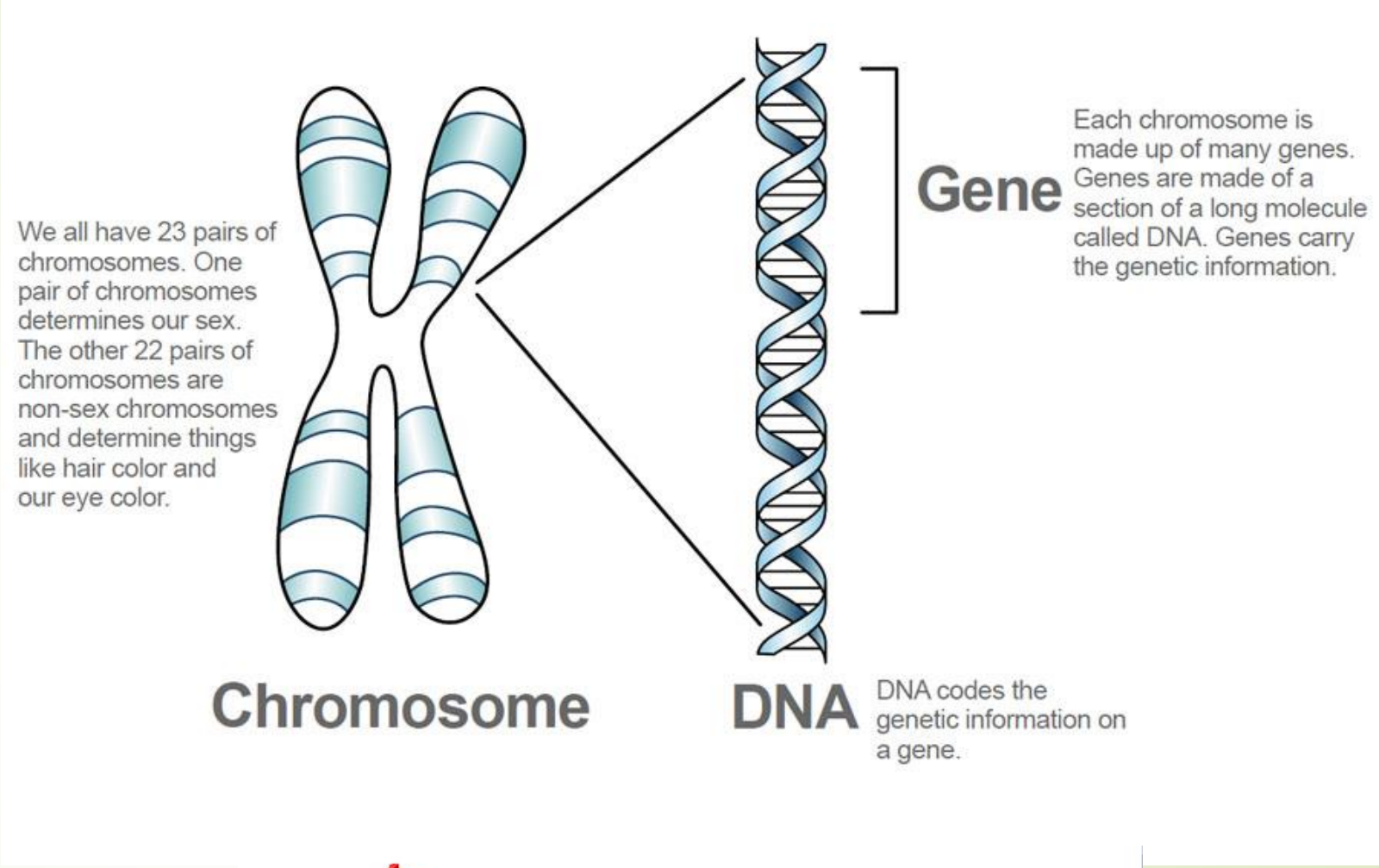
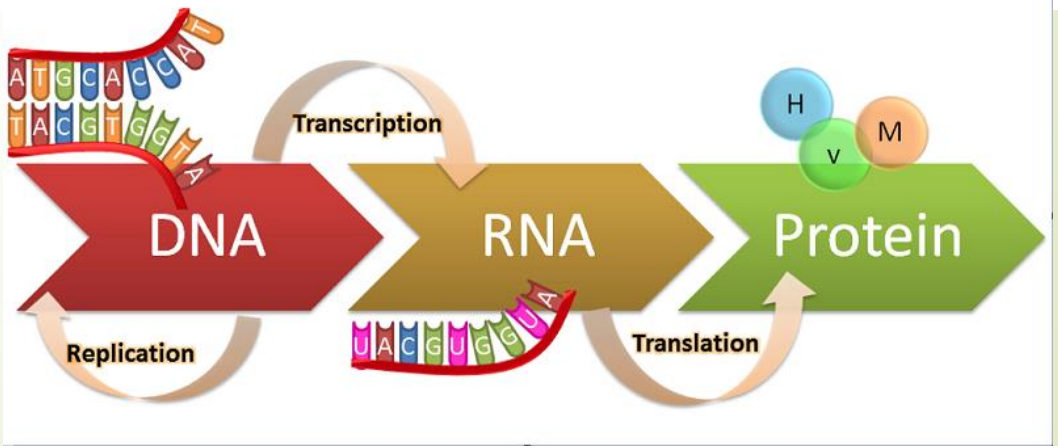
Unit 7

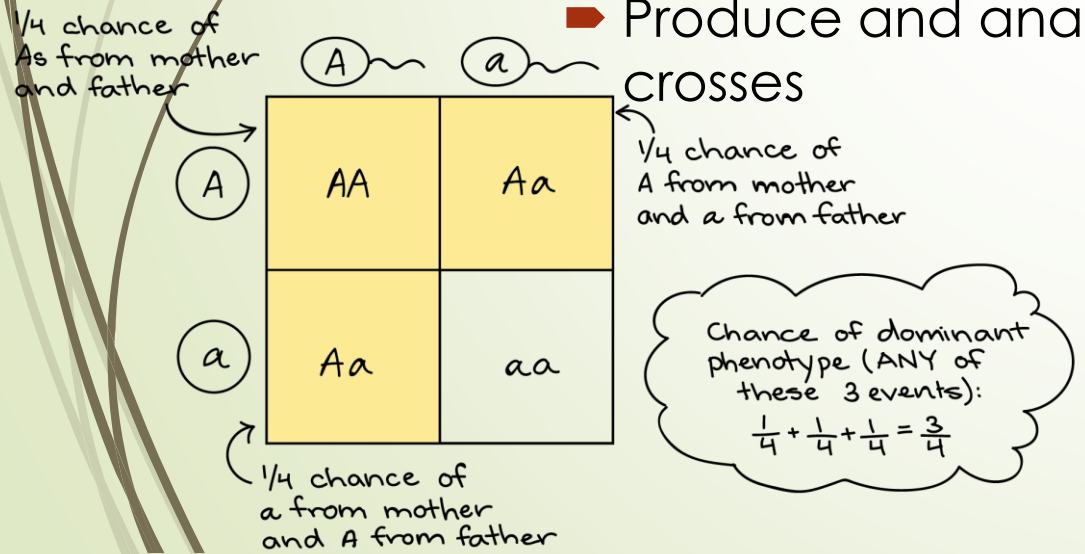
Genetics

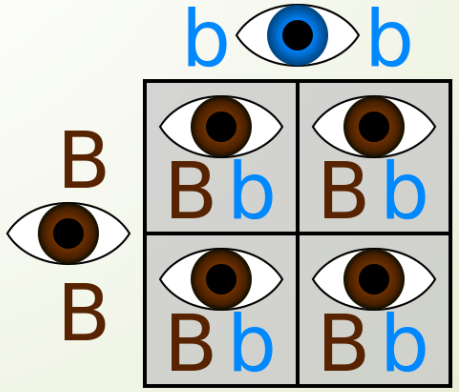




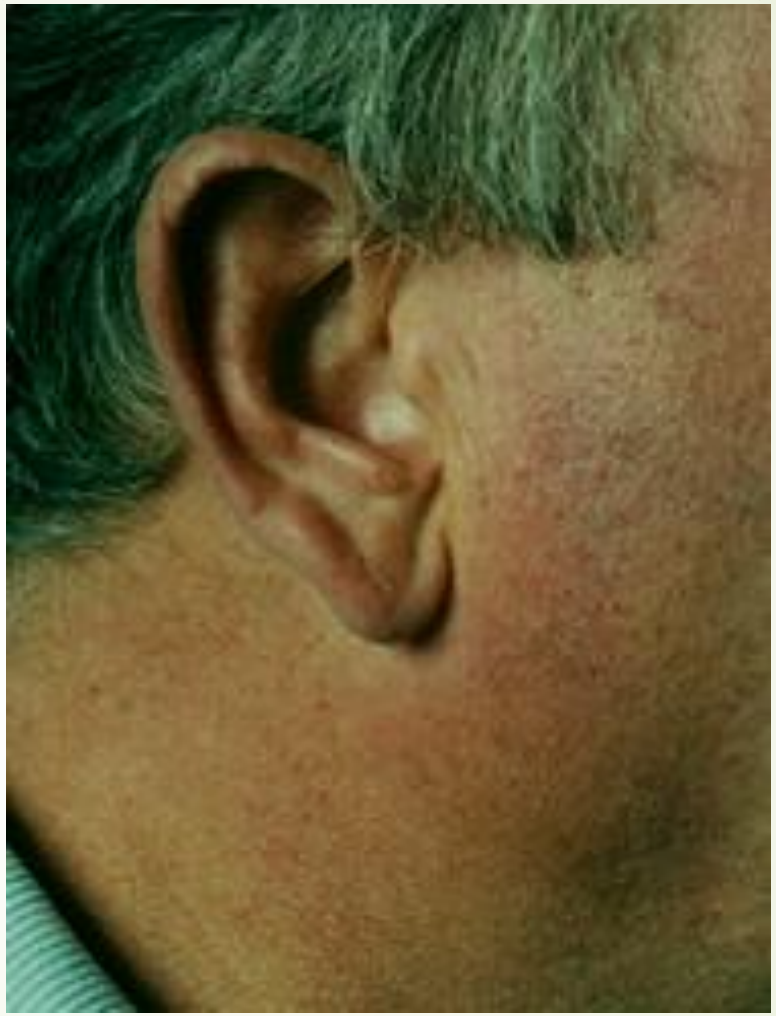
Topic 1: Mendel & Basic Crosses

- By the end of this topic, I should be able to:
  - Use basic genetic vocabulary (genotype, phenotype, homozygous, heterozygous, dominant, recessive)
  - Describe the experiments of Gregor Mendel and the laws he established
  - Produce and analyze Punnett squares for basic monohybrid crosses





