Taste Blind?

Part 1: Are you PTC taste blind?

You might have heard of red-green colorblindness, but I bet you haven't heard of "taste blindness." Just as there are people who can't tell the difference between the colors red and green, there are people who can't taste a certain type of bitter flavor. And just like color blindness, it's genetic.

1. You have two bags of taste paper—Control Paper and PTC Paper.

   - Touch one of the paper strips from the bag labeled "Control Paper" to the tip of your tongue.

   - Touch one of the paper strips from the bag labeled "PTC Taste Paper" to the tip of your tongue.

2. If both papers just taste like paper, you are a **non-taster** for PTC. If one tastes bitter and the other just tastes like paper, you are a **taster.**

3. Are you a taster or a non-taster? ___________________________

4. How many students in your class are tasters? ____________________

5. How many students in your class are non-tasters? _______________

Percentage of tasters = number of tasters/total number in class X 100

6. What percentage of the students in your class are tasters? ___________________

7. What percentage of the students in your class are non-tasters? ___________________

8. How might the nervous system of a taster be different from the nervous system of a non-taster? List at least <u>two</u> possible differences.

   - ____
   - ____

Part 2: PTC Tasting and the Nervous System

1. Below is a description of what happens in the body when people taste bitter substances such as PTC. For each of the statements below, write the letter of the picture from the **Taste and Your Nervous System** diagram sheet that best illustrates the statement.

   _____ The tongue is covered with bumps called papillae. Each papilla contains many microscope taste buds.

   _____ When PTC molecules enter the mouth, they dissolve in saliva and enter the taste buds through a pore.

   _____ Each taste bud is filled with taste cells—the cells that can tell when PTC is dissolved in a person's saliva (spit).

   _____ The tips of the taste cells are covered with bitter taste receptor proteins. The dominant taster gene (T) makes a receptor protein that has the correct shape to match with the PTC molecules. People who are tasters have PTC receptors that fit with PTC molecules.

   _____ When a PTC molecule fits into the receptor proteins, it will excite that taste cell and cause it to send an impulse (electrical signal) to other cells in the nervous system.

   _____ Nerves conduct the impulses from the taste cells to relay areas and then the taste center of the brain. The taste center is the part of the brain that is responsible for the conscious sensation of BITTER!

2. Apply what you learned to make a drawing to illustrate the information below.

   Non-tasters have a version of the taste receptor that cannot detect PTC because the PTC molecule will not fit into it.

Your Drawing

3. Some people gradually or suddenly lose their ability to taste some foods or all foods. Explain two possible changes in the nervous system that could result in a change in the ability to taste.

   - ____
   - ____

Part 3: Taste Receptors and Evolution

PTC is not found in nature, but people who can taste PTC are likely to taste other bitter substances that occur naturally. These bitter substances share the potential of being toxic. Some plants produce bitter tasting toxic compounds in order to protect themselves from being eaten. Human's ability to taste bitter flavors offered a survival advantage by protecting ancient people from poisonous plants.

Upon further testing, it was found that about 25 percent of the population is unable to taste PTC while 75 percent finds it bitter. In the family studies that followed, taste-blindness was found to be inherited as a recessive trait. Because animal studies showed that apes are different from humans in that all of them are "PTC tasters," human non-tasters are thought to have somehow appeared later in evolution.

A bitter taste sensation triggers unlearned gaping, tongue thrusting, and oral ejection behaviors in human newborns and many animal species. People who taste a bitter food also may learn to avoid that food in the future.

Today, bitter taste sensitivity may have harmful consequences for human health by causing people to avoid bitter-tasting vegetables or medicines, some of which might lower the risk of cancer and heart disease.

1. What change might have caused the appearance of human non-tasters?

   ____

2. What might be an evolutionary advantage to being a bitter taster?

   ____

3. What might be an evolutionary disadvantage of being a bitter taster?

   ____

4. How could scientists and the medical and food industries use an understanding of the biology of bitter taste sensations to help improve human health?

