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?

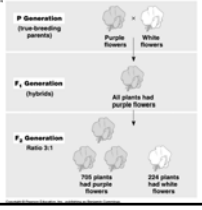
What exactly <u>was</u> passed down from parents to offspring?

No idea about: Genes, chromosomes, DNA, mitosis and meiosis

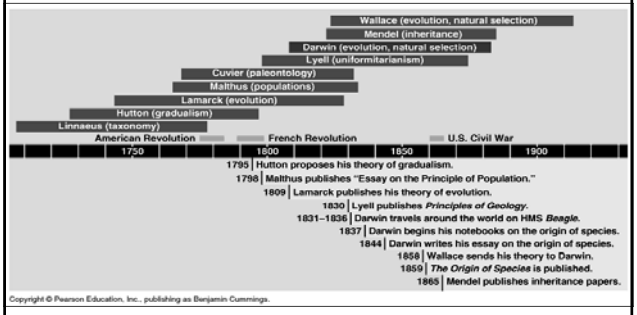
Blending vs. particulate inheritance?

Flower color is variable in four-o'clocks.

A "living histogram"—distribution of height in a college class



Gregor Mendel



Austrian contemporary of Darwin
Published shortly after Darwin - but work was "buried"

Fig 22.1

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

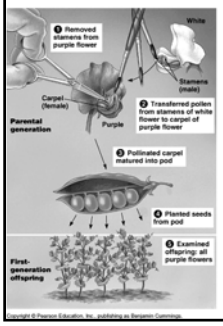
Mendel didn't know about chromosomes either!

• Results were buried for ~40 years – not broadly accepted until ~16 years after his death.

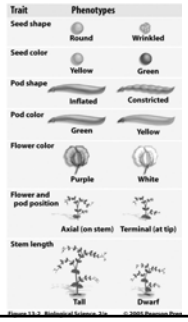
•Early in the 20th century, Sutton and Boveri (working independently) formulated the chromosome theory of inheritance, which proposes that meiosis causes the patterns of inheritance that Mendel observed.

Why did his experiments succeed?

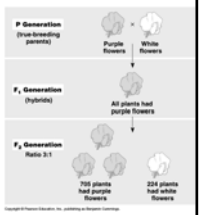
1. Control over fertilization



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)

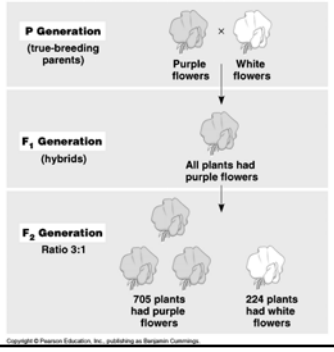
C. Law of independent assortment (of traits)

A. Mendel's experiments: Simple cross

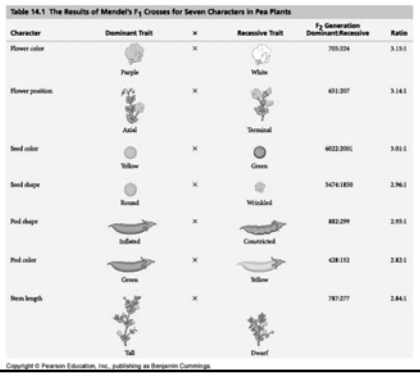
P - true breeding parents with different traits for same character.

F_1 - Cross two of same generation

F_2 - evaluate resulting traits: 3 to 1



Mendel tested many traits



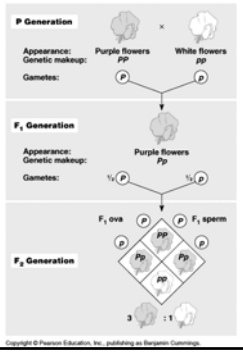
3 to 1!!!

