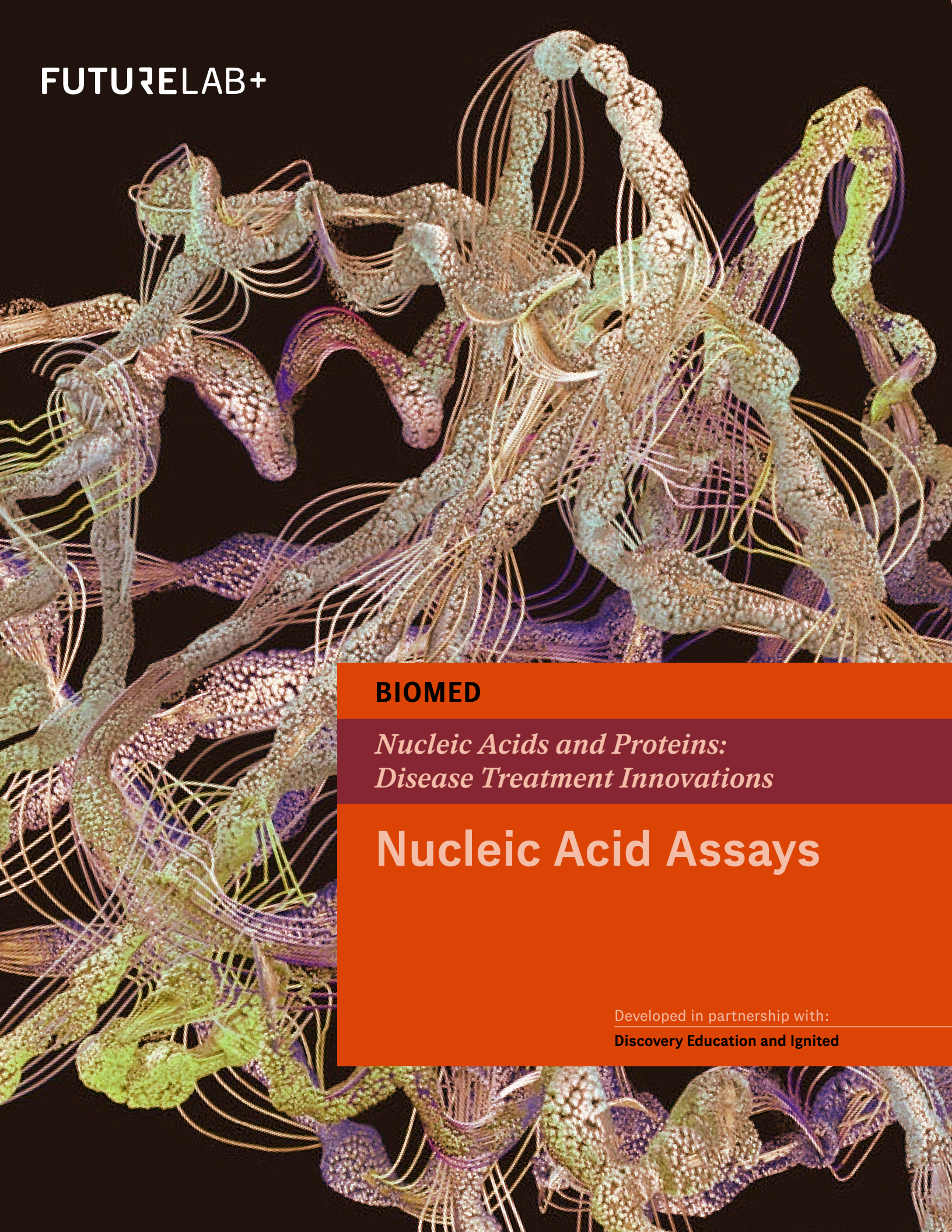
FUTURELAB+



BIOMED

Nucleic Acids and Proteins: Disease Treatment Innovations

Nucleic Acid Assays

Developed in partnership with:

Discovery Education and Ignited

In this Lesson Plan:

Print the **Teacher Section** →

Print the **Student Section** →

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

Select the appropriate printer icon above to print either section in its entirety.

Follow the tips below in the Range field of your Print panel to print single pages or page ranges:

Single Pages (use a comma): T3, T6

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Cover Image
This is an illustration of a protein.

BIOMED / NUCLEIC ACIDS AND PROTEINS: DISEASE TREATMENT INNOVATIONS

Nucleic Acid Assays

DRIVING QUESTION

How are nucleic acid assays used in medicine?

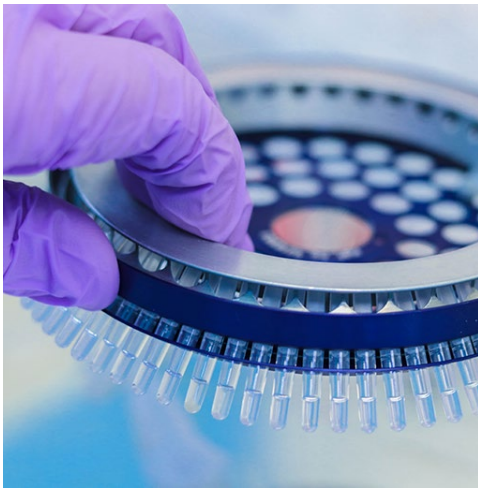
OVERVIEW

Nucleic acids are essential molecules for the functioning of a cell and subsequently an organism. DNA is necessary to create another nucleic acid, RNA. Together these two macromolecules participate in the process of protein synthesis. Genetic information can help scientists with diagnosing a disease or preventing it from occurring in the future. An assay is a test performed in the lab that results in useful information for scientists, such as the quantity of a certain molecule or its function. Common assays used in the lab are centered around nucleic acids, including polymerase chain reactions, northern blots, southern blots, and DNA microarrays. In addition, nucleic acid-based drugs are used to treat many diseases of the human body.

In this lesson, students will research nucleic acid-based tests currently used in medicine. As head lab technicians, they will be responsible for being knowledgeable on topics, such as how nucleic acids can be used as drug targets or when to use a certain nucleic acid assay. Students will learn the basis of gel electrophoresis and how it is used in nucleic acid research. They will also review when to use certain methods of nucleic identification. Therapeutic uses of nucleic acids, such as the techniques of RNAi, gene therapy, CRISPR, and antisense, will also be researched. Ultimately students will create informational material as well as a model of how these tests target the disease.

ACTIVITY DURATION

Five class sessions
(45 minutes each)



ESSENTIAL QUESTIONS

What types of laboratory tests utilize nucleic acids?

How do nucleic acids play a role in diagnosing disease?

How do nucleic acids play a role in treating disease?

