Chapter 9
Fundamentals of Genetics

- Genetics – study of how traits are transmitted from parents to offspring.
- Gregor Mendel – (1850's) – Austrian monk – tended the garden and taught math at the monastery. Famous for experiments with garden peas.
- Heredity – transmission of traits from parents to offspring…..Mendel's knowledge of statistics proved valuable here.
- Mendel studied the now famous 7 traits of pea plants….See pg. 167
- Mendel was lucky!! He chose pea traits that were controlled by a single gene….this made them easy to study. "Polygenic traits" (controlled by many traits) could have spelled disaster.

- **Pollination** – pollen grains are transferred from the anther (male) to the stigma (female) reproductive parts of a flower. See fig. 9-1 on pg. 166.
- **Self-Pollination** – pollen is transferred from the anther to the stigma on the same plant.
- **Cross-Pollination** – transfer of pollen between flowers on different plants.
- **NOTE:** Pea plants normally reproduce by self-pollination.

- Mendel manually took over the pea pollination process. This gave him control over who the parents would be for his genetic crosses.
- Mendel was smart!!! He began with parent plants that were PURE (they always produced offspring with that trait)for each trait.
- **Purebred** – an organism that is pure for a specific trait. Ex. Purebred Tall pea plant (TT). Where T = tall and t = short.
- **Hybrid** – contain a mix of genes for a specific trait. Ex. Hybrid Tall (Tt).
- **Mendel's Terminology:**
  1. P1 Generation – (Parental Generation) – Parents are purebred. They are produced by self-pollination of plants over many generations.

(pp)

	p	**p**
P	Pp	Pp
P	Pp	Pp

(PP)
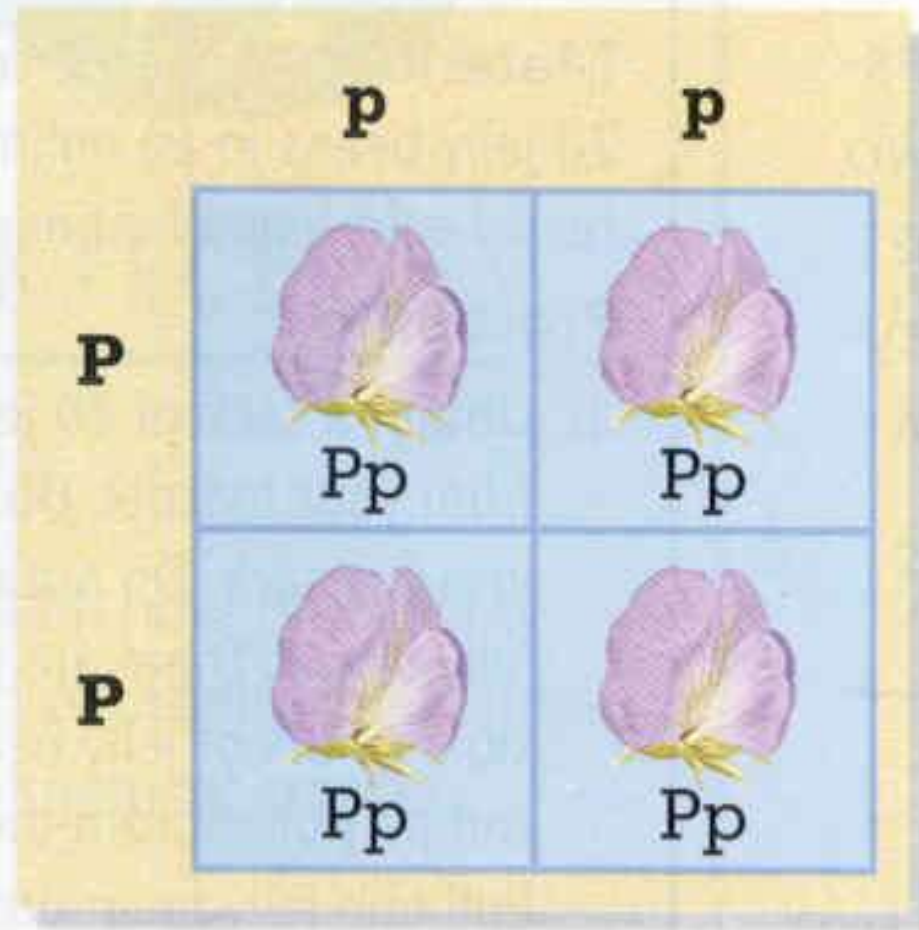
2. <u>F1 Generation</u> – (First Filial Generation) – Offspring from a cross from a P1 generation. Produced by cross-pollination.

3. <u>F2 Generation</u> – (Second Filial Generation) – produced by self-pollination of 2 organisms from the F1 Generation.

- Mendel did 100's of crosses using the above described methods. See results on pg. 167. Notice that all of the ratios are 3 : 1.

- <u>Mendel's Conclusions:</u>
  1. Something within the peas controlled the traits he saw.
  2. Each trait was inherited from a separate "factor".
  3. Since there were 2 alternative forms for each trait (Tall vs. Short), there must be a pair of "factors" controlling each trait.

- <u>Dominant Factor (trait)</u> – Always shows up in the F1 generation. It masks or "dominates" the other factors.

