Pharmacogenomics
Medicinal Therapy of the Future

Brian Ruhmann
Academy Lead Teacher
Medical Academy for Science and Technology
Miami Dade County Schools
bsruhmann@dadeschools.net

Abstract

Personalized medicine is the medicine of the future. Pharmacogenomics is the pharmacological component of personalized medicine. Personalized medicine, and by extension pharmacogenomics, will require a expanding the definition of health care professional. The recruitment and training of these professionals will become more specialized. Exposing high schools students to this evolving field of medicine will assist in this recruitment of these health professionals.

The pharmacogenomics unit will expose the students to principles of pharmacogenomics, the potential of pharmacogenomics to increase patient outcomes and decrease adverse events. The pharmacogenomics lesson will utilize: a webquest to develop the basic concepts, case studies to identify the clinical need and outcomes of pharmacogenomics, and a micro-assay array lab to explore the scientific techniques employed in this research.

Rationale

Personalized medicine is the medicine of the future. Healthcare practitioners of the future are not going to be just our doctors, nurses and allied health practitioners; but also geneticists, biotechnologists, biostatisticians, and medical researchers. Our genetic make-up will drive the medical care as much as our symptoms. Personalized medicine is the tailoring of medical interventions to maximize outcomes based on an individual's genetic profile. The customization of the interventions includes treatments, medication regimens, and prevention strategies (Ginsburg & Willard, 2009).

This evolution of medicine will require a broadening of the definition of healthcare practitioner; and subsequent training and recruitment of these practitioners.

Exposure to and awareness of these other healthcare practitioner opportunities has been limited. The challenge is to how to make not only post-graduates and undergraduate students aware of these professions; but also high school students.

The purpose of the personalized medicine unit is to expose high school students to science of personalized medicine. The pharmacogenomics lesson is designed to investigate the impact of a patient's genetic profile on a pharmaceutical therapy. The customization of the pharmaceutical therapy to a patient's genetic profile will create better therapeutic outcomes and decreased adverse events. The pharmacogenomics lesson utilizes interrupted case studies and a micro-assay lab to examine the variability in patient response to clopidogrel and the clinical consequences of the variability.

Action Research Intervention

The pharmacogenomics lesson has the following components:

- Pre/Post Test
- Pharmacogenomics Webquest
- Percutaneous Transluminal Cutaneous Angioplasty-Clopidogrel Interrupted Case Study
- CYP2C19 Genotype and Clopidogrel Micro Assay Lab

The lesson will be delivered using the Team Based Learning protocol.

Connections to Bench to Bedside Program

The following components were drawn directly from participation in the Bench to Bedside Program:

- Pharmacogenomics Pre/Post-Test
- Pharmacogenomics Webquest

- Micro Assay Lab

Data Collection and Analysis

Pre- and post-test scores on the pharmacogenomics pre/post-test will be collected and analyzed using a two tailed t-test to assess effectiveness of the lesson. Additionally, a student evaluation of the unit will be collected.

Literature

Ginsburg, G. S., & Willard, H. F. (2009). Genomic and personalized medicine: Foundations and applications. *Translational Research, 154*(6), 277-287. doi:10.1016/j.trsl.2009.09.005

SINGLE LESSON PLAN

Teacher: Ruhmann	**Content Area/Grade: 11th Grade Acad.**	**Date:**

Unit Name:	Pharmacogenomicss

Unit Goal What unit goal does this daily lesson address?	**Standard(s)/Benchmark(s)** What standard(s)/benchmark(s) does this daily lesson address?
Pharmocogenomics is the study of how an individual's genetic profile influences their response to drug regiment.	

Students will understand that… What should the students understand by the end of today's lesson?	**Essential Questions** What essential question(s) does this lesson address?
• Pharmacogenomics •	How does and individual's genetic profile impact their response to pharmaceutical therapy?

Connecting Concepts How will you review yesterday's content and connect today's lesson to it?	**Organizing Students for Learning** How will students be organized today for the lessons activities?
•	Team Based Learning Groups

LEARNING EXPERIENCES, INSTRUCTION AND RESOURCES

What activities or experiences (from your Unit Plan) will students engage in today?

