FUTURELAB+

BIOMED

Behind the Scenes of Scientific Breakthroughs

Unit Overview

Developed in partnership with:

Discovery Education and Ignited

BIOMED / BEHIND THE SCENES OF SCIENTIFIC BREAKTHROUGHS

Unit Overview

FINAL PROJECT PRODUCT

Scientific Breakthrough in Longevity
Interactive Job Board

OVERVIEW

In this unit, students will explore the idea of increasing the human life span. They will take various scientists' roles and learn more about aging cells, genetic sequencing, bioengineering, stem cells, and senolytics. Students will work together to create an interactive job board seeking additional members for a team of scientists that have made a scientific breakthrough in the area of aging and longevity. They will choose one scientific breakthrough briefing as the focus of their research and determine the careers needed to help them move forward to develop and implement a specific drug, treatment, or therapy that could extend or improve the human life span. The job board will include a short video introducing their research and breakthroughs, and provide career profiles for the positions they wish to add to the team to reach their research and human health goals.

STUDENT-FACING UNIT TASK

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 along the drug and treatment development pathway so that people can benefit from your discovery and live longer and healthier lives. In your role as project manager, biotechnology researcher, biotech recruiter, and design specialist, your team will choose one of the scientific breakthroughs in longevity briefings to be the focus of your project. You will conduct research to learn more about your scientific breakthrough and create a short informational video about it. Next, your team will determine the positions that are needed to move your breakthrough along the development and implementation pathway and create career snapshots explaining the job duties and roles. Finally, the team will create an interactive job board using the digital presentation platform Emaze (*www.emaze.com*) that will include your introductory video, job snapshots, and interactive components that seek to attract diverse members to your team to complete the pathway to the use of your breakthrough to extend the human life span.

Lesson 1: Cellular Aging

DRIVING QUESTION

Can science increase the longevity of a cell?

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify the important characteristics that determine whether a cell has aged. **Describe** the process of cell autophagy. **Outline** regions of DNA and their roles. **Describe** the significance of a chromosome's telomere. **Gather** information from online research sources. **Understand** the current research on cellular aging. **CTE:** A3.1, A5.1, A5.2	Students will be introduced to careers in the fields of **biomedical research** and **bioinformatics.** Students will take on the role of collaborative biomedical researchers and share their research with possible stakeholders. They will also discover how this role connects to the **commercialization** phase of the product life cycle.	Colored pencils Construction paper Henrietta Lacks Video Capture Sheet Hallmarks of Cellular Aging presentation Hallmarks of Cellular Aging Rubric Autophagy WebQuest Capture Sheet Biomedical Research Conference Diseases and Lifestyle factors of Cellular Aging Internal and External Changes in Cellular Aging Capture Sheet Glue or tape Ruler Scissors Design journal	In this lesson, students will learn about the hallmarks of cellular aging through a WebQuest and the reading of articles from scientific journals. Students will play the role of biomedical researcher and bioinformatician. They will utilize their knowledge to produce an artifact depicting the internal and external changes of cells as they age.	For students to be able to devise techniques that could prolong life, they need to have an understanding of the mechanisms that cause cellular aging. The identification of cell biomarkers involved in cellular aging is important, as these biomarkers could be used as targets of therapy.

Lesson 2: Genetic Sequencing

DRIVING QUESTION

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

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Navigate the National Center for Biological Information (NCBI) website and Basic Local Alignment Search Tool (BLAST) program. **Identify** human disease genes and **determine** chromosomal locations using a BLAST search. **Describe** how genomic sequencing has changed over the years since the human genome project. **Identify** social justice issues of genome sequencing that may affect the general population. **Identify** cancer health disparities in the United States. **Create** a public service announcement video to inform certain races or ethnicities about a type of cancer that affects their demographic more than it affects others. **Describe** environmental and genetic factors that increase longevity. **Synthesize** current research to determine the ownership of DNA. **Construct** an evidence-based argument considering the views of multiple stakeholders. **CTE:** A2.4, A3.1, A5.1, A5.2	Students will be introduced to careers in the fields of **genetics, genetic counseling,** and **bioethics.** This lesson connects to the **discovery** phase of the product life cycle as students identify the implications on therapeutics and drug availability, when diverse genetic data is limited.	Sequencing Human DNA Cancer Health Disparities Cancer PSA Longevity Genes The Ownership of DNA Glue or tape Poster board Sticky notes Design journal	In this lesson, students will review a timeline on the various techniques that have been utilized to sequence a genome. They will also get insight into the health disparities of genomic sequencing. Students will learn how companies are utilizing genomic sequencing data. The perspectives of different stakeholders will be explored in a discussion of ownership of DNA.	Information learned from sequencing a human genome can be utilized in a variety of ways. Research in this field can improve disease prognoses by identifying possible drug targets. Additionally, continued advances in genomic sequencing can allow for more insight into the genes that seem to play a role in longevity among individuals living the longest and who are exceptionally healthy as they age.

