

**Genetics  
Since  
Mendel**

**GLE 0707.4.4**

**Predict the probable  
appearance of offspring based  
on the genetic characteristics  
of the parents.**

## **What You'll Learn**

- **Explain how traits are inherited by incomplete dominance**
- **Compare multiple alleles and polygenic inheritance, and give examples of each.**
- **Describe two human genetics disorders and how they are inherited.**
- **Explain how sex-linked traits are passed to offspring.**

## Why it's important!

- Most of your inherited traits involve more complex patterns of inheritance than Mendel discovered.

## Incomplete Dominance

- When the offspring of two homozygous parents show an intermediate phenotype, this inheritance is called incomplete dominance.
- Examples of incomplete dominance include the flower color of some plant breeds and the coat color of some horse breeds.

**Punnett square**

		Chestnut horse (CC)	
		C	C
Cremello horse (C'C')	C'	CC'	CC'
	C'	CC'	CC'

Genotypes: All CC'  
Phenotypes: All palomino horses



Chestnut horse



Cremello horse



Palomino horse

## Multiple Alleles

- **Many traits are controlled by more than two alleles.**
- **A trait that is controlled by more than two alleles is said to be controlled by multiple alleles.**
- **Example: Blood Type**
  - **Blood type in humans is an example of multiple alleles that produce only four phenotypes.**
  - **The alleles for blood types are called A, B, and O.**

<https://www.youtube.com/watch?v=ZUouiuqUYng>

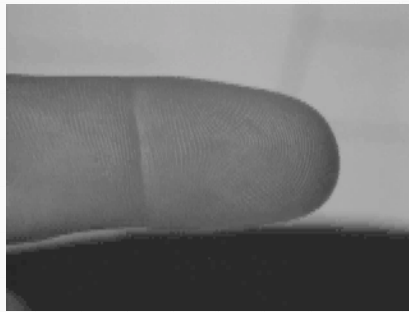
## Multiple Alleles

- **When a person inherits one A allele and one B allele for blood type, both are expressed phenotype AB.**
- **A person with phenotype A blood has the genetic makeup, or genotype AA or AO.**



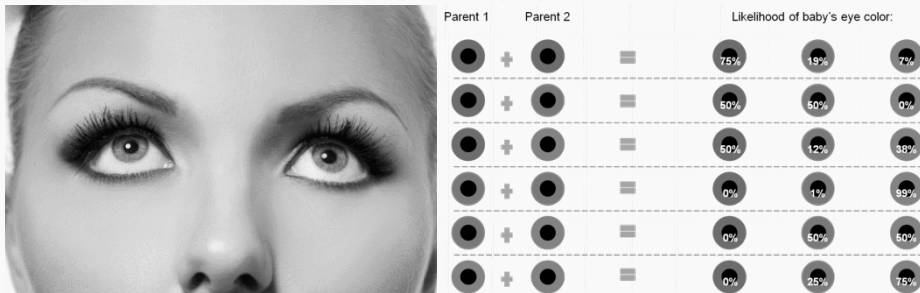
## Polygenic Inheritance

- Polygenic inheritance occurs when a group of gene pairs acts together to produce a trait.
- The effects of many alleles produces a wide variety of phenotypes.
- <https://www.youtube.com/watch?v=gouqTq5p168> - 3 minutes



## Polygenic Inheritance

- Your height and the color of your eyes and skin are just some of the many human traits controlled by polygenic inheritance.
- It is estimated that three to six gene pairs control your skin color.
- The environment also plays an important role in the expression of traits controlled by polygenic inheritance.
- <http://www.newkidscenter.com/Baby-Eye-Color.html>



