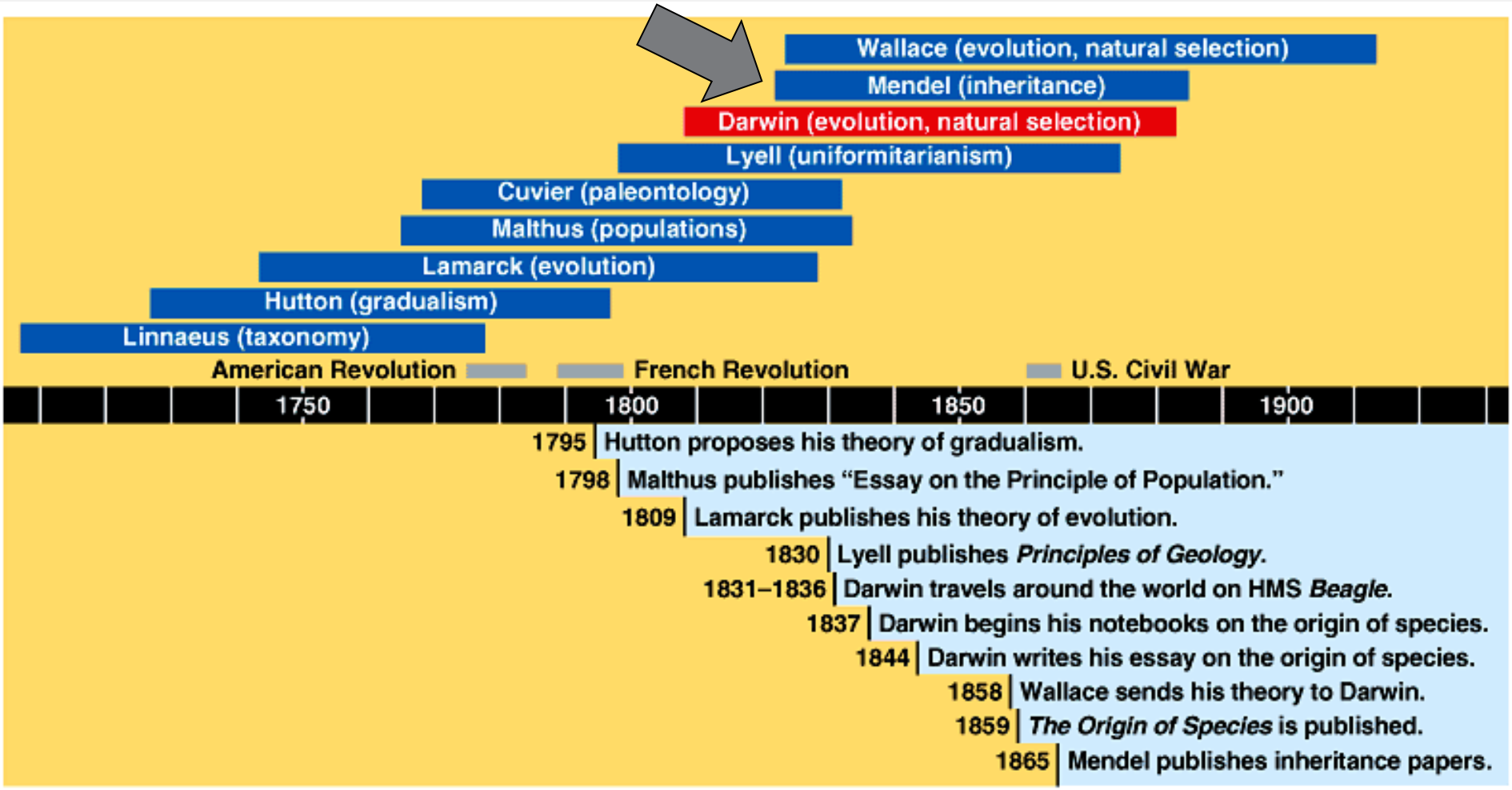
Mendelian Genetics

Evolutionary Timeline



Gregor Mendel (1822-1884)

- Studied peas
- → Laws for inheritance of Traits

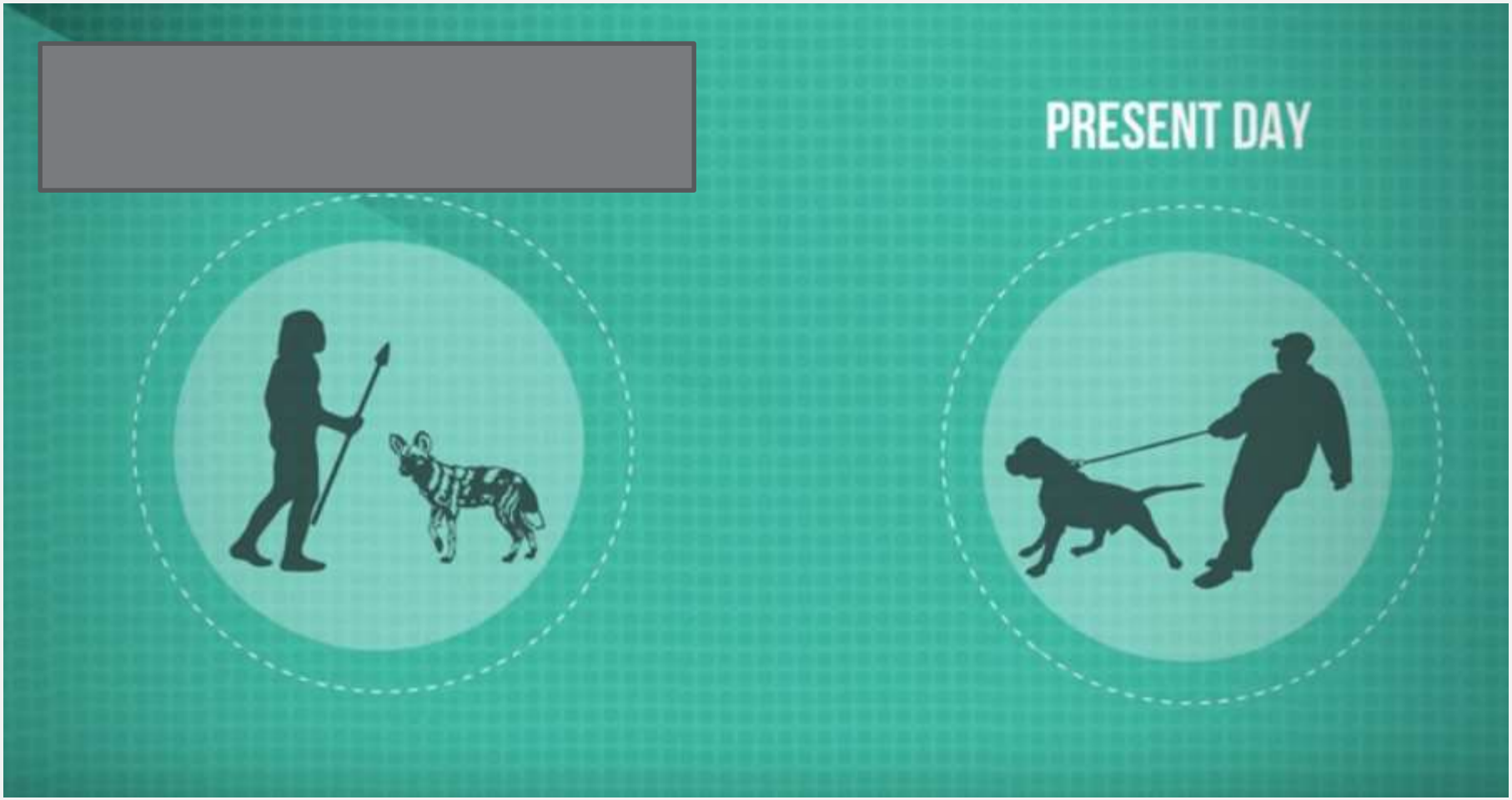
Described offspring from 28,000 pea crosses


Mendel's Pea Plant Experiments

Selective Breeding

- Humans control the mating or breeding of plants and animals → desired traits

Selective Breeding =



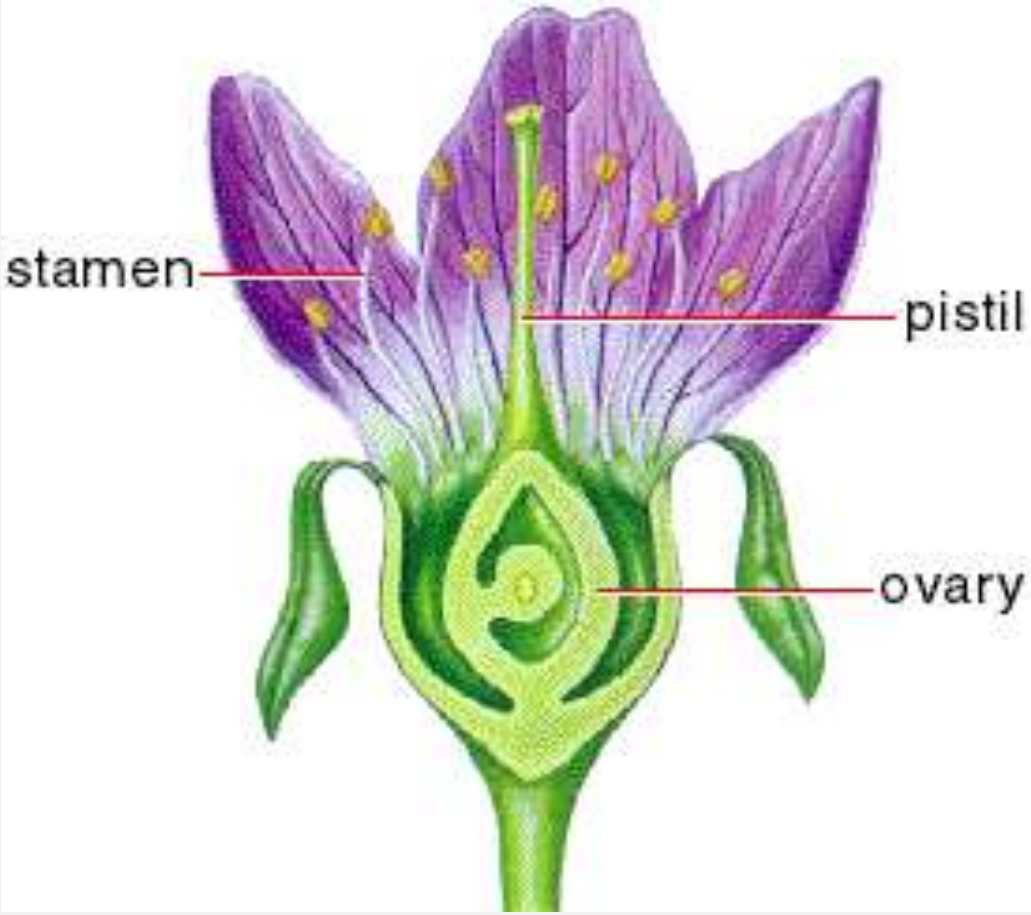
List Pros and Cons of selective breeding

Why peas, *Pisum sativum*?

