Non-Mendelian Genetics Notes

Non Mendelian?!?

- Mendel's observations from his pea garden were the basis for all genetics.
- BUT as our investigations, research, and technology advanced, we discovered that not all traits are inherited as easily as "dominant" or "recessive".
- The traits that are not quite as basic as dominant/recessive are considered to be "Non-Mendelian".

Incomplete Dominance

- No recessive allele for these traits.
- Both variations/alleles are dominant.
- Both dominant alleles are PARTIALLY (or incompletely) expressed physically.
- To the naked eye, these traits can appear like a "blending" of the 2 dominant alleles, BUT ALLELES DO NOT BLEND! It just looks that way because both of the alleles are kind of expressed.

YouTube Video on Incomplete vs Codominance

- **Example #1:**
  - Long Watermelon = One Dominant Variation = LL
    Round Watermelon = One Dominant Variation = RR
    The Heterozygote = LR = Oval Watermelon
  - In this example, it would look like the oval shape is a blending of long and round. BUT it's really that the long variations are being expressed, elongating the center of the melon, at the SAME TIME that the round variations are being expressed, making the ends rounded.
  - Again, both dominant variations are PARTIALLY expressed. Giving that "blending" appearance (though we know nothing is blended).

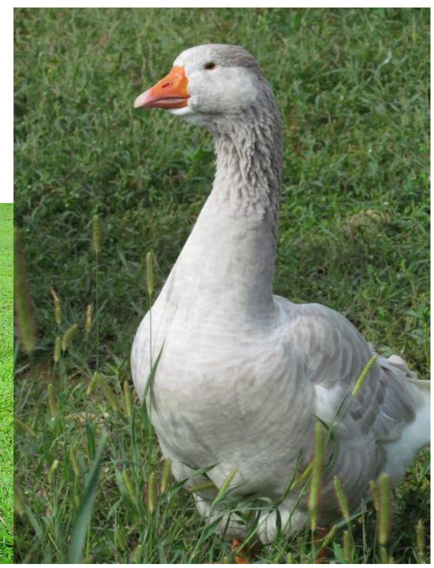
- **Example #2:**
    - Black Goose = One Dominant Variation = BB
      White Goose = One Dominant Variation = WW
      The Heterozygote = BW = Grey Goose

    - In this example, the grey coloring seems like an "in between" or "blending" of black and white. BUT again, what's really happening is that in some areas of the feathers the Black pigment is being produced, and at the SAME TIME the White pigment is being produced in other areas of the feathers.

    - To the naked eye the heterozygote goose looks grey, but really, it's like a mix of super small black and white spots.

    - Again, both dominant variations are PARTIALLY expressed. Giving that "blending" appearance (though we know nothing is blended).





- **Example #3:**
  - Red Flower = One Dominant Variation = RR
    White Flower = One Dominant Variation = WW
    The Heterozygote = RW = Pink Flower

  - This example is just like the grey goose! It appears like the pink flowers are a blend of the red and white variations, but really, super small areas of the petals have red pigment, other super small areas of the petals have white pigment, and to the naked eye it looks Pink.

- **Punnett Square with Incomplete Dominance:**
  - Identify your 2 dominant variations.
  - Assign letters to represent each dominant variation.
  - Write the letters as UPPER CASE (because they are dominant).

  - Let's Say…
    One Parent = Homozygous Dominant Red = RR → At the top
    One Parent = Homozygous Dominant White = WW → On the side

	R	R
W	RW	RW
W	RW	RW

Codominance

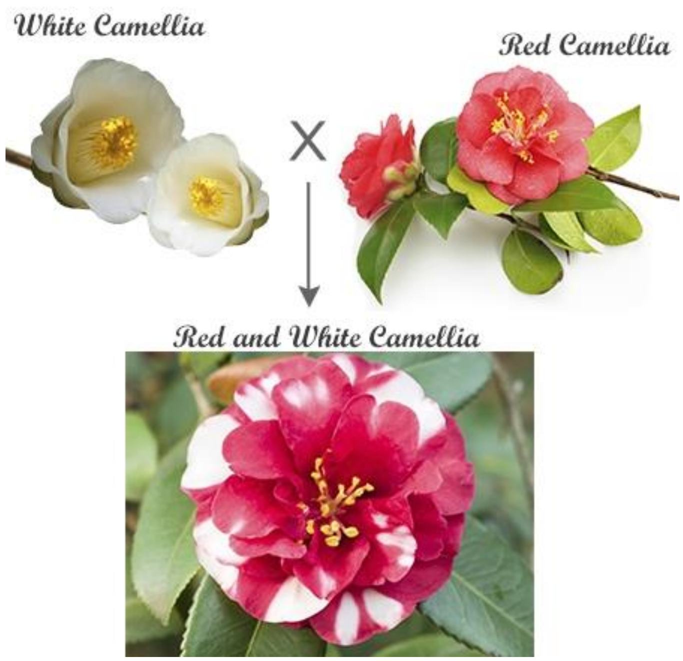
- No recessive allele for these traits.
- Both variations/alleles are dominant.
- Both dominant alleles are FULLY expressed physically.
  (This is why it is “co”. “Co” means “together”. So both dominant traits are fully expressed together.)
- This will NOT look like a blending or in-between of variations. You will FULLY see both variations simultaneously.

