Blue is the New Black

How genes can influence appearance.

Backstory

Humans have selectively bred plants and animals for thousands of years in order to create variations most useful to our purposes.

This has resulted in turning wild plants from things like this:

to this:

and this:

and this:

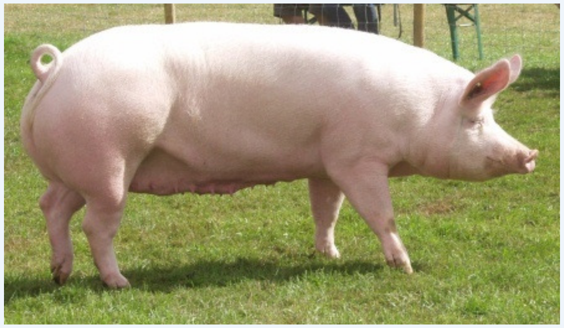
We have changed animals from this:

and this:

and this:

to this:

to this:



to this:

For example, if a person wanted a strong horse to pull a cart, they would find the biggest, strongest horse they could and breed it to another big, strong horse.

If they did this over enough generations, they learned they could turn this:

to this:

We didn't always know it, but we were using genetics to shape wild animals into the domesticated versions we found useful.

This is because physical characteristics are based on genes coded into DNA.

Predictable Patterns

Often, the kinds of offspring that are produced from a particular parental match can be somewhat predictable.

Take, for example, coat color in mammals. Many mammals have very predictable colors:

Polar bears are white……….. raccoons have masks………….. tigers have stripes….… and so on.

This is because coat color is based on the DNA passed down from parent to offspring.

The same is true for a breed of dog called the Greater Swiss Mountain Dog.

They have a tri colored coat consisting of black, red, and white which exhibits a fairly predictable pattern.

This is because the black, red, and white pattern is passed from parents to offspring on the DNA contained within gametes.

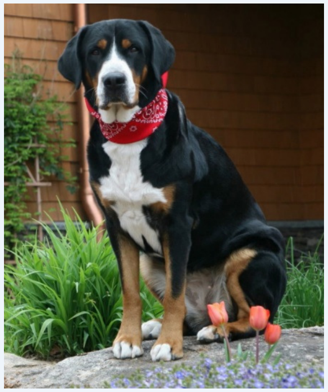
Father

Daughter

So, explain this….

Dad

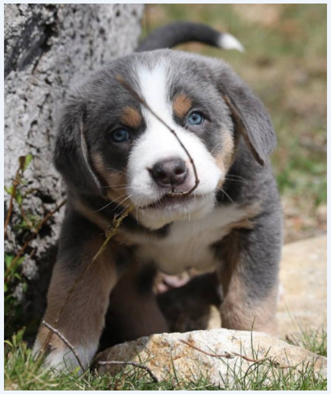
Mom



Son

These two black, red, and white parents were bred together and produced this blue, tan, and white baby.

What's more…. his littermates looked like this:



Blue is the New Black

Blue is known to occur on rare occasions in Greater Swiss Mountain Dogs, but is considered a "fault."

The breeder of this litter was shocked to find 5 of the 6 puppies were blue! She went back 4 generations and only found black dogs.

Because blue is known to occur in Swissies, the breeder knew it could ***not*** be a new, random mutation.

