

# Blood Circulation Simulation

Grade 5

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**Science Content Standards:** Grade 5, 2b — *Students know* how blood circulates through the heart chambers, lungs, and body and how carbon dioxide and oxygen are exchanged in the lungs and tissues.

**Lesson Concept:** Blood circulates through the heart chambers and body organs like lungs, kidneys, and intestines.

## Conceptual Flow:

- ▶ The circulatory system carries oxygen and nutrients to various body parts through blood.
  - The organs and tissues of the circulatory system provide the body's cells with the oxygen and nutrients needed for life.
  - The organs and tissues of the circulatory system help the body's cells rid themselves of wastes.
  - Circulatory system picks up nutrients from the digestive system to deliver to the cells.
- ▶ The heart is the mechanism that moves blood.
  - The heart has four chambers.
  - The heart pumps the blood to various body parts.
    - Veins transport blood to the heart and arteries transport blood away from the heart.
    - Arteries transport blood to capillaries and cells and veins from capillaries and cells.
    - Capillaries are thin vessels that allow enriched blood to seep into cells and depleted blood to leave.
    - Nitrogenous cellular wastes are delivered to the kidneys for disposal.

## Teacher Background:

Structures of the cardiovascular and circulatory systems, including the heart and lungs, promote the circulation of blood and exchange of gas. The left side of the heart is responsible for pumping blood through arteries to all the tissues of the body delivering oxygen. Oxygen-poor blood returns to the heart through veins. The right side of the heart is responsible for pumping blood to the lungs, where the blood eliminates its carbon dioxide and receives a fresh

supply of oxygen. Exhaling expels the carbon dioxide that was transported to the lungs by the blood; inhaling allows the intake of oxygen, which is picked up by the blood.

(Adapted and excerpted from the *Science Framework for California Public Schools: Kindergarten Through Grade Twelve*)

The right ventricle pumps oxygen-poor blood into arteries that lead to the lungs. These are the only arteries in the body that carry oxygen-poor blood. In the capillaries of the lungs, blood takes up oxygen and releases carbon dioxide. Oxygen-rich blood travels through veins to the left atrium. These are the only veins in the body that carry oxygen-rich blood. The heart pumps oxygen-rich blood from the left ventricle into arteries and then into capillaries. As the blood travels through capillaries, it transports oxygen, nutrients, and water to the cells of the body. At the same time, waste materials and carbon dioxide are carried away. Oxygen-poor blood travels back to the heart and is delivered into the right atrium by two large veins. To summarize: oxygen-poor blood from the body goes to the right atrium, to the right ventricle, to the lungs. Oxygen-rich blood goes from the lungs to the left atrium, to the left ventricle, then out to the body.

(Excerpted from *Holt Life Science*, 5<sup>th</sup> grade)

Your students might ask “what is the ‘waste’ that the blood drops off?” That waste is not digestive waste (that gets eliminated from the gut, while nutrients get absorbed into the blood from the walls of the intestine). Also, it's not carbon dioxide (CO<sub>2</sub>), which is a cellular waste produced by cell maintenance and by cells burning sugar for energy (CO<sub>2</sub> is not the only cellular waste). Most of the “waste” that is disposed of by the kidneys is nitrogen-based wastes from the cell “factories” building and breaking down all the “machinery” of the body, which contains a lot of protein and thus nitrogen. So, those are cellular wastes resulting from cells maintaining themselves. (Explanation by Cathy Koehler, Content Cadre Member)

Note: In this lesson, the students simulate “blood,” not “blood cells.” This is because blood cells themselves do not carry nutrients. So to avoid creating misconceptions, we are making all the traveling students “Blood”, and have them carry nutrients, oxygen (O<sub>2</sub>), waste, and Carbon dioxide (CO<sub>2</sub>). That concept is overall correct, and we don't need to get into details about the actual things floating around in the blood that may carry stuff ... it's all just part of blood. (Suggestion by Cathy Koehler, Content Cadre Member)

## Materials Needed for the Lesson:

### Teacher Materials and Preparation

- Five one-liter bottles of red colored water (to show the amount of blood students have in their bodies).
- Make a copy of the “Blood Flow Schematic” and follow it to help you set up the game outdoors.
- Make an overhead of the Student Recording Sheet, “My Journey As Blood.”