OBJECTIVES

Students will be able to:

Explain the use of nucleic acids in gel electrophoresis.

Describe how nucleic acids are used in northern and southern blots and microarrays.

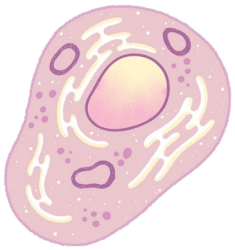
Outline nucleic acid-based tests that are used in medicine.

Discuss how drugs can be made and delivered using nucleic acids.

Identify scientific data generated using common nucleic acid assays.

BACKGROUND INFORMATION

In this lesson, students should be familiar with the function, structure, and examples of nucleic acids (DNA and RNA). They should understand the significance of complementary DNA or RNA because it is the basis of nucleic acid-based assays and drugs. Students also should be familiar with the process of replication to understand PCR and transcription to better understand the northern blot procedure.



Materials

- Aluminum Foil
- Beads
- One Cardboard Box per Group
- Construction Paper
- Cotton Balls
- Cotton Swabs
- Glue or Tape
- Pieces of Foam
- Pipe Cleaners
- Scissors
- Toothpicks
- Laboratory Technique: Gel Electrophoresis Simulation Capture Sheet
- Nucleic Acid Assays Presentation Assignment
- Nucleic Acid Assays Presentation Assignment Rubric
- Nucleic Acid-Based Assay Review
- Nucleic Acid-Based Tests Used in Medicine Assignment
- Nucleic Acid-Based Tests Used in Medicine Rubric
- Nucleic Acid-Based Drugs Model Assignment
- Nucleic Acid-Based Drugs Model Rubric
- Nucleic Acid Assay Scramble Capture Sheet
- 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 discuss social justice issues around the use of nucleic acid-based tests used in medicine. A discussion on the challenges facing various ethnic and socioeconomic groups will require students to practice the social awareness skill of sensitivity, as well as self management to notice if this makes them uncomfortable. Students will practice empathetic behavior and show understanding of other classmates' thoughts and opinions on the topic.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

This lesson employs culturally and linguistically responsive strategies in order to encourage learners from all backgrounds to engage in a format that is comfortable for them. Equitable practices allow students to safely discuss necessary conversations, such as health disparities and questions involving specific communities, while centering students' learning in their personal experience. There will be discussion of the significance of representation in the data used in therapeutic-based research. Students will have opportunities to address issues of social justice and the lack of representation of other non-European groups.

ADVANCING INCLUSIVE RESEARCH

Genetic diseases affect BIPOC communities at higher rates than non-BIPOC communities. In order to develop treatments that work for everyone, it is important to establish trust with communities that were historically mistreated by medicine. It is also crucial that tests and treatments are made accessible to historically marginalized groups. These foundational steps would allow for more BIPOC participants in clinical trials and a greater understanding of how treatments affect all people.

COMPUTATIONAL THINKING PRACTICES

Nucleic acid assays are tests that doctors use to diagnose genetic disease. These tests are examples of how the computational thinking strategy of collecting data helps scientists design courses of treatment for their patients.

CONNECTIONS TO THE PRODUCT LIFE CYCLE

In this lesson, students will learn about the various uses of nucleic acids in medicine. They will discover that many therapeutic methods utilize nucleic acids. This phase of the product life cycle would include the drug target identification phase, occurring during **discovery**. Additionally nucleic acid assays, such as northern or southern blots, also have a role in the product life cycle. They would commonly be used to ensure the presence of the correct RNA or DNA molecule. Students will be able to understand that nucleic acid assays are used during the discovery phase as well.

Have you ever wondered…

How do doctors know that someone has been infected with a virus or bacteria?

Some laboratory tests are used to determine the presence of a pathogen. The nucleic acids of the pathogen are discovered using the blood or tissue from an infected individual.

How do doctors discover a gene mutation?

Mutations in genes can cause diseases, such as cancers, to occur. Scientists can perform certain tests in the lab to determine if an individual's genes have been altered. These tests enable doctors to provide more specific treatment or prevention options to a patient.

MAKE CONNECTIONS!

How does this connect to the larger unit storyline?

In this lesson, students will discuss various nucleic acid-based assays used in medicine. This is essential for them to understand the laboratory tools used to diagnose and treat different diseases.

How does this connect to careers?

Laboratory technicians are responsible for using techniques in the lab to help assist scientists in completing research. They also perform routine jobs that assist in the creation of medicines.

Molecular biologists are responsible for using various techniques in the lab to investigate the molecules of the cell. They help make sense of the intricacies of the cell, such as function and structure. They manipulate molecules of the cell to gain insight into the relationship of cell components to one another.

Biochemists are knowledgeable on the intersection between biology and chemistry. Their research focuses on the role of chemical reactions on the function of living organisms. They play an important role in determining the efficacy of a drug in its development stage.

How does this connect to our world?

Infectious diseases account for one of the leading causes of death worldwide, particularly in low-income countries and in young children. Nucleic acid-based tests can be used to diagnose these diseases and also assist doctors with creating a treatment plan. They also assist in determining whether or not an individual's genes have been altered. Scientists are continually improving on these assays in order to optimize efficiency, effectiveness, and cost.

Day 1

LEARNING OUTCOMES

Students will be able to:

Explain how gel electrophoresis can be used to separate nucleic acids.

Perform steps of gel electrophoresis using a simulation.

INDUSTRY AND CAREER CONNECTION

Emphasize to students that a major soft skill needed as a biochemist includes being a motivated learner and having a sense of commitment. During these activities, students will read information and have to answer questions. Although the material may not be interesting to them, students will need to keep in mind that this information is essential for their success in a lab environment.

Procedure

Teacher note > *The simulation for this activity can be found here. Be sure to review the simulation so you will be able to answer any operational questions from students.*

Whole Group (5 minutes)	
1	Let students know that they will talk about a laboratory technique used in labs every day. This technique involves nucleic acids.
2	Ask students if they remember the function of nucleic acids or examples of nucleic acids.
3	Remind students and have them get out their KWL chart on DNA and RNA purification created in Lesson 3 on Day 2. Let them know that they can use this on the assignment to help answer the questions.
4	Share with students that there are other techniques used in the lab that depend on nucleic acids.
5	Pass out the assignment *Laboratory Technique: Gel Electrophoresis Simulation Capture Sheet*.
6	Notify students that they will use a *simulation* to learn about this technique.

Individual (30 minutes)	
1	Have students review the components of the simulation to ensure they know how to navigate the simulation.
2	Have students run the simulation and simulate the steps of gel electrophoresis while answering the questions from the *Laboratory Technique: Gel Electrophoresis Simulation Capture Sheet*.
3	As students work, note the most challenging question and any misconceptions.

