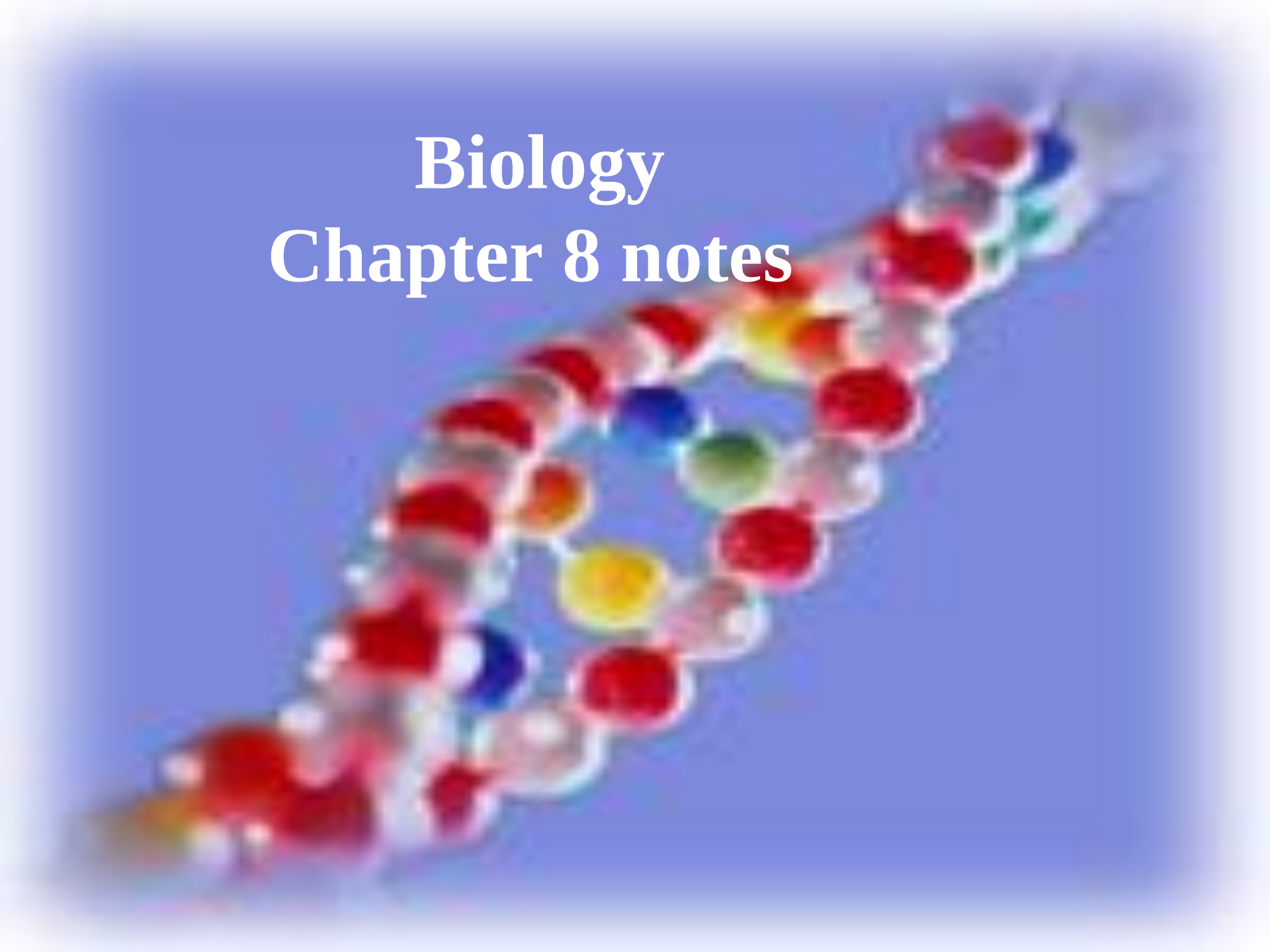
Biology
Chapter 8 notes



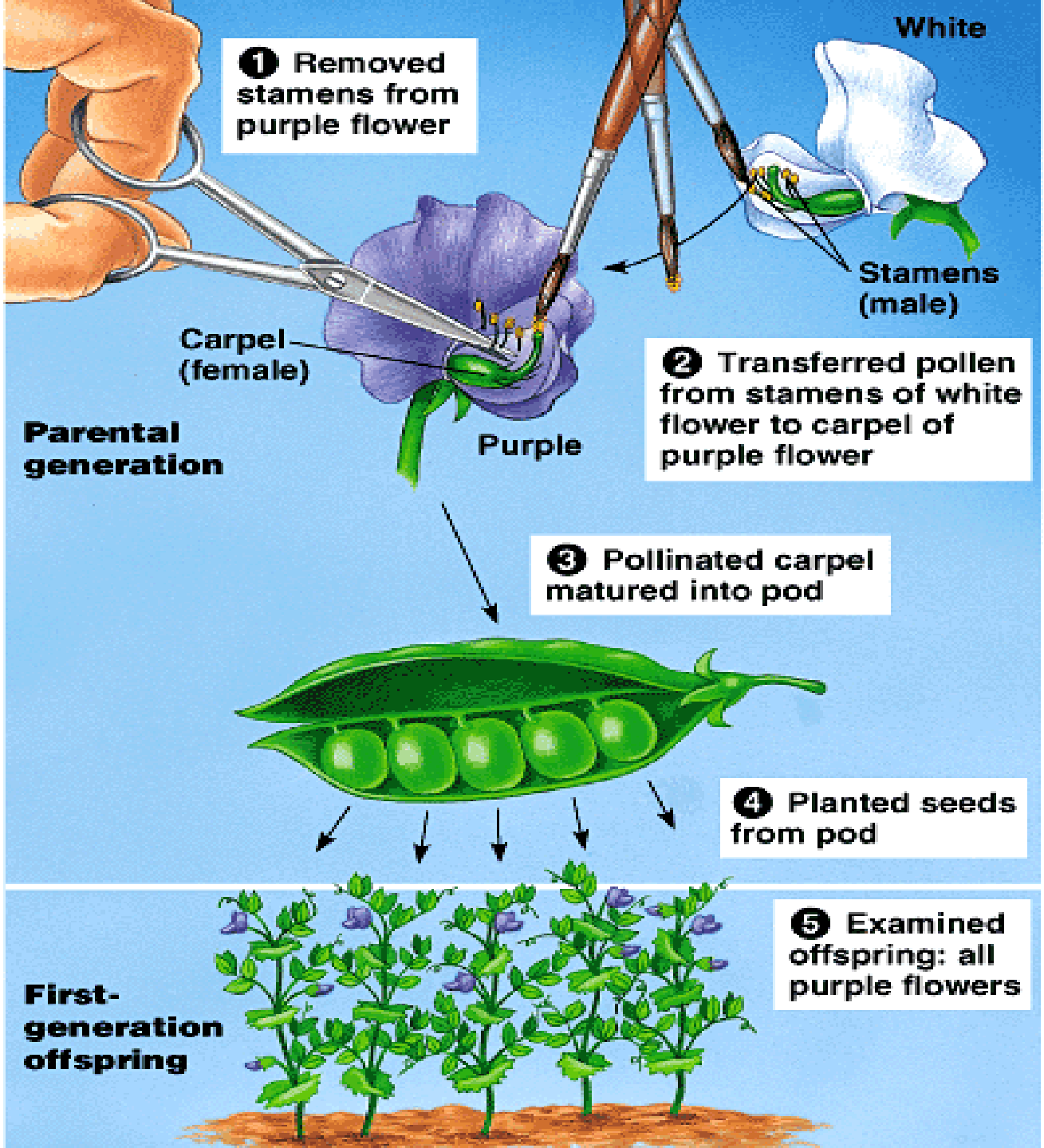
Principles of Genetics

- **Gregor Mendel (The father of modern genetics)***
- **Gregor Mendel was a monk in a monastery in Czechoslovakia. (1822-1884)**

Mendel's Work

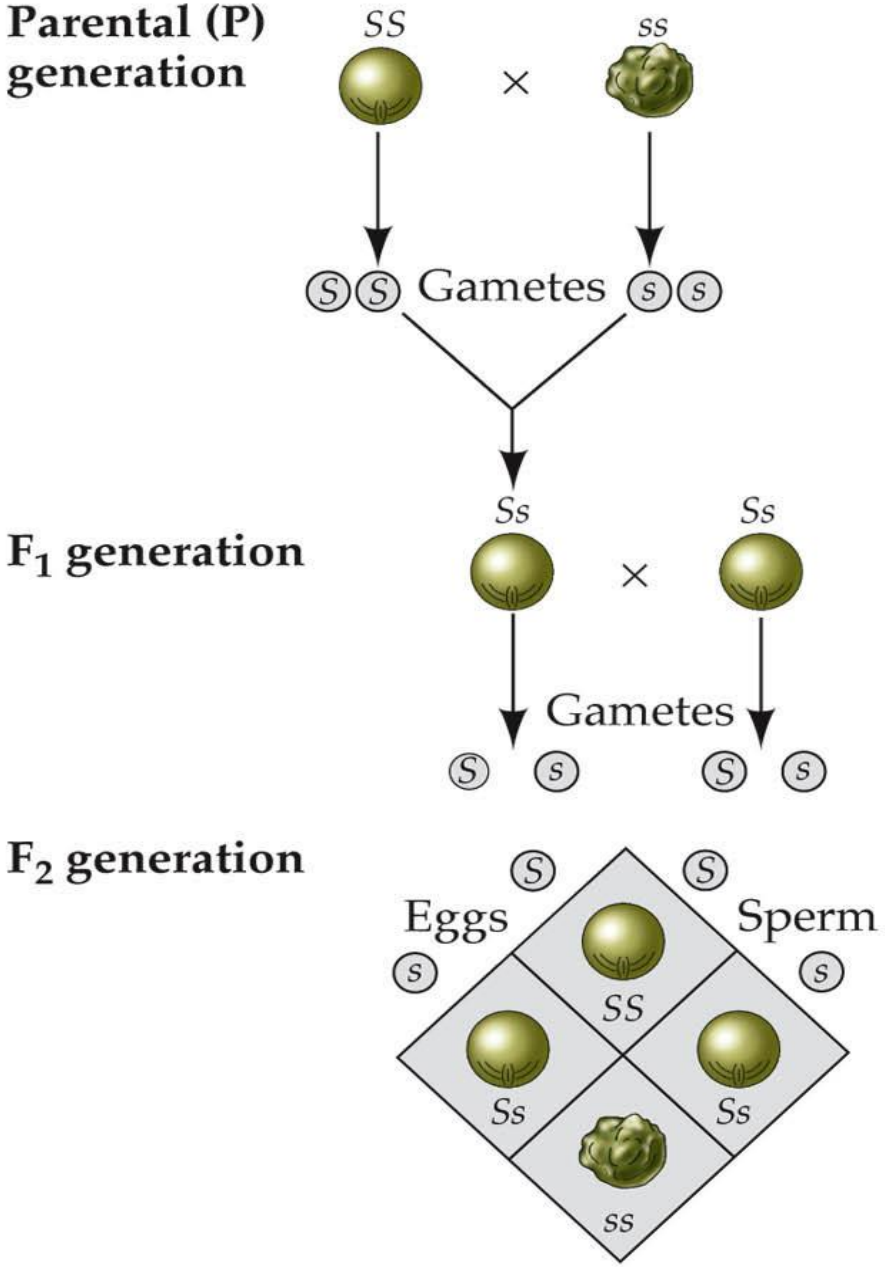
- **Mendel released his report on genetics in pea plants in 1866**
- **Mendel worked with traits in pea plants because the reproduced quickly and he could easily maintain a large number of one species to study**
- **There are no ethical limitations involved in crossing pea plants**

