

FUTURELAB+

**BIOMED**

*Crowdsourcing Innovations  
in Biotechnology*

# Mock Wearable Tech Innovation Project

Design Journal

Developed in partnership with:

**Discovery Education and Ignited**

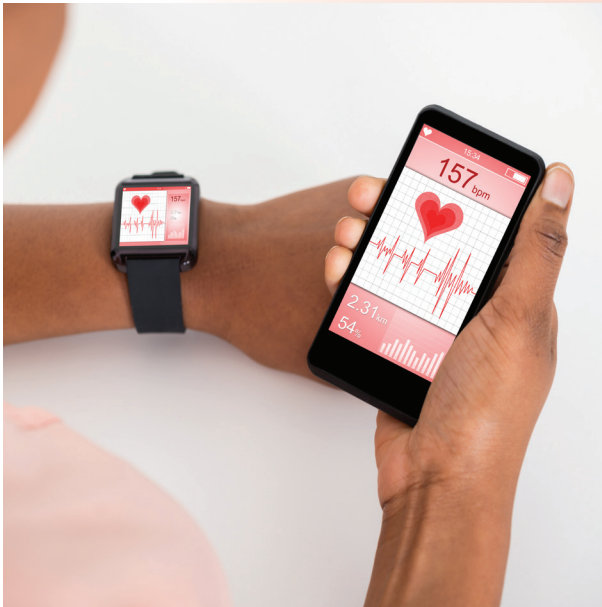
## Mock Wearable Tech Innovation Project

### BACKGROUND

Typically, a patient at risk or diagnosed with an infectious or chronic disease would have to see a physician and go through various tests to obtain information about his or her health and the progression or recession of any disease. This meant that a spike in blood pressure when the patient is at home could lead to an unforeseen heart attack or stroke. Or, a person could unknowingly have an increased immune response in their body that, if undetected, could lead to the development of chronic liver disease.

Wearable technology is changing this. Beginning with products such as smartwatches that could monitor heart rate, the field of “wearable tech” is growing at a fast pace. According to the American Society of Mechanical Engineers, more than 400 million people were predicted to use wearable technology in 2020. Wearable technology allows the wearer to get immediate and up-to-date information on vital signs (such as respiration and pulse rate) and other health-related data from something that they wear on their body, not just at the doctor’s office, but at home, at work, at school, and at all times of the day.

The data that wearable tech collects are known as biomarkers. Biomarkers are an objective measure of what is happening in the body or in a cell at any given moment. Biomarkers can also be predictors of disease, and therefore knowledge of biomarkers can serve as an early warning system for health-related issues if detected. While familiar biomarkers include heart rate and blood pressure, molecules such as proteins and hormones can also serve as biomarkers that can now be detected in sweat, vapor from a person’s breath, and even the membranes of the eye by amazing medical wearable technology.



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## Examples of Wearable Technology

### PROJECT SUMMARY

You are part of a team that is tasked with solving a crowdsourcing innovation challenge. The crowdsourcing platform is looking for new and innovative wearable technology that will help to discover or monitor biomarkers of health-related issues, such as heart disease, diabetes, cancer, and infectious diseases, to 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, a video presentation about the wearable technology product will be uploaded to the mock innovation challenge platform. The video should explain the importance of the wearable technology, model its use, and show how those at risk for or diagnosed with the disease or a physician will use the information collected to monitor health.



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## Proposal Requirements

### *Research for the project must include:*

- 1 Description of the disease, including symptoms, risk factors, and populations impacted most by this disease
- 2 Statistics that show the impact of the disease in the selected innovation challenge nationally or globally
- 3 Specific biomarkers for the disease and what they indicate about a person's health
- 4 Existing wearable technology for the disease and how they work

### *The 2-D or 3-D prototype model must include:*

- 1 The ability to be easily worn by a person in a non-invasive way
- 2 An explanation of how the device would collect biomarker data in a realistic way
- 3 Information about how a person or physician would access data from the wearable technology

### *The innovation challenge video presentation must include:*

- 1 Background information on the disease and statistics supporting why this is an important issue related to human health
- 2 An explanation of how the biomarkers can provide clues about the disease on which the challenge focuses
- 3 An explanation, with diagrams, of how your wearable technology will be worn, how it will function to collect biomarker data, and how a person will access the information collected by the device

