ORGAN DONATION/TRANSPLANTATION LESSONS
for NYS Regents Living Environment

A series of five engaging lessons to either be spread throughout the homeostasis unit as a progressive case study or taught in succession at the end of the unit as a review.
Acknowledgements

This guide was written as a collaboration between the New York City Department of Education and LiveOnNY.

Contributing Authors

Ingrid Buntschuh
Citywide Instructional Lead, High School Science

Anna Poole
Citywide Instructional Specialist, Secondary Science

Christie (Minjeong) Kim
Teacher, Mott Hall Charter School

Miriam Stanford-Cusack
Teacher, A. Philip Randolph Campus High School
Special Thanks To

Greg Borman
Director of Science, NYCDOE

Sandy Brawer
Executive Director, Business Services, NYCDOE

James Pardes
Vice President, Marketing & Communications, LiveOnNY

Julia Rivera
Director, Communications, LiveOnNY

Scott Wohl
Senior Manager, Community Engagement & Activation, LiveOnNY

Phoebe Kmeck
Manager, Community Programs & Volunteer Services, LiveOnNY

Ingrid Lafalaise
Assistant Principal, ACORN Community High School

Richard Numeroff
Relay Productions Inc.

Dr. Devon John, Dr. Amy Friedman, Sandy, Robin, Kelli, Shelby, Kelvin, and Merida
Video Volunteers
Special Thanks to the Following People for Piloting Earlier Versions of these Lessons

Kamilla Hussein
Shirley Labardy
Beata Sadigh
Bayside High School

Cyntra Bernardo
Donna Nathan
Brooklyn Technical High School

Joseph Chirayil
DeWitt Clinton High School

Yuka Bell
Amy Morales
High School for Environmental Studies

Jerry Cintron
Stuyvesant High School

Scott Greenfield
Tottenville High School
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTRODUCTION</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>IMPLEMENTATION</strong></td>
<td>7</td>
</tr>
<tr>
<td><strong>LESSON OVERVIEW</strong></td>
<td>8</td>
</tr>
<tr>
<td><strong>LESSON 1</strong></td>
<td>9</td>
</tr>
<tr>
<td>Teacher Pages</td>
<td></td>
</tr>
<tr>
<td>Case Study: What is it Like to be Ava?</td>
<td>12</td>
</tr>
<tr>
<td>Savannah’s Blog: My Life with CF</td>
<td>14</td>
</tr>
<tr>
<td>Quick Facts Infographic</td>
<td>16</td>
</tr>
<tr>
<td>Optional Organ Donor Anticipation Guide (for Quick Facts sheet)</td>
<td>18</td>
</tr>
<tr>
<td>Video Transcript: Organ Donor Family: Sandy and Robin, Parents of Janine</td>
<td>19</td>
</tr>
<tr>
<td>Video Transcript: Organ Donor Family: Kelli, Mother of Thomas</td>
<td>21</td>
</tr>
<tr>
<td><strong>LESSON 2</strong></td>
<td>22</td>
</tr>
<tr>
<td>Teacher Pages</td>
<td></td>
</tr>
<tr>
<td>Case Study: Why is Ava’s Heart Worn Out?</td>
<td>26</td>
</tr>
<tr>
<td>Oxygen Transport Game</td>
<td></td>
</tr>
<tr>
<td>Teacher’s Guide: Whole-Class Simulation Version</td>
<td>28</td>
</tr>
<tr>
<td>Game Map</td>
<td>31</td>
</tr>
<tr>
<td>Game Piece Printouts</td>
<td>32</td>
</tr>
<tr>
<td>Teacher’s Guide: Alternate Desktop Version</td>
<td>47</td>
</tr>
<tr>
<td>Game Board and Piece Printouts</td>
<td>49</td>
</tr>
<tr>
<td><strong>LESSON 3</strong></td>
<td>55</td>
</tr>
<tr>
<td>Teacher Pages</td>
<td></td>
</tr>
<tr>
<td>Reading: The Immune System and Transplants</td>
<td>58</td>
</tr>
<tr>
<td>Assignment: The Immune System and Transplants</td>
<td>59</td>
</tr>
<tr>
<td>Video Transcript: Transplant Surgeon: Dr. Devon John</td>
<td>60</td>
</tr>
<tr>
<td>Video Transcript: Transplant Surgeon: Dr. Amy Friedman</td>
<td>61</td>
</tr>
<tr>
<td>Video Transcript: Organ Recipient: Shelby</td>
<td>62</td>
</tr>
<tr>
<td>Video Transcript: Organ Recipient: Kelvin</td>
<td>64</td>
</tr>
<tr>
<td>Video Transcript: Organ Recipient: Merida</td>
<td>65</td>
</tr>
<tr>
<td><strong>LESSON 4</strong></td>
<td>66</td>
</tr>
<tr>
<td>Teacher Pages</td>
<td>66</td>
</tr>
<tr>
<td>Organ Donation/Transplantation Project Outline</td>
<td>68</td>
</tr>
<tr>
<td>Poster Templates</td>
<td>69</td>
</tr>
</tbody>
</table>
Introduction
On August 18, 2016, Governor Cuomo signed a law reducing the age at which New Yorkers can register to be organ donors from 18 to 16. All New Yorkers aged 16 or older are now asked whether they would like to register as organ donors when they get their drivers licenses and permits, register to vote, or apply for an IDNYC card. In order to make an informed decision, high school students need to understand what organ donation is and why they are being asked about it.

In this set of lessons, students learn about organ donation and cystic fibrosis through the eyes of a student, Lavon, and his new classmate, Ava, who has cystic fibrosis. This series of lessons provides an engaging, real-world context for the teaching of Living Environment content related to homeostasis and immunity. The interactive activities can be incorporated into your course either as a progressive case study, with the lessons being taught throughout the unit, or as a culminating set of lessons, providing review of the unit. Students have opportunities to engage with multiple non-fiction source materials, including infographics, blogs, video interviews, and texts. The final project incorporates structured group work as well as student choice in a final piece of writing.
Implementation

This set of lessons has been designed to be used in either of two ways:

1) Distributed throughout the homeostasis unit, these lessons can provide a motivating story and connecting thread.
   • Lesson 1 would be used at the beginning of the homeostasis unit
   • Lesson 2 would be used at the end of the body systems section
   • Lesson 3 would be used at the end of the immunity section
   • Lessons 4 and 5 would serve as the culminating activities for the whole unit

2) Used at the end of the homeostasis unit, these lessons can serve as a review of material taught throughout the unit.
   • Lessons 1 through 5 would be taught, in sequence, as the culminating lessons for the whole unit
Lesson Overview

<table>
<thead>
<tr>
<th>Lesson One - What is cystic fibrosis and how do people live with it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>This lesson connects what students have already learned about the interconnectedness of body systems to an understanding of how cystic fibrosis (CF) affects the body. Students read a blog of a person with CF, complete a T-chart, review a fact sheet, watch a video about organ donation, and discuss their findings.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lesson Two - How does cystic fibrosis affect homeostasis?</th>
</tr>
</thead>
<tbody>
<tr>
<td>This lesson connects what students have already learned about homeostasis to the interactions between the circulatory and respiratory systems. Students model oxygen transport in the body in a healthy person and in people with cystic fibrosis and with sickle cell disease.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lesson Three - Why does the body reject some transplanted organs and how can this rejection be minimized?</th>
</tr>
</thead>
<tbody>
<tr>
<td>This lesson connects what students have already learned about the immune response to organ transplantation and possible rejection. Students watch videos, read text and answer questions about antigen-antibody responses to mismatched organs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lesson Four - What do doctors and recipients need to know before considering organ transplantation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>This lesson combines a review of homeostasis and the immune response with important information regarding receiving an organ transplant. Students use what they have learned to create a poster addressing factors and concerns for consideration by organ recipients.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lesson Five - How does organ donation/transplantation work and is registering as an organ donor right for me?</th>
</tr>
</thead>
<tbody>
<tr>
<td>This lesson is a culminating activity in which students use what they have learned from creating the poster in Lesson 4 to write a letter from either themselves or Lavon to their families.</td>
</tr>
</tbody>
</table>
Lesson 1
Cystic Fibrosis and Organ Donation

Purpose/Connection
This lesson connects what students have already learned about the interconnectedness of body systems to an understanding of how cystic fibrosis (CF) affects the body. Students read a blog of a person with CF, complete a T-chart, review a fact sheet, watch a video about organ donation, and discuss their findings.

Guiding Question/Aim
What is cystic fibrosis and how do people live with it?

Instructional Objectives
● Students will be able to describe cystic fibrosis
● Students will be able to identify treatments for cystic fibrosis and the reasons for those treatments
● Students will be able to explain why organ donations are needed

Vocabulary
• algorithms • affiliated • contagious • corneal • cystic fibrosis • disfigure • ducts • harbor
• lymphoma • mucus • nebulizer • platelet • prospective • respective • revoke • sterilized
• synthetic • thrive • transfusions • viability

Materials
● Reading assignment and graphic organizer: What Is It Like to Be Ava?
● Reading assignment: Savanna Fuller – My Life with CF
  http://savannahfuller.blogspot.com/ (print version included in this packet)
● Handout: Quick Facts: Organ, Eye, and Tissue Donation and Transplantation
● LiveOnNY Organ Donor Family video:
  Organ Donor Family: Sandy and Robin, Parents of Janine (6:54)
  https://vimeo.com/232544635/4d600df474, or
  Organ Donor Family: Kelli, Mother of Thomas (2:57)
  https://vimeo.com/223005016/3325457085
● Optional:
  ● Images of “CF mechanical vest,” “nebulizer,” “CF medications,” etc. (not included)
Suggested Sequence of Activities - Lesson 1

1. Use What Is It Like to Be Ava? to introduce the story of Lavon and Ava.
2. Read Savannah Fuller's blog entry, My Life with CF, and use it to fill in the T-chart.  
   Optional: You may want to show students the vest and nebulizer video and/or additional images to help them understand the treatments Savannah mentions.
3. Have the class discuss (with the purpose of suggesting organ donation as a solution): If all of these treatments stop working for Ava, what could be done to help Ava stay alive?
4. Have the class review the Quick Facts sheet. Have students share a few facts from the sheet that seem relevant to keeping Ava alive.  
   Optional: You may want to give students the optional anticipation guide before giving them the Quick Facts sheet.
5. Watch one of the LiveOnNY Organ Donor Family videos and discuss:  
   - What does it mean to become an organ donor?
   - How would you feel about becoming an organ donor and why?
   - Why is it important for families to talk about their wishes with one another?  
   (Organ Donor Family: Sandy and Robin, Parents of Janine and Organ Donor Family: Kelli, Mother of Thomas are available at time of printing)  
   Optional: You may want to use the closed captioning and/or give students the transcript of the video.
6. Exit Assessment or Discussion:  
   What is cystic fibrosis and how do people live with it? What role can organ donation/transplantation play?

