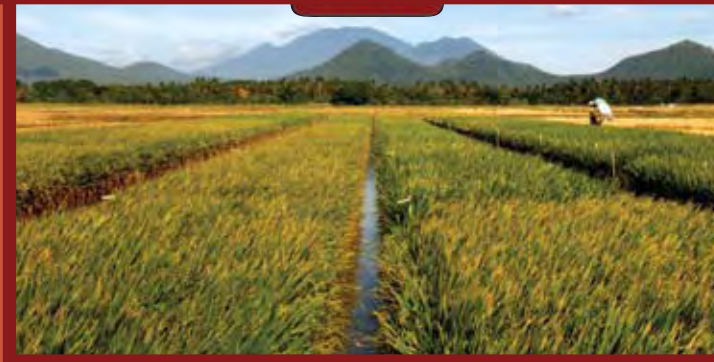


PBIS



GENETICS

As a student scientist, you will...





What's the Big Question?

*How can knowledge of **genetics** help feed the world?*

Over ten thousand years ago, humans lived as hunters and gatherers. They moved from place to place and relied entirely on wild plants they gathered and animals they could hunt for food. People then began growing plants for food. This was the beginning of **agriculture**. Learning to grow food changed the way people lived. Once people learned to plant seeds and harvest plants, they began to settle into permanent communities.



genetics: the science of how characteristics are passed down from one generation to the next.

agriculture: the production of food and other goods by growing plants and raising animals.

What Does Growing Food Have to Do with Genetics?

Wild plants changed genetically as a result of planting, harvesting, storing, and planting again. For example, some wild grass plants had seeds that clung to their stalks, while others had seeds that easily fell off during harvesting. When humans collected seeds from the wild grasses, they were able to gather more seeds from the plants with seeds that stayed on. More seeds from these plants would have been planted each year. Gradually, the plants with these genetic qualities would increase in number.

trait: a physical or behavioral characteristic of an individual that can be passed down to the next generation.

drought: a long period, lasting weeks or months, with little or no rainfall.

Over the following thousands of years, people used a similar process to transform wild plants into plants with **traits** that made the plants suitable for agriculture. Although they did not know it, these people were using genetics to grow plants for food. They did this by choosing seeds from plants that had the traits they wanted in their crops.

Most people on Earth now rely on agriculture to provide the food they need. However, farming and growing food is easier in certain places on Earth than in others. In many places, some years the environment in an area is more suitable for growing crops than in other years. Unsuitable weather conditions, such as too much rain, causing flooding, or too little rain, causing **droughts**, can make farming difficult. Insects and plant diseases can destroy crops. Sometimes people cannot grow enough food to feed themselves and their families. Farmers and scientists constantly work to find and develop plants and seeds that grow well under many different conditions.

In this Unit, you will conduct the same kinds of investigations as farmers and scientists. You will learn about genetics. You will then use genetics to make recommendations about which plants will produce the most food and the most nutritious food.

*Welcome to Genetics!
Enjoy being a student scientist.*

Think about the Big Question

In this Unit, you will think about how genetics might help to produce food to feed the world. You might think this problem only affects people in other parts of the world. You might not think this is something that matters to you. But everyone needs enough nutritious food to live. Growing more food and food that is more nutritious should be a concern of every person on Earth.

Get Started: Think about Grains You Eat

You will look at ingredient labels from several foods. Each of the foods is made from one or more common **grains**. Grains are grass plants that are grown for their edible seeds. There are many types of grains—corn, wheat, rice, rye, and barley are very common in the United States. Work with your group to find the grains listed on each ingredient label. Think about how important grains are to your diet.

1. Carefully read each food-ingredient label. Look for the names of the grains on each label. List each grain you find.
2. Reread each label to count the number of times each grain appears. Make a tally mark next to each grain when it appears in a list.

grain: usually a type of grass grown for its edible seeds. Grains include wheat, rice, corn, oats, barley, buckwheat, quinoa, millet, and others. Also used to describe the seed of grain plants, as in *rice grain*.

