

THE CIRCULATION GAME

Target age group: grades 4-8

Number of players: 2-6

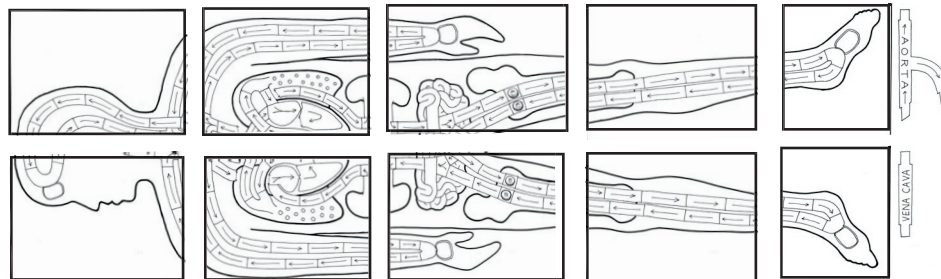
Materials needed: Copies of the pattern pages printed onto white card stock, clear tape (the wide kind used for mailing packages works best), scissors, X-acto knife (could possibly substitute scissors), colored pencils, thin cardboard, white glue

Time allowance: Assembly will need to be done well head of playing session, as there is white glue that needs to dry. Assembly time largely depends upon how much coloring is done and how fast it gets done. Cut and paste time is less than 30 minutes. Do the token and spinner pages first so that the glue can be drying while you assemble the board. Allow at least 45 minutes to play the game.

Directions for assembly of game:

Trim off the blank edge strips from around the board sections, then tape them together with clear tape. The sections go together as indicated below:

TIP: Put the clear tape on the back, not on the front.



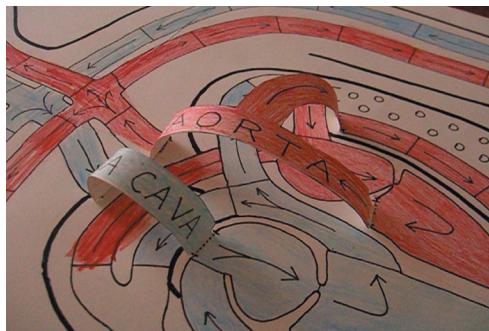
Trim off these end sections that have the vessels printed on them.

Use colored pencils to lightly color the arteries red and the veins blue.

(By the way, the blood in the veins is NOT blue, as the old die-hard myth says. It is a variation of red. Coloring veins blue just seems to be the obvious and understandable way to differentiate them from the arteries. The color blue has been used so standardly over the years that some students have come to think that the blood inside them is blue, too. But this is not the case.)

Cut out the aorta and the vena cava. Color the aorta red and the vena cava blue.

Using a sharp X-acto knife (or razor blade or scissor blade) cut the slits in the heart area, indicated by the dotted lines. Slide the tabs on the ends of the aorta and vena cava into these slits, as shown below.



To prepare the game tokens, copy the pattern pages for the heart spinner and the tokens onto white card stock. Color the heart if you want to (but it is not absolutely necessary-- you can play the game with a black and white spinner). Choose a color for each team (there are just two teams in this game) and color the sets of tokens accordingly. You will find more coloring instructions on the tokens page. After you finish coloring, use white glue to glue these pages to pieces of thin cardboard, such as a large cereal box or a shirt box. Don't use too much glue! You don't want big runny blobs, as this will cause wrinkling and warping. Apply a thin, even layer, then press down while they are drying. You may want to put plastic wrap on top of them then set a heavy stack of books on top for an hour or so.

BEFORE YOU PLAY:

Read the following paragraph out loud to all the players (or at least relay the general concepts to the students in your own words).

“This game is about some of the important jobs your blood does as it circulates throughout your body. In this game, you will help the blood pick up oxygen from the lungs, and food from the intestines, and deliver them to the individual cells of the body. The blood will also pick up carbon dioxide and other wastes produced by the cells and get rid of them by taking them to the lungs or the kidneys.

In reality, your blood does more than just these jobs. For example, there are other kinds of blood cells, not just red cells. You have white cells that fight infection, and you have platelets that make clots and scabs when you get cut. Also, your blood picks up enzymes made by one part of the body and delivers them to other parts that need them. There are minerals and salts dissolved in your blood, not just sugar and protein. But if this game covered all of these topics, it would be so complicated no one would want to play it!

The object of this game is to get oxygen and food to the cells, then get rid of the waste products produced by the cells. (This game shows just one cell in each hand and foot, but you know that there are actually millions of cells.) The cells will use the oxygen to burn the sugar and release energy. In this burning process, which is surprisingly similar to how a car engine works, carbon dioxide is produced as a waste product. Your body does not need protein for energy. The proteins are the ingredients your cells need in order to make repairs and build new cells. The cards marked “waste” represent the waste products made by the cells as they use up the proteins. It’s just like a construction site-- there’s always a mess to clean up afterwards!

You also need to know that waste clean up isn’t just done by the kidneys alone. The liver is the first place the wastes go. The liver de-toxifies the garbage and sorts it out. After that, the kidneys can flush the waste out. To make the game easier, we just skipped the liver and went straight to the end of the process where the kidneys do their flushing.

Have fun playing the game and don’t ever forget how incredibly complicated and very amazing your body is!”

How to play:

Set up the board by doing the following:

Put two carbon dioxide tokens--one of each team’s color-- on or near the cell in each hand, in each foot, and in the head.

Put two waste tokens--one of each team’s color-- on or near the cell in each hand, in each foot, and in the head.

Put all the sugar tokens in the intestines (on either side, it doesn’t matter which).

Put all the oxygen tokens in the lungs (on either side, it doesn’t matter which).

Give each team their five red blood cells.

The object of the game is to deliver all the oxygen and food to the cells, take all the carbon dioxide to the lungs, and take all the waste to the kidneys.

- Divide your players into two teams. You can have teams of only one player, or you can have as many as four players on a team. Flip a coin to determine which team will go first.
- Someone on the first team spins the heart spinner. The numbers on the spinner represent “beats” of the heart. Each player on the team will get to move a token that number of spaces.

(NOTE: You also have the option of letting only one player on the team move per turn. For example, on turn one, player A moves, on turn two player B moves, on turn three player C moves, then on turn four it's back to player A's turn again. This will slow down the pace of the game somewhat, but might make it less confusing for certain types of players. A slower pace may be better for your players.)

- Players must start out by delivering oxygen and food to the cells. To move a food token, simply move it out of the intestines and into the blood stream. To move an oxygen token, you must place it on top of a blood cell token. Oxygen and carbon dioxide “ride” on red blood cells. The blood cells act like little delivery trucks, taking these gases where they need to go. Blood cells must come onto the game board at the top of the femur bone (in the leg) at the space marked with a picture of a red cell. The femur is a major site of red blood cell production, so this is an appropriate place for the red cell tokens to begin their journey. You may have as many red cells in circulation as you want to, as long as they start out from the femur. Red cells can keep circulating; they do not need to be “retired” after one round. In reality, your body eventually retires and replaces cells, but they are good for several weeks at least, so in this game, the cells can keep circulating and make multiple pick-ups and deliveries.

