Basic Genetic Concepts & Terms

Genetics: what is it?

- What is genetics?
  - "Genetics is the study of **heredity**, the process in which a parent passes certain **genes** onto their children." (http://www.nlm.nih.gov/medlineplus/ency/article/002048.htm)

- What does that mean?
  - Children **inherit** their biological parents' genes that express specific **traits**, such as some physical characteristics, natural talents, and genetic disorders.

Word Match Activity

Match the genetic terms to their corresponding parts of the illustration.

- **base pair**
- **cell**
- **chromosome**
- **DNA (Deoxyribonucleic Acid)**
- **double helix***
- **genes**
- **nucleus**

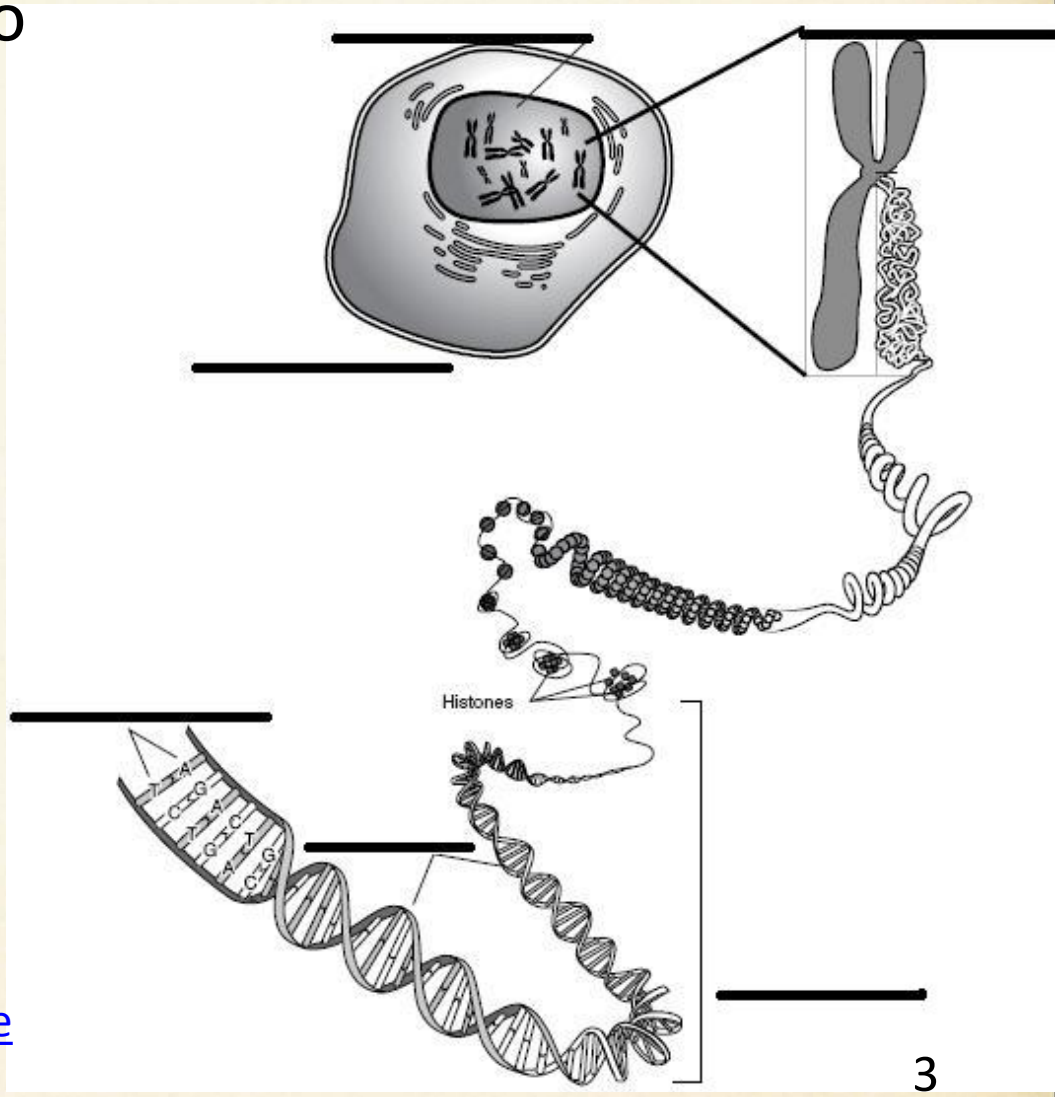


Illustration Source: Talking Glossary of Genetic Terms
http://www.genome.gov/glossary.cfm?key=chromosome

Word Match Activity

- base pair
- cell
- chromosome
- DNA (Deoxyribonucleic Acid)
- double helix*
- genes
- nucleus

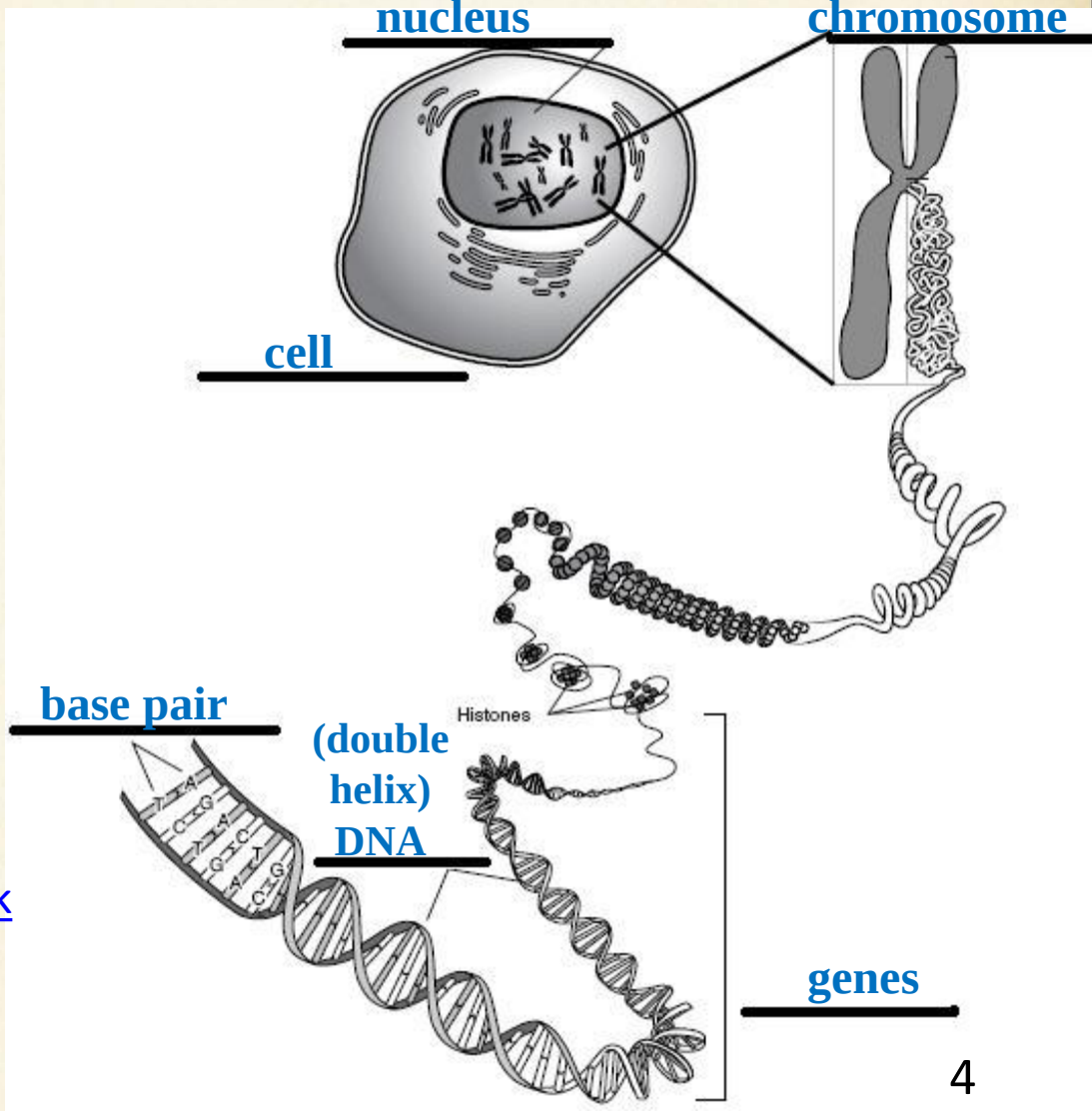


Illustration Source: Talking Glossary of Genetic Terms
http://www.genome.gov/glossary.cfm?key=chromosome

Genetic Concepts

- **H**_____ describes how some traits are passed from parents to their children.
- The traits are expressed by **g**____, which are small sections of DNA that are coded for specific traits.
- Genes are found on **ch**_____.
- Humans have two sets of _____ (hint: a number) chromosomes—one set from each parent.

Genetic Concepts

- **Heredity** describes how some traits are passed from parents to their children.
- The traits are expressed by **genes**, which are small sections of DNA that are coded for specific traits.
- Genes are found on **chromosomes**.
- Humans have two sets of **23** chromosomes—one set from each parent.

Genetic Terms

Use library resources to define the following words and write their definitions using your own words.

- **allele:**
- **genes:**
- **dominant :**
- **recessive:**
- **homozygous:**
- **heterozygous:**
- **genotype:**
- **phenotype:**
- **Mendelian Inheritance:**

Mendelian Inheritance

1. The inherited traits are determined by genes that are passed from parents to children.

2. A child inherits two sets of genes—one from each parent.

3. A trait may not be observable, but its gene can be passed to the next generation.

Mendelian Inheritance

Each person has 2 copies of every gene—one copy from mom and a second copy from dad. These copies may come in different variations, known as **alleles**, that express different traits.

For example, 2 alleles in the gene for freckles are inherited from mom and dad:

- allele from mom = has freckles (F)
- allele from dad = no freckles (f)
- child has the inherited gene pair of alleles, **Ff** (F allele from mom and f allele from dad).

Pre-lesson Activity slide notes for suggested discussion guides for teachers

Slide 1: This set of slides can be used as a review or introduction of basic genetic concepts that students should know before the Lessons 1 and 2.

Slide 2: Conduct a brief class discussion to assess students' knowledge and assumptions about genetics, while providing the information to those students who may not have any prior knowledge.

Slice 3: Hand out the Word Match Activity worksheet and ask students to work in pairs to complete the worksheet. If needed, tell students that "double helix*" is paired with another term, and that both terms should be placed in one of the six areas indicated on the illustration.

Slide 4: Have students volunteer the answers and clarify that "double helix" is the structure of DNA.

Slide 5: Use this overhead for students to complete the 4 sentences.

Slide 6: Have students volunteer their answers, and help students understand that the inherited traits are passed from one generation to the next as the parents' chromosomes are copied and passed to their children.