Hot Cereal

Nutrition Facts
Serving Size 1/4 cup dry oz. (40g)
Servings Per Container 17

Amount Per Serving Dry

Calories 140 **Calories from Fat** 10

% Daily Value

Total Fat 1g **2%**

Saturated Fat 0g **0%**

Trans Fat 0g

Cholesterol 0mg **0%**

INGREDIENTS: WHOLE GRAIN WHEAT, CORN, RYE, TRITICALE, OATS, SOY, MILLET, BARLEY, BROWN RICE, OAT BRAN, FLAXSEED.

Rice Medley

Nutrition Facts
Serving Size 1/4 cup (45g)
Servings Per Container About 20

Amount Per Serving

Calories 160 **Calories from Fat** 15

% Daily Value

Total Fat 1.5g **2%**

Saturated Fat 0g **0%**

Trans Fat 0g

Cholesterol 0mg **0%**

INGREDIENTS: TEX-S-MATI BROWN RICE, RED RICE, PEARLED BARLEY, RYE BERRIES.

Barley Soup

Nutrition Facts
Serving Size 1.5 cups (40g)
Servings Per Container About 3

Amount Per Serving

Calories 217 **Calories from Fat** 39

% Daily Value

Total Fat 5g **0%**

Saturated Fat 0g **0%**

Trans Fat 0g

Cholesterol 0mg **0%**

INGREDIENTS: BARLEY, VEGETABLE BROTH, GARBANZO BEANS, CARROTS, CELERY, TOMATOES, GARLIC POWDER, SALT, PARSLEY, PAPRIKA, BLACK PEPPER.

Tortilla Chips

Nutrition Facts

Serving Size 1 oz. (28g/about 9 chips)
Servings Per Container 9

Amount Per Serving

Calories 140 Calories from Fat 50

% Daily Value

Total Fat 6g **9%**

Saturated Fat 0.5g **3%**

Trans Fat 0g

Cholesterol 0mg **0%**

INGREDIENTS: STONE-GROUND ORGANIC CORN, VEGETABLE OIL (CONTAINS ONE OR MORE OF THE FOLLOWING: CANOLA, SUNFLOWER, OR SOYBEAN OIL), SALT.

Grain Bread

Nutrition Facts

Serving Size 1 slice (43g)
Servings Per Container 16

Amount Per Serving

Calories 100 Calories from Fat 15

% Daily Value

Total Fat 1.5g **2%**

Saturated Fat 0.5g **0%**

Trans Fat 0g

Cholesterol 0mg **0%**

INGREDIENTS: WHOLE WHEAT FLOUR, STEEL CUT WHEAT, MALTED WHEAT FLAKES, CORN MEAL, ROLLED OATS, RYE FLAKES, WHEAT GLUTEN, HONEY, OAT FIBER, CONTAINS 2% OR LESS OF THE FOLLOWING: SOYBEAN OIL, BROWN SUGAR, YEAST, MOLASSES, SALT, CULTURED WHEAT FLOUR, FLAXSEED, CRUSHED WHEAT, WHEAT BRAN, SESAME SEEDS, BARLEY FLAKES, TRITICALE FLAKES, SALTED SUNFLOWER SEEDS, SOY LECITHIN, VINEGAR.

Crunchy Cereal

Nutrition Facts

Serving Size 1 cup (32g/1.1 oz.)
Servings Per Container About 9

Amount Per Serving

Calories 120 Calories from Fat 0

% Daily Value

Total Fat 0g **0%**

Saturated Fat 0g **0%**

Trans Fat 0g

Cholesterol 0mg **0%**

INGREDIENTS: ORGANIC LONG GRAIN RICE, ORGANIC EVAPORATED CANE JUICE, ORGANIC WHOLE WHEAT, ORGANIC FREEZE-DRIED STRAWBERRIES, SEA SALT, ORGANIC BROWN RICE SYRUP, FREEZE-DRIED RASPBERRIES.



Stop and Think

1. Which grain did you find to be the most common in the ingredient labels?
2. How often do you think you eat the most common grain?
3. Which grain do you think you eat most frequently? Is it the grain that you found most common in the labels you looked at?
4. A common grain is wheat. Wheat is often used to make bread. How important do you think wheat is as a food source?
5. Another common grain is rice. Rice is eaten alone and is used in a number of other foods. How important do you think rice is as a food source?

