

Vessels by Design: Basic Vessel Anatomy

Activity 3A

Activity Objectives:

Using cross sectional images of blood vessels and a stylized diagram of the circulatory system, students will be able to:

- ▶ Identify the different parts of veins, arteries, and capillaries
- ▶ Identify and describe the function and structure of each blood vessel layer
- ▶ Define critical attributes of veins, arteries, and capillaries through observations
- ▶ Describe how the structure of blood vessels allows them to do their job(s)
- ▶ Compare and contrast structure and function of veins, arteries, and capillaries
- ▶ Describe how the circulatory and respiratory systems are interdependent
- ▶ Describe pulmonary and systemic circulation in the human body

Activity Description:

Part 1 Layers of the Blood Vessels Organizer:

A graphic organizer of the blood vessel layers with explanations of the structure and function of each layer will be created by students.

Part 2 Structure and Function of Blood Vessels Concept Map and Venn Diagram:

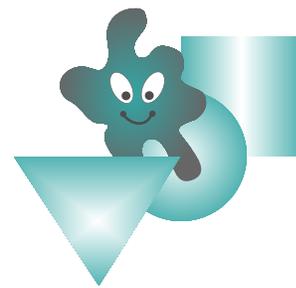
Students will then be able to describe the structure and function of different blood vessels by using images to complete a concept map and Venn diagram. In groups, students will be able to compare cross section images of veins, arteries, and capillaries. Students will have the opportunity to identify and observe the differences of the blood vessel layers and describe them in their graphic organizer.

Part 3 Blood Flow Mat:

A kinesthetic activity will be used to help students observe the inner workings of the blood vessels to further help define the structure and function of veins, arteries, and capillaries and to explore pulmonary and systemic circulation.

Activity Background:

The three main types of blood vessels are arteries, veins, and capillaries. These vessels are primarily made up of five different layers: tunic adventitia, external elastic tissue, smooth muscle, internal elastic tissue, and endothelium. Each of these layers serves a different function.



Activity Overview



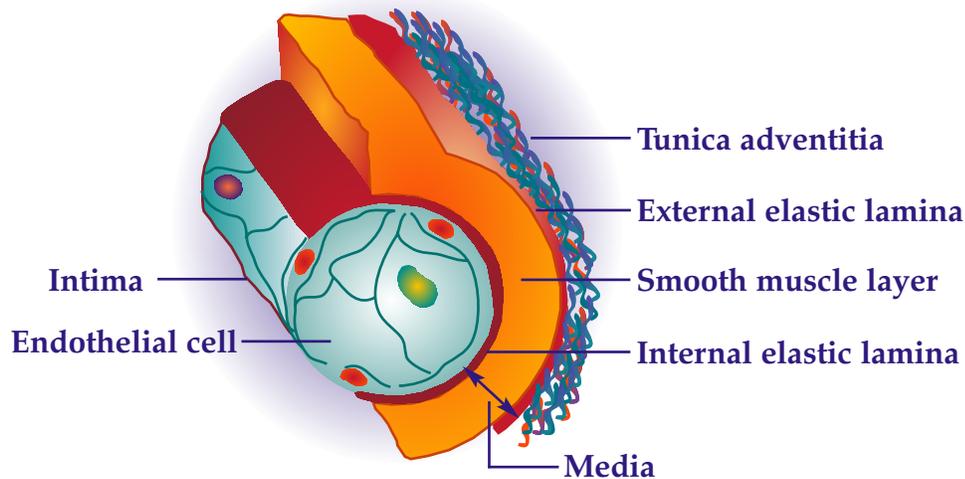


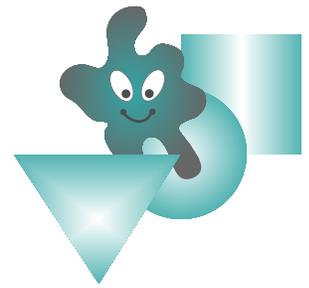
Figure 1 Cross Section of a Blood Vessel

Look at *Figure 1, Cross Section of a Blood Vessel*. Do you notice how the *tunica adventitia* looks something like Velcro? This strong layer is made of connective tissue, collagen, and elastic fibers. The function of Velcro on a gym bag is to keep the two pieces of your gym bag closed. Similarly, the *tunica adventitia* helps anchor the blood vessel in surrounding tissues. It also helps the vessels to not over expand from pressure of the blood inside.