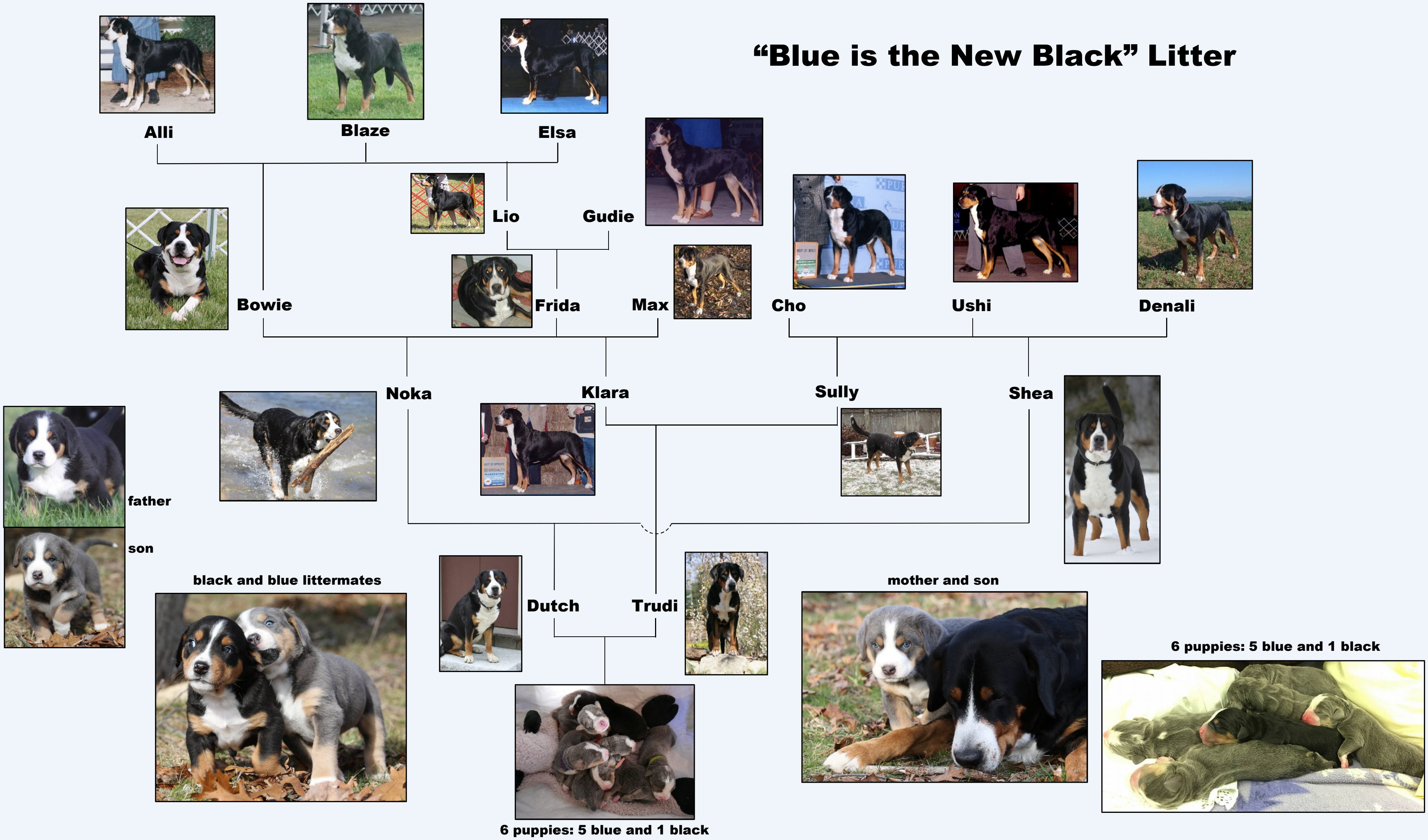
She called the litter "Blue is the New Black" and started investigating the pedigree to determine where all this blue had come from.

She eventually figured out what happened and how to avoid this happening in the future – all based on genetics.

Your job will be do the same.

Mr. Blue Sky

“Blue is the New Black” Litter



Objectives

Over the course of this lesson, you will do the following:

- Understand the patterns of heritable traits
- Understand how different traits can influence each other in physical expression
- Learn how to predict what offspring will look like based on the genetics of the parents
- Determine the heritance pattern of blue coat color in Greater Swiss Mountain Dogs
- Calculate the statistical probability of the "Blue is the New Black" litter

Gregor Mendel

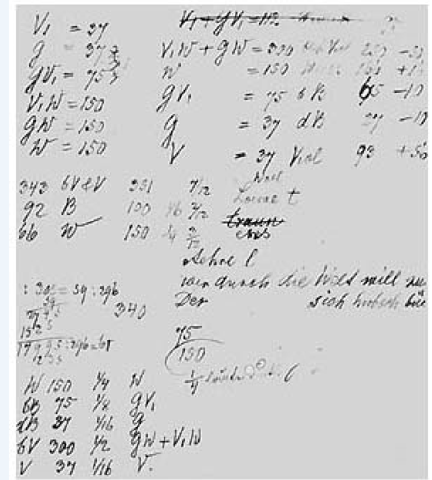
19th century Austrian monk.
b. 1822 d. 1884

Interested in inheritance patterns and studied pea plants in attempt to figure them out.

