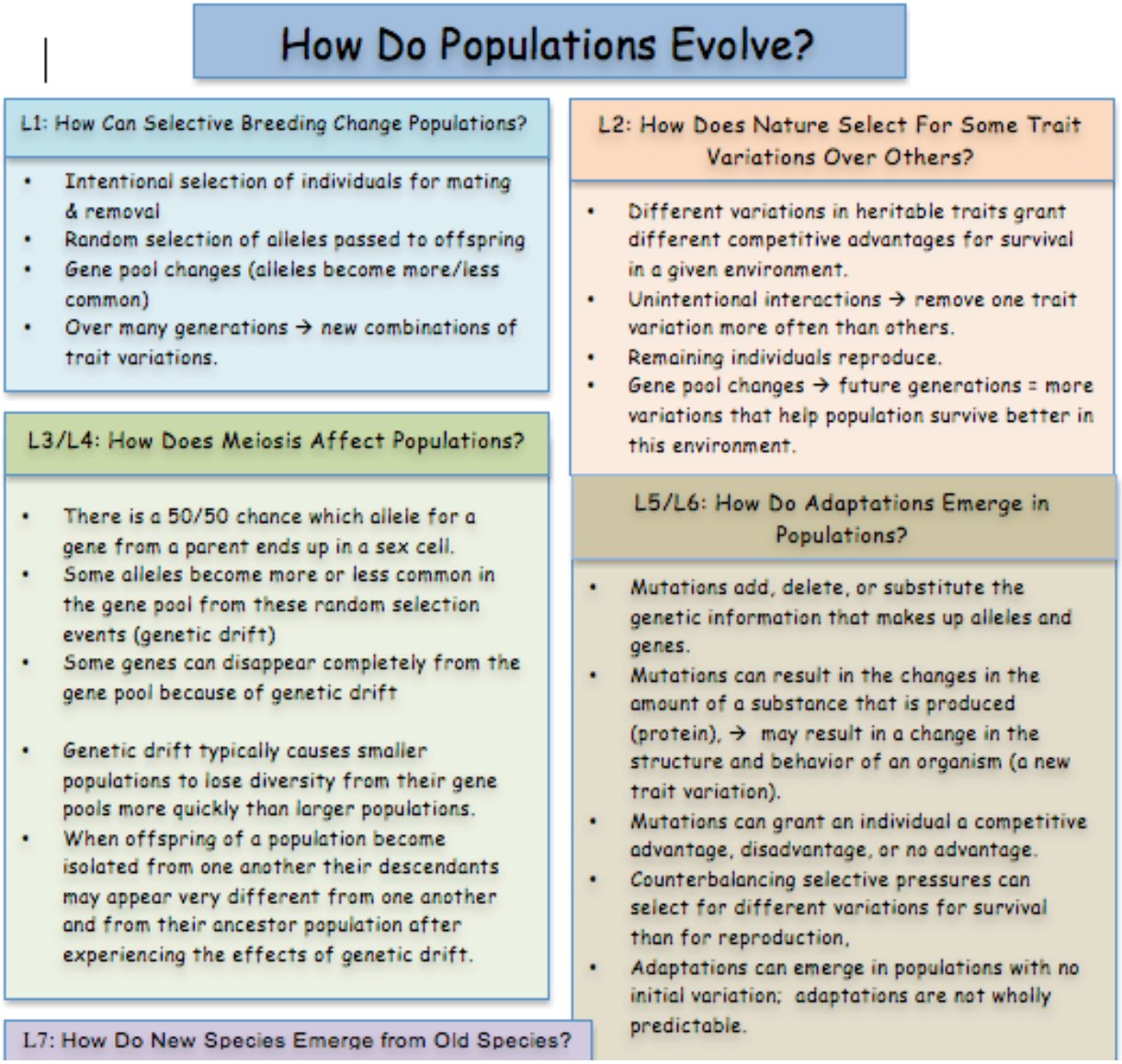
Groups that tested mates vs. predators

- Example result: mates only in one environment tend to drive the emergence of garish colors (so that mates attract attention and stick out).
- Example result: Predators only in one environment result in color that blend into the background (so that bugs are hard to find).
- Example result: When both mates and predators interact within the same environment, they may counterbalance each other's selective pressure, causing adaptations that are midway between garish colors & colors that blend in.
- ***Summarize with this idea:*** ***Selection for mating leads to different adaptations then selection for predation.***

Post these two principles (**bold** is newly added to the prior principles from the last lesson):

- A new trait might grant individual(s) a competitive advantage for survival **and/or reproduction** in an environment (an adaptation), or a competitive disadvantage, or neither.
- Advantageous traits tend to accumulate in populations over many generations yielding a population progressively better adapted to survive **and reproduce** in that environment over time.

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: Assign the homework for this lesson (Reading 7.1 – Adaptation for Sexual Selection). 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