- <u>Recessive Factor (trait)</u> – Does not appear in F1, but reappears in the F2. When paired with a recessive factor has no effect on the appearance of an organism.

- <u>Exs.</u> – Tall is dominant over short in peas. Green pods is dominant over yellow pods in peas. Brown hair is dominant over blond in humans.

- ** Each sperm or egg cell (Gametes) receives only 1 "factor"for a trait.
- <u>Law of Segregation</u> – a pair of factors is segregated (separated) during Meiosis to form sperm and egg cells (gametes).
- Fertilization (union of sperm and egg) causes us to have a PAIR of "factors" for a specific trait.

Female parent

Female gametes (1:1)

Male parent

Male gametes (1:1)

Genotypic ratio 1:2:1
(1 YY: 2 Yy: 1 yy)
Phenotypic ratio 3:1
(3 yellow: 1 green)

- Law of Independent Assortment = "Factors" for different traits are distributed to gametes independently of each other. This causes a random mixing of factors from one gamete to the next. See fig. 9-3 on pg.169. Therefore..........

- Mendel noticed that when he tracked 2 traits at the same time, they were not inherited together. Ex. Plant height and pod color.

- Mendel was lucky again!!! He picked traits that were all on different chromosomes.

- Modern Molecular Genetics – Study of the structure and function of chromosomes and genes……Agrees with most of Mendel's findings.
- Gene – Segment of DNA that controls a particular trait.
- Allele = Several alternative forms of a gene. Ex. Hair color – brown, black, blond, red.
- NOTE – Today Mendel's "factors" are now called ALLELES !!!!!
- When studying genetic crosses, letters are used to represent alleles…..
- Capital Letters = Dominant Allele

    Lower Case Letters = Recessive Allele

    Exs. T = tall, t = short, G = green pod, g = yellow pod
- Every individual has 2 alleles for each trait (1 from mom and 1 from dad).

- Genetic Crosses – help predict probable genetic make-up and appearance of offspring of a particular cross.
- Genotype = the genetic make-up of an organism, or the alleles it inherits from its parents. Genotypes are shown as capital or lower case letters.

  - Exs. PP or Pp could be the genotype for a purple flower in peas. Also, TT or Tt could be the genotype for a tall pea plant and tt would be the genotype for a short plant.
- Phenotype = the APPEARANCE of an organism as a result of its genotype.

  - Pp genotype = purple flower phenotype

  - TT genotype = tall phenotype

  - Gg genotype = green pod phenotype
- Homozygous - both alleles in a pair are the same (the organism is a Purebred for that trait)…..Exs. TT, GG, gg, PP, tt
- Heterozygous – 2 alleles in the pair are different (organism is a Hybrid)……Exs. Tt, Gg, Pp

- Probability – the possibility that a specific event will occur. See equation below…..

Probability = Number of events of choice Divided by Number of possible events. See pg. 173.

- Ex….What is the probability of getting a pea plant that produces yellow seeds?
- Mendel's results: 6,022 yellow seeds to 2,001 green seeds. 6,022 + 2,001 = 8,023.
- 6,022 is the number of yellow seed plants, OR the "number of events of choice". 8,023 is the total "number of possible events".
- Following the equation: 6,022 divided by 8,023 is very close to ¾ or .75 or 75%. Therefore the probability of getting a yellow seeded plant in a cross is 75%.

- Monohybrid Cross – studies only 1 trait at a time…..Ex. Flower color.
- Punnett Square – used to predict the probability that certain traits will be inherited. See fig. 9-5 on pg. 174.
- Study, very carefully, the 4 different examples of Monohybrid crosses using Punnett Squares on pages 174 and 175. You must be sure you are familiar with following terms in order to work out these crosses…..Purebred, Hybrid, Dominant, Recessive, Heterozygous, Homozygous, Alleles, Genotype, Phenotype. Try to work out each cross on your own without looking at the figures in the book and then check to see how you did.

- Complete Dominance – 1 allele is completely dominant over the other. Exs. Tall vs. Short, Purple flower vs. White Flower.

- Incomplete Dominance – occurs when 2 or more alleles have an influence on Phenotype (appearance). Results in a phenotype somewhere in between both parents. Ex. 4 O'clock Flowers – Red crossed with a White gives offspring with Pink flowers. See fig. 9-9 on page 176.

- Codominance – Neither allele is dominant or recessive. BOTH alleles show up in hybrid offspring. Ex. A Roan coat in horses – Both red hair and white show up in coat. See fig. 9-10 on pg. 176.

- Dihybrid Cross – Studies 2 different traits at the same time. More complicated because there are more possible combinations of alleles to work out. Study the example shown on pgs. 177 and 178.
- You should know some classic ratios for certain monohybrid and dihybrid crosses. These are listed below.

1. Monohybrid cross (1 trait studied)with 2 Heterozygous (Hybrid) parents:

   - Genotype Ratio = 1:2:1 In the case of pea plant height, this would be 1TT : 2Tt : tt.

   - Phenotype Ratio = 3:1 or 3 Tall : 1 Short.

2. Dihybrid cross (2 traits studied) with 2 parents that are heterozygous (hybrid) for both traits:

   -Phenotype Ratio = 9:3:3:1 See the top of pg. 178 for the appearances.