Discovered basic patterns that are now the foundation of genetics – known as the Father of Genetics.

Work went largely unrecognized until several decades after his death.

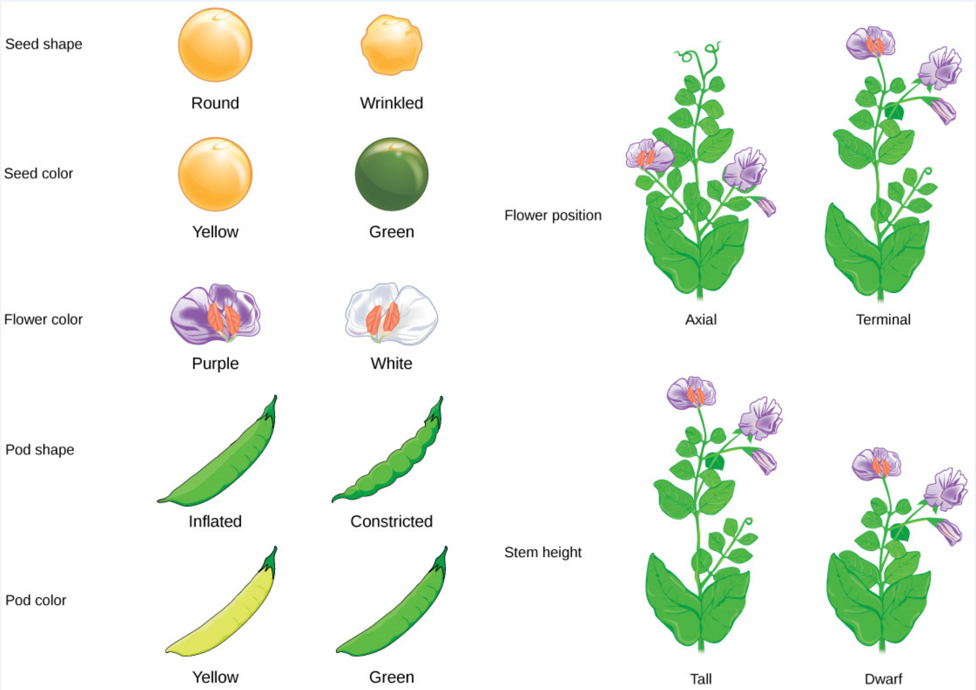
Even Charles Darwin, who was working at the same time, never knew what Mendel had discovered.



Courtesy of the Mendelianum, Moravian Museum, Brno. Noncommercial, educational use only

Why pea plants?

- They were easy to grow and count.
- Mendel could carefully select parents by using a brush to pollinate them.
- They had traits that were easily identifiable.

