FUTURELAB+

BIOMED

Crowdsourcing Innovations in Biotechnology

Current Wearable Devices and Data Collection

Developed in partnership with:

Discovery Education and Ignited

In this Lesson Plan:

Print the **Teacher Section** →

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

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Cover Image
An image of a cell that has been divided by mitosis. Two diploid cells in late telophase are shown.

BIOMED / CROWDSOURCING INNOVATIONS IN BIOTECHNOLOGY

Current Wearable Devices and Data Collection

DRIVING QUESTION

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

OVERVIEW

Wearable technology involves a blend of concepts from innovations in hardware and software. Throughout history people have worn devices on the body that convey and collect information or sensor technology in or on the fabric of clothing. As technology advances and develops, there will be more cross-fertilization of technology design and fashion, increasing the need for employees in a myriad of careers from textiles, to engineering, to patent law.

As a culmination of their learning from 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 healthcare 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.

ACTIVITY DURATION

Five class sessions
(45 minutes each)

ESSENTIAL QUESTIONS

What challenges and opportunities present themselves with the ongoing growth of the wearable technology industry?

What engineering design principles are most important in the development of wearable technology used to solve societal issues?

How can current wearable technology be integrated into existing health systems and digital applications?

OBJECTIVES

Students will be able to:

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.

BACKGROUND INFORMATION

While the history of wearable technology as we know it has its origins in the 1950s and 1960s, the pre-history of this technology reaches back to the 1500s with pocket watches and eventually wristwatches watches (Iowa Department of Cultural Affairs). Science fiction in writing and filmmaking, as well as advancements in military technology, had much to do with the ideas and development of more practical and useful wearable technology. Microchips and the advent of smaller, more powerful computer technology has ushered wearable technology into a pioneering phase in which advances seem to come at a lightning pace.

Materials

- **Biomarkers Review Chart**
- **Wearable Device K-W-L Chart**
- **Wearable Technology Presentation Rubric**
- **Existing Wearable Device Research Capture Sheet**
- **Division of Labor Chart Capture Sheet**
- **Prototype Design Capture Sheet**
- **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***
- **Needle-nose Pliers***
- **Scissors***

* denotes an extension activity

Pedagogical Framing

Instructional materials are designed to meet national education and industry standards to focus on in-demand skills needed across the full product development life cycle—from molecule to medicine—which will also expose students and educators to the breadth of education and career pathways across biotechnology.

Through this collection, educators are equipped with strategies to engage students from diverse racial, ethnic, and cultural groups, providing them with quality, equitable, and liberating educational experiences that validate and affirm student identity.

Units are designed to be problem-based and focus on workforce skill development to empower students with the knowledge and tools to be the change in reducing health disparities in communities.

SOCIAL-EMOTIONAL LEARNING

Students practice self-management skills, such as persevering in the face of setbacks and frustrations, while pursuing research on diseases. Some students will have had personal experience with disease, and carry that experience with them into sensitive discussions. This requires all discussion participants to demonstrate empathy and practice social awareness.

CULTURALLY AND LINGUISTICALLY RESPONSIVE INSTRUCTION

Students use note-taking strategies and small group work to strengthen their understanding of how wearable devices can help detect diseases such as COVID-19, which disproportionately impact communities of color. Students also participate in an outreach activity that encourages them to showcase their diverse cultural and linguistic skills in an effort to encourage historically marginalized communities to participate in medical data collection. There are opportunities for affirming and validating the contributions of culturally and linguistically diverse people in relevant research and other scientific endeavors. It is essential for instructors to note that wearable devices are prohibitively expensive for many and it is important to contextualize their use with conversations on privilege.

ADVANCING INCLUSIVE RESEARCH

Students investigate how wearable technology can be used in underprivileged communities and help address barriers to access to healthcare. This supports engaging diverse populations in all phases of clinical research.