Attached Lobe **Unattached Lobe**



Unattached Earlobe—dominant—chromosome 21

Hitchhiker's Thumb

Regular Thumb

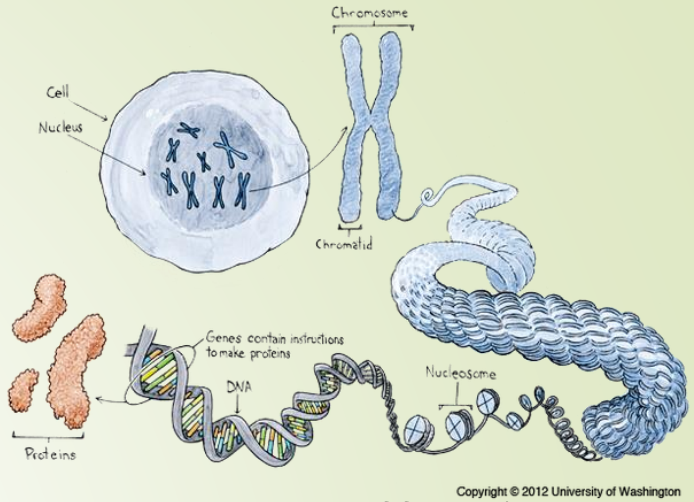
Straight Thumb is dominant--
--chromosome 17

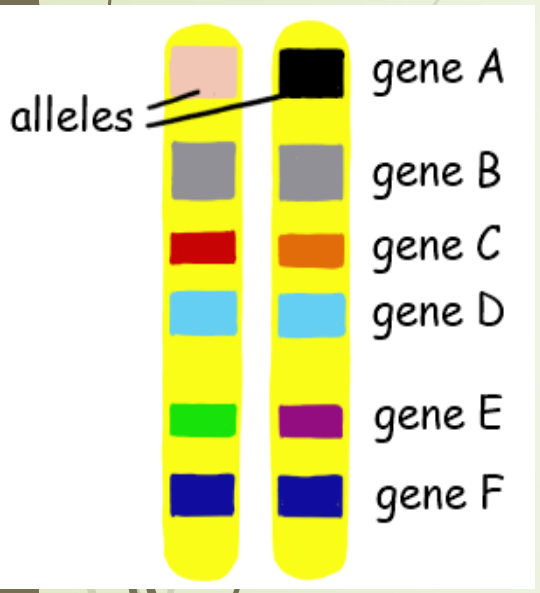
Short Second Toe

Long Second Toe

Long Second Toe Dominant---
Chromosome 20 TT or Tt

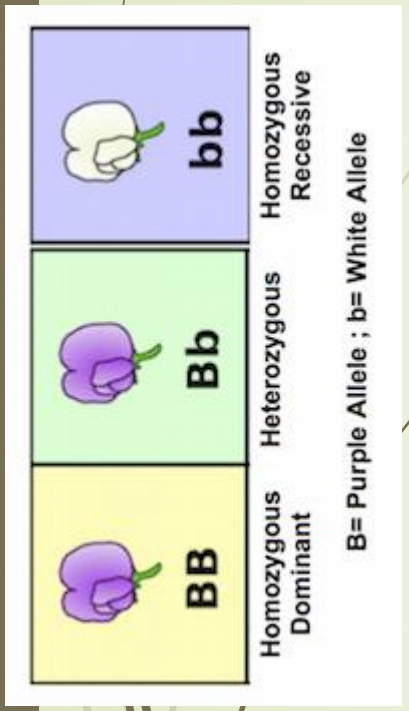
IMPORTANT GENETIC VOCABULARY:





- **Genetics** – the study of heredity
- **Heredity** - characteristics inherited from parents to offspring through genes (*passing of traits from parent to offspring*)
- **Trait** - specific characteristic that can be passed from parent to offspring (*hair color, flower color, seed pod*)
- **Gene** – protein code found on the DNA that determines a trait (*section of DNA that codes for a protein/trait*)
- **Allele** – a different form of the same gene that specifically designates what that trait will look like *(variation of a gene/trait*)

IMPORTANT GENETIC VOCABULARY:

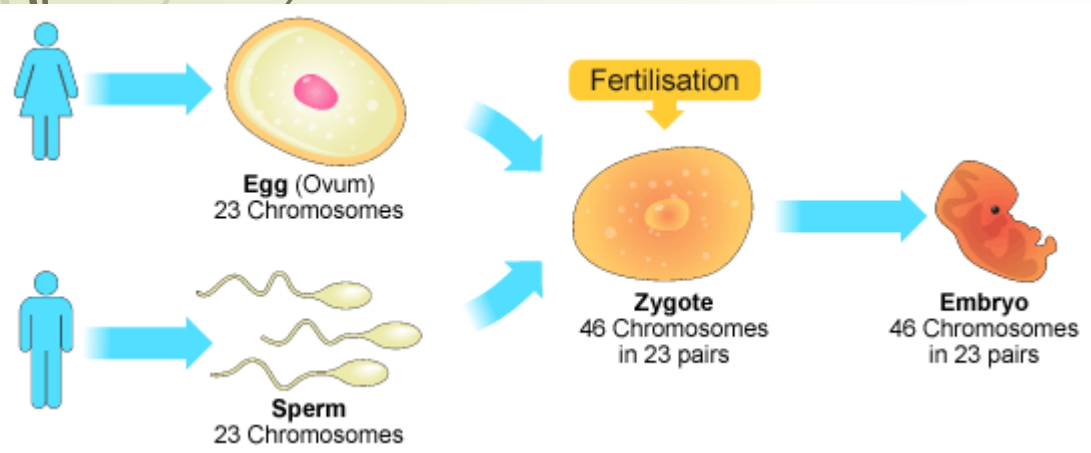


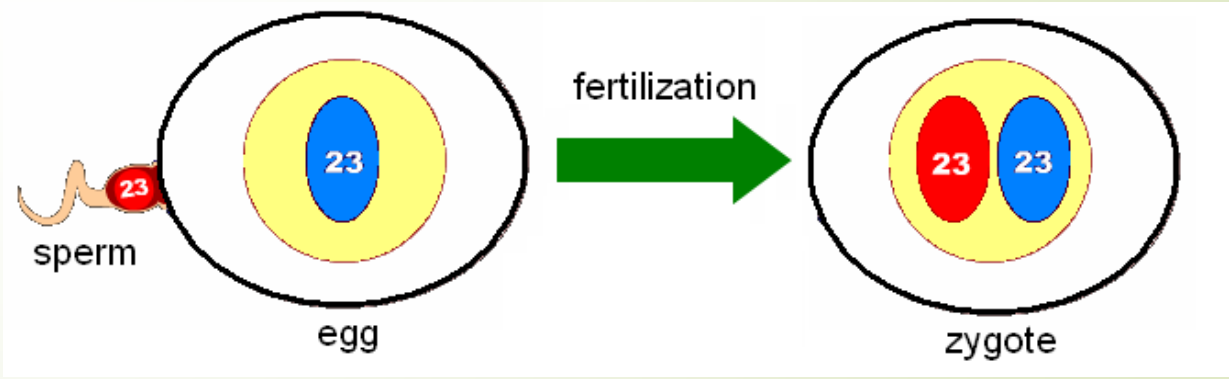
- **Dominant** – the trait that is visible (seen), always expressed (BB)
- **Recessive** – the trait that is **sometimes hidden** (not seen) when paired with a dominant trait. Only visible (seen) when there are 2 recessive alleles being expressed (bb)
- **Homozygous:** organisms that have 2 identical alleles for a particular trait and are called true-breeds (purebred – BB)
- **Heterozygous**: organisms have 2 different alleles for the same trait and are called hybrids (Bb).
- **Genotype:** Refers to the genetic make up of an organism. (Tt, Ss)
- **Phenotype**: Refers to the physical appearance of an organism. (Tall or short, yellow or green, short tail or long tail)

How are genes inherited?

- Humans have 2 sets of chromosomes for a total of 46 chromosomes. Each parent contributes only 1 set of chromosomes to their child.

- When a sperm cell (23 chromosomes) and an egg cell (23 chromosomes) join during fertilization, it results in a zygote (46 chromosomes).





