Beyond Mendel's Laws

Incomplete Dominance
Co-dominance and
Multiple Alleles

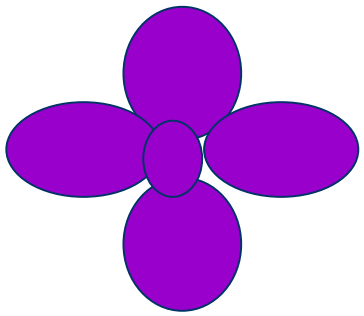
Mendel's Studies

- He found …
  - that inherited traits were either dominant or recessive
  - Dominant alleles expresses over the recessive always

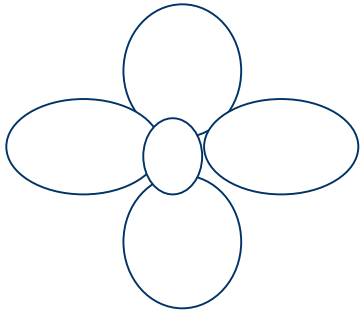
Review: Dominant/Recessive

- One allele is dominant over the other (capable of masking the recessive allele)

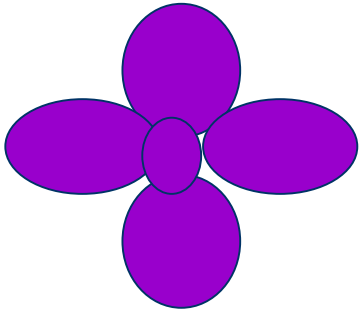
PP = purple



pp = white



Pp = purple



Review Problem: Dominant/Recessive

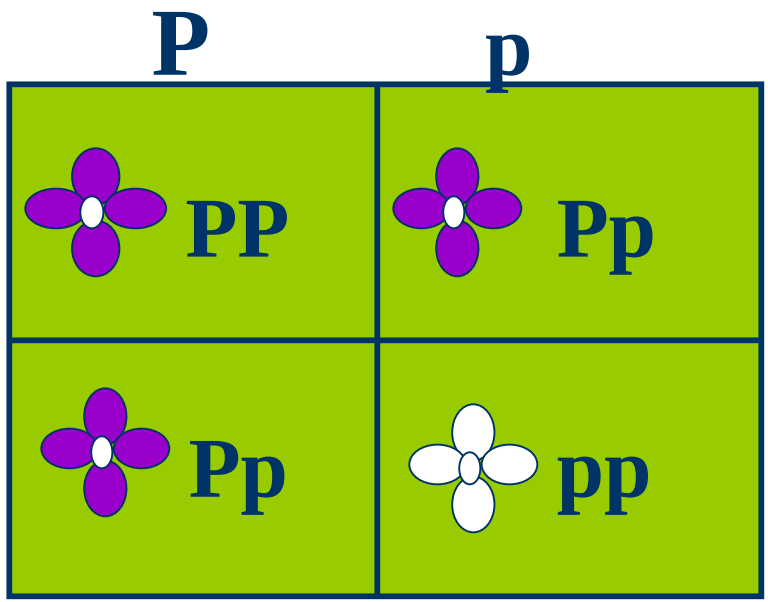
- In pea plants, purple flowers (P) are dominant over white flowers (p) show the cross between two heterozygous plants.

GENOTYPES:

- PP (1); Pp (2); pp (1)
- ratio 1:2:1

PHENOTYPES:

- purple (3); white (1)
- ratio 3:1



Are there always dominants and recessives?

- Not all traits are purely dominant or purely recessive
- In some cases, neither are dominant
- When this happens it is known as **Incomplete dominance**

Lucky…….. I guess so?

- Why was Mendel lucky?
  - Think back to the traits he chose, what was special about them?
  - They all had a dominant and recessive allele and expressed either on or the other
- But what happens when this does not happen

So what do you think?

- If neither trait is dominant, what do you think happens?
  - Do they both show?
  - Neither?
  - A Mixture?

- Well, in actuality, there is a mixture of traits

Blending of the Traits

- The blending give intermediate expression
- What is intermediate expression?
  - New phenotypes that are shown when incomplete dominance of genes occurs
- In what sorts of individuals can this happen?
  - Only in the heterozygous individuals, but why?