Lesson 3: The Human Genome Project

DRIVING QUESTION

Will a better understanding of the human genome structure help us increase life span or even live forever?

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Investigate the DNA sequencing technique and its industrial applications. **Examine** the difference between the genome and the proteome. **Recognize** the steps leading to the synthesis of proteins. **Study** factors that link genes to longevity. **CTE:** A3.1	Students will be introduced to the careers of **bioinformatician** and **geneticist.** The lesson addresses **all** the components of the **Product Life Cycle**, from DNA sequencing to the different applications involving the proteome and artificial intelligence. This will give students the skills required to understand how biological structures can be manipulated and engineered to fulfill the goal of extending the human life span and allow them to take part in one of the most industrially active quests by creating a method to slow aging.	Ping pong balls Large clear trash bag Plastic wrap Hot glue or super glue Scissors Tape Artificial intelligence Rubric Guide to Popplet interview Guide to Popplet Interview Rubric Our Genes, Our Value! Protein-Making Project Guide References Word cloud Design journal	In this lesson, students will learn how DNA sequencing works. They will learn about the genome and the proteome and understand the impact on the protein function of modifying the DNA sequence. Students will summarize their learning by creating a miniature biotechnology unit for a middle school science class.	Progress in technologies has helped extend the human life span. Scientists have discovered that only 2 percent of the genome leads to the production of proteins. What does the other 98 percent do? Scientists have discovered that these segments of DNA could be involved in the regulation of proteins. Could this be the secret of longevity? Students will explore DNA through sequencing of the genome and links to its proteome.

Lesson 4: Can an Organism Have No Parents?

DRIVING QUESTION

Could we start synthesizing better versions of genes and should we?

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify methods for artificial DNA synthesis. **Apply** knowledge of DNA replication to artificial DNA synthesis. **Examine** ethical questions arising from synthetic biology. **Develop** a model showing the creation of a new organism with a synthetic genome. **CTE:** 4.3, 5.4, 5.6, A2.6, A5.1	Students will be introduced to the careers of a **synthetic genomic researcher** and **computational biologist.** This lesson addresses the **development** aspect of the product life cycle. It focuses on how to synthesize DNA and the methods involved.	DNA Synthesis—Mission Not Impossible! Three Truths and a Lie What are the Boundaries of Synthetic Biology? Computational Synthetic Biology Video Sequencing Synthetic Organism Poster Rubric Sticky notes (different colors) Design journal	In this lesson, students will understand the difference between DNA replication within the cell and DNA synthesized artificially. They will explore the new technologies capable of producing millions of DNA copies per minute, and weigh the limitations and ethical questions arising from altering, modifying, and using genetic material. The week will conclude with students building a model of artificially synthesized DNA. They will discuss potential ethical concerns encountered and present the model to the class.	In the past, cells and organisms were thought to be derived from parent cells or to serve as templates for new cells to be created. However, recent findings show that scientists are now able to synthesize DNA entirely, independently, and without a support template. This could lead the way to important applications, including the possibility to cure inherited diseases.

Lesson 5: Bioengineering of Organisms

DRIVING QUESTION

How are GMOs affecting society and evolution?