YouTube Video on Incomplete vs Codominance

- **Example #1:**
    - Brown Cow = One Dominant Variation = BB
      White Cow = One Dominant Variation = WW
      The Heterozygote = White & Brown Spotted Cow = BW
    - In this example, you see BOTH the brown AND white pigment FULLY at the same time!


- **Example #2:**
  - Red Flower = One Dominant Variation = RR
    White Flower = One Dominant Variation = WW
    The Heterozygote = RW = Red AND White Flower

  - In this example you see BOTH the red and white coloring FULLY at the same time!



- **Punnett Square with Codominance:**
    - Identify your 2 dominant variations.
    - Assign letters to represent each dominant variation.
    - Write the letters as UPPER CASE (because they are dominant).

    - Let's Say…
      One Parent = Homozygous Dominant Red = RR → At the top
      One Parent = Homozygous Dominant White = WW → On the side

The set up here is the exact same as Incomplete Dominance!

BUT, you need to know that it is codominance!

So RW here means Red and White (not pink!).

	R	R
W	RW	RW
W	RW	RW

Multiple Allele

- ☺ It's what it sounds like…. There are more than just 2 alleles for these traits.

- **Example #1:**
  - Blood Types ☺
  - There are 3 variations one can inherit…. A , B , O
    (If you've taken anatomy, you may remember that there is an Rh or Positive variation. This trait follows a separate inheritance, regular dominant and recessive.)
  - A and B are dominant, but O is recessive!
    But it still follows regular laws of inheritance, so you can only inherit 2 variations.
  - In blood typing, the variations produce antigens (or protein I.D. tags) on your red blood cells. Someone who inherits variations AB, will have A and B antigens on their red blood cells. Someone who inherits variations AO, will only have A antigens on their red blood cells (you can think of O like zero or nothing).
  - Let's Say….
    One parent has blood type A = $I^A I^A$ → Put at the top
    One parent has blood type AB = $I^A I^B$ → Put on the side

This also shows and proves to us, that just because you are genetically related to your parents, does not mean you have the same blood type, and can donate to each other!!!

Blood Type A = $I^A I^A$ or $I^A i$ Genotype

Blood Type B = $I^B I^B$ or $I^B i$ Genotype

Blood Type AB = $I^A I^B$ Genotype

Blood Type O = i i Genotype

☺ The I/i's represent the immunoglobin or protein that is produced from these traits.

	I^A	I^A
I^A	$I^A I^A$	$I^A I^A$
I^B	$I^A I^B$	$I^A I^B$

YouTube Video on Multiple Allele Traits

Polygenic

- Poly = Many
  Genic = Genes

- Polygenic Traits are ones which are a culmination of MANY GENES being expressed at the same time.

- A lot of our physical traits come from polygenic traits, and are not as simple as one-two- or three variations.

- **Examples:**
  - Height
  - Body Weight
  - Body Dimensions
  - Hair Color
  - Skin Color
  - Eye Color

- ***Think….***
  That's why no single person has the exact same "brown" colored hair. Because your hair color is actually the result of several hair pigment genes, all with different variations, being produced at the same time! Same with eye color and skin color!

- This is also why these types of physical features cannot be predicted!

  You could have 2 super tall parents, that produce a shorter child. Why?!
  Because the child happened to randomly inherit the recessive shorter gene variations, for most of the genes that make up their height.

  You could have 2 parents with lighter skin, that produce a child with darker skin. Why?!
  Because the child happened to randomly inherit the dominant darker pigment variations for most of the genes that make up their skin color.

YouTube Video on Polygenic Traits

Sex-Linked

- These are traits found only on the sex chromosomes.
- Remember we have 2 types…. X and Y.
- Females have 2 X Chromosomes (XX),
  Males have an X and a Y Chromosome (XY).
- The ideas of inheritance here are the same as basic dominant (upper case letters) and recessive (lower case letters).

  BUT you write the letters like tiny exponents on the chromosomes (kind of like we saw in blood typing)!
- **Examples:**
  - Color Blindness, Hair Loss / Balding, Hemophilia (a blood clotting disorder), and DMD (A type of muscular dystrophy you might remember from Biology) are all RECESSIVE, X-LINKED TRAITS.
  - Recessive = Need only recessive for it to be expressed = Lower Case Letters
  - **X-Linked** = The Trait is only on the X-Chromosome

YouTube Video **on Sex Linked Traits**

- **Punnett Square with Sex-Linked Traits:**
  - Identify your variations (dominant and recessive).
  - Assign letters to represent each variation (upper case and lower case).
  - Identify each parent's genotype.

  - ***Let's Say…***
    Hemophilia is a recessive, x-linked trait.
    The Father is Normal (does not have Hemophilia) = Dominant Variation on the X-Chromosome = X^H Y
    The Mother is Normal (does not have Hemophilia), but is a Carrier (Heterozygous) = X^H X^h

Normal Male = X^H Y
Male with Recessive Disorder = X^h Y

(Males cannot be carriers, they only have 1 x-chromosome.)

Normal Female = X^H X^H
Female Carrier = X^H X^h
Female with Recessive Disorder = X^h X^h

	X^H	Y
X^H	X^HX^H	X^HY
X^h	X^HX^h	X^hY

This shows us some interesting information! (1) There is always a 50% random chance of having a boy OR a girl! (2) "Normal" parents can produce children with recessive disorders! (3) Traits do not "skip" generations, the recessive trait just doesn't show up all the time!

YouTube Video **on Non Mendelian Genetics from College Board**