FUTURELAB+

Behind the Scenes of Scientific Breakthroughs

Genetic Sequencing

Developed in partnership with:
Discovery Education and Ignited

In this Lesson Plan:

Print the **Teacher Section** → 🖨

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This document is separated into two sections, For Teachers [T] *and* Student Resources [S]*, which can be printed independently.*

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This image shows an illustration of a genome sequence map.
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Cover Image
This is a conceptual illustration of genetic engineering.

BIOMED / BEHIND THE SCENES OF SCIENTIFIC BREAKTHROUGHS

Genetic Sequencing

DRIVING QUESTION

How can information discovered from genomic sequencing be used to prolong life?

ESSENTIAL QUESTIONS

How is an individual's genome sequenced?

What advances in the genetic sequencing of human DNA have been made?

What are the advantages and disadvantages of genome sequencing?

OVERVIEW

Genomic sequencing has fast-tracked science, allowing for more efficient and less laborious research. The most popular instance of genomic sequencing is the Human Genome Project[1], which culminated in 2003 with the announcement of a complete genetic blueprint for a human being. There are many different applications of genomic sequencing, from determining the origin of your ancestors to creating specific drugs.

In this lesson, students will review a timeline of the various techniques that have been utilized to sequence a genome. They will also get insight into the health disparities of genomic sequencing. Students will also learn how companies are utilizing genomic sequencing data. A discussion on the thoughts of ownership of DNA will be had using the perspective of many different stakeholders.

OBJECTIVES

Students will be able to:

Navigate the National Center for Biological Information (NCBI) website and BLAST program.

Identify human disease genes and **determine** chromosomal locations using a BLAST search.

Describe how genomic sequencing has changed over the years since the Human Genome Project.

Determine social justice issues of genome sequencing that may affect the general population.

Recognize cancer health disparities in the United States.

Create a public service announcement video to inform certain races/ethnicities about a type of cancer that affects their demographic more than it affects others.

Describe environmental and genetic factors that increase longevity.

Synthesize current research to determine the ownership of DNA.

Construct an evidence-based argument considering the views of multiple stakeholders.

[1] human-genome-project

BACKGROUND INFORMATION

It would be helpful for students to recall information about the structure of DNA and how it is copied during the interphase of the cell cycle. Although the tools used continue to advance, the basic rule for the complementary base pairing of nucleotides is the same. In addition, students should be reminded of certain techniques, such as PCR and gel electrophoresis. This will make sure they understand the use of these tools in genome sequencing. They should also be familiar with the processes of gene expression, transcription, and translation to provide relevancy for genomic sequencing.

Materials
Glue or Tape
Poster Board
Sticky Notes
Modeling Recombinant DNA Capture Sheet
Cancer Health Disparities Capture Sheet
Cancer PSA Capture Sheet
Longevity Genes Capture Sheet
The Ownership of DNA Assignment
The Ownership of DNA Assignment Rubric
Design Journal

Pedagogical Framing

Instructional materials are designed to meet national education and industry standards to focus on in-demand skills needed across the full product development life cycle—from molecule to medicine— which will also expose students and educators to the breadth of education and career pathways across biotechnology.

Through this collection, educators are equipped with strategies to engage students from diverse racial, ethnic, and cultural groups, providing them with quality, equitable, and liberating educational experiences that validate and affirm student identity.

Units are designed to be problem-based and focus on workforce skill development to empower students with the knowledge and tools to be the change in reducing health disparities in communities.

SOCIAL-EMOTIONAL LEARNING

Students will construct an evidence-based argument considering the views of multiple stakeholders. Because students will have to refute and defend their stances, they should remain open-minded and respectful of others' opinions.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Students will discuss the current data in genetic sequencing regarding ethnic/racial groups. Students will learn that most of the data used to discover possible drug targets are of European ancestry. They will make connections to the health disparities that this causes globally. Students also participate in activities that encourage them to showcase their diverse cultural and linguistic skills to reflect on why historically marginalized communities are not selected to participate in medical data collection. There are opportunities for affirming and validating the contributions of culturally and linguistically diverse people in relevant research and other scientific endeavors.

ADVANCING INCLUSIVE RESEARCH

Students will discover the connection and implications in the lack of diversity in genetic data available. In order to personalize medicine and ensure targets for therapeutics, health care professionals and researchers must work toward closing these data gaps.

COMPUTATIONAL THINKING PRACTICES

In this lesson, students analyze data using a BLAST search to identify the gene and chromosome on a given nucleotide sequence in order to determine the associated genetic disease. They look for patterns in genome-wide studies along with abstract information from a video and make connections to the patterns and trends uncovered in their observations. Students work in pairs to research and collect data about cancer health disparities in the United States, and then use the computational thinking strategy of decomposing problems to create a public service announcement that summarizes their research and educates certain populations about a specific type of cancer.