   ____

Part 4: PTC Tasting and Broccoli Tasting

1. Do you like broccoli? Or, are you a "picky eater" who does not like broccoli? Circle the statement that **best** describes you.

I like uncooked broccoli
It does not have a bitter taste

I don't like uncooked broccoli
It has a bitter taste

Research Question:
Is there a **correlation** between the ability to taste PTC and the avoidance of (not liking) broccoli?

Correlation: a relationship between two variables which tend to occur together.

2. **Hypothesis:** If there is a correlation between PTC tasting and avoidance of broccoli, then

____

____

3. Your teacher has prepared 4 signs. Stand by the sign that best describes you.

Tasters who like uncooked broccoli	Tasters who do not like uncooked broccoli	Non-tasters who like uncooked broccoli	Non-tasters who do not like uncooked broccoli

4. Count the number of people at each sign. Then organize this information by completing the data table below.

Correlation of PTC Tasting and Liking Broccoli

Variables		**Number of People**
PTC Tasters	**Like uncooked broccoli**	
	Do not like uncooked broccoli	
Non-tasters	**Like uncooked broccoli**	
	Do not like uncooked broccoli	

5. Prepare a <u>bar graph</u> to illustrate the data in your data table. Label the vertical axis and the four bars.

Title: ____

6. What conclusions can you make based on the data in your data table?

7. Do the results of your experiment support your hypothesis? Explain why or why not.

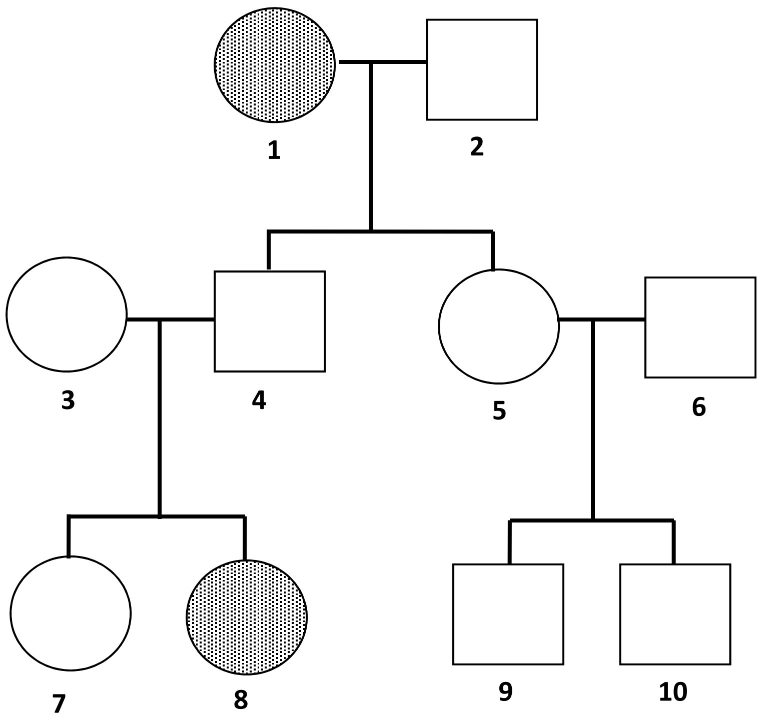
8. Describe one change you could make to improve this experiment.

Part 5: PTC Inheritance

There are two versions of the PTC tasting gene—a dominant **T** allele and a recessive **t** allele. The **T** allele codes for the production of a taste receptor on the tongue that works. The **t** allele codes for the production of a taste receptor that does not work. Persons with one or two dominant **T** alleles (***TT*** or ***Tt*** genotypes) have the "***taster***" phenotype. Persons with two recessive alleles (***tt*** genotype) have the "***non-taster***" phenotype. The "*non-taster*" phenotype is therefore described as a "recessive" trait.

The pedigree below shows the pattern of inheritance for PTC tasting in for a family. Squares are males, circles are females.

- People with the "*Taster*" phenotype are indicated by white symbols
- People with the "Non-taster" phenotype are indicated by gray symbols



1. Write the **genotype** inside the symbol for each person in the pedigree. If you cannot be certain whether the person is **TT** or **Tt**, write **T?**.