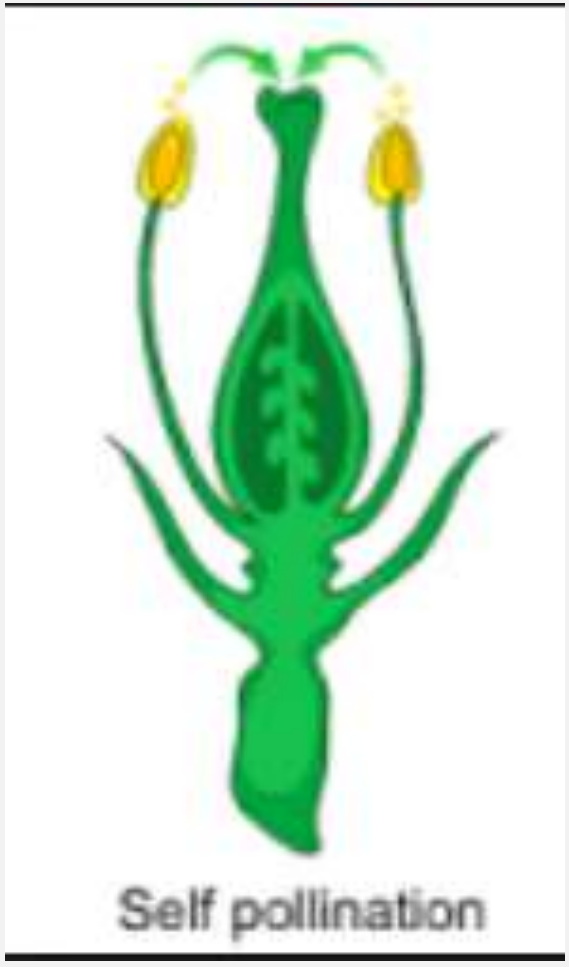
- lots of offspring = lots of data

Pea flowers have male and female parts

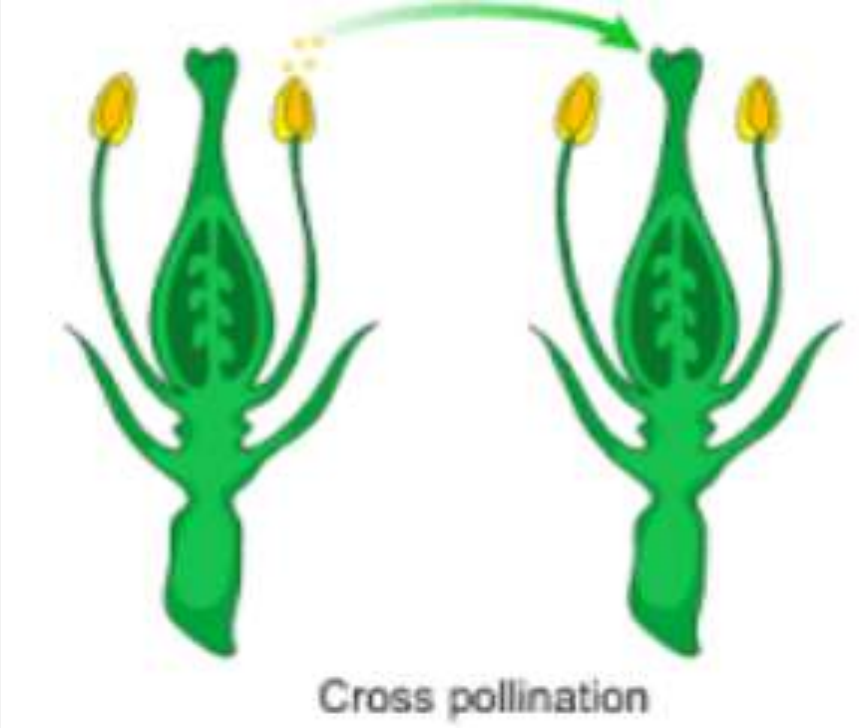
- **Pollen contains sperm**
  - **–Produced by the <u>stamen</u>**
- **Flowers contain eggs**
  - **–Produced in an <u>ovary</u>**



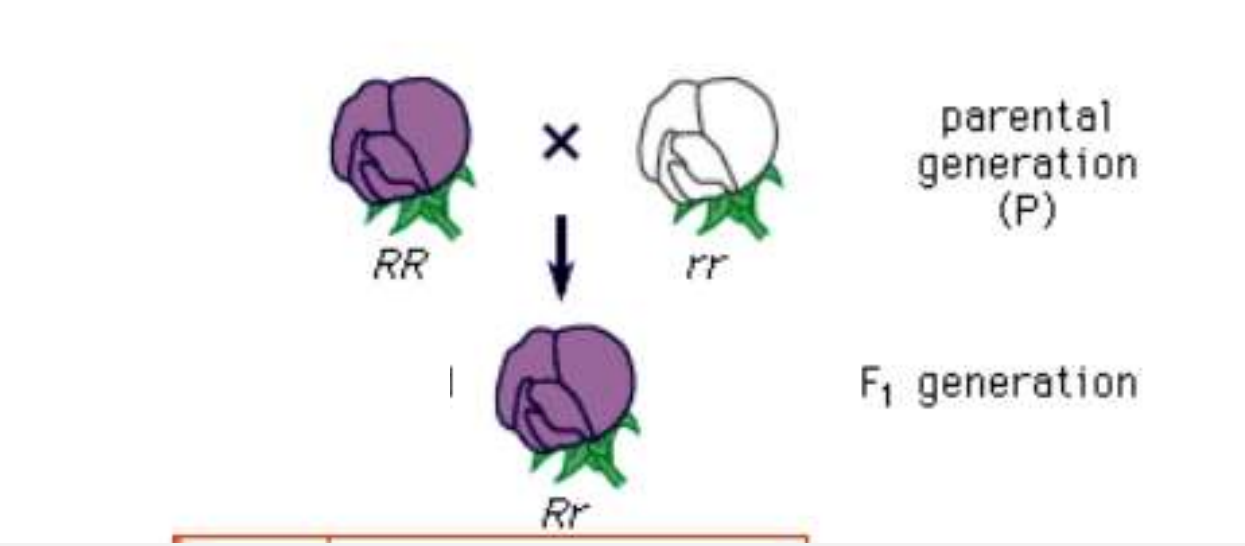
Self-pollinate→ pure bred plants



Cross-pollinate → hybrids



Mendel Described Particulate Inheritance = Traits are inherited as “particles” from parents



Now we call Mendel's "particles" genes

Genes = pieces of DNA on chromosomes

Cells of sexually reproducing organisms

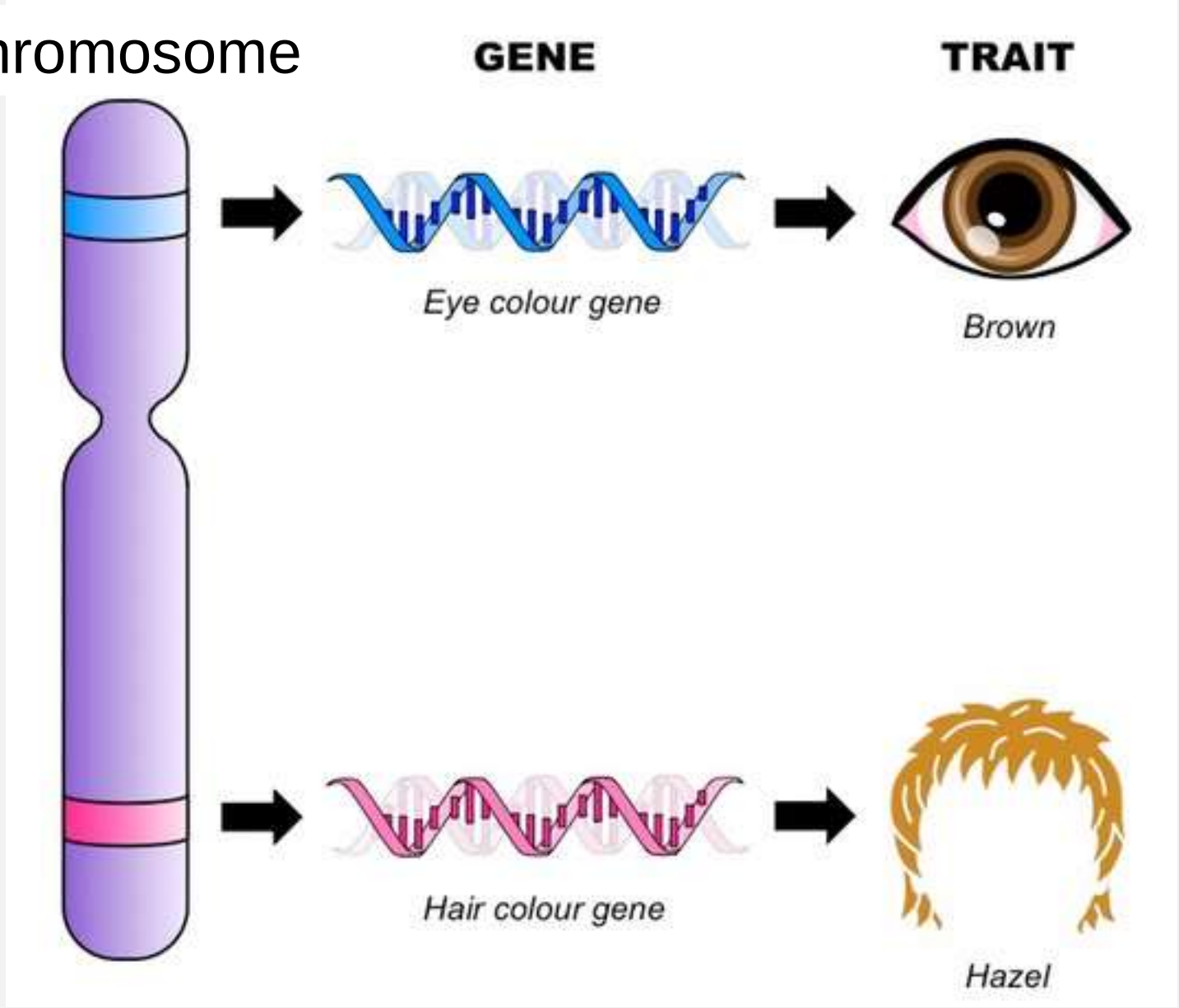
- Body cells have 2 copies of gene
- Why?
- One copy from each parent

