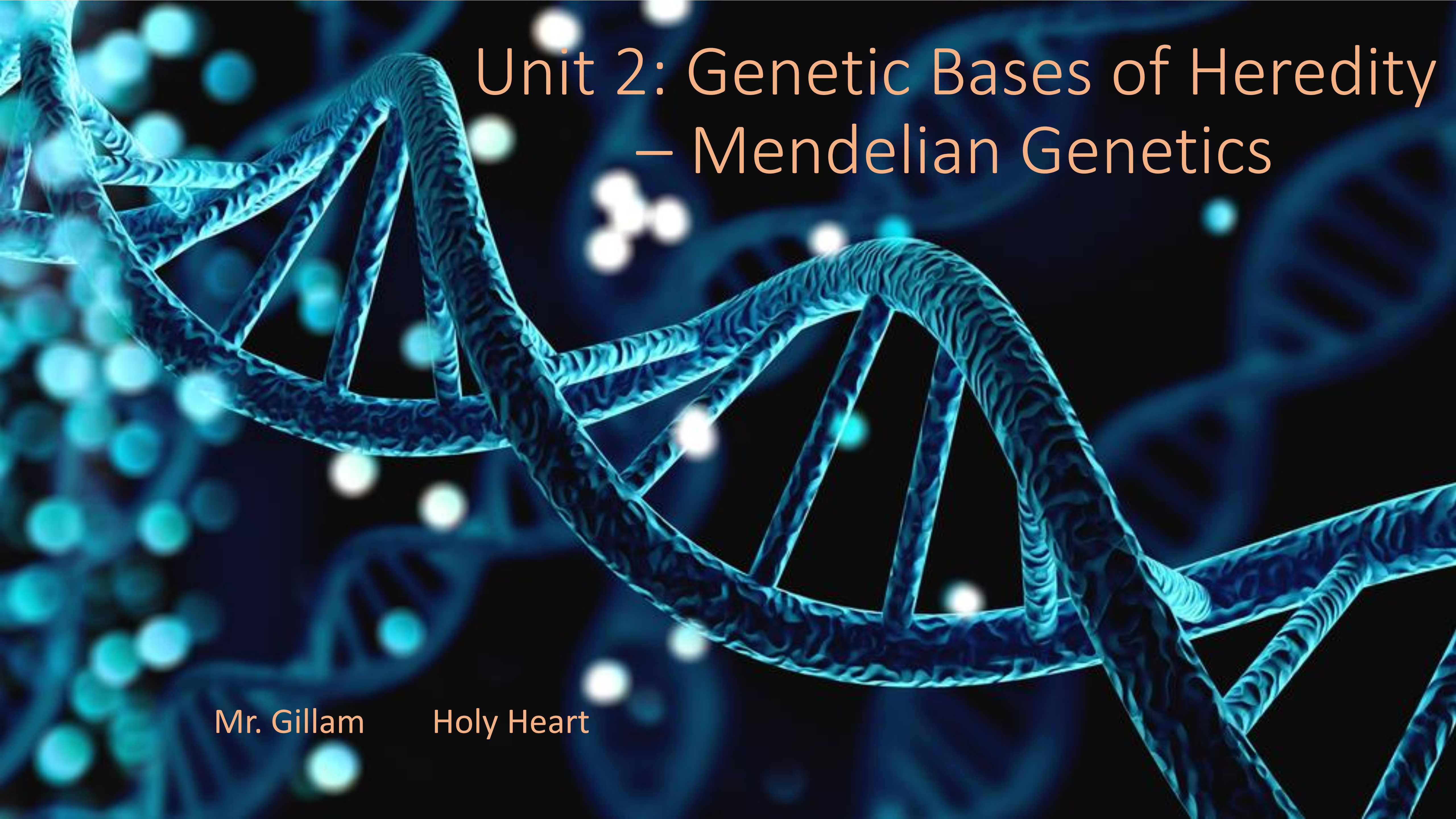
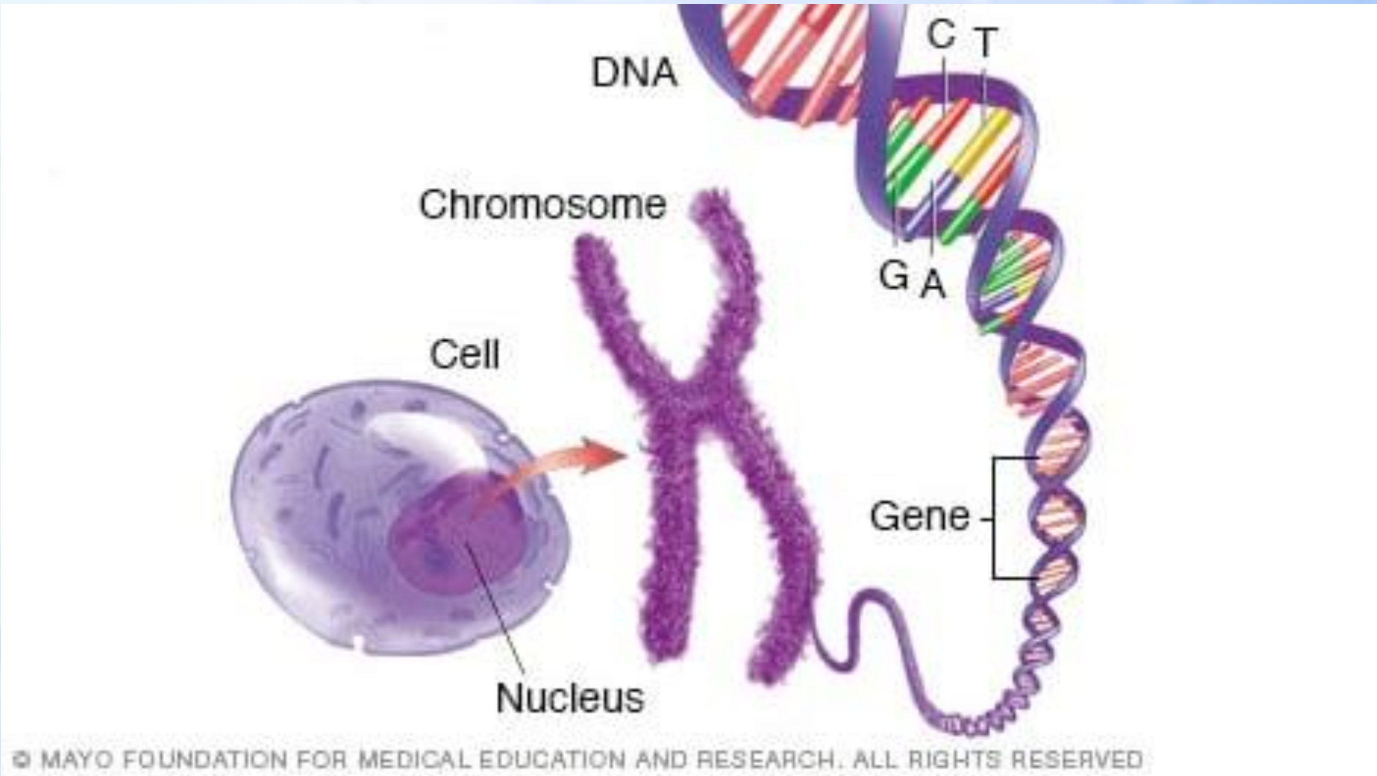


Unit 2: Genetic Bases of Heredity – Mendelian Genetics

Mr. Gillam Holy Heart

- **genetics** the study of heredity, or the passing of traits from parents to offspring



Historical Explanations of Inheritance

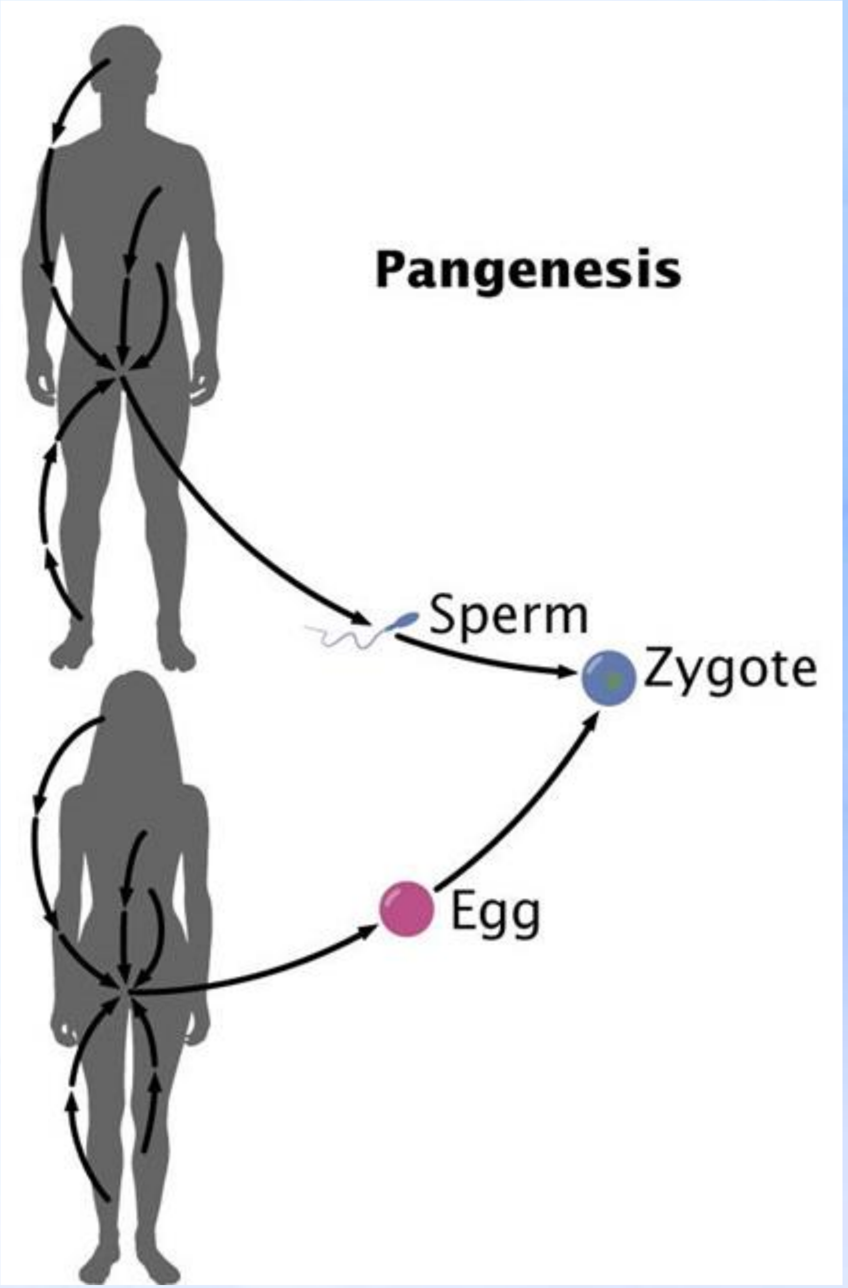
- Early experiments included breeding plants and animals in specific ways to produce offspring with desirable characteristics.
- Canines, such as the Eurasian wolf (*Canis lupus lupus*), humans have used special breeding practices to gradually develop breeds of dogs with specific attributes.

Patterns of Inheritance

Eurasian wolf (*Canis lupus lupus*) | Great Pyrenees (*Canis familiaris*) | Newfoundland (*Canis familiaris*) | Labrador retriever (*Canis familiaris*)

Figure 14.1 The Great Pyrenees is one of the oldest known dog breeds, bred several thousand years ago to protect sheep herds from wolves and bears. With its partially webbed feet, the Newfoundland is a powerful swimmer, famous for water rescues as well as a sweet, gentle temperament. With its short, dense, water-resistant coat, the Labrador retriever was developed to retrieve ducks and fish. Its playfulness makes it one of the most popular dog breeds worldwide.

- The Greek philosopher Aristotle (384–322 B.C.E.) proposed the first widely accepted theory of inheritance, called *pangenesis*.
- According to this theory, egg and sperm consist of particles, called pangenes, from all parts of the body.
- Upon fertilization of the egg by a sperm, the pangenes develop into the parts of the body from which they were derived.



- In 1677, the amateur scientist Antony van Leeuwenhoek (1632–1723) discovered living sperm in semen with his exquisitely designed single-lens microscopes.

- He believed that he saw a complete miniature person, called a homunculus, in the head of sperm.

- Leeuwenhoek believed that the homunculus came from the father but developed in the mother.

- During the 1800s, when the breeding of ornamental plants was becoming popular, scientists observed that the offspring had characteristics of *both* parent plants.
- The idea of blending became the working theory of inheritance. Scientists believed that characteristics of the parents blended in the offspring in a way that was irreversible. In other words, scientists believed that the original parental characteristics would not reappear in future generations.
- None of the explanations of inheritance proposed prior to the 1850s stood the test of time.

Developing a Theory of Inheritance: Gregor Mendel's Experiments

- The work of a monk and teacher named **Gregor Mendel** (1822–1884) laid the foundation for the field of genetics, the science of inheritance.
- Between the years 1856 and 1863, Mendel bred, tended, and analyzed over **28 000 pea plants** in the monastery garden. He observed many different traits, or characteristics.

