FUTURELAB+

BIOMED

Nucleic Acids and Proteins: Disease Treatment Innovations

Mechanisms of Drug Delivery

Developed in partnership with:
Discovery Education and Ignited

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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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Cover Image
This is an illustration of a protein.

BIOMED / NUCLEIC ACIDS AND PROTEINS: DISEASE TREATMENT INNOVATIONS

Mechanisms of Drug Delivery

DRIVING QUESTION

How are nucleic acids and proteins used as pharmaceuticals?

OVERVIEW

In this lesson, students will use what they learned about nucleic acids and proteins to advance their understanding into the pharmaceutical stage. Students will explore common drug delivery mechanisms as well as emerging techniques. They will review existing technologies and explore the potential use of nucleic acids and proteins as medicines of the future. The week will culminate with the students working in groups to recommend two drug delivery mechanisms based on a variety of criteria and then present their findings.

ACTIVITY DURATION

Five class sessions
(45 minutes each)

ESSENTIAL QUESTIONS

How does the route of drug administration impact where the drug acts?

What are the benefits of using proteins as medicine?

What are the ethical considerations of patenting biological materials?

OBJECTIVES

Students will be able to:

Distinguish different features of various drug administration routes.

Investigate the benefits of proteins and nucleic acids as medicine.

Recommend drug administration methods based on drug designs.

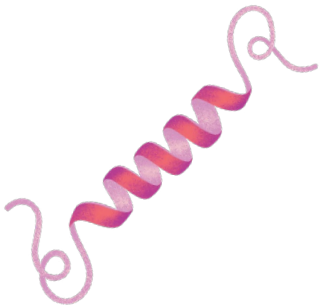
Critique drug administration methods based on pain, ease of use, global distribution contributions, and patient monitoring.

BACKGROUND INFORMATION

Students should be able to describe how DNA is used in order to create a final protein. They should also be familiar with protein modifications in order to understand the limitations of some protein production methods. The aforementioned topics are discussed in previous lessons in this unit. Students should also be familiar with certain equipment used in the lab, such as centrifuges, gel electrophoresis, and agar plates.

Materials

- **Several Sheets of Large Chart Paper**
- **Drug Administration Sort**
- **Drug Administration Anticipation Guide**
- **Drug Delivery Systems Capture Sheet**
- **Drug Delivery WebQuest**
- **Biologics Exit Ticket**
- **Which Therapy? Capture Sheet**
- **Gene Patenting Argument Capture Sheet**
- **Gene Patenting Rubric**
- **Final Project Packet**
- **Social Awareness Campaign Guidelines and Planning**
- **Patient Profiles**
- **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 spend the week working in cooperative groups. Students will have the opportunity to determine their own thoughts about genetic patenting and discuss their opinions with other students in a controlled and professional manner. Students engage in discussion, and possible debate, during which they will demonstrate self-awareness of their own opinions and experiences, as well as social management skills, in order to discuss a potentially polarizing topic with their peers.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

This lesson allows students to look at the topic of drug administration and the pros and cons of genetic patenting. They will construct their own arguments to determine if a potential lack of access to care and testing for lower-income patients might occur if drug companies were allowed patents of genetic materials. They are being challenged to explore direct sources with little oversight from the instructor. This will require students to consider the challenges of diverse cultures and conditions in their communities and around the world. They will assess the direct impact of the potential effect on low-income communities, which could be a personal factor for some students. The lesson provides for a culturally and linguistically responsive approach in order to validate and affirm cultural differences, while building content connections to the real world.

ADVANCING INCLUSIVE RESEARCH

BIPOC communities are more likely to suffer from diseases that require organ transplants, but also less likely to receive transplants. Recent studies into organ transplantation have identified that organ procurement organizations do not prioritize organ retrieval from BIPOC patients. This limits the number of organs available to BIPOC patients because donors and patients from the same background and ethnicity are more likely to be a match. More research must be done to identify breakdowns in the organ retrieval and donation process in order to establish health equity.

COMPUTATIONAL THINKING PRACTICES

As students learn about different types of drugs and how they are administered, they use the computational thinking strategies of abstraction and building models. Students learn about an important class of treatment called biologics, which are treatments derived from living organisms, such as organ transplants or stem cells. As students examine how some biologics, such as monoclonal antibodies, function within the body, they see how scientists use abstraction to isolate affected cells for treatment. This allows the patient to experience fewer side effects from the therapy.