Please note, teachers should be prepared to answer and ask questions about organ donation that are not part of the factual information in the lesson packet. Some research and additional time may be required to make the lesson go smoothly.

Extension

- Either do some deeper research into one of the facts on the fact sheet or find a relevant fact that you could add to the fact sheet.
- Investigate another disease that could result in the need for organ donation/transplantation. How does the disease disrupt homeostasis? How does a donated organ help solve the problem?
Standards

NYS Living Environment

- 4.1.2c The components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment. To successfully accomplish this, organisms possess a diversity of control mechanisms that detect deviations and make corrective actions.
- 4.1.2d If there is a disruption in any human system, there may be a corresponding imbalance in homeostasis.
- 4.5.2a Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.

NYS Next Generation ELA Learning Standards

- 9-10.RST.1 Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc. attending to the precise details of the source. Understand and follow a detailed set of directions.
- 9-10.RST.4 Determine the meaning of symbols, key terms, and other content-specific words and phrases as they are used in scientific or technical sources; describe how the inclusion of charts, graphs, diagrams, data influence conclusion(s).
- 9-10.WHST.2: Write informative/explanatory text focused on discipline-specific content.
What Is It Like to Be Ava?

Lavon was excited to see a new girl in class a few weeks ago. Because she coughed a lot and some kids were worried about getting sick, she explained to the class that she coughs because she has cystic fibrosis, or CF. She said that since CF is a genetic disease it is not contagious. Ava explained that in her body, mucus, kind of like what is in your nose, builds up in her organs, including her lungs and pancreas. The mucus in her lungs makes it hard to breathe and also makes her cough. The mucus also traps bacteria, which leads to infections and damages her lungs.

Recently Ava was out of school for a whole week. Complications related to the cystic fibrosis had put her in the hospital. Now she is back in class. It is hard to believe that Ava’s body is having such a hard time! She seems like a regular kid, except for the coughing. She likes running and biking, and she is really funny. When Lavon asks her if she has to do any special stuff to stay healthy, she sends him to a blog written by another girl, Savannah Fuller, who also has CF.

Savannah Fuller: My Life with CF

http://savannahfuller.blogspot.com/

Please read Savannah’s blog and make a T-chart with the treatments she does on one side and the reasons for the treatments on the other side. Please continue on the back of this paper.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Reason for Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Explain, in your own words, what cystic fibrosis is to a student who is not in your class.
My name is Savannah, I’m 17 years old and I have Cystic Fibrosis. I was diagnosed with CF at only 8 months old due to "failure to thrive." That means I wasn’t gaining any weight, which is a classic symptom of CF.

From the outside looking in, you would never know I had CF. However, there is a ton of effort that goes into maintaining my health.

Because the ducts in my pancreas are blocked with thick mucus, I have to take synthetic enzymes before eating so my body will digest the food and absorb the nutrients better. I have bottles of enzymes all over the house and keep a pill case full of them in my purse for when I go out to eat. I take anywhere from 3-5 enzymes prior to eating, depending on the richness of the food I’m eating. And that’s not all. I still need to supplement with daily vitamins to make up for the nutrients that the enzymes didn’t help absorb. Sometimes all of these pills make me full before I even start a meal!

To thin the mucus and help prevent infections, I do 3 or 4 breathing treatments every single day. I also do my vest twice a day, 20 minutes each time. Breathing is most difficult for me when I wake up. I always start my morning with a treatment and I make sure I do one any time before I leave the house, just to ensure I feel the best that I can. Often times that means waking up an hour earlier than most people would or leaving a bit later than you would have liked, but you gotta do what you gotta do. And for me, health will always come first.

Along with breathing treatments, I also use a mechanical vest each day that literally shakes my insides to help loosen the thick, sticky mucus in my lungs. As a result, I cough the mucus up and out. It’s not my favorite thing to do, but better out than in!

After using my nebulizer, the nebulizer cups have to be sterilized before I can use them again. I use a baby bottle sterilizer to clean my nebs. If they are not sterilized with hot steam, they may harbor germs that could possibly cause an infection in my lungs.
Growing up, I was always encouraged to participate in all kinds of exercise. I have taken ballet, tap, taekwondo, yoga, aerobics, and currently I enjoy weight training 3-4 times a week. Exercise is important to give my lungs a workout as well as the rest of my body.

Four times a year I have to go to Columbia, SC to visit my pulmonologist, a doctor who specializes in lungs, to have different tests performed. The reason we have to travel 3 hours away to Columbia to see the pulmonologist is because they have to be a center that is certified by the Cystic Fibrosis Foundation to treat CF patients, since it is a rare disease.

So, if you’re wondering, here’s a breakdown of my typical day. Currently I am homeschooled, so this is not an "average" schedule, but it is genuinely what I do every day. And I can work this around what I’m doing on a particular day.

9:00 am - Wake up and do my first breathing treatment
10:00 am - Eat breakfast with enzymes, then take my first round of morning meds
11:00 am -- 2:00pm - Do school work for the day
2:30pm - Eat lunch with enzymes and take afternoon meds
2:30 -- 3:00pm - Do afternoon breathing treatment with The Vest
3:00pm - 4:00pm - Exercise
4:30pm - Have a snack such as fruit or cheese and crackers
5:00pm - Take evening meds
7:30pm - Eat dinner with enzymes
8:30 -- 9:00pm - Do nightly breathing treatment with The Vest

Now if I went to "regular" school this schedule would be so much more difficult to maintain. Not impossible, but definitely challenging. That’s why my parents and I found it best for me to just do online school.

I’ve never let CF stop me from anything I want to do. I feel just as normal as anybody else. Even though I have a lot of extra things to do each day, I still live a pretty normal life.
Organ Donation & Transplantation Fact Sheet | January 2018

### the basics

- One organ donor can save up to **eight lives**. One tissue donor can improve the lives of up to 50 people.
- There are two types of consent for deceased donation: **first person consent**, which is authorization via registration, living will or last will & testament by the individual who wishes to become a donor, and **third person consent**, which is authorization for donation by a legally authorized party for an individual who is not registered or who has not otherwise legally declared consent.

### the wait

- **114,997** people on the national waiting list for organs
- **9,383** people waiting in NYS
- **8,117** people waiting in the NY metropolitan area

### the truths

- **Doctors will do everything in their power to save you**
  - Organ donation only occurs after the death of a patient is declared by a physician who, legally, must not be affiliated with donation.

- **It is supported by most religions**
  - Most major religions support organ donation including Judaism, Buddhism, Islam, Christianity, and more (see page 2).

- **Don’t rule yourself out**
  - There is no age limit for donation, the oldest donor on record was 96. Regarding medical conditions, doctors will make a determination regarding the viability of organs at the time of death.

- **Traditional funeral services are possible**
  - Organ donation does not disfigure the body or delay funeral arrangements. Open-casket viewings are possible. Families of donors are not responsible for medical costs related to donation.

### quick facts

- Organ, eye, and tissue donation & transplantation

- **HEARTS:**
  - 3,983
  - (NYS: 365)

- **LIVERS:**
  - 13,874
  - (NYS: 1,092)

- **PANCREAS:**
  - 894
  - (NYS: 182)

- **KIDNEYS:**
  - 95,335
  - (NYS: 7,801)

- **LUNGS:**
  - 1,373
  - (NYS: 64)

- **INTESTINES:**
  - 247
  - (NYS: 8)

### The Wait

- Nationally, most patients wait **one to two years** for an organ transplant. In NYS, most patients wait **three to five years**.
- Every **10 minutes** another person is added to the national transplant waiting list. The list is managed by the United Network for Organ Sharing (UNOS). UNOS uses algorithms to appropriately match candidates with compatible organs.

### Hearts

- **3,983**
  - (NYS: 365)

### Livers

- **13,874**
  - (NYS: 1,092)

### Kidneys

- **95,335**
  - (NYS: 7,801)

### Lungs

- **1,373**
  - (NYS: 64)

### Intestines

- **247**
  - (NYS: 8)

### 50th

- NYS ranks last in the nation in percent of residents registered as organ donors.

### Every 18 hours someone in NYS dies waiting for an organ.

- **31%** of NYS residents are registered organ donors.
- **56%** of residents across the rest of the U.S.

Source: Organ Procurement and Transplant Network and Donate Life America
quick facts
organ, eye, and tissue donation & transplantation

types of donation

There are two types of donation: living donation and deceased donation. Living donation provides an opportunity for an individual to save a life while still living. Deceased donation occurs after the prospective donor is declared deceased by a physician. This fact sheet provides information on deceased donation, however living donation is also an option for those who wish to save lives through organ donation. Living donors may donate a kidney, a third of the liver, and in some rare cases, a portion of the pancreas or intestine and a lung (see page 1).

signing up

In NYS, you can register to become an organ donor when you visit the DMV, register to vote, apply for an idNYC card, register for health insurance through the health benefits exchange, or at LongLiveNY.org.

