# SNP Analysis and Pharmaogenetics

## Abstract

Students learn about Single Nucleotide Polymorphisms (SNPs) in DNA sequences and how they can be used to match patients with appropriate medications. Students locate the SNPs in DNA sequences for fourteen patients, categorize them into haplotypes (same SNPs), and prescribe a medication to a fictitious patient based on their DNA sequence.

## Learning Objectives

- Students will learn about a key Pharmacogenetic approach to tailoring prescription medication to an individual's genotype.
- Students will learn that single nucleotide substitutions in DNA sequences are known as Single Nucleotide Polymorphisms (SNPs).
- Students will locate SNPs in genetic sequences.
- Students will learn that people with the same SNPs in a particular region of DNA are grouped into haplotypes.
- Students will group DNA sequences into haplotypes based on the SNPs those sequences contain.
- Students will learn that people with different haplotypes may have a different response to the same medication.

## Estimated time

- Class time 30 minutes
- Prep time 45 minutes

## Materials

- Student pages
- Highlighter
- Scissors

## Background Information

One of the goals of pharmacogenetics is to correlate variation in drug response to genetic variation. The most common type of variation in DNA is a single base substitution, known as a Single Nucleotide Polymorphism (SNP). For example, an adenine in one sequence of DNA is placed where a cytosine is located in another. Because SNPs tend to be inherited in groups, scientists can break a larger population into sub-groups, called haplotypes, based on the SNPs those individuals possess. The hope is to correlate differences in drug response and disease risk to haplotype groups.

SNPs occur roughly once in every 300 base pairs. This means there are 10 million SNPs in the entire genome (genome = 3 billion nucleotides). In order to be classified as a SNP, the substitution must occur in at least 1% of the population. Most SNPs occur outside of genes and therefore have no

effect on genes or their protein products; these are known as linked SNPs. SNPs located within genes are called causative SNPs and fall into two categories: coding and non-coding. Coding SNPs change the protein product of the gene, and non-coding SNPs, which are located in the regulatory sequence of the gene, affect how much protein is produced from the affected gene.

SNPs tend to be inherited in groups. These groups of SNPs and their various possible combinations are known as haplotypes.

For example:

Haplotype One: c t t g g a c t g a t

Haplotype Two: c t g g g a t t g c t

The field of pharmacogenetics aims to define haplotype groups and use them in the following ways: (a) correlate haplotypes to drug response for particular medications and (b) correlate haplotypes to risk for particular diseases.

If pharmacogenetics is successful, in the future a physician may first determine to which haplotype group a patient belongs, and then prescribe a course of treatment based on which medications and dosages are most successful with that haplotype.

## Instructions

**1.** Begin class by asking the class the following questions:

- Are any of you allergic to any medications?
- Have you ever had an adverse reaction to a medication?
- Have you ever taken a medication that didn't work that well?

**2.** Inform the class that:

- People respond differently to medications.
- Each year, 106,000 Americans die from adverse drug reactions and 2.2 million suffer serious side effects; others have no problems at all.
- Scientists, physicians and the pharmaceutical companies think that variation in response to drugs could be due to genetic variation.
- A new field called pharmacogenetics is emerging that aims to figure out how an individuals' genetic make-up might correlate to their reaction to specific drugs.
- If pharmacogenetics is successful, in the future a physician might prescribe a course of treatment based on an individuals' genotype. In order to make this a reality, scientists are endeavoring to group people into categories (called haplotypes) based on differences in their genotype and to correlate the response to specific medications for each category. Today's activity highlights how scientists might do this.

**3.** Hand out the student pages, highlighters and scissors to the students. Instruct them to follow the directions to carry out the activity.

## Extensions

- For reinforcement, have students visit SNiPping Away at the Problem, an online activity in the Pharmacogenomics: Drugs Designed for You module on the Genetic Science Learning Center website (see Additional Resources). Pay particular attention to the Making SNPs Make Sense animation that is part of this piece.
- This activity uses the drug albuterol as an example. Students may find information about how albuterol works on the cellular level, as well as how many different haplotypes are currently being compared against albuterol effectiveness in the Making SNPs Make Sense animation on the SNiPping Away at the Problem page in the Pharmacogenetics: Drugs Designed for You module on the Genetic Science Learning Center website (see Additional Resources)

## Adaptations

- Provide only pages 3-4 for students to work with while you read the instructions contained in pages 1-2 aloud to the class.
- If highlighters are not available, students may use pen, pencil or colored pencil to circle or underline the SNP locations in the DNA Sequence Data (page 4).

## Misconception

SNPs are sometimes confused with disease-causing mutations. They are different in the following ways:

- Many SNPs are located outside of genes and therefore have no effect on any protein product.
- To be classified as a SNP, the nucleotide substitution must occur in at least one percent of the population. No disease-causing mutation is this common.

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