CONNECTIONS TO THE PRODUCT LIFE CYCLE

This lesson focuses on the **discovery** aspect of the product life cycle. Students will be working with the goal of drug route recommendation, which would fall in early clinical development or early clinical trials.

Have you ever wondered…

How do mRNA vaccines work?

Unlike typical vaccines, mRNA vaccines do not contain any part of the virus. Instead, they function by teaching your body to react to certain parts of the virus by instructing a number of the body's own cells to make viral proteins. These cells quickly die and all that remains are our immune system's memory cells poised to defend the next time they find the same viral proteins.

Why are some medicines given as pills and others are given as shots?

Drug administration routes can vary for a number of reasons, including the form that the drug is available in, where the physician or pharmacist would like the drug to interact with the body, speed of action, etc. Some drugs are available in only one format while others are available to be administered in multiple ways. The decision of how it should be available is first made by researchers while pharmacists and doctors may choose from multiple routes when delivering the medication to a patient.

MAKE CONNECTIONS!

How does this connect to the larger unit storyline?

This lesson is the culmination of the storyline. Up until this point, students have been studying the function of DNA and its manipulation as well as how to purify and alter biological substances. In this lesson, students will learn about drug administration and current biologics. They will use this along with prior learning to make administration recommendations for two new drugs.

How does this connect to careers?

Patent attorneys work with innovation companies to ensure their work is protected. Scientific research is expensive and biotechnology firms must protect their intellectual property assets to continue their work. In the case of biologics, patent attorneys must demonstrate how the drug is a new creation and differs substantially from standard nucleic acids and proteins.

Regulatory documentation scientists ensure that the research and testing process meets all necessary standards as well as the final product. They often need to be well-versed in the requirements of multiple countries so their products may be used broadly.

How does this connect to our world?

Human beings are consumers of medicine and, as such, have an investment in its functionality. Students will have utilized dozens of medications in their lives, and this unit will allow them to better understand how and why these drugs are administered. This lesson will also better engage them in emerging biotechnologies that will not only become more prevalent in their lifespan, but may also pique interest in their creation and production as they move forward in their science education.

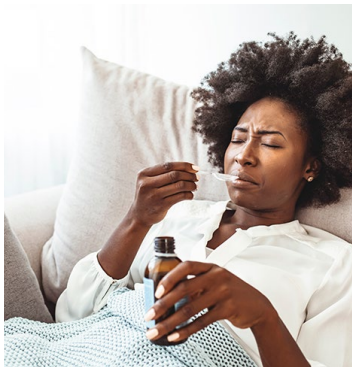
Day 1

LEARNING OUTCOMES

Students will be able to:

Distinguish different features of various drug administration routes.

Summarize a nonfiction text on drug delivery systems.



Procedure

Small Group (20 minutes)

1 Students should move into groups of four for this activity and using the *Round Table* discussion protocol, they will summarize and discuss the information from the article provided.

2 Hand out a large sheet of chart paper to each group. Direct students to divide the reading of the article into sections based on the headings (divide the Pharmacokinetics section into two readings and add the last heading section to the second Pharmacokinetics section for an even distribution of facts), so that each member of the group is responsible for reporting on a section.

3 Have students read the article *Pharmaceutical Drug Administration & Pharmacokinetics Defined*. Students should silently record on their paper any facts that they think are important from their section of the reading. After the article has been read, have students begin the Round Table discussion protocol, reading aloud their own notes to the group. Other students may then, write their own notes, add on to other students' comments, draw pictures, or use arrows and other symbols to show connections between different pieces of information.

Teacher Note > *You may want to group students and chunk the reading so students are focused on a small portion of the text.*

4 After the groups have finished with their discussions of the information from the article, give each group a stack of matching cards cut from the *Drug Administration Sort Capture Sheet*. Students will sort the cards into piles based on the drug administration route. Give students about seven minutes to encourage discussion amongst the group and time to reference their round table notes.

Teacher Note > *You may give students designations for the piles (enteral route, topical route, or parenteral route), according to the headings from the article. However, to encourage higher-level thinking, you can simply direct students to sort the cards according to what they learned in the article. They will make their own designations.*

5 Ask a member from each group to volunteer to *Raise a Righteous Hand* and share how his or her group sorted the cards and why. Allow time for questions and responses to differing opinions of the sorting of the cards.