## Impact of the Environment

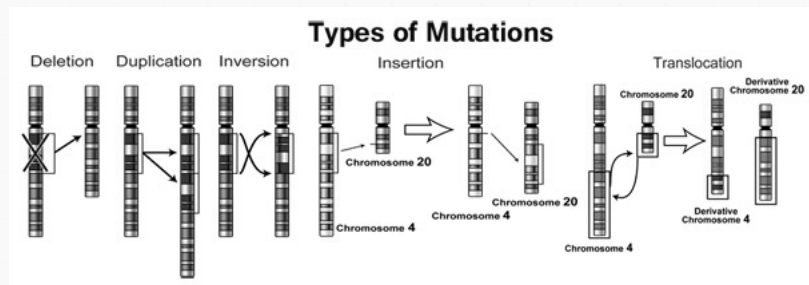
- Your environment plays a role in how some of your genes are expressed or whether they are expressed at all.
- Environmental influence can be internal or external.
  - Ex. Male birds are colorful, not the females.
  - A chemical in their body determines the expression of color.
- Some people have genes that make them at risk for developing certain cancers
  - Skin cancer genes
    - Limit exposure to sun and take care of skin. A person may never get skin cancer.



- Himalayan rabbits have alleles for dark-colored hair.
- This allele is able to be expressed in low temperatures
- Only the ears, nose, feet and tail have dark-colored hair.

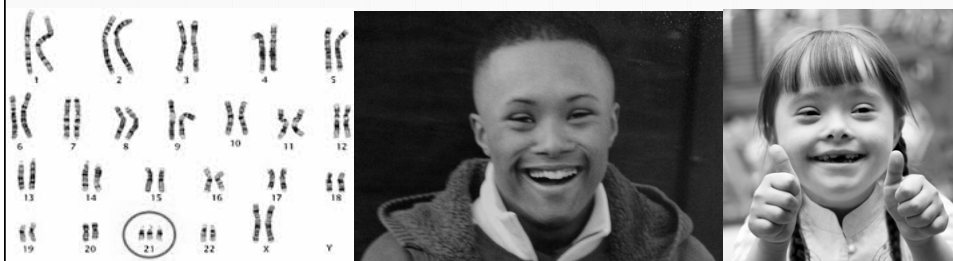
## Human Genes and Mutations

- Sometimes a gene undergoes a change and the trait is expressed differently.
- Errors can occur in DNA when copied. This can cause mutations.
- Certain chemicals can produce mutation in plants or animals, including humans; X-rays and radioactive also causes it.



## Chromosome Disorders

- Problems can occur in incorrect number of chromosomes.
- In humans, it is usually fatal to unborn embryo or baby after birth.
- Ex. Down syndrome (three copies of chromosome 21 are in fertilized egg)
  - Individuals with Down's Syndrome are usually short, exhibit learning disabilities, and have heart problems.

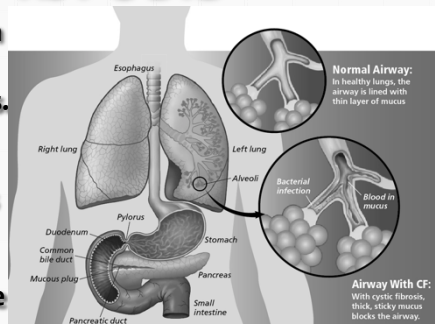


## Recessive Genetic Disorders

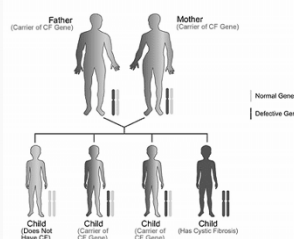
- Many human genetic disorders, such as cystic fibrosis, are caused by recessive genes.
- Some recessive genes are the result of a mutation within the gene.
- Many of these alleles are rare.
- Such genetic disorders occur when both parents have a recessive allele responsible for this disorder.
- Because the parents are heterozygous, they don't show any symptoms.
- If each parent passes the recessive allele to the child, the child inherits both recessive alleles and will have a recessive genetic disorder.

# Cystic Fibrosis

- Cystic fibrosis is the most common genetic disorder that can lead to death among Caucasian Americans.
- In most people, a thin fluid is produced that lubricates the lungs and intestinal tract.
- People with cystic fibrosis produce thick mucus instead of this thin fluid.
- The thick mucus builds up in the lungs and makes it hard to breathe.
- This buildup often results in repeated bacterial respiratory infections.



