Anthro 101:
Human Biological Evolution

Lecture 3: Genetics & Inheritance

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What is Genetics???

- Spend a few minutes discussing…

Genetics..

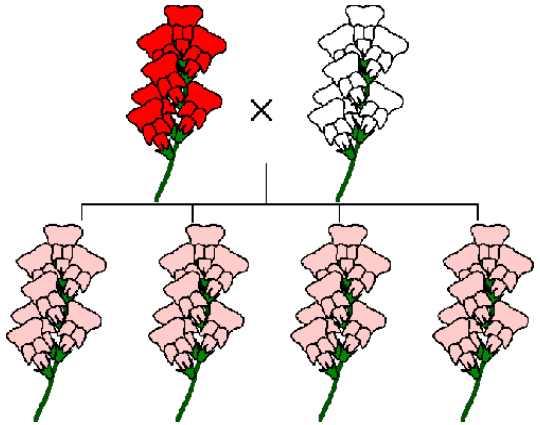
- Genetics is the scientific study of heredity.
- Heredity is what makes each species unique.

Who was the man when it came to genetics?

- https://www.youtube.com/watch?v=CBezq1fFUEA

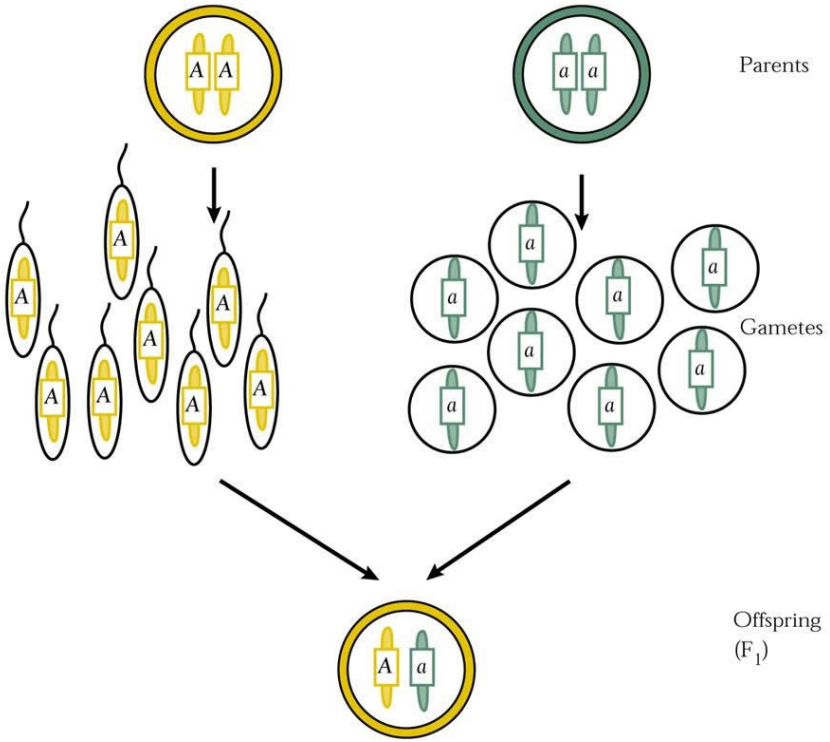
Mendel's Work

- Mendel used true-breeding plants which means if they were left to breed with themselves they would produce offspring identical to themselves.
- Mendel studied 7 different traits in pea plants.
- A trait is a specific characteristic that varies from one individual to another.



Mendel showed simple genetic principles

- **Segregation**
  - Traits determined jointly by pairs of alleles
  - Either allele can end up in a gamete
  - Zygotes get 1 allele from mom, 1 allele from dad

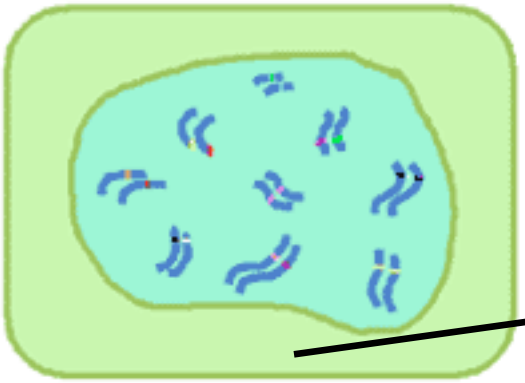


- **Dominance**
  - <u>Sometimes</u>, two different alleles at a gene loci (heterozygous) only one is expressed