CONNECTIONS TO THE PRODUCT LIFE CYCLE

This lesson connects to the **discovery** phase of the product life cycle as students identify the implications on therapeutics and drug availability when diverse genetic data is limited.

CIVICS

During Day 4 students will discover research illuminated by genomic sequencing about characteristics that provide clues to human longevity. Students will discuss the right to ownership of DNA. They will discover various perspectives on the issue and understand that certain choices can have short- or long-term effects on people's lives directly through the application or indirectly through research progress.

Have you ever wondered…

How do companies, such as Ancestry.com and 23andMe, obtain information about ancestry to provide to its consumers?

Companies utilize specific regions in a sequence of DNA to help identify an individual's haplogroup, which is a group of people that share a common ancestor. As a group, the genetic sequences are very similar with some regions being highly conserved and others including SNPs.

Why would an individual want to get his or her genome sequenced?

There are many benefits of having your genome sequenced. Having your genome sequenced and analyzed can help with prevention and treatment of diseases. With knowledge of the genome, individuals can identify whether or not they are at risk for certain diseases based on identified mutations. In addition, treatments can be created that would be specific and targeted based on the genetic sequence, which would make them more effective.

How can genomic sequencing be used in other fields besides medicine?

The use of genomic sequencing has expanded beyond clinical medicine. Public health agencies benefit from using genetic sequencing to diagnose or identify a pathogen. The agricultural industry can utilize genomic sequencing to discover genes that can be used to improve crops or cattle.

MAKE CONNECTIONS!

How does this connect to the larger unit storyline?

Information learned from sequencing a human genome can be utilized in a variety of ways. Research in this field can improve the outlook of diseases by identifying possible drug targets. Additionally, continued advances in genomic sequencing can allow for more insight into the genes that seem to play a role in individuals living the longest and who are exceptionally healthy as they age.

How does this connect to careers?

Geneticists research information regarding the genes of an organism. They are essential in determining the function and importance of certain genes. Research in this area allows for the discovery of possible drug targets to improve many ailments and diseases affected by genetics.

Genetic counselors are responsible for providing information to clients regarding their genetics. These scientists can help determine whether or not an individual may have a certain genetic mutation or predisposition to the disease.

Bioethicists are responsible for helping to answer questions regarding moral issues in the fields of healthcare, science, and technology.

How does this connect to our world?

Technological advances in genomic sequencing have significantly improved since the 1970s. The clarity of the data and price have enabled many stakeholders, both for-profit and nonprofit, to utilize the results to inform many practices. The better the tool used in genetic sequencing, the more information about similarities and differences among organisms can be discovered. These findings can help determine possible drug targets for specific medicines used to treat ailments represented by certain ethnic groups.

Day 1

Students will be able to:

Navigate the National Center for Biological Information (NCBI) website and BLAST program.

Compare a given nucleotide sequence with known sequences in BLAST.

Analyze the results of a BLAST search.

Identify human disease genes and **determine** chromosomal locations using a BLAST search.

This image shows a DNA sequencing result sheet.

Procedure

Whole Group (10 minutes)

1   Explain to students that the Human Genome Project was an international collaborative research program that aimed to provide a complete mapping of all the genes in a human being. All our genes together are called our genome. Developing a map of the human genome is important because it provides information from DNA to develop new ways to treat, cure, or prevent thousands of diseases that affect humans.

2   Invite students to answer the following questions in a whole group discussion using *Raise a Righteous Hand* protocol:

   a.   Have you heard of companies that offer DNA testing kits?

   b.   Does anyone know of a friend or relative that has had his or her genome sequenced?

   c.   What are some reasons someone would want to sequence his or her genome?

3   Share with students that several companies sequence genetic information from individuals to determine the country of ancestry or origin.

4   Introduce the *What is Genomic Sequencing?* video clip and explain that it will briefly review the structure of DNA and how it can be sequenced. Project the following questions on the board and provide enough time for students to read them. Explain that while they watch the video, they should be listening to find the answers to these questions.

   a.   Q: What breaks apart the DNA into smaller pieces?

       A: high frequency sound waves

   b.   Q: Why are special tags added to the end of the DNA fragment?

       A: The tags are added to help the DNA attach to a glass slide

   c.   Q: The DNA fragments are copied hundreds of thousands of times. What technique can be used to make copies of DNA?

       A: PCR (not stated in the video, but is a review of prior content).