The *elastic tissue* and *smooth muscle layers* work like the elastic in clothing. The elastic tissue, with the help of the thick smooth muscle cell layer, allows the blood vessels to stretch and return to their normal size when the heart is pumping blood to the lungs or other parts of the body. These layers of elastic tissues and smooth muscle cells are known as the *media*. Not all blood vessels have the elastic layers so in these cases the smooth muscle works on its own to stretch and contract as blood is pushed through by the heart.

The innermost layer is the *intima*, made up of endothelial cells and an elastic matrix containing a few smooth muscle cells. The intima lines the *lumen* (open part of the blood vessels through which blood flows). The intima layer is made of *endothelial cells that work like a gate*. The cells are side by side and can touch to create a tight seal or can have spaces between cells, allowing substances to move in and out of the cardiovascular system.

Although all three types of blood vessels; veins, arteries, and capillaries carry blood and are part of the cardiovascular system, each type of vessel has a unique structure and function to help our body maintain homeostasis. Blood vessels also come in different sizes, depending upon the job they must do.



Activity Overview



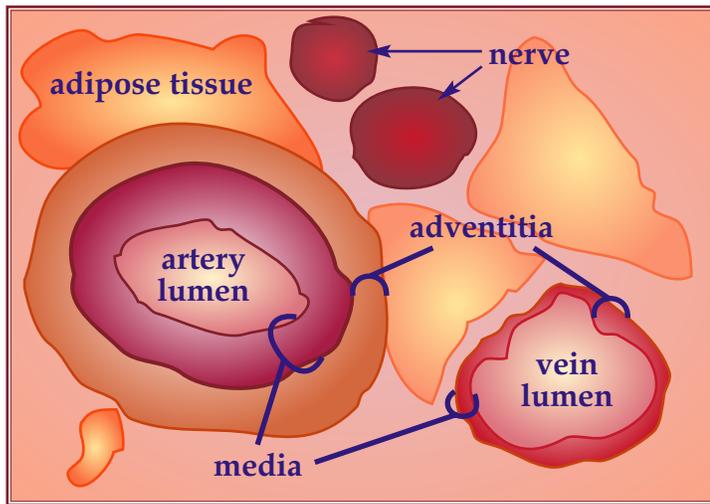


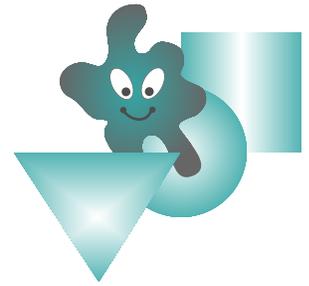
Figure 2 Arteries and Veins

Arteries are blood vessels that carry blood away from the heart to all of the cells in our body. That's a lot of work! Most arteries carry *oxygen-rich* blood away from the heart to the body, however, pulmonary arteries are different in that they take *oxygen-poor* blood away from the heart to the lungs. In the lungs, the oxygen poor blood drops off carbon dioxide and picks up a new supply of oxygen.

Compare the artery and vein in *Figure 2*. What makes them different? If you noticed that the *media* (middle layer that is made of elastic tissue and smooth muscle) in the artery is larger than the media in the vein, you are correct. The artery has a thick media because it has to withstand higher pressure of blood coming from the heart when it pumps.

Arteries coming from the heart typically are made of more elastic tissue; then as they branch away from the heart, they gradually start to have more smooth muscle and less elastic tissue. *Elastic arteries* have the largest diameter and are the arteries with more elastic tissue. *Muscular arteries* are the medium to small sized arteries that have more...smooth muscle! The smallest of the arteries that connect to the capillaries are the *arterioles* that have a thinner wall of smooth muscle cells.

