



FUTU~~R~~ELAB+

BIOMED

*Behind the Scenes of Scientific
Breakthroughs*

Ethical Considerations and Longevity

Developed in partnership with:
Discovery Education and Ignited

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Cover Image

This is a conceptual illustration of genetic engineering.

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BIOMED / BEHIND THE SCENES OF SCIENTIFIC BREAKTHROUGHS

Ethical Considerations and Longevity

DRIVING QUESTION

How does the study of bioethics contribute to the advancement of biomedical research and practices?

OVERVIEW

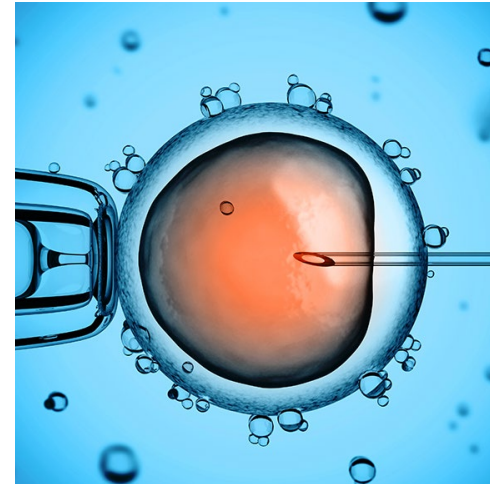
Bioethics is a broad field that encompasses various disciplines. A few controversial topics that fall under its umbrella include human cloning, artificial reproduction, genetic engineering, right-to-die or assisted suicide, and abortion. To put in simpler terms, bioethics is the study of cases and questions that are related to the proper use of new technologies in science, research, and medicine. To quote the character Ian Malcom from Jurassic Park, “Science is so preoccupied with whether or not they could, they didn’t stop to think if they SHOULD.”

In this lesson, students will have the opportunity to analyze their own ethical stance on many of today’s hot-button topics. Also, students will research famous bioethics case studies as well as discuss bioethics topics.

Then students work in groups to create an interactive job board that seeks to add members to a team of scientists who have made a breakthrough in the area of aging and longevity. They will choose one scientific breakthrough briefing as the focus for their research, and determine the careers needed to help them move forward to develop and implement a specific drug, treatment, or therapy that could help extend or improve the human lifespan.

ACTIVITY DURATION

Five class sessions
(45 minutes each)



ESSENTIAL QUESTIONS

How has the need for ethical reasoning increased in science and medicine over the past two centuries?

What careers are involved in the development and regulations surrounding breakthroughs in biotechnology?

Should the use of biomedical testing be restricted or regulated?

OBJECTIVES

Students will be able to:

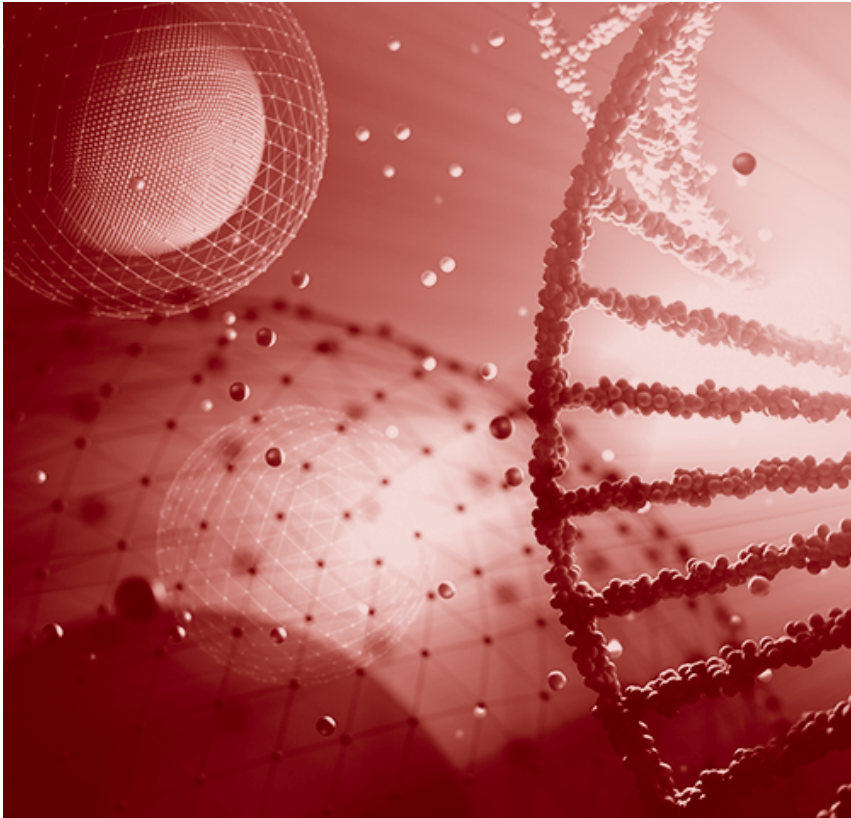
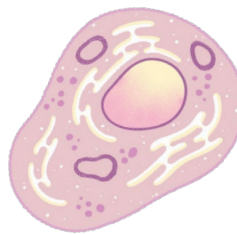
Distinguish the characteristics of ethical reasoning.

Analyze the ethical issues surrounding the techniques used to bioengineer plants and animals.

Investigate and **understand** the mechanisms of inheritance and the synthesis of proteins, including the use and misuse of genetic information and the impact of DNA technologies.

BACKGROUND INFORMATION

Bioethics combines politics, law, biotechnology, medicine, and philosophy in order to address ethical issues in the medical and scientific disciplines. Coinciding with the advent of new and improved technologies designed to extend and improve the quality of life, the modern era of health care ethics, later to be known as bioethics, began in the mid 1960s with a series of articles that approached ethical problems in clinical research. As the use of more and more unethical treatments came to light, the importance of the incorporation of ethics in the biomedical sciences increased exponentially.

**Materials****Computers with Internet Access****Question Identity Assignment****Ethical Scenario****Case Study Video Storyboard
Capture Sheet****Case Study Video Rubric****Socratic Seminar Prompts****Socratic Seminar Preparation
Homework****Socratic Seminar Capture Sheet
Parts 1 and 2****Socratic Seminar Observer
Capture Sheet****Socratic Seminar Reflection****Socratic Seminar Participation
Rubric****Scientific Breakthrough Briefings****Final Project Packet****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

Social and emotional learning opportunities are available in this lesson as any lesson in ethics would be likely to have, yet with added gravity due to the often sensitive responses and personal connections to the content being explored. Students must use self-awareness to develop their own definition of bioethics. They are required to analyze scenarios and case studies of various ethical dilemmas, which allows them to practice their social awareness and social management behaviors as they respond respectfully and authentically to any scenarios that might impact fellow students. In the responsible decision-making domain, students will develop and solidify claims based on evidence as well as reflect on and evaluate community impact.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Daily activities in this lesson require sensitivity in response to discussion scenarios, such as the Tuskegee syphilis study, the story of Henrietta Lacks, and the history of eugenics. The instructional strategies used throughout the lesson are designed so that students have opportunities to be culturally and linguistically responsive to one another's possible personal or historical experiences with any of the scenarios. Students are encouraged to bring their cultural framework into the learning process. This leads to a more equitable classroom experience for all learners.

