Mendelian Genetics

Gregor Mendel

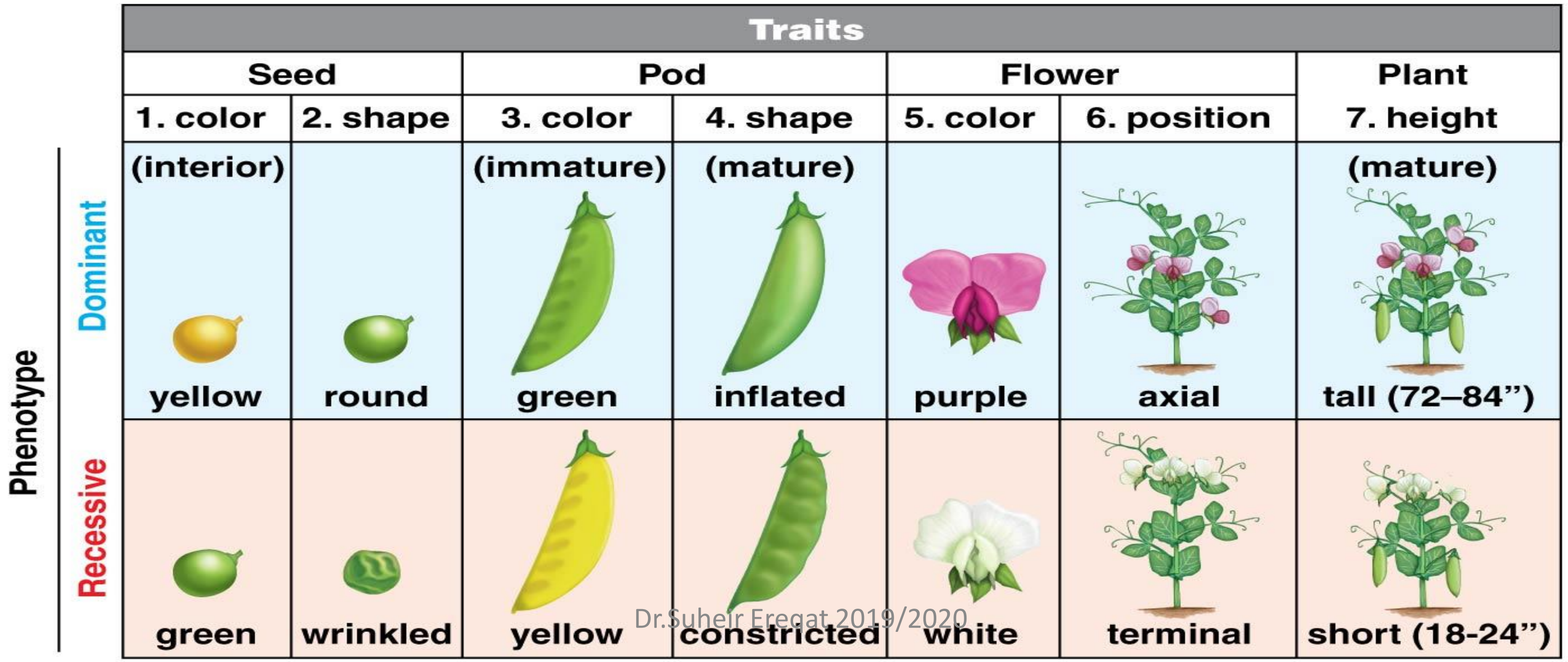
- Born in 1822 in Czechoslovakia.
- Became a monk at a monastery in 1843.
- had interests in statistics.
- Between 1856 and 1863 he grew and tested over 28,000 pea plants

The Blending Theory of Inheritance

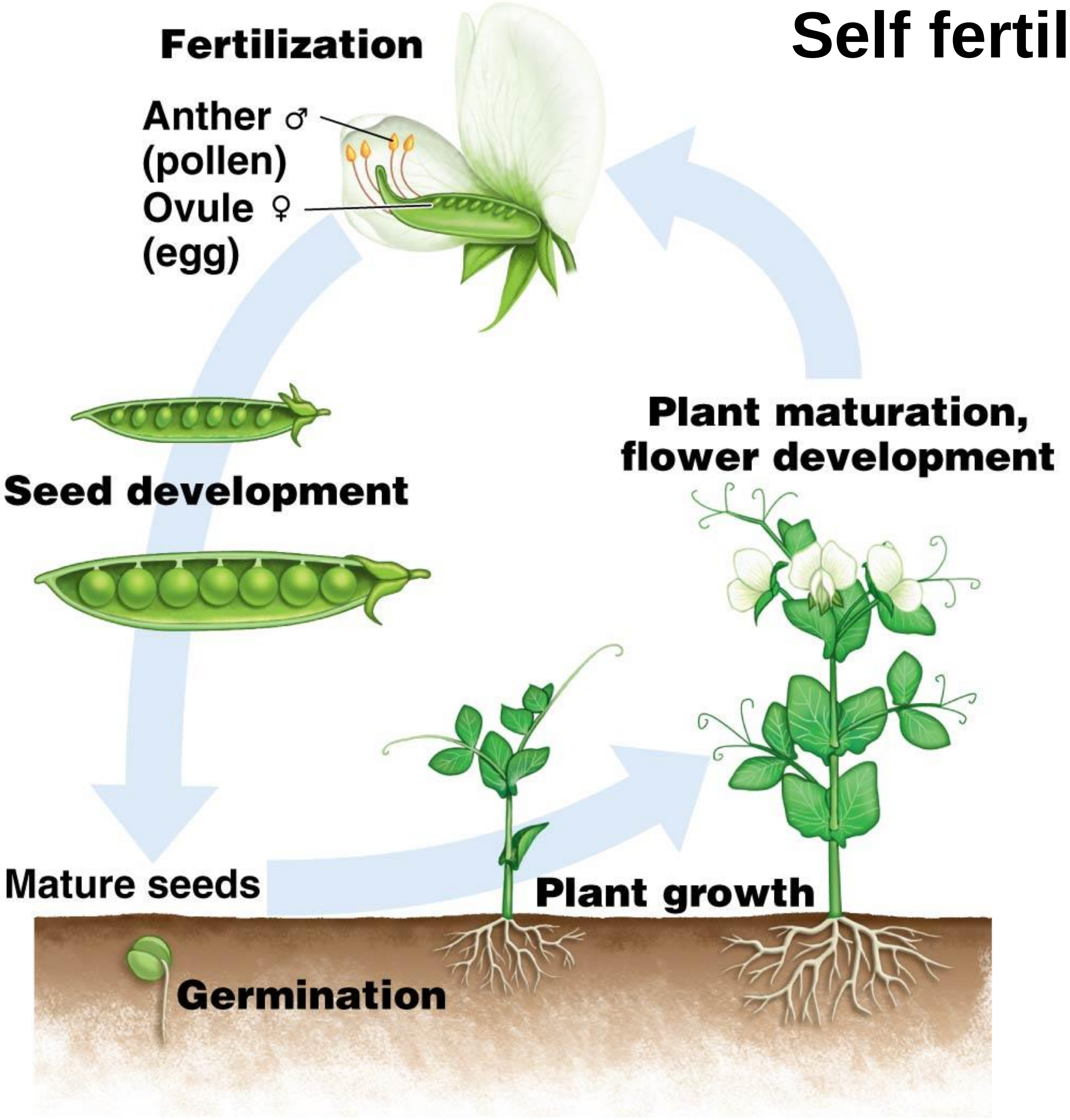
- Mendel’s experiments tested the **blending theory** of heredity
- It viewed the traits in offspring as a mixture of the parental traits
- Under this theory, a black cat and a white one, if crossed, would produce gray kittens, and the black and white traits would never reappear if the gray kittens were crossed to each other

Mendel’s experiment: Why Peas?

