#### **Incomplete** Dominance

 Incomplete dominance results in a phenotype that is a <u>blend</u> 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 N (no fire) that follow incomplete dominance, what are the phenotypes for the following dragon-fire genotypes?

- FF
  - FN
  - -NN

#### **Incomplete** Dominance

 Incomplete dominance results in a phenotype that is a <u>blend</u> 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 N (no fire) that follow incomplete dominance, what are the phenotypes for the following dragon-fire genotypes:

<u>GenotypesPhenotypes</u>

**FFstrong fire** 

**FNmoderate fire** (blended trait) **NNno fire** 

## Codominance

 Codominance results in a phenotype that shows both traits 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>GenotypesPhenotypes</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>GenotypesPhenotypes</u>

BB blue tailGG green tailBGblue & green tail (both traits)

#### **Regulatory Genes**

- Regulatory genes <u>regulate</u> 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)

# **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 <u>average</u> of the heights of a wizard and a giantess, (5+20)/2=12.5 ft, which shows **incomplete dominance**. 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 the 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 the 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

How would you describe the following characters' magical ability?

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

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. 11

How would you describe the following characters' magical ability?

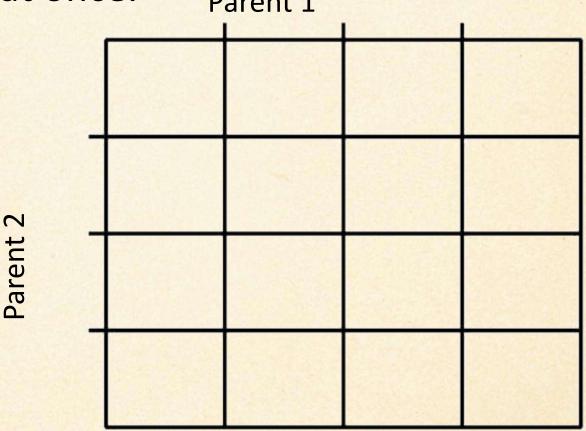
- Harry has strong magical ability
- Hermione has strong magical ability
- Ron has average magical ability
- Dumbledore has strong magical ability
- Aunt Petunia has no magical ability
- Mr. Filch has weak magical ability

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

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

<u>Strength</u>—has strong, average, or weak magical ability

 Introducing: Dihybrids. They allow you to cross two genes at once.
 Parent 1



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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?

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 <u>silenced by another regulatory gene</u>.
- 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

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) mm

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) – mm

### Magical Genes: Summary of 2 Genes

- Must be ss to have magical ability:
  - MMss = very powerful wizard
  - Mmss = average wizard
  - mmss = very weak wizard (or squib)
- If you have at least one S you are a Muggle:
  - MMSs, MmSs, mmSs = a Muggle who could have children with magical ability with a spouse with at least one s
  - MMSS, MmSS, mmSS = 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 (Mmss)
- Dumbledore: strong magical ability (MMss)
- Aunt Petunia: no magical ability (MMSs, MmSs, mmSs, MMSS, MmSS, mmSS)
- Mr. Filch: weak magical ability (mmss)

# 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 mm allele pair.

Hermione's parents' possible genotypes are:

– MMSs, or MmSs

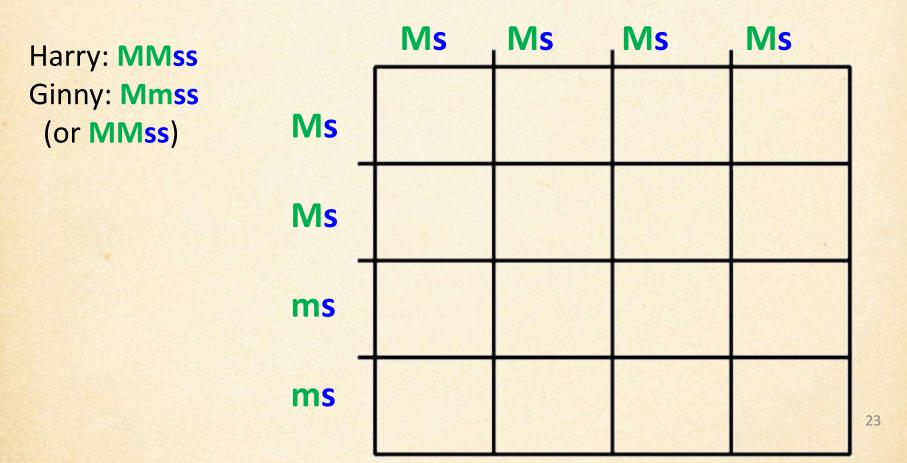
### Harry and Ginny's Children

**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 Mmss.
- 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.

# Magic Runs in Families: Harry & Ginny

You pair one gene allele with another like so...



# 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 mmSS.

-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.