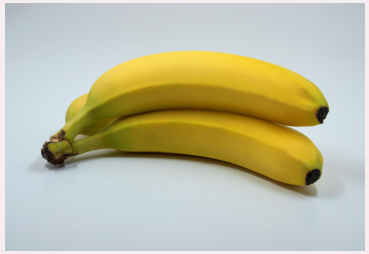
LESSON 11: Do asexual organisms have genetic material if they don't have sperm and eggs?

PREVIOUS LESSON *In the previous lesson, we read about ways farmers breed animals for specific traits, and we ran a computer simulation to try our hand at selective breeding. We figured out that by breeding animals with beneficial traits more often, we could increase the frequency they are seen in the population.*

THIS LESSON

INVESTIGATION

1 day



We question whether asexual organisms have genetic material if they don't have sex cells. Then we plan an investigation to break open cells and test if asexual organisms (bananas) have genetic information. We carry out our investigations and discuss the results as a class.

NEXT LESSON *We will do research about an organism that uses asexual reproduction, and share what we learn. We will discuss how the genetic information of offspring from asexual reprodcution compares to that of the parent. We will observe and bisect live planaria to see if they will, in fact, be identical after they've regenerated.*

BUILDING TOWARD NGSS

MS-LS1-5, MS-LS3-1, MS-LS3-2, MS-LS4-5

WHAT STUDENTS WILL DO

Plan and carry out an investigation to produce data to serve as the basis for evidence that asexual organisms have genetic information inside their cells that can be visualized (scale) even though they are not produced from sperm and eggs.

WHAT STUDENTS WILL FIGURE OUT

- There is genetic information inside asexual organisms even though they dont have sperm and eggs.
- Genetic information is a physical structure. We can use tools to see it with our eyes.
- The genetic information seems really long because there are thousands of genes.

Lesson 11 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	2 min	**NAVIGATION** Recall what we figured out from the prior lesson and navigate to today's work.	A	
2	5 min	**BRAINSTORM IDEAS FOR HOW TO GET AT THE GENETIC INFORMATION** Have students work with a partner to come up with initial ideas for how to get chromosomes out from inside the nuclei of cells.	B-C	board space to draw
3	10 min	**EXAMINE PROTOCOL TO EXTRACT CHROMOSOMES** Students watch a video of how a scientist extracts genetic information from humans, then review and discuss the protocol they will use to extract DNA from bananas and strawberries.	D-E	projector and speakers to show videos from https://www.teachersopensciedfieldtest.org/muscles
4	18 min	**CARRY OUT EXPERIMENT TO EXTRACT GENETIC INFORMATION FROM PLANTS** Students prepare for and carry out the Extracting Genetic Information Lab in small groups.	F-G	Extracting Genetic Information Lab
5	8 min	**CLASS DISCUSSION AND PROGRESS TRACKER UPDATE** Record what students figured out from the lab investigation.	H-J	
6	2 min	**DISCUSS NEXT STEPS** As a class discuss next steps that the group should take.	K	

End of day 1

Lesson 11 • Materials List

	per student	per group	per class
Extracting Genetic Information Lab materials	• safety goggles • science notebook	• 1 QT heavy duty ziplock bag • 1 piece of cheesecloth 4"x4" • 20 mL of 91-100% isopropyl alcohol • 1 plastic 100mL beaker • 1 wooden skewer • 20 mL of warm water in a coffee cup • 1 TBS salt • 1 TBS dish soap • 1 rubber band • spoon • either ½ a banana or three strawberries	
Lesson materials	• science notebook		• board space to draw • projector and speakers to show videos from https://www.teachersopensciedfieldtest.org/muscles

Materials preparation (40 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Set aside some space on your board to make a class data table.