2. Write the numbers (shown under each symbol) for each of the individuals who:
   - Are homozygous recessive ___________
   - Are homozygous dominant ___________
   - Are heterozygous ___________
   - Could be either homozygous dominant or heterozygous ___________

Homozygous = has two identical alleles
Heterozygous = has two different alleles

Genetic testing can be used to determine a person's genotype for the PTC tasting gene. A scientist:

- Collected DNA samples from **each member of the family (1-10) shown in the pedigree on the previous page.**
- Used a special laboratory technique called PCR (polymerase chain reaction) to make copies of the PTC alleles for each family member.
- Placed these PTC gene allele copies into different wells (1-10) of an electrophoresis gel.
- Put the gel into a gel electrophoresis chamber and turned on the electrical current which caused the **small gene pieces moved further in the electrophoresis gel than the large gene pieces.**

Your lab kit contains a <u>simulated</u> paper gel that is like the one that the scientist made. The gene pieces (which are made of DNA) are not visible unless the gel is stained. You will need to stain the DNA (the PTC gene alleles) to make it visible.

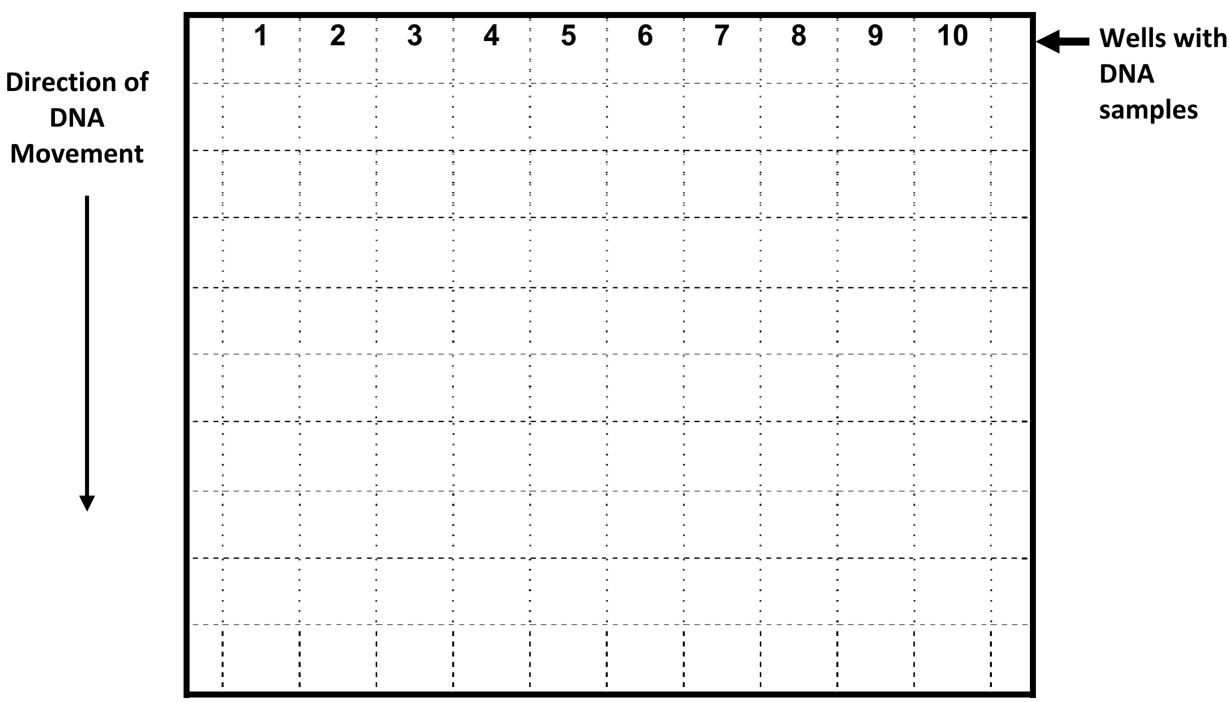
1. Add just enough water to the plate to completely cover the bottom of the white plate or tray.