COMPUTATIONAL THINKING PRACTICES

Wearables allow consumers to collect more data on their health than ever before. This relatively new product category is rife with product design innovations. Students examine the computational thinking strategy of building models by constructing a model of a circuit like one that might be used in a wearable device. They also use the skill of building models to design and iterate a wearable device prototype.

CONNECTION TO THE PRODUCT LIFE CYCLE

This lesson focuses on the **manufacturing** phase of the product life cycle. Students design, code, create, and pitch an idea for a wearable device for a specific use case. They also research the method of patenting their device and discuss the role a patent attorney would play in the process. The prototype design components incorporate various aspects of the Product Life Cycle and include the following: drawings, dimensions, materials needed, features and components, necessary safety measures if needed, scale-up process of manufacturing, pricing, and a patent of design using a patent attorney.

Have you ever wondered…

How do you ensure the use of wearable technology is representative of society and account for the broad population?

Society stands to benefit greatly due to advances in wearable technology. The increase in biomarker identification and measurement by wearable technology can be used to provide early warning information of an individual's health status. Wearable technology is being used now in contact tracing of infectious diseases.

How can medical professionals utilize data from wearable technology in order to better care for patients?

Using biomarker data that is immediately available provides health and medical professionals with needed information that can be used for early diagnosis of medical issues, which could save time and even money in healthcare costs.

How do you ensure patient trust in technology and data collection?

The ability to monitor health is sometimes a double-edged sword because the same information that may be used to save lives can also be used to deny people and communities adequate healthcare and health insurance.

MAKE CONNECTIONS!

How does this connect to the larger storyline?	*How does this connect to careers?*	*How does this connect to our world?*
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.	***Patent attorneys*** not only have law degrees, but also usually professional and even doctorate degrees in the disciplines and industries in which they are employed. Patent attorneys specialize in copyright law, which helps protect the proprietary status of original works and devices.	The recent advent of newer and more effective technological and scientific advancements in wearable technology has helped people with chronic diseases live longer, healthier lives.

Day 1

LEARNING OUTCOMES

Students will be able to:

Compile a list of biomarkers and develop a chart describing their individual characteristics.

Analyze classroom polling data on wearable technology.

COMPUTATIONAL THINKING IN ACTION

Here, students are using the computational thinking strategy of collecting data to build a dataset on biomarkers.

INDUSTRY AND CAREER CONNECTION

Remind students about their role as an academic researcher this week, emphasizing essential soft skills that will be used in this activity, including being organized and detail oriented. A major technical skill that will be used to help complete this activity is effective note taking. Mention that academic researchers must also maintain clear records in order to be able to utilize or reference them as a source of information.

COMPUTATIONAL THINKING IN ACTION

By participating in this poll, students are developing real-time experience with the computational thinking strategy of collecting data.

Procedure

Teacher Note > *The teacher will need to sign up for a free polling site, such as Poll Everywhere, that allows real-time class polling.*

Individual (20 minutes)

1	Using websites *List of Qualified Biomarkers* and *Using Biomarkers to Collect Health Data*, have students compile a list of 15 biomarkers, what diseases or conditions they test for, and how the information for each biomarker is gathered. This information will go in the *Biomarkers Review Chart* capture sheet.

Teacher Note > *Emphasize that biomarkers can be measured outside the body as well as inside the body. Heart rate and blood oxygenation can be measured outside the body with wearable devices. Mention that Apple and Samsung watches have trackers for running and cycling.*

2	Ask students to fill out the K and W columns of the *Wearable Device K-W-L Chart*.
3	Have students watch *Beating Stress Through Early Detection*.
4	Have students will fill out the L column of the *Wearable Device K-W-L Chart*.

Whole Group (15 minutes)

1	Discuss student answers from the *Wearable Device K-W-L Chart*.
2	Conduct a class poll via *Poll Everywhere*. Have students use either their smartphones or laptops to poll what types of wearable technology they have used OR are aware of at that time OR what they may have in their homes.