Day 1
Continued

Procedure

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d. Q: What do the colors reveal for each fragment?

A: The colors reveal the specific type of nitrogen base.

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e. Q: The video stated that medical experts can analyze and compare the DNA sequences to identify variants. What is another term that we use to describe a variant or change in the DNA sequence?

A: mutation

Small Group (20 minutes)

1   Explain to students that they will use the National Center for Biotechnology Information site to identify several sequences of nucleotide bases from DNA samples.

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2   Distribute the *Modeling Recombinant DNA Capture Sheet* to each student and review the Background with them. Explain to students that they will work with a partner and use a BLAST (Basic Logical Alignment Search Tool) search to determine what genetic disease is associated with the nucleotide sequences they have been given. They will be able to identify the gene and chromosome on which it is found and briefly describe the genetic disease.

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3   Demonstrate how to use a BLAST search and sequence the first human gene to model how they should complete the activity.

Individual (10 minutes)

Once students have identified each gene, have them select one disease that they would like to learn more about and conduct research. Have them present their findings in a 1–2 paragraph summary. They should also update their **Design Journal** to capture how content learned in this lesson connects to the information they are investigating and to the creation of their final project.

Teacher Note > *This summary may be collected as an Exit Ticket and used as a formative assessment.*

INDUSTRY AND CAREER CONNECTION

Emphasize to students that a major soft skill needed for a geneticist is being an organized, motivated learner. In this lesson, students will be learning a lot of information and will need to keep organized notes to be able to use them on the review activity in the next class. As research advances are always being made, geneticists have to be open to learning about new techniques in the field of genetics. Similarly, students will learn a lot of information that may seem unrelated to the lab. Let students know that having a background of information will assist with understanding new techniques that are often iterations of past methods.

Day 2

Procedure

Students will be able to:

Examine data to determine patterns and trends.

Develop questions based on the examination of data.

Describe how genomic sequencing has changed over the years since the Human Genome Project.

Determine social justice issues of genome sequencing that may affect the general population.

Whole Group (10 minutes)

1   Have students examine *Exhibit 1* and work with elbow partners to identify any trends, observations, or patterns (TOP strategy) they notice. Share with students that this data was gathered by reviewing all current (2017) papers that have been researched and written about genome-wide studies.

Exhibit 1 **Disease Area**	**Demographic Group**		
	Europeans (%)	Asians (%)	Under-represented populations (%)
Any type of cancer (n = 413)	67	29	4
Breast cancer (n = 59)	61	34	5
Gastrointestinal cancer (n = 47)	53	47	0
Lung cancer (n = 55)	44	49	7
Kidney cancer (n = 19)	84	11	5
Blood cancer (n = 52)	56	44	0
Reproductive cancer (n = 120)	81	13	6
Other cancers (n = 61)	82	16	2
Any noncancer disease or disorder (n = 2,404)	71	20	8
Cardiovascular disease (n = 219)	68	20	12
Neurologic disease (n = 418)	82	14	4
Respiratory disease (n = 111)	77	12	11
Gastrointestinal disease (n = 131)	78	21	1
Reproductive system disease (n = 93)	70	26	4

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Day 2

Continued

Procedure

Kidney disease (n = 56)	70	23	7
Blood disorder (n = 155)	71	17	12
Other diseases (n = 1,221)	68	23	9

2 Using the TOP strategy—where each pair chooses either a Trend, Observation, or Pattern they found in the data—invite each pair to share their choices with the class. The teacher can invite a student to make a class observation list on the board or on a large piece of poster paper.

3 Invite partners to review the trends, observations, and patterns the class made and develop 1–2 questions they have after reviewing the data.

Possible questions:

- Why are some diseases more common in particular demographic groups?
- Why are Europeans and Asians the only demographic groups represented in the studies?
- Why are the percentages considerably lower for underrepresented populations?
- Why are diseases in underrepresented populations not being studied?

Small Group (30 minutes)

1 Explain that students will work with a partner to summarize their learning with the *Tweet, Tweet!* strategy while watching the Ted Talk video: *Keolu Fox: Why Genetic Research Must Be More Diverse*. Using the Twitter social media format encourages students to pay attention to important details, summarize them succinctly, use #hashtags intentionally for categorization, and adopt a point of view in a larger conversation.