Mendel's interpretation

- one factor from each parent

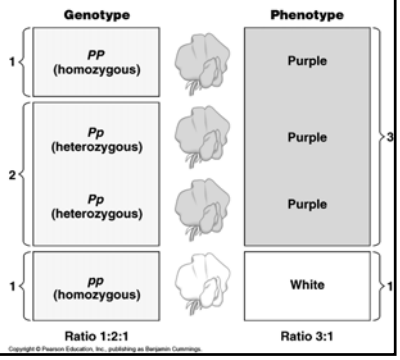
- dominant vs. recessive

- ***particulate inheritance***: can get pure traits back



Genotype vs. phenotype

homozygous vs. heterozygous



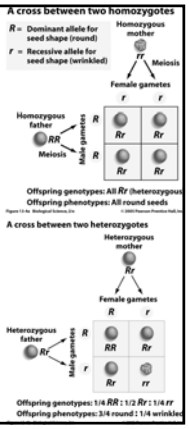
B. Law of segregation of alleles

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.

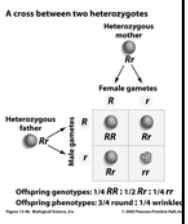
All possible combinations, random combinations



2. Rules of probability

1. "Both-and rule"
   - chance of 2 or more independent events both occurring together
   - <u>multiply</u> probabilities of each event

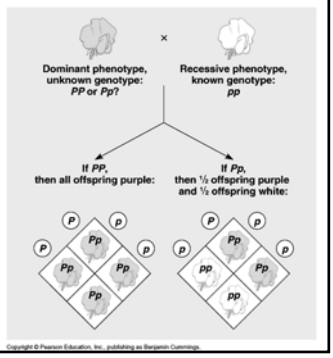
2. "Either-or rule"
   - probability of an event when several ways for it to occur
   - add probabilities of each pathway



3. OK, prove it! The testcross

Dominant phenotype: what genotype?

Predictions follow from particulate inheritance



4. What do we know now?

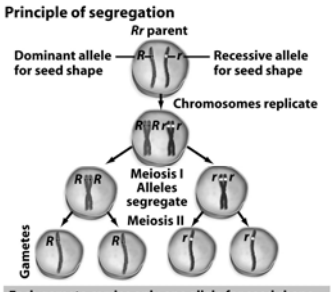
How does the law of segregation relate to meiosis?

Chromosomes, genes, and alleles

Alleles segregate on the homologous chromosomes

Homologous chromosomes separate after doubling

Sister chromatids separate



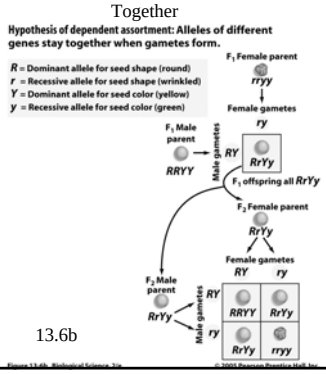
13.9

C. Law of independent assortment

What about two or more characters? Are they inherited together or independently?

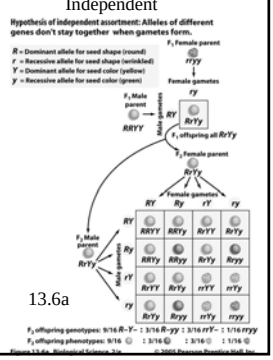
1. Two traits: an example

Together



13.6b

Independent



13.6a

Mendel's results

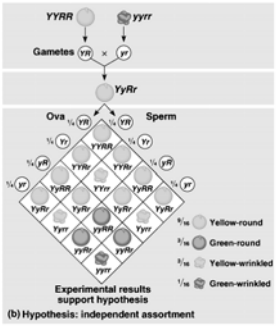
F_2 generation phenotype				
Number	315	101	108	32
Fraction of offspring	9/16	3/16	3/16	1/16

556 total

Figure 13-6c Biological Science, 2/e

Which hypothesis does this support?

