FUNDAMENTALS OF GENETICS

Chapter 9- Biology

Genetics – Vocabulary

1) Allele
2) Anther
3) Cross-pollination
4) Dominant
5) F_1 Generation
6) F_2 Generation
7) Genetics
8) Heredity
9) Law of independent assortment
10) Law of segregation
11) Molecular genetics
12) P1 Generation
13) Pollination
14) Pure
15) Recessive
16) Test Cross
17) self-pollination
18) Stigma
19) Strain
20) Trait
21) Codominance
22) Complete dominance
23) Dihybrid
24) Genotype
25) Genotypic ratio
26) Heterzygous
27) Homzygous
28) Incomplete dominance
29) Monohybrid cross
30) Phenotype
31) Phenotypic ratio
32) Probability
33) Punnett square

The Legacy of Gregor Mendel

- Gregor Mendel, “Father of Genetics”, a monk that used his science and mathematics background to study heredity

- Inheritance- the passing of traits by heredity
- Heredity- the transmission of traits from parents to their offspring

Mendel studied the heredity patterns of pea plants

1. Seed texture (round vs. wrinkled)
2. Seed color (yellow vs. green)
3. Seed coat color (colored vs. white)
4. Pod appearance (inflated vs. constricted)
5. Pod color (green vs. yellow)
6. Position of flowers along stem (axial vs. terminal)
7. Stem Length (tall vs. short)

- Mendel studied these characteristics to find a predictable pattern of inheritance

1. Mendel's Experiments

a. **pure-** always produced offspring with a particular trait

b. **Strain-** denotes that all organisms are pure for a specific trait

c. Mendel produced strains of plants to study each characteristic

d. **Self-pollination-** a reproductive process in which fertilization occurs within a single plant

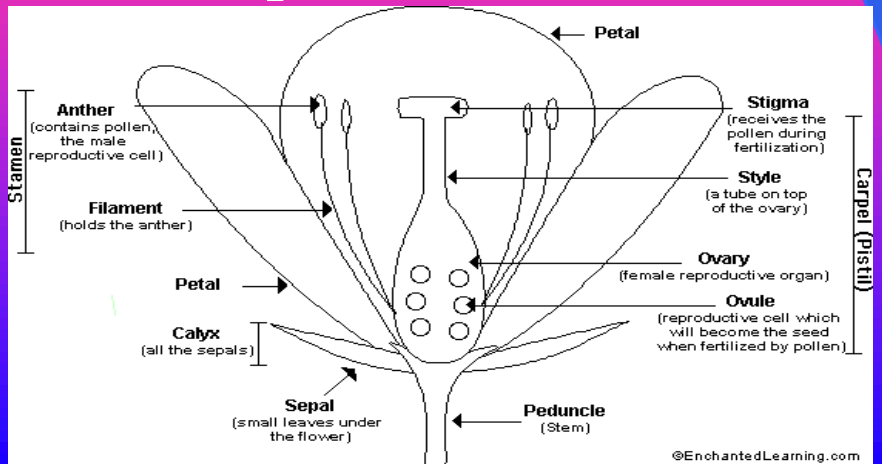
   1. Mendel used this technique to produce his strains

e. in plants, both sperm and egg is produced inside the flower

1. Anthers produce pollen grains that contain sperm

2. Eggs are produced in structures called ovules, found in stigma

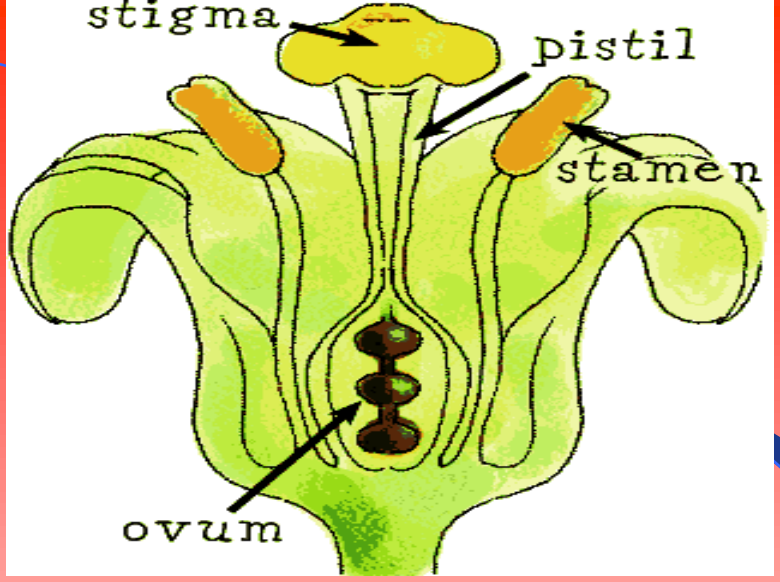
f. **<u>Pollination-</u>** the transfer of pollen from one anther to stigma



g. By self-pollination, Mendel produced 14 strains of plants (1 for each characteristics)

1. **Parental generation (P_1 generation)** –a strain produced through self-pollination

2. Mendel called each of the 14 strains a parental generation



h. Cross-pollination- the transfer of pollen from the anther of a plant pure for one trait to the stigma of another plant pure for the contrasting trait

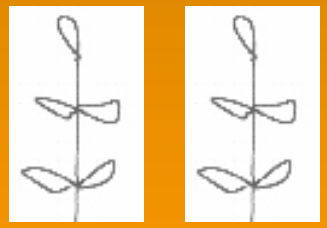
1. This was the next step Mendel took in his experiments, by crossing the different strains

2. He then recorded how many of each type of offspring each P1 produced

i. First filial generation (F_1 generation)- the offspring of the P_1 generation

j. Mendel then took the F1 generation and self-pollinated them producing a **second filial generation (F_2 generation)-**offspring of the F_1 generation