Why only in heterozygotes

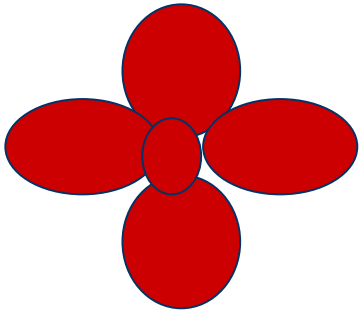
- We know that homozygous individuals have the same allele for both trait (BB or bb)

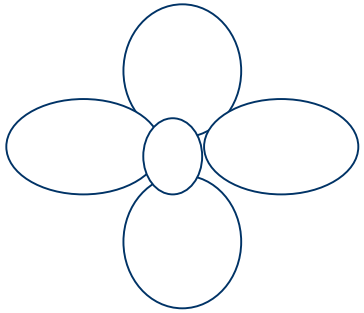
- Heterozygous individuals have different alleles for both traits and therefore both of the traits share in expression levels producing some hybrid traits

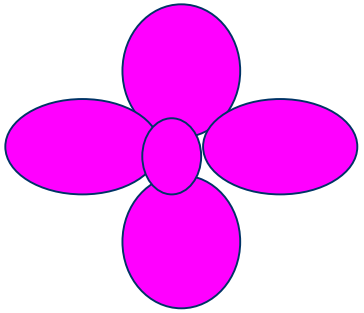
Incomplete Dominance

- A third (new) phenotype appears in the heterozygous condition

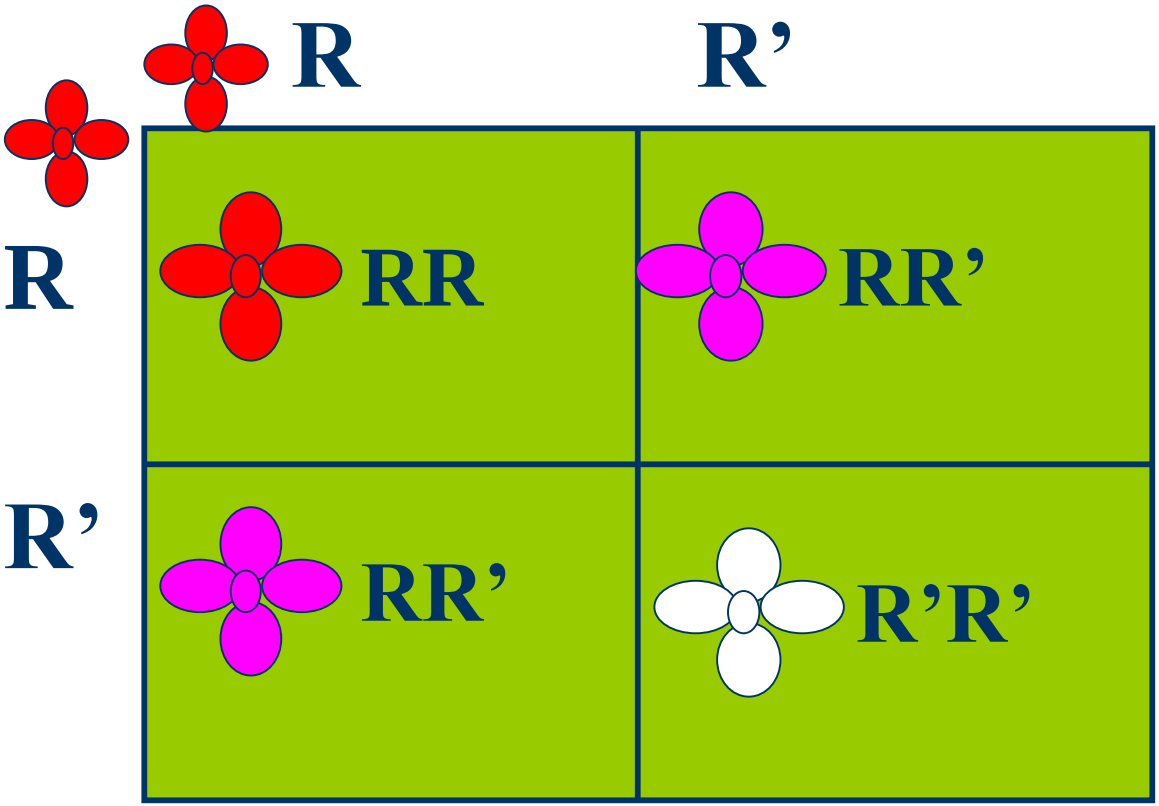
RR = red **R'R' = white** **RR' = pink**