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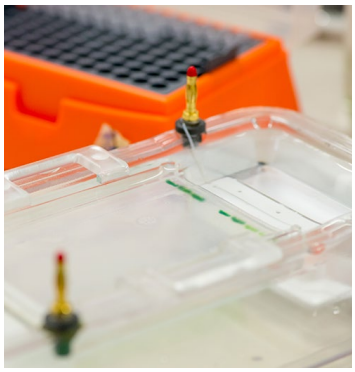
Day 1

Continued



Procedure

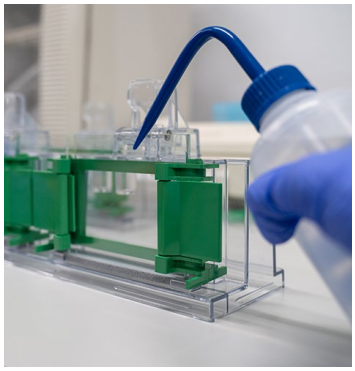
Whole Group (10 minutes)	
1	Review the answers to the questions.
2	Emphasize the understanding behind the reasons why a salt buffer is used in the gel electrophoresis box (to increase the electric current), why the negative electrode is attached to the top of the electrophoresis box, where the DNA is located (DNA is negatively charged), and why a DNA standard needs to be used (could not approximate the size of the DNA strands).
3	Let students know that in the next class you will discuss lab techniques that use nucleic acids.

Day 2

LEARNING OUTCOMES

Students will be able to:

Describe how nucleic acids are used in northern and southern blots, polymerase chain reactions, and microarrays.



Procedure

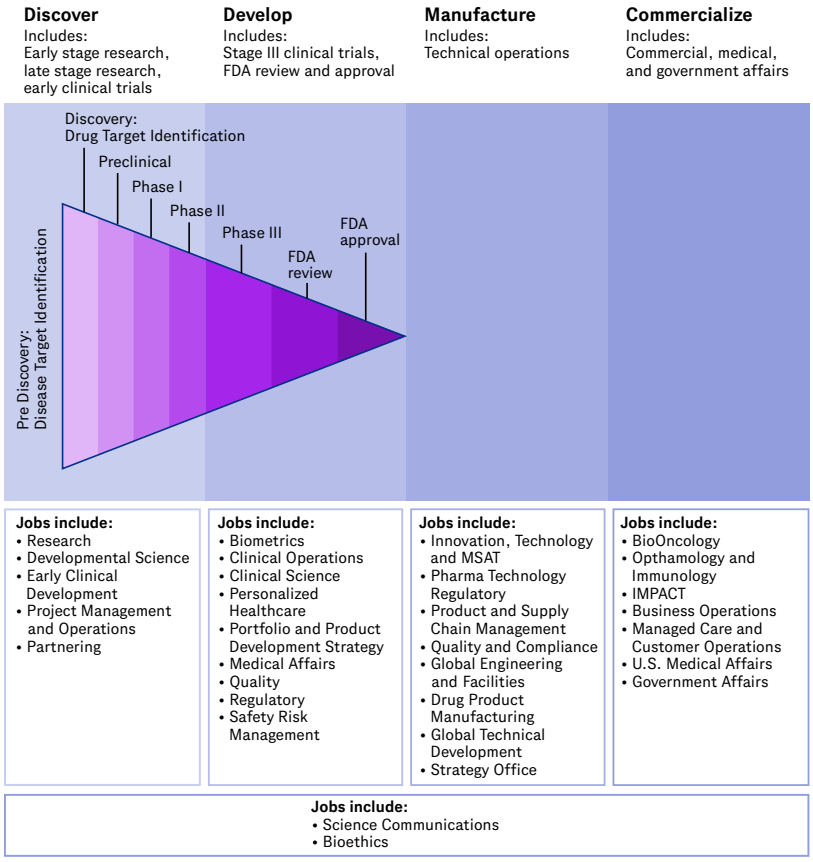
Whole Group (5 minutes)

1 Let students know that they will be reviewing different methods used in the labs to investigate various characteristics of nucleic acids.

2 Ask students if they remember what nucleic acids are made up of (nucleotides, including Adenine, Thymine, Guanine, Cytosine, and Uracil).

3 Remind students that they reviewed gel electrophoresis yesterday, which is one of the nucleic acid assays.

4 Tell students that the laboratory techniques learned in the previous class session and in this session are involved in the product cycle of medicine. Show a picture of the life cycle and ask students if they know where gel electrophoresis would fit in the cycle (**discovery** phase to evaluate the performance of a drug or medicine; to ensure that a particular product or medicine is effective).



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Day 2

Continued

Procedure

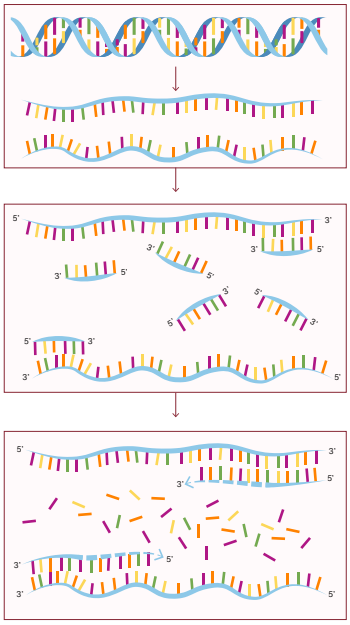
5	Let students know that they will play the role of the head lab technician to create a PowerPoint or Google presentation for other lab technicians that join the lab.

Teacher Note > *Authentic role play is critical to representation and inclusivity.*

6	Hand out the *Nucleic Acid Assays Presentation Assignment*. Review the components of the assignment, including the rubric.
7	Split the class into groups of four students.

COMPUTATIONAL THINKING IN ACTION

Here, students are using the computational thinking strategy of collecting data to examine different types of nucleic acid assays. They are also using the computational thinking strategy of decomposition to divide up their research project by assigning roles.



Small Group (40 minutes)

1	Assign each group a nucleic acid assay: northern blot, southern blot, DNA microarrays, and polymerase chain reaction.
2	Give students five minutes to assign responsibilities to each group member:

a. Project Manager—responsible for asking and answering questions about the project, ensuring that all members are staying on task, helping out other members when needed, assuring quality control of presentation

b. Researcher (two students)—responsible for conducting and organizing research using appropriate sources, recording any citations needed

c. Artistic Design—responsible for designing and creating the presentation, adding information, and ensuring that layout and images are pleasing to the eye and easy to view and understand for the audience

Teacher Note > *You may want to make cards with these roles and responsibilities for each group or display in a table sign. If time permits, invite students to present.*

3	Allow students to complete the assignment.

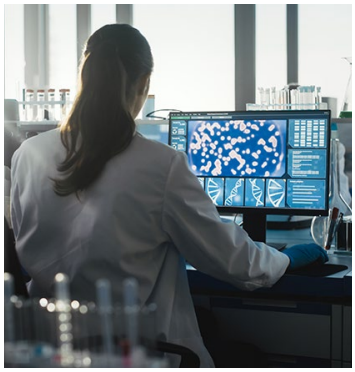
Day 3

LEARNING OUTCOMES

Students will be able to:

Outline nucleic acid-based tests that are used in medicine.