- **Mendel's WorkMendel crossed round and wrinkled plants and short and tall plants**


White
1 Removed stamens from purple flower
Stamens (male)
Carpel (female)
2 Transferred pollen from stamens of white flower to carpel of purple flower
Parental generation
Purple
3 Pollinated carpel matured into pod
4 Planted seeds from pod
First-generation offspring
5 Examined offspring: all purple flowers

The results of Mendel's experiments

- **Round and a wrinkled were crossed (parent cross)**
- **The offspring were all round (first filial or also called the f1 generation)**
- **Mendel then crossed the all round seeds from the first cross**
- **The result of this cross was a three round to one wrinkled ratio (second filial, or the f2 generation)**



LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 10.4 Mendel's Explanation of Experiment 1**

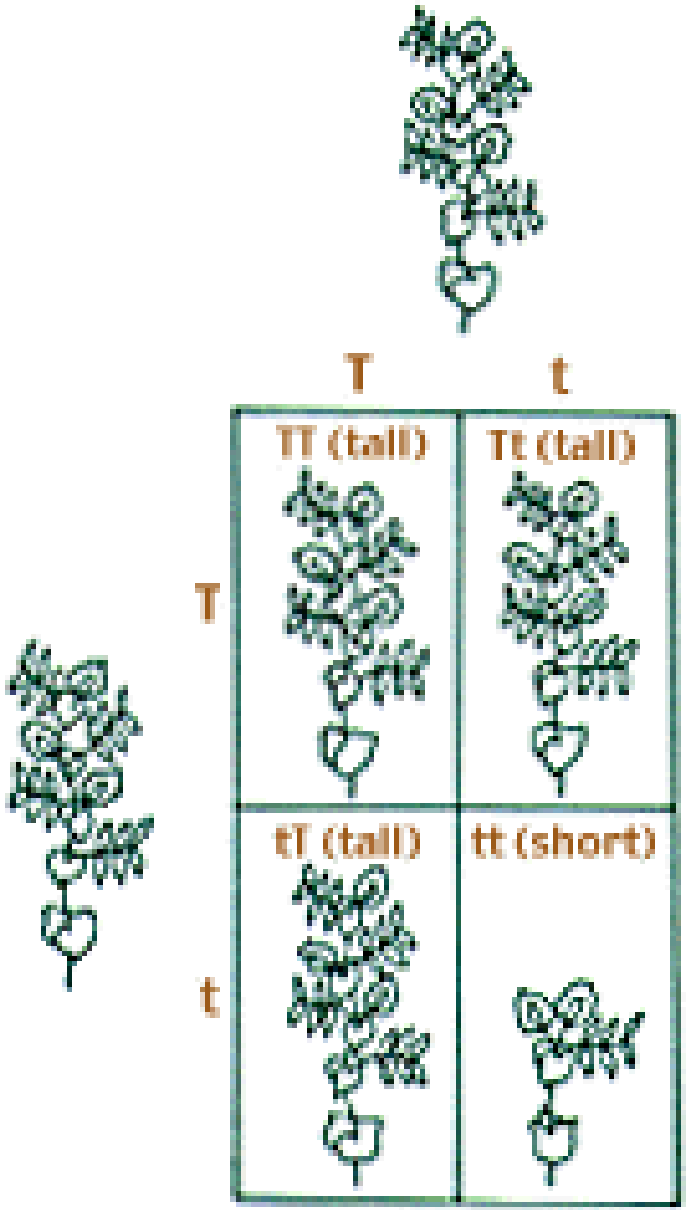
10.1 Mendel's Results from Monohybrid Crosses

PARENTAL GENERATION PHENOTYPES			F_2 GENERATION PHENOTYPES			
DOMINANT		RECESSIVE	DOMINANT	RECESSIVE	TOTAL	RATIO
Spherical seeds	×	Wrinkled seeds	5,474	1,850	7,324	2.96:1
Yellow seeds	×	Green seeds	6,022	2,001	8,023	3.01:1
Purple flowers	×	White flowers	705	224	929	3.15:1
Inflated pods	×	Constricted pods	882	299	1,181	2.95:1
Green pods	×	Yellow pods	428	152	580	2.82:1
Axial flowers	×	Terminal flowers	651	207	858	3.14:1
Tall stems (1 m)	×	Dwarf stems (0.3 m)	787	277	1,064	2.84:1

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Table 10.1

Mendel's results

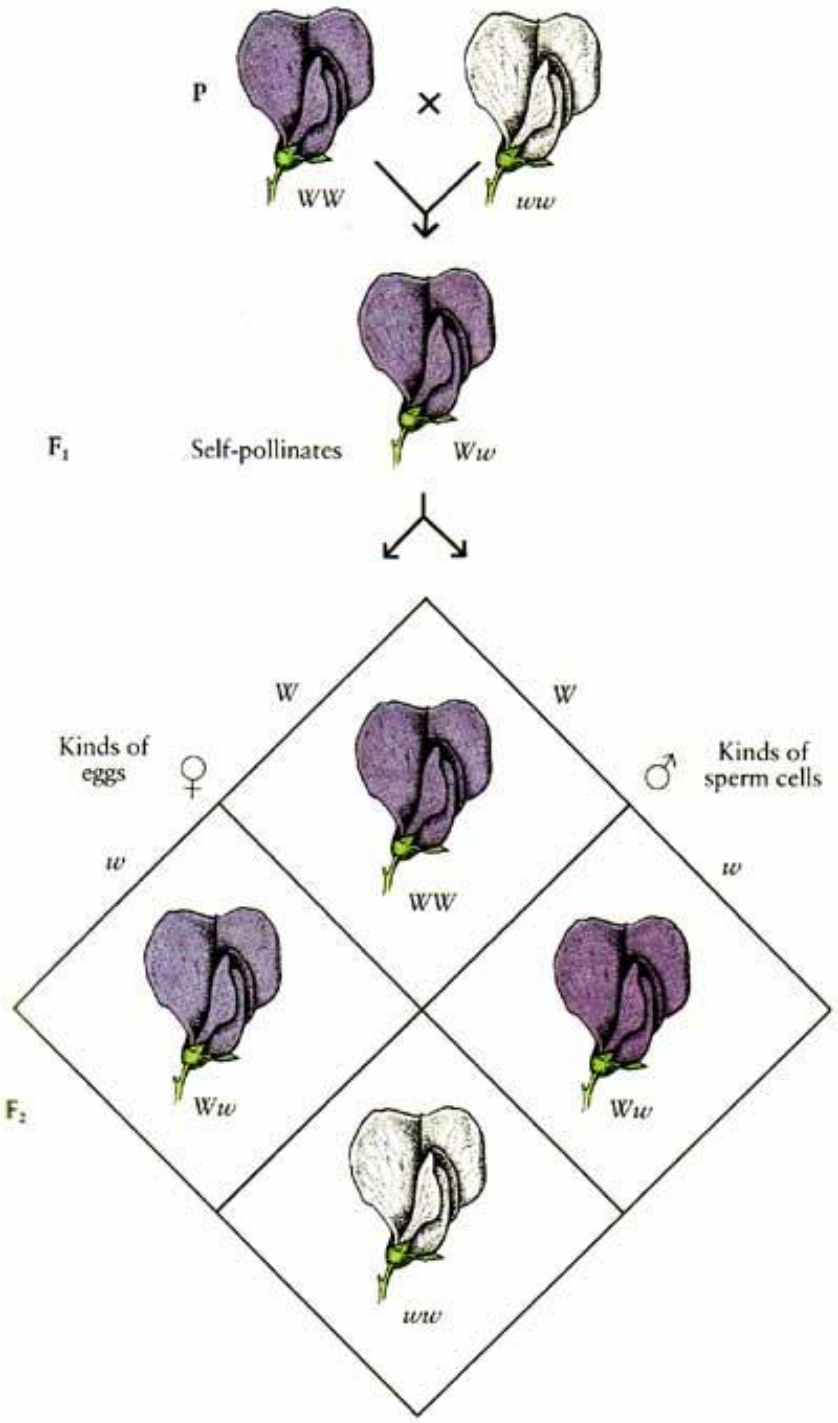
- **Mendel noted that the round trait was <u>dominant</u> to the wrinkled trait.**
- **The wrinkled trait was called the <u>recessive</u> trait because it was masked over by the dominant.**