- Gametes = Eggs and Sperm

- How many copies of each gene do gametes have
- Gametes = only 1 copy of each trait
- Why?
- Meiosis → gametes with ½ number of chromosomes

Draw and label a chromosome with lots of genes
then answer questions 1-3

Chromosome

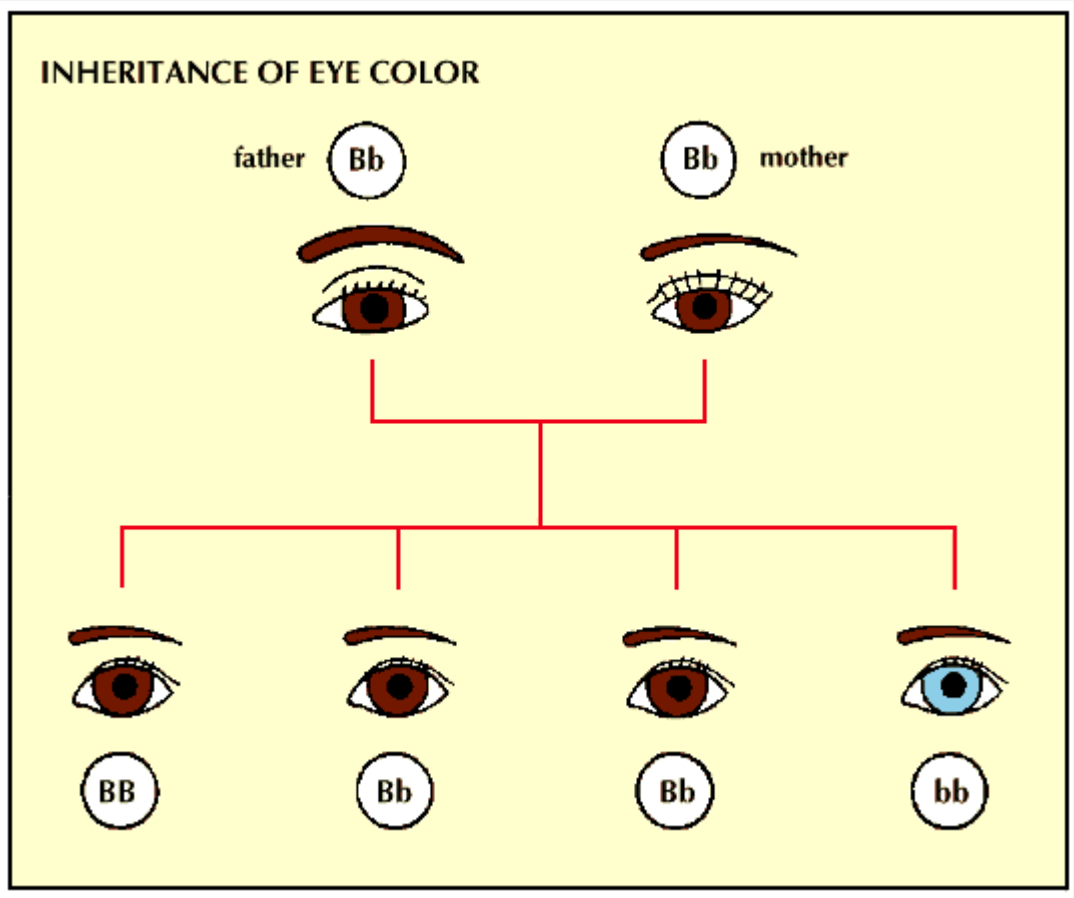


Genetics Vocabulary

- **Traits –**
  - characteristics determined by genes
- **Hereditary molecule**
  - =DNA
- **Genes =**
  - pieces of DNA → traits
  - Found on chromosomes

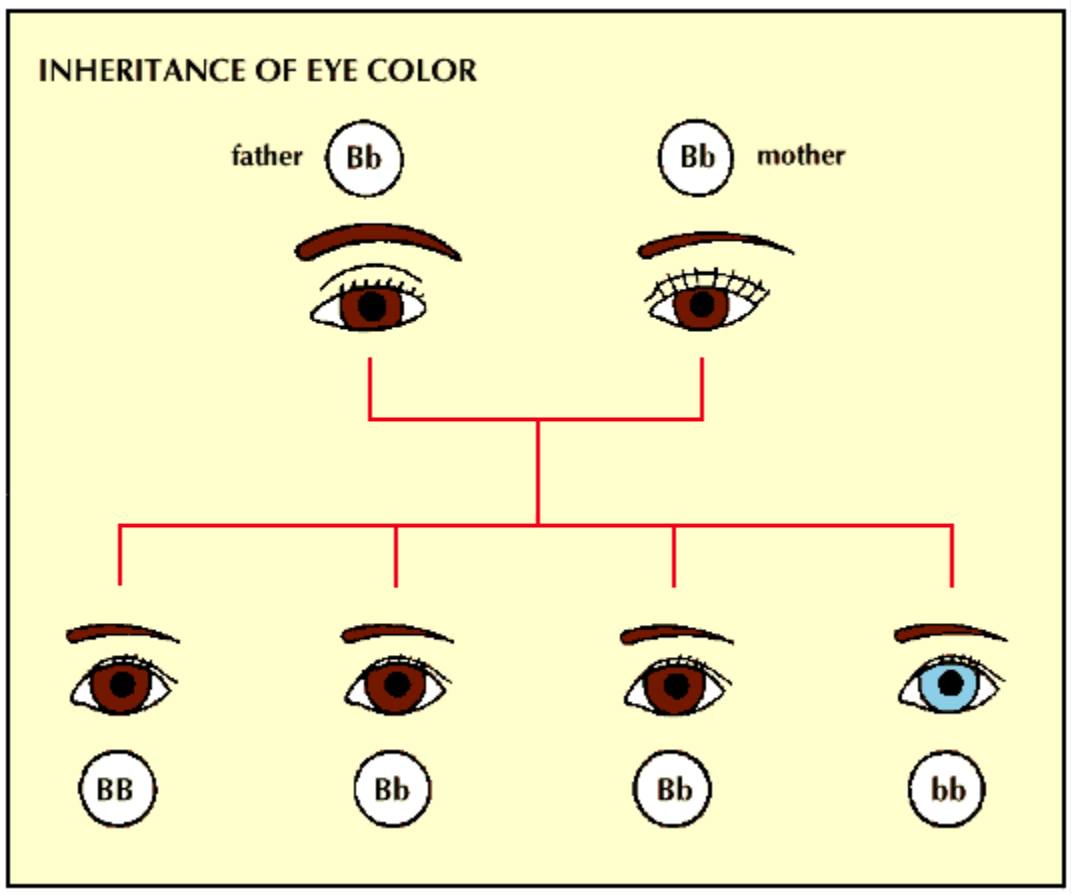
Dominant Genes / alleles

- Only need one copy → trait (ex: brown eyes



Recessive Genes / Alleles

- need 2 copies → trait
- ex: blue eyes (ee)



Genotypes

- Describes the genes inherited
  - **Homozygous = (BB or bb)**
  - **Heterozygous = (Bb)**

Phenotype

- Describes a physical characteristic
- Ex: brown or blue

Mendel studied 7 different traits

Flower color	Flower position	Stem length	Seed shapes	Seed color	Pod shapes	Pod color
purple 	axial 	short 	round 	yellow 	inflated 	yellow 
white 	terminal 	tall 	wrinkled 	green 	constricted 	green 

How Mendel Began

Mendel produced pure strains by self-pollinating several generations

Genotype & Phenotype in Flowers

All genes occur in pairs =2 copies (one from each parent)

Flower color Genotypes

R

r

Which genotype is dominant

R

Genotype & Phenotype in Flowers

Flower color Phenotypes

R=Red
r=white

Which phenotype is dominant

Red

Questions

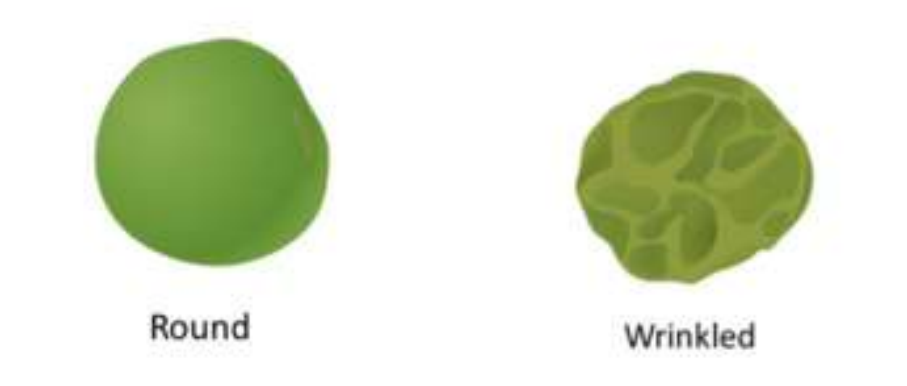
- List the possible genotypes
  - RR Rr rr
- List the possible phenotypes for each genotype
  - Red red white
- Which genotypes are homozygous
  - RR rr

Pure bred plants = homozygous

- What is the genotype for a plant that is homozygous dominant?
- RR
- What is the genotype for a plant that is homozygous recessive?
- rr

Mendel's (P_1) Pure bred Cross

- Trait = Seed Shape
- Alleles = R – Round and r – Wrinkled
- Cross:

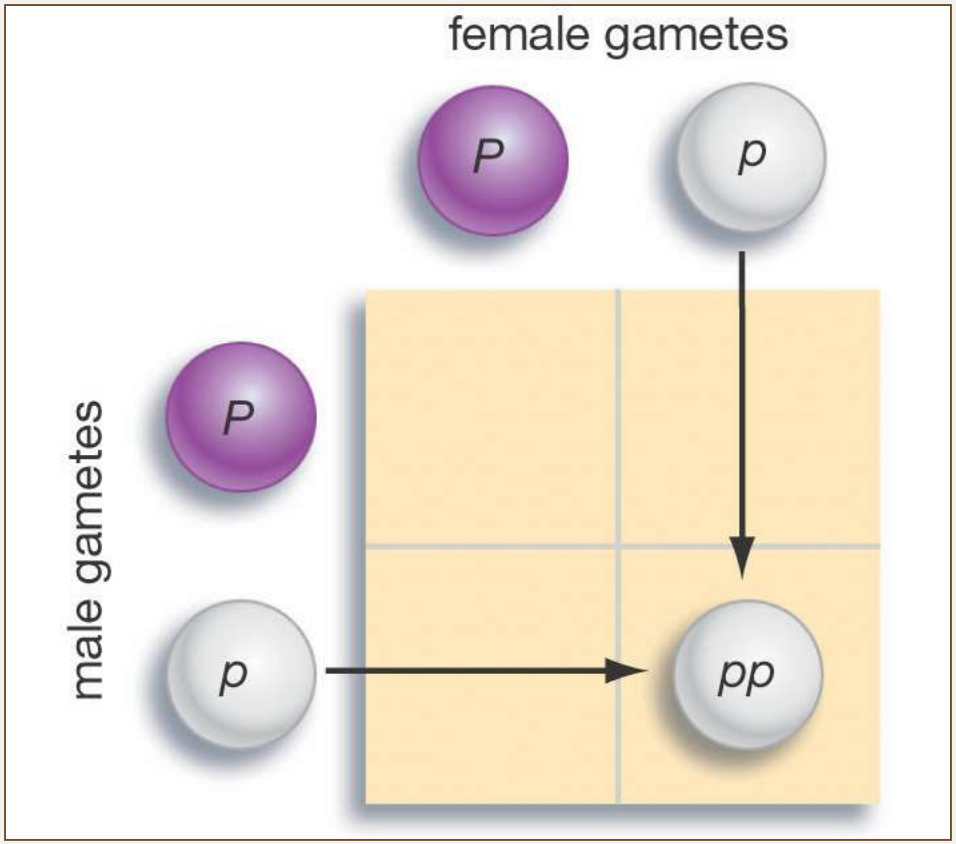


- Homozygous round x Homozygous wrinkled
- RR **x** rr

Predict what the offspring will look like and what their genotype will be

Punnett Square

- Used to determine the probability of inheriting a trait



Mendel's (P_1) Pure bred Cross

- Trait = Seed Shape
- Alleles = R – Round and r – Wrinkled
- Cross:
- Homozygous round x Homozygous wrinkled
- RR **x** rr

	r	r
R	Rr	Rr
R	Rr	Rr

Offspring

Genotypes:

100% Rr

Phenotypes:

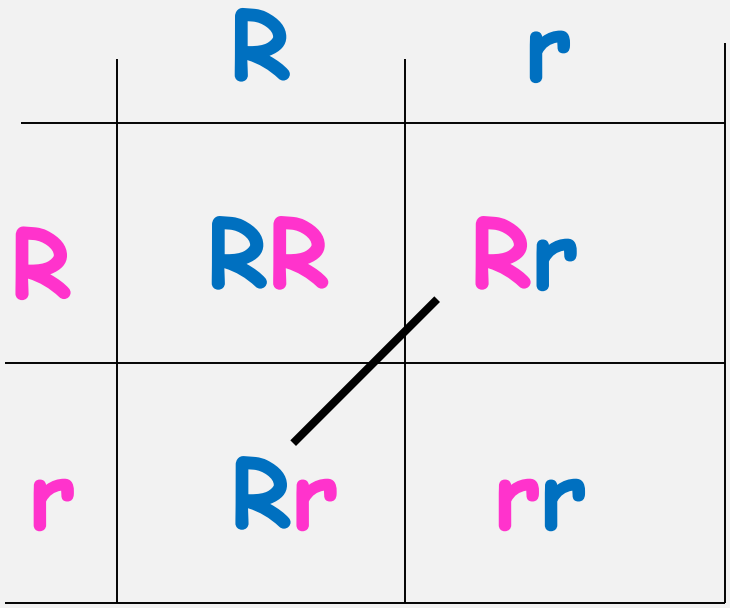
100% Round

Mendel's F1 heterozygous cross

- **Cut stamens to prevent self-pollination**
- **Cross pollinate offspring of the P1 cross**

F_1 Monohybrid Cross

- Trait: Seed Shape
- Genes: R – Round r – Wrinkled
- Cross: Heterozygous x Heterozygous
- Rr x Rr



Offspring

Genotypes: RR, Rr, rr

Genotype Ratio: 1:2:1

25% : 50% : 25%

Phenotypes: Round & wrinkled

Phenotype Ratio: 3:1

75% : 25%

Mendel's Experimental Results

Table 11.2 Ratios of Dominant to Recessive in Mendel's Plants

Dominant trait	Recessive trait	Ratio of dominant to recessive in F_2 generation
Smooth seed	Wrinkled seed	2.96:1 (5,474 smooth, 1,850 wrinkled)
Yellow seed	Green seed	3.01:1 (6,022 yellow, 2,001 green)
Inflated pod	Wrinkled pod	2.95:1 (882 inflated, 299 wrinkled)
Green pod	Yellow pod	2.82:1 (428 green, 152 yellow)
Purple flower	White flower	3.14:1 (705 purple, 224 white)
Flower on stem	Flower at tip	3.14:1 (651 along stem, 207 at tip)
Tall stem	Dwarf stem	2.84:1 (787 tall plants, 277 dwarfs)
	Average ratio, all traits:	**3:1**

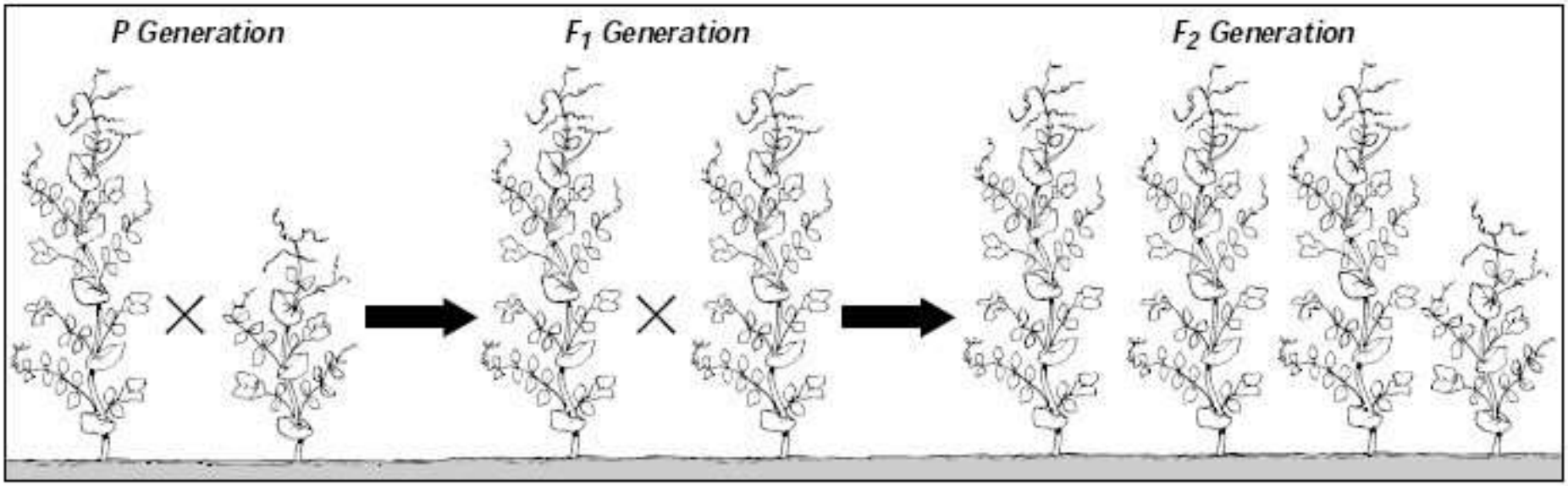
Mendel's hybrid cross results

- Expected is 3 round :1 wrinkled
- Mendel observed ratio → 2.96:1
- The discrepancy is due to statistical error
- The **larger the sample size the closer you get to expected ratio**

Remember

- More times you repeat an experiment → more accurate results

Following the Generations



Cross 2 Pure Plants TT x tt

Results in all Hybrids Tt

Cross 2 Hybrids get 3:1 (tall:Short) 1TT, 2Tt, 1tt

Genes and Environment Determine Characteristics

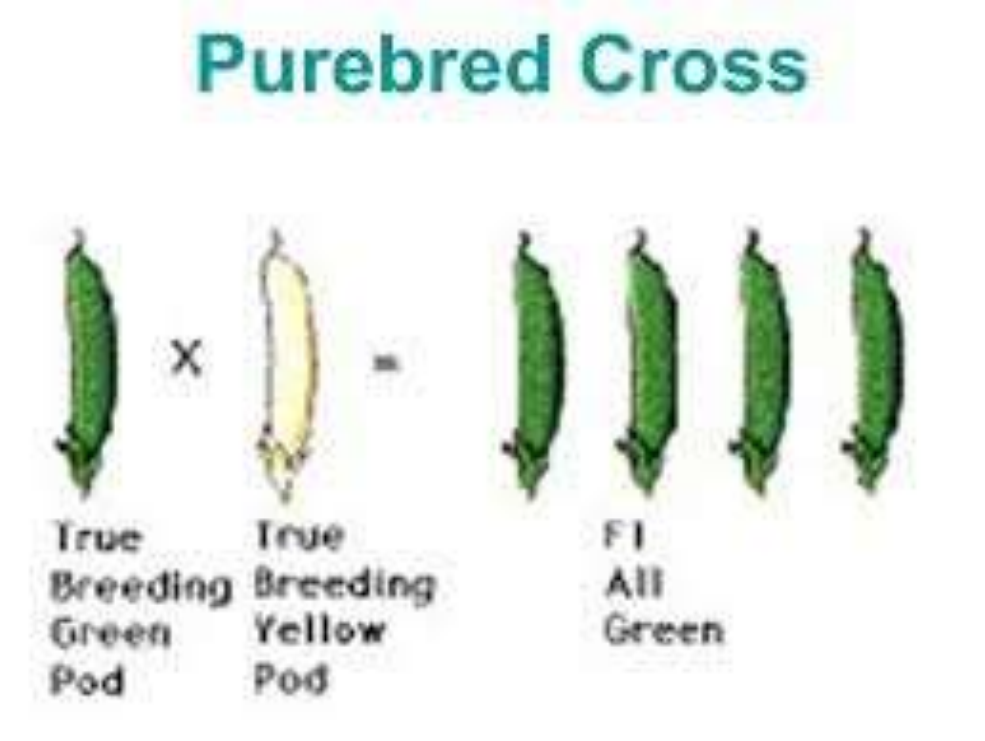
Remember:
the environment controls gene expression