2 Create three to four hashtags (categories) related to the main idea of the media.
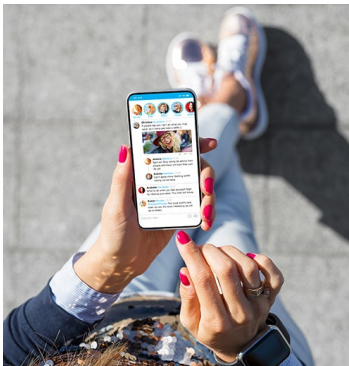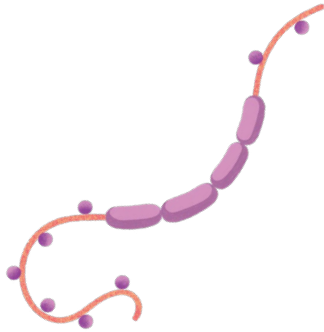
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Day 2
Continued

Procedure

3   Review the elements of a tweet:

    a.   Username: also known as a "handle"

    b.   Brevity: tweets are limited to 280 characters in length

    c.   Hashtags: tweets are organized by the hashtags used

4   Provide each student with at least three sticky notes and ask them to determine their "handle" and write it at the top of each note.

5   Students will watch the video together and pause occasionally to "tweet" something they learned on their sticky notes.

6   Have students post their sticky notes under the hashtag that most relates to their tweet.

7   Conclude by having students participate in a *Gallery Walk* and create reply tweets to at least three other students.

Small Group (5 minutes)

Invite students to make connections between the video they watched and the data they examined. In small groups of two to three, have students brainstorm social justice issues that may come into play with genomic sequencing being available and used on the general population.

Some issues may include:

- Due to cost, it may not be accessible to everyone.
- Not everyone has health insurance.
- Certain demographic groups may lack trust in the use of the genomic sequencing.
- Ownership of DNA must be determined once it is sequenced.

Day 3

Students will be able to:

Discuss how genome sequencing could benefit everyone more equally and improve health equity.

Recognize cancer health disparities in the United States.

Create a public service announcement video to inform certain races/ethnicities about a type of cancer that affects their demographic more than it affects others.

Procedure

Whole Group (5 minutes)

1   Review the social justice issues the students developed from the previous lesson. Have students work in small groups of three to answer the following questions:

    a.   Why is it important to gather genome sequencing from all demographics?

    b.   Do the rates of developing and dying from breast cancer vary among various racial and ethnic groups?

    c.   How can genome sequencing be more equitable and improve health disparities?

2   Invite students to share their answers with another group and decide which answers they will share with the class.

Small Group (15 minutes)

1   Distribute the *Cancer Health Disparities Capture Sheet* and share that students will work with a partner to learn about cancer health disparities in the United States. Before the students watch the video, invite them to develop a definition of health disparity.

    Then have them watch the video:
    Cancer Health Disparities | Did You Know?

2   Instruct students that they will pause periodically throughout the video to answer the questions on their *Cancer Health Disparities Capture Sheet*.

3   Conclude the activity by asking students to write a one paragraph reflection on the video sharing three to five things they learned.

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Day 3
Continued

Procedure

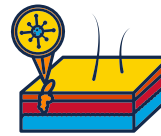| Individual (25 minutes) |
| --- |

1   Assign students one of the following types of cancer:

    a. bladder

    b. leukemia

    c. lung

    d. melanoma of skin

    e. pancreas

    f. kidney

    g. thyroid

    h. non-Hodgkin lymphoma

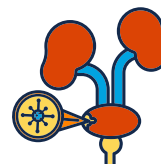Lung cancer   Skin cancer   Kidney cancer
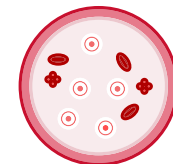
Pancreatic cancer   Bladder cancer   Leukemia

2   Distribute the *Cancer PSA Capture Sheet* and review the directions and project criteria with them. Instruct them to highlight or circle the cancer that was assigned to them.

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Day 3
Continued

Procedure

3   Introduce them to the *National Cancer Institute: Cancer Stat Facts* website. This link will show statistics for bladder cancer. Review the following information on the website:

    a.   Statistics at a glance

    b.   Survival statistics

    c.   New cases and deaths

    d.   Trends in rates

    e.   More about this cancer

    f.   Where to find their assigned cancer in the left column

4   Explain that students will use the *Cancer PSA Capture Sheet* to collect their research. Once their research is complete, they will create a public service announcement (PSA) video that summarizes their research and tries to inform certain races/ethnicities about this type of cancer. They can use *Flip*, or another video sharing app, to create their three-minute PSA.

5   Inform students that they will watch other PSA videos in the next class and provide feedback to their classmates.

Day 4

Students will be able to:

Critique and **provide** feedback on public service announcement videos.

Describe environmental and genetic factors that increase longevity.