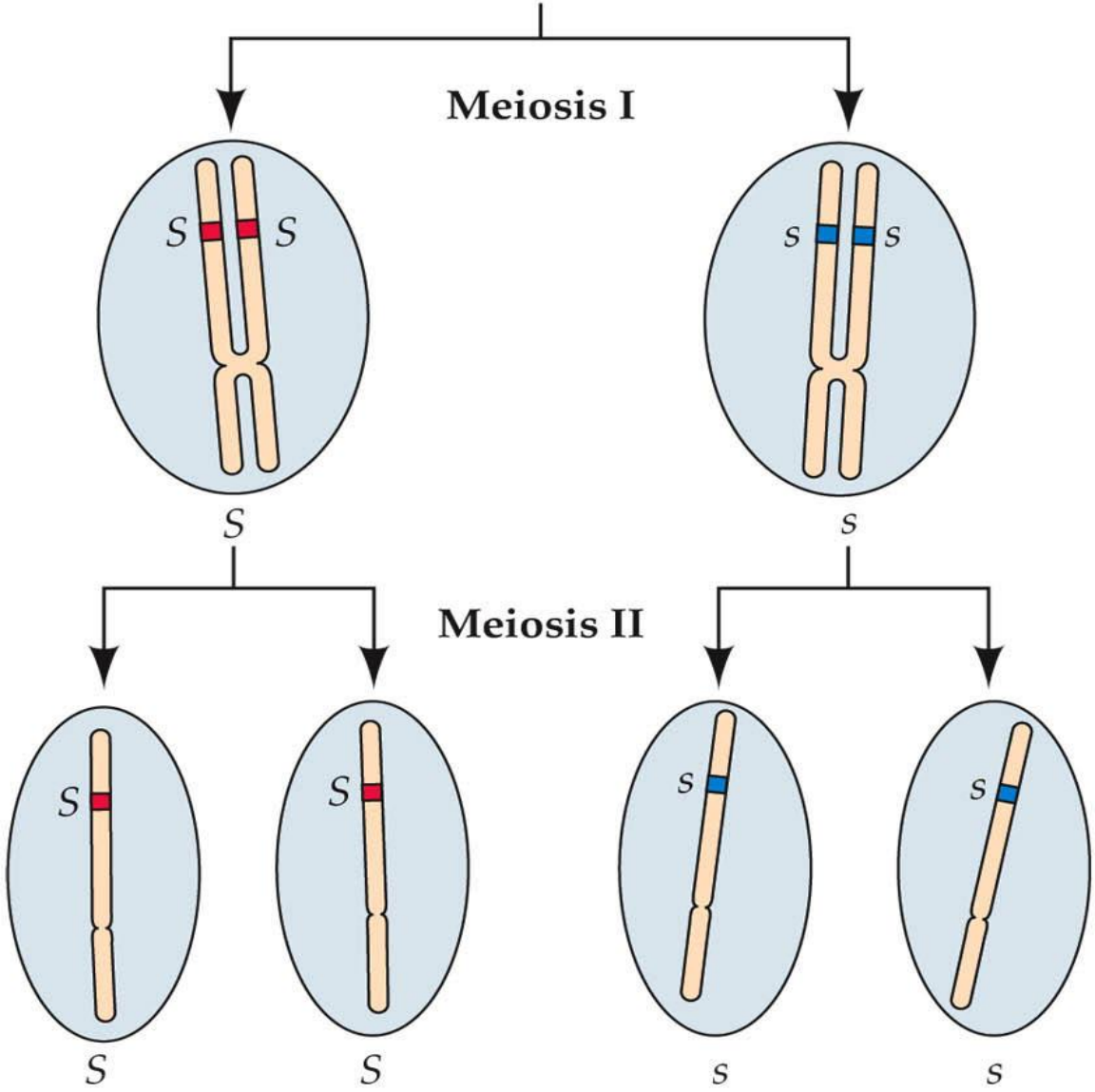


Mendel's hypothesis

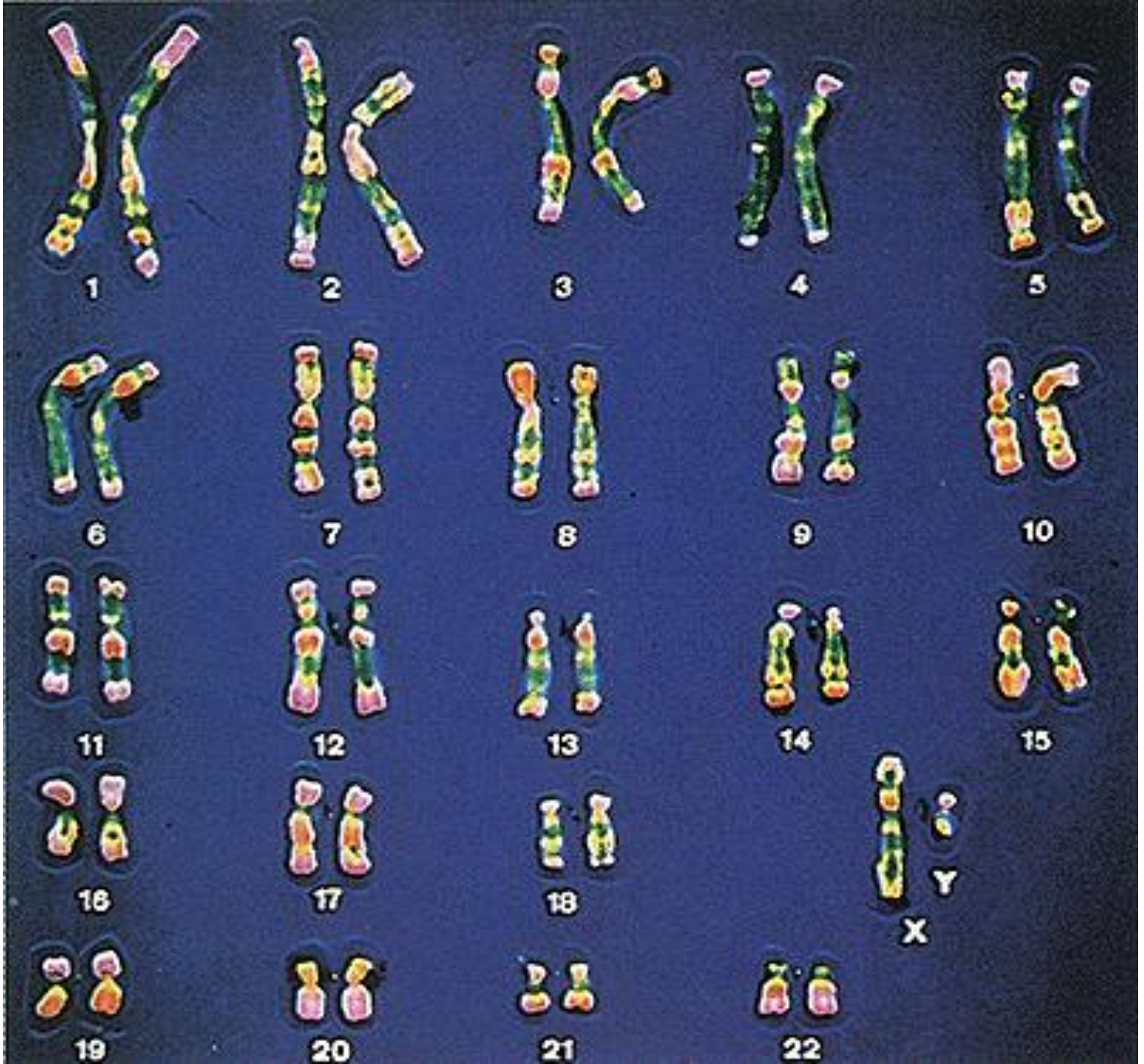
- **For every characteristic there must be a pair factor**
- **One trait came from the sperm and one from the egg. These traits are now called genes.**
- **Mendel reasoned that genes separate during gamete formation. (We now call this process meiosis)**

What was Mendel's hypothesis?*





LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 10.5 Meiosis Accounts for the Segregation of Alleles (Part 2)**


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
X
Y
19
20
21
22

Terms

- **Parental Cross*- Cross between original parents (Where study starts)**
- **First filial or F1*- result from parental or original cross**
- **Second filial or F2 generation*- results of the cross of F1 generation**
- **Dominant*- The trait that always appears if it is present and is represented by a capital letter.**
- **Recessive*- is the trait that can be masked over by the dominant trait and is presented by a lower case letter.**

Solving Genetics Problems and Probability

- **Probability/ Chance**
- **Product rule- Multiply the individual probabilities to get the over all probabilities**
  - **½ x ½ x ½ x ½ = 1/16**
- **Product rule can be used to solve probable allele combination**

Letters are used to represent genes

- **Dominant is always represented by Capital recessive is always represented by lower case**
- **Wrinkled**
- **Parent cross**
  - **RR X rr**
    - **F1 are all round Rr**
  - **F2 cross Rr X Rr**
    - **F2 results are 1 RR to 2 Rr to 1 rr**

	R	R
r	Rr	Rr
r	Rr	Rr

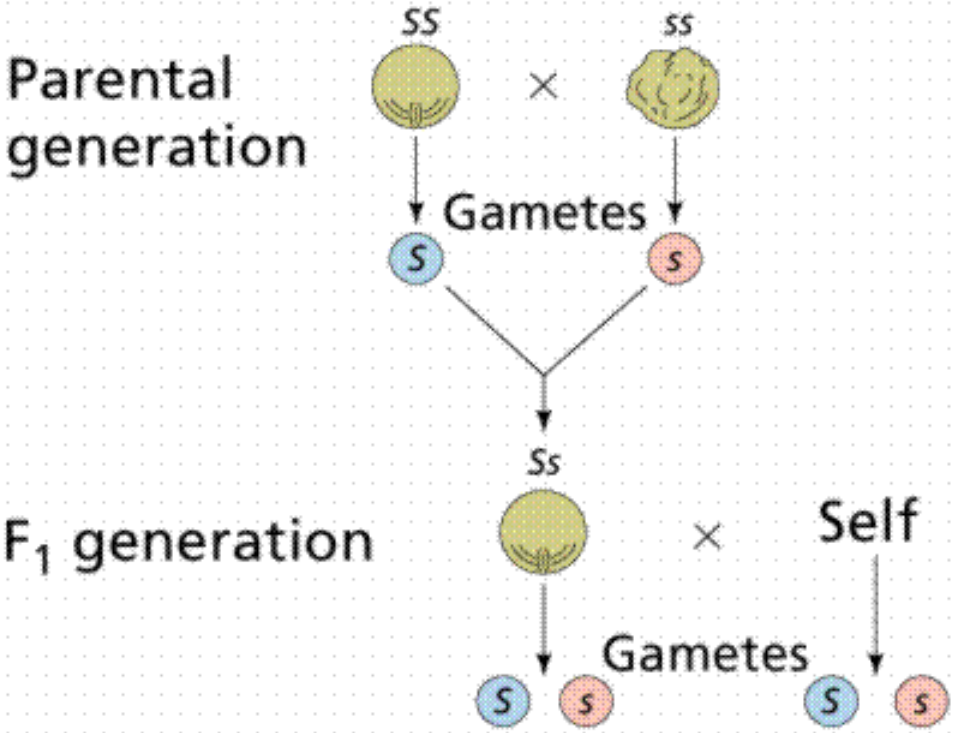
Punnett square shows meiosis and crossing results.

- **Example: Rr X rr**

	R	r
r	Rr	rr
r	Rr	rr

Principle of segregation*

- **During gamete formation the pair of genes responsible for each trait separates so that each gamete receives only one gene for each trait.**



More Terminology:

- **Alleles*- the genes for each trait**
- **genotype- is the alleles an organism has**
- **phenotype*- is the visible feature determined by the genotype**
- **homozygous*- containing two alleles that are the same, rr or RR**
- **homozygous recessive*- both alleles are recessive, rr**
- **homozygous dominant*- both alleles are dominant, RR**
- **heterozygous*- have and allele for each trait Rr**

Punnett Square*

- **Most of the time we will use the punnett square**
- **The probability of the offspring is reported in ratios**
- **Example: Cross two heterozygous round**

