FUTURELAB+

BIOMED

Crowdsourcing Innovations in Biotechnology

Unit Overview

Developed in partnership with:

Discovery Education and Ignited

BIOMED / CROWDSOURCING INNOVATIONS IN BIOTECHNOLOGY

Unit Overview

FINAL PROJECT PRODUCT

Mock Wearable Tech Innovation Project

OVERVIEW

In this unit, students will discover what biomarkers are and how they can be important indicators of a person's health. They will learn how cells divide, and that errors in the process can provide clues about cellular damage linked to both infectious and chronic diseases. They will also look at how growing and studying cell lines in a laboratory can give important information about cellular mutations and processes, yet bring up bioethical questions that must be answered. Students will look at the field of bioinformatics, and analyze data to help determine how biomarkers can be used to help diagnose disease and how wearable technology can provide early detection or help patients diagnosed with infectious or chronic disease by giving real-time biomarker information to the wearer. For their final project for Unit 1, students will learn how crowdsourcing can be a valuable tool to help solve local and global problems. They will explore the connection between biomarkers and wearable technology. Finally, students will be introduced to mock innovation challenges that they will need to solve by creating a prototype model of a wearable tech product designed to track important biomarkers for the disease. They will create a video presentation that shows how their wearable technology will help the patient, using biomarkers as indicators of health.

STUDENT-FACING UNIT TASK

You are part of a team tasked with solving a crowdsourcing innovation challenge. The crowdsourcing platform is looking for new and innovative wearable technology that will help discover or monitor biomarkers of health-related issues, such as heart disease, diabetes, cancer, and infectious diseases. In this way, the technology will help patients manage or prevent disease. In your role as a project manager, researcher, designer, or sales and marketing specialist, you will work with your team to research information about the disease your challenge addresses and the biomarkers that can relay important information about the disease. The team will create a prototype model of a wearable technology product that is designed to track important biomarkers for the disease on which your challenge focuses. Finally, you will create and upload a video presentation about the wearable technology product to the mock innovation challenge platform. The video should explain the importance of wearable technology, model its use, and show how those at risk for or diagnosed with the disease, or their physicians, could use the information collected to monitor health.

Lesson 1: Cell Biology and Biomarkers

DRIVING QUESTION

How are cells a source of biomarker data?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify the difference between "prokaryotic" and "eukaryotic" cells. **Describe** the structure and function of cellular organelles. **Define** "biomarker" and **explain** how scientists use biomarkers in drug discovery. **CTE:** A4.1, A5.1	Students will be introduced to careers in the fields of **academic research** and **bioelectronic engineering**. Students will explore the **discovery** phase of the product life cycle, in which new product ideas are researched.	What are Biomarkers? Biomarker Rundown Capture Sheet Cell Type graphic organizer Paper Slide Video Rubric Markers, colored pencils, or crayons Blank paper Crowdsourcing for Science Jigsaw KWL—Is Stress Something to Stress About? Innovation Challenges Design journal	In this lesson, students will identify different cellular organelles and describe their structure and function in a cell. This includes a discussion on the two basic cell types: prokaryotic and eukaryotic. Students will also define "biomarker" and explain how scientists use biomarkers in drug discovery. As a kickoff to their unit project, students will learn how crowdsourcing can be a valuable tool to help solve local and global problems. They will explore the connection between biomarkers and wearable technology. Finally, students will be introduced to mock innovation challenges that they will be asked to solve by the end of the unit.	This lesson will assist students with defining "wearable device" or using available data to prevent and/or help treat diseases. Students will be introduced to the mock innovation challenge, in which they will create a wearable device that will help diagnose, monitor, or treat a patient. Students will be asked to consider how their device will help solve problems around access and/or health disparities in their community.

