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*Pre-Lab, Skills, and Standards Alignments*

**PTC: USING A SINGLE NUCLEOTIDE POLYMORPHISM (SNP) TO PREDICT BITTER TASTING ABILITY**

The ability to taste the bitter compound PTC (phenylthiocarbamide) is often used to illustrate Mendelian inheritance. Three SNPs (single nucleotide polymorphisms) in the gene encoding the PTC taste receptor strongly affect tasting ability. In this experiment, students extract DNA from cheek cells and use PCR to amplify a short region of the gene. After a diagnostic restriction digest, student genotypes are scored on an agarose gel, allowing them to predict their phenotypes. Students then test their tasting ability and compare genotypes and phenotypes. This experiment is a close analog to how “precision or personalized medicine” uses genotypes to predict drug response.

**Lab Length:** 6 hours

**Suggested Pre-Lab Teaching**

- DNA structure and function
- Central Dogma (genes to proteins)
- Mendelian genetics
- DNA replication
- Polymerase Chain Reaction (PCR)

**Lab Skills**

- Follow a multi-step protocol to complete a controlled experiment.
- Measure small volumes of liquid using micropipettes.
- Isolate DNA from human epithelial cells.
- Amplify DNA sequences using PCR.
- Visualize DNA using agarose gel electrophoresis.
- Utilize bioinformatics tools to determine amplicon size, and identify gene polymorphisms.

**Conceptual Knowledge/Skills** (Post Lab)

- Explain how to use PCR to amplify DNA.
- Predict experimental and control results.
- Conceptualize genetic basis for phenotypic differences.
- Describe how genotyping can be used in personalized medicine.



**New York State Science Learning Standards/NGSS**

| Science and Engineering Practices  | Disciplinary Core Ideas  | Cross Cutting Concepts  |
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| <p><u>Engaging in Argument from Evidence</u><br/>Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.</p> | <p><u>LS1.A: Structure and Function</u><br/>All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (HS-LS1-1) (secondary to HS-LS3-1)</p> <p><u>LS3.A: Inheritance of Traits</u><br/>Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (HS-LS3-1)</p> <p><u>LS3.B: Variation of Traits</u><br/>Advances in biotechnology have allowed organisms to be modified genetically. (HS-LS3-2)</p> <p><u>LS4.B: Natural Selection</u><br/>The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (HS-LS4-3)</p> | <p><u>Science is a Human Endeavor</u><br/>Science and engineering are influenced by society and society is influenced by science and engineering.<br/>Technological advances have influenced the progress of science and science has influenced advances in technology.</p> <p><u>Patterns</u><br/>Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.</p> <p><u>Cause and Effect</u><br/>Systems can be designed to cause a desired effect.</p> <p><u>Structure and Function</u><br/>The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.</p> <p><u>Stability and Change</u><br/>Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.</p> |



| <b>AP Biology Lab Alignment</b>  | <b>AP Biology Learning Objective</b>  | <b>AP Biology Science Skill</b>  |
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| <i>Extension of AP Biology Investigation #9 – Restriction Enzyme Analysis of DNA</i> | <b>IST – 1.P:</b> Explain the use of genetic engineering techniques in analyzing or manipulating DNA. | <b>6D:</b> Explain the relationship between experimental results and larger biological concepts, processes, or theories. |

| <b>NYS Living Environment Standard 1</b>   | <b>NYS Living Environment Standard 4</b>  |
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| <p><b>Performance Indicators</b></p> <p>1.1 Elaborate on basic scientific and personal explanations of natural phenomena.<br/>           2.1 Devise ways of making observations to test proposed explanations.<br/>           3.3 Assess correspondence between the predicted result contained in the hypothesis and actual result, and reach a conclusion as to whether the explanation on which the prediction was based is supported.</p> | <p><b>Performance Indicators</b></p> <p>2.1 Explain how the structure and replication of genetic material result in offspring that resemble their parents.<br/>           3.1 Explain the mechanisms and patterns of evolution.<br/>           5.1 Explain the basic biochemical processes in living organisms and their importance in maintaining dynamic equilibrium.</p> |