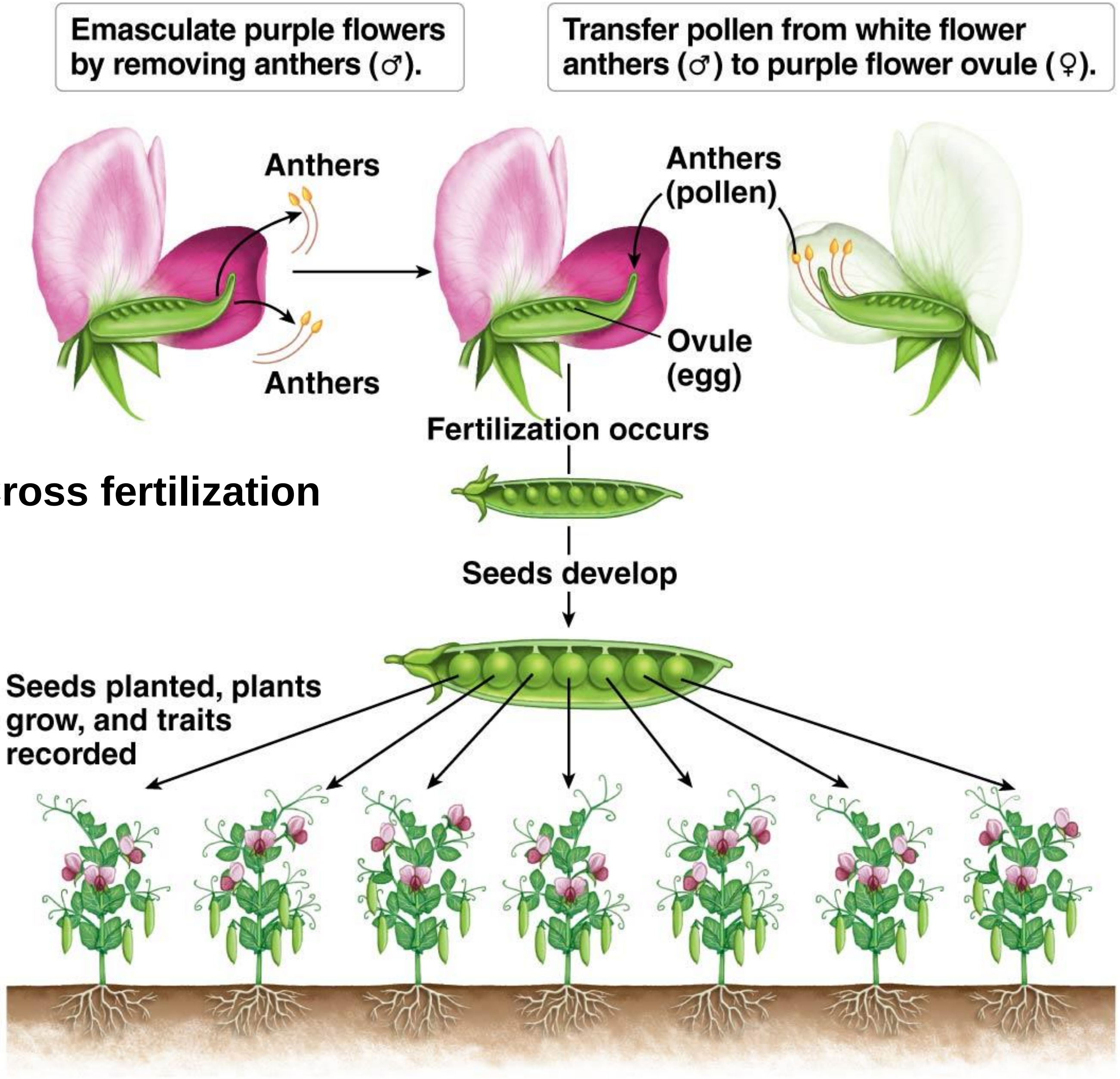
- Easy to grow.
- Easily identifiable traits
- Can work with large numbers of samples



Self fertilization



Cross fertilization



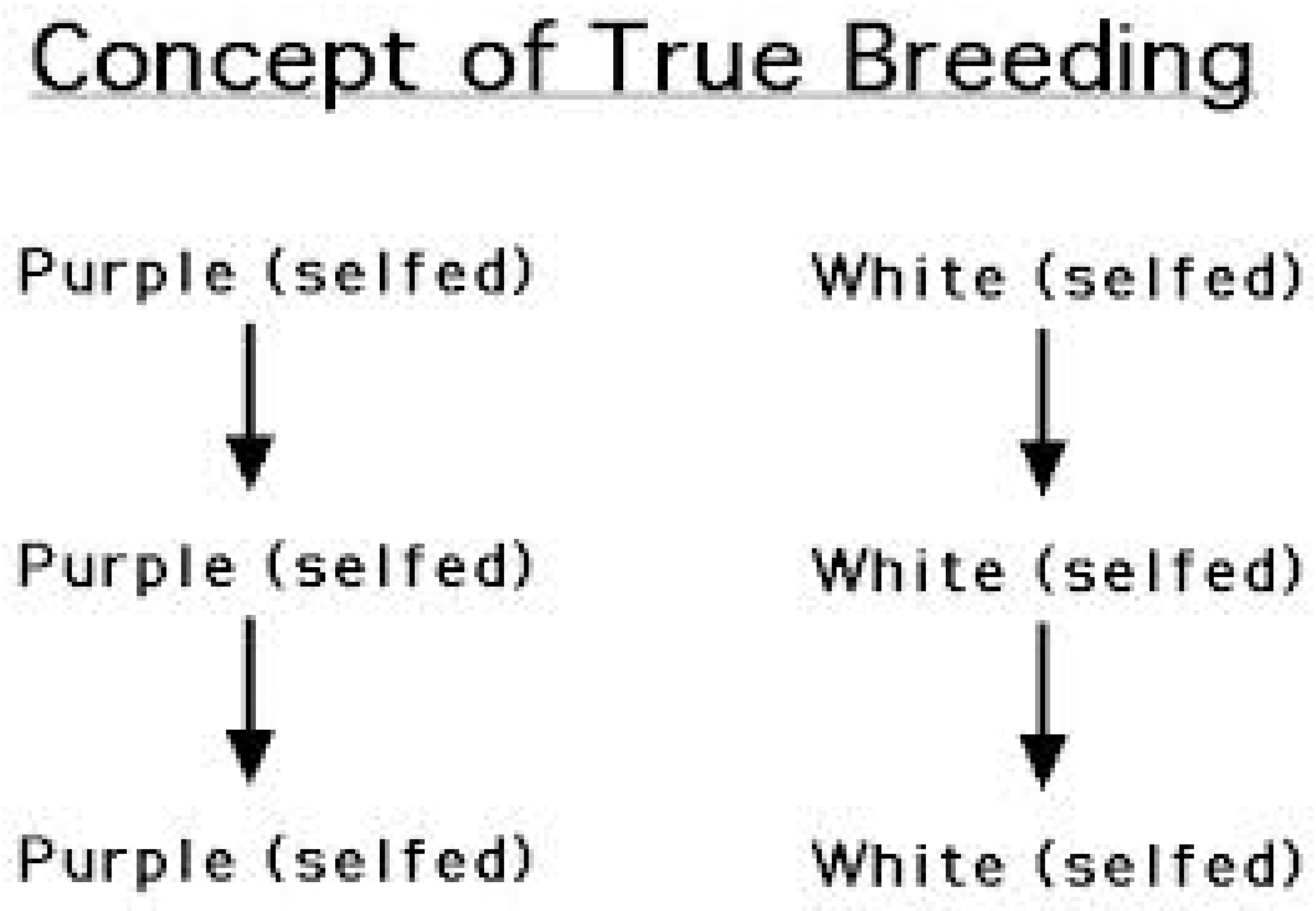
Pure-Breeding Strains to Begin Experimental Crosses