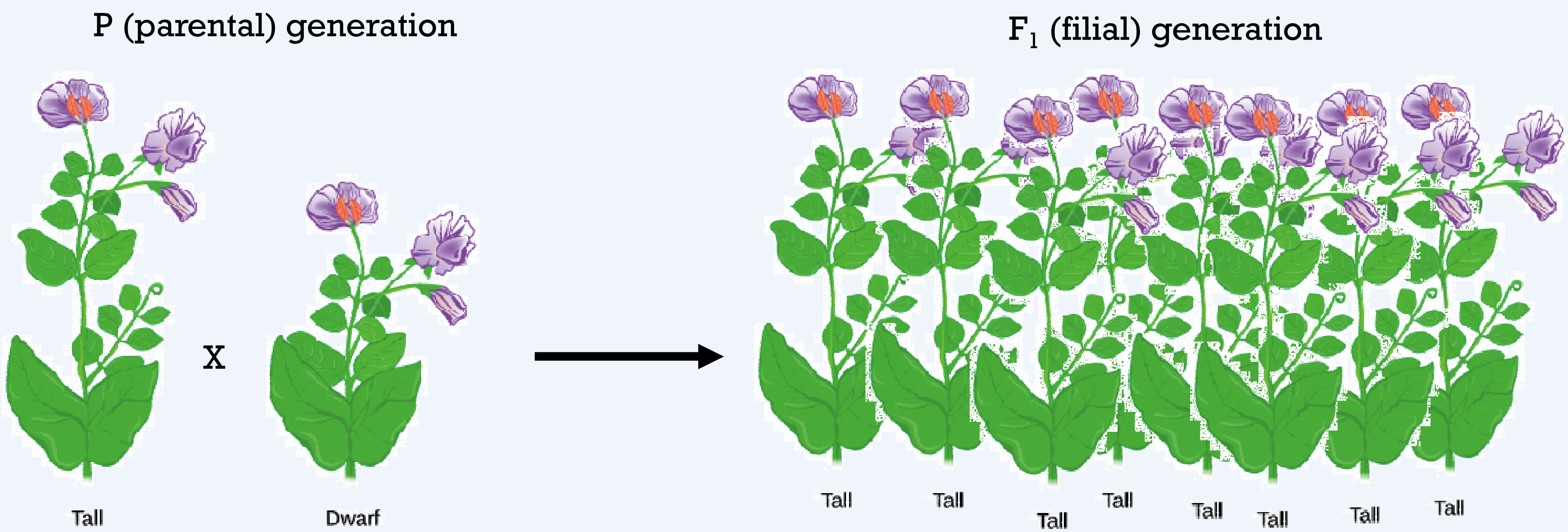


*Distribute *Biology Inquiries* Worksheet 4.1

Tall x Short

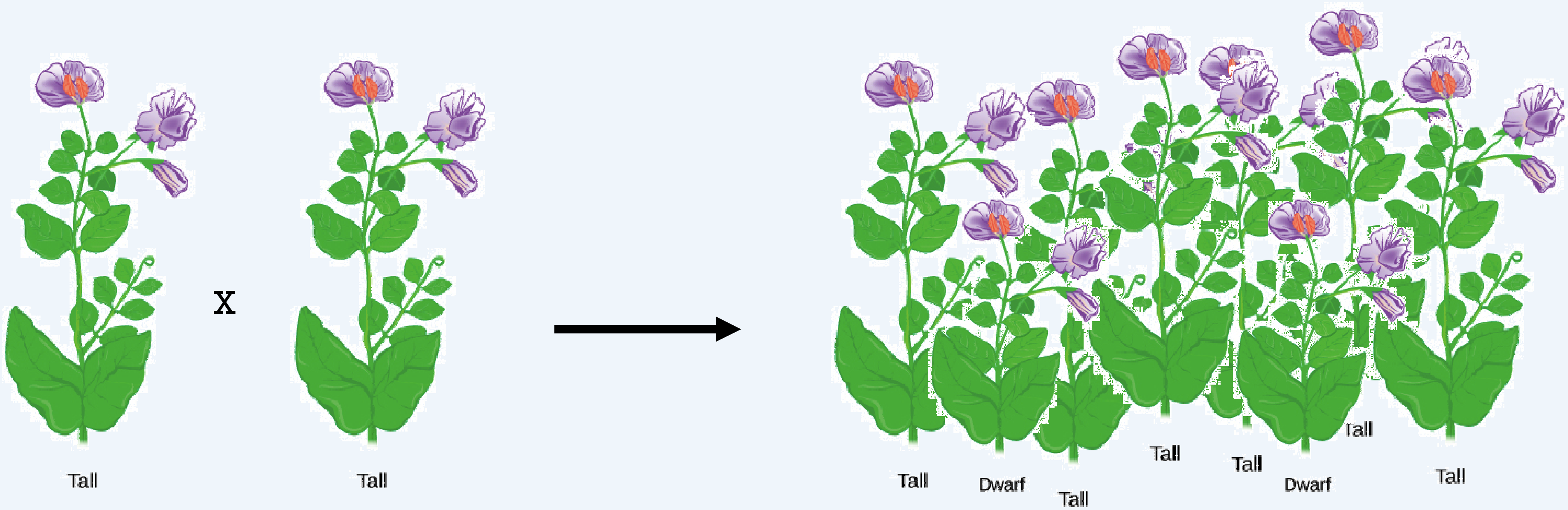
First Mendel mad sure he had “true breeding” plants.