ADVANCING INCLUSIVE RESEARCH

Many of the assignments require students to be cognizant of gender, SES, race, and ethnicity. Once again, the Tuskegee and Lacks case studies highlight how citizens were exploited and subject to unethical situations due to their race/ethnicity, gender, and socioeconomic standing.

COMPUTATIONAL THINKING PRACTICES

Students find and observe patterns as they analyze various bioethical scenarios and then decompose problems by examining ethical, moral, and legal issues in biomedical research. They use the computational thinking practice of developing algorithms while storyboarding a famous bioethics case. In researching bioethical topics based upon real-world scenarios, students observe patterns, collect and analyze data, and decompose problems. They debate bioethical decisions and apply their learning by taking on the role of scientists involved in the research and discovery of a scientific breakthrough in the fields of human aging and longevity.

CONNECTIONS TO THE PRODUCT LIFE CYCLE

This lesson connects to all stages of the product life cycle (**discover, develop, manufacture, and commercialize**) while assessing the ethical dilemmas of vaccinations and the use of euthanasia drugs. Day 3 will require students to make the ethical decision of vaccine distribution during a deadly pandemic, which connects to the **develop** and **manufacture** stages of the product life cycle.

Have you ever wondered...

Why is human cloning so controversial?

Although mammalian cloning is commonplace today, human cloning remains illegal. Authorities in the bioscience, religious, and ethics communities have debated the pros and cons of human cloning. This debate is crucial in preparing us for the immediate and long-range effects of cloning and in rethinking whether laws should allow for human beings to be cloned.

Why is there a debate about GMOs?

GMO foods have taken over the food industry in the past two decades to the point that if food in the grocery store is not labelled as certified organic, there is a great chance that it has actually been genetically modified. While some tout GMO foods as a way to save millions from starvation, others see the modification of genes as “playing God.”

How has biotechnology been used to enhance human health?

The advancements in biotechnology have enhanced the quality and quantity of foods, medicines, and overall products utilized by everyday consumers. This has contributed to an overall increase in life quality and expectancy. Some of these advancements have come with a myriad of ethical concerns, however.

MAKE CONNECTIONS!

How does this connect to the larger unit storyline?

Manipulating and increasing the human lifespan is an important but controversial topic. Humankind’s quest to extend life beyond present capabilities brings a plethora of legal and ethical debates and challenges. Genetic sequencing, bioengineering of plants and other organisms, and cloning of all types are just a few of the topics in bioscientific research today that incite ethical debate. The study of bioethics is necessary to keep in check our advancing technical capabilities.

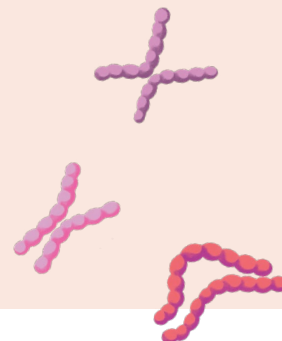
How does this connect to careers?

Bioethicists are involved with consulting and making decisions in a myriad of ethical and legal issues dealing with bioscience and medical research. Sometimes it is the bioethicist’s responsibility to educate and inform the public on the details about issues that affect them.

Bioethicists’ services are wanted and required by the healthcare industry, academia, oversight and compliance boards, policy organizations, pharmaceutical and biotech companies, and think tanks.

How does this connect to our world?

Because the world of bioscience and global health have such an important role to play in our lifetime, the study of the ethics surrounding these disciplines and topics would and should play an equally important part. For example, subjects such as end-of-life decisions, organ-harvesting, and the modifying of the genomes of living species are debated and discussed on a daily basis.



Day 1

Procedure

LEARNING OUTCOMES

Students will be able to:

Understand the relationship between ethics and bioethics.

Analyze various bioethical scenarios.

Develop their own definition of bioethics.

COMPUTATIONAL THINKING IN ACTION

Using a virtual tool to collect data allows results to be shared and discussed in real time.

Teacher's Note > Remind students to update their Design Journal to capture how content in this lesson will connect to the information they are investigating and to the creation of their final product.

Whole Group (30 minutes)

- 1 Provide a short introduction to bioethics by letting students know what they will be doing for the next five sessions.
- 2 Play the video *What is Bioethics?* (2:35)
- 3 Use a virtual polling platform (i.e., *Poll everywhere* OR *Crowdsignal*), to have students answer the following questions on any previous knowledge they may have about bioethics:
 - a. If you took a genetic exam for a potentially deadly disease, would you like to know the results?
 - b. Should students be forced to have vaccinations for illnesses that are potentially contagious?
 - c. Should there be a limit to how much humans are able to use technology to modify the natural world?
 - d. Should it be legal to clone animals for food and/or pets?
 - e. Should terminally ill patients be able to give themselves fatal doses of medicine?
- 4 After the poll is closed, have a discussion with the class about how they answered the questions.
- 5 Share with the class that they were just practicing the study of “bioethics.”

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Day 1

Continued

Procedure

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- | | |
|---|--|
| 6 | On the board or projected on a screen, provide students with an initial definition of <i>ethics</i> as “the branch of knowledge that seeks to determine what a person should do, or the best course of action, and provides reasons why. It also helps provide moral principles that govern how people behave and treat one another on all levels of society.” |
|---|--|
-
- | | |
|---|---|
| 7 | The teacher will introduce the career roles and responsibilities of bioethicists. |
|---|---|
-

Teacher’s Note > *If time permits, have students read “What Can You Do With a Masters in Bioethics?”, to learn more about the varying careers in the bioethics field. Explain to students that this is a field that is growing as science and technology drive ethical concerns in our world.*

Individual (5 minutes)

Considering the previous information, students will develop their own definition of “bioethics” in their **Design Journals**.

Small Group (10 minutes)

Students will perform a *Think-Pair-Share* activity and discuss their definitions of “bioethics.” Ask: *What do they think of each other’s definition? How are they similar? How are they different? After looking at your partner’s definition, is there anything about your own that you would change?* Have students record their definition in their **Design Journal**.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

The popular Think-Pair-Share model, and its variations, asks students to consider a question on their own, and then provides an opportunity for students to discuss it in pairs, and finally together with the whole class or another pair to form the square. This activity works ideally with questions that encourage deeper thinking, problem-solving, and/or critical analysis.

