

**Genetics:** The scientific study of **heredity**.

– **Heredity:** The passing of physical characteristics from parents to **offspring**.

• **Traits:** the different forms of a characteristic

- Ex.) eye color: blue, brown, green
- Ex.) height: short, medium, tall



• Traits can be passed from generation to generation through 2 primary methods ....

1. **Asexual reproduction**
2. **Sexual reproduction**

• **Asexual reproduction** is the process by which an organism is created from a single parent and inherits genes from only one parent.

1. Bacteria divide asexually via **binary fission**.

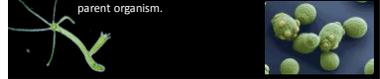
- **Binary fission** is the subdivision of a cell into two or more parts and the regeneration of those parts into two separate cells.



2. **Viruses** take control of host cells to produce more viruses.

3. Hydras and yeasts are able to reproduce by **budding**.

- **Budding** is a form of asexual reproduction in which a new organism grows on another one.
- The new organism remains **attached** as it grows, separating from the parent organism only when it is mature.
- Since the reproduction is **asexual**, the newly created organism is a clone and is genetically **identical** to the parent organism.



• **Gregor Mendel**

- Austrian priest/monk
- born July 22, 1822; died January 6, 1884
- Known as “**The Father of Genetics**”



– In his job as the monastery **gardener**, Mendel worked extensively with **pea plants** to determine how traits are passed from generation to generation.



• Mendel's experiments

– Mendel **fertilized** pea plants by cross-pollinating the flowers of purebred pea plants.

- **Fertilization:** the process by which the egg & sperm cell of an organism combine to form a new organism.
- **Pollination:** the transfer of pollen from the pistil of a flower to the stamen of another flower.



- **Pistil:** plant structure that produces the female gamete or sex cell (egg) of a flower
- **Stamen:** plant structure that produces the male gamete or sex cell (sperm) of a flower
- **purebred:** the offspring of many generations with the same traits.
  - Ex.) Short parents always produce short offspring.
  - Ex.) Blue-eyed parents always produced blue-eyed offspring.

– Mendel **removed** the pollen-producing structures from a pink flower and then brushed the pollen from a white flower onto the pink flower.

- These **initial** plants, or parent plants, are called the **P generation**
- The plants that are **produced** from the seeds of the P generation are called the **1<sup>st</sup> filial** or **F<sub>1</sub> generation**.
- **Filial** comes from the latin words for son “**filius**” and daughter “**filia**.”
- The plants that are produced from the seeds of the F<sub>1</sub> generation are called the **2<sup>nd</sup> filial** or **F<sub>2</sub> generation**.

– Mendel observed that **only 1 form of the trait was present in the F<sub>1</sub> generation**.

- Ex.) Yellow plants (P generation) crossed with green plants (P generation) always produced yellow plants (F<sub>1</sub> generation).

– Mendel further observed that **in the F<sub>2</sub> generation, ¾ of the plants showed 1 form of the trait while ¼ showed the other “missing” form of the trait**.

- Ex.) Yellow plants (F<sub>1</sub> generation) crossed with Yellow plants (F<sub>1</sub> generation) produced Yellow plants ¾ of the time & green plants ¼ of the time.

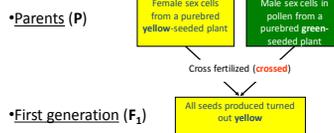
– The same results held true for all purebred traits.

- Ex.) Seed shape, stem height, pod shape, pod color, seed coat color.



Mendel's breeding experiments

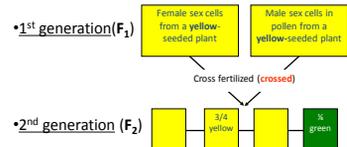
**Example 1: Seed color from Parents to F<sub>1</sub>**



© 2007 Paul Hise

Mendel's breeding experiments

**Example 2: Seed color from F<sub>1</sub> to F<sub>2</sub>**



© 2007 Paul Hise

**Mendel concluded**

- Mendel believed that individual factors or sets of genetic "information" must control the **inheritance** of traits.
- The **factors** that control traits exist in pairs.
- Each parent (mother & father) contributes 1 of the **factors**.
- One factor in the pair can mask or hide the other factor.
  - Gene:** the factors that control a particular trait.
    - Ex.) eye color, height, hair color, nose shape, etc.
  - Allele:** the different forms of a gene
    - Ex.) eye color: brown, blue, green



- Dominant allele**
  - The form of the gene that will always show up in an organism if present and working correctly.
  - Typically represented by the 1<sup>st</sup> capital letter of the dominant allele for a trait.
    - Ex.) Seed shape: round (R)
    - Ex.) Seed color: yellow (Y)
- Recessive allele**
  - The form of the gene that will only show up if the dominant allele is not present or working correctly.
  - Typically represented by the lower case letter of the dominant allele for a trait.
    - Ex.) Seed shape: wrinkled (r)
    - Ex.) Seed color: green (y)



**Dominance versus Prevalence**

- Just because a particular trait is dominant, meaning the trait will show up if the gene is present & working properly, does not mean it is more prevalent.
  - Prevalent:** majority; happens, takes place or is found most often.
    - Ex.) Seed color: Yellow is dominant; Green is prevalent
    - Ex.) Widow's peak: Having one is dominant; Not having one is prevalent
- This is good because there are some **genetic diseases** that are found on a **dominant** gene but they are less prevalent in society.