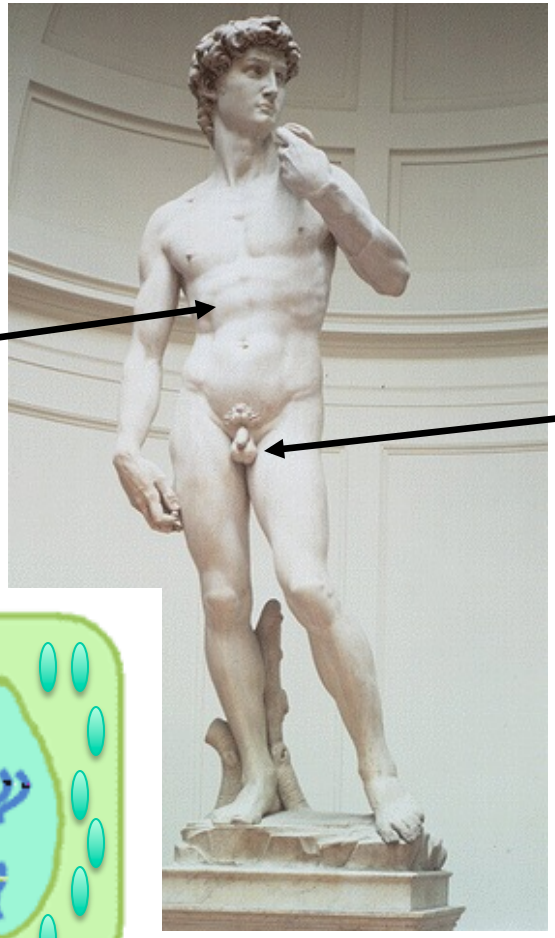
More on Mendel's Work

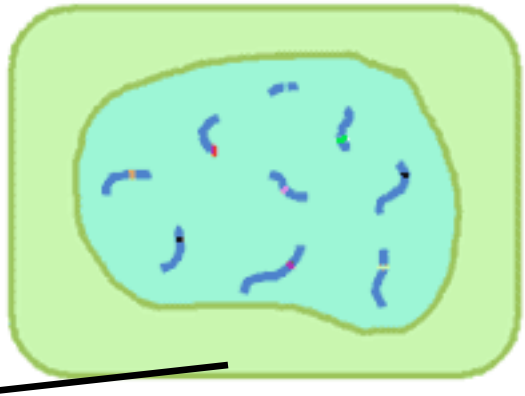
- Hybrids are offspring from parents with different traits.
- Genes are the chemical factors that determine a trait.
- The different forms of a gene are called alleles.

Lets get down to the basics
Somatic cells & Gametes both contain DNA

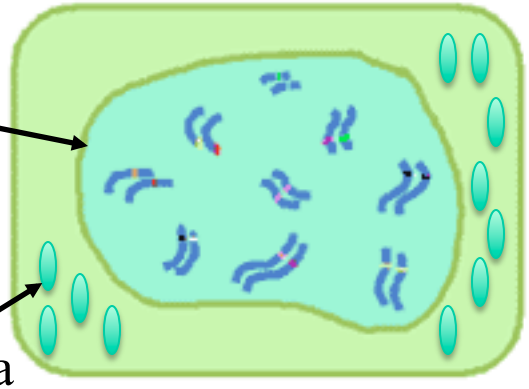


Somatic Cell





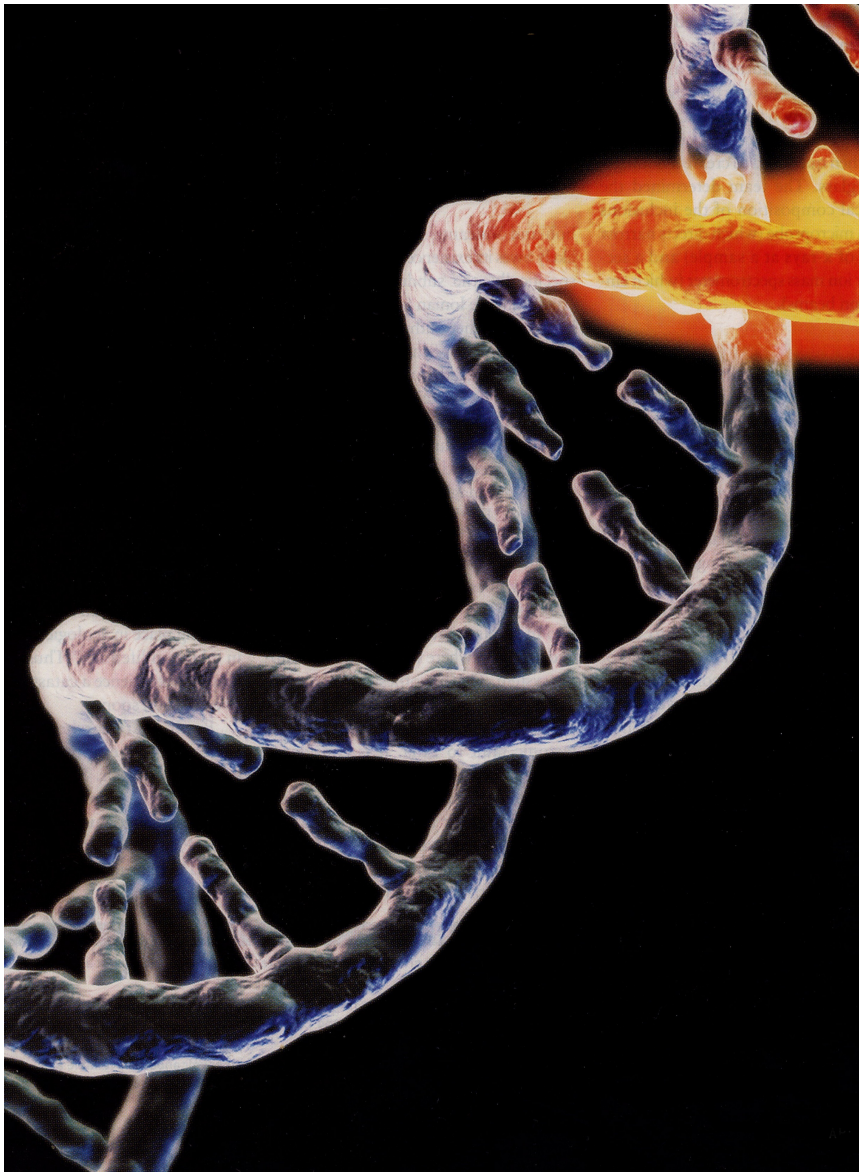
Gamete Cell



DNA in nucleus, mtDNA in mitochondria

DNA Basics

- 99.99% of all DNA in the nucleus of a cell
- DNA long strands of biochemical information (legos or beads)
- Sections of DNA form functional units = **genes**
- Genes are **recipes** for proteins
- Proteins serve functions in the body = traits



