Connections to Curriculum

- ✓ Scientific Inquiry
- ✓ Decision Making
- ✓ Group Work
- ✓ Personal Perspectives/ Reflection
- ✓ B11-3-01 Design and execute an experiment to investigate an aspect of the transportation or respiratory system.
- ✓ B11-3-05 Describe the blood donation process and investigate related issues.
- ✓ B11-3-14 Identify major structures and function of the human respiratory systems from a diagram, model, or specimen.

Senior Years Science Teachers' Handbook

Chapter 4: Science-Technology-Society-Environment Connections

- ✓ 4.14 Case Studies of STSE Issues
- ✓ 4.15 Evaluating Medical Technology

Unit 3

Transportation and Respiration

Giving the Breath of Life Lesson Plan

Objectives

Students will

- demonstrate understanding of lung health issues
- critically assess compatibility issues
- analyze the need for and possibility of receiving a lung transplant

Materials

- straws (one per student)
- coffee stir sticks (one per student)
- Breath of Life: Student Reflections (BLM 3.1) (one per student)
- Giving the Breath of Life (BLM 3.2) (one per student)
- group of balloons tied together (plus a pin to pop)
- blood typing cards (BLM 3.3) (one per student)
- HLA cards (BLM 3.4) (one per student)

Introduction

1. Ask students to count the number of inhalations they take in one minute—time will be kept for 30 seconds and students can then double their count. Students record this number and reflections on the Breath of Life: Student Reflections sheet (BLM 3.1).
   Note: Teacher should keep time for students to ensure that students are concentrating on their own breathing and not the time.
2. Hand out straws. Ask students to count their breaths for the same amount of time while breathing through the straw. Students may have to hold their nose to ensure breathing is through the straw alone. Students record this number and reflections on the Student Reflections sheet. *Note: Teacher should instruct students to discontinue breathing through the straw if breathing becomes too heavily strained or they become dizzy.*
3. Hand out coffee stir sticks/thinner straws. Repeat step 2.

(*continued*)

4. Facilitate a group discussion. Ask students if they know what is being demonstrated by this activity. Answer: Problems with breathing/lung disease.

   - First demonstration is regular breathing.
   - Second demonstration is primary lung disease (due to smoking, lung infection, or other causes).
   - Third demonstration is chronic lung disease (due to emphysema, cystic fibrosis, or pulmonary hypertension—high blood pressure in pulmonary capillaries).

   Ask students to record this information on the Student Reflections sheet.

5. To further demonstrate the devastating effects of emphysema present the students with a bunch of balloons tied together with various strings. Balloons may be hidden from the students until this time in a garbage bag and this arrangement can be used to reinforce the parts of the respiratory system (balloons = alveoli; strings = bronchioles; strings tied in a bunch = bronchi; garbage bag containing alveoli = lungs).

   Ask students to review the structure and function of the alveoli. *(Answer: numerous, thin membrane, moist surface, facilitates gas transfer).*

   Pop the balloons one by one in front of students, informing them that this is what happens due to emphysema; the systematic destruction of alveoli (leave a few balloons unpopped—for now. Ask the students what the effect of this destruction would be on the human system (hard time breathing, shortness of breath, wheezing, decreased tolerance of physical activity, coughing). Inform students that in addition to ineffective alveoli, sometimes the bronchioles become restricted in their ability to facilitate gas transfer. Demonstrate this by cutting the balloons from the string. Inform students that this has the same effect as the destruction of alveoli. Ask students to include this on their reflection sheet as well.

6. Discuss treatment options available for those who suffer from emphysema or other COPD (chronic obstructive pulmonary disease). *Answers include: immediate cessation of smoking (if a smoker), bronchiole dilating medication (puffers), oxygen therapy, and perhaps transplant.*

Lesson and Assessment

1. Hand out Giving the Breath of Life sheets (BLM 3.2).

2. For the learning activity, students are required to have a blood type. If students are aware of their own ABO and Rh antigens, they are more than welcome to use those. If students do not know their own blood type, they are welcome to choose a blood type card from those provided (BLM 3.3). The proportion of cards is somewhat representative of the frequency in the population. They are, in this case, not random.