Lesson Sequence

Activating Prior Knowledge		☐ ABC Brainstorming ☐ KWL ☐ Anticipation Guide ☐ Card Sort ☐ Think-Pair-Share
Explicit Instruction		☐ Motivational Hook ☐ Lecture ☐ Demonstration ☐ Note-taking Guide

<table>
<tr><th colspan="4">Lesson Sequence</th><th>Resources and Materials</th></tr>
<tr><td>Group Processing of New Information</td><td></td><td>☐ Jigsaw
☐ Reciprocal Teaching
☐ Concept Attainment
☐ Think-Pair-Share</td><td rowspan="3">☐ Lab / Inquiry Activity</td><td rowspan="5">☐ Computer
☐ LCD Projector
☐ Paper
☐ Pencils
☐ Whiteboards
☐ Markers
☐ Butcher Paper
☐ Response Cards
☐ Post-it Notes
☐ Video Clip(s):

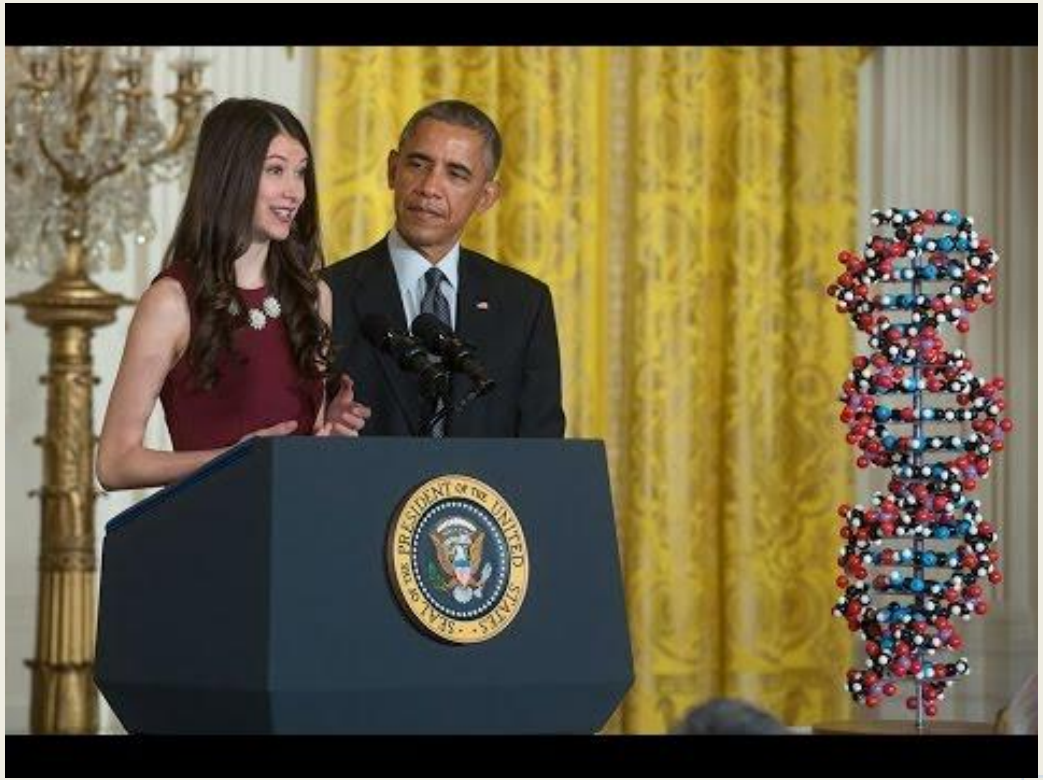
☐ Website(s):

☐ Lab Materials:</td></tr>
<tr><td>Elaborative Questioning</td><td></td><td>☐ Inferential Questions
☐ Analytic Questions
☐ Philosophical Chairs</td></tr>
<tr><td>Demonstrating Understanding</td><td></td><td>☐ Graphic Organizers
☐ Picture Notes
☐ Flow Charts
☐ Concept Maps
☐ Mnemonics
☐ Graffiti</td></tr>
<tr><td>Reflection</td><td></td><td>☐ Reflective Journals
☐ Think Logs
☐ Exit Ticket (Student Learning)</td><td></td></tr>
<tr><td>Daily Progress Monitoring Assessment</td><td></td><td>☐ Quiz
☐ Journal
☐ Exit Ticket (for Content)
☐ Response Cards</td><td></td></tr>
<tr><td colspan="4">Based in the results from your Daily Progress Monitoring Assessment, what concepts need to be revisited in the next lesson?</td><td>Homework</td></tr>
</table>

Pharmacogenomics

Evolving Medicine

Precision Medicine



Objectives

- Pharmacogenomics
- Evolving Medical Professions
- Team Based Learning
  - RAT
  - Inquiry Activities

PreTest

Webquest

Readiness Assurance Test

Readiness Assurance Test

- iRAT
- tRAT

PTCA Case Study

- Coronary Occlusion Event-PTCA (Part A)
  - TBL Questions
- PTCA-Clopedrogel Therapy (Part B)
  - TBL Questions

Clopedrogel Response Micro Assay Lab

TBL Follow Up Activity

Medical Profession Concept Map

- Individual
- Group
- Gallery Walk

Post Test

Unit Reflection

UNIT PLAN

Unit Title: Pharmocogenomics	**Content Area/Grade: Pharmaceutical Sciences**
Teacher: Ruhmann	**Implementation Time Frame: 6 hours**

STAGE 1: THE DESIRED RESULTS
What are my learning goals?

