



<p>Phenotype = Blue Eyes</p>  <p>Genotype = bb Recessive = b</p>	<p>Phenotype = Brown Eyes</p>  <p>Genotype = Bb or BB Dominant = B</p>
--	---



CHAPTER 11 GENETICS

Genetic discoveries 45 minutes

Impacts, Issues:

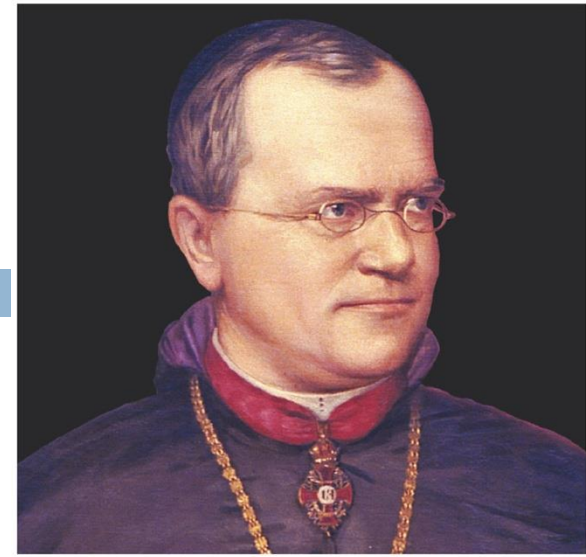
The Color of Skin



© Brooks/Cole, Cengage Learning

- Like most human traits, skin color has a genetic basis; more than 100 gene products affect the synthesis and deposition of melanins
 - ▣ In the picture of fraternal twins. , both grandmas were European descent and both grandfathers are African

11.1 Mendel, Pea Plants, and Inheritance Patterns

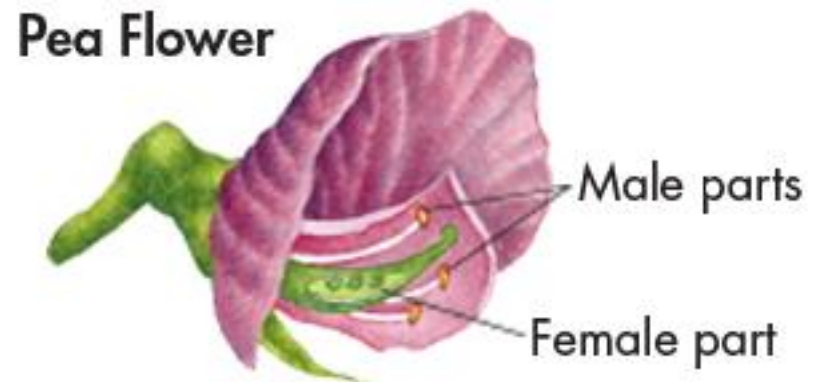


© Brooks/Cole, Cengage Learning

- Recurring inheritance patterns are observable outcomes of sexual reproduction
- Before the discovery of genes, it was thought that inherited traits resulted from a blend of parental characters
- Mendel was a monk with training in plant breeding and mathematics

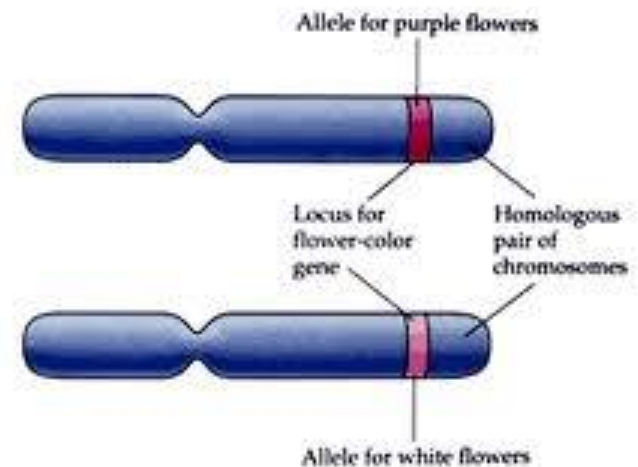
11.1 The work of Gregor Mendel

- **Genetics** = the study of heredity (passing down of characteristics from parent to offspring)
- Gregor Mendel = “the father of genetics”
 - ▣ Born in 1822 – Austrian monk
 - ▣ Worked with pea plants that were self-pollinating and true-breeding (the offspring always looked like the parent)



Important Genetic Terms

- **Trait** = a specific characteristic (pea color, hair color)
- **Gene** = the factors that are passed from parent to offspring (found at a locus on a chromosome)
- **Allele** = the different forms of a gene

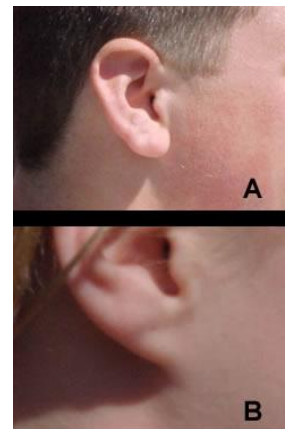


Terms Used in Modern Genetics

- A **mutation** is a permanent change in a gene
 - May cause a trait to change
- A **hybrid** has nonidentical alleles for a trait
 - Offspring of a cross between two individuals that breed true for different forms of a trait are hybrids