Example Cross



Real Life Examples

Snapdragon

Roses

Carnation

Problem: Incomplete Dominance

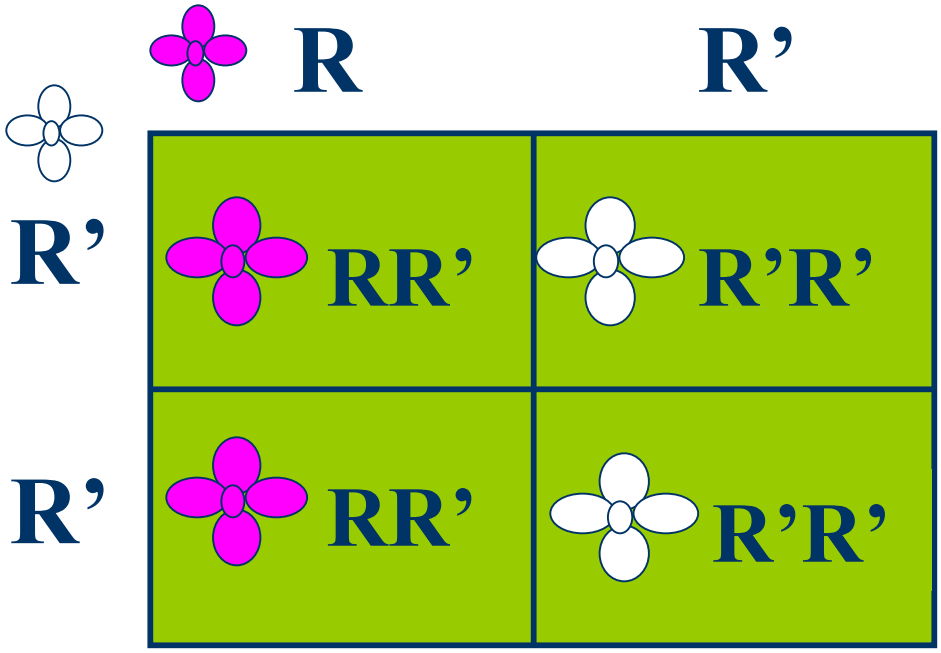
- Show the cross between a pink and a white flower.

GENOTYPES:

- Rr (2); rr (2)
- ratio 1:1

PHENOTYPES:

- pink (2); white (2)
- ratio 1:1



Why does it happen?

- Individuals with a single R (ie., RR') allele are unable to make enough red pigment to produce the red flowers

- Individuals that are white produce no red pigment

What have we seen?

- We have seen now that some alleles can be dominant, others recessive, and some are not, and we call these incomplete dominant

- Are there any other combinations of alleles that we may be interested in looking at?

What about this

- Is there a possibility that two alleles for the same trait can both be dominant?
  - Short answer yes
- But what does this mean for expression?
  - Are the individuals going to take one over another
  - Neither?
  - Both?

Expression

- When we have two alleles that are both dominant we actually get expression of both

- We will use the example of chickens
  - Some chickens are black
  - Some chickens are white

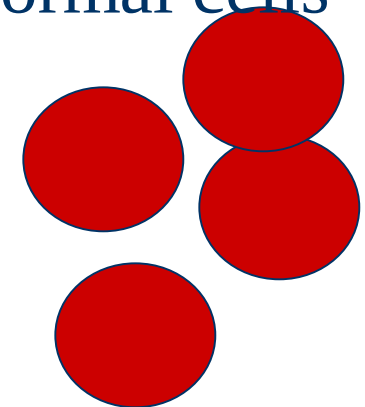
Expression

Example

Co-dominance in Humans

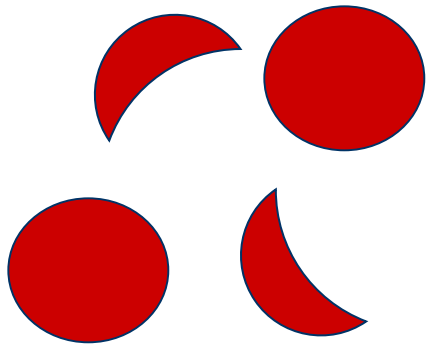
- The heterozygous condition, **both** alleles are expressed equally
- Sickle Cell Anemia in Humans

NN = normal cells



SS = sickle cells

NS = some of each



Human Example – Electron Micrograph

- Individuals with NS are also called carriers

- This means that they carry the gene for sickle cell anemia, but it is not expressed to its fullest extent

Think Back

- Could changes in an individual be good for an individual in some cases?
  - Yes! Of course they could
- What is an advantage of having sickle cell anemia?
  - Individuals with this become immune to malaria