2. Add the entire contents of the tube of DNA Stain to the water in the plate. This stain will bind to the DNA pieces (PTC genes) and turn them pink.

3. Use a stirrer to mix the stain until it is completely dissolved.

4. Place the simulated paper gel into the stain in the plate.

5. Draw the pattern of bands on the drawing of the gel below.



Remember that the gene for non-taster is recessive. That means that individuals 1 and 8 on the pedigree and the simulated gel are homozygous recessive and have the **tt** genotype.

6. **Shorter DNA pieces move further in the gel than longer DNA pieces.** According to the gel, which piece is **shorter**—the T allele (taster) or the t allele (non-taster)? Circle one. *Hint: Refer to both the pedigree and the electrophoresis gel.*

   T = taster allele **t = non-taster allele**

   Support your answer with information from the electrophoresis gel and the pedigree.

   ____

   ____

7. According to the gel, which individuals (1-10) are homozygous dominant for the PTC gene?

   ____

   Support your answer with information from the electrophoresis gel and the pedigree.

   ____

   ____

8. According to the gel, which individuals (1-10) are heterozygous for the PTC gene?

   ____

   Support your answer with information from the electrophoresis gel and the pedigree.

   ____

   ____

9. If couple 5 and 6 have another child, what is the probability that the child could be a non-taster? Support your answer with an explanation or a Punnett square diagram.

   ____

   ____

10. If person **8** and a person who is heterozygous for the PTC trait have a child, what is the probability that the child could be a non-taster? Support your answer with an explanation or a Punnett square diagram.

____

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Want to learn more about the genetics of PTC tasting? Explore ***Online Mendelian Inheritance in Man: PTC*** *http://omim.org/entry/171200.*

Part 6: PTC Population Genetics and Evolution

Scientists who study population genetics and evolution have proposed that evolution will **not** occur in a population when these seven conditions are met:

- Mutations are not occurring
- Natural selection is not occurring
- The population is infinitely large
- All members of the population breed
- All mating is totally random
- All members produce the same number of offspring
- There is no migration into or out of the population

However, because it is highly unlikely that any of these seven conditions will happen in the real world, evolution is the inevitable result. In other words, **evolution will occur when any of the seven conditions are not met**.

Describe a **fictitious scenario** or write a **science fiction story** that explains the **rapid evolution** of a human population with ONLY homozygous dominant (TT) tasters.

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Part 7: PTC Population Genetics

Students counted the number of tasters and non-tasters in the biology classes at a school. They found that there were 128 tasters and 72 non-tasters in these classes.

Frequency of trait = number of student with trait/total number of students

1. Calculate the frequency of tasters in the classes

2. Calculate the frequency of non-tasters in the classes

Hardy-Weinberg equations:

$$p^2 + 2pq + q^2 = 1$$

$$p + q = 1$$

p = frequency of dominant allele

q = frequency of recessive allele

$\mathbf{p^2}$ = frequency of homozygous dominant individuals

$\mathbf{q^2}$ = frequency of homozygous recessive individuals

2pq = frequency of heterozygous individuals

3. What is $\mathbf{q^2}$ (the frequency of non-tasters in the classes)? _______________

   Explain how you arrived at your answer.

4. What is **q** (the frequency of the non-taster allele in the classes)? _______________

   Explain how you arrived at your answer.

5. What is **p** (the frequency of the taster allele in the classes)? ______________
   Explain how you arrived at your answer.

6. What is **p^2** (the frequency of homozygous tasters in the classes)? ______________
   Explain how you arrived at your answer.

7. What is **2pq** (the frequency of heterozygous tasters in the classes)? ______________
   Explain how you arrived at your answer.

8. What is $p^2 + 2pq$ (the frequency of tasters in the classes)? ______________
   Explain how you arrived at your answer.

9. Explain how is it possible to have more tasters than non-tasters in the classes when the allele frequency for non-tasters is higher than the allele frequency for tasters.
   ____
   ____