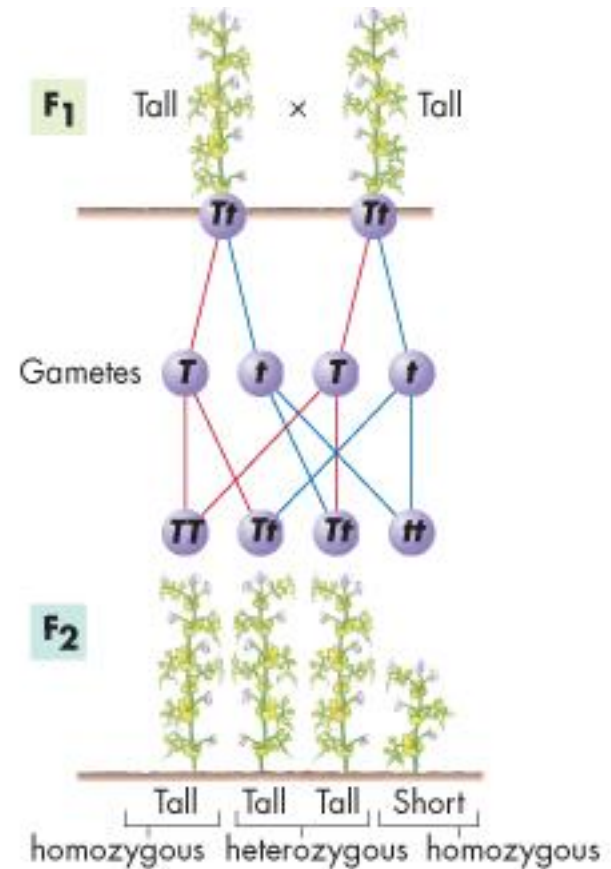
Mendel's Conclusions

- An individual's characteristics are determined by factors (**genes**) that are passed from one parental generation to the next
- **Principle of dominance** = some alleles are dominant and some are recessive
 - ▣ **Dominant** = need one allele (form of the gene) for the trait to be expressed
 - ▣ **Recessive** = need two alleles for the trait to be expressed



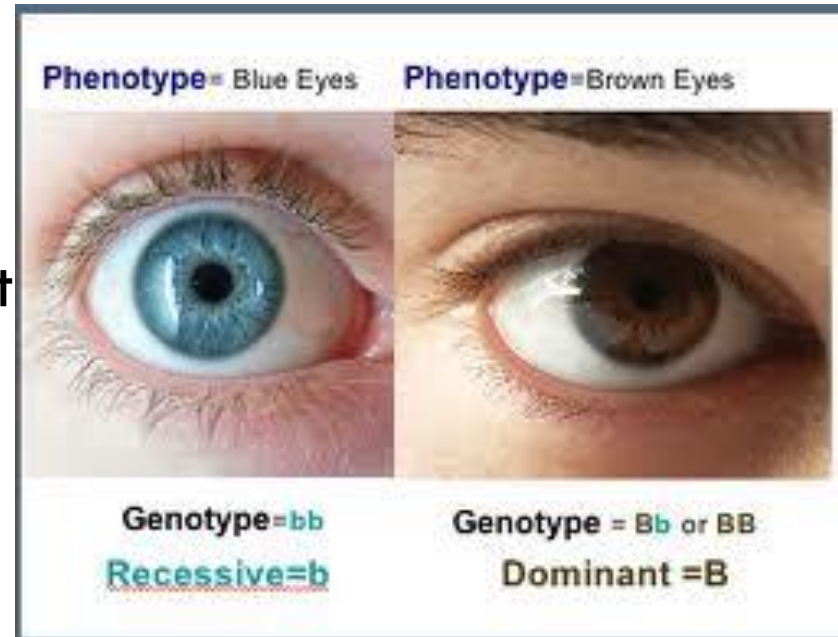
Genetics and probability

- **Dominant** alleles are written in **upper case** $T = \text{tall}$
- **Recessive** alleles are written in **lower case** $t = \text{short}$
- In this example:
 - There is a 50% chance that the plant the offspring will get a “T” allele
 - There is a 50% chance the plant will get a “t” allele



Even more genetic terminology

- **Genotype** = the genetic makeup of an organism
 - ▣ **Homozygous** = organisms that have two identical alleles for a gene (BB or bb)
 - ▣ **Heterozygous** = organisms that have two different alleles for a gene (Bb)
- **Phenotype** = the physical appearance of an organism

