- For additional materials and preparation, see “Directions for the Blood Circulation Game” and follow the directions to prepare for the game.

**Student Handouts**

- For Engage: “The Heart and the Flow of Blood”
- Student Recording Sheet: “My Journey As Blood”
- Student Assessment #1: “Diagram of Blood Flow”
- Student Assessment #2: “Functions of the Circulatory System”
- For students who are role-playing blood: “Directions for Students Who Are Blood”
- For Students Monitors of various stations, provide the correct card from the “Cards for Directions for Stations.”

If possible, have an adult be the “Heart Monitor” and provide the “Heart Station (Heart Monitor Card).” A student may also take this role.

## 5E Lesson: Blood Circulation Simulation

Teacher Does	Student Does	Concept
<p><b>ENGAGE:</b>  <i>How much blood do you think each of us contain?</i></p> <p>Show five 1-liter bottles of dark red water.</p> <ul style="list-style-type: none"> <li>▶ <i>This is how much blood is flowing through your body.</i></li> <li>▶ <i>Where is your heart?</i></li> <li>▶ <i>How do you think the blood flows through your body?</i></li> </ul> <p>Distribute the Student Handout, “The Heart and Flow of Blood.” Give instructions:</p> <ul style="list-style-type: none"> <li>▶ <i>On the outline of the human body, put a mark where the heart would be on the body and then use a pencil to show how you think the blood moves through the body.</i></li> <li>▶ <i>Then over on the blank side of the paper, draw what you think the heart actually looks like and label any of the parts you know.</i></li> <li>▶ <i>You only have 5 minutes. Do the best you can in the short time. I’m not looking at artistic ability; I want to learn what you know.</i></li> </ul> <p>Have a couple of students share their drawings.</p>	<p><b>Expected Student Response (ESR):</b> gallons; lots; a few cups</p> <p><b>(ESR):</b> In the middle of our chest.</p> <p><b>ESR:</b> It goes from your heart to everywhere in your body.</p> <p>Put a mark on where the heart is located and show how the blood flows through the body.</p> <p>Draw a picture of the heart showing a detailed drawing of the heart (size, shape) and label parts.</p>	<p>The heart has four chambers for blood to flow through.</p> <p>The circulatory system transports oxygen, carbon dioxide, and nutrients through the human body.</p>

Teacher Does	Student Does	Concept
<p><b><u>EXPLORE:</u></b></p> <ul style="list-style-type: none"> <li>▶ <i>Today we are going to do a simulation where you will play the role of blood flowing through the body.</i></li> <li>▶ <i>I am going to explain the game, then we will go outside and have some students model the game, and then everyone will play the game.</i></li> </ul> <p>Make a diagram on the board showing the stations: <b>heart, lungs, intestines, kidneys, right and left arms, right and left legs, and the head.</b></p> <ol style="list-style-type: none"> <li>1. <i>Everyone (except the Student Monitors) will represent "Blood" and will get one OXYGEN Card and five NUTRIENT Cards and a DESTINATION STICK. You will be given a recording sheet to record your movements during the game.</i></li> <li>2. <i>We will start by everyone going to the destination on your stick.</i></li> <li>3. <i>If your destination is a body part like a leg, arm, or head (that is not an internal organ), give the body part at that location a NUTRIENT Card and an OXYGEN Card. You will receive one CARBON DIOXIDE Card and one WASTE Card. The person at the station has the instructions for what to do in case you forget. If the destination is an internal organ (like a kidney or intestines) follow the instructions that the "organ" tells you.</i></li> <li>4. <i>From that destination, you will go to the HEART. Stand in line behind all other Blood that are also going into the heart. (The blood flows in a line). Once it is your turn, give the Heart Monitor your Destination Stick.</i></li> <li>5. <i>From the HEART you must go to the LUNGS (stand in line behind all the other blood also going to the lungs). Once it is your turn, throw all your CO<sub>2</sub> cards into the Lung CO<sub>2</sub> bucket, and take one O<sub>2</sub> card from the Lung O<sub>2</sub> supply bucket.</i></li> <li>6. <i>Go back to the heart (stand in line behind other blood coming from the lung and going to the heart). Show the Heart Monitor your O<sub>2</sub> card, and the Heart Monitor will give you a</i></li> </ol>		<p>Blood circulates through the heart chambers and body organs, such as lungs, kidneys, and intestines.</p>