Slide 7: (*Optional*) For this task, pre-arrange with a school librarian or media specialist to provide students with the computers with the web sites, "Talking Glossary of Genetic Terms" (http://www.genome.gov/10002096) and/or "DNA from the Beginning's Classical Genetics" (http://www.dnaftb.org/dnaftb/), in addition to other reference materials student pairs can used to complete the task.

Hand out the Basic Genetic Terms worksheet and provide reference materials for students to use in completing the worksheet.

Have student pairs take turns in sharing their definitions and examples of the terms. (See the Basic Genetic Terms for Teachers for sample definitions and examples.)

Slide 8: Review key concepts of Mendelian Inheritance with students. For #3, ask students what situations may call for an unobservable trait to be passed from parents to children. Students may be able to apply their understanding of dominant and recessive traits where parents with both dominant and recessive traits only show dominant traits while being able to pass their recessive traits to the next generation.

Slide 9: Review with students the term "allele" (a variant form of a gene) and help students understand that each gene has a pair or two alleles—one allele from mom and the other from dad.

Genetics in *Harry Potter*'s World
Lesson 1

- Phenotypes & Genotypes
- Dominant & Recessive Traits
- Punnett Square

Genetics in *Harry Potter*?

- What types of inherited genetic traits are described in the *Harry Potter* series?

Inherited Physical Traits in *Harry Potter*

"All the Weasleys have red hair, freckles, and more children than they can afford."
-- Draco Malfoy (*Sorcerers Stone*, Ch.6)

He was almost twice as tall as a normal man and at least five times as wide.
(*Sorcerer's Stone*, Ch.1)

Harry had a thin face, knobby knees, black hair, and bright green eyes.
(*Sorcerer's Stone*, Ch.1)

A pale boy with a pointed face and white-blond hair, Draco greatly resembled his father. His mother was blonde too...
(*Goblet of Fire*, Ch.8)

Applying Genetics to the *Harry Potter* Characters

- What are some **phenotypes** (observable traits) described in the four excerpts from the *Harry Potter* books?

Applying Genetics to the *Harry Potter* Characters

- What are some **phenotypes** (observable traits) described in the four excerpts from the *Harry Potter* books?
  - Freckles
  - Hair color
  - Eye color
  - Height

Applying Genetics to the *Harry Potter* Characters

- A genetic trait can be described in two ways:
  - **Phenotypes** are observable traits resulting from how one's genes are expressed. Ex., hair color, a talent, sickle cell disease, etc.
  - A **Genotype** consists of two letters that represent a gene's allele pair that results in a phenotype.

Example: Freckles

- Two possible **phenotypes** for freckles are:
  - **Has Freckles** (observable)
  - **No freckles** (observable)
- A **genotype** for freckles is indicated by two alleles in one of the genes that causes freckles. The possible alleles using the first letter of the trait "f" are:
  - **F** (dominant) = **Has Freckles**
  - **f** (recessive) = **No freckles**

Question: Using **F** and **f**, what are possible **genotypes** of the allele pair for freckles?

Freckles: Genotypes & Phenotypes

Question: Using **F** and **f**, what are possible **genotypes** of the allele pair for freckles?

Genotype (alleles inherited from parents)		**Phenotype** (physical appearance)
F F	======	has freckles
F f	======	has freckles
f f	======	no freckles

One dominant allele (**F**) is sufficient for its trait (has freckles) to be observable, but both alleles have to be recessive (**f**) for the recessive trait (no freckles) to be observable.

Example: Red Hair

- In one of the genes that determines hair color, red hair is **recessive** to brown hair. One way to describe these hair color alleles are:
  - Red hair = **r** (notes recessive red color)
  - Brown hair = **R** (notes dominant brown color)

Question: Using **r** (red hair) and **R** (brown hair) alleles, what possible **genotypes** of the allele pair are there?

Genotype (allele pair) **Phenotype** (appearance)

Example: Red Hair

Question: Using **R** (brown hair) and **r** (red hair) alleles, what possible **genotypes** of the allele pair are there?

Genotype (allele pair)		**Phenotype** (appearance)
RR	======	brown hair
Rr	======	brown hair
rr	======	red hair

Punnett Square:
Heredity Prediction Diagram

Punnett Square: Freckles Case 1

Mom has freckles and dad has none. And each parent has a homozygous genotype (the two alleles in the gene are the same).

Their **genotypes** are:

Mom = _____

Dad = _____

Punnett Square: Freckles Case 1

The parents' homozygous genotypes are:

Mom = **F F**

Dad = **f f**

Punnett Square

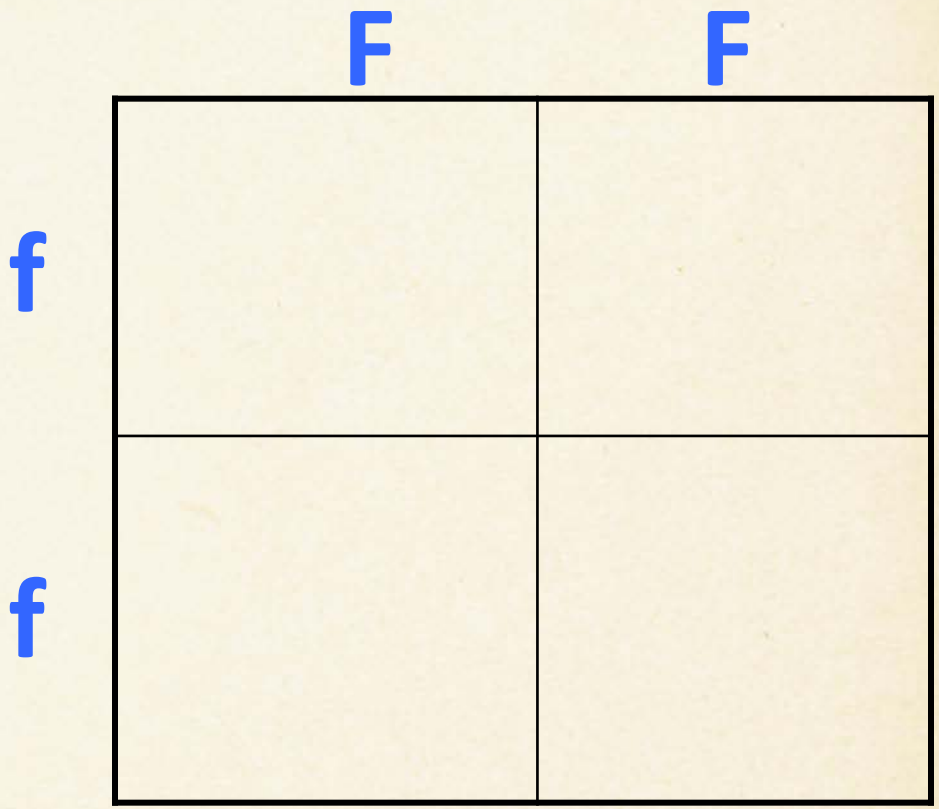
Punnett Square: Freckles Case 1

The parents' homozygous genotypes are:

Mom = F F

Dad = f f

Using the parents' genotypes, each inner square is filled with a possible genotype for their child.



Punnett Square: Freckles Case 1

The parents' homozygous genotypes are:

Mom = F F

Dad = f f

All possible genotypes of their children have a freckle-dominant allele, predicting a 100% chance of their children having freckles.

	F	F
f	Ff	Ff
f	Ff	Ff

Punnett Square: Freckles Case 2

What happens if both mom and dad have freckles, and their genotypes are heterozygous (the two alleles in the gene are different)?

Their **genotypes** are:

Mom = _____

Dad = _____

Punnett Square: Freckles Case 2

The parents' heterozygous genotypes are:

Mom = **F f**

Dad = **F f**

Punnett Square

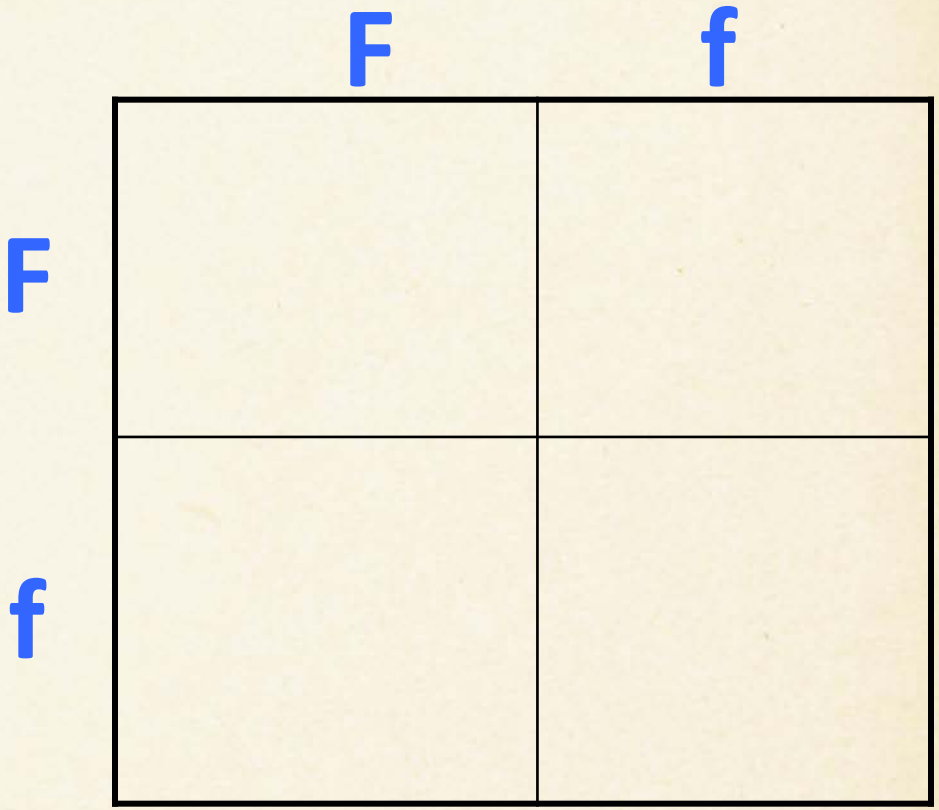
Punnett Square: Freckles Case 2

The parents' heterozygous genotypes are:

Mom = F f

Dad = F f

Using the parents' genotypes, each inner square is filled with a possible genotype for their child.



Punnett Square: Freckles Case 2

The parents' heterozygous genotypes are:

Mom = F f

Dad = F f

There is a 75% probability that their child will have freckles, or a 25% chance of a child with no freckles.

	F	f
F	FF	Ff
f	Ff	ff

Punnett Square: Weasley Family

All Weasley children have **freckles** and **red hair**. Use a Punnett Square to predict the most likely genotypes of their parents, Molly and Arthur Weasley, for the two traits.

Use the following allele possibilities that we identified previously:

- **r** (notes recessive red color) = Red hair
- **R** (notes dominant brown color) = Brown hair
- **F** (dominant) = Has Freckles
- **f** (recessive) = No freckles

Punnett Square: Weasley Family

All Weasley children have freckles and red hair—100% probability. Possible genotypes for their red hair (recessive trait) and freckles (dominant trait) are: **rr** only for red hair and **Ff** or **FF** for freckles. The Punnett Squares show the following genotypes for the children:

rr	**rr**
rr	**rr**

Both parents have rr.

