Chapter 9
Genetics
Section 1

MENDEL’S LEGACY
• **Genetics** is the field of biology devoted to understanding how characteristics are transmitted from parents to offspring
• Genetics was founded with the work of Gregor Johann Mendel, an Austrian monk who experimented with garden peas
• This section describes Mendel’s experiments and the principles of genetics that resulted from them
Gregor Mendel

- Knowledge of statistics valuable to his research on heredity → handing down of characteristics from parent to offspring
- Did experiments on garden pea, *Pisum sativum*
Mendel’s Garden Peas

- Observed 7 characteristics
  - Each occurred in two contrasting traits

- Plant height (long/short stems)
- Flower position (side/top)
- Pod color (green/yellow)
- Pod appearance (big/small)
- Seed texture (smooth/wrinkled)
- Seed color (yellow/green)
- Flower color (purple/white)
Self-Pollination

- Pollen transferred from the anthers of a flower to stigma of either the same flower or a flower on the same plant
Cross-Pollination

- Pollen transferred from anthers of a flower to stigma of a flower on a different plant
Mendel’s Experiments

- Studied each characteristic and its contrasting traits individually
- Began with **true-breeding** plants → always produce offspring with same trait
- **Strain** → plants that are pure for a specific trait
Produced strains by allowing plants to self-pollinate for several generations
Eventually got 14 strains, one for each of contrasting traits
Each strain was called parental generation, or P1 generation
Then he cross-pollinated two plants, one for each contrasting trait

- Resulting offspring were **first filial generation, \( F_1 \) generation**
Mendel took 2 F1 offspring and self-pollinated them

- **Second filial generation, $F_2$**
Mendel’s Results

- F1 generation ratio of 4:0 for contrasting traits
- F2 generation ratio of 3:1 for contrasting traits

Hypothesis: each trait inherited by controlling factor
  - Must be pair of factors for each trait
Mendel’s Conclusion

• Whenever he crossed P1 strains, one trait was NEVER in F1 generation
• That trait would come back in 25% (1/4) of F2 generation

• Hypothesized trait appearing in F1 was controlled by dominant factor because it masked (dominated) the other
• Trait that did NOT appear in F1 was recessive
• Dominant factor represented by capital letter
  ◦ Yellow seed = Y

• Recessive factor represented by lower case letter
  ◦ Green seed = y
Law of Segregation

- One of two laws that come from Mendel’s experiments

- *A pair of factors is segregated, or separated, during the formation of gametes* (meiosis)
Law of Independent Assortment

- 2\textsuperscript{nd} law that comes from his experiments
- Mendel crossed plants that differed in TWO characteristics
- Traits produced by dominant factors don’t always appear together
  - Green pod on white flowering plant

- Factors for different characteristics are distributed to gametes independently
Chromosomes and Genes

- **Molecular genetics** → study of structure and function of chromosomes and genes
- Remember a gene is a segment of DNA on a chromosome that controls a trait
  - Chromosomes occur in pairs, so genes occur in pairs
- Each of several alternative forms of a gene → **allele**
  - Mendel’s “factors” alleles
Alleles

- Since each trait has alternative forms (alleles), letters are used to represent dominance and recessiveness

- Ex. Yellow seeds may be YY or Yy, since the Y will mask, or dominate, the y
Section 2

GENETIC CROSSES

![Diagram of a genetic cross between Parent 1 (F, f) and Parent 2 (F, f)]
Genetic Crosses

- **Genotype** → genetic makeup of an organism (Yy)

- **Phenotype** → the physical appearance of an organism (yellow seed)
• When both alleles of a pair are alike, the organism is **homozygous** for that characteristic
  ◦ YY or yy

• When alleles are different, the organism is **heterozygous** for that characteristic
  ◦ Yy
Probability

- Likelihood that a specific event will occur
  - Can be decimal, percentage, fraction

- Probability = number of times an event is expect to happen
  number of opportunities for an even to happen
• Ex. Dominant trait of yellow seed color appeared in F2 generation 6,022 times
• Recessive trait of green seed appeared 2,001 times
• $6,022 + 2,001 = 8,023$ total individuals
• $6,022/8,023 = 0.75$ (75% dominant)
• $2,001/8,023 = 0.25$ (25% recessive)
Predicting Results

- Cross between individuals that involves only 1 set of contrasting traits → monohybrid cross

- Use **Punnett square** to predict results of monohybrid cross
Genotypic Ratios

- Creating a ratio to express probability of GENOTYPES
- Write possible genotypes
  - TT, Tt, tt
- Ratio reflects probability
  - TT:Tt:tt = 1:2:1
Phenotypic Ratios

- Ratio of phenotypes
- $T = \text{tall}, \ t = \text{short}$
- Ratio of tall:short
  - 3:1
Testcross

- How do you tell if a yellow seed is YY or Yy?
  - Use **testcross**
- Cross with homozygous recessive

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If 100% offspring are yellow, then genotype of parent is homozygous dominant.

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If offspring are 50/50, then genotype of parent is heterozygous.
Incomplete Dominance

- **Compete dominance** → dominant allele complete masks recessive allele
- **Incomplete dominance** → alleles mix/blend
- Ex. Four o’clock flowers →
Codominance

- BOTH alleles expressed in heterozygous offspring
- Neither allele dominant or recessive
- Ex. Blood type, roan horses
  - RR’ to show different alleles
Dihybrid Crosses

- Cross between individuals that involves TWO pairs of contrasting traits
- More complicated, more possible combinations
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### TtBb x TtBb

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- TTBB = 1/16
- TTBb = 2/16
- TtBB = 2/16
- Ttbb = 2/16
- TtBb = 4/16
- TTbb = 1/16
- ttBB = 1/16
- ttBb = 2/16
- ttbb = 1/16

- 9/16 56.25% tall, blue
- 3/16 18.75% tall, brown
- 3/16 18.75% short, blue
- 1/16 6.25% short, brown