Those aged 16 and 17 can register their consent to become an organ donor. Parents/guardians will be notified at the time of the potential donation and, if they wish, can revoke the option. Once the registered minor turns 18 the parent/guardian option to revoke consent is no longer available.

the history

- 1906: first corneal transplant
- 1954: first successful kidney transplant
- 1967: first successful heart transplant
- 1977: first computer-based organ matching system implemented
- 1983: cyclosporine is introduced (immune suppressant)
- 1998: first successful hand transplant
- 2001: first time the number of living donors (6,528) exceeded the number of deceased donors (6,081)
- 2010: first successful full face transplant
- 2013: the HIV Organ Policy Equity (HOPE) Act was passed allowing for research into transplanting organs from HIV+ donors to HIV+ patients

religious perspectives

Generally, all major religions support organ donation as a final act of compassion and generosity. For instance, Judaism believes that if it is possible to donate an organ to save a life, it is obligatory to do so. Similarly, Catholicism views organ donation as an act of charity, fraternal love and self-sacrifice; while, the Islamic faith believes in the principle of saving human lives and permits donation as a means of achieving that noble end. Prospective donors may wish to continue the conversation regarding organ donation with their respective religious leaders. See below for quotes regarding donation from religious authorities.

catholicism

“Organ donation is a testimony of love for our neighbor.”
- Pope Francis, October 2014

judaism

“...Whoever saves a life, it is considered as if he saved an entire world.”
- Jerusalem Talmud, Sanhedrin 4:1 (22A)

islam

“Whoever saves the life of one person it would be as if he saved the life of all mankind”
- Holy Qur’an, Chapter 5 vs. 32

number of deceased donor transplants performed in NYS in 2017: 1,707

number of deceased donor transplants performed in the U.S. in 2017: 28,587

1,707

28,587

Information provided by LiveOnNY
Organ Donation & Transplantation Fact Sheet | January 2018
Based on what you currently know about organ donation, please mark the following statements as “true” or “false.” You will then look at a fact sheet and write down evidence to support or refute the original statements.

<table>
<thead>
<tr>
<th>Before True or False?</th>
<th>Statement</th>
<th>After True or False?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Each organ donor can save one life.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidence:</td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td>A doctor will not try as hard to save your life if you are an organ donor.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidence:</td>
<td></td>
</tr>
<tr>
<td>3)</td>
<td>56% of New York State residents are registered organ donors compared to 31% nationwide.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidence:</td>
<td></td>
</tr>
<tr>
<td>4)</td>
<td>Kidneys are the most needed organs, both in the country and in New York State.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidence:</td>
<td></td>
</tr>
<tr>
<td>5)</td>
<td>You must be 21 to become an organ donor in New York State.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidence:</td>
<td></td>
</tr>
<tr>
<td>6)</td>
<td>Most religions are against organ donation.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidence:</td>
<td></td>
</tr>
</tbody>
</table>
00:05 - So, Janine was a typical teenager, 17-years-old, a senior in high school. She had just gotten her driver's license four months before November of 2009. And when the license came, out floated a bright red piece of paper that said on it, "You may not sign up to be an organ donor until your 18th birthday." And Janine got very upset because she had expressed the intense desire to be an organ donor, and let me know in no uncertain terms that that's what she had wanted. Unfortunately, four months later, she was in an accident and did not recover, and we followed her wishes and were able to donate her organs. We actually approached her doctor and informed him that she wanted to be an organ donor, which was interesting because he looked at me and said, "That's wonderful, and I'm thrilled, but because of conflict of interests, I will send someone else in to speak with you about it" because he as the person taking care of her could not coordinate that himself.

01:16 - The importance of not having the doctor talk to us is that, the myth is that doctors won't take care of you 'cause they're more interested in getting organs from people to save others. And we found that the care that we've gotten from the hospital was no different because we were interested in trying to make sure that her organs survived and that she was able to help others. We knew at that point, they pretty much told us that there was no hope for her recovery and that she would just wind up being on life support and her organs would eventually just decay. So, we wanted to make sure we honored her wishes and made a difference in the world 'cause that's what she would've wanted to do.

02:03 - So for me, it was an easy decision because Janine had expressed her wishes to me.

02:08 - It was a struggle for me. Me more than them, and I don't know if that's because of father-daughter, I don't know what it was.

02:16 - She hadn't talked to the rest of the family about it. She had only spoken to me.

02:21 - And I wasn't aware of it until unfortunately her accident and when she became seriously ill. So, it was a very hard decision for me to make, and I was struggling with it, not having that background information that my wife had. And again, that was my daughter there. All I was thinking about was her. So, I didn't have the context of what she said and what she wanted. I only had it from what my wife told me, and then of course I realized this came from her, and it was a decision we had to make no matter what my feelings were. It was after that that I learned the importance of the
decision and how it really affects people's lives and opened my eyes a lot. So, it was a lot of educating, a lot of learning we all have to do 'cause we all come to the table with preconceived notions, and I think we need to learn and help make smart and good decisions even when we don't think something is possible. Who thinks about "I'm gonna get hurt" or "Something's gonna happen to a family member." You need to have the conversations so that people understand and know your wishes.

03:33 - Janine was able to donate her kidneys, her liver, her eyes, bone, skin, heart valves, and many other parts that we hadn't even considered were possible to be donated. The only thing she wasn't able to donate was her heart because there had been damage to that in the accident. The amazing thing is that we were with her when they took her off life support, and you have to think about this. It's the moment of the deepest grief that a parent could ever have, but the knowledge that other families were getting a phone call saying, "Come into the hospital. You're getting the organ that's going to keep you alive" really helps to balance that grief and really helps to uplift you as a family. Once we made the decision to do the organ donation and in the six plus years since we lost Janine, there are days that are very, very hard to get through because you miss her so much, but then you start thinking about the other people who still have their loved ones. And you start thinking about the ripple effect and the geometric progression of people signing up to be organ donors and lives being saved, and that really helps you get through the hard times.

04:59 - And eventually we've gotten to meet some of the recipients of her kidney, her liver, and it was a very uplifting moment to see people thriving and to see families happy to have their loved ones with us. It kind of gave us a little bit of support in knowing what we've gone through and helps us get through the days, sometimes just knowing the impact that she's had and how she's affected others.

05:31 - When we met the recipients, there was a woman who had received one of Janine's kidneys. She was I think in her late 30s, and her parents were with her, and her mom grabbed me, hugged me, and said, "Thank you for saving my baby." That's how we feel about what we did. It's made a tremendous impact in the world. It keeps the legacy going, the momentum going. We call it the gift of life. Janine gave the gift of life to so many people that we don't even, some of whom we've met and some of who we never will even know.

06:09 - As a parent, you're thinking about your daughter who's seriously injured, and you're not thinking about anything else. So, I talk to people and just say, when you're healthy and you're not thinking about things, just make sure you have conversations in your household about what your future wishes might be. You never know when something happens, and things take place. I always say that you cannot prevent a tragedy from happening, but you can make something good out of it. You know, people have to make their own decision. My daughter, our daughter, made it clear for us.
Organ Donor Family: Kelli, Mother of Thomas

Video Transcript

Video Duration: 2:57

00:05 - - Thomas was a very special person. He was not only beautiful on the outside, but he was beautiful on the inside. I mean, of course, he's my son and every parent says how remarkable their child is, but, truthfully, he really was that kind of a person. He was a very selfless person. He was always looking to put his peers and his elders ahead of himself, always looking for that person who needed that type of friendship, needed a companion, needed to just know that they were validated, that they were never alone. And that was just truthfully who Tom was. On Thomas's 16th birthday, Tom asked, just like every other 16-year-old to go to the DMV so that he could take the test to get his learner's permit. So, Tom just found out that he had passed the test and, at that time, had verbally announced that he wanted to be an organ donor. Originally, he tried to see on the form if he could check off to be an organ donor, but until this year, you couldn't legally sign off as a 16-year-old to register to be an organ donor. But, he verbally had made it clear to myself and my husband that he wanted to. Thomas was a varsity football player who was injured during a Wednesday night football game. He sustained a head injury that the doctors had, the surgeon had taken him in for surgery to see if they could help. And, during that surgery, they had discovered that Thomas was not going to be saved. We knew that this would be what Tom wanted and we knew that if we were to follow through with his wishes, we would be giving the gift of life, and that's a very priceless thing that you can do for somebody. Thomas was able to donate both corneas, he was able to donate his heart, his liver, his kidneys, his pancreas, skin tissue, bones, veins. Right after Tom had passed and we were staying in touch with LiveOn New York to find out how the recipients were doing, something had just come over us and we kind of felt the need to have that connection with them as soon as possible. I'm not really sure how many lives Thomas has saved. We do know that we had the opportunity to meet with his heart recipient, his kidney recipient, and then a kidney and pancreas recipient so far. We did have word, actually, from the recipient that got his skin. We're waiting to meet with the recipient for his liver and for his corneas. Although my son was no longer in the physical sense with us here, he was with them. So, in essence, it was like we were all brought back together again. Knowing Thomas's character, we would've gone ahead with organ donation even if we hadn't had the conversation. But, because we did have that conversation before we knew Thomas's wishes and it made it easier for us to make that decision to give the gift of life.
Purpose/Connection
This lesson connects what students have already learned about homeostasis to the interactions between the circulatory and respiratory systems. Students model oxygen transport in the body in a healthy person and in people with cystic fibrosis and with sickle cell disease.

Guiding Question/Aim
How does cystic fibrosis affect homeostasis?

Instructional Objectives
● Students will be able to model oxygen transport in a healthy person, in a person with cystic fibrosis, and in a person with sickle cell disease (SCD).
● Students will be able to explain how weakened lungs could lead to a weakened heart.
● Students will be able to compare and contrast cystic fibrosis and sickle cell disease with regard to oxygen transport difficulties and effective treatments.

Vocabulary
• atrium • sickle cell disease • simulation • transfusion • transplant • transport • ventricle

Materials
● Reading Assignment and Questions: Why is Ava’s Heart Worn Out? (Student Version – Class Simulation or Student Version – Desktop Game)
● Oxygen Transport Game: teacher’s guide, game board pieces, role cards, gas cards
● 2 timers (for game)
Optional:
● O2 Transport Game Demo (mp4): https://vimeo.com/248788184/8ea495cfae
● Alternate "Desktop Game" board and pieces
● NIH SCD explanation with a video of a student with SCD (The page has Spanish translation): https://www.nhlbi.nih.gov/health/health-topics/topics/scd
**Suggested Sequence of Activities - Lesson 2**

Note: If students have not already studied sickle cell disease, you will have to supplement the lesson with this information.

1. Students read and answer questions 1 and 2 on the top of the first page of “Why Is Ava’s Heart Worn Out?”
   Optional vocabulary questions:
   - Look at the words “transplant,” “transfusion,” and “transport.” How are the meanings similar? (Think about what the prefix “trans” means.)
   - Explain how the meanings of “transplant,” “transfusion,” and “transport” are different. Try to use the word roots in your explanation.

3. Introduce the Oxygen Transport Game to the class. (The steps below apply to both the regular and the alternate desktop versions of the game.)