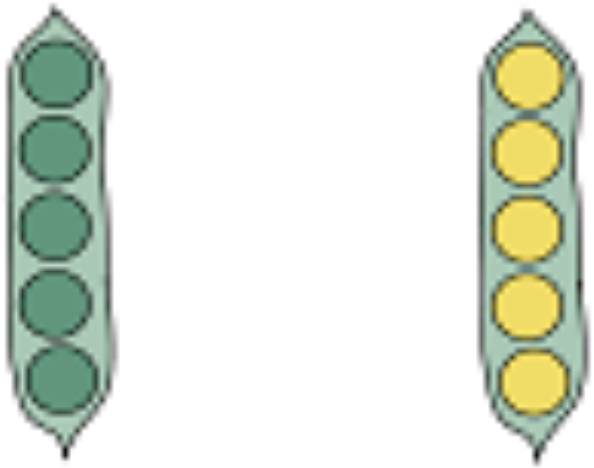
Universal Genetic Code

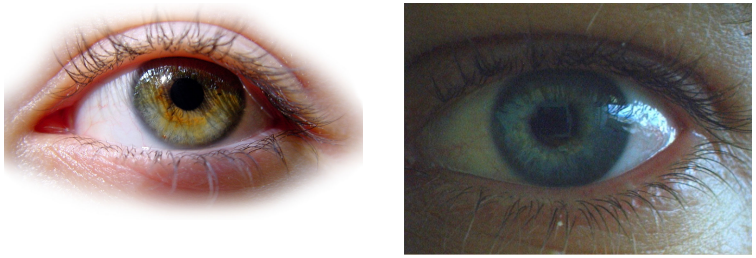
- All living organisms have DNA made of the same material that serves similar functions
- The universality of the genetic code implies a common ancestry for all life on the planet
- Organisms differ in the amount of DNA
- BUT the most important differences are in the *arrangement* of the DNA.
  - Different order of nucleotides → different proteins

Reminders

- Every Thursday AHS 143
  - Before Class- I'm at the tables
  - First Quiz, Tuesday????

Genotype / Phenotype





Phenotype: observable traits

The proteins that are built using the recipe.

Genotype: the alleles you carry

The recipe in your DNA.

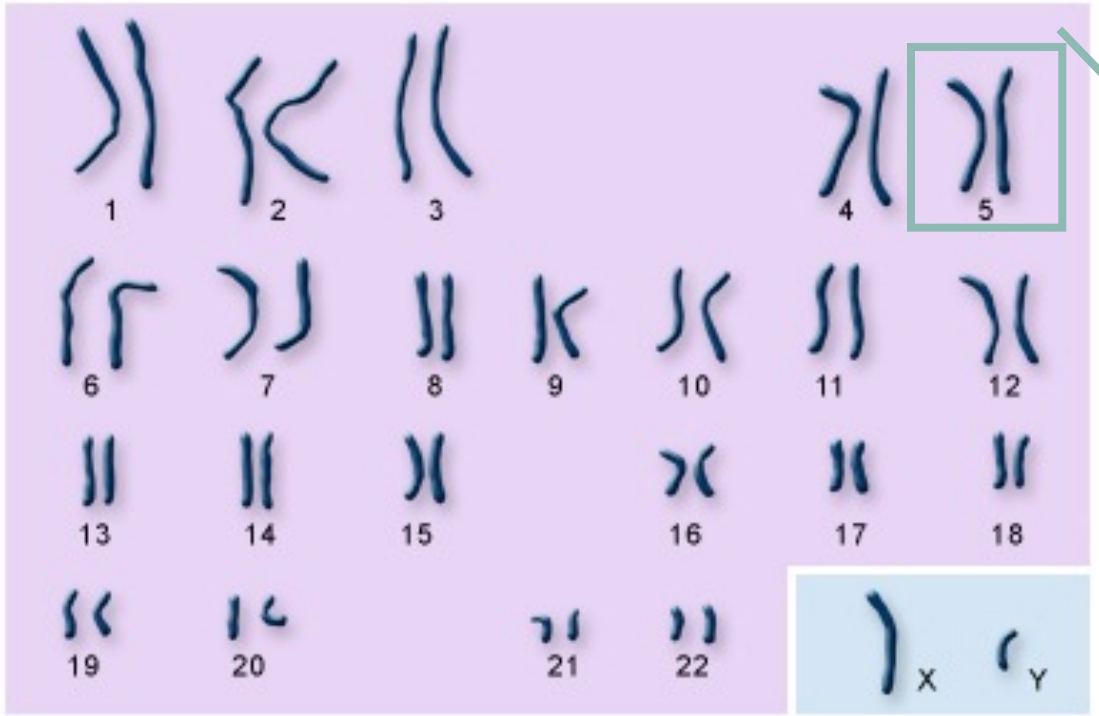
Questions?

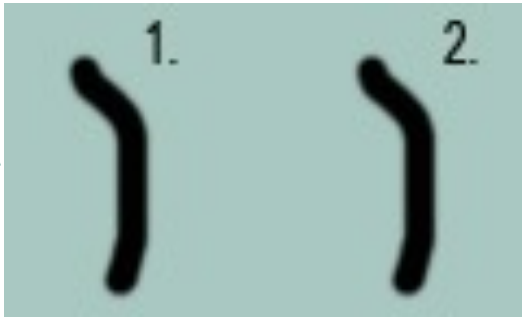
- What are Phenotypes?
- What are Genotypes?
- Why is the Universal genetic code important?