It provides peer to peer scaffolding and support to learners who might have trouble with specialized vocabulary or general professional, scientific language structures

Day 2

Procedure

LEARNING OUTCOMES

Students will be able to:

Defend decisions based on an ethical scenario.

Differentiate between types of questions that arise in bioethical scenarios.

Differentiate between ethical, moral, and legal issues in biomedical research.



CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Using an online format to post comments anonymously allows culturally diverse students to be certain of their thoughts, spelling, and ideas before posting publicly. This allows for discussions to be non-threatening, even if ideas are controversial or unpopular.

Small Group (5 minutes)

- 1 Present the class with the following scenario.

“Dave, who has asthma, has two extra inhalers in his bookbag. These inhalers are prescribed to him and are for his use only. One day, he notices that his friend, Buster, is having a hard time catching his breath. Buster has never been diagnosed with asthma, so he does not own an inhaler. Dave’s parents informed him in the past that he is not to give his inhaler to use by anyone else. He also knows that the school policy forbids using and sharing medication with other students without a doctor’s note and the school nurse’s consent. Does Dave give Buster his inhaler to use?”
- 2 In the same Think-Pair-Share groups from Day 1, give groups three minutes to discuss the ethical scenario.

Teacher’s Note > *Consider having students read a case study in place of the scenario: [National Center for Case Study Teaching in Science](#).*

Whole Group (20 minutes)

- 1 Ask three students to share some of their ideas, using the [Raise a Righteous Hand](#) discussion protocol, about the scenario of whether or not Dave should give Buster his inhaler. Record students’ thoughts on a projected note-taking app, such as [Padlet](#).
- 2 Bring to students’ attention the importance of providing explanations and reasons in bioethics by telling them that ethics is a discipline that deals with finding and giving reasons to support or oppose a position.
- 3 Ask students if they have any questions about the case. Using [Padlet](#), or similar note-taking app, students will share those questions anonymously. Save these questions to the Padlet board and project for the classroom.

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Day 2

Continued

Procedure

-
- 4 Introduce students to the different types of questions usually found in bioethics cases (ethical, scientific, legal, or personal/cultural/religious).
-
- a. Ethical questions—questions that imply a difficult decision may be needed due to conflicting moral choices and dilemmas. They have no right or wrong answers that would satisfy all parties but are instead based on well-reasoned justifications.
-
- b. Scientific questions—questions that can be explored through scientific inquiry and observation. They rely on empirical and measurable evidence. They are usually objective in nature, although not always.
-
- c. Legal questions—questions that ask what the law says about a particular issue.
-
- d. Personal questions—questions that relate directly to the speaker and are more than likely influenced by cultural bias. Religious/cultural questions ask what would be in accordance with a particular belief or practice, or the common practices of a particular culture.
-
- 5 Remind students that different types of questions were presented by the class in the Dave and Buster scenario, and that each of the four types of questions presented are important in making decisions in ethical cases. It is also important to know that some questions may be a combination of two, and sometimes, three types. This lets students know that bioethics is never “black and white” but usually always multi-dimensional. As long as people have the human right to express opinions and beliefs surrounding scientific and research practices and developments, there will be a need for bioethics.
-
- 6 Tell students they will be presented with several different types of questions, and they will pair up to determine what type of question they think each is.

COMPUTATIONAL THINKING IN ACTION

Here, students utilize the practices of observing patterns and decomposing problems in order to decipher the question type.

Small Group (20 minutes)

-
- 1 Students will get back into their pair groups and complete the *Question Identity Assignment*.
-
- 2 The assignment will be turned in at the end of class as an Exit Ticket.

Day 3

LEARNING OUTCOMES

Students will be able to:

Discuss the ethics of animal cloning.

Research ethical issues due to evolving scientific research.

Compose a video news report about famous bioethics cases.



Procedure

Whole Group (5 minutes)

- 1 Students will watch Utah State University's *First There Was Dolly: Lessons Learned from Animal Cloning*.
- 2 Have a brief discussion with the class about the controversies, positives, and negatives of animal cloning. Ask: *Should it be a common practice? Why should humans clone animals? Why should they NOT clone animals? How would bioethicists confront this issue?*

Small Group (40 minutes)

- 1 In groups of three or four, students will produce and record a video on a famous bioethics case. Student videos should be in the form of a news report on the case and should involve visuals and researched facts and figures.
- 2 Student news reports should be no longer than 5 minutes each.
- 3 In advance of the groups choosing their case studies, write each study down on a small piece of paper and fold that paper so the name cannot be seen. The student groups will draw their study from a hat, paper bag, or box.
- 4 Cases to choose from:
 - Ferguson v. City of Charleston (2001)
 - Guatemalan STD Study (1946–1948)
 - Skid row Cancer study
 - Study 329
 - Baby Doe Law and Baby M
 - Betty and George Coumbias
 - Terri Schiavo case
 - The Monster Study
 - Eugenics—Law for the Prevention of Progeny with Hereditary Diseases
 - The use of genetically modified foods such as hybrid corn and Golden Rice

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Day 3

Continued

COMPUTATIONAL THINKING IN ACTION

This exercise incorporates algorithmic thinking by having students think through the steps of their news report. The finished video evidences their use of decomposing problems and abstracting information in order to communicate effectively about the bioethics case.

Procedure

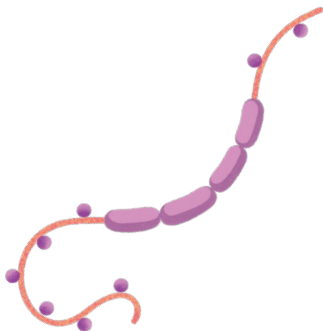
- 5 Student news reports should consist of the following information:
 - The scientific basis of the case (i.e., inheritance of traits, structure, and function)
 - Specific statistics where applicable (i.e., Eugenics study, GMO use nationally, and globally)
 - The major stakeholders in the case
 - The variety of ethical dilemmas in the case
 - The final outcome of the case
 - Lessons learned and laws enacted due to the case (if applicable)
 - Similar cases before and after the case (if applicable)
- 6 Provide each group with a blank [Case Study Video Storyboard Capture Sheet](#) to map out their video.
- 7 Finished videos will be uploaded and shared onto class website, [Flip](#), or another collaborative video sharing platform for peer evaluation to be assigned as homework.

Optional Activity (25 minutes)

- 1 Distribute the [Ethical Scenario Capture Sheet](#). Have students answer the questions individually.
- 2 Students pair up and share their ethical decisions with their classmates. Give them two minutes to discuss. Repeat until they have spoken with at least five classmates.
- 3 Have students self-reflect on their answers. On the back of their [Ethical Scenario Capture Sheet](#), they will respond to the prompt:

After hearing the choices of my classmates as well as my own self-reflection, I wish to...