Open notes quiz

Mendel's Laws

1) Law of Dominance

- Pure bred cross experiments → law of dominance

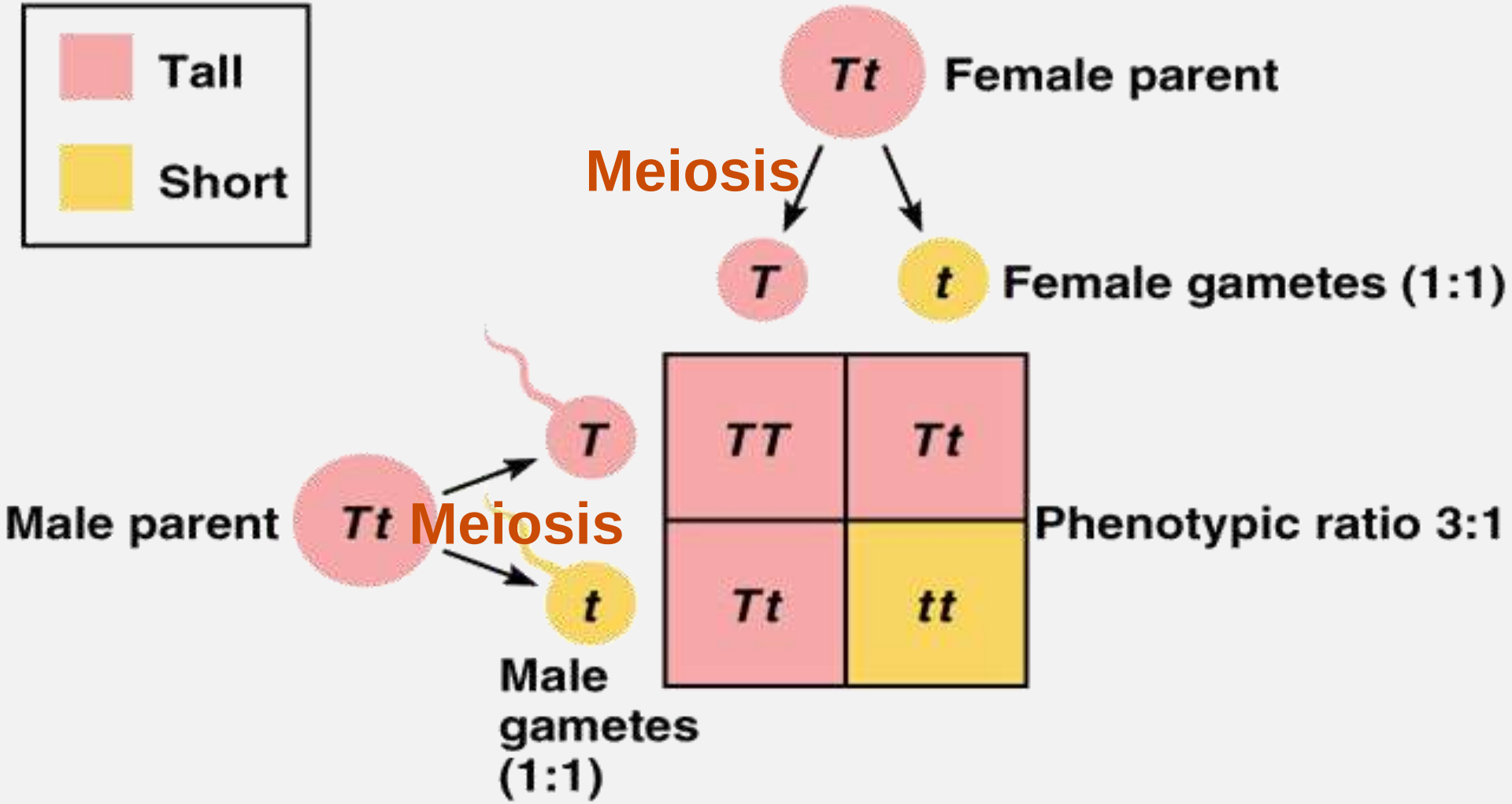


2) Law of Segregation

a) Meiosis → gametes with one copy of each gene

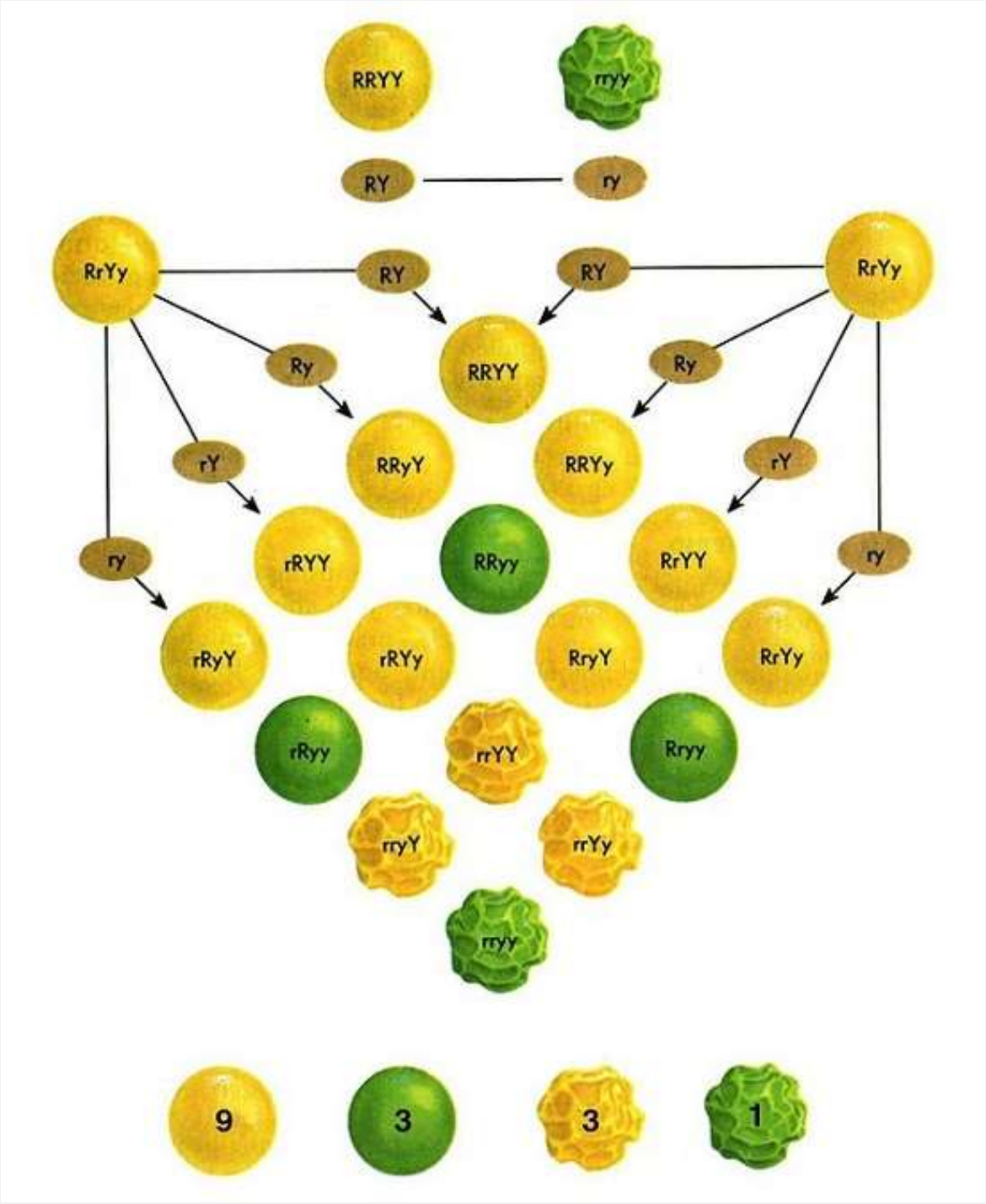
b) Genes are "recombined" at fertilization,
→ Offspring = 2copies of each

Applying the Law of Segregation



3) **Law of Independent Assortment**

- Different traits are sorted out independently →
- **every gamete is different**