4. Play the Oxygen Transport Game for a healthy body (Round 1) and record the number of oxygen cards collected by “Muscles & Organs” in the data table.

5. Students work in small groups to design a modification(s) to the game that would model oxygen transport in a person with cystic fibrosis (question 3a-b).

6. Come to a consensus as a class on how to modify the game, and play Round 2 – Cystic Fibrosis using your class’s modification(s).
   - Record the number of oxygen cards collected by “Muscles & Organs” in the data table.
   - Students answer questions 4 and 5.

7. Students work in small groups to design a modification(s) to the game that would model oxygen transport in a person with sickle cell disease (question 6a-b).
   Remind students to work off of the “healthy lungs” model (do not include the CF modifications).

8. Come to a consensus as a class on how to modify the game, and play Round 3 – Sickle Cell Disease using your class’s modification(s).
   - Record the number of oxygen cards collected by “Muscles & Organs” in the data table.
   - Students answer questions 7-9.

9. Exit Assessment or Discussion:
   Engage students in closing dialogue: “How does cystic fibrosis affect homeostasis, and why was Ava’s heart worn out?”

**Extension**

- Have students evaluate the game as a model of circulation. Ask them to identify which key features are well-represented in the game, and which features are absent or poorly represented. They may also make suggestions for improving the model.
Use this simulation to model a number of other conditions. Possibilities include:

- Simulate the increase in heart rate that occurs with exercise and have muscles turn excess CO₂ into lactic acid
- Simulate low O₂ availability and altitude sickness
- Model coronary circulation and simulate a heart attack
- Introduce cholesterol/blood vessel narrowing or clot formation
- Ask students to create a guide for modeling a situation or medical condition of their choice not addressed in class

**Standards**

**NYS Living Environment**

- **4.1.2a** Important levels of organization for structure and function include organelles, cells, tissues, organs, organ systems, and whole organisms.
- **4.1.2b** Humans are complex organisms. They require multiple systems for digestion, respiration, reproduction, circulation, excretion, movement, coordination, and immunity. The systems interact to perform the life functions.
- **4.1.2c** The components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment. To successfully accomplish this, organisms possess a diversity of control mechanisms that detect deviations and make corrective actions.
- **4.1.2d** If there is a disruption in any human system, there may be a corresponding imbalance in homeostasis.
- **4.1.2e** The organs and systems of the body help to provide all the cells with their basic needs. The cells of the body are of different kinds and are grouped in ways that enhance how they function together.
- **4.5.2a** Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.
- **4.5.2h** Disease may also be caused by inheritance, toxic substances, poor nutrition, organ malfunction, and some personal behavior. Some effects show up right away; others may not show up for many years.
- **4.5.3a** Dynamic equilibrium results from detection of and response to stimuli. Organisms detect and respond to change in a variety of ways both at the cellular level and at the organismal level.
- **4.5.3b** Feedback mechanisms have evolved that maintain homeostasis. Examples include the changes in heart rate or respiratory rate in response to increased activity in muscle cells, the maintenance of blood sugar levels by insulin from the pancreas, and the changes in openings in the leaves of plants by guard cells to regulate water loss and gas exchange.
NYS Next Generation ELA Learning Standards

- 9-10.RST.1 Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc. attending to the precise details of the source. Understand and follow a detailed set of directions.
- 9-10.RST.4 Determine the meaning of symbols, key terms, and other content-specific words and phrases as they are used in scientific or technical sources; describe how the inclusion of charts, graphs, diagrams, data influence conclusion(s).
- 9-10.WHST.2: Write informative/explanatory text focused on discipline-specific content.
Why Is Ava’s Heart Worn Out?

Ava is not in school again today. She is very sick. She is currently on the transplant list for both lungs and a heart. Lavon knew that her lungs were in trouble, but what happened with her heart? Lavon does remember that there was some connection between the lungs and the heart in the “Making Connections” lab. Maybe that could help explain why Ava’s heart is suffering.

1) In what way do the heart and lungs depend on one another? Use your experience in the “Making Connections” lab to support your answer.

Lavon also wonders about his Uncle Darius. Uncle Darius has sickle cell disease; some of his red blood cells are shaped differently and interfere with oxygen transport. Uncle Darius is often tired and has had to have blood transfusions, but no one has said anything about Uncle Darius needing a heart or a lung transplant. Lavon is looking forward to being old enough to donate blood so that he can help his Uncle Darius and other people who need it.

2) Explain how sickle cell disease affects oxygen transport in the body.

Play the Oxygen Transport Game - Round 1 (Healthy Body). Fill in the data your class collects in the table below.

<table>
<thead>
<tr>
<th>Round</th>
<th>Number of O₂ Cards Collected by “Muscle &amp; Organs”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Healthy Body</td>
<td></td>
</tr>
<tr>
<td>2: Cystic Fibrosis</td>
<td></td>
</tr>
<tr>
<td>3: Sickle Cell Disease</td>
<td></td>
</tr>
</tbody>
</table>

Working in a small group, answer question 3a-b.

3) Recall how CF affects the lungs. How might this be modeled in the game? With your group, design a game modification that could represent cystic fibrosis.
   a. What would change? Describe your new rule(s) so someone could follow your instructions to play the game.
b. Explain how this game modification models cystic fibrosis.

---

Play Round 2 (Cystic Fibrosis). In your data table, record the number of oxygen cards collected.

4) What would need to happen in order for the muscles and other organs in a CF patient to receive the same amount of oxygen as a healthy body in the same period of time?

5) How could lungs that have to work very hard to get oxygen for the body cause the heart to become damaged?

---

Working in a small group, answer question 6.

6) How might you model sickle cell disease in the oxygen transport game? With your group, design a game modification that could represent sickle cell disease.
   a. What would change? Describe your new rule(s) so someone could follow your instructions to play the game.
   b. Explain how this game modification models sickle cell disease.

---

Play Round 3 (Sickle Cell Disease). In your data table, record the number of oxygen cards collected.

7) Compare your results for the three rounds of game play. What do you notice?

8) Why will a lung transplant help Ava, but not Uncle Darius?

9) Why will a blood transfusion help Uncle Darius, but not Ava?
Oxygen Transport Game Teacher’s Guide: Whole-Class Simulation Version

Overview: This game is designed as a simulation of oxygen and carbon dioxide exchange in the human body. Students will play the role of red blood cells, carrying oxygen from the lungs, through the heart, to muscles and organs. They will then exchange their oxygen for carbon dioxide and travel back to the heart and lungs. The game is played in three rounds – healthy, cystic fibrosis, and sickle cell disease – in order for students to experience typical blood gas homeostasis and two different disruptions to respiratory-circulatory system interactions.

Components:

- **Game Map** for room set-up
- **Location Sheets:** 1 Lungs/CF Lungs; 1 Muscles & Organs; 1 Heart – Right Atrium; 1 Heart – Left Atrium; 1 Heart – Right Ventricle; 1 Heart – Left Ventricle; Blood Vessel spots (enough for all students to circulate); Arrows (as necessary)
- **Gas Cards:** CO₂, O₂
- **Role Cards:** 1 Lungs/CF Lungs; 1 Muscles & Organs; 1 Heart; RBCs; Sickle RBCs
- **2 Timers:** 1 to help the heart keep the beat; 1 to keep time for the entire round.

Setup and Introduction:

1. Introduce the game and its purpose to students. Emphasize that students should pay particular attention to the circulation and exchange of gases, and the locations at which the exchanges take place.
2. Explain the game “map” and the different components of the game (gas cards, roles, locations & blood vessel spots).
3. Explain the rules of play: only red blood cells will circulate. They will travel singly or in groups of 2, 3, or 4 – depending on physical space in the classroom and game time. (Multiple students moving together can be justified with the explanation that each RBC can carry up to four oxygen molecules.) RBCs will move exactly one spot in the direction of the arrows each time the heart calls “Pump!” When RBCs reach a location of gas exchange, they should exchange their gas card with the student/organ at that location.
4. Assign roles to all students. It is recommended that students wear the role cards – either taping them to their clothing, placing them in a reusable name tag holder, or stringing them as a necklace. Give students enough time to read their role description. Answer any clarifying questions.
5. Lungs, Heart, and Muscles & Organs students should take their places. Make sure Heart has a timer (and a loud voice). Lungs should start with O₂ cards and Muscles & Organs should start with CO₂ cards. RBCs can line up to enter circulation. For the purposes of this model, RBC’s can enter at the lungs to receive O₂. *(You may want to discuss this as a limitation of the model during debrief or reflection.)*

Game Play:

1. Play Round 1 – Healthy Model. In this round, the heart should yell “pump” every three seconds. Game play should last until each RBC has completed at least one full circuit. (The teacher should calculate this ahead of time based on the number of steps needed for all students to enter and circulate.) See the Round 1 Premise and Background Information and Facilitation Tips for more information.
2. At the end of the round, Muscles & Organs should count the number of O₂ cards acquired. Record this information on the board for the whole class. (This will later be compared to the number of O₂ cards collected in the SAME amount of time and at the SAME heart rate for the CF and Sickle Cell Disease rounds.)
3. Allow time for small groups of students to discuss and modify the game so that it simulates gas exchange in a person with CF. Come to a consensus as a class. See the Round 2 Premise and Background Information and Modification Suggestions.
4. Play Round 2 with students for the same amount of time and at the same heart rate as in Round 1, incorporating the class’s modification. At the end of the round, Muscles & Organs should count the number of O₂ cards acquired. Record this information on the board for the whole class.
5. Allow time for small groups of students to discuss and modify the game again, this time for a simulation of sickle cell disease. Remind students to work off the “healthy lungs” model (i.e. do not include the CF modifications). Come to a consensus as a class. See the Round 3 Premise and Background Information and Modification Suggestions.

6. Play Round 3 with students for the same amount of time and at the same heart rate as in Round 1, incorporating the class’s modification. At the end of the round, Muscles & Organs should count the number of O₂ cards acquired. Record this information on the board for the whole class.

**Round 1 – Healthy Model:**

**Premise and Background Information:** The purpose of this round is for students to recall and experience the interaction between the respiratory and circulatory systems in a healthy individual. This reinforces the concepts of homeostasis and feedback mechanisms they explored in the “Making Connections” lab activity. This round also serves as a foundational model students will adapt in order to illustrate their understanding of cystic fibrosis and sickle cell disease.

