Carolina LabSheets™

Investigating a Lethal Trait

In this lab, students investigate a lethal trait, albinism, using corn seedlings.

Needed Materials

Green:Albino Corn Seed, pack of 100 (177130)
planting trays with covers
potting soil (159705) or similar product
scoop for potting soil
springwater or conditioned tap water
buckets or other containers for mixing potting soil and water
large spatula for mixing soil and water
light bank or greenhouse

Using the Correct Water

Springwater is ideal for keeping the potting soil moist, and is available from Carolina Biological Supply Company. Unlike tap water, springwater contains no harmful chemicals that might kill the seedlings, and it contains trace minerals that cannot be found in distilled water. If you use store-bought springwater, make certain that it is completely free of chemical additives. If you use tap water, you must condition it first. Many municipalities add chlorine or chloramines to kill bacteria in drinking water. Unfortunately, these disinfectants can harm the seedlings. To remove the chemicals, use a tap water conditioner available from Carolina Biological Supply or from a local pet store.

Optional Materials

Item 177050, the Carolina BioKits®: Albino Corn kit, includes 5 packs of the seed used with this LabSheet, and these two activities can be done together. The 177050 kit comes with planting trays and potting soil.

Safety

Ensure that students understand and adhere to safe laboratory practices when performing any activity in the classroom or lab. Demonstrate the protocol for correctly using the instruments and materials necessary to complete the activities, and emphasize the importance of proper usage. Use personal protective equipment such as safety glasses or goggles, gloves, and aprons when appropriate. Model proper laboratory safety practices for your students and require them to adhere to all laboratory safety rules.

Procedures

Monitor students as they plant the seeds. Thirty to 40 seeds can be planted in a tray with a surface area of 15 cm × 15 cm (6" × 6"). It is best to use a deep tray that will hold a layer of potting soil at least 6 cm (2 ½") deep; this allows for uninhibited growth of the roots. Deeper is better. A clear plastic cover or plastic bag will prevent the potting soil from drying out during germination. After the seedlings reach a height of about 4 cm (1 ½"), the cover can be removed. However, be sure to check soil moisture levels at least daily. If the soil dries out, all of the seedlings may die, ruining the investigation.

Most bagged potting soils will be dry. Put dry potting soil into a bucket or other large container, and stir in some water. If the potting soil becomes muck, you have added too much water; add more dry potting soil. Pinch a sample between your thumb and index finger. The potting soil should remain in a cohesive clump when you release the pressure, but no water should drip.

To grow properly, the green seedlings need light. If you do not have access to a greenhouse, set up a light bank and test it to be certain it works properly. You can use our Plant Light Bank (158999) or you can make your own light bank using three shop lights. Use fluorescent lights, because incandescent lights emit too much heat and will damage or kill the seedlings. Trays should go under the light bank within 48 hours of planting. The lights can be left on, or use a timer set to a 16 hour light, 8 hour dark cycle.

On the day before the lab, cover the corn seed with approximately 3 times their volume of springwater or conditioned (dechlorinated) tap water. This will hydrate the seeds and initiate germination. Do not allow the seeds to soak for much more than 24 hours; prolonged soaking may cause the seeds to decay.

Counting the day of planting as Day 0, seedlings will come up about 4 days after planting (i.e., Day 4). The initial observation of seedlings can be done between Day 5 and Day 10. Albinos will begin to die around Day 14, and final observations can be done between Day 16 and Day 20, at which time all the albino plants will have died.

Students can work individually or in groups of 2 to 4. For the "Planting" activity, students or groups will need the following materials:

planting trays
moist potting soil
scoop for potting soil
hydrated seeds

The number of seeds needed per group depends on the size of the trays used. We recommend that each group have at least 10 seeds, and more is better, to increase the likelihood that every group has at least one plant with the lethal albino trait.

Students will need access to their trays of seedlings for the initial and final observations.

Optional

Data from the initial observation of the seedlings can be totaled for the class, and the results analyzed as an F_2 with a 3:1 ratio of normal green to albino. Students can research and report on lethal traits having a different pattern of inheritance. For example, the first lethal trait to be analyzed genetically (Lucien Cuenot 1905) involved a 2:1 ratio in the F_2. Students also can research and report on the lethal traits of humans and/or other organisms.

Exhaustion of starch reserves in the seed causes the death of the albino seedlings. You can demonstrate this fact by using a razor to carefully trim the seed remnant from an albino seedling and from a normal seedling. Although the normal seedling may be stunted, it will continue to grow; the albino, conversely, will die in 4 or 5 days. The starch from the seed that is being metabolized can be studied by cutting open a soaked seed and scraping some of the endosperm into a drop of water on a microscope slide. The amyloplasts (starch bodies) will be visible as irregular spheres. Repeat this at 4-day intervals to see the gradual breakdown of the amyloplasts.