- The tokens must circulate through the arteries and veins, space by space, following the direction the arrows are pointing. (When they get to the heart, the pathway makes some twists and turns!) When a blood cells visits the lungs, it may pick up an oxygen token if it needs one, or it may drop off a carbon dioxide if it has been carrying one. Food and waste tokens don't pick up anything in the lungs--they just pass through.

- When a food token or an oxygen gets dropped off at a cell in a hand or foot or in the head, those tokens remain there for the rest of the game (anywhere in that area--they don't have to be on the cell).

- When a waste token gets dropped off in the kidneys, it stays there for the rest of the game.

- When a red blood cell drops off an oxygen at a cell, it will then immediately pick up a carbon dioxide. When a food token is dropped off, a waste token immediately replaces it.

- Players will need to coordinate their efforts in order to get all the tasks done efficiently without wasting moves.

- The first team to get all their oxygens to the cells, all the food to the cells, all the wastes to the kidneys and all the carbon dioxides to the lungs, wins the game.

- If you encounter odd situations that are not covered by these rules, you may add your own rules as well. As long as everyone is playing by the same rules, the game is fair.

EXTRA SCIENCE FACTS YOU MAY WANT TO MENTION:

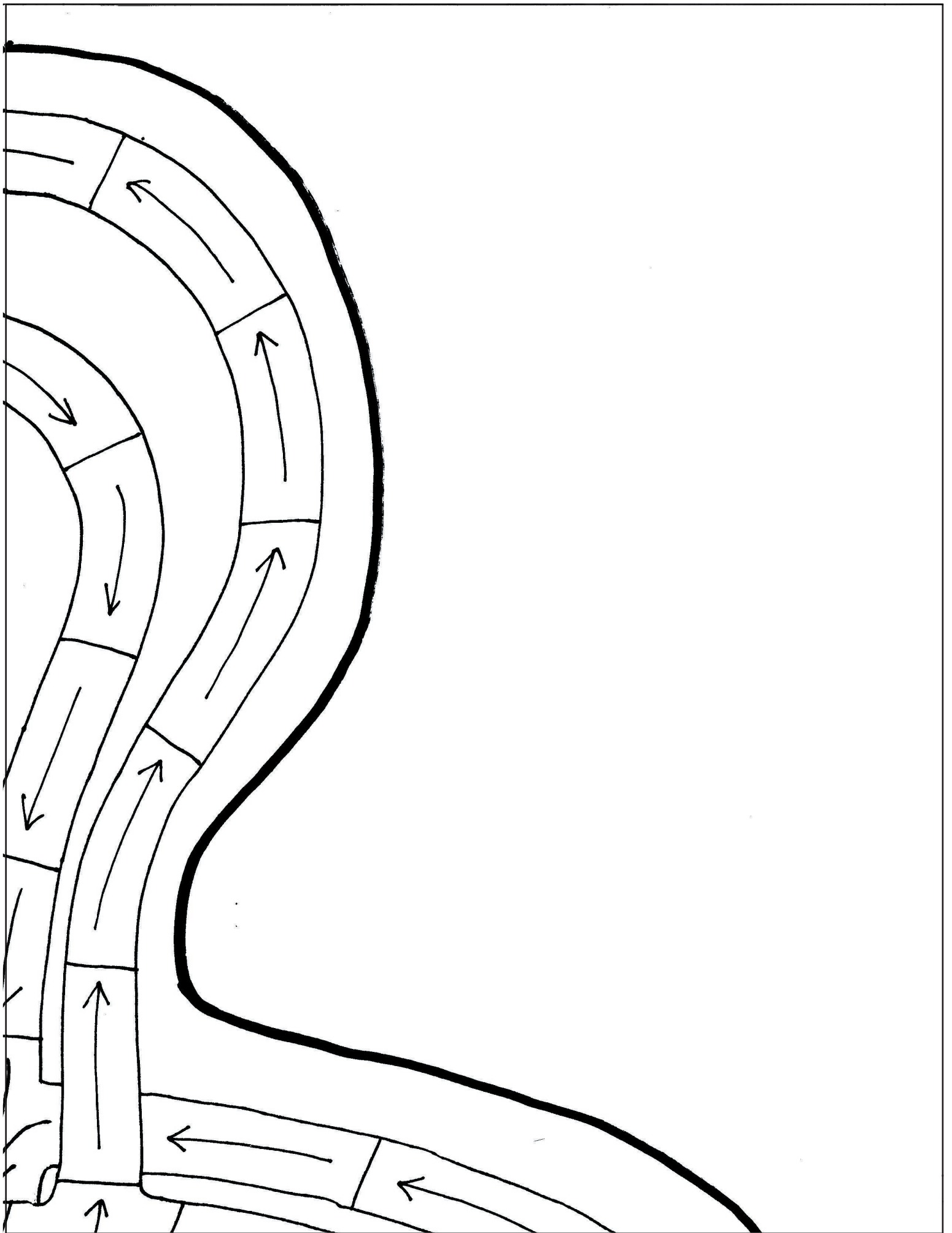
- *The arteries and veins near the heart are very large. They get smaller and smaller the further they get from the heart, until they get down to being so small you can't see them without a microscope. These really tiny vessels are called “capillaries” which comes from the Latin word for “hair” (because they are very thin just like hairs are very thin).*