Ff/FF	**Ff/FF**
Ff/FF	**Ff/FF**

At least one parent has **FF**.

.

Punnett Square: The Potters

Question 1: Harry has dark/brown hair like his father, but his mom had red hair. Using the genotypes of **rr**, **Rr**, and **RR**, what possible genotypes does each of the Potters have?

Questions 2: Harry marries Ginny who has red hair. What are possible genotypes of their children's hair colors?

Use a Punnett Square to demonstrate how you arrived at your answers.

Punnett Square: The Potters

Question 1: Harry has dark/brown hair like his father, but his mom had red hair. Using the genotypes of **rr**, **Rr**, and **RR**, what possible genotypes does each of the Potters have?

The phenotypes of the Potters are:

James Potter (dad)—dark/brown hair

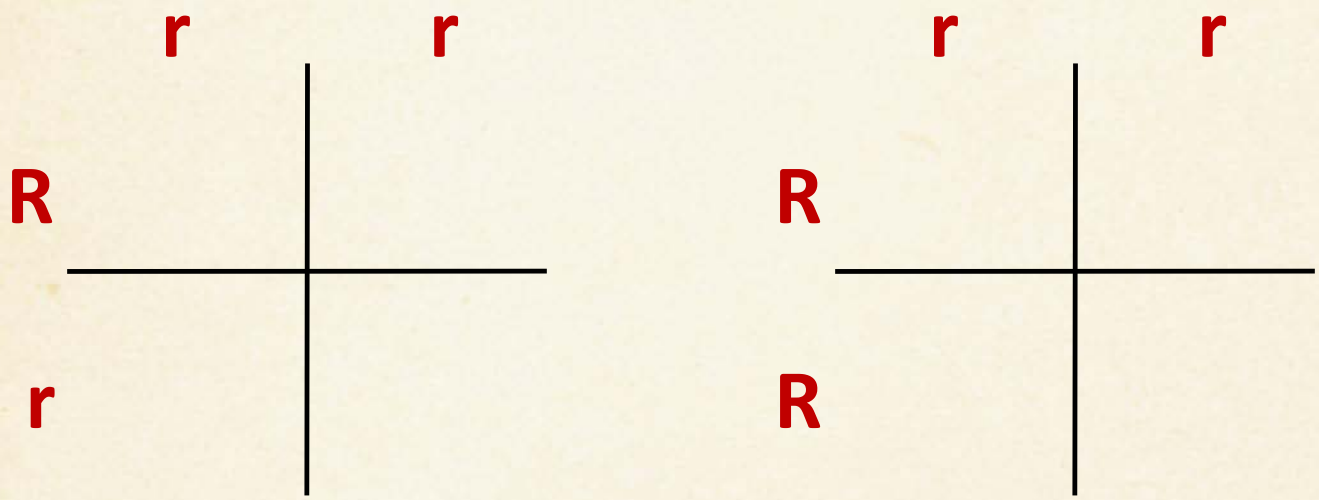
Lily Potter (mom)—red hair

Harry Potter—dark/brown hair

Punnett Square: The Potters

Using the genotypes of **rr**, **Rr**, and **RR**, what are possible genotypes for Harry's parents?

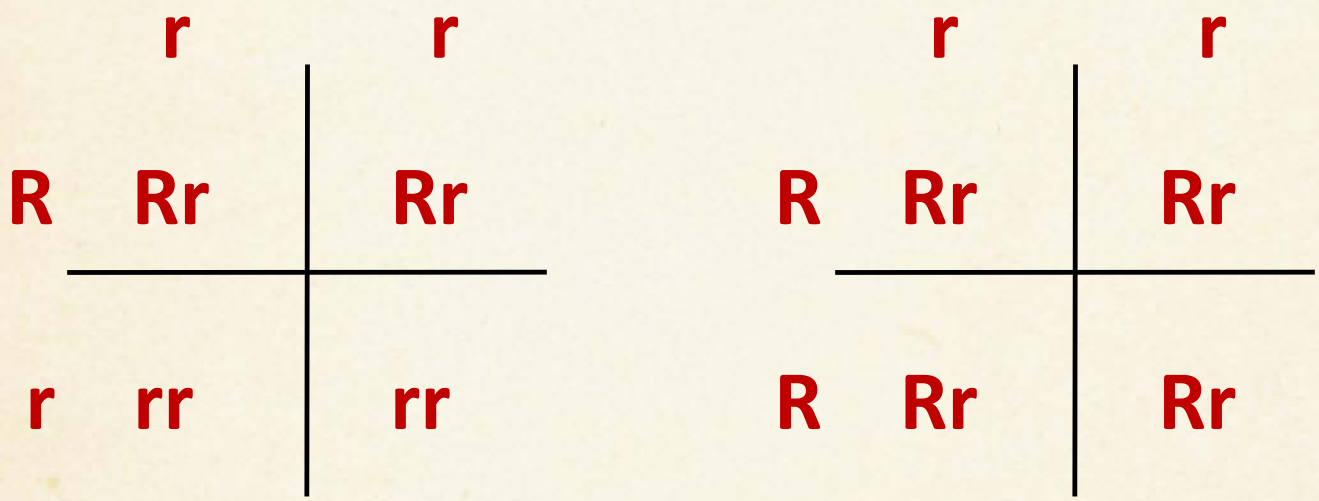
- Mom-Lily (red hair) = **rr**
- Dad-James (dark hair) = **Rr or RR**



The parents' genotypes lead to 2 Punnett squares.

Punnett Square: The Potters

Given Harry's parents' possible genotypes, the two Punnett Squares can be completed as follows:



In this situation, the **only possible** genotype for Harry's dark hair is **Rr**.

Punnett Square: The Potters

Questions 2: Harry marries Ginny who has red hair. What are possible genotypes of their children's hair colors?

Punnett Square: Harry & Ginny

Harry marries Ginny who has red hair. What are the possible genotypes of their children's hair colors?

First, what are the genotypes for Harry's and Ginny's hair colors?

Harry's genotype = **Rr**

Ginny's genotype = **rr**

Punnett Square: Harry & Ginny

Harry marries Ginny who has red hair. What are possible genotypes of their children's hair colors?

Given Harry and Ginny's genotypes, **Rr** and **rr**, we can fill in the Punnett Square for their children's genotypes.

	r	**r**
R	**Rr**	**Rr**
r	**rr**	**rr**

Their children have a 50% chance of being either red- or dark-haired.

Human Mendelian Trait Examples

- **Achoo Syndrome-** People with this sneeze as a reflex when they see sunlight, after having been in a dark room. It's a dominant trait.
- **Ear wax (wet/dry)-** Wet ear wax, or ear wax that is brown and sticky, is the dominant trait. Dry ear wax, or ear wax that is flaky, dry, and grayish-brown, is recessive.
- **Advanced Sleep Phase Syndrome-** People with this go to bed and wake up unusually early. It's a dominant trait.

Lesson 1 slide notes for suggested discussion guides for teachers

Slide 1: Tell students that they will be applying the genetic terms they reviewed previously to some of the *Harry Potter* characters. If possible, display the Basic Genetic Terms Worksheet for Teachers for students to refer to as needed during the lesson.

Slide 2: Conduct a brief discussion to help students identify examples of genetic physical traits observed in different characters in *Harry Potter*.

Slice 3: Read aloud these excerpts as examples of possible genetic traits described in the series.

Slide 4: Review the definition of phenotype from the Basic Genetic Terms for Teachers sheet on display, and have students identify some of the phenotypes, observable traits, described in the excerpts on slide 3.

Slide 5: Let students know that they will be exploring the phenotypes and genotypes of these four physical traits.

Slide 6: Remind students about the terms phenotypes and genotypes, and help students understand that a genotype contains the allele pair containing genetic codes that results in a phenotype.

Slide 7: Model how to identify phenotypes and genotypes for a genetic trait using freckles as an example. Discuss and help students understand that genotypes are often represented by a letter from a trait, and that an upper-case letter connotes a dominant trait and a lower-case for a recessive trait.

Slide 8: Demonstrate how a genotype consists of two letters that represent the two or pair of alleles inherited from two parents. And apply the definitions of the terms, dominant and recessive from Basic Genetic Terms for Teachers, to the gene responsible for freckles—when a gene has an allele pair with one dominant and the other recessive traits, the dominant trait overrides recessive one. You can also reintroduce the term, heterozygous which applies to an allele pair with two different forms of the gene.

Slide 9: Have students think aloud about what the possible allele letters are for red hair color that is recessive to the brown color. Ask students how they would respond to the question in identifying possible genotypes and their corresponding phenotypes for this example.

Slide 10: Provide the answer for the question. Reiterate that the dominant trait becomes observable or expressed over the recessive trait. At least one allele with a dominant trait in the allele pair of a gene results in the dominant trait phenotype, while the recessive trait phenotype requires that both alleles in the gene have to be recessive.

Slide 11: Introduce the Punnett Square to students as a graphic way to evaluate probability and possibility of genotypes of parents and children. If appropriate, provide an introduction using the suggested web sites in the Background Information section of the lesson plan web site.

Slide 12: Review the terms, homozygous and heterozygous, from Basic Genetic Terms for Teachers on display. Ask students to determine the genotypes of parents with freckles using the earlier example used in the class. Guide students to justify their answers.

Slide 13: Clarify the answers and justification for them. Model how the word "homozygous" is used to solve the parents' genotypes for freckles.

Slide 14: Demonstrate how both parents' genotypes are placed on the square before determining their children's possible genotypes.

Slide 15: Allow students to explore how the Punnett Square helps determine the children's possible genotype(s) and their probability.

Slide 16: Conduct a brief question-and-answer session with the slides 16-19. Coach students in using their knowledge to solve the question step by step.

Slide 17-18: Assess students' understanding of how to use the Punnett Square and how they apply genetic terms and concepts through discussion. And help students work through any misconceptions along the way.

Slide 19: Ask or help students interpret the Punnett Square information into a probability/chance in percentages.

Slide 20: Guide students in using Punnett Square to determine the parents' genotypes when their children's genotypes are known.

Slide 21: Think aloud about how known genotypes of children can provide the probable genotypes of their parents. The Punnett Square is filled with the children's possible genotypes (derived from all of them having red hair and freckles) that are used to draw conclusions on the possible genotypes of their parents.

Slide 22: Distribute the Potters' Hair Color handout to each student and have students work in pairs to answer the two questions on the handout. If needed, display slide 10 to remind students about the genotypes they worked on between red and brown hair colors.

Have student pairs volunteer their answers, and guide their reasoning using slides 23-25 for Question 1, and slides 27-28 for Question 2.

Slide 23: Ask students how the described hair colors of Lily, James and Harry Potter may help determine their genotypes for that trait. If needed, clarify that different phenotypes, observable traits, result from different allele combinations of a genotype. This means their described hair colors provide information about the genotypes that resulted in their respective hair colors.