Test the videos:
- a scientist shares how to extract genetic information found at https://www.teachersopensciedfieldtest.org/muscles
- (optional) banana growth and harvesting found at https://www.teachersopensciedfieldtest.org/muscles

Day 1: Extracting Genetic Information Lab

- **Group size:** 3 or 4 students
- **Setup:**
  - Watch the three teacher preparation videos on the field test website.
  - Each group of students should extract DNA from either strawberries or a banana.
  - Precut bananas in half.
  - Heat up 200mL of water in a tea kettle - should be warm but not close to boiling so it does not melt the plastic bag.
- Prepare the following materials for each student group:
  - 1 QT heavy duty ziplock bag
  - 1 piece of cheesecloth 4"x4"
  - 20 mL of 91-100% isopropyl alcohol
  - 1 plastic 100mL beaker
  - 1 wooden skewer

    - 20 mL of warm water in a coffee cup
    - 1 TBS salt
    - 1 TBS dish soap
    - 1 rubber band
    - spoon
    - either ½ a banana or three strawberries

- **Notes for during the lab:**
    - Make sure students do not agitate the bags too much after adding the soap. Too many bubbles will make straining the liquid difficult and could lower DNA yield.

- **Safety:** Use proper eyewear in case of splashing of soapy liquid or alcohol.

- **Disposal:** All materials can be disposed of in regular trash receptacles.

- **Storage:** All materials can be stored at room temperature. Place strawberries in the refrigerator if purchased more than 24 hours in advance of the lab to avoid molding.

Lesson 11 • Where We Are Going and NOT Going

Where We Are Going

In this lab we discuss extracting "genetic information" from inside of cells. This is the term used in the middle school grade band according to the Framework for K-12 Science Education. If your students have previously been exposed to the term "DNA" you can help make this connection for your students based on their previous background knowledge.

This lesson helps build on the DCI pieces, "All cells contain genetic information" (p145 Framework for K-12 Science Education), and "Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring." In order to understand that asexual organisims transfer their genetic inforamtion to offspring, students first need to be convinced that they have it in the first place.

This is important because in Lesson 5 our framing for what is passed down from parents to offspring is through the sperm and egg, and inside those are mostly genetic information. So students may reason that if asexual organisms don't have sex cells, then they must not have genetic information either. This is not true, of course. So, in this lesson students gather evidence that genetic information can be seen in both sexual and asexual organisms.

Where We Are NOT Going

In this lesson we are not getting into the complexities of how many organisms can reproduce both sexually and asexually. Strawberries can send runners to start new plants asexually, however they still need to be pollinated to bear fruit. This is not the case with conventional bananas. Wild bananas and bananas of other varieties do make seeds. However, the bananas you find in the grocery store are all made from extensions from the mother banana plant rather than seeds.

This lesson does not go into the issues of having very low genetic diversity in the banana gene pool worldwide. There are serious concerns, and diseases in the past have wiped out varieties because basically all bananas we eat are genetically identical. This line of thinking could be a great extension opportunity if students are interested in pursuing it.

LEARNING PLAN for LESSON 11

1 · NAVIGATION

2 min

MATERIALS: None

Turn and talk to recall the conversation about sexual vs. asexual reproduction from last class. Display **slide A**.

Say, *At the end of last class we were thinking about asexual vs. sexually reproducing plants.*

After students turn and talk, have partners share out ideas with the whole class.

Suggested prompt	Sample student response
What are some differences between asexual and sexually reproducing plants?	*Sexually reproducing plants need pollination where pollen has to get to the ovary/pistil, but asexual plants dont need pollen and pistils to reproduce.* *Asexual organisms don't have sex cells, which in plants are the pollen and ovary/pistils.*
How does a sexually reproducing organism get its genetic material?	*From its parents.*
And what structures pass on that genetic information?	*The sex cells (pollen and ovaries) from the parents come together and give the baby its genetic information.*
Ok, genetic information comes from the sex cells in sexually reproducing organisms. *So if asexual living things don't use sex cells to reproduce, then do you think asexual organisms even have genetic information?*	*I don't know.* *Doesn't every living thing have to have genetic information?* *Don't they just make babies from themselves somehow? Maybe they don't need genes?*
How could we collect evidence to know if asexual organisms have genetic information or not?	*Maybe we can see it some way?* *Could we look it up?* *Is there a way to test for it?*

Summarize the discussion.

