Mendelian Genetics

Mendelian Genetics

- Also referred to as “transmission genetics”
- Principles that describe how traits are passed from parents to offspring.

NOTE: You **are responsible** for the material on the interactive CD that came with your text. If you do not have the CD, you will need to make arrangements. Either share with a classmate or come to me to check out the extra copy I have available for 24-hour checkout. (Hint: don’t wait until the night before the test)

Gregor Mendel (1822-1884)

Augustinian monk in what is now the Czech Republic

Kept extremely accurate records of his experiments with the garden pea

Restricted his studies to a very few, discrete, contrasting traits

Described many of the foundational principles of trait transmission.

Definitions

Monohybrid cross: A cross involving mating two individuals, each of which expresses only one of a pair of contrasting traits (e.g. round/wrinkled peas, yellow/green peas, purple/white flowers, tall/dwarf stem)

Parental generation (P_1): The original parents

First filial generation (F_1): Offspring resulting from parental mating.

Second filial generation (F_2): Offspring resulting from the self-crossing of individuals from the F1 generation.

Seeds: round/wrinkled

yellow/green

Pods: full/constricted

green/yellow

Flowers: violet/white

Stem: axial/terminal

tall/dwarf

Definitions

True breeding individuals: When allowed to self-fertilize, the plants produce only offspring like themselves (or, homozygous), generation after generation. (Note: self-pollination is the norm)

e.g., True-breeding tall plants only produced tall plants when self-pollinated. True breeding dwarf plants only produced dwarf offspring.

Definitions

Reciprocal Crosses: Crosses were created such that the parental source of each trait was monitored and both types were represented in crosses of the parental generation.

For example, ♂tall x ♀dwarf and ♂dwarf x ♀tall.

Note: Mendel observed that it did not matter which P_1 plant served as the source of pollen and which served as the source for the ovum. (The traits were not sex-linked)

Outcomes

Transmission genetics studies examine the outcomes of many matings.

Data are expressed as **ratios**. For example, in one study, Mendel examined 1064 F_2 offspring and observed 787 tall plants and 277 dwarf plants, giving rise to a ratio of 2.8 tall : 1 dwarf, or about **3:1**

Monhybrid Cross

Mate tall stemmed pea plant to dwarf stem pea plant.

Outcome (F_1): All tall! (The dwarf trait disappeared.)

When individuals from the F_1 were allowed to self-pollinate, the dwarf trait re-appeared in the resulting F_2 generation. Approximately 25% of the offspring were dwarf. (3:1 ratio of tall:dwarf)

Mendel's First Three Postulates

1. Unit factors (genes) in pairs

A specific unit factor exists for each trait (tall gene and dwarf gene). Each diploid individual has two unit factors, one of which was inherited from each parent.

Factors occur in pairs; therefore, three combinations are possible: two tall, two dwarf or one of each.

The combination inherited determines stem height.

Mendel's First Three Postulates

2. Dominance/Recessiveness

When two unlike unit factors responsible for a single characteristic are present in a single individual, one factor is dominant to the other, which is recessive.

Expression of the trait that disappeared in the F_1 but reappeared in the F_2 generation (dwarf) is under the influence of the trait that appeared regardless of generation (tall). *The trait that is always apparent (tall) is dominant to the trait that is not always apparent (dwarf, recessive).*

Mendel's First Three Postulates

3. Independent Segregation

During the formation of gametes, the paired unit factors separate randomly so that each gamete receives one or the other with equal likelihood.

There is an equal probability that each gamete will receive either the tall unit factor or the dwarf unit factor.

Monohybrid Cross

P_1 tall plants with identical tall unit factors x P_1 dwarf plants with identical dwarf unit factors.

Tall is dominant to dwarf, so all F_1 plants were tall.

When the gametes form in the F_1 plants, each gamete will receive *either* the tall gene *or* the dwarf gene.

Monohybrid Cross

When the F_1 are allowed to randomly self-fertilize, there are four gamete pairings possible in the F_2 generation, each occurring at the same frequency:

1. tall/tall
2. tall/dwarf
3. dwarf/tall
4. dwarf/dwarf

Monohybrid Cross—(F_2 appearance)

Gamete Combination	Plant size
tall/tall	tall
tall/dwarf	tall
dwarf/tall	tall
dwarf/dwarf	dwarf

Combinations 2 and 3 will yield tall plants because of dominance/recessiveness, so the appearance of the resulting F_2 generation is ¾ tall, ¼ dwarf.

Monohybrid Cross—Gametes Contributed

The dominant unit factor is usually assigned a capital letter (D is tall)

The recessive unit factor is usually assigned a small letter (d is dwarf)

Terminology

Genotype	Phenotype
tall/tall (DD)	(tall)
tall/dwarf (Dd)	(tall)
dwarf/tall (dD)	(tall)
dwarf/dwarf (dd)	(dwarf)

Terminology

Genes are unit factors

Alleles are alternative forms of a single gene (e.g. tall [D] vs. dwarf [d])

Phenotype is the *appearance* of an individual (e.g. tall plant vs. dwarf plant)

Genotype is indicated by the two unit factors (alleles) present in a given individual (DD vs Dd vs dd); the *genetic makeup* of an individual.