**Hybrid**

- An organism that has 2 different **alleles** for a particular trait
  - Ex.) Seed shape: Rr
  - Ex.) Seed color: Yy
  - Ex.) Pod shape: Ss
  - Ex.) Stem height: Tt
- The **opposite** of a purebred organism that has 2 of the same alleles for a particular trait.
  - Ex.) Seed shape: RR or rr
  - Ex.) Seed color: YY or yy
  - Ex.) Pod shape: SS or ss
  - Ex.) Stem height: TT or tt

**Genetics Using Punnett Squares**

**A VERY IMPORTANT TOOL**

A **PUNNETT SQUARE** is a tool used to predict the possible genotypes for the offspring of two known parents

	PARENT "1" GENES	
PARENT "2" GENES		

**TERMS TO KNOW**

ALLELES	Different forms of a trait that a gene may have	T, t
HOMOZYGOUS	An organisms with two alleles that are the same	TT, tt
HETEROZYGOUS	An organism with two different alleles for a trait	Tt, Gg

**TERMS TO KNOW**

HYBRID	Same as heterozygous	Tt, Gg
DOMINANT	A trait that dominates or covers up the other form of a trait	Represented by an UPPERCASE LETTER T OR G
RECESSIVE	The trait being dominated or cover up by the dominate trait	Represented by a lowercase letter t or g

**TERMS TO KNOW**

PHENOTYPE	The physical appearance of an organism (what it looks like)	Tall, short, wrinkled, green
GENOTYPE	The gene order of an organism (what its genes look like)	TT, GG, Tt, gg Gg, tt
RATIO	The relationship in numbers between two or more things	3:1, 2:2, 1:2:1

**HOW TO USE A MONOHYBRID (ONE TRAIT) PUNNETT SQUARE**

THE PARENTS' ALLELES GO ON THE OUTSIDE OF THE SQUARE

BB X bb

	B	B
b		
b		

**HOW TO USE A MONOHYBRID (ONE TRAIT) PUNNETT SQUARE**

Drop the letters on the top, into each square.

	B	B
b	B b	B b
b	B b	B b

Move each letter on the side, into each square

The UPPERCASE letter should always go first.

**HOW TO USE A MONOHYBRID (ONE TRAIT) PUNNETT SQUARE**

What do the results show us?

If "B" is the dominant allele for black and "b" is the recessive allele for brown, then we make predictions about the outcomes using the Punnett Square

	B	B
b	Bb	Bb
b	Bb	Bb

RESULTS:

Phenotypic: 100% BLACK  
4:0 RATIO, BLACK TO BROWN

Genotypic: 100% Bb  
4:0 ALL Bb

**HOW TO USE A PUNNETT SQUARE**

Let's look at another Punnett Square and predict the outcome.

"T" is the dominate allele for tallness and "t" is the recessive allele for shortness

	T	t
T	TT	Tt
t	Tt	tt

WHAT ARE THE RESULTS?

Phenotypic:  
75% TALL  
25% SHORT  
3 TO 1  
TALL : SHORT

Genotypic:  
1TT : 2Tt : 1tt  
1:2:1  
25 %TT  
50% Tt  
25% tt

**Punnett Squares**

Now that we have learned the basics of genetics lets walk through some examples using Punnett Squares.

	W	w
W	WW	Ww
w	Ww	ww

Write the capital letter first

Lets say:  
W- dominant white  
w- recessive violet

Parents in this cross are heterozygous (Ww).

**Note:** Make sure I can tell your capital letters from lowercase letters.

What percentage of the offspring will have violet flowers?

**ANSWER: 25% (homozygous recessive)**

Red hair (R) is dominant over blond hair (r). Make a cross between a heterozygous red head and a blond.

	R	r
r	Rr	rr
r	Rr	rr

What percentage of the offspring will have red hair? 50%

Let's try some more...

In pea plants, tall pea plants (T) are dominant over short pea plants (t). Construct a Punnett Square for a heterozygous tall pea plant and a short pea plant.

	T	t
t	Tt	tt
t	Tt	tt

What are the percentage of phenotypes?  
50% tall  
50% short



Black eyes (R) is dominant over red eyes (r) in rats. Make a cross between a homozygous rat with black eyes and a rat with red eyes.