- Mendel took 2 years prior to beginning his experiments to establish **pure-breeding (or true-breeding) strains**

- These are strains that consistently produce the same phenotype

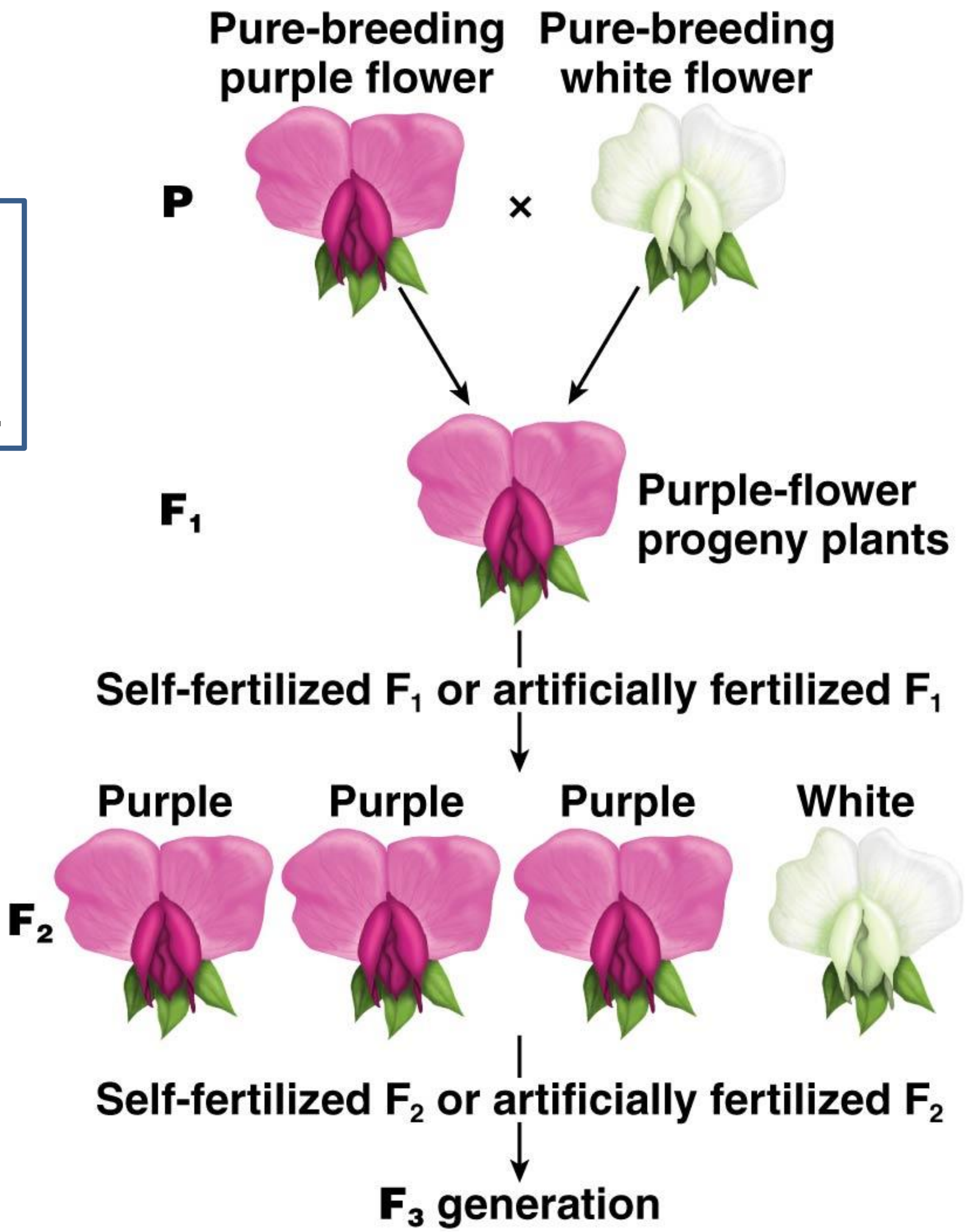
- Each experiment began with crosses between two pure-breeding **parental generation** plants (**P generation**) that produced offspring called $\mathbf{F_1}$ (**first filial generation**)

True-breeding= Pure-breeding=Pure line.



Mendel crossed plants showing contrasting traits.

Monohybrid cross reveal the principle of segregation
And the concept of Dominance



Mendel's Law of Segregation

1. Plant traits are handed down through _“hereditary factors”_ in the pollen and egg.

2. Because offspring obtain hereditary factors from both parents, each plant must contain two factors for every trait.

3. The factors in a pair segregate (separate) during the formation of sex cells, and each pollen or egg receives only one member of the pair.

Dominant and Recessive Traits

- The trait shown by the F_1 offspring was called the **dominant phenotype** (purple flower, e.g.)

- The trait that was not apparent in the F_1 was called the **recessive phenotype** (white flower, e.g.)

- When F_1 were crossed, 75% of the resulting F_2 had the dominant trait, but the recessive trait reappeared in the other 25%

Today, scientists refer to

The modern scientific term for "purebred" is **homozygous** (identical alleles).

the "factors" that control traits as **genes**. The different forms of a gene are called **alleles.**

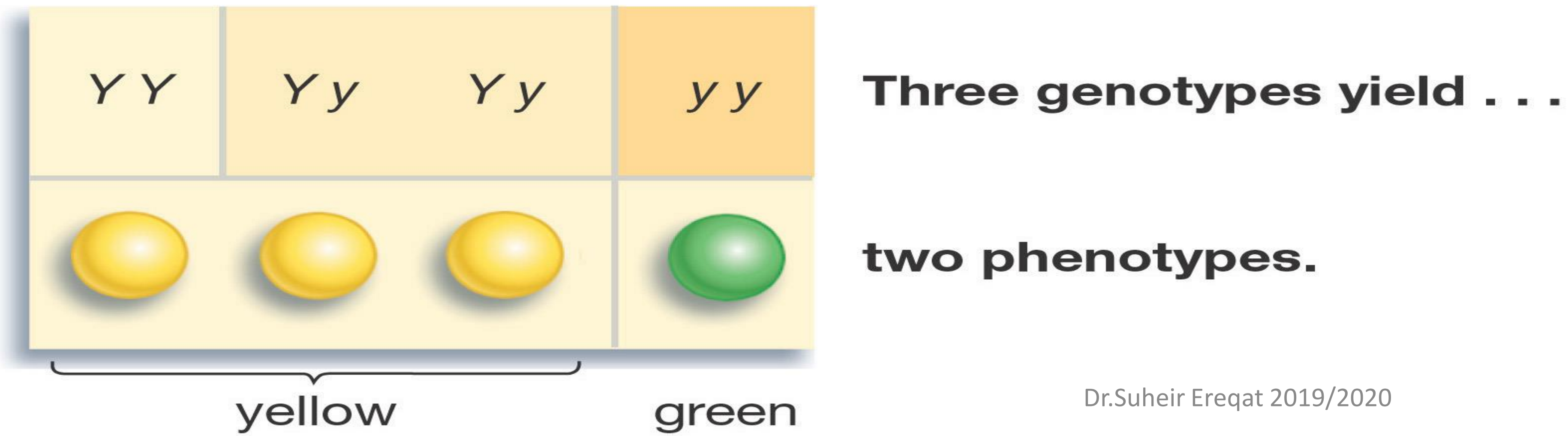
Alleles that mask or hide other alleles, such as the "round" allele, are said to be **dominant.**