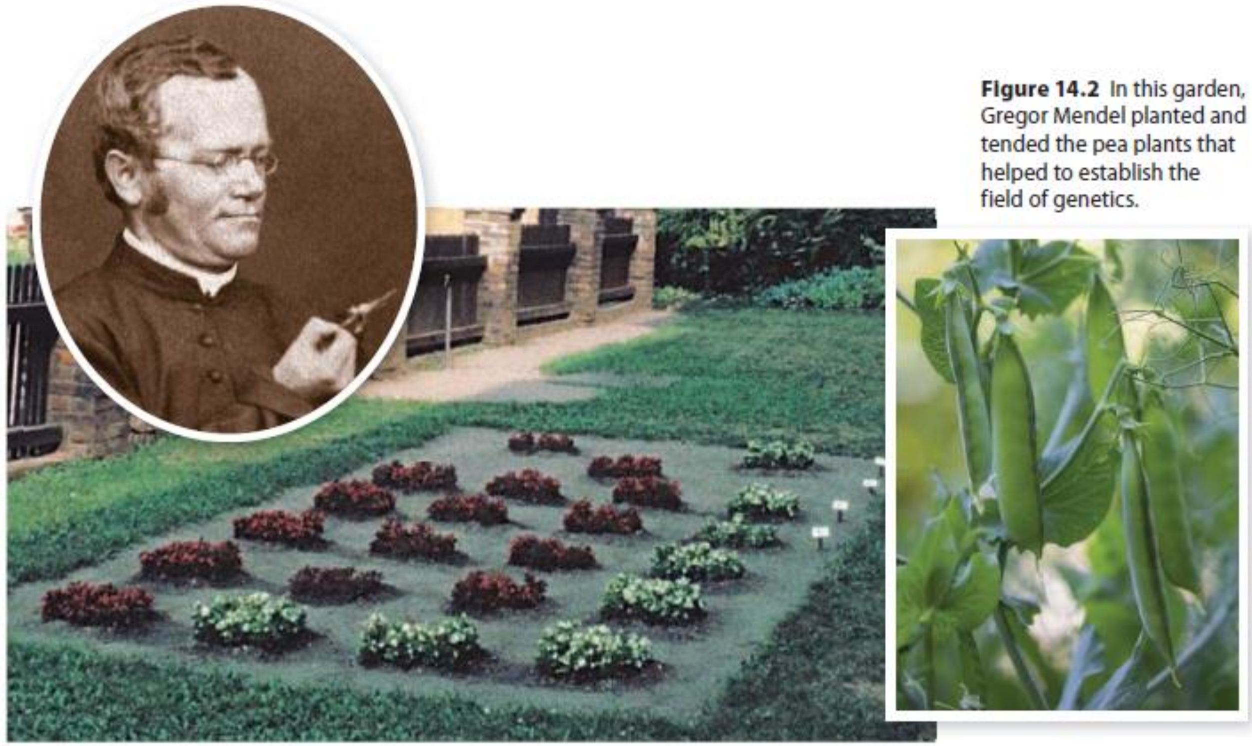
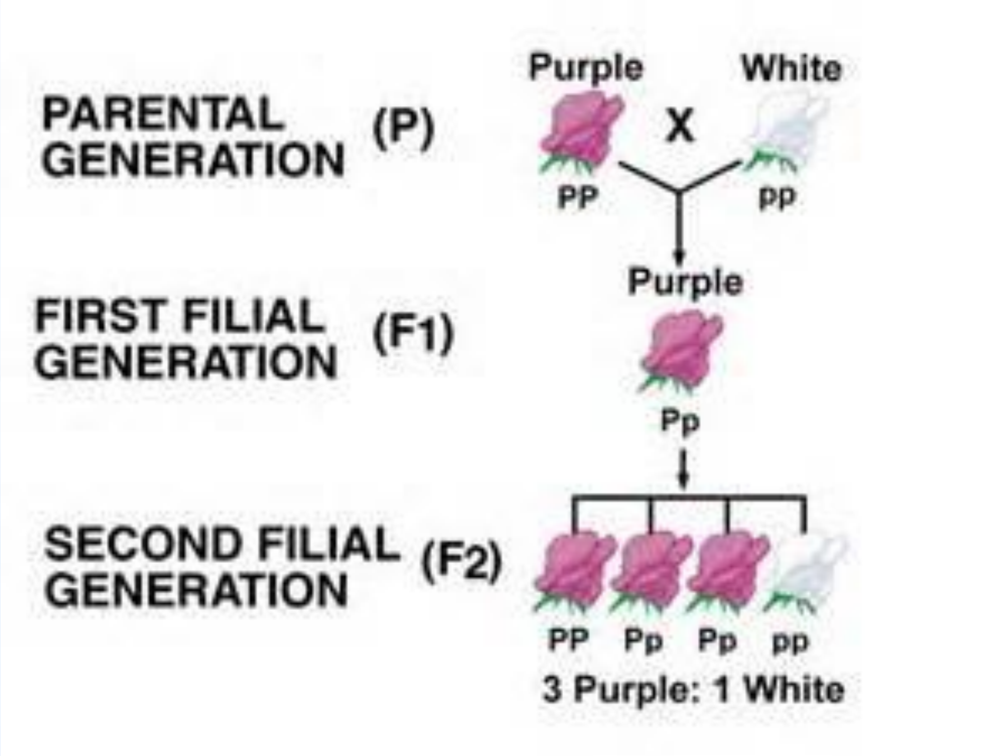


Figure 14.2 In this garden, Gregor Mendel planted and tended the pea plants that helped to establish the field of genetics.

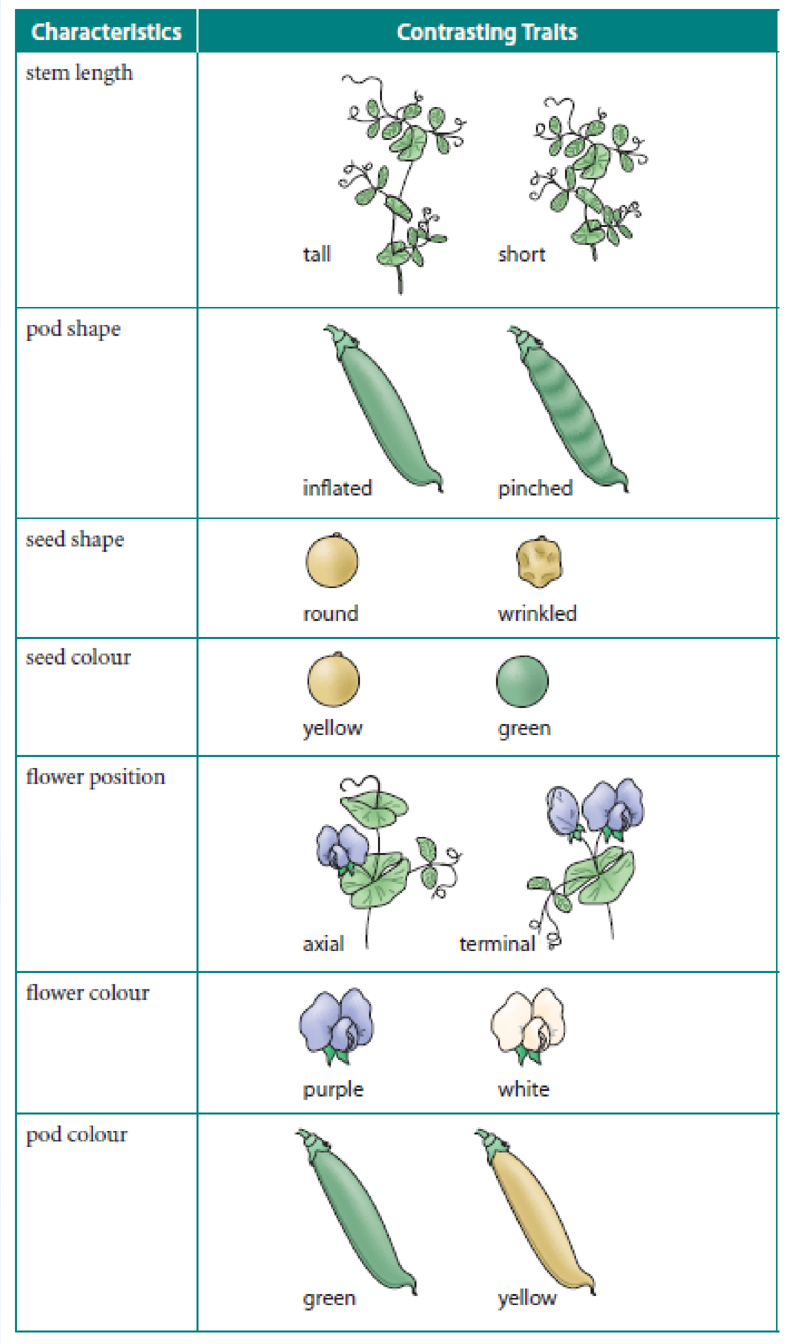
- Before doing any experiments, Mendel let the plants self-pollinate to ensure that they were true-breeding.
- True-breeding plants exhibit the same characteristics generation after generation.
- He crossed true breeding purple flowers with true breeding white flowers **(Parent generation).**
- Then he crossed their offspring **(F_1 generation)** with each other to create a new set of offspring **(F_2 generation)**
- **P generation** parent generation
- **F_1 generation** first filial
- **F_2 generation** second filial



Mendel's Peas

- Mendel studied seven **traits** that were expressed in two forms.
- Mendel observed that, for every trait, the F1 plants showed only one of the two parental characteristics.
- In the **cross between plants with round seeds and plants with wrinkled seeds,** all the seeds in the F1 generation were **round**. Although all the F1 plants had a copy of each form of the factor for seed shape, only one form was shown, or expressed.

- **Why?**

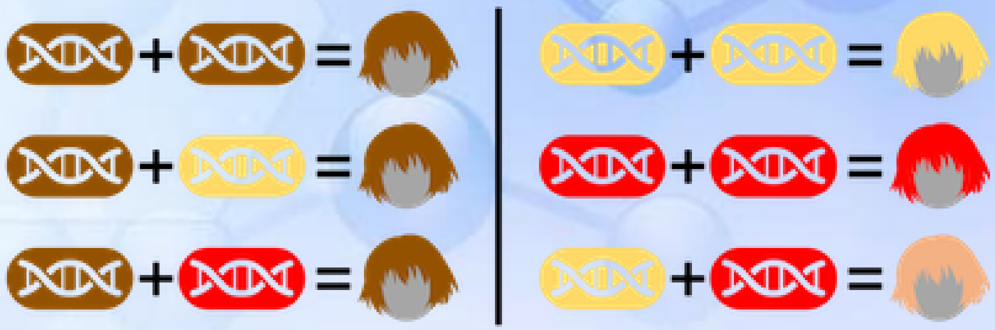


Characteristics	Contrasting Traits	
stem length	tall	short
pod shape	inflated	pinched
seed shape	round	wrinkled
seed colour	yellow	green
flower position	axial	terminal
flower colour	purple	white
pod colour	green	yellow

- **complete dominance** inheritance whereby dominant trait (or allele) conceals presence of recessive trait (or allele)
- **dominant** trait (or allele) expressed when present.
- **recessive** trait (or allele) not expressed when the dominant form is present

Gene	The set of information that controls a trait
Alleles	The different forms of a gene
Dominant Allele	An allele whose trait always shows up in the organism when the allele is present
Recessive Allele	The allele that is masked when a dominant allele is present
Hybrid	An organism that has two different alleles for a trait

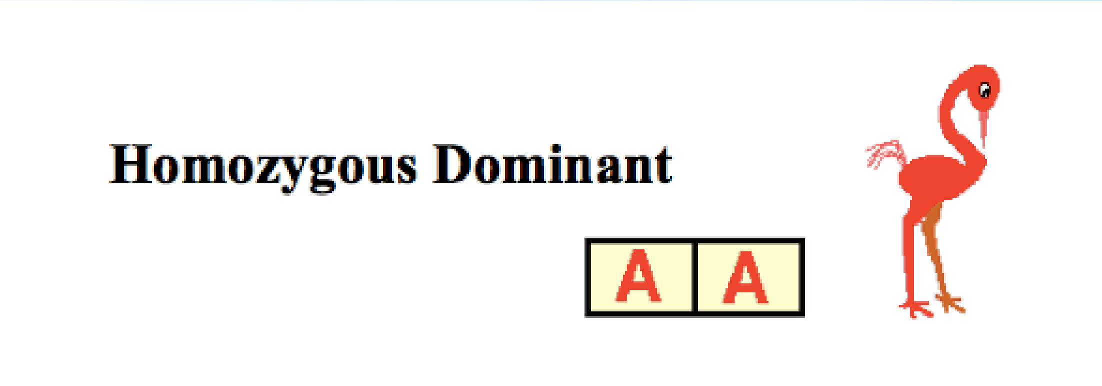
- A **gene** is a portion of DNA that determines a certain trait. Genes are responsible for the expression of traits.
- An **allele** is a specific form of a gene. Alleles are responsible for the variations in which a given trait can be expressed.

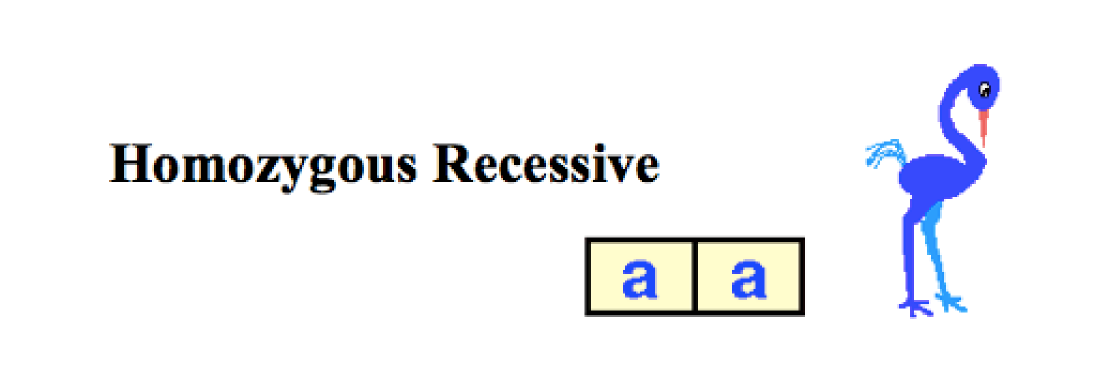


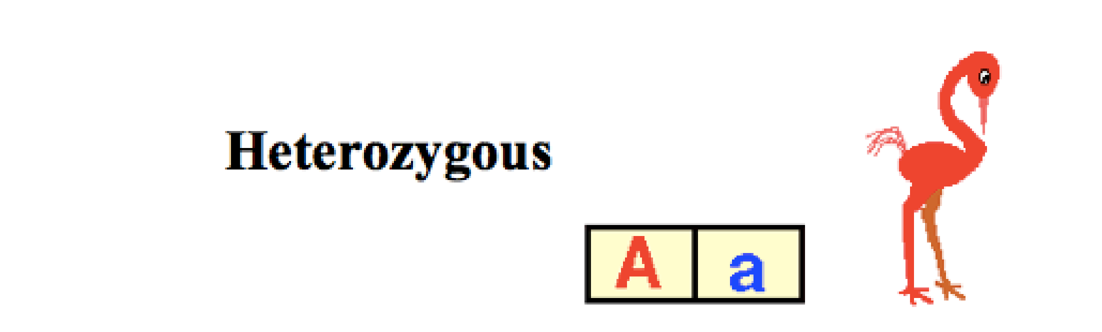
- **genotype** combination of alleles for a trait (what the actual genetics/alleles are)
- Genotype can be written various ways. (e.g., *Rr*, R_1R_2, *RR′*, *RW*, I^AI^B).