What the heck is DNA?

http://www.youtube.com/watch?v=8kK2zwjRV0M

Chromosomes = packages of DNA
Cells have 2 versions of each chromosome – we have 23 homologous pairs, 46 total



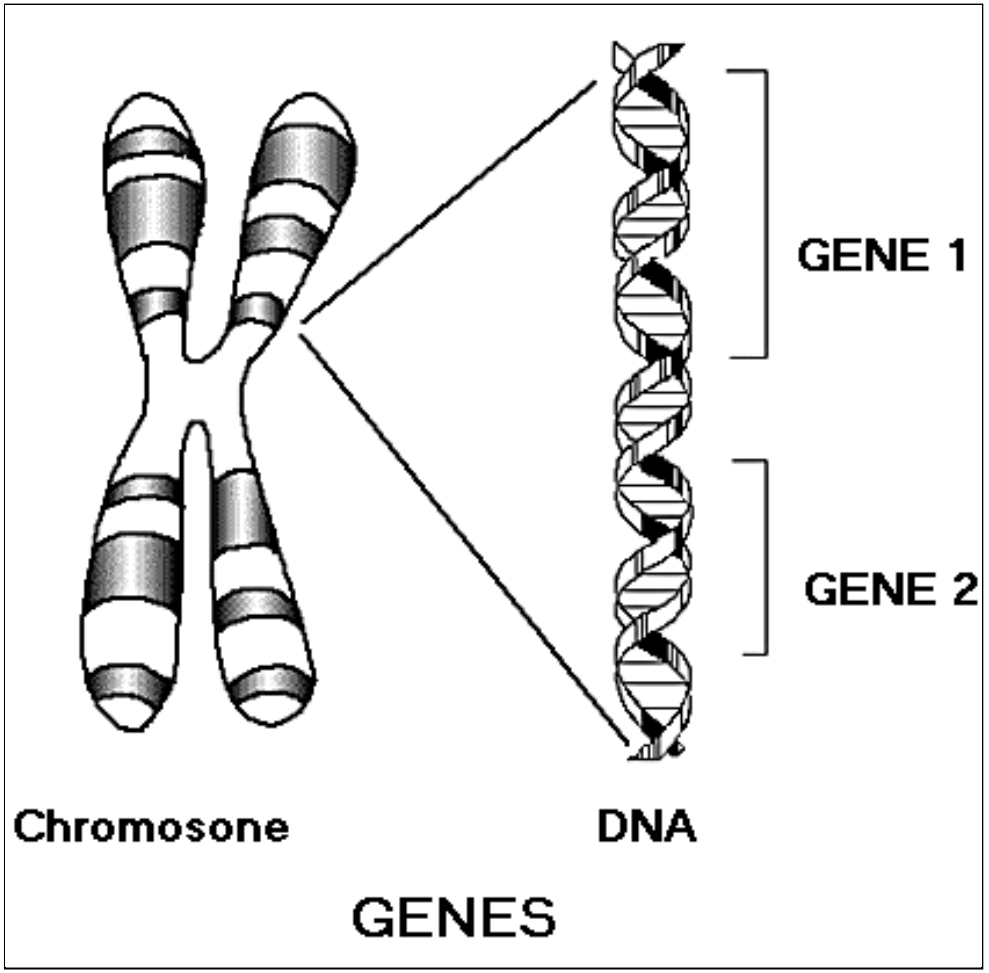


Homologous Chromosomes

U.S. National Library of Medicine

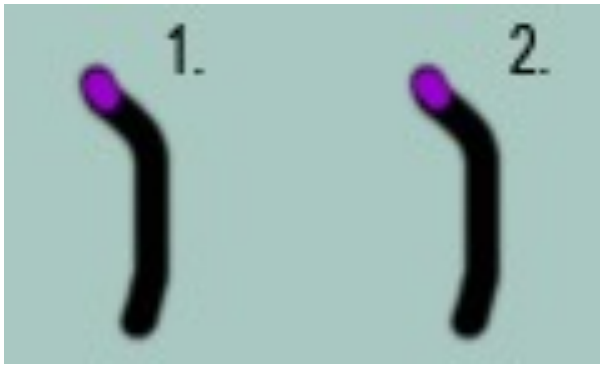
Genes are segments on chromosomes

- Genes on chromosomes like beads on a string
- Each gene has a specific location = **locus**
  - **Gene loci**
- There can be different *versions* of the same kind of gene: these are called **alleles**
- Homologous alleles work together to produce phenotype

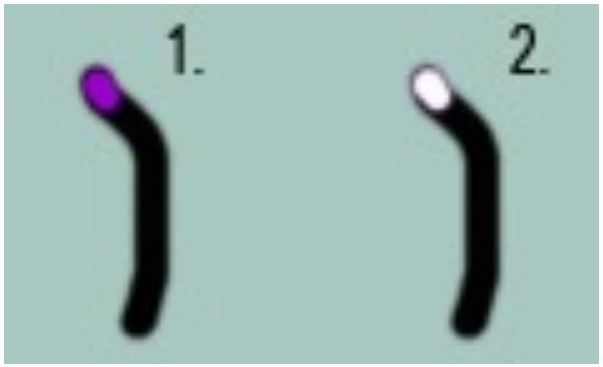


Homozygous vs. Heterozygous Genotypes

- **Homozygous:** the same allele at the same locus on both versions of the chromosome

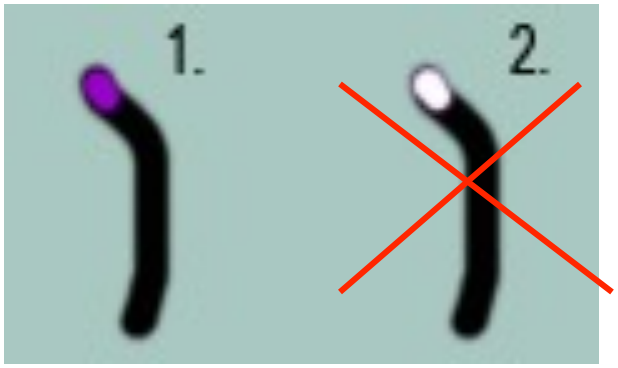


- **Heterozygous:** a different allele at a particular locus on each chromosome

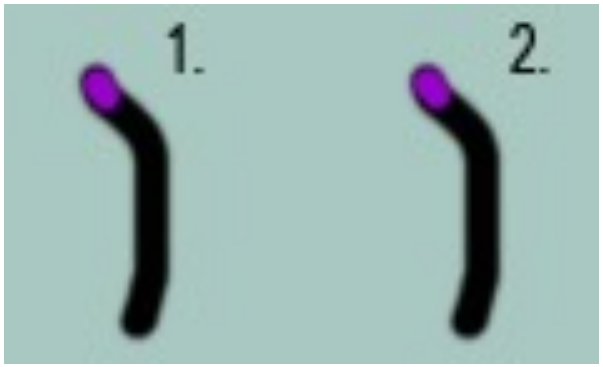


Dominant & recessive alleles

- 2 different alleles (**heterozygous**) = Aa
- <u>Sometimes</u> one of the alleles "overrides" the effects of other: this is called **dominance = A > a**
- A **dominant** allele overrides the effects of a **recessive** allele