Procedure

Whole Group (20 minutes)

1 Explain to students that they will be watching one public service announcement video for each type of cancer that was not assigned to them.

2 Students will be required to post at least one question and one comment that is constructive feedback for each video they view.

3 When students are finished, they need to answer the questions posted for their PSA video.

Whole Group (5 minutes)

1 Introduce the *10 Famous Centenarians You Might Remember* and ask students if they can construct a definition for the term centenarian.

2 Explain to students that they will respond to certain statements by *voting with their feet*. Explain that if they strongly agree with the statement, they can walk to the left side of the room. If they strongly disagree with the statement, they can walk to the right side of the room. If they are somewhere in between, they can choose where to stand in the middle.

3 Invite students to stand. Read each statement, one at a time, and provide students with enough time to move to the area of the classroom that demonstrates their beliefs.

   a. Being healthy should be considered a right of an American.

   b. When children are born, DNA sequencing should be available at no cost to the parent.

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Day 4
Continued

Procedure

Individual (20 minutes)

1   Ask students if they think that there are genes responsible for prolonging life or longevity genes. What do they think would be an example of a "longevity gene" or a gene that is important in living a longer life? Tell them to think about important processes in the body (that are required for living).

2   Distribute the *Longevity Genes Capture Sheet* to each student and explain that they will be reading the article *Is longevity determined by genetics?* from the United States National Library of Medicine. In this article, scientists have identified a few genes that are associated with long life spans.

3   Students will read the article and answer the questions on the *Longevity Genes Capture Sheet*.

4   As a closure, ask students to do a *Quick Write*: Would they consider getting their DNA sequenced? Explain why or why not using specific information they have learned from this lesson and add any updates to their **Design Journal**.

Day 5

Procedure

Students will be able to:

Synthesize current research to determine the ownership of DNA.

Construct an evidence-based argument considering the views of multiple stakeholders.

Teacher Note > *Remind students to update their Design Journal to capture how content learned in this lesson connects to the information they are investigating and to the creation of their final product.*

Whole Group (5 minutes)

1   As an activator, ask students if they actually own their DNA. Are there instances in which your DNA does or does not belong to you? There are no right or wrong answers, so encourage students to share their opinions with the class.

2   Explain to students that they will conduct research in small groups of three to develop an understanding of how collecting and sharing genetic data has brought new concerns about the ownership, privacy, and security of DNA.

Small Group (20 minutes)

1   Distribute *The Ownership of DNA Assignment* to each student. Inform students that they will be gathering information by forming expert groups.

2   Group students into three equal "Expert Groups"

Group 1 = Understanding Ownership and Privacy of Genetic Data
Group 2 = Genetics Legislation
Group 3 = Privacy in Genomics

These groups should be strategically organized heterogeneously with regard to student ability. The students in these groups are responsible for becoming "Experts'' in their topic of study.

3   After the "Experts" have gathered to learn their assigned topics in-depth, they can then be dispersed into numbered groups, which will contain one "Expert" from each group. During this time, "Experts" will present to the other members of the group.

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Day 5
Continued

Procedure

Small Groups (20 minutes)

1. Have students work with a partner to develop interview questions for a new and upcoming bioethicist. Explain that bioethicists are responsible for helping to answer questions that refer to problems with moral elements in health, healthcare, science, or technology. As advances in technology such as genomic sequencing increase, more concerns surrounding its use and implementation arise.

2. Each interview question should be from a different stakeholder's perspective.

   a. Consumers of at-home genetic sequencing kits who are concerned with use and access to their genome.

   b. Biotech companies that utilize genomic sequencing techniques to obtain results and sequence 100s of genomes a day.

   c. Company owners of at-home genetic sequencing kits who have a desire for consumers to learn more about their health or ancestry; believes genome information can be very useful and would like to have access to the genome to help inform their practice, particularly with health.

   d. Doctors/scientists who desire to improve therapeutics of certain diseases and want to use genome information for research.

   e. Clinical patient groups who are concerned with use and access to their genome.

3. Students will have to construct an evidence-based response to each stakeholder question.

4. Have one student role play the interviewer and the other role play the bioethicist. They can record the interview presenting their research.

National Standards

Next Generation Science Standards

LS1.A: Structure and Function
All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins.

Science and Engineering Practices
Constructing an explanation
Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

Crosscutting Concepts
Patterns
Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Structure and Function
Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Scale, Proportion, and Quantity
Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Career and Technical Education (CTE)

A2.4
Understand the critical need for ethical policies and procedures for institutions engaged in biotechnology research and product development.

A3.1
Define and describe the structure and function of DNA ribonucleic acid (RNA) and proteins, explain the consequences of DNA mutations on proteins.