Teacher Note > *Be sensitive to the socioeconomic status of students in the class. These may be devices that are prohibitively expensive for many and we do not want to create the impression of entitlement or that those devices should be the norm.*

3	Use the discussion protocol *Raise a Righteous Hand* to ask students if they know of anyone with Apple or Samsung smart watches. Ask if they are aware that those devices can monitor activity, such as steps, running distance, cycling distance, along with heart rate and blood oxygen. If they are aware of those capabilities, ask if they have seen them used.

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Day 1

Continued

Procedure

4 Give students a *Moment of Silence* to process the question: How can these devices be used to diagnose, treat, or monitor disease? Then have students use the participation protocol *Whip Around* to answer the question.

Teacher Note > *If students do not have a smartphone or laptop present, provide examples of wearable technology and share these examples with the class.*

Individual (10 minutes)

1 Remind students about the requirements for their final project. Give students the opportunity to do a *Quick Write* in their journals about the wearable device they will create. Ask students to consider the following questions:

a. What disease will your wearable device be used to diagnose, treat, or monitor?

b. Will your device help address health disparities in your community?

c. What obstacles around data privacy or access might you encounter?

Day 2

LEARNING OUTCOMES

Students will be able to:

Discuss and **critique** the role of wearable technology in human history.

Formulate methods in which wearable devices can be used during times of pandemics.

Explain future wearable technology.

INDUSTRY AND CAREER CONNECTION

In this activity, students will be tasked with using the academic researcher soft skills of openness to learning and time management. They will need to display openness to learning as they will be placed in groups with other students and required to take notes. They also will need to stay on task and manage their time wisely because they will be working together in groups. Lastly, being detail-oriented and keeping records or notes is essential as they will be utilizing these notes to complete a presentation.

Procedure

Whole Group (10 minutes)

1. Project the bulleted list from the page *A brief history of wearable computing* and facilitate a brief class discussion on the history of wearable technology. Emphasize these specific discussion questions:
   - **a.** What was considered high-tech throughout history?
   - **b.** What may be missing from this list?
   - **c.** What instances of wearable technology have you seen in popular culture (i.e. movies, TV, books) that are in use today?
   - **d.** What do you think may appear on the list in coming years?

2. Tell students that they are going to have an opportunity to see what some students are doing with wearable devices now. Students will use the strategy *AEIOU* while they view the video *"How Can Wearable Technology Help Frontline Workers?"* Students should record:

   A = Adjective: List a word or two that describes something you saw or learned.
   E = Emotion: Describe how a particular part of the video made you feel.
   I = Interesting: Write something you found interesting about the topic.
   O = Oh!: Describe something that caused you to say "Oh!" or surprised you.
   U = Um?: Write a question you have, or what you want to learn more about.

Teacher Note > *Because the video is less than a minute, the video may need to be replayed so students are able to complete the "AEIOU" activity.*

3. Have students share some questions they may still have.

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Day 2

Continued

Procedure

Small Group (35 minutes)

1 Have student groups research and then create a multimedia presentation, using a technology of their choice, devising ways in which wearable technology can be used to stem outbreaks of infectious diseases, as well as to diagnose and prevent certain chronic diseases. Emphasize to students that this exercise is to consider hypothetical situations. Students should consider the questions:

a. What are specific ways that these wearable devices can be used to decrease inequities and issues surrounding access in BIPOC communities?

b. How can trust be built within the community toward wearable devices and data collection?

Teacher Note > *This activity highlights the C3 framework of "Taking Informed Action."*

2 Ask groups to upload their presentations to the class website for students to peer review and evaluate as homework.

Day 3

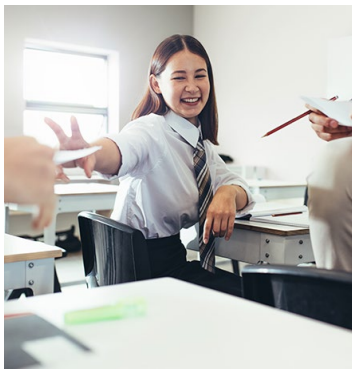
LEARNING OUTCOMES

Students will be able to:

Select a mock innovation challenge.