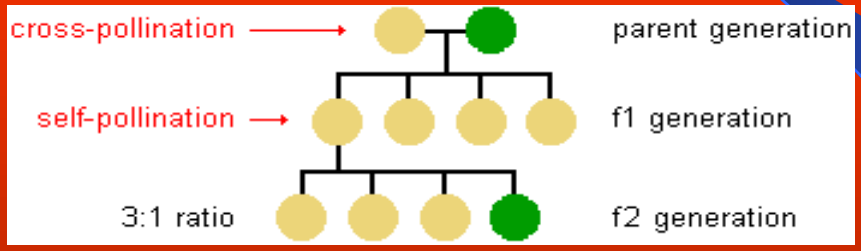
k. Mendel performed thousands of crosses and documented the results of each

P_1 

F_1 

2. Mendel's Results and Conclusions

a. Whenever Mendel crossed strains, one of the P_1 traits vanished from all F_1 plants



b. In every case though, the trait reappeared in a ratio of 3:1 in the F_2 generation

c. Mendel called the trait that appeared in the F_1 generation dominant and the trait that reappeared in the F_2 generation recessive

TABLE 9-1 Mendel's Crosses and Results

Characteristic	P cross	F_1 generation	F_2 generation	Actual ratio	Probability ratio
Position of flowers along stem	 axial × terminal	 axial	651 axial 207 terminal	3.14:1	3:1
Height of plant	 tall × short	 tall	787 tall 277 short	2.84:1	3:1
Pod appearance	 inflated × constricted	inflated	882 inflated 299 constricted	2.95:1	3:1
Pod color	 green × yellow	green	428 green 152 yellow	2.82:1	3:1
Seed texture	 smooth × wrinkled	smooth	5,474 smooth 1,850 wrinkled	2.96:1	3:1
Seed color	 yellow × green	yellow	6,022 yellow 2,001 green	3.01:1	3:1
Flower color	 purple × white	purple	705 purple 224 white	3.15:1	3:1

d. Mendel concluded that the patterns of inheritance were governed by three principles

1. Principle of dominance and recessiveness
2. Principle of segregation
3. Principle of independent assortment

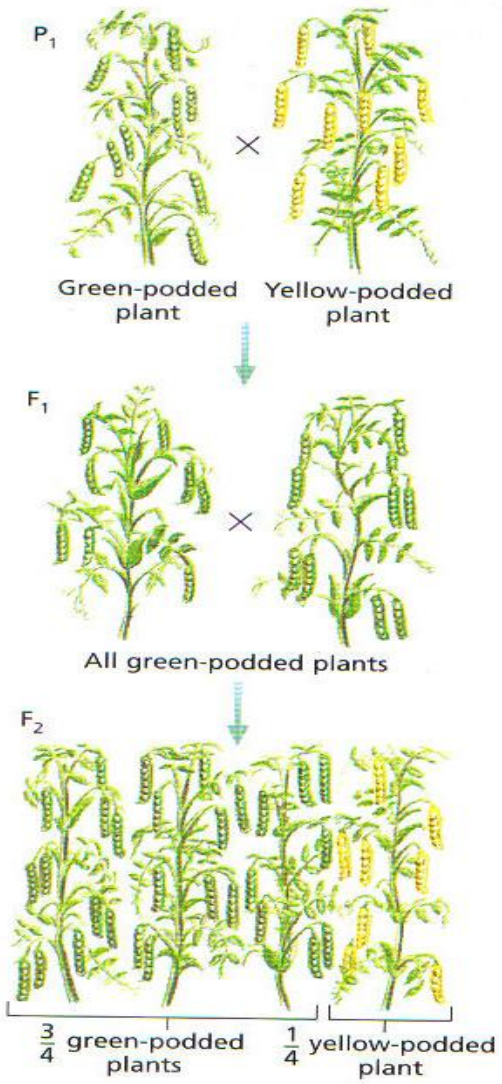
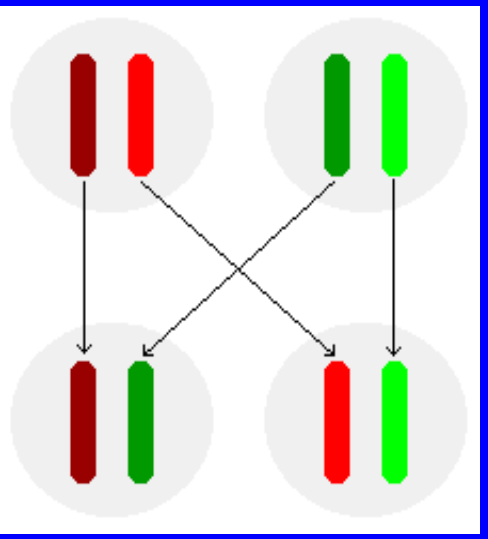


FIGURE 9-2

Pure green-podded pea plants crossed with pure yellow-podded pea plants produce only green-podded plants. Yet when the F_1 generation is permitted to self-pollinate, some yellow-podded plants appear in the F_2 generation.

e. Principle of Dominance and Recessiveness

1. **Definition:** one factor in a pair may mask the other factor, preventing it from having an effect



2. **Dominant:** the factor that masks or dominants the other factor of this trait
3. **Recessive:** the factor that is masked in the presence of a dominant factor for that characteristic

f. Principle of Segregation

1. **Definition:** the two factors for a characteristics segregate, or separate, during the formation of eggs and sperms

g. Principle of Independent Assortment

1. **Defintion:** factors for different characteristics are distributed to reproductive cells independently