Lesson 2: Mitosis and Meiosis

DRIVING QUESTION

What do biomarkers look for to identify diseases?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Distinguish between "mitosis" and "meiosis." **Develop** a claim with supporting evidence, including the different types of cellular biomarkers. **Describe** the significance of cell cycle regulation with regard to cancer. **CTE:** A4.4, A5.1	Students will be introduced to careers in the fields of **genetic counseling** and **academic research**. Students will learn about the **discovery** and **development** phases of the product life cycle.	*"How a Vitamin D Test Misdiagnosed African-Americans"* Chart paper Cell Division Video Capture Sheet Mitosis Lab Meiosis notes organizer Mitosis and Meiosis Similarities and Differences Design journal	In this lesson, students will investigate how cells grow and reproduce through the processes of mitosis and meiosis. This will assist with the understanding of the cell components necessary for an organism to function and the identification of cellular biomarkers. Students will also learn how cellular biomarkers, such as abnormalities in cell division, can be important indicators of diseases such as cancer.	By the end of this lesson, students will have identified at least two different biomarkers of a specific disease. Ultimately, this will assist them with envisioning a wearable device or using available data to prevent and/or help treat diseases.

Lesson 3: Errors in Cell Replication

DRIVING QUESTION

How does a cell normally check for and address abnormalities?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Recognize various types of mutations and their effects. **Relate** the role of mutations to the development of genetic disorders. **Describe** some benefits of genetic variation and relate them to human evolution. **Develop** a chart summarizing the different classes of mutations and the diseases that may result from them. **CTE:** 4.3, 5.4, 5.6, A4.4, A5.1, A6.1	Students will be introduced to careers in the field of **genetic counseling**. Students will learn that gene editing technology is in the **manufacturing** phase of the product life cycle, where it is being used in treatments like the Covid-19 vaccines.	Mutations K-W-L Chart Mutation Type Effects Difference vs. Disease Capture Sheet Cell Cycle and Cancer Lab Find the Cancer Capture Sheet Microscopes Microscope Slides of healthy and diseased tissues Marfan Syndrome Pedigree Medical Specialty Report Form Diagnosis of Richard's Disorder Design journal	In this lesson, students will investigate the classes and types of mutations and how these have a wide range of effects on an organism. Students will also learn how manipulating a strand of DNA can cause variations in the corresponding mRNA chains and amino acid sequences. Finally, they will learn how geneticists use math to calculate mutation frequency to better understand the disorders they cause.	Students will discover that genetic diseases are often the result of errors in cell replication and that wearable technology can collect information via digital biomarkers that act as indicators for the presence and/or severity of potential genetic diseases. As a result, wearable technology can be crucial in helping diagnose, manage, and treat these diseases.

Lesson 4: Cell Damage

DRIVING QUESTION

How do changes at the cellular level lead to systemic disease?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Explain how a disease can cause or be caused by cellular dysfunction. **Identify** changes at the cellular and tissue level that are indicative of disease. **Present** a report detailing the differences in biomarkers between healthy and unhealthy tissue. **CTE:** A5.2	Students will be introduced to the **medical science liaison** and **histology technician** career fields. Students will learn that breakthroughs in histology, which are relatively new but promising, exist between the **discovery** and **development** phases of the product life cycle.	Computers with internet access Cellular Hierarchy Capture Sheet Cellular Hierarchy Rubric Prediction Exit Ticket Sickle Cell Rubrics Multiple Sclerosis Guided Research Multiple Sclerosis Device Rubric Healthy Lifestyles Capture Sheet Healthy Lifestyle PSA Rubrics Presentation responses Investigating Biomarkers Capture Sheet Investigating Biomarkers Rubric Design journal	In this lesson, students will examine how changes at the cellular level can produce systemic disease. They will investigate lifestyle choices that lead to cellular damage and potential illness. Finally, students will create an investigation comparing biomarkers in healthy and diseased tissue.	This unit connects to the previous study on the role of altered or diminished cellular function in disease. By learning about the cellular basis of a disease, students will begin to grasp how illness starts at the minuscule level to affect tissue and organ function, ultimately altering healthy biomarkers. This unit gives students a broad basis for understanding pathophysiology, which will be expanded on in the following lessons as they progress to developing their novel wearable technology device.

