

Mendel's Pea Plants

Why Do You Look Like Your Family?

For a long time people understood that **traits**, the qualities or characteristics of an organism, are passed down through families. The rules of how this worked were unclear. The work of Gregor Mendel was crucial in explaining **heredity**, the passage of traits from one generation to the next.

Mendel's Experiments

What does the word "inherit" mean? To **inherit** is to receive a characteristic through the transmission of hereditary material, also known as DNA. You can inherit a parent's eye color, hair color, or even the shape of your nose and ears!

Genetics is the study of the process of inheritance. The field of genetics seeks to explain how traits are passed on from one generation to the next.

In the late 1850s, an Austrian monk named Gregor Mendel (pictured to the right) performed the first genetics experiment, which is why we consider him the "Father of Genetics."



To study genetics, Mendel chose to work with pea plants for three reasons: 1) they have easily identifiable traits, 2) they grow quickly, and 3) they can self-pollinate or be cross-pollinated.

Self-pollination means that only one flower is involved; the flower's pollen lands on its own reproductive organs. Cross-pollination is done by hand, by moving pollen from one flower to the stigma of another. As a result, one plant's DNA combines with another plant's DNA to produce offspring. This is called a "cross." Since Mendel could move pollen between plants, he could carefully control and then observe the results of crosses between two different types of plants.

He studied the inheritance patterns for many different traits in peas, including round seeds versus wrinkled seeds, white versus purple flowers, and tall versus short plants.

Mendel's First Experiment

In Mendel's first experiment, he crossed a short plant and a tall plant. Most people would assume the offspring would be medium-sized plants, but Mendel saw something unexpected: the offspring were all tall!

Mendel's Second Experiment

In Mendel's second experiment, he allowed the offspring from the first experiment to pollinate each other. He found that 75% of the offspring were tall and 25% of the offspring were short.

The Pattern of Inheritance

In Mendel's experiments, he saw that the short trait skipped a generation. By analyzing almost 30,000 plants, Mendel discovered that three out of four plants would have one version of the trait and one out of every four would have the other version.

This discovery did not just apply to the height of the plant; Mendel studied numerous other pea plant traits, such as seed shape, seed color, flower color, pod shape, pod color, and the position of the pods. When Mendel studied the color of the flowers on the pea plants (purple or white) he saw the same effect. The color of the flowers did not blend together – purple showed itself 75% of the time and white showed itself 25% of the time. A summary of his results is shown in the image to the right.

Character	Dominant Trait	×	Recessive Trait	F ₂ Generation	
				Dominant: Recessive	Ratio
Flower color	Purple 	×	White 	705:224	3.15:1
Flower position	Axial 	×	Terminal 	651:207	3.14:1
Seed color	Yellow 	×	Green 	6,022:2,001	3.01:1
Seed shape	Round 	×	Wrinkled 	5,474:1,850	2.96:1
Pod shape	Inflated 	×	Constricted 	882:299	2.95:1
Pod color	Green 	×	Yellow 	428:152	2.82:1
Stem length	Tall 	×	Dwarf 	787:277	2.84:1

Review of “Mendel’s Pea Plants” Reading

1. Where does your appearance come from?
2. Describe Gregor Mendel’s significance in the study of genetics.

Mendel's Laws and Genetics

What Does It Mean To Be Dominant?

The most powerful or influential individual in a group is sometimes called dominant. In genetics, a dominant trait means nearly the same thing. A **dominant trait** is the most influential and masks other versions of a trait. Do you remember what happened when Mendel crossed purple-flowered plants and white-flowered plants? All the offspring had purple flowers. There was no blending of traits in any of Mendel's experiments. Mendel had to come up with a theory of inheritance to explain his results. He developed a theory called the law of segregation.

The Law of Segregation

Mendel proposed that there were two possibilities for each hereditary factor, such as a purple factor or a white factor. He also proposed that a factor is inherited from each parent. One factor is dominant to the other. The other factor that is masked is called the **recessive trait**, meaning that when both factors are present, only the effects of the dominant factor are noticeable.