Round X Round

Rr X Rr

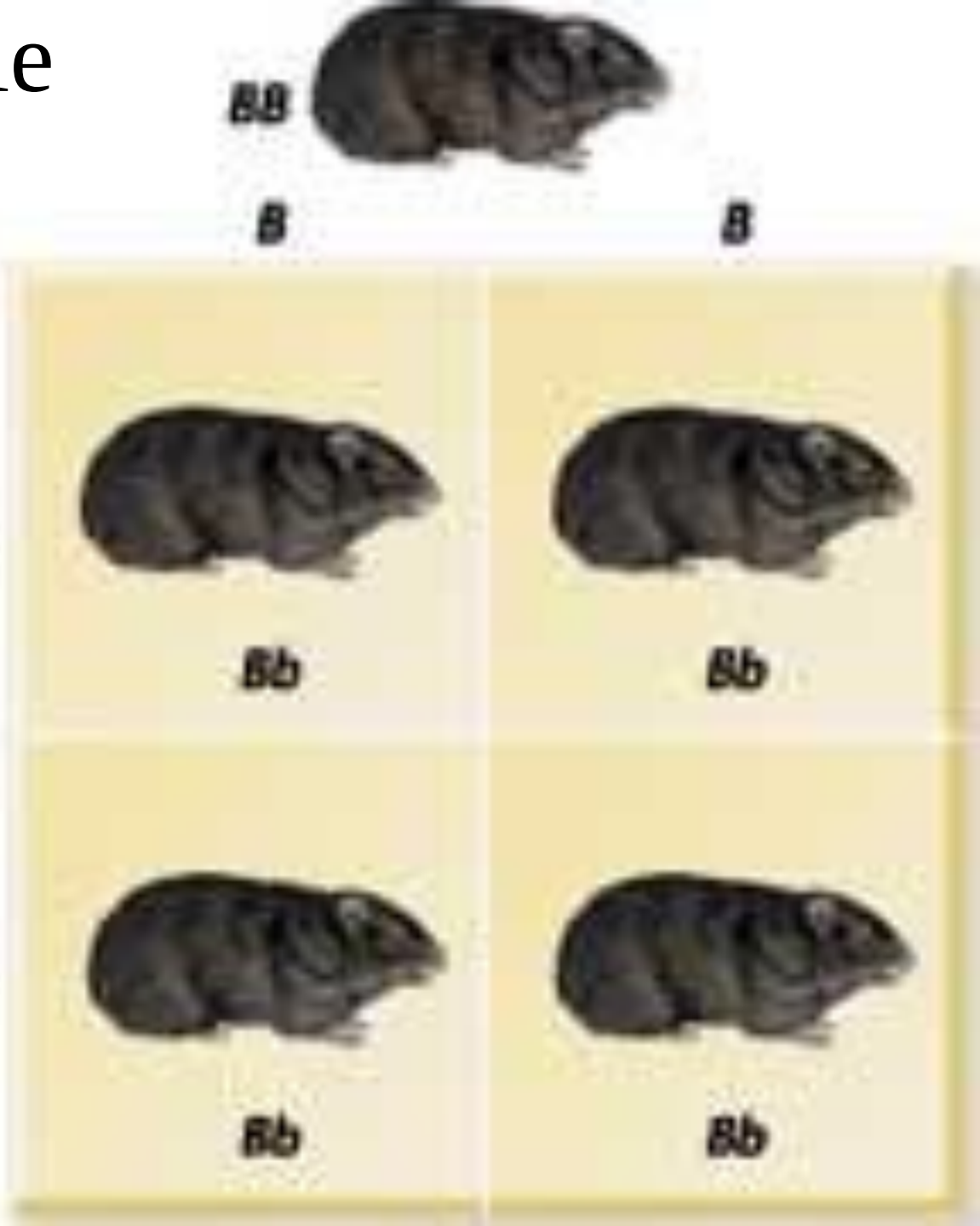
Gametes	R	r
R	RR	Rr
r	Rr	rr

a. Phenotypic ratio is three round to one wrinkled

b. Genotypic ratio is 1 RR : 2Rr : 1rr

Example

- Cross a homozygous black guinea pig with a white. Black is dominant to white.

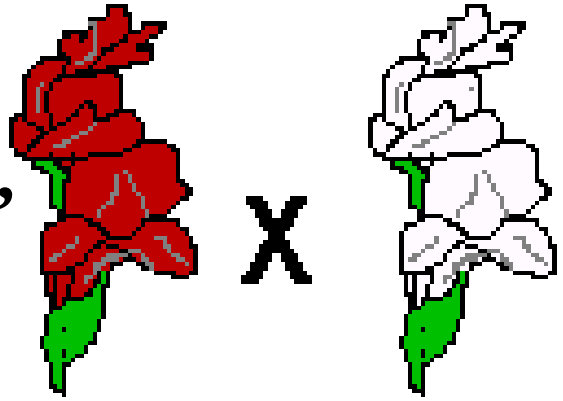


Co dominance

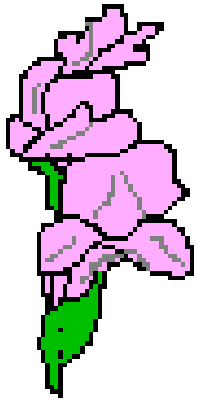
- **(Incomplete Dominance)* Neither allele is dominant, so each trait is expressed equally**
- **Example: In Four-O-clocks a cross between red and white flower produce pink flowers.**

  Red X White

  RR X R'R'