Slide 24: Have students volunteer their answers to each question while providing details on how they arrived at their answers. Confirm and correct based on the correct or false reasoning and answers that students provide.

Slide 25: Clarify that Harry cannot have RR genotype which also result in dark/brown hair color. The only possible genotype for his hair is Rr. Also ask students to consider what else the two Punnett Squares show about the possible hair colors that Harry's sibling could have. Guide students to think about the two different Punnett Squares and have them use the percentage to indicate the probability of each. For example, one Punnett Square shows that Harry's sibling has 50% chance of having brown/dark or red hair. But the other Punnett Square shows that his sibling will have brown/dark hair just like him—100% chance.

Slide 26-28: Restate Question 2 and ask students to volunteer their answer and explain how they arrived at the answer.

Slide 29: Display this Human Mendelian Trait Examples chart and distribute the Human Mandelian Traits worksheet. Allow students to work in pairs and have student pairs share their findings. Collect the completed worksheet to evaluate students' understanding of the concepts covered during the lesson.

Genetics in *Harry Potter*'s World
Lesson 2

- Beyond Mendelian Inheritance
- Genetics of Magical Ability

Rules of Inheritance

- Some traits follow the simple rules of Mendelian inheritance of dominant and recessive genes.
- Complex traits follow different patterns of inheritance that may involve multiples genes and other factors. For example,
  - **Incomplete or blended dominance**
  - **Codominance**
  - **Multiple alleles**
  - **Regulatory genes**

  Any guesses on what these terms may mean?

Incomplete Dominance

- Incomplete dominance results in a phenotype that is a blend of a heterozygous allele pair.
  Ex., **Red flower** + **Blue flower** => **Purple flower**

- If the dragons in *Harry Potter* have fire-power alleles F (strong fire) and F' (no fire) that follow incomplete dominance, what are the phenotypes for the following dragon-fire genotypes?
  - **FF**
  - **FF'**
  - **F'F'**

Incomplete Dominance

- **Incomplete dominance** results in a phenotype that is a blend of the two traits in an allele pair.
  Ex., **Red flower** + **Blue flower** => **Purple flower**

- If the Dragons in *Harry Potter* have fire-power alleles F (strong fire) and F' (no fire) that follow incomplete dominance, what are the phenotypes for the following dragon-fire genotypes:

Genotypes	Phenotypes
FF	**strong fire**
FF'	**moderate fire** (blended trait)
F'F'	**no fire**

Codominance

- **Codominance** results in a phenotype that shows <u>both traits</u> of an allele pair.
  Ex., **Red flower** + **White flower** => **Red** & **White** spotted flower

- If merpeople have tail color alleles **B** (blue) and **G** (green) that follow the codominance inheritance rule, what are possible genotypes and phenotypes?

<u>Genotypes</u> <u>Phenotypes</u>

Codominance

- **Codominance** results in a phenotype that shows <u>both traits</u> of an allele pair.
  Ex., **Red flower** + **White flower** => **Red** & **White** spotted flower (both traits)

- If merpeople have tail color alleles **B** (blue) and **G** (green) that follow the codominance inheritance rule, what are possible genotypes and phenotypes?

<u>Genotypes</u>	<u>Phenotypes</u>
BB	blue tail
GG	green tail
BG	blue & green tail (both traits)

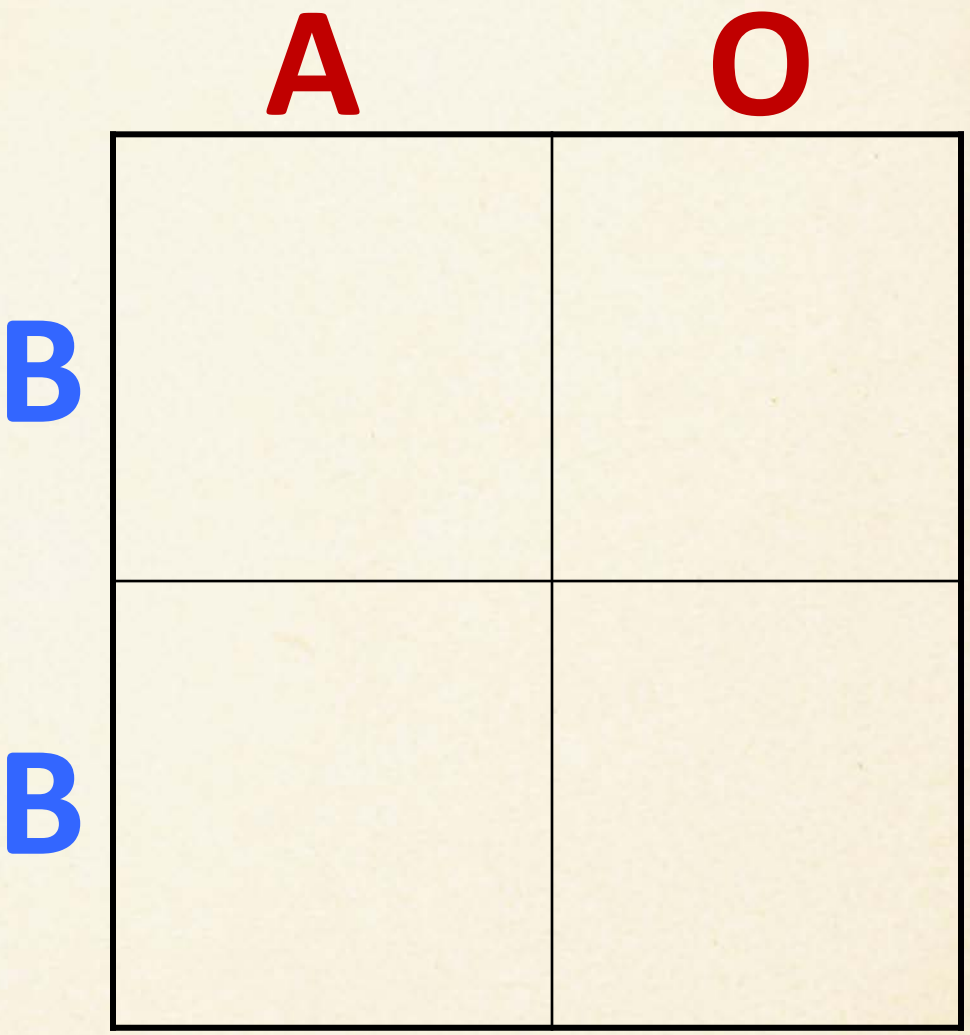
Multiple alleles

- **Multiple alleles** have more than 2 variations.
  Ex., human blood type has 3 different allele variants, A, B, and O.

Genotypes	Phenotypes
AA, AO	A blood type
AB	AB blood type
BB, BO	B blood type
OO	O blood type

Multiple Alleles: Human Blood type

If parents have A (AO) and B (BB) blood types, what are the possible genotypes and phenotypes of their children?



Multiple Alleles: Human Blood type

If parents have A (AO) and B (BB) blood types, what are possible genotypes and phenotypes of their children?

Genotypes: AB and BO

Phenotypes: AB and B blood types

	A	O
B	AB	BO
B	AB	BO

Regulatory Genes

- **Regulatory genes** regulate the expression of other genes.
- For example, a regulatory gene may 'silence' another gene from expressing its dominant trait. The Manx cat has no tail because it has a regulatory gene that silences the gene that expresses the tail. This tail-silencing gene is **dominant** and has possible alleles:

  S = silences tail gene = no tail (Manx cat)

  s = doesn't silence tail gene = has tail (non-Manx cat)

Question: Can 2 Manx cats without tails have a kitten with a tail? Show your answer using a Punnett square.

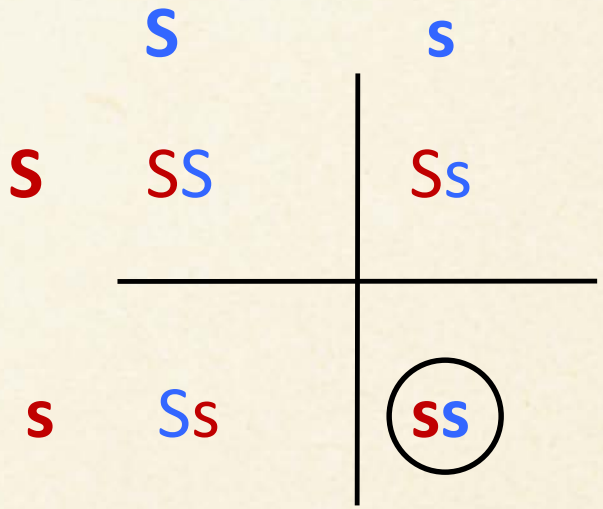
Regulatory Genes: Manx Cat

Question: Can 2 Manx cats without tails have a kitten with a tail? Show your answer using a Punnett square.

The possible alleles for the tail-silencing gene are:

S = no tail (dominant)

s = has tail (recessive)



Only if both parent cats have the heterozygous genotype, Ss. Then, there is a 25% chance for their having a kitten with a tail.

Complex Traits in *Harry Potter*

- What kind of gene inheritance may be responsible for Hagrid's height, which is about 12 feet?

- What is the genotype for Harry's eye color? If he had any siblings, what colors would their eyes be?

Complex Trait: Hagrid's Height

- Hagrid's father was a wizard and his mother was a giantess. The normal heights for giants and wizards are: Giants = about 20 ft. & Wizard = 5-6 ft.
- Given that Hagrid is described to be about 12 ft., what type of genetic inheritance may be at work for Hagrid's height?

Complex Trait: Hagrid's Height

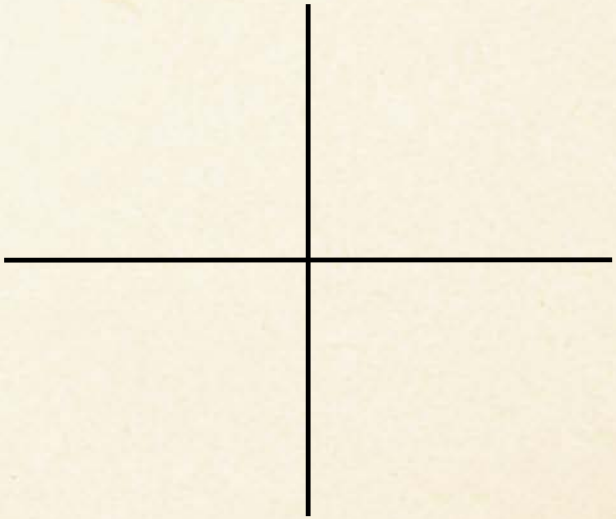
- Hagrid's father was a wizard and his mother was a giantess. The normal heights for giants and wizards are: Giants = 20-25 ft. & Wizard = 5-6 ft.
- Given that Hagrid is described to about 12 ft., what type of genetic inheritance may be at work for Hagrid's height?

