

# Laboratory Investigation 7D

Chapter 7: Modern Genetics

## Human Genetics

You may refer to pages 102-107  
in your textbook for a general  
discussion of genetics.  
Time required: 50 minutes

### Background Material

Physical traits are observable characteristics. While each of us shares some of our traits with many other people, our own individual combination of traits is what makes each of us look unique.

Physical traits are determined by specific segments of DNA called genes. Multiple genes are grouped together to form chromosomes, which reside in the nucleus of the cell. Every cell (except the gametes) in an individual's body contains two copies of each gene. This is due to the fact that both mother and father contribute a copy at the time of conception. This original genetic material is copied each time a cell divides so that all cells contain the same DNA. Genes store the information needed for the cell to assemble proteins, which eventually yield specific physical traits.

Most genes have two or more variations, called alleles. For example, the gene for hairline shape has two alleles – widow's peak or straight. An individual may inherit two identical or two different alleles from their parents. When two different alleles are present they interact in specific ways. For many of the traits included in this activity, the alleles interact in what is called a dominant or a recessive manner. The traits due to dominant alleles are always observed, even when a recessive allele is present. Traits due to recessive alleles are only observed when two recessive alleles are present. For example, the allele for widow's peak is dominant and the allele for straight hairline is recessive. If an individual inherits:

- Two widow's peak alleles (both dominant), their hairline will have a peak
- One widow's peak allele (dominant) and one straight hairline allele (recessive), they will have a widow's peak
- Two straight hairline alleles (recessive), their hairline will be straight.

A widespread misconception is that traits due to dominant alleles are the most common in the population. While this is sometimes true, it is not always the case. For example, the allele for Huntington's Disease is dominant, while the allele for not developing this disorder is recessive. At most, only 1 in 20,000 people will get Huntington's; most people have two recessive, normal alleles.

Most human genetic traits are the product of interactions between several genes. Many of the traits included in this activity, however, are part of the small number that may be due to only one pair of alleles. More information about these traits is listed below. Note that scientists usually use the shorthand of a "dominant trait" rather than saying that a trait is due to a dominant allele.

- **Gender** – Females have two X chromosomes, while males have an X and a Y chromosome. Maleness is determined by a specific region of the Y chromosome. Femaleness results from the lack of this region.
- **Earlobe attachment** – Some scientists have reported that this trait is due to a pair of alleles for which unattached earlobes is dominant and attached earlobes is recessive. Other scientists have reported that this trait is probably due to several genes.
- **Thumb extension** – This trait is reportedly due to a pair of alleles; straight thumb is dominant and hitchhiker's thumb is recessive.
- **Tongue rolling** – Tongue rolling ability may be due to a pair of alleles with the ability to roll the tongue a dominant trait and the lack of tongue rolling ability a recessive trait. However, many twins do not share the trait, so it may not be inherited.
- **Dimples** – Dimples are reportedly due to a pair of alleles with dimples dominant (people may exhibit a dimple on only one side of the face) and a lack of dimples recessive.
- **Handedness** – Some scientists have reported that handedness is due to a pair of alleles with right handedness dominant and left handedness recessive. However, other scientists have reported that the interaction of four alleles is responsible for this trait.

- **Freckles** – This trait is reportedly due to a single gene; the presence of freckles is dominant, the absence of freckles is recessive.
- **Hair curl** – Early geneticists reported that curly hair was dominant and straight hair was recessive. More recent scientists believe that more than two alleles may be involved.
- **Cleft chin** – This trait is reportedly due to a pair of alleles with a cleft chin dominant and a smooth chin recessive.
- **Allergies** – While allergic reactions are induced by things a person comes in contact with, such as dust, particular foods, and pollen, the tendency to have allergies is inherited. If a parent has allergies, there is a one in four (25%) chance that their child will also have allergy problems. This risk increases if both parents have allergies.
- **Hairline shape** – This trait is reportedly due to a pair of alleles with a widow's peak dominant and a straight hairline recessive.
- **Hand clasping** – Some scientists report that there may be a genetic component to their trait while others have found no evidence to support this.
- **Colorblindness** – Colorblindness is due to a recessive allele located on the X chromosome. Women have two X chromosomes, one of which usually carries the allele for normal color vision. Therefore, few women are colorblind. Men only have one X chromosome, so if they carry the allele for colorblindness, they will exhibit this trait. Thus, colorblindness is seen more frequently in men than in women.
- **Sodium Benzoate tasting** – the most common taste reactions to sodium benzoate are: sweet, salty, or bitter, although some people note other or no responses.
- **Thiourea tastikng** – if you note a very bitter taste reaction, then you are a taster of thiourea. If the taste is like that of the Control Taste Paper, then you are a nontaster.

### PTC Tasting

For some people the chemical phenylthiocarbamide (PTC) tastes very bitter. For others, it is tasteless.

The ability to taste PTC shows dominant inheritance and is controlled by a gene on chromosomes 7. This gene codes for part of the bitter taste receptor in tongue cells. One of its five alleles (forms) causes a lack of ability to sense bitter tastes; the other four alleles produce intermediate to fully sensitive taste abilities. Approximately 75% of people can taste PTC while the remaining 25% cannot.