A5.1
Use the Internet and the World Wide Web to collect and share scientific information.

A5.2
Use a variety of methods, including literature searches in libraries, computer databases, and online for gathering background information, making observations, and collecting and organizing data.

Cancer Health Disparities Capture Sheet

Directions
Complete the questions to discover how cancer affects people from different populations and groups.

Before watching the video

Construct your own definition of health disparity.

Answers will vary

While watching the video

1. How did the video define health disparity?

Certain population groups in the United States suffer more from cancer and its effects than others.

2. Who has the highest rate of new diagnosis and cancer death rate?

Black men and women

3. Who has the highest rates of prostate cancer?

Black males

4. Who has the highest rate of new diagnosis for breast cancer?

White women

5. Who has the highest death rate for breast cancer?

Black women

6. What three groups have the highest rates of liver cancer?

Asian/Pacific Islander,
American Indian/Alaska Native,
Hispanic

7. Who has a higher rate of cervical cancer than other groups?

Hispanic women

8. What are some causes of disparities in cancer rates?

Low socioeconomic status

Living in geographically isolated areas

Lack of medical coverage

Barriers to early detection and screening

Unequal access to treatments

Underlying biological differences

Longevity Genes Capture Sheet

Directions
Use the following resource: Is longevity determined by genetics? to answer the analysis questions below.

1. What influences longevity of life?

Genetics, the environment, and lifestyle

2. Provide some examples of how life has improved since the 1900s.

Availability of food and clean water, better housing and living conditions, reduced exposure to infectious diseases, and access to medical care

3. What is the average life expectancy of an American today?

80

4. What similarities do people with longevity share?

Do not smoke, are not obese, and cope well with stress

5. Do longer lifespans tend to run in families? Provide evidence from the text.

Longer life spans tend to run in families, which suggests that shared genetics, lifestyle, or both play an important role in determining longevity.

6. What genes are associated with longevity?

APOE, FOXO3, and CETP genes

7. Before the age of 80, what is a stronger determinant of a longer lifespan?

Lifestyle is a stronger determinant of health and life span than genetics.

8. After the age of 80, what is a stronger determinant of a longer lifespan?

Genetics

9. What cellular functions contribute to a longer life?

DNA repair, maintenance of the ends of chromosomes (regions called telomeres), and protection of cells from damage caused by unstable oxygen-containing molecules (free radicals).

10. Conduct research on the following longevity genes to determine their function.

APOE	Provides instructions for making a protein called apolipoprotein E. This protein combines with fats (lipids) in the body to form molecules called lipoproteins. Lipoproteins are responsible for packaging cholesterol and other fats and carrying them through the bloodstream. Maintaining normal levels of cholesterol is essential for the prevention of disorders that affect the heart and blood vessels (cardiovascular diseases), including heart attack and stroke.
FOXO3	Preserves the brain's ability to regenerate—prevents STEM cells from dividing under unhealthy environmental conditions
CETP	Creates a crucial protein involved in the regulation of high density lipoprotein (HDL) levels and may affect susceptibility to age-related diseases, including atherosclerosis and Alzheimer's Disease (AD)

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Modeling Recombinant DNA Capture Sheet

Objective

In this activity, you will use the National Center for Biotechnology Information site to identify genes using sequences of nucleotide bases from DNA samples.
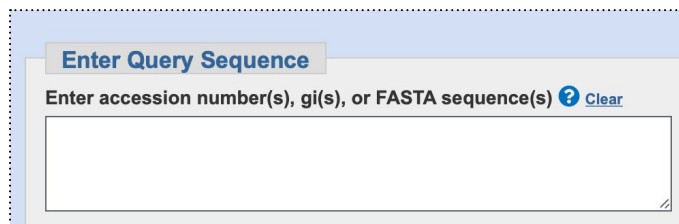
Background

The Basic Local Alignment Search Tool (BLAST) finds regions of local similarity between sequences. The program compares nucleotide or protein sequences to sequence databases and calculates the statistical significance of matches. BLAST can be used to infer functional and evolutionary relationships between sequences as well as help identify members of gene families.

Directions

You will be given nucleotide sequences found in real human DNA that is associated with a genetic disease caused by a mutation. Your job is to compare the sequences you are given with the nucleotide sequence of most known genes, using BLAST to search genetic databases.

Procedures

1. Click on the link to use the United States National Library of Medicine's BLAST:
   Basic Local Alignment Search Tool

2. Select nucleotide BLAST.

3. Copy and paste the gene sequences on the next page into the top box. Scroll down to the bottom of the page to click the blue BLAST button. The program will run through all the known sequences and find a match. Depending on how busy the server is, it may take a while.