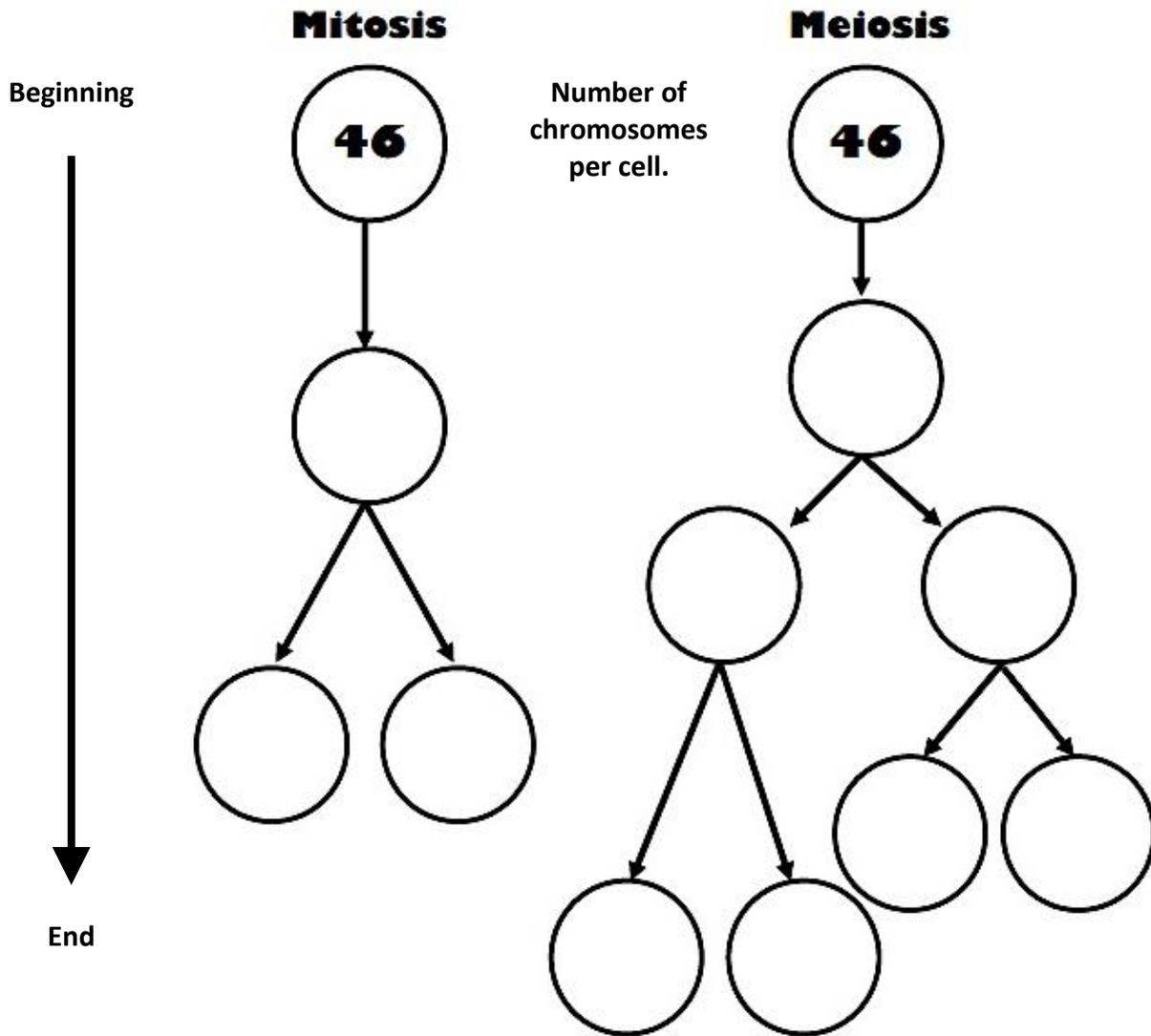
Although you have two hereditary factors for each trait, each parent can only pass on one of these factors to the offspring. When the sex cells (sperm or eggs) form, the hereditary factors must separate, so there is only one factor per gamete. In other words, the factors are "segregated" in each gamete. Mendel's law of segregation states that the two hereditary factors separate when gametes are formed. When fertilization occurs, the offspring receive one hereditary factor from each gamete, so the resulting offspring have two factors.

Example Cross

This law explains what Mendel had seen in his first experiment, when a tall plant was crossed with a short plant. The two hereditary factors in this case were the short and tall factors. Each individual in the first generation of offspring would have one of each factor, and as the tall factor is dominant to the short factor (the recessive factor), all the plants appeared tall. In describing genetic crosses, letters are used. The dominant factor is represented with a capital letter (T for tall) while the recessive factor is represented by a lowercase letter (t). For the T and t factors, three combinations are possible: TT, Tt, and tt. TT plants will be tall, while plants with tt will be short. Since T is dominant to t, plants that are Tt will be tall because the dominant factor masks the recessive factor.

Meiosis

When organisms must produce sex cells, ones that are meant to be passed on to offspring, they go through a form of cell division called **meiosis** (MY-oh-sis). In meiosis, a cell goes through regular cell division but there is another step added to the end: the cell divides again. As a result the four daughter cells have half of the number of chromosomes of the parent cell.