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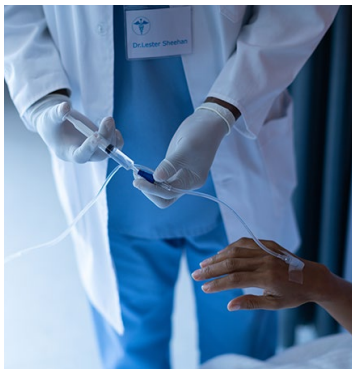
Day 1

Continued

Procedure



Individual Work (5 minutes)

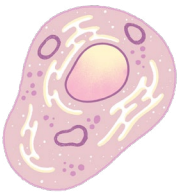
Students do not need to move away from their groups but will individually complete a *Drug Administration Anticipation Guide* to explore their thoughts and prior learning before reading the upcoming article.

Small Group (20 minutes)

Teacher Note > *The paper is easily subdivided into the sections "What Are Drug Delivery Systems", "What Technologies Are...", and "What Are Some Important...". The second section is larger than the others and can be broken in half for two readers in groups of four.*

1	In groups of three or four, students will each read a section of the *Drug Delivery Systems* paper silently. They will use the *Placemat* strategy to summarize the information and create group questions. Distribute a large sheet of chart paper to each group.
2	Each student should write a summary of their reading selection on their section of the chart paper. Each member will read his or her summary aloud. As they do so, the other group members should write down an important fact and response question in regards to the reading on their *Drug Delivery Systems Capture Sheet*.
3	After all students have read their summaries and written their responses, group members should take turns reading and discussing the questions that arose from the reading. These will be placed into the center section of the placemat chart paper.
4	Distribute the *Biologics Exit Ticket* and have students respond to one of the prompts as a *Quick Write*.

Teacher Note > *Make sure to note the questions in the center of each group's chart paper. These questions may be used for journaling, Exit Tickets, assessment questions, and Socratic discussion. This activity pulls on all SEL domains and hits on several indicators of effective teaching.*



Day 2

Procedure

LEARNING OUTCOMES

Students will be able to:

Investigate unique drug delivery systems.

Create higher-level questions about biologic pharmaceuticals.

COMPUTATIONAL THINKING IN ACTION

Biologics are drugs that are made from organic material. Biologics include everything from breast milk to organ transplants and stem cells. Many biologics, such as monoclonal antibodies, target specific areas of cells in order to fight bacteria and viruses. This is an example of how scientists can use the computational thinking strategy of abstraction to isolate pathogens and neutralize them without harming the rest of the body.

Small Group (15 minutes)

In groups of two or three, students should access a device and complete the *Drug Delivery WebQuest Capture Sheet*.

Whole Group (5 minutes)

Ask students what they remember about their work on Nucleic Acid Drugs (in Day 4 of the Nucleic Acid Assays Lesson) using the *Train or Pass it On* protocol. What features made them good pharmaceuticals? Repeat the process for students' work on Enzyme Replacement Therapy (in Day 3 of the Protein Modification Lesson).

Small Group (25 minutes)

1	Students can remain in the same groups as you distribute the article *Defining the Difference: What Makes Biologics Unique* to each student and a blank envelope to each group. Students will take turns reading segments of the article aloud to each other, while the others follow along silently. As they listen, they should underline any concepts they think would make for good questions.
2	When the group has finished reading, students should discuss and write a higher-level question that relates to the text. Groups will write the question on the front of the envelope and place a piece of paper with the answer to the question inside the envelope.
3	When signaled, groups will pass their envelopes on to other groups. Each group will read the question received, discuss it as a group, and write their own answers. They will then check the answer in the envelope and add theirs. The envelopes will then be switched again until every group has received every envelope. As the envelopes move, students should read not just the original group's response, but the responses of the other groups as well.
4	Distribute the *Biologics Exit Ticket* and have students respond to one of the prompts as a *Quick Write*.

Teacher's Note > *Review Give One, Get One, as the above is a variation of that in a group setting using envelopes to collect answers. Higher-level questioning can be encouraged by supplying displays of Bloom's hierarchy or by supplying higher-level sentence starters on the board, such as "What might happen if...", "How could one create...", etc.*

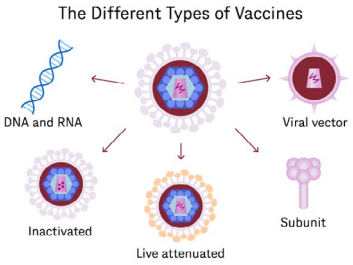
Day 3

LEARNING OUTCOMES

Students will be able to:

Compare protein and nucleic acid therapies.