3. Chromosomes and Genes
   a. Mendel's findings are consistent with what we believe today, but back in 1865, scientists found this odd
   b. Gene: a segment of DNA on a chromosome that controls a particular hereditary trait
      1. Since chromosomes occur in pairs, genes occur in pairs
   c. Allele: alternative forms of a gene

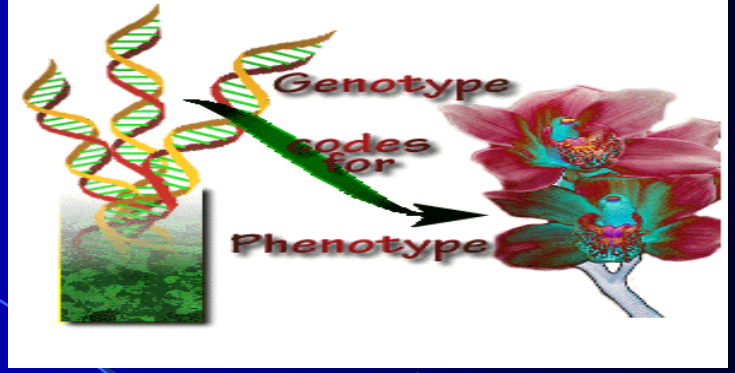
d. Scientists use capital letter for dominant alleles and lowercase letters for recessive alleles

1. Tallness (T) is dominant to shortness (t)
2. Green (G) is dominant to yellow (g)

GENOTYPES	Resulting Phenotypes
Homozygous Dominant (YY)	Yellow
Heterozygous (Yy)	Yellow
Homozygous Recessive (yy)	Green

where
Y = the dominant allele for yellow &
y = the recessive allele for green

B. GENETIC CROSSES



1. Genotype and Phenotype

a. **Geneotype**: the genetic makeup of an organism

b. **Phenotype**: the external appearance of an organism

c. An organism can have a phenotype of tall, but have a genotype of either TT or Tt

d. **Homozygous**: when both pairs of alleles are the same for a characteristic

1. May be homozygous recessive or dominant

e. **Heterozygous**: when the two alleles for a characteristics are not the same

f. Mendel studied traits that had only two alleles, but there are characteristics that have many alleles

1. **Multiple alleles:** when three or more alleles control a trait
2. Human blood and hair color- examples

2. Probability

a. **Definition:** the likelihood that a specific event will occur

b. Probability = $\frac{\text{number of one kind of event}}{\text{number of all events}}$

c. Expressed as a decimal, percentage, or fraction

d. Example: F1 yellow seed appeared 3 times
green seed appeared 1
Total= 4 times

probability of yellow seed: ¾, 75%, or .75

probability of green seed: ¼, 25%, or .25

3. Predicting Results of Monohybrid Crosses

*__monohybrid cross:__ a cross between individuals that involve one pair of contrasting traits

*__Punnett square:__ a diagram that aids in predicting probability

a. Example #1: Homozygous x Homozygous

BB x BB

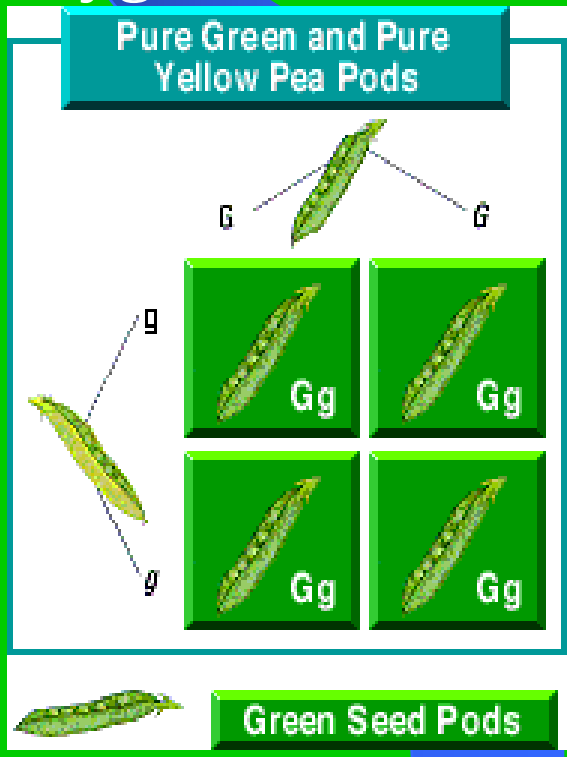
	B	**B**
B	**BB**	**BB**
B	**BB**	**BB**