Enter Query Sequence

Enter accession number(s), gi(s), or FASTA sequence(s) ❓ Clear

4. The closest match will be shown at the top with a short description. For more information on your sequence click the link and select "Related Information Gene—associated gene details" on the next page. This will give you the description of the gene that your sequence matched.

5. Complete the data table under each of the gene sequences provided. The first one has been done as an example for you.

6. After identifying each gene, select one disease that you would like to learn more about and conduct research. Summarize your findings in 1–2 paragraphs.

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Modeling Recombinant DNA Capture Sheet

Gene Sequence Analysis

1

ATG GCG ACC CTG GAA AAA GCT
GAT GAA GGC CTT CGA GTC CCT
CAA GTC CTT CCA GCA GCA GCA
GCA GCA GCA GCA GCA GCA GCA
GCA GCA GCA GCA GCA GCA GC

Name of Gene	*Huntington gene*
Chromosome	*chromosome 4*
Identify the Disease	*Huntington disease— an autosomal dominant disease*

3

ATG CTC ACA TTC ATG GCC TCT
GAC AGC GAG GAA GAA GTG TGT
GAT GAG CGG ACG TCC CTA ATG
TCG GCC GAG AGC CCC AGC CCG
CGC TCC TGC CAG GAG GGC AGG
CAG GGC CCA GAG GAT GGA G

Name of Gene	
Chromosome	
Identify the Disease	

2

ATG GCG GGT CTG ACG GCG GCG
GCC CCG CGG CCC GGA GTC CTC
CTG CTC CTG CTG TCC ATC CTC
CAC CCC TCT CGG CCT GGA GGG
GTC CCT GGG GCC ATT CCT GGT
GGA GTT CCT GGA GGA GTC TT

Name of Gene	
Chromosome	
Identify the Disease	

4

ATG TTT TAT ACA GGT GTA GCC
TGT AAG AGA TGA AGC CTG GTA
TTT ATA GAA ATT GAC TTA TTT
TAT TCT CAT ATT TAC ATG TGC
ATA ATT TTC CAT ATG CCA GAA
AAG TTG AAT AGT ATC AGA TTC
CAA ATC T

Name of Gene	
Chromosome	
Identify the Disease	

Continues next page >

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Modeling Recombinant DNA Capture Sheet

Continued

Gene Sequence Analysis

5

ATG CGT CGA GGG CGT CTG CTG
GAG ATC GCC CTG GGA TTT ACC
GTG CTT TTA GCG TCC TAC ACG
AGC CAT GGG GCG GAC GCC AAT
TTG GAG GCT GGG AAC GTG AAG
GAA ACC AGA GCC AGT CGG GCC

Name of Gene	
Chromosome	
Identify the Disease	

7

ATG TTG TGCAAT ATC CAT CTA
CTG TAG TTA AGA TAT TCA GTA
GTT TGT TTT TCA TAA GCA TGT
AAT TGA TCA TAT TTC TGC CAA
GGA TGT GCC TTC AAC TTT ATA
ATT ATA GTG TTG TAA AAT ATT
TTT GTC TG

Name of Gene	
Chromosome	
Identify the Disease	

6

ATG CCG CCC AAA ACC CCC CGA
AAA ACG GCC GCC ACC GCC GCC
GCT GCC GCC GCG GAA CCC GGC
ACC GCC GCC GCC GCC CCC TCC
TGA GGG ACC CAG AGC AGG ACA
GCG GCC CGG AGG AC

Name of Gene	
Chromosome	
Identify the Disease	

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Cancer Health Disparities Capture Sheet

Directions
Complete the questions to discover how cancer affects people from different populations and groups.

Before watching the video

Construct your own definition of health disparity.

_____

_____

_____

_____

_____

_____

While watching the video

1. How did the video define health disparity?

_____

_____

_____

_____

_____

_____

2. Who has the highest rate of new diagnosis and cancer death rate?

_____

3. Who has the highest rates of prostate cancer?

_____

4. Who has the highest rate of new diagnosis for breast cancer?

_____

5. Who has the highest death rate for breast cancer?

_____

6. What three groups have the highest rates of liver cancer?

_____

_____

_____

7. Who has a higher rate of cervical cancer than other groups?

_____

8. What are some causes of disparities in cancer rates?

_____

_____

_____

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Cancer PSA Capture Sheet

Objective
To create a public service announcement (PSA) informing certain races/ethnicities about cancer disparities.