- **homozygous** individual with identical alleles for a trait
  - **Homozygous dominant** having two dominant alleles (BB)
  - **Homozygous recessive** having two recessive alleles (bb)

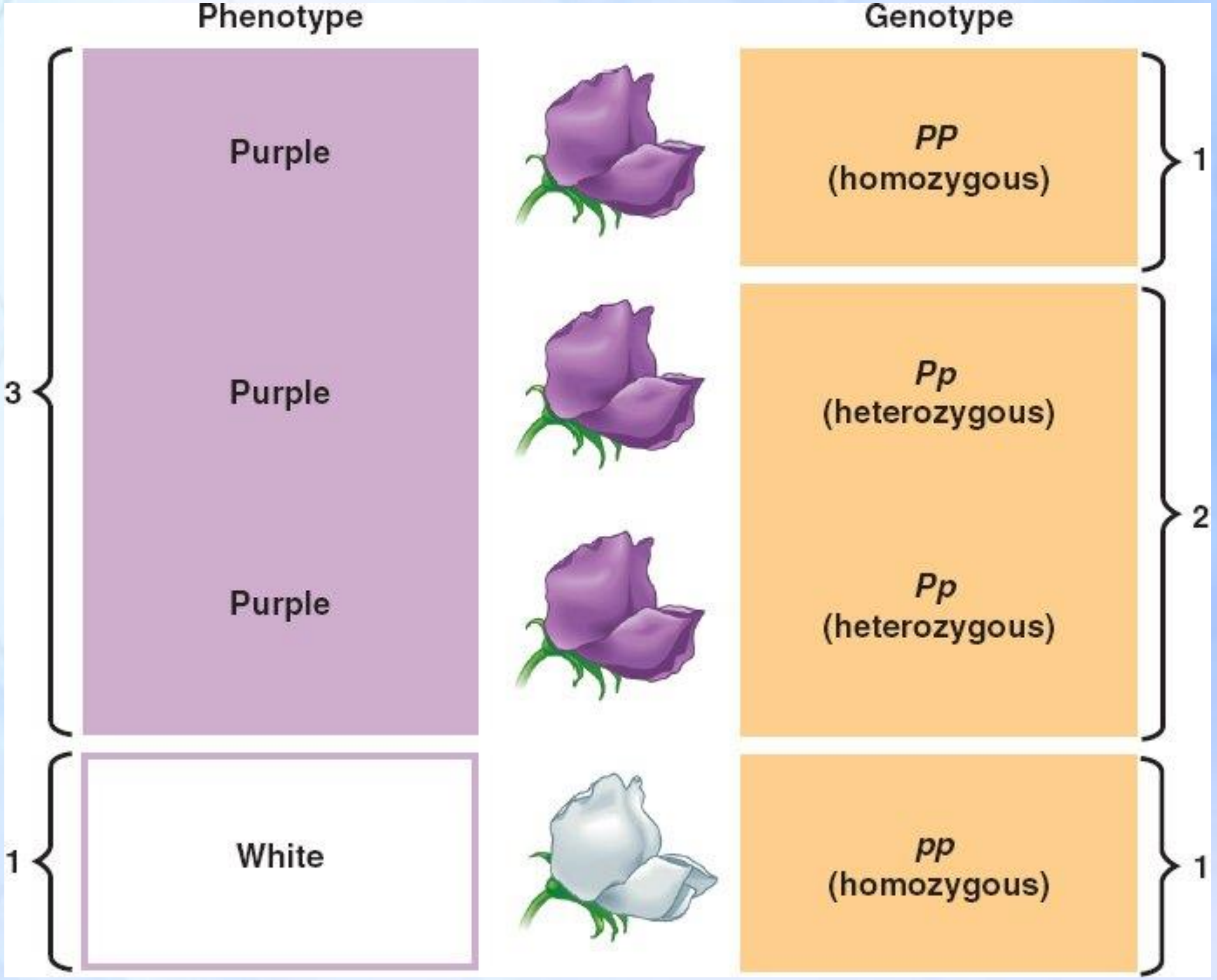
- **heterozygous** individual with different alleles for a trait





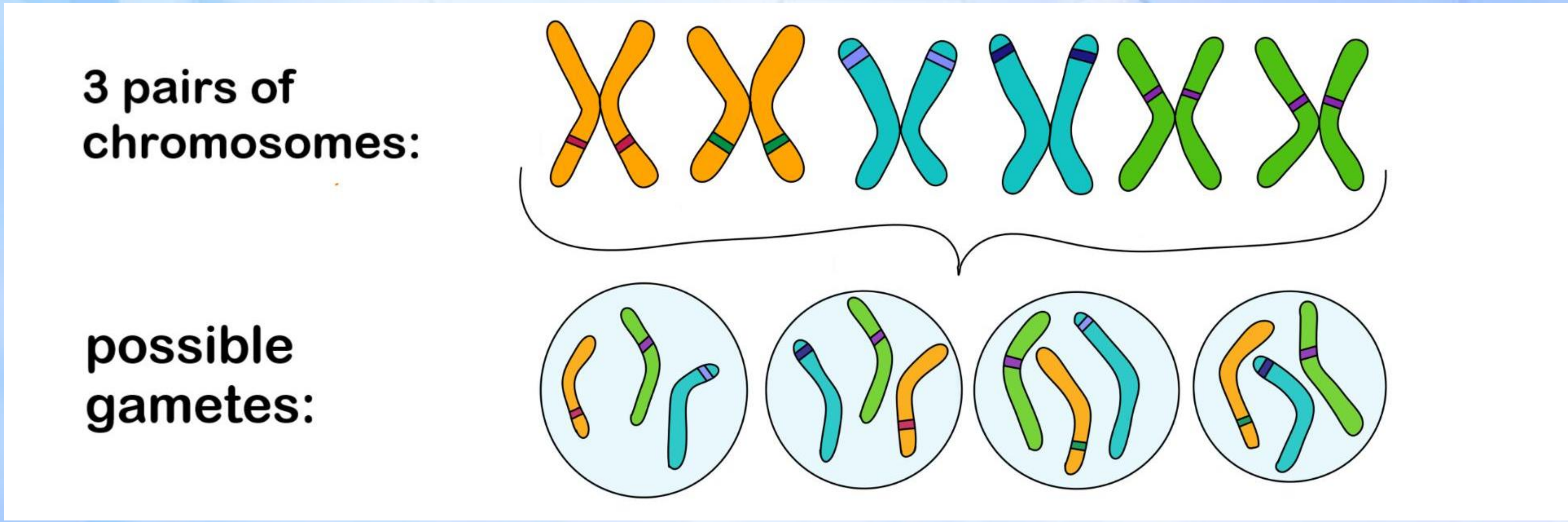


❖**phenotype** visible expression of a trait (what you see)

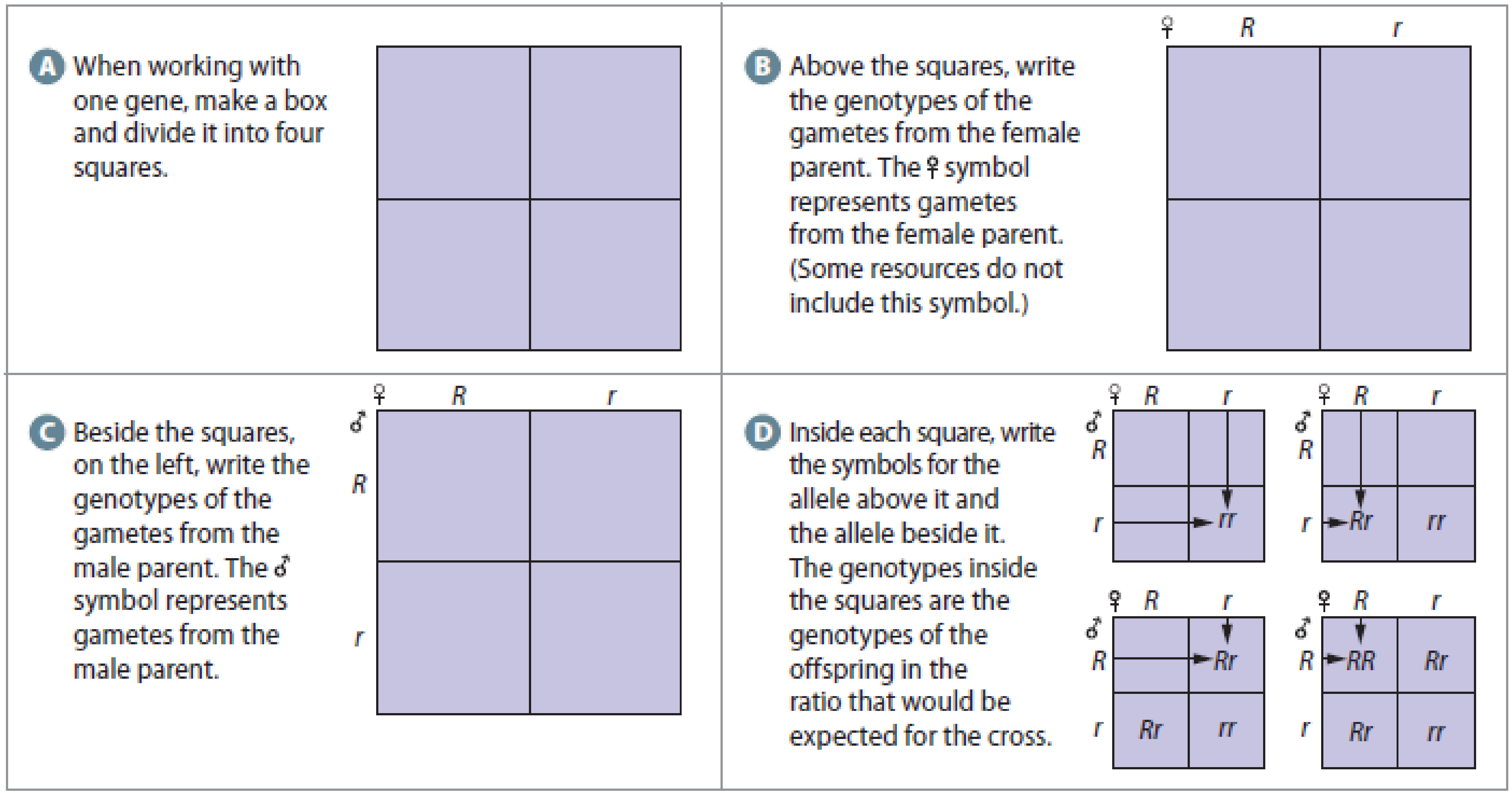


Mendel's First Law

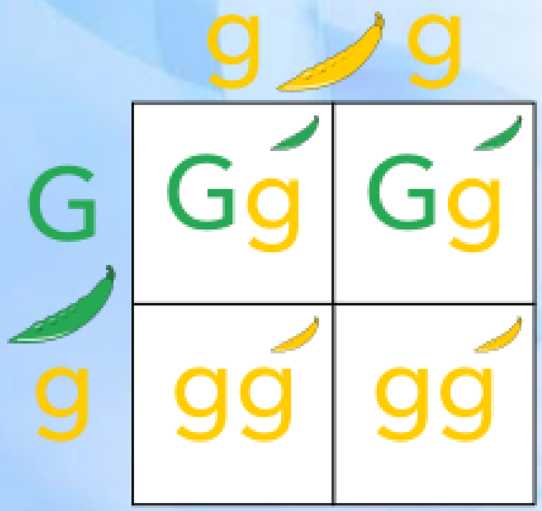
- **The Law of Segregation**
- All individuals have two copies of each factor.
- These copies segregate (separate) randomly during gamete formation, and each gamete receives one copy of every factor.
- **law of segregation** an inherited trait is determined by pairs of factors (alleles) that segregate so that each gamete contains one copy



❖**Punnett square** grid showing possible results of genetic crosses



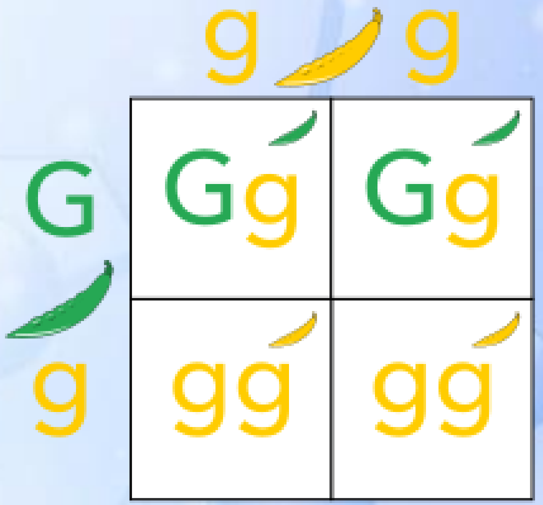
- **Genotypic ratio** describes the number of times a genotype would appear in the offspring after a cross.



Genotypic Ratio
2 Gg : 2 gg
50% Gg : 50% gg

❖ **Phenotypic ratio** pertains to the relative number of offspring manifesting a particular trait or combination of traits. It can be determined by doing a cross and identifying the frequency of a trait or trait combinations that will be expressed based on the genotypes of the offspring.

Remember the capital letter G is dominant so if it is present, the colour will be Green.