Mendel's Pea Plants

- Mendel cross pollinated his true-breeding plants

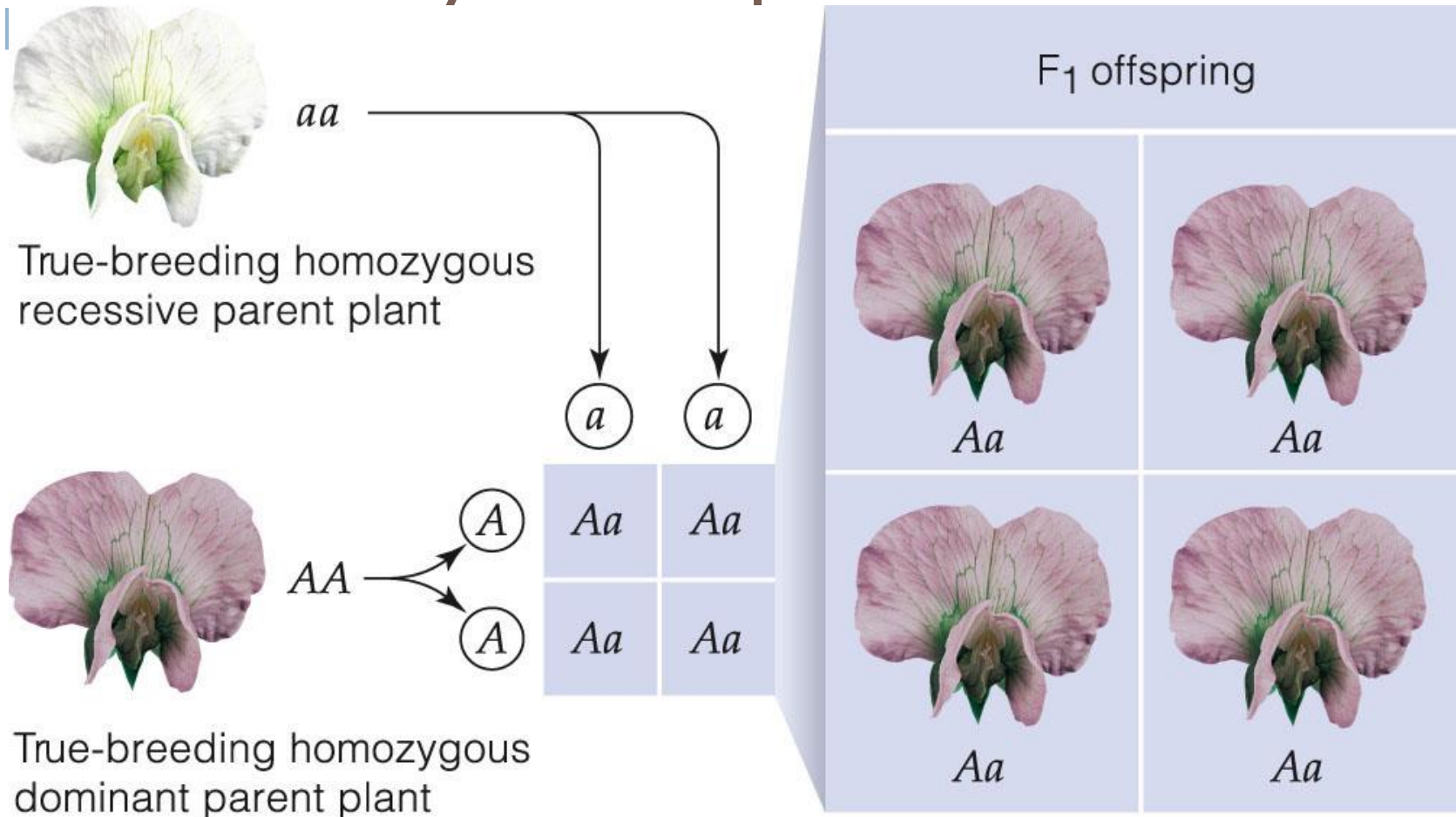


Mendel's Seven F ₁ Crosses on Pea Plants							
	Seed Shape	Seed Color	Seed Coat	Pod Shape	Pod Color	Flower Position	Plant Height
P	Round x	Yellow x	Gray x	Smooth x	Green x	Axial x	Tall x
	Wrinkled	Green	White	Constricted	Yellow	Terminal	Short
F ₁	↓	↓	↓	↓	↓	↓	↓
	Round	Yellow	Gray	Smooth	Green	Axial	Tall