A **recessive allele**, such as the wrinkle allele, is masked, or covered up, whenever the dominant allele is present.

the offspring of crosses between parents with contrasting traits=Hybrid
Hybrid Alleles= **heterozygous**

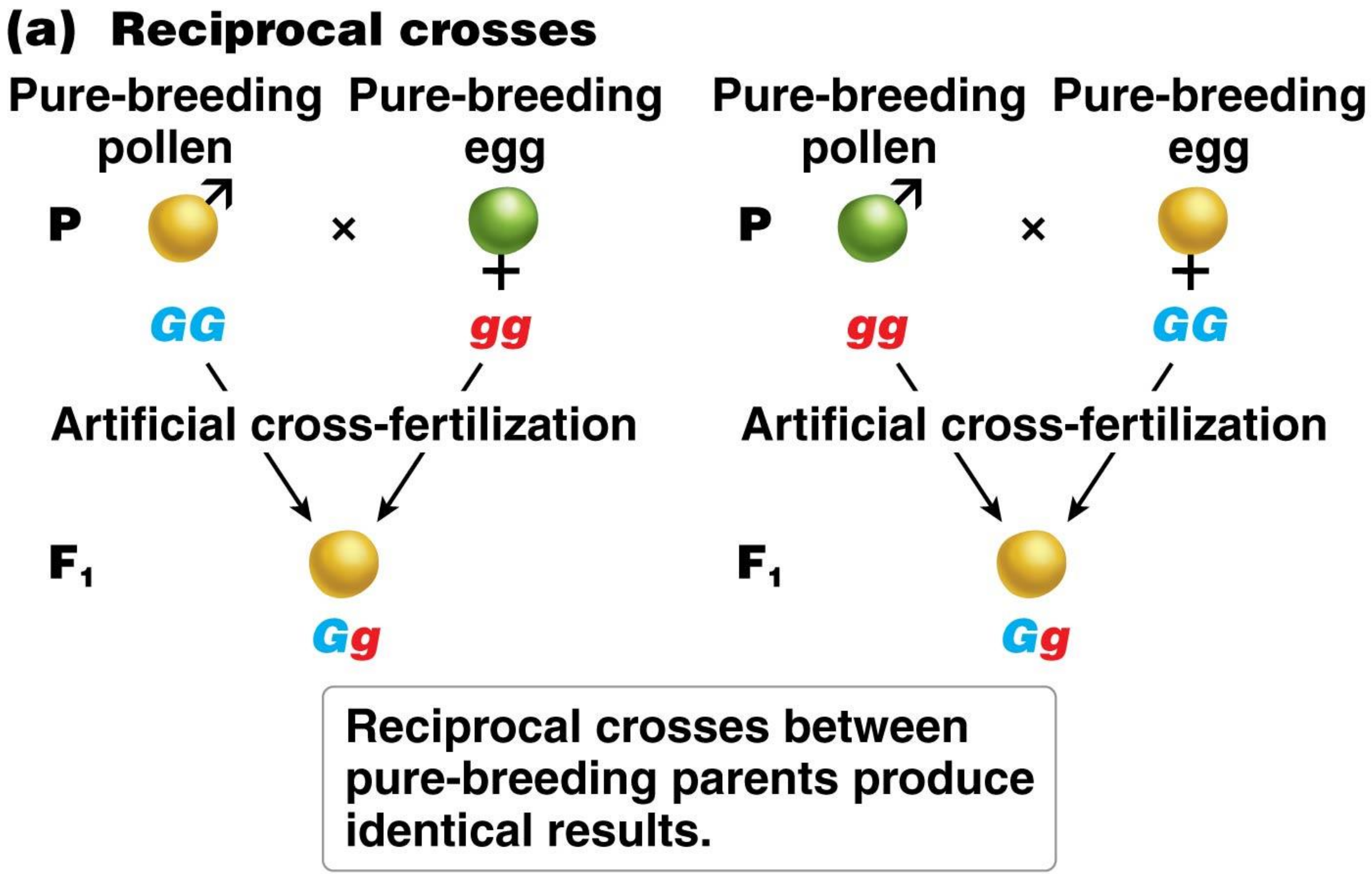
Glossary and Definitions

- **Dominant trait** - a trait that shows in a heterozygote
- **Recessive trait** - a trait that is hidden in a heterozygote



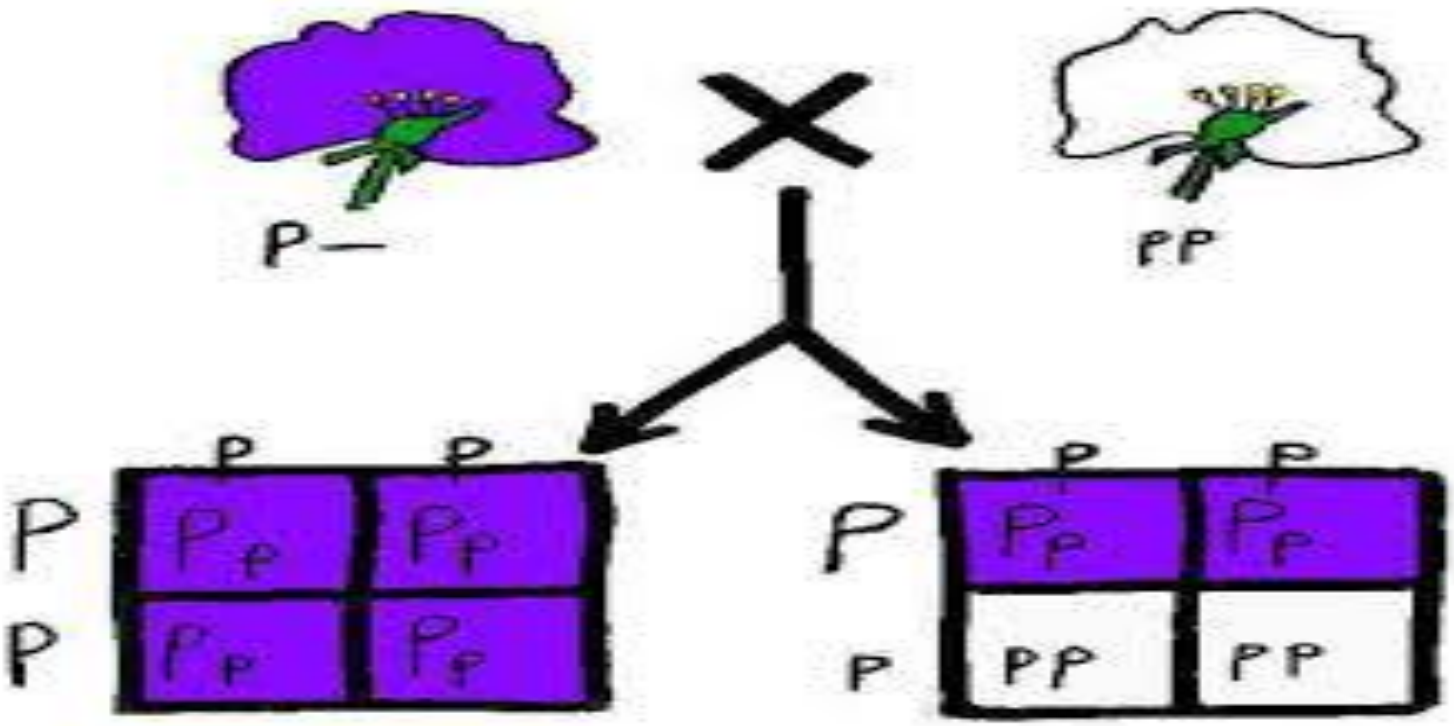
Replicate-, Reciprocal- and Test-Cross Analysis