Teacher Does	Student Does	Concept
<ul style="list-style-type: none"> <li>▶ Does the blood flow in a circle in the body?</li> <li>▶ We call this the circulatory system, because the blood “circulates” through the body. Webster’s definition for circulate is “to move in a regular course and return to the same point.” Does the blood in the body circulate according to the dictionary meaning of circulate? Please explain.</li> <li>▶ <i>Let’s find out what you have learned and if you have changed your thinking about how blood circulates in the body.</i></li> </ul> <p>Distribute Student Assessment #1 “Diagram of Blood Flow.”</p> <ul style="list-style-type: none"> <li>▶ <i>Make a diagram and explain how the blood circulates in the body.</i></li> </ul> <p>Distribute Student Assessment #2 “Functions of the Circulatory System” and ask student to complete these.</p> <p>Review the assessments and discuss their understandings with students.</p>	<p>the lungs it goes back to the heart.</p> <p><b>ESR:</b> No, the blood does not flow in a circle.</p> <p>Do final assessment independently.</p> <p>Students complete Assessment #1.</p> <p>Students complete Assessment #2.</p>	<p>Blood delivers oxygen and nutrients to body cells. Blood removes carbon dioxide and waste from body cells.</p>
<p><b><u>EXTEND:</u></b></p> <p>Think of an example where something circulates and explain. How are these similar and different from our circulatory system?</p> <p>As a homework assignment, students may wish to make a “Heart House” out of a cereal box. For directions go to:  <a href="http://www.childrensheartinstitute.org/kidsonly/hearthse.htm">www.childrensheartinstitute.org/kidsonly/hearthse.htm</a></p> <p>Do the TLC Lesson “The Heart Circulates Blood”:  <a href="http://www.lakesc.lake.k12.ca.us/lessons/pdf/Grade5_Heart-Circulates-Blood_TLC2010.pdf">www.lakesc.lake.k12.ca.us/lessons/pdf/Grade5_Heart-Circulates-Blood_TLC2010.pdf</a></p>	<p><b>ESR:</b> Air circulating through a heater and the house; water circulating through the swimming pool and the filter.</p>	<p>Materials circulate for different reasons/functions.</p>

**Input Question: (Engage)** Where is your heart?

**Process Question: (Engage)** How you think the blood flows through your body?  
**(Explain)** Make a diagram and explain how the blood circulates in the body.