Theorize potential drug delivery methods for specific illnesses.



Procedure

Whole Group (15 minutes)

1	Using the *Give One, Get One* strategy, have each student take a piece of paper and fold it in half. On the left, students should write the heading "Give One" and on the right, they should write the heading "Get One."
2	Students will read the Silencing and Therapeutics sections of *RNA FAQs*.
3	At the conclusion of the reading, students should converse with other classmates quietly. If the classmate has written something different from what the student wrote, then the student should record their classmate's "Give One" in their "Get One" column and the classmate will do the same.

Small Group (20 minutes)

1	In groups of three or four, students will read the articles on *Gene Therapies* and *Building a Platform for Protein Therapeutics*.
2	Students will create a T-Chart with the heading GENE THERAPY on one side and PROTEIN THERAPY on the other. They should then compare the two therapies by writing facts from the articles. Students should focus on the potential applications of the treatment as well as potential drawbacks.
3	Groups will then complete the *Which Therapy? Capture Sheet*. Students will read brief descriptions of different medical conditions and decide whether they think patients would benefit more from gene therapy or protein therapy and why. Emphasize that this is not for accuracy (many disorders could potentially be treated by both), but about their ability to think critically about the application of these therapies.
4	Lead a class discussion using a *Stand and Share* discussion protocol, asking students to share their ideas on which treatment might be more beneficial for each medical condition.
5	As a wrap-up, have students respond to the lesson questions in their **Design Journal**. They will consider the drug administration's impact and the benefits of using proteins as medicine.

Day 4

Procedure

LEARNING OUTCOMES

Students will be able to:

Argue the merits of genetic patenting.

Assess their own beliefs on genetic patenting.

Small Group (12 minutes)

Have students will move into groups of three or four while you distribute to each group the *Gene Patenting Rubric*. Students will each read aloud a paragraph of *Genetic Patents: Where Should Society Draw the Line?*, while the others follow along silently. If time allows, they should discuss the content quietly before the next segment.

Whole Group (3 minutes)

Using the *Vote with Your Feet* strategy, designate one end of the room as strongly disagree with patenting genetic material and the other end as strongly agree with a company's right to patent genetic materials. Direct students to form a single file line from one side of the room to the other, based on their own beliefs. Students will need to discuss their beliefs with their classmates in order to determine their place in line.

Small Group (15 minutes)

1. Break the students into groups of four based on their places in line.
2. Groups will use the information from the earlier reading to develop an argument for or against gene patenting using the *Gene Patenting Argument Capture Sheet*.

Whole Group (15 minutes)

1. Facilitate the student presentations of their arguments. This can be accomplished by:
   - **a.** Having every group read their concluding paragraph.
   - **b.** Staging a mock debate between groups.

Day 5

Procedure

LEARNING OUTCOMES

Students will be able to:

Design an innovative nucleic acid or protein-based drug delivery system for a disease based on a fictional patient profile.

Create a presentation detailing how their drug delivery innovation will work to end or prevent the disease, including a 2-D model or animation and a plan for a clinical drug trial that ensures equity in medical research.

COMPUTATIONAL THINKING IN ACTION

In this activity, students use the computational thinking strategy of building models to develop a prototype of a new drug delivery system. Models help engineers test and refine products before manufacturing them.

Small Group (45 minutes)

1	Explain to students that for their final project, they will be playing the role of a drug research and development team that has been tasked to come up with a novel drug delivery system for a specific disease that does not yet have a cure or preventative drug or treatment. Ask students to form groups of four.
2	Distribute one of the four *Patient Profiles* to each group, or allow groups to choose one. Student groups should review the patient profile to learn about the disease with which the patient is afflicted and how it affects the patient's daily life. Remind students that as medical professionals in the biotech industry, their goal is to go to work each day to be helpful and find new and better ways to help people.
3	Next, give each team a copy of the *Final Project Packet*, *Social Awareness Campaign Guidelines and Planning Capture Sheets*, and the Unit Rubric that was introduced in lesson 1. Explain to students that for their presentation of the project, they will be presenting their drug delivery innovation at a mock "Mystery Disease Conference" to which they have been invited. Tell groups that their presentation should detail how their drug innovation will work to cure or prevent disease and will be done in the style of a *Pecha Kucha*.
4	Students should review the packet as it details all necessary components of the project including research, a 2-D model or animation, a flowchart or timeline of a clinical trial for their drug innovation, and a 20-slide *Pecha Kucha* slideshow. They will consider the mechanism of the disease and the treatments and drugs that already exist to create something that will improve upon these to cure or prevent the disease. They should use their **Design Journal** to help guide them as they create the components of their presentation to ensure they use ideas and information they learned throughout the unit.