Hagrid's height is close to the average of the heights of a wizard and a giantess, (5+20)/2=12.5 ft, which shows **incomplete dominance**.

Complex Trait: Hippogriff Coats

- Hippogriff coats come in many colors, like horse coats; coat color has multiple alleles:
  - **C** = chestnut (codominant with other colors)
  - **W** = white (codominant with other colors)
  - **B** = black (codominant with other colors)
- Draw a Punnett square for the parents of a red roan (**CW**) hippogriff. ("Red roan" means it's covered in both white hairs and chestnut hairs.)

One parent has a chestnut coat (**CC**). The other has a white coat (**WW**).



Complex Traits: Hippogriff Coats

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  - **C** = chestnut (codominant with other colors)
  - **W** = white (codominant with other colors)
  - **B** = black (codominant with other colors)
- Draw a Punnett square for the parents of a red roan (**CW**) hippogriff. ("Red roan" means it's covered in both white hairs and chestnut hairs.)

One parent has a chestnut coat (**CC**). The other has a white coat (**WW**). 100% of their offspring will have red roan coats (**CW**).

	W	**W**
C	**CW**	**CW**
C	**CW**	**CW**

Complex-Trait Activity: Magical Ability

(independent group activity)

In the *Harry Potter* series, characters are born with or without magical ability. Those with magical ability also show very strong, normal or weak ability.

Assuming that magical ability is inherited, identify the possible phenotypes and genotypes of the following characters: Harry, Hermione, Ron, Dumbledore, Aunt Petunia, and Mr. Filch

Hints: Start by identifying phenotypes which will provide possible genotypes. Also consider whether simple Mendelian or complex traits apply to the magical ability traits.

Complex-Trait Activity: Magical Ability

(guided activity)

In the *Harry Potter* series, characters are born with or without magical ability. Those with magical ability also show very strong, normal or weak ability.

Assuming that magical ability is a genetic trait, what are possible phenotypes and genotypes of the following characters?
Harry, Hermione, Ron, Dumbledore, Aunt Petunia, and Mr. Filch

Magical Ability: Possible Phenotypes

How would you describe the following characters' magical ability?

- Harry
- Hermione
- Ron
- Dumbledore
- Aunt Petunia
- Mr. Filch

Magical Ability: Possible Phenotypes

How would you describe the following characters' magical ability?

- Harry has strong magical ability
- Hermione has strong magical ability
- Ron has average magical ability
- Dumbledore has strong magical ability
- Aunt Petunia has no magical ability
- Mr. Filch has weak magical ability

The descriptions divide into two different categories of observable traits—1) expression and 2) strength of magical ability, which may indicate two genes responsible for the ability.

Magical Ability: Possible Phenotypes

How would you describe the following characters' magical ability?

- Harry has strong magical ability
- Hermione has strong magical ability
- Ron has average magical ability
- Dumbledore has strong magical ability
- Aunt Petunia has no magical ability
- Mr. Filch has weak magical ability

Each category of magical ability description represents a gene responsible for certain observable traits:

Expression—has the ability or doesn't have the ability

Strength—has strong, average, or weak magical ability

Magical Ability: Possible Genotypes

What are the possible genotypes that may correspond to the 2 genes (expression and strength of magical ability) below?

Gene 1: expression of magical ability

- Expressed (witches & wizards)
- Not expressed (Muggles do not have magical ability)

Gene 2: strength of magical ability

- Strong
- Average
- Weak (i.e., squibs)

Hint: Are the two phenotypes complex traits and not simple Mendelian traits? If so, what type of complex trait are they?

Magical Ability: Possible Genotypes

What are possible genotypes for the phenotypes of expressed and not expressed magical ability?

- Two Muggle parents can have a child with magical ability, like Hermione➔ Muggles must have a gene for magic that is not expressed or silenced by another regulatory gene.
- The possible alleles for the silencing gene are: **S (dominant)** or **s (recessive)**. The genotypes of the allele pair for expressed or not expressed phenotypes are:

  Expressed (witches & wizards) **—ss**

  Not expressed (Muggles) **—SS, Ss**

Magical Ability: Possible Genotypes

What are possible genotypes for the phenotypes of the strength of magical ability?

- There are three phenotypes described for the strength of magical ability: strong, average, or weak.
- Given "strong + weak=average", the magical strength gene with **M (strong ability)** and **M' (weak ability)** alleles affected by incomplete dominance can produce the genotypes corresponding to the three different phenotypes:

  Strong ability **—MM**
  Average ability**—MM'** (incomplete dominance)
  Weak ability (i.e., squibs) **—M'M'**

Magical Ability: Possible Genotypes

Summary of phenotypes and genotypes for magical ability

There are two genes related to magical ability. Possible genotypes of the two genes (two pairs of alleles) are:

Expressed (witches & wizards) **—ss**
Not expressed (muggles) **—Ss, SS** (silencing gene)

Strong **—MM**
Good/normal**—MM'** (incomplete dominance)
Weak (i.e., squibs) **—M'M'**

Magical Genes: Summary of 2 Genes

- Must be **ss** to have magical ability:
  - **MMss** = very powerful wizard
  - **MM'ss** = average wizard
  - **M'M'ss** = very weak wizard (or squib)

- If you have at least one **S** you are a Muggle:
  - **MMSs**, **MM'Ss**, **M'M'Ss** = a Muggle who could have children with magical ability with a spouse with at least one **s**
  - **MMSS**, **MM'SS**, **M'M'SS** = a Muggle who would never have children with magical ability

Magical Ability: Characters' Genotypes

Using the genotype summary, what are possible genotypes of each character?

- Harry: strong magical ability **(MMss)**
- Hermione: average magical ability **(MMss)**
- Ron: average magical ability **(MM'ss)**
- Dumbledore: strong magical ability **(MMss)**
- Aunt Petunia: no magical ability **(MMSs, MM'Ss, M'M'Ss, MMSS, MM'SS, M'M'SS)**
- Mr. Filch: weak magical ability **(M'M'ss)**

Magic Runs in Families

Answer the following questions and provide reasoning for your answers:

- Hermione's possible genotype is **MMss**, indicating her strong magical ability. What are possible genotypes of Hermione's parents who are Muggles without the ability?
- Harry Potter married Ginny Weasley. Will all of their children have magical ability?
- Could Dudley Dursley potentially have children with magical ability?

Hermione's Parents

Question: What are possible genotypes of Hermione's parents who are Muggles (no magical ability)?

- Hermione's genotype is **MMss**.
  - For Hermione's inherited **ss**, both of her Muggle parents must have **Ss**.
  - For Hermione's inherited **MM**, both parents may have **MM** or **MM'**, but neither parents can have **M'M'** allele pair.
- Hermione's parents' possible genotypes are:
  - **MMSs**, or **MM'Ss**

Harry and Ginny's Children

Question: Will all of Harry and Ginny's children have magical ability?

- Parents' magical genes:
  - Harry's genotype is **MMss**.
  - Ginny's genotype may be **MMss** or **MM'ss**.
- Harry's and Ginny's children's genotypes:
  - Since Harry and Ginny each has an **ss** allele pair, they can only pass **s** alleles to their children. Therefore, all of their children having inherited **ss** allele pair, have magical ability.

Dudley's Children

Question: Could Dudley Dursley potentially have children with magical ability?

- Dudley's parents' genotypes:
  - **Vernon Dursley** is about as magic-less as one can get. So let's assume Vernon's genotype is **M'M'SS**.
  - **Petunia**'s sister Lily Potter had magical ability. So, Petunia can have a genotype of **SS** or **Ss** allele pair.
- Dudley's genotypes:
  - If Dudley inherited **S** allele from both parents, he cannot have kids with magical ability.
  - If Dudley inherited an **s** allele from Petunia, he can have kids with magical ability with a Muggle with an **Ss** allele pair, or a witch possessing an **ss** allele pair.

Lesson 2 slide notes for teachers

Slide 1: Return students' completed Human Mendelian Traits worksheets and review the Mendelian inheritance concept along with genetic terms covered in previous lesson.

Slide 2: Have students guess how these examples of genetic rules may work. Encourage students to guess a definition or provide an example for each term

Slide 3: Define and provide an example for incomplete dominance, and help students understand and apply the concept to the dragon's fire power. Students may ask about using F and F' instead of lower and upper-case letters. Provide clarification that lower and upper-case letters are used to indicate alleles with dominant or recessive traits. And explain that incomplete dominance is indicated with apostrophe (') on an upper case letter.

Slide 4: Provide the answers for the phenotypes related to the three different genotypes for the dragon-fire trait.

Slide 5: Define and provide an example for codominance, and help students understand and apply the concept to merpeople's tail colors. Clarify the important distinction between codominance and incomplete dominance--the former resulting in a blended or averaged phenotype, the latter showing a mixture of two traits, each trait being observable.

Slide 6: Provide the answers for both genotypes and phenotypes for merpeople's tail colors.

Slide 7: Explain the multiple alleles—more than 2 variant forms of a gene—related to human blood types. Students may observe additional relationship among the blood types: O is recessive to A and B; A and B are codominant. However they may also notice that the recessive O blood type does not use lower case letter as all blood types are indicated with upper case letters.

Slide 8: Guide and review with students how to use the Punnett square to determine possible blood types of children with known genotypes of parents' blood-types.

Slide 9: Compare students' answers and provide further explanation as needed.

Slide 10: Define and provide the example of a silencing regulatory gene in Manx cats. Have students work in pairs to answer whether two Manx cats without tails can have a kitten with a tail.

Slide 11: Have student pairs volunteer their answers and review the answer using a Punnett square.

Slide 12: Pose these two questions and help students think about the types of information that they should consider to answer the questions.

Slide 13: Demonstrate how Hagrid's height might be a phenotype of an incomplete/blended trait. Concerning estimated average heights for wizards and giants, wizards are humans whose average height may be about 5-6 ft., and giants' height is approximated at 20 ft. by Hermione at the beginning of the chapter 24 in *Harry Potter and the Goblet of Fire*.

Slide 14: If necessary, remind students of the examples of incomplete dominance using previous slide 4.

Slide 15: Inform students about the multiple alleles related to hippogriff coat colors. Have students use the Punnett square to determine possible genotypes for different hippogriffs.

Slide 16: Have students provide their findings and use this slide to guide and clarify reasoning behind the answers.

Slide 17: If appropriate, have students work in groups of 3 or 4 to find the genotypes of several characters in *Harry Potter*. Support those students with little knowledge of *Harry* Potter, by provide background information on each character. Brief descriptions of these characters are available in the Vocabulary section of the lesson plan web site.

Have groups present their answers, along with how they arrived at their answers. When reviewing student groups' work, use the slides 19-27 to guide students in applying the concepts that they have learned in identifying the characters' possible genotypes of their magical ability.

Slide 18: Present the guided activity. Have students work in groups of 3 so that the activity is conducted as question-and-answer sessions that alternate between group work and class discussion.

Slide 19: Have students describe the characters' magical ability. If groups differ in their descriptions, you can determine the description by majority vote.

