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, taste blindness can be genetic.

1. You have a small bag containing two strips of taste paper:
    - One strip of PTC paper (with a bitter chemical called PTC)
    - One strip of control paper (with no PTC)

2. One at a time, touch each of the paper strips to the tip of your tongue.

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

4. Are you a taster or a non-taster? ______________________________

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 the Nervous System** diagram sheet that best illustrates the statement.

   ______ The tongue is covered with bumps called papillae. Each papilla contains many microscopic taste buds.

   ______ When PTC molecules enter the mouth, they dissolve in saliva (spit) 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.

   ______ 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 to 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. In the box below, make a drawing that illustrates how Diagram F could be changed to represent bitter taste receptor proteins in a non-taster.

Your Drawing

3. Explain why a person might be able to taste some flavors but not be able to taste PTC.

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

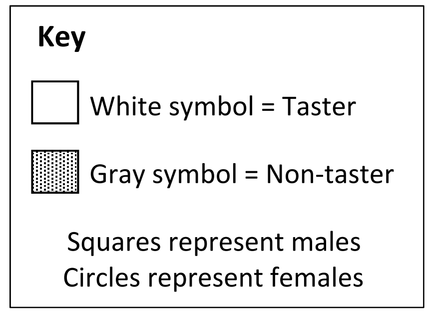
   - ____
   - ____

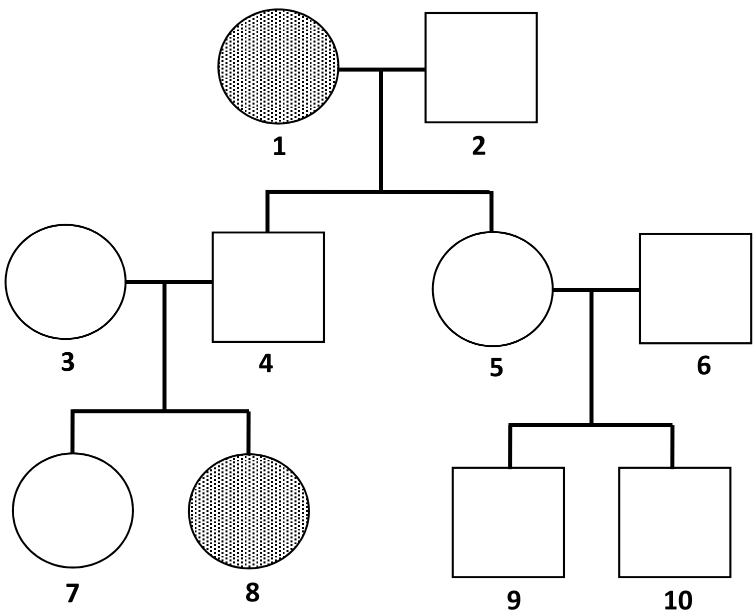
Part 3: PTC Inheritance - A Family Pedigree Chart

The family pedigree below shows the pattern of inheritance for PTC tasting in a family.
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 that can attach to PTC.
- The **t** allele codes for the production of a taste receptor that cannot attach to PTC.

Individuals with one or two dominant **T** alleles (**TT** or **Tt** genotypes) have the "**taster**" phenotype.
Individuals with two recessive alleles (**tt** genotype) have the "**non-taster**" phenotype.





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?.

   Hints for completing the genotypes on the pedigree:
   - *Because non-taster is a recessive trait, all non-tasters are **tt**.*
   - *Because taster is a dominant trait, all tasters have at least one **T** gene.*
   - *If a taster has a non-taster parent (tt) or a non-taster child, the taster also has a **t** gene.*
   - *Mark all other tasters as **T ?***

Homozygous = has two identical alleles

Heterozygous = has two different alleles

2. Write the numbers (shown under the each symbol) for each individual in the pedigree who:

- is homozygous recessive. ____________________________
- is homozygous dominant. ____________________________
- is heterozygous. ____________________________
- could be either homozygous dominant or heterozygous. ____________________________

Part 4: PTC Inheritance - Genetic Testing for the Family

Notice that you could <u>not</u> use the pedigree to determine the genotypes of all members of the family. Genetic testing can be used to determine a person's genotype for the PTC tasting alleles.

A scientist collected DNA samples from **each member of the family (1-10) shown in the pedigree on Part 4.** The scientist followed these steps to test the DNA samples for the PTC tasting alleles:

- A special laboratory technique was used to make copies of the PTC gene alleles (pieces of DNA) in the DNA samples from each family member.
- The PTC gene allele copies (pieces of DNA) were then placed into different wells (1-10) of an electrophoresis gel.
- The gel was placed into an electrophoresis chamber and an electrical current was turned on. The electrical current caused the pieces of DNA to move through the electrophoresis gel. The small (shorter) DNA pieces moved further through the electrophoresis gel than the large (longer) DNA pieces.