Mendel's Monohybrid Experiments

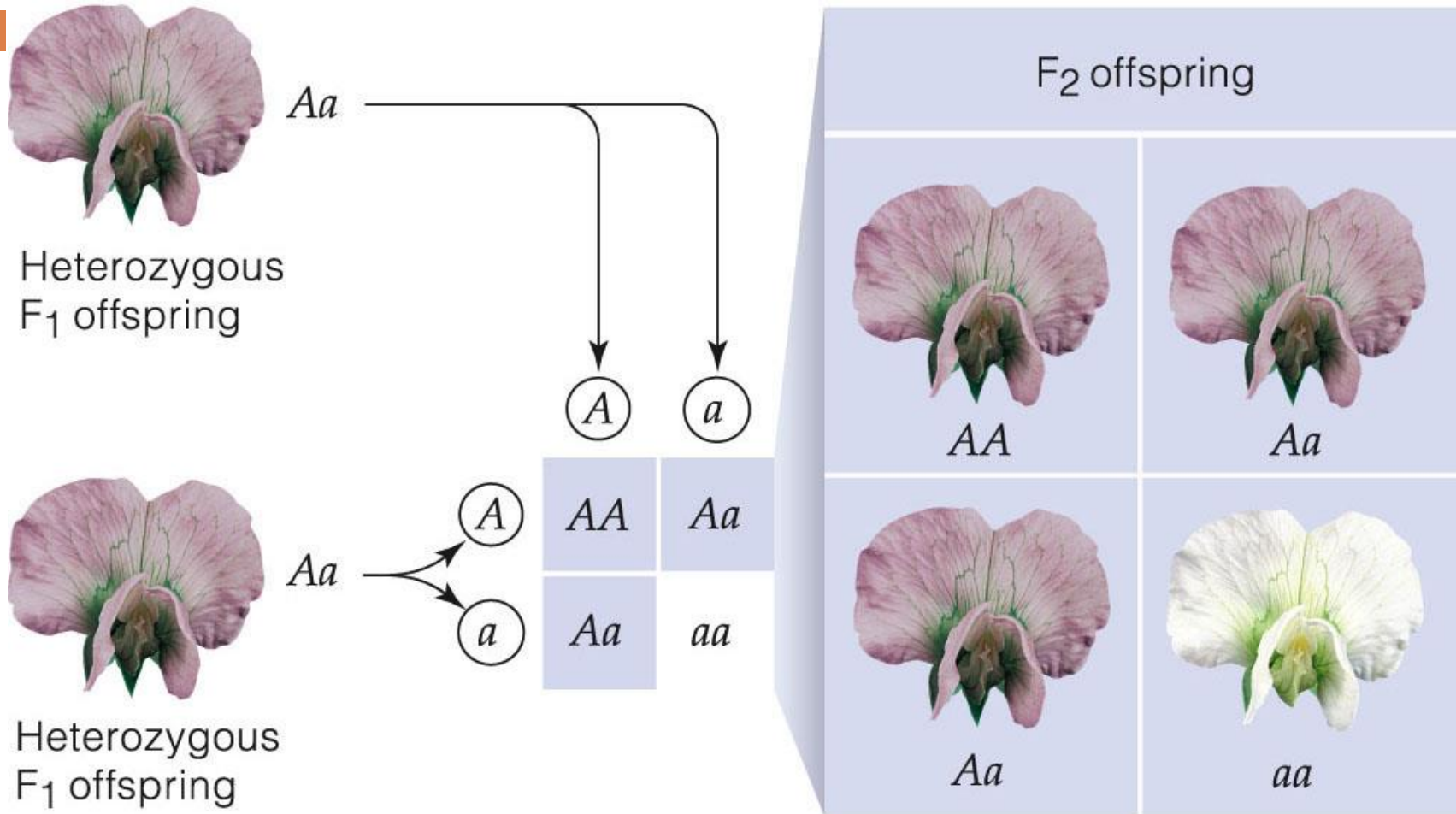
Trait Studied	Dominant Form	Recessive Form	F ₂ Dominant-to-Recessive Ratio
Seed shape	 5,474 round	 1,850 wrinkled	2.98 to 1
Seed color	 6,022 yellow	 2,001 green	3.01 to 1
Pod shape	 882 inflated	 299 wrinkled	2.95 to 1
Pod color	 428 green	 152 yellow	2.82 to 1
Flower color	 705 purple	 224 white	3.15 to 1
Flower position	 651 along stem	 207 at tip	3.14 to 1
Stem length	 787 tall	 277 dwarf	2.84 to 1

Phenotype Ratios in a Monohybrid Experiment



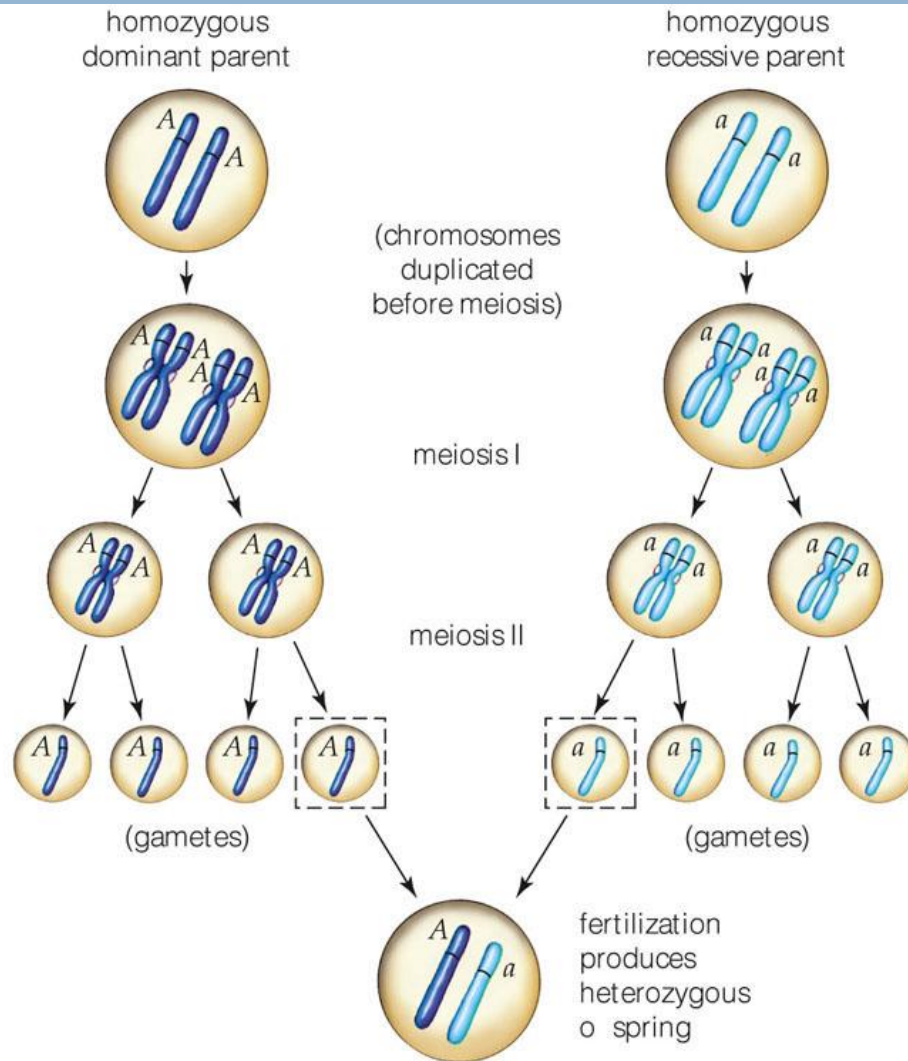
B A cross between two plants that breed true for different forms of a trait produces F_1 offspring that are identically heterozygous.