The smallest of the blood vessels are the *capillaries*. They are so small that red blood cells line up single file and some even fold to pass through. The capillaries have a thin, smooth muscle and endothelium layer because the function of this vessel is to allow for the exchange of materials by diffusion. *Diffusion* occurs when oxygen and nutrients in *oxygen-rich* blood from the heart pass through the capillary walls to surrounding body cells. At the same time, carbon dioxide waste and other byproducts move out of surrounding body cells, through capillary walls, and into the capillaries. The blood becomes *oxygen-poor* and must travel back to the heart so it can be pumped to the lungs to pick up more oxygen and drop off carbon dioxide waste. See *Figure 3*.



Activity Overview



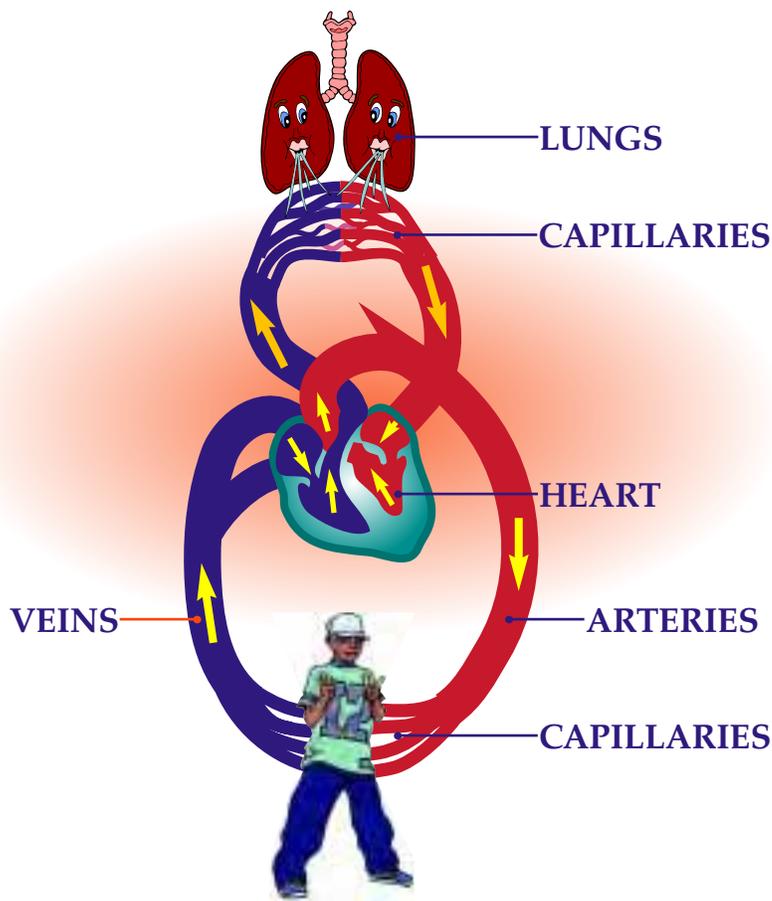
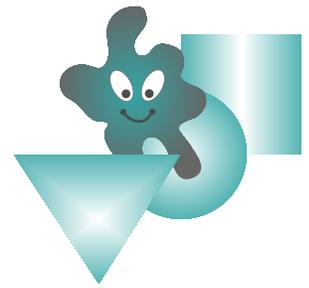


Figure 3 Blood Vessels

As it leaves the capillaries, *oxygen-poor* blood is pumped into tiny veins called the *venules*, then into small veins, medium-sized veins, and finally into the large veins. *Veins* carry blood *toward the heart* and are larger in diameter closer to the heart. In general, veins carry *oxygen-poor* blood *from the body back to the heart*. The *pulmonary veins*, however, carry oxygen-rich blood from the lungs back to the heart. Veins do not have the internal or external elastic layers that arteries have. Since veins do not have these layers and have a thick tunica adventitia, the veins are able to stretch (dilate) more than the arteries. Veins also have valves that keep the blood from flowing backwards away from the heart. So, veins too, are designed specifically for the job they must do.