Problem: Co-dominance

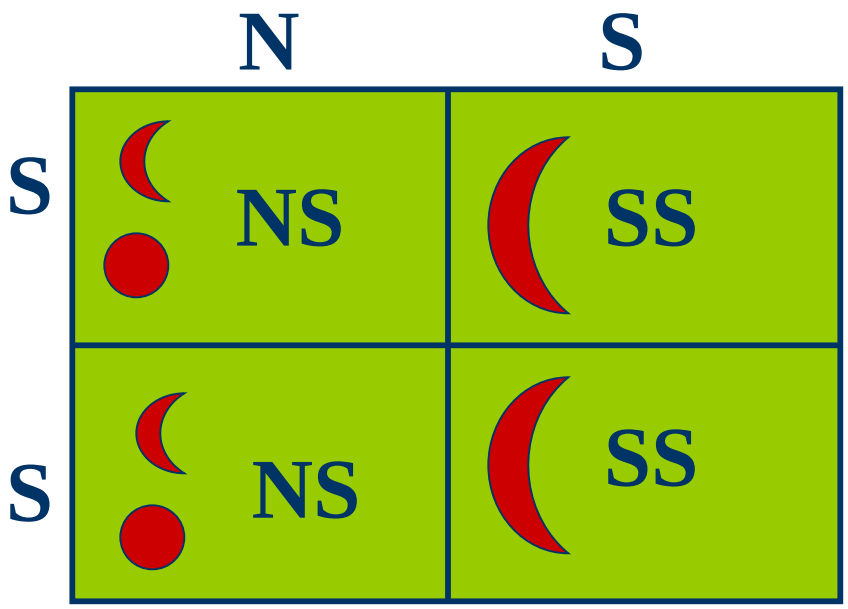
- Show the cross between an individual with sickle-cell anemia and another who is a carrier but not sick.

GENOTYPES:

- NS (2) SS (2)
- ratio 1:1

PHENOTYPES:

- carrier (2); sick (2)
- ratio 1:1



Another Tally

- So far we have looked at dominance, recessiveness, Incomplete dominance and Co-Dominance
- But what do all of these have in common despite their differences
  - They all use two possible allele types
  - It either it is or it is not

Actuality

TO BE OR NOT TO BE

That is the question

Or is it?

What are the other possibilities

- Is there a remote possibility that no alleles could be present but expression happens
  - No that is not possible
- What about if there are more than two alleles, is that possible
  - Yes of course

Creatively this is called

Multiple Alleles

What does that mean?

- Many genes that control specific traits have more than two alleles
- This means that there are far more possibilities for different phenotypes

MORE VARIABILITY

Multiple Alleles Example

- What trait can you think of in humans that can be a multiple allele?
  - Blood type in humans
- What are the possible Blood Alleles?
  - A, B, O
- What about the Blood Types?
  - Type **A**, Type **B**, Type **AB**, Type **O**

Rules for Blood Type

- A and B are co-dominant
  - AA = Type A
  - BB = Type B
  - AB = Type AB
- A and B are dominant over O
  - AO = type A
  - BO = type B
  - OO = type O

Co-dominance

- What did we say was co-dominance?
  - It was when there was more than one allele present that was dominant and both were expressed
- What about dominance
  - When one allele is more dominant that another and will be expressed over another

How does this account for bloods alleles?

- A, B, and O are the alleles
- If A and B are co-dominant, then when they are both present they will be represented with A and B giving us blood type AB

- When A and O and B and O are present you get AO and BO but because A and B are dominant over O, you get blood type A and blood type B

The universal donor

- When you have two of the O blood alleles, you get OO giving you blood type O
- This is known as the universal donor

What these code for

- The genes determine what kind of glycoprotein your blood cell has on the surface
  - Blood Type A – only A glycoproteins
  - Blood Type B – only B glycoproteins
  - Blood Type AB – has both
  - Blood Type O – has neither

Problem: Multiple Alleles

- Show the cross between a mother who has type O blood and a father who has type AB blood.

GENOTYPES:

- AO (2) BO (2)
- ratio 1:1

PHENOTYPES:

- type A (2); type B (2)
- ratio 1:1

	O	O
A	AO	AO
B	BO	BO

Problem: Multiple Alleles

- Show the cross between a mother who is heterozygous for type B blood and a father who is heterozygous for type A blood.

GENOTYPES:

-AB (1); BO (1);
AO (1); OO (1)
- ratio 1:1:1:1

PHENOTYPES:

-type AB (1); type B (1)
type A (1); type O (1)
- ratio 1:1:1:1

	A	O
B	AB	BO
O	AO	OO

In Class Work – Use it Wisely

- Read Pages 204-207
- Complete Questions on worksheet