 - Keep my original answers (give reasons why)
 - Change some of my answers (give reasons why)
 - Change all of my answers (give reasons why)



Day 4

Procedure

LEARNING OUTCOMES

Students will be able to:





Annotate a text and **create** probing questions on bioethical topics.

Engage in academic dialogue about bioethical topics.

Compare and **contrast** perspectives on ethical decisions.

Prior to Class

Assign students to read the article *Science and Ethics* and complete the *Socratic Seminar Preparation Homework* prior to today's Socratic Seminar. Their first task is read through the article to get an initial impression of the information. Their second task is to read deeply and deliberately while annotating the text:

| | |
|---|--|
|  | Circle unfamiliar vocabulary and concepts |
|  | Underline key ideas and details |
|  | Place a star in the margin where you have a personal connection or a real-world example. |
|  | Place a question mark in the margin where you have a question. |

This is a long and complex article. Make sure all students have access to a paper and electronic copy. To differentiate, you may want to assign shorter chunks for struggling students to annotate.

On the day of the seminar, place laminated or plastic display signs around the room with Socratic Seminar Prompts found on the *Preparing for the Socratic Seminar* Educator Resource.

Whole Group (5 minutes)

- 1 Explain to students that they will be participating in a *Socratic Seminar*. The purpose of a Socratic Seminar is to facilitate a deeper understanding of ideas and values through shared discussion.
- 2 Remind students that they will base their ideas or values on the text that was assigned for homework.

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Day 4

Continued



Procedure

-
- 3 Review seminar norms with students:
- Do not raise hands.
 - Listen carefully.
 - Address one another respectfully.
 - Base any opinions on the text.
 - Use sensitivity to take turns and not interrupt others.
 - No side conversations, address all comments directly to the group.
 - Be courageous in presenting your own thoughts and reasoning but be flexible and willing to change your mind in the face of new and compelling evidence.

Individual (5 minutes)

Have students prepare for the Socratic Seminar by using the [Socratic Seminar Capture Sheet, Part 1](#) to identify vocabulary words, concepts or questions they have prior to beginning.

Small Group (10 minutes)

- 1 Have students form groups of three and share what they identified in the reading.
-
- 2 As students listen to group members share, they should add additional ideas or information to their [Socratic Seminar Capture Sheet, Part 1](#).
-
- 3 Students should record their group members' personal or real-life connections to their [Socratic Seminar Capture Sheet, Part 2](#).

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Day 4

Continued

Procedure

Whole Group (25 minutes)

- 1 Students will engage in the Socratic Seminar. Make sure all students are sitting in a circular formation so they may all see one another, with the teacher sitting at the students' level as well. The teacher may request a student to volunteer as seminar leader or may designate someone in advance. The seminar leader will review the guidelines with the group. Socratic Seminar Guidelines:
 - A seminar is a dialogue not a debate.
 - We are searching for understanding, not for right answers.
 - We are all equals.
 - The text is the teacher.
 - We listen to each other and respond respectfully, even when we disagree.
 - We ask questions that build upon others' ideas and questions.
 - The seminar leader is a guide, and leads with questions.
 - Be comfortable with silence and awkward pauses.
- 2 Teachers should also assign at least one student to complete the *Socratic Seminar Observer Capture Sheet*. Make sure the observer has either the last few minutes of the class to share observations or the first few minutes of the next class to do so.
- 3 The seminar leader provides structure for the conversation by:
 - Using the sentence stems to pose key questions.
 - Asking participants to clarify, elaborate, and cite the passage to support their responses.
 - Refocusing the conversation by restating the opening question and using additional questions to elicit conversation.
 - Recording the main ideas discussed and keep track of each person's contributions.
 - Summarizing the main points or ask if a student can do so at the end of the discussion.
- 4 After the seminar, ask debrief and reflection questions. Allow the seminar leader to share his or her experience as a facilitator.
- 5 As a homework assignment, have students complete the *Socratic Seminar Reflection*.
- 6 Optional: students could also complete the *Socratic Seminar Participation Rubric* as a self-reflection of their contributions during the Socratic Seminar.

SOCIAL-EMOTIONAL LEARNING

Consider how the classroom community is being inclusive and fostering a safe and brave space for dialog throughout the Socratic Seminar learning experience.

Days 5–7

Procedure

LEARNING OUTCOMES

Students will be able to:

Research a recent scientific breakthrough in the field of aging and human longevity and the jobs that take a treatment or therapy from the initial discovery through testing, approval, and implementation phases so they may be used by humans.

Create an interactive job board that introduces potential employees to their scientific breakthrough and advertises the careers that are needed for this breakthrough to become available for use by humans to extend the human lifespan.



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

Small Group (45 minutes)

- 1 Explain to students that for their final project they will work in teams and play the role of scientists involved in the research and discovery of a scientific breakthrough in the fields of human aging and longevity. Ask students to form groups of four.
- 2 Distribute or allow groups to choose one of the four [Scientific Breakthrough Briefings](#) in aging and longevity. Student groups should review their scientific briefing to learn how the discovery or discoveries have potential to lessen or reverse the effects of aging and age-related disease in humans. Explain to students that the initial discovery is just the beginning of being able to improve human health. Ask students to share what they think happens next in the product cycle — *What are the next steps involved in being able to take a discovery and make it into a drug, treatment, or therapy that humans can use?* Allow students to share their ideas with the class.

Teacher Note > *It may be helpful to review the website [Learn About Drug and Device Approvals](#) to help review the process they were introduced to in earlier units.*

- 3 Next give each team a copy of the [Final Project Packet](#). Explain to students that for their presentation of the project, they will be creating an interactive job board that seeks to advertise their group's scientific breakthrough and define the careers that are needed for the next steps of treatment or therapy implementation to potential new team members in various fields, such as legal council, regulatory affairs, and advocacy relations. Tell groups that each job board should detail how the scientific breakthrough could be used to lessen or reverse the harmful effects of human aging and age-related disease, with a special focus and concentration on their communities, and will be completed using the digital presentation platform [Emaze](#) or another platform of their choice.

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Days 5–7

Continued

Procedure

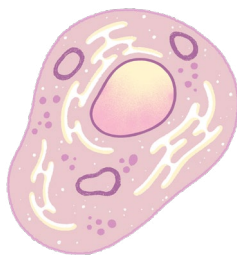
-
- 4 Students should review the packet, which details all necessary components of the project including research, an introductory video, and career profiles for the additional team members that are needed. They will add interactive elements that will make their job board more informative and appealing to potential team members. They should use their **Design Journal** to help guide them as they create the components of their job board to ensure they use ideas and information they learned throughout the unit.
-
- 5 Students should use the remainder of the class to begin work on their final project.
-

Small Group (45 minutes)

- 1 Students should have at least one to two more full class periods to create their introductory videos and career profiles. These elements should be added to their interactive job board.
-
- 2 Upon project completion, groups should provide the links to their job boards so that classmates can view each groups' projects and learn more about various scientific breakthroughs. Students may give brief feedback to other groups or take questions and comments from their peers in a whole-group final activity.
-

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Quality checking with peer feedback allows for the validation and affirmation of the student work, while bridging to standard English and building consistent appropriate language for interpersonal interaction with others.