## Engineering Design Process Journal

Name

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Group Members

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Start Date

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Due Date

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## Engineering Design Process Journal

<b>Step 1:</b> Define the Problem	<b>Step 2:</b> Brainstorm	<b>Step 3:</b> Research and Generate Ideas	<b>Step 4:</b> Identify Criteria and Specify Constraints	<b>Step 5:</b> Explore Possibilities	<b>Step 6:</b> Select an Approach	<b>Step 7:</b> Develop the Design Proposal	<b>Step 8:</b> Make a Model or Prototype	<b>Step 9:</b> Test and Evaluate Design Using Specifications	<b>Step 10:</b> Refine the Design	<b>Step 11:</b> Modify and Present for Market	<b>Step 12:</b> Communicate Processes and Results
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### Step 1: Define the Problem

According to the Innovation Challenge your team has chosen, what is the problem and/or the need that justifies the project?

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What evidence do you see of this problem when you think about what you have learned in the previous lessons for this unit?

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What are the three requested products?

1. 

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2. 

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3. 

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Describe what needs to be communicated in each product?

1. 

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2. 

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3. 

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How can a proposed design increase a person's ability to obtain information about his or her health and disease?

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What are the constraints for this design?

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What critical questions need to be answered to produce these components?

1. 

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2. 

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3. 

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What do you already know about these questions?

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What resources will you use to find out more information about these questions?

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## Engineering Design Process Journal

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### Step 2: Brainstorm

Discuss initial ideas with the whole group. In the space provided, sketch and label three or four possible types of wearable technology that could collect biomarker data for the disease on which your innovation challenge is focused. Remember to be creative!

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## Engineering Design Process Journal

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### Step 3: Research and Generate Ideas

### Resource List

In the table below, record possible questions you need to answer to gather more information prior to committing to one of your ideas. What resources are available to assist you in answering your questions?

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<b>Possible Questions</b> Generate a list of specific questions that need to be answered.	<b>Research Results</b>	<b>Any Additional Design Ideas Generated During Research</b> Notes or sketches

### Question Prompts

- What are specific biomarkers for this disease or human health issue?
- Has this problem been solved previously? If so, what are the shortcomings of these solutions?
- Is there a similar product with components that could apply to this solution?
- What types of materials should the solution be made from? Is there information to help me choose the material for the product?
- What data resources might be helpful when designing my solution?

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### Lesson Connections

#### LESSON 1: Cell Biology and Biomarkers

Use the capture sheets and information learned from this lesson to answer the following questions:

What are some of the important differences between prokaryotic and eukaryotic cells?

What are cellular organelles and how does their structure and function influence their role?

How do biomarkers relate to cellular organelles and their function?



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## Engineering Design Process Journal

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### Making Connections

**What I learned from this lesson:**

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**How this connects to the project:**

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**Which part(s) of the project does this lesson address and how might it be used?**

**Research**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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## Lesson Connections

### LESSON 2: Mitosis and Meiosis

Use the capture sheets and information learned from this lesson to answer the following questions:

**How are the processes of mitosis and meiosis both similar and different?**

**How do errors in cell division relate to human health and disease? How can biomarkers indicate when errors are occurring in mitosis or meiosis?**

**Should biomarker data be interpreted the same way for all people—why or why not?**

*(Cite specific examples from the lesson.)*

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**Which part(s) of the project does this lesson address and how might it be used?**

**Research**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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## Engineering Design Process Journal

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### Lesson Connections

#### LESSON 3: Errors in Cell Replication

Use the capture sheets and information learned from this lesson to answer the following questions:

**On a cellular level, what is a mutation and what can be some of the causes of mutations?**

**What are some of the consequences for human health when a mutation occurs in the genetic material? Are there biotechnological tools that may help reduce the impact of harmful mutations?**

**How can information about genetic mutations act as biomarkers? Can this information be used to monitor and make predictions about human health and disease?**

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### Making Connections

**What I learned from this lesson:**

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**How this connects to the project:**

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**Which part(s) of the project does this lesson address and how might it be used?**

**Research**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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## Lesson Connections

### LESSON 4: Cell Damage

Use the capture sheets and information learned from this lesson to answer the following questions:

**How can lifestyle choices impact the normal function of cells?**

**In what ways can biomarkers reveal disruptions in cellular function?**

*Cite specific information from the "Investigating Biomarkers" activity to help you answer this question.*

**Why is it important to design biomarker monitoring technology in a way that will be usable and available for all people? What are some ways that accessibility can be incorporated into design and sales of products?**

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### Making Connections

**What I learned from this lesson:**

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**How this connects to the project:**

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**Which part(s) of the project does this lesson address and how might it be used?**

**Research**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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## Engineering Design Process Journal

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## Lesson Connections

### LESSON 5: Culturing Cells

Use the capture sheets and information learned from this lesson to answer the following questions:

**How can primary cells and cell lines in a laboratory provide the ability to collect important data about human health and disease?**

**What are some of the ethical questions that must be answered when discussing the use of cell lines for research?**

**Why might it be beneficial for wearable technology to be used for research purposes and data collection in addition to benefitting the wearer? What are some ways a product could encourage participation in medical research for populations that are lacking data?**



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### Making Connections

**What I learned from this lesson:**

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**How this connects to the project:**

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**Which part(s) of the project does this lesson address and how might it be used?**

**Research**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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## Engineering Design Process Journal

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### Lesson Connections

#### LESSON 6: Infectious Diseases

Use the capture sheets and information learned from this lesson to answer the following questions:

**In what ways is an infectious disease different from a chronic disease?**

**What are some biomarkers that can be used to diagnose an infectious disease?  
What are tools that may be needed to identify these types of biomarkers?**

**What information is important to communicate when discussing a disease diagnosis and treatment with a community of people?**

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### Making Connections

**What I learned from this lesson:**

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**How this connects to the project:**

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**Which part(s) of the project does this lesson address and how might it be used?**

**Research**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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## Engineering Design Process Journal

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## Lesson Connections

### LESSON 7: Chronic Diseases

Use the capture sheets and information learned from this lesson to answer the following questions:

**Why is it important to study and collect data about chronic diseases locally and globally?**

**Why is information about biomarkers of chronic disease so valuable and important for patients who have been diagnosed with or are at risk of these types of diseases?**

**How might the use of wearable biomarker technology help to prevent chronic disease? Where would it be most important to ensure accessibility of wearable technology for chronic disease in the United States?**

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## Engineering Design Process Journal

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### Making Connections

**What I learned from this lesson:**

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**How this connects to the project:**

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**Which part(s) of the project does this lesson address and how might it be used?**

**Research**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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## Engineering Design Process Journal

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### Lesson Connections

#### LESSON 8: Data Generated by Healthy and Diseased Patients

Use the capture sheets and information learned from this lesson to answer the following questions:

**What are biometrics and what information can they provide about a person's health?**

**What are some potential risks or negative consequences that could come from the sharing of a person's biometrics?**

**What could be a positive outcome for a person or population from allowing open access to biometric data?**

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### Making Connections

**What I learned from this lesson:**

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**How this connects to the project:**

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**Which part(s) of the project does this lesson address and how might it be used?**

**Research**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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# FUTURELAB+

## Engineering Design Process Journal

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### Lesson Connections

#### LESSON 9: Statistically Significant Biomarkers

Use the capture sheets and information learned from this lesson to answer the following questions:

Why is it important to be able to distinguish between correlation and causation when analyzing medical and disease-related data?

What are potential consequences for patients if biomarker data significance is interpreted incorrectly?

How could statistical tests be helpful when communicating biomarker data to patients in a way that is understandable and reliable?



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### Making Connections

**What I learned from this lesson:**

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**How this connects to the project:**

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**Which part(s) of the project does this lesson address and how might it be used?**

**Research**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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## Engineering Design Process Journal

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### Lesson Connections

#### LESSON 10: Current Wearable Devices and Data Collection

Use the capture sheets and information learned from this lesson to answer the following questions:

**What are some of the advantages of wearable technology over the traditional way of collecting biomarkers (i.e. going to a doctor's office or hospital)?**

**What are some of the important factors to take into consideration for the customer or patient when conceptualizing and designing wearable technology?**

**What data is necessary or useful when deciding the demographic(s) for which a wearable technology device should be designed and marketed?**

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**What I learned from this lesson:**

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**Prototype Model Design and Production**

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**Product Video Presentation**

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### Step 4: Identify Criteria and Specify Constraints

What are specific criteria and constraints for your chosen innovation challenge?