Analyze the benefits and challenges of wearable health monitors.

Explore existing wearable technologies.



Procedure

Whole Group (15 minutes)	
1	Explain to students that in this culmination of Unit 1, they will be choosing one of the four crowdsourcing mock innovation challenges (to which they were introduced at the beginning of the unit). They now have investigated enough information about biomarkers to propose a solution.
2	Display or give students copies of each of the mock innovation challenges. Ask students to select the challenge to which they want to propose a solution. Then, invite students to write their names on pieces of scrap paper or notecards. Place four boxes, containers, or paper bags labeled with challenges 1–4 somewhere in the room. Ask each student to place the paper with his or her name in the container for the challenge he or she would like to solve. Randomly form teams of 3–4 and ask students to move to sit with their new working group.
3	Ask students to think about what can be learned about a person from the data collected by wearable technology. Allow students to briefly share their initial ideas. Remind students to consider how their design can address inequities in access to wearables and how addressing those inequities may have a positive effect on health inequities in BIPOC communities.
4	Display, or download and print, the infographic *Big Data Wearable Health Monitors.* Ask students to analyze it with their group for five minutes. Again, ask students to share anything that was surprising to them or information they learned about how wearable technology is being developed in the healthcare industry.

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Day 3

Continued

Procedure

Small Group (30 minutes)	
1	Explain to students that before they can begin creating their wearable technology innovation, they should explore and evaluate what types of treatments already exist for the disease they will be focusing on. Give each group a copy of the *Existing Wearable Device Research* capture sheet. Students should compare their capture sheet to the constraints of the overarching project.
2	Give students 20 minutes to work as a group to research and complete the capture sheet. If there are student groups who have chosen the same innovation challenge, they should collaborate and share the innovations they discovered with each other and add any additional ones to their capture sheets.
3	Ask student groups to share some of the wearable technology they learned about in their research with the class. This may provide new ideas to groups as they discover the wide array of innovations that may be helpful for patients suffering from disease. They may also share some of the tradeoffs they see in these products.

Day 4

LEARNING OUTCOMES

Students will be able to:

Determine equitable roles for each group member.

Create a working list of tasks and timeline for the mock innovation challenge.

Procedure

Small Group (45 minutes)

1 Give each group a copy of the *Division of Labor Chart* capture sheet. Ask students to assign roles to each of the members of their team, including a project manager, head of research and development, design engineer, and sales and marketing specialist. They should read the responsibilities for each role carefully and decide who in their group is best suited for that role based on their interests and skills.

Teacher Note > *This culminating task brings together the five domains of the SEL Framework.*

2 Once roles are assigned, students should begin to create a working list of tasks that must be completed for the project using the guidelines from the innovation platform and the rubric. They should assign each role the specific tasks they are responsible for and set a tentative deadline for the work to be completed.

Teacher Note > *As soon as groups are formed, students should decide what method(s) of communication will be used.*

3 To serve as a progress check, the instructor should rotate to each group to ensure that students have started their list of tasks and to answer any questions that students have about the project.

Day 5

LEARNING OUTCOMES

Students will be able to:

Create a prototype sketch of their wearable technology product.

Provide feedback to other groups on their initial design, description, and materials.

Refine the design based on feedback, research, and testing.

Film a video presentation to showcase the final prototype, targeted to a specific audience and supported by data.

Procedure

Teacher Note > *You may need to accommodate for more time depending on final project.*

Small Group (45 minutes)	
1	Begin by asking students to review the division of *Division of Labor Chart* capture sheet they created in the previous class period. Explain to students that they will need to complete the tasks they have been assigned and work together to create their prototype model and video presentation of their wearable technology innovation for the mock crowdsourcing platform.
2	Tell students that while research is certainly one of the essential features they will need to create their product, it does not mean that all roles in the group can begin working on their individual tasks. Hand out a copy of the *Prototype Design* capture sheet and ask the group to get out their existing *Wearable Device Research* capture sheet that they created the previous lesson.
3	Ask the group to brainstorm initial product ideas using the information on their existing *Wearable Device Research* capture sheet. Give groups 15–20 minutes to discuss and come up with an initial idea as well as for the design engineer to create a prototype sketch.
4	When all groups are finished, ask them to give their prototype sketch sheet to another group. Ask the group to take 10 minutes to review the prototype sketch sheet. Students will use sticky notes to provide written feedback on the initial design, description, and materials.
5	Once all groups have finished reviewing the prototype designs, they should return the sketch sheet with their feedback to the original group.