**Output Question:** Think of an example where something circulates and explain.

## TEACHER MATERIAL

# Directions for the Blood Circulation Game

### Materials and Preparation

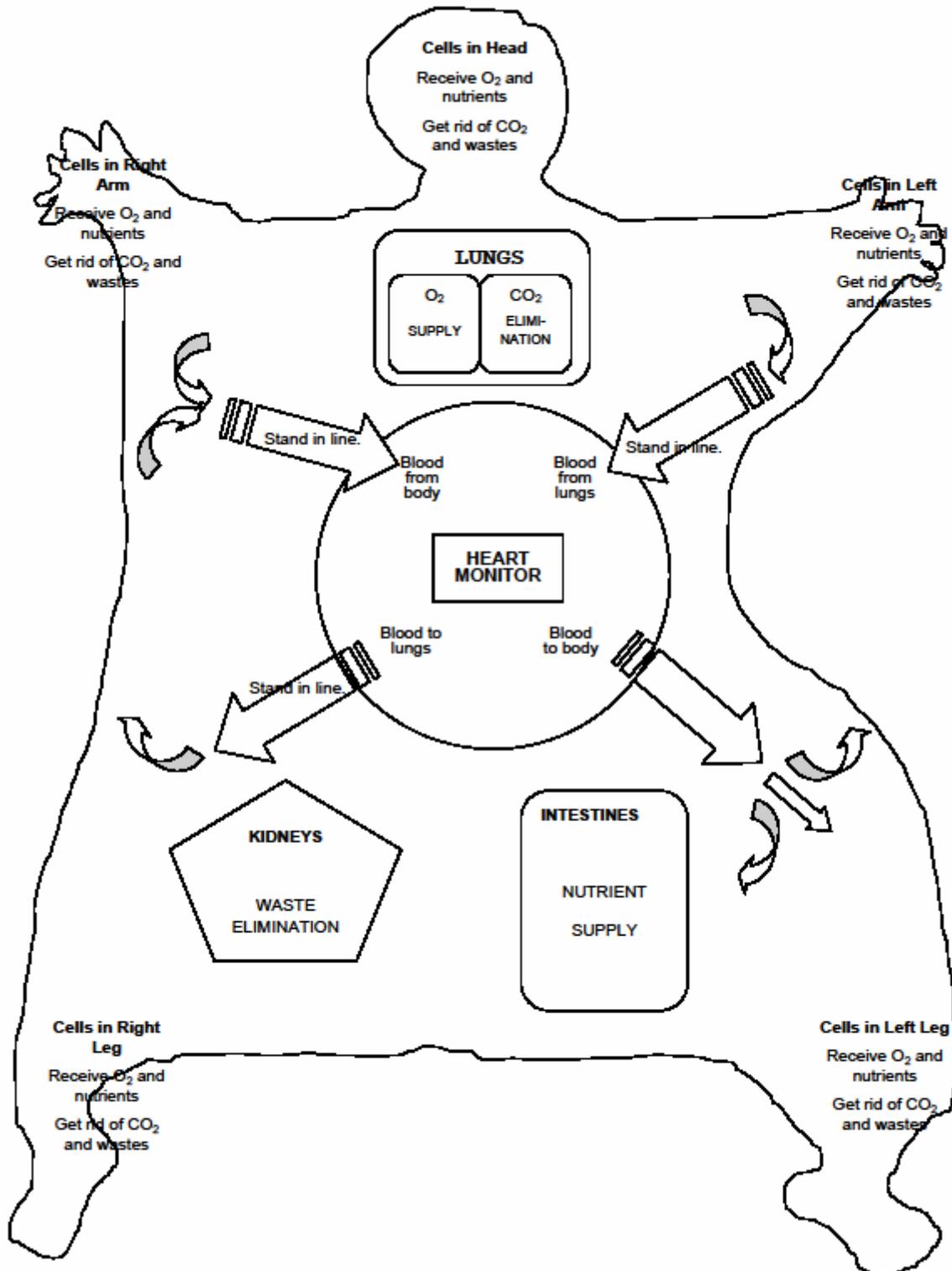
1. Copy on colored paper (or card stock) the pages (Nutrient Cards; Waste Cards; Oxygen Cards; and Carbon Dioxide Cards) included in this lesson. Cut apart the cards after copying enough pages to total the following:
  - 400+ small squares labeled “Nutrients” (orange or any other available color)
  - 400+ small squares labeled “Waste” (yellow or any other available color)
  - 400+ small squares labeled “Carbon dioxide: CO<sub>2</sub>” (green or any other available color)
  - 400+ small squares labeled “Oxygen: O<sub>2</sub>” (pink or any other available color)
2. Obtain four small buckets or other containers to hold the cards described above; label each one:
  - Intestine – Nutrients
  - Kidney – Wastes
  - Lungs – CO<sub>2</sub> wastes
  - Lungs – O<sub>2</sub> supply
3. Make eight signs to hang around necks of students who will be the Station Monitors. Label, one of each, as:
  - Lungs
  - Kidney
  - Intestines
  - Cell in Left Arm
  - Cell in Right Arm
  - Cell in Left Leg
  - Cell in Right Leg
  - Cell in Head
4. Make Destination Sticks: Use 12-inch rulers and tape masking tape on part of the ruler. Then write on the tape. Make five of each: heart, lungs, intestines, kidneys, right arm, left arm, right leg, left leg, and head.
5. If you can play this game outside, make a large chalk outline of a human body on the playground. (**See “Blood Flow Schematic.”**) Label the heart, lungs, kidneys, intestines, right arm, left arm, right leg, left leg, and head. (These will be stations). Indicate with arrows the direction of the movement. (If you have to play the game inside the classroom, try to set up a central area for the heart and place the other organs and body parts around the classroom to appropriately match the “Blood Flow Schematic”).
6. Copy and cut apart “Cards for Directions for Stations”.
  - a. At the three organ stations (kidneys, intestines, and lungs), place the labeled buckets as appropriate. Assign one Station Monitor to each of those organs and provide them with a corresponding card from “Cards for Directions for Station”. Ask students to read their cards and make certain they understand what they are supposed to do.
  - b. At each of the five body parts stations (right arm, left arm, right leg, left leg, head) assign one student to be a Station Monitor (they will also role-play a body cell at each of these