Create a presentation covering nucleic acid-based tests.



Procedure

Teacher note > *Be sure all students have access to each group's presentation. Upload them to one location so the students can use them for the assignment.*

Whole Group (3 minutes)	
1	Let students know that today they will discuss how the tests that they researched yesterday are used in medicine.
2	Tell them that they will use the nucleic acid-based tests assignment from the last class.
3	Let them know that they will use the presentations of other groups to help answer the questions.
4	Hand out the *Nucleic Acid-based Assay Review*.

Individual (15 minutes)	
1	Give students 15 minutes to complete their capture sheets.
2	As students work, gauge their understanding by noting the most challenging questions and misconceptions.

Whole Group (7 minutes)	
1	Call on students to answer questions that you feel they had the most trouble with. Be sure that students are supporting their answers with information from the completed Nucleic Acid Assays Assignment from Day 2.
2	Tell students that for the rest of the class, they will be researching examples of nucleic acid-based tests that are used in medicine.
3	Hand out and review the *Nucleic Acid-Based Tests Used in Medicine Assignment*.

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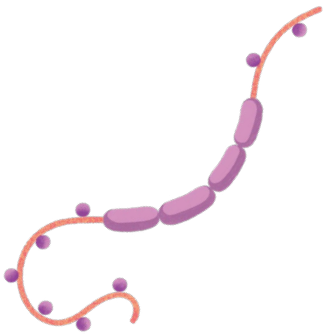
Day 3

Continued

Procedure

4		Gauge student understanding by providing students with the statements that follow. Let students know that after each statement, if they agree they should stand and if they disagree they will continue to sit. Let them know that BIPOC means Black, Indigenous, and People of Color.
5		Choose 1 or 2 of the statements, and ask students to elaborate on their positions.
	a.	Nucleic acid-bases tests can benefit BIPOC communities. (Let them know that they will learn more about this aspect in this session. Remind them that they may have read earlier in class about using these tests to detect diseases in another group's presentation.)
	b.	BIPOC communities are limited in their access to testing. Often, lack of insurance and cost are barriers to access.
	c.	Nucleic acid-bases tests can only be used to diagnose disease. (Let them know they will be learning more about other ways nucleic acid-based tests are used).
	d.	Not everyone will be able to afford nucleic acid based testing.
	e.	Nucleic acid-bases tests can be used on humans and microorganisms Remind students that both humans and microorganisms are made of nucleic acids (DNA/RNA).
6		Split the class into groups of three or four students.



Small Group (20 minutes)		
1		Let students know that before they start, they need to decide on which components will be completed by each student.
2		Monitor student progress by giving them time checks.
3		When about 15 minutes have passed, let them know that they should be on their way to completing half of the components of the presentation.
4		Let them know that they will need to complete the assignment for homework and submit during the next class.

Day 4

Procedure

LEARNING OUTCOMES

Students will be able to:

Discuss how drugs can be made and delivered using nucleic acids (gene therapy, antisense, and RNAi).

Identify cultural issues in the human genome.

Create a model on nucleic acid-based systems for drug delivery.

COMPUTATIONAL THINKING IN ACTION

The Human Genome project is one of the best examples of how the computational thinking strategy of collecting data helps us solve real-world problems. Because of the Human Genome Project, scientists are discovering new treatments for disease all the time.

Teacher note > *Although students reviewed PCR and CRISPR during Lesson 2 of this unit, it was not in the context discussed in this unit. Ensure students understand that the description of the process will be similar, but the role this time is unique as it is used in medicine. For this group, choose students that had the most challenges with PCR. Be sure students show you their model designs prior to getting started with actually building the model. Ensure that students have included both the drug-delivery process as well as the disease target.*

Whole Group (10 minutes)	
1	Let students know that today they will be researching how drugs can be made and delivered using nucleic acids. Ask students if they have heard of the Human Genome Project.
2	Tell students that this project has allowed scientists to sequence the entire human genome and provided them with information about the structure and function of the entire set of human genes or the human genome. Based on information from the video *How to Sequence the Human Genome*, we now know the DNA sequence of all genes in the human body. Ask students why this would be important to know in terms of medicine (scientists can determine possible factors that contribute to certain diseases).
3	Tell students that this knowledge is now used to help identify new targets for drug creation.
4	Hand out the *Nucleic Acid-Based Drugs Model Assignment*. Have students focus on the two graphs at the top of the paper. Give them two minutes to analyze the data and formulate a conclusion.
5	Ask for students to share their findings. If the students have not shared the next conclusion, share with them that most of the genomic data (almost 80 percent) was collected from individuals of European descent.

Teacher Note > *It may be alarming for students to see the lack of representation on the graphs. Be prepared to talk through why this lack of diversity is problematic. These graphs reflect the disparities and inequities across medicine and science. Ensuring diverse data collection not only helps to treat diseases that disproportionately affect certain populations, but, is part of the key to addressing equity and access issues globally.*

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Day 4

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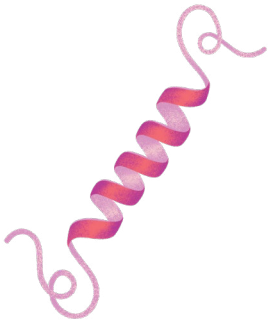
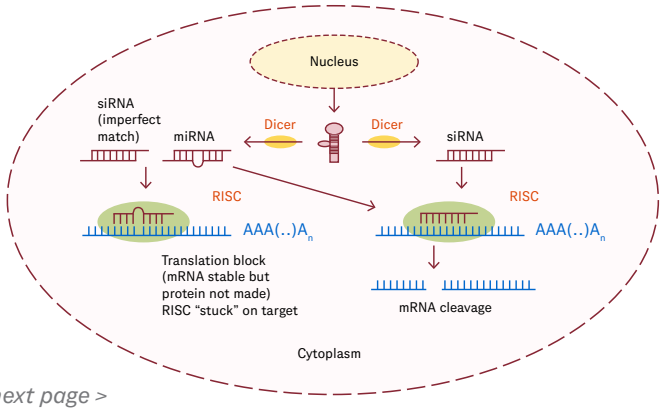