Guide students to think about how to define different kinds/categories of magical ability that apply to all characters, such as Hermione (a powerful witch whose parents do not have any magical ability), Mr. Filch (a squib with very weak magical power, although he is of a wizarding family), and aunt Petunia (a Muggle who has no magical power and whose parents were also Muggles, but has a sister, Harry's mom, with magical power).

Slides 20-22, walk through identifying two categories (i.e., genes) of magical traits demonstrated by the characters, which is one way to be inclusive of different observable magical traits in the characters in *Harry Potter*.

Slide 20: List the characters' magical ability that is represented in two categories of the descriptions of magical ability observed among the characters. This includes Harry's aunt, Petunia who has no magical ability that is defined as a Muggle in the *Harry Potter* novels.

Have students review all different observable traits related to magical ability—different strengths of magical ability (strong, average, or weak) as well as the presence or expression of the ability.

Help students build a connection from the two categories of observable magical traits to the corresponding two genes that are responsible for the two categories of observable magical traits: 1) expression of magical ability, and 2) strength of the ability.

Slide 21: Help students distinguish the two different categories/genes that affect magical ability and identify the possible observable traits from the characters' descriptions above.

Slide 22: Have students work in their groups to identify possible genotypes for the two genes' phenotypes—expressed or unexpressed magical ability; and strong, average or week ability—that the characters demonstrate.

State the hint and help students apply their understanding of the complex traits they learned about previously. If appropriate, provide additional hints by reminding students about the previous examples of different complex traits—Manx cats' regulatory gene that silences the 'expression' of a tail; and dragon fire power under incomplete dominance creating an 'average' trait between strong and no fire power.

Slide 23: Have student groups share the possible genotypes for the expression of magical ability.

Ask what types of inheritance rule(s) they applied to create genotypes that account for all possibilities of how magical ability is expressed or not expressed in the characters—i.e., does it include Muggles, who show no magical ability but can have a child with magical ability?

Guide students in expressing their reasons behind how they determined the possible genotypes for the phenotypes of the characters' magical ability. Work through misconceptions through discussion, and clarify that Muggles with no

magical ability seem to have a gene for magic as they are able to produce children with the ability, such as Hermione and Lily. And this doesn't allow magical ability to be simply dominant or recessive, in which case the Muggles will not be able to have children with magical ability. One possible way for magical ability not to express but for its gene to be passed down to the next generation is if there is another gene that regulates (silences or expresses) the gene for magic.

Slide 24: Have student groups share the possible genotypes for the strength of magical ability. Clarify that this gene may be silenced or expressed by the other regulatory gene, but also is responsible for how powerful the magical ability is—strong, average, or weak.

Ask student groups to demonstrate how their possible genotypes account for all possibilities of magical strength demonstrated by the characters. Discuss that one way to account for the three different magical strengths is to apply incomplete/blended dominance to the gene for the strength of magical ability. If needed, review slide 4 where examples were presented earlier in the lesson.

Slide 25: Summarize all possible genotypes for the two genes—a gene for expression of magical ability and another gene for strength of magical ability.

Slide 26: Apply the possible genotypes of the two genes to the phenotypes of witches, wizards, and Muggles, and the strength of magical ability they demonstrate.

If needed, explain that the letters represent the two allele pairs in the two genes—one regulatory and the other magic strength genes—that affect magical ability.

Slide 27: Have student groups assign possible genotypes for the magical ability of the characters. As groups volunteer their answers, use the Summary slide 26 to clarify as needed.

Slide 28: Distribute the handout to all students and have students work in their groups to answer these three questions.

If appropriate, display slides 25 and 26 for students to refer to as they work to answer the questions on the handout.

Slide 29: Have student groups volunteer their answers and how they arrived at their answers. Clarify and correct answers as needed.

Slide 30: Have student groups volunteer their answers and how they arrived at their answers. Clarify and correct answers as needed.

Slide 31: Have student groups volunteer their answers and how they arrived at their answers. Clarify and correct answers as needed.

Student Name _____
Date _____
Class Period _____

Word Match Activity

Instructions: Match the following genetic terms to their corresponding parts of the illustration: **base pair, cell, chromosome, DNA (Deoxyribonucleic Acid), double helix*, genes, nucleus**

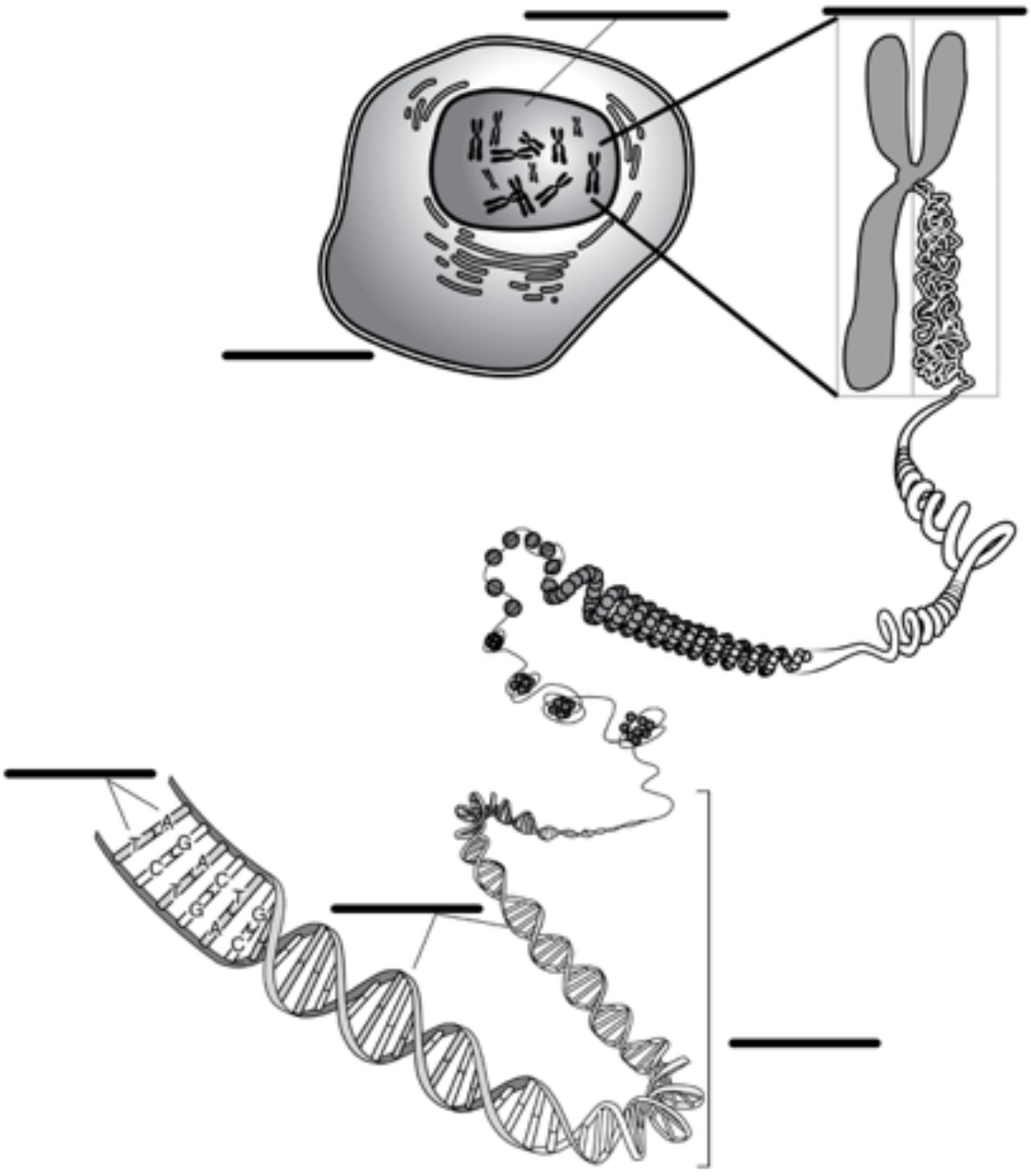


Illustration Source: Talking Glossary of Genetic Terms http://www.genome.gov/glossary.cfm?key=chromosome

Student Name _____
Date _____
Class Period _____

Teacher's Word Match Activity

Instructions: Match the following genetic terms to their corresponding parts of the illustration: **base pair, cell, chromosome, DNA (Deoxyribonucleic Acid), double helix*, genes, nucleus**

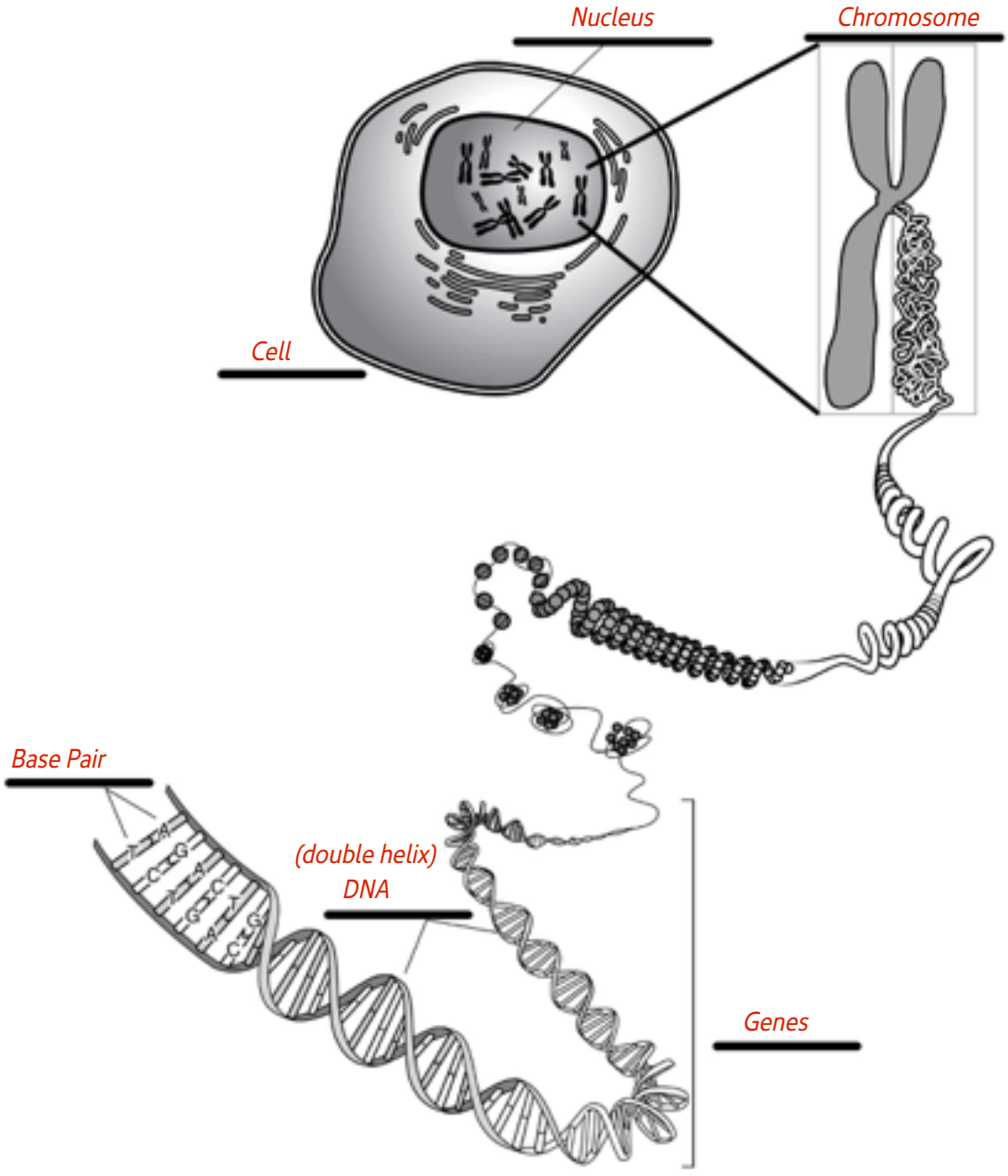


Illustration Source: Talking Glossary of Genetic Terms http://www.genome.gov/glossary.cfm?key=chromosome

Student Name _____
Date _____
Class Period _____

Basic Genetic Terms

Instructions: Use the available reference resources to complete the table below. After finding out the definition of each word, rewrite the definition using your own words (middle column), and provide an example of how you may use the word (right column).