	R	R
r	Rr	Rr
r	Rr	Rr

What is the possibility of a red eye off springs?  
0% ☹️



**APPLY YOUR KNOWLEDGE**

1. WHICH OF THE FOLLOWING HAS THE hh GENOTYPE?

	H	h
H	4	1
h	3	2

A. 1 & 3  
 B. 2  
 C. 4  
 D. NONE

2. WHICH OF THE FOLLOWING IS A TRUE STATEMENT?

A. INDIVIDUAL 4 IS RECESSIVE  
 B. INDIVIDUALS 1 & 3 ARE HETEROZYGOUS  
 C. INDIVIDUAL 2 IS DOMINANT  
 D. ALL INDIVIDUALS ARE FEMALE

**APPLY YOUR KNOWLEDGE**

3. IF B IS THE ALLELE FOR BLACK FUR AND b IS THE ALLELE FOR WHITE FUR, WHAT PERCENT WOULD BE BLACK?

	B	b
B	BB	Bb
b	Bb	bb

A. 25%  
 B. 50%  
 C. 100%  
 D. 75%

4. WHAT FRACTION IS HOMOZYGOUS DOMINANT IN THE ABOVE CROSS?

A. 1/2  
 B. 1/4  
 C. 1/3  
 D. 3/4

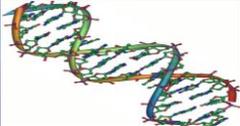
**APPLY YOUR KNOWLEDGE**

5. IN THIS CROSS, WHAT IS THE RATIO OF BB TO Bb?

	B	B
B	BB	BB
b	Bb	Bb

A. 3 : 1  
 B. 4 : 1  
 C. 2 : 2  
 D. 0 : 4

**Dominant and Recessive Traits in Humans**




What are the Dominant and Recessive Traits in Humans?

- ▣ There are over 200 traits that are transmitted from generation to generation in humans. These interesting aspects of human genetics are known as hereditary traits



There are two or more variations in most of the genes called alleles. An individual can inherit same pair of alleles or two different pairs of alleles. When there are two different alleles, they are expressed in a different way. The trait that is expressed in case of two different alleles, gives rise to the dominant and recessive traits in humans. When a dominant allele is present, it is always observed that the dominant trait is expressed. The recessive trait is observed only in case there are two recessive alleles present.

**Common Dominant and Recessive Traits in Humans:**

*Widow's Peak:*

The widow's peak allele is dominant and the straight allele is recessive.

*Bent Pinkie:*

You can try to bend your pinkie finger inwards towards your ring finger or fourth finger. If you are able to do so, it means you have inherited the dominant version of the gene that causes the distal segment of the pinkie to bend.

*Crossing of Thumbs:*

Do you find your left thumb crossing your right thumb? If yes, then you probably have inherited 1 or 2 copies of the dominant gene. In case of 2 recessive genes inherited, you will find your right thumb placed over your left thumb.

*Earlobe Attachment:*

Some people have their ear lobes attached to the side of the head and some people have free ear lobes. This is due to a gene that is dominant for unattached ear lobes and recessive in case of attached ear lobes.

*Rolling of Tongue:*

If you can roll the lateral edges of your tongue together, then this means you have inherited a dominant trait. Those who are unable to do so are expressing inheritance of recessive gene for tongue rolling.



### Cleft Chin:

People who have a cleft chin have inherited a dominant gene and those with smooth chin have recessive gene.



### Dimples:

Have you fallen for the cute dimples of Brad Pitt? Well, Brad Pitt and people all over the world with dimples are expressing the dominant gene for dimples. Whereas, people without dimples have recessive genes



### Handedness:

The gene for right-handedness is dominant and the gene for left hand is recessive. Thus, majority of the people have inherited the dominant gene resulting in right-handedness.



### Natural Curly Hair:

The gene for naturally curly hair is dominant and the gene for straight hair is recessive. (Does this mean I have one dominant and one recessive gene that resulted in my wavy hair? Interesting.)



### Freckles:

All those with freckles, you have inherited at least one pair of dominant gene for freckles. Those without freckles have inherited two recessive genes for freckles.