Procedure

6	Emphasize to students that the information we have learned about genes is very important, but that there is still more work to be done in utilizing nucleic acid drugs in all ethnic groups. Ask students to identify disadvantages of utilizing genomic data not representative of the population majority to make medicine. (Drugs may not be as effective on other ethnic groups compared to those of European descent. Scientists could be unaware of genomic data from other ethnic groups that could be used as solutions to ailments of specific ethnicities.)
7	Ask students to identify an advantage of using drugs based on nucleic acids versus non-nucleic acid-based pharmaceuticals. (Nucleic acids used as drugs are based on sequences found in genes in the human body. This would make them more compatible with the human body and be associated with less side effects. These nucleic acid-based drugs result in more personalized medicine. They require less effort from the screening to the actual creation of the drugs.)
8	Show students that nucleic acid isolation is a part of the first phase of the product cycle of medicine, the **discovery** phase. Scientists use nucleic acids to identify drug targets.
9	Let students know that today they will work in small groups to create a model of one of the nucleic acid-based systems used to deliver drugs. Remind students that two of the 2020 winners of the Nobel peace prize are two women who discovered one of the systems called CRISPR.
10	Provide a visual example of one of the processes: *RNAi*
11	Explain to students that their models will include all of the components in the images related to each nucleic acid-based drug. Tell them to look for two reputable resources describing their assigned drug method. Simplified model for the RNA pathway 

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Day 4

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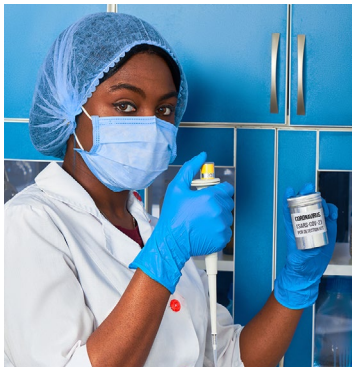

Procedure

12	Ask students to identify the phase of the product cycle of medicine at which these examples of nucleic acid-based drugs would be included in the manufacture or commercialization phases, since these drugs have been approved and/or are in the discovery (drug target identification) stages with scientists identifying targets to be able to use these assays.
13	Split the class into groups of four to five students.
14	Assign each group a disease, including the ones listed below. The asterisks (*) represent diseases with nucleic acid assays that are more complicated than the others. Use this to help differentiate when creating and assigning each group a disease. • Cystic Fibrosis • Melanoma* • Ovarian Cancer • Prostate Cancer* • Breast Cancer* • HIV • Hepatitis C • COVID-19

Small Group (35 minutes)

1	Let students know they will have five minutes to brainstorm how to create the model.
2	Have them spend another 10 minutes to create a labeled outline for their model. Once the outline is complete, students should check in with the instructor for approval before building their models.
3	Students will spend the last 20 minutes actually building the model using the available materials.
4	As time allows, have students respond to the lesson questions in their **Design Journal**. They will consider the role that nucleic acids play in diagnosing and treating diseases.

Day 5

LEARNING OUTCOMES

Students will be able to:

Analyze models of nucleic acid-based drug delivery.

Identify the purpose and results of nucleic acid assays.

Procedure

Teacher note > *The reflection can be omitted to ensure enough time for the model presentations and completion of the Nucleic Acid Assay Scramble. Students complete a table on the common nucleic acid assays and the scientific data that can be generated.*

Whole Group (25 minutes)	
1	Ask each student group to present the models from last class. Ask students to highlight each of the following aspects of their model:
	a. Outline of the use of the drug delivery system
	b. Specific diseases that are treated using this system
	c. Reasons for choosing the materials they used to create the model.
2	Give students 10 minutes to complete a reflection about their models. Include the following:
	a. How did their designs work well? How do they need to be improved?
	b. What would they change about the process of creating the model?
3	Tell students that they will now review common nucleic acids assays discussed on Day 3 by completing a table. This table will include the results of each of the tests.
4	Hand out the *Nucleic Acid Assay Scramble Capture Sheet*.

Individual (20 minutes)	
1	As students work, gauge understanding and note common challenges among students.
2	Provide a time check for students halfway through the work session. Let them know that they should have at least one column or four boxes completed.
3	At the end of class, tell students to complete the remaining components of the chart for homework.

National Standards

Next Generation Science Standards

Science and Engineering Practices

Developing and using models

Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems. Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Crosscutting Concepts

Systems and System Models

Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

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)

A3.3

Employ standard techniques of DNA extraction, purification, restriction digests, bacterial cell culture, agarose gel electrophoresis, document, and evaluate results.

A9.2

Identify several products obtained through recombinant DNA technology.

A9.3

Outline the steps in production and delivery of a product made through recombinant DNA technology.

Laboratory Technique:
Gel Electrophoresis Simulation Capture Sheet

ANSWER KEY **Do not share with students**

Directions
As you move through the Gel Electrophoresis simulation, answer the questions below.

1. What is the problem?

Need to determine the length of the DNA strands

2. What is the purpose of gel electrophoresis?

To sort and measure the DNA strands

3. When do scientists use gel electrophoresis?

When they need to determine the size of DNA/sort DNA by length

4. What is a gel?

The filter used to separate DNA strands

5. What is electrophoresis?

The method used to move the DNA strands through the gel filter using an electric current

6. Which strands move faster through the gel?

Shorter strands

7. Where will longer strands be found in the gel?

At the top of the gel

8. Why do the DNA strands need to be stained?

To be seen; makes them visible to the naked eye

9. What do the bands on the gel represent?

Groups of DNA strands

10. Explain each step in the process of gel electrophoresis.

    a. Step 1

Make a gel: mix agarose and salt solution buffer. Microwave the mixture, then pour into a gel mold. Place a comb at the top, let gel solidify for 30 minutes, then remove the comb.

    b. Step 2

Set up the gel apparatus: pour the buffer into the electrophoresis box, then place the gel into the electrophoresis box slightly covered with the buffer.

    c. Step 3

Load the DNA sample into the gel: use the micropipette to place buffer into DNA sample, then use a micropipette to transfer the DNA sample into the well of the gel. Load the DNA standard into the well of the gel.

    d. Step 4

Hook up the electrical current and run the gel. Attach the (black) negative cord closest to the end where the DNA is located to the negative portion of the power source. Hook up the (red) positive cord to the positive portion of the power source. Then turn on the power source.

    e. Step 5

Stain the gel and analyze the results. Place gel into EtBr (Ethidium Bromide) staining solution, wait for 1.5 hours, remove from buffer, and view the gel using a UV light box.

11. In the style of a comic book, draw pictures of the process of gel electrophoresis as you complete the simulation. Label each of the steps sequentially (i.e., Step 1, Step 2, etc.) in each of the five frames below and include the major events that happen in each step in your storyline. See example image, showing Step 1.