**Whole-Class Version Facilitation Tips:**

1. You may want to play this round twice – once as a slower practice run. You may find it useful to do a smaller simulation as a practice run with the rest of the class watching.
2. Make sure that all students have enough space at each spot or station, and that there is a clear space between each spot/station. Both the physical movement with each pump and the locations of gas exchange are important for students to experience in this round.
3. All students should be actively participating in the game/simulation. In order to facilitate this with a large class, you may choose to have enough blood vessel spots for all RBC’s to circulate one at a time. Alternatively, you can have RBC’s circulate in groups of 2, 3, or 4, moving from spot to spot together. (Multiple students moving together can be justified with the explanation that each RBC can carry up to four oxygen molecules.) If students move in groups, you may want to have additional students playing lungs and muscles & organs in order to fully facilitate gas exchange between “pumps.”

**Round 2 – Cystic Fibrosis Model:**

**Premise and Background Information:** The purpose of this model is to have students apply their understanding of CF to the circulation game model. They will have to design a game modification that models the experience of a patient with CF, explaining and justifying their reasoning. In addition, it reinforces the connection between the respiratory and circulatory systems, allowing students to discover why Ava’s heart became damaged because of her lung dysfunction.

**Rules:** Switch “Lungs” station to “CF Lungs”. Game play follows the basic format established in Round 1 and should be played for the same amount of time and at the same heart rate as in Round 1. The modifications agreed upon as a class should be used in this round. Note that students will have their own small group’s modification suggestions written on their handout, and these will not necessarily match the modifications actually enacted.

**Possible Modification:** Have one student moderate the rate of oxygen the “lungs” give to the red blood cells. Although there is an abundance of O₂ available, the lungs can only transfer one O₂ card for every second RBC (or similar); this differentiates between CF lungs and healthy lungs in a low-oxygen environment.

**Round 3 – Sickle Cell Disease Model:**

**Premise and Background Information:** The purpose of introducing this illness is twofold. First, it allows students to contrast the appropriate treatments for the two diseases in the case study – CF and Sickle Cell Disease – and identify the situations in which organ transplants and blood transfusions are useful. Second, it makes connections to the genetic basis of disease, specifically how a point mutation can result in sickle cell disease.
**Rules:** Switch “CF Lungs” station back to “Lungs” and turn over blood vessel spots to the side with the sickle cell illustration. Game play follows the basic format established in Round 1 and should be played for the same amount of time and at the same heart rate as in Round 1. The modifications agreed upon as a class should be used in this round. *Note that students will have their own small group’s modification suggestions written on their handout, and these will not necessarily match the modifications actually enacted.*

**Possible modification:** Some students who were RBCs are now sickle RBCs and are not allowed to participate in oxygen transport, or may be removed from the bloodstream to model the shortened lifespan of sickle cells. *Note that this modification does not simulate a sickle cell’s slowed movement through the bloodstream or the blockages that cause sickle cell crises. Your students may identify different ways to model these aspects of sickle cell disease.*
Oxygen Transport Game Map

Remaining Students:
- RBC (all rounds)
- Sickle RBC (Sickle Cell round only)

Lungs
Need:
- 1 container for CO₂
- 1 container for O₂
- Teacher or student to moderate gas exchange

Muscles and Organs
Need:
- 1 container for CO₂
- 1 container for O₂
- At least one student to moderate gas exchange

(RBCs can enter here)
Heart

Right Atrium

This work is a derivative of "Aorta" by Osnimf, used under CC0. Retrieved from https://commons.wikimedia.org/w/index.php?curid=398536
Heart

Left Atrium

This work is a derivative of "Aorta" by Osnimf, used under CC0. Retrieved from https://commons.wikimedia.org/w/index.php?curid=398536
Heart

Left Ventricle

This work is a derivative of "Aorta" by Osnimf, used under CC0. Retrieved from https://commons.wikimedia.org/w/index.php?curid=398536
Muscles and Organs

(including the heart)

Leave your $O_2$ molecule here if you are carrying one.

Pick up a $CO_2$ molecule.
Lungs

Leave your CO$_2$ molecule here if you are carrying one.

Pick up an O$_2$ molecule, if available.
This work is a derivative of “Modified sickle cell 01” by NHLBI, https://www.ncbi.nlm.nih.gov/pubmedhealth/PMHT0022014/?figure=1, used under CC-PD-USGov-NIH. Retrieved from https://commons.wikimedia.org/w/index.php?curid=44965281
This work is a derivative of “Risk-Factors-for-Sickle-Cell-Anemia (1)2” by Diana Grib, used under CC BY-SA 4.0. Retrieved from https://commons.wikimedia.org/w/index.php?curid=45979326
Your job is to transport O₂ from the lungs to muscles and organs, and to return waste CO₂ from the body to the lungs.

You will move 1 spot forward with each heart beat – make sure that you exchange gas cards quickly at the Lungs and Muscles & Organs stations!
• Unfortunately, the mutation in your hemoglobin has caused you to become sickle-shaped!
• Follow your class’s game modifications for this round.
Lungs

- Your job is to facilitate gas exchange with the Red Blood Cells:
  - Collect a CO₂ card from each RBC that enters the lungs
  - Give each RBC an O₂ card before they leave the lungs (if there is an O₂ card available)
- You will have to be quick because the RBCs move into and then out of the lungs with each heart beat!

CF Lungs

- The role of the lungs is to take up CO₂ from the red blood cells and provide them with O₂ in exchange.
- Your job is to facilitate gas exchange with the RBCs as best you can, by following the game modification instructions for this round.
Heart

- Your job is to pump in order to circulate blood through the body.
- **Every 3 seconds**, you will yell “Pump!” loud enough for your classmates to hear, but not so loud that people outside your classroom can hear you!
- Your teacher will tell you when to end the round of gameplay.

Muscles & Organs

- You need oxygen in order to function properly. So, your job in the game is to take O₂ cards from RBCs as they pass through your station, and give the RBCs your waste CO₂ to carry back to the lungs.
- You will have to be quick because the RBCs move into and then out of your station with each heart beat!
Oxygen Transport Game Teacher’s Guide: Alternate Desktop Version

Overview: This game is designed as a simulation of oxygen and carbon dioxide exchange in the human body. Students will play the role of red blood cells, carrying oxygen from the lungs, through the heart, to muscles and organs. They will then exchange their oxygen for carbon dioxide and travel back to the heart and lungs. The game is played in three rounds – healthy, cystic fibrosis, and sickle cell disease – in order for students to experience typical blood gas homeostasis and two different disruptions to respiratory-circulatory system interactions.

Components:
- **Game Boards:** 1 per small group of students
- **Game Pieces:** RBCs, Sickle RBCs, CO₂, O₂
- **Timer** (to maintain regular heart beat and time each round)

Setup and Introduction:
1. Introduce the game and its purpose to students. Emphasize that students should pay particular attention to the circulation and exchange of gases, and the locations at which the exchanges take place.
2. Explain the game setup and the different components of the game.
   - One student at each table/small group of students should play the role of “Lungs” and be in charge of gas exchange when RBCs reach the lungs on the game board. (It is important to have a student in this role so that the Lungs’ ability to exchange gases can be modified in the CF round of play.)
   - Remaining students will be RBCs (fold game pieces along the dotted line) and can line up their game pieces to enter circulation. (*You may want to discuss this as a limitation of the model during debrief or reflection.*)
   - Lungs should start with O₂ cards. CO₂ cards should be placed at the Muscles & Organs.
3. Explain the rules of play: RBCs will move exactly one spot in the direction of the arrows each time the teacher, playing the role of the Heart, calls “Pump!” When RBCs reach the lungs, the student playing “Lungs” will moderate gas exchange. RBCs should exchange their O₂ for CO₂ when they reach the Muscles & Organs spot on the game board.

Game Play:
1. **Play Round 1 – Healthy Model.** In this round, the heart (teacher) should yell “pump” every three seconds. Game play should last until each RBC has completed at least one full circuit. (The teacher should calculate this ahead of time.) *See the Round 1 Premise and Background Information for more information.*
2. **At the end of the round, have each group count the number of O₂ cards accumulated at the Muscles & Organs location. Record the class total on the board.** (This will later be compared to the number of O₂ cards collected in the SAME amount of time for the CF and Sickle Cell Disease rounds.)
3. **Allow time for small groups of students to discuss and modify the game so that it simulates gas exchange in a person with CF. Come to a consensus as a class. See the Round 2 Premise and Background Information and Modification Suggestions.**
4. **Play Round 2 for the same amount of time and at the same heart rate as in Round 1 incorporating the class’s agreed-upon modification.** At the end of the round, have each group count the number of O₂ cards accumulated at the Muscles & Organs location. Record the class total on the board.
5. **Allow time for small groups of students to discuss and modify the game again, this time for a simulation of sickle cell disease. Remind students to work off the “healthy lungs” model (i.e. do not include the CF modifications). Come to a consensus as a class. See the Round 3 Premise and Background Information and Modification Suggestions.**
6. **Play Round 3 for the same amount of time and at the same heart rate as in Round 1 incorporating the class’s agreed-upon modification.** At the end of the round, have each group count the number of O₂ cards accumulated at the Muscles & Organs location. Record the class total on the board.
Round 1 – Healthy Model:

Premise and Background Information: The purpose of this round is for students to recall and experience the interaction between the respiratory and circulatory systems in a healthy individual. This reinforces the concepts of homeostasis and feedback mechanisms they explored in the “Making Connections” lab activity. This round also serves as a foundational model students will adapt in order to illustrate their understanding of cystic fibrosis and sickle cell disease.

Round 2 – Cystic Fibrosis Model:

Premise and Background Information: The purpose of this model is to have students apply their understanding of CF to the circulation game model. They will have to design a game modification that models the experience of a patient with CF, explaining and justifying their reasoning. In addition, it reinforces the connection between the respiratory and circulatory systems, allowing students to discover why Ava’s heart became damaged because of her lung dysfunction.

Rules: Game play follows the basic format established in Round 1 and should be played for the same amount of time and at the same heart rate as in Round 1. The modifications agreed upon as a class should be used by all groups in this round. Note that students will have their own small group’s modification suggestions written on their handout, and these will not necessarily match the modifications actually enacted.