We have homologous chromosomes (1 from each parent)… we inherit 2 copies of each gene

EXAMPLES OF DOMINANT TRAITS

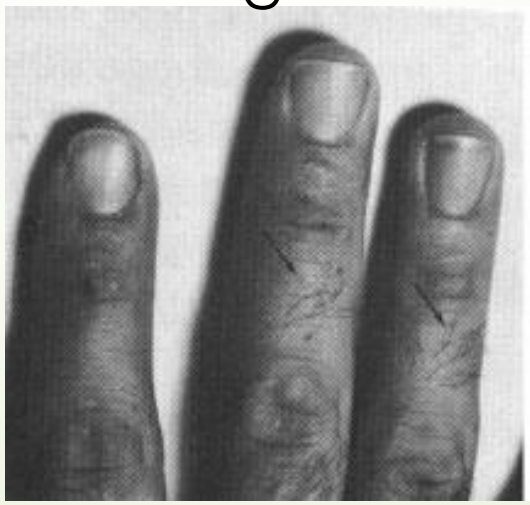
Tongue Rolling

Cheek Dimples

Red Eye Color in Flies

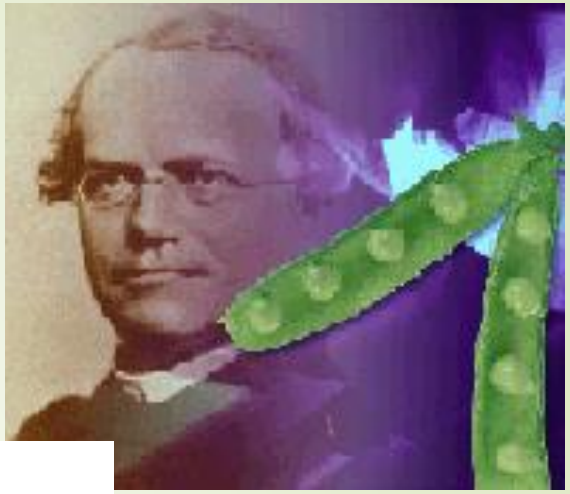
Widow's Peak

Mid-Digit Hair



Cleft Chin

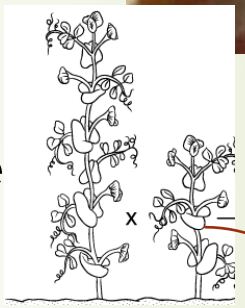
MENDELIAN GENETICS



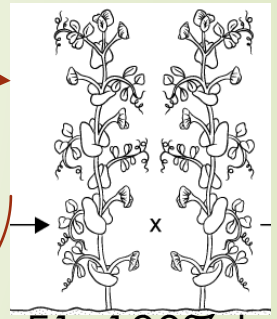
Known as "The Father of Genetics"

Studied English Pea Plants (1800s) to determine inheritance of traits.

Used Cross Pollination in plants to determine the process of inheritance.



P: tall x short



F1: 100% tall

Determined Generations:

(1). **Parental Generation** (purebreds – homozygous)
PP or pp Genotypes

(2). **F1 Generation** (hybrids – heterozygous Pp)

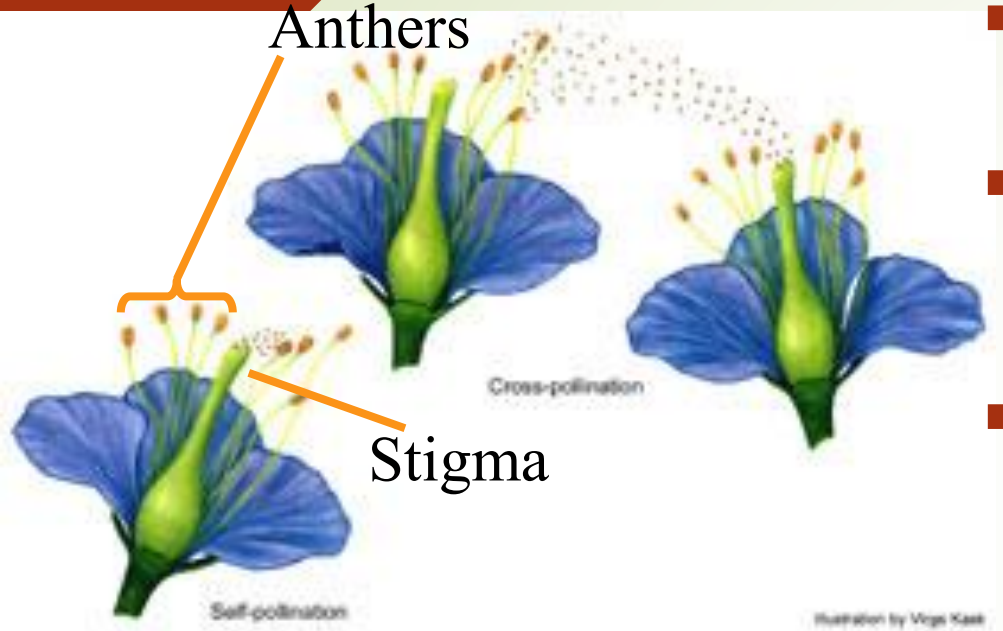
(3). **F2 Generation** (3:1 ratio of traits PP, Pp, pp)

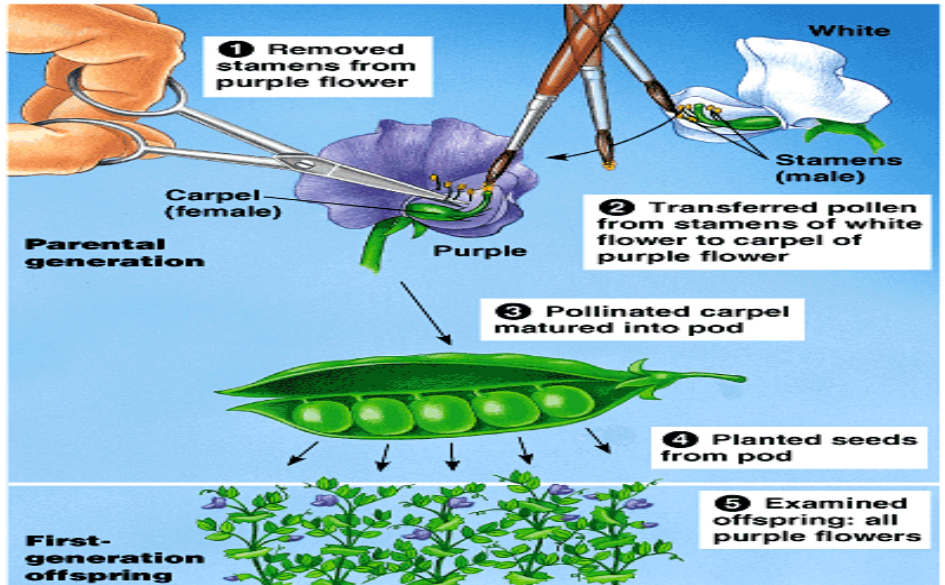
F2: 75% tall; 25% short

Why Use Pea Plants?

- Rapid reproduction.
- Male and female parts on same plant.
- Distinctive traits.
- Ability to control pollination and fertilization.

Some terms to know:



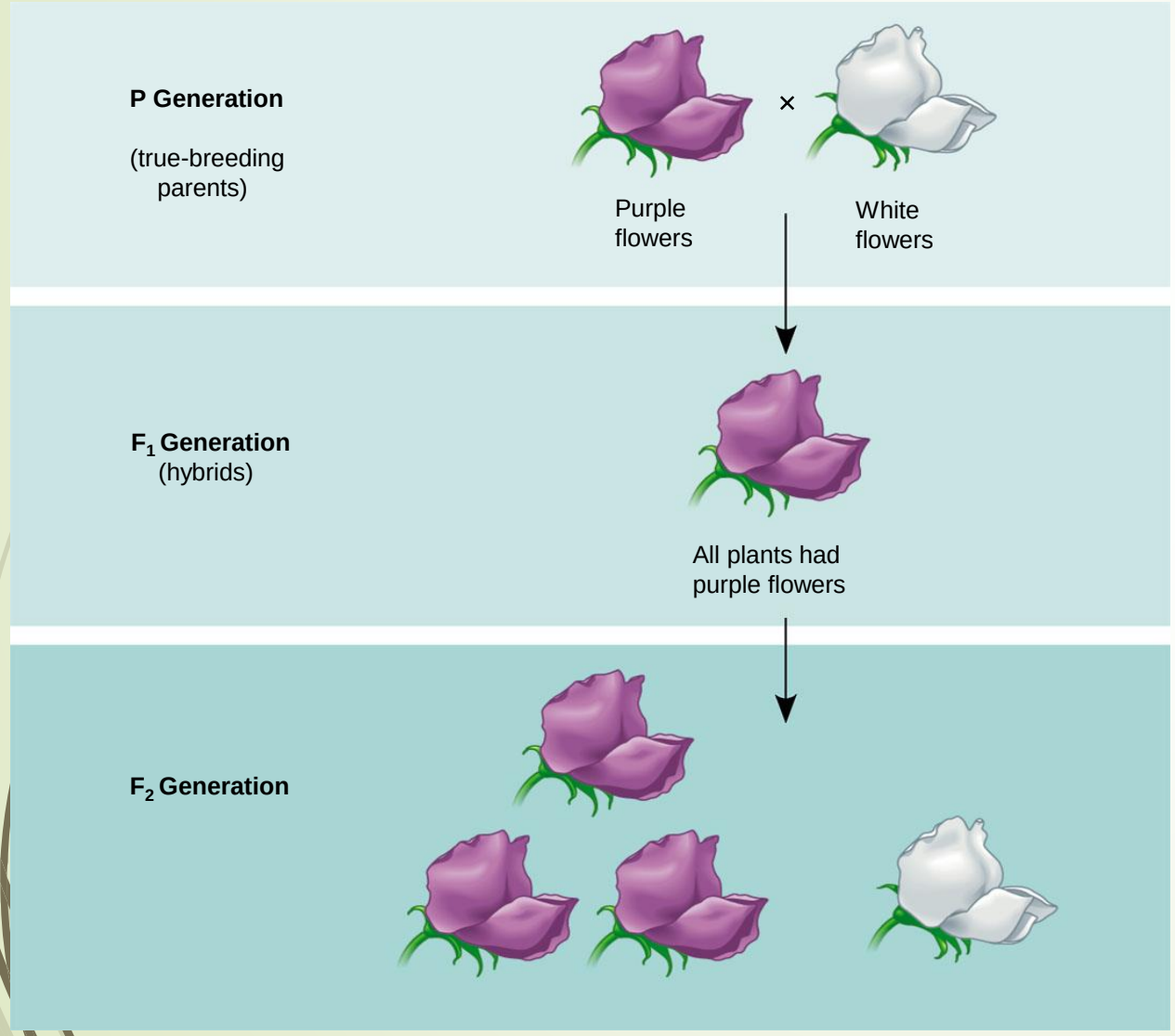


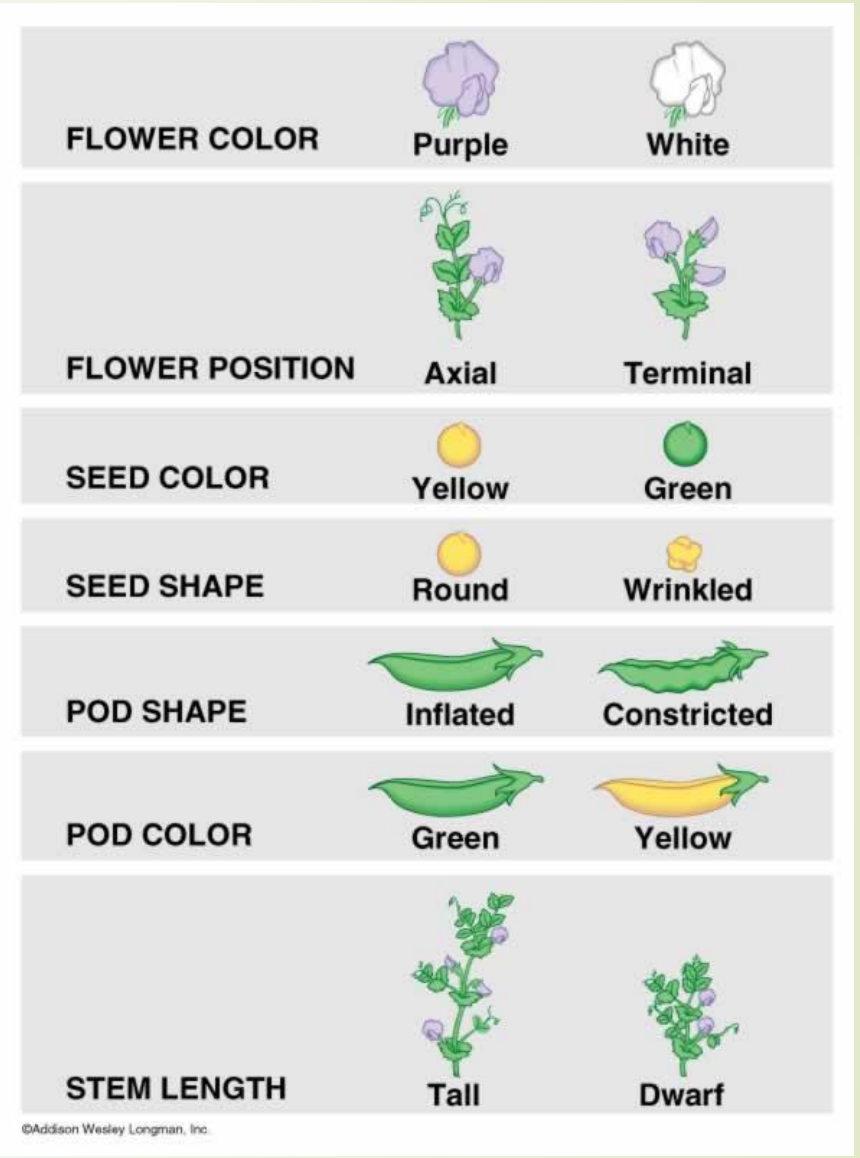
- Self-pollinating--sperm cells in pollen fertilize egg cells in the same plant
- Fertilization--during sexual reproduction, male and female reproductive cells join and produce a new cell.
- True-breeding peas--when they self-pollinated, they would produce offspring identical to themselves.

Cross-pollination-two different plants pollinating to produce seeds.

He wanted to produce seeds from two different plants.

- He took off the pollen-bearing male parts
- he dusted pollen from another plant


P Generation
(true-breeding parents)
Purple flowers
×
White flowers
F1 Generation
(hybrids)
All plants had purple flowers
F2 Generation


FLOWER COLOR
Purple
White
FLOWER POSITION
Axial
Terminal
SEED COLOR
Yellow
Green
SEED SHAPE
Round
Wrinkled
POD SHAPE
Inflated
Constricted
POD COLOR
Green
Yellow
STEM LENGTH
Tall
Dwarf
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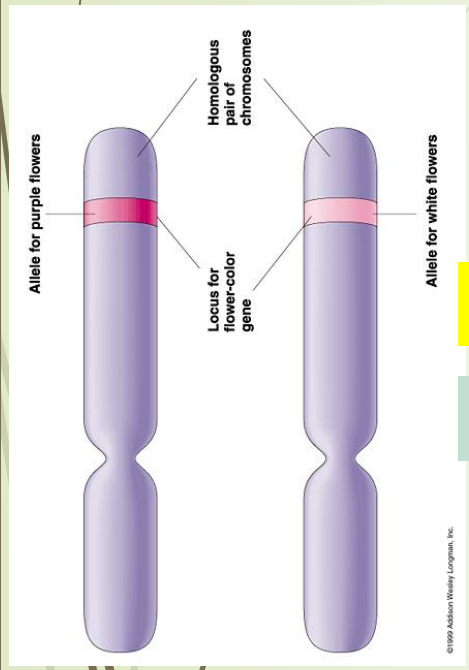
1st set of experiments

- Single factor cross (looking at one trait: monohybrid)
- Cross pollinated plants with opposite characteristics to see which trait would appear in the F1 hybrid
- Concluded individual factors called genes (that have different forms called alleles) control each trait of a living thing (and one may be dominant over another)

	Flower color	Flower position	Seed color	Seed shape	Pod shape	Pod color	Stem length
P	Purple × White	Axial × Terminal	Yellow × Green	Round × Wrinkled	Inflated × Constricted	Green × Yellow	Tall × Dwarf
F_1	Purple	Axial	Yellow	Round	Inflated	Green	Tall

The Law of Dominance (LAW 1)

- Alleles can be either dominant or recessive (strong or weak)
  - Dominant alleles are observable
  - Recessive alleles are not usually observable, when the dominant allele is present (can still be in genotype)



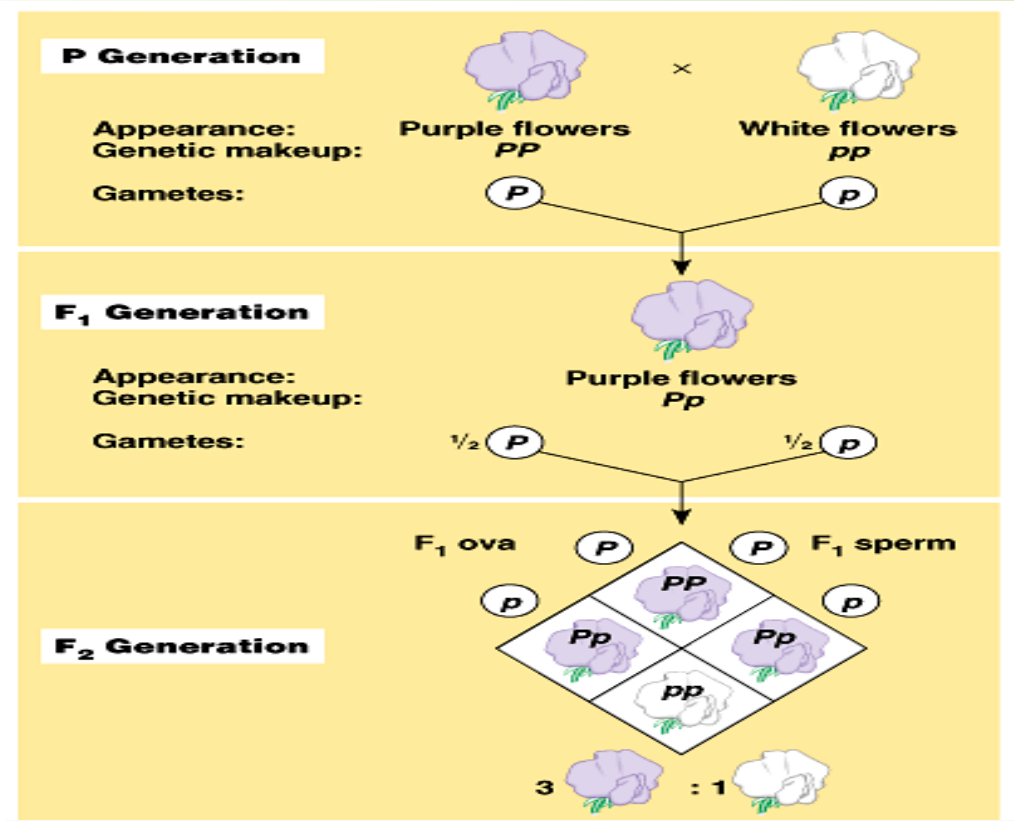
- A CAPITAL LETTER = DOMINANT allele (Ex. A = Purple allele)
- A lower case letter = recessive allele (Ex. a= White allele)