Teacher Note > *This section practices nurturing the SEL growth mindset and giving feedback to others.*

6	Student groups should use the remainder of Days 3 and 4 to complete their tasks, such as doing research, revising their sketches, and planning their presentations.
7	The instructor should meet with each group throughout or at the end of each class session to check the group's progress and ensure students are completing their tasks and to answer any questions that students have about the project.

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Day 5

Continued

Procedure

8	Students should begin filming the video that will be uploaded to the mock video website for the crowdsourcing challenge. Students can use laptops, smartphones, or tablets to record their videos. Video editing software is available for students online through sites such as Vimeo Create, and WeVideo or through programs like iMovie and Touchcast. Students should be sure to follow the guidelines on the project rubric to ensure that all information can be learned through their video.

Teacher Note > *Another option is to allow students to do a wearable technology LIVE pitch challenge whether in person or online.*

9	Once students have recorded, edited, and uploaded their videos to the video platform the instructor has given them, students should take time to view each of the videos in class or on their own. If time allows, groups should give each other feedback on the information they learned from their project and any improvement suggestions or questions they have.

Extension

LEARNING OUTCOMES

Students will be able to:

Design and construct a simple circuit.

Code and create a pitch idea for wearable technologies.

Consider how wearable technology could be used in underprivileged communities and how to address barriers to healthcare access. For example, detecting preeclampsia in pregnant women through the use of an app could be linked to wearable technology that helps pregnant women detect health complications and improve outcomes.

What access issues might patients have with your device? How will you overcome these obstacles (i.e., no access to WiFi)?

Materials

- **LED light**
- **Conductive thread or copper tape**
- **3V (coin) lithium battery**
- **Coin cell battery housing**
- **Needle nose pliers**
- **Fabric, scrap material, glove, felt**
- **Kids' sewing needle or hole punch**
- **Scissors**
- **Hot glue gun (optional)**

Procedure

Extension 1

1. As an addition or extension to this lesson, the instructor could encourage groups to create an additional language because reaching a diverse audience is important, especially in health-related fields. Students can use Google Translate (under "tools" in Google Docs) to create a translated script and record their new video. Video editing programs can also be used to split and add vocal tracks to already existing videos.

Extension 2: Code and Pitch

1. This lesson is provided as an optional activity. This extension will require some elementary coding experience. If the students do not have this experience, there will be a simple coding tutorial connected with this lesson. Utilize this site for ideas on which free programs to teach basic coding: *Top 10 Free Coding Programs for Kids.*
2. Pass out materials for circuit building.
3. Have students brainstorm ideas for a piece of wearable technology.
4. Students will use conductive thread provided on a small piece of fabric in order to create a simple circuit with the goal of turning on an LED light.
5. Students should secure the battery housing initially (i.e., using hot glue to attach the battery housing to the fabric so it will not move while sewing). Provide the following instructions.
   - **a.** Thread the conductive thread into the needle. After cutting the thread, make a knot at one end (two or three knots should be sufficient). Cut off any dangling pieces of thread.
   - **b.** Sew several loops to secure the battery housing terminals to the fabric. ALWAYS start with the negative terminal. Each terminal will connect to the corresponding output on the LED light; positive terminal goes to the positive leg of the LED; negative terminal goes to the negative leg of the LED.
   - **c.** When the loops are through the terminal, make two or three loops near it in order to make a contact point for the path of the circuit. Make knots to secure the thread to the fabric.