RRYY
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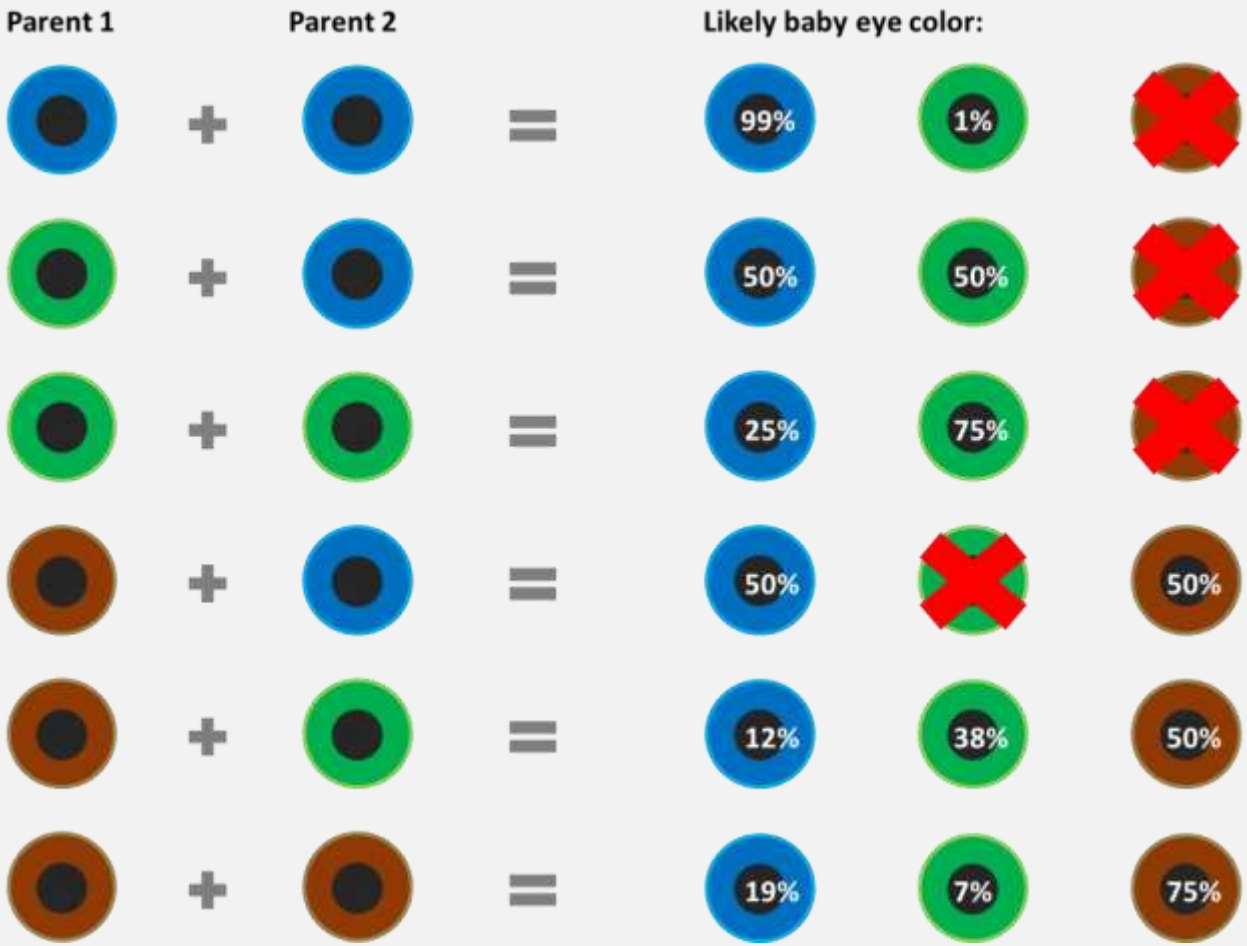
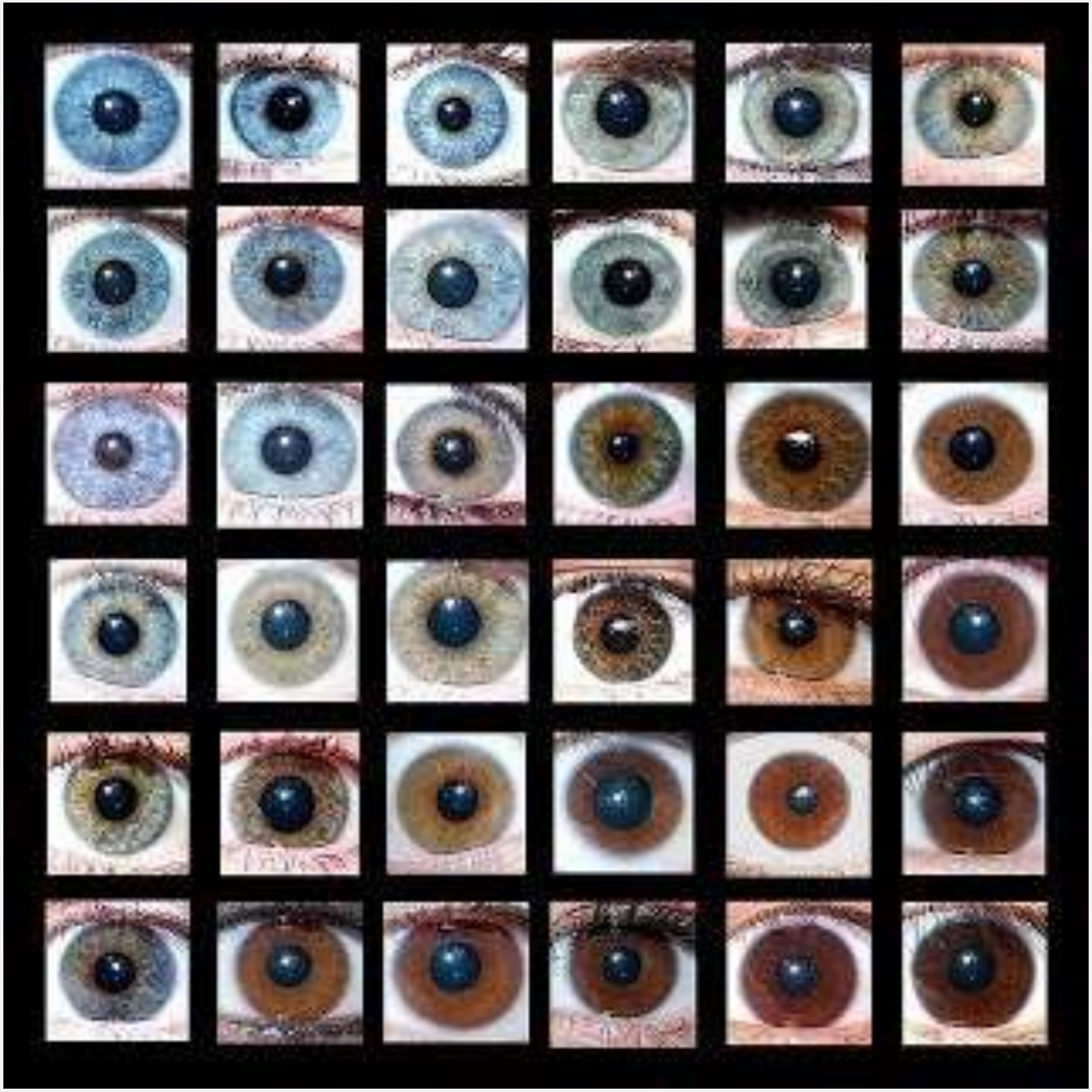
1

Exceptions to Mendel’s laws

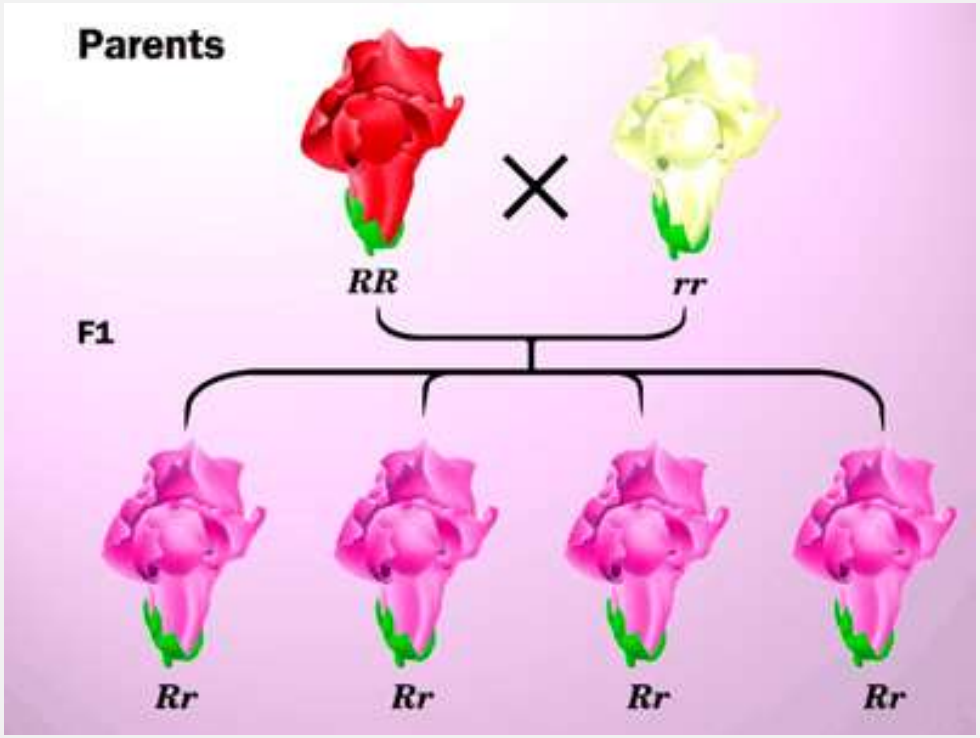
Some traits = controlled by multiple genes
Ex: eye color