Your lab kit contains a <u>simulated</u> paper gel that is like the one that the scientist made. The alleles (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 40 ml of water to the plastic plate (use the small measuring cup to measure out the water).

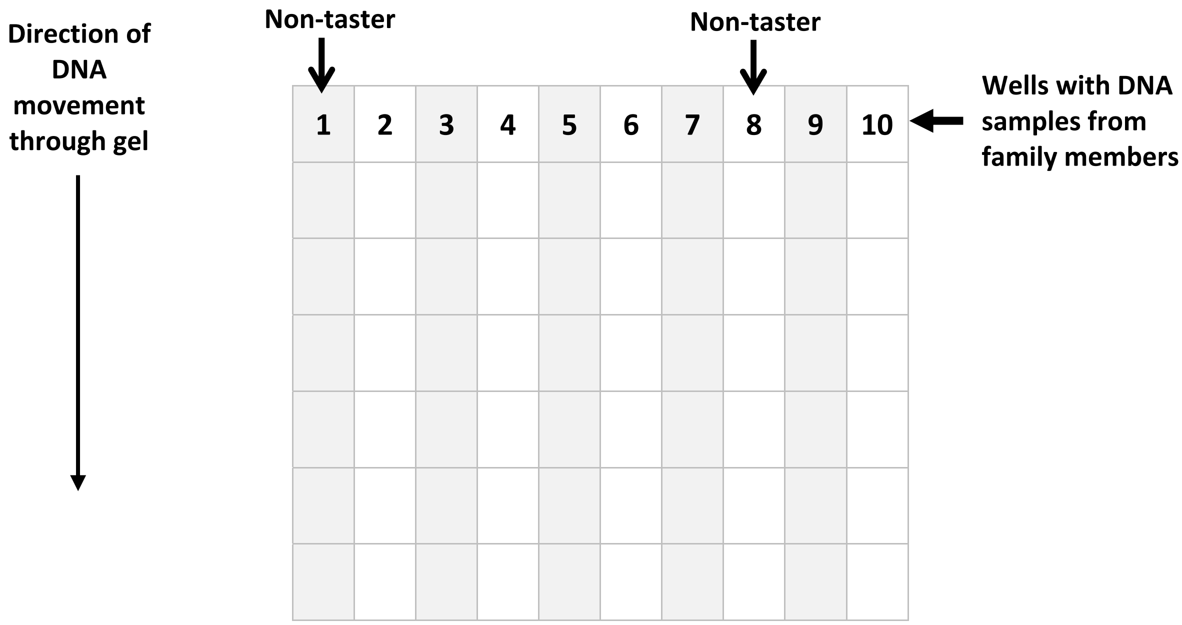
2. Pour the contents of the DNA Stain tube into the water in the plate.

3. Use the plastic stirrer to stir the water until the DNA Stain is completely dissolved.

4. Submerge the paper gel into the DNA Stain solution. If the paper gel floats, use the stirrer to gently push the paper gel into the DNA Stain solution.

5. The DNA Stain will bind to the DNA pieces (PTC gene alleles) and turn them pink. You will see pink bands appear on the paper gel.

6. Draw the pattern of pink bands on the picture of the gel below.



> Remember that the gene for non-taster is recessive. That means that family members 1 and 8 on the pedigree <u>and</u> the simulated gel are homozygous recessive and have the **tt** genotype.

7. **Shorter DNA pieces move further in the gel than longer DNA pieces.** According to the gel, which piece is <u>shorter</u> – the **T** allele (taster) or the **t** allele (non–taster)?

   Circle one choice below. *Hint: Refer to both the pedigree and the electrophoresis gel.*

   T = **taster allele that makes a PTC receptor that works**

   t = **non-taster allele that makes a PTC receptor that does <u>not</u> work**

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

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   ____

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

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

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9. According to the gel, which individuals are **heterozygous** for the PTC gene?

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

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10. If couple **5** and **6** has another child, what is the probability that the child could be a <u>non-taster</u>? Support your answer with an explanation or a Punnett square.

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11. 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 <u>non-taster</u>? Support your answer with an explanation or a Punnett square.

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Part 5: 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 chemicals 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.

About 25 percent of people are unable to taste PTC (non-tasters) while 75 percent of people find it bitter (tasters). In studies of families, taste-blindness was found to be inherited as a recessive trait. Animal studies have shown that all apes are "PTC tasters," therefore human non-tasters are thought to have appeared when the gene for PTC tasting mutated so that it no longer functioned properly.

A bitter taste sensation triggers unlearned behaviors in human newborns and many animal species – such as gaping, tongue thrusting, and oral ejection (spitting out the bitter item). People and animals 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?

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2. What might be an evolutionary <u>advantage</u> to being a bitter taster?

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3. What might be an evolutionary <u>disadvantage</u> of being a bitter taster?

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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?

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