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify applications of bioengineering. **Apply** DNA editing to health issues. **Examine** regulations and precautions linked to DNA editing. **Understand** markers involved in aging-isolation techniques. **Outline** the laboratory equipment needed to purify proteins. **List** the tags used in protein purification. **Investigate** current examples of proteins that are used in humans and isolated from nonhuman sources. **CTE:** A1.3, A5.2	Students will be introduced to careers in the fields of **artificial intelligence engineering** and **biomedical engineering.** The lesson addresses the **discovery** phase of the product life cycle, as students learn about the important steps in the production of bioengineered organisms.	Gene Modification DNA Editing Rubric How to Slow Aging! Increase Life Expectancy Poster Rubric Design journal	In this lesson, students will review the techniques used to create bioengineered organisms and genetic modifications. They will understand the ways viable animal products can be used to deliver drugs. They will study the limits and ethical restrictions associated with manipulating and altering human DNA.	DNA has long been the subject of changes and modifications. However, scientists are now able to alter DNA molecules to remove segments not relevant to the project, or that cause a health problem, and replace them with segments required to achieve their goal. Applications include agriculture, pharmaceuticals, and health.

Lesson 6: Bioengineering of Plants

DRIVING QUESTION

How are genetically modified plants (GMO) made and used?

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Investigate different means of modifying plants. **Analyze** data on GMO usage trends in the United States. **Explore** a variety of ways GMO plants can improve health. **Debate** statements regarding golden rice. **CTE:** 4.3, A1.4, A5.1, A5.2, A6.4	Students will learn about careers in **plant biology** and **bioethics.** This lesson focuses on the **discover, develop,** and **commercialize** phases of the product life cycle. Students will learn the techniques scientists use to modify plants in the lab and information on developing technologies in various levels of testing. They will also explore domestic and international regulation policy related to these products, safety testing over the years, and local and global debates, ranging from human health and economic benefits to health concerns and impacts on ethnic and cultural traditions.	GMO Plan Rubric GMO WebQuest GMO WebQuest Rubric United States vs Europe GMO graphic organizer GMO Data Analysis Rubric GMO Safety Article response GMO Safety Article Response Rubric How Do GMOs Improve Health? Poster Rubric GMO Trading Card Rubric Golden Rice Anticipation Guide Golden Rice journal response Golden Rice Journal Response Rubric Statement reflection Debate Rubric Sticky notes Trading card templates (printed) Design journal	This lesson will introduce students to genetically modified plants and how they may be used to boost human health and potentially increase the human life span. Students will work to present both the facts and the controversy around their usage. The class will begin by exploring the differences between GMO products and traditional crossbreeding. They will then investigate GMO health testing. They will analyze data on the usage of different GMO crops in the United States and present on potential health advantages. The lesson will conclude with a class debate on the topic of golden rice.	Genetically modified plants have the potential to improve the health of many, especially those in areas that suffer from food scarcity or whose diets lack specific nutrients. When we look at improving health, the food we eat is one of the first things to be considered. If we want to extend the human life span—and, perhaps more importantly, to improve the quality of life during those years—we need to explore the options available to us through our diet. Better diet and improved nutrition are two important considerations that could potentially be more easily managed through the cultivation and distribution of GMO crops.

Lesson 7: Therapeutic Cloning and Embryonic Stem Cells

DRIVING QUESTION

How can the use of therapeutic cloning and embryonic stem cells improve human health?

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Investigate potential applications of cloning. **Differentiate** varieties of stem cells. **Compare** reproductive and therapeutic cloning. **Explore** different applications of tissue regeneration. **Create** a presentation on the ethical considerations regarding cloning. **CTE:** A5.1, A5.2	Students will learn about the career of **developmental and molecular biologist.** This lesson focuses on the **discovery** and **development** phases of the product life cycle of medicine. Students will learn about the variety of stem cells available for research and their benefits and limitations. They will also learn about research applications for cloning and health-care applications for these therapies currently in development or in clinical testing.	Crayons or colored pencils Cloning Walk Around Survey Cloning One-Pager Rubric History of Cloning Rubric Stem Cell Scenario Capture Sheet Reproductive Cloning vs Therapeutic Cloning Rubric Lab Grown Organoids Capture Sheet Ethics of Cloning Presentation Rubric Design journal	Students will begin this lesson by being introduced to the uses of cloning. They will then learn about the different types of stem cells and their potential applications. The class will explore problems with reproductive cloning, engage in a cloning interactive, explore therapeutic cloning as a means of producing tissue and organs, and create a presentation on the ethics of cloning.	The use of cloning and stem cell therapies offers potential treatments and cures to individuals suffering from many previously untreatable illnesses and injuries. When we look at extending the human life span and improving quality of life, we must consider emerging technologies, especially those with as much potential as cloning and stem cell therapies. Developing these therapies has been hindered by the expansive ethical considerations intricately tied to this research. However, with the development of induced pluripotent stem cells and through cloning techniques, these developments may move to the forefront of reproductive and reconstructive treatments.