Say, *It sounds like we would need to collect some evidence to be sure if asexual organisms even have genetic material. If there was a way to see it somehow or visualize it, that would help answer our question of whether genetic material is inside asexual organisms or not.*

2 · BRAINSTORM IDEAS FOR HOW TO GET AT THE GENETIC INFORMATION

5 min

MATERIALS: board space to draw

Brainstorm ideas for how to get at genetic information in an Initial Ideas discussion. Display **slide B**.

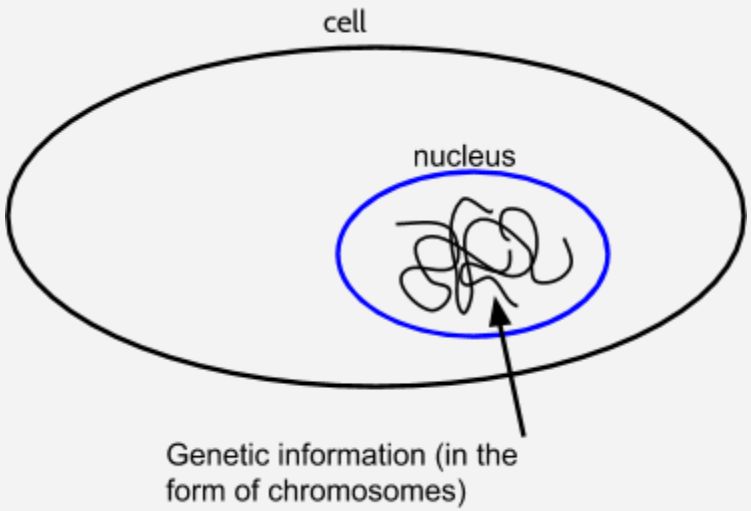
KEY IDEAS

Purpose of this discussion: Students need an opportunity to think through the steps one might take to get at genetic information to see if it's inside a living thing. This is important so that students can make meaning and connections to the steps in the DNA extraction protocol that they will use to see if genetic information is inside asexual organisms too.

Listen for these ideas:

- We would need to break open or get inside cells.
- We would need to break open or get inside the nucleus.
- We would need a way to make the genetic info or chromosomes visible to our eyes because it's really small.

Suggested prompt	Sample student response
We learned where genetic information is kept in living things. Where is genetic information/ chromosomes found inside the cells of organisms that reproduce sexually?	*Genetic information is found inside the nucleus of cells.*



Draw on the board where chromosomes are found inside cells based on what students shared. Have students use the visual you put on the board and turn and talk with a partner about how to get at chromosomes inside of cells. Display **slide C**.

After students share out their ideas to the class, summarize and transition to the next activity.

Say, *So if we wanted to see firsthand evidence of these pieces of genetic information, we would need a way to somehow get inside the cell, break open the nucleus, and then visualize the chromosomes because they are so small.*

3 · EXAMINE PROTOCOL TO EXTRACT CHROMOSOMES

10 min

MATERIALS: projector and speakers to show videos from https://www.teachersopensciedfieldtest.org/muscles

Watch a video of how scientists extract genetic information from humans. Show **slide D**.

Say, *Scientists have figured out a way to get at chromosomes using some of the ideas you described. I have a video for us to look at scientists showing us how they extract genetic information from a sexually reproducing organism - humans. Let's see what the scientist does.*

Play the video of a scientist extracting genetic information found at https://www.teachersopensciedfieldtest.org/muscles Have students turn and talk about the question on the slide. Then have students share their thoughts with the whole group.

Suggested prompt	Sample student response
How could we repurpose the procedure the scientist explained to investigate our question?	*Maybe we could use their procedure to see if genetic information could be inside different living things.* *We could use it to test if there is genetic information inside asexual plants.*

Analyze the substances to extract genetic information from cells. Display **slide E**. Work through the information on the slide together as a class.