3. Students are required to have specific HLA antigen markers to determine tissue type compatibility. There are only three provided in this activity (BLM 3.4). Students choose randomly from the HLA marker cards provided by the teacher. By only having three possible HLA markers, the instance of marker compatibility should increase. *Note: Teachers should print the Blood Typing and HLA marker cards (BLMs 3.3 and 3.4). It may be a good idea to laminate the cards to keep them for future use.*

Breath of Life: Student Reflections

Part A: My Regular Breath

Table 1: Timed Breathing Rate

# of breaths after 30 seconds	# of breaths/ minute

During this time I felt: _____

_____

_____

_____

_____

_____

Part B: Breathing through a Straw

Table 2: Timed Breathing Rate through a Straw

# of breaths after 30 seconds	# of breaths/ minute

During this time I felt: _____

_____

_____

_____

_____

_____

Part C: Breathing through a Narrow Diameter Straw

Table 3: Timed Breathing Rate through a Narrow Diameter Straw

# of breaths after 30 seconds	# of breaths/ minute

During this time I felt: _____

_____

_____

_____

_____

_____

Analysis:

Part A represented: _____

Part B represented : _____

Part C represented: _____

My understanding of a chronic lung disease is _____

_____

_____

_____

_____

_____

Name: _____

Giving the Breath of Life

Background

Chronic obstructive pulmonary disease (COPD) is characterized by the substantial restriction of air flow into and/or out of large segments of lung tissue. The result is an extensive loss in total lung volume as well as the amount of oxygen that can be transported around the body. This has great potential to affect the day-to-day life of a person suffering from COPD. Tasks that people with healthy lungs take for granted, such as walking down a hallway, picking up a baby, playing with your pet, suddenly become too much for a person with COPD, and they end up gasping and struggling to breathe the same air that flows so easily into and out of the lungs of a healthy individual.

A lung transplant is a treatment option for some who suffer from very advanced forms of COPD such as cystic fibrosis. The person who receives the lung transplant (the recipient) must first meet with a respirologist who determines if the patient qualifies to be assessed for a transplant (the parameters include, but are not limited to, a non-smoker status, assessment of quality of life after the procedure, and weight restrictions). Once the assessment deems the patient suitable for the surgery, a more involved series of tests take place through meeting with no less than 16 individual medical staff (e.g., doctors, nurses, therapists, transplant staff). These tests include blood tests, CT scans, chest X-rays, and tissue typing. A lung transplant is unique in that it not only must match the donor and recipient in terms of blood and tissue typing (based on blood and major histocompatibility complex [MHC]—human lymphocyte associated [HLA] antigens) but also size.

Even when matches in all areas are found, the recipient must still take high doses of immunosuppressant medication in an effort to reduce the chance of tissue rejection. Immunogeneticists, specialists that study antibody-antigen reactions, monitor the patient closely.

Lung transplants may involve the transplantation of a single lung or a double lung. More often, double lung transplants come from deceased donors, and single lung from deceased and living donors. However, in rare and extremely urgent cases, a double lung transplant from living donors is possible. Two donors are needed, since each donor can only donate a portion of their lung. Tissue typing must be exact in both cases. A living lung donation is still a new procedure and is not currently performed in Manitoba—however, Manitoba at one time did perform the first living double lung transplant.

Learning Activity: To Whom Can You Donate?