Lab: Longevity Markers: How Are You So Old?

DRIVING QUESTION

How can we detect unique genome features of humans who live the longest?

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Extract DNA from their cheek cells, **visualize** the DNA using agarose gel electrophoresis, and **analyze** a sample DNA sequence with BLAST using protocols. **Describe** how gel electrophoresis separates molecules based on size and charge using scientific text. **Describe**, using scientific text, the factors that affect longevity, including particular genetic variations (single nucleotide polymorphisms, or SNPs) and the methods used to study these genes. **Determine** if there is an association between the SNP rs2802288 and longevity and support the claim with evidence using genotype data. **CTE:** A3.3, A8.1, A8.6, A8.7	In this lab, students will play the role of **geneticist** and **bioinformatician.** When developing new techniques and treatments for aging-related illness or to increase life span, an important step is to understand what is unique about the genomes of humans who live the longest, which genetic markers are associated with longevity, and the mechanism by which they act.	Preparing the Classroom for the Lab **(for teacher)** Sample Permission Slip for Student DNA Extraction **(for teacher to customize)** Building Lab Skills: Agarose Gel Electrophoresis **(one per student)** Background reading: Genetic Markers of Longevity **(one per student)** Phenomenon charts **(one per group)** GWAS results **(one per group)** Vocabulary tool **(one per student)** Student Protocol—Part 1: DNA Extraction **(one per pair)** Student Protocol—Part 2: Agarose Gel Electrophoresis **(one per pair)** Student Protocol—Part 3: DNA Sequence Analysis with BLAST **(one per pair)** Student Guide **(one per student)** Alternative Student Protocol—Part 1: Strawberry DNA Extraction **(optional)** ** See Unit 4 lab document for a full list of the reagents, equipment, and consumables for the Part 1: DNA Extraction and Part 2: Agarose Gel Electrophoresis labs.*	In this lab, students will model the steps that may be conducted in a genome-wide association study (GWAS) study of longevity. First, students will have the opportunity to perform a DNA extraction from their own cheek cells (or from strawberries) and use gel electrophoresis to verify that they successfully isolated DNA. Next, they will send their DNA off to be sequenced and receive a string of nucleotides around the SNP rs2802288. Using BLAST, they will then be able to determine what gene this SNP is a part of. Finally, they will analyze genotype data from a mock GWAS of 100 individuals and determine if the data suggests there is an association between rs2802288 and longevity.	In the quest to understand the many factors that influence aging and life span, it is important to include a discussion of genetic factors. The study of longevity genes is a developing science that has many implications for how we treat and prevent age-related diseases and improve the quality of life for an aging population. This subject is also of great interest to researchers and individuals who are attempting to manipulate and increase the human life span.

Lesson 8: Senolytics: Our War Against Aging!

DRIVING QUESTION

How can we improve the quality of life for the aging population?