PTC-like chemicals are found in the Brassica family of vegetables, such as cabbage, Brussels sprouts, and broccoli. People who can taste PTC often do not enjoy eating these vegetables, since they taste bitter to them. Non-tasters tend not to notice bitter tastes and therefore may be more likely to become addicted to nicotine (which is bitter).

Some scientists think that tasters have fewer cavities, suggesting that there might be a substance in the saliva of tasters that inhibits the bacteria that cause cavities to form. Others think that PTC tasting may be in some way connected with thyroid function.

PTC tasting was a chance discovery in 1931.

### Materials

control taste paper; PTC taste paper; Sodium Benzoate taste paper; Thiourea taste paper; An Inventory of My Traits Survey

### Procedures

1. Each person needs to fill out the survey, "An Inventory of My Traits." Staple the surveys to the back of the lab.
2. Fill out the Data Table by going around to each group and gathering data. Make sure each student is included.

Data Table		
Trait	Yes (#)	No (#)
Male		
Detached earlobes		
Hitchhiker's thumb		
Tongue rolling		
Dimples		
Right-handed		
Freckles		
Naturally curly hair		
Cleft chin		
Allergies		
Widow's peak		
Cross left thumb over right		
See the colors red and green		
Taste PTC		
Taste Sodium Benzoate		
Tast Thiourea		

3. Calculate the frequency of each trait by taking the number of students with the trait and dividing that by the number of students in the class. To get percent you must take that quotient and multiply by 100. Fill out the Frequency chart.

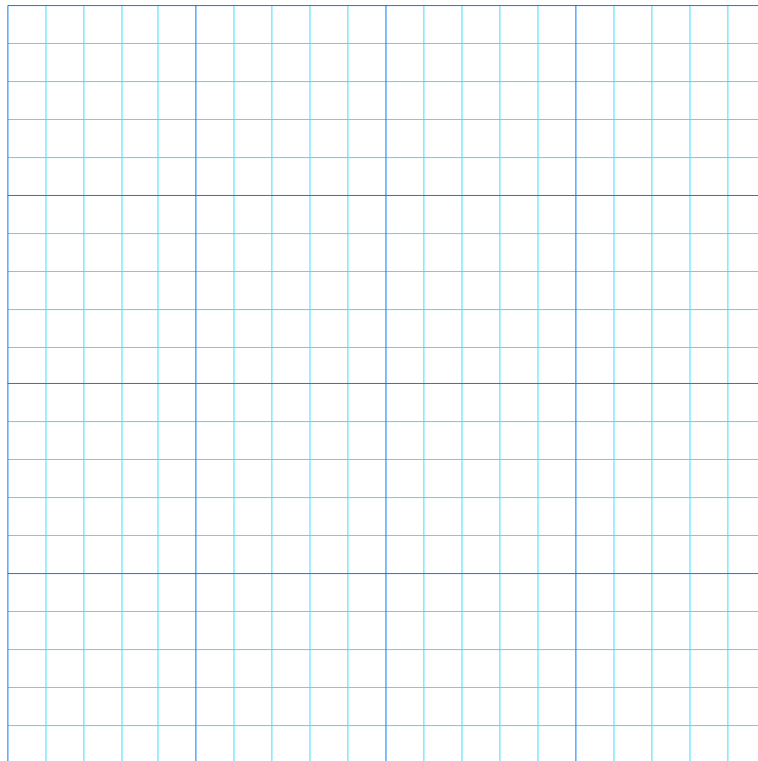
Frequency Table	
Trait	Frequency (%)
Male	
Detached earlobes	
Hitchhiker's thumb	
Tongue rolling	
Dimples	
Right-handed	
Freckles	
Naturally curly hair	
Cleft chin	
Allergies	
Widow's peak	
Cross left thumb over right	
See the colors red and green	
Taste PTC	
Taste Sodium Benzoate	
Tast Thiourea	

Compare the frequency of traits in the classroom population with the frequency in the general population:

Trait	Frequencies
<b>Gender</b>	Female – 50% Male – 50%
<b>Thumb extension</b>	Straight thumb – 75% Hitchhiker’s thumb – 25%
<b>Tongue rolling</b>	Can roll tongue – 70% Can not roll tongue – 30%
<b>Handedness</b>	Right handed – 93% Left handed – 7%
<b>Hand clasping</b>	Left thumb on top – 55% Right thumb on top – 44% No preference – 1%
<b>Color vision</b>	Normal females – almost 100% Colorblind females – less than 1% Normal males – 92% Colorblind males – 8%

4. Make a bar graph showing how many people in your group answered, “yes” for each trait.

**Number  
of  
Students**



**Trait**

**Summing up**

1. What traits do you have in common with your lab partner?

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2. What different traits do you have comparing yourself with your lab partner?

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3. Which traits were the most common in your class?

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4. Which traits were the least common in your class?

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5. Are the most common traits always dominant?

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6. Did the frequency of any traits in the classroom population come close to the frequency in the general population? If so, which one(s).

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7. Which trait had the highest frequency?

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