body parts). Provide the Station Monitors with the appropriate card from “Cards for Directions for Stations”). Provide each of the five Station Monitors with 60 WASTE cards and 60 CARBON DIOXIDE cards.

- c. Assign one Station Monitor (preferably an adult) to be the “heart monitor” and provide the “Heart Station Heart Monitor Card”. This person will direct traffic in the heart.
7. All the rest of the students will be blood. (See note about “blood” versus “blood cells” in the “Teacher Background.”)

# TEACHER MATERIAL

## Blood Flow Schematic



## Cards for Directions for Stations

### Kidney Station (Internal Organ Station)

When blood arrives have the blood place all of their **waste** cards into the Kidney waste bucket.

### Lungs Station (Internal Organ Station)

When blood arrives have the blood place all their **carbon dioxide (CO<sub>2</sub>)** cards into the Lung CO<sub>2</sub> waste bucket, and give them **ONE O<sub>2</sub>** card from the Lung oxygen supply bucket.

### Intestines Station (Internal Organ Station)

When blood arrives you give the blood **FIVE nutrient** cards from the Intestine nutrient bucket.

### The Head Station (Body Station)

When blood arrives you ask the blood for a **nutrient** card and an **oxygen (O<sub>2</sub>)** card, and in exchange you give the blood a **waste** card and a **carbon dioxide (CO<sub>2</sub>)** card.

### Right Arm Station (Body Station)

When blood arrives you ask the blood for a **nutrient card** and an **oxygen (O<sub>2</sub>)** card, and in exchange you give the blood a **waste** card and a **carbon dioxide (CO<sub>2</sub>)** card.

### Left Arm Station (Body Station)

When blood arrives you ask the blood for a **nutrient** card and an **oxygen (O<sub>2</sub>)** card, and in exchange you give the blood a **waste** card and a **carbon dioxide (CO<sub>2</sub>)** card.

### Right Leg Station (Body Station)

When blood arrives you ask the blood for a **nutrient** card and an **oxygen (O<sub>2</sub>)** card, and in exchange you give the blood a **waste** card and a **carbon dioxide (CO<sub>2</sub>)** card.

### Left Leg Station (Body Station)

When blood arrives you ask the blood for a **nutrient** card and an **oxygen (O<sub>2</sub>)** card, and in exchange you give the blood cell a **waste** card and a **carbon dioxide (CO<sub>2</sub>)** card.