National Standards

Next Generation Science Standards

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

Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

Constructing an explanation

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

Engaging in argument from evidence

Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.

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.

Patterns

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

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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National Standards

**Career and
Technical
Education
(CTE)***Continued*

A2.1

Know the relationship between morality and ethics in the development of biotechnology health care products

A5.1

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

A5.2

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

A7.1

Identify agencies at the local, state, and federal levels.

Educator Resources

Preparing for the Socratic Seminar

The Socratic Seminar provides a productive setting for discourse and facilitates a spirit of shared inquiry among students as they uncover meaning in a specific text or learning experience.

Ahead of the lesson, students read and annotate the article, posing open-ended questions, making connections, and analyzing the content. This gives them an opportunity to think critically, analyze multiple meanings and viewpoints, and begin to formulate ideas with clarity and confidence. During class, provide a few minutes for small groups to share their annotations and take notes as they formulate ideas for the class dialog.

In preparation for the Socratic Seminar, consider which students might take on the role of Leader or Facilitator, and who might be a good fit as Observer(s). Post the Socratic Seminar Prompts around the room for all students to consider throughout the discussion. Also provide them to the Seminar Leader. The seminar leader provides structure for the conversation by:

- *Using prompts and sentence stems to pose key questions.*
- *Asking participants to clarify, elaborate, and cite the passage to support their responses.*
- *Refocusing the conversation by restating the opening question and using additional questions to elicit conversation.*
- *Recording the main ideas discussed and keeping track of each person's contributions.*
- *Summarizing the main points or asking if a student can do so at the end of the discussion.*

Socratic Seminar Prompts

Prompts and sentence stems are repeated on the next page to be cut out and laminated for student use.

Key Interpretive Questions

(select ONE to focus on and begin the discussion)

- What is the main idea or underlying value in the text?
- What are the concerns raised by the text?
- Why is this text important?

Clarification Questions

(to promote deeper conversation)

- What do you mean by _____?
- Could you give us an example? expand on that? explain further?
- Could you put that another way?
- What would you say is your main point?
- What evidence supports your claim?

Viewpoint Questions

(to move the discussion along)

- Who has a different perspective?
- What would someone who disagrees with this say?
- How does this relate to what (someone else) said?
- Has anyone changed their mind? What prompted a change in thinking?
- Why have you chosen this perspective?

Closing Questions

(to bring the discussion back before wrapping up)

- Why is this material important?
- How do the ideas in the text relate to our lives?
- Do you agree with the author?

Debrief Questions

- Do you feel like you understand the text at a deeper level?
- How was the process for us? Did we adhere to the norms?
- Did you achieve your goal to participate?
- What was one thing you noticed about the seminar?
- What worked well for you? What was challenging?

Educator Resources

Preparing for the Socratic Seminar

Continued

Key Interpretive Questions

(select ONE to focus on and begin the discussion)

- What is the main idea or underlying value in the text?
- What are the concerns raised by the text?
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(to bring the discussion back before wrapping up)

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- Do you feel like you understand the text at a deeper level?
- How was the process for us? Did we adhere to the norms?
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- What was one thing you noticed about the seminar?
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Viewpoint Questions

(to move the discussion along)

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- What would someone who disagrees with this say?
- How does this relate to what (someone else) said?
- Has anyone changed their mind? What prompted a change in thinking?
- Why have you chosen this perspective?

Question Identity Assignment**ANSWER KEY****Do not share with students****Directions***Match up the question written with the type of question.**Remember, some questions may be a combination**of more than one type.*

| Question | Type | Type of Question | Key |
|---|---------|---------------------|-----|
| 1. Should you lie to protect the safety of your loved ones? | E | Ethical Question | E |
| 2. What is the law concerning abortion in this state? | L | Scientific Question | S |
| 3. Is killing always wrong? | E | Legal Question | L |
| 4. Does a mutation in a gene alter the structure of the corresponding protein? | S | Personal Question | P |
| 5. How do vaccines and antibiotics work? | S | | |
| 6. Should people who donate an organ while they are still alive be allowed to choose who receives it? | E | | |
| 7. When, if ever, should people insert genes from one species into another? | E | | |
| 8. Do you like football or soccer? | P | | |
| 9. How should parents discipline their children? | E, P | | |
| 10. Is it fair to require students to wear a school uniform? | E | | |
| 11. Is it legal to sell a kidney in the United States? | L | | |
| 12. Should genes be patented? | E | | |
| 13. Should students be allowed to refuse to recite the Pledge of Allegiance? | E, L | | |
| 14. At what time do you brush your teeth? | P | | |
| 15. Whom should you marry? | E, L, P | | |

Continues next page >

Question Identity Assignment**ANSWER KEY****Do not share with students***Continued*

| Question | Type | Type of Question | Key |
|---|---------|---------------------|-----|
| 16. Should you use someone else's prescription drugs? | L | Ethical Question | E |
| 17. Do you prefer The Beatles or The Rolling Stones? | P | Scientific Question | S |
| 18. Should someone kill one person in order to save the lives of many people? | E | Legal Question | L |
| 19. Should you credit the person who gave you an idea for which you end up becoming famous? | E, L | Personal Question | P |
| 20. Is the cloning of human embryos allowed in France? | L | | |
| 21. Should athletes be allowed to take steroids? | E | | |
| 22. What kind of rights should be granted to a 30-year-old whose brain development is the equivalent of a six-year-old? | E | | |
| 23. How does the digestive system make waste products? | S | | |
| 24. Should people distribute spare organs to those who are the most likely to die without the transplant or to those who have the best chance of living longest after the transplant? | E | | |
| 25. If a student tells a counselor in confidence that he or she is having suicidal thoughts, does the counselor have an obligation to tell anyone else? | E, L | | |
| For questions 26–30, formulate questions that satisfy the type(s) given. | | | |
| 26. Student responses will vary. | L | | |
| 27. Student responses will vary. | E, P, S | | |
| 28. Student responses will vary. | E, S | | |
| 29. Student responses will vary. | S, L | | |
| 30. Student responses will vary. | E, P | | |

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Question Identity Assignment

Directions

Match up the question written with the type of question.
Remember, some questions may be a combination
of more than one type.