Materials

- measuring tape
- Blood Type Card (BLM 3.3) (if necessary)
- HLA Antigens Marker card (BLM 3.4)

In this investigation, you will

- critically assess compatibility issues among classmates
- analyze the need for and possibility of receiving a lung transplant

Learning Activity

1. What Are Your General Characteristics?
   a. In the space provided below, draw a diagram of the lungs as they would be seen if viewed from a chest X-ray. Label the following structures: lung, trachea, bronchi branch, bronchi. An X-ray cannot pick up the microscopic divisions that follow the bronchi (bronchioles and alveolus).

   b. Using your measuring tape, record your chest circumference (area around the fullest part of your rib cage) below.

      _____ centimetres

   c. Do you know your blood type? If so, record your actual blood type (ABO and Rh antigens) below. If not, ask your teacher to assign you a blood type.

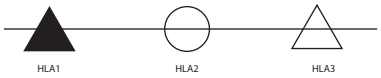
      Blood Type: _____

   d. Tissue typing plays a large role in determining compatibility in lung transplants. It involves matching HLA antigens. HLA antigens are proteins found on the surface of most cells in your body and allow your body to recognize self from non-self cells. A close match of HLA antigens reduces the chance of the immune system attacking the newly transplanted lung. Medical professionals determine about six of these HLA markers to be the most important to be matched between transplant donors and recipients. *Note: Most transplant centres look at more than just six HLA markers, but we will use six in this instance to expedite the learning activity.*

Draw a card from your teacher that represents your HLA antigens.
Draw these antigens below

Use the chart provided to determine the type of HLA antigens you have.
Record the sequence of the antigens below.

For example, if your HLA markers are



your sequence would be 1+
2-
3-

Your sequence:

Record all your information on the card below and cut along the dotted line. This card now represents your assessment profile. You will use this information to compare with other students in the class.

My Transplant Assessment Profile

Age: _____

Chest Circumference: _____

Blood Type: _____

HLA Antigen Sequence: _____

My Match's Transplant Assessment Profile

Age: _____

Chest Circumference: _____

Blood Type: _____

HLA Antigen Sequence: _____

e. Find someone who is a match with your criteria. A match is considered to be someone who
   - has a chest circumference within 10 centimetres of your own
   - has the same blood type or is a suitable donor according to the chart below
   - has the **exact** same HLA antigen sequence

		CAN RECEIVE (+)							
		O -	O +	B -	B +	A -	A +	AB -	AB +
BLOOD TYPE	AB +	+	+	+	+	+	+	+	+
	AB -	+		+		+		+	
	A +	+	+			+	+		
	A -	+				+			
	B +	+	+	+	+				
	B -	+		+					
	O +	+	+						
	O -	+							

Record your match's profile beside yours on your Assessment Profile card.

Note: You may or may not find a match among your classmates. If you do not find a suitable match, address this in the discussion section of this learning activity.

Analysis

1. a. Were you able to find a match to your specific needs?

   _____

   b. If yes, what were the major challenges you faced in finding a match? If no, why do you think you had trouble finding a match?

_____

_____

_____

_____

2. What were the limitations presented in this learning activity? Were there any factors left unconsidered? What could be done differently that could add to the realism of this learning activity?

_____

_____

Application—Case Studies

Use your own transplant assessment when responding to the following cases.

1. Jackson is a 13-year-old middle school student who is suffering from cystic fibrosis. His lungs are mostly obstructed making it hard for him to walk from class to class during the school day without gasping for air. He wants to participate in gym class and some other school clubs with his friends, but his breathing makes it difficult for this to be accomplished. His health in other capacities is very good. His chest circumference is 86 centimetres. His blood type is AB+ and HLA antigen sequence is 1+ 2+ 3- 4- 5- 6+

   a. Is Jackson a candidate for a lung transplant? _____
   b. Can you be a possible donor for Jackson? Explain your answer.