	Mitosis	Meiosis
Type of Cell		
# Chromosomes per Cell		
# of Cells Made		
Cell Similarity		

An Inventory of My Traits Instructions

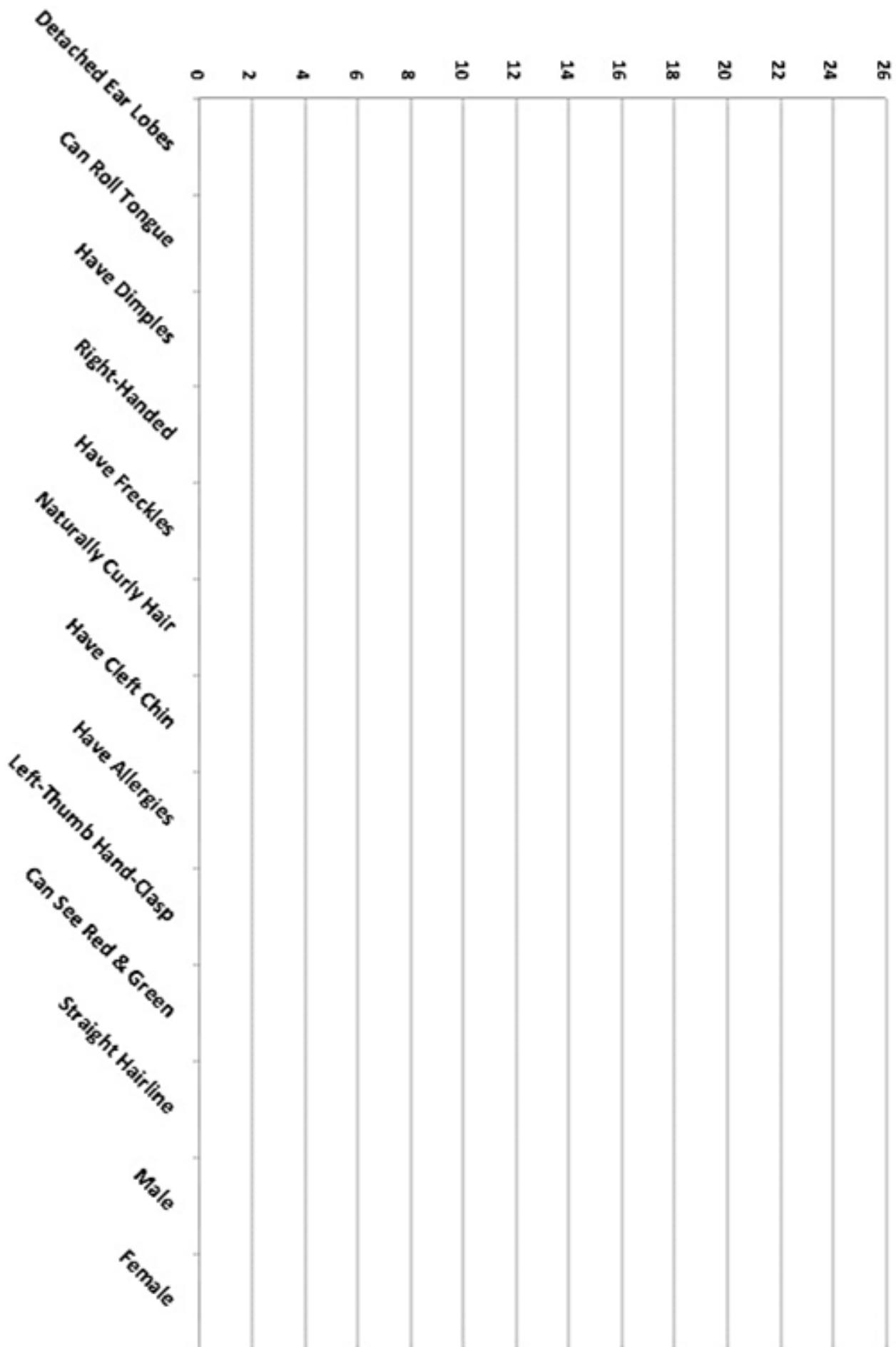
<p>1. I have detached earlobes.</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: center;">Attached Earlobes Detached Earlobes</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>2. I can roll my tongue.</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>3. I have dimples.</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>4. I am right-handed.</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>5. I have freckles.</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>6. I have naturally curly hair.</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>7. I have a cleft chin.</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <p>Cleft Chin</p>  </div>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>8. I have allergies.</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>9. I cross my left thumb over my right when I clasp my hands.</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>10. I can see the colors red and green. (I am not colorblind.)</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>11. The hairline on my forehead is straight.</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: center;">Widow's peak Straight hairline</p>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
<p>12. I am a:</p>	<input type="checkbox"/> Male	<input type="checkbox"/> Female

Group Trait Survey (Group = 2-4 people)

Trait	# Yes	# No	Dominant – D Recessive – R Tied – ?	Same (✓) or Different (X) from Class Graph	Same (✓) or Different (X) from All Students Graph
Detached Earlobes					
Tongue Rolling					
Dimples					
Right-Handed					
Freckles					
Curly Hair					
Cleft Chin					
Allergies					
Cross left thumb over my right.					
See the colors red and green.					
Have a straight hairline.					