Possible Modification: Have the “Lungs” alter the rate at which they give O₂ to the RBCs. Although there is an abundance of O₂ available, the lungs can only transfer one O₂ card for every second RBC (or similar); this differentiates between CF lungs and healthy lungs in a low-oxygen environment.

Round 3 – Sickle Cell Disease Model:

Premise and Background Information: The purpose of introducing this illness is twofold. First, it allows students to contrast the appropriate treatments for the two diseases in the case study – CF and Sickle Cell Disease – and identify the situations in which organ transplants and blood transfusions are useful. Second, it makes connections to the genetic basis of disease, specifically how a point mutation can result in sickle cell disease.

Rules: (RBCs can change their game piece to sickle RBCs, if desired.) Game play follows the basic format established in Round 1 and should be played for the same amount of time and at the same heart rate as in Round 1. The modifications agreed upon as a class should be used by all groups in this round. Note that students will have their own small group’s modification suggestions written on their handout, and these will not necessarily match the modifications actually enacted.

Possible modification: Some students who were RBCs are now sickle RBCs and are not allowed to participate in oxygen transport, or may be removed from the bloodstream to model the shortened lifespan of sickle cells. Note that this modification does not simulate a sickle cell’s slowed movement through the bloodstream or the blockages that cause sickle cell crises. Your students may identify different ways to model these aspects of sickle cell disease.
RBC Start → Lungs → Right Ventricle → Right Atrium → Muscles & Organs

Lungs:
- Gas exchange

Muscles & Organs:
- Leave your O₂ molecule here if you are carrying one.
- Pick up a CO₂ molecule.

Left Atrium → Left Ventricle

Picture attributions on reverse
Do not remove
Picture Attributions:

**Lungs**: Work is a derivative of "Air and Food Pathways" by Alan Hoofring (Illustrator), used under CC-PD-USGov-HHS-NIH. Retrieved from https://commons.wikimedia.org/w/index.php?curid=24052130

**Blood Vessel**: Work is a derivative of “Modified sickle cell 01” by NHLBI, https://www.ncbi.nlm.nih.gov/pubmedhealth/PMHT0022014/?figure=1, used under CC-PD-USGov-NIH. Retrieved from https://commons.wikimedia.org/w/index.php?curid=44965281

**Heart**: Work is a derivative of "Aorta" by Osnimf, used under CC0. Retrieved from https://commons.wikimedia.org/w/index.php?curid=398536


Lesson 3
The Immune Response to Transplants

Purpose/Connection
This lesson connects what students have already learned about the immune response to organ transplantation and possible rejection. Students watch videos, read text and answer questions about antigen-antibody responses to mismatched organs.

Guiding Question/Aim
Why does the body reject some transplanted organs and how can this rejection be minimized?

Instructional Objectives
- Students will be able to describe the immune response to foreign antigens.
- Students will be able to identify risk factors and explain the mechanism by which transplanted organs might be rejected.
- Students will be able to justify the need for immunosuppressant drugs.

Vocabulary
- algorithm
- allocate
- antibody
- antigen
- B-cell
- endocytosis
- human leukocyte antigens (HLA)
- immunity
- immunosuppressant
- leukocyte
- lymphocyte
- major histocompatibility complex (MHC)
- mismatch
- phagocytes
- protein receptor
- T-cell
- transplant
- transplant rejection

Materials
- LiveOnNY transplant surgeon video:
  Transplant Surgeon: Dr. Devon John (2:51) [https://vimeo.com/230044910/64e572a1f7](https://vimeo.com/230044910/64e572a1f7), or
  Transplant Surgeon: Dr. Amy Friedman (4:25) [https://vimeo.com/230046755/dfbed8bdf1](https://vimeo.com/230046755/dfbed8bdf1)
- Reading assignment: The Immune System and Transplants
- LiveOnNY organ recipient video:
  Organ Recipient: Shelby (5:11) [https://vimeo.com/230047840/4a1d46ecc2](https://vimeo.com/230047840/4a1d46ecc2), or
  Organ Recipient: Kelvin (4:49) [https://vimeo.com/230049622/d7c084c734](https://vimeo.com/230049622/d7c084c734), or
  Organ Recipient: Merida (3:12) [https://vimeo.com/230048875/7117f3ab01](https://vimeo.com/230048875/7117f3ab01)
Optional:
- Transcripts of Transplant Surgeon and Organ Recipient videos
- Additional immune system information: https://www.nobelprize.org/educational/medicine/immunity/immune-detail.html

Suggested Sequence of Activities - Lesson 3
1. Review the immune response. (See vocabulary list for words that will come up.)
2. Watch one of the LiveOnNY transplant surgeon videos and write down any facts you think are important to consider before Ava gets a transplant. (Transplant Surgeon: Dr. Devon John and Transplant Surgeon: Dr. Amy Friedman are available at time of publication)
   Optional: You may want to use the closed captioning and/or give students the transcript to the video.
3. Read The Immune System and Transplants and use it to do the assignment at the top of the reading.
4. Have the class discuss “What does it mean for a donor organ to be matched with a recipient?”
5. Watch one of the LiveOnNY organ recipient videos and write down any facts you think are important to consider before Ava gets a transplant. (Organ Recipient: Shelby, Organ Recipient: Kelvin and Organ Recipient: Merida are available at time of printing)
   Optional: You may want to use the closed captioning and/or give students the transcript to the video.
6. Write a paragraph using information from the reading and videos that explains rejection factors and why immunosuppressant drugs are necessary.
7. Exit Assessment or Discussion:
   Engage students in closing dialogue: “Why does the body reject some transplanted organs and how can this rejection be minimized?”

Extension
- Why was Shelby (or Kelvin) out of breath all the time when nothing was wrong with her/his lungs? (Note that this links back to Lesson 2.)

- Why might taking immunosuppressant drugs lead to cancer?
  Here are some resources:
Standards

NYS Living Environment

- 4.1.2c The components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment. To successfully accomplish this, organisms possess a diversity of control mechanisms that detect deviations and make corrective actions.
- 4.1.2d If there is a disruption in any human system, there may be a corresponding imbalance in homeostasis.
- 4.5.2a Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.
- 4.5.2c The immune system protects against antigens associated with pathogenic organisms or foreign substances and some cancer cells.

NYS Next Generation ELA Learning Standards

- 9-10.RST.1 Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc. attending to the precise details of the source. Understand and follow a detailed set of directions.
- 9-10.RST.4 Determine the meaning of symbols, key terms, and other content-specific words and phrases as they are used in scientific or technical sources; describe how the inclusion of charts, graphs, diagrams, data influence conclusion(s).
- 9-10.WHST.2: Write informative/explanatory text focused on discipline-specific content.
- 9-10.WHST.7: Draw evidence from informational texts to support analysis, reflection, and research.
The Immune System and Transplants

**Assignment:** Imagine that you are Ava speaking with Abdul, a teenager you met at the hospital who will receive a kidney transplant from his father. Abdul does not want to take immunosuppressant drugs. Use the information below and your knowledge of the immune system to explain why the medications are necessary. Be sure to include specifics about antigen-antibody interactions as they relate to transplants.

**Reading:** The immune system is how the body protects itself against pathogens and outside invaders. It uses white blood cells, also known as leukocytes, to attack organisms that cause disease.

White blood cells (WBCs) are made and live in lymphoid organs such as the spleen and thymus but circulate through the body using blood vessels. **B cells** and **T cells** are two types of WBCs that have different functions but work together to hunt down and destroy organisms and substances that may be harmful. B cells are like security guards that notice when an invader enters the body, and T cells are sent to destroy the invaders.

When foreign **antigens** (marker proteins on the surface of a cell) are detected, B cells bind to and display the antigens. Once a T cell recognizes the B cell’s display of the antigen, it activates the B cell to produce **antibodies**. Antibodies are proteins that are specialized to bind to specific antigens and mark them for destruction. Once produced, the antibodies will always be present in the body and on guard looking for the foreign antigen.

Once the antibody finds and binds to the antigen, a T cell or a phagocyte will know to come destroy it. **Phagocytes** are WBCs that engulf and destroy invaders through a process called **endocytosis**. This whole process is what is known as **immunity**.

Not all antigens are foreign. All of the cells in our body have antigens that mark them as “self” cells, so we know not to destroy them. Antigens on organ cells are different for different people. The most important antigens group together and form what is called the major histocompatibility complex (MHC).

Because we all have some different antigens, a transplant recipient’s immune system might see the cells of the donor organ as a danger. This is known as a **mismatch** and can cause **transplant rejection**.

To try to prevent transplant rejection, the recipient’s and donor’s human leukocyte antigens (HLA) are matched using a histocompatibility test. Although they can never be exactly the same, the better they match, the less likely the new organ will be rejected. This is why the best donors are often twins or family members with the same, or similar, genetics.

**Immunosuppressant** drugs are used to reduce the efficiency of the recipient’s immune system so that it cannot effectively destroy the new tissue. Modern immunosuppressant drugs are effective enough to nearly completely prevent organ rejection.
The Immune System and Transplants

Assignment: You are Ava speaking with Abdul, a teenager you met at the hospital who will receive a kidney transplant from his father. Abdul does not want to take immunosuppressant drugs. Explain why the medications are necessary. Be sure to include specifics about the antigen-antibody interactions as they relate to transplants.
Transplant Surgeon: Dr. Devon John