### Heart Station (Heart Monitor Card)

Your job is to certain that all blood goes to the lungs to refuel on oxygen before they go to a place in the body. Before you give blood a body Destination Stick, the blood **must show** you that they have **TWO oxygen (O<sub>2</sub>)** cards and have **just come from the lungs**. If they don't have two oxygen cards, they must go to the lungs. If they just came from a destination, they must give you the **Destination Stick** back, and go to the lungs before coming back to you for another Destination Stick.

## Nutrients Cards

Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Nutrients	Nutrients	Nutrients	Nutrients	Nutrients
Nutrients	Nutrients	Nutrients	Nutrients	Nutrients

# Waste Cards

Waste	Waste	Waste	Waste	Waste
Waste	Waste	Waste	Waste	Waste
Waste	Waste	Waste	Waste	Waste
Waste	Waste	Waste	Waste	Waste
Waste	Waste	Waste	Waste	Waste
Waste	Waste	Waste	Waste	Waste

# Oxygen Cards

Oxygen O <sub>2</sub>				
Oxygen O <sub>2</sub>				
Oxygen O <sub>2</sub>				
Oxygen O <sub>2</sub>				
Oxygen O <sub>2</sub>				
Oxygen O <sub>2</sub>				
Oxygen O <sub>2</sub>				

## Carbon Dioxide Cards

Carbon dioxide CO <sub>2</sub>				
Carbon dioxide CO <sub>2</sub>				
Carbon dioxide CO <sub>2</sub>				
Carbon dioxide CO <sub>2</sub>				
Carbon dioxide CO <sub>2</sub>				
Carbon dioxide CO <sub>2</sub>				
Carbon dioxide CO <sub>2</sub>				

**STUDENT HANDOUT**

**Directions for Students Who Are BLOOD**

1. Get one OXYGEN card and five NUTRIENT cards and a DESTINATION STICK from your teacher.
2. Go to the destination on your stick.
3. If the destination is a body part, give the body part cell at that location a NUTRIENT card and an OXYGEN card, and in exchange have the cell at the destination give you one CARBON DIOXIDE card and one WASTE card.

If the destination is an internal organ (kidney, lung, or intestines) follow the instructions that the organ tells you.

4. Go to the HEART. Stand in line behind all other Blood that are also going into the heart. Once it is your turn, give the Heart Monitor your Destination Stick.
5. Go to the LUNGS (stand in line behind all the other blood also going to the lungs). Once it is your turn, throw all your CO<sub>2</sub> cards into the Lung CO<sub>2</sub> bucket, and take one O<sub>2</sub> card from the O<sub>2</sub> supply bucket in the Lung.
6. Go back to the HEART (stand in line behind other blood coming from the lung and going to the heart). Show the Heart Monitor your O<sub>2</sub> card, and the heart monitor will give you a Destination Stick. Go to the destination on that stick.
7. Follow directions in the same order as before, from # 3-6 above.

STUDENT HANDOUT FOR "ENGAGE"

# The Heart and the Flow of Blood

Draw the heart and label the parts.