Get Started

A Letter from the Philippines

You just explored the importance of grains in your diets. Rice is an important grain and is a **staple food** for many people in the world. That means it is a basic and necessary food in their diets.

staple food: a basic or necessary food item.

The letter on the next page is from a girl about your age. She lives in the Philippines, a country made up of about 7000 islands. The capital of the Philippines, Manila, is about 13,600 km (8600 mi) from New York City. As you read this letter, imagine the importance of rice in this family's life.





insecticide:
a substance
used to kill
insects.

*Rice harvests
produce different
amounts of
rice each year
depending on the
weather, the quality
of the soil, and the
presence of insects
and pests.*

Hello Friends.

My name is Amihan. I live in the Quezon province in the Philippines. I am twelve years old. I have two brothers and two sisters. Rice is very important in our lives. We eat it three times a day. Even my favorite dessert is made with rice. Every year, on May 15, we have a festival to celebrate the rice harvest.

This year we are lucky. We have plenty of rice to eat. When there is lots of rice, my parents are happy. But last year, the harvest was not very good. My father says he cannot tell anymore when the rains will come. Sometimes they don't and then there is no rice crop.

Even when the rains come, insects may harm the rice plants. My father used to spread **insecticides**. But one day he became sick. The doctor told him that many insecticides are poisonous to people. My parents seem worried.

Two months ago, some scientists from the city came to our farm. The scientists are trying to make a new rice plant. They hope the new rice plant will grow even when the weather is bad. And insects will not eat the new rice plant, so my father will not get sick from spraying insecticides.

The scientists want my family to help them. They will give us the seeds to plant. When the new plants grow, we will tell the scientists how much rice we get.

I am happy the scientists are helping us solve the problems we are having growing enough rice.

Thank you.

Amihan

Stop and Think



The letter tells you how important rice is in the Philippines, and it explains problems people of the Philippines are having growing enough rice to keep everyone healthy. Use the letter to answer the following questions:

1. What are the problems faced by the rice farmers? List two problems rice farmers have.
2. How do you think scientists might help the farmers? Describe one way the scientists might help the farmers solve their problems.
3. How do you think farmers might help the scientists? Describe how the farmers might help the work of the scientists.

What's the *Big Challenge*?

You are just beginning to understand the importance of grains in people's diets. As you read in the letter, rice is an important grain in the diets of people in the Philippines. In fact, rice is the most important food in the diets of people around the world. More people on Earth depend on rice as their main source of nutrition than any other food.

In this Unit, you are considering a *Big Question* about providing food for people in the world. To help you answer the *Big Question*, you will also be working to achieve a *Big Challenge*. You will provide advice about developing a rice plant that is nutritious and can be grown in places that do not get a lot of rain. The letter on the next page from the *Rice for a Better World Institute* presents the challenge.

Many cultures around the world celebrate rice harvesting.





Research Announcement

To: All Interested Scientists

From: The Rice for a Better World Institute (RBWI)

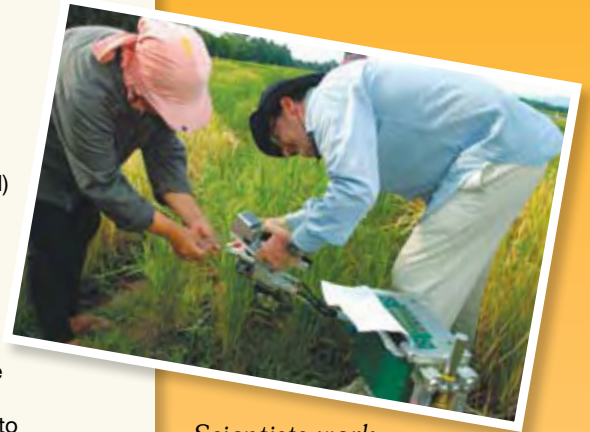
Subject: Request for research collaboration

The RBWI is dedicated to improving rice plants to help farmers around the world grow more productive rice plants.