Video Transcript

Video Duration: 2:51

00:05 - - Good day, my name is Dr. Devon John a transplant surgeon who practices at Downstate Medical Center in Brooklyn. I'm here to answer some of the questions you may have about organ and tissue transplantation. The human body's complex. And it is made up of interdependent systems that, are in turn, made up of organs and tissues. Homeostasis is dependent on the proper function of these. Many diseases can lead to organ and tissue dysfunction, such as kidney failure, which is sometimes caused by high blood pressure. Over the last 60 years medical science has developed methods to manage these failures. One such approach is organ and tissue transplantation. Organs that can be transplanted include hearts, lungs, liver, kidneys, pancreas, and small intestine. Tissues that are transplanted include corneas, skin, bones, heart valves, blood vessels, and bone marrow. There are two sources of organs and tissues. Deceased donors and living donors. Deceased donors are individuals who have recently expired. These donors can provide all the previously described organs and tissues. Living donors can and typically provide a single kidney, part of a liver, and bone marrow. Transplantation requires teams who identify, procure, allocate and implant specific organs into the patients who need them. When organs are retrieved they are kept in cold preservation solutions around three degrees Celsius and can stay outside the body only for a limited time, usually less than 24 hours. Who receives any given deceased donor organ is based on organ specific algorithms. These take into consideration many factors such as blood type, severity of disease, tissue typing and the length of time on the wait list. The system is as fair as possible for the many people waiting for the limited number of available donor organs. Transplantation usually replaces a failed organ or tissue, but it may or may not treat the primary cause of organ failure. For example, kidney failure caused by diabetes replaces a kidney, but does not cure diabetes. On the other hand, replacing a cornea damaged by eye trauma usually leads to a cure. The success of organ transplantation has made it the standard care for many diseases. It is fully supported by the federal government, major religions, and health insurance providers.
00:05 - I'm Doctor Amy Friedman. I'm an organ transplant surgeon, which means that I'm a general surgeon. I can do appendectomies, et cetera, and I also have specialized in the skills of doing organ transplants, specifically of the liver, pancreas, and kidneys. Transplantation is the last resource when an organ that is essential is diseased and ultimately has failed. We don't transplant if there is another way to treat the problem, and we've really gotten so advanced in our ability to prevent the rejection of these organs, which is a whole other exciting area of the science of transplantation that now, we can do quality of life transplants. And these include, shockingly, hands, face, and we can even do a uterus transplant. If you come to me and you need an organ replacement, I cannot just go to the store and pluck one off of the shelf for you. The organ has to come from another human being. A common misconception or myth is that if you register as an organ donor and come to a hospital, that you won't be fully cared for. Nothing could be further from the truth. It is only if you have died that organs can be recovered for transplantation, and in fact, you have to be on a ventilator for those organs to be in satisfactory condition to be able to be recycled to save another life. Each donor candidate is assessed very comprehensively to see which organs are still functioning well enough, even though the person has died, to be able to tolerate the process of removing them, keeping them away from blood flow for a little while, and then transplanting them into another recipient. So we think about the level of function of each of those organs, and we want to be certain that we're not introducing a new problem like an infection or a cancer with the organ. I know that if that person takes their medications reliably and follows a reasonably healthy lifestyle that they will have an excellent chance of living a long life, being a productive member of society, being a family member, and being physically indistinguishable from other people that you see on the streets. Look, any good surgeon can take out an organ. The skill of transplantation is keeping that organ in good enough condition with adequate length of all of the blood vessels and the other structures to be able to use that organ again in another person for transplantation. When we stop blood flow to the organ, we wash the blood out with a special solution. We cool it down by putting it in ice. We transport it, sometimes thousands of miles, and we then perform the second operation, and when that heart starts beating again, when that urine comes from the kidney, when that liver pinks up, it is a magical moment because we know that the life has been saved. We have reached an amazing time in transplantation. We can do the transplants. We can prevent rejection. Now, we have to deal with the shortage of organs. In the future, as research continues, we will be able to use animal organs that have been given human attributes so that they're not rejected by our immune system or we'll be able to build and grow human organs in the laboratory. Many lives will be saved. There are fascinating scientific, ethical, all kinds of questions to be answered, and I invite you to join us. It's a great field.
00:05 - I was born with a disease called restrictive cardiomyopathy, and basically what that means is that my heart muscle was stiff. So it didn't pump blood throughout my body. So, your heart is pumping freely right now, and as a baby my heart was very stiff, so it was barely moving. It was working overtime. And because of that, I progressively got sicker, and I ended up in heart failure. One day, I had gotten so sick, I ended up in the emergency room. It had gotten to the point where I couldn't even walk up a flight of stairs. I would come crying to my mom and say, "Can you please carry me up these stairs? I can't walk. I can't breathe." I would come home from school, blue in the lips, huffing and puffing for air. I ended up living in the hospital for two months, immediately put on the transplant list, and I waited. I waited for two months for my heart. And, yeah, I received it January 12, 2004. I received it from a little girl, she was nine years old, from Texas. After my transplant, I... It's as if I never had anything wrong with me. I have a healthy heart. I'm able to walk. I'm able to run. I'm able to exercise. I'm able to do things that I was never able to do. When people ask me, "How has it affected your life, your daily life?" I'm alive. And that's something... I would not be sitting here in front of you if it wasn't for my heart transplant. Granted, I have to take about 15 pills a day, anti-rejection medications. But I'll take it, if it means giving me a life. Some risks that I have to face, I've already faced one of them. There's unfortunately... Obviously taking all this medication is keeping me alive. But it does have its fair share of side effects. One being that about 10% of patients end up developing lymphoma, cancer. And I was one of the lucky few. In 2013, I was diagnosed with post-transplant Hodgkin like lymphoma, and I ended up undergoing chemotherapy for about eight months. I had over 30 blood and platelet transfusions, and I'm... I'm now two years cancer free. So I beat that one also. And obviously, there's more risks my way, but I don't think there's anything that I can't tackle at this point. I'm just living. I'm living my dreams. I know that sounds so cliche, but I really am. I am an organ donor. I'm not sure if anyone wants my organs, I'm not sure if they will be in good shape when the time comes, but I am either way. Because I'm not gonna rule myself our prematurely, and there's so many parts of the body that can be donated to save someone's life. I mean, you could even just change someone's life with the cornea of your eye. If someone wants that, they got it, it's all theirs. So, I'll give it to them. I always tell people, "What are you gonna do with your organs?" I mean, you're either gonna be buried six feet underground, your organs are gonna be decomposed, or you're gonna choose to be cremated and they're gonna be burnt. So why not let them live on? Why not give someone a healthy organ, to let them live? I did speak to the donor family after I received my heart transplant. I wrote them... I wrote them a very nice letter, thanking them for the gift that they had given me. And we kept in contact for a while, and we had a very nice relationship, and I'm just so appreciative for that second chance of life that they had given me. So my mom thinks that I've developed some traits or tastes from my organ donor. So she always says that I, you know, my love for steak, my love for meat and big meals comes from the little girl that I got my heart from, because we did find out that she was a big eater. But I know that everything that I've learned in medicine and science, I don't really think that's so possible, but it's fun to think about. It's fun to think that I have a little piece of her with me. You know? I was so inspired after my heart transplant. I knew I wanted to go into the medical field, and I asked my doctor, you know, "Do you guys still have my heart?" They had it in the
hospital. They were doing a lot of research on it, because it was a very rare heart disease. And, I ended
up going to pathology lab. They pulled my heart from a jar, handed it to me. I put on gloves, I put on a
mask, and I took a picture holding my very own heart. That was incredible. It was surreal, actually.
Honestly, I think that holding my heart was almost like, "Here, I made it." I beat this. I survived. And it's
just one more thing that I had to conquer in my life.
00:05 – My name is Kelvin Smith, and I am 54 years old. I've always been an athlete, and something happened when I was about 37. I started to feel shortness of breath, and that was really unusual to me because I always really had a lot of endurance and stamina, and all of a sudden, something just went wrong. I had to get a pacemaker which eventually graduated to a defibrillator. And my cardiologist, my third cardiologist finally said, you know, one day you'll probably have to have a heart transplant. It made myself very emotional, my family obviously. No one understood what organ donation was about. So to go from someone who, all I did was lift weights and play football, baseball to whereas I couldn't do just ordinary things like bring in, let’s say, the groceries, shoveling snow, that was tough. When your heart is not working properly, that causes a lot of things to go. That can cause fluid buildup, AKA congestion. The congestion may push up against your lungs. That congestion also will affect your liver. That's why you'll see them a lot of times tapping on your liver to see how congested you really are. And this just forces all the organs to work harder, hence, shortness of breath. I can remember like it was yesterday the doctor said, when he said those words, it kind of floored me and to just fathom, to actually cut your chest open, take your heart out, and put the heart of someone else in, that was just something that was just, just couldn't comprehend it. And when he told me I had to go back to my car to explain that to my son who was in the car, that your dad might need a heart transplant in order to continue to live, on my way to the elevator, all I could was cry. As a grown man, I cried because that was just such the unknown, and now I had to explain it to, I think my son had to be about 19 years old. I was told about immunosuppressants. I guess I thought I was smart enough, but I didn't understand exactly what that meant. So it was explained to me that my immune system would have to be lowered in order for the heart to survive. So that much I got, but I didn't understand how many immunosuppressants. But I would have to take pills for the rest of my life, and which was okay with me at that point because I was just trying to live at that point. Immunosuppressants would have been the least of my worries at that point. Post-transplant, everything becomes a balancing act with the immunosuppressants. You have to make sure, what the doctors are trying to do is to make sure that you have enough and not too little because either way, it can cause rejection. And I started out with 54 pills, twice a day. So eventually as time went on, you’re tested every week for a month, and then eventually, it starts to wean off, every two weeks. And eventually it goes to every month until they get the right balance of immunosuppressants to make sure that you’re not going to be in rejection. I would love to meet my donor family. The main reason is to show them that their loved one continues to live on in me, to show them that their gift didn't go in vain. I think that would be very special to all of us. Nine years out of transplant, I feel, I feel good. I do feel like a 54 year old, but I feel good. I feel strong. I work three jobs. I still coach. Personal train. Everything physical I pretty much do. Shortness of breath, no more than the next person. I don't even worry about the stares anymore. I got this scar on my chest. I see that as a badge of courage, a badge of honor. Having to be in the gym and take a handful of pills at 10 o’clock doesn't bother me anymore 'cause I understand how special that is. I'm just really, really eternally grateful to my donor.
Hi, my name is Merida, and I have recently received a kidney transplant about six months ago in Pennsylvania. I was born with two kidneys, and I had to have one removed when I was three weeks old due to an infection. I lived a pretty healthy lifestyle most of my life, and about three years ago, I found out that I was going to have to be listed to receive a transplant. Afterwards, I would say the day after my transplant, I felt wonderful. It was really like night and day. I had a burst of energy. I felt great. My skin color, my complexion had changed. My eating habits had changed, as well. I had a great appetite, and I was very surprised at right after receiving my transplant that the doctors came and take me for a walk, which was a surprise for me 'cause I thought I was going to be in bed for a few days, but we went for a walk and everything, my blood work and my reaction to the medicine went really, really well. I didn't have any side effects, and I stayed in the hospital for about four days. There are some risks after transplantation. However, they don't outweigh not having a transplant. After my surgery, I started out with about nine medications, which were about 26 pills, half in the morning, half in the evening. Now, after six months, I'm down to four medication, and I haven't experienced any of the side effects. I was told that, perhaps, you may have some issues with your bones, your knees may hurt a bit, but I haven't experienced any. After having the transplant, taking the medications allows me to eat a lot more now. Before my transplant, I was limited on the things that I could eat. I couldn't have a lot of cheese which meant I had to cut out pizza dates with my daughter, but afterwards, now, we can pretty much have movie nights and have pizza and have popcorn because of the benefits of having a transplant. I don't know much about my donor as of yet. I do know that she is a young lady, and I really, really want to meet her family. If it wasn't for my donor and her family, I would not be here today to be able to continue living and helping others. I have a teenage daughter, and she is 16 years old, and this year, she's gonna be a high school senior, and she's gone through with me on my journey and experience what I've experienced, and after my transplant, we have discussed the gift of life and being a organ donor and how important it is. She knows that someone else has saved my life and has saved other people's life, as well, so this year, she's gonna get her permit, and she's so excited to get that little heart on her permit, and she also decided, you know, that she wants to make the decision to be a organ donor because she knows how much this has helped her as well as myself, but this allows me to be able to go to her graduation and to see her off to college and to continue living and being there for her.
Purpose/Connection
This lesson combines a review of homeostasis and the immune response with important information regarding receiving an organ transplant. Students use what they have learned to create a poster addressing factors and concerns for consideration by organ recipients.