Unit Goal
Students will understand that…

Pharmocogenomics is the study of how an individual's genetic profile influences their response to drug regiment.

Standard(s)/Benchmark(s)
What standard(s)/benchmark(s) does this daily lesson address?

Related Misconceptions
What misconceptions are predictable?

- All individuals respond the same to drug regimen in similar ways
- Drugs are equally effective across all individuals

Essential Questions
What questions will foster inquiry, understanding and transfer of learning?

How can we use an individual's genetic profile to guide drug therapy choices in order to increase patient outcomes and decrease adverse events.

Students will know…
Vocabulary, terminology, definitions

Vocabulary

- Pharmacogenomics
- Micro Assay
- Percutaneous Transluminal Coronary Angioplasty

Students will know…
key facts, formulas, critical details, important events, important people, timelines

Other Essential Knowledge

- Pathophysiology and treatment of coronary artery occlusion
- Adverse effects of Plavix drug therapy
- Genetic influences on patient response to Plavix drug therapy

Students will be able to…
Specific skills students will acquire as a result of this unit

- Collaboratively work in team
- Perform and interpret micro-array analysis of genetic profile for Plavix drug response
- Read and interpret case study

STAGE 2: ASSESSMENT EVIDENCE

What evidence will show that my students have achieved the learning goals?

Performance tasks:

Through what specific "real-world" performance task(s) will students demonstrate their understanding of the learning goals?

- MicroAssay Lab
- Interrupted Case Study-Plavix
- Medical Professions Managing Case Concept Map

Rubric

By what criteria will "performance of understanding" be judged?

Other Evidence: What other evidence needs to be collected in order to monitor student progress on these concepts and skills along the way?	**Self-Assessment/Reflection** How will students reflect and self-assess their learning?
• Pretest/Post Test • iRAT/tRat Assessment of Pharmacogenomic Webquest •	Reflection

STAGE 3: LEARNING EXPERIENCES, INSTRUCTION, AND RESOURCES
What activities will help my students achieve the learning goals?

What **W**here	**What** is expected? How will you ensure that students are aware of the learning goals? **Where** are your students? How will you establish your students' prior knowledge?	• State Objectives • Pre-Test •
Hook **H**old	How will you **hook** students at the beginning of the unit? How will you **hold** their attention throughout the units?	• Obama Precision Medicine Video • Case Study • Micro Assay Lab • TBL
Experience **E**xplore **E**quip	What critical input **experience** will help students **explore** the key ideas and essential questions? How will you **equip** your students with needed skills and knowledge?	Webquest with RAT Follow-Up
Reflect **R**ethink **R**ehearsing **R**evising **R**efining	How will you encourage students to **reflect** and **rethink**? How will you guide students in the process of **rehearsing**, **revising**, and **refining** their work?	• TBL • Unit Reflection •
Exhibit **E**valuate	How will you help students to **exhibit** and **self-evaluate** their developing skills, knowledge and understanding throughout the unit?	• RAT • Inquiry Activities Assessment • Medical Professional Concept Map
Tailor	How will you **tailor** your instruction to meet the different needs, interests and abilities of all learners in your classroom?	• Team Based Learning Groups
Organize	How will you **organize** and sequence the learning activities to maximize the engagement and achievement of all students?	• Pharmacogenomics Webquest • iRat/tRat Assessment • Interrupted PTCA/Plavix Case Study • Plavix Micro Assay Case Study

Big Idea:		**Standard(s)/Benchmark(s):**
Unit: Pharmacogenomics		**Sample Activities**
Grade: 9-12		
Score 4.0	**In addition to Score 3.0, in-depth inferences and applications that go beyond what was taught.**	
Score 3.0	**The student:** **The student exhibits no major errors or omissions**	
Score 2.0	**There are no major errors or omissions regarding the simpler details and processes as the student:** • Recognizes or recalls specific terminology • Performs basic processes, such as: **However, the student exhibits major errors or omissions regarding the more complex ideas and processes**	
Score 1.0	**With help, a partial understanding of some of the simpler details and processes and some of the more complex ideas and processes.**	
Score 0.0	**Even with help, no understanding or skills demonstrated.**	