We have had some successes in the past, but we need to address a new and bigger problem now. The world population is growing fast. Our task is to address this situation by developing rice plants that are more nutritious and will produce more rice.

With the help of genetic technology, we have already developed several new varieties of rice. Each variety has traits that help it grow well in particular environments and under particular conditions. But for the future, we must develop new plants to address the problems rice farmers are facing. These farmers need rice plants that will grow when there is not a lot of rain.

We invite you to join the international team of researchers and farmers in the Philippines working on this project. We will keep you updated on the progress of our research from time to time. You will also be able to count on the farmers to carry out field experiments for you.



Scientists work with farmers to solve the problems of growing rice.

Identify Criteria and Constraints

criteria: goals that must be satisfied to successfully achieve a challenge.

constraints: factors that limit how you can solve a problem.

In this Unit, your challenge will be to make recommendations about developing a new rice plant that will produce more rice and more nutritious rice. Before you start, make sure you understand the **criteria** and **constraints** of your challenge. Criteria are conditions that must be satisfied to achieve the challenge. In this case, the rice plant you develop must produce more rice and more nutritious rice than the plants the farmers are now using.

Constraints are factors that limit how you can solve the problem. You cannot grow the rice in your classroom. The farmers must grow the rice in their own fields. You can only suggest ways for the scientists to work with the farmers in developing the new rice plant. The farmers can carry out any field experiments you need to conduct. Think about other constraints that may affect your solution. Record your criteria and constraints in a table like the one on the next page so you can refer to them as you move through the Unit.

Make recommendations about developing a new rice plant that will produce more rice and more nutritious rice

Criteria	Constraints

Conference

Your *Big Question* for this Unit is *How can knowledge of genetics help feed the world?* Your *Big Challenge* is to advise the *Rice for a Better World Institute* about developing a rice plant that can produce more rice and rice that is more nutritious. Think about what you need to investigate to address the *Big Challenge* and answer the *Big Question*.

Working by yourself, develop two questions you have about rice. Develop two more questions you need to answer so that you can successfully answer the *Big Question* or achieve the *Big Challenge*. Remember that your questions should be interesting to you, require several resources to answer, and require collecting and using data. These should not be yes/no questions or questions with one-word answers.

When you have completed your questions, share all of your questions with the members of your group. Make sure each question meets the criteria for a good question. Reword questions that do not meet the criteria. Choose two of the most interesting questions of each kind to share with the class. Give your teacher a list with the rest of the questions so they can be used later.

Create a Project Board

When you are trying to answer a difficult question or solve a hard problem, it is helpful to organize your work. You will be using a *Project Board* throughout this Unit to keep track of your progress and the things you still need to do. Your class will keep a class *Project Board* and you will use your own copy of the *Project Board* for reference.

Remember that the *Project Board* has space to answer five guiding questions:

- What do we think we know?
- What do we need to investigate?

- What are we learning?
- What is our evidence?
- What does it mean for the challenge or question?

To start this *Project Board*, identify and record the *Big Question* and the *Big Challenge* for this Unit:

Big Question: How can knowledge of genetics help feed the world?

Big Challenge: Make recommendations about developing a new rice plant that will produce more rice and more nutritious rice.

What do we think we know?

In the first column of the *Project Board*, record what you think you know about the problems faced by the rice farmers and how a new rice plant might help them. How do you think rice is grown? Think about why the farmers may need a new plant to solve their problems. Why can't they continue to plant the rice they have?

Discuss what you know about the work of scientists who develop new plants. What do the scientists need to do? Don't worry if you don't know the answer. Think about what you would do if you were that scientist. Scientists work in different ways when trying to solve a problem. Discussing the different ideas they might have is important. Often, by putting together the best ideas that come up during their discussions, scientists discover a better way to address a problem.

What do we need to investigate?

Perhaps not all students in your class agree on the main problems farmers face in growing rice. Or maybe you and other members of your class have different opinions about how scientists can help the farmers. Use this column to keep track of what you would need to investigate to address the *Big Challenge*. Make sure you also record what you need to find out about rice plants and other things you are not sure about and need to find out more about.

You will return to the rest of the *Project Board* throughout the Unit. For now, work with your class to fill in the first two columns.