Phenotype Ratios in a Monohybrid Experiment



C A cross between the F₁ offspring is the monohybrid experiment. The phenotype ratio of F₂ offspring in this example is 3:1 (3 purple to 1 white).

Segregation of Alleles at a Gene Locus



Mendel's Law of Segregation

- Mendel observed a phenotype ratio of 3:1 in the F_2 offspring of his monohybrid crosses
 - ▣ Consistent with the probability of the aa genotype in the offspring of a heterozygous cross ($Aa \times Aa$)
- This is the basis of Mendel's law of **segregation**
 - ▣ Diploid cells have pairs of genes on pairs of homologous chromosomes
 - ▣ The two genes of each pair separate during meiosis, and end up in different gametes

Testcrosses

□ Testcross

- A method of determining if an individual is heterozygous or homozygous dominant
- An individual with unknown genotype is crossed with one that is homozygous recessive ($AA \times aa$) or ($Aa \times aa$)

Applying Mendel's Principles

- Mendelian genetics is based on **probability** = the likelihood that an event would occur



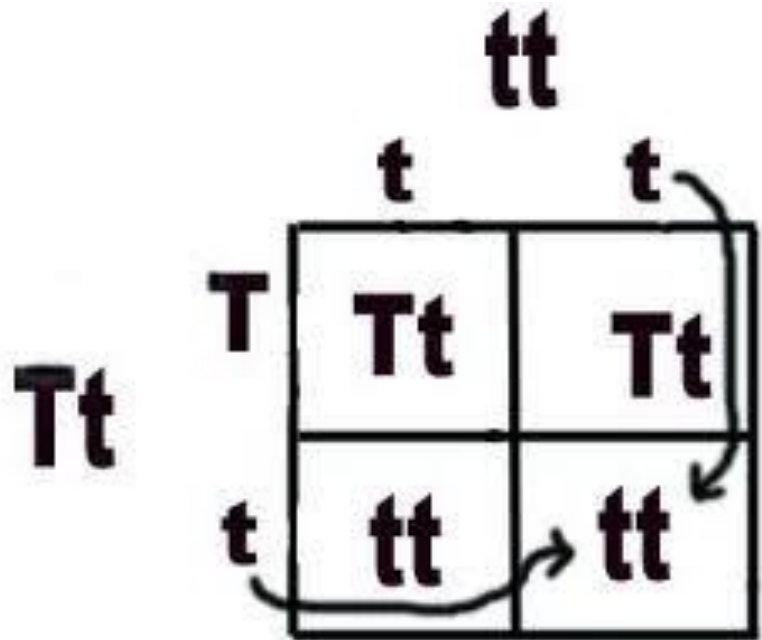
Punnett Squares

- **Punnett squares** = a diagram that uses probability to predict the possible genotype and phenotype combination in crosses

T = tall

t = small

(choose a letter from the dominant allele)



Oh no! You need to think!!!!

- For each example, write the genotype and phenotype.