Total # of Male Students				
Total # of Female Students				

Class Traits



Modern Genetics

Did Mendel Know About DNA?

No, people did not understand that DNA is our hereditary material until long after Mendel's time. Our modern understanding of DNA and chromosomes helped to explain why Mendel's rules worked.

Modern Genetics

Mendel laid the foundation for modern genetics, but there were still a lot of questions he left unanswered. What exactly are the dominant and recessive factors that determine how all organisms look? And how do these factors work?

Since Mendel's time, scientists have discovered the answers to these questions. Genetic material is made out of DNA. It is the DNA that makes up the hereditary factors that Mendel identified. By applying our modern knowledge of DNA and chromosomes, we can explain Mendel's findings and build on them.

Traits, Genes, and Alleles

Recall that our DNA is wound into chromosomes. Each of our chromosomes contains a long chain of DNA that encodes hundreds, if not thousands, of **genes** (segments of DNA that control a particular trait). Each of these genes can have slightly different versions from individual to individual. These versions of genes are called **alleles**. For example, remember that for the height gene in pea plants there are two possible factors. These factors are alleles. There is a dominant allele for tallness (T) and a recessive allele for shortness (t).

Genotype and Phenotype

A **genotype** is a way to describe the combination of alleles that an individual has for a certain gene (see the table below). For each gene, an organism has two alleles, one on each chromosome inherited from parents. The genotype is represented by letter combinations, such as TT, Tt, and tt.

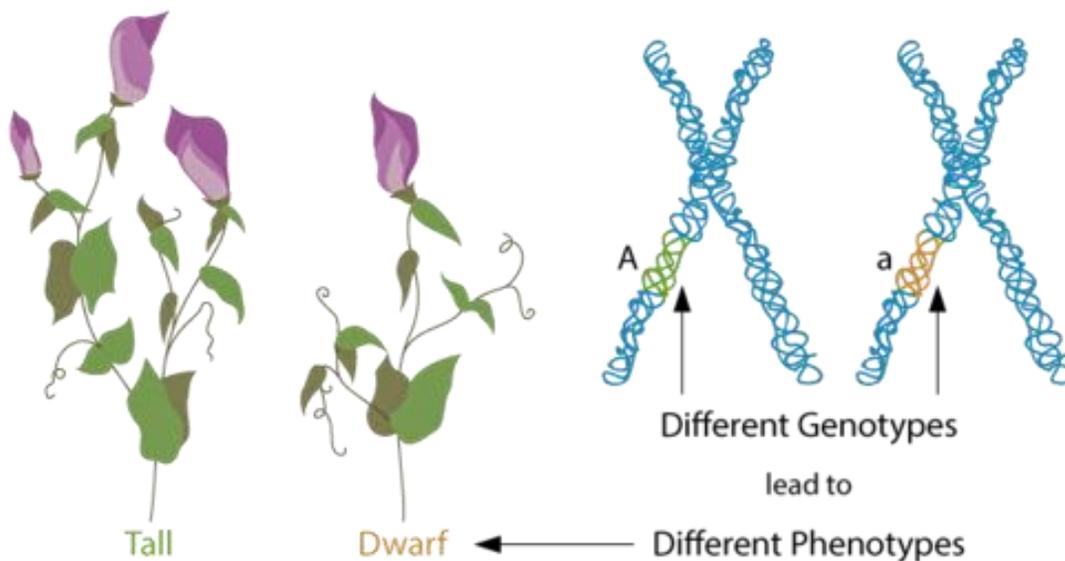
When an organism has two of the same allele for a specific gene, it is called **homozygous**, or purebred. An organism can either be homozygous dominant (TT) or homozygous recessive (tt). If an organism has two different alleles for the gene (Tt), it is known as **heterozygous**, or a hybrid.

Genotype	Definition	Example
Homozygous (or "purebred")	Two of the same allele.	TT or tt
Heterozygous (or "hybrid")	One dominant allele and one recessive.	Tt
Homozygous Dominant	Two dominant alleles.	TT
Homozygous Recessive	Two recessive alleles.	tt

Phenotype is a way to describe the traits you can see. The genotype is like a recipe for a cake, while the phenotype is like the cake made from the recipe. The genotype determines the phenotype. For example, the phenotypes of Mendel's pea plants were either tall or short, or they were purple-flowered or white-flowered.

