Teacher Guide: Exploring Pharmacogenomics

ACTIVITY OVERVIEW

Abstract:
Students navigate the *Pharmacogenomics: Drugs Designed for You* module to learn about pharmacogenomics while completing a web quest.

Module:
Pharmacogenomics: Drugs Designed for You

Prior Knowledge Needed:
None

Key Concepts:
Pharmacogenomics; drug response; genetic variation; disease risk; drug development

Materials:
Computers with Internet access, student handouts, pencils and/or pens

Appropriate For:
Ages: 12 - 18
USA grades: 7 - 12

Prep Time:
15 minutes

Class Time:
45 minutes

Activity Overview Web Address:
http://gslc.genetics.utah.edu/teachers/tindex/overview.cfm?id=196

Other activities in the ***Pharmacogenomics: Drugs Designed for You*** module can be found at:

http://gslc.genetics.utah.edu/teachers/tindex/

TABLE OF CONTENTS

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I. PEDAGOGY

A. Learning Objectives

- Students will learn about pharmacogenomics.
- Students will learn how information about genetic variation may be used to predict differences in drug response.
- Students will learn how information about genetic variation may be used to assess disease risk.
- Students will practice reading for information.

B. Teaching Strategies

1. Timeline

- 2-3 weeks before activity:
  - reserve a computer lab with Internet access
- 1 day before activity:
  - make copies of the student pages (S-1 to S-4), one for each student
- Day of activity:
  - take students to the computer lab and pass out student handouts for them to complete

2. Classroom Implementation

- Hand out the *Exploring Pharmacogenomics* web quest (student pages S-1 to S-5)
- Bring your class to the computer lab and have them log on to http://gslc.genetics.utah.edu/ and click on the *Pharmacogenomics: Drugs Designed for You* module.
- Instruct your students to use this module to answer the questions on the *Exploring Pharmacogenomics* web quest.

3. Assessment Suggestions

- Use the completed *Exploring Pharmacogenomics* web quest as an assessment.

4. Extensions

- Please see Additional Resources for more Pharmacogenomics activities.

II. ADDITIONAL RESOURCES

A. Activity Resources linked from the online Activity Overview at:

http://gslc.genetics.utah.edu/teachers/tindex/overview.cfm?id=

- Website: Classroom Activities Index: *Pharmacogenomics: Drugs Designed for You* - Online and Print-and-Go™ activities covering topics in pharmacogenomics.

III. MATERIALS

A. Detailed Materials List

- Computers with Internet access
- Student handouts (pages S-1 to S-5)

IV. STANDARDS

A. U.S. National Science Education Standards

Grades 5-8:

- Content Standard C: Life Science - Reproduction and Heredity; the characteristics of an organism can be described in terms of a combination of traits. Some traits are inherited and others result from interaction with the environment.

Grades 9-12:

- Content Standard C: Life Science - Molecular Basis of Heredity; in all organisms, the instructions for specifying the characteristics of an organism are carried in DNA.
- Content Standard F: Science in Personal and Social Perspectives - Personal and Community Health; many diseases can be prevented, controlled or cured.

B. AAAS Benchmarks for Science Literacy

Grades 9-12:

- The Human Organism: Physical Health - new medical techniques, efficient health care delivery systems, improved sanitation, and a fuller understanding of the nature of disease give today's human beings a better chance of staying healthy than their forebears had.
- The Designed World: Health Technology - knowledge of genetics is opening whole new fields of health care.

C. Utah Secondary Science Core Curriculum

Intended Learning Outcomes for Seventh and Eighth Grade Integrated Science

Students will be able to:
5. Demonstrate Awareness of the Social and Historical Aspects of Science
   a. Cite examples of how science affects life.

Intended Learning Outcomes for Biology
Students will be able to:
5. Demonstrate Awareness of the Social and Historical Aspects of Science
   a. Cite examples of how science affects human life.

Biology (9-12)

Standard 4: Students will understand that genetic information coded in DNA is passed from parents to offspring by sexual and asexual reproduction. The basic structure of DNA is the same in all living things. Changes in DNA may alter genetic expression.