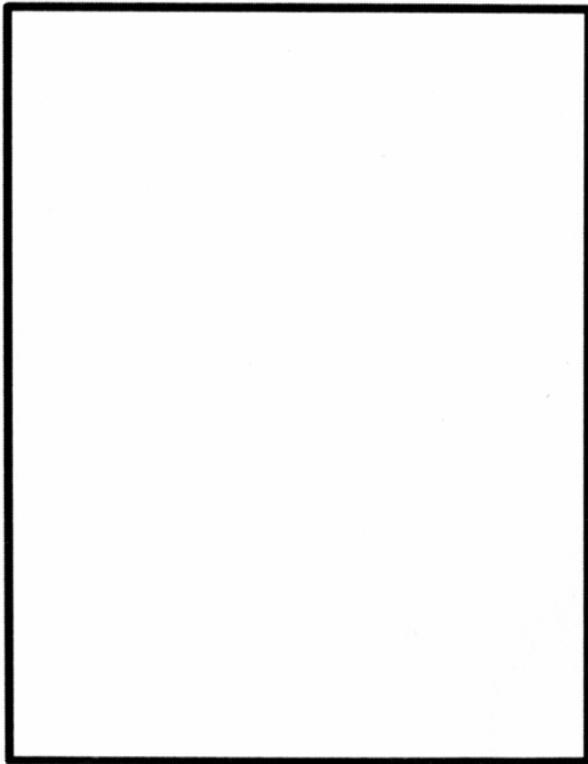
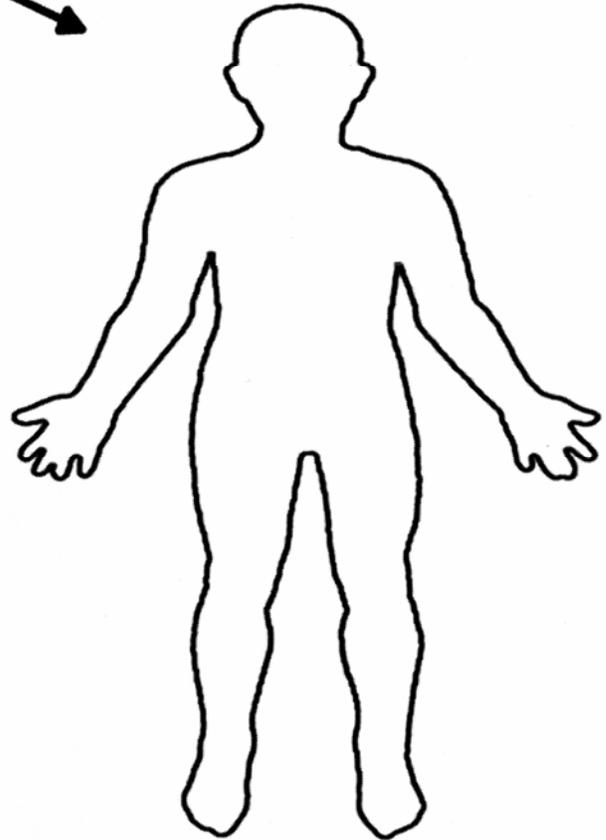