Group Name

.....

| Question | Type | Type of Question | Key |
|---|------|---------------------|-----|
| 1. Should you lie to protect the safety of your loved ones? | | Ethical Question | E |
| 2. What is the law concerning abortion in this state? | | Scientific Question | S |
| 3. Is killing always wrong? | | Legal Question | L |
| 4. Does a mutation in a gene alter the structure of the corresponding protein? | | Personal Question | P |
| 5. How do vaccines and antibiotics work? | | | |
| 6. Should people who donate an organ while they are still alive be allowed to choose who receives it? | | | |
| 7. When, if ever, should people insert genes from one species into another? | | | |
| 8. Do you like football or soccer? | | | |
| 9. How should parents discipline their children? | | | |
| 10. Is it fair to require students to wear a school uniform? | | | |
| 11. Is it legal to sell a kidney in the United States? | | | |
| 12. Should genes be patented? | | | |
| 13. Should students be allowed to refuse to recite the Pledge of Allegiance? | | | |
| 14. At what time do you brush your teeth? | | | |
| 15. Whom should you marry? | | | |

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Question Identity Assignment

Continued

| Question | Type | Type of Question | Key |
|---|---------|---------------------|-----|
| 16. Should you use someone else's prescription drugs? | | Ethical Question | E |
| 17. Do you prefer The Beatles or The Rolling Stones? | | Scientific Question | S |
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| 19. Should you credit the person who gave you an idea for which you end up becoming famous? | | Personal Question | P |
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| For questions 26–30, formulate questions that satisfy the type(s) given. | | | |
| 26. | L | | |
| 27. | E, P, S | | |
| 28. | E, S | | |
| 29. | S, L | | |
| 30. | E, P | | |

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Ethical Scenario

Scenario

The world is in the grips of a deadly pandemic of a flu-like virus. It causes respiratory failure and has a 20 percent mortality rate. Millions have died and tens of millions have gotten sick. Worldwide economies are on the verge of collapse. Your community has been adversely affected and the virus has not spared many. A new vaccine has been developed and has proven to be effective in all ages but is in scarce supply. There is enough vaccine to treat half of the residents in your community during the next wave. Those who are not vaccinated and catch the virus have a one in five chance of dying within a few days.

There are ten people who need the vaccine at this time, but there is only enough to vaccinate six people.

Who gets the vaccine?

- A three-year-old child who recently lost both of her parents to the virus
- A nurse who works on treating those sickened with the virus
- A garbage collector
- A mother and son; the mother refuses to take the vaccine if her son cannot also be inoculated (so that would count for two doses)
- Teacher in a middle school that has lost five teachers and seven students to the virus
- Woman who is eight weeks pregnant
- A health aid who works at a nursing home
- The mayor of the community
- Ten-year-old twins (two doses)
- A 75-year-old grandmother who is the primary caregiver to her seven grandchildren

| Who should get the shot? | How did you decide? |
|--------------------------|---------------------|
| | |
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| | |

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Case Study Video Storyboard Capture Sheet

Directions

Use this storyboard to plan your news report on a famous bioethics case.

| | | |
|--------|--------|--------|
| | | |
| Scene: | Scene: | Scene: |

| | | |
|--------|--------|--------|
| | | |
| Scene: | Scene: | Scene: |

Continues next page >

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Case Study Video Storyboard Capture Sheet
Continued

| | | |
|--------|--------|--------|
| | | |
| Scene: | Scene: | Scene: |

| | | |
|--------|--------|--------|
| | | |
| Scene: | Scene: | Scene: |

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Case Study Video Rubric

Group Name _____

| Score | 4 | 3 | 2 | 1 |
|--|---|--|---|--|
| Content and Organization | Case study shows a continuous progression of ideas and tells a complete story that is easy to follow. Well-documented and organized facts and figures. Excellent, well-thought-out explanation shows superior effort. | Case study was fairly well-documented and organized with researched facts and figures. Format is easy to follow. Explanation shows good effort. | Portions of case study may be poorly documented and/or organized with researched facts and figures. Hard to follow the progression of the story. Explanation shows some effort. | Not organized. Has no documented facts and figures. Difficult to follow. Poor quality shows poor effort. |
| Creativity and Elements of Design | Excellent sense of design. Effective camera techniques used for the video and pictures. Video and pictures are focused and of good quality. Smooth transitions are appropriate and aid in delivery of the presentation. | Good use of graphics and/or other design elements. Some transitions are inappropriately placed. Sound quality is acceptable. Video clips or pictures are clear and in focus. | Minimal use of design elements. No transitions. Sound is lacking or inappropriate or scratchy. Some pictures or video clips may be out of focus or "shaky." | Use of elements detracts from video. Too many or too gaudy graphics; too many clips, backgrounds and/or sounds detract from content. Pictures or video clips may be out of focus or "shaky." |
| Mechanics <i>spelling, grammar, sources documented, etc.</i> | Grammar, spelling, punctuation, and capitalization are correct; sources are documented correctly, and copyright law has been followed. | Includes two to three grammatical errors, misspellings, or punctuation errors; sources are documented correctly and copyright law has been followed. | Includes three to four grammatical errors, misspellings, or punctuation errors; some sources are documented, but not correctly. | Includes five or more grammatical errors, misspellings, or punctuation errors; sources are not documented. |
| Final Score | | | | |

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Case Study Video Rubric

Continued

Group Name _____

| Score | 4 | 3 | 2 | 1 |
|---------------|--|--|--|---|
| Collaboration | Effective teamwork. The final product represents something that would have been impossible to accomplish working alone. Students select group members based on good working relationships. All students in the group participate actively 100% of the time. Each student excels in every activity. | Students worked together and were assigned different roles. Students select group members based on good working relationships. All students in the group participate actively 100% of the time. Most students excel in the activities. | Presentation is a result of a group effort, but only some members contributed. Students select group members according to social desires. Some students in the group participate actively. Few students excel in the activities. | Obvious that the presentation was created by one person. Students make poor choices for group members. The group is unable to complete the video in a timely fashion. |
| Final Score | | | | |





Comments:

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Socratic Seminar Preparation Homework

Directions

Read the article [Science and Ethics](#) in preparation for this week's Socratic Seminar. Form an initial impression of the information on your first read-through, using the space on this page to take notes. Then read through a second time to gain a deeper understanding and annotate the text:

| | |
|---|---|
|  | Circle unfamiliar vocabulary and concepts |
|  | Underline key ideas and details |
|  | Place a star in the margin where you have a personal connection or a real-world example |
|  | Place a question mark in the margin where you have a question |

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

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Socratic Seminar Capture Sheet, Part 1

Science and Ethics

Directions

Complete this section individually prior to beginning the Socratic Seminar. Add to this section during your small group discussion.

| | What are some vocabulary words or concepts that you need clarified? | In which paragraph(s) does this appear? | What are some questions you have? |
|---|---|---|-----------------------------------|
| 1 | | | |
| 2 | | | |
| 3 | | | |