What is the phenotype of a pea plant that is homozygous dominant (TT) for the tall trait? What is the phenotype of a pea plant that is heterozygous (Tt)? They will both be tall! Remember, the recessive phenotype will be expressed only when the dominant allele is absent, or when an individual is homozygous recessive (tt).

Different genotypes (AA, Aa, aa or TT, Tt, tt) will lead to different phenotypes, or different appearances of the organism.



Modern Genetics Practice

----- Whole Class -----

Use the information provided and your knowledge of genetics to answer each question.

1. For each genotype below, indicate whether it is a heterozygous (He) OR homozygous (Ho).

TT _____ Bb _____ DD _____ Ff _____ tt _____ dd _____

Dd _____ ff _____ Tt _____ bb _____ BB _____ FF _____

Which of the genotypes in #1 would be considered purebred? _____

Which of the genotypes in #1 would be hybrids? _____

2. Determine the phenotype for each genotype using the information provided about SpongeBob.

Yellow body color is dominant to blue.

BB _____ Bb _____ bb _____

Square shape is dominant to round.

RR _____ Rr _____ rr _____

3. For each phenotype, give the genotypes that are possible for Patrick.

A tall head (H) is dominant to short (h).

Tall = _____ Short = _____

Pink body color (B) is dominant to yellow (b).

Pink body = _____ Yellow body = _____

----- Pairs -----

4. Use the information for SpongeBob's traits to write the phenotype (physical appearance) for each item.

A. GG – _____

B. bb – _____

C. Rr – _____

D. EE – _____

E. Ee – _____

F. gg – _____

Characteristic	Dominant Gene	Recessive Gene
Body Shape	Squarepants (R)	Roundpants (r)
Body Color	Yellow (B)	Blue (b)
Eye Shape	Round (E)	Oval (e)
Nose Style	Long (G)	Stubby (g)

G. rr – _____

H. Bb – _____

5. Use the information in the chart in #1 to write the genotype (or genotypes) for each trait below.

A. Yellow Body – _____

B. Roundpants – _____

C. Oval Eyes – _____

D. Long Nose – _____

E. Stubby Nose – _____

F. Round Eyes – _____

G. Squarepants – _____

H. Blue Body – _____

6. Determine the genotypes for each using the information in the chart in #1.

A. Heterozygous Round Eyes – _____

B. Purebred Squarepants – _____

C. Homozygous Long Nose – _____

D. Hybrid Yellow Body – _____

----- *Individual* -----

Complete each definition.

7. Organisms that are purebred, also called _____, have gene pairs with genes that are the _____.
8. Organisms that are hybrids, also called _____, have gene pairs with genes that are _____.
9. Genotypes are two-_____ codes that represent the actual _____ inherited.
10. Phenotypes are the _____ of an organism and are determined by the _____.

11. Classify each of the following gene pairs as heterozygous (He) or homozygous (Ho).

TT _____ Bb _____ dd _____ Ff _____ Rr _____

12. Give the possible genotypes for each trait based on the information provided in the chart.

Characteristic	Dominant Gene	Recessive Gene
Body Shape	Squarepants (R)	Roundpants (r)
Body Color	Yellow (B)	Blue (b)
Eye Shape	Round (E)	Oval (e)

- | | |
|---|--|
| <p>A. Purebred Squarepants – _____</p> <p>B. Hybrid Round Eyes – _____</p> <p>C. Heterozygous Squarepants – _____</p> | <p>D. Blue Body – _____</p> <p>E. Purebred Roundpants – _____</p> <p>F. Homozygous Yellow Body – _____</p> |
|---|--|

13. Give the phenotypes for each genotype based on the information provided in the chart.

rr – _____ Bb – _____ ee – _____

Rr – _____ EE – _____ BB – _____

Punnett Squares

What's the Chance of a Coin Landing on Heads?

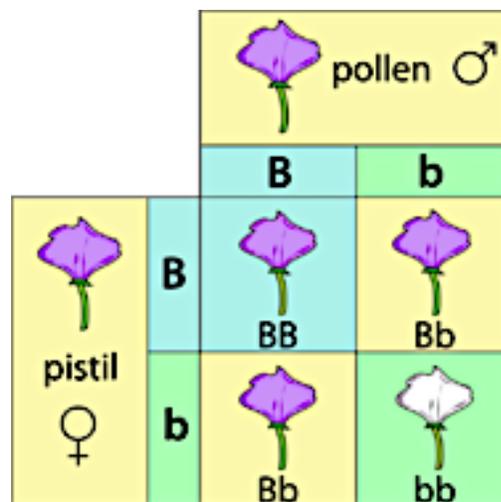
There is always a 50-50 chance that a coin will land on heads. Half the time it will land on heads and half the time it will land on tails. What is the chance of it landing on heads twice in a row? What about three times? These rules of **probability**, or the chance that an event will occur, also apply to genetics. If a parent has one dominant and one recessive factor for a trait, then, on average, half the time the dominant factor will be passed on, and half the time the recessive factor will be passed on.