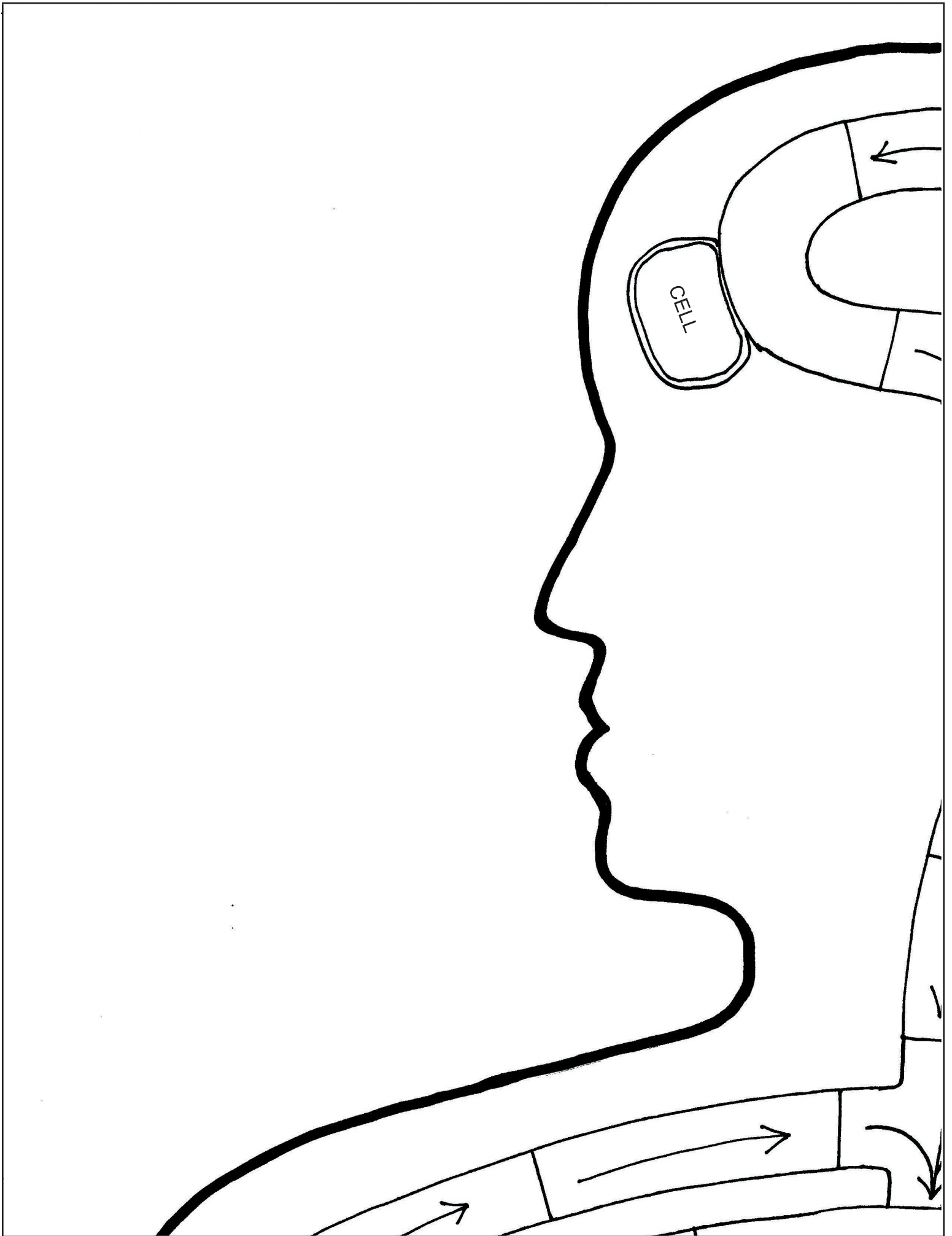
- *The capillaries don't go into the cells, they just sit right next to them. The nutrients just go right through the walls of the cells and the capillaries, diffusing in and out as they are needed. If you house were a cell, it would be like having a conveyor belt of food going right past your windows. You could open a window and reach out and take anything that you wanted as it went by. (Pretty cool, eh?)*

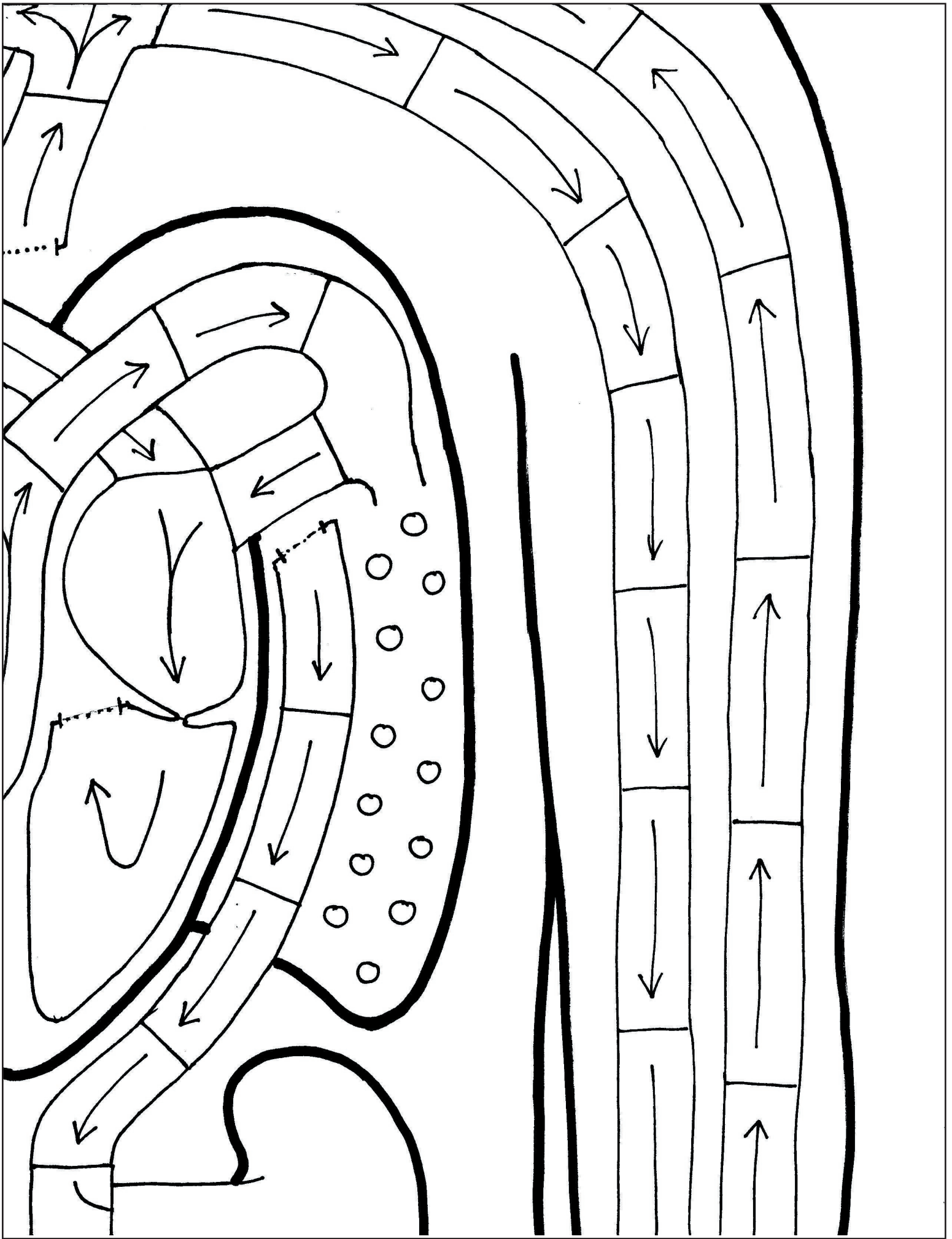
- *Red blood cells contain a substance called hemoglobin. Hemoglobin contains iron, the key ingredient necessary for attracting the gas molecules to the red cells.*