Say, *I have a protocol to take out genetic information from inside cells that uses slightly different substances than the video we watched, but the substances do similar things. As you look through the substances with a partner, talk about the following questions: 1. Could we use these same substances in our class? 2. What questions do you have about these substances?*

Transition to discussing control groups needed for experimentation.

Suggested prompt	Sample student response
Who can remind us, what question are we trying to investigate?	*We're trying to figure out if we asexual plants have genetic information in them like sexual plants do.*
So if we try to pull out genetic information from an asexual plants using the solutions we just looked at like salt, soap and alcohol, how will we know that the solutions worked? What do we need to do to control for this?	*We need a control group. Something to compare our asexual samples to.*
What kind of living thing are we sure that does have genetic information?	*Sexually reproducing organisms have sperm and eggs and would have genetic information*

Summarize the discussion for the class.
Say, *So we need to compare our asexual plants to something that reproduces sexually so we know that our methods work. I have two plants that we can use for this experiment: bananas and strawberries. Bananas that we find at the grocery store reproduce asexually. And in order to produce a strawberry fruit, you need pollination where the female parts (pistils) need the male parts (pollen) to make a fruit.*

ADDITIONAL GUIDANCE	Using bananas as an example of asexually reproducing organisms may get a few giggles from students at this age. You might need to prepare your students to have a mature discussion around asexual reproducton. Also, if there are certain students that you think might have a particularly difficult time staying composed during the lab, place those students in a group that is assigned to test strawberries.
ALTERNATE ACTIVITY	Watch the video from https://www.teachersopensciedfieldtest.org/muscles about how bananas are grown and harvested if you think your students need more background knowledge about banana harvesting.

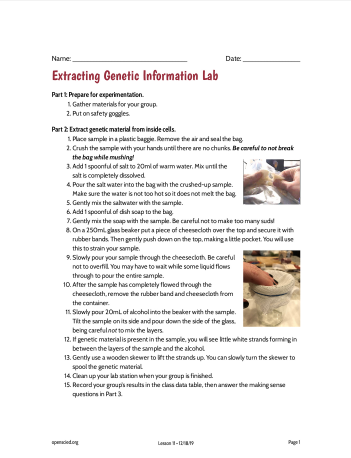
4 · CARRY OUT EXPERIMENT TO EXTRACT GENETIC INFORMATION FROM PLANTS

18 min

MATERIALS: Extracting Genetic Information Lab

Prepare students for the lab experiment. Place students in groups of 3 or 4. Project **slide F**. Assign each group to extract genetic information from either strawberries or bananas. Hand out one copy of *Extracting Genetic Information Lab* to each student. Have students write our question and make a data table in their science notebooks.

Make a prediction in science notebooks. Ask students to write down in their science notebooks their predictions to the question, "Do you think your sample will contain genetic material? Why or why not?"



Name: _____ Date: _____

Extracting Genetic Information Lab

Part 1: Prepare for experimentation.

1. Gather materials for your group.
2. Put on safety goggles.

Part 2: Extract genetic material from inside cells.

1. Place sample in a plastic baggie. Remove the air and seal the bag.
2. Crush the sample with your hands until there are no chunks. ***Be careful to not break the bag while mushing!***
3. Add 1 spoonful of salt to 20ml of warm water. Mix until the salt is completely dissolved.
4. Pour the salt water into the bag with the crushed-up sample. Make sure the water is not too hot so it does not melt the bag.
5. Gently mix the saltwater with the sample.
6. Add 1 spoonful of dish soap to the bag.
7. Gently mix the soap with the sample. Be careful not to make too many suds!
8. On a 250ml, glass beaker put a piece of cheesecloth over the top and secure it with rubber bands. Then gently push down on the top, making a little pocket. You will use this to strain your sample.
9. Slowly pour your sample through the cheesecloth. Be careful not to overfill. You may have to wait while some liquid flows through to pour the entire sample.
10. After the sample has completely flowed through the cheesecloth, remove the rubber band and cheesecloth from the container.
11. Slowly pour 20mL of alcohol into the beaker with the sample. Tilt the sample on its side and pour down the side of the glass, being careful not to mix the layers.
12. If genetic material is present in the sample, you will see little white strands forming in between the layers of the sample and the alcohol.
13. Gently use a wooden skewer to lift the strands up. You can slowly turn the skewer to spool the genetic material.
14. Clean up your lab station when your group is finished.
15. Record your group's results in the class data table, then answer the making sense questions in Part 3.