Terminology

Homozygous: An individual possesses two of the *same* allele for a given trait (DD or dd).

Heterozygous: An individual possesses two *different* alleles for a given trait (Dd)

(The nouns are *homozygote* and *heterozygote*)

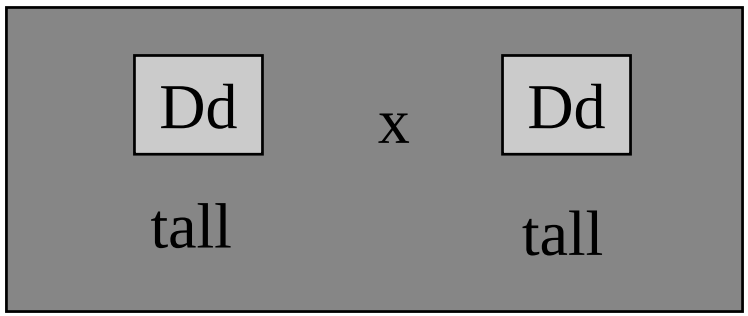
Punnett Squares

Graphics that help determine the phenotype and genotype outcomes of gamete fertilization.

Devised by Reginald C. Punnett

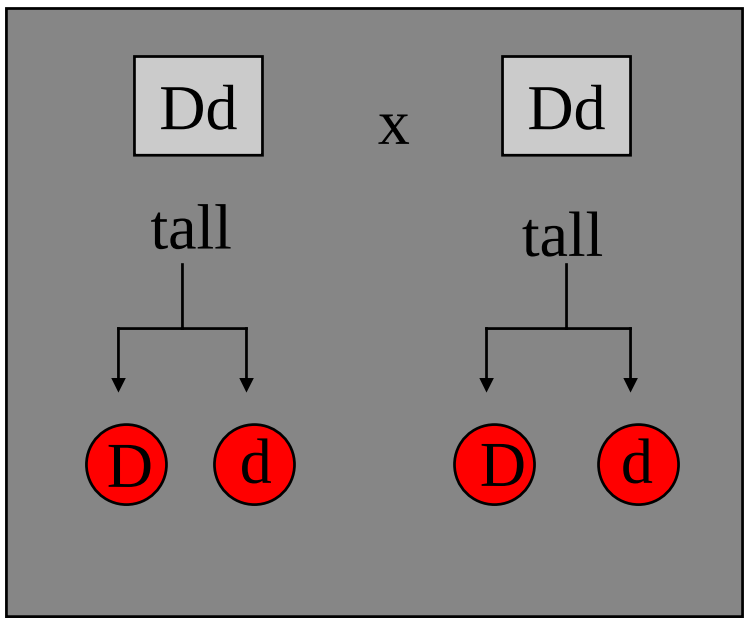
Punnett Squares

F1 Cross



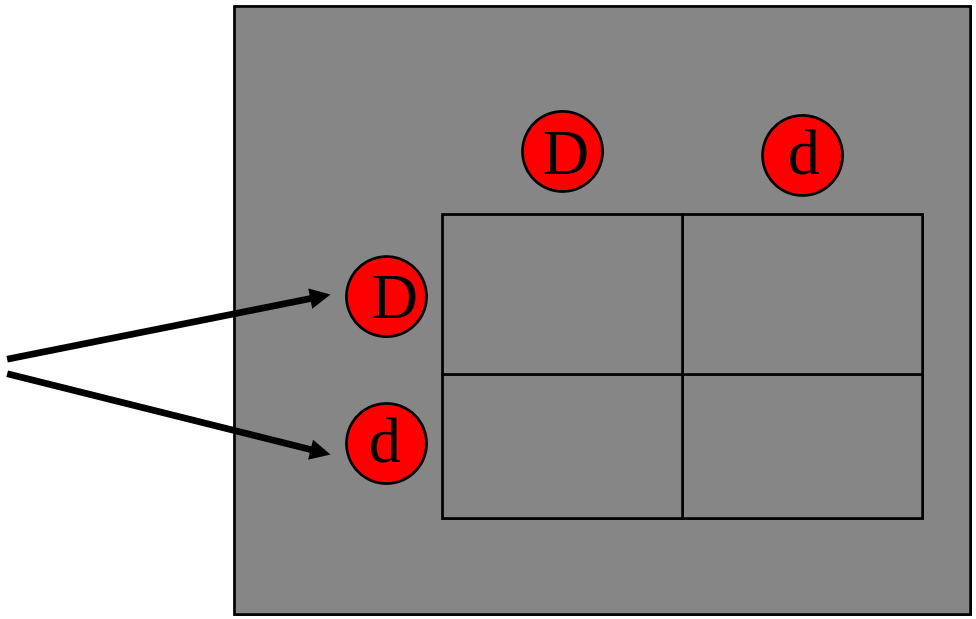
Punnett Square

Gametes produced by F_1 parents



Setting up the Punnett Square

Each gamete is arranged to show the possible contributions from a parent



Setting up the Punnett Square—Fertilization