Lesson 5: Culturing Cells

DRIVING QUESTION

What is the role of cell culturing in the lab?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Construct a comparison of primary cells and cell lines. **Distinguish** between scenarios requiring primary cells and those requiring cell lines. **Examine** ethical considerations when working with human tissue. **Create** engaging and thoughtful interview questions for a cell culture technician or cell biologist. **CTE:** 8.4, A4.2, A7.4, A7.6	Students will be introduced to the careers of **cell culture technician** and **biomanufacturing technician**. This lesson connects to the **discovery** phase of the product life cycle as the mass culturing of cells is often conducted in the early phases of research and product development.	Primary Cells vs. Cell Lines Cell Scenarios Capture Sheet Bioethical Response Bioethical Response Rubric Cell Culture and Henrietta Lacks Cell Culture Technician WebQuest Stem Cell Donation Poster Rubric Interview with a cell culture technician Design journal	In this lesson, students will explore the role of cell culture technicians in the greater functioning of the lab. They will compare and contrast the different types of cells available for research, investigate ethical dilemmas present when working with human specimens, and ultimately create an informed interview based on their newly acquired knowledge.	At the end of the lesson, students will better understand the nature of cellular research. They will demonstrate this knowledge by constructing thoughtful and informed interview questions which will be presented to a real cell culture technician and/or cell biologist.

Lesson 6: Infectious Diseases

DRIVING QUESTION

How does the body know the difference between an infectious disease and a chronic disease?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify the cause of infectious diseases and list examples. **Identify** the causes of chronic diseases and list examples. **Differentiate** between infectious and chronic diseases, including identification of related biomarkers. **Apply** knowledge of the differences between infectious and chronic diseases to determine the cause of illness. **CTE:** A5.2	Students will learn about the careers in **epidemiology, biological and medical informatics,** and **science communications**. This lesson focuses on the **discovery** phase as students identify biomarkers of infectious and chronic diseases. The **commercialization** of the product is also included in the product life cycle.	Chart paper Computers with internet access Fight Germs: Wash Your Hands video questions Learn An Infectious Disease Capture Sheet Case Study Library Infectious disease infographic assignment Infographic Rubric Markers Rulers Design journal	In this lesson, students will play the role of an infectious disease scientist and create an infographic showing information about a new imaginary infectious disease. Students will be assessed on whether the information in their infographic is relevant to health-care workers' needs.	A biomarker can be used to determine the health of an individual. If proper biomarkers can be established, a wearable device might be able to tell what type of illness one has.

Lesson 7: Chronic Diseases

DRIVING QUESTION

How do chronic diseases differ from infectious diseases?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify and **describe** various chronic diseases. **Assess** the impact of chronic diseases on human populations. **Recommend** preventive measures for risk factors of chronic diseases. **Describe**, **produce**, and **film** a video on cell biomarkers for chronic diseases. **CTE:** 4.1, 4.3, A5.1, A5.2	Students will learn about careers in the field of **chronic disease epidemiology**. This lesson focuses on the **discovery** aspect of the product life cycle as students investigate biomarkers and the geographical prevalence of chronic diseases.	Chronic Disease Poster Presentation Rubric Preventative Program Proposal Grading Rubric PLACES database assignment Slideshow Project Grading Rubric Communicable and Non-communicable Diseases Venn diagram Computers with internet access Grading rubric for poster project Markers Notecards Poster board Writing tools	In this lesson, students will identify and describe various chronic diseases and assess the impact of chronic diseases on human populations. They will then recommend preventive measures for risk factors of chronic diseases.	Wearable technology can collect information via digital biomarkers that act as indicators for the presence and/or severity of many chronic diseases. As a result, wearable technology can be crucial in helping diagnose, manage, and treat these diseases.