Objective 3: Explain how the structure and replication of DNA are essential to heredity and protein synthesis

f. Research, report, and debate genetic technologies that may improve the quality of life (e.g., genetic engineering, cloning, gene splicing).

V. CREDITS

Activity created by:
Molly Malone, Genetic Science Learning Center
Pete Anderson, Genetic Science Learning Center (illustrations)

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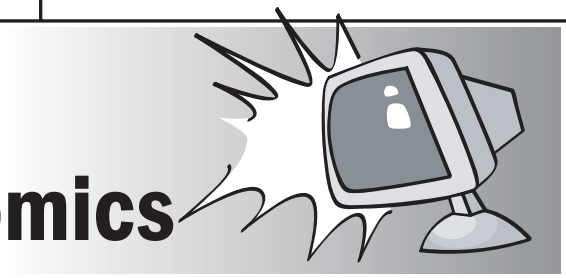
Exploring Pharmacogenomics



Log on to: http://gslc.genetics.utah.edu/units/pharma/ and explore this module to find the answers to the questions below.

Hint: the Search feature on this website may or may not help you find what you are looking for; it is best to go through the module to find the answers.

Questions:

1. Complete the following table:

	Pharmacogenomics	Pharmacogenetics
Definition	Uses large groups of patients to evaluate how candidate drugs interact with a range of genes and their protein products.	Evaluates how an individual's genetic make up corresponds to the response to a particular medication.
Goal	Increase the efficiency of the drug development process and develop products that will benefit the largest population.	Tailor medical treatments to the individual, increasing their effectiveness while reducing side effects.
Benefits	Reduce the time and money it takes to design superior medications that effectively treat specific patient populations.	Tests that predict patient drug response, match drugs with the patient and assess disease risk.

2. What is a SNP?

A Single Nucleotide Polymorphism. They are single-nucleotide substitutions of one base for another.

To be classified as a SNP, it must be present in at least __1__ % of the population.

3. How many SNPs occur throughout the human genome?

10 million (or one in every 300 base pairs.)

4. Briefly explain how physicians might ***Apply SNP Profiles to Drug Choices*** when designing a treatment for a patient.

Use the following words: SNP profile, known data, predict

(Answers will vary)
In the future, a physician might first determine a patient's ***SNP profile***, compare it with ***known data*** and ***predict*** the patient's response to a medication. The physician would then prescribe medication based on what is known to work best with that patent's SNP profile.

5. Test 3 wart medications on the Pus-Poppin' frogs to answer the following questions:

List the five steps involved in this activity:

1. Determine SNP Profile
2. Test Wart Medications
3. Match Drugs to Frogs
4. Test Drugs on New Frog
5. Drug Company Development Strategy

Which frog showed a positive response to Ribbitra without any side effects?

Pee-wee Croakley

What was the SNP Profile for this frog? 5G; 11G

Which SNP was unique to this frog? 11G

Which frog showed a positive response to Clarhoppin without any side effects?

Artemous Amphibious

What was the SNP Profile for this frog? 5C; 11T

Which SNP was unique to this frog? 5C; 11T

Which frog do you predict will respond best to Zertoadinoxx?

The Hopster

What was the SNP profile for this frog? 5G; 11A

According to the study done by ***Gribbenhop Pharmaceuticals***, which SNP profile appears in the largest percentage of the population?

5G; 11G

Which drug is most effective for individuals with that SNP profile?

Ribbitra

6. Measuring gene expression and determining which genes play a role in a particular health condition might lead to the following future applications (remember, obesity is only an example) :

- Creating diagnostic tests to predict whether a patient has a genetic predisposition to a disease.
- Designing drugs intended to treat or prevent a particular disease.
- Designing drugs to control expression of disease genes.

7. The presence of which molecule indicates a gene is on in a cell?

mRNA

8. List the steps involved in using microarray analysis to identify which genes are "on" in a tissue or cell sample.

Collect samples of appropriate tissue.

Isolate mRNA.