Aa



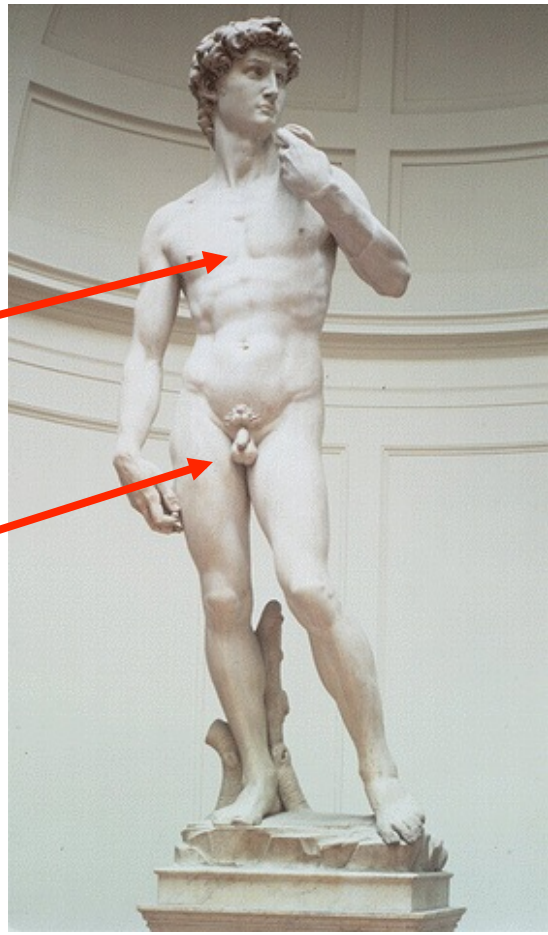
AA or aa

Cell Division: Sharing the recipe

- DNA replicates before cell division
  - Two types of replication:

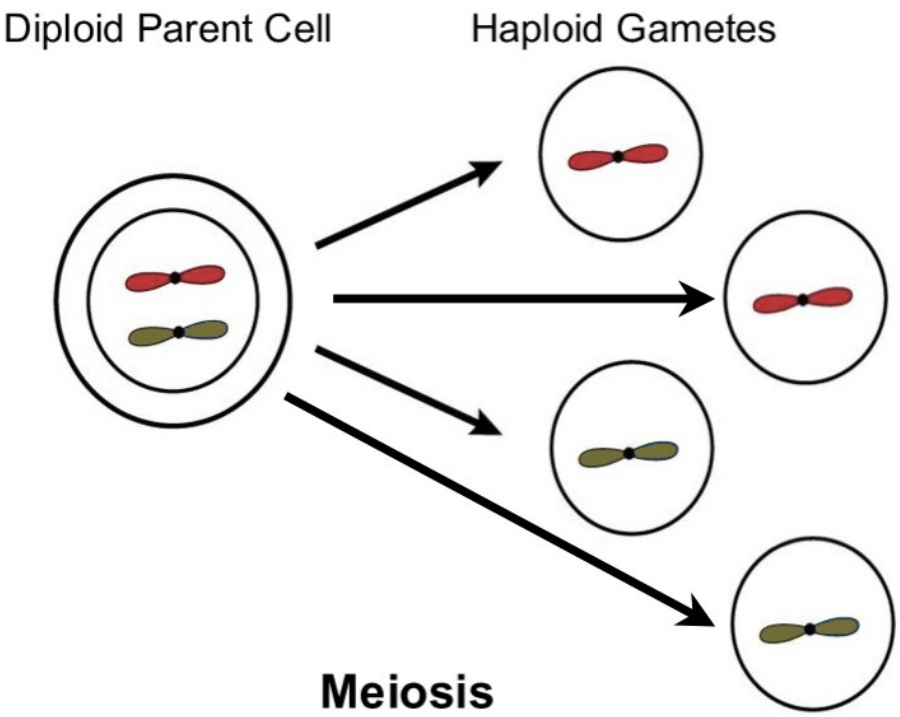
- **Mitosis:** makes a new somatic (body) cell

- **Meiosis:** makes gametes (sex cells, sperm and eggs) used in sexual reproduction