Activity Materials: (Per group)

- 1 Copy *Student Data Page* per student
- 1 Copy *Student Information Page* (per student)
- Scissors
- Glue
- Map Pencils or markers
- Yarn for Character Cards (to be worn around necks of participants)
- *Character Cards* (cut and laminated for reuse)
- *Blood Flow Mat* enlarged and painted onto an old bed sheet, shower curtain, or butcher paper
- 1 *Glucose disk* (cut out and laminated for reuse)
- 1 set *Simulation Cards* (cut, folded, and laminated for reuse)



Activity Overview

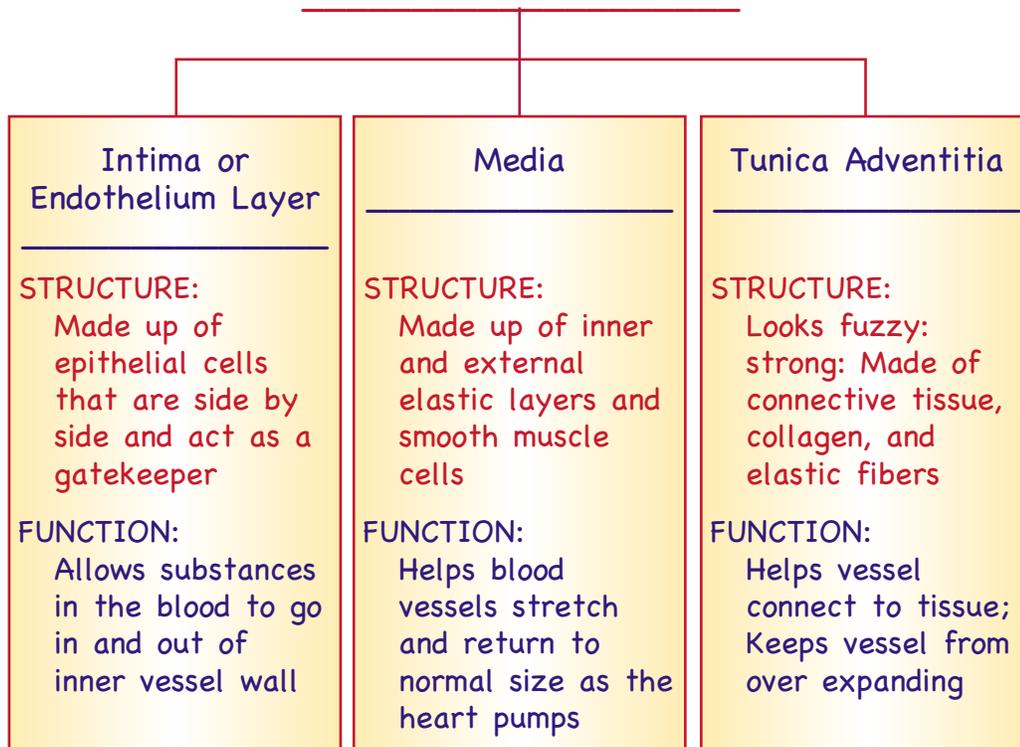


Activity Management Suggestions:

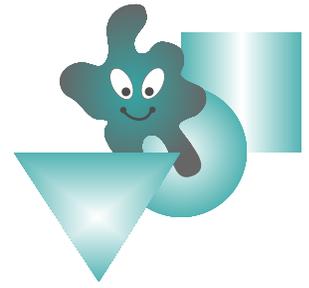
1. Assemble a *Layers of the Blood Vessel Organizer* for an exemplar that students can use as a guide.
2. Students will read the background information on the blood vessel layers and create a blood vessel graphic organizer that will define the structure and function of the layers.

Key points students need to include on their blood vessel organizer:

LAYERS OF THE BLOOD



3. Students will then use their blood vessel organizers as they analyze the pictures of different types of blood vessels.
4. Give each group the three blood vessel images included in this activity and allow time for students to make observations and write them down. Teacher versions are