Directions

1. Checkmark the cancer you have been assigned:

☐ Bladder	☐ Pancreas
☐ Leukemia	☐ Kidney
☐ Lung	☐ Thyroid
☐ Melanoma of skin	☐ Non-Hodgkin lymphoma

2. Conduct research on your assigned cancer and analyze the statistics to find health disparities.
   Cancer of Any Site—Cancer Stat Facts

3. Use this research to create a three-minute public service announcement (PSA) video using Flipgrid to summarize your research and inform certain races/ethnicities about this type of cancer.

Cancer PSA Research Questions

Estimated new cases in 2021: *How many people might be diagnosed with this cancer type this year?*

....

Percentage of all new cancer cases: *How common is this cancer compared to other cancers?*

....

Death rate: *Is there a particular race/ethnicity that has a higher death rate?*

....

Most affected sex: *Is this cancer type more common in men or women?*

....

Most affected races/ethnicities: *What races/ ethnicities are more susceptible to this cancer type?*

....

Description: *How does this cancer type affect the body?*

....

Risk factors: *What factors increase the risk of developing this cancer? List 3–5.*

....

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Longevity Genes Capture Sheet

Directions
Use the following resource: Is longevity determined by genetics? to answer the analysis questions below.

1. What influences longevity of life?

_____

_____

_____

_____

2. Provide some examples of how life has improved since the 1900s.

_____

_____

_____

_____

3. What is the average life expectancy of an American today?

_____

4. What similarities do people with longevity share?

_____

_____

_____

_____

5. Do longer lifespans tend to run in families? Provide evidence from the text.

_____

_____

_____

_____

6. What genes are associated with longevity?

_____

Continues next page >

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Longevity Genes Capture Sheet

Continued

7. Before the age of 80, what is a stronger determinant of a longer lifespan?

    _____

    _____

    _____

    _____

    _____

    _____

    _____

8. After the age of 80, what is a stronger determinant of a longer lifespan?

    _____

9. What cellular functions contribute to a longer life?

    _____

    _____

    _____

    _____

    _____

    _____

10. Conduct research on the following longevity genes to determine their function.

    _____

    APOE

    ....

    FOXO3

    ....

    CETP

    ....

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The Ownership of DNA Assignment

Background

With the rapid increase in genome sequencing technology, there have been many companies that have begun to find various ways to utilize these techniques. DNA has to be collected from an individual in order to obtain genetic sequencing information. After the task is completed, these companies provide results to the individual, while also outlining certain issues around the privacy of their genetic data.

For this assignment, you and your partner will develop five interview questions for a well-known bioethicist. Each interview question should be from each of the stakeholder perspectives listed. Using the research gathered from the expert groups, one partner will answer the questions in the role of the bioethicist. The other will play the role of the interviewer. The bioethicist must provide an argument with supporting evidence that answers the question, *Who owns a genome?* This interview will be recorded to demonstrate what the students have learned from their research.

Expert Groups

1. *Understanding Ownership and Privacy of Genetic Data*
2. *Genetics Legislation*
3. *Privacy in Genomics*

Stakeholders

1. Consumers of at-home genetic sequencing kits who are concerned with use and access to their genome
2. Biotech companies that utilize genomic sequencing techniques to obtain results and sequence 100s of genomes a day
3. Company owners of at-home genetic sequencing kits who have a desire for consumers to learn more about their health or ancestry; believes genome information can be very useful and would like to have access to the genome to help inform their practice, particularly with health
4. Doctors and scientists who desire to improve therapeutics of certain diseases and want to use genome information for research
5. Clinical patient groups who are concerned with use and access to their genomes

Interview

In a three-minute interview, you will have the opportunity to state your claim and reasoning supported by evidence. The bioethicist should spend the first part of the interview answering the question, *Who owns a genome?* The second part of the interview should be spent refuting arguments held by other groups using evidence from your research

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The Ownership of DNA Assignment Rubric

Score	4	3	2	1
Stance and Evidence	The stance is clear, passionate, and presented in a creative way; evidence is specific to support.	The stance is clear, passionate and evidence is specific to support.	The stance and evidence is present.	The stance and/or the evidence is not present.
Rebuttal and Evidence	The rebuttal is succinct and effective; the evidence used further supports the stance.	The rebuttal is succinct and effective; the evidence used further supports the stance.	The rebuttal and evidence is present, although neither is effective.	The rebuttal and/or evidence is not present.
Time Limit	The arguments were completed in two minutes; time is spaced out efficiently.	The arguments were completed, but ran over the two minute time period, or time is not spaced out efficiently.	The arguments were completed in less than two minutes.	The arguments were completed in one minute or less.
Final Score				

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