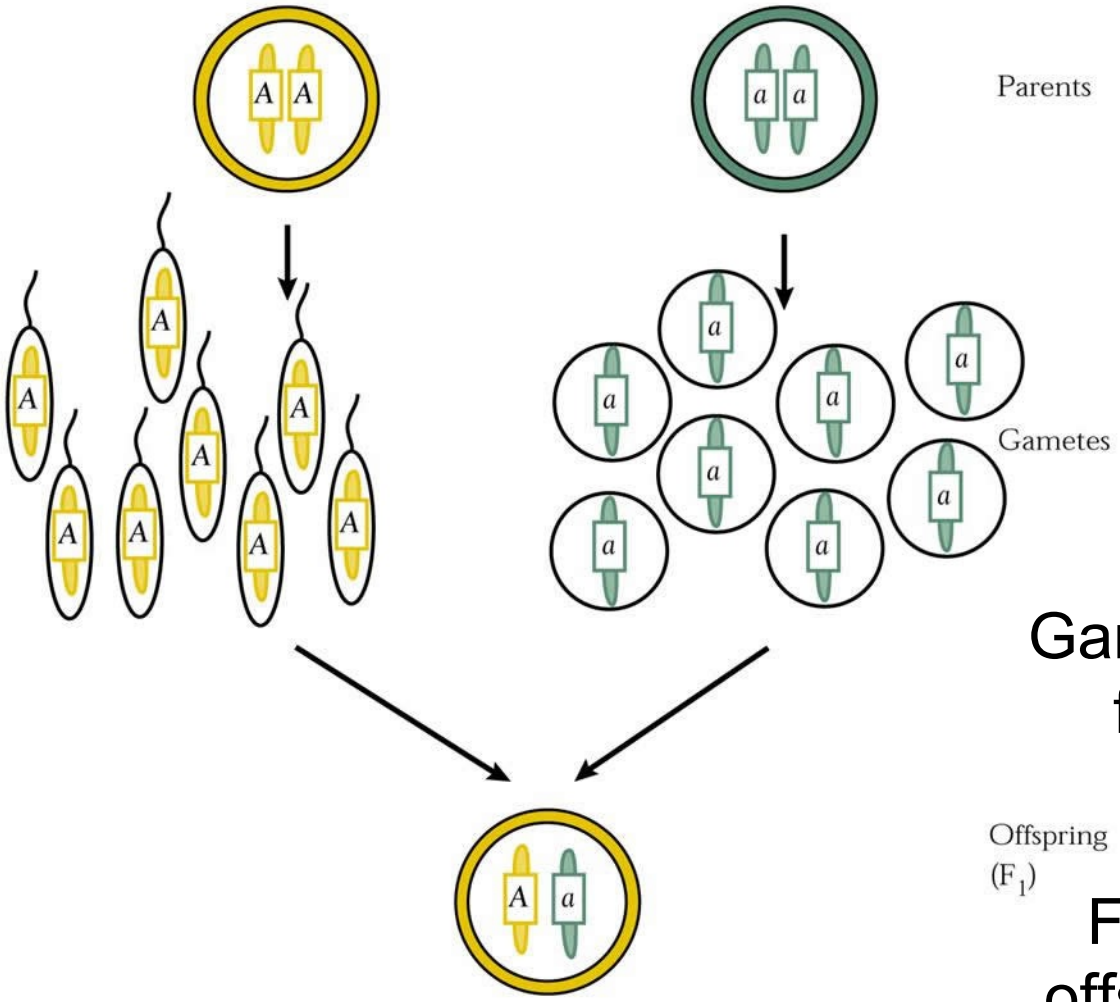


Meiosis: production of gametes

- Gametes (eggs and sperm) have only 1 copy of each chromosome
- Chromosome pairs duplicate and divide into singles, distributed between 4 gametes
- When gametes fuse during sexual reproduction, they create a zygote with full set of chromosomes



To make a new organism



Parents make **gametes**

Gametes from two parents fuse to form offspring

For each chromosome, offspring carry two copies: one from each parent

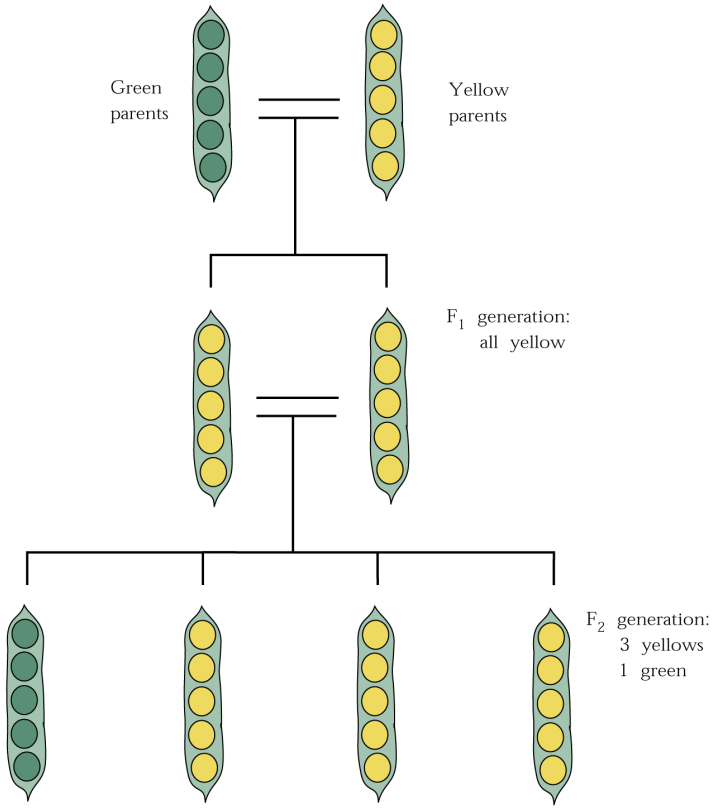
Recombination is important for evolution

- **Recombination**
  - shuffling of alleles during meiosis = **unique gametes**
    - Independent assortment of alleles at different gene loci
  - Mixing of alleles during sexual reproduction = **unique offspring**

