Tracking Traits

Teacher Section

Overview Why do families share similar features like eye and hair color? Why aren't they exact clones of each other? These questions and many more will be answered as well look into the fascinating world of genetics!

Genetics asks which features are passed on from generation to generation in living things. It also tries to explain how those features are passed on (or not passed on). Which features are stay and leave depend on the genes of the organism and the environment the organism lives in. Genes are the "inheritance factors "described in Mendel's laws. The genes are passed on from generation to generation and instruct the cell how to make proteins. A genotype refers to the genetic make-up of a trait, while phenotype refers to the physical manifestation of the trait.

Suggested Time 30-45 minutes

Objectives Many characteristics of an organism are inherited from the parents. An inherited trait can be determined by one or more genes. Students will define the terms "dominant" and "recessive" related to genetic traits, and use a Punnet square to determine possible genetic traits of offspring.

Materials (per lab group)

- Paper and Genetics Table
- Crayons or markers
- Two different coins
- Coin (like a penny)

Lab Preparation

1. Print out copies of the student worksheets.
2. Read over the Background Lesson Reading before teaching this class.
3. Watch the video for this experiment to prepare for teaching this class.

Background Lesson Reading

Mendel developed **the law of segregation**—a law that still serves as a fundamental law of modern genetics. The law states that each organism gets two copies of the same gene, which separate (the "segregation" in the name of the law) when gametes are produced.

Mendel used this law to resolve the curious results found in the short pea plant/tall pea plant experiment. He guessed that each plant has two copies of the same trait, but could only pass on one copy through reproduction. He then guessed that some traits were more dominant—more likely to show itself in the offspring—than others. For example, the *tall* trait was more dominant than the *short* trait. He called these traits that were more likely to be chosen (like the tall trait) **dominant**, and the traits less likely to be chosen (like the short trait) **recessive**.

His experiments showed that if a plant with a dominant trait and a plant with a recessive trait reproduced the F1 generation would be 100% dominant trait. For example, all of the offspring of the tall and short plant were tall. But, the F2 would always be 75% dominant and 25% recessive—and F2 generation that was 75% tall and 25% short, in our example.

The dominant traits are designated by a capital letter, and the recessive traits are designated by a lowercase letter. For example, the dominant trait "tall" is designated the letter *T*, while short is given the lowercase letter *t*. Since the plants have two copies of each trait the combinations can be either TT, Tt, tT, or tt.

If both copies are dominant, than the dominant trait is seen (TT= tall plant). If there's a mix, than the dominant trait is seen (Tt/tT = tall plant). If both traits are recessive, than the recessive trait is seen (tt = short plant). Since three of the four options result in tall plants, and one of the four results in short plants, it makes sense that Mendel observed the results he did.

That's because after the first generation of TT X tt all of the plants were Tt and tT. But, when the tT/Tt generation was crossed, the plants could have all four combinations. Three out of the four combinations (TT, tT, and Tt) yield dominant traits, while the fourth combination (tt) yields short plants. Thus ¾ = 75%, and ¼ = 25%.

A good way of visualizing these results is with **Punnett Squares**. Punnett squares are simply tables we can use to show the possible combinations of traits. In our Tall/short example we can draw this Punnett Square:

Parental (P) Generation: TT crossed with tt

	The Recessive Plant		
The Dominant Plant		**t**	**t**
	T	Tt	Tt
	T	Tt	Tt

Result: 100% Tt. 100% tall.

F1 Generation: Tt crossed with Tt

	T	**t**
T	TT	Tt
t	tT	tt

Result: 25% TT, 50% Tt, 25% tt. 75% tall, 25% short.

Genotype and Phenotype Genotype and phenotype are the words we use to describe what genes an organism has, and which traits are expressed, respectively. They are extremely useful because organisms do not express all of their genes—mostly the dominant ones. We use the word "genotype" to describe the genetic composition of a cell. Is the cell a TT? Is it a Tt? Is it a tt? To talk about which genes an organism has we use the word "genotype".

Phenotype, on the other hand, is just used to describe the appearance of the organism. Is it round? Wrinkled? Tall? Short? The phenotype is the physical trait expressed.

Lesson

1. Ask students to think of a physical feature that they share with one or both of their biological parents OR they can think of a famous family that has a shared trait. Let a few students share out.
2. Tell students one feature about you and your parents or offspring. Eye color or hair color can be good examples. For example, "*My mother and I have black hair.*" Or you can discuss a trait that you do not have. For example, "My mother and I do not have freckles."
3. Explain: *These traits are called genetic traits, because they are determined by our genes. We get our genes from our parents; we get one half from our mother and one half from our father.*
4. Draw a fictitious family on the board: a mother with blue eyes and black hair, a father with brown eyes and blond hair a child with no eyes and no hair. Ask: *What color eyes do you think the child will have?*
5. Explain: *The child will either have blue eyes or brown eyes. It will not have a mixture of those two colors.*
6. Check understanding: *So, if in the same family, the mother has black hair (draw them) and the father has blond hair, what are the possibilities for the child?* Tell a partner. *The child can either have black hair or blond hair.*
7. Explain: *The way we represent these traits is with two letters that represent genes. One letter comes from the mother, and one from the father. Each trait is either dominant or recessive. So, if the mother has black hair, one of her two hair genes is for black hair. Let's label that as capital B. (B for black and capital because black hair is a dominant trait.) We are going to give this mother a small b for her second hair gene, because we are going to assume that one of her parents passed a recessive hair color gene down to her.*
8. Explain: *Since the father has blond hair, he must have two recessive genes (because otherwise the dominant trait would have appeared.) So his hair color genes are represented as bb*.
9. Explain: *So, for this family, for the trait of hair color, we have Bb crossed with bb.*
10. Check understanding: *What would we have for eye color, assuming brown is represented by B and blue by b? What two eye color genes would the mother have, and what would the father have? The mother has blue eyes, so her eye color gene would necessarily be bb, and the father would have to have at least one B. The other could be either B or b, let's just pick b.*
11. Explain: *So in this family, we cross bb with Bb for eye color.*
12. Now there is one final step to figure out the possibilities for the child's genes. For hair color, we have BB x bb. There are always four possibilities when crossing genes. Draw a Punnet square on the board. Demonstrate crossing.
13. Have students do the same for eye color in this example, Bb x bb.
14. Explain: You are going to determine offspring gene traits and then draw them.