Phenotypic Ratio
2 Green : 2 Yellow
50% Green: 50% Yellow

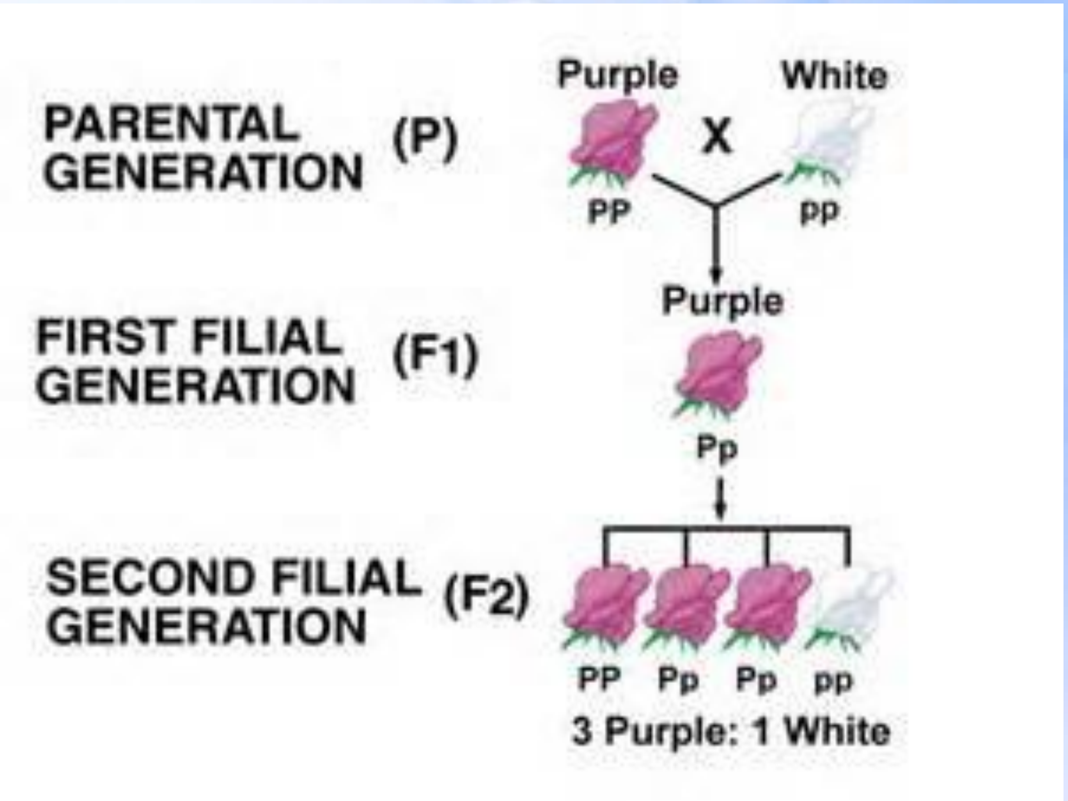
Investigation 14.A

- Modelling a Monohybrid Cross

Mendel's Monohybrid cross

- **monohybrid cross** cross between individuals that differ in one trait. They are both homozygous, one is dominant and the other is recessive.

- All offspring in the F1 generation will be Heterozygous.
- The resulting F2 generation will have a
  - 1:2:1 Genotypic Ratio
  - 3:1 Phenotypic Ratio



One Trait Crosses

- In humans, black hair colour is completely dominant to red hair colour. If a homozygous black haired male has children with a homozygous red haired female, what are the genotypic and phenotypic ratios?

First write down the genotypes of the parents

Male: BB
Female: bb

Male is BB (all capitals) because it is homozygous dominant
Female is bb (all small letters) because it is homozygous recessive

Now we draw a Punnett square and write the possible gametes for the female on top and the male on the left side.

Now we complete the table, capitals always go in front

♂ \ ♀	b	b
B	Bb	Bb
B	Bb	Bb

Genotypic Ratio: 4 Bb
Phenotypic Ratio: 4 Black Hair

One Trait Crosses

- In humans, black hair colour is completely dominant to red hair colour. If a heterozygous black haired male has children with a homozygous red haired female, what are the genotypic and phenotypic ratios?

First write down the genotypes of the parents

Male: Bb
Female: bb

Male is Bb because it is heterozygous
Female is bb (all small letters) because it is homozygous recessive

Now we draw a Punnett square and write the possible gametes for the female on top and the male on the left side.

Now we complete the table, capitals always go in front

♂ \ ♀	b	b
B	Bb	Bb
b	bb	bb

Genotypic Ratio: 2 Bb : 2 bb
Phenotypic Ratio: 2 Black Hair : 2 Red Hair

One Trait Crosses

- In humans, black hair colour is completely dominant to red hair colour. If a heterozygous black haired male has children with a heterozygous black haired female, what are the genotypic and phenotypic ratios?

First write down the genotypes of the parents

Male: Bb
Female: Bb

Male is Bb because it is heterozygous
Female is Bb because it is heterozygous

Now we draw a Punnett square and write the possible gametes for the female on top and the male on the left side.

♂ \ ♀	B	b
B	BB	Bb
b	Bb	bb

Now we complete the table, capitals always go in front

Genotypic Ratio: 1 BB : 2 Bb : 1 bb
Phenotypic Ratio: 3 Black Hair : 1 Red Hair

Somewhat Harder One Trait Crosses

- In pea plants green seeds are dominant to yellow seeds. If a heterozygous plant is crossed with a homozygous recessive plant, what percent of the offspring will be yellow?

Parent 1: Gg
Parent 2: gg

	G	g
g	Gg	gg
g	Gg	gg

50% of the offspring will be yellow

Somewhat Harder One Trait Crosses

- In pea plants green seeds are dominant to yellow seeds. If a heterozygous plant is crossed with another heterozygous pea plant, what percent of the offspring will have the same genotype as the parents?

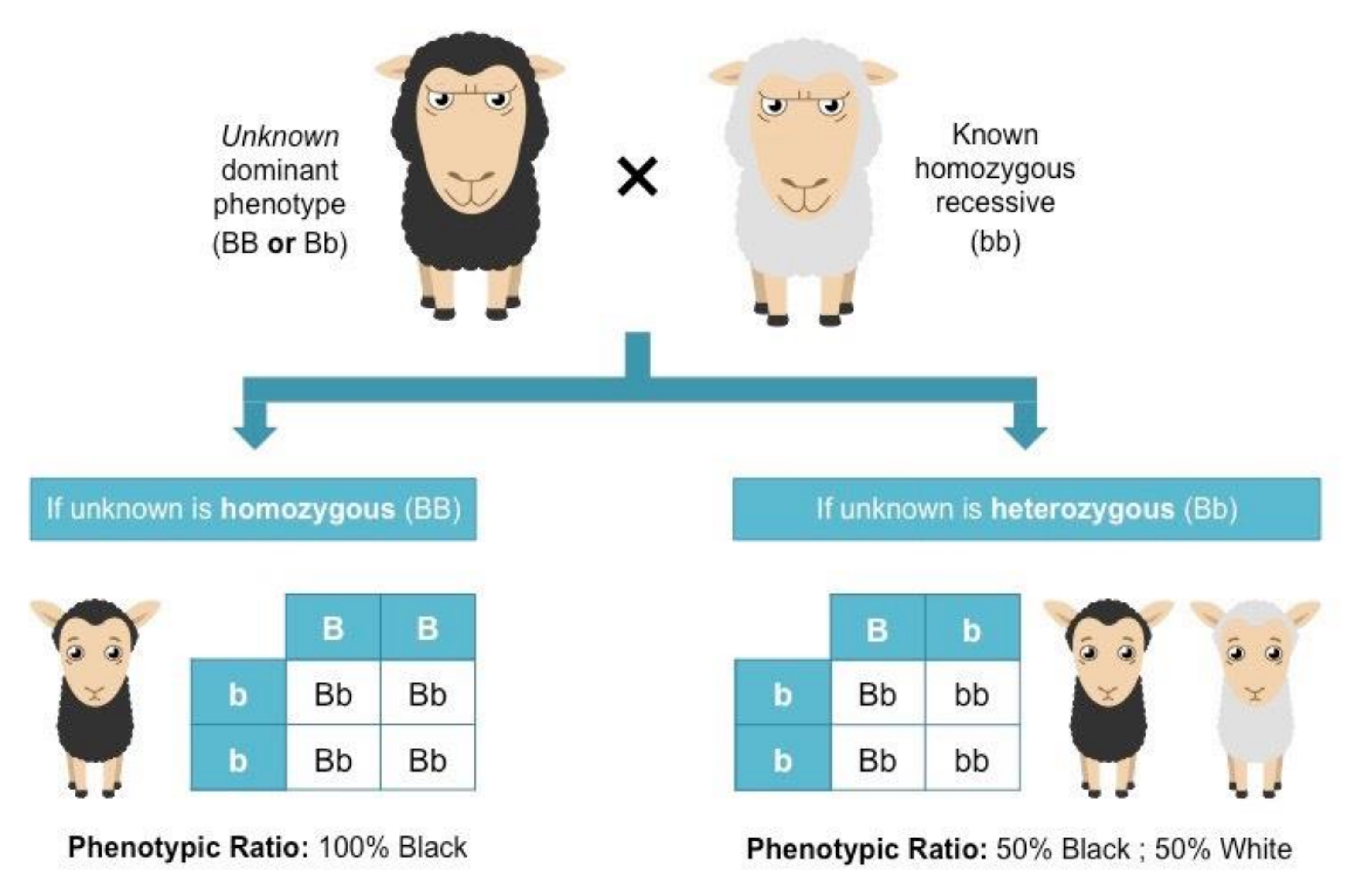
Parent 1: Gg
Parent 2: Gg

	G	g
G	GG	Gg
g	Gg	gg

50% of the offspring will be Gg (same as the parents)

Test Cross

- **test cross** cross between homozygous recessive individual and an individual with unknown genotype
- You can use Punnett squares to predict the genotypes and phenotypes of the offspring of the test crosses.



Much Harder One Trait Cross Questions

- If tallness is a dominant trait of pea plants, what are the genotypes of two pea plants that produce 146 tall and 52 short plants when mated?

The first thing we do in a question like this is calculate percent's.

146 tall/198 in total = 73.7% = 75%
52 short/ 198 in total = 26.3% = 25%

Always round percent's to 25%, 50%, and 75%, in single trait crosses when given this type of question

Now make a Punnett Square to represent the information

We will use T for tall and t for short

tt (short) has to be 25% so we will put that in the bottom right corner, 1 out of 4 blocks.

This means that both parents have a recessive allele so we write that on the Punnett Square and fill in the other small t's that have to be present in the other two boxes

Since 75% were tall and it is dominant the other three boxes must have at least one big T so we can write those in.

Now we can finally write the parents alleles on the outside and complete the last box.

	T	t
T	TT	T t
t	Tt	tt

The parents are Tt, Tt

Much Harder One Trait Cross Questions

- If tallness is a dominant trait of pea plants, what are the genotypes of two pea plants that produce 153 tall and 144 short plants when mated?

The first thing we do in a question like this is calculate percent's.

153 tall/297 in total = 51.5% = 50%
144 short/ 297 in total = 48.5% = 50%

Always round percent's to 25%, 50%, and 75%, in single trait crosses when given this type of question

Now make a Punnett Square to represent the information

We will use T for tall and t for short

tt (short) has to be 50% so we will put that in the bottom two boxes

This means that both parents have a recessive allele so we write that on the Punnett Square and fill in the other small t that has to be present in the other box

Since 50% were tall and it is dominant the other two boxes must have at least one big T so we can write those in.

Now we can finally write the parents alleles on the outside and complete the last box.

The parents are Tt, tt

	t	t
T	Tt	T t
t	tt	tt

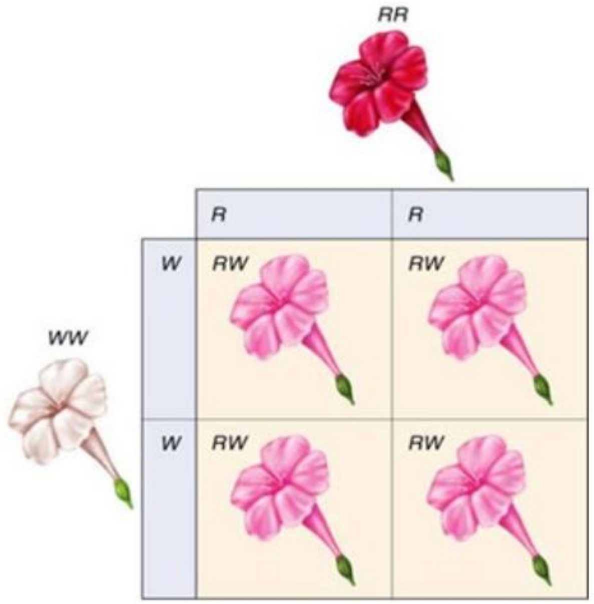
Activity 14.1 Working With Punnett Squares

Exit Card #1

Incomplete Dominance

- **incomplete dominance** neither allele for the same gene conceals the presence of the other – blending of the two traits
- When representing incomplete dominance, upper-case and lower-case letters are not generally used to represent the alleles.
- Some geneticists use all upper-case letters, with subscripts to denote the alleles.

- Don't forger about different notations for alleles *R_1R_2, RR', RW, C^RC^W* we will now start to see it appearing.