   _____

   _____

   _____

   _____

2. Lily is a 28-year-old mother of a young daughter. She suffers from pulmonary hypertension (high blood pressure in arteries that supply blood to the lungs). For most of her life Lily used anticoagulants to reduce the instance of blood clots forming in her pulmonary arteries due to the high blood pressure. Doctors have decided that the medication is now contributing to the other symptoms she is exhibiting. In order to improve her quality of life for the future, they decided that a single lung transplant is her best option. After being admitted to the hospital for a series of tests, it is determined that Lily's blood type is A-, her chest circumference is 71 centimetres, and her HLA antigen sequence is yet to be determined.

   a. Is Lily a candidate for a lung transplant? _____
   b. Based on the information given, can you be a possible donor for Lily? Explain your answer.

   _____

   _____

   _____

   _____

3. Lou is a 62-year-old man who is suffering from emphysema that is the result of 45 years of smoking cigarettes. Lou refuses to give up his addiction even though the emphysema is progressing to the point where he experiences severe shortness of breath. Sometimes his lips turn blue due to lack of oxygen. Lou has been admitted to the hospital eight times due to serious hypoxia (low blood oxygen)—and the condition is only getting worse. During his trips to the emergency room, doctors have determined his blood type to be O- and his chest circumference is 1.3 metres. His HLA antigen sequence is unknown since Lou has not seen the transplant team.

   a. Is Lou a candidate for a lung transplant? _____
   b. Can you be a possible donor for Lou? Explain your answer.