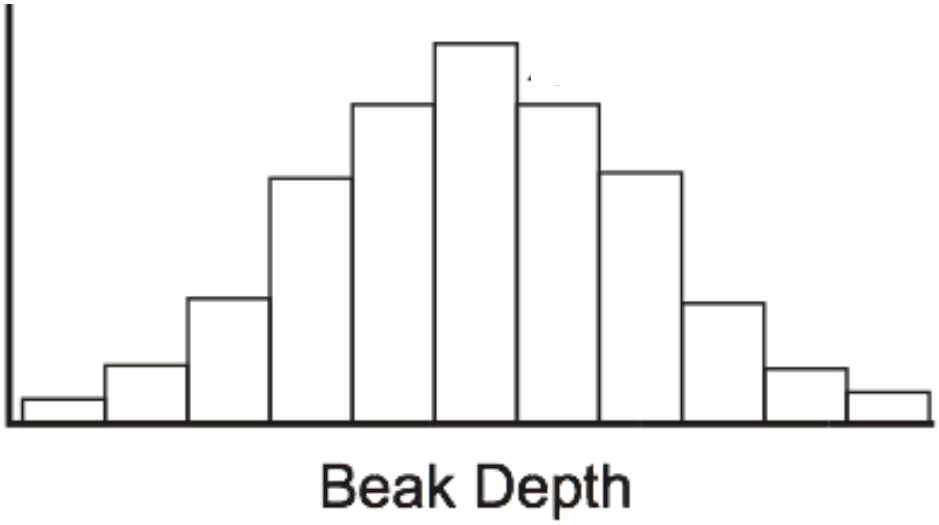
- The fate of a new mutation is unrelated to other traits
  - *New traits can spread **independently** in a population*

- Novel combinations of traits can appear in offspring
  - *This provides new phenotypes for natural selection to act upon*

Mendel studied discontinuous (discrete) traits



Darwin observed continuous variation



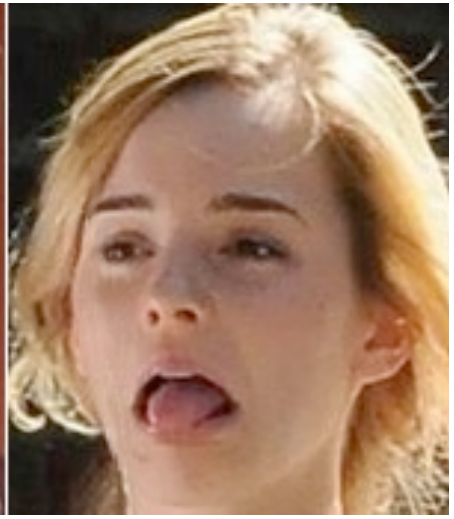
MOST traits vary along a continuum

Continuous Traits

- Height
- Weight
- Skin color

Discontinuous Traits

- Finger number
- Litter size
- Rolling tongue



Simple Mendelian inheritance is rare (discontinuous traits)

- Lots of traits are linked and so get inherited as a package deal
  - Linked (same chromosome)
- Lots of alleles for a gene aren't clearly dominant/recessive
  - Codominance: Sickle-cell anemia
  - Complex dominance: ABO blood type
- Lots of single genes controls multiple traits
  - Pleiotropy
- **Lots of genes work together to affect the same trait = Polygenic inheritance**