Answers Vary

Nucleic Acid-Based Assay Review

ANSWER KEY **Do not share with students**

Directions
Complete the question based on your understanding of nucleic acid assays.

1. Which technique utilizes RNA?

northern blot

2. Which technique(s) use DNA?

southern blot and microarrays

3. Which techniques use both DNA and RNA?

none of them

4. Which techniques can use gel electrophoresis?

northern blot, southern blot, and PCR

5. Which technique uses many probes to bind to a DNA sequence?

microarrays

6. You want to determine whether an individual possesses a certain mutation, which procedure would you use?

DNA microarrays—they compare genetic sequences

7. You want to determine the presence of a virus in a sample of blood, which procedure would you use?

PCR tests can find evidence of disease in the earliest stages of infection.

8. Which procedure(s) use hybridization as a part of its procedure?

northern blot, southern blot, DNA microarray

9. Which procedure uses a chip?

DNA microarray

Nucleic Acid Assay Scramble

ANSWER KEY **Do not share with students**

Directions

You will play the role of a lab technician and help the lead scientist of the lab. The lead scientist has mixed up data from various assays. Your task will be to complete the table below. The images will need to be input into the correct boxes for "Description of Assay" and "Lab Results." You will complete this on the computer, copy the images, and paste them into their correct spaces in the table. One of the images will be used twice.

Nucleic Acid Assay	**Purpose**	**Description of Assay**	**Lab Results** *if the process is successful*	**Lab Results** *examples*
Northern Blot	To identify certain mRNA sequences	4		3
Southern Blot	To identify a certain DNA sequence	7		3
DNA Microarray	To identify a certain nucleotide sequence	5		2
PCR	To identify a certain DNA sequence	6		1

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Laboratory Technique:
Gel Electrophoresis Simulation Capture Sheet

Directions
As you move through the Gel Electrophoresis simulation, answer the questions below.

1. What is the problem?

2. What is the purpose of gel electrophoresis?

3. When do scientists use gel electrophoresis?

4. What is a gel?

5. What is electrophoresis?

6. Which strands move faster through the gel?

7. Where will longer strands be found in the gel?

8. Why do the DNA strands need to be stained?

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Laboratory Technique:
Gel Electrophoresis Simulation Capture Sheet

Continued

9. What do the bands on the gel represent?

10. Explain each step in the process of gel electrophoresis.

a. Step 1

b. Step 2

c. Step 3

d. Step 4

e. Step 5

Continues next page >

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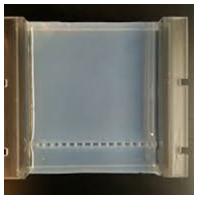
Laboratory Technique:
Gel Electrophoresis Simulation Capture Sheet

Continued

11. In the style of a comic book, draw pictures of the process of gel electrophoresis as you complete the simulation. Label each of the steps sequentially (i.e., Step 1, Step 2, etc.) in each of the five frames below and include the major events that happen in each step in your storyline. See example image, showing Step 1.



Reference for Step 1: Load DNA into wells or holes at the top

The Process of Gel Electrophoresis	Step 1	Step 2
Step 3	Step 4	Step 5

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Nucleic Acid Assays Presentation Assignment

Directions

You have been tasked with creating a presentation for other lab technicians. This Microsoft PowerPoint or Google Slideshow will help new lab technicians understand the nucleic acid-based assays commonly used in the lab. This presentation should include the following information:

1. *Description of the purpose of the technique*
2. *Example of when and how the technique is used*
3. *Step-by-step process of using the technique*
4. *One disadvantage and one advantage of using the technique*

Online Resources

Resources

Nucleic Acid Testing

Nucleic acid testing-benefits and constraints

DNA Microarray

DNA Microarray Technology Fact Sheet

DNA Microarray

Northern Blot

Northern Blot

Northern Blot

Northern blotting

Southern Blot

Southern Blot

PCR

Polymerase Chain Reaction (PCR) Fact Sheet

PCR Virtual lab

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Nucleic Acid Assays Presentation Assignment Rubric

Score	4	3	2	1
Organization	The presentation is clearly organized and the components build upon one another.	The presentation is organized but can be improved in terms of how the components build upon one another.	The presentation is not organized.	The presentation is not organized and is missing components.
Process	The process is accurate and is outlined step-by-step.	The process is accurate and outlined, but not in a step-by-step format.	The process is not accurate.	The process is unclear or not included.
Advantages or Disadvantages	More than one advantage and disadvantage is listed and is related to the use of the technique.	At least one advantage and disadvantage is listed and is related to the use of the technique.	At least one advantage or one disadvantage is listed, but not clearly related to the use of the technique.	Advantages and disadvantages are missing.
Final Score				

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Nucleic Acid-Based Assay Review

Directions
Complete the question based on your understanding of nucleic acid assays.

1. Which technique utilizes RNA?

2. Which technique(s) use DNA?

3. Which techniques use both DNA and RNA?

4. Which techniques can use gel electrophoresis?

5. Which technique uses many probes to bind to a DNA sequence?

6. You want to determine whether an individual possesses a certain mutation, which procedure would you use?

7. You want to determine the presence of a virus in a sample of blood, which procedure would you use?

8. Which procedure(s) use hybridization as a part of its procedure?

9. Which procedure uses a chip?

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Nucleic Acid-Based Tests Used in Medicine Assignment

Directions

You will create a presentation on a specific nucleic acid-based test used to diagnose a specific disease. A specific disease will be assigned to each group. You will be able to use the references below as well as information from other Internet searches (i.e., using the name of your assigned disease and "nucleic acid-based tests" in a Google search). The presentation should include the following:

1. *Describe the assigned disease, including the symptoms and its incidence.*
2. *Identify the method used prior to the nucleic acid-based test (if applicable).*
3. *Identify two tests that can be used to diagnose one disease.*
4. *Describe how these tests are used for this disease.*
5. *Identify two issues of social justice that may arise with the use of this test (or other nucleic acid-based tests).*
6. *Use of at least two resources.*

Resources

Nucleic Acid Based Tests

Improving Healthcare and laboratory medicine: the past, present, and future of molecular diagnostics

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Nucleic Acid-Based Tests Used in Medicine Rubric

Score	4	3	2	1
Description of Disease	A description of the disease, its symptoms, and incidence are included. Additional facts and/or visuals (graphs, pictures) are also included.	A description of the disease, its symptoms, and incidence are included.	An undetailed description of the disease is present.	No description of the disease or any other information is included.
Description of Test	Includes a detailed summary of the purpose of the test and a clear description of its specific use in the disease.	Includes a summary of the purpose of the test and a description of its specific use in the disease.	Includes a brief summary of the purpose of the test, but the description of the specific use of the test in the disease is missing.	No summary of the purpose of the test or description of its specific use in the disease.
Social Justice	At least two issues are included and are relevant and specific to the test.	At least two issues are included and relevant, but not specific to the test.	Only one relevant issue is included and specific to the test.	No social justice issues are included.
Final Score				