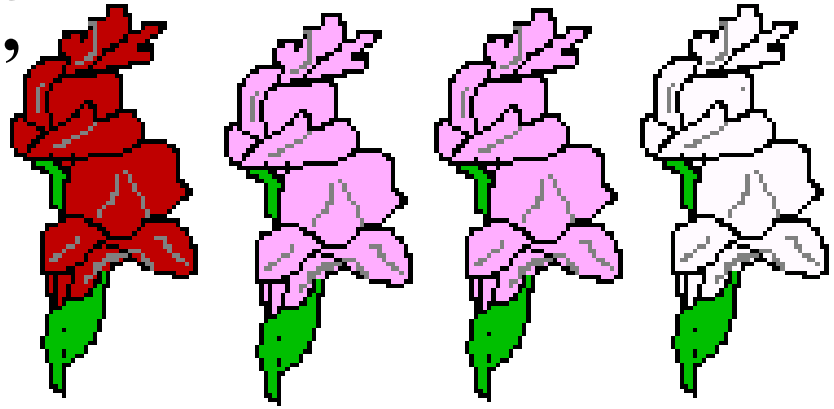


Parental (P) generation

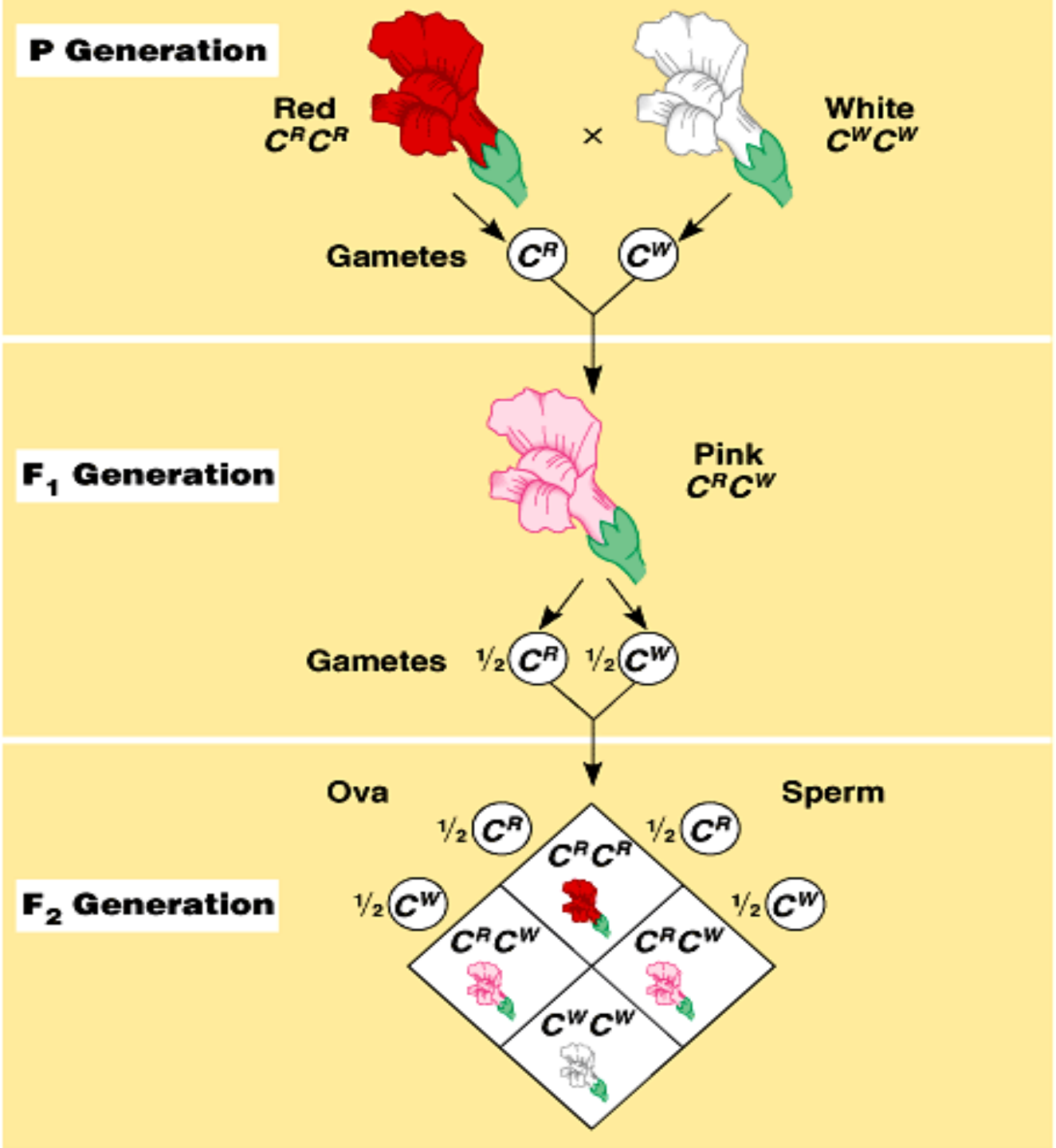


F_1 generation

all pink

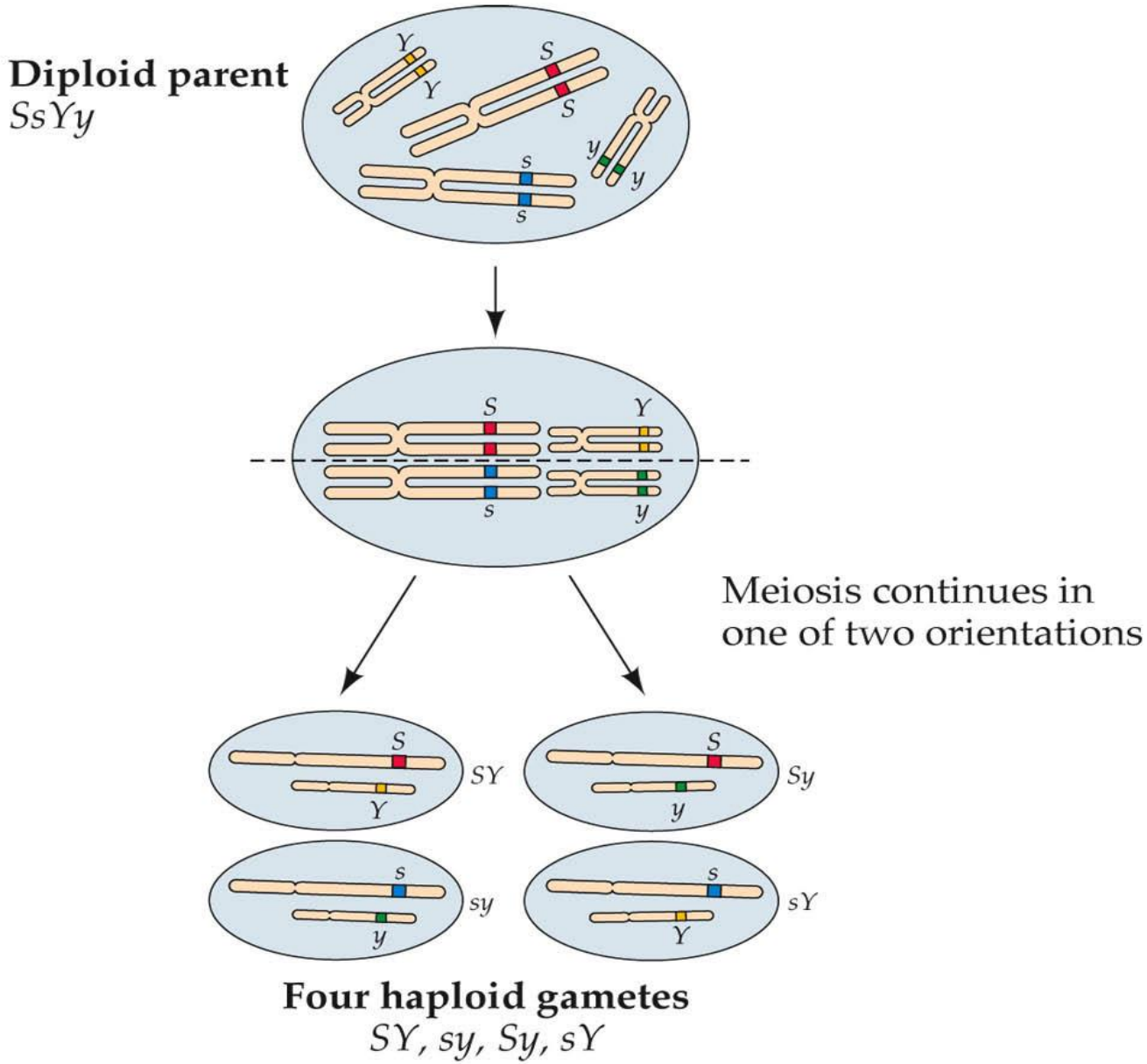


F_2 generation


P Generation
Red
C^RC^R
×
White
C^WC^W
Gametes
C^R
C^W
F_1 Generation
Pink
C^RC^W
Gametes
$\frac{1}{2}C^R$
$\frac{1}{2}C^W$
F_2 Generation
Ova
Sperm
$\frac{1}{2}C^R$
$\frac{1}{2}C^R$
$\frac{1}{2}C^W$
$\frac{1}{2}C^W$
C^RC^R
C^RC^W
C^RC^W
C^WC^W

Two traits

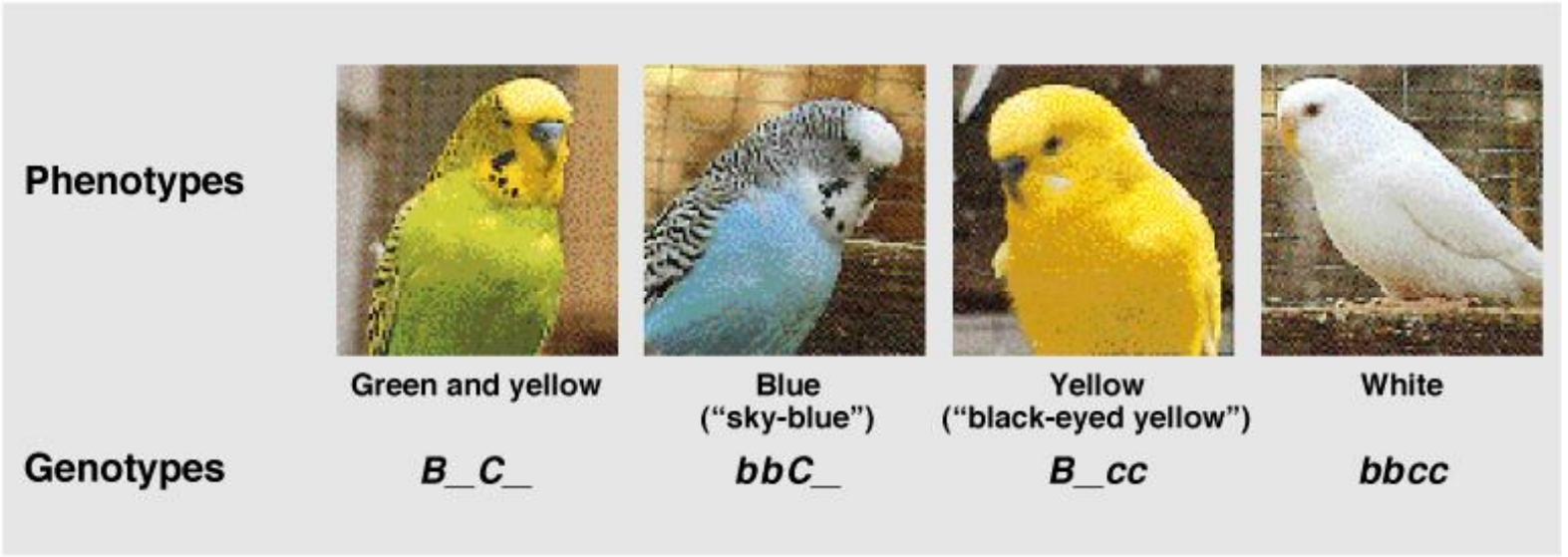
- **Mendel found when working with more than one trait that each allele would segregate independently**
- **Principle of independent assortment*- Alleles segregate independently during gamete formation**
- **When you figure genetics problem you take each allele separate**

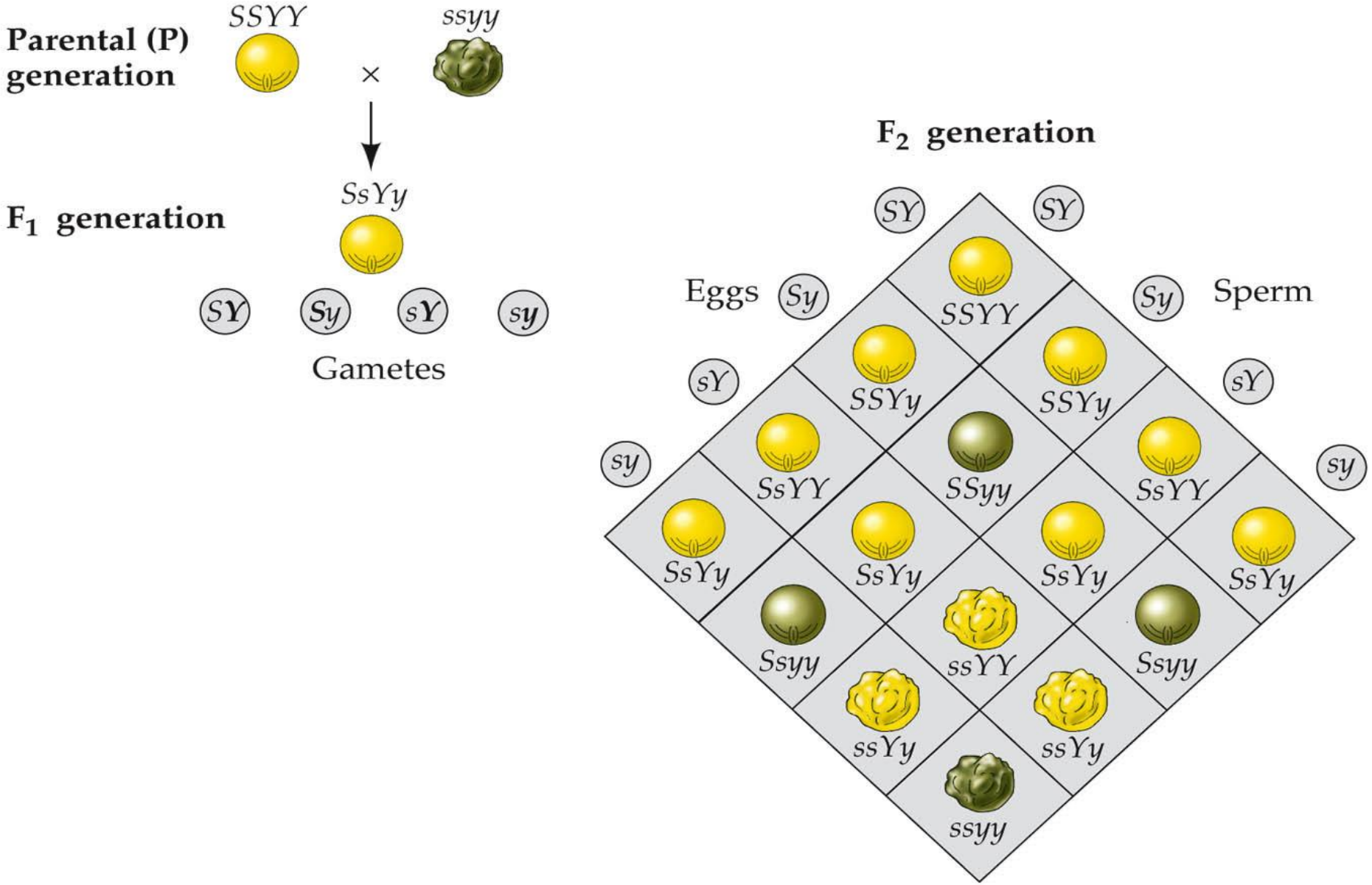


LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 10.8 Meiosis Accounts for Independent Assortment of Alleles**

Two Independent Genes and Parakeet Color

- In this case, yellow & blue make green





LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 10.7 Independent Assortment