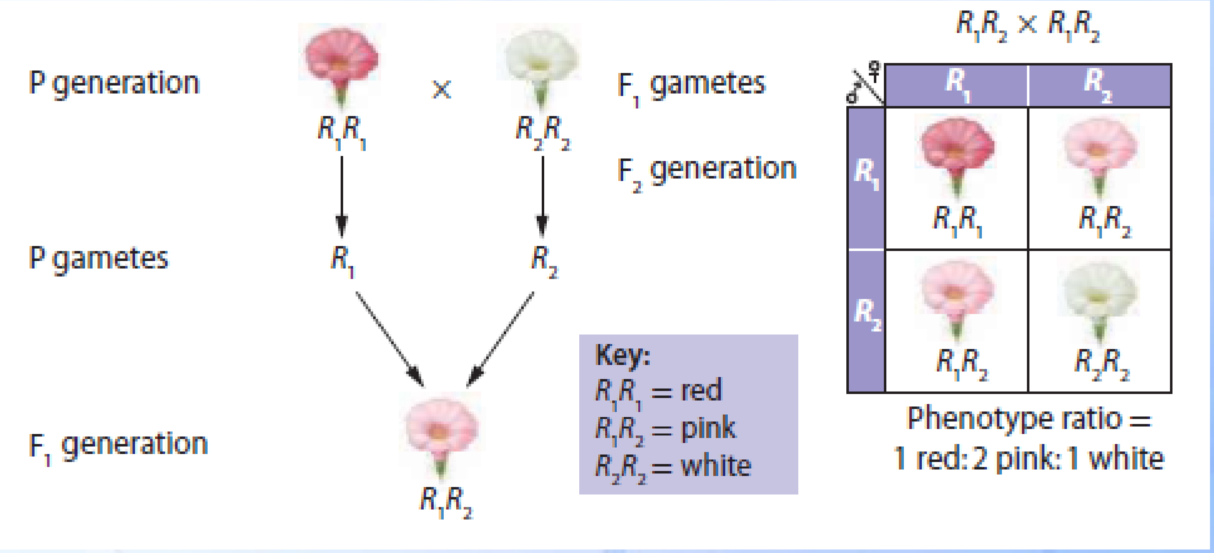
- Red= RR
- White= WW

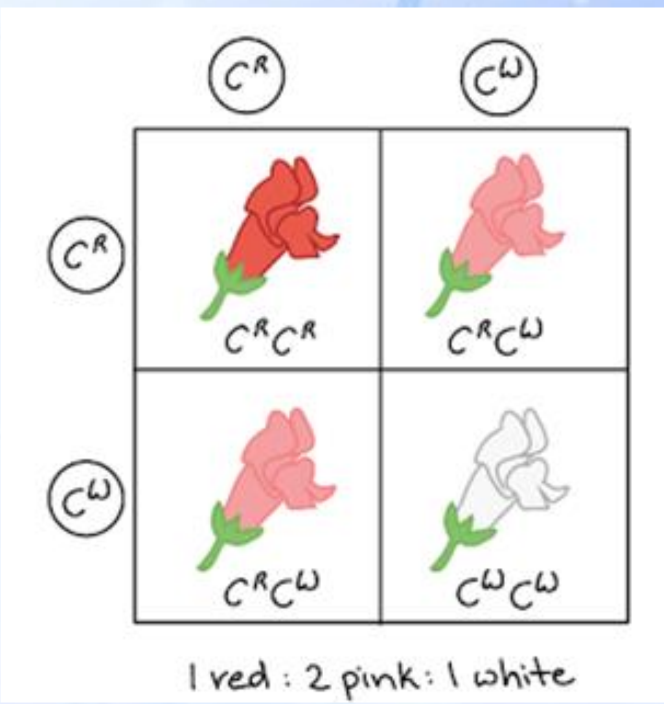
- RW= pink- each allele is equally expressed to result in a blended product

Incomplete Dominance

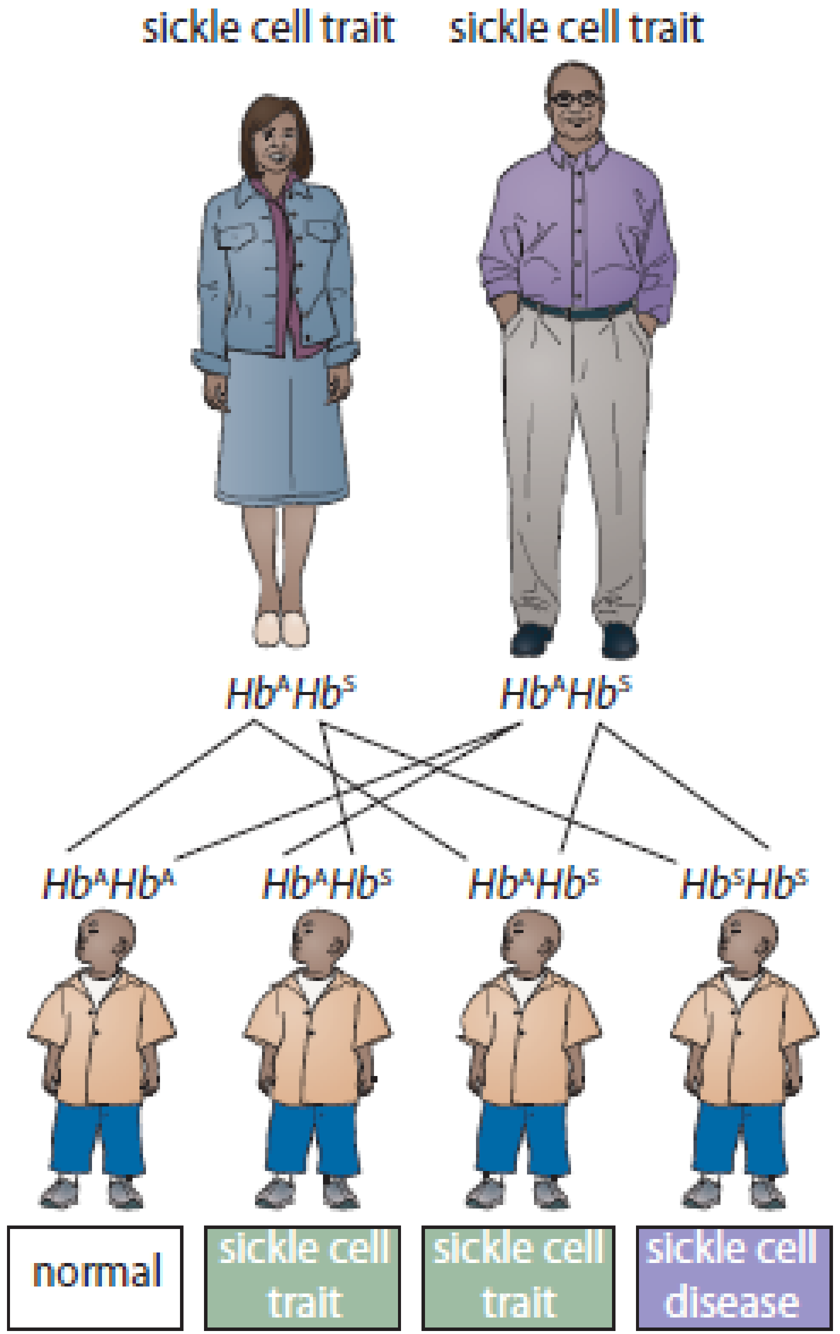
- The allele for red flowers in the four o’clock plant directs the synthesis of red pigment.

- When only one allele is present, the flower cannot make enough pigment to make the flowers red, resulting in incomplete dominance (pink flowers).





- The allele for normal hemoglobin is represented as Hb^A, and the allele for sickle cell hemoglobin is represented as Hb^S.
- Individuals who are homozygous ($Hb^S Hb^S$) have sickle cell disease.



♂ \ ♀	Hb^A	Hb^S
Hb^A	$Hb^A Hb^A$	$Hb^A Hb^S$
Hb^S	$Hb^A Hb^S$	$Hb^S Hb^S$

Figure 14.11 When a man and a woman are both heterozygous for the sickle cell gene, there is a one in four chance that they will have a child with sickle cell disease.

Incomplete Dominance

- In humans, hair is incompletely dominant. The combination of straight hair and curly hair produces wavy hair. What are the phenotypic and genotypic ratios if a male with pure straight hair has a child with a female with wavy hair?

First write down the genotypes you will be using, their meanings and the parent generation

H^S = Straight Hair

H^C = Curly Hair

Male: H^SH^S

Female: H^SH^C

Now we draw a Punnett square and write the possible gametes for the female on top and the male on the left side.

Now we complete the table

	H^S	H^C
H^S	H^SH^S	H^SH^C
H^S	H^SH^S	H^SH^C

Genotypic Ratio: 2 H^SH^S : 2 H^SH^C

Phenotypic Ratio: 2 Straight Hair: 2 Wavy Hair

Co-dominance

- **co-dominance** two alleles for a gene are expressed equally
- **The expressed trait is a combination of the phenotypes of both alleles for the gene.**
- A roan horse or cow is an excellent, visible example of co-dominance.
- A roan animal is a heterozygote in which both the base colour and white are fully expressed.
- If you look closely at the individual hairs on a blue roan you will see a mixture of black hairs and white hairs.
- One allele is expressed in the white hairs, and the other allele is expressed in the black hairs.
- A red roan has a mixture of chestnut-coloured hairs and white hairs.

- The roan colouring of a horse usually does not affect the head, mane, and tail.
- This horse’s body looks blue because black and white hairs are thoroughly mixed.
- A blue roan ($H^B H^W$) is the product of a mating between black ($H^B H^B$) and white ($H^W H^W$) parents.

Co-dominance

Now we draw a Punnett square and write the possible gametes for the female on top and the male on the left side.

- In Rhododendron Flowers, Flower colour is Co-dominant. The combination of a red allele and a white allele produces a red and white flower mix. What are the phenotypic and genotypic ratios if a red flower and a white flower plant are crossed?

First write down the genotypes you will be using, their meanings and the parent generation

R = Red Flower Allele

W = White Flower Allele

Flower 1: RR

Flower 2: WW

Now we complete the table

	W	W
R	RW	RW
R	RW	RW

Genotypic Ratio: 4 RW

Phenotypic Ratio: 4 Red and White Mixed Petals

Activity 14.3

- Analyzing Co-dominant and Incomplete Dominant Inheritance

- Exit Card #2

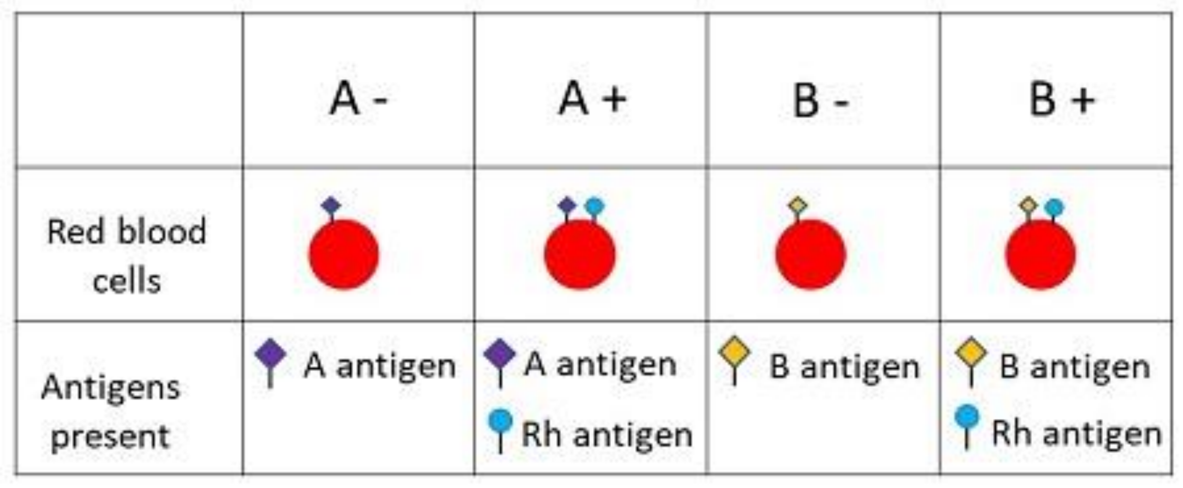
Multiple Alleles (A type of Co-dominance)

- **Multiple alleles** refer to the occurrence of a gene with more than two alleles for a particular gene.
- In humans, a single gene determines a person's ABO blood type.
- This gene determines the type of antigen, if any, that is attached to the cell membrane of red blood cells.
- The gene is designated I, and it has three common alleles: I^A, I^B, and i.

Table 14.2 ABO Blood Types

Genotype	Phenotype	Antigen
ii	O	none
$I^A i$	A	A
$I^A I^A$	A	A
$I^B i$	B	B
$I^B I^B$	B	B
$I^A I^B$	AB	A and B

- **Rh factor,** also called **Rhesus factor**, is a type of protein found on the outside of red blood cells.
- The protein is genetically inherited (passed down from your parents).
- If you have the protein, you are Rh-positive.
- If you did not inherit the protein, you are Rh-negative. The majority of people, about 85%, are Rh-positive.



	A -	A +	B -	B +
Red blood cells				
Antigens present	A antigen	A antigen Rh antigen	B antigen	B antigen Rh antigen

- If you have the A and Rh antigens, your blood type is A-positive (A+).
- If your blood has the B antigen but not the Rh antigen, your blood type is B-negative (B–).
- Rh blood type is even more important for pregnant women.

Multiple Alleles

- What is the probability that a man who has heterozygous type A blood and a woman who has heterozygous type B blood will have a child with type O blood?
- What are the genotypic and phenotypic ratios?

First write down the genotypes of the parents.

Man = I^Ai

Woman = I^Bi

Now we draw a Punnett square and write the possible gametes for the female on top and the male on the left side.

Now we complete the table

	I^B	i
I^A	I^AI^B	I^Ai
i	I^Bi	ii

25% chance of type O blood (ii)

Genotypic Ratio: 1 I^AI^B : 1 I^Bi : 1 I^Ai : 1 ii

Phenotypic Ratio: 25% Type AB Blood, 25% Type B Blood, 25% Type A Blood, 25% Type O Blood

Multiple Alleles

- What is the probability that a man who has homozygous type A+ blood and a woman who has heterozygous type B- blood will have a child with type A+ blood?
- Simplified (we will see the complex version soon)

First write down the genotypes of the parents.

Man = $I^{A+}I^{A+}$
Woman = $I^{B-}i$

Now we draw a Punnett square and write the possible gametes for the female on top and the male on the left side.

