Engineering Extension
Genetics Grade 7

How to Use this Supplement

This supplement to the CIBL Genetics science kit provides an opportunity to integrate engineering. You might want to consider when you would like to use this extension before you begin the unit, but it works naturally after teaching the activity titled "Alien Bugs." The Center for Inquiry-Based Learning provides this supplement with the Genetics kit. All activities use materials either already in the kit or readily available at your school.

Student handouts are at the back of the lesson in the Black Line Master (BLM) section.

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Read Carefully Before Using This Supplement

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Design a Colony

Activity Description & Estimated Class Time

This engineering extension takes approximately four class periods and uses bugs that students created in the Alien Bugs activity. Students are challenged to design a plan to ensure that their bug and a mate can produce offspring that will survive and reproduce on a new planet. In Part 1, students receive information about conditions on the new planets and choose the best planet for their bug, even though no bug and planet are a perfect match. They also design an ideal genotype for their bug's mate so that the offspring will have a good chance to survive. In part 2, students learn that they will not be able to take their "designer mate" to the new planet. Instead, they must carefully choose a mate from other bugs that are also going to that planet. Again, their goal is to produce offspring that will survive. Each part takes 2 class periods.

Part 1 Design a Mate

Materials for Small Groups

- BLM 1 Alien Bug Traits
- BLM 2 Alien Bug Crosses
- BLM 3 Planets
- 2 pennies

Materials for Individual Students

- Each student needs to have the bug they created from the Alien Bugs activity. If they did not make one or if they have lost it, they need to make a new one. Directions for making bugs are in the Alien Bugs activity.

Preparation

1. Make one copy each of BLM 1 and BLM 2 per team.
2. Obtain enough pennies for each team to have a coin to flip.
3. Be sure all students have a bug created from the direction in the Alien Bugs activity.

Procedure

1. Explain to the class that the bug they created in "Alien Bugs" will be sent to another planet with hopes of it flourishing and populating the planet. Students' first job is to determine which planet their bug is best suited to live on. Next, they will design a reproductive strategy that ensures future populations will thrive.
2. Hand out BLM 1 *Alien Bug Traits* and have each student record the phenotype of their bug in the appropriate column.
3. Next, ask each student to record their bug's genotype on BLM 1. Determining the genotype for recessive traits and the eyes is simple because there is only

Procedure Continued

one genotype for each trait. When a bug has a dominant trait, the student needs to flip a coin to determine whether the trait is heterozygous or homozygous. Share this information with the class with regard to the coin flips:

Heads = heterozygous **Tails = homozygous**

5. Hand out BLM 3 Planets. Have each student read the sheet and choose the planet where they think their bug is most likely to succeed.

   Notebook prompt: Which planet did you choose? What criteria did you use to choose which planet would be most successful for your bug?

6. Design a Mate Challenge. Tell students that they will send their bug to the planet they selected and provide a mate to accompany their bug for breeding purposes. They will design the genotype of this mate with the goal of producing offspring that can live and reproduce in their planet's environment. Ask students to fill out BLM 1 with the mate they design. Remind them of the following:

   - Be sure to design a mate that you think is most likely to create offspring with your bug that will live and reproduce.
   - These alien bugs usually have about 100 offspring each season. You want as many offspring as possible to have traits that help them survive and reproduce. However, they don't all have to live and reproduce. Any plan that results in a breeding population of viable offspring can succeed.

7. Point out that the environment of each planet requires a bug to have 3 particular traits in order to survive. Ask students to use BLM 2 Alien Bug Crosses to make a Punnett square for each of the traits that they identify as essential for their planet.

8. Ask each student to write a report that predicts the successes of their reproductive plan. The report should include:

   - An overall prediction of the likelihood that the pair will produce viable offspring along with evidence to support this prediction.
   - A list of traits that are *most* likely to be inherited along with evidence supporting the likelihood that each trait will be inherited.
   - A list of ideal modifications to your original alien bug's genotype that might improve success. This should include an explanation of how the modification improves chances of offspring success.

Part 2 Choose a Mate

Materials for Small Groups

- BLM 1 Alien Bug Traits
- BLM 2 Alien Bug Crosses

Materials for Individual Students

- Each student's picture of their bug.