Experiment

1. Review the instructions on their worksheets and then break the students into their lab groups.
2. Hand each group their materials and give them time to perform their experiment and write down their observations.
3. First you're going to create the genetic make-up of the parents. Here's how:
4. Take out the Genetics Data Table, and flip the first coin to create the genetic profile for the mother.
5. Flip the coin and in the Mother's Hair trait column, write **D for dominant** if the coin reads heads, and **R for recessive if tails** in the table.
6. Flip the coin again. In the Mother's Hair trait column right after the first trait, write **D for dominant** if the coin reads heads, and **R for recessive if tails** in the table.
7. If you flipped heads the first time and tails the second, you'd write "DR" in the Mother's Hair box.

8. Continue this process for all of Mother's traits. You should have two letters in each box for the entire column.
9. Repeat these steps for Father. When you've completely filled out Mother's and Father's columns, you've completed the paternal genetic profile.
10. Will the child be a boy or a girl? To determine this, flip the second coin. **Heads for a boy, tails for a girl.** After this is decided, circle *boy* or *girl* under "child 1" on the Genetics Data Table.
11. Now the first coin will represent the gene from the mother and the second coin will represent the gene from the father.
12. Start with the Hair trait: Flip both coins. **If the first coin is tails, take the first trait from the mother. If the first coin is heads, take the second trait**.
13. For example, if the first coin is tails, and the mother's code is DR, then write "D" in the child one column for hair.
14. Do the same thing for the father's traits with the second coin. For example, if the second coin is heads, and the father's code is DR, then write "R" in the Hair Trait column of child 1.
15. By the end of this step, child 1 should have one letter from the mother, and one letter for the father in child 1's hair trait column.
16. Use the same steps used to find the genetic code for the hair trait to find the code for the rest of the traits. By the end all the traits should have one letter from the mother's genetic code and one letter from the father's genetic code.
17. Grab a sheet of paper and start drawing the child. If the genetic code for a trait has a "D" in it, then the dominant trait is used.
18. For example, if the hair color is DD, DR, or RD then the hair color is dark. If the hair color code is RR, then hair color is light. Draw the traits on your paper! You can repeat this for as many children as you would like in your family.
19. Are all families alike? What if you try this process again for another family? Do you see any similarities or differences? Do similar features come from dominant genes? Do differences come from recessive genes? What other traits would you include? Write this in your science journal!

Exercises

1. What is the difference between a genotype and a phenotype? (Genotype describes the genetic makeup of the cell: Bb for example. Phenotype describes the appearance that the trait causes: Black hair, for example.)
2. What is a dominant trait? (The trait that is more likely to show up)
3. What is a recessive trait? (The trait that is less likely to show up)
4. Assume B=Black hair and b=blond hair. Make a Punnett square to cross Bb with bb. Tell each possible hair color of the offspring.

	B	b
b	Bb	bb
b	Bb	bb

5. Why don't traits simply average out in offspring. For example, why does a tall plant crossed with a short plant not yield a bunch of average-sized plants?(Because discreet genes are passed down, and then the dominant trait or recessive trait appears. They do not mix. The plants will either be tall or short.)
6. In your activity, what percent of the children expressed the dominant allele of each trait? Did you get Mendel's results? Do the calculations and check it out!

Closure Before moving on, ask your students if they have any recommendations or unanswered questions that they can work out on their own. Brainstorming extension ideas is a great way to add more science studies to your class time.

Tracking Traits

Student Worksheet

Name_____

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What to Learn Many characteristics of an organism are inherited from the parents. An inherited trait can be determined by one or more genes. This lab will show you how to define the terms "dominant" and "recessive" related to genetic traits, and use a Punnet square to determine possible genetic traits of offspring.

Materials

- Paper and Genetics Table
- Crayons or markers
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Experiment

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Tracking Traits Data Table

Trait or Feature	Dominant	Recessive	Mother	Father	Child 1 Boy or Girl?	Child 2 Boy or Girl?	Child 3 Boy or Girl?
Hair	*Dark Hair Color (black or dark brown)*	*Light Hair Color (red or blonde)*					
Eyes	*Brown/Hazel/Green*	*Blue/Grey*					
Eye Placement	*Close*	*Far*					
Eyebrows	*Bushy*	*Thin*					
Mouth Size	*Long*	*Average*					
Nose	*Pointed*	*Rounded*					
Freckles	*Yes*	*No*					

There are many genetic traits. Can you make up a table of your own in your science journal?

18. Draw the family:

Reading

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F1 Generation: Tt crossed with Tt

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Exercises

1. What is the difference between a genotype and a phenotype?

2. What is a dominant trait?

3. What is a recessive trait?

4. Assume B=Black hair and b=blond hair. Make a Punnet square to cross Bb with bb. Tell what the possibilities are for offspring hair color.

5. Why don't traits simply average out in offspring. For example, why does a tall plant crossed with a short plant not yield a bunch of average-sized plants?

6. In your activity, what percent of the children expressed the dominant allele of each trait? Did you get Mendel's results? Do the calculations and check it out!

Answers to Exercises: Tracking Traits

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