- Mendel made many **replicate crosses**, producing hundreds or thousands of progeny, by repeating each cross several times
- He performed **reciprocal crosses**, in which the same genotypes are crossed, but the sexes of the parents are reversed
- He also performed **test crosses**

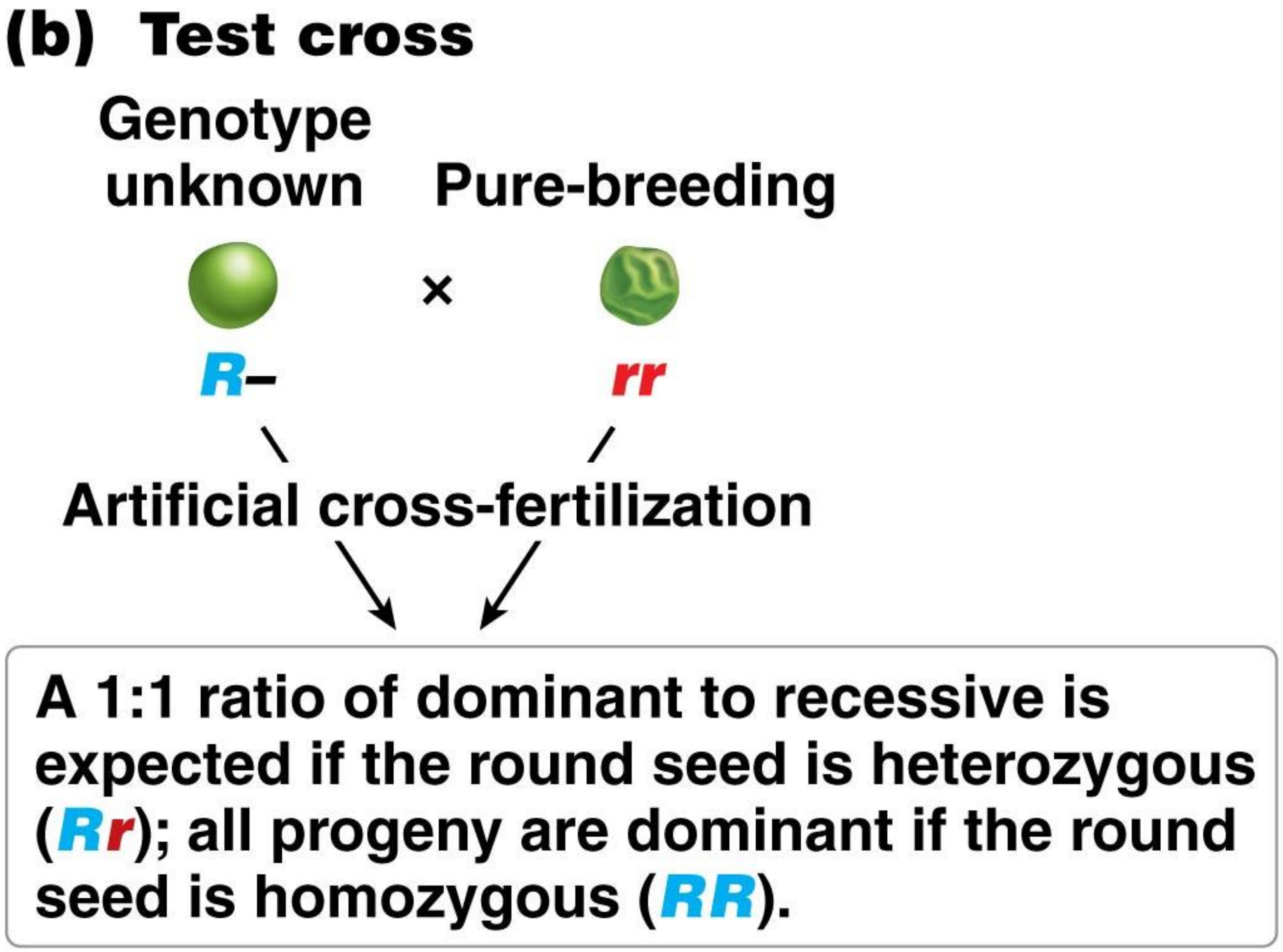

(a) Reciprocal crosses
Pure-breeding pollen
Pure-breeding egg
P
×
GG
gg
Artificial cross-fertilization
F1
Gg
Pure-breeding pollen
Pure-breeding egg
P
×
gg
GG
Artificial cross-fertilization
F1
Gg
Reciprocal crosses between pure-breeding parents produce identical results.