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Day 5

Continued

Procedure

5	Students should use the remainder of the class to begin work on their final projects. They should have at least one more full class period to create their *Pecha Kucha*, model or animation, and flow chart or timeline. If an additional class period is available for practice, that may be helpful as their presentation is timed to the second.
6	Groups should each present their *Pecha Kucha* on the final day of the unit, and each presentation should take approximately 7–8 minutes. (The presentation itself will be timed at 6:40—20 slides at 20 seconds per slide.) Students should receive brief feedback at the end of their presentation, taking questions and comments from their peers.

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.

ETS1.B: Developing Possible Solutions
When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

Science and Engineering Practices
Obtaining, evaluating, and communicating information
Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).

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.

Career and Technical Education (CTE)

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

A9.2
Identify several products obtained through recombinant DNA technology.

A9.3
Outline the steps in the production and delivery of a product made through recombinant DNA technology.

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National Standards

CTE *Continued*	**4.1** Use electronic reference materials to gather information and produce products and services.
	4.2 Employ Web-based communications responsibly and effectively to explore complex systems and issues.
	4.3 Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources.
	4.4 Discern the quality and value of information collected using digital technologies, and recognize bias and intent of the associated sources.
	5.4 Interpret information and draw conclusions, based on the best analysis, to make informed decisions.
	5.6 Read, interpret, and extract information from documents.

Drug Administration Sort Paper

ANSWER KEY — **Do not share with students**

Directions

Cut out the cards and sort them into piles based on the drug administration route.

Anaphylactic Reaction	Severe hyper-response of the bodily offenses to an allergen
Buccal	Between the gum and cheek, avoids stomach acid
Enteral	Oral medications
Ophthalmic	Through the eye
Topical	Skin or membranous linings
Localized effect	Transdermal
Parenteral	Not oral or skin/membrane, often involves needles
Intravenous	High levels in the bloodstream that then decrease
Oral medication absorption	Small intestine

Drug Delivery WebQuest Capture Sheet

ANSWER KEY **Do not share with students**

Directions
Work in groups to complete the questions. Start by reading this article on regional cancer therapies.

1. Why is the hyperthermic intraperitoneal solution heated?

It may improve absorption and kill free-floating cancer cells in the abdomen.

2. What are the benefits of HIPEC over typical chemotherapy?

HIPEC can be concentrated in one area, allows for higher doses while minimizing side effects and reduces the drug's effects on the rest of the body.

3. What type of cancer is chemoembolization typically treating?

Liver cancer

4. How do chemotherapy ports function and what is their benefit?

Chemotherapy ports are implanted under the skin and connect to a large vein that healthcare workers can connect via specialized needles. The port reduces the number of IV sticks a patient must endure.

5. What do insulin pumps eliminate the need for?

Multiple needle sticks

6. What are the three components of an insulin pump?

The computer, the drug reservoir, and the infusion set

7. How often does an infusion set need to be changed?

Every two to three days

8. What device can be worn in conjunction with the insulin pump? What is its purpose?

A continuous glucose monitor (CGM) monitors glucose levels and informs the pump. It can also inform the wearer if their levels go too high or too low.

9. What is a nanoparticle?

A particle about 1–100 nm in size.

10. What causes tumors in our bodies?

Uncontrolled division of cancer cells in the body

11. What is the downside to chemotherapy and radiation?

These therapies also target healthy cells, destroying them, and leading to side effects like hair loss.

12. How does nanotherapy work?

Nanoparticles are filled with a cancer drug and a targeting ligand is attached. The particles are injected into the bloodstream where they then seek out and bind to receptor ligands on the cancer cells.

13. Why don't nanoparticles attack healthy cells?

Healthy cells have tight junctions with their blood vessels and the nanoparticles are unable to cross.

14. What are the benefits of nanoparticle delivery?

It will increase the number of cancer cells that die while protecting more healthy cells

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Drug Administration Sort Paper

Directions
Cut out the cards and sort them into piles based on the drug administration route.