Genetic Terms	Definitions in Your Own Words	An Example
Allele		
Genes		
Dominant		
Recessive		
Homozygous		
Heterozygous		
Genotype		

Student Name _____
Date _____
Class Period _____

Basic Genetic Terms

Genetic Terms	Definitions in Your Own Words	An Example
Phenotype		
Mendelian Inheritance		

Student Name _____
Date _____
Class Period _____

Teacher's Basic Genetic Terms

Instructions: Use the available reference resources to complete the table below. After finding out the definition of each word, rewrite the definition using your own words (middle column), and provide an example of how you may use the word (right column).

Genetic Terms	Definitions in Your Own Words	An Example
Allele	*Different forms of a gene, which produce variations in a genetically inherited trait.*	*Different alleles produce different hair colors—brown, blond, red, black, etc.*
Genes	*Genes are parts of DNA and carry hereditary information passed from parents to children.*	*Genes contain blue- print for each individual for her or his specific traits.*
Dominant	*Dominant version (allele) of a gene shows its specific trait even if only one parent passed the gene to the child.*	*When a child inherits dominant brown- hair gene form (allele) from dad, the child will have brown hair.*
Recessive	*Recessive gene shows its specific trait when both parents pass the gene to the child.*	*When a child inherits recessive blue- eye gene form (allele) from both mom and dad, the child will have blue eyes.*
Homozygous	*Two of the same form of a gene—one from mom and the other from dad.*	*Inheriting the same blue eye gene form from both parents result in a homozygous gene.*
Heterozygous	*Two different forms of a gene—one from mom and the other from dad are different.*	*Inheriting different eye color gene forms from mom and dad result in a heterozygous gene.*
Genotype	*Internal heredity information that contain genetic code.*	*Blue eye and brown eye have different genotypes—one is coded for blue and the other for brown.*

Student Name _____
Date _____
Class Period _____

Teacher's Basic Genetic Terms

Genetic Terms	Definitions in Your Own Words	An Example
Phenotype	*Outwardly expressed traits or characteristics.*	*Both having or not having a widow's peak are phenotypes.*
Mendelian Inheritance	*A simple genetic rule where a gene only comes in dominant or recessive forms.*	*Some genetic traits follow Mendelian Inheritance, while other genetic traits follow different inheritance patterns or rules.*

Student Name _____
Date _____
Class Period _____

Harry Potter Terms and Characters

The following characters and terms from the *Harry Potter* series are found in this lesson plan.

- **Muggles** in the Harry Potter series refer to those who show no magical ability. For example, people who live unaware of the magical world are called Muggles by witches and wizards with magical ability.
- **Harry,** a wizard, is the son of **Lily and James Potter**. Lily Potter had two parents without any magical ability—i.e., Muggles. Lily's sister, **Petunia**, does not have the ability either.
- **Hermione** is one of Harry's best friends and is a powerful witch. She has parents who are Muggles, meaning they do not possess magical ability.
- **Ron Weasley,** another wizard, is one of Harry's best friends and is the son of **Mr. and Mrs. Weasley**, and **Ginny Weasley's** brother. He has other siblings, all of whom have red hair and freckles.
- **Dumbledore** is a powerful wizard who is the headmaster of the Hogwarts School of Witchcraft and Wizardry.
- **Mr. Filch** is the caretaker of the Hogwarts School of Witchcraft and Wizardry. Both of his parents have magical ability, but he has very weak magical ability, himself. Witches and wizards with weak magical ability are called **squibs** in the Harry Potter series.
- **Dudley Dursley** is Harry's cousin, the only son of his maternal aunt, **Petunia**, who is married to **Vernon Dursley**.
- **Hagrid** is the Keeper of the Keys and Grounds of Hogwarts School of Witchcraft and Wizardry, and teaches the class, Care of Magical Creatures. His father was a human wizard, while his mother was a giantess.
- A **hippogriff** is a creature with the head, wings, and forelimbs of a giant eagle, and the body of a horse. Their coat colors come in the same varieties as horses' coats (e.g., chestnut, black, gray, roan, white, etc.)

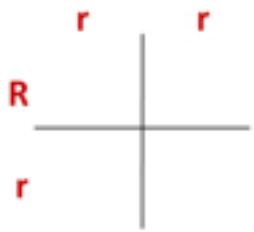
**For information on more characters and lineages from the Harry Potter series, refer to* The Harry Potter Lexicon at *www.hp-lexicon.org.*

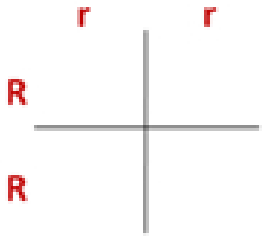
Student Name _____
Date _____
Class Period _____

Hair Colors

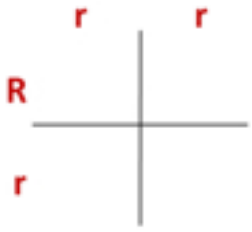
Instructions: Solve the two questions below and use a Punnett square to demonstrate how you arrived at your answers.

Question 1: Harry has dark hair like his father, but his mom had red hair. Using the genotypes of rr (red hair), Rr (dark/brown hair), RR (dark/brown hair), what possible genotypes does each of the Potters have?





Question 2: Harry marries Ginny who has red hair. What are possible genotypes of their children's hair colors?



Student Name _____
Date _____
Class Period _____

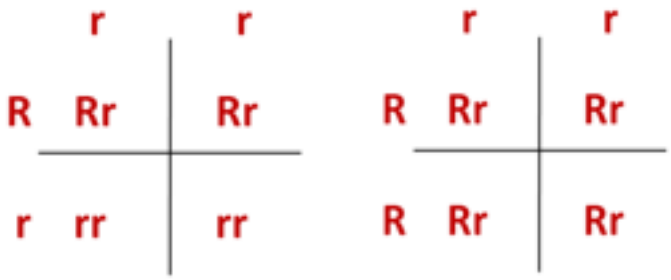
Teacher's Hair Colors

Instructions: Solve the two questions below and use a Punnett square to demonstrate how you arrived at your answers.

Question 1: Harry has dark hair like his father, but his mom had red hair. Using the genotypes of rr (red hair), Rr (dark/brown hair), RR (dark/brown hair), what possible genotypes does each of the Potters have?

The phenotypes of the Potters are:
James Potter (dad)—dark/brown hair→ Rr or RR
Lily Potter (mom)—red hair→ rr
Harry Potter—dark/brown hair→ Rr

- *In this situation, the only possible genotype for Harry's dark hair is Rr.*



Question 2: Harry marries Ginny who has red hair. What are possible genotypes of their children's hair colors?

Given Harry and Ginny's genotypes, Rr and rr, we can fill in the Punnett Square for their children's genotypes.

- *Their children have a 50% chance of being either red-or dark-haired.*

Student Name _____
Date _____
Class Period _____

Human Mendelian Traits

Mendelian Traits are those traits which follow Mendel's rules of only 2 possible versions of a gene (1 dominant, 1 recessive). There are only a few examples of this in humans.

1. Use the chart below to determine your phenotype (observable characteristic) and possible genotype(s) (a pair or pairs of alleles). Since you cannot do a genetic test right now, if you have the dominant phenotype, you should include both the homozygous and heterozygous genotypes—see the example for Advanced Sleep Phase Syndrome in the first row.

Trait	**Possible Alleles**	**Your Phenotype**	**Your Genotype(s)**
Advanced Sleep Phase Syndrome	Wakes up very early (E) Wakes up at normal time (e)	*Ex., wakes up very early*	*EE (homozygous) or Ee (heterozygous)*
Achoo Syndrome	Sneezes in the sun (A) Doesn't sneeze in the sun (a)		
Ear wax (wet/dry)	Wet (W) Dry (w)		

2. Did you have mostly dominant or recessive traits? _____

3. Compare your findings with other students.

   a. For which trait were most students dominant?

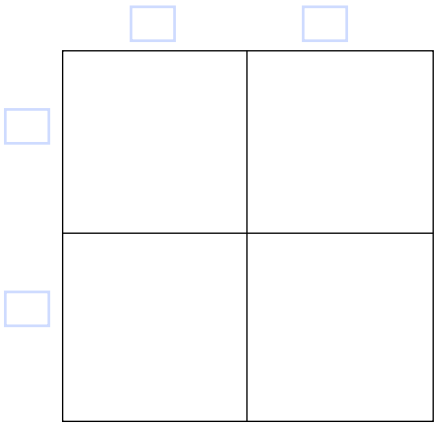
   b. For which trait were most students recessive?

Student Name _____
Date _____
Class Period _____

4. First complete the Punnett Squares below using your own genotype for each trait. If you have a dominant trait, choose to use either the heterozygous or homozygous genotype. The other person's genotype is provided. After completing the Punnett Square, identify possible phenotypes of offspring and the probability of each phenotype in percentage.

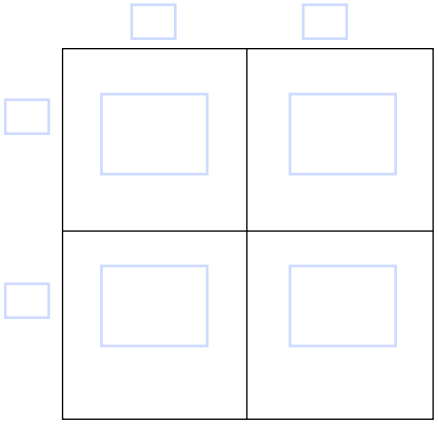
a) Achoo Syndrome genotypes: Yours _____ & the other person's Aa.