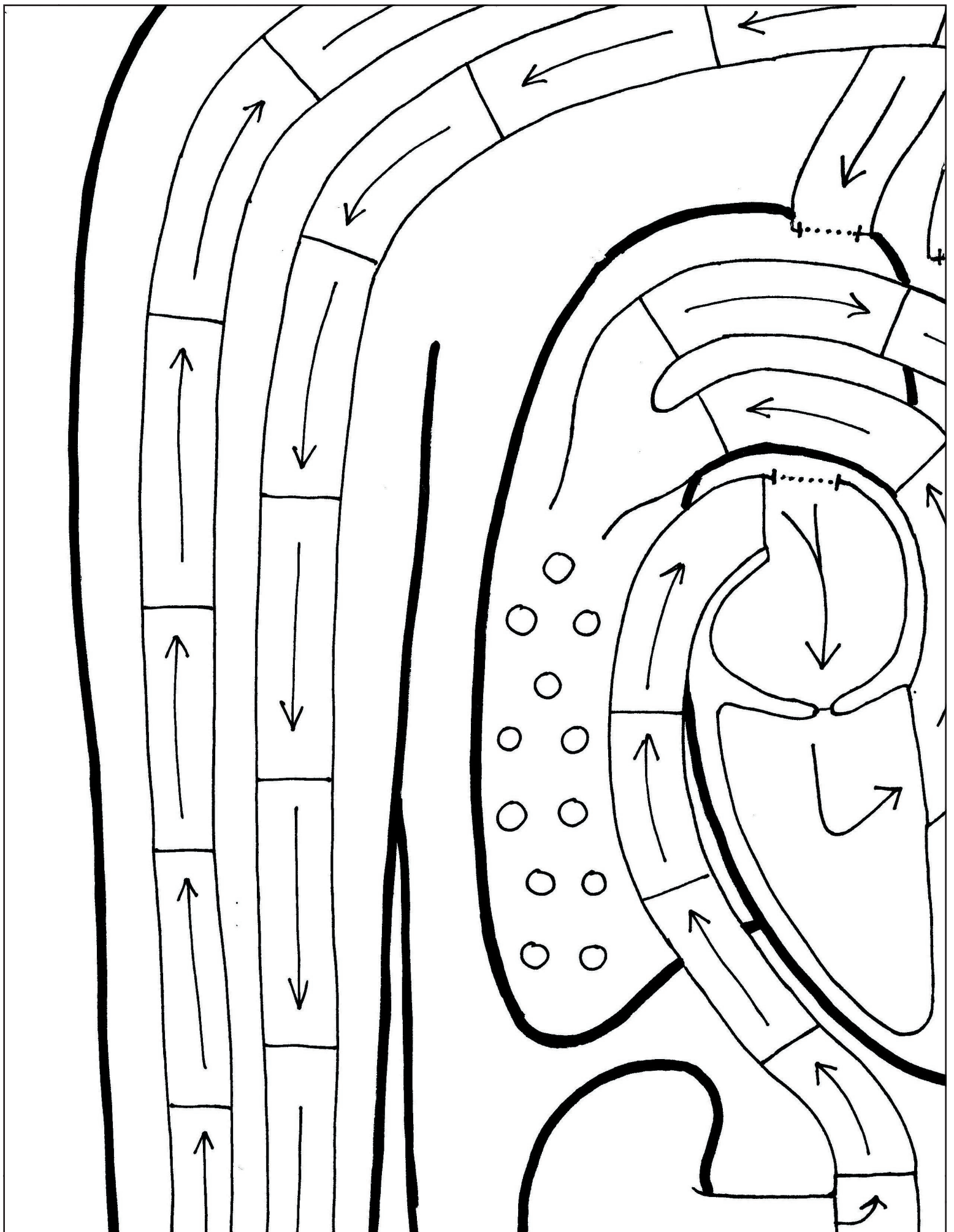
- *An average person has over 60 trillion red cells. If all their red cells were laid out next to each other, they would cover an area the size of four tennis courts!*