Anaphylactic Reaction	Topical	Enteral
Parenteral	Buccal	Ophthalmic
Intravenous	Localized effect	Oral medication absorption
Small intestine	Skin or membranous linings	Between the gum and cheek, avoids stomach acid
Not oral or skin/membrane, often involves needles	Through the eye	High levels in the bloodstream that then decrease
Oral medications	Severe hyper-response of the bodily offenses to an allergen	Transdermal

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Drug Administration Anticipation Guide

Directions
Respond to whether you agree or disagree with each statement.
Briefly share your reasoning in the appropriate column.

		Support	Concerns
The way in which a drug is administered does not make a difference.	☐ Agree ☐ Disagree		
Administering drugs by microneedles does not cause pain.	☐ Agree ☐ Disagree		
Medicines for humans can be grown through plant viruses.	☐ Agree ☐ Disagree		
Imaging technology and drug administration are two separate fields of study.	☐ Agree ☐ Disagree		

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Drug Delivery Systems Capture Sheet

Directions
Write a summary of your reading selection to share with the group. Take notes as your group members share their summaries.

My section summary:

Group member #1 section title:

Important fact from summary:

Question I had after hearing the summary:

Continues next page >

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Drug Delivery Systems Capture Sheet

Continued

Group member #2 section title:

Important fact from summary:

Question I had after hearing the summary:

Group member #3 section title:

Important fact from summary:

Question I had after hearing the summary:

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Drug Delivery WebQuest Capture Sheet

Directions
Work in groups to complete the questions. Start by reading this article on regional cancer therapies.

Find an article or video on Intraperitoneal Chemotherapy.

1. Why is the hyperthermic intraperitoneal solution heated?

2. What are the benefits of HIPEC over typical chemotherapy?

3. What type of cancer is chemoembolization typically treating?

4. How do chemotherapy ports function and what is their benefit?

Next, find an article or video on Insulin Pumps, or access this YouTube video on insulin pump technology: What is an insulin pump?

5. What do insulin pumps eliminate the need for?

6. What are the three components of an insulin pump?

7. How often does an infusion set need to be changed?

8. What device can be worn in conjunction with the insulin pump? What is its purpose?

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Drug Delivery WebQuest Capture Sheet

Continued

Finally, find an article or video on nanotechnology in drug delivery systems, or access this YouTube video: Nanoparticles for Drug Delivery.

9. What is a nanoparticle?

10. What causes tumors in the body?

11. What is the downside of chemotherapy and radiation therapy?

12. How does nanotherapy work?

13. Why don't nanoparticles attack healthy cells?

14. What are the benefits of nanoparticle delivery?

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Biologics Exit Ticket

Directions
Respond with a Quick Write to one of the following prompts in regards to your reading on biologics:

Many diseases and disorders were mentioned as benefiting from biologics. Which disease or disorder do you think may benefit from these therapies in the future?

One of the molecule types created is antibodies. How do antibodies work and why would it be beneficial to manufacture them?

One concern with biologics is their high cost and the barrier this may create for many disease sufferers. What could be done to help this problem?

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Which Therapy? Capture Sheet

Directions

Read the brief descriptions of different medical conditions. In your response, decide whether you think patients would benefit more from gene therapy or protein therapy, and why.

1. Acromegaly is a hormonal disorder that is the result of the body producing too much growth hormone. In adults, this presents as specific features continuing to grow, such as hands and feet, noses, jaws, and brows. In children, this condition is often called "gigantism". It is caused by a tumor in the pituitary gland.

2. Tay Sachs is a hereditary disorder that destroys the nerves in the spinal cord and brain. Motor development begins to slow and then deteriorates around six months of age. It is caused by a single gene mutation.

3. Hemophilia is a disorder in which a person does not produce the necessary proteins for their blood to clot effectively. It is a genetic disorder inherited on the X-chromosome and is most prevalent in males.

4. Phenylketonuria (PKU) is a genetic disorder characterized by the inability to process a specific amino acid. If undetected, this disorder can cause substantial brain damage. However, screenings of newborns are now commonplace. Sufferers are placed on a low-protein diet, and if caught early, develop normally but must remain on the diet for the rest of their lives.

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Gene Patenting Argument Capture Sheet

Directions
Based on your reading and class discussion, develop an argument for or against gene patenting.