Guiding Question/Aim
What do doctors and recipients need to know before considering organ transplantation?

Instructional Objectives
- Students will be able to describe homeostasis and how the breakdown of homeostasis is responsible for organ failure and the need for transplanted organs.
- Students will be able to describe the immune response to transplanted organs.
- Students will understand important factors and concerns for consideration by organ recipients.

Vocabulary
Synthesis lesson – no new vocabulary

Materials
- Assignment Sheet: Organ Donation/Transplantation Project
- Poster Templates: Organ Receiving, Immune Response, and Homeostasis
- Handouts and notes from previous lessons to be used for reference
- Poster-Making Materials (poster paper, construction paper, markers, glue)

Suggested Sequence of Activities - Lesson 4
Please note - This lesson is designed to help students pull together the information they have learned over the previous three lessons. You may decide that this lesson is not necessary, that you want each student to individually pull together information for
all three topics, or that you want to do something else. Please modify the lesson so that it is useful to your students.

1. Read the Organ Donation/Transplantation Project and establish a completion timeline by filling in the blank lines in the procedure.
2. Assign students to home groups of three, with each member of the group responsible for one of the three templates for the poster (Organ Receiving, Immune Response, and Homeostasis).
3. Have students form expert groups consisting of students responsible for the same poster template (Organ Receiving, Immune Response, and Homeostasis). These students use their handouts and notes from previous lessons to complete one template each, to be taken back to their home group.
4. Students return to their home groups, share what they have learned, and assemble the templates into a poster by simply sticking the templates to a larger sheet of paper.
5. Exit Assessment or Discussion: Engage students in closing dialogue: “What do doctors and recipients need to know before considering organ transplantation?”

**Standards**

**NYS Living Environment**

- 4.1.2c The components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment. To successfully accomplish this, organisms possess a diversity of control mechanisms that detect deviations and make corrective actions.
- 4.1.2d If there is a disruption in any human system, there may be a corresponding imbalance in homeostasis.
- 4.5.2a Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.
- 4.5.2c The immune system protects against antigens associated with pathogenic organisms or foreign substances and some cancer cells.

**NYS Next Generation ELA Learning Standards**

- 9-10.RST.1 Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc. attending to the precise details of the source. Understand and follow a detailed set of directions.
- 9-10.WHST.2: Write informative/explanatory text focused on discipline-specific content.
- 9-10.WHST.7: Draw evidence from informational texts to support analysis, reflection, and research.
Organ Donation/Transplantation Project

Part 1 - Poster

Procedure:
In a small group use the materials provided in class and your knowledge of biology to answer questions and provide an illustration about one aspect of organ donation/transplantation (organ receiving, immune response, or homeostasis). Each person in the group completes a summary page for a group poster.

Poster Due _________________

Part 2 - Letter

Procedure:
Write a letter using the instructions and rubric provided by your teacher.

Letter due _________________
Organ Receiving

What risks are associated with receiving an organ transplant?

What does a doctor need to know about the donor?

How are donor organs and recipients “matched” for a transplant?

How can risks be minimized?
Immune Response

Illustration with labels

What is it responsible for in the body?

How does it work?

What does the organ recipient need to know about the immune response?

What can go wrong?
Homeostasis

Illustration with labels

What is it responsible for in the body?

How does it work?

What does the organ recipient need to know about homeostasis?

What can go wrong?
Purpose/Connection
This lesson is a culminating activity in which students use what they have learned from creating the poster in Lesson 4 to write a letter from either themselves or Lavon to their families.

Guiding Question/Aim
How does organ donation/transplantation work and is registering as an organ donor right for me?

Instructional Objectives
- Students will be able to describe homeostasis and how the breakdown of homeostasis is responsible for organ failure and the need for transplanted organs.
- Students will be able to describe the immune response to transplanted organs.
- Students will understand important factors and concerns for organ donors and recipients to consider.

Vocabulary
Synthesis lesson – no new vocabulary

Materials
- Student-created posters to be used for gallery walk and reference
- Sticky notes
- Assignment Sheet: Organ Donation Letter
- Rubric: Organ Donation Letter Scoring Rubric

Suggested Sequence of Activities - Lesson 5
1. Hang student posters on the walls for a carousel/gallery walk
2. With their home group, students travel to the other posters and use sticky notes to either add information to their classmates’ posters or write down information they would like to add to their own poster.
3. Student groups return to their own posters where they add sticky notes of information they gathered on their gallery walk and read those left by other groups.

4. Individually, students use the information on their posters to create an outline for the letter described on the Organ Donation Letter handout. [The letter can be written at home or in class on the next day.]

5. Exit Assessment or Discussion:
   Engage students in closing dialogue: “What are some important points to include in your letter?”

**Standards**

**NYS Living Environment**

- 4.1.2c The components of the human body, from organ systems to cell organelles, interact to maintain a balanced internal environment. To successfully accomplish this, organisms possess a diversity of control mechanisms that detect deviations and make corrective actions.
- 4.1.2d If there is a disruption in any human system, there may be a corresponding imbalance in homeostasis.
- 4.5.2a Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.
- 4.5.2c The immune system protects against antigens associated with pathogenic organisms or foreign substances and some cancer cells.

**NYS Next Generation ELA Learning Standards**

- 9-10.RST.1 Cite specific evidence to support analysis of scientific and technical texts, charts, diagrams, etc. attending to the precise details of the source. Understand and follow a detailed set of directions.
- 9-10.WHST.1: Write arguments focused on discipline-specific content.
- 9-10.WHST.7: Draw evidence from informational texts to support analysis, reflection, and research.
Organ Donation Letter

**Topic:** How does organ donation work and is it right for me/Lavon?

As either yourself or Lavon, write a letter to your family, informing them of what you have learned from reading texts, watching videos, and researching homeostasis, the immune response, and organ donation. Let them know what you have decided regarding organ donation and why you have come to that decision. Provide examples to illustrate and clarify your position. As you may recall from the Quick Facts infographic, until people are 18, families have the right to override their decisions about organ donation, so please make sure that you are clear and provide supporting evidence.

Your letter must include the following:

a. **Introduction:** Write a description of the current state of organ donation in New York.
   - What facts about organ donation are relevant to making this decision?

b. **Body:**
   - Describe the roles of homeostasis and the immune system in the need for and response to organ donation/transplantation. Include what these systems are responsible for in the body, how they work, and what can go wrong with them. Make sure your family understands the meaning of any technical words you choose to use.
   - Make sure you have explained how organ donation/transplantation works and why organs may be rejected, including what the doctor needs to know about the donor, what risks are involved and how they can be minimized.

c. **Conclusion:** Based on your research, what you have learned in class, and your feelings on the topic, summarize your decision and why you came to that decision. (Make sure you continue to speak from the point of view of either yourself or Lavon.)
# Organ Donation Letter Scoring Rubric

<table>
<thead>
<tr>
<th>Scoring Category</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scientifically Accurate (40%)</strong></td>
<td>All scientific facts are clearly explained, accurate, and serve to enhance the explanation.</td>
<td>Almost all scientific facts are clearly explained, accurate, and serve to enhance the explanation.</td>
<td>Some scientific facts are clearly explained, accurate, and serve to enhance the explanation.</td>
<td>Scientific facts are included, but may be inaccurate, poorly explained, or not in support of the explanation.</td>
</tr>
<tr>
<td><strong>Citing Evidence (40%)</strong></td>
<td>Cites specific evidence to support your explanation, attending to the precise details of explanations or descriptions. Use at least one source not provided in class.</td>
<td>Cites at least two sources of evidence, but none from outside class.</td>
<td>Generally alludes to evidence; but draws only from one source.</td>
<td>No mention of evidence despite offering an explanation.</td>
</tr>
<tr>
<td><strong>Construction / Organization (10%)</strong></td>
<td>Ideas and information are organized logically using appropriate transitional words/ phrases; includes an introduction with a clear body and a conclusion.</td>
<td>Ideas and information are somewhat organized logically using transitional words/ phrases; includes an introduction with a clear body and a conclusion.</td>
<td>Ideas and information are minimally organized using transitional words/ phrases; includes an introduction with a body and a conclusion.</td>
<td>Poorly constructed paragraphs; essay is unfocused and lacks clarity.</td>
</tr>
<tr>
<td><strong>Mechanics / Conventions (10%)</strong></td>
<td>Uses precise language. Tone is consistently appropriate for audience. Nearly perfect grammar, spelling, and syntax. Technical words are appropriately used and explained.</td>
<td>Uses language and tone mostly appropriate for audience. Few grammar, spelling, and syntax errors. Technical words are appropriately used and explained.</td>
<td>Uses language and tone generally appropriate for audience. Noted amount of grammar, spelling, and syntax errors that do not interfere with understanding. Technical words are appropriately used but often not explained.</td>
<td>Grammar and/or spelling errors interfere with understanding. Technical words are not used at all or used inappropriately and not explained.</td>
</tr>
</tbody>
</table>