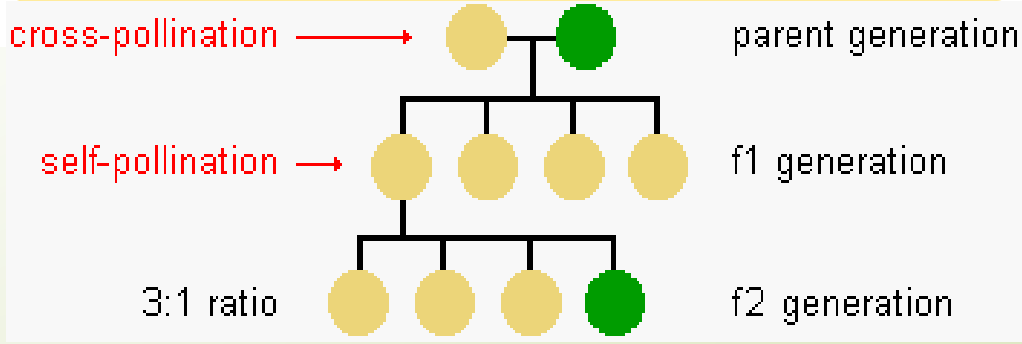
- Each trait requires TWO alleles
  - AA = *homozygous dominant*
  - Aa = *heterozygous*
  - aa = *homozygous recessive*

Genotypes ***Phenotypes*** ***Description of genotype***

2nd set of experiments

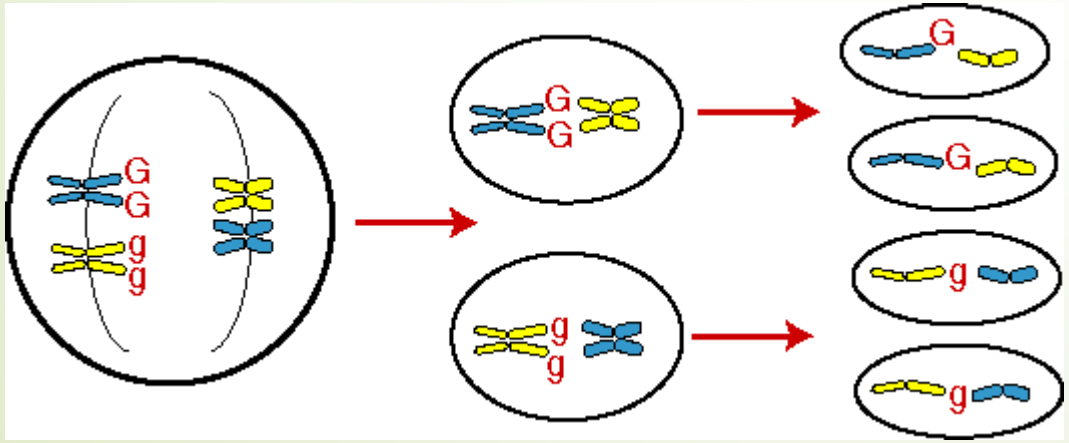
- Wanted to know what happened to recessive factors so let F1 hybrids self pollinate
- Concluded that a dominant allele had covered up (masked) the recessive allele in the F1 generation
- Observed that a recessive allele had segregated from dominant allele in the F2 generation

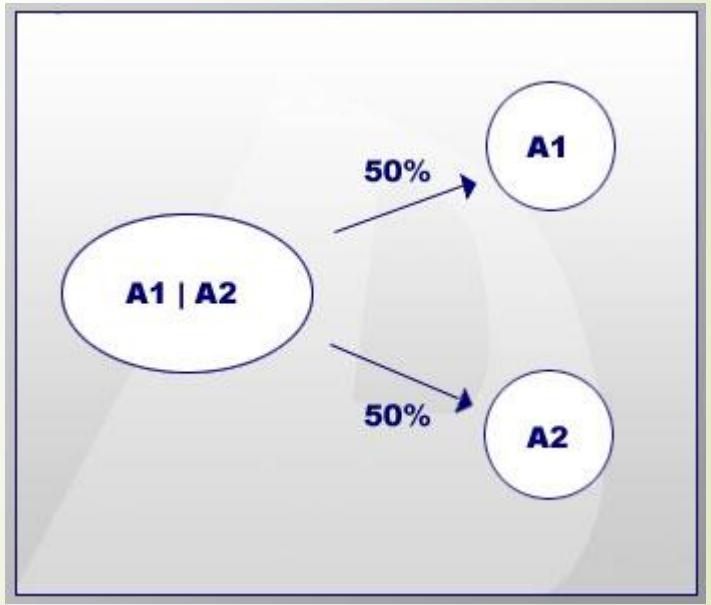


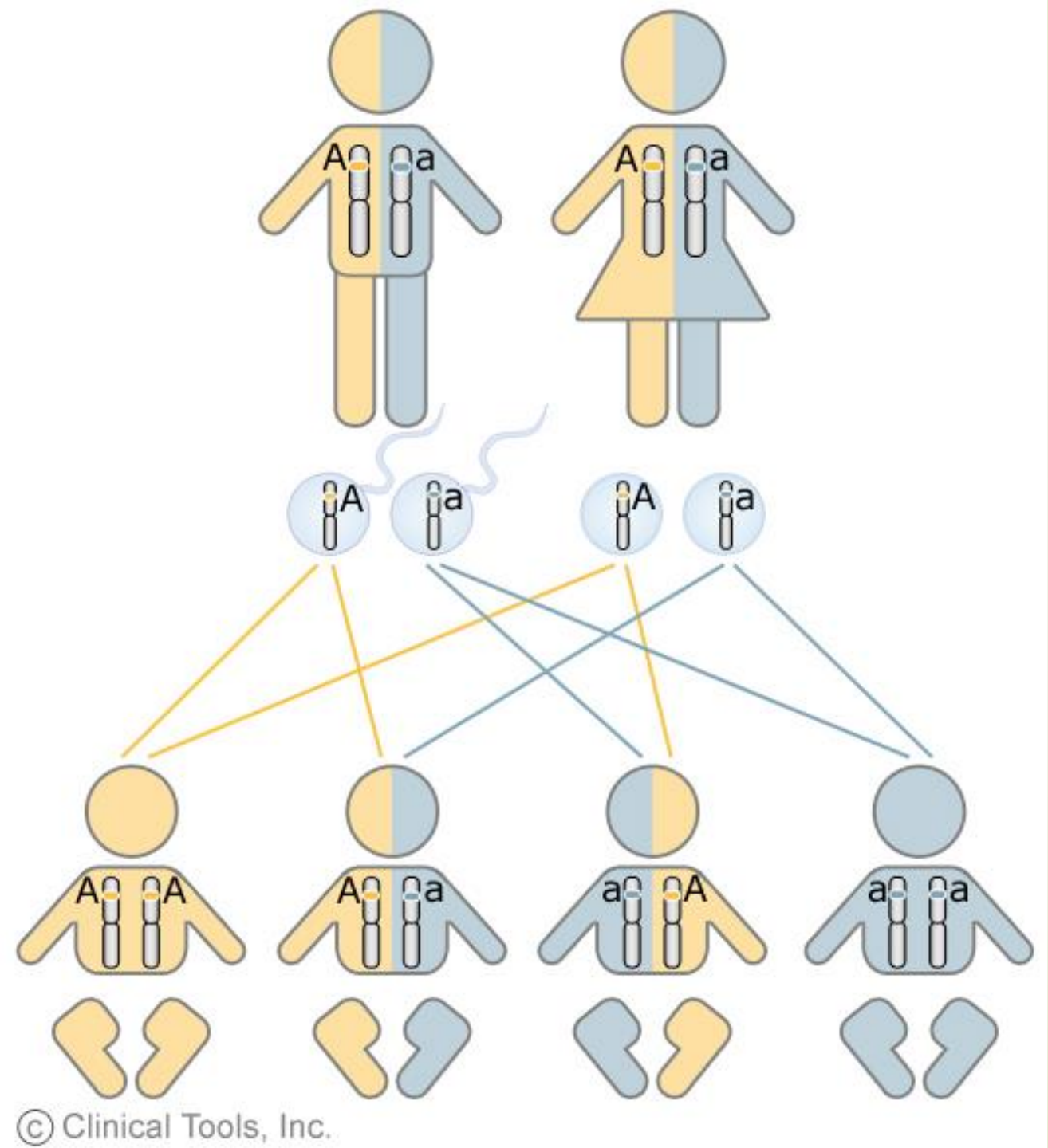


The Law of Segregation (LAW 2)

- Alleles for a gene separate when forming a sperm and egg (meiosis)
- There are TWO alleles for each trait (1 in each of the chromosome pairs)
- When eggs and sperm are made, the <u>two alleles are separated from each other</u> (on their respective homologous chromosomes)