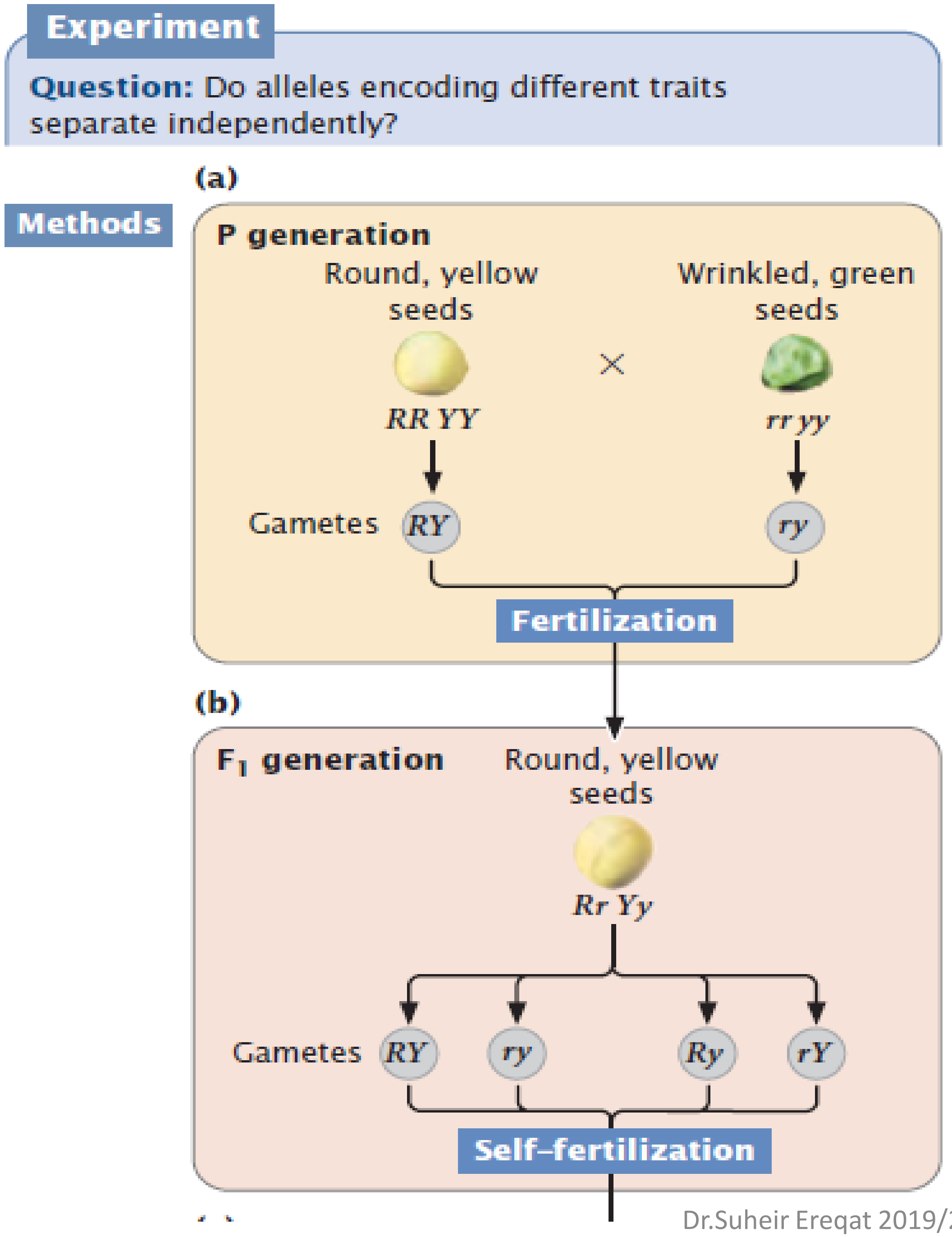
Test cross

A cross between individual with unknown genotype with a homozygous recessive genotype



More examples……

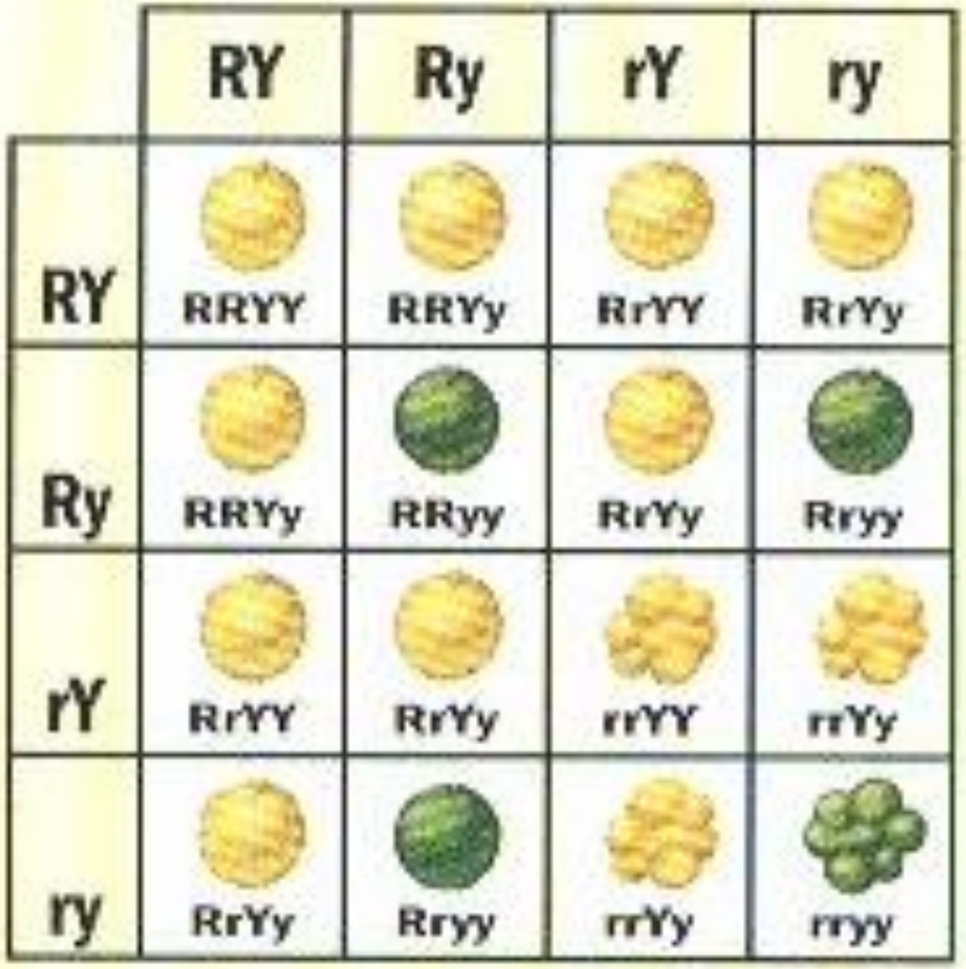




Dihybrid Crosses Reveal the Principle of Independent Assortment

Dihybrid Cross

RrYy X RrYy



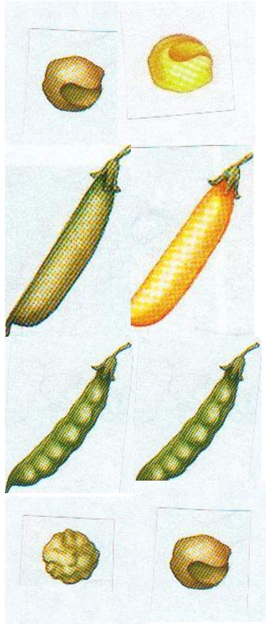
Round/Yellow: 9
Round/green: 3
wrinkled/Yellow: 3
wrinkled/green: 1