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Nucleic Acid-Based Drugs Model Assignment, Part 1

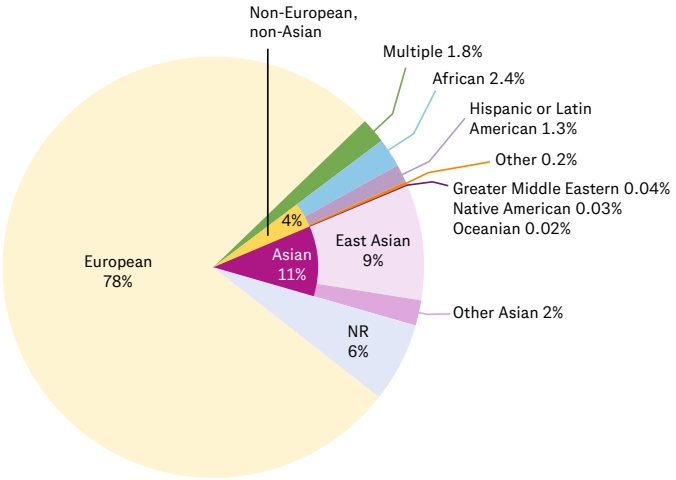
Directions

Work with your group members to complete the tasks below.

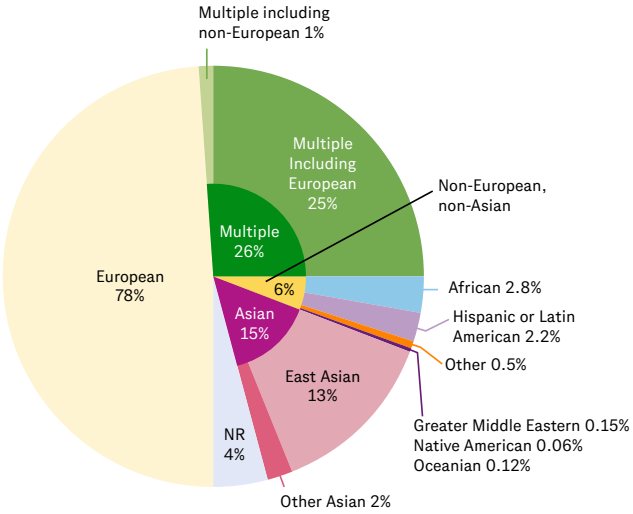
Analyze the following data. In one or two sentences, identify a conclusion from your analysis.

Representation of Different Ethnic Groups Genome-wide Research

Individuals



Studies



Your Conclusion

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Nucleic Acid-Based Drugs Model Assignment, Part 2

Continued

Directions

The lab you work in is anticipating the release of a few nucleic acid-based drugs in the next few months. Your group is tasked with creating a model to help others understand the new drug being manufactured. A model is a smaller representation of a larger process or item. The drug your model will represent will include only the general method of treating a disease. You can make up any disease target; be sure it connects with the specific nucleic acid-based drug.

For example, a nucleic acid-based drug that uses the RNAi method of treating the disease would involve a model with:

- *the genetic sequence of the drug target*
- *the components of RNAi*
- *any other important cell components*

You will use the following materials to build your model:

Construction Paper	One Cardboard Box per Group
Tape	Aluminum Foil
Pieces of Foam	Beads
Cotton Balls	Cotton Swabs
Toothpicks	Pipe Cleaner

Your group will be assigned one of the following nucleic acid drug methods:

Gene Therapy	*Antisense/Antisense Example*
RNAi/RNAi example	*CRISPR*

Draw a picture of your model below. Be sure to label important parts, such as the specific drug target and any actions occurring as a result of the drug.

Each of the models must:

1. *Include a specific disease target.*
2. *Model how the drug would work (using disease target).*
3. *Include labels on model.*
4. *Include a short description (no more than one paragraph).*
5. *Include two resources.*

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Nucleic Acid-Based Drugs Model Rubric

Score	4	3	2	1
Disease target	The disease target is obvious and clearly identified.	The disease target is identified.	The disease target is identified but is inaccurate.	The disease target is not identified.
Presentation	All students can clearly discuss the model's components and use.	Most students can clearly discuss the model's components and use.	Only half of the students can discuss the model's components and use.	Very few students can clearly discuss the model's components and use.
References	At least two references were used and were specific to the test.	At least two references were used but were not both specific to the test.	One resource was used.	No resources were used.
Final Score				

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Nucleic Acid Assay Scramble Capture Sheet

Directions

You will play the role of a lab technician and help the lead scientist of the lab. The lead scientist has mixed up data from various assays. Your task will be to complete the table below. The images will need to be input into the correct boxes for "Description of Assay" and "Lab Results." You will complete this on the computer, copy the images, and paste them into their correct spaces in the table. One of the images will be used twice.

Nucleic Acid Assay	**Purpose**	**Description of Assay**	**Lab Results** *if the process is successful*	**Lab Results** *examples*
Northern Blot				
Southern Blot				
DNA Microarray				
PCR				

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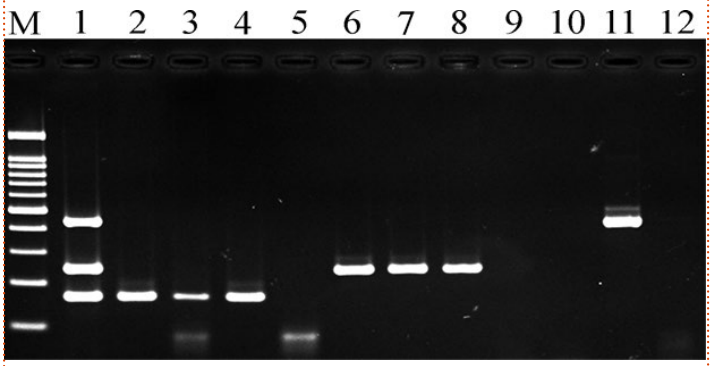
Nucleic Acid Assay Scramble Capture Sheet

Continued

1.



