BIOL 3000-001 CHAPTER 3: MENDELIAN GENETICS 8/30

I. Introduction

A. Gregor Johann Mendel laid the foundation for genetic research as he explored the concept of the gene as a distinct hereditary unit & the ways in which genes are transmitted

1. Known as transmission genetics

II. Mendel Used a Model Experimental Approach to Study Patterns of Inheritance

A. 1856 Mendel performed his first set of hybridization experiments with the garden pea

B. Mendel showed remarkable insight into the methodology necessary for good experimental biology

C.

Character	Contrasting traits	F_1	F_2 Ratios
Seed Shape	Round / Wrinkled	All Round	3:1
Seed Color	Yellow/Green	All Yellow	3:1
Pod Shape	Full / Constricted	All Full	3:1
Pod color	Green / Yellow	All Green	3:1
Flower color	Violet / White	All violet	3:1
Flower position	Axial / terminal	All axial	3:1
Stem height	Tall / Dwarf	All tall	3:1

D. Mendel had discovered the basis for the transmission of hereditary traits

III. The Monohybrid Cross Reveals How One Trait is Transmitted from Generation to Generation

A. Monohybrid Cross is made by mating true-breeding individuals (AA and aa)

1. The parental generation is known as P_1 (AA or aa)

2. Their offspring, the first filial generation is known as F_1 (all will be Aa)

3. The offspring of the F_1 generation is the second filial generation F_2

a. Genotypic ratio 1:2:1 (AA, Aa, aa)

b. Phenotypic ratio 3:1 (dominant, recessive)

4. reciprocal crosses: when the sex of the genotypes are reversed (had the same results)

B. Mendel's First Three Postulates

1. Genetic characters are controlled by unit factors that exist in pairs in individuals

2. When two unit factors are present, one is dominant to the other, which is recessive

3. During the formation of gametes the paired unit factors separate randomly

C. Modern Genetic Terminology

1. Phenotype: the visible expression of a trait / physical appearance of the offspring

2. Genes: unit factors of inheritance → genotype: the genetic make-up of the offspring

3. Alleles: alternative forms of a single gene

4. homozygous: When both alleles are the same

5. heterozygous: When both alleles are different

D. Punnett Squares: Each of the possible gametes is assigned a column or a row; the vertical columns represent those of the female parent, and the horizontal rows represent those of the male parent.

1. AA × aa [P_1]

[F_1]

	A	A
a	Aa	Aa
a	Aa	Aa

→

[F_2]

	A	a
A	AA	Aa
a	Aa	aa

E. The Testcross: One Character

1. testcross: the organism expressing the dominant phenotype, but of unknown genotype is crossed to a known homozygous recessive individual.

a. If genotype is AA, then F_1 will have dominant phenotype

b. If genotype is Aa, then phenotypes will appear in a 1:1 ratio

IV. Mendel's Dihybrid Cross Generated a Unique F_2 Ratio

A. Dihybrid cross: a cross involving two pairs of contrasting traits (AABB × aabb)

B. Mendel's Fourth Postulate: Independent Assortment

1. Dihybrid crosses are easier to understand if they are thought of as two monohybrid crosses conducted separately with their resulting ratios multiplied together (Mendel's 9:3:3:1 dihybrid ratio)

2. Product law of probability: When two independent events occur simultaneously, the combined probability is equal to the product of their individual probabilities.

3. Independent Assortment: During gamete formation, segregating pairs of unit factors assort independently of each other.

4. AaBb × AaBb

3/4 dominant A < 3/4 dominant B = 9/16 A-B-; 1/4 recessive b = 3/16 A-bb

1/4 recessive a < 3/4 dominant B = 3/16 aaB-; 1/4 recessive b = 1/16 aabb

C. The Testcross: Two Characters

1. The organism expressing two dominant phenotypes but of unknown genotype is crossed to a known homozygous recessive individual for both traits.

a. If genotype is AABB, then F_1 will have dominant phenotype

b. If genotype is AaBb then F_1 will have a 9:3:3:1 ratio of phenotypes

V. The Trihybrid Cross Demonstrates That Mendel's Principles Apply to Inheritance of Multiple Traits

A. Trihybrid cross: a cross involving three pairs of contrasting traits (AABBCC × aabbcc)

B. The Forked-Line Method/Branch Diagram: used rather than a punnett square to solve complex crosses

C. AaBbCc × AaBbCc (27:9:9:9:3:3:3:1 ratio)

F_2
- 3/4 dominant A
  - 3/4 dominant B
    - 3/4 dominant C — 27/64 A-B-C-
    - 1/4 recessive c — 9/64 A-B-cc
  - 1/4 recessive b
    - 3/4 dominant C — 9/64 A-bbC-
    - 1/4 recessive c — 3/64 A-bbcc
- 1/4 recessive a
  - 3/4 dominant B
    - 3/4 dominant C — 9/64 aaB-C-
    - 1/4 recessive c — 3/64 aaB-cc
  - 1/4 recessive b
    - 3/4 dominant C — 3/64 aabbC-
    - 1/4 recessive c — 1/64 aabbcc

VI. Mendel's Work Was Rediscovered in the Early Twentieth Century

A. Continuous variation: offspring were a blend of their parents' phenotypes (Darwin & Wallace)

B. Discontinuous variation: variation was due to discrete units (Mendel)

C. The Chromosomal Theory of Inheritance: the idea that genetic material is contained within chromosomes

1. Walter Flemming discovered chromosomes in the nuclei in 1879

a. Hugo de Vries, Karl Correns, & Erich Tschermak conducted hybridization experiments

b. Mendel's work had predicted all of their results

2. Walter Sutton & Theodor Boveri are credited with initiating the chromosomal theory of inheritance

D. The Correlation between Mendel's Unit Factors & the Behavior of Chromosomes during Meiosis

1. Diploid number (2n) = specific number of chromosomes present in somatic cells

2. Haploid number (n) = number of chromosomes in each gamete = 1/2 of diploid (2n)

3. Diploid number of chromosomes is composed of homologous pairs

4. A chromosome is composed of a large number of linearly ordered, information-containing genes

a. locus: the location of a gene on a given chromosome

5. During mitosis/meiosis homologous chromosomes are the same size & share a centromere (not XY)

6. Homologous chromosomes form pairs/synapse

7. Homologs contain identical, linearly-ordered gene loci

VII. Independent Assortment Leads to Extensive Genetic Variation

A. The number of possible gametes is 2^n where n = the haploid number (genetic variation)

a. 8×10^6 different gametes per parent = 64×10^{13} different offspring per couple

VIII. Laws of Probability Help to Explain Genetic Events

A. Probability ranges from 0–1

B. Product law can be applied to two events occuring simultaneously when the result of one event does not affect the result of the other