BB x bb

	b	**b**
B	**bB**	**bB**
B	**bB**	**bB**

bb x bb

	b	**b**
b	**bb**	bb
b	**bb**	bb



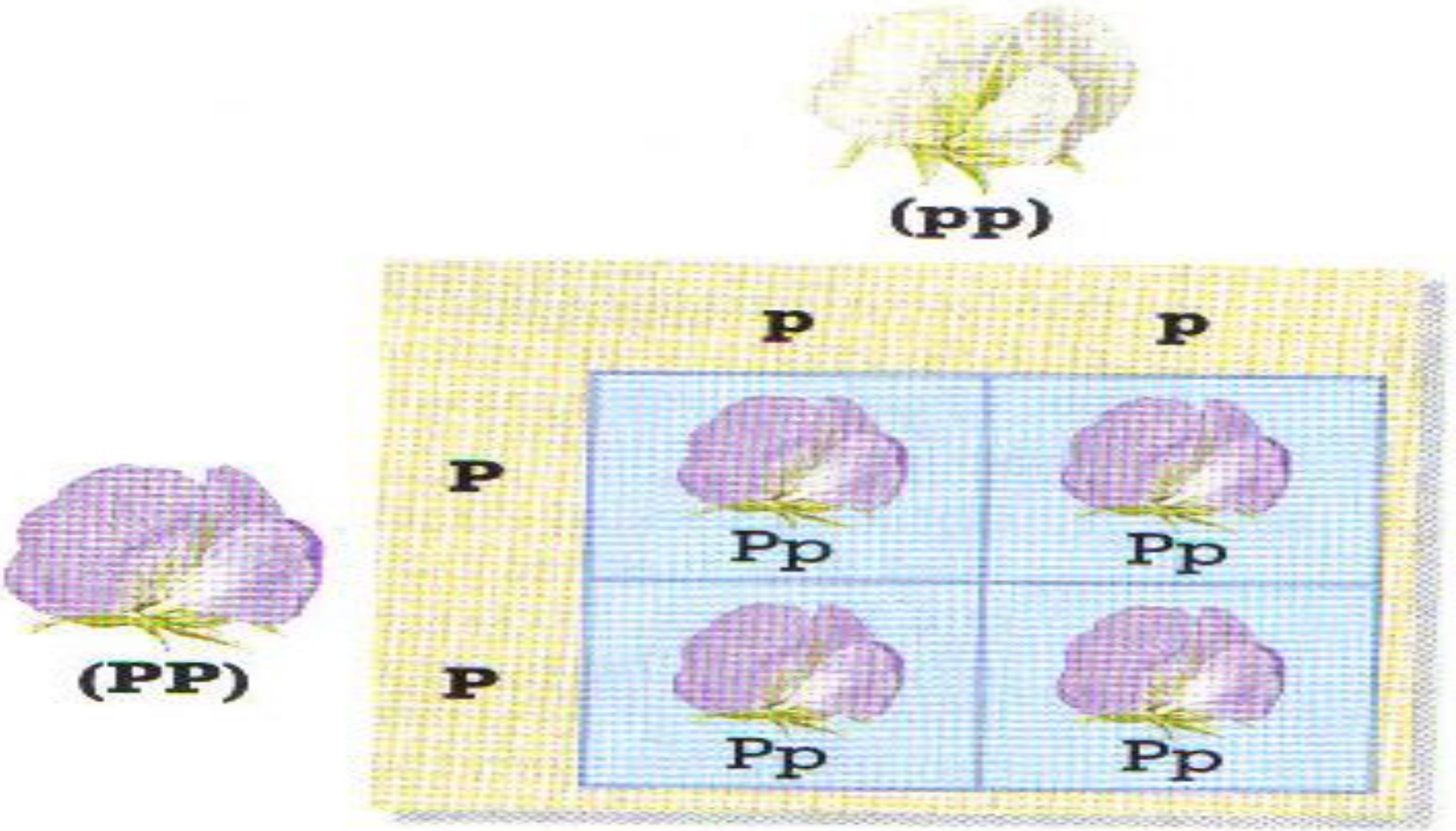
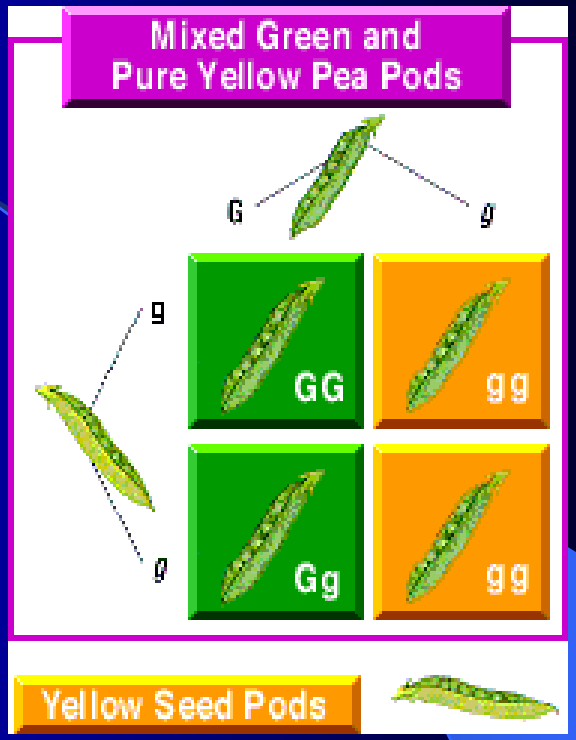


FIGURE 9-5

A pea plant homozygous for purple flowers crossed with a pea plant homozygous for white flowers will produce only purple-flowering offspring. Note that all of the offspring will be heterozygous for flower color.