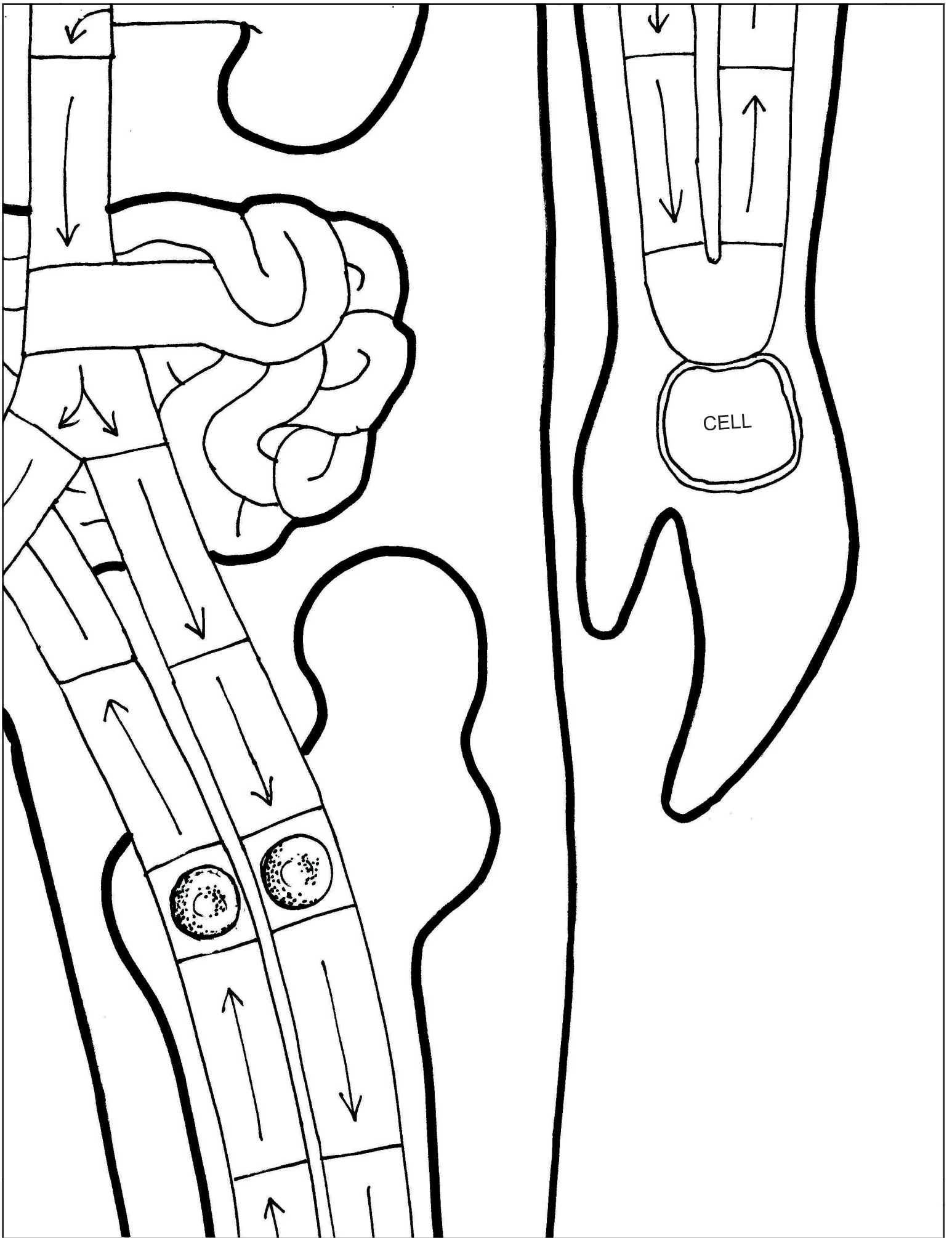


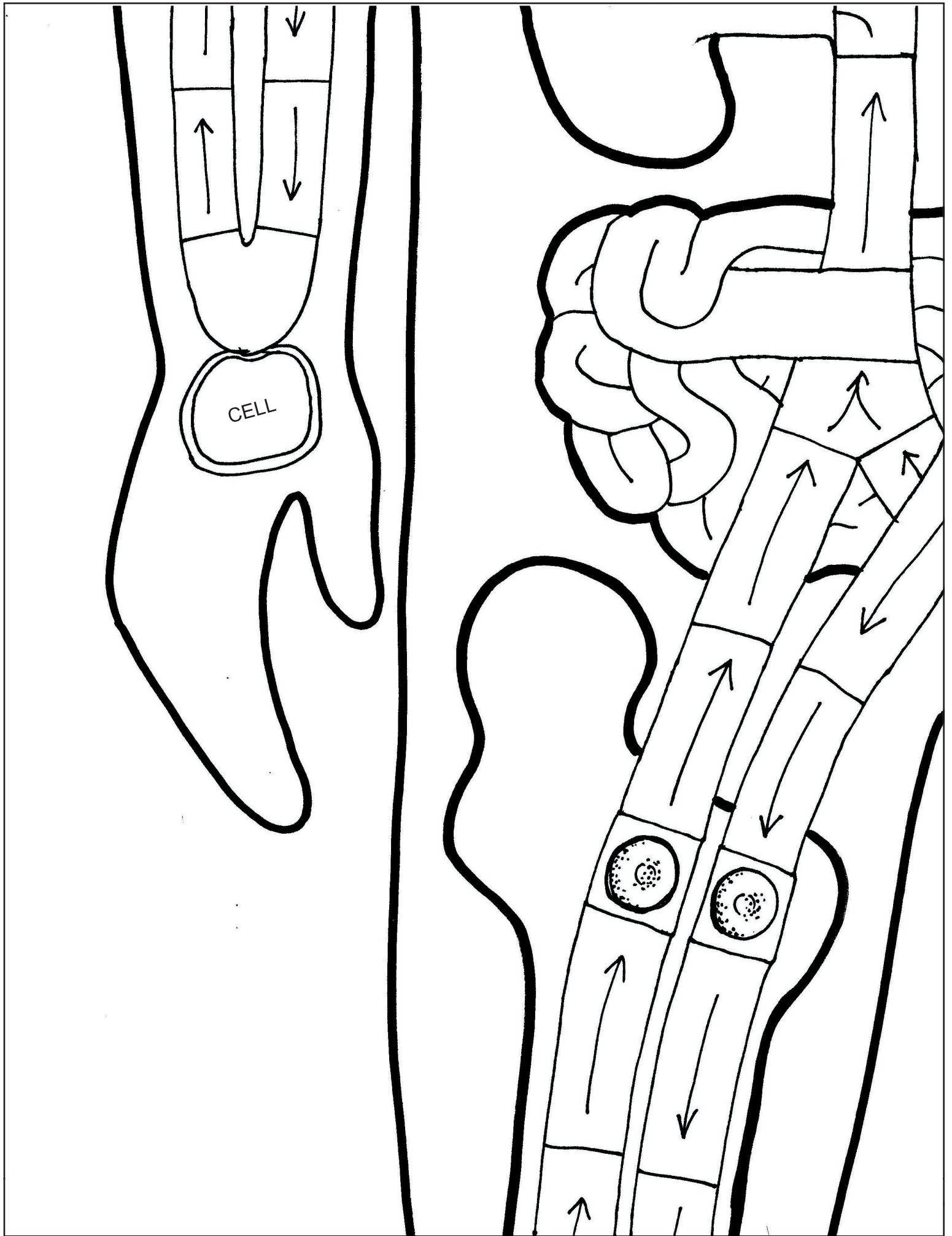