Continues next page >

Extension

Continued

Procedure

	d.	Secure the positive terminal of the battery housing (remember to make a knot at the end of the thread before sewing). Sew the same number of loops as the previous terminal. Once the loops are complete and the terminal is secure, tie a knot to secure the thread, and cut away any dangling thread pieces.
6		Tell students to secure the LED light to the fabric (the shorter leg of an LED is the negative side and the longer leg is the positive side). Sometimes, there is a flat end on the plastic portion of the LED that will let you know which side is negative or positive.
	a.	Curl the legs of the LED light with pliers. This will make it easier to sew the conductive thread around the legs of the light. Remember which light is positive and which one is negative.
	b.	First, sew the conductive thread around the negative polarity leg to secure it to the fabric. Make sure to tie the end of the thread with a knot to secure the stitch. Once secured, tie a knot to close and cut off any dangling pieces of thread.
	c.	Secure the positive polarity leg of the LED using the conductive thread in the same method as the negative leg.
7		Next, tell students to stitch together the circuit. The polarity of the LED must match the polarity of the battery (negative to negative; positive to positive).
	a.	Remember to thread the needle and knot at the end of the piece of thread.
	b.	Start at the contact point near the negative battery housing terminal.
	c.	A basic in-and-out stitch will be needed, where each stitch is the same length on the bottom as on the top of the fabric. Those who are more advanced at sewing should feel free to use more advanced techniques.
	d.	Once the LED terminal is reached, make sure the thread makes good contact with the negative leg of the LED light.
	e.	Tie a knot at the end of the stitch.
8		Repeat step #7 for the positive connection.
9		When the circuit path is sewn, test by inserting the 3V battery into the battery housing (positive to positive; negative to negative).

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Extension

Continued

Procedure

10	The LED light should light up, meaning you have properly closed the circuit. If the light does NOT light up, check to confirm that the connections are closed, and the conductive thread only touches its target.
11	Another idea for wearable technology is to sew conductive thread onto the finger of a glove. Make sure that the conductive thread is in contact with both the finger of the user and the outside of the glove. No circuits are needed for this method.

Teacher Note > *Emphasize to students that a patent attorney drafts, files, and prosecutes patents, trademarks, and designs. They need to have a technical background in the field of the invention. They should understand how an invention works. By having students design a simple circuit, they can relate how a patent attorney would need to know the inner workings of a wearable device.*

INDUSTRY AND CAREER CONNECTION

Time management and the ability to set priorities are the soft skills utilized in this activity. Because there is a limited amount of time for this activity, it would be important for students to prioritize steps in order to work efficiently and successfully finish the task. A technical skill necessary for this activity includes following the protocol or instructions, including checking the rubric to ensure they have completed all required steps.

Small Group

1	Ask students to compare their individual designs with those of the other students in their groups, providing feedback and support.
2	Have students design, code, create, and pitch an idea for a wearable device while also researching the method of patenting their device and discuss the role a patent attorney would play in the process. They will decide who will work on each aspect of the design, check with each other throughout the project, and make sure that all components and information is represented. Student groups should develop prototypes using poster paper. Prototype designs must include the following information:

a. drawings

b. dimensions

c. materials needed

d. features and components

e. necessary safety measures if needed

f. scale-up process of manufacturing

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Extension

Continued

COMPUTATIONAL THINKING IN ACTION

By designing and iterating prototypes of wearable devices, students get hands-on experience with the computational thinking strategy of building models.

Procedure

g. pricing

h. how their design can address inequities in the access to wearables

i. how addressing those inequalities may have a positive effect on health inequalities in BIPOC communities

j. a patent of design using a patent attorney

Allow for time so that when initial designs are complete, groups may swap their design prototypes with another group for peer feedback using sticky notes attached to the design paper. After, ask groups to revise their designs based on these critiques.

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
Constructing Explanations and Designing Solutions
Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.

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

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

Stability and Change
Much of science deals with constructing explanations of how things change and how they remain stable.