b. Example 2: Homozygous x Heterozygous

	R	R
R	RR	RR
r	Rr	Rr

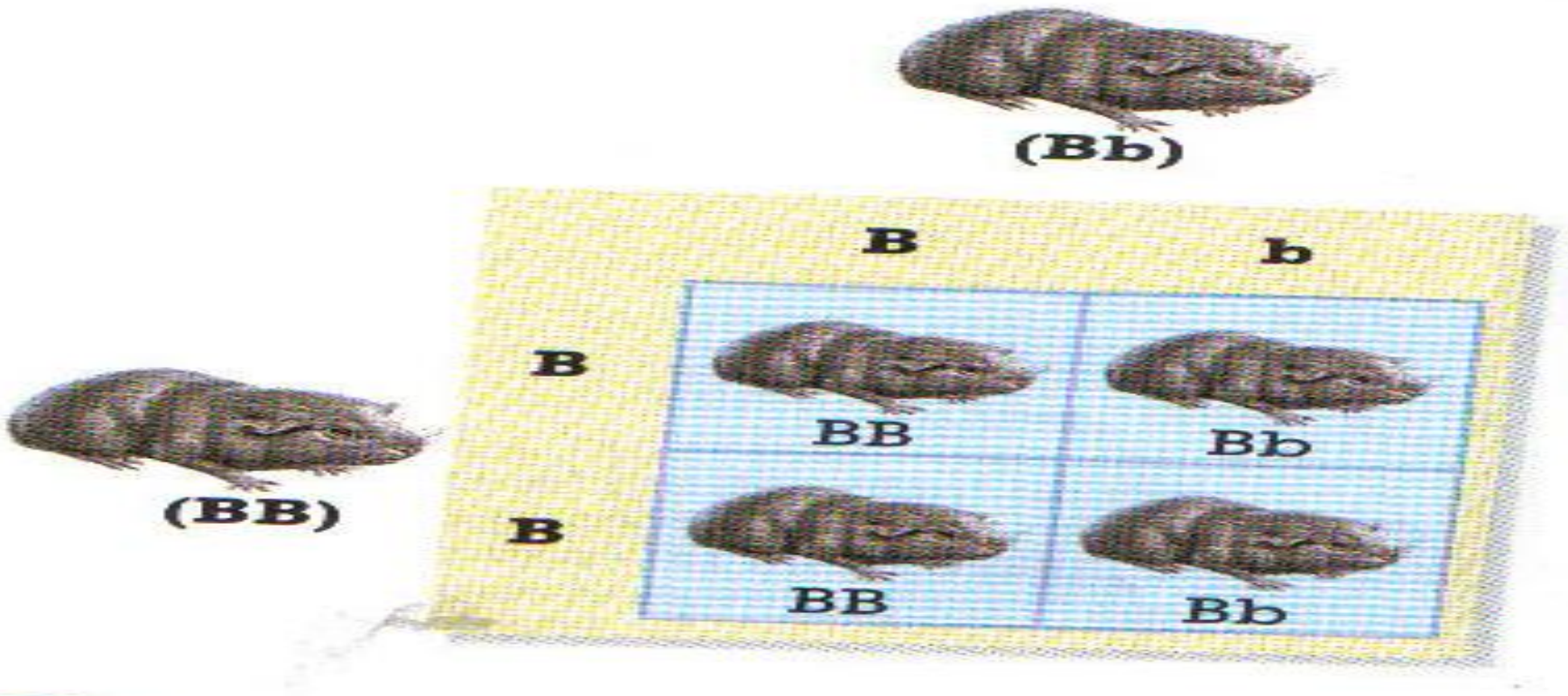


	b	b
B	Bb	Bb
b	bb	bb

FIGURE 3

FIGURE 9-6

Crossing a guinea pig homozygous for black coat color with one heterozygous for black coat color produces all black-coated offspring. Note that half of the offspring are predicted to be homozygous for coat color.



c. Example 3: Heterozygous x Heterozygous

	R	r
R	RR	Rr
r	Rr	rr

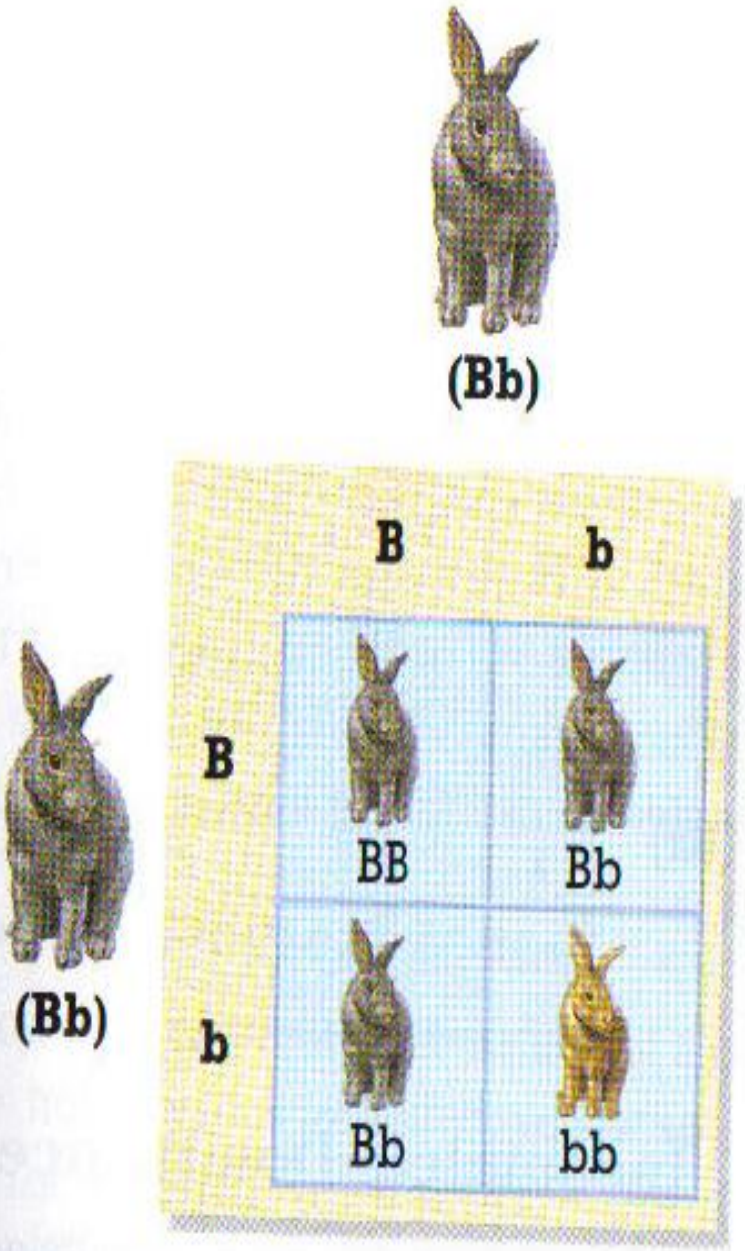


FIGURE 9-7

Crossing two rabbits that are both heterozygous for black coat color tends to produce 50 percent heterozygous black individuals, 25 percent homozygous black individuals, and 25 percent homozygous brown individuals.