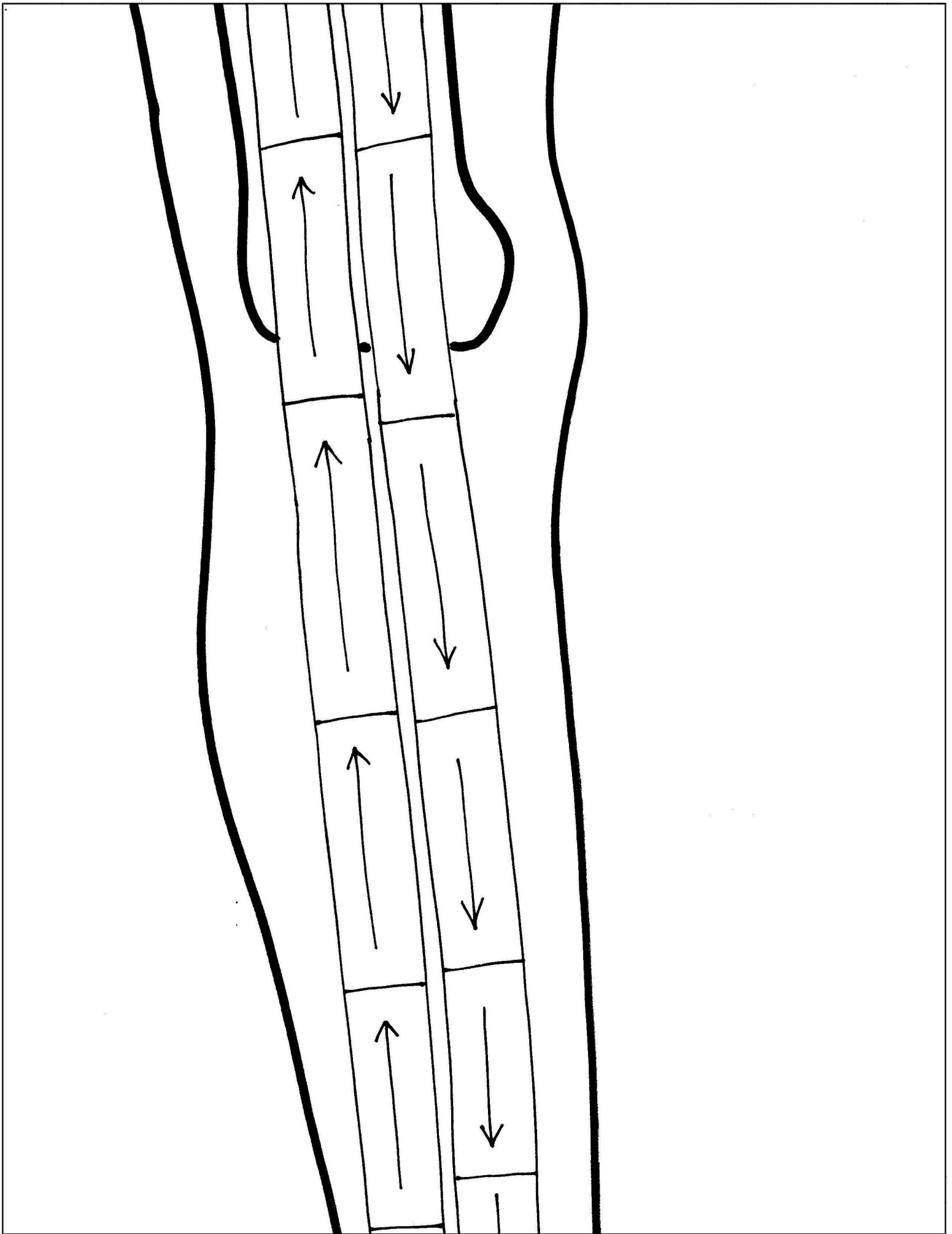


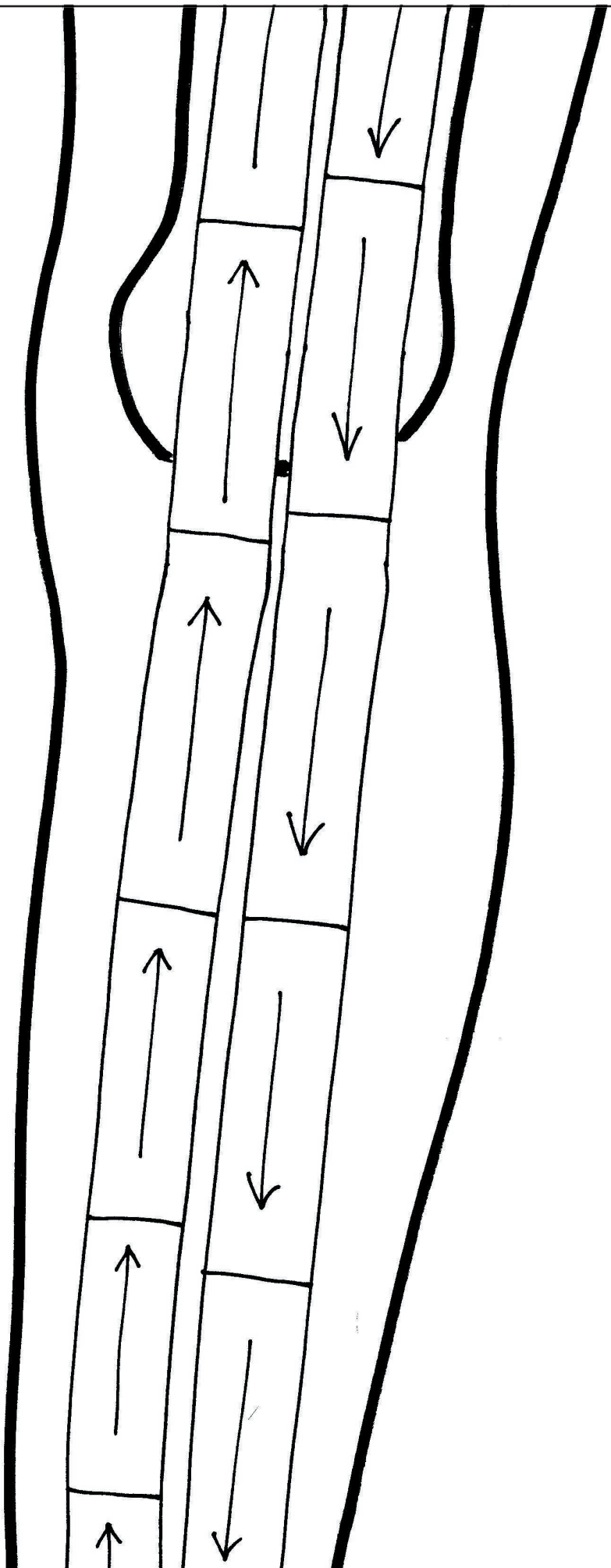