Inheritance of Cystic Fibrosis (CF)



# Gender Determination

- Each egg produced by a female normally contains one X chromosome.
- Males produce sperm that normally have either an X or a Y chromosome.
- When a sperm with an X chromosome fertilizes an egg, the offspring is a female, XX.
- A male offspring, XY is the result of a Y-containing sperm fertilizing an egg.

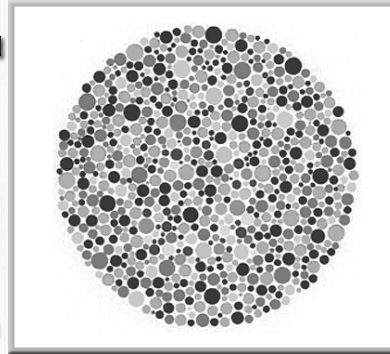
<https://www.youtube.com/watch?v=Nrv5yqEMQ4Q> 3 min.



Figure 8  
How do the X (left) and Y (right) chromosomes differ from one another in shape and size?

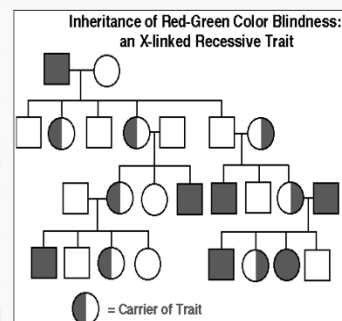
## Sex-linked Disorders

- An allele inherited on a sex chromosome is called a sex-linked gene.
- Color blindness is a sex-linked disorder in which people cannot distinguish between certain colors, particularly red and green.
- <https://www.youtube.com/watch?v=8OGA4rGDk3M> 6:52 min
- This trait is a recessive allele on the X chromosome.
- Because males have only one X chromosome, a male with this allele on his X chromosome is color-blind.
- A color-blind female occurs only when both of her X chromosomes have the allele for this trait.



## Pedigrees Trace Traits

- A pedigree is a visual tool for following a trait through generations of a family.
- Males = squares Females = circles
- Filled circles/squares represent trait seen in person
- Half colored circles/squares represent carriers (heterozygous for the trait and it is not seen)
- Empty circles or squares do not have the trait nor carriers of it.





## Using Pedigrees

- **A pedigree is a useful tool for a geneticist.**
  - **Geneticists need to understand:**
    - **Who had a trait through several generations**
    - **If a trait is recessive, dominant, sex-linked or has some other pattern of inheritance**
    - **How a trait is inherited – to predict the probability that a baby will be born with a specific trait**
- **Pedigrees also are important in breeding animals or plants**
  - **Use for source of food (increase their yield and nutritional value)**
  - **For desired physical and ability traits**

## Q & A

- **Why is color blindness a sex-linked trait?**
- **This trait is sex-linked because the alleles for this trait are carried on the X-chromosome, one of the sex chromosomes. Color-blindness is caused by a recessive allele and because males get only one X-chromosome, they are more likely to be color-blind than females.**

## Q & A

- ❑ In Himalayan rabbits, dark-colored fur is only found on cooler parts of the rabbits' bodies. This is an example of \_\_\_\_\_.
  - ❑ A. how sex-linked conditions change coat color
  - ❑ B. the risk of cancer in rabbits with light fur
  - ❑ C. the impact of internal environment on gene expression
  - ❑ D. what hybrid rabbits look like
- ❑ The correct answer is C. The alleles for dark fur color are controlled by the internal temperature of the rabbits. These alleles are expressed only at lower temperatures.

## Q & A

- ❑ If an individual has three copies of chromosome 21, what condition will result?
  - ❑ A. color blindness
  - ❑ B. cystic fibrosis
  - ❑ C. Down's syndrome
  - ❑ D. Hemophilia
- ❑ The correct answer is C. Down's syndrome occurs when there are three copies of chromosome 21 instead of the usual two.

# Exit Ticket

- Complete section 2 review.