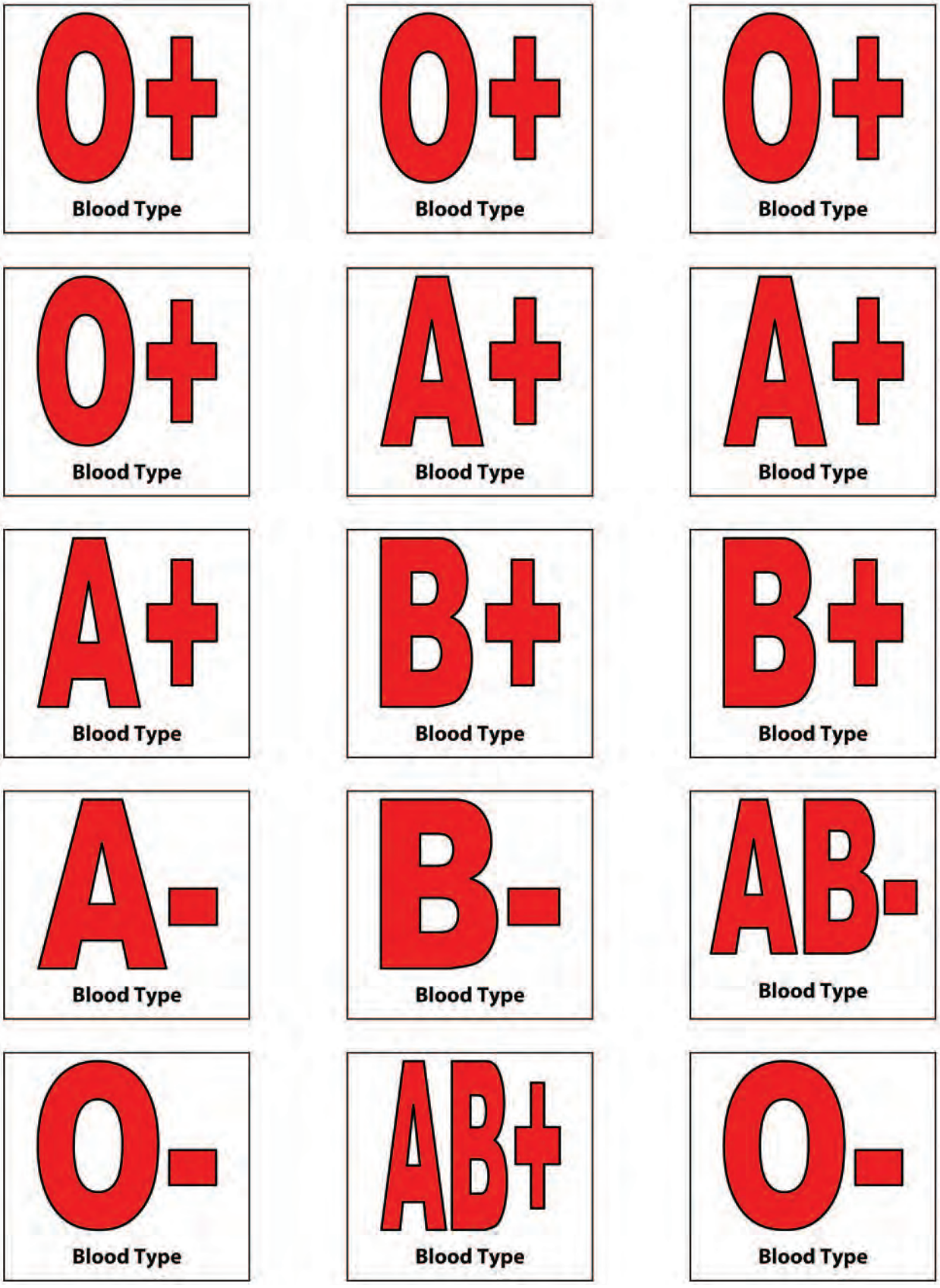
   _____

   _____

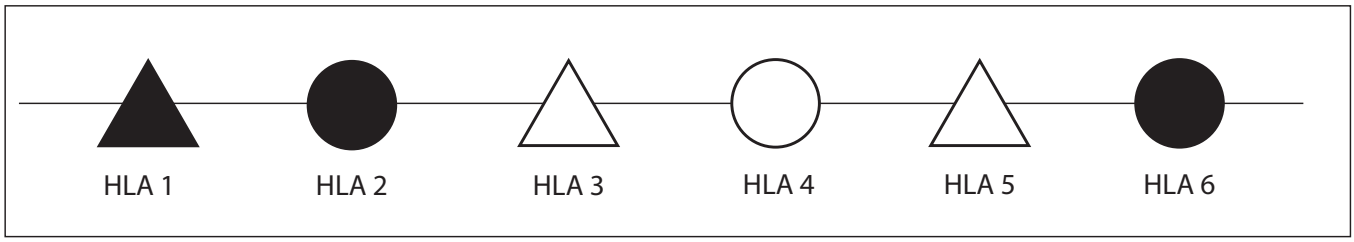
   _____

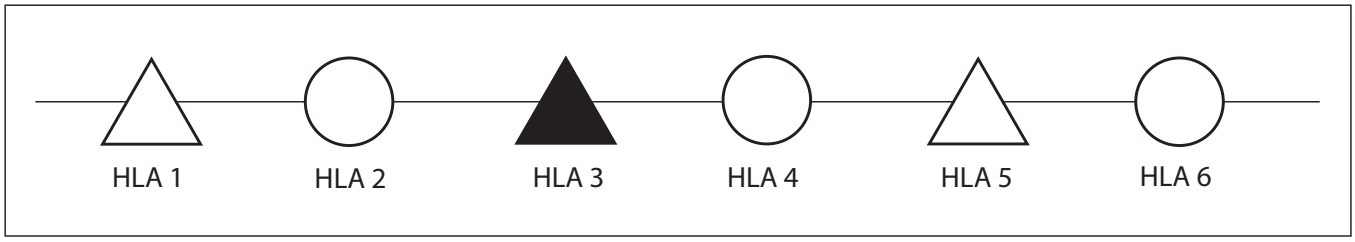
   _____

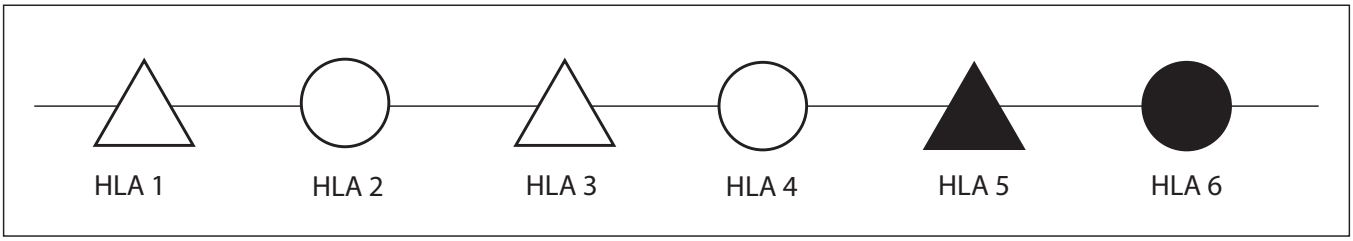
Blood Typing Cards

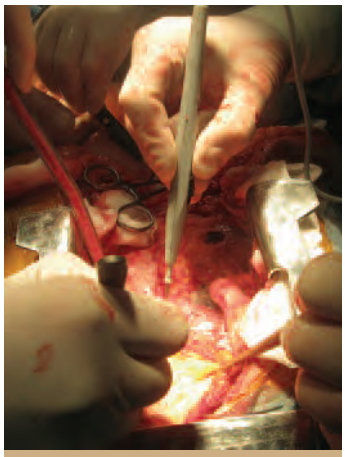


HLA Antigen Markers









Connections to Curriculum

- ✓ Scientific Inquiry
- ✓ Decision Making
- ✓ Group Work
- ✓ Personal Perspectives/ Reflection
- ✓ B11-3-01 Design and execute an experiment to investigate an aspect of the transportation or respiratory system.
- ✓ B11-3-08 Describe the cardiac cycle. Include: systole, diastole
- ✓ B11-3-16 Investigate and describe conditions/disorders associated with transportation and/or respiration in the human body.
- ✓ B11-3-17 Identify personal lifestyle choices that contribute to cardiovascular and respiratory wellness.

Senior Years Science Teachers' Handbook

Chapter 4: Science-Technology-Society-Environment Connections

- ✓ 4.14 Case Studies of STSE Issues
- ✓ 4.15 Evaluating Medical Technology

Operation Heart Transplant Lesson Plan

Objectives

Students will

- have an opportunity to engage in an online simulation of a heart transplant procedure
- work creatively with the vocabulary particular to the human heart anatomy and heart transplantation through building a crossword puzzle

Materials

- Operation Heart Transplant Crossword (BLM 3.5)
- computer with Internet connection (fast connection recommended)
- LCD projector (or similar equipment)

Instructions

1. Guide students through a simulated heart transplant by navigating through the "Electric Heart—Operation: Heart Transplant" simulation on the PBS website at <www.pbs.org/wgbh/nova/eheart/transplant.html>.
2. Teacher may lead or ask for student participation. This is a great activity for using interactive whiteboards such as Smart Boards.
3. Following the simulation, hand out the Operation Heart Transplant Crossword assignment (BLM 3.5), where students are asked to use the vocabulary from the simulation to create crossword puzzle clues.

Operation Heart Transplant Crossword

Use the word list below (or one developed by you or your class) to create a crossword puzzle. Place the words in the blank grid either horizontally or vertically, making sure to use one letter in at least two words at one time (like a real crossword puzzle).