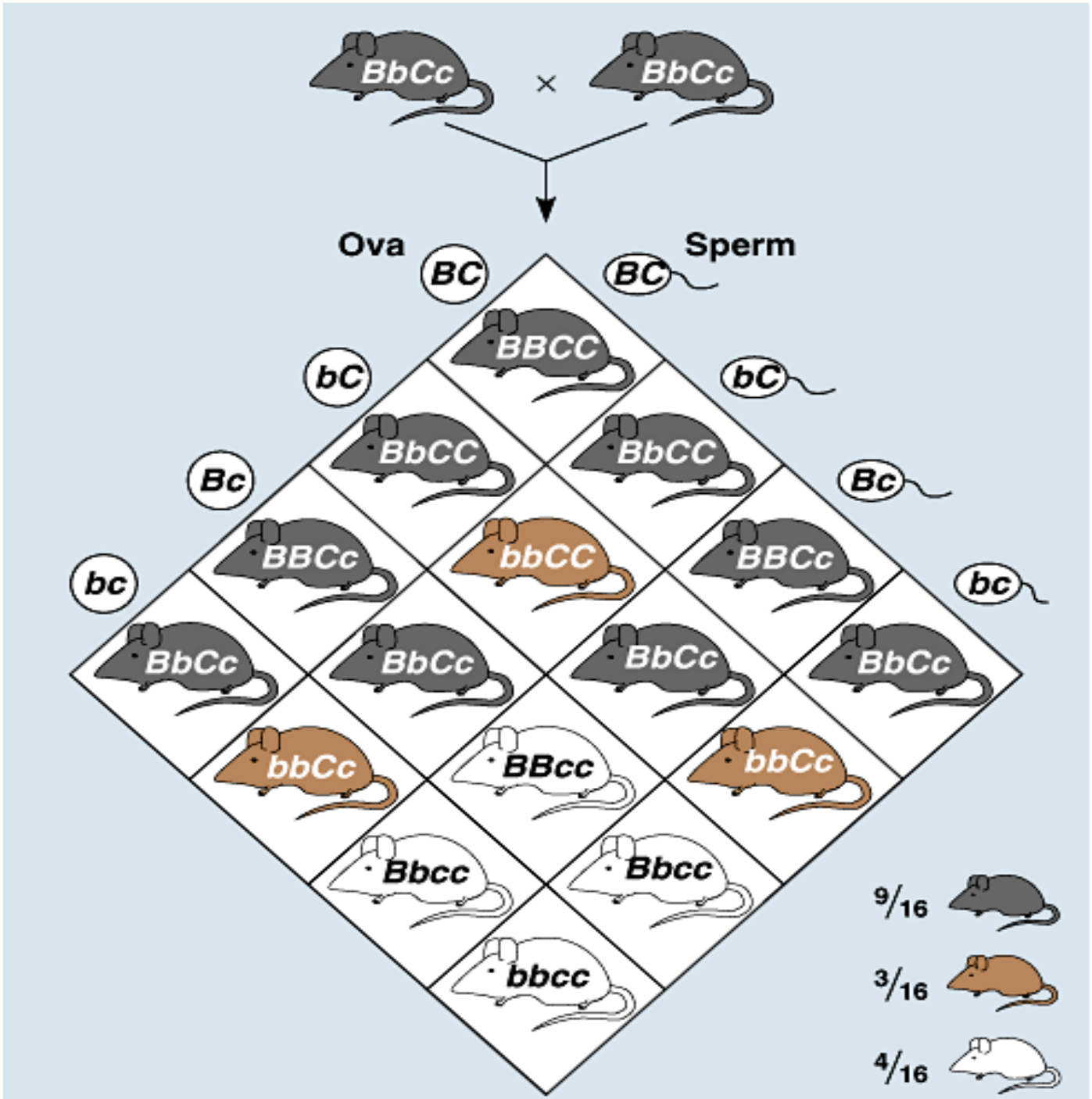
Example:

- **TtRr X TtRr**
- **Heterozygous tall round crossed with a heterozygous tall round (dihybrid cross)**
- **Write all the possible allele combinations**

gametes	TR	Tr	tR	tr
TR	TTRR	TTRr	TtRR	TtRr
Tr	TTRr	TTrr	TtRr	Ttrr
tR	TtRR	TtRr	ttRR	ttRr
tr	TtRr	Ttrr	ttRr	ttrr

- **Phenotypic ratio 9 Tall Round: 3 Tall Wrinkled: 3 Short Round: 1 Short Wrinkled**

5. Geno 1:1:2:2:4:2:2:1:1

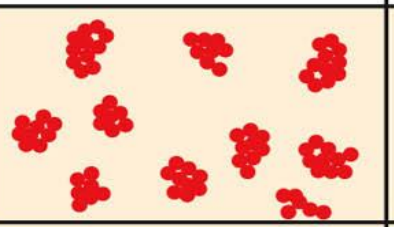
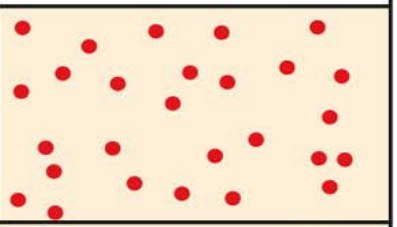
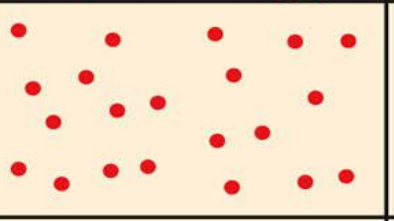
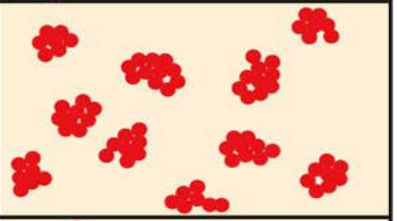
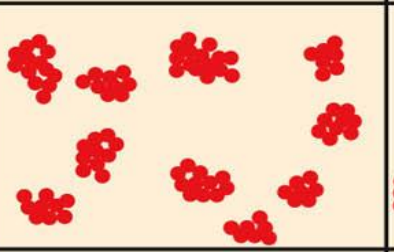
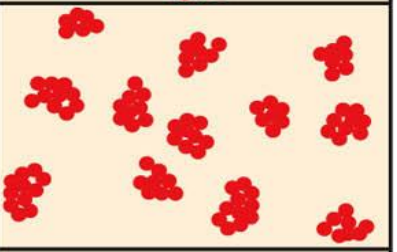
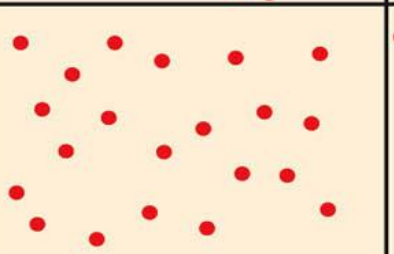
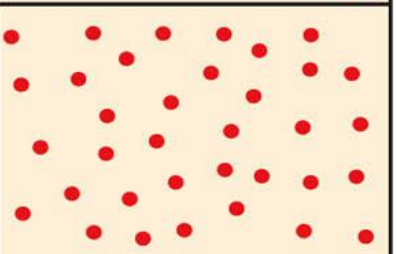

BbCc
×
BbCc
Ova
Sperm
BC
BC
bC
bC
Bc
Bc
bc
bc
BBCC
BbCC
BbCC
BBCc
bbCC
BBCc
BbCc
BbCc
BbCc
BbCc
bbCc
BBcc
bbCc
Bbcc
Bbcc
bbcc
9/16
3/16
4/16

Multiple Alleles-

- **A condition which a given trait is controlled by more than two different alleles.**
- **Example: Would be blood type A, AB,B,O**
  - **A & B are codominant and O is recessive to A&B**
  - **AO X BO**

gametes	B	O
A	AB	AO
O	BO	OO

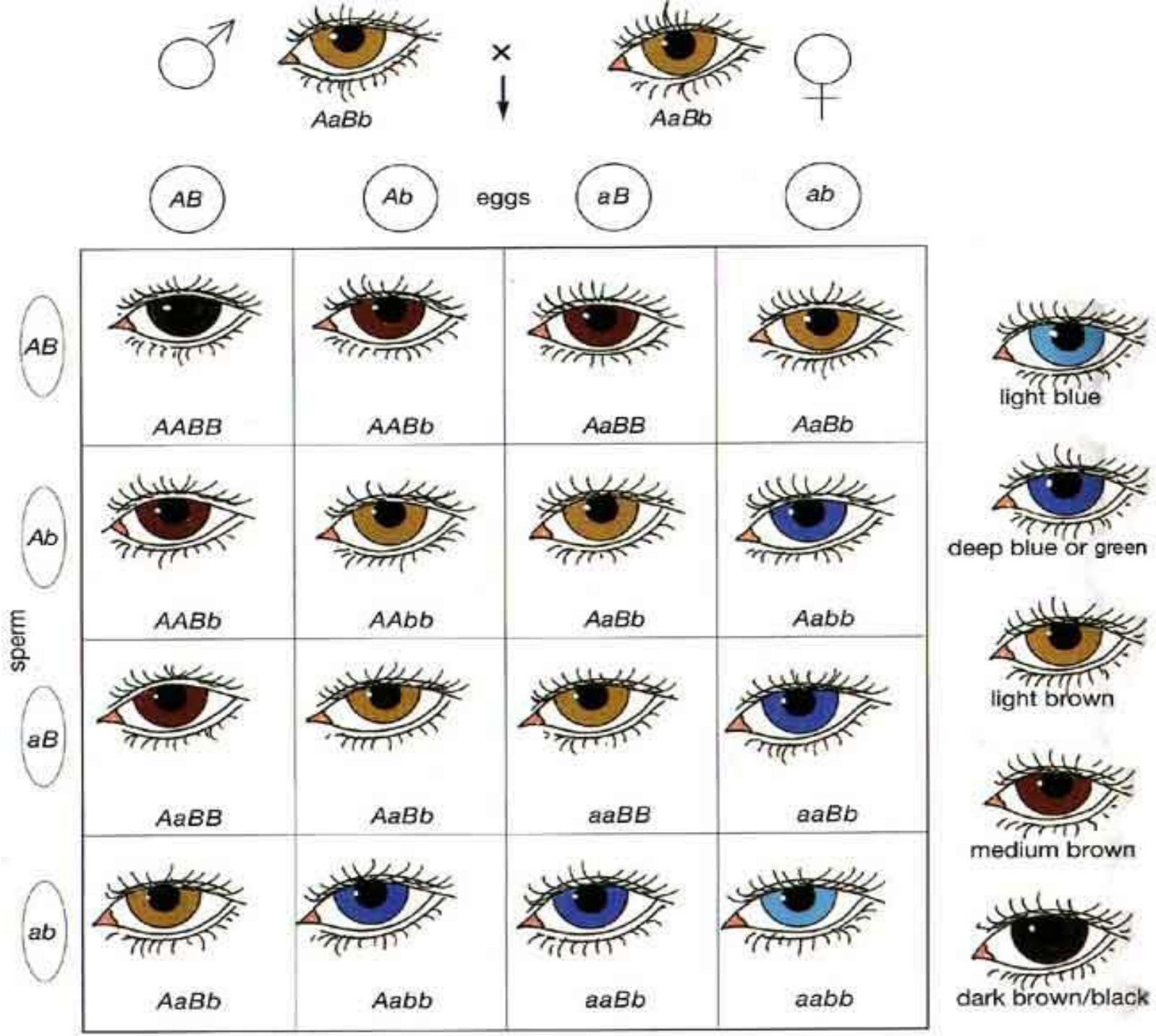
  - **Genotype 1:1:1:1 and same phenotype**