Lab: Diagnosing Diabetes

DRIVING QUESTION

How can we use glucometers, biosensors that measure blood glucose concentration, to detect if someone has diabetes?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify a blood glucose concentration that is considered normal, prediabetic, and diabetic using scientific guidelines. **Calculate** proportions for solutions of different concentrations in mg/dL using computational thinking. **Measure** mass and volume using a lab scale and graduated cylinders. **Develop** a claim about the likeliness that a patient has diabetes using evidence collected from the lab and scientific reasoning. **CTE:** None Listed	In this lab, students will play the role of **lab technicians** and **medical device engineers**. Students will practice the **research** stage of the product life cycle to understand how to use biosensors to collect the relevant biometric data.	Preparing the Classroom for the Lab **(for teacher)** Background Reading: Diabetes and Blood Glucose **(one per student)** Background Reading: Making Solutions **(one per student)** Vocabulary Tool **(one per student)** Patient Profile Cards **(one per pair)** Student Guide **(one per student)** Student Protocol **(one per pair)** **Lab Equipment and Reagents:** Glucose/Dextrose **(~35–40g)** Scales/balances **(at least one for every four students, ideally one per pair)** Weigh paper **(one per pair)** Beakers/containers **(one per pair, size dependent on the solution the pair makes)** Graduated cylinders (or volumetric flasks) **(one per pair, size dependent on the solution the pair makes)** Stirring implement (rod, craft stick, spoon, etc.) **(one per pair)** Weighing implement (scoop, spoon, etc.) **(one per pair)** Small containers (glass or plastic beakers, condiment cups, etc.) **(two per pair)** Label tape **(one per pair)** Permanent marker **(one per pair)** Glucometers **(one per pair)*** Glucometer strips **(six per pair)*** Calculators **(one per student)** * *Diastix (used to measure glucose concentration in urine similar to a pH strip) may be used as a cheaper alternative to glucometers.*	In this lab, students will first make glucose solutions of known concentrations to evaluate the reliability of the glucometer and consider the impacts of lab technique error. Then, students will receive a patient's "blood" sample to perform a mock oral glucose tolerance test and use a glucometer to measure its glucose concentration. Finally, using their understanding of diabetes, students will make a claim about the likeliness of their patient having diabetes. They will support their claim with evidence and scientific reasoning.	Blood glucose concentration is a biomarker that can be used to determine if a person has a chronic condition such as diabetes. Devices like glucometers can be used by diabetics to track their blood-glucose concentrations.

Lesson 8: Data Generated by Healthy and Diseased Patients

DRIVING QUESTION

How can data collection from scientific, insurance, and social sources help us prevent or keep diseases under control?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Identify various biomarkers and sources that link biomarkers in healthy and diseased patients. **Discover** how to use knowledge to source specific information about biomarkers from the internet. **Apply** knowledge of internet data collection to source specific information about biomarkers. **Develop** a method to select the most efficient biomarker in terms of disease prevention and management. **Create** a database to compare data from different sources and show who could access it. **CTE:** 4.1, 4.3, 5.4, 5.6, A1.4, A2.6, A5.1	Students will learn about careers in **data science** and **laboratory management**. This lesson connects to the **discovery** phase of the product life cycle as students use their knowledge of data collection to source specific information about diseases. Students also examine the **manufacture** and **commercialization** life cycle phases as they study the use of biometrics by private enterprises.	Chart paper Internet access Racial Bias and Its Effect on Healthcare Tuskegee Guided Research Tuskegee Poster Rubric Design journal	In this lesson, students will examine how biomarkers can be used for commercial ends. They will debate whether everyone can have access to this information and find options to use biomarkers to improve well-being through personalized health care and at the same time avoid compromising critical personal data.	Students will investigate the link between biomarkers and diseases. They will identify different sources online that provide information about biomarkers and diseases.

Lesson 9: Statistically Significant Biomarkers

DRIVING QUESTION

How do we know whether the trends in biomarker data are significant enough to be considered unique for a disease?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Determine which statistical tests might help identify relationships present in data. **Explain** the importance of representative and balanced data collection. **CTE:** A2.4, A5.1, A6.1	Students will explore the careers of **biostatistician** and **bioethicist**. Students will collect data and run a T-test on their results. They will then consider how this type of testing may be beneficial in the **manufacturing** phase of the product life cycle.	Introduction to T-Tests Puzzle Experiment P-Value Capture Sheet Scientific Honesty Paragraph Rubric Analyzing a Scientific Paper Analyzing a Scientific Paper Rubric Design journal	In this lesson, students will explore the importance of representative and honest data collection. They will also learn how common statistical tests can be used to find relationships in data. The lesson culminates in students assuming the role of a biostatistician—applying this new knowledge to a previously selected scientific article.	At the end of this lesson, students will be able to explain how statisticians attempt to prove causality and apply their understanding of common statistical tests to a scientific article of their choice.