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Discuss the process of cell senescence in the body. **Discuss** why removing senescent cells would benefit an organism. **Define** senolytic drugs as those that use small molecules to target and remove these cells from the body. **Summarize** the potential benefits of senolytics. **CTE:** A3.1, A4.1, A5.1	Students will learn about the careers of **pharmacokinetic scientist, biomedical researcher,** and **molecular biologist.** During days one and two, students will discuss the **discovery** phase of the product cycle of medicine. Through research, students will discover information that could be used as possible biomarkers or drug targets. On day 5, students will create an infographic to introduce a new commercial drug, highlighting the **commercialization** phase of the product life cycle of medicine.	Copies of journal article, "Can Destroying Senescent Cells Treat Age-Related Disease?" Causes of Senescence Museum of Senescence Senescent Cell Removal Signs of Cellular Senescence Senolytics infographic Ruler Scissors Glue or tape Colored pencils Cardboard boxes Tape Scissors Aluminum foil Cotton swabs or cotton balls Foam cups and plates Beads Pipe cleaners Modeling clay	In this lesson, students will review the most recent evidence on senescent cells. They will build models of the causes of senescence. Finally, they will summarize information to describe the potential benefits of senolytics.	Identifying how cell senescence works is essential to ensuring proper drug targets and understanding how cells age. Removing senescent cells has been shown in lab animals to extend life span and may soon be adapted to allow humans to live longer.

Lesson 9: Ethical Considerations and Longevity

DRIVING QUESTION

How does the study of bioethics contribute to the advancement of bio-medical research and practices?

Student Objectives	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
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 use and misuse of genetic information and the impact of DNA technologies. **CTE:** A2.1, A5.1, A5.2	Students will learn about the career of **bioethicist.** This lesson connects to all stages of the product life cycle—**discover, develop, manufacture,** and **commercialize**—by assessing the ethical dilemmas of vaccinations and the use of euthanasia drugs, making ethical decisions about vaccine distribution during a deadly pandemic, and learning about unethical testing of medicine by a pharmaceutical company.	Bioethics Group Debate Instructions Bioethics Group Debate Rubric Case Study Video Storyboard Case Study Video Rubric Computers with internet access Ethical Scenario Question Identity assignment Writing utensils Design journal	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 and debate bioethics topics.	Manipulating and increasing the human life span is an important but controversial topic. Humankind's quest to extend life has inspired numerous 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 ensure ethical pursuit of advancing technical capabilities.

Career and Technical Education (CTE) Standards

Anchor Standards

4.0 Technology

Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Health Science and Medical Technology sector workplace environment. (Direct alignment with Writing Standards WS 11–12.6)

4.3
Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources.

5.0 Problem Solving and Critical Thinking

Conduct short, as well as more sustained, research to create alternative solutions to answer a question or solve a problem unique to the Health Science and Medical Technology sector using critical and creative thinking, logical reasoning, analysis, inquiry, and problem-solving techniques. (Direct alignment with WS 11-12.7)

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.

Health Science and Medical Technology Standards

A1.0

Define and assess biotechnology and recognize the diverse applications and impact on society.

A1.3
Recognize the role of innovation in the creation of emerging biotechnology careers, including those in nanotechnology, biofuels, and forensics.

A1.4
Research and identify public misunderstandings related to biotechnology and discern the source of these misunderstandings.

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Career and Technical Education (CTE) Standards

Health Science and Medical Technology Standards

Continued

A2.0
Understand the ethical, moral, legal, and cultural issues related to the use of biotechnology research and product development.

A2.1
Know the relationship between morality and ethics in the development of biotechnology health care products.

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

A2.6
Prepare a presentation comparing the benefits and harm that can be the result of biotechnology innovations in both the research and application phases and which course of action will result in the best outcomes.

A3.0
Demonstrate competencies in the fundamentals of molecular cell biology, including deoxyribonucleic acid (DNA) and proteins and standard techniques for their purification and manipulation.

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

A3.3
Employ standard techniques of DNA extraction, purification, restriction digests, bacterial cell culture, and agarose gel electrophoresis, and document and evaluate results.

A4.0
Recognize basic concepts in cell biology and become familiar with the laboratory tools used for their analysis.

A4.1
Use electronic reference materials to gather information and produce products and services.

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Career and Technical Education (CTE) Standards

Health Science and Medical Technology Standards

Continued

A5.0
Integrate computer skills into program components.

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.

A6.0
Implement use of the metric system, orders of magnitude, and the pH scale in preparation of reagents, analysis of data, and graphing.

A6.4
Create data tables and graphs using Excel for the purpose of collecting and analyzing data.

A8.0
Follow sustainable and safe practices with high regard for quality control.

A8.1
Follow written protocols and oral directions to perform a variety of laboratory and technical tasks.