Linked traits are inherited together

Codominance:
Two alleles, three phenotypes

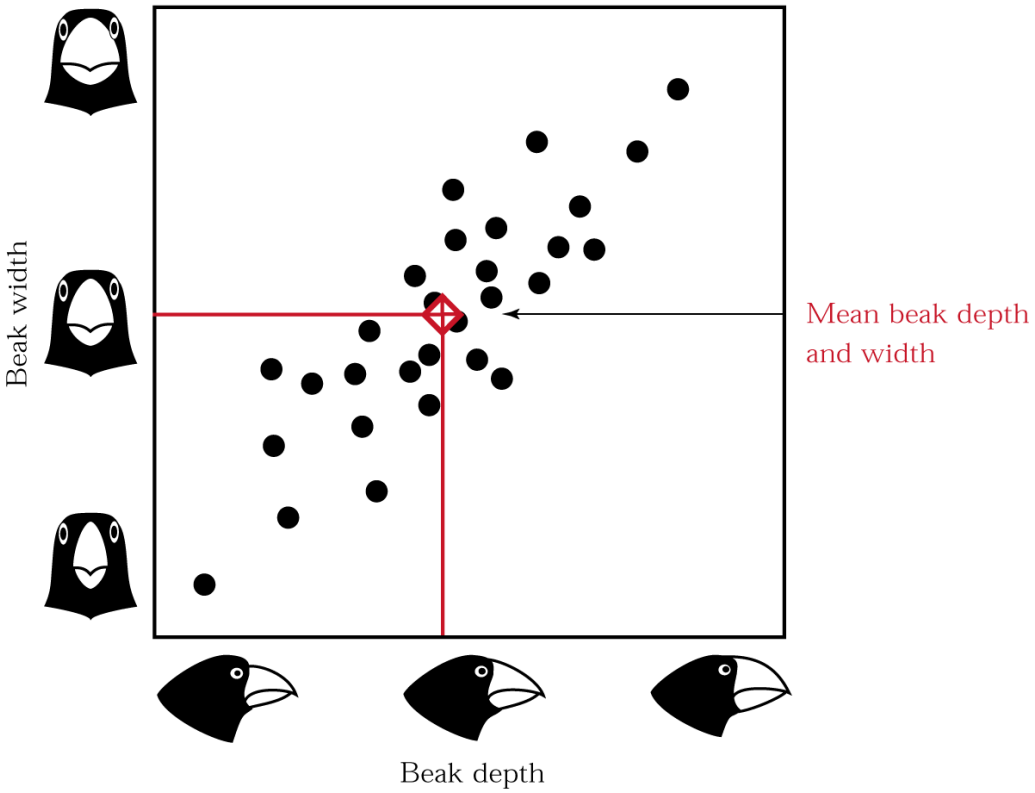
Sickle-cell anemia

- Normal hemoglobin (**A**) allele
- Sickling hemoglobin (**S**) allele

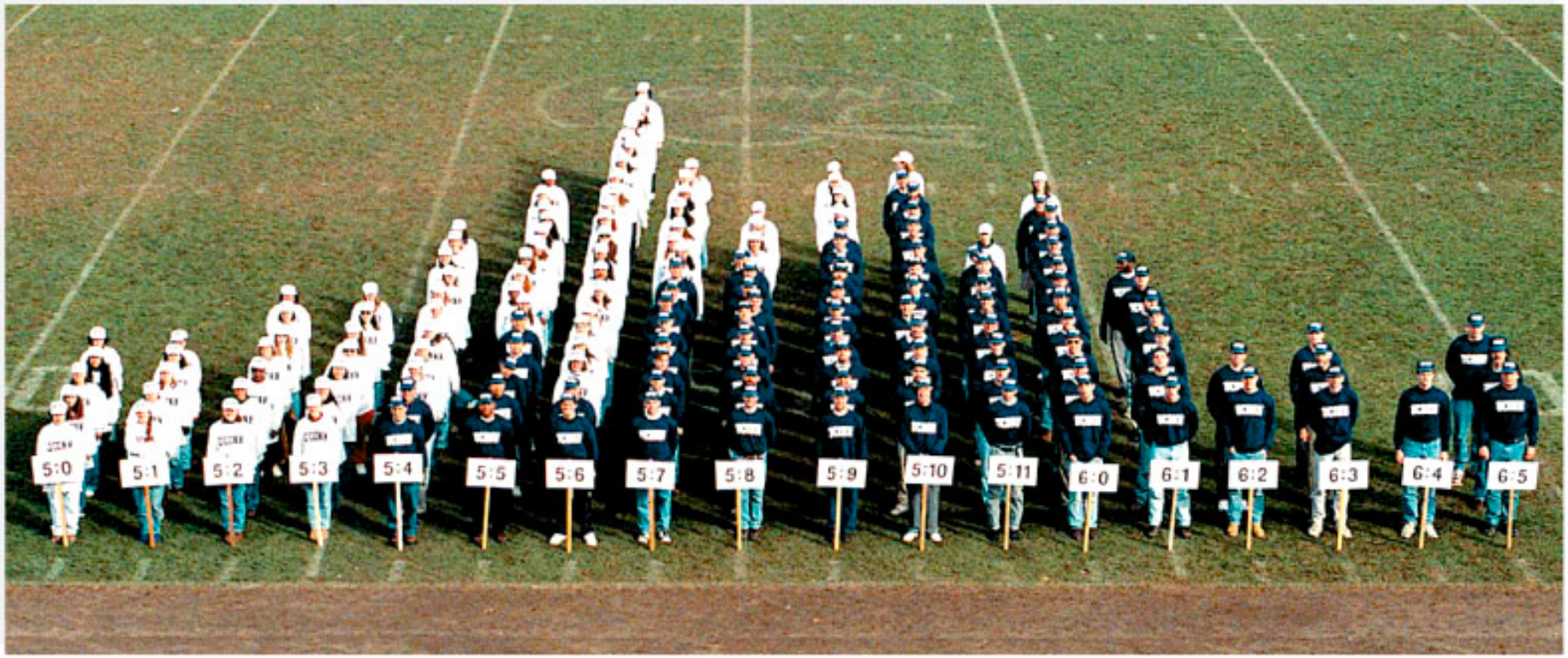
- Three genotypes **and** three phenotypes:
  - **AA** = normal blood cells
  - **SS** = sickled blood cells
  - **AS** = slightly impaired blood cells, greater defense against malaria

Pleiotropy: One gene controls two traits

- In Darwin's finches, beak traits are correlated
- Depth & width vary together
  - Deeper & wider
  - Shallow & narrow
- Correlations arise when one gene affects multiple traits



Polygenic Traits: Many genes, continuous variation



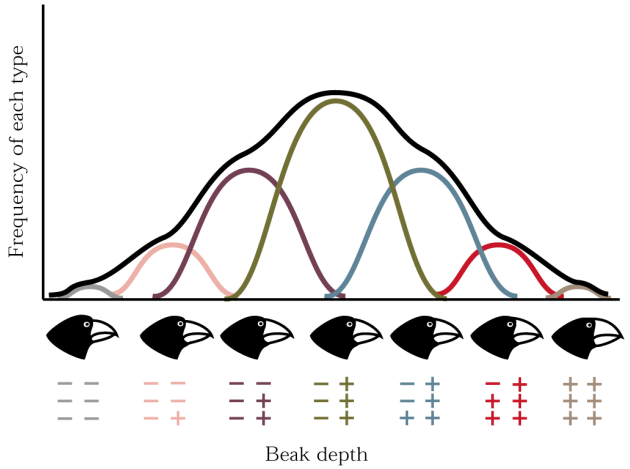
- Many genes affect each trait
- Each one has small effect
- Generates a continuous range of variation in the trait

- Height
  - Over 700 genes
  - variation in height

Variation is maintained in the DNA

- Intermediate types common, but genetic variation is maintained
  - MOST individuals have some + and some – alleles for height
- Recessive alleles hidden by dominant alleles
  - Still passed into gametes & remain in population
- Much of the variation is "hidden" from selection
  - **If a trait is affected by genes at many loci**
  - **Many different genotypes may have similar selective fate**
  - Some variation is protected
- Neutral mutations can be hidden

Variation is essential for Natural Selection – without differences in traits, nothing to "select" & survival is random



All this variation! Where does it come from?

- **Mutation**
- **Meiosis**
  - Recombination of alleles into unique gametes
  - increases genetic variation at a faster rate than mutation
- **Sexual Reproduction**
  - Recombination of alleles from unique gametes into unique offspring
  - New phenotypes for NS to act upon
- **Complex genetic inheritance**
  - Polygenic traits
  - Environment interacts with genotype

More Questions

- What are some of the causes of variation?
- What is Pleiotropy?
- Why is recombination important for evolution?

Reminder

- Quiz 1 next Thursday