d. Example 4: Testcross

1. **Testcross:** the procedure in which an individual of unknown genotype is crossed with a homozygous recessive individual

   a. A testcross can determine any genotype of an individual with a dominant phenotype

2. If all the offspring has a dominant phenotype, then the individual in question must have been homozygous dominant for the trait

3. If the offspring has a 1:1 ratio of dominant to recessive trait, the individual in question must have been heterozygous for the trait

	R	R
r	Rr	Rr
r	Rr	Rr

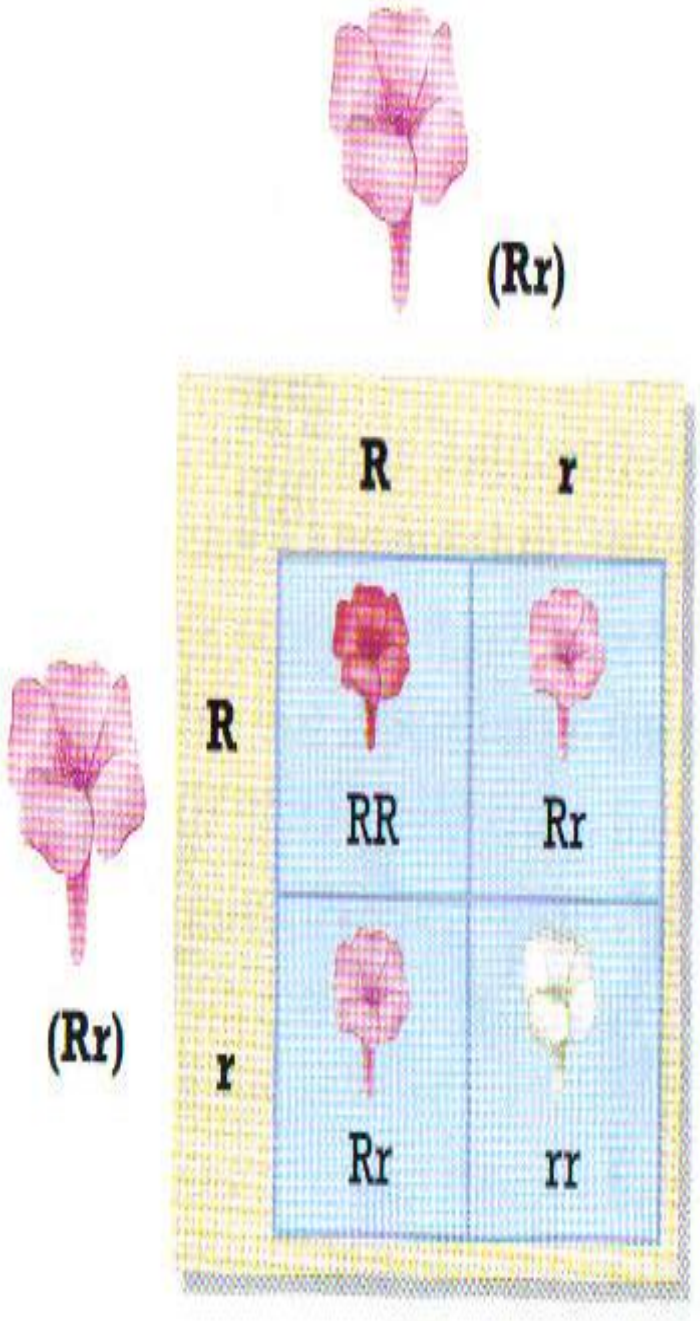
	R	r
r	Rr	rr
r	Rr	rr

e. Example 5: Incomplete Dominance

1. **Incomplete dominance:** is the phenomenon that occurs when two or more alleles influence the phenotype
2. This results in an trait intermediate between dominant and recessive
3. Example: Japanese four o'clocks (red, pink,white)

FIGURE 9-9

When red-flowering four o'clocks are crossed with white-flowering four o'clocks, all of the F_1 offspring produce pink flowers, an intermediate between the two phenotypes. When the F_1 generation is interbred, red-flowering, pink-flowering, and white-flowering plants are produced because the trait for red flower color has incomplete dominance over the trait for white flower color.



4. Predicting results of a Dihybrid cross

*__dihybrid cross:__ is a cross between individuals that involves two pairs of contrasting traits

a. Example 6: Homozygous dominant vs Homozygous recessive

AAGG x aagg

A- axial
a-terminal
G- green
g- yellow

	AG	AG	AG	AG
ag	AaGg	AaGg	AaGg	AaGg
ag	AaGg	AaGg	AaGg	AaGg
ag	AaGg	AaGg	AaGg	AaGg
ag	AaGg	AaGg	AaGg	AaGg