Make DNA copies of mRNA and label them with different colors.

Apply labeled DNA samples to microarray.

Scan microarray and analyze data.

9. Why do scientists perform protein expression analysis?

(Answers will vary)

To determine which proteins are being made and functioning in a cell or tissue sample. The presence of mRNA does not necessarily mean that the protein is being produced properly.

10. Go ***Beyond the Stethoscope*** and complete the ***Pharmacogenetics and Medical Care*** story below (you may draw a picture where applicable):

Latrice has been diagnosed with _____leukemia_____.

Her doctor wants to prescribe Purinethol, a common chemotherapy drug that works by…

(Answers will vary)
incorporating itself into rapidly dividing cancer cells and killing them.

Some patients suffer severe side effects from Purinethol because they…

(Answers will vary)
vary in their level of TPMT, an enzyme responsible for breaking down Purinethol.

89 % of the population can handle a full dose of Purinethol.

11 % of the population can handle a reduced dose of Purinethol.

0.33 % of the population suffers serious side effects from Purinethol.

This difference is caused by...

(Answers will vary)
genetic variation that affects the level of TPMT activity in the body.

To determine what dosage of Purinethol, if any, Latrice can handle Latrice's doctor...

(Answers will vary)
will take a blood sample and send it to a lab for SNP profiling. This will determine which TPMT variation Latrice has.

11. In 2-3 sentences, highlight what would be different about the drug development process using pharmacogenomics.

(Answers will vary)
In the future, the drug development process will not be as random, and take less time and money. Genetic information will be used to first target genes or proteins involved in disease, and then drugs will be designed to purposely target these genes or proteins. Currently, compounds are simply tested until those that are effective are found. Genetic information will also be used to identify which people in a population respond well to the drug and to determine candidates for further clinical trials.

12. List which of the ***Challenges and Issues*** involved in Pharmacogenomics seem most important to you. Then, choose one and explain why you think it is important. You may use the back of this paper.

(Answers will vary)

Name_____ Date_____

Exploring Pharmacogenomics

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Questions:

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Goal		
Benefits		

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To be classified as a SNP, it must be present in at least _____ % of the population.

3. How many SNPs occur throughout the human genome?

4. Briefly explain how physicians might ***Apply SNP Profiles to Drug Choices*** when designing a treatment for a patient.
   Use the following words: SNP profile, known data, predict

5. Test 3 wart medications on the Pus-Poppin' frogs to answer the following questions:

   List the five steps involved in this activity:

   1.

   2.

   3.

   4.

   5.

   Which frog showed a positive response to Ribbitra without any side effects?

   What was the SNP Profile for this frog? _____

   Which SNP was unique to this frog? _____

Which frog showed a positive response to Clarhoppin without any side effects?

What was the SNP Profile for this frog? _____

Which SNP was unique to this frog? _____

Which frog do you predict will respond best to Zertoadinoxx?

What was the SNP profile for this frog? _____

According to the study done by ***Gribbenhop Pharmaceuticals***, which SNP profile appears in the largest percentage of the population?

Which drug is most effective for individuals with that SNP profile?

6. Measuring gene expression and determining which genes play a role in a particular health condition might lead to the following future applications (remember, obesity is only an example):

-
-
-

7. The presence of which molecule indicates a gene is on in a cell?

8. List the steps involved in using microarray analysis to identify which genes are "on" in a tissue or cell sample.

9. Why do scientists perform protein expression analysis?

10. Go ***Beyond the Stethoscope*** and complete the ***Pharmacogenetics and Medical Care*** story below (you may draw a picture where applicable):

Latrice has been diagnosed with _____.

Her doctor wants to prescribe Purinethol, a common chemotherapy drug that works by...

Some patients suffer severe side effects from Purinethol because they...

_____ % of the population can handle a full dose of Purinethol.

_____ % of the population can handle a reduced dose of Purinethol.

_____% of the population suffers serious side effects from Purinethol.

This difference is caused by...

To determine what dosage of Purinethol, if any, Latrice can handle Latrice's doctor...

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