

STEM PROJECT ACTIVATOR

Functional Genomics & Individualized Medicine

Project Details

COURSE

Life Science, Biology, Anatomy and Physiology

GRADE SPAN

9–12

DURATION

Two forty-five to sixty-minute sessions

CONCEPT

Genomics and Genetic Testing

OVERVIEW

Students will investigate the human genome in an effort to understand how genetic mutations can lead to disease. Students will explore the methodology of screening for these mutations, as well as how the medical field is beginning to use mutations as a starting point for personalized treatment. Students will compare and contrast the concept of individualized medicine with more traditional treatments, and will create a process infographic that outlines both methods. Students will then ultimately respond to a writing prompt in which they weigh the potential benefits of personalized medicine against its ethical considerations.

ESSENTIAL QUESTION

How can a pill that uses radiation help doctors diagnose and treat diseases?

MATERIALS

- Device with internet access and projection capabilities, one for the teacher
- Devices with internet access, one for each student or student pairs
- Videos: to project
 - 9 Types of Infographics [video](#)
 - My Genome Sequence [video](#)
 - Wall Street Journal [video](#)*
 - Time Magazine [video](#)

- Articles:
 - American Society of Clinical Oncology [article](#)*
 - National Cancer Institute [article](#)*
 - Cleveland Clinic [article](#)*
 - National Cancer Institute [overview](#)*
- Infographic Evaluation Criteria, one per student
- Essay Evaluation Criteria, one per student
- Personalized Medicine Essay Notes Sheet, one per student
- White copy paper, at least two sheets per student
- Colored pencils, markers, and/or crayons for students to share

**Suggested but not required. See Create Step 3 for additional details.*

PROCEDURE

Think

- 1 Present students with the following scenario: You have decided to apply pre-med to several universities and you're getting a head start on one of your college essays. Your top choice school requires an essay regarding the ethical implications of personalized medicine...but in order to do complete this, you have to gain an understanding of what it entails!
- 2 Ask student pairs to discuss: How do you think most doctors decide treatment for their patients? In general, make sure the discussion leads to the idea that there tends to be standard treatment protocols for different sicknesses and diseases. While these may fluctuate slightly as a result of a patient's age, weight, overall health, etc., some variation of the standard treatments is usually the go-to option.
- 3 Explain that the concept of personalized medicine is moving toward a new type of treatment. Explain that you will show two short videos. As they watch, students should listen carefully for information that described genome sequencing and why it is important.
 - a. Video 1: [How to Sequence the Human Genome video](#) (until 4:18)
 - b. Video 2: [My Genome Sequence video](#) (0:46 – end)
- 4 Give students the headline: "Could Genome Sequencing Save Lives?" With a partner, direct students to use information from the videos to develop a one-paragraph summary of an article that could accompany this headline, being sure to include what genome sequencing and why it is important. Encourage pairs to share their article summaries with the class.

Sample Answer: DNA acts as the body’s instruction manual. The complete set of your DNA is called your genome sequence. Only 1% of your entire genome sequence differs from others. Sometimes these differences can cause health problems. Doctors are beginning to perform genome sequencing, which is a process in which scientists take a blood sample, remove the DNA and read its sequence—and then compare this sequence to other people’s genome sequences. By doing this, scientists are able to find glitches or mutations in the original DNA. This discovery can help doctors not only diagnose health problems but also consider options for treatment that have the potential to be much more effective than standard treatment options.

Create

- 1 Task students with creating a process infographic that compares the process of personalized medicine and traditional treatment plans following a cancer diagnosis. Distribute the infographic evaluation criteria so students can review what is expected. Then show a segment of the 9 Types of Infographics video (from 3:53–4:48) to review what a process infographic consists of.
- 2 Direct students to make a simple T-chart to organize their personalized medicine versus standard treatment notes for their infographic.
- 3 Then give students time to perform research. A suggested research pathway includes:
 - a. Students may begin to take notes by watching this Wall Street Journal [video](#) (5:55–7:44).
 - b. Next, students can read this [article](#) from the National Cancer Institute.
 - c. Students may then fill in any gaps in their notes with their own research. Other suggested sources include an [explanation](#) of cancer-related gene mutations from the American Society of Clinical Oncology, the Stanford Center’s Genomics and Personalized Medicine [website](#), this short Cleveland Clinic [article](#) and an [overview](#) from the National Cancer Institute about standard treatment options.

Sample research notes may include:

Personalized Medicine:

- Doctors take a biopsy, in which sample tissue is removed from the tumor.
- Genomic sequencing is performed on this tissue, and doctors look for any genetic changes that may be causing the cancer to form and grow.
- If doctors are able to identify the DNA alteration that is causing the growth of the tumor and treatment already exists for this alteration, this information is used to evaluate which treatment the tumor is most likely to respond to. Doctors may also be able to determine if any inherited genetic mutations exist that should be taken into consideration.

- Once treatment begins, ongoing tests for DNA mutations will continue throughout the course of treatment.
- However, because this is a new field of medicine, it is not certain that targeted therapies will exist or that DNA alterations can be identified.

Standard Treatment:

- Doctors perform tests to determine the type of cancer, its size and whether it has spread. (Tests may include blood tests, imagery scans and/or biopsies.)
 - Depending on the type of cancer and its stage, treatments include surgery, chemotherapy, radiation therapy, and/or immunotherapy.
 - While some patients will have only one type of treatment, the majority of patients will undergo a combination of treatments such as surgery and chemotherapy, or chemotherapy followed by radiation.
 - If the therapy is effective, doctors traditionally move on to a more aggressive form of treatment.
- 4 When students have sufficient research, they should begin to synthesize and summarize their research in order to create their infographic. Remind students that the purpose of the infographic is to help viewers easily compare the two types of treatment. It may be helpful for students to confer with a partner before they begin drafting their design on the white paper. If time allows, students may create a final copy using a free online infographic tool or a graphic design software program.