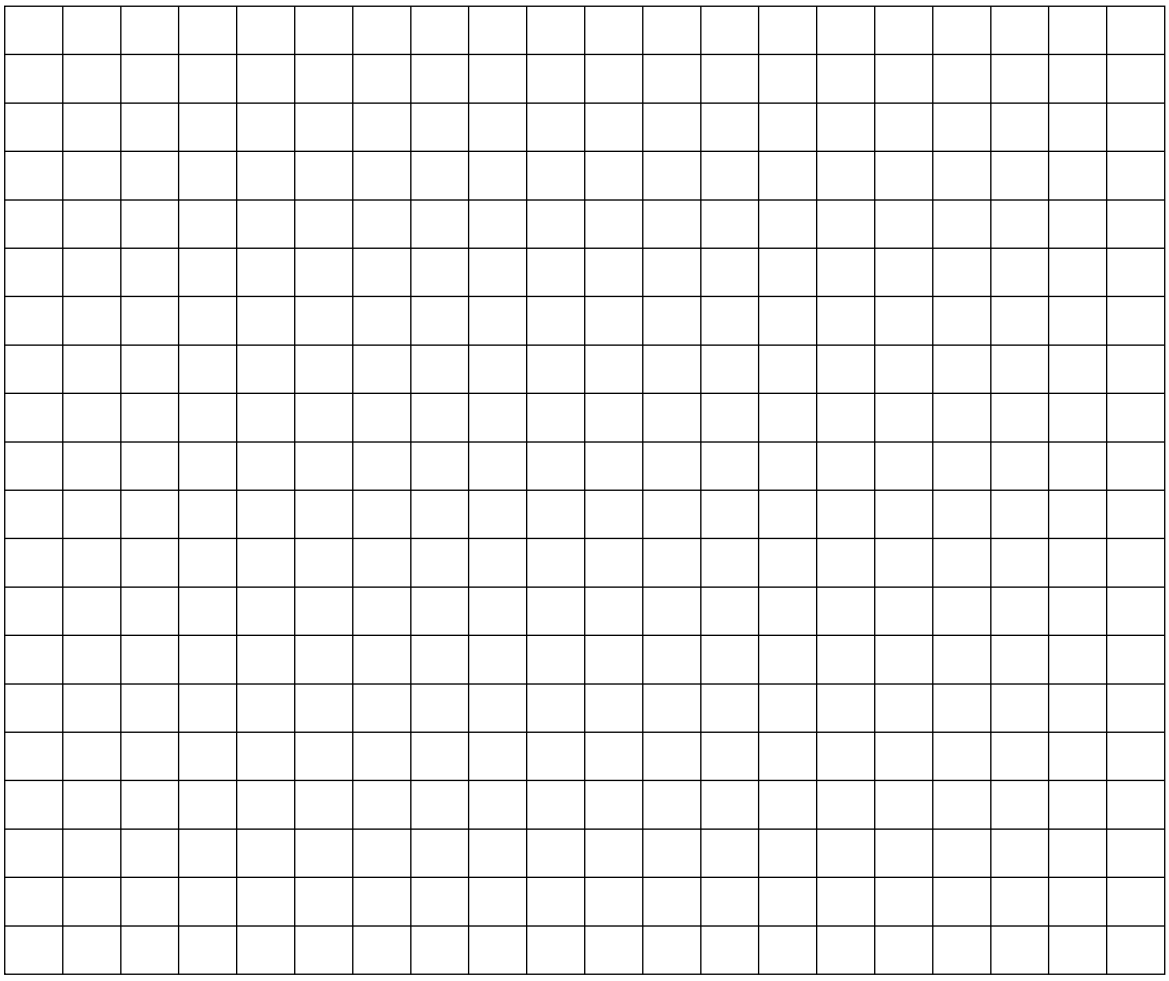
When complete, number the first letter in each word.

Create clues for each word under the appropriate heading (either "Across" or "Down").

When this template is complete, use the accompanying grid to make your final copy. This time, SHADE in only the **unused** squares in the grid, keeping the squares needed to fill in the words blank. Remember to number the squares the same way you numbered the clues.

Suggested Word List

DEOXYGENATED	DEFIBRILLATOR	HAEMOSTATS
OXYGENTATED	SCALPEL	STERNUM
PULMONARY	ATRIA	AORTA



Clues

ACROSS

DOWN

Operation Heart Transplant Crossword Final Draft