1) The Rr flower

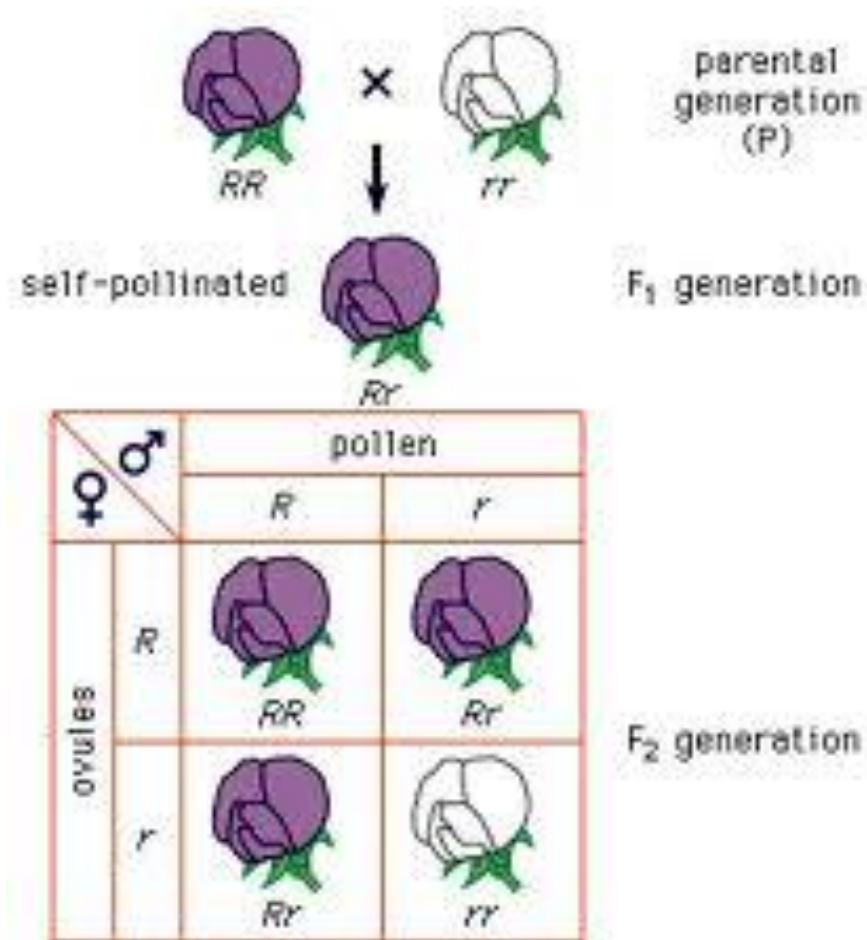
Genotype Rr

Phenotype Purple

2) The rr flower

Genotype rr

Phenotype white



Monohybrid cross

In peas, yellow seeds are dominant to green.

Complete the following cross $Yy \times yy$

1) Make a key – yellow = Y
green = y

2) Parental genotypes – if not given

$yy \times Yy$

3) Set up the Punnett square

4) Figure out the phenotypic and

genotypic ratio

Phenotypic ratio - 1 yellow : 1 green

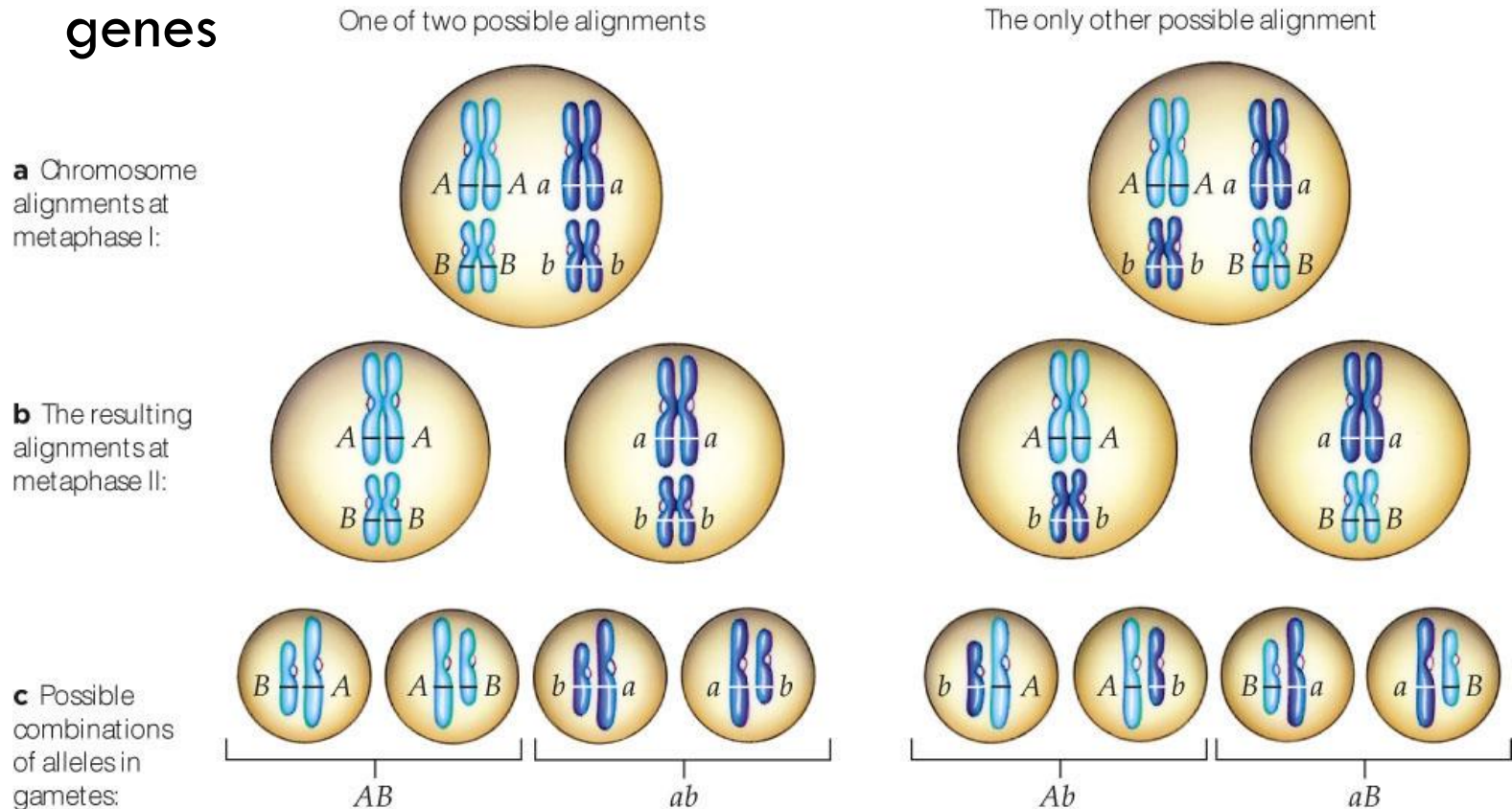
Genotypic ratio - 1 Yy : 1 yy

	Y	y
y	Yy	yy
y	Yy	yy

11.3 Mendel's Law of Independent Assortment

□ Mendel's law of **independent assortment**

- Many genes are sorted into gametes independently of other genes



Dihybrid cross

- When there are 2 traits it is a **dihybrid cross**.
- Genes for different traits can segregate independently during the formation of gametes

The image displays two Punnett squares for a dihybrid cross. The left square illustrates the segregation of alleles, with red arrows showing the independent assortment of alleles into gametes. The right square shows the resulting 16 possible genotypes for the offspring.