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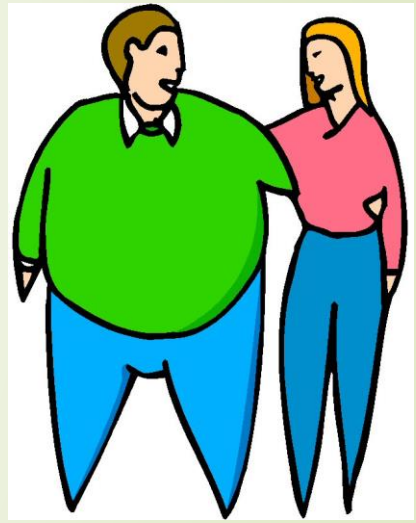
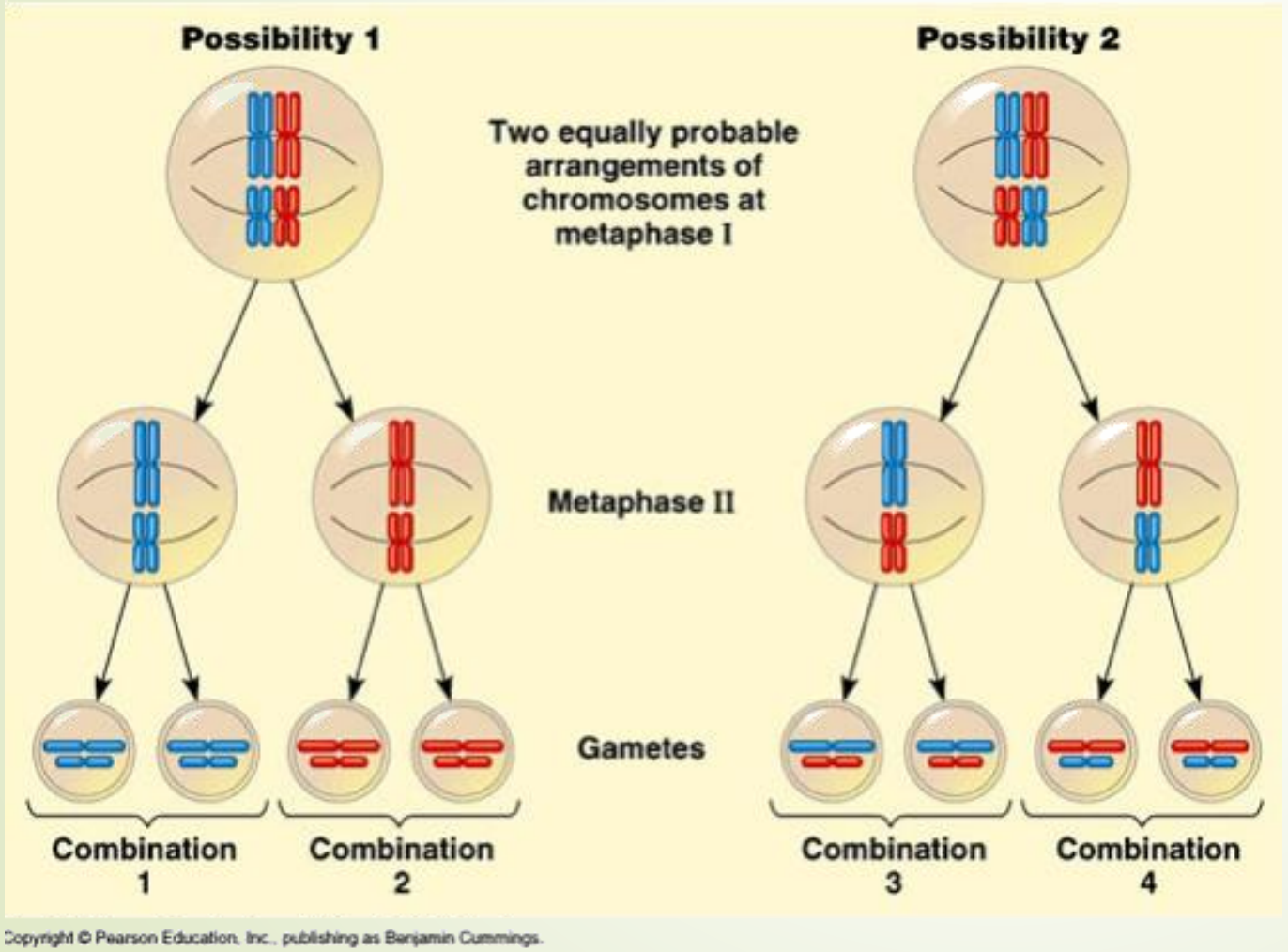
Law of Independent Assortment (LAW 3)

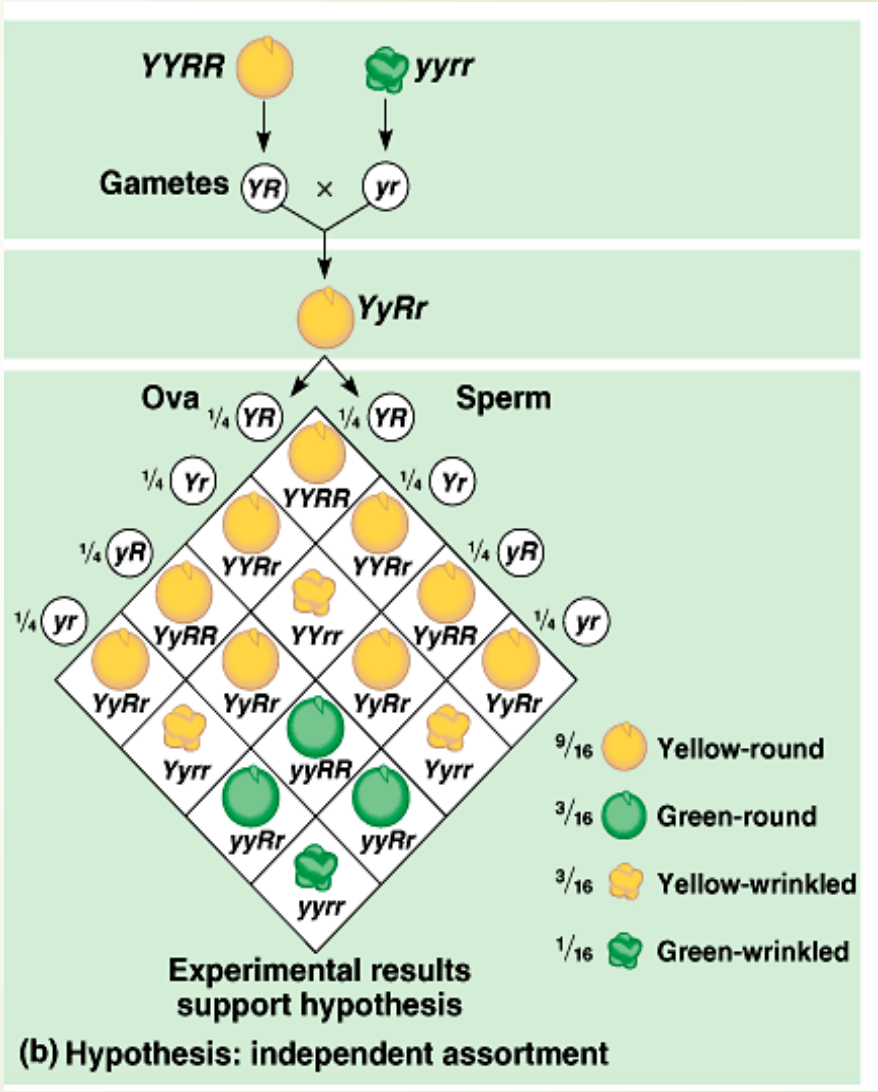
- Alleles for different genes are distributed to sperm and egg independently
- Could be
  - tall and fat
  - Short and thin
  - Tall and thin
  - Short and fat
- Why all siblings do not look exactly alike
- Each pair of alleles sorts out independently during gamete formation
  - Ex. Brown hair and brown eyes aren't connected



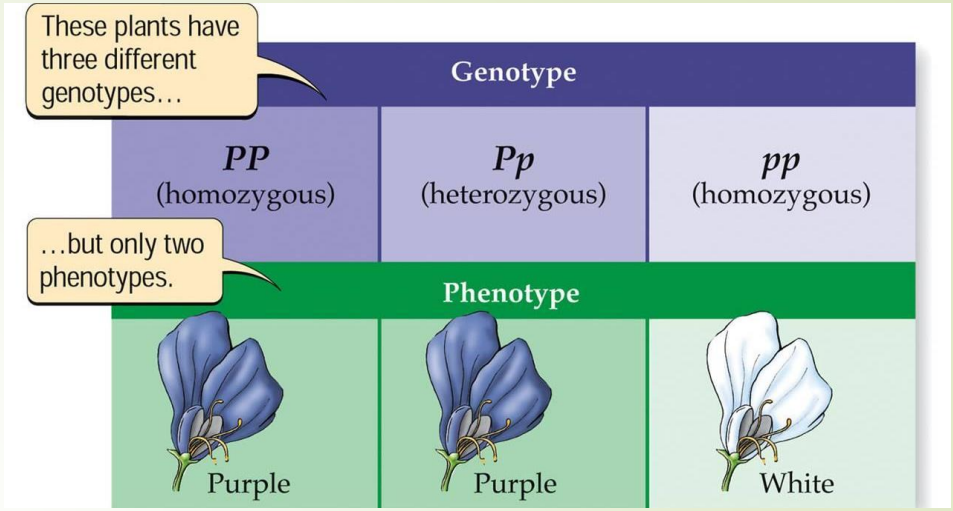
INDEPENDENT ASSORTMENT

"the random alignment of homologous chromosomes at metaphase plate (Metaphase I)"





http://fig.cox.miami.edu/~cmallery/150/mitosis/c13x9independent-assortment.jpg

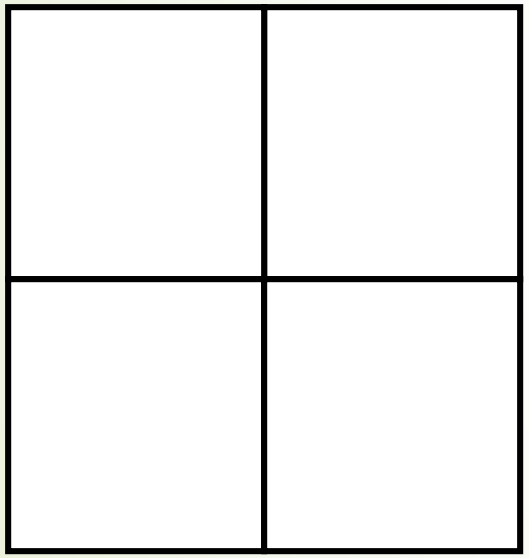


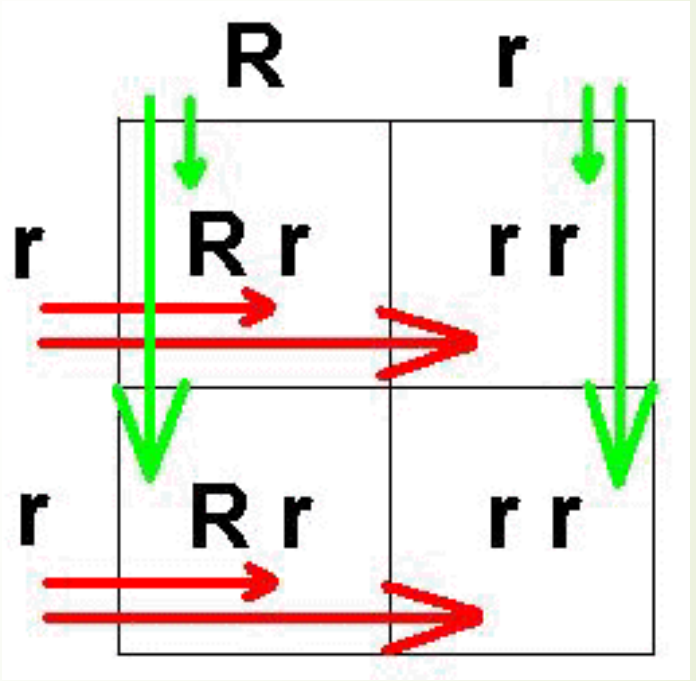
Tools for determining likelihood of an organism inheriting a specific trait