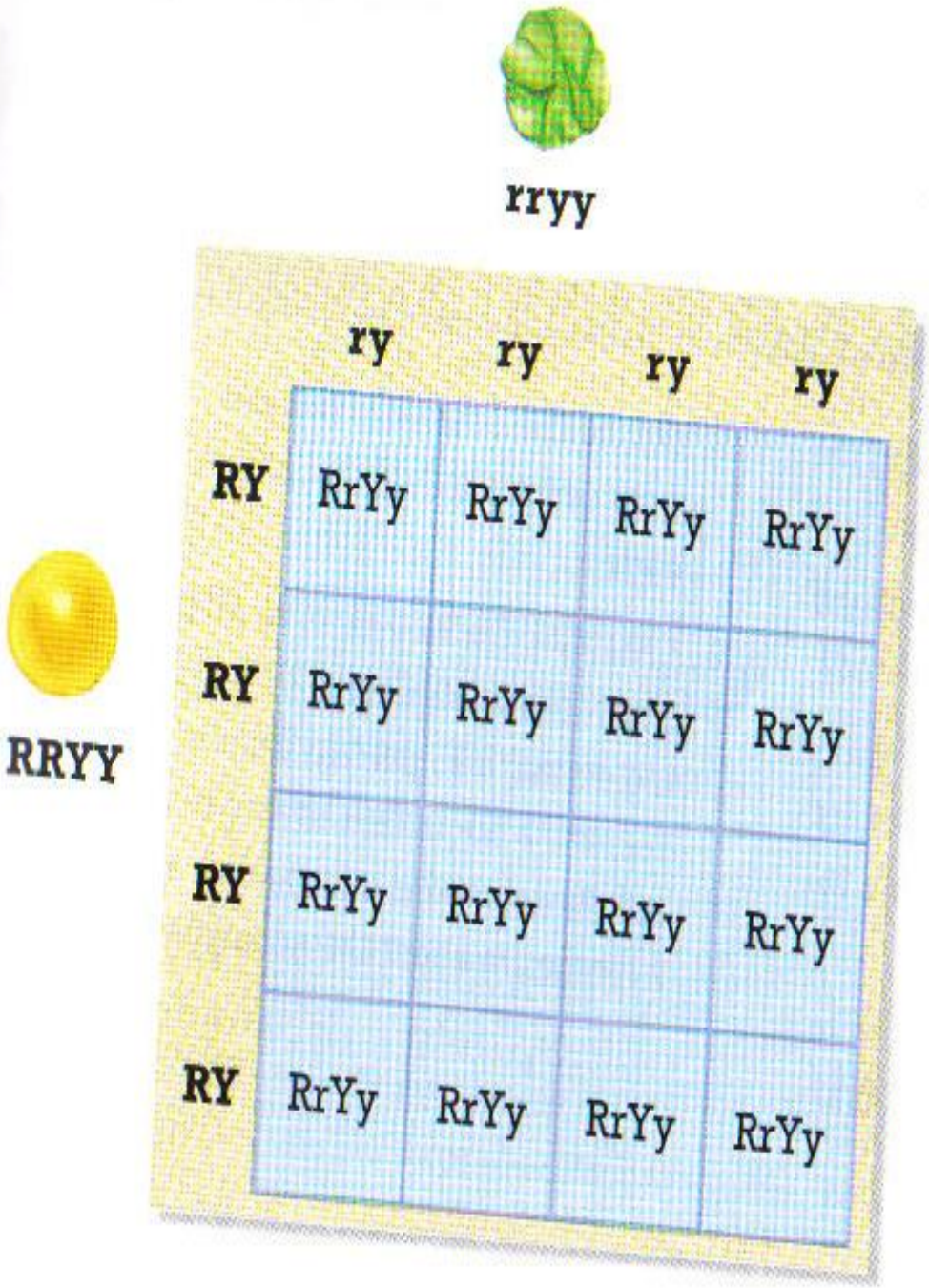


FIGURE 9-11

This Punnett square shows a dihybrid cross between a pea plant that is homozygous recessive for wrinkled, green seeds *(rryy)* and a pea plant that is homozygous dominant for smooth, yellow seeds *(RRYY)*.

