Part I: Which goes with which?

You will receive a handful of several different kinds of rice. Your job is to sort them.

1. How can you tell the difference between these grains of rice? Which characteristics would you use to divide these rice grains into groups.
   a. _____*Shape*_____
   b. _____*Color*_____
   c. _____*Other like size, smell, shine, etc.*_

2. Sort your rice into groups.

   Leave this open ended, and let students decide how many groups there should be.

3. Organize your groups on a blank sheet of paper. Put the groups that are most similar closest together. Put the groups that are most different farthest apart.

   Consider copying this sheet onto HALF of an 11x17 sheet of paper. Then students can use the other half for sorting and drawing the groups.

4. Draw an outline around each group. Number the group. Trace three grains of rice inside the group.

USDA-ARS

Part II: Phenotype

1. Pick the two piles that are most different from one another. Describe the PHYSICAL APPEARANCE of each group. (What color is it? How long are the grains? How does it feel? How does it smell?)

Group Number _____	Group Number _____
a. _____*white color*_____	a. _____*white color*_____
b. _____*long, thin grain*_____	b. _____*short, round grain*_____
c. _____*many grains broken*_____	c. _____*few grains broken*_____

The purpose of this step is to get the students to focus on and articulate the physical similarities and differences between the piles before thinking about what causes those similarities and differences (genetics!)

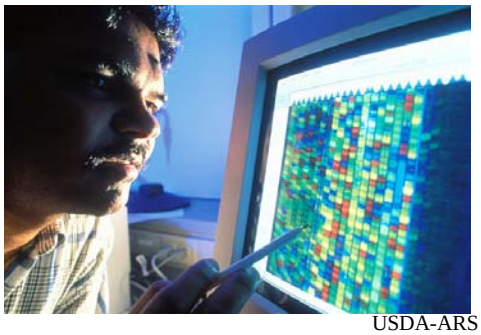
What you've just described is the **PHENOTYPE**. A phenotype is the physical description of something… in this case, a grain of rice.

2. Do all the grains of rice in Group 1 have the same phenotype? Why or why not?
Probably not. The grains won't have the same phenotype because a) groups may include more than one variety, b) environmental variation causes differences even within the same variety. c) some grains may be broken, abraded, etc.

I'm trying to get at the notion that SOMETHING is different between the grains… and get students to start thinking about the things they cannot see.

3. Does the rice in Group 1 have the same phenotype as the rice in Group 2? Why or why not?
Definitely not. Difference in phenotype are the reason for division into different croups. The rice in one group should be physically different from the rice in another group.

USDA-ARS


USDA-ARS

Part III: Genotype

1. What is a gene?

   A gene is a stable unit of inheritance. It is a segment of DNA that encodes a protein.

2. Does a grain of rice have genes? Why or why not?

   Yes, though that a static object like a grain of rice has genes may not be obvious to students.

3. How are genes related to phenotype?

   Genes, in large part, determine physical appearance or phenotype. This answer is really a bit more complicated … since the environment plays a role too.

A **GENOTYPE** is the genes that an individual has (whether that individual is a rice plant, a lizard, or a human being).

4. Do all the grains of rice in Group 1 have the same genotype? Why or why not?
   This will depend on the group. If the grains are all from the same variety, they could have the same genotype. Rice varieties self-pollinate, so there is very little, if any, genetic variation within a variety. However, if a group includes more than one variety, then there could easily be different genotypes in the group.

5. Does the rice in Group 1 have the same genotype as the rice in Group 2? Why or why not?
   Group 1 should have a different genotype from Group 2. Presumably, difference in genotype underlie the physical difference that lead students to create the different croups.

Part IV: Applying what you've learned

1. Someone tells you that a rice plant has purple grain. Is this a genotype or a phenotype?

   Phenotype. Purple grain is a physical description.

2. Someone tells you that a rice plant has a gene for a puple pigment called anthocyanin. Is this a genotype or a phenotype?

   Genotype. This gives you information about the genes involved.

Part V: Comparing varieties

	Color	Length	Taste of cooked rice	Texture of cooked rice	Country of origin?	Fact
1) Himalayan red rice	*Red husk, white grain*	*Long grain*	*Nutty flavor*	*Dry and fluffy*	*Nepal*	*It has been grown in Nepal (in the foot hills of the Himalayan mountains) for thousands of years.*
2) Brown basmati rice	*Brown husk, white grain*	*Long grain*	*Nutty flavor*	*Dry and fluffy*	*India*	*India is the largest producer. Pakistan is the second largest.* *It is the same as with basmati but it still has its bran layer.*
3) Bamboo rice	*No husk, green grain*	*Short grain*	*Green tea flavor*	*Slightly sticky*	*China*	*Its green color comes from bamboo juice.* *It can be used in sushi, risotto or pilaf..*
4) Sweet brown rice	*Brown husk, white grain*	*Short grain*	*Nutty flavor*	*Sticky*	*Japan*	*It is also called "waxy rice" or "mochi".* *It is steamed, ground, pounded and molded into a dense sweet rice cake called "mochi."*
5) Thai purple rice	*Purple and tan husk, white grain*	*Short grain*	*Nutty flavor*	*Sticky*	*Thailand*	*Thai legend says that eating too much purple sticky rice will make you fall asleep.* *It is called kao neow dom in Thai.* *It is often used to make a sweet pudding.*
6) Basmati rice	*No husk, white grain*	*Long grain*	*Bland flavor*	*Dry and fluffy*	*India*	*India is the largest producer. Pakistan is the second largest.* *It is the most expensive of all rice varieties.* *It is also called the "Fragrant one."*
7) Calrose rice	*No husk, white grain*	*Medium grain*	*Clean, bland flavor*	*Separate grains*	*United States*	*Calrose rice is grown in California.* *It is exported to Japan, Turkey and Jordan.* *It is used in Korean, Japanese and Spanish food.*
8) Arborio rice	*No husk, white grain with spot*	*Medium grain*	*Rice flavor*	*Sticky*	*Italy*	*Arborio rice is named for a town in Italy.* *It is used to make risotto.* *The rice is grown in cool, wet conditions.*
9) Chinese black rice	*Black husk, white grain*	*Medium grain*	*Nutty flavor*	*Sticky*	*China*	*It sometimes called "Forbidden Rice and was once the food of China's emperors.* *It is used to make rice puddings and rice salads.*