Several investigative projects are possible. For example, plants bend toward light (positive phototropism) and normally etiolate (elongate) when grown under decreased light. Do albino plants show the same responses? If all the plants are grown without light, will there be any difference in their phenotypes?

Answer Key to Questions Asked on the Student LabSheet

Initial Observation of Seedlings

1. Observe the germinated seedlings. What two phenotypes do you observe?

   Normal green and **White (albino)**
   Note: Some students may note that the albino plants are much shorter than the green plants. They may relate this to the fact that the green plants have two food sources—starch in the seed and glucose from photosynthesis—while the albino plants have only starch in the seed.

2. Count the number of seedlings of each phenotype and the total number of seedlings, and record the results here:

   Sample data. Actual counts will vary.
   Normal green. 85
   Albino. 37
   Total 122

3. What do you think will happen to the seedlings over the next several days of growth? Explain your thinking.

   The green seedlings will develop normally. The albino seedlings will die after they use up the food energy stored in the seed. They lack chlorophyll and therefore cannot make their own food by photosynthesis.

Final Observation of Seedlings

1. Count the number of seedlings of each phenotype and the total number of seedlings, and record the results here:

   Sample data. Actual counts will vary.
   Normal green. 85
   Albino. 0
   Total 85

2. Do these results meet your expectations for what would happen to the seedlings?

   Yes, the albino seedlings all died, and the green seedlings developed normally.

3. What is a lethal trait? How do your results illustrate lethality?

   A lethal trait is an inherited characteristic that results in the early death of the organism that possesses it. Albinism is a lethal trait of corn because all the albino plants lack chlorophyll and cannot make their own food by photosynthesis. Therefore, they die as seedlings after their food supply in the seed is exhausted.

4. Under cultivation, the lethal allele for albino has been maintained in a population of corn for decades. How is this possible?

   The lethal albino allele is recessive to the allele for normal green. Heterozygous plants can carry the albino allele but have normal green pigmentation. If two heterozygous plants are crossed, about one-fourth of their offspring (seed) will be homozygous for the albino trait.

   Instructor Note: This is how we maintain the allele. We plant 177130 Green:Albino seed in rows. The albino seedlings die and the plants that reach maturity are self-pollinated. Heterozygous plants produce ears that have albino seeds. Albino seeds have no pigment and have a pearly luster. These ears are saved.

5. Suppose the seedlings were part of a wild (i.e., uncultivated) population. What would you expect to happen to the lethal allele over several generations of plants? Explain your thinking.

   Students' answers will reflect their knowledge of population genetics, and especially the Hardy-Weinberg laws. Some might think that the albino allele will be lost. Others might argue, more correctly, that if the population is large enough, the frequency of the allele will drop for a few generations until it reaches Hardy-Weinberg equilibrium. It is even possible to argue that if the heterozygous condition has an advantage over homozygous normal green, the frequency of the allele could remain constant or even increase. See our Population Genetics BioKit® (177080) for an exploration of this topic using corn.

NAME _____

DATE _____

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In this activity, you will study two contrasting phenotypes, one lethal, through an observation of corn seedlings.

Planting

Fill a planting tray with moist potting soil to a depth of at least 4 cm (1 ½"). Deeper is better. Place your corn seeds on the surface of the potting soil about 2 cm (¾") apart, in rows also spaced about 2 cm apart. Cover the seeds with a 1.5 to 2 cm (⅝ to ¾") layer of moist potting soil. Mark your tray with your group number and the current date. Put a plastic cover on your tray and leave the tray in the place indicated by your teacher.

Initial Observation of Seedlings

1. Observe the germinated seedlings. What two phenotypes do you observe?

   _____ and _____

2. Count the number of seedlings of each phenotype and the total number of seedlings, and record the results here:

   _____

   _____

   Total:_____

3. What do you think will happen to the seedlings over the next several days of growth? Explain your thinking.

   _____

   _____

   _____

   _____

Final Observation of Seedlings

1. Count the number of seedlings of each phenotype and the total number of seedlings, and record the results here:

   _____

   _____

   Total:_____

2. Do these results meet your expectations for what would happen to the seedlings?

3. What is a lethal trait? How do your results illustrate lethality?

4. Under cultivation, the lethal allele for albino has been maintained in a population of corn for decades. How is this possible?

5. Suppose the seedlings were part of a wild (i.e., uncultivated) population. What would you expect to happen to the lethal allele over several generations of plants? Explain your thinking.

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