9:3:3:1

What is the probability of round yellow seeds=9/16

Law of Independent Assortment

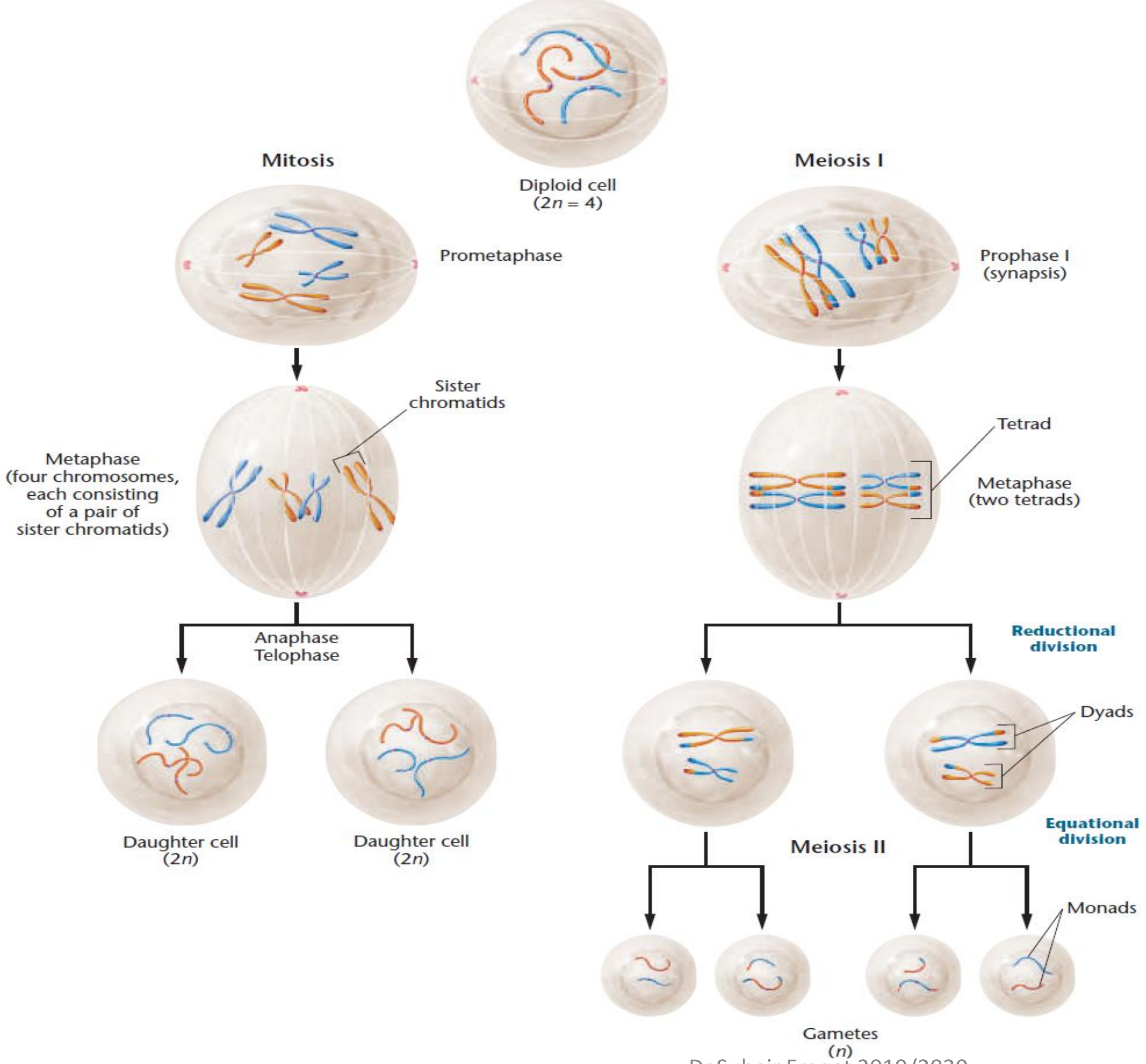
Mendel's second law, the Law of Independent Assortment, states that alleles at different loci separate independently during the formation of gametes.



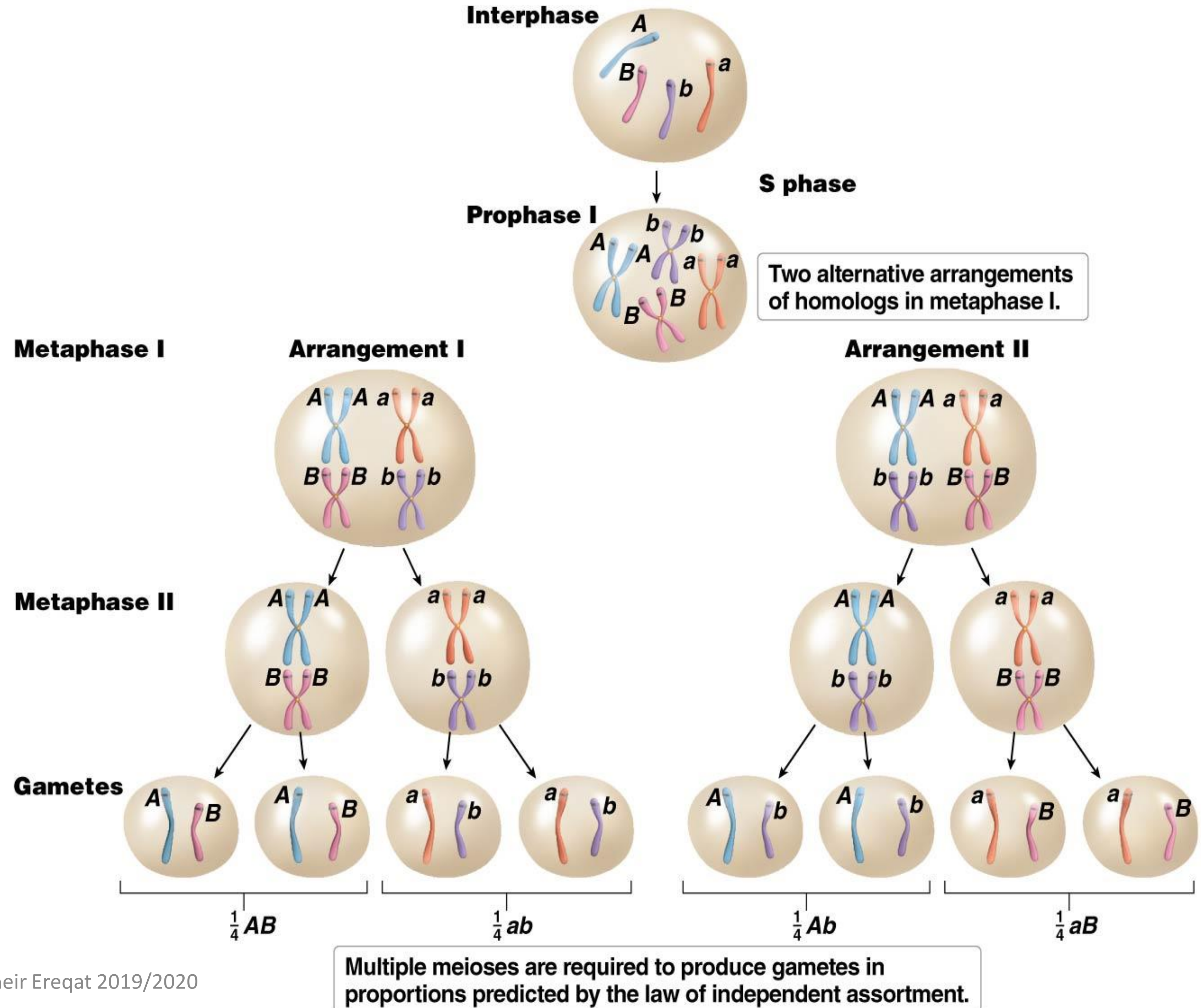
The donation of one allele from each pair is independent of any other pair. For example, if the plant donates the yellow seed allele it does not mean that it will also donate the yellow pod allele