	TG	tG	Tg	tg
TG				
tG			TtGg	
Tg				
tg				

	TG	tG	Tg	tg
TG	TTGG	TtGG	TTGg	TtGg
tG	TtGG	ttGG	TtGg	ttGg
Tg	TTGg	TtGg	TTgg	Ttgg
tg	TtGg	ttGg	Ttgg	ttgg

Dihybrid cross

□ EXAMPLE PROBLEM

Cross two plants that are heterozygous for height and pod color. Tall is dominant to short and green pods are dominant to yellow

Step 1 – Make a key and determine the parents

Tall = T Green = G

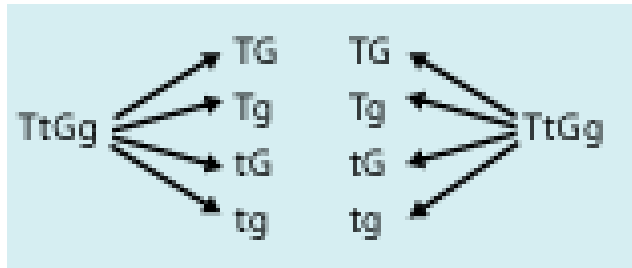
Short = t Yellow = g

Step 2 – Write the genotypes of the parents

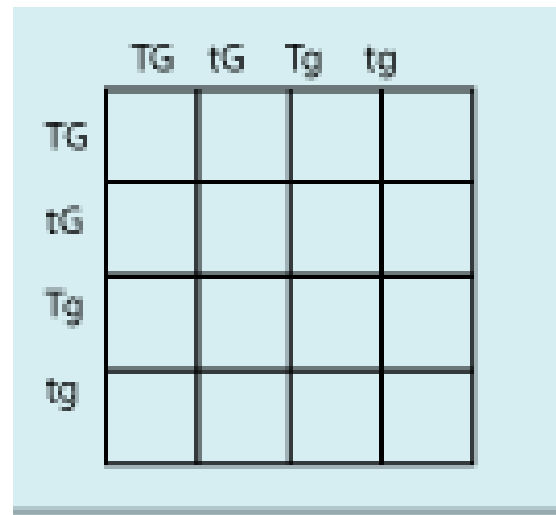
TtGg x TtGg

Dihybrid cross

Step 3 – Determine the possible allele combinations for the gametes



Step 4 – Set up the 16 square Punnett square



Dihybrid cross example

Step 5 – Complete the Punnett square

The image shows two Punnett squares for a dihybrid cross. The left square is partially filled with red arrows indicating the placement of alleles. The right square is fully filled with the resulting genotypes.

	TG	tG	Tg	tg
TG				
tG			TtGg	
Tg				
tg		tTgG		

	TG	tG	Tg	tg
TG	TTGG	TtGG	TTGg	TtGg
tG	TtGG	ttGG	TtGg	ttGg
Tg	TTGg	TtGg	TTgg	Ttgg
tg	TtGg	ttGg	Ttgg	ttgg

Step 6 – Determine the phenotypic ratio

9 tall green: 3 tall yellow: 3 short green: 1 short yellow

P
generation

A Meiosis in homozygous individuals results in one kind of gamete.

B A cross between plants homozygous for two different traits yields one possible combination of gametes:



parent plant
homozygous
for purple flowers
and long stems

parent plant
homozygous
for white flowers
and short stems

AABB

aabb

AB

×

ab

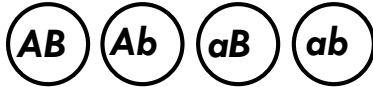




F₁ generation

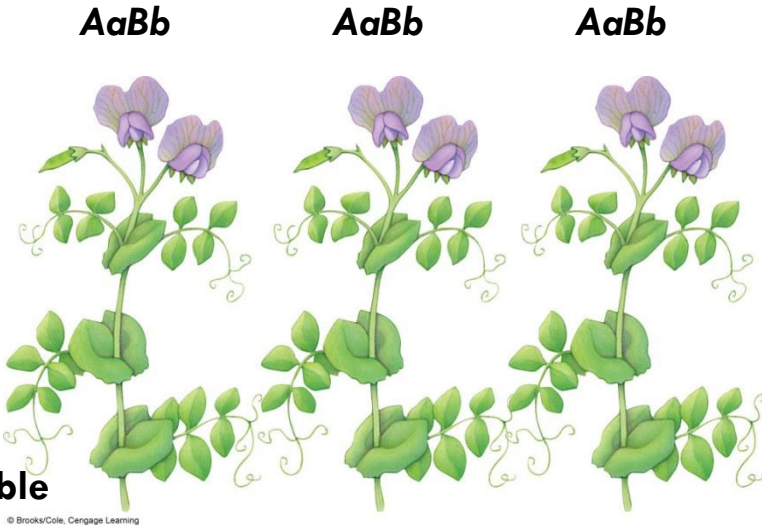
All F₁ offspring are *AaBb*,
with purple flowers and tall stems.