Then he crossed a true breeding tall plant to a true breeding short plant.



First Filial Cross: Tall x Tall

Mendel crossed two tall plants from his F_1 generation.



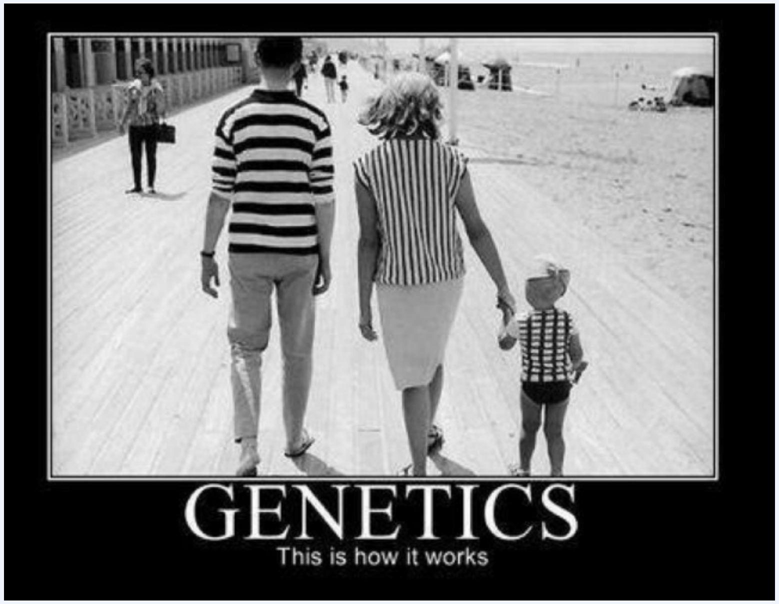
Mendelian Genetics

Vocabulary:

- heredity
- character
- trait
- generation
- parental (P) generation
- filial (F) generation

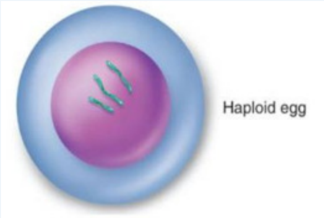
Heredity is the passing of genetic traits from parent to offspring.

How does this happen?



Heredity

mom

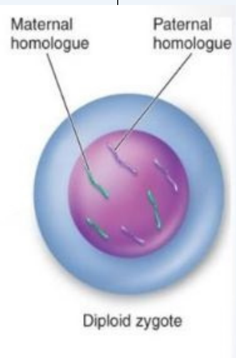


dad

meiosis creates gametes

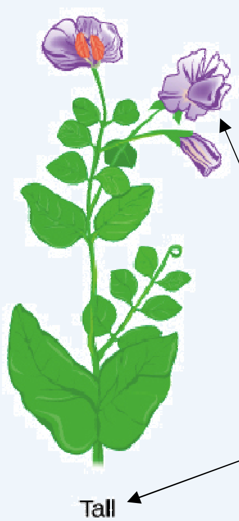
gametes are joined via sexual reproduction

offspring grows and develops, has genetic information from both parents (heredity)



Characters and Traits

The physical features that are inherited are called characters.
The possible versions of those characters are called traits.



Characters?

