

Module Guide: Pharmacogenomics: Drugs Designed for You

Module Overview

Abstract:

This guide for teaching the *Pharmacogenomics: Drugs Designed for You* module includes: (1) Essential Questions and Enduring Understandings, (2) suggested uses for each activity, (3) sample lesson plans for 2-5 days, and (4) science education standards.

Appropriate For:

Ages: 12 - 20
USA grades: 7 - 14

Class Time:

1-5 class periods, as suggested in this guide

Module Overview Web Address:

<http://gslc.genetics.utah.edu/teachers/tindex/overview.cfm?id=199>

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Essential Questions and Enduring Understandings

This module was developed utilizing a set of Essential Questions (EQ) and Enduring Understandings (EU)¹. The Essential Questions are designed to guide student inquiry as they explore the topic of pharmacogenomics. The associated Enduring Understandings represent the fundamental concepts students should gain from their study of this topic, and which we hope they will remember long after the course has ended.

EQ: *Why do individuals respond differently to medications?*

EU: Individuals respond differently to medications due to variations in genotype and environmental factors.

EQ: *How can Pharmacogenomics reduce side effects and improve efficacy of medications?*

EU: Pharmacogenomics will lead to diagnostic genetic tests that predict a patient's response to specific drugs, and match patients with effective and safe medications based on their genotype.

EQ: *How else might Pharmacogenomics personalize medicine?*

EU: Pharmacogenomics will lead to personalized disease prevention strategies by using genetic tests to estimate a patient's risk of getting a particular disease.

EQ: *How will Pharmacogenomics impact the drug development process?*

EU: By adding genetic data to the drug development process, pharmacogenomics will reduce the overall cost and time it takes to develop new medications.

¹Wiggins, G and McTighe J (1998) *Understanding by Design*. Association for Supervision and Curriculum Development, Alexandria, VA.

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Activity Type Table









We assume that each teacher using this module will select and order activities in a way that reflects their teaching style and that is appropriate for their students. Many of the activities in this module can be used in multiple ways, such as a “hook” to engage student interest, content delivery, or assessment. To assist you in planning your lesson or unit, the Activity Type Table lists the module activities, their mode of delivery (online and/or paper), and suggested uses.










Interactive Web activity, estimated time = 10 min., longer if noted with an “*”



Print-and-Go™ activity, see Activity Overview for estimated time

Activity	Engage	Content Delivery	Reinforcement	Alternative to Online	Extension	Assessment
Exploring Pharmacogenomics 	X	X				
Pharmaco-What? Introducing Personalized Medicine 	X	X				
Wanna Buy Some Drugs? 	X		X			
SNiPping Away at the Problem 		X				
SNP Analysis and Pharmacogenetics 			X	X	X	
Pus-Poppin’ Frogs  *	X	X	X			X
Keeping an Eye on Gene Expression 		X				
Profiling Technique: Microarray Analysis 		X				

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Activity	Engage	Content Delivery	Reinforcement	Alternative to Online	Extension	Assessment
Macromodel of Microarray 	X	X		X		
Profiling Technique: Protein Expression Analysis 		X				
Beyond the Stethoscope: Your Doctor's New Genetic Tools 	X	X	X			
Drug Development Today and Tomorrow 		X		X		
Challenges and Issues in Pharmacogenomics 				X		
Mapping Pharmacogenomics Concepts 	X	X				X
Additional Resources 				X		

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Sample Lesson Plans











To assist you in planning your lesson or unit we provide sample timelines for 2, 4, and 5 days of instruction. A brief summary of each activity is included to assist you in visualizing the flow of instruction. The timelines below are suggested for a 50 minute class period. If you teach in a block, adjust as necessary. Activity overviews and print materials (where applicable) for activities listed below can be found in the online Classroom Activities Index for this module (<http://gslc.genetics.utah.edu/teachers/>).

A. TIMELINE 1 : 2 Class Periods

Day 1: 50 minutes	Wanna Buy Some Drugs? 	Students complete a short reading and fill out a Drug Information Sheet to learn that many commonly prescribed medications cause adverse side effects.
	Pharmaco-What?: Introducing Personalized Medicine 	Students learn what pharmacogenomics is and how this field might use genetic information to personalize medicine.
Day 2: 50 minutes	Exploring Pharmacogenomics  *	Students navigate the <i>Pharmacogenomics: Drugs Designed for You</i> module while completing a web quest.
Day 2: (alternate) 50 minutes	SNiPping Away at the Problem  *	Online content delivery regarding single nucleotide polymorphisms (SNPs) and how they might be used in pharmacogenomics.
	<i>Choose One:</i> • Pus Poppin' Frogs  *	An interactive online activity where students act as researchers to correlate genetic variation with drug response, and use information from their "study" to make recommendations about medical treatment and drug development.
	• SNP Analysis and Pharmacogenetics 	Students compare DNA sequences of 14 patients, locate single nucleotide polymorphisms (SNPs), and use them to match patients with appropriate medications.
	Beyond the Stethoscope: Your Doctor's New Genetic Tools  *	An example of pharmacogenetics already in action. This activity follows a young girl with leukemia whose doctor uses genetic tests to determine the proper chemotherapy treatment for her disease.









