Teacher Information

Curricular goals
Design an authentic learning experience that:

- links engineering practices with content in the biological sciences.
- incorporates the human empathy component of the engineering-design process.
- develops higher-order thinking skills by requiring students to take ownership of the research, development, and implementation of their ideas.
- results in a final “solution” which cannot be pre-determined prior to beginning the unit.

Implementation timeline

<table>
<thead>
<tr>
<th>Day</th>
<th>Topic</th>
<th>Suggested activities</th>
<th>Standards focus</th>
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</table>
| Day 1| Engaging students and introducing the problem | Formative assessment: KWL chart  
Heart of the Matter (heart disease video)  
How Engineering is Changing Surgery (Daily Planet video—DaVinci Robot)  
Project 500—Medical Innovations (article)  
Optional extension: Disease and steroid use  
HW: Research heart disease  
Research and define key words                  | Design thinking  
Content background  
Asking Questions and Defining Problems |
| Day 2| Establishing empathy                   | Reading a fictional story  
Discussing a nonfiction article  
Interviewing heart-disease patients  
Video—Telegraph UK  
HW: Reflective paragraph  | Design thinking  
Crosscurricular with ELA |
| Day 3| Brainstorming                          | Complete the “L” from Day 1 KWL chart  
Brainstorm and sketch  
One-to-two minute share-out  
Show supplies that will be available for the next day  
HW: Complete the design worksheet | Design thinking  
Developing and Using Models  
Planning and Carrying Out Investigations |
| Day 4| Building and testing                   | Build and test—no design constraints | Planning and Carrying Out Investigations |
| Days 5 and 6 | Evaluating, redesigning, retesting | Self-evaluation (design worksheet)  
Develop a revised plan (design worksheet)  
Peer evaluation (with rubric)  
Redesign, retest, collect data  
HW: Complete design worksheets, data-collection worksheets, and peer review |
|--------------|-------------------------------|---------------------------------------------------------------------------------|
| Day 7        | Evaluating and wrapping up    | Present poster and student-made video clips  
Final write-up and model presentation  
Watch: TED Talk on “Future of Medicine”  
Read: Dissolvable stents |

**Engineering-design cycle**

- Empathize
- Define problem
- Brainstorm
- Design
- Plan
- Create
- Test
- Iterate
Materials needed (per group):

*For clogged arteries:*
- 8 in. of 1 in.-diameter tubing**
- Canned icing (three cans needed per class of 28 students)
- Transparent tape
- Knife

*For device construction*
- 1 pipe cleaner
- 10 in. thin wire
- 2 long, thin balloons
- 1 small balloon pump

*For the “flow” measurement station:*
- Stopwatch
- 2-liter plastic bottle
- Wash basins or plastic bins
- Towels (for clean-up)
Step-by-step preparation for the clogged arteries*
(Total prep time 30/minutes)

1. Gather icing, knife, tubing, and transparent tape. Cut enough tubing so that each group has four 2-in. pieces.
2. Pack the icing into each of the tubes until the icing is approximately 1.5 in. deep.
3. Tape the tubes together with transparent tape so that the icing makes one complete section. Make enough “arteries” so that each group has two arteries to work with.
4. Chill the “arteries” overnight in a refrigerator.
5. Using a straw, create a narrow opening in each of the “arteries” to allow minimal blood flow.
6. Clean up. Tubing may be cleaned by placing it on the top rack of a dishwasher and setting the washer to the “light” or “glass” setting. If a dishwasher is not available, tubing can also be cleaned by hand.

** PVC can be used in place of vinyl tubing.

Additional information may be found at www.teachengineering.org, the original authors of this specific activity.
**Modifications**

Suggested modifications for the learning disabled vary according to the type and degree of the disability. Be sure that groups are evenly balanced. For example, a student with dyslexia should be paired with another student with strong reading skills. A student with ADHD or other disability that makes following multistep instructions difficult should receive frequent check-ins and should be paired with another student who does not find it difficult to remain on task. Reviewing data collection sheets prior to data collection and providing a “first, next, finally” checklist on the board can also be helpful.

Extensions for gifted students include performing the procedure using a stent as well as decreasing the diameter of the tubing. Students may also be asked to use ratios or other mathematics to display their data and compare trials.