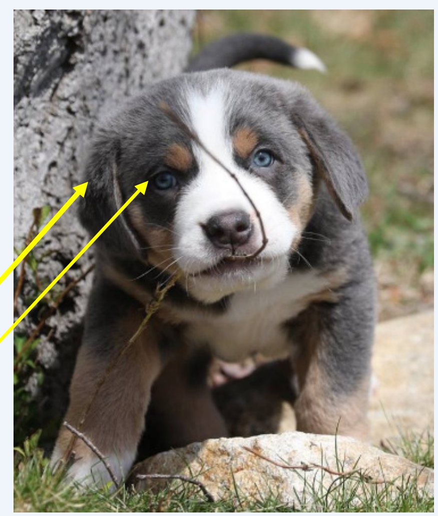
flower color
height

coat color
eye color

Traits?

purple
tall

blue
gray



Generations

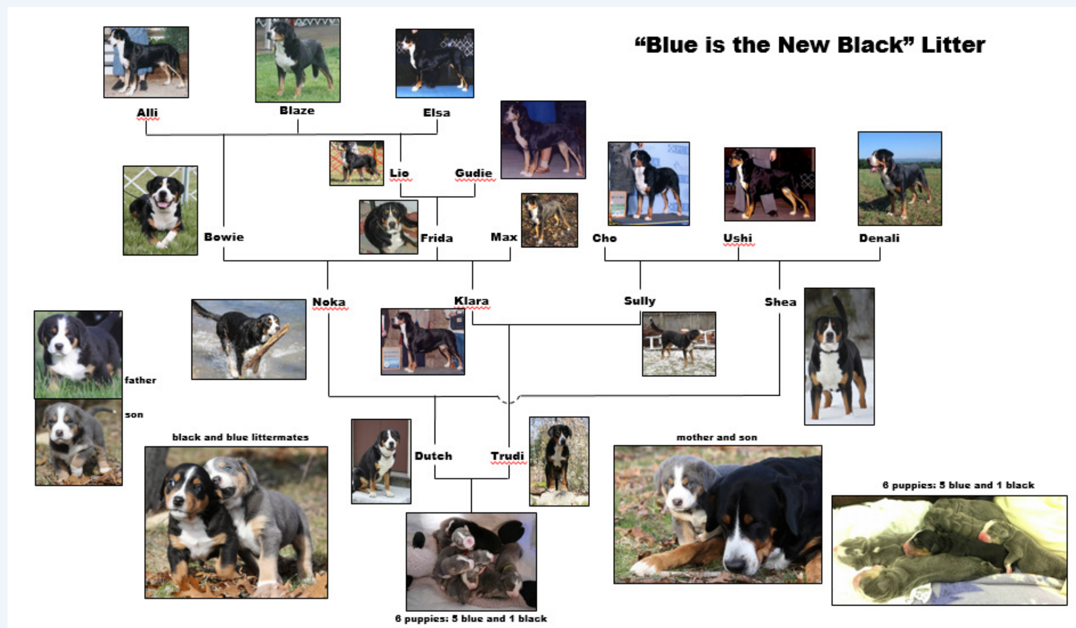
P = parental
F = filial

A generation is a group of offspring and decedents from a given group of parents.

P generation = parents
F_1 generation = offspring of first cross
F_2 generation = offspring of second cross
and so on…

Determine the generations of:

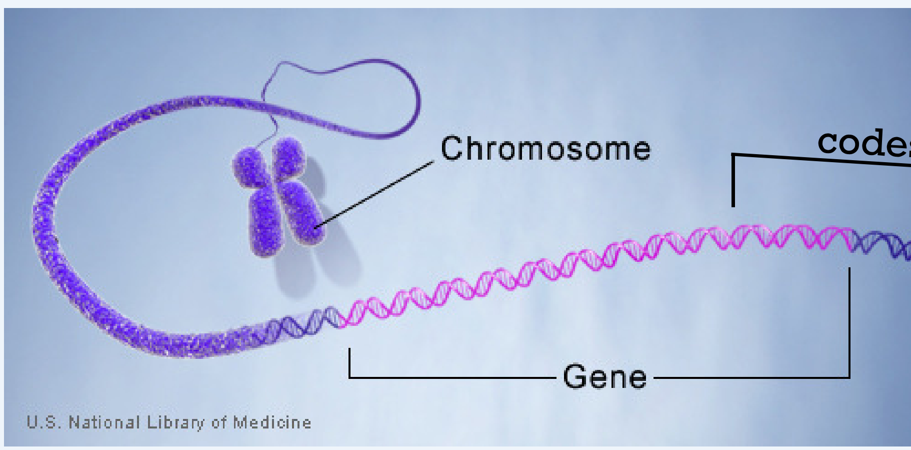
P = Alli x Blaze



Vocabulary:

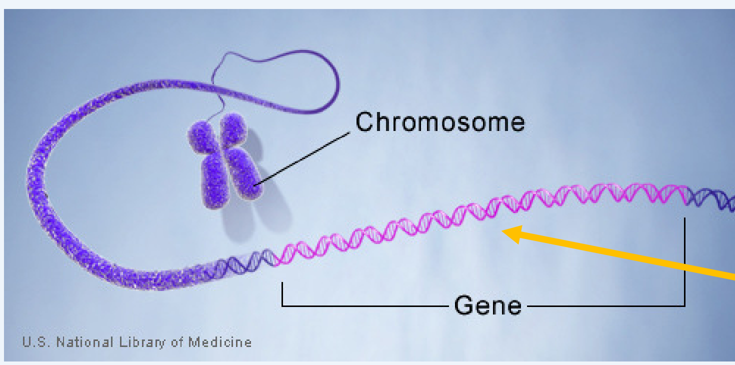
- gene
- genotype
- phenotype
- allele
- dominant
- recessive
- homozygous
- heterozygous

A gene is a unit of heredity made up of a section of DNA.
One gene codes for one character.



Different genes (sections of DNA) code for eye color, height, bone thickness, etc.

While only one section of DNA comprises a gene, that one section may have several different versions. These different versions are called alleles.



blue allele OR black allele

A dominant allele is one that is always expressed.

- Dominant alleles are represented as capital letters.

A recessive allele is one that is not expressed if the dominant allele is also present.

- Recessive alleles are represented as lowercase letters.

gene	dominant	recessive	letter
seed shape	round		R
		wrinkled	r
seed color	yellow		Y
		green	y
flower color	purple		P
		white	p

The genotype of a particular individual is the combination of alleles that individual has for a particular gene.

A genotype that has two dominant alleles is said to be homozygous dominant. (RR)

A genotype that has two recessive alleles is said to be homozygous recessive. (rr)

A genotype that has one dominant and one recessive allele is said to be heterozygous. (Rr)

What is the genotype?

AA

Gg

dd

ee

Ff

Hh

TT

jj

Yy

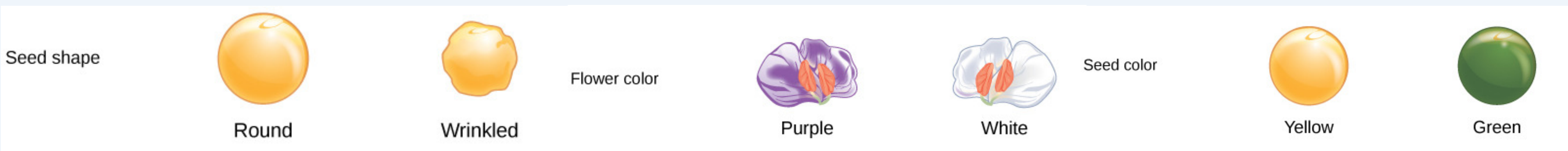
xx

KK

The phenotype of an individual is the physical expression of that individual's genotype.

A genotype that contains the dominant allele will show the dominant phenotype.

A genotype that contains only recessive alleles will show the recessive phenotype.



Given that round, purple, and yellow are dominant traits.

Give the following for each individual:
phenotype
genotype(s)
letters of genotype(s)

Check your notes

- Gregor Mendel
  - Father of Genetics
  - Plants used
  - What he found
  - (predictable patterns)
- Understand and use the terms:
  - heredity
  - characters
  - traits
  - generation
  - P generation, F generations
  - allele
  - dominant
  - recessive
  - phenotype – dominant and recessive
  - genotype – dominant, recessive, heterozygous

Punnett Squares

We use a grid system, known as the Punnett square, to help us solve genetics problems.