A8.6
Properly and safely use and monitor a variety of scientific equipment, including pH meters, microscopes, spectrophotometers, pipets, micropipettes, and balances.

A8.7
Determine which equipment is appropriate to use for a given task and the units of measurement used.

Third Party Evaluator Evidence/Findings

Completed by: American Institutes for Research

Sponsored by Genentech, Futurelab+ brings together a coalition of partners to develop an innovative, modular, two-year biotechnology curriculum, including instructional materials, to expose students and educators to the breadth of education and career pathways across biotechnology. To increase adoption and access to such curricula in California and beyond, the modular curriculum was designed to align with the *California Career Technical Education (CTE) Model Curriculum Standards for Biotechnology*, meet at least one year of the *University of California science (D) subject requirement*, and incorporate some of the three-dimensional learning innovations of the *Next Generation Science Standards* (NGSS).

The two-year biotechnology curriculum provides four core units per year; each core unit has nine lessons and a lab that each take approximately one week to complete, or 9–10 weeks for the full unit. In total, the biotechnology curriculum has 72 lessons and eight labs that span two full instructional years. Because the Futurelab+ biotechnology curriculum is modular, teachers can select specific units and materials to design biotechnology courses that are relevant and appropriate for their students and teaching environment.

Unit 4: Behind the Scenes of Scientific Breakthroughs

Version Reviewed/Date: March 24, 2022

California (CTE) Model Curriculum Standards for Biotechnology

Full Report

[Futurelab+... priority to meet California CTE Biotech Standards...] Evidence of which California CTE Biotechnology standards are addressed within the curriculum and where they are addressed is included in the *full report*.

University of California Science (D)

Full Report

Because teachers and schools can choose which portions of the curriculum to include in their final course designs, this *report series* provides evidence of where each unit meets specific criteria for the UC science (D) subject requirement and, when incorporated into a full year-long course, where the curriculum could meet at least one year of the UC science (D) subject requirement, contingent upon review and approval by UC. Subsequently, the evidence provided within the report can be used by teachers for submitting Futurelab+ course materials for UC science (D) subject approval.

The purpose of this report is to provide evidence for alignment of Unit 4 of the Futurelab+ Biotechnology Curriculum with the UC science (D) subject requirement. To help educators submit their final courses for UC science (D) subject review, the American Institutes for Research (AIR) also provides a sample unit and lab summaries, which follow the guidelines for writing a UC science (D) course (March 17, 2021).

Specifically, AIR reviewed each unit for evidence of the extent to which they meet the eight Course Content Guidelines for the UC science (D) subject requirement. This report provides specific examples to demonstrate where and how materials satisfy these criteria. Based on our review, we believe there is a strong body of evidence that will translate to Unit 4 meeting the UC science (D) subject matter requirement.

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Third Party Evaluator Evidence/Findings

Continued

Next Generation Science Standards (NGSS)

Full Report

As an organizational partner, the American Institutes for Research (AIR) provided external feedback on alignment to the three sets of standards to Futurelab+ curriculum developers during the formative period of the biotechnology curriculum. AIR is now providing external feedback and evidence on the final curriculum's alignment to each set of standards: CTE, UC science (D) subject requirement, and NGSS in a series of three reports. The eight reports in the NGSS series provide feedback on aspects of NGSS in a sample of the curriculum (one lesson from each unit). AIR randomly selected Lesson 1 (Cellular Aging) from Unit 4 (Behind the Scenes of Scientific Breakthroughs) for this report.

Of note, because the primary design element of the curriculum was alignment to CTE, AIR used the NGSS Lesson Screener (not the Educators Evaluating the Quality of Instructional Products [EQuIP] Rubric) to identify aspects of the curriculum that incorporate NGSS. The EQuIP Rubric is typically used to determine whether a unit was designed for the NGSS. Because the curriculum was designed to align primarily to CTE standards, it was not expected that the curriculum would meet all NGSS criteria. Nevertheless, in their current form, the materials from Unit 4, Lesson 1, meet three NGSS criteria and are approaching the remaining three NGSS criteria. AIR created the approaching rating to indicate where a modification to materials would increase the rating to adequate. For more information, please see the *full report*.