openscied.org Lesson 11 – 12.18.19 Page 1

SAFETY PRECAUTIONS	Have students wear safety goggles while performing the experiment to avoid splashing soap or isopropyl alcohol/ethanol in their eyes.

Project **slide G**. Have students gather materials and carry out the experimental protocol. While students are carrying out the experiment, create a large class data table on the board for students to record their group's data.

Sample our group tested	Is our sample from an organism that reproduces sexually or asexually?	Results: Was genetic information found in our sample?

5 · CLASS DISCUSSION AND PROGRESS TRACKER UPDATE

8 min

MATERIALS: science notebook

Discuss the results of the experiment as a class. Project **slide H**. Refer to the class data table. Both samples, bananas and strawberries, should have genetic information inside. Students may have noticed other surprising things when conducting the experiment, such as that genetic information is really long and there might seem like a lot inside an organism. Encourage students to think about what this might mean in terms of how many genes living things have inside of them.

Suggested prompt	Sample student response
Looking at our compiled data table, what patterns do we see in our data?	*Both bananas and strawberries have genetic information inside!*
So what have we figured out about the question we had for this lesson?	*Even though asexual organisms don't have sex cells, they still have genetic information inside.*
Think about the genetic information you pulled out. Did anything surprise you about the scale of the genetic information you extracted?	*It was surprisingly long for such a little fruit.* *There seemed to be quite a lot of it!*
Hold up a group's genetic information spooled around the wooden skewer.	*It's a physical thing! Like we can really see it now with our eyes.*
We read that the alcohol was supposed to help the genetic information clump together to make it visible. So if it was clumped up when we pulled it out, how long do you think it would be not clumped together?	*I don't know!* *Maybe 1 foot?*

✱ SUPPORTING STUDENTS IN DEVELOPING AND USING SCALE, PROPORTION, AND QUANTITY

Students are using the CCC of scale to think about how genetic information is both very small yet also very long! The facts given to the students about the human genome to support thinking about how large genetic information are not central to understanding the DCIs. However, they may help prepare students to generalize out in Lesson 13. If students have a concept of just how many genes are in humans, they might start wondering how genes of any organism work. Do they all work like myostatin? What are all those genes doing?

Project **slide I**. Share the information on the slide with students, then ask the question on the slide.

Suggested prompts	Sample student responses	Follow-up questions
Why do you think our genetic information is so long?	*I don't really know.* *Maybe we need a lot of genes?* *Do all genes make proteins like myostatin?*	*Humans have 20,000-25,000 genes!✱*

Have students individually update their Progress Tracker. Project **slide J**. Have students individually record what they figured out in a two-column Progress Tracker. A sample is shown below of what students might say.

Question	What I figured out in words/pictures
Do asexual organisms have genetic material if they don't have sperm and eggs?	• There is genetic information inside asexual organisms even though they don't have sperm and eggs. • Genetic information is a physical structure. We can use tools to see it with our eyes. • The genetic information seems really long because there are thousands of genes.

6 · DISCUSS NEXT STEPS

2 min

MATERIALS: None

Navigate to the next lesson. Project **slide K**. Summarize what the class just figured out, then ask the question on the slide.

Say, *We just figured out that even though asexual organisms don't have sex cells, they still have genetic information inside. So do you think asexual organisms still pass on their genetic information to their offspring?*

Turn and talk to a partner about asexual reproduction. If there is time, you can have a few students share their responses with the class. Otherwise, tell students you can pick up here next time to further explore asexual reproduction.