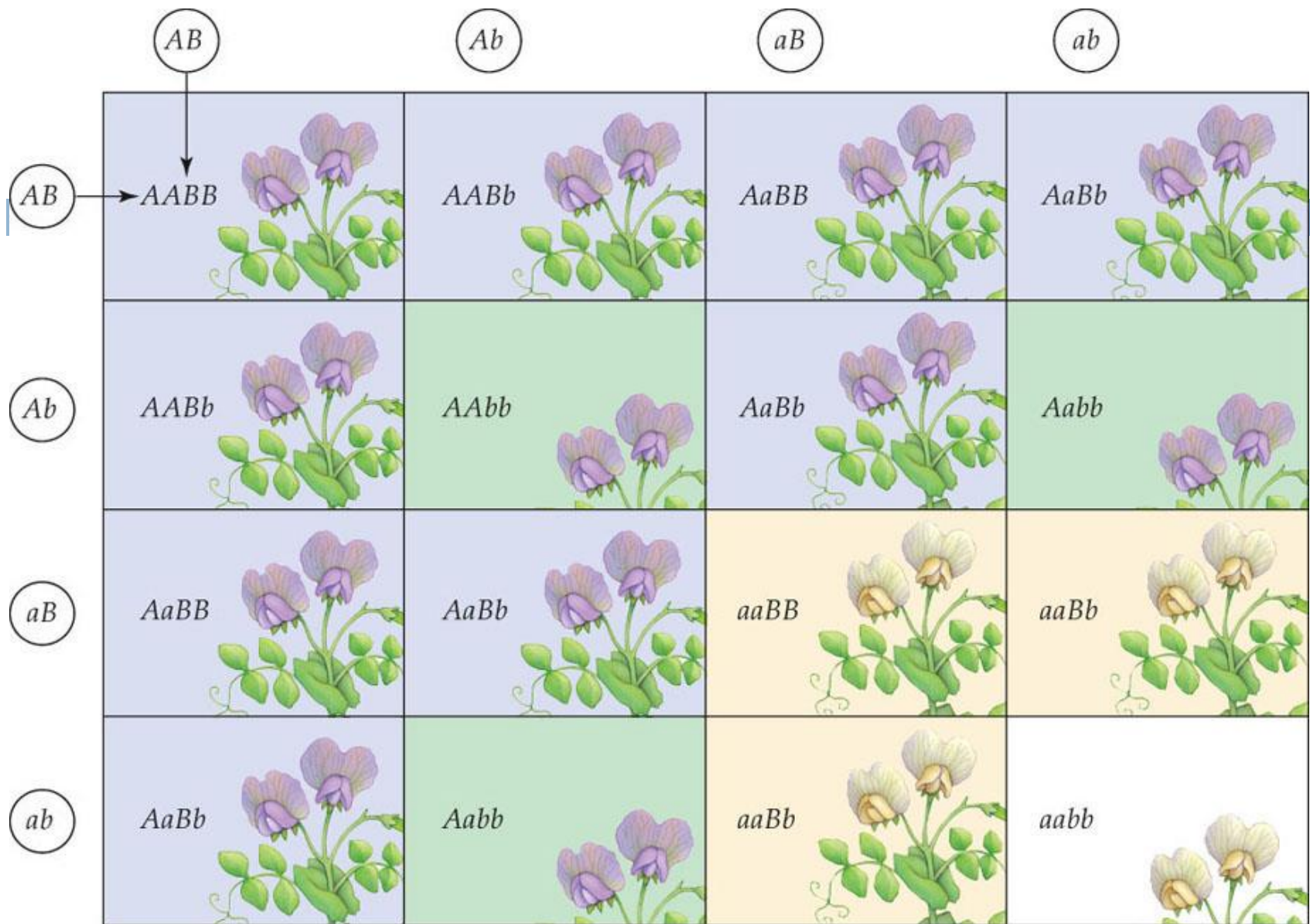
C Meiosis in *AaBb* dihybrid plants results
in four kinds of gametes:



F₂ generation

These gametes can meet up in one of 16 possible
ways when the dihybrids are
crossed (*AaBb* X *AaBb*):





D Out of 16 possible genetic outcomes of this dihybrid cross, 9 will result in plants that are purple-flowered and tall; 3, purple-flowered and short; 3, white-flowered and tall; and 1, white-flowered and short. The ratio of phenotypes of this dihybrid cross is 9:3:3:1.

Mendel's Law of Independent Assortment

- Mendel's dihybrid experiments showed that “units” specifying one trait segregated into gametes separately from “units” for other traits
- *Exception:* Genes that have loci very close to one another on a chromosome tend to stay together during meiosis

- In moose, brown coat color (B) is dominant to albino (no pigment) (b) and rough coat (R) is dominant to smooth coat (r). A homozygous brown, homozygous rough male mates with a albino, smooth female.
- Draw Punnett squares and determine the expected phenotypic ratios for the:
 - ▣ **a)** F1 generation
 - ▣ **b)** F2 generation
 - ▣ **c)** cross between an F1 moose and a moose with the genotype BBRr

□ a) F1 generation = 100% BbRr = **100% Brown, rough**

□ b) F2 generation =

9 brown rough: 3 brown smooth: 3 albino rough: 1 albino smooth

□ c) cross between an F1 mouse and a mouse with the genotype BBrr

= BBrr x BbRr = **3 Brown rough: 1 brown smooth**