#### Criteria

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#### Constraints

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#### Potential Materials Needed

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# FUTURELAB+

## Engineering Design Process Journal

Step 1: Define the Problem	Step 2: Brainstorm	Step 3: Research and Generate Ideas	Step 4: Identify Criteria and Specify Constraints	Step 5: Explore Possibilities	Step 6: Select an Approach	Step 7: Develop the Design Proposal	Step 8: Make a Model or Prototype	Step 9: Test and Evaluate Design Using Specifications	Step 10: Refine the Design	Step 11: Modify and Present for Market	Step 12: Communicate Processes and Results
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### Step 6: Select an Approach

Use the following decision matrix to assist in selecting one of your ideas for further development. To use the tool, complete the following steps:

- 1 Enter the criteria and constraints of the project in the first column.
- 2 Use a numeric value to rate each solution against the criteria or constraint. (2 = totally meets the requirement, 1 = somewhat meets the requirement, 0 = does not meet the requirement)
- 3 Total the columns and circle the highest score.

Criteria or Constraint	Sketch/Idea 1	Sketch/Idea 2	Sketch/Idea 3
<b>Other criteria:</b> A single rating for your own “nice-to-have” desirable criteria and universal design criteria (such as <i>Robustness, Aesthetics, Skill Required, Safety</i> ):			
<b>Total</b>			

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### Step 7: Develop the Design Proposal

Now that your group has decided on the best solution, you need to develop a plan to meet your innovation challenge. Some of these components will come in at different points during the unit. Your solution proposal must include the following components:

- 1 Background information on the disease on which your innovation challenge focuses and the biomarkers that are related to it.
- 2 Statistics and data showing the prevalence and disparities related to the disease, as well as case studies or examples showing that early detection or monitoring can help prevent or treat the disease.
- 3 A 2-D or 3-D prototype model that shows how the wearable technology will look, be worn, and theoretically function.
- 4 An explanation of how your wearable device collects biomarker data, and how this information can help a patient who is at risk of or has been diagnosed with a disease.
- 5 Information about the demographic(s) at which your wearable technology will be marketed as well as an explanation of how the reasoning is supported by data.

*Your written solution proposal may be attached to this Design Journal, inserted into the space provided, or submitted digitally according to the teacher's direction.*

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### Step 8: Make a Model or Prototype

In the space below, document (using digital pictures) your construction of the model or prototype. Be sure to include a picture of the final model or prototype.

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### Step 9: Test and Evaluate Design Using Specifications

How will you test or obtain feedback about your prototype or model?

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What data will you collect during testing?

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In the space below, document the type of test you performed and the results.

#### Description of Test Performed

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#### Test Results

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### Step 11: Modify and Present for Market

What changes (if any) did you make to your product after considering data and feedback in the Test and Evaluate Design Using Specifications and Refine the Design steps of this project?

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### Presentation of the Product

#### The video presentation must include:

- 1 Background information on the disease on which your innovation challenge focuses, including statistics showing the prevalence and disparities related to the disease and data that early detection or monitoring can help prevent or treat the disease.
- 2 A brief explanation of what biomarkers are and description of some of the important biomarkers for your disease.
- 3 Presentation of and a description or modeling of how the 2-D or 3-D prototype wearable technology will look and be worn.
- 4 An explanation of how your wearable technology collects biomarker data and how the patient or physician will access and interpret this data in relation to the person's health.
- 5 Features that are targeted to your specific audience. (For example, if your target audience is non-English speaking, it may be helpful to add subtitles in that language or record a second video with a voiceover in the native language of that group.)

Explain in the space below, if this were for an actual crowdsourcing innovation challenge (rather than a fictional one) what further work would need to be done to prepare the product and/or presentation for the marketplace and actual implementation?

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### Step 12: Communicate Processes and Results

Summarize your results by answering the following questions.

1 What were the best elements about your product?

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2 What were the weaknesses of your product?

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3 If you were to take your initial engineering prototype and create a production prototype that would eventually be manufactured and sold to disease patients, what modifications would you make to your wearable technology?

*Explain the reasoning behind any changes or improvements you would make.*

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