Lesson 10: Current Wearable Devices and Data Collection

DRIVING QUESTION

How can the data collected from wearable devices assist in maintaining a healthy lifestyle?

Student Objectives and CTE Standards	Connections to Careers and the Product Life Cycle	Lesson Materials	Lesson Overview	Phenomena and Connection to the Unit Storyline
Determine connections between biomarkers and wearable technology in the biotechnology and engineering industries. **Organize** a community outreach activity using wearable technologies. **Research** and **propose** solutions to a real-world issue by **developing** a piece of wearable technology. **CTE:** 2.4, A5.1, A6.1	Students will explore the career of **patent attorney**. This lesson focuses on the **manufacturing** phase of the product life cycle.	Biomarkers Review Chart Wearable Device K-W-L Chart Wearable Technology Presentation Rubric Existing Wearable Device Research Division of Labor Chart Prototype design Rubric for Biotech Unit 1 Challenge Design journal (that has been completed throughout the unit) Internet access 3V (coin) lithium battery* Coin cell battery housing* Computers with internet access Conductive thread or copper tape* Fabric/scrap material/glove/felt* Hot glue gun* Kids' sewing needle or hole punch* * *denotes an extension activity*	As a culmination of the Unit 1 lessons, students will determine connections between biomarkers and wearable technology in the biotechnology and engineering industries. They will use this information to design a piece of wearable technology and organize a community outreach activity for their solution. Students will research, create, and submit a solution to a mock crowdsourcing innovation challenge. Students will begin by analyzing data from wearable devices to find trends that health-care practitioners can use for a new treatment and learn how next-generation technologies, such as virtual reality, can support training. Students will use a mock open innovation platform to evaluate and select a challenge they are passionate about solving. They will collaborate to discover a solution to a problem within the innovation ecosystem that does not currently have a solution. Students will present their information via a multimedia presentation uploaded to a video streaming site for feedback and evaluation by their peers.	Wearable technology can collect information via digital biomarkers that act as indicators for the presence and/or severity of many chronic diseases. As a result, wearable technology can be crucial in helping diagnose, manage, and treat these diseases.

Career and Technical Education (CTE) Standards

Anchor Standards

2.0 Communications
Acquire and accurately use Health Science and Medical Technology sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats. (Direct alignment with Language Standards LS 9–10, 11–12.6)

2.4
Demonstrate elements of written and electronic communication, such as accurate spelling, grammar, and format.

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)

4.1
Use electronic reference materials to gather information and produce products and services.

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 Writing Standards 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.

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Career and Technical Education (CTE) Standards

Anchor Standards

Continued

8.0 Ethics and Legal Responsibilities
Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms. (Direct alignment with Speaking and Listening Standards SLS 11–12.1d)

8.4
Explain the importance of personal integrity, confidentiality, and ethical behavior in the workplace.

Health Science and Medical Technology Standards

A1.0
Define and assess biotechnology and recognize the diverse applications and impact on society.

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

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

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.

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

A4.1
List and describe the structure and function of a cellular organelle.

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Career and Technical Education (CTE) Standards

Health Science and Medical Technology Standards

Continued

A4.2
Describe conditions that promote cell growth under aseptic conditions in the laboratory and workplace.

A4.4
Explain the basic concepts of cell growth and reproduction, DNA replication, mitosis, meiosis, and protein synthesis.

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

A6.1
Apply knowledge of symbols, algebra, and statistics to a graphical data presentation.

A7.0
Understand the function of regulatory agencies for the biotechnology industry and the lasting impact of routine laboratory and communication practices on product development and manufacturing.

A7.4
Understand a patent and use online resources to search a patent database.

A7.6
Articulate issues of ethical concern, including plagiarism, copyrights, trademarks, and patents, and use online data resources and searchable databases to investigate a copyright, trademark, or patent.

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 1: Crowdsourcing Innovations in Biotechnology

Version Reviewed/Date: September 28, 2021
Version 1 Archive: *Archive*

Edits have been made to this collection post-report and are live on futurelabplus.com.

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 1 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 1 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 6 (Infectious Diseases) from Unit 1 (Crowdsourcing Innovations in Biotechnology) 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 1, Lesson 6, meet three NGSS criteria and approach 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*.