Career and Technical Education (CTE)

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

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

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

Biomarkers Review Chart

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

Directions
Using the websites provided, compile a list of 15 biomarkers, where they originate, what disease or conditions they test for, and how the information for each biomarker is gathered.

List of Qualified Biomarkers

Using Biomarkers to Collect Health Data

Biomarker	Origin	Disease or Condition	Gathering Method
Ex. Red blood cell count	Bone marrow broken down in the spleen and liver	Elevated due to dehydration, high testosterone; May be low due to nutrient deficiencies (rion, Vitamin B6, Vitamin B12, folate), kidney disfunction, chronic inflammation, anemia, blood loss	Blood sample

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Biomarkers Review Chart

Directions
Using the websites provided, compile a list of 15 biomarkers, where they originate, what disease or conditions they test for, and how the information for each biomarker is gathered.

List of Qualified Biomarkers

Using Biomarkers to Collect Health Data

Biomarker	Origin	Disease or Condition	Gathering Method

Continues next page >

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Biomarkers Review Chart

Continued

Biomarker	Origin	Disease or Condition	Gathering Method

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Wearable Device K-W-L Chart

Directions
Before viewing the video, complete the K column of this chart with all the things you already know about wearable devices, and begin the W column with things you wonder about the topic. Then, as you watch the video, add to the W column with any information you want to know more about and list anything you have learned in the L column. Be prepared to discuss your answers!

K *Three things I already **knew** about wearable devices*	**W** *Three things I **want** to know about wearable devices*	**L** *Three things I have **learned** about wearable devices*

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Wearable Technology Presentation Rubric

Group Name _____

Score	4	3	2	1
Clarity of Ideas	Presentation is easy to read; text guides the audience and serves as an aid.	Presentation is readable; text guides the audience or presenter.	Presentation is sometimes difficult to follow; zooming effect is excessive.	Presentation is difficult to understand.
Oral Presentation	Presenter demonstrates a thorough understanding of content and speaks knowledgeably about content.	Presenter demonstrates a good understanding of content and is able to speak knowledgeably about most talking points.	Presenter demonstrates limited understanding of content and relies upon text for most of the presentation.	Presenter demonstrates little or no understanding of content and reads text directly from communicate with the audience.
Content	Ideas are interesting and thought-provoking; depth of knowledge is demonstrated.	Ideas are interesting; some are thought-provoking; depth of knowledge is somewhat demonstrated.	Ideas are not particularly interesting or thought-provoking; depth of knowledge is lacking.	Ideas are illogical or unclear.
Organization	The path moves logically from one idea to the next; ideas build on each other and are grouped in a way that makes sense.	The path moves logically from one idea to the next; ideas are grouped logically.	The path moves in a seemingly arbitrary way; ideas are not grouped or are grouped arbitrarily.	There is no path and/or grouping.
Multimedia	Effective use of images, videos and links to enhance and support content.	Includes adequate photos, videos, and/or links to support content.	More visual elements would add to the presentation.	Does not include visual elements.
Spelling and Grammar	No spelling or grammatical mistakes.	Minor spelling or grammatical mistakes.	Some serious spelling or grammatical mistakes.	Spelling or grammar hinders clear communication of ideas.
Originality	Content is original and in the students' own word.	Most content is original and in the students' own words.	Some content is original and in the students' own words.	Content is not in the students' own words.
Final Score				

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Existing Wearable Device Research Capture Sheet

Directions

Research wearable devices that already exist for your chosen innovation challenge. Your group should try to discover and research three products. The final row is optional for any additional wearable technology you come across. Complete the chart below.

Disease we focus on: _____

	Name of Product and Physical Description	Brief Explanation of How it Works	Biomarkers Used to Collect Data	Shortcomings of the Product or Ways it Could Potentially Be Improved	Could this Device Address Health Disparities?
1					
2					
3					
+					

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Division of Labor Chart Capture Sheet

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

Project Manager
Oversees the project, ensures that all team 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.