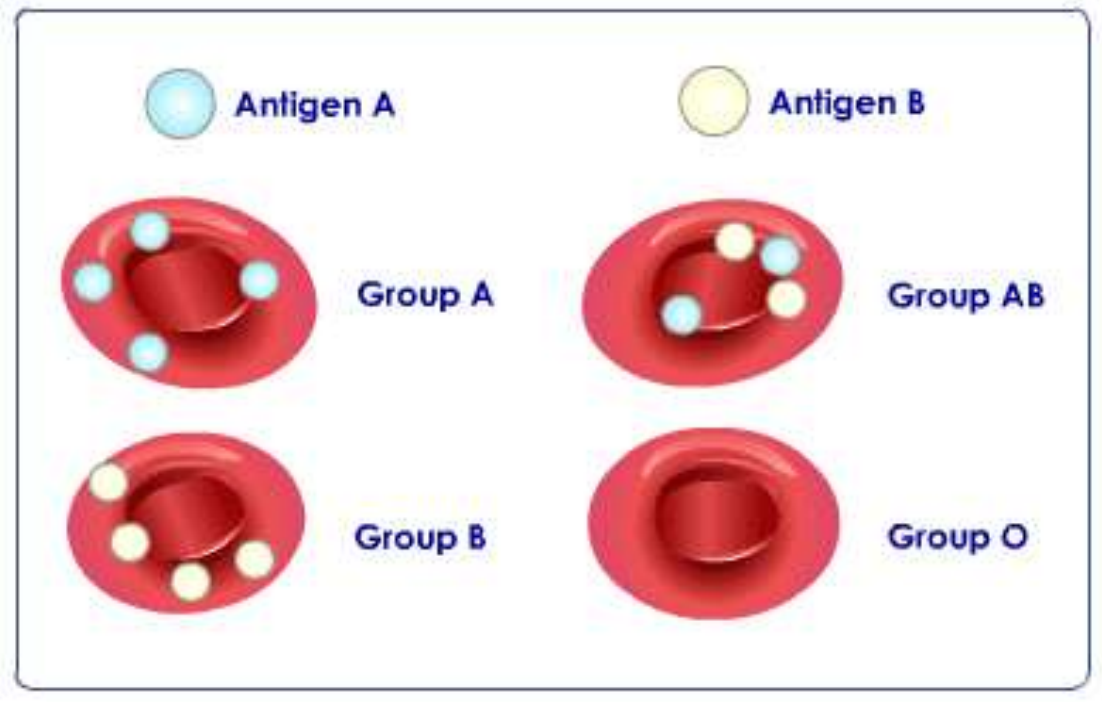
Incomplete dominance

- Neither trait is dominant
- Ex: Red flowers + white flowers →
- Pink



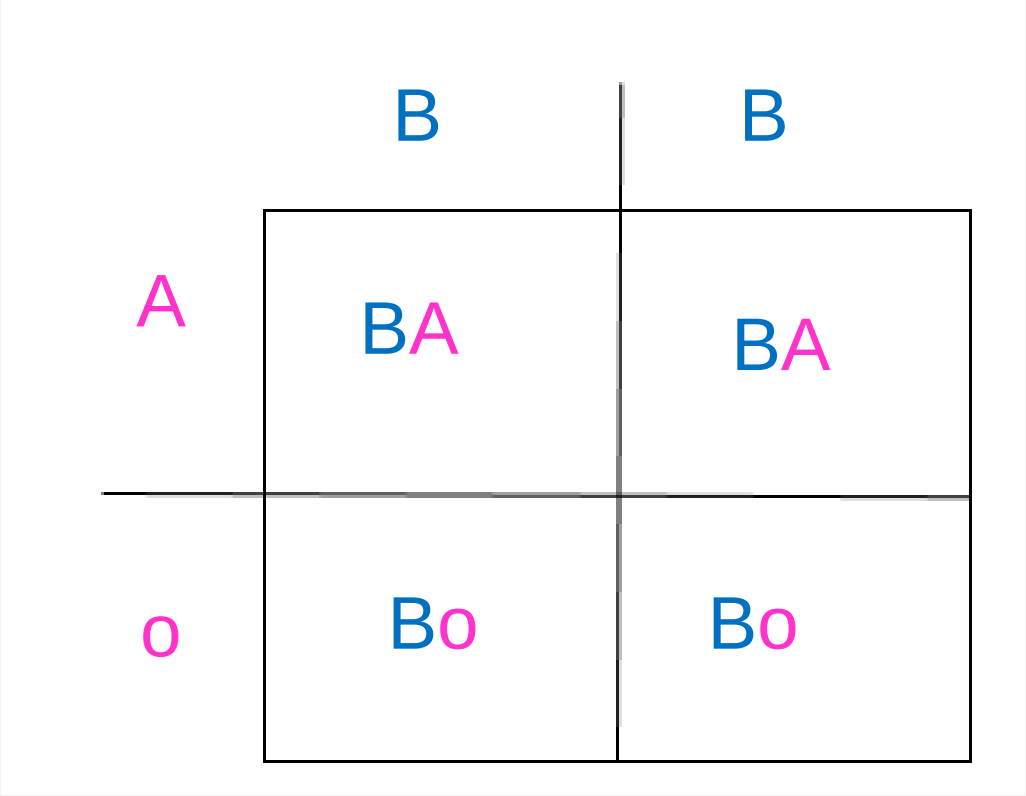
Codominance

- Both traits get expressed
- Ex: AB blood types



Do the codominance problems in notes

- Father (homozygous B) X Mother (heterozygous A)
- BB X Ao



<u>Offspring</u>
50% AB
50% B

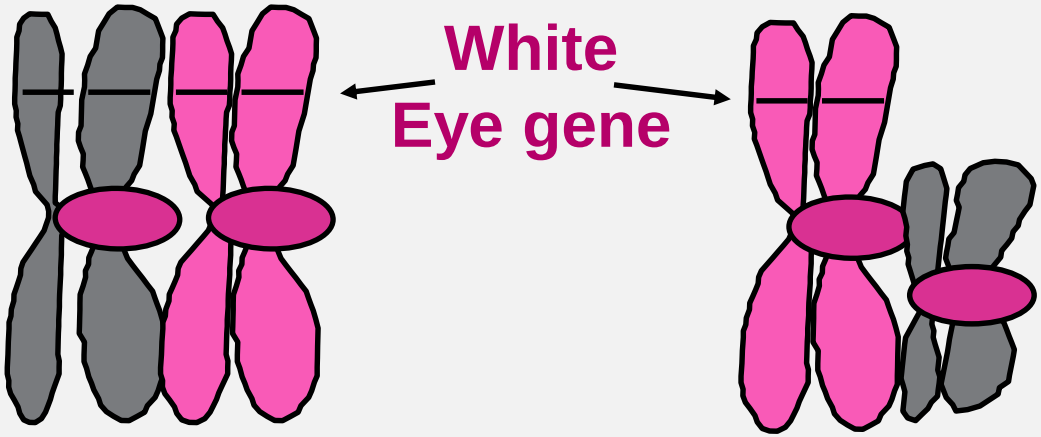
Do 2 practice problems in notes

Sex Linked traits

- Answer video questions in notes
- Meal worm body cells = 20
- Meal worm egg cells = 10
- Meal worm sperm cells = 10
- Difference =
- males have one small chromosome

- Sex linked traits = traits (genes) found on sex chromosomes
- Sex chromosomes are X and Y
- Females have XX
- Males have XY