Statement of belief: *What do you think?*	
Support for your point of view: *Why do you think this?*	
Support for the opposition: *What might the other group bring up to support their viewpoint?*	
Rebuttal	
Conclusion	

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Gene Patenting Rubric

	Score	3	2	1
	Overall Structure	Strong belief statement, no obvious spelling or grammatical errors noted, sentences are complete.	Argument contains a decent belief statement, sentences are all fairly short, minor errors.	Argument is short and lacks many of the necessary components, spelling and grammatical errors present.
	Support Facts	Supporting facts are detailed and do a good job at reinforcing the belief statement.	Some facts provided to support the belief statement.	No facts to support the belief statement are provided.
	Opposition Facts	Supporting facts are detailed and do a good job at demonstrating the opposition's viewpoint.	Some facts provided to support the opposition.	No facts to support the opposition are provided.
	Rebuttal	Rebuttal does a great job at refuting the opposition's position.	Rebuttal is present but brief, does not do a great job at refuting the opposition's position.	No rebuttal present.
	Conclusion	Conclusion does a great job of summarizing the writer's argument.	Conclusion is present but brief, does not do a great job at summarizing the writer's position.	No conclusion present.
	Final Score			

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Final Project Packet—Mystery Drug Presentation

For your final project for this unit, you will become part of a drug research and development team that has been given the opportunity to present at a mock Mystery Disease Conference. Your team will be introduced to a specific disease that has conventional treatments, but does not yet have a cure by reading the profile of a patient who suffers from the disease.

Your presentation will be given in the style of a *Pecha Kucha*, where you will prepare 20 slides and discuss each slide for 20 seconds. Your presentation should introduce the audience to the patient and disease, and introduce an innovative drug delivery system or technology that could help to cure or prevent the disease. (See your **Design Journal** for a link to an example Pecha Kucha on Huntington's Disease.)

In your role as a *project manager, biomedical technician, clinical researcher,* or *health information specialist*, you will choose a patient profile and work with your group to research information about the disease with which your patient is diagnosed, including the mechanism of the disease and the benefits and drawbacks of conventional treatments.

Next, your group will design a potential innovative drug delivery system for the disease, using information about nucleic acid and protein-based treatments from the lessons in this unit. This will include a sketch or animation of how the drug delivery system will work to be included in the Pecha Kucha. To end the presentation, the group will outline a detailed clinical trial plan that will give important data about the drug's effectiveness, while ensuring equity to all people to begin the pathway to your drug's approval by the FDA.

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Final Project Packet—Mystery Drug Presentation

Division of Labor Chart

Directions

Assign each member of your group one or more of the following roles:

Project Manager

Oversees the project, ensures that all group members meet deadlines, helps out where needed in all departments, communicates with the instructor about project questions and concerns, completes final proofreading for all project materials.

Biomedical Technician

Responsible for research about the disease with which the patient has been diagnosed, including how it works in the body, and current drugs that are used to treat and prevent further symptoms. Leads the innovative drug delivery design process and creation of the 2-D model or animation, adding knowledge of how nucleic acids and proteins can be used in treatment for disease. Communicates with the project manager and other group members to ensure that all have an accurate understanding of the disease and identifies information that should be included in the design of the drug innovation.

Clinical Researcher

Is in charge of creating the flowchart or timeline for the clinical trial of the drug innovation. Works closely with the biomedical technician to ensure an understanding of groups that are disproportionately impacted by the disease or a lack of equity in treatment and how the drug innovation will work to cure or prevent the disease. Does research on how clinical trials are planned and run, and works to ensure equity in the design of the clinical trial.

Health Information Specialist

Works with the biomedical technician and clinical researcher to ensure that information from research, models/animations, and flowchart/timelines are created in a way that will be understandable and convey information succinctly and clearly. Is in charge of writing the script for the Pecha Kucha presentation so that the audience will be informed in a way that minimizes confusion and is entertaining and inspiring.

Continues next page >

Group Members:

_____

_____

_____

_____

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Final Project Packet—Mystery Drug Presentation

Division of Labor Chart

Continued

Directions

Use the chart below to keep track of how much time each team member spends on each task. There should be a fair and even division of labor for this project.