Probability and Punnett Squares

A **Punnett square** is a special tool used to predict the offspring from a cross, or a mating between two parents. This example of a Punnett square shows the results of a cross between two purple flowers that each have one dominant factor and one recessive factor (Bb).

Results:

- Top left box: BB (or purple flowers).
- Top right box: Bb (or purple flowers).
- Lower left box: Bb (or purple flowers).
- Lower right box: bb (or white flowers).



A Little Help With Math Conversions

Number of Offspring	Fraction	Percentage	Ratio
0 out of 4	0/4	0%	0 to 4
1 out of 4	1/4	25%	1 to 3
2 out of 4	2/4	50%	2 to 2
3 out of 4	3/4	75%	3 to 1
4 out of 4	4/4	100%	4 to 0

Punnett Square Notes

1. Read the word problem carefully.

“In pea plants, smooth peas are dominant over wrinkled peas. If a heterozygous plant with smooth peas is crossed with a homozygous plant with wrinkled peas, what percentage of the offspring will have wrinkled peas?”

2. Underline or highlight information about the traits (Which is dominant? What genotype does each parent have?).
3. Underline or highlight (whichever you haven't already done) the question about offspring that is being asked.
4. Write out the genotypes for each parent.

Plant #1:

Plant #2:

5. Set up the Punnett square.
6. Solve the Punnett square.
7. Circle the results that are part of the answer to the question.
8. Write out the answer to the question in a complete sentence.

Punnett Squares Practice

----- *Whole Class* -----

1. SpongeBob SquarePants recently met SpongeSusie Roundpants at a dance. SpongeBob is heterozygous for his square shape, but SpongeSusie is round. Create a Punnett square to show the possibilities that would result if SpongeBob and SpongeSusie had children. Square = R, round = r.

A. List the possible genotypes and phenotypes for their children.

B. What are the chances of a child with a square shape? _____ out of _____ or _____%

C. What are the chances of a child with a round shape? _____ out of _____ or _____%

2. Patrick met Patti at the dance. Both of them are heterozygous for their pink body color, which is dominant over a yellow body color. Create a Punnett square to show the possibilities that would result if Patrick and Patti had children. Pink = B, yellow = b.

A. List the possible genotypes and phenotypes for their children.

B. What are the chances of a child with a pink body? _____ out of _____ or _____%

C. What are the chances of a child with a yellow body? _____ out of _____ or _____%

3. Everyone in Squidward's family has light blue skin, which is the dominant trait for body color in his hometown of Squid Valley. His family brags that they are a "purebred" line. He recently married a nice girl who has light green skin, which is a recessive trait. Create a Punnett square to show the possibilities that would result if Squidward and his new bride had children. Use B to represent the dominant gene and b to represent the recessive gene.

A. List the possible genotypes and phenotypes for their children.

B. What are the chances of a child with light blue skin? _____%

C. What are the chances of a child with light green skin? _____%

D. Would Squidward's children still be considered purebreds? Explain!

4. Assume that one of Squidward's sons, who is heterozygous for the light blue body color, married a girl that was also heterozygous. Create a Punnett square to show the possibilities that would result if they had children.

A. List the possible genotypes and phenotypes for their children.

B. What are the chances of a child with light blue skin? _____%

C. What are the chances of a child with light green skin? _____%

5. Mr. Krabbs and his wife recently had a Lil' Krabby, but it has not been a happy occasion for them. Mrs. Krabbs has been upset since she first saw her new baby who had short eyeballs. She claims that the hospital goofed and mixed up her baby with someone else's baby. Mr. Krabbs is homozygous for his tall eyeballs, while his wife is heterozygous for her tall eyeballs. Create a Punnett square using T for the dominant gene and t for the recessive one.

A. List the possible genotypes and phenotypes for their children.

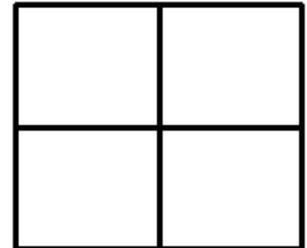
B. Did the hospital make a mistake? Explain your answer.

----- Pairs -----

6. One of SpongeBob's cousins, SpongeBillyBob, recently met a cute squarepants gal, SpongeGerdy, at a local dance and fell in love. Use your knowledge of genetics to answer the questions below.

A. If SpongeGerdy's father is a heterozygous squarepants and her mother is a roundpants, what is her genotype? Complete the Punnett square to show the possible genotypes that would result to help you determine Gerdy's genotype. Squarepants = R, roundpants = r.