Example: White eye color in fruit flies



XX chromosome - female **Xy chromosome - male**

- Males only get 1 copy of the gene
- Females get 2

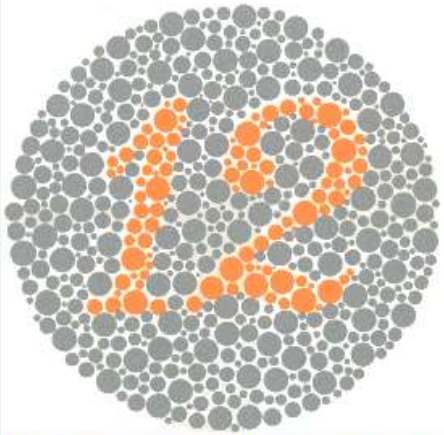
Sex-linked recessive traits

- More common in boys
- Because they only need to inherit one

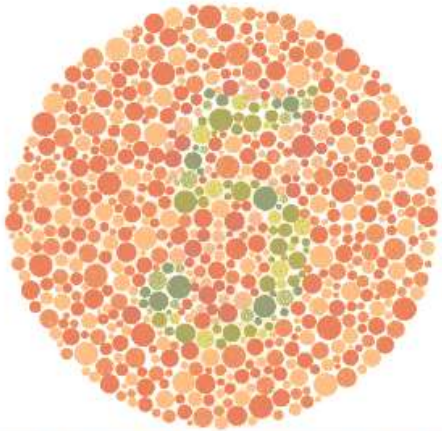
REMEMBER

- GENES are on CHROMOSOMES
- X and Y are different types of sex chromosomes

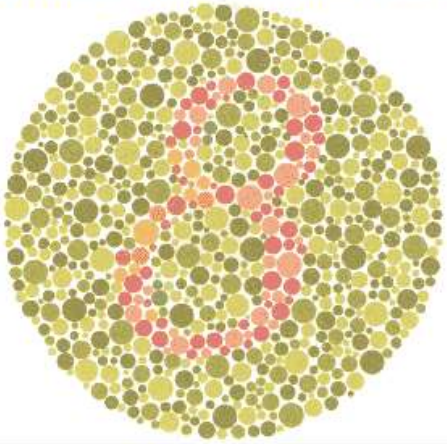
Ishihara Color Blindness Test Plate 1



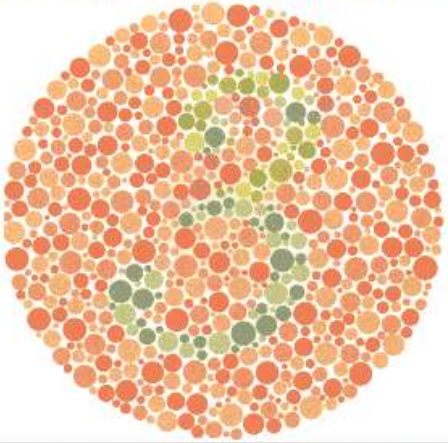
Ishihara Color Blindness Test Plate 4



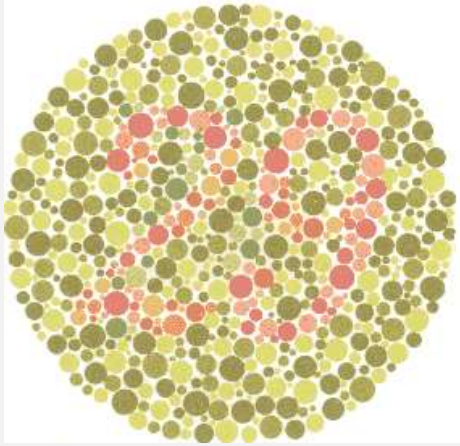
Ishihara Color Blindness Test Plate 2



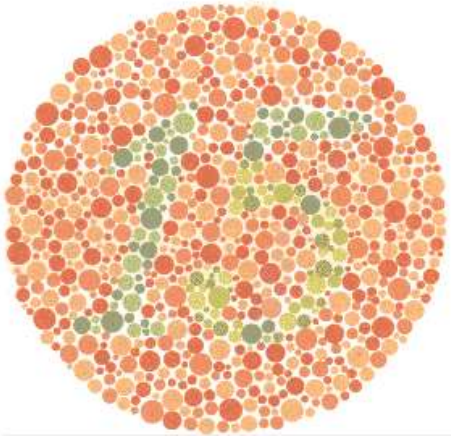
Ishihara Color Blindness Test Plate 5



Ishihara Color Blindness Test Plate 3

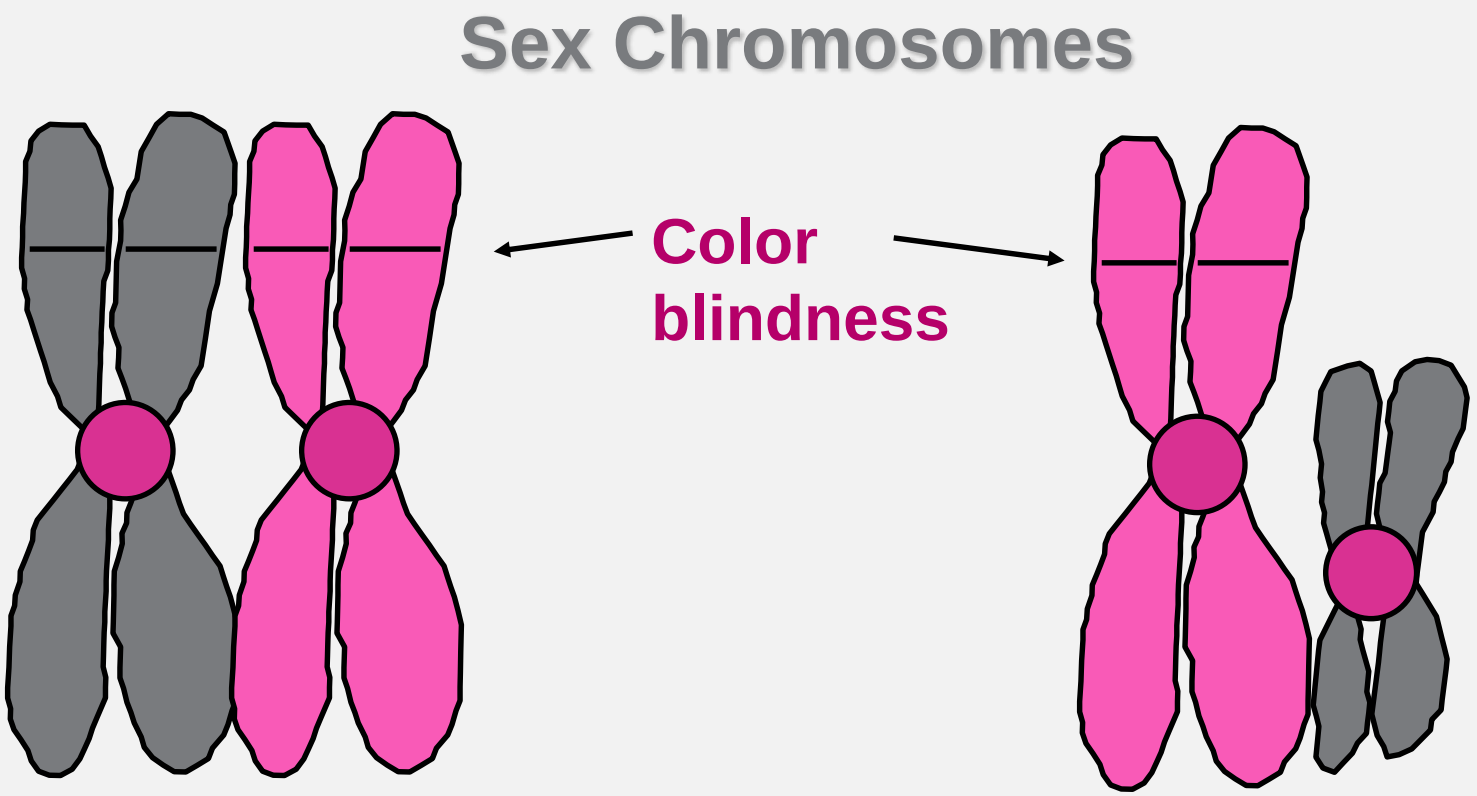


Ishihara Color Blindness Test Plate 6



Sex-linked Trait Problem

Example: color blindness in humans is sex-linked

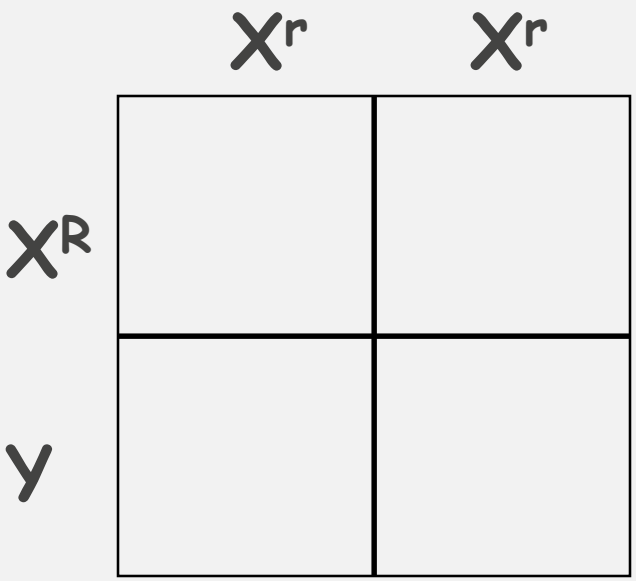


Sex-linked Trait Problem

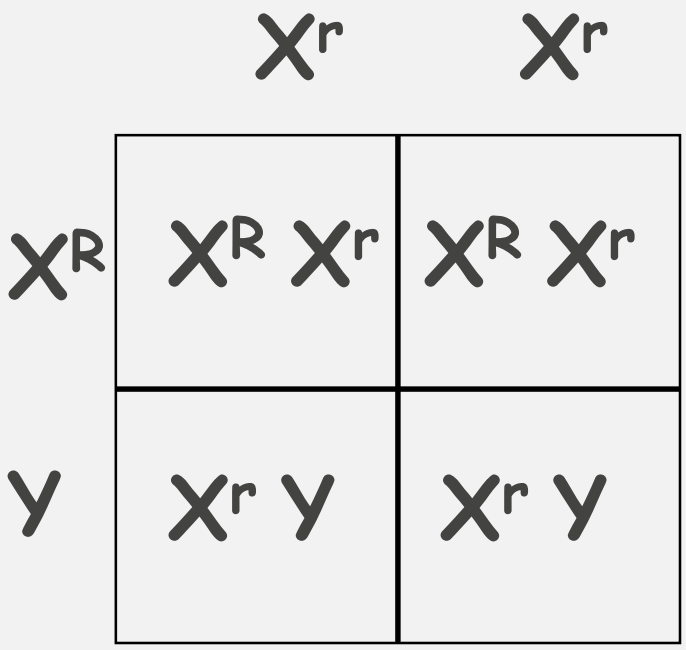
- **Example: color blindness**
  - **R = normal color vision**
  - **r = color blind**

- **normal male x color blind female**

X^RY x X^rX^r



Sex-linked Trait Solution:

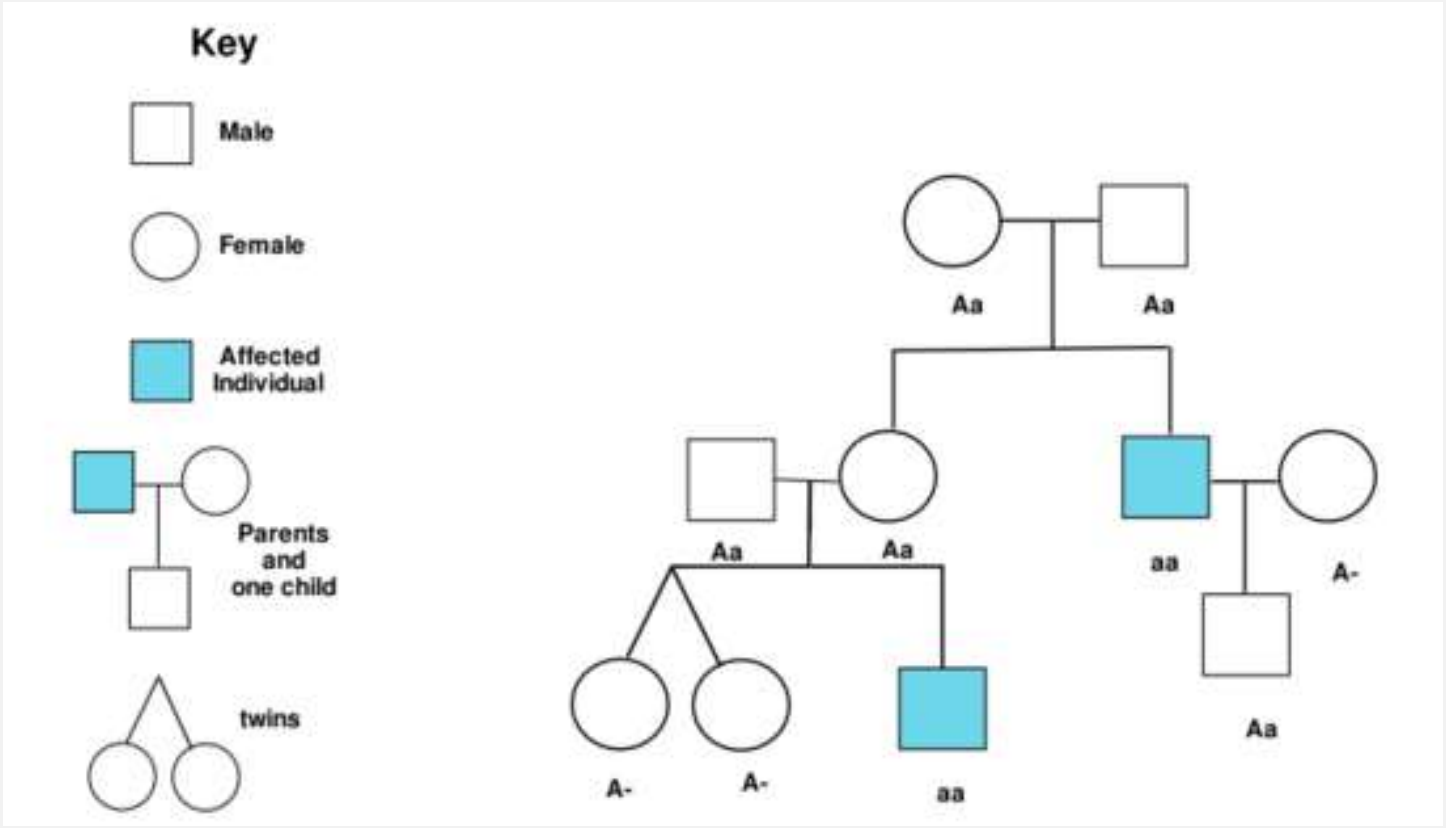


Normal vision father → <u>all daughters = normal vision</u>

Color blind mother → <u>all sons colorblind</u>

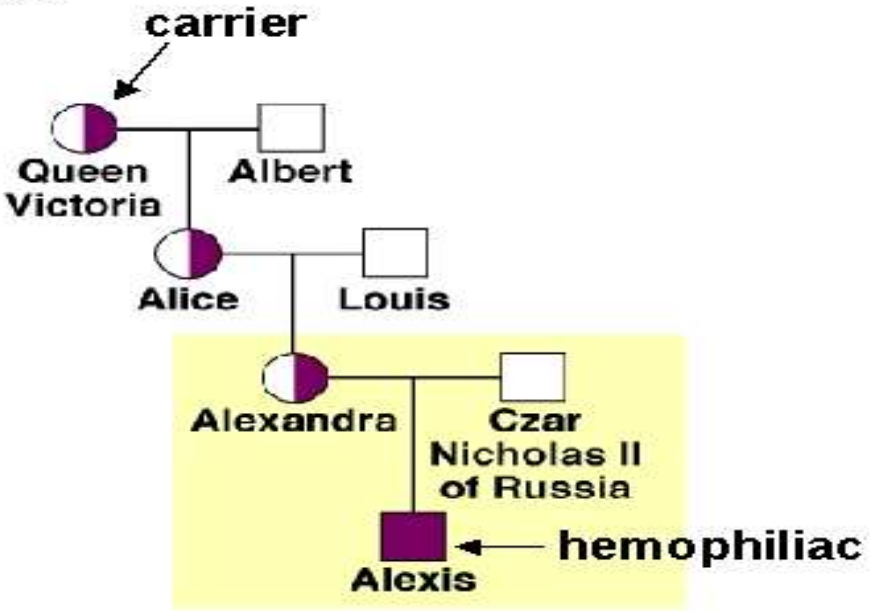
Pedigree Charts

- Diagrams to follow traits through generations.
- For recessive traits **carriers have one copy of the trait but are not affected**



Female Carriers

In a sex-linked trait (like hemophilia), women are carriers, and men have the phenotype more often.



Answer animation questions in notes

Practice questions in notes