# Introduction to Engineering: 1.A.V

**Biomedical Engineering**

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sessions</strong></td>
<td></td>
</tr>
</tbody>
</table>
  Session I: How biomedical engineers help people – 10 minutes  
  Session II: How to remove a blood clot – 25 minutes  
  Session III: How the lungs work – 25 minutes |
| **Seasonality** | N/A |
| **Instructional Mode(s)** | Whole class |
| **Team Size** | N/A |
| **MA Frameworks** |  
  1. Ask questions about objects, organisms, and events in the environment.  
  2. Tell about why and what would happen if?  
  3. Make predictions based on observed patterns.  
  4. Name and use simple equipment and tools to gather data and extend the senses.  
  5. Record observations and data with pictures, numbers, or written statements.  
  6. Discuss observations with others.  
  **Technology/Engineering**  
  1. **Materials and Tools**  
  1.3 Identify and describe the safe and proper use of tools and materials to construct simple structures |
| **WPS Benchmarks** |  
  01.SC.IS.01  
  01.SC.IS.02  
  01.SC.IS.03  
  01.SC.IS.04  
  01.SC.IS.05  
  01.SC.IS.06  
  01.SC.TE.03 |
| **Key Words** | Biomedical engineer, blood clot, lungs, thermometer, wheelchair, x-ray machine |

## Summary

This lesson will teach students about biomedical engineering. Each student will create their own instrument to remove a “blood clot” and test their designs to see how well they performed. The students will then complete an activity using balloons to simulate how the lungs work. The students will also learn some of the different ways that biomedical engineers help to make sick people become healthy.

## Learning Objectives

*Massachusetts Frameworks for Grades Pre K-2*

**Skills of Inquiry**

1. Ask questions about objects, organisms, and events in the environment.  
2. Tell about why and what would happen if?
3. Make predictions based on observed patterns.
4. Name and use simple equipment and tools to gather data and extend the senses.
5. Record observations and data with pictures, numbers, or written statements.
6. Discuss observations with others.

Technology/Engineering

1. **Materials and Tools**
   1.3 Identify and describe the safe and proper use of tools and materials to construct simple structures

2002 Worcester Public Schools (WPS) Benchmarks for Grade 1

- 01.SC.IS.01 Ask questions about objects, organisms, and events in the environment.
- 01.SC.IS.02 Tell about why and what would happen if?
- 01.SC.IS.03 Make predictions based on observed patterns.
- 01.SC.IS.04 Name and use simple equipment and tools to gather data and extend the senses.
- 01.SC.IS.05 Record observations and data with pictures, numbers, or written statements.
- 01.SC.IS.06 Discuss observations with others.
- 01.SC.TE.03 Identify and describe the safe and proper use of tools and materials (e.g., glue, scissors, tape, ruler, paper, toothpicks, straws, spools) to construct simple structure.

**Additional Learning Objectives**

1. Understand how biomedical engineers help people.
2. Know what a blood clot is and why it is dangerous.
3. Understand how the lungs expand when air enters them.

**Required Background Knowledge**

1. Introduction to engineering – Sparky's Engineer 1.A.1

**Essential Questions**

1. What is a biomedical engineer?
2. How can biomedical engineers help people get better?
3. What is a blood clot?
4. What are lungs?

Introduction / Motivation
Ask students if they can remember what a biomedical engineer is. See if any of the students can give examples of what biomedical engineers help to make.

Procedure

Session I: How biomedical engineers help people – 10 minutes

Instructor preparation:
1. Print out the attached pictures of thermometer, wheelchair, and x-ray prior to teaching the lesson.

The instructor will:
1. Show the attached pictures of a thermometer, wheelchair, and x-ray machine one at a time. Explain that a biomedical engineer helped to design all of these tools.
2. For each picture have the students identify what the object is and what it is used for. Ask the students if they know of different variations of the objects (such as a manual wheelchair compared to a motorized wheelchair) and why there are different versions.
3. Ask the students if they can think of any other devices that a biomedical engineer might have helped to create.

Session II: How to remove a blood clot – 25 minutes

Instructor preparation:
1. Put cotton ball inside the center of clear plastic tubing as shown in the picture. (This will be used to simulate how a blood clot stops blood flow.) Make enough of these for each student (or teams of students) and yourself.
2. Set aside a small amount of water and add red food coloring to resemble blood.
3. Print 1 of the attached picture of a blood clot for the entire class. Print one “My Tool to Remove a Blood Clot” worksheet for every student.
4. Prepare a bag of materials for each student including at least 6 paperclips, 3 rubber bands, 1 pipe cleaner, 2 pop sickle sticks, 10” of string, and any other materials that may be helpful to remove the cotton ball from the tubing.

**The instructor will:**

1. Explain to students what a blood clot is and that it can be dangerous because it stops the blood from flowing. Show the printed picture of a blood clot to the class so they can see what it looks like.
2. With the one prepared plastic tube and water, demonstrate how water cannot flow through the straw because of the clot. Show the students that if the straw is empty that the water flows through with no problem.
3. Distribute the bags of materials and plastic tubing with cotton ball to students.
4. Instruct students to examine the materials provided to them in the bag and to think of how they can use 2 or more of the materials together to create a tool to remove the cotton ball. Have them think about pros and cons of the different materials. (e.g. the pipe cleaner might bend and not be strong enough)
5. Distribute the attached worksheet “My Tool to Remove a Blood Clot” and have the students use the engineering design process to create their tool.

6. Instruct students to make their tool using the materials provided. Below is an example tool that can be made by unfolding 6 paperclips and connecting them with rubber bands.

![Example tool made from paperclips and rubber bands](image)

7. Have the students test their tools and try to remove the cotton ball. Discuss whose tool worked the best and why.

![Tested tool](image)

**Session III: How the lungs work – 25 minutes**

**Instructor preparation:**

1. Gather 5 different straws of varying sizes for each student (can cut into different lengths). Make sure that each student has the same variety and lengths of straws.

![Collected straws](image)
2. Gather enough Y connectors so that each student has their own. These connectors can be used the following year if you clean them with ethanol after each use.

3. Gather 2 balloons for each student. 12” helium quality balloons work well.
4. Gather enough rulers so that the students can measure the length of the straws.
5. Print out 1 “Which Straw is Best?” worksheet for each student.

*The instructor will:*

1. Distribute straws, Y connectors, saran wrap, balloons, and “Which Straw is Best?” worksheet to students.
2. Instruct students to attach the 2 balloons to the ends of the y connector and a straw to the remaining end. Wrap saran wrap around where the straw connects to the y connector to seal it.

3. Have the students measure the length of the straws and record it on “Which Straw is Best?” worksheet.
4. Have the students blow into the straw to inflate the balloons. Explain that this is how lungs work when air enters into them.

![Image of a person blowing into a straw to inflate balloons]

5. Instruct the students to try all of the straws and compare which is easiest and which is hardest. Have the students write down their observations on the worksheet.

6. Discuss with the class which straws were better or worse and why.

**Materials List**

<table>
<thead>
<tr>
<th>Materials per class</th>
<th>Amount</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pictures</td>
<td>One</td>
<td>Attachment section</td>
</tr>
<tr>
<td>1' plastic tubing</td>
<td>One</td>
<td>Home improvement store</td>
</tr>
<tr>
<td>Cotton ball</td>
<td>One</td>
<td>Drugstore</td>
</tr>
<tr>
<td>Water with red food coloring</td>
<td>1 cup</td>
<td>Food coloring at grocery store</td>
</tr>
<tr>
<td>Saran wrap</td>
<td>One box</td>
<td>Grocery store</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials per student</th>
<th>Amount</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1' plastic tubing</td>
<td>1 per student</td>
<td>Home improvement store</td>
</tr>
<tr>
<td>Cotton ball</td>
<td>1 per student</td>
<td>Drugstore</td>
</tr>
<tr>
<td>&quot;My Tool to Remove a Blood Clot&quot; worksheet</td>
<td>1 per student</td>
<td>Attachment section</td>
</tr>
<tr>
<td>Paper clips</td>
<td>6 per student</td>
<td>Drugstore</td>
</tr>
<tr>
<td>Rubber bands</td>
<td>3 per student</td>
<td>Drugstore</td>
</tr>
<tr>
<td>Pipe cleaner</td>
<td>1 per student</td>
<td>Craft store</td>
</tr>
<tr>
<td>Popsicle sticks</td>
<td>2 per student</td>
<td>Craft store</td>
</tr>
<tr>
<td>10&quot; string</td>
<td>1 per student</td>
<td>Craft store</td>
</tr>
<tr>
<td>&quot;Which Straw is Best?&quot; worksheet</td>
<td>1 per student</td>
<td>Attachment section</td>
</tr>
<tr>
<td>Plastic Y connector</td>
<td>1 per student</td>
<td>Home improvement store</td>
</tr>
<tr>
<td>Straws of varying size</td>
<td>5 per student</td>
<td>Grocery store</td>
</tr>
<tr>
<td>Ruler</td>
<td>1 per student</td>
<td>Craft store</td>
</tr>
<tr>
<td>Balloon (12&quot; helium quality)</td>
<td>2 per student</td>
<td>Drugstore</td>
</tr>
</tbody>
</table>
Vocabulary with Definitions

1. **Biomedical Engineer** – a person who designs tools that doctors and nurses use to help sick people get better. They create motorized wheelchairs, medicine, stitches, and artificial legs.

2. **Blood clot** – a clump of blood that stops blood from flowing.

3. **Lungs** – organs in the chest that allow people to breathe.

4. **Thermometer** – an instrument used to measure temperature.

5. **Wheelchair** – a chair that can be rolled around to help people get around.

6. **X-ray machine** – a machine used to see inside the body.

Assessment / Evaluation of Students

The instructor may assess the students in any/all of the following manners:

1. Ask questions about what biomedical engineers help to make.

2. Ask students why certain blood clot removing tools worked better or worse.

3. Ask students which straw allowed them to blow up the balloons the most.

Lesson Extensions

None

Attachments

1. Thermometer picture

2. Wheelchair picture

3. X-ray picture

4. Blood clot picture

5. “My Tool to Remove a Blood Clot” worksheet

6. “Which Straw is Best?” worksheet

Troubleshooting Tips

None

Safety Issues

Students should be supervised at all times and should not share straws for sanitation purposes.
Additional Resources
None

References for Pictures
Thermometer

Wheelchair
http://www.waldosworld.org/gallery03/wheelchair.jpg

X-ray machine
http://www.hasslefreeteclipart.com/clipart_medical/xray.gif

Blood clot
http://www.msouza.net/59328630.jpg

Key Words
Biomedical engineer, blood clot, lungs, thermometer, wheelchair, x-ray machine
THINK: What materials would be best to remove a blood clot and why:

____________________________________

DESIGN: My tool looks like:

CREATE: Time to make our blood clot removing tools!

TEST: Will your tool get the blood clot out?
Which Straw is Best?

First measure each straw and record the length below. Then test each straw and record if it was harder or easier to fill the balloons. Then decide which straw would be the best to use and which one would be the worst.

<table>
<thead>
<tr>
<th>Straw</th>
<th>Length</th>
<th>Hard/Easy to Fill the Balloons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straw 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straw 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straw 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Straw 5</td>
<td></td>
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</tbody>
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Best

Worst