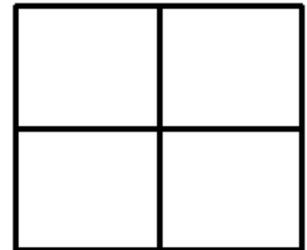
What is Gerdy's genotype? _____



B. SpongeBillyBob is heterozygous for his squarepants shape. What is his genotype? _____

C. Complete the Punnett square to show the possibilities that would result if Billy Bob & Gerdy had children.

D. List the possible genotypes and phenotypes for the kids.



E. What is the probability of kids with squarepants? _____ %

F. What is the probability of kids with roundpants? _____ %

7. SpongeBob's aunt and uncle, SpongeWilma and SpongeWilbur, have the biggest round eyes in the family. Wilma is believed to be heterozygous for her round eye shape, while Wilbur's family brags that they are a pure line. Complete the Punnett square to show the possibilities that would result if SpongeWilma and SpongeWilbur had children. Round Eyes = E, Oval Eyes = e.

A. Give the genotype for each person. Wilma – _____ Wilbur – _____

B. Complete the Punnett square to show the possibilities that would result if they had children.

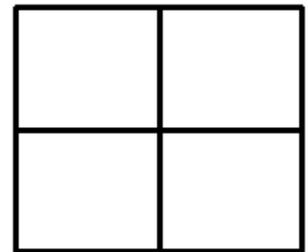


C. List the possible genotypes and phenotypes for the kids.

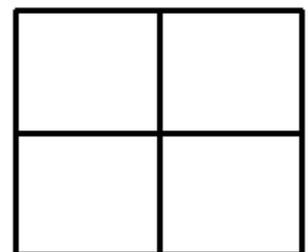
D. What is the probability that the kids would have round eyes? _____ %

E. What is the probability that the kids would be oval eyes? _____ %

8. SpongeBob's mother is so proud of her son and his new wife, SpongeSusie, as they are expecting a little sponge. She knows that they have a 50% chance of having a little roundpants, but is also hoping the new arrival will be blue (a recessive trait) like SpongeSusie and many members of her family. If SpongeBob is heterozygous for his yellow body color, what are the chances that the baby sponge will be blue? Create a Punnett square to help you answer this question.



9. SpongeBob's aunt is famous around town for her itty, bitty stubby nose! She recently met a cute squarepants fellow who also has a stubby nose, which is a recessive trait. Would it be possible for them to have a child with a regular long nose? Why or why not? Create a Punnett square to help you answer this question.



----- Individual -----

10. Spongebob's cousin, SpongeJimBob, is a heterozygous yellow sponge. He recently married a blue sponge gal. Yellow = B, Blue = b.

- A. Create a Punnett square to help you answer the questions.
- B. What are the possible genotypes and phenotypes for the offspring?
- C. What percentage would be yellow? _____ %
- D. What percentage would be blue? _____ %

11. SpongeJimBob has oval eyes, while his bride is believed to be homozygous for her round eye shape. Create a Punnett square to help you answer the questions. Round Eyes = E, Oval Eyes = e.

- A. What are the possible genotypes and phenotypes for the offspring?
- B. What percentage would have round eyes? _____ %
- C. What percentage would have oval eyes? _____ %

12. In pea plants, purple flowers are dominant to white flowers. If a homozygous dominant plant is crossed with a homozygous recessive plant, what percentage of offspring will be white? (Use the letter R for the genotypes.)

13. In cats, short hair is dominant to long hair. If a heterozygous short-haired cat is crossed with a homozygous long-haired cat, what percentage of offspring will have short hair? (Use the letter H for the genotypes.)

14. In humans, brown eyes are dominant to blue. If a homozygous dominant person has children with a heterozygous dominant person, what percentage of the offspring will be heterozygous? (Use the letter E for the genotypes.)

15. In bunnies, black hair is dominant to brown. If all of the offspring in a cross are heterozygous, what must the genotypes of the parents be? (Use the letter B for the genotypes).

Genetics Practice

1. For each genotype, indicate whether it is heterozygous (**He**) or homozygous (**Ho**).

AA _____

Ee _____

NN _____

Bb _____

FF _____

Rr _____

dd _____

gg _____

tt _____

Hh _____

2. For each of the **genotypes**, write the **phenotype** you'd see.

Purple flowers are dominant to white flowers.

Brown eyes are dominant to blue eyes.

FF _____

BB _____

Ff _____

Bb _____

ff _____

bb _____

Round seeds are dominant to wrinkled seeds.

Bobtails in cats are recessive to long tails.

RR _____

TT _____

Rr _____

Tt _____

rr _____

tt _____

3. For each **phenotype**, list the possible **genotype(s)**.

Straight hair is dominant to curly.