Punnett squares; probability

What is a Punnett Square ?

- A tool or grid used to predict and compare the genetic variations that will result in a cross of two organisms traits.





Probability: Likelihood that event will occur

Probability predicts average outcome from a *LARGE* # of events

Small # of events not always "accurate"

- Punnett squares are used to predict and compare the genetic variations that result from a cross using the *principles of probability*
  - Ratios:
    - ¼ : fractions
    - 3:1 (dominant phenotype to recessive phenotype)
    - 1:2:1 (DD: Dd: dd)
  - Percentages:
    - ½ = 50%

Dominant and Recessive
(T = Tall & t = short
Cross: Tt x Tt

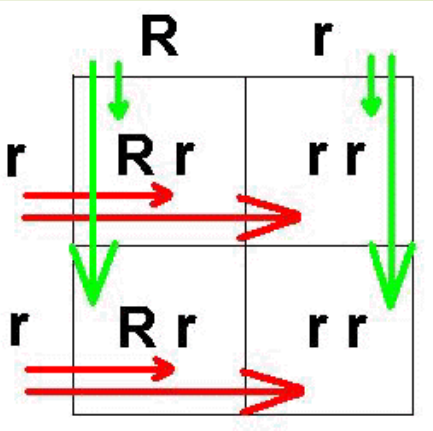
	T	t
T	TT	Tt
t	Tt	tt

Genotypic ratio: 1 : 2 : 1 (TT=25% Tt=50% tt=25%)

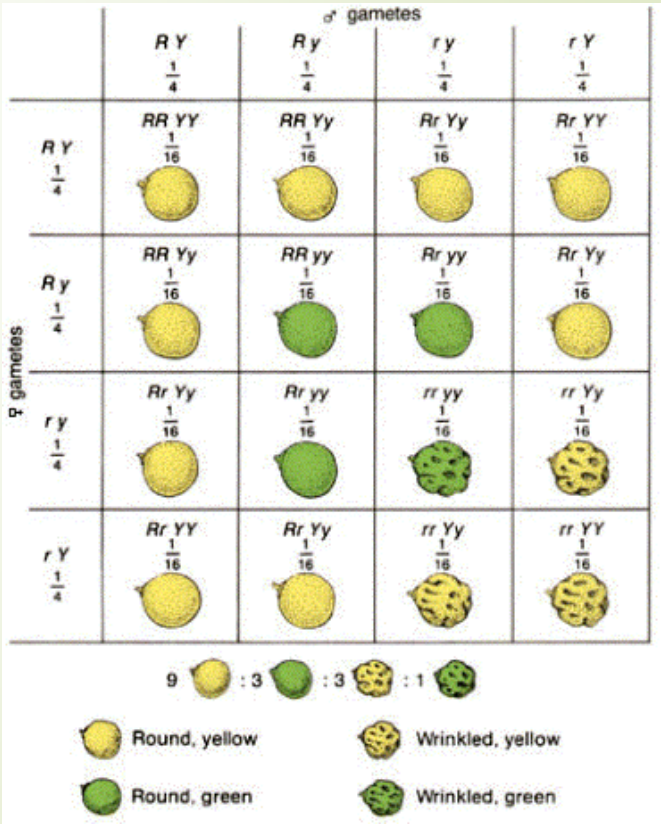
Phenotypic ratio: 3 : 1 (Tall=75% Short=25%)

Two Types of Punnett Squares

Monohybrid: A Punnett Square that tests for the inheritance of one trait (example: long necks)

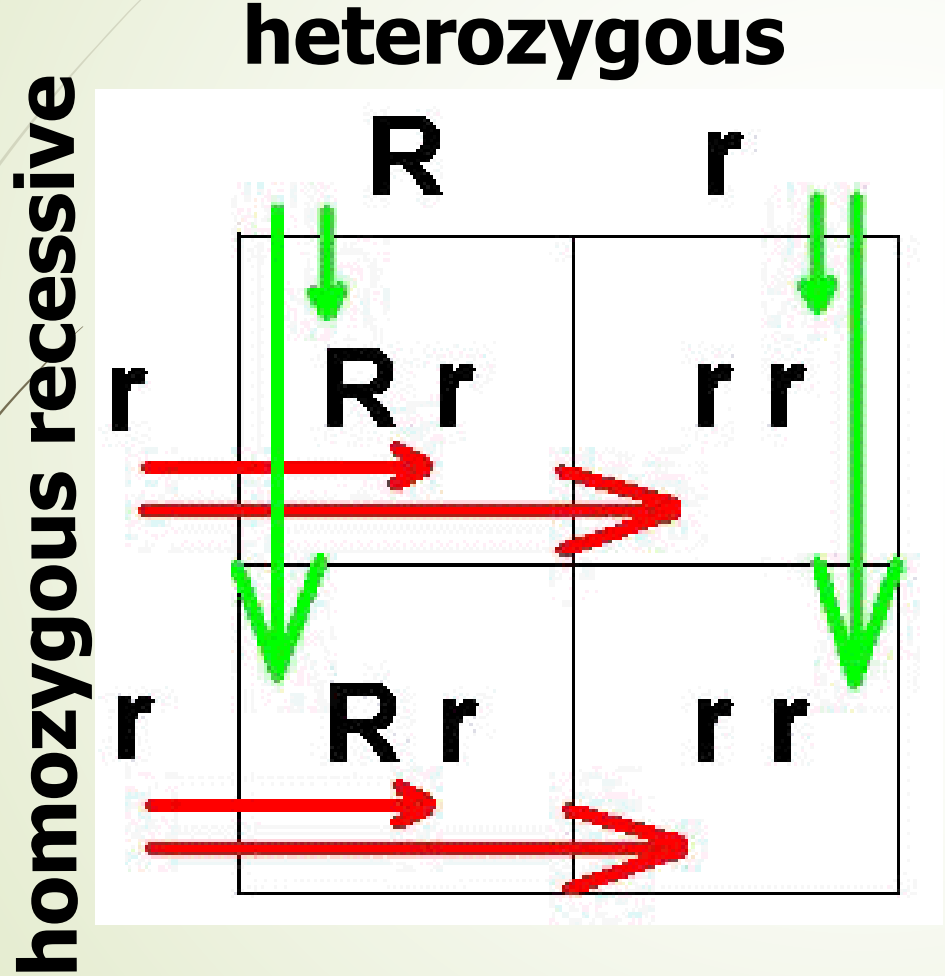


Dihybrid: A Punnett Square that tests for the inheritance of two traits (example: long necks and fur color).



Punnett Squares

RED HEADS (r) vs BLONDES (R)



Genotypes

Rr - 50%

rr - 50%

Phenotypes

Red - 50%

Blonde - 50%

Example 1: Homozygous x Homozygous

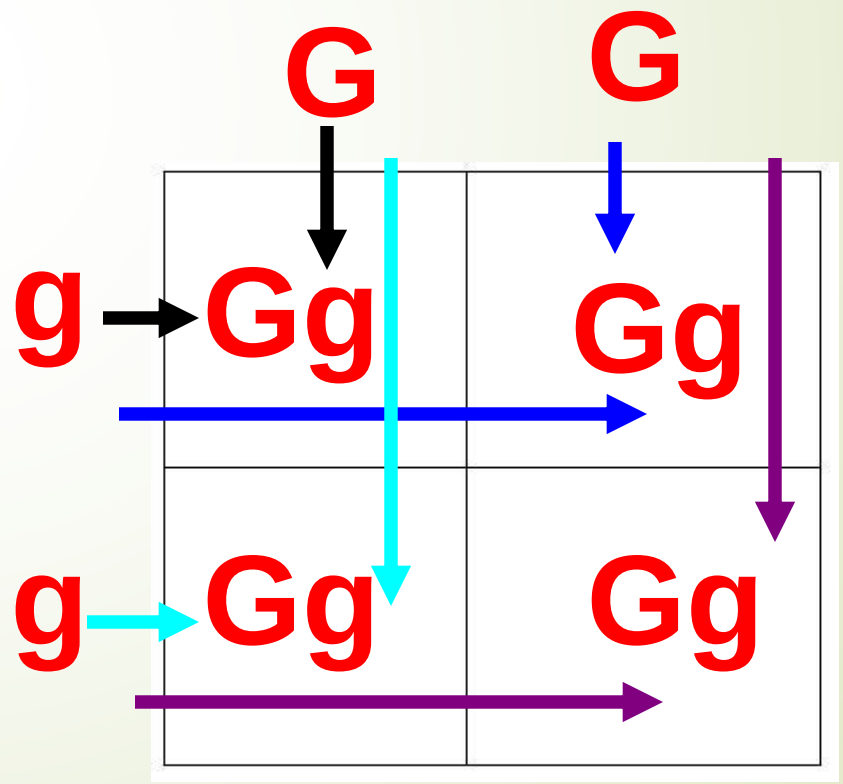
Situation: One parent is homozygous for green pods(GG) and the other parent is homozygous for yellow pods(gg).