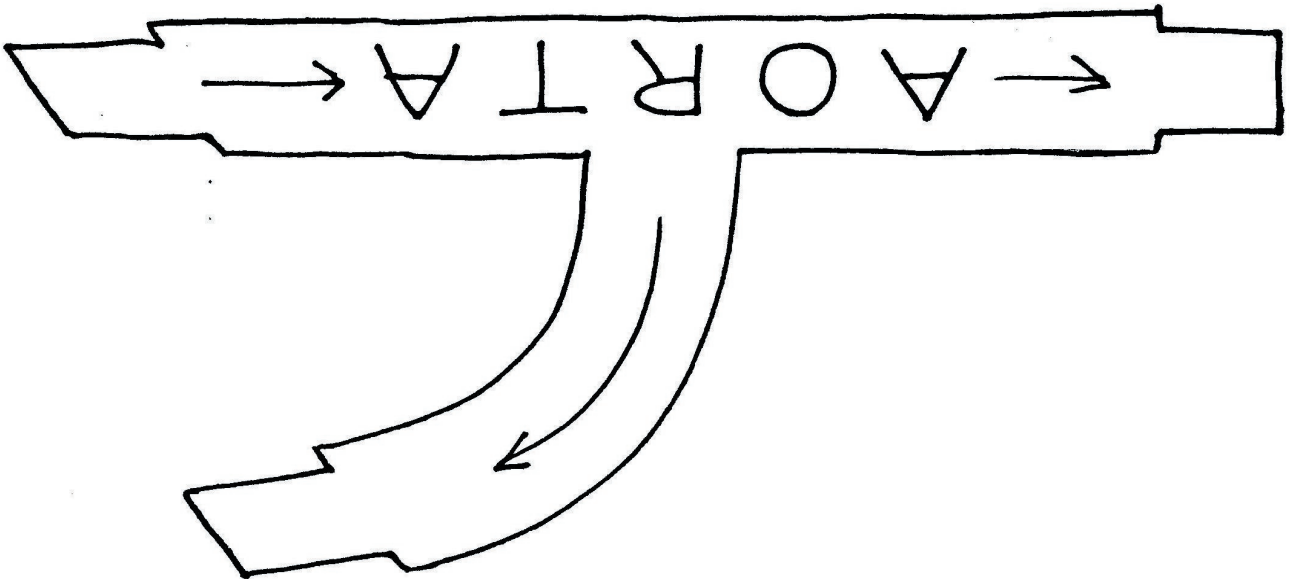
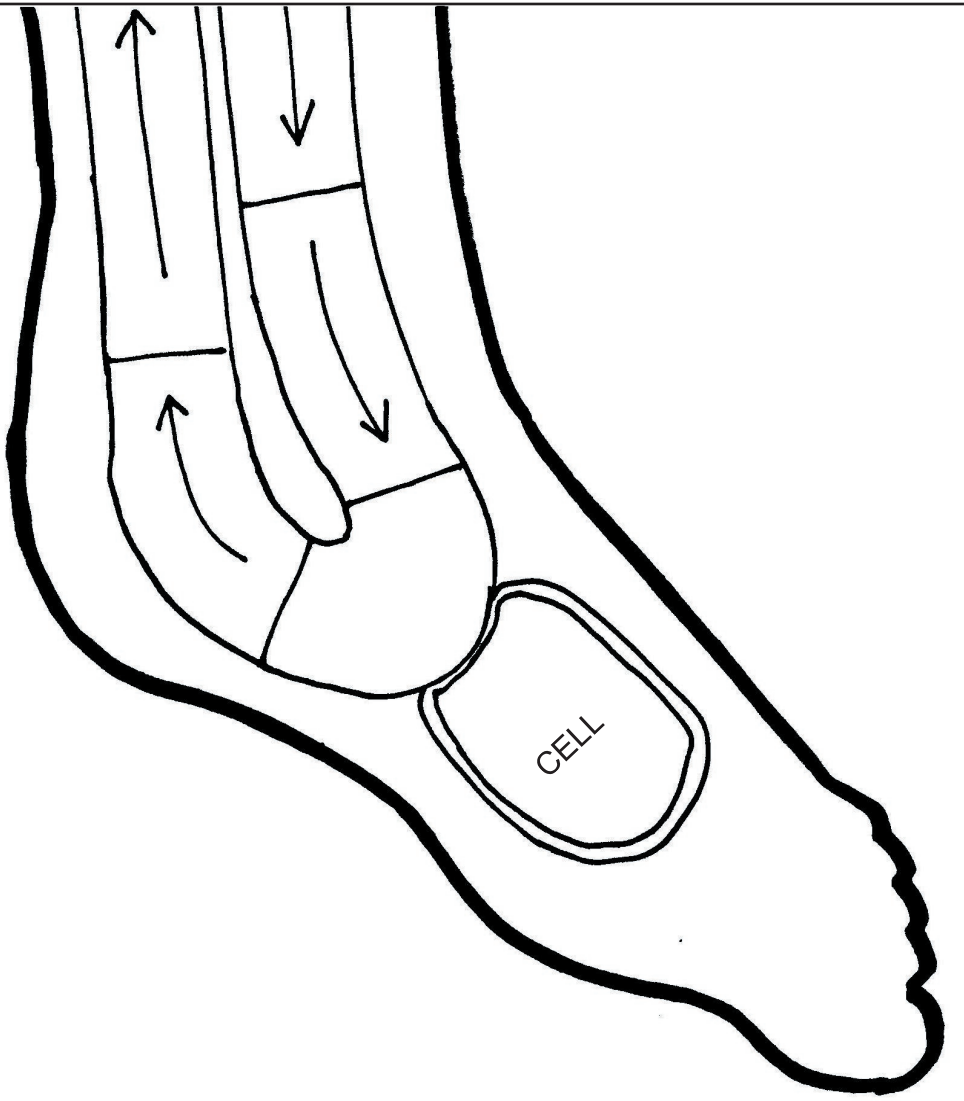