Research and Development
Responsible for Internet research about specific biomarkers related to the product and disease. Communicates with project manager, design engineer, and sales and marketing specialist to ensure that all members of the group understand how biomarkers can be used to monitor the disease they have focused on.

Design Engineer
Designs ways that biomarkers could be collected from the patient or person using wearable technology. Creates a 2-D or 3-D prototype model from materials and provides specific explanations of how this wearable technology will collect and upload or present data to health care specialists and to the person using the device.

Sales and Marketing Specialist
Ensures that the group's innovation improves upon but does not copy existing products, works on the development of a name and marketing for the product, is responsible for planning and executing the multimedia presentation of the prototype and ensuring timely uploading to streaming video website.

Continues next page >

Team Members:

_____

_____

_____

_____

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Division of Labor Chart Capture Sheet

Continued

Directions

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

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

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Prototype Design Capture Sheet

Directions

Brief explanation of how your wearable technology innovation will work or achieve the goal of the project:

Initial sketch of your wearable technology innovation with materials labeled:

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Rubric for Biotech Unit I Challenge: Developing and Using Models

Observable features of the student journal	Meets Expectations 8–10 points	Progressing 5–7 points	No attempt 0 points
Research			
a. Journals contained evidence that the student used learning from previous lessons as a foundation for the design of their product as well as additional research specific to their chosen disease.			
Prototype Model			
a. There was a detailed prototype sketch with a 2-D or 3-D engineering prototype model and students can explain how the model will function to meet the challenge.			
b. Model accurately and creatively addressed how biomarker data will be collected from the human body in a way that is appropriate for the disease.			
Video Presentation			
a. Presentation showed in an accurate, organized, and entertaining way how the wearable technology will meet the criteria and constraints of the challenge.			
b. Research to support the model was presented and information about how the wearable technology model is to be used is clearly shown.			
c. The presentation was targeted to the specific audience that has a higher risk of this disease as supported by data.			
Final Score			
Grade			

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Rubric for Biotech Unit I Challenge: Mock Crowdsourcing Innovation Challenge

Constructing Explanations and Designing Solutions

Observable features of the student group performance	**Meets Expectations** 8–10 points	**Progressing** 5–7 points	**No attempt** 0 points
Create design solution using scientific knowledge			
a. Students used knowledge about biomarkers to explain what disease the wearable device will target and the data it will provide.			
b. Students identified the cell type and/or organelle(s) that are the source of their biomarker data.			
c. Students identified if the disease being targeted is chronic or infectious.			
d. Students explained if and/or how a disruption in the cell cycle or genetic mutation is related to the disease or the source of biomarkers.			
e. Students identified how the biomarker data is collected in the prototype model.			
f. Students identified how the biomarker data collected will be used to identify disease or improve a patient's overall health.			
g. Students identified how to improve upon existing medical wearable technology.			
h. Students compared the benefits and harm that could result from their biotechnology innovation.			
Describe criteria and constraints			
a. Students described criteria (how does this design meet the challenge) and constraints (for example, cost, space, and materials) for their product.			

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Rubric for Biotech Unit I Challenge: Mock Crowdsourcing Innovation Challenge

Constructing Explanations and Designing Solutions

Continued

Observable features of the student journal	Meets Expectations 8–10 points	Progressing 5–7 points	No attempt 0 points
Evaluating potential solutions			
a. Students used data and research to determine how the product is different or improves upon existing similar products.			
b. Students determined the target population or demographic based on research and data showing racial or ethnic disparities in medicine and/or the prevalence of their disease locally or globally.			
c. Students explained the accessibility considerations of their design to meet the needs of diverse communities.			
Refining or optimizing the solutions			
a. Students made revisions to the model based on testing, peer feedback, and evidence from data collection.			
Final Score			
Grade			

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References

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Occupational Portrait of a Watchmaker, between 1840 and 1860.
State Historical Society of Iowa, 2021

Cowen, Amy.
Sewing Electronics: Wearables that Light Up.
Science Buddies, 2015

Wearable Tech
Space Foundation, 2020