Parent Genotypes: GG X gg

Offspring Ratios

-Genotype: 100% Gg

-Phenotype: 100% green



Example 2: Homozygous X Heterozygous

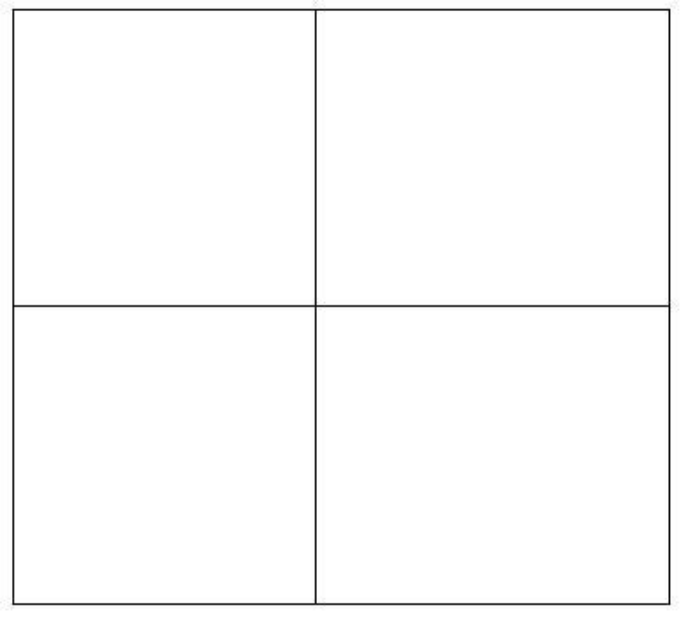
Situation: One parent is homozygous for green pods, and the other parent is heterozygous.

Parent Genotypes: GG x Gg

Offspring Ratios

-Genotype: 50% GG, 50% Gg

-Phenotype: 100% green



Example 3: Heterozygous X Heterozygous

Situation: Both parents are heterozygous for pod color

Parent Genotypes: Gg x Gg

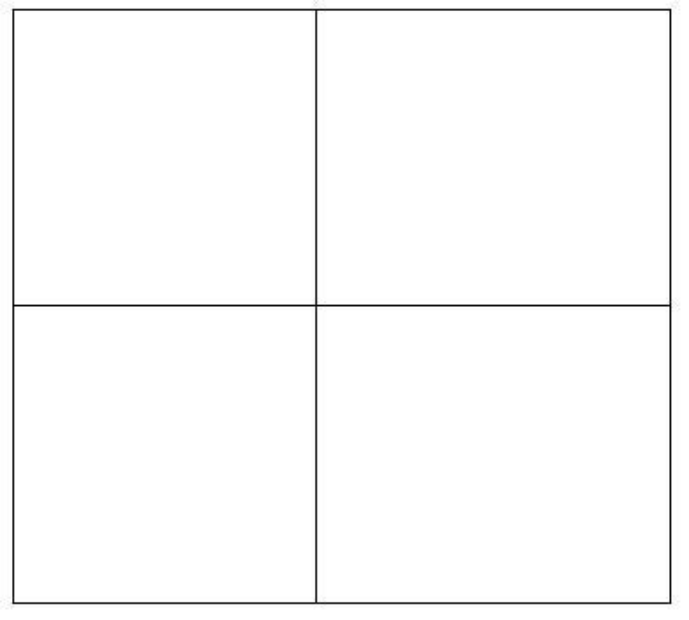
Offspring Ratios

-Genotype: 25% GG

50% Gg

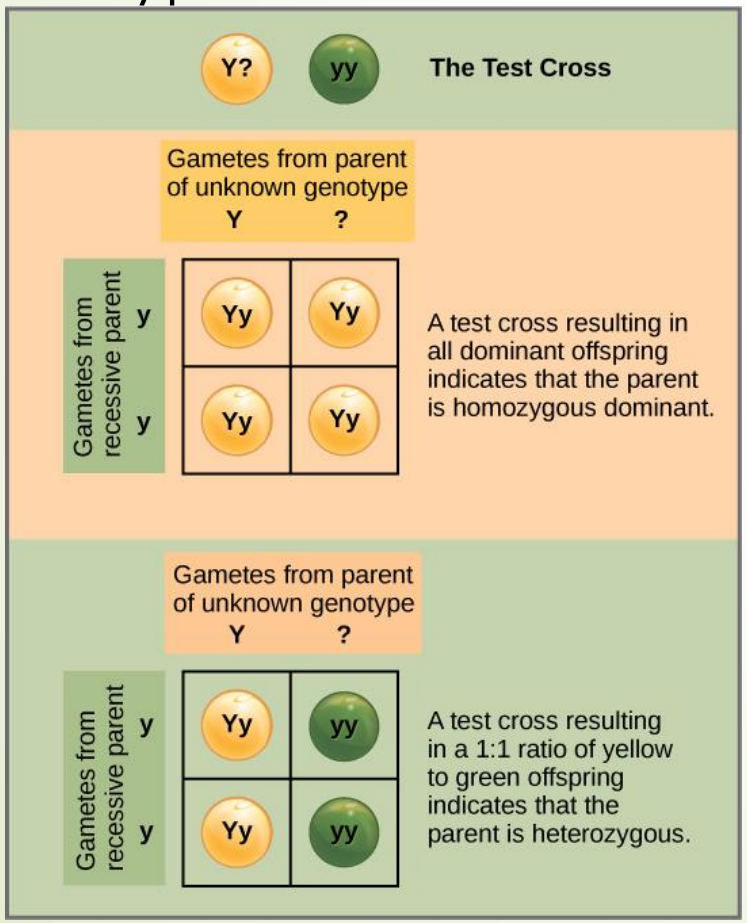
25% gg

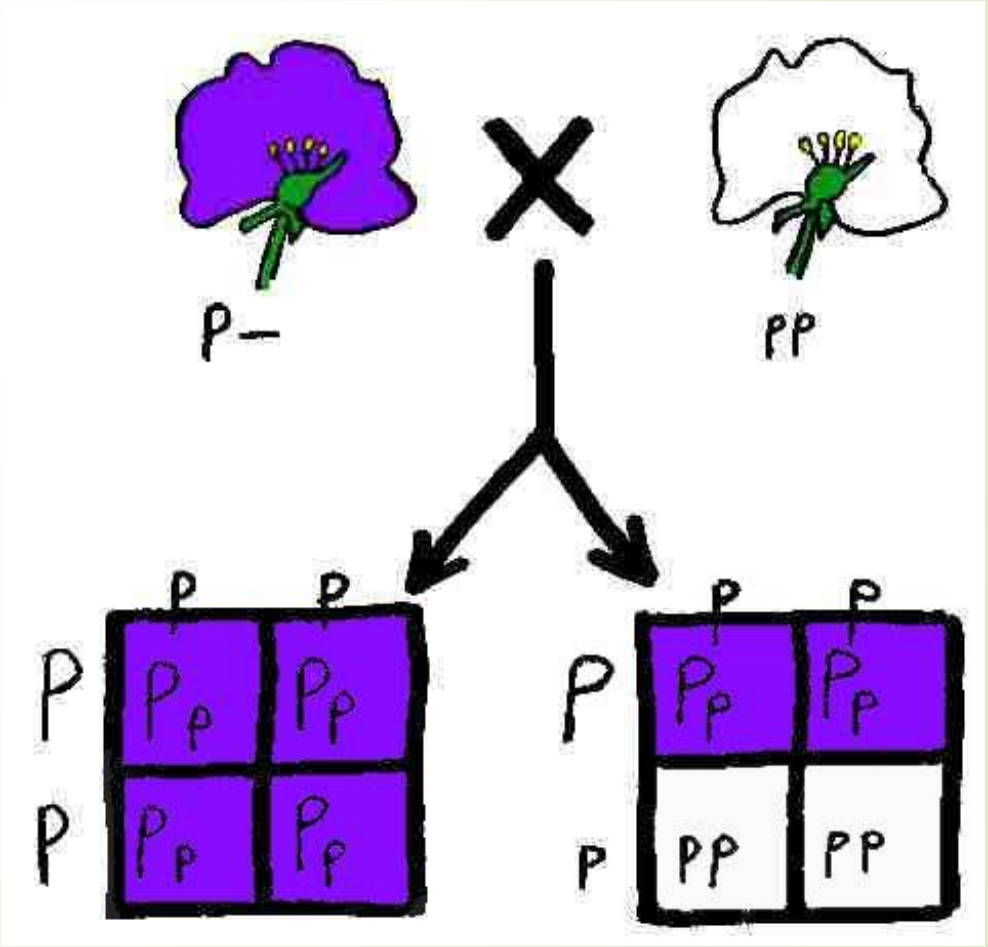
-Phenotype: 75% green, 25% yellow



Test Cross

- Process of crossing an unknown genotype individual to a homozygous recessive individual to determine what the unknown genotype is.





Example 4: Testcross

Situation: a green-podded plant with an unknown genotype is crossed with a yellow-podded plant. The offspring genotype ratios are given below.

Genotype Ratio: 50% Gg, 50% gg

Question: What was the genotype of the parent green-podded plant? **Gg**

	?	?
g	Gg	gg
g	Gg	gg