Rules of probability



From YyRr x YyRr

Yellow round:
YYRR YYRr YyRR YyRr
(1/4*1/4) + (2*1/4*1/4)+(2*1/4*1/4)+(4*1/4*1/4) = 9/16

Green round:
yyRR yyRr
(1/4*1/4) + (2*1/4*1/4) = 3/16

Yellow wrinkled:
YYrr Yyrr
(1/4*1/4) + (2*1/4*1/4) = 3/16

Green wrinkled:
yyrr (1/4*1/4) = 1/16

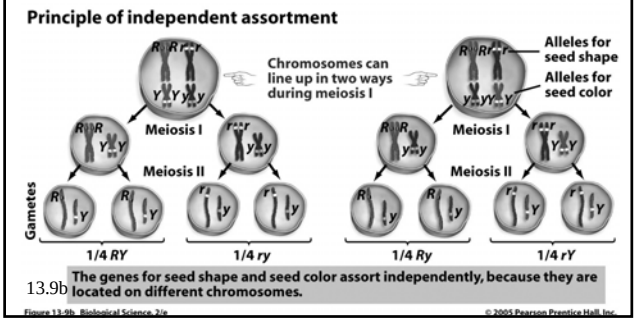
Law of independent assortment (of characters)

"Independent segregation of each pair of alleles (i.e., genes coding for each character) during gamete formation."

2. What we know now:

Mendel's independent assortment referred to characters.

How does this relate to independent assortment of chromosomes in meiosis?



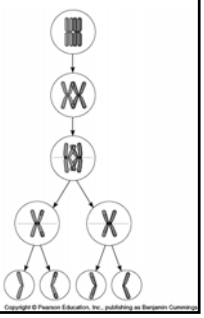
13.9b

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.



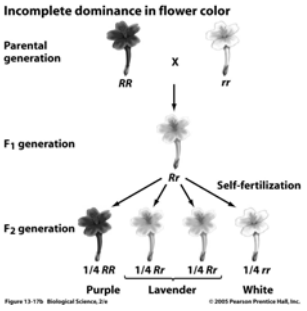
Did Mendel get lucky?

(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

III. Complications

A. Incomplete dominance



Is this the same as blending?

B. Multiple alleles – co-dominance

TABLE 13.1 The ABO Blood Types in Humans

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, I^A, and I^B.

Phenotype (blood type)	Genotype
O	ii
A	I^AI^A or I^Ai
B	I^BI^B or I^Bi
AB	I^AI^B

i = recessive
I^A and I^B = codominant

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

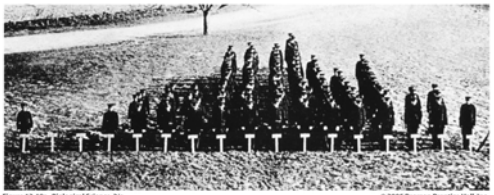
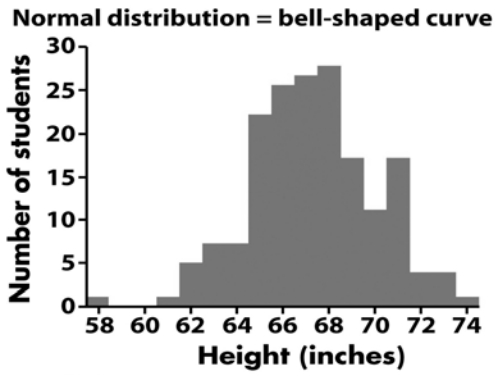


fig. 13.19



13.19b Figure 13-19b Biological Science, 2/e

© 2005 Pearson Prentice Hall, Inc.

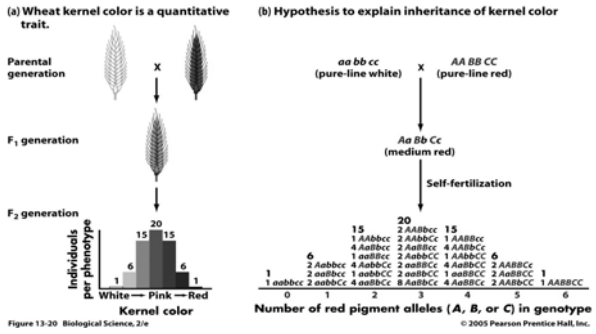


Figure 13-20 Biological Science, 2/e

© 2005 Pearson Prentice Hall, Inc.

13.20

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.