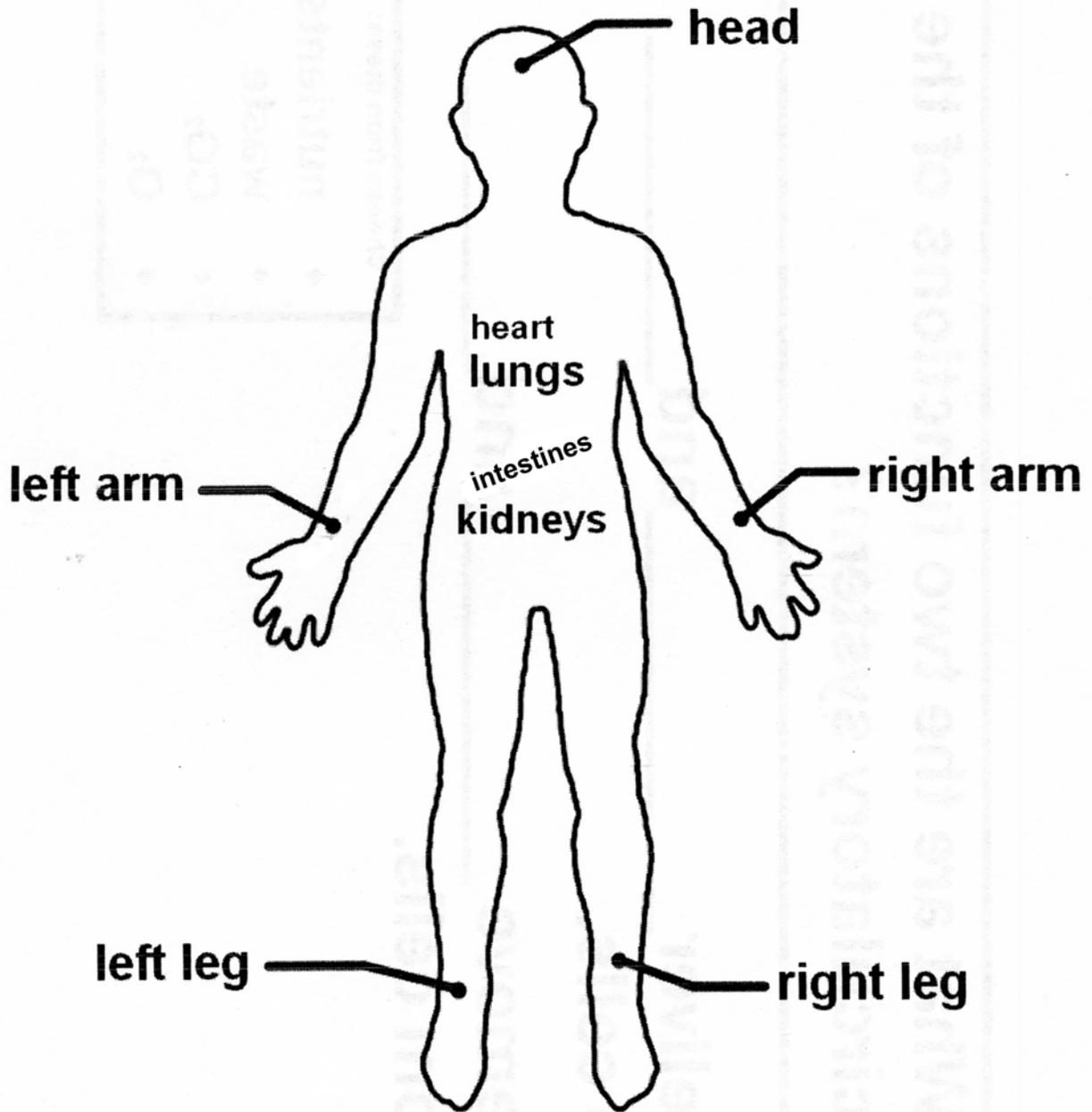
Diagram the location of the heart. Diagram the flow of blood through the body.



**STUDENT RECORDING SHEET**  
**My Journey As Blood**

1. \_\_\_\_\_  
(Body Destination)
- 2 Heart (**leave** your Destination Stick)
3. Lungs (place all of your CO<sub>2</sub> cards in the CO<sub>2</sub> bucket and take one O<sub>2</sub> card)
4. Heart (**get** a Destination Stick)
5. \_\_\_\_\_  
(Body Destination)
6. Heart (**leave** your Destination Stick)
7. Lungs
8. Heart (**get** a Destination Stick)
9. \_\_\_\_\_  
(Body Destination)
10. Heart (**leave** your Destination Stick)
11. Lungs
12. Heart (**get** a Destination Stick)
13. \_\_\_\_\_  
(Body Destination)
14. Heart (**leave** your Destination Stick)
15. Lungs
16. Heart (**get** a Destination Stick)
17. \_\_\_\_\_  
(Body Destination)

**STUDENT ASSESSMENT 1**  
**Diagram of Blood Flow**



1. Use arrows on the body above to show how the blood circulates in the body.
2. On the back of this sheet, explain how the blood circulates in the body. (You may use your copy of "My Journey As Blood" to help you.)

**STUDENT ASSESSMENT 2**

**Functions of the Circulatory System**

What are the two functions of the circulatory system?  
(Fill in the blanks below.)

1. Blood delivers \_\_\_\_\_ and \_\_\_\_\_ to body cells.
2. Blood removes \_\_\_\_\_ and \_\_\_\_\_ from body cells.

Word bank: oxygen (O<sub>2</sub>), waste, nutrients, carbon dioxide (CO<sub>2</sub>)