THEORY OF INHERITANCE
Review: Mendelian Inheritance

- A mendelian trait is **controlled by a single gene that has only two alleles.**

- Either the **dominant or the recessive allele may carry a defect or mutation that can cause a genetic disorder.**

- **Examples of Genetic Disorders:**
  - Albinism
  - Huntington’s Disease
  - Cystic Fibrosis
  - Tay-Sachs Disease
Chromosome Theory of Inheritance

- **Genes are located on chromosomes** and the behavior of chromosomes during meiosis accounts for inheritance patterns, which closely parallels predicted Mendelian patterns.

- **Mendelian genetics** principles (segregation, independent assortment, and dominance) support chromosome theory of inheritance.

- Due to current technology, inheritance patterns and genetic variations are now understood using the chromosome theory of inheritance.
  - Because of this there have been new developments since Mendel’s principles of genetics.
Gene Linkage

- **Genes** that are located **on the same chromosome** will be inherited together
  - These genes travel together during gamete formation
  - This is an exception to the Mendelian principle of **independent assortment** because linked genes do not segregate independently
Crossing Over

- Process in which alleles in close proximity to each other on homologous chromosomes are exchanged. This results in new combinations of alleles:
  - When chromosomes pair up during meiosis I, sometimes sections of the two chromosomes become crossed.
  - The two crossed sections break off and usually reattach.
  - When the genes are rearranged, new combinations of alleles are formed.

- Crossing-over explains how linked genes can be separated resulting in greater genetic diversity that could not be explained by Mendel’s principles of genetics.
Benefits of Crossing Over?

- Genetic Diversity!!!!
Incomplete Dominance

- A condition in which one allele is not completely dominant over another.
  - The phenotype expressed is somewhere between the two possible parent phenotypes and is displayed as a blend of the two.

- Example:
  - Snapdragons
**Codominance**

- Occurs when both alleles for a gene are expressed completely.
  - The phenotype expressed shows evidence of both alleles being present.
- Use only capital letters in the punnett square notation.
Multiple Alleles

- Can exist for a particular trait even though only two alleles are inherited.

- For example, three alleles exist for blood type (A, B, and O), which result in four different blood groups.

- Mendel’s principles of genetics did not explain that many traits are controlled by more than one gene.
Polygenic Traits

- Traits that are controlled by two or more genes.
- These traits often show a great variety of phenotypes, e.g. skin color.
- Mendel’s principles of genetics did not explain that many traits are controlled by more than one gene.
Sex – Linked Traits

- The result of genes that are carried on either the X or the Y chromosome
- This is an exception to Mendel’s principle of independent assortment, which does not explain sex-linked traits.
- In organisms that undergo sexual reproduction, one pair of chromosomes determines the sex of the organism
  - Female’s sex chromosomes = XX (each carries same genes)
  - Male’s sex chromosomes = XY
  - During meiosis I, when chromosome pairs separate, each gamete from female parents receives an X, but male can give either an X or Y chromosome
Sex – Linked Traits

- A Punnett square for the cross shows that there is an equal chance of offspring being male (XY) or female (XX)
Sex – Linked Traits

- In humans, the Y chromosome carries very few genes.
- X chromosome contains a number of genes that affect many traits.
- Genes on sex chromosomes are called sex-linked genes.
- Sex-linked genes are expressed differently from an autosomal gene.
Sex – Linked Genes

- If a gene is linked on the X chromosome (X-linked)
  - Female offspring will inherit the gene as they do all other chromosomes (X from father and X from mother).
    - The principles of dominance will apply.
  - Male offspring will inherit the gene on their X chromosome, but not on the Y chromosome
  - Since males have one X chromosome, they express the allele whether it is dominant or recessive; there is no second allele to mask the effects of the other allele
For example, the trait for color blindness is located on the X chromosome:
- X chromosomes carrying a gene for normal vision can be coded $X^C$
- X chromosomes carrying a gene for color-blindness can be coded for $X^c$
- Y chromosomes that all lack this gene can be coded Y
- Only offspring that have the $X^C$ gene will have normal vision

Hemophilia is also a sex-linked trait

In rare cases, a female can express the sex-linked, recessive trait.