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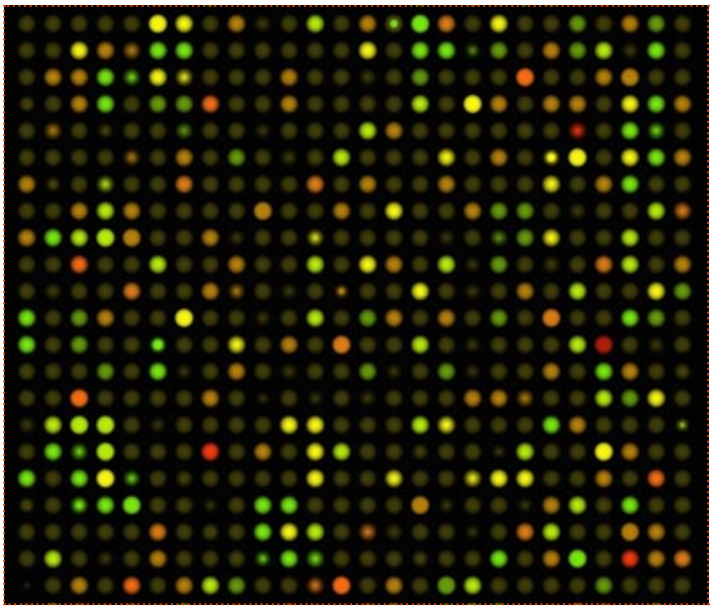

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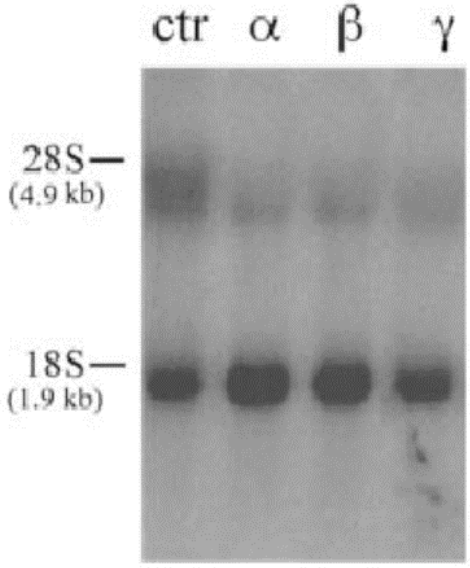

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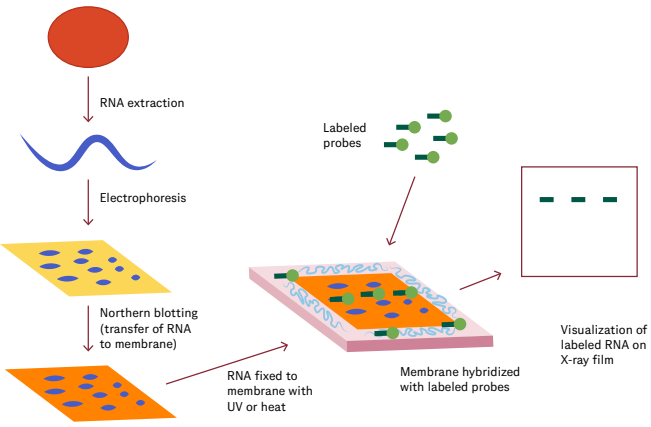

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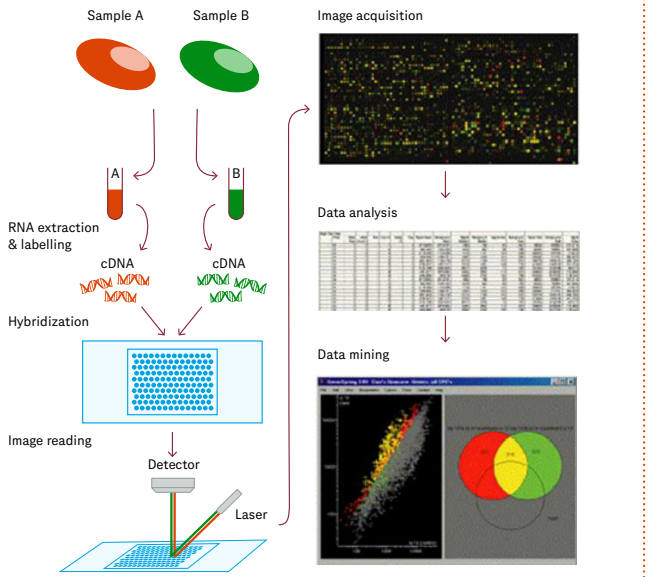
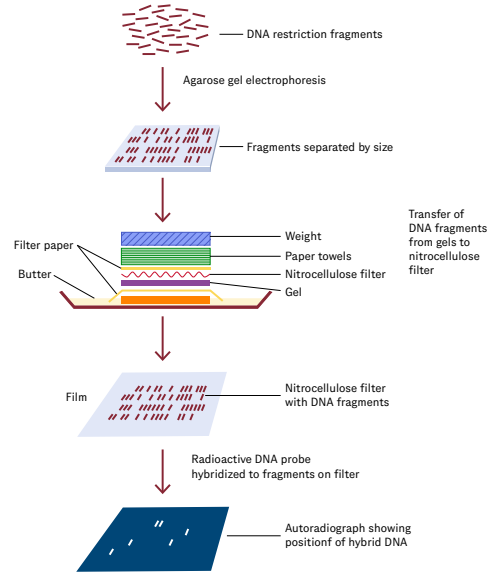
Nucleic Acid Assay Scramble Capture Sheet

Continued

5.



7.



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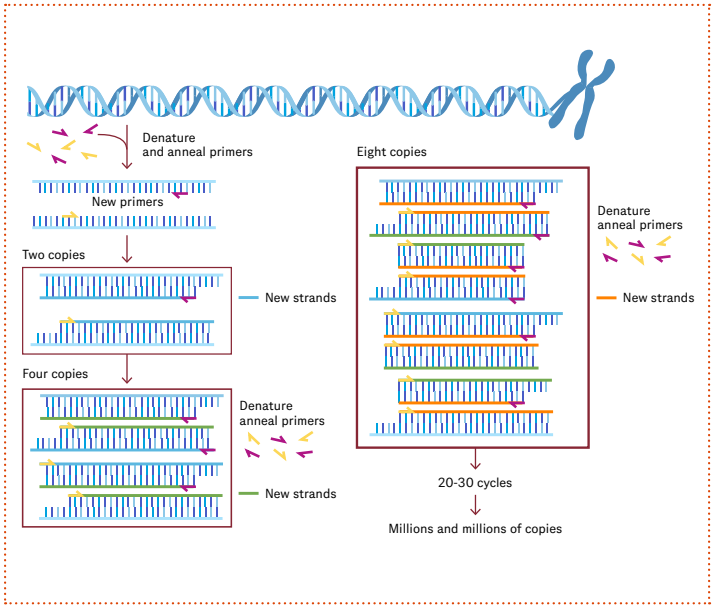

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