Now we complete the table

	I^{B-}	i
I^{A+}	$I^{A+}I^{B-}$	$I^{A+}i$
I^{A+}	$I^{A+}I^{B-}$	$I^{A+}i$

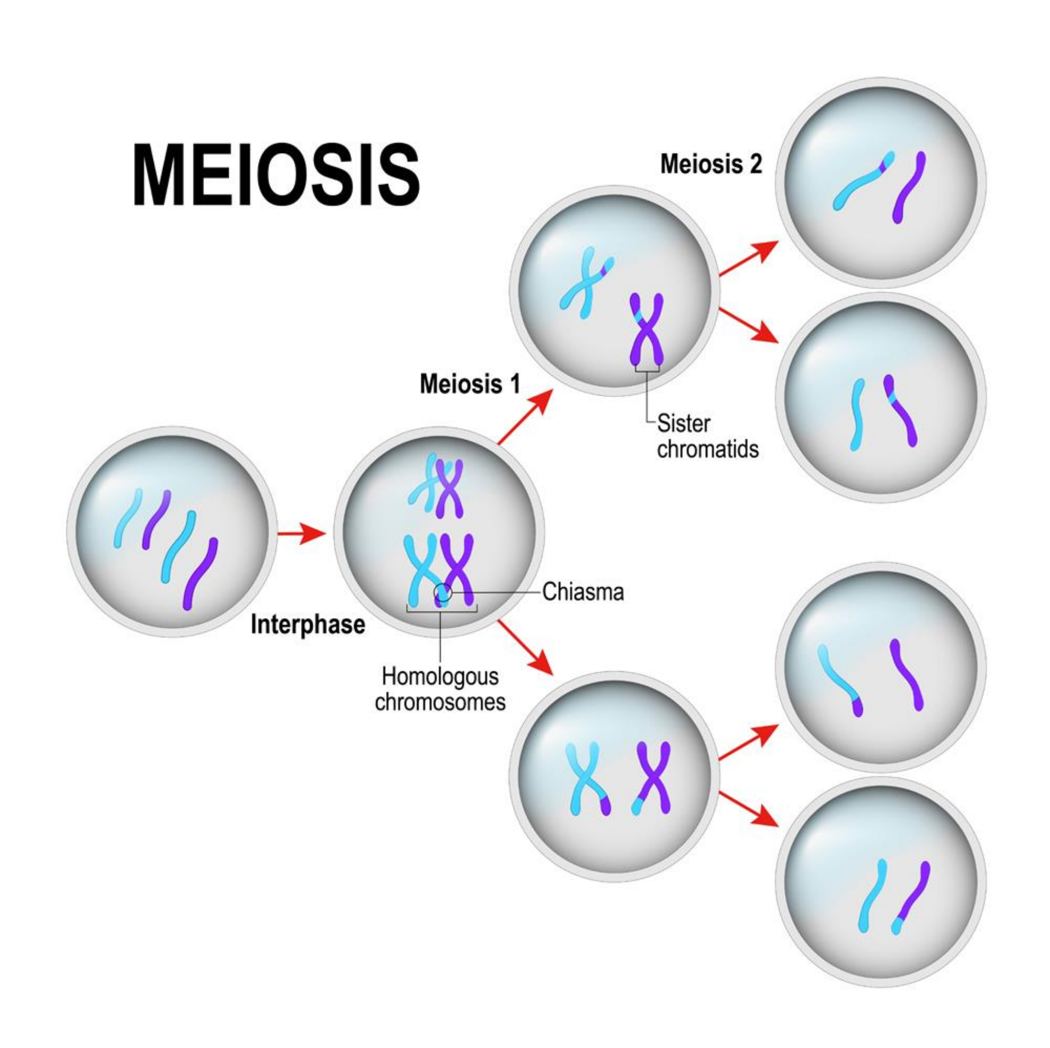
50% chance of type A+ blood

- Exit Card #3

Mendel's Second Law

- **law of independent assortment** two alleles for a gene assort independently of alleles for other genes during gamete formation (not always true)

- If genes are located close to each other during crossing over in meiosis, they often move together.



Two Trait Crosses

- A cross that involved two different traits which each have their own pair of alleles

- For example Mendel compared the shape of seeds, round (R) vs wrinkled (r) and colour, green (y) vs yellow (Y) at the same time.

- 4x4 = 16 boxes
- However you will not always need to do 16, a lot the time it will be 4 or 8

	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

Two Trait Crosses

- In rabbits, gray hair is dominant to white hair and , black eyes are dominant to red eyes. What is the phenotypic and genotypic ratio between a male rabbit with homozygous gray hair and red eyes and a rabbit with heterozygous gray hair and heterozygous black eyes?

Create a label key and the parents

G = Gray hair
g = white hair
B = Black eyes
b = red eyes

Now use the distributive property from math to make all possible combinations for the gametes

Cross out any duplicates

No duplicates

Now create a table and do the cross.

Parents

Male: GGbb

Gb ~~Gb~~ ~~Gb~~ ~~Gb~~

Female: GgBb

GB Gb gB gb

	GB	Gb	gB	gb
Gb	GGBb	GGbb	GgBb	Ggbb

Genotypic Ratio: 1GGBb : 1 GGbb : 1 GgBb : 1 Ggbb

Phenotypic Ratio: 50% Gray Black eyes : 50% Gray Red Eyes

Two Trait Crosses

B = Barbed
b = smooth
N = Non-resistance
n = resistance

- An aquatic arthropod called a Cyclops has antennae that are either smooth or barbed. The allele for barbs (B) is dominant over smooth (bb). In the same organism Non-resistance to pesticides (N) is dominant over resistance to pesticides (nn). A Cyclops that is resistant to pesticides and has heterozygous barbed antennae is crossed with one that is smooth and heterozygous for Non-resistance. What is the chance of an offspring that is heterozygous for both traits?

Parents

Cyclops 1: Bbnn

Bn ~~Bn~~ bn ~~bn~~

Cyclops 2: bbNn

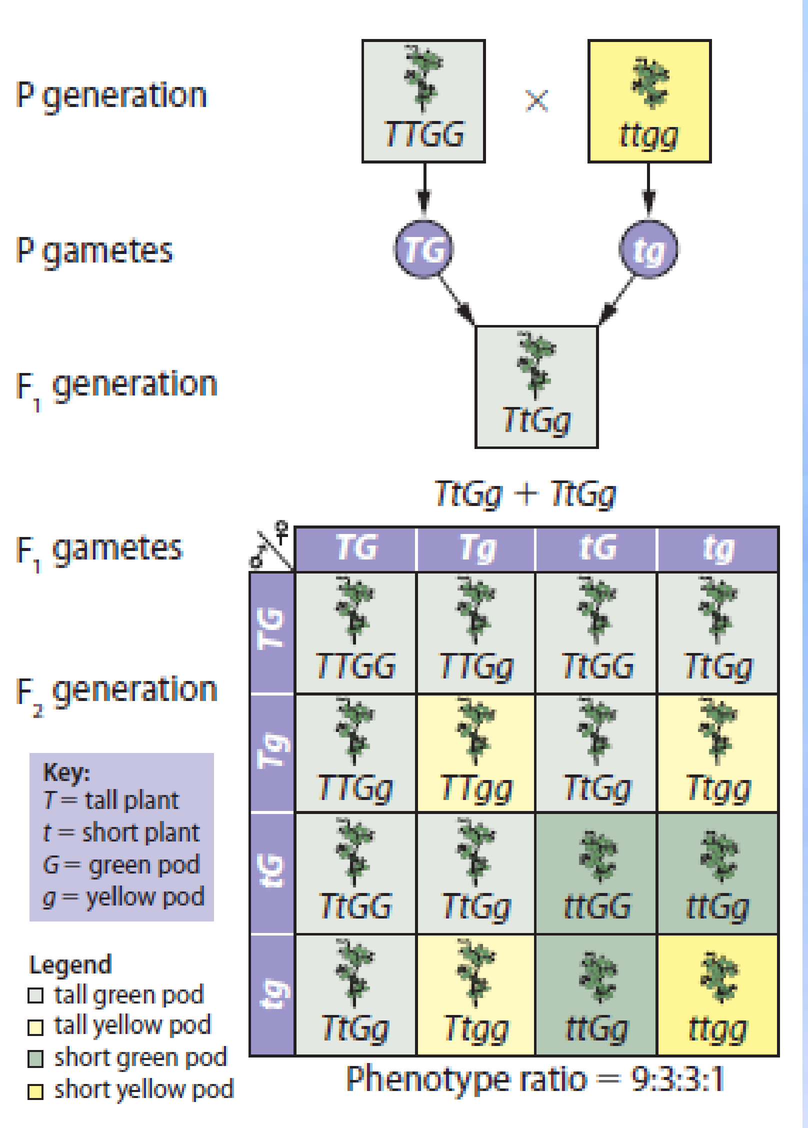
bN bn ~~bN~~ ~~bn~~

	bN	bn
Bn	BbNn	Bbnn
bn	bbNn	bbnn

There is a 25% chance of having offspring that are heterozygous for both traits (BbNn)

Mendel’s Dihybrid Cross

- **dihybrid cross** cross between individuals that differ in two traits
- Mendel crossed plants that were true-breeding for two different traits with plants that were **true-breeding** for the **opposite** form of the **same two traits**.
- Mendel crossed **true-breeding tall plants that had green pods (TTGG)** with **true-breeding short plants that had yellow pods (ttgg).**
- This produced an **F1 generation** of plants that were all heterozygous for both traits **(TtGg).**
- Mendel allowed the **F1 plants to self-pollinate** and then **analyzed** the traits of the **F2 plants**.
- The cross **TtGg × TtGg** produced F2 plants with the phenotypes of tall with green pods, tall with yellow pods, short with green pods, and short with yellow pods in a ratio of **9:3:3:1**. Phenotypic Ratio
- For **every dihybrid** cross that Mendel carried out and analyzed, he found the same pattern in the F2 generation.



Activity 14.2

- Analyzing a Dihybrid Cross

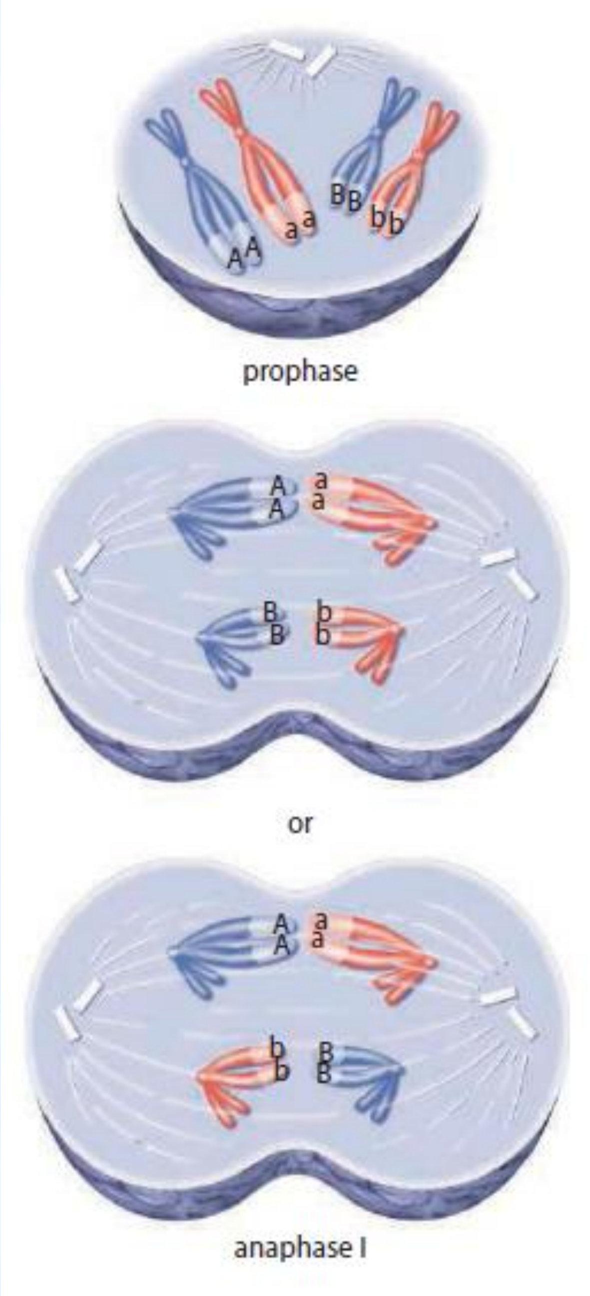
- Exit Card #4

Chromosome Theory of Inheritance

- in 1902, **Walter Sutton** (1877–1916), a graduate student at Columbia University in New York, studied sperm development in **grasshoppers.**
- Sutton examined the processes of **segregation of homologous chromosomes** and migration of sister chromatids **during meiosis I and meiosis II.**
- Sutton realized that the distribution of chromosomes into developing gametes **follows the pattern for the inherited factors proposed by Mendel.**
- These factors come in pairs, as do chromosomes. During gamete formation, the factors segregate just as homologous chromosomes do.
- Sutton published a paper proposing the theory that the inherited factors described by Mendel are carried on chromosomes.
- Around the same time, German biologist **Theodor Boveri** (1862–1915) was studying **chromosomes during meiosis in sea urchins**.
- Working independently of Sutton, Boveri proposed the **same theory** to explain Mendel's observations.

Chromosome Theory of Inheritance

- **chromosome theory of inheritance** inherited factors (now known as genes) are carried on chromosomes
- **AKA**
- genes are located on chromosomes, and chromosomes provide the basis for the segregation and independent assortment of genes.
- Often referred to as the **Sutton-Boveri chromosome theory of inheritance.**

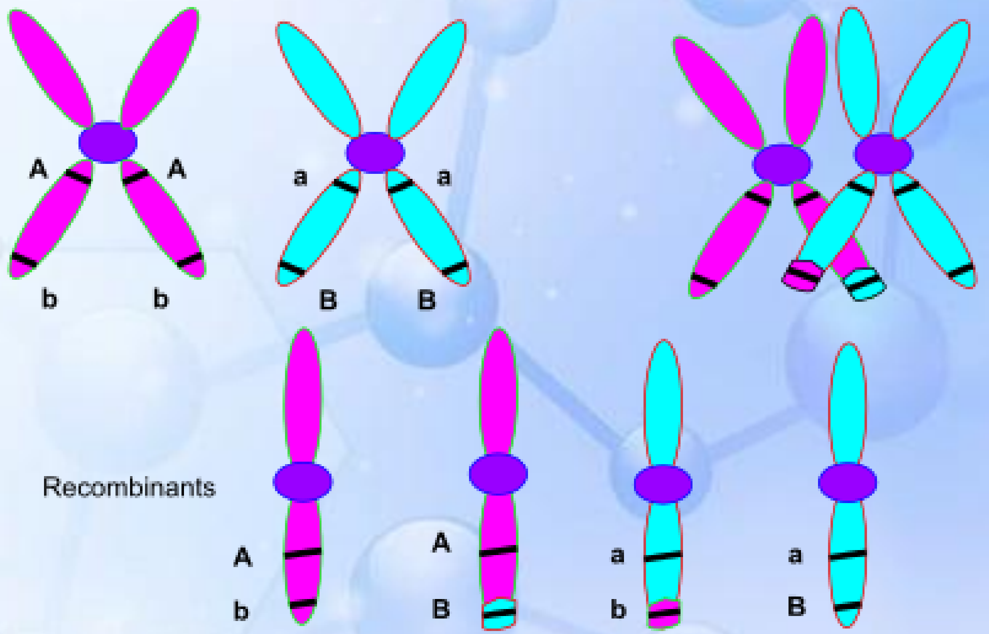


Genes On The Same Chromosome

- Sutton predicted that when alleles of two different genes are on the same chromosome they do not assort independently. **(not really – crossing over)**

- **linked genes** genes on the same chromosome

- Experimental data show, however, that linked genes segregate on a regular basis.