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Socratic Seminar Capture Sheet, Part 2

Personal and/or Real-Life Connections

Directions
Complete this section with your small group,
prior to beginning the Socratic Seminar.

| Group Member 1 | Group Member 2 | Group Member 3 |
|----------------|----------------|----------------|
| | | |

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Socratic Seminar Observer Capture Sheet

Directions
Answer the reflective questions during the class Socratic Seminar.

| Question | Notes |
|--|-------|
| How does the seminar leader set the tone? | |
| What do you notice about the participation of group members? Does everyone participate? Is participation balanced? | |
| What do you notice about the interaction among group members? | |
| What kinds of questions are asked? | |
| What do you notice about participants' body language? | |

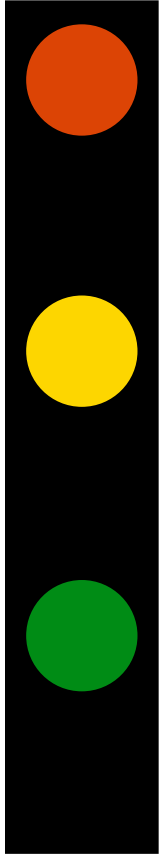
Additional observations or comments:

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Socratic Seminar Reflection

Directions

After your class participates in the Socratic Seminar, reflect using the questions below.



Stop What idea made you stop and think?

Slow Down What idea caused you to slow down in order to research or investigate further?

Go What idea are you going to take with you?

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Socratic Seminar Participation Rubric

Name _____

| Score | 4 | 3 | 2 | 1 |
|-------------------------|--|---|--|---|
| Discussion | Student offers enough solid analysis, without prompting, to move the conversation forward and demonstrates a deep knowledge of the text and the questions. | Student offers solid analysis without prompting and demonstrates a solid knowledge of the text and the questions. | Student offers some analysis, but may need prompting and demonstrates a general knowledge of the text and questions. | Student offers little to no commentary. |
| Preparation | Student is prepared, with completed notes and annotated text; remarks often refer back to specific parts of the text. | Student is prepared, with notes and marked or annotated text; remarks sometimes refer to the text. | Student is prepared, with some notes and marked or annotated text; remarks rarely refer to the text. | Student is missing notes or annotations; there are no remarks that refer to the text. |
| Active Listening | Student consistently demonstrates active listening to other participants or offers clarification and follow-up that extends the conversation. | Student often demonstrates active listening to others or offers clarification and follow-up. | Student sometimes demonstrates active listening to others or offers little clarification to the conversation. | Student rarely or never demonstrates active listening to others. |
| Final Score | | | | |

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Scientific Breakthrough Briefings

Prevention of Protein Aggregation

Overview

Aggregation of misfolded proteins has long been assumed to be involved in neurological diseases, such as Alzheimer's disease, in which these aggregates form the classic plaques and tangles. Scientists are learning that preventing such protein aggregation misfolding generally preserves health.

Directions

1. Study how protein aggregation is related to the biology of aging and neurodegenerative diseases in humans.
2. Determine why organisms lose control over the quality and integrity of proteins as they age, and how the recognition of protein misfolding stress is communicated to other parts of the body.

Links for further information

Top Breakthroughs in Aging Research

Study Sheds Light on Link Between Diseases Like Alzheimer's and Normal Aging in the Brain

Delaying the Aging Process—Andrew Dillin, PhD

Autophagy: Drugging the Yin and Yang of the Cell

Scientist Involved

Notable Breakthroughs

Ana Maria Cuervo, MD, PhD

Dr. Cuervo is a leader in research on protein aggregation and autophagy in cells. She is recognized for studies on autophagy failure and how it contributes to age-related disease and drug development to reinvigorate autophagy in cells.

Andrew Dillin, PhD

Dr. Dillin is exploring heat shock, a major factor in the degradation and unravelling of proteins, and is working to alter this through gene editing by increasing the number of chaperone genes in the cell with the protein, HSF-1.

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Scientific Breakthrough Briefings

Removal of Senescent Cells

Overview

Often called “zombie cells,” these are cells that could once replicate to repair aging tissue but have now lost that capacity due to internal damage. It turns out that they degrade surrounding tissue by secreting harmful molecules. A long-time controversy has been whether senescent cells really had any damaging impact on us. We now know that they do—and why. We also know that accumulated senescent cells can be removed.

Directions

1. Determine the impact that senescent cells have on the human body and aging process.
2. Discover techniques and therapies to remove senescent cells from the body to extend human lifespan.

Links for further information

[*Top Breakthroughs in Aging Research*](#)

[*Overview of Cell Senescence*](#)

[*A New Compound Removes Senescent Cells and Reduces Toxicity in Cancer Treatment*](#)

Scientist Involved

Notable Breakthroughs

Judy Campisi, PhD

Dr. Campisi is a professor of Biogerontology and Director of the Campisi Lab at the Buck Institute for Research on Aging, and Scientific Co-Founder of Unity Biotech and is involved in working toward getting senolytic drugs into clinical trials with specific disease indications, such as osteoarthritis and glaucoma. Dr. Campisi previously co-authored research about how eliminating senescent cells can help obese mice avoid developing diabetes.

James L. Kirkland, MD, PhD

Dr. Kirkland was senior author on a study that found that a combination of the leukemia drug dasatinib and the natural plant pigment quercetin extended not just how long mice live, but also the time they live in good health. The first-ever small pilot trial in humans was completed in early 2019, paving the way for larger trials in the near future.

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Scientific Breakthrough Briefings

Drugs That Extend Life In Mice

Overview

Since aging processes in mice and humans are similar, this suggests that these drugs may be formulated to prevent or alleviate multiple chronic diseases in humans. One of these drugs, rapamycin, has remarkable age-related effects already.

Directions

1. Determine how drugs such as rapamycin, metformin, and elamipretide can delay the onset of aging-related disease in animals such as mice and dogs.
2. Compare the effect of these drugs in animals to potential delay and reversal of diseases such as Alzheimer's, diabetes, and mitochondrial degradation in aging humans.

Links for further information

[Top Breakthroughs in Aging Research](#)

[Drugs extend healthy lifespan in mice](#)

[Dog Aging Project: Home](#)

[Study: Rapamycin prevents age-related brain vascular deterioration](#)

Scientist Involved

Notable Breakthroughs

Daniel Promislow, PhD

Dr. Promislow is leading the Dog Aging Project that is looking to help identify risk factors that influence human life span and the effects of rapamycin to increase life span. Because dogs age significantly more rapidly than humans, data on aging can be generated much more rapidly using a dog model than in human studies.

Peter Rabinovich, MD, PhD

Dr. Rabinovitch discovered that the drug elamipretide may boost the function of mitochondria, because of clear and immediate benefits shown in old mice on heart and muscle, brain and kidney injury, Type II diabetes, glaucoma, and potentially in Alzheimer's disease.