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B. TIMELINE 4 Class Periods

Day 1: 50 minutes	Wanna Buy Some Drugs? 	Students complete a short reading and fill out a Drug Information Sheet to learn that many commonly prescribed medications cause adverse side effects.
	Pharmaco-What? Introducing Personalized Medicine 	Students learn what pharmacogenomics is and how this field might use genetic information to personalize medicine.
Day 2: 50 minutes	<i>Choose One:</i> • SNiPping Away at the Problem 	Online content delivery regarding single nucleotide polymorphisms (SNPs) and how they might be used in pharmacogenomics.
	• SNP Analysis and Pharmacogenetics 	Students compare DNA sequences of 14 patients, locate single nucleotide polymorphisms (SNPs), and use them to match patients with appropriate medications.
	Pus Poppin' Frogs  *	An interactive online activity where students act as researchers to correlate genetic variation with drug response, and use information from their "study" to make recommendations about medical treatment and drug development.
Day 3: 50 minutes	Keeping an Eye on Gene Expression 	Students learn about how studying differences in gene expression will lead to personalized medical treatments and health risk assessments.
	Profiling Technique: Microarray Analysis 	Learn about the technology used to determine which genes are "on" and which are "off" in a tissue sample.
	Macromodel of Microarray 	A pizza box and ping-pong ball model that demonstrates the principles of microarray technology.
Day 4: 50 minutes	Beyond the Stethoscope: Your Doctor's New Genetic Tools  *	An example of pharmacogenetics already in action. This activity follows a young girl with leukemia whose doctor uses genetic tests to determine the proper chemotherapy treatment for her disease.
	Mapping Pharmacogenomics Concepts 	Sum up this module's content by organizing the main points and issues for Pharmacogenomics into a concept map.






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C. TIMELINE 5 Class Periods

Day 1: 50 minutes	Wanna Buy Some Drugs? 	Students complete a short reading and fill out a Drug Information Sheet to learn that many commonly prescribed medications cause adverse side effects.
	Pharmaco-What? Introducing Personalized Medicine 	Students learn what pharmacogenomics is and how this field might use genetic information to personalize medicine.
Day 2: 50 minutes	SNiPping Away at the Problem 	Online content delivery regarding single nucleotide polymorphisms (SNPs) and how they might be used in pharmacogenomics.
	Pus-Poppin' Frogs 	An interactive online activity where students act as researchers to correlate genetic variation with drug response, and use information from their "study" to make recommendations about medical treatment and drug development.
Day 3: 50 minutes	Keeping an Eye on Gene Expression 	Students learn about how studying differences in gene expression will lead to personalized medical treatments and health risk assessments.
	Profiling Technique: Microarray Analysis 	Learn about the technology used to determine which genes are "on" and which are "off" in a tissue sample.
	Macromodel of Microarray 	A pizza box and ping-pong ball model that demonstrates the principles of microarray technology.
	Profiling Technique: Protein Expression Analysis 	Learn how the presence or absence of proteins in a cell can be determined and how this information leads to a better understanding of disease.

Option: You may use the Exploring Pharmacogenomics worksheet (Pages S-1 - S-5) along with the activities for days 1-5.

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TIMELINE 6 days - continued		
Day 4: 50 minutes	Beyond the Stethoscope: Your Doctor's New Genetic Tools  *	An example of pharmacogenetics already in action. This activity follows a young girl with leukemia whose doctor uses genetic tests to determine the proper chemotherapy treatment for her disease.
	SNP Analysis and Pharmacogenetics 	Students compare DNA sequences of 14 patients, locate single nucleotide polymorphisms (SNPs), and use them to match patients with appropriate medications.
Day 5: 50 minutes	Drug Development Today and Tomorrow 	Follow a drug through development today and in the future. Learn how Pharmacogenomics might make the development process more efficient and less expensive.
	Challenges and Issues in Pharmacogenetics 	Ponder the technical, economic, and ethical challenges Pharmacogenomics faces.
	Mapping Pharmacogenomics Concepts 	Sum up this module's content by organizing the main points and issues for Pharmacogenomics into a concept map.

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STANDARDS

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.
- Content Standard E: Science and Technology - Understandings About Science and Technology; science helps drive technology, as it addresses questions that demand more sophisticated instruments and provides principles for better instrumentation and technique.

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 E: Science and Technology - Understandings About Science and Technology; science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge.
- 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 6-8:

- The Nature of Technology: Technology and Science - technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information.
- Habits of Mind: Communication Skills - organize information in simple tables and graphs and identify relationships they reveal.

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.
- The Nature of Technology: Technology and Science - technological problems often create a demand for new scientific knowledge, and new technologies make it possible for scientists to extend their research in new ways or to undertake entirely new lines

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of research. The very availability of new technology itself often sparks scientific advances.

C. Utah Secondary Science Core Curriculum

Intended Learning Outcomes for Seventh and Eighth Grade Integrated Science

Students will be able to:

1. Use Science Process and Thinking Skills
 - c. Develop and use categories to classify subjects studied.
5. Demonstrate Awareness of the Social and Historical Aspects of Science
 - a. Cite examples of how science affects life.
 - b. Give instances of how technological advances have influenced the progress of science and how science has influenced advances in technology.
6. Communicate Effectively Using Science Language and Reasoning
 - f. Construct models to describe concepts and principles.

Intended Learning Outcomes for Biology

Students will be able to:

1. Use Science Process and Thinking Skills
 - c. Evaluate, sort, and sequence data according to given criteria
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

Credits:

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