Morgan and The Chromosome Theory of Inheritance

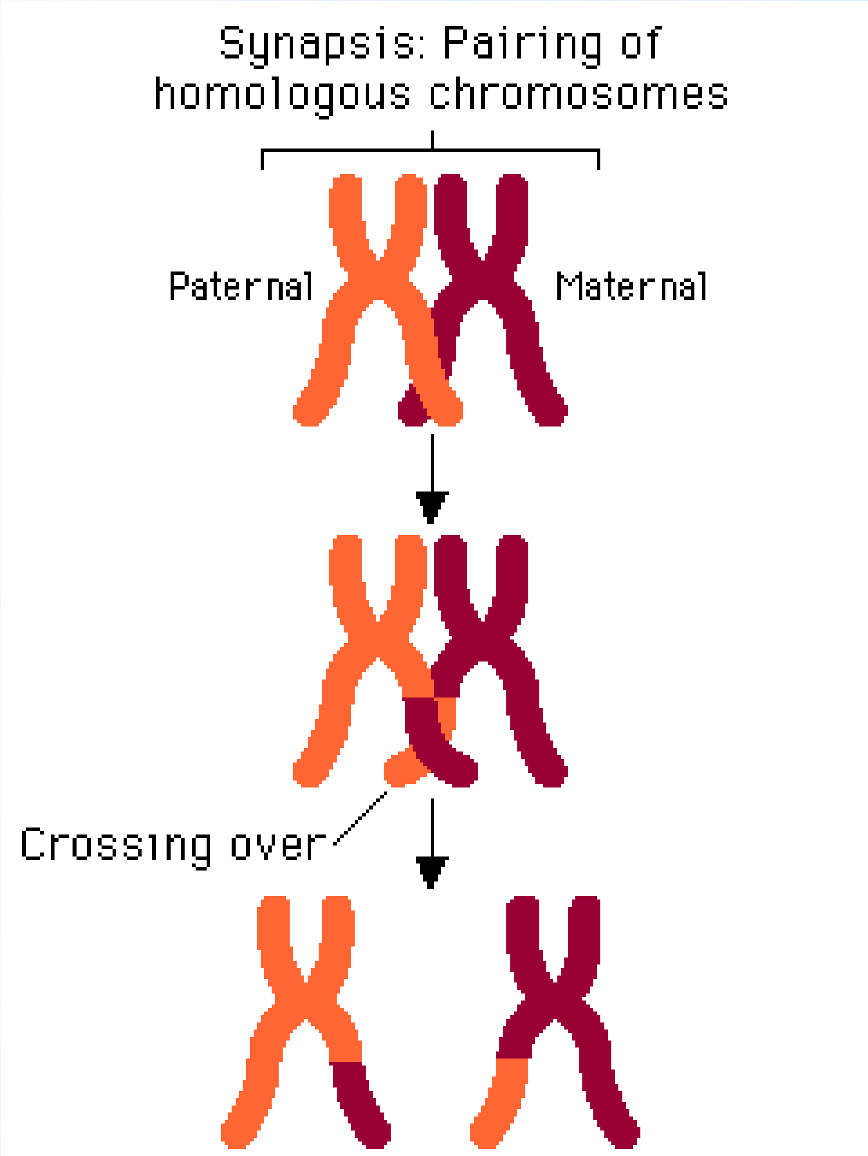
- Thomas Morgan was skeptical of Suttons work and did experiments with **fruit flies (Drosophila).**
- He came to the same conclusion that genes were indeed carried on chromosomes.
- He developed the theory of **Sex-Linkage** by identifying the gene for white eyes in fruit flies was carried on the **X chromosome**.
- One of his students Alfred Sturtevant had assigned genes a numerical value based on location along the chromosome and found that linked genes could separate with predictability because of **Crossing Over**.

Crossing Over

- Crossing over is a random event and occurs, with equal probability, at nearly any point on the sister chromatids, except near the centromere. This means that a crossover is more likely to occur between genes that are farther apart on a chromosome than between genes that are closer together.

- Morgan and his students came up with a new definition for the chromosome theory of inheritance

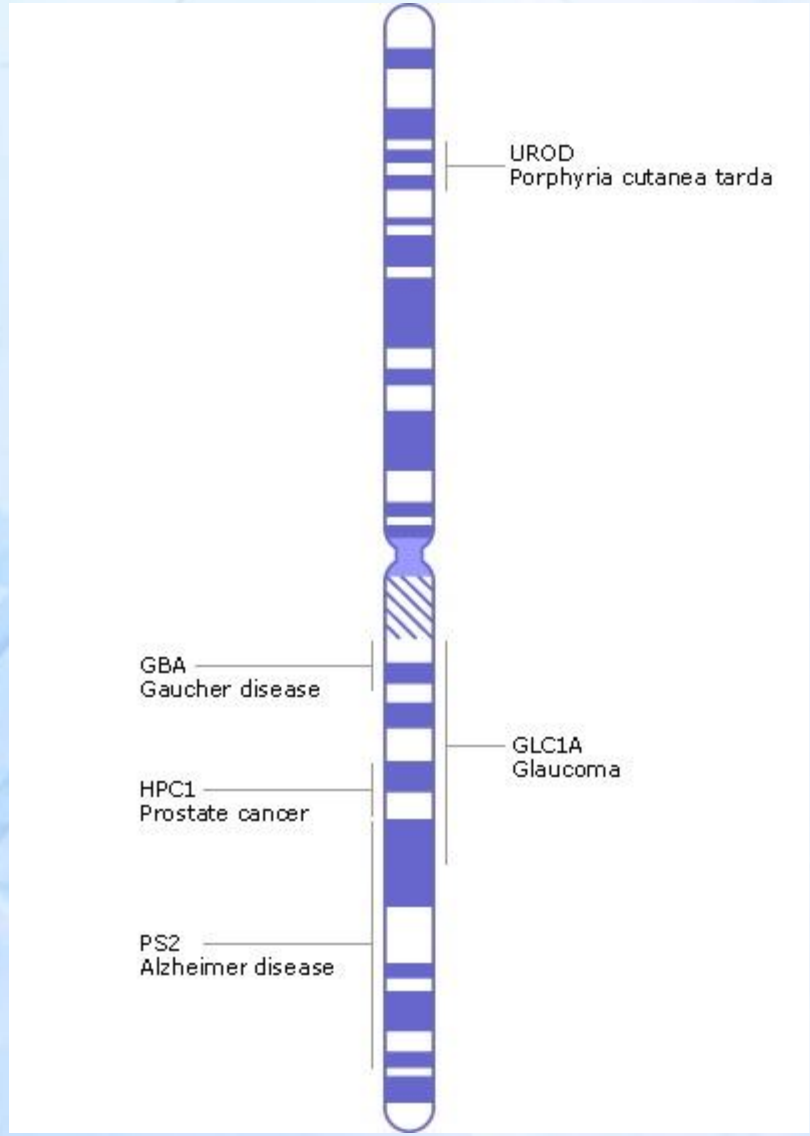
- **Gene linkage and crossing over increase variation in offspring**



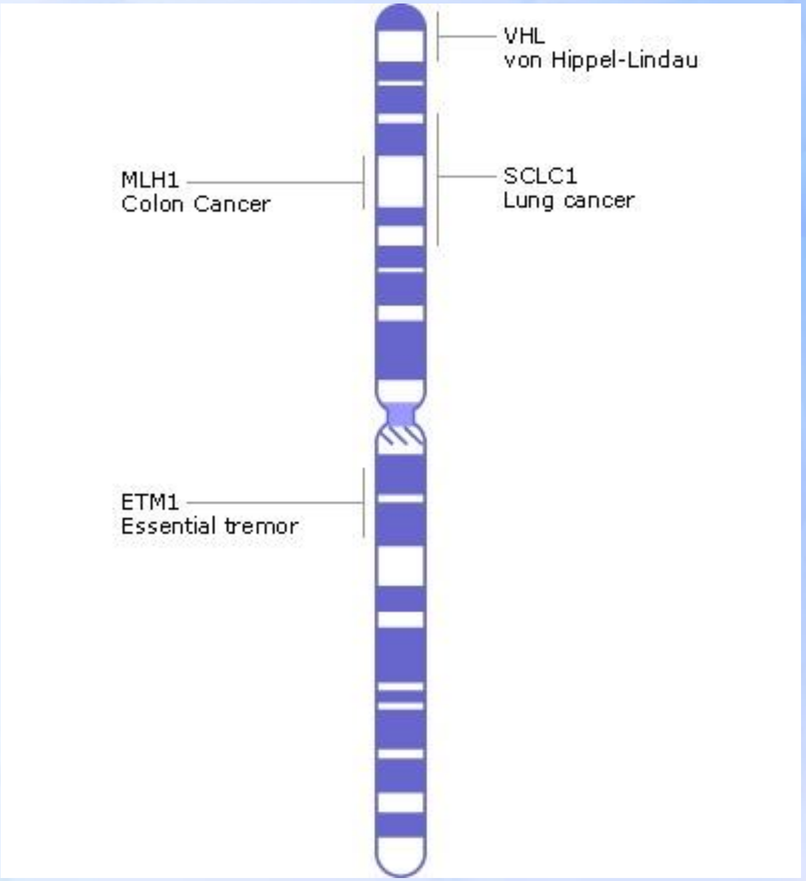
Modern Chromosome Theory of Inheritance

- The gene-chromosome theory now states that **genes exist at specific sites arranged in a linear manner along chromosomes.**

Chromosome 1



Chromosome 3



Sex Linkage

- **sex-linked trait** trait controlled by genes on X or Y chromosomes

- Eye colour in fruit flies is X linked and carried on the X chromosome.
- What are the phenotypes of the offspring if you were to cross a homozygous red eyed female and a white eyed male fruit fly?

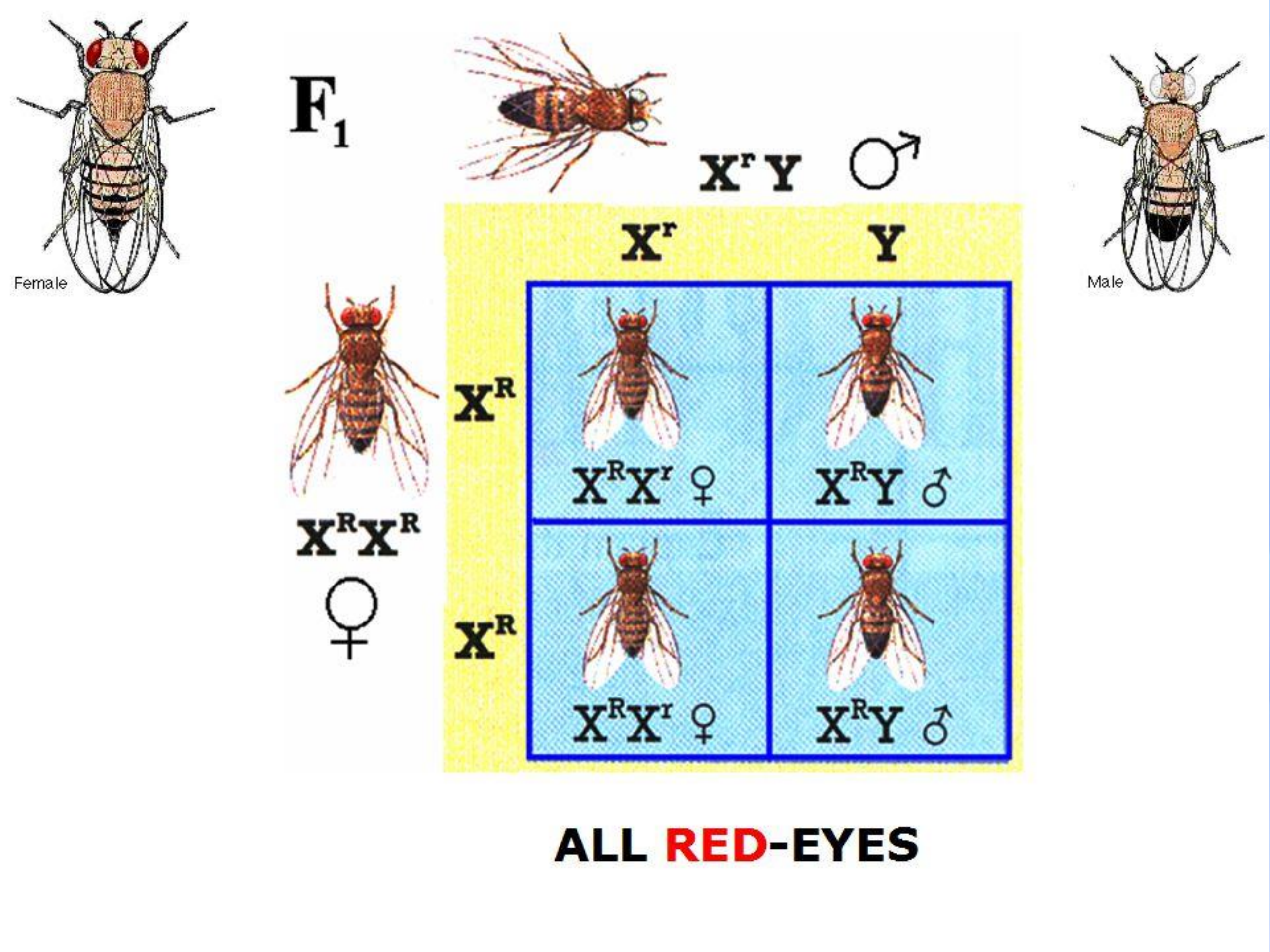
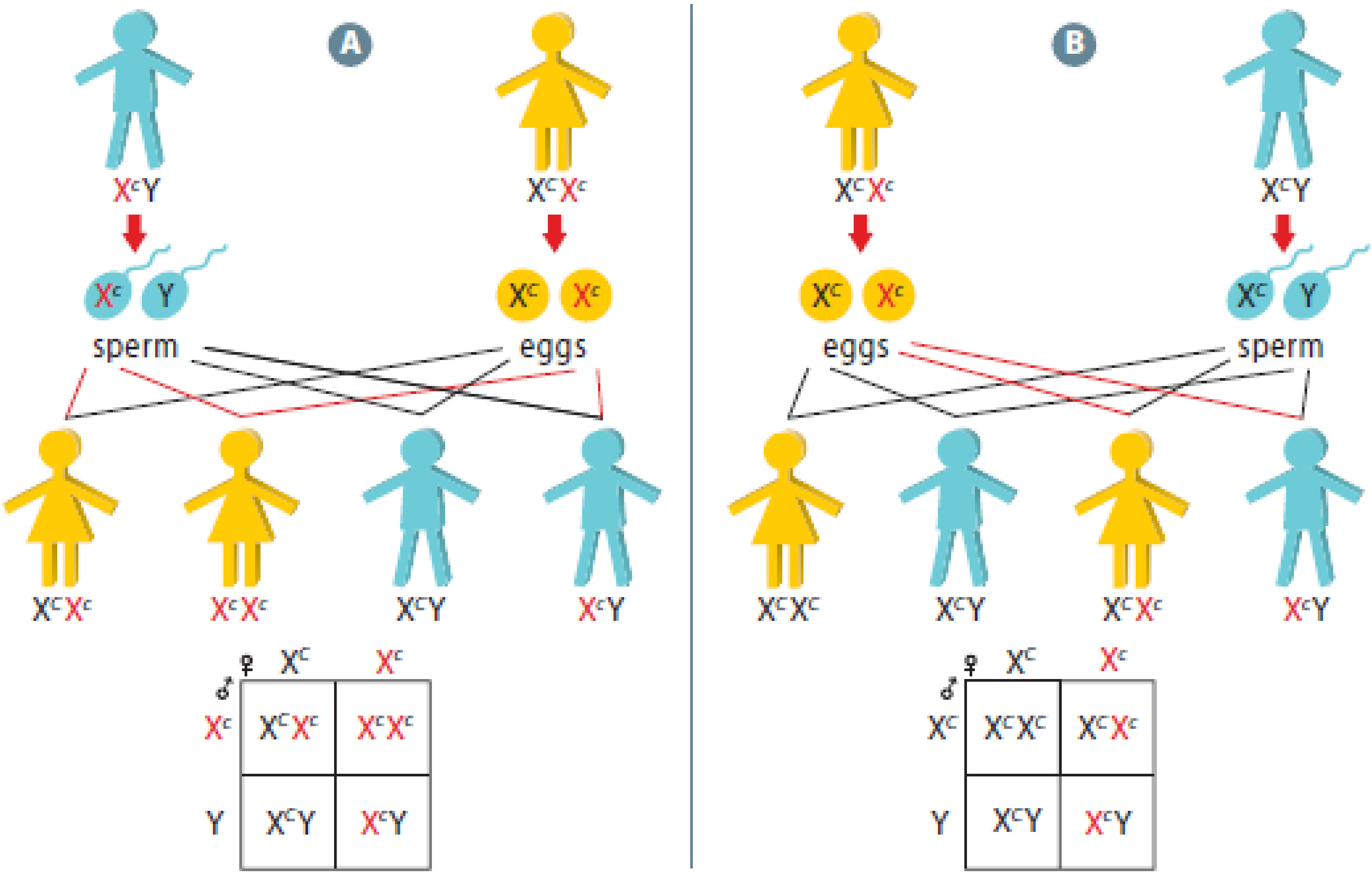