Straight Hair: _____

Curly Hair: _____

Pointed heads are dominant to round heads.

Pointed: _____

Round: _____

4. Solve the Punnett squares for each of the crosses listed below. Round seeds are dominant to wrinkled seeds.

A. RR x rr

What percentage of the offspring will be **wrinkled**?

Express your answer as a fraction. _____

Express your answer as a ratio. _____

B. rr x rr

What percentage of the offspring will be **homozygous**? _____

Express your answer as a fraction. _____

Express your answer as a ratio. _____

C. RR x Rr

What percentage of the offspring will be **heterozygous**? _____

Express your answer as a fraction. _____

Express your answer as a ratio. _____

D. Rr x Rr

What percentage of the offspring will be **round**?

Express your answer as a fraction. _____

Express your answer as a ratio. _____

5. Set up and solve the Punnett square for the problems listed below.

Show your work here!

A. A TT (tall) plant is crossed with a tt (short) plant.

What percentage of the offspring will be **tall**? _____

Express it as a fraction. _____

Express it as a ratio. _____

Show your work here!

B. A Tt plants is crossed with a Tt plant.

What percentage of the offspring will be **short**? _____

Express it as a fraction. _____

Express it as a ratio. _____

Show your work here!

C. A heterozygous round-seeded plant is crossed with a homozygous wrinkled-seeded plant.

What are the genotypes of the parents?

_____ x _____

What percentage of the offspring will be **homozygous**? _____

Express it as a fraction. _____

Express it as a ratio. _____

3. In guinea pigs, the allele for **short hair is dominant**.

A. What genotype would a heterozygous short-haired guinea pig have? _____

B. What genotype would a purebreeding short-haired guinea pig have? _____

C. What genotype would a long-haired guinea pig have? _____

Vocabulary Practice

- _____ 1. Heterozygous A. Having the same alleles for a particular gene. (Ex. BB, bb)
- _____ 2. Homozygous B. An organism's inherited appearance.
- _____ 3. Genotype C. Having different alleles for a particular gene. (Ex. Bb)
- _____ 4. Phenotype D. The inherited combination of alleles (the "letter code").
-
- _____ 5. Dominant Trait A. The passing of traits from parent to offspring.
- _____ 6. Recessive Trait B. The trait observed only when two recessive alleles for the same characteristic are inherited. (Ex. bb)
- _____ 7. Genes C. Different forms of a single gene (or trait).
- _____ 8. Alleles D. The trait observed when at least one dominant allele for a characteristic is inherited. (Ex. BB, Bb)
- _____ 9. Heredity E. Segments of DNA that carry hereditary instructions; located on chromosomes.

10. **Solve:** In rabbits, black fur is dominant over white fur. If a heterozygous rabbit with black fur is crossed with a homozygous rabbit with white fur, what percentage of the offspring will have white fur?

Non-Mendelian Genetics

How Would Mendel Explain Blood Types?

The inheritance of traits is not always as simple as Mendel's rules. Each characteristic Mendel investigated was controlled by one gene that had only two possible alleles, one of which was completely dominant over the other. We now know that inheritance is often more complicated than this. In blood types, for example, there are actually three alleles instead of two.

Exceptions to Mendel's Rules

In all of Mendel's experiments, he worked with traits where a single gene controlled the trait. Each also had one allele that was always dominant over the recessive allele. But this is not always true.

There are exceptions to Mendel's rules, and these exceptions usually have something to do with the dominant allele. If you cross a homozygous red flower with a homozygous white flower, according to Mendel's laws, what color flower should result from the cross? Either a completely red or completely white flower, depending on which allele is dominant. But since Mendel's time, scientists have discovered this is not always the case.

Incomplete Dominance

One allele is *not* always completely dominant over another allele. Sometimes an individual has a phenotype that is split between the two parents because one allele is not dominant over another. This pattern of inheritance is called **incomplete dominance**. One of the genes for flower color in snapdragons has two alleles, one for red flowers and one for white flowers.

A plant that is homozygous for a red allele (RR) will have red flowers, while a plant that is homozygous for the white allele will have white flowers (WW). But, if those two plants are crossed, the offspring will have pink flowers (RW). Neither the red nor the white allele is dominant, so the phenotype of the offspring is a blend of the two parents.

Codominance

Another exception to Mendel's laws is a phenomenon called **codominance**. In codominance, multiple traits can show up at the same time. For example, if having red petals is codominant with having blue petals, a plant that inherits red petals from one parent and blue petals from another will have some red and some blue petals.

Inherited v. Acquired Traits

Traits that result solely from the DNA inherited from parents are called **inherited**. But not all traits are the result of DNA. Traits that are the result of the influence of environment and relationships are called **acquired**. Some traits can be a result of the interaction of inherited and acquired traits.