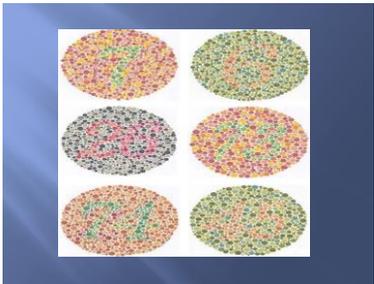
**Allergies:**

People with allergies may have inherited the gene for allergy from at least one of the parent. It is seen that a parent with allergies has a chance that one of four of their children may develop allergy. The chances of child inheriting allergy from a parent is about 25% and the risk increases if both parents have allergies



**Color Blindness:**

Color blindness is a genetic disorder that is seen due to presence of a recessive allele located on the X chromosome. There are two X chromosome in women and one of them usually carries an allele for normal vision. In men, there is only one X chromosome and if they carry an allele for color blindness, they will express this trait. This is the reason that more number of men are colorblind as compared to women



These were just a few dominant and physical traits in humans. Other dominant and recessive traits in humans include:

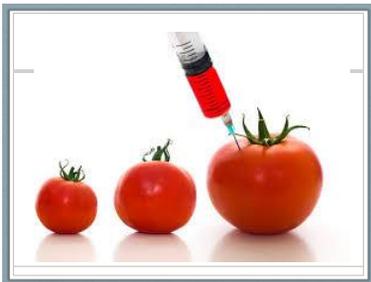
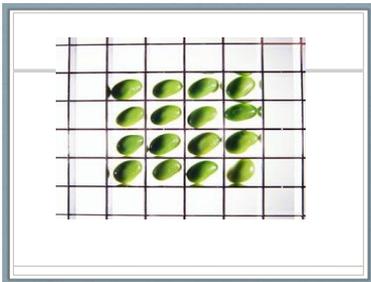
Dominant Trait in Humans	Recessive Trait in Humans
A blood type	O blood type
Abundant body hair	Little body hair
Astigmatism	Normal vision
B blood type	O blood type
Baldness (in male)	Not bald
Broad lips	Thin lips
Broad nose	Narrow nose
Dwarfism	Normal growth
Hazel or green eyes	Blue or gray eyes
High blood pressure	Normal blood pressure
Large eyes	Small eyes
Migraine	Normal
Mongolian Fold	No fold in eyes
Nearsightedness	Normal vision
Rh factor (+)	No factor (Rh -)
Second toe longest	First or big toe longest
Short stature	Tall stature
Six fingers	Five fingers normal
Webbed fingers	Normal fingers
Tone deafness	Normal tone hearing
White hair streak	Normal hair coloring

**Genetically Modified Organisms (GMOs)**

**Vocabulary**

**(Write the following definitions in your notebook on PAGE 8)**

- **Genetically Modified Organism (GMO)** – the result of a laboratory process of taking genes from one species and inserting them into another in an attempt to obtain a desired trait or characteristic.
- **Genes:** short sequences of DNA.
- **DNA** – Holds genetic information found in nucleus.



### Food for Thought:

Do you believe that Genetically Modified Foods are Good or Bad? Explain.

Write your response down on page 8 of your notebook.

Jeopardy

Genes and Chromosomes	Basics
<u>100</u>	<u>100</u>
<u>200</u>	<u>200</u>
<u>300</u>	<u>300</u>
<u>400</u>	<u>400</u>
<u>500</u>	<u>500</u>
<u>1000</u>	<u>1000</u>

**Genes & Chromosomes for 100**

Answer:  
The genetic material that makes up genes and chromosomes.

**Genes & Chromosomes for 100**

Question:  
What is DNA?

**Genes & Chromosomes for 200**

Answer:  
These are the different versions that genes may have.

**Genes & Chromosomes for 200**

Question:  
What are alleles?

**Genes & Chromosomes for 300**

Answer:  
Describes the condition when an organism has identical versions of a gene.

**Genes & Chromosomes for 300**

Question:  
What is homozygous?

**Genes & Chromosomes for 400**

Answer:  
The version of the gene that is always seen (or expressed) when an organism is heterozygous for a particular trait.



### Genes & Chromosomes for 400

Question:  
What is dominant?



### Genes & Chromosomes for 500

Answer:  
A random change or mistake in a gene or chromosome.



### Genes & Chromosomes for 500

Question:  
What is a mutation?



### Genes & Chromosomes for 1000

Answer:  
The number of chromosomes found in human cells having the full complement of genetic material.



### Genes & Chromosomes for 1000

Question:  
What is 46 chromosomes (or 23 pairs)?



### Basics for 100

Answer:  
Part of the cell where chromosomes are **usually** found.



### Basics for 100

Question:  
What is the nucleus?



### Basics for 200

Answer:  
Type of reproduction, such as budding, in which new organisms are produced from a single parent organism.



### Basics for 200

Question:  
What is asexual reproduction?





### Basics for 300

Answer:  
Family record showing the inheritance of a trait over several generations.



### Basics for 300

Question:  
What is a pedigree?



### Basics for 400

Answer:  
Shows the linear sequence of genes on a chromosome.



### Basics for 400

Question:  
What is a chromosome map?



### Basics for 500

Answer:  
Genotype of males.



### Basics for 500

Question:  
What is XY?



### Basics for 1000

Answer:  
U.S. government funded project having the aim of identifying the approximately 100,000 genes in the human DNA.



### Basics for 1000

Question:  
What is the Human Genome Project?