Figure 14.17 An allele for sex-linked colour vision deficiency is passed to the next generation. Males can pass the X-linked recessive trait only to their daughters (**A**). Females who are heterozygous for the condition have a 50 percent chance of passing the recessive allele to a child (**B**). Can a man with normal vision have a child who has the condition?



B) Yes if his partner is a carrier, he can have a son with the condition but not a daughter

Sex Linkage and One Trait Crosses

- In fruit flies, the gene for red eyes is dominant over the gene for white eyes. The trait is sex-linked on the X chromosome. What are the genotypic and phenotypic ratios if a heterozygous red-eyed female is crossed with a white eyed male?

First write down the genotypes you will be using, their meanings and the parent generation

X^R = Red Eyes

X^r = White Eyes

Y = Male

Male: X^rY

Female: X^RX^r

	X^R	X^r
X^r	X^RX^r	X^rX^r
Y	X^RY	X^rY

Genotypic Ratio: 1 X^RX^r : 1X^rX^r : 1 X^RY : 1 X^rY

Phenotypic Ratio: 25% Female Carrier : 25% Female White Eyed : 25% Red Eyed Male : 25% Male White Eyed

Activity 14.4

- Sex-linked Inheritance Patterns

- Exit Card #5

Polygenic Inheritance

- **continuous trait** trait for which phenotypes vary between extremes
- Human Height

- **polygenic trait** trait controlled by many genes
- Corn Ear Length
- Eye Colour

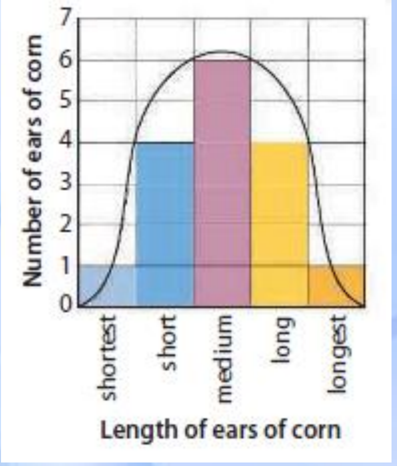
Polygenic Inheritance in Corn

- ❖Ear length is controlled by two genes, A and B. In true-breeding corn with the genotype AABB, four dominant alleles contribute to ear length.
- ❖As a result, this genotype has the longest ears.
- ❖True breeding corn with the genotype aabb has four recessive alleles, none of which contribute to ear length. Thus, this genotype has the shortest ears.
- ❖If true-breeding lines for shortest ears of corn and longest ears of corn are crossed, the F1 generation will have medium length ears (AaBb) where two dominant alleles contribute to ear length.
- ❖P - AABB × aabb F1 - AaBb
- ❖If we cross two of the F1 generation we get the Punnett square to the right.

A

AaBb (♀) × AaBb (♂)

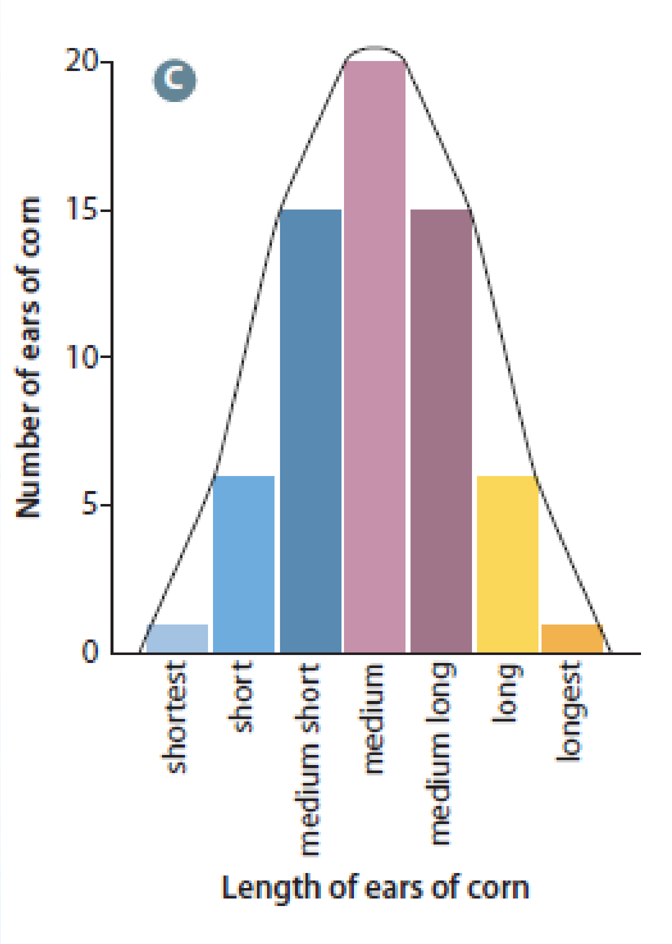
♂ \ ♀	AB	Ab	aB	ab
AB	AABB longest	AABb long	AaBB long	AaBb medium
Ab	AABb long	AAbb medium	AaBb medium	Aabb short
aB	AaBB long	AaBb medium	aaBB medium	aaBb short
ab	AaBb medium	Aabb short	aaBb short	aabb shortest



Phenotypic ratio =
1 shortest : 4 short : 6 medium : 4 long : 1 longest

- If there are three genes (A, B, and C), creating a range of zero to six contributing alleles, there is a more continuous distribution of phenotypes.

- If three genes control ear length, there is a phenotypic ratio of 1:6:15:20:15:6:1.



Polygenic Inheritance Example

- The table below shows the gene pairs involved in determining eye color. If a man with grey-blue eyes is crossed with a woman with green eyes, what are the genotype and phenotype ratios of their offspring?

Genotype	Eye Colour
AA BB	black-brown
AA Bb	dark brown
AA bb	brown
Aa BB	brown-green flecked
Aa Bb	light brown
Aa bb	grey-blue
aa BB	green
aa Bb	dark blue
aa bb	light blue

Parents

Male: Aabb

Ab ~~Ab~~ ab ~~ab~~

Female: aaBB

aB ~~aB~~ ~~aB~~ ~~aB~~

	aB
Ab	AaBb
ab	aaBb

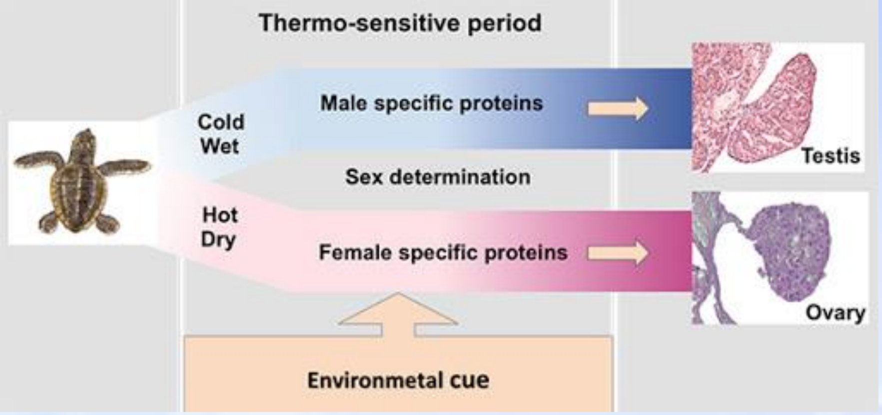
Genotypic Ratio: 1 AaBb : 1 aaBb

Phenotypic Ratio: 50% Light Brown Eyes : 50% Dark Blue Eyes

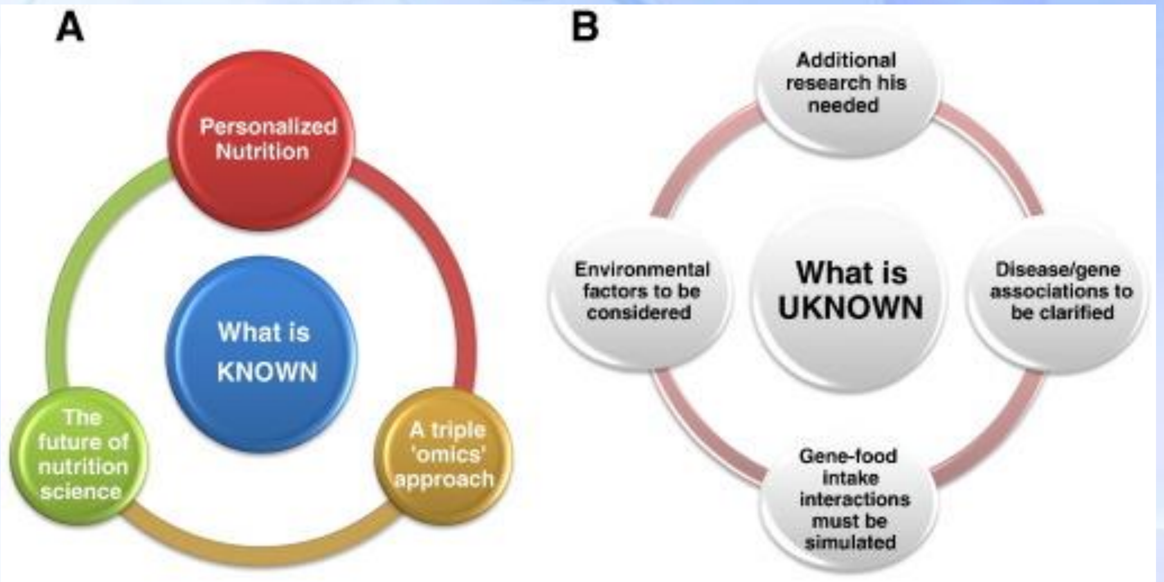
- Exit Card #6

Genes and the Environment

- ❖Environmental conditions often affect the expression of genetic traits.
- ❖Some genes are influenced by temperature.
  - ❖Siamese Cats - Their fur is pigmented on the cooler parts of their bodies: the face, ears, tails, and feet. Dark colouring is the result of a gene that is only active below a certain temperature.
  - ❖Curly Wings Fruit Flies - If flies that are homozygous for curly wings are raised at 25 °C, their wings will be curly. If they are raised at 16 °C, their wings will be straight.
  - ❖Seasonal Changes in Hares – Snowshow Hares change colour from brown in summer to white in winter with the seasonal temperature changes
  - ❖Sex determination in reptiles – certain species of reptiles such as turtles – if the eggs are incubated at high temperature they produce females, at low temperatures they produce males.



- Some genes are influenced by sunlight
  - Human Skin – natural skin colour darkens do to exposure to sunlight (tanning)
  - Hair Colour – The sun bleaches your hair and causes it to become lighter
- Some genes are influenced by PH
  - Hydrangea Plant – a neutral soil will give pink flowers while an acidic soil will give blue flowers.
- Some genes are influenced by diet/nutrition
  - Diet and Nutrition can affect gene expression



STSE

- CONNECTIONS + SOCIAL AND ENVIRONMENTAL CONTEXT
- Gene Expression and the Environment