

3. Exceptions to Mendel's Laws

- many traits have more complex patterns of inheritance resulting from gene interactions that do not follow Mendel's Laws
- three examples are Lack of Dominance, Multiple Alleles and Sex-Linked Traits

Amoeba Sisters: Incomplete Dominance <https://www.youtube.com/watch?v=YJHGfbW55l0>

a) Lack of Dominance

- traits where both alleles for the trait interact so one allele cannot completely mask the other
= creates a new phenotype expressed by the hybrid (heterozygote)

i) Incomplete Dominance

- blending of traits resulting with the phenotype being somewhere between the phenotypes of homozygous parents
= like paint on a palette

Ie. Flowers such as Four O'Clocks, Snapdragons

R = red

W = white

$$RR \times WW \rightarrow RW$$

the allele for red flowers is not completely dominant over the allele for white flowers resulting in pink (RW) flowers

ii) Codominance

- when 2 genes are both dominant therefore both traits appear simultaneously

Ie. Cattle coat color

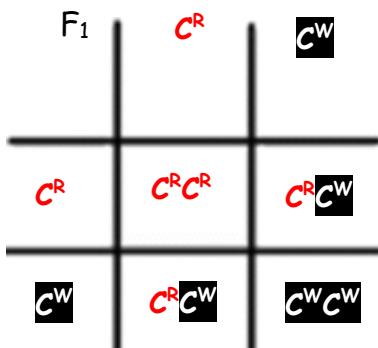
$$P_1 = C^R C^R \times C^W C^W \rightarrow C^R C^W$$

- homozygous white cows crossed with homozygous red bulls will produce roan calves (red and white hair interspersed)



**Phenotypic and genotypic ratios for Incomplete Dominance and Co-Dominance are the same because both alleles are expressed so each new genotype gives us a new phenotype.

$$F_1 = C^R C^W \times C^R C^W$$



Results:

Phenotype =

25% red, 50% roan, 25% white

Genotype =

25% $C^R C^R$, 50% $C^R C^W$, 25% $C^W C^W$

Ratio: 1:2:1

Practice Now by Completing the Bikini Bottom Genetics Incomplete Dominance Worksheet 3-1

b. Multiple Alleles [Amoeba Sisters: Multiple Alleles](https://www.youtube.com/watch?v=9O5JQqlngFY&t=10s)

- some traits have more than two alleles available within a population
 - being that an individual can only carry 2 of the possible alleles which alleles an offspring inherits depends on which alleles the parents had to pass on
- Ie. Human Blood Types The ABO System.
- there are three alleles which control production of blood factors: I^a , I^b , and i
 - these three alleles are responsible for the four possible human blood types: A, B, AB, & O
- I^a causes blood factor A
 I^b causes blood factor B
 i causes neither to form
- I^a & I^b are codominant but are both dominant to i ($I^A = I^B > i$)

PHENOTYPE (Blood Type)	POSSIBLE GENOTYPE
A	$I^A I^A$ or $I^A i$
B	$I^B I^B$ or $I^B i$
AB	$I^A I^B$
O	ii

		Mother	
		i	i
Father	I^A	$I^A i$	$I^A i$
	I^B	$I^B i$	$I^B i$

Half of the children predicted to be Type A, and half Type B.

Practice Now by Completing the Bloodtype and Inheritance Worksheet 3-2 & 3-3

c. Sex-Linked Genes (aka X-Linked Genes)

- in sexually reproducing organisms 1 set of chromosomes differs between males & females which are referred to as sex chromosomes (females have XX and males have XY)
- Y chromosomes are smaller and carry very few genes = just makes the offspring male)
- females can only contribute an X while males can contribute an X or a Y to offspring
= males determine the sex of the offspring
- X-linked genes are only on the X chromosome
- because males have only 1 X chromosome (inherited from their mother), males will express all traits on their X chromosome as there are no alleles on the Y chromosome to mask them while females can be carriers of recessive traits

Ie. Colorblindness is a recessive X-linked trait

X^B	X^b
X	$X^B X^B$ $X^B X^b$
Y	$X^B Y$ $X^b Y$

1/2 of the females will be carriers
1/2 of the females will be normal
1/2 of the males will be normal
1/2 of the males will be colorblind

Normal sight male marries a normal sight female carrying the trait

B = normal sight b = colorblind

Male: $X^B Y$ Female: $X^B X^B$

What proportion of the OFFSPRING will be colorblind? $\frac{1}{4} = 25\%$

What proportion of the MALES will be affected by this trait? $\frac{1}{2} = 50\%$

What is the probability of having a child carrying this trait? $\frac{1}{4} = 25\%$

****Carriers have the allele but DO NOT express it.

Practice Now by Completing the Gene Linkage & Sex Linked Traits Worksheet 3-4

Optional video: [Amoeba Sisters X-linked traits](https://www.youtube.com/watch?v=h2xufrHWG3E)