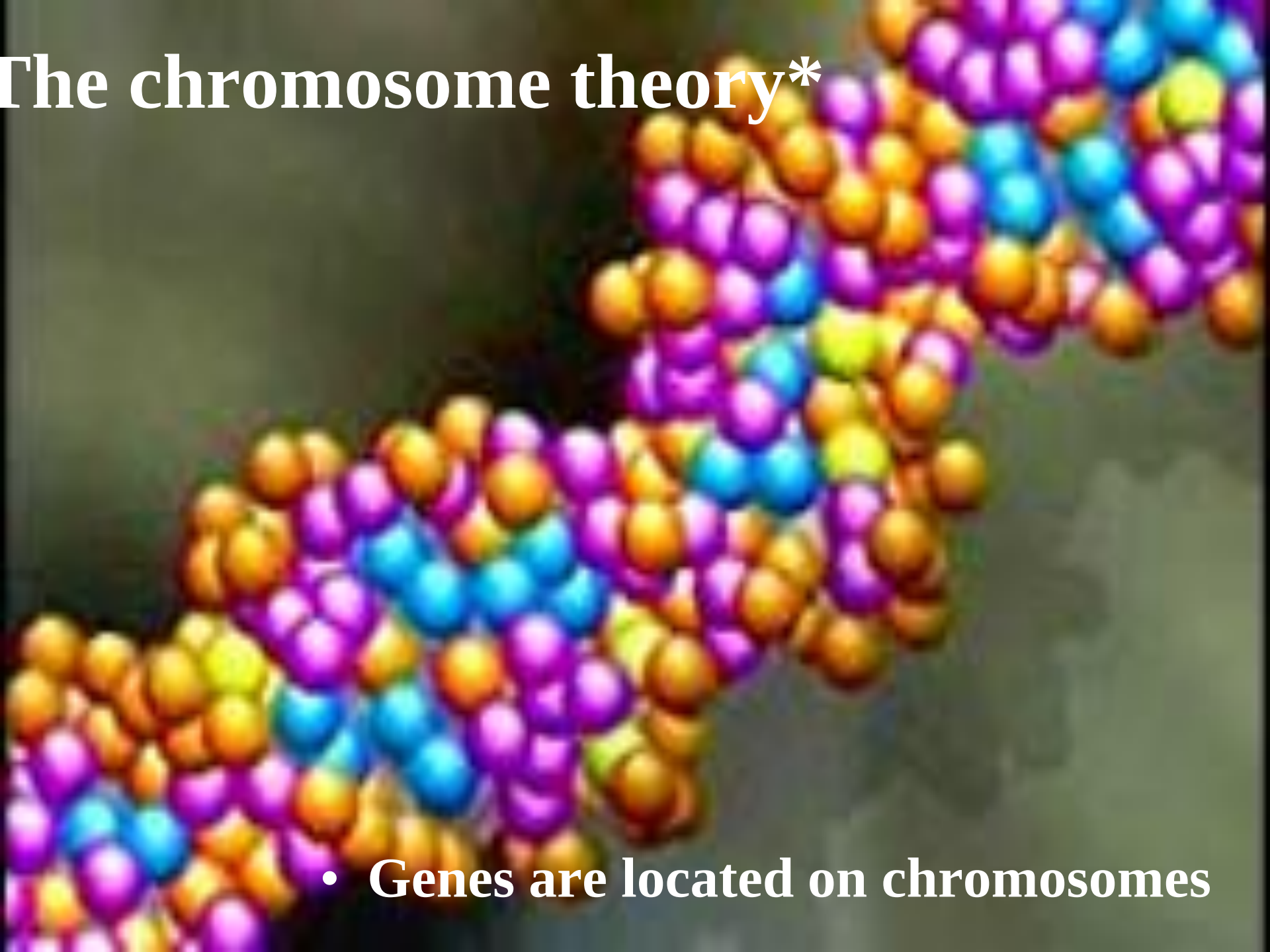
Blood type of cells	Genotype	Antibodies made by body	Reaction to added antibodies	
			Anti-A	Anti-B
A	$I^A I^A$ or $I^A i^O$	Anti-B		
B	$I^B I^B$ or $I^B i^O$	Anti-A		
AB	$I^A I^B$	Neither anti-A nor anti-B		
O	$i^O i^O$	Both anti-A and anti-B		

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 10.14 ABO Blood Reactions Are Important in Transfusions**

Polygenic inheritance

- **A condition controlled by many genes that effect one trait such as skin color and hair color.**


AaBb
AaBb
AB
Ab
eggs
aB
ab
sperm
AB
Ab
aB
ab
AABB
AABb
AaBB
AaBb
AABb
AAbb
AaBb
Aabb
AaBB
AaBb
aaBB
aaBb
AaBb
Aabb
aaBb
aabb
light blue
deep blue or green
light brown
medium brown
dark brown/black



The chromosome theory*

- Genes are located on chromosomes

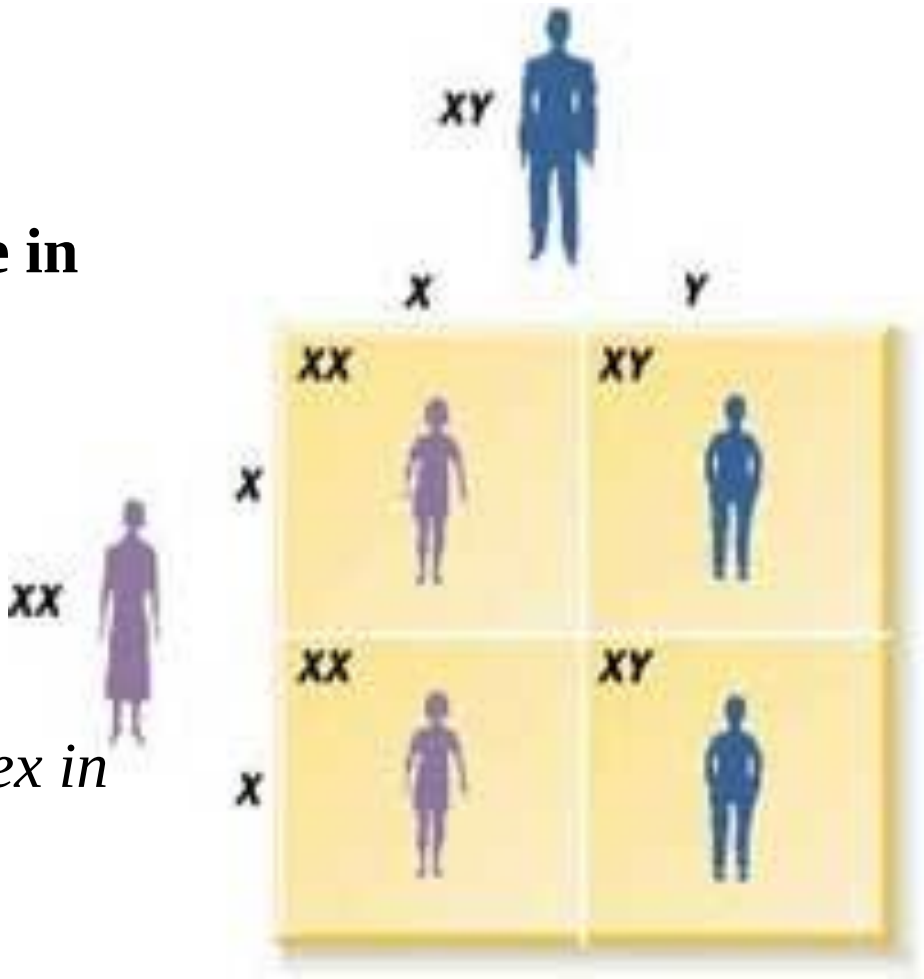
Theory proven by Thomas Hunt Morgan

- **Sex Determinantion***
- **Sex chromosomes**
- **X and Y Chromosome**
- **XY is male and XX is female in most species**

XY x XX

- **Autosomes- All other chromosomes in the body**

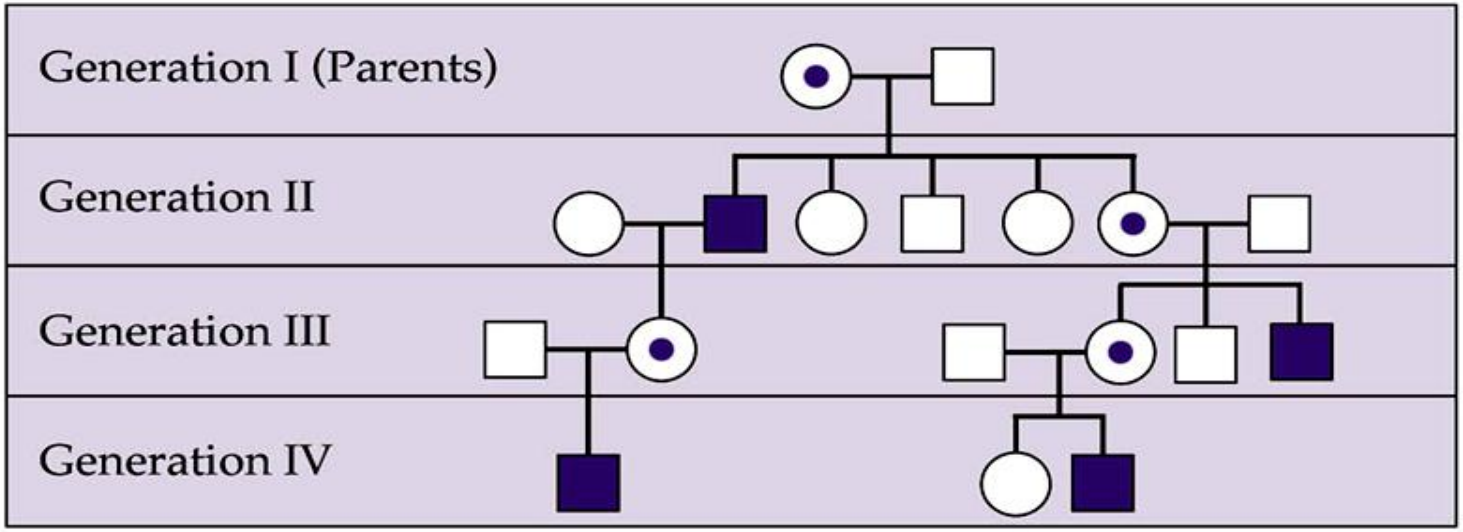
*Explain how the X and the y sex chromosomes determine the sex in humans.**

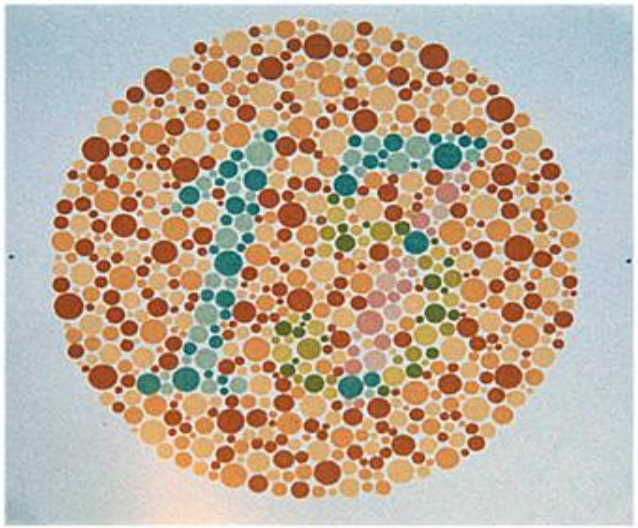


Sex-linked Inheritance

- **Genes linked to a sex chromosome**
- **The X chromosome has more room for genes than the Y Chromosomes**
- **Color blindness and hemophilia are examples of sex linked traits**
- **Example: Use X^N for Normal vision and X^n for Color blindness.**

