Simple Genetics

- **Chromosome** – The long (verrry long) DNA molecules that hold your genetic information.
- The genetic information on a chromosome is split into sections called **genes**.
  - Individual genes can play a role in determining the **traits** of an organism.
    - *Example traits*: the color of its eyes, the density of its muscles, how curly or straight its hair will be, whether its cell membranes will allow certain molecules through.
  - All genes come in more than one version. The different versions are called **alleles**.
    - *Example alleles*: In house cats, a fur color gene comes in a “dark colors” version (black, dark brown, or orange fur) and a “light colors” version (gray, light brown, cream).
    - We usually only study traits that have 2 alleles, but some traits have many more than 2.
- Chromosomes come in matched pairs called **homologous chromosomes**.
  - Homologous chromosomes carry the same genes, but might have different alleles of those genes.
  - Humans have 23 pairs of homologous chromosomes for a total of 46.
- The 23rd pair in humans are called the **sex chromosomes** because they determine whether you are male or female.
  - Unlike the other pairs, sex chromosomes are only well-matched in females. In males, one chromosome has been cut off so it's much shorter than the other.
  - The “full” sex chromosome is called an X, and the shortened one is called a Y.
  - So, women have “XX” sex chromosomes but men have “XY” instead.
  - Because the Y chromosome is missing a lot of genes, some traits in males are determined by just the one X chromosome, with no paired chromosome to share the load. These are called **sex-linked traits** because they are related to the sex chromosomes.
- The two chromosomes in a pair might have the same allele for a trait, or different alleles.
  - If the alleles are the same, we say the organism is **homozygous** or **pure** for that trait.
  - If the alleles are different, we say the organism is **heterozygous** or **hybrid** for that trait.
- For some genes, one allele is “stronger” than the other and will take over when it's there.
  - The stronger alleles are called **dominant**, and are written with capital letters (T, B, R).
  - The weaker alleles are called **recessive**, and are written with little letters (t, b, r).
- Because an organism's traits are affected by genes, we need words to distinguish between the traits and the genes that contribute to them:
  - A description of an organism's traits (brown eyes, curly hair, etc.) is called its **phenotype**.
  - A statement of which alleles an organism has (Tt, TT, or tt, for example) is called its **genotype**.
- Therefore, simple traits will always fall under one of three categories:
  - Dominant phenotype, pure/homozygous genotype (ex. GG).
  - Dominant phenotype, hybrid/heterzygous genotype (ex. Gg).
  - Recessive phenotype, pure/homozygous genotype (ex. gg).
- Special charts called **Punnett Squares** can be used to predict the genotypes and phenotypes of offspring if you know the genotypes of the parents.
- A lot of this stuff was discovered in the 1800s by a monk named **Gregor Mendel**!
  - Not all genes and traits work this way! This is the simplest kind of genetics, and most of our traits are much more complicated, determined by the combined work of many genes all at once.

There are only six possible Punnett Squares.

There are only six possible Punnett squares for the simple one-gene traits studied at this level. In the examples below, the dominant allele is *G* and the recessive is *g*. Boxes for organisms with the dominant phenotype are shaded. Remember, hybrid genotypes result in a dominant phenotype!

1. Both parents pure dominant

	G	G
G	GG	GG
G	GG	GG

All offspring pure dominant.

2. Both parents pure recessive

	g	g
g	gg	gg
g	gg	gg

All offspring are pure recessive.

3. 1 parent pure dominant, 1 pure recessive

	g	g
G	Gg	Gg
G	Gg	Gg

All offspring are hybrid.

4. Both parents hybrid

	G	g
G	GG	Gg
g	Gg	gg

Offspring might show either phenotype and have any genotype.

5. 1 parent hybrid, 1 pure dominant

	G	G
G	GG	GG
g	Gg	Gg

All offspring show dominant phenotype, but can have pure or hybrid genotypes.

6. 1 parent hybrid, 1 pure recessive

	g	g
G	Gg	Gg
g	gg	gg

Offspring might show either phenotype, but all dominant offspring are hybrids.

If you know a family's phenotypes (traits) but not their genotypes ("letters"), then...

When both parents show the recessive phenotype:

- All offspring will also show the recessive phenotype. [Case 2]

When both parents show the dominant phenotype:

- Some offspring might show the recessive phenotype, which means that both parents are hybrids. [Case 4]
- Offspring might all show the dominant phenotype, which means at least one parent was probably pure for the dominant trait. It's impossible to tell whether the other is also pure without more information. [Cases 1 and 5] (It could also be Case 4, and you just haven't gotten "lucky" with any recessive offspring yet.)

When one parent shows dominant and the other shows recessive:

- Some offspring might show the recessive phenotype, which means the dominant parent was hybrid. [Case 6]
- Offspring might all show the dominant phenotype, which means that the dominant parent was pure for that trait. [Case 3] (Or they were hybrid as in Case 6, but you got unlucky.)

(Revised 2012-02-28.)