Given the genotypes of parents, we can predict the probability (likelihood expressed as a percentage or decimal) of the genotype of any particular offspring.

$$\text{probability} = \frac{\text{number of one kind of possible outcome}}{\text{total number of possible outcomes}}$$

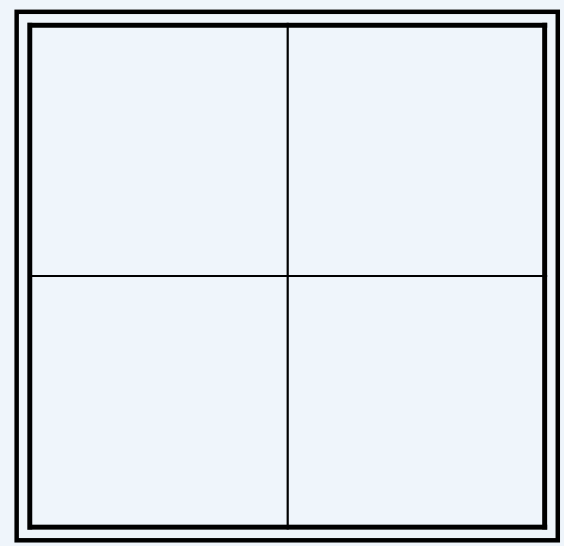
It is important to note: the Punnett square only tells you the probability of genotypes for *each separate individual* produced by a particular cross.

It *will not accurately predict the exact numbers* of each genotype a cross will produce over the course of many offspring.

How to complete a Punnet square…

- A useful tool to do genetic crosses
- For a cross, you need a square divided by four….
- Looks like a window pane…

We use the Punnett square
to predict the genotypes and
phenotypes of offspring.



Using a Punnett Square

<u>STEPS</u>:

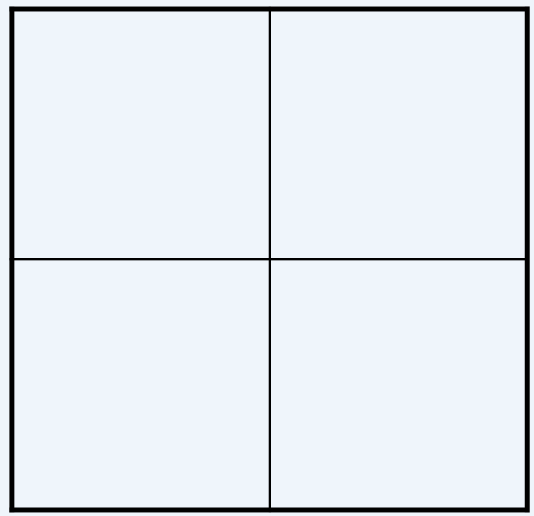
1. determine the genotypes of the parent organisms
2. write down your "cross" (mating)
3. draw a p-square

Parent genotypes:

TT and *t t*

Cross

TT × ***t t***



Punnett square

4. "split" the letters of the genotype for each parent & put them "outside" the p-square

5. determine the possible genotypes of the offspring by filling in the p-square

6. summarize results (genotypes & phenotypes of offspring)

P generation

T T × ***t t***

	T	**T**
t	T t	T t
t	T t	T t

F_1 generation

Genotypes:
100% T t

Phenotypes:
100% Tall plants

Monohybrid cross: F_2 generation

- If you let the F1 generation self-fertilize, the next monohybrid cross would be:

T *t* × **T *t***

(tall) (tall)

	T	***t***
T	**T T**	**T *t***
t	**T *t***	***t t***

What are the possible genotypes, ratios, and probabilities?

What are the possible phenotypes, ratios, and probabilities?

Genotypes:	probability
1 TT= Tall	0.25
2 T*t* = Tall	0.5
1 *tt* = short	0.25

Genotypic ratio= 1:2:1

Phenotype:	probability
3 Tall	0.75
1 dwarf	0.25

Phenotypic ratio= 3:1

Practice Problems

Complete Dominance

Incomplete Dominance

Blood Typing

Dihybrid Crosses