Connect

- 1 Once students have completed their infographics, they have the background required to begin research for their essay on the ethical implications of personalized medicine. Distribute the Essay Evaluation Criteria as well as the Personalized Medicine Essay Note Sheet and review the requirements together.
- 2 Direct students to fill in their notes sheet with any applicable details they have already learned while researching for their infographic. Then instruct them to determine what research they still need to perform before they can write their essay.
- 3 Before students begin their independent research, show this *Time Magazine* [video](#). Encourage student pairs to discuss what notes they can add to their Note Sheet.
- 4 Students should then use the Internet to search for current news and journal articles that will help them consider the benefits and implications of personalized medicine. Remind students that there is not correct or incorrect answer, but they must be able to support their position with concrete details

and reputable sources.

- 5 When they are ready, students may use their research to begin their essay. Students should refer to the essay evaluation criteria to remain on task and develop an essay that will impress the university's admissions officer!

Career Connections

Read through each of the career descriptions below, and consider: What role(s) would each career have played in the scenario you just investigated? Which career sounds the most interesting to you and why?

- **Bioengineers** work across all medical fields to apply the principals of engineering to biological processes. Those who work in genetics help us better understand diseases and work to develop more efficient treatment methods. To watch a bioengineer career profile, [click here](#).
- **Bioinformaticians** deal with data related to biological issues, including the human genome. Some bioinformaticians study and analyze this data, while others develop tools and algorithms to help with the data analysis. For a peek into the life of a bioinformatician, [click here](#).
- **Physicians** play an integral role in the prevention and treatment of diseases, no matter the type of treatment used. Physicians must collaborate with other healthcare specialists to determine the best course of treatment for their patients. To learn more about becoming a doctor, [click here](#).

INFOGRAPHIC EVALUATION CRITERIA

Your work will be evaluated based on the following criteria. Your infographic must:

- Outline at least 3 traditional treatment steps following a cancer diagnosis. Steps are clear and well-described.
- Outline at least 3 steps that personalized medicine may take following a cancer diagnosis. Steps are clear and well-described.
- Clearly illustrate the differences between the two strategies.
- Present information in a concise, logical and visually appealing manner.

Criteria	2	1	0
Traditional Cancer Treatment	Infographic clearly and concisely explains at least three steps that traditional treatment may include following a cancer diagnosis.	Infographic clearly and concisely describes two steps that traditional treatment includes following a cancer diagnosis, or describes three steps in a way that is unclear.	Student describes 1 or fewer steps.
Personalized Medicine Cancer Treatment	Infographic clearly and concisely explains at least three steps that a personalized medicine approach may take following a cancer diagnosis.	Infographic clearly and concisely describes two steps that a personalized medicine approach may take following a cancer diagnosis, or describes three steps in a way that is unclear.	Students describes 1 or fewer steps.
Presentation	The information is presented in a clear, logical, and visually appealing manner.	The information is presented in a somewhat clear, logical and visually appealing manner but improvements could be made in several areas.	The way in which the information is presented is confusing and not visually appealing.



Name _____ Date _____

Personalized Medicine Essay Notes Sheet

Directions

Use the notes sheet below as you gather research to help you answer the question:

When considering the future of personalized medicine, how could you balance the value of personalized medicine with any ethical considerations? Explain your response in detail.

Proven and/or Potential Benefits of Personalized Medicine:	Source(s)
Ethical Considerations of Personalized Medicine:	Source(s)

ESSAY EVALUATION CRITERIA

Your essay will be evaluated based on the following criteria:

- Your reasoning behind your response to the essay question: When considering the future of personalized medicine, how could you balance the value of personalized medicine with any ethical considerations? Explain your response in detail.
- Explanation of the potential benefits of personalized medicine
- Explanation of the ethical considerations of personalized medicine

Criteria	2	1	0
Personalized Medicine: Proven and/or Potential Benefits	Written response clearly explains at least two benefits of personalized medicine. The benefits are thoughtfully explained and sources are referenced.	Written response clearly explains at least one benefit of personalized medicine, or describes two benefits in a way that is unclear. Sources may or may not be referenced.	Student inadequately explains 1 or fewer benefits of personalized medicine. Sources may or may not be referenced.
Personalized Medicine: Ethical Considerations	Written response clearly explains at least two ethical considerations of personalized medicine. The considerations are thoughtfully explained and sources are referenced.	Written response clearly explains at least one ethical consideration of personalized medicine, or describes two ethical considerations in a way that is unclear. Sources may or may not be referenced.	Student inadequately explains 1 or fewer ethical considerations of personalized medicine. Sources may or may not be referenced.

<p>Personalized Medicine: Take a Stance</p>	<p>The response clearly articulates the student’s stance on how to balance personalized medicine with its ethical considerations, and uses at least one counter-example (e.g. an example of an un-balanced situation) to support their position.</p>	<p>The response clearly articulates the student’s stance on how to balance personalized medicine with its ethical considerations, but does not use a counter-example to support their position. Or, the response somewhat presents how to maintain this balance and includes a counter-example to support their position.</p>	<p>The response does not explain how to balance personalized medicine with its ethical considerations nor does it provide a counter-example to support their opinion.</p>
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