b. Example 7: Heterozygous x Heterozygous

AaBb x AaBb

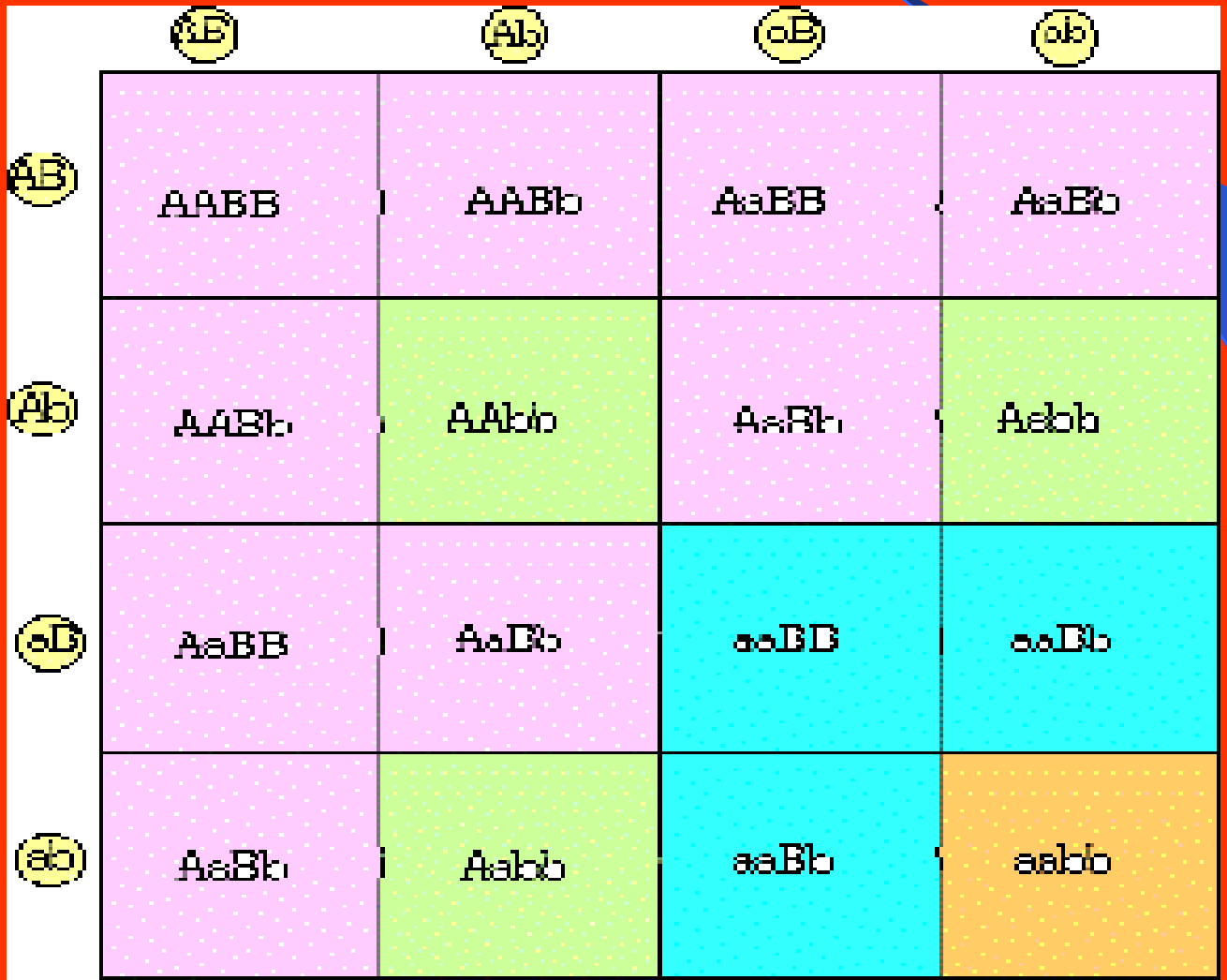
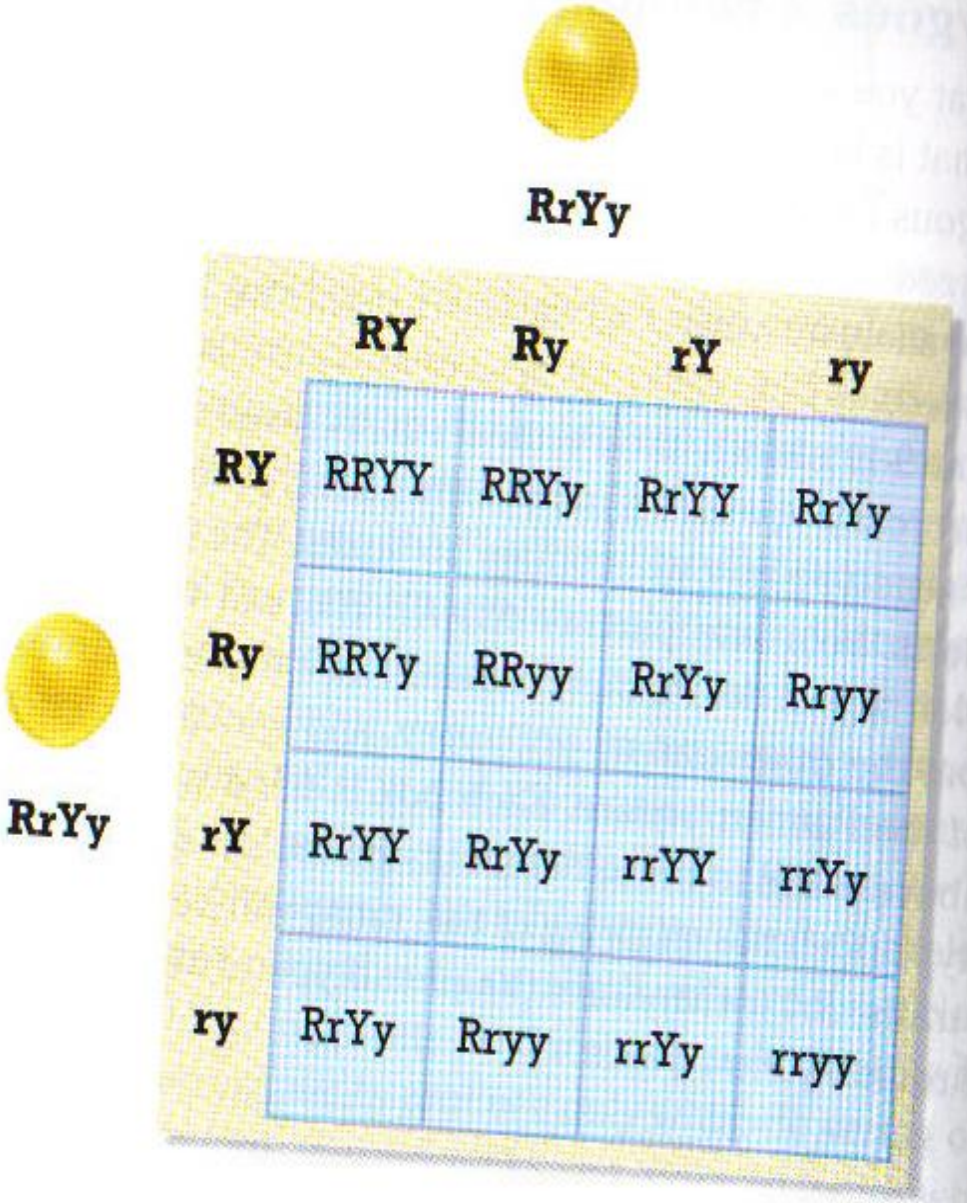


FIGURE 9-12

A dihybrid cross of two individuals heterozygous for both traits is likely to result in nine different genotypes and four different phenotypes.

- 1/16 with wrinkled, green seeds (genotype *rryy*)



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