Female who carries gene for phenotype of interest on one X chromosome





LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 10.24 Red-Green Color Blindness is a Sex-Linked Trait in Humans**

Many Genes – One Effect

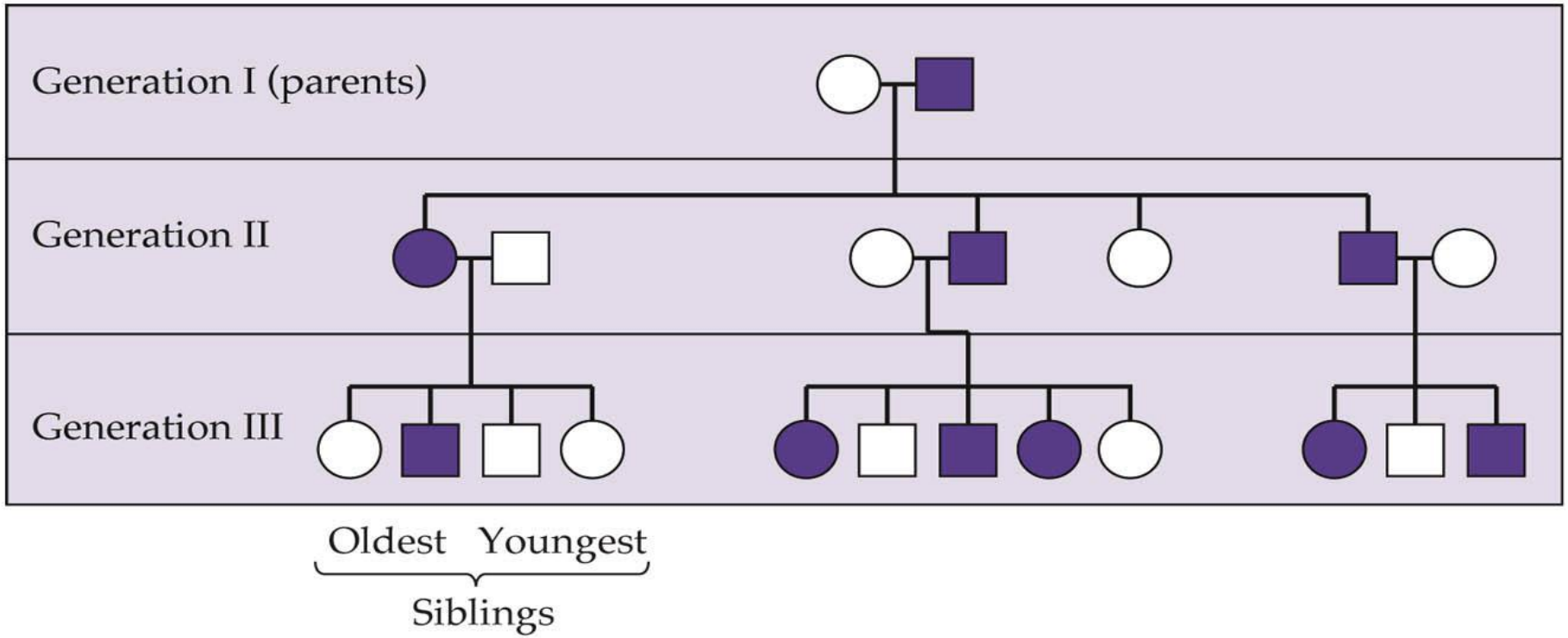
- **Presence of many phenotypes from one extreme to another, is an example of continuous variation (polygenic) inheritance.**
- **Skin color, hair color, Example p 215**

Possible genotypes	CC, Cc^{ch}, Cc^{h}, Cc	$c^{ch}c^{ch}$	$c^{ch}c^{h}$, $c^{ch}c$	$c^{h}c^{h}$, $c^{h}c$	cc
Phenotype	Dark gray	Chinchilla	Light gray	Himalayan	Albino

LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 10.12 Inheritance of Coat Color in Rabbits**

Expression of Genes

- **Modifier genes – Genes that causes another gene to be**
- **Eye color is an example of this p 217**
- **Read Math Connection p217, & Biology, Technology, and Society p 220 & 221**



LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, **Figure 10.10 Pedigree Analysis and Dominant Inheritance**

Genetics Problems

In a certain plant, the gene G represents green seeds and the gene g represents yellow seeds. A green seeded plant, GG, is crossed with a yellow seeded plant gg. The offspring of this first cross, all green, Gg, are then crossed with one another to produce the second generation. The offspring expected from this second cross are calculated by setting up a chart:

1. What is the branch of biology that studies how these plant character are inherited?
2. The chart used to determine the offspring is called what?
3. The offspring produced from the first cross belong to the _____ generation.
4. The offspring produced form the second cross belong to the _____generation.
5. The single letters along the top and side of the chart represent the types of _____produced by each parent.
6. Only one letter is written along each box in the chart because genes _____ during gamete formation.

7. The fact that all offspring produced from the first cross have green seeds can be explained by the law of _____.
8. Which of these plant traits is recessive?
9. Expressions such as GG, Gg,or gg represent a plant's _____.
10. Descriptions such as green of yellow represent a plant's _____.
11. A plant that is GG is said to be_____for that trait.
12. Which genotype(s)for seed color in this plant is(are)heterozygous
13. Write the phenotypic ratio of offspring produced from the first cross.
14. Write the genotypic ratio of offspring produced from the second cross.
15. Write the phenotypic ratio of offspring produced form the second cross
16. Write the genotype(s) of yellow seeded offspring produced from the second cross..

Define the following

Allele-

Genotype-

Phenotype-

Homozygous

Heterozygous-

- State the law of dominance-
- What is the probability of a dice turning up a 6 on a single throw?
- 10 tosses of a coin result in heads, what is the probability the next toss will be heads?
- Two coins are tossed together 40 times. How many times should both land on tails?
- A heterozygous brown eyed man marries a heterozygous brown eyed woman What is the genotypic and phenotypic ratio of their offspring. (Brown is dominant to blue)
- Cross a homozygous dominant tall plant with a homozygous recessive plant. Give the genotypic and phenotypic ratios.
- In plants a trait for tall (T) is dominant to short (t). Determine the expected genotypic and phenotypic ratios resulting from crosses between
  - (a) homozygous tall and short.
  - (b) two heterozygous tall
  - (c) heterozygous tall and short

- In a flower, the heterozygous condition is pink. Determine the expected genotypic and phenotypic ratio's resulting from crosses between: (Co dominance or Incomplete dominance)
  - two heterozygous flowers
  - a pink and a white flower.
- A box has 8 balls in it, 2 red, 2 green, and four white. What is the probability of drawing out:
  - a red ball
  - a white ball
  - a red or white ball

- In man, brown eyes (B) is dominant to blue eyes (b) and right-handers are dominant. to left (r). What is the genetypic and phenotypic ratio of the following crosses: homozygous brown-eyed, right handed man with a heterozygous brown-eyed, heterozygous right-handed woman.

- Blue-eyed, heterozygous right-handed man with a heterozygous brown-eyed left handed woman.
- What is the phenotypic ratio of a cross between two organisms which are AaBb?
- In Andalusian fowl, B is the gene for black plumage. B'is the gene for white plumage. The genes show co-dominance. The heterozygous condition results is blue plumage. List the genotypic and phenotypic ratios from the crop of:
  - Black X Blue
  - Blue X Blue
- In guinea pigs rough coat (R) is dominant **to** smooth coat (r), and black color (B) is dominant to albino (b).. Calculate the genotypic and phenotypic ratio of the following.
  - Male Bbrr x Female BbRr
  - BBRr X Bbrr
- T or F Alleles segregate independently during gamete formation.

- On ears of corn, each kernel can be considered as an offspring. the kernels on four ears were counted for the color trait, purple or white, and the sweetness trait, starchy or sweet. The count-ing gave these phenotypic ratios for the four ears:
  - Ear 1: 3 purple: I white
  - Ear 2: 3 starchy: 1 sweet
  - Ear 3: 9 purple, starchy: 3 purple, sweet: 3 white starchy: 1 white sweet
  - Ear 4: 1 white: 1 purple
    - Which traits are recessive?
    - Which traits are dominant?
    - What must have been the parental genotypes that produced ear 1.
    - What must have been the parental genotypes that produced ear 2.
    - What must have been the parental genotypes that produced ear 3.
    - What must have been the parental genotypes that produced ear 4.

- In fruit flies, the gene for brown body color, B, is dominant to the gene for yellow body color,b. The gene-for long wings, L, is dominant to the gene for short wings, l. A brown, short winged male is bred to a yellow, long-winged female. Of the offspring produced, half are brown, long-winged and half are yellow, long-winged.

  (a) What is the most probable genotype of the male?

  (b) What is the most probable genotype of the female?

  In four o'clocks, the genes for red flowers, R, and white flower, R', show co-dominance. The heterozygous condition results in pink. A gardener crosses a red four o'clock with a pink one. - What is the genotypic and phenotypic ratios?

- In guinea pigs, the gene for black fur, B, is dominant to the gene for white fur, b. The gene for rough coat, R, is dominant to the gene for smooth coat, r. If a homozygous black, heterozygous rough pig is bred to a white, smooth pig, what is the expected genotypic ratio of the offspring?

- In rabbits, black fur is dependent on a dominant gene, B and brown on the recessive allele, b. Normal length fur is determined by a dominant gene, R and short(rex) by the recessive allele r What would the result of a cross between a heterozygous black, hetero-zygous normal haired rabbit with a brown short haired rabbit? What would the resulting phenotype be?

- In fruit flies, the gene for straight wings S, is dominant to the gene for curly wings, s.

  a. If two flies, when bred, produced 98 straight winged and 102 curly winged offspring, what were the most probable parental genotypes?

  b. What were the phenotypes of the parents in question a?

  c. What was the genotype of the straight winged offspring in question one?

  d. What was the genotype of the curly winged offspring in question one?

  e. If two different flies, when bred, produced 152 straight winged and 49 curly winged offspring, what were the most probable parental genotypes?

- In fruit flies, the gene for brown body color, B, is dominant to the gene for yellow body color, b. The gene for long wings, L, is dominant to the gene for short wings, 1. A brown, short-winged male is bred to a yellow, long winged female. Of the offspring produced, half are brown, long winged and half are yellow, long winged.

  a. What is the most probable genotype of the male parent?

  b. What is the most probable genotype of the female parent?

- Suppose that on Mars there exist creatures with three genes controlling hair color. The gene for green hair, H^g, is dominant to both the gene for purple hair, H^p, and the gene for orange hair, H^o. The gene for purple hair is also dominant to the gene for orange hair. Assume that inheritance of traits on Mars occurs the same way as on earth.
  - What genotype(s)could a creature with orange hair have?
  - What is the possible genotype(s)of a creature with purple hair?
  - What is(are)the possible genotype(s) of a creature with green hair?
  - What is the genotypic ratio expected among offspring produced by parents having genotypes H^gH^g and H^pH^o?
  - What would the probable phenotypic ratio of parents having the genotype H^oH^g and H^oH^o.
  - What color of hair would 4 creatures with orange hair produce?