Teacher Notes. Genetic Diversity of Rice

Overview and concepts

Overview

This activity is: 1) an introduction to genetic diversity in rice, and 2) an application of the concepts of genotype and phenotype. It also includes directions for a rice tasting (comparing varieties).

Concepts covered

Genotype, phenotype, genetic diversity.

Prior knowledge required

Students should have familiarity with the following:

- **Organisms** (including plants) are composed of **cells.**
- **Cells** are composed of parts that can't be seen with the naked eye (in most cases). One of these cell parts is the **nucleus**. The nucleus contains **genes** and **DNA**.
- **Genes** are made up of DNA and encode **proteins.**
- **Plants** produce **seeds.** Rice grain is a seed.

Activity notes

Time frame

- Activity: One day for the sorting activity and answering the questions. One half day for rice tasting (comparing varieties).

Materials

- Nine varieties of rice. See below.
- Sorting set: Mixed rice seed for sorting
- Measurement equipment: Scale, ruler, etc.
- Cooking set of rice (½ cup of each variety)
- Rice cookers
- Cups and spoons for eating rice
- Diverse set of rice (preferably in Petri dishes to discourage tasting of raw rice.)
- Info sheets on the diverse set of rice (preferably laminated)

Preparation

- Order / purchase the rice a few weeks before the activity. Rice sources listed below. Extra rice can be kept fresh for up to a year in a sealed container kept in a refrigerator.

Company (all are available from Amazon.com)	Variety	Characteristics	Region/cuisine
http://www.amazon.com/Himalayan-Red-Rice-1-lb/dp/B000FA3L24/ref=pd_bxgy_gf_img_a	1. Himalayan Red Rice	Red colored pericarp (bran), nutty flavor, long grain	Nepal
http://www.amazon.com/Spicy-World-Premium-Brown-Basmati/dp/B000LVTWLG/ref=sr_1_3?ie=UTF8&s=gourmet-food&qid=1205286474&sr=1-3	2. Brown Basmati	Long grain, white color, brown pericarp (bran), not sticky	India
http://www.amazon.com/Green-Bamboo-Rice-1-lb/dp/B000F9ZDKS/ref=pd_sbs_gf_img_3	3. Bamboo Rice	Short grain, sticky texture.Green color comes from bamboo juice	China
http://www.amazon.com/Sweet-Brown-Rice-1-lb/dp/B0001BUMNI	4. Sweet Brown Rice	Short grain, sticky textutre, brown pericarp (bran)	Thailand
http://www.amazon.com/Barry-Farm-Purple-Sticky-Rice/dp/B000FA1HBQ/ref=pd_sim_gf_img_2	5. Purple sticky Rice	Sticky rice, purple colored pericarp (bran), nutty flavor	Thailand
http://www.amazon.com/S-Gourmet-Grains-Indian-Basmati/dp/B0001VULNY/ref=sr_1_9?ie=UTF8&s=gourmet-food&qid=1205286604&sr=1-9	6. Basmati Rice	Long grain, white color, not at all sticky	India
http://www.amazon.com/Spicy-World-Premium-Calrose-Rice/dp/B000JSSMZI/ref=sr_1_2?ie=UTF8&s=gourmet-food&qid=1205286745&sr=1-2	7. Calrose Rice (often sold under Goya name)	White color, medium grain.	Japan Grown in California.
http://www.amazon.com/Barry-Farm-Arborio-Rice-lb/dp/B0001BULDE/ref=pd_sim_gf_img_8	8. Arborio	Medium grain, white color, white dot at center of grain,	Italy
http://www.ricegourmet.com/About_RiceVarieties.htm	9. Chinese Black	Not sticky, deep purple pericarp (bran), medium grain	China

Taking it further

- Genotype and phenotype. The way that plants look does not necessarily reflect how similar or different their genetics are. For example, the African and Asian white rice varieties rice are very different genetically even though their phenotypes can be very similar.
- More genotype and phenotype. On the other hand, varieties of rice can look very different and can grow very differently. Yet their genetics are not necessarily very different.
- Human Genetics. There is a strong parallel with human genetics, where phenotypic differences often reflect very small genetic differences.