Table 3.2 Comparison of the principles of segregation and independent assortment

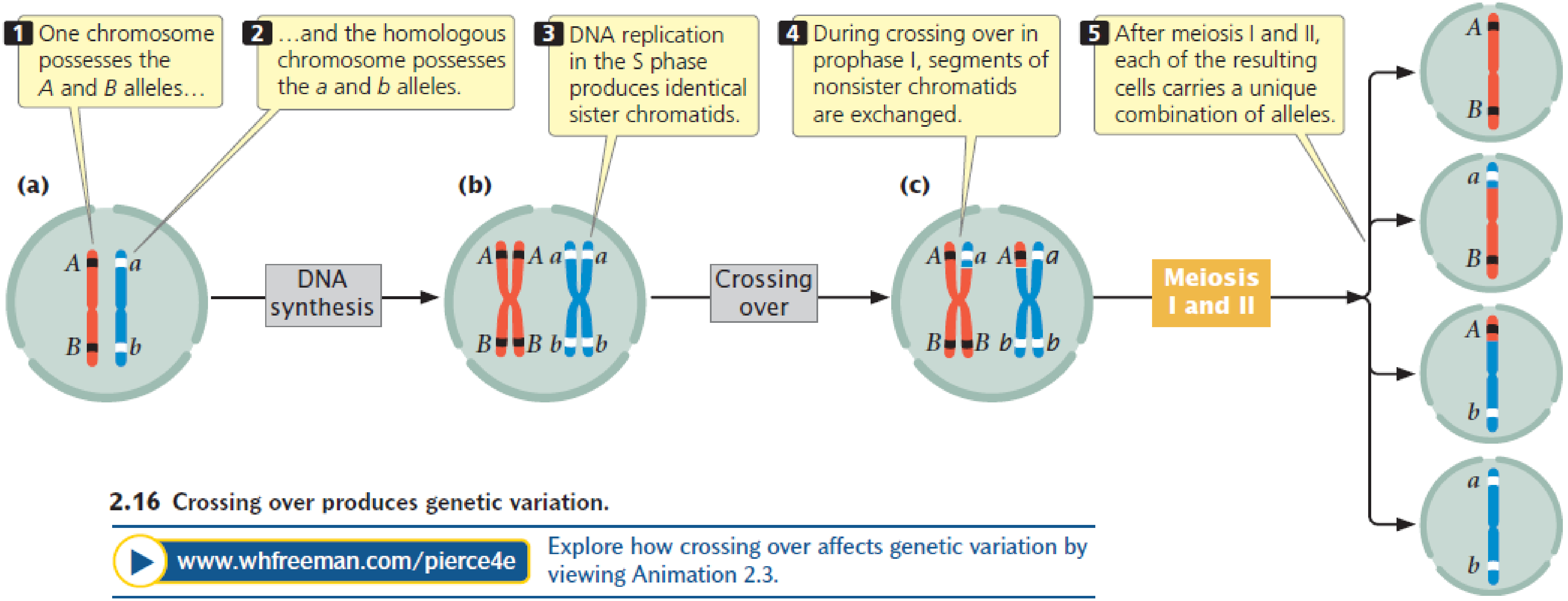
Principle	Observation	Stage of Meiosis
Segregation (Mendel's first law)	1. Each individual organism possesses two alleles encoding a trait.	Before meiosis
	2. Alleles separate when gametes are formed.	Anaphase I
	3. Alleles separate in equal proportions.	Anaphase I
Independent assortment (Mendel's second law)	Alleles at different loci separate independently.	Anaphase I



Cell division
Synapsis and crossing over


Interphase
S phase
Prophase I
Two alternative arrangements of homologs in metaphase I.
Metaphase I
Arrangement I
Arrangement II
Metaphase II
Gametes
1/4 AB
1/4 ab
1/4 Ab
1/4 aB
Multiple meioses are required to produce gametes in proportions predicted by the law of independent assortment.

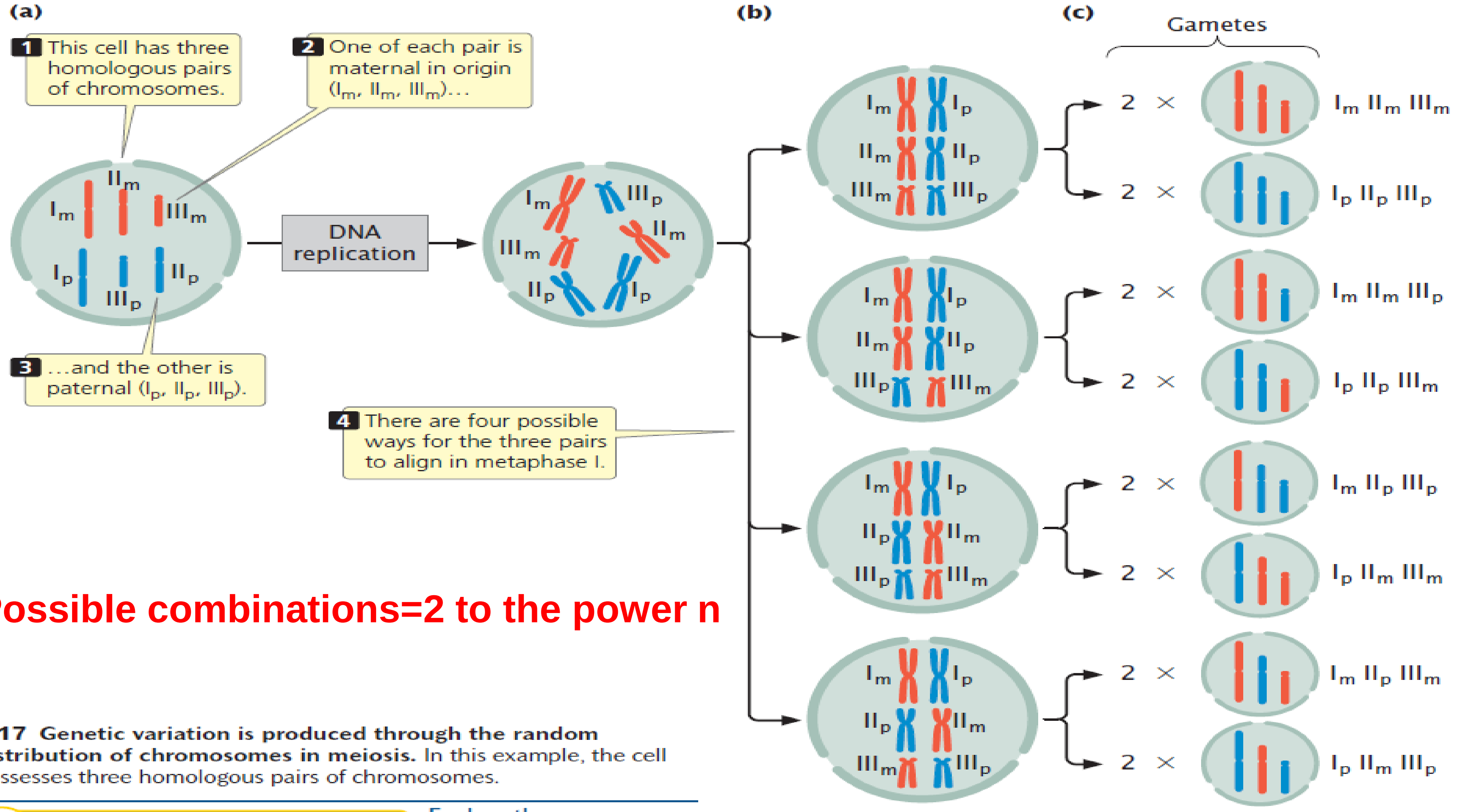
Genetic variation: I. Crossing Over



2.16 Crossing over produces genetic variation.

www.whfreeman.com/pierce4e Explore how crossing over affects genetic variation by viewing Animation 2.3.

II.Random Separation of Homologous Chromosomes



Possible combinations=2 to the power n

Conclusion: Eight different combinations of chromosomes in the gametes are possible, depending on how the chromosomes align and separate in meiosis I and II.

2.17 Genetic variation is produced through the random distribution of chromosomes in meiosis. In this example, the cell possesses three homologous pairs of chromosomes.

www.whfreeman.com/pierce4e Explore the random distribution of chromosomes by viewing Animation 2.3.

Gene Linkage

- Are genes “linked” to each other on chromosomes?
- Morgan found that many genes are linked together.
- It was determined that chromosomes, not genes, assort independently during meiosis.

Linked Genes

- Genes carried on the same chromosome
  - Linked during transmission from parent to offspring
  - Inherited like single genes
- Recombination can break linkage
- Genes that are close together on the same chromosome belong to the same linkage group