List Possible Phenotypes **% (Probability of Inheritance)**



b) Ear wax genotypes: Yours _____ & the other person's ww.

List Possible Phenotypes **% (Probability of Inheritance)**



Student Name _____
Date _____
Class Period _____

Teacher's Human Mendelian Traits

Mendelian Traits are those traits which follow Mendel's rules of only 2 possible versions of a gene (1 dominant, 1 recessive). There are only a few examples of this in humans.

1. Use the chart below to determine your phenotype (observable characteristic) and possible genotype(s) (a pair or pairs of alleles). Since you cannot do a genetic test right now, if you have the dominant phenotype, you should include both the homozygous and heterozygous genotypes—see the example for Advanced Sleep Phase Syndrome in the first row.
   [Note: Review each trait to ensure that students know what to look for.]

Trait	**Possible Alleles**	**Your Phenotype**	**Your Genotype(s)**
Advanced Sleep Phase Syndrome	Wakes up very early (E) Wakes up at normal time (e)	*Ex., wakes up very early*	*EE (homozygous) or Ee (heterozygous)*
Achoo Syndrome	Sneezes in the sun (A) Doesn't sneeze in the sun (a)		
Ear wax (wet/dry)	Wet (W) Dry (w)		

2. Did you have mostly dominant or recessive traits? _____
   [Note: Discuss with students what may affect the balance between the number of dominant and recessive traits. Use the class data to point out that a dominant gene isn't always the most common trait observed. For examples, your students' data may show that there are fewer people with Achoo Syndrome, even though it is a dominant trait.]

3. Compare your findings with other students.
   [Note: This is to help students practice applying the terms "dominant" and "recessive." Clarify so that students understand that the dominance and recessiveness of these traits do not indicate that one is better than the other. If needed, have students consider how a recessive gene, although not expressed phenotypically in a parent, can be passed to offspring, keeping the recessive gene in the gene pool.]

   a. For which trait were most students dominant?

   b. For which trait were most students recessive?

Student Name _____
Date _____
Class Period _____

4. First complete the Punnett Squares below using your own genotype for each trait. If you have a dominant trait, choose to use either the heterozygous or homozygous genotype. The other person's genotype is provided. After completing the Punnett Square, identify possible phenotypes of offspring and the probability of each phenotype in percentage.

[Note: Use the following exercises to assess students' proficiency and provide additional instructions as needed, so that they become comfortable using the Punnett square.]

a) Achoo Syndrome genotypes: Yours _____ & the other person's Aa.

List Possible Phenotypes **% (Probability of Inheritance)**

b) Ear wax genotypes: Yours _____ & the other person's ww.

List Possible Phenotypes **% (Probability of Inheritance)**

Student Name _____
Date _____
Class Period _____

Complex Traits

1) Incomplete dominance

Let's assume that dragons show incomplete dominance for fire breathing. The Fallele provides lots of fire and the F' allele gives no fire. (a) If a dragon that has very strong fire is crossed with a dragon that has moderate fire, what will their offspring be like? (b) Under what conditions can a baby dragon be born that never has fire? Justify your answer with Punnett Squares.

2) Codominance

Let's say that the color of merpeople's tail is controlled by a codominant gene and the alleles are blue (B) and green (G). Show a cross between two merpeople who have bluish-green tails (BG). Give the offspring phenotypes with percentages.

Student Name _____
Date _____
Class Period _____

Teacher's Complex Traits

1) Incomplete dominance

Let's assume that dragons show incomplete dominance for fire breathing. The Fallele provides lots of fire and the F' allele gives no fire. (a) If a dragon that has very strong fire is crossed with a dragon that has moderate fire, what will their offspring be like? (b) Under what conditions can a baby dragon be born that never has fire? Justify your answer with Punnett Squares.

[Note:

a) Parent dragons with FF (strong) and FF' (moderate) have a 50% chance of having a baby dragon with strong fire (FF) or with moderate fire (FF').

b) A baby dragon with no fire (F'F') can be produced by two dragons with no fire (F'F' X F'F'), both with moderate fire (FF' X FF'), or one with no fire and the other with moderate fire (F'F' X FF').]

2) Codominance

Let's say that the color of merpeople's tail is controlled by a codominant gene and the alleles are blue (B) and green (G). Show a cross between two merpeople who have bluish-green tails (BG). Give the offspring phenotypes with percentages.

[Note: Between parents with BG and BG tail color genotype, their children have 50% chance having blue-green tails and 25% chance having blue or green tails.]

Student Name _____
Date _____
Class Period _____

Magic Runs in Families

Instructions: Use the genetic concepts and terms you have learned to find answers and explain your answers to the following three questions.

Question 1: Hermione's possible genotypes are MMss or MM'ss. What are possible genotypes of Hermione's parents who are Muggles?

Question 2: Harry Potter married Ginny Weasley. Will all of their children have magical ability?

Question 3: Could Dudley Dursley potentially have children with magical ability?

Student Name _____
Date _____
Class Period _____

Teacher's Magic Runs in Families

Instructions: Use the genetic concepts and terms you have learned to find answers and explain your answers to the following three questions.

Question 1: Hermione's possible genotypes are MMss or MM'ss. What are possible genotypes of Hermione's parents who are Muggles?

- *Hermione's genotype is MMss.*
  - *For Hermione's inherited ss, both of her Muggle parents must have Ss.*
  - *For Hermione's inherited MM, both parents may have MM or MM', but neither parents can have M'M' allele pair.*
- *Hermione's parents' possible genotypes are:*
  - *MMSs, or MM'Ss*

Question 2: Harry Potter married Ginny Weasley. Will all of their children have magical ability?

- *Parents' magical genes:*
  - *Harry's genotype is MMss.*
    - *Ginny's genotype may be MMss or MM'ss.*
- *Harry's and Ginny's children's genotypes:*
  - *Since Harry and Ginny each has an ss allele pair, they can only pass s alleles to their children. Therefore, all of their children having inherited ss allele pair, have magical ability.*

Question 3: Could Dudley Dursley potentially have children with magical ability?

- *Dudley's parents' genotypes:*
  - *Vernon Dursley is about as magic- less as one can get. So let's assume Vernon's genotype is M'M'SS.*
  - *Petunia's sister Lily Potter had magical ability. So, Petunia can have a genotype of SS or Ss allele pair.*
- *Dudley's genotypes:*
  - *If Dudley inherited S allele from both parents, he cannot have kids with magical ability.*
  - *If Dudley inherited an s allele from Petunia, he can have kids with magical ability with a Muggle with an Ss allele pair, or a witch possessing an ss allele pair.*

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Monster Genetics Lab

You have learned about many different patterns of inheritance. Some are simple dominant or recessive, as in Mendelian traits. Some are more complex, such as incomplete dominant or codominant traits. In this lab you will investigate how a combination of these genes works to create an organism.

Part 1 Procedure:

1. Flip a coin twice to determine the genotype for each trait and record it in the data table.

   Heads = allele 1, Tails = allele 2 (Example: if you flipped heads twice, your monster will have two copies of allele 1 for his genotype.)

2. Determine the phenotype resulting from the allele pair for each trait.

3. Repeat steps 1-2 for each trait and complete the female monster's Table 1.

Table 1: Genotypes & Phenotypes for Female Monster

Trait	Allele 1	Allele 1	Genotype	Phenotype
Eye	Two small eyes (E)	One large eye (e)		
Eye Color (incomplete)	Red (R)	White (R')		
Skin Color (codominant)	Green (G)	Blue (B)		
Tail Shape	Curly (C)	Straight (c)		
Tail Color	Purple (P)	Orange (p)		
Tail (regulatory gene)	Have tail (T)	No tail (t)		
Teeth	Sharp (S)	Round (s)		

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Trait	Allele 1	Allele 1	Genotype	Phenotype
Feet (incomplete)	Four toes (F)	Two toes (F')		
Horn Color	Purple (W)	White (w)		
Ear shape	Pointy (Y)	Round (y)		
Ears (regulatory)	No ears (N)	Two ears (n)		
Claws	Long (L)	Short (l)		

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Monster Genetics Lab

Part 2 Procedure:

The female monster (described in Table 1) and a male monster (see Table 2 below) plan to have baby monsters. They are interested in finding out for each trait the probability that their offspring will have that trait.

1. Fill in the missing genetic information in the table for the male.

Table 1: Genotypes & Phenotypes for Female Monster

Trait	Genotype	Phenotype
Eyes	ee	
Eye Color (incomplete)		White
Skin Color (codominant)		Green
Tail Shape		Straight
Tail Color	Pp	
Tail (regulatory gene)		No Tail
Teeth		Round
Feet (incomplete)	FF'	
Horn Color	ww	
Ear shape	yy	

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Monster Genetics Lab

Trait	Genotype	Phenotype
Ears (regulatory)		Have 2 ears
Claws		Short

2. Create Punnett squares (attach your work to this handout) to predict what traits would result from a cross between the two monsters for each trait, and answer the following questions:

a. Eyes – What percent of offspring will have only one eye? _____

b. Eye Color – What percent of offspring will have red eyes? _____

c. Skin Color – What percent of offspring will have green skin? _____

d. Tail – What percent of offspring will have a tail? _____

e. Feet – What percent of offspring will have three toes? _____

f. Horn Color – What percent of offspring will have purple horns? _____

g. Ears – What percent of offspring will have ears? _____

h. Claws – What percent of offspring will have long claws? _____

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Teacher's Monster Genetics Lab

[Note: The two lab activities allow students to apply their knowledge of simple and complex genetic traits. Students demonstrate how they are able to apply and synthesize what they have learned in a fun activity. If possible, allow students to illustrate both parent and child monsters based on the genetic information identified for all three monsters during the lab.]

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Part 1 Procedure:

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Tail Color	Purple (P)	Orange (p)		
Tail (regulatory gene)	Have tail (T)	No tail (t)		

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Trait	Allele 1	Allele 1	Genotype	Phenotype
Teeth	Sharp (S)	Round (s)		
Feet (incomplete)	Four toes (F)	Two toes (F')		
Horn Color	Purple (W)	White (w)		
Ear shape	Pointy (Y)	Round (y)		
Ears (regulatory)	No ears (N)	Two ears (n)		
Claws	Long (L)	Short (l)		

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Teacher's Monster Genetics Lab

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1. Fill in the missing genetic information in the table for the male.

Table 1: Genotypes & Phenotypes for Female Monster

Trait	Genotype	Phenotype
Eyes	ee	
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Skin Color (codominant)		Green
Tail Shape		Straight
Tail Color	Pp	
Tail (regulatory gene)		No Tail
Teeth		Round
Feet (incomplete)	FF'	
Horn Color	ww	
Ear shape	yy	

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Teacher's Monster Genetics Lab

Trait	Genotype	Phenotype
Ears (regulatory)		Have 2 ears
Claws		Short

2. Create Punnett squares (attach your work to this handout) to predict what traits would result from a cross between the two monsters for each trait, and answer the following questions:

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g. Ears – What percent of offspring will have ears? _____

h. Claws – What percent of offspring will have long claws? _____