Other Scientists Involved:

Nil Barzili, MD, Matt Kaeberlein, PhD, David J. Marcinek, PhD, David Sinclair, PhD, AO

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Scientific Breakthrough Briefings

Young Blood Has Rejuvenating Properties

Overview

Blood of young animals contains molecules that can actually rejuvenate damaged heart, brain, and muscle in older adult animals. Although the identity of these molecules is still uncertain, researchers are curious to learn if humans have similar molecular rejuvenation patterns, which could help prevent or delay disorders like dementia and heart failure.

Directions

1. Determine which molecules in blood rejuvenate the effects of aging in major organs in animals.
2. Compare the molecular-induced rejuvenation patterns in humans with those in other animals.

Links for further information

Top Breakthroughs in Aging Research
Young Blood and Old Blood
Making old hearts younger—HSCI researchers find protein that reverses some effects of aging in mice

Scientist Involved

Notable Breakthroughs

Thomas Rando, MD, PhD

Dr. Rando was the first to research the role of young blood in reversing aging processes and has explored what is in young blood that has this potential therapeutic benefit. He is also working to understand what is actually changing in the old cells, at a molecular level, that makes them seem younger.

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Final Project Packet: Interactive Job Board

Directions

For the final project of this unit, you are part of a team that has just made a scientific breakthrough in the field of aging and longevity. Your team of scientists is looking to hire people who will help you take your breakthrough through the drug and treatment development pathway so that people may be able to benefit from your discovery and live longer, healthier lives.

In your role as a project manager, biotechnology researcher, biotech recruiter, and design specialist, your team will choose one of the scientific breakthrough briefings that will become the focus of your project. You will conduct research to learn more about your scientific breakthrough, and create a short video that informs the viewer about it. Next, your team will determine the jobs that are needed to move your breakthrough through the development and implementation pathway and create career snapshots that explain the job duties and roles.

Finally, the team will create an interactive job board using the digital presentation platform [Emaze](#) that will include your introductory video, career snapshots, and interactive components that seek to attract diverse members to your team to complete the pathway to the use of your breakthrough as a treatment or drug that works to extend the human lifespan.

Please include the following:

Longevity Scientific Breakthrough Introductory Video

- 1 A definition of the problem that the breakthrough is helping to solve or the goal of the breakthrough.
- 2 A summary of the scientific breakthrough, defining any new medical or biological terminology.
- 3 The incorporation of images or video clips that help to explain your scientific breakthrough.

Career Snapshots

- 1 Brief information about the job duties of the career and interests that a person in the field may have.
- 2 Description of how and where the career fits into the line of research and process of testing and approval for the scientific breakthrough.

Interactive Job Board

- 1 The introductory video your group created for your scientific breakthrough.
- 2 The five or more career snapshots your group created.
- 3 Interactive features to engage the viewer that may include links, video, audio, and social media components.

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Final Project Packet: Division of Labor Chart

Directions

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

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

| Title | Description | Group Member Assigned |
|--------------------------------------|--|-----------------------|
| 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. | |
| Biotechnology Researcher | Responsible for research about the disease with which the patient has been diagnosed, including how it affects 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. | |
| Biotech Recruiter | Is in charge of determining which careers are needed to move the scientific breakthrough along the pathway to becoming an approved treatment or drug for humans. Creates five or more career snapshots (using Google Slides, Canva, or another digital website). Works closely with the biotechnology researcher to ensure an understanding of groups that are disproportionately impacted in the medical research and development field, and determines why to incorporate all groups into potential job recruiting practices. | |
| 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. | |

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Final Project Packet: Division of Labor Chart

Continued

2. 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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Final Project Packet: Planning

Project Component: *Research*

GOAL: *The goal of this portion of the project is to learn about the scientific breakthrough in longevity that your group has chosen and how it furthers the goal of extending the human lifespan.*

Information that should be included in your research:

- 1 Information about the disease, including the disease mechanism, symptoms, causes, and demographics of the disease using data.
- 2 A cost and benefits comparison of traditional treatments to manage symptoms.
- 3 An explanation of the potential drug's target that is related to the disease mechanism.
- 4 Brainstorming about how the drug innovation will work and if it will use nucleic acid or protein modification, isolation, or purification.
- 5 An explanation of how the innovative drug delivery system could work to cure the disease.

Note Use your **Design Journal** and internet research to find information.

Continues next page >

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Final Project Packet: Planning

*Project Component:
Longevity Scientific Breakthrough
Introductory Video*

GOAL: *In this portion of the project, the group will create a short video that introduces their chosen scientific breakthrough to the viewer, explaining how it works to increase the human lifespan.*

The video should:

- 1** Define the problem that the breakthrough is helping to solve or the goal of the breakthrough.
- 2** Summarize the scientific breakthrough, defining any new medical or biological terminology.
- 3** Incorporate images or video clips that help to explain your scientific breakthrough.

Note Examples of similar videos can be found in the Unit **Design Journal**.

Continues next page >

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Final Project Packet: Planning

*Project Component:
Longevity Scientific Breakthrough
Introductory Video*

Continued

Storyboard for Video (planning component)

| | | |
|--------------|----|----|
| | | |
| 1. (Opening) | 2. | 3. |

| | | |
|----|----|--------------|
| | | |
| 4. | 5. | 6. (Closing) |

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Final Project Packet: Planning

Project Component: Career Snapshots

GOAL: *In this portion of the project, the biotech recruiter will research careers necessary for the development and approval of treatments that will extend the human lifespan. Each biotech recruiter will use an online platform to create five or more career profiles that provide information about the duties and expectations of each career to attract employees to the team.*

Content that should be included:

- 1 Brief overview of the job duties of the career and interests that a person in the field may have.
- 2 How and where the career fits into the line of research and process of testing and approval for the scientific breakthrough.

Note Use the following article to help get you started when thinking about important careers in the drug or treatment development pathway:

[Making the Leap: When, How, and Why a Career in Drug Discovery May Be Right for You](#)

Note Examples of career snapshot infographics can be found in the Unit **Design Journal**.

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Final Project Packet: Planning

*Project Component:
Interactive Job Board*

GOAL: *This portion of the project will allow the team to present information about their scientific breakthrough in longevity and attract new team members by presenting the careers needed to move the innovation through the research and development phases so that they can be ready for human use.*

Content that should be included:

- 1 The introductory video your group created for your scientific breakthrough
- 2 The five or more career snapshots your group created
Interactive features to engage the viewer that may include links, video, audio, and social media components

Note Begin by choosing the template that your group feels will work best for your interactive job board.

Note Tutorials for creating presentations on [Emaze](#) can be found in the Unit **Design Journal**.

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