	Description of Task	Role(s) Responsible for Task	Due Date for Task	Is Task Completed?
1				
2				
3				
4				
5				
6				
7				
8				

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Social Awareness Campaign Guidelines and Planning

Project Component: Research

GOAL: *The goal of this portion of the project is to learn about the disease that your patient is faced with and what existing treatments or drugs exist to help alleviate or diminish health issues related to the disease.*

Information that should be included your research (use your **Design Journal** and internet research to find information):

Information about how your disease impacts a person's health, the causes, and other facts and statistics by going to the website *Medline Plus: Health Topics*

An explanation of the leading existing drugs or therapies are used to treat the disease, how they work and what the limitations of each is

Comparison of various nucleic acid treatments and technologies work versus protein treatments and technologies

A storyboard for your PSA using the template that follows

Brainstorming and/or an explanation of how a new theoretical drug delivery system might stop the disease or prevent it completely using cellular or biomolecular components such as nucleic acids or proteins

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Social Awareness Campaign Guidelines and Planning

Project Component: 2-D Model or Animation

GOAL: *In this portion of the project, the group will create a 2-D model on paper or digitally or create an animation of their innovative drug delivery that details the mechanism of action.*

Examples of 2-D models and animations of the mechanism of action for other drugs and treatments can be found in the unit **Design Journal**.

To get started:

Decide on how your drug innovation will work to cure or prevent your disease.

Determine if it is more appropriate to use nucleic acid or protein techniques in your drug innovation by reviewing information recorded in your **Design Journal**.

Create a storyboard for your 2-D model or animation that shows the steps of how your drug innovation will work—"the mechanism of action"—using the template on the next page.

Create a storyboard for your PSA using the template on the next page.

Decide if you will create a model on paper or which digital design or drawing program you will use, or if creating an animation, decide which program you will use (Animaker or Powtoon).

Continues next page >

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Social Awareness Campaign Guidelines and Planning

Project Component: 2-D Model or Animation

Continued

Drug Innovation Mechanism of Action Storyboard

Step 1	Step 2	Step 3
Step 4	Step 5	Step 6

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Social Awareness Campaign Guidelines and Planning

Project Component: Clinical Trial Flowchart or Timeline

GOAL: *In this portion of the project, a clinical trial will be designed for the drug delivery innovation as part of the drug testing and approval pathway. The clinical trial should be designed for equity in medical research.*

Examples of flowcharts and timelines for clinical trials can be found in the unit **Design Journal**.

To get started:

Research how clinical trials for drugs are designed—use the webpage *Step 3: Clinical Research*.

Identify those who may be more prone to the disease by going to the following databases: *CDC Data and Statistics*.

Decide which online website you will use to create your flowchart or timeline (example: Lucidchart or Canva's timeline template).

Determine how you will ensure equity in your clinical trial by reading the *What are Clinical Trials and Studies?* article.

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Social Awareness Campaign Guidelines and Planning

Project Component: Pecha Kucha Slideshow

GOAL: *This portion of the project will allow the groups to present information about their drug delivery innovations in a purposeful, concise, and professional way. You must follow the Pecha Kucha guidelines and reserve time for practice before your group presents!*

To get started:

Decide on the slideshow program that you will use to create your presentation (Google Slides, Keynote, PowerPoint).

Create a presentation that contains 20 slides. Set each slide to play for 20 seconds before automatically advancing to the next slide.

Create a script for the Pecha Kucha using the script template, that includes ideas about the images that you want to include in your slideshow.

Add the images to the slideshow

PRACTICE! PRACTICE! PRACTICE!

Continues next page >

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Social Awareness Campaign Guidelines and Planning

Project Component: Pecha Kucha Slideshow

Continued

Script for Pecha Kucha

Slide	Topic	Image	Script
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Continues next page >

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Social Awareness Campaign Guidelines and Planning

Project Component: Pecha Kucha Slideshow

Continued

Script for Pecha Kucha

Slide	Topic	Image	Script
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

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Patient Profiles

Directions
As a group, choose one of the four Patient Profiles. Review the selected profile to learn about the disease the patient is inflicted with and how it affects their daily lives. Remember, as medical professionals in the biotech industry, your goal is to go to work each day to help others and find new and better ways to help people.

Patient Profile 1

Name: Trevor

Diagnosis: HIV

Trevor's Story

Patient Profile 2

Name: Miriam

Diagnosis: Breast Cancer

Miriam's Story

Patient Profile 3

Name: Erika

Diagnosis: Congestive Heart Failure

Erika's Story

Patient Profile 4

Name: Jose

Diagnosis: Alzheimer's Disease

Jose's Story