Mendelian Genetics
Reading: Chap. 13, pp. 265-276, 282-286
I. Intro
   A. Motivating question
   B. Mendel
II. Mendel’s findings
   A. Mendel’s experiments
   B. Law of segregation of alleles
   C. Law of independent assortment of traits
III. Complications

Terms and Concepts
- character, trait, alleles, locus
- homozygous/heterozygous
- phenotype/genotype
- P, F1, F2
- dominant/recessive
- law of segregation
- law of independent assortment
- Testcross
- Rules of probability
- Incomplete dominance
- codominance
- Quantitative characteristics

What Darwin didn’t know:
How did heritability work?
What exactly was passed down from parents to offspring?
No idea about: Genes, chromosomes, DNA, mitosis and meiosis

Gregor Mendel
Austrian contemporary of Darwin
Published shortly after Darwin - but work was “buried”

Who was Mendel?
- Austrian monk
- Background in agriculture (grew up on a farm)
- Failed his teacher’s exam
- University of Vienna: math, causes of variation in plants
- Teaching at the Brünn
Modern School
What did he do?
Pea breeding
Testing mechanisms of inheritance: blending vs. acquired characteristics (e.g., Lamarck)
Used many different characters
Published results in 1865

Mendel didn’t know about chromosomes either!
• Results were buried for ~40 years – not broadly accepted until ~16 years after his death.
• Early in the 20th century, Sutton and Boveri (working independently) formulated the chromosome theory of inheritance, which proposes that meiosis causes the patterns of inheritance that Mendel observed.

Why did his experiments succeed?
1. Control over fertilization
2. “Either/or” characters
3. True breeding parents
4. Multiple generations: P, F1, F2

II. What did Mendel find?
A. Mendel’s experiments
B. Law of segregation (of alleles)
C. Law of independent assortment (of traits)

A. Mendel’s experiments: Simple cross
P - true breeding parents with different traits for same character.
F1 - Cross two of same generation
F2 - evaluate resulting traits: 3 to 1

Mendel tested many traits

3 to 1!!!
Mendel’s interpretation

- one factor from each parent

- dominant vs. recessive

- particulate inheritance: can get pure traits back

Genotype vs. phenotype

homozygous vs. heterozygous

B. Law of segregation of alleles

1. The factors controlling the trait of an individual go into different gametes.
   Cross true breeding lines (homozygotes), get all heterozygous offspring
   When heterozygous plants produce gametes, the two parental factors segregate: half the gametes get one type, half get the other type.

   All possible combinations, random combinations

2. Rules of probability

   1. “Both-and rule”
      - chance of 2 or more independent events both occurring together
      - multiply probabilities of each event

   2. “Either-or rule”
      - probability of an event when several ways for it to occur
      - add probabilities of each pathway

3. OK, prove it! The testcross

   Dominant phenotype: what genotype?
   Predictions follow from particulate inheritance

4. What do we know now?
How does the law of segregation relate to meiosis? Chromosomes, genes, and alleles

1. Two traits: an example

Rules of probability

Law of independent assortment (of characters)
2. What we know now:
Mendel’s independent assortment referred to characters.
How does this relate to independent assortment of chromosomes in meiosis?

Principle of independent assortment

<table>
<thead>
<tr>
<th>Chromosomes</th>
<th>Alleles for seed shape</th>
<th>Alleles for seed color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meiosis I</td>
<td>F^r</td>
<td>F^r</td>
</tr>
<tr>
<td>Meiosis II</td>
<td>F^r</td>
<td>F^y</td>
</tr>
<tr>
<td>Meiosis I</td>
<td>F^r</td>
<td>F^y</td>
</tr>
<tr>
<td>Meiosis II</td>
<td>F^r</td>
<td>F^y</td>
</tr>
</tbody>
</table>

The genes for seed shape and seed color assort independently, because they are located on different chromosomes.

What if genes for two traits are on the same chromosome?

- Independent or linked?
- Linked, except for…?
  - Crossing over
  - Depends how close they are:
    - genes further apart are more likely to behave as independent.

Did Mendel get lucky?

(not that way - he was a monk!)

1. Genes for traits he studied were either on separate chromosomes, or
2. Far enough apart on the same chromosome that they assorted independently

B. Multiple alleles – co-dominance

<table>
<thead>
<tr>
<th>TABLE 13.1 The ABO Blood Types in Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td>In humans, the four different ABO blood types are produced by the alleles present at a single locus. Three alleles are common in most populations: i, F^A, and F^B.</td>
</tr>
<tr>
<td>Phenotype (blood type)</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>O</td>
</tr>
<tr>
<td>A</td>
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<tr>
<td>B</td>
</tr>
<tr>
<td>AB</td>
</tr>
<tr>
<td>i = recessive</td>
</tr>
<tr>
<td>F^A and F^B = codominant</td>
</tr>
</tbody>
</table>

III. Complications

A. Incomplete dominance

- Flower color is variable in four colors:
  - Parental generation
  - F1 generation
  - Self-fertilization

- Is this the same as blending?

B. Multiple alleles – co-dominance

- Red hair?

C. Complications: Quantitative Characters

- One trait determined by multiple genes
- Could lead to perception of “blending” but that’s not what it is.

A “living histogram”—distribution of height in a college class
IV. Summary: KEY CONCEPTS

Mendel discovered that in garden peas, individuals have two factors, or versions, representing each trait. 
- We now know these are alleles - different versions of each gene.
- Prior to the formation of eggs and sperm, the two alleles of each gene separate.
- One allele is transmitted to each egg or sperm cell.

KEY CONCEPTS

Genes are located on chromosomes.

The separation of homologous chromosomes during meiosis I explains why alleles of the same gene segregate to different gametes.

KEY CONCEPTS

If genes are located on different chromosomes, then the alleles of each gene are transmitted to egg cells and sperm cells independently of each other.

KEY CONCEPTS

Important exceptions exist to the rules that individuals have two alleles of each gene and that alleles of different genes are transmitted independently.
- Genes on the same chromosome are not transmitted independently of each other.
- Some traits are controlled by more than one gene, or genes exhibit incomplete dominance or are co-dominant.