Procedure

1. Explain to the class that, due to cost overruns, the project to populate other planets with the alien bugs has been modified. It will be too expensive to design and create mates, and bring them to the planet. Instead, your team will have to choose a mate from the group of bugs that go to the planet.
2. Ask students to have BLM 1 Alien Bug Traits available, and the picture of their original alien bug. Have them get together in groups based on the planets they chose to send their bugs.
3. Ask students to analyze the potential mates that plan to live on their planet. They will need to circulate and look at BLM 1 for their potential mates.
4. Give each student BLM 2 Alien Crosses to help with their analysis. Students will use BLM 2 to analyze crosses between their bug and potential mates. Ask the class to use BLM 2 to record the classmate's name, the genotypes, and the phenotypes.
5. Ask students to use Punnett squares the same way as before to analyze the proportion of traits in the population of offspring.
6. Ask students to write a report on the viability of their bugs' offspring. Reports should include the following:
   - A prediction of the likelihood that the pair will produce viable offspring with evidence to support the prediction,
   - Traits *most* likely to be inherited with evidence supporting the likelihood of each trait appearing in the population of offspring,
   - Traits *least* likely to be inherited with evidence showing that each trait is less likely to be inherited.

Optional: Students can also be randomly assigned (or randomly select) classmates and planets so that resulting offspring are suited to a planet (or not) only by chance. This provides a basis to evaluate how well students' designed strategies have worked.

Name_____

Date _____

Design a Colony
Alien Bug Traits

Dominant/Recessive

Trait	Symbols	Dominant Phenotype	Recessive Phenotype
Legs	L, l	six legs	four legs
Mouth	M, m	pincer	teeth
Stinger	S, s	multi-stinger	single stinger
Wings	W, w	long	short
Body	B, b	striped	spotted

Incomplete Dominance

Eyes	E^TE^T= TV eyes	E^PE^P= periscope eyes	E^TE^P= big eyes

My Bug

Trait	Phenotype	Genotype
Legs		
Mouth		
Stinger		
Wings		
Body		
Eyes		

Mate

Trait	Phenotype	Genotype
Legs		
Mouth		
Stinger		
Wings		
Body		
Eyes		

Name_____

Date _____

Design a Colony

Alien Bug Crosses

mate genotype_____

my bug genotype	possible sex cells	( )	( )
_____	( )		
	( )		

%	phenotype

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mate genotype_____

my bug genotype	possible sex cells	( )	( )
_____	( )		
	( )		

%	phenotype

---

mate genotype_____

my bug genotype	possible sex cells	( )	( )
_____	( )		
	( )		

%	phenotype

Planet Gargantuan

This planet is very large. Bugs need long wings to fly the long distances there. Life on Gargantuan is abundant, and most prey is small. Bugs there need a pincher mouth to capture these small organisms. Gargantuan also hosts many predators. Long wings help bugs escape the predators, but bugs on Gargantuan also need camouflage to help them hide. Predators there easily see stripes, but can barely see a spotted belly. The Gargantuan sun is extremely bright. Because television eyes cannot reduce the amount of light that they see, the Gargantuan sun quickly blinds bugs with these eyes.

Planet Hornswabble

Hornswabble is a small planet. It has a limited amount of life, and most life there is small, fast moving, and difficult to detect. To find prey there, bugs must have periscope eyes. In order to catch prey on Hornswabble, bugs must be very quick. To have enough speed, bugs need small wings and six legs. Hornswabble's only predators prefer to eat multi-stinger bugs, making multi-stingers a big disadvantage for bugs on Hornswabble.

Planet Vicious

Just as it sounds, Planet Vicious is full of predators. Camouflage is the best way for bugs on Planet Vicious to avoid this abundance of predators. A striped body is hard for Planet Vicious predators to see, making striped bugs much more likely to survive. A multi-stinger also helps bugs defend against predators. Bugs must have teeth to eat the leaves and grass on Planet Vicious. A pincher is a poor tool for eating the leaves and grass that grow there. The peculiar plants on Planet Vicious also tend to get tangled in six legs, making six legs a big disadvantage.