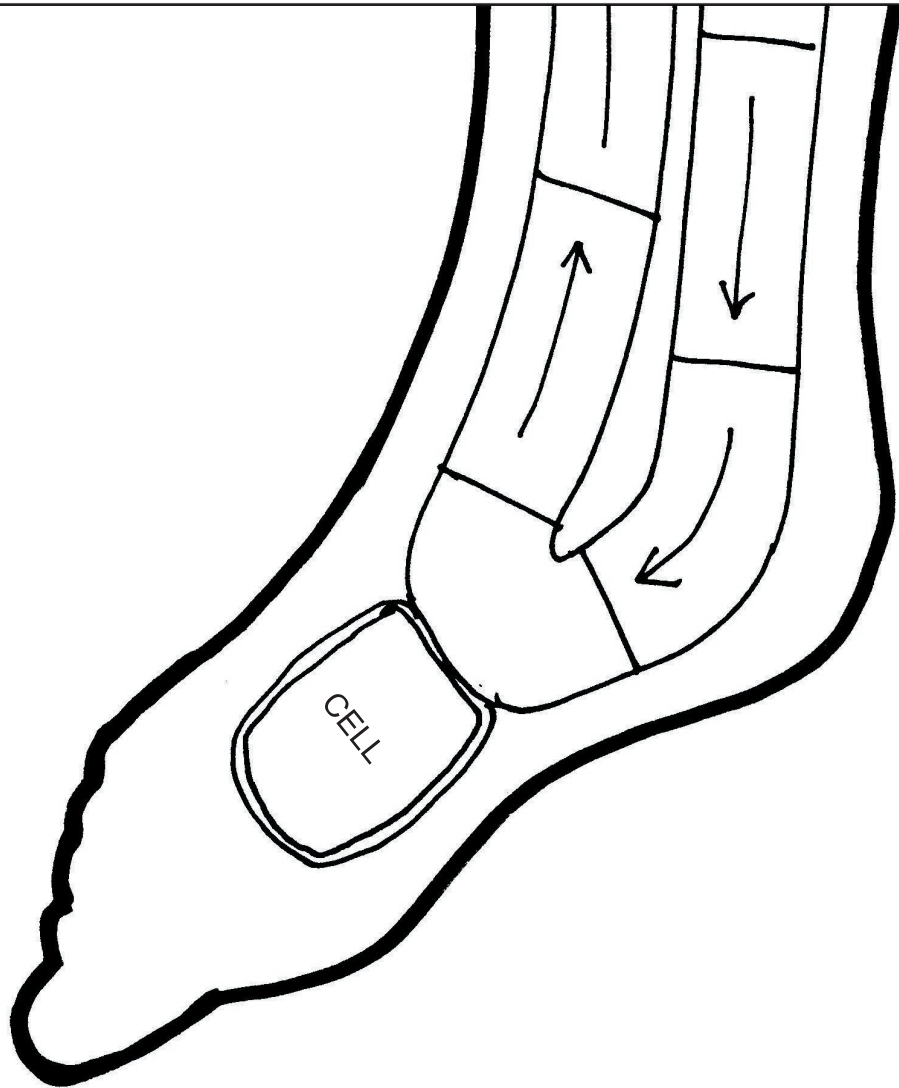




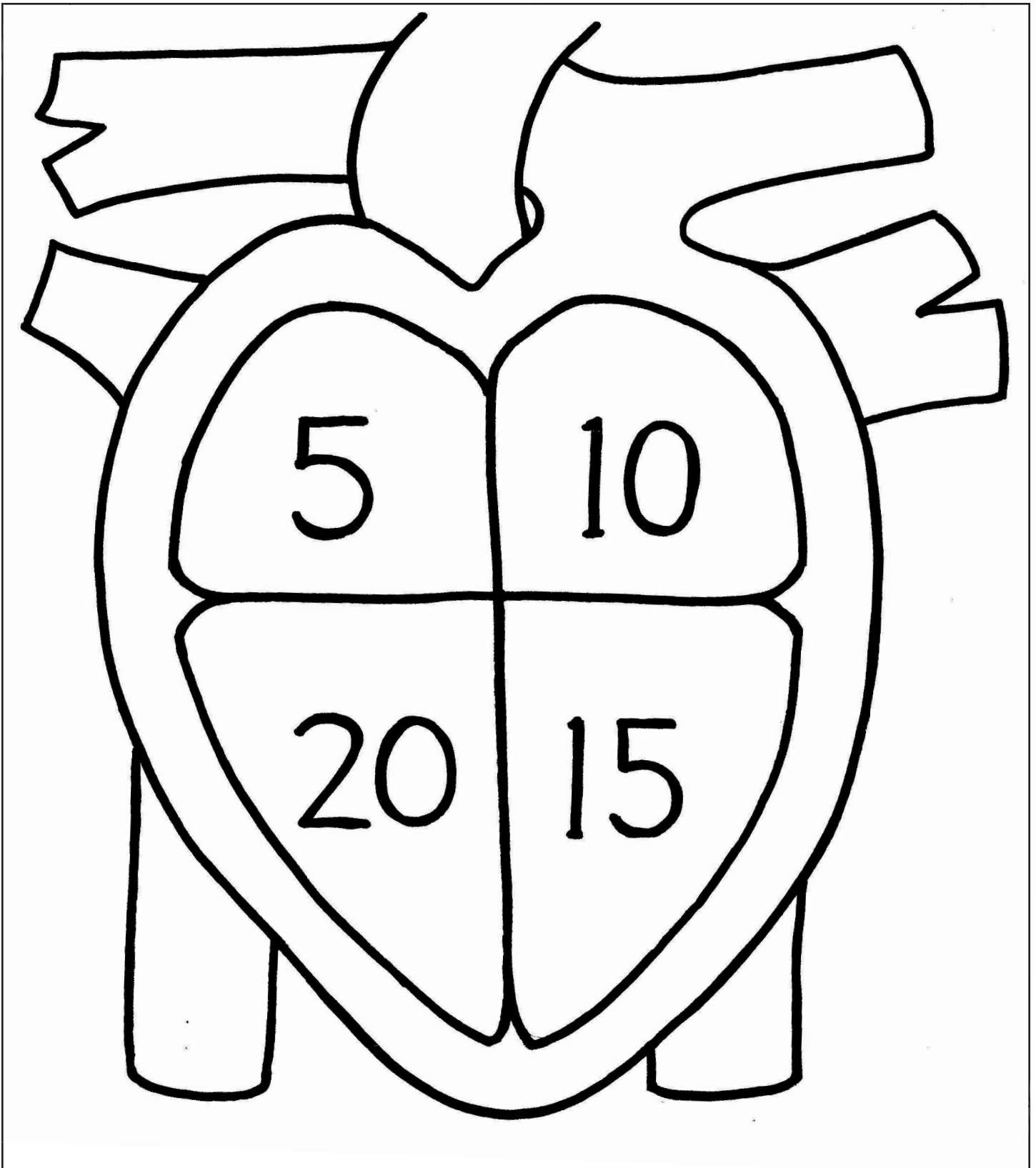




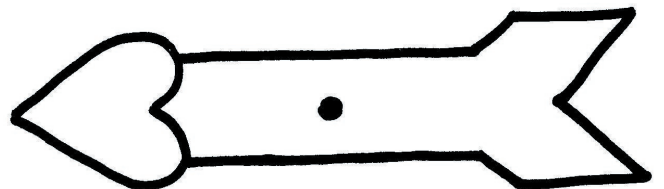




VENA CAVA



After you have done any coloring you want to, glue this sheet to a piece of thin cardboard, such as a shirt box or a cereal box. Use glue sparingly and press smooth as it dries. (You could put plastic wrap on both sides, then set it under a stack of heavy books to dry.) After it is dry, cut out arrow and heart square and assemble them to make a spinner, using a paper fastener to attach the arrow. If it has trouble spinning freely, try adding a washer between the arrow and the heart.

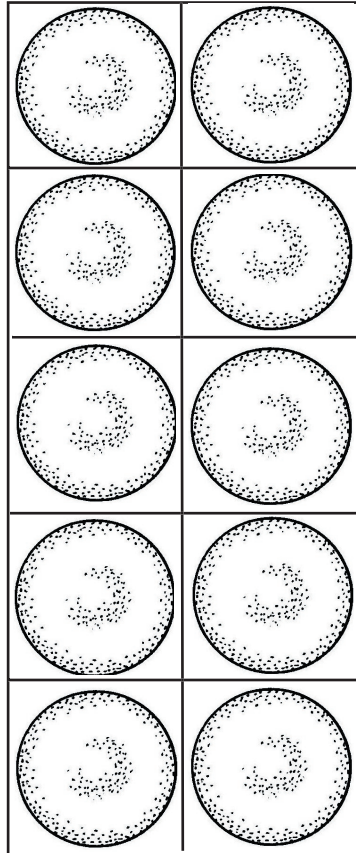


TOKENS

Copy this sheet onto white card stock, do the coloring, then glue it to a piece of thin cardboard (not corrugated). After the glue is dry, cut out the tokens.

Choose two colors (one for each team) and make one column one of the colors, and the other column the other color. (Each team will need five O₂s and five CO₂s.)

O ₂	O ₂
O ₂	O ₂
O ₂	O ₂
O ₂	O ₂
O ₂	O ₂
CO ₂	CO ₂
CO ₂	CO ₂
CO ₂	CO ₂
CO ₂	CO ₂
CO ₂	CO ₂



Each team will need ten red blood cells. Color the cells red, but color the outside corners of the squares to match the team colors you chose for the O₂ and CO₂ cards. Make five cells for each team.

SUGAR & PROTEIN	SUGAR & PROTEIN	SUGAR & PROTEIN	SUGAR & PROTEIN	SUGAR & PROTEIN
WASTE	WASTE	WASTE	WASTE	WASTE
SUGAR & PROTEIN	SUGAR & PROTEIN	SUGAR & PROTEIN	SUGAR & PROTEIN	SUGAR & PROTEIN
WASTE	WASTE	WASTE	WASTE	WASTE

Each team will need five SUGAR/PROTEIN tokens and five WASTE tokens. Color them their team colors.