

Student activity packet

Student goals

Learning goals for the student include:

- using engineering practices and the engineering-design process to develop, analyze, and repeatedly test a viable solution to a proposed problem.
- recognizing the importance of human empathy and its impact on the design process.
- deepening the understanding of the heart and associated medical problems.
- understanding the cyclical relationship between science and engineering.

Key words

- artery
- biomedical engineering
- blood vessel
- circulation
- circulatory system
- engineering-design process
- heart attack
- human body
- medical
- stroke
- balloon catheter
- bioengineering
- catheter
- bypass surgery
- model
- plaque (as it relates to heart disease)
- prototype
- stent
- plaque

Heart dissection

After viewing the video “Sheep Heart Dissection” and using the iPad app Explore the Heart in 3D, students should be able to answer the following questions:

1. What is the function of the heart in relation to the rest of the body? (**To pump blood throughout the body.**)
2. To what subsystem(s) does the heart belong? (**Cardiac subsystem, vascular subsystem.**)
3. Using the Explore the Heart in 3D app as a conceptual model, describe how the various parts of heart work together to pump blood throughout the body. Also, include a diagram showing the direction of blood flow through the heart and associated veins/arteries. (**See the Explore the Heart in 3D app’s Anatomy tab for a detailed description of blood flow. Another good reference is www.medicinenet.com/heart_how_the_heart_works/page3.htm.)**)
4. What is plaque, and what is the consequence of increased plaque/cholesterol build-up? What does this build-up mean for the rest of the body systems? (**See the conceptual model [iPad app]. Students will see a thickening of the arteries and a subsequent decrease in blood-flow rate. Discuss how this leads to decreased blood, nutrients, oxygen, etc., reaching the rest of the body.**)
5. Describe how a heart malfunction affects the entire body system. Be specific.

Should you be interested in a more detailed study of the heart, we recommend visiting the Biology Corner website (see article Resources) for complete dissection instructions and student questions.

Research questions

After watching the videos and conducting independent research on bypass surgery and coronary heart disease, you should be able to answer the following questions:

1. What is coronary heart disease? Approximately how many people, and of what age groups, are affected?
2. In a patient with heart disease, what needs to be done to help the artery? What difficulties might doctors face when performing this procedure?
3. What is the current treatment for heart conditions? How might this treatment be different from treatments of 10 years ago? 20 years ago? 50 years ago? (Focus on the size of the incision, types of equipment used, and type of procedure performed.)
4. What do doctors do before, during, and after surgery to ensure that patients remain healthy (and survive the procedure)?
5. What are some of the risks involved in bypass surgery?
6. What is a heart-bypass machine? When is it used? For how long?

Design worksheet 1

Problem: Your challenge today is to create a device that could remove or flatten the built-up plaque inside artery walls. How are you going to go about doing this without harming your patient?

First, you are going to do some **team brainstorming**.

What ideas do you have about how we might unclog a blocked artery?

Which of the above methods do you think will be the most successful? Why?

Which method would you like to try first?

Now, it is time to **design**. Your team has two identical, blocked arteries and a set of materials. Use the materials to develop a device to improve blood flow in the artery. Remember, you do not have to use all the materials. Keep in mind that you do not want to just knock the plaque off the wall and leave it in the bloodstream, and you do not want to hurt the fragile inside wall of the arteries. Once you are confident in your design, submit it to the teacher for approval.

Data collection worksheet- I

Now it is time to measure the blood flow through the artery to determine the effectiveness of the treatment you provided. Be sure to make detailed observations of all that you see. If a video recorder is available, you should focus on the procedure as opposed to the person performing the procedure.

Trial I

Artery type	Time for two liters of water to flow through artery (in seconds)
Clear artery	
Blocked artery	
Cleared artery #1	
Cleared artery #2	

Rank the arteries. Begin with the one which had the most flow:

- 1.
- 2.
- 3.
- 4.

Import photos here.

Upload your video to your Google folder.

Did your artery clearing devices work? If so, how well did it work?
If not, why do you think it did not work?

Did your procedure consider the health and safety of the patient? Please be specific.

How could your design be improved in the future?

Design and data-collection worksheet 2

Trial II

Describe how your design in Trial II is different from that of Trial I. Why did you make the changes that you did? In other words, what are you hoping to accomplish or do better?

Artery type	Time for 2 liters of water to flow through artery (in seconds)
Clear artery	
Blocked artery	
Cleared artery #1	
Cleared artery #2	

Rank the arteries (include arteries from Trial I). Begin with the one that had the most flow:

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.

Upload your video to your Google folder.

In which trial did you get the best results? Why? What was it about your design change that made the difference?

Peer evaluation

You are now going to explain your design and project results to a peer group for evaluation. If you have time, you may create a presentation (Google, Keynote, etc.) to help you explain what you did and why.

Rank your classmate's design.

Question	Yes/very (explain why)	No/not so much (explain why)
How effective was the design?		
Did the team solve the problem?		
Did they show other ways to solve the problem?		
Did they try other ways to solve the problem?		

Final report template

Problem

Constraints (Things you had to keep in mind OR things you could not do. Bullet points are fine.)

Changes/redesign (Bullet points are fine. Pictures with captions would also be acceptable.)

Conclusion

- Paragraph one: What are the functions of the cardiovascular and respiratory systems? How do the two systems interact?
- Paragraph two: What is coronary heart disease (causes, symptoms, etc.)?
- Paragraph three: What was the problem you were trying to solve? Why is the problem important to solve?
- Paragraph four: What was your original plan to solve the problem? How (and why) did your designs change over time?
- Paragraph five: Did you solve the problem? What were you able to do? What were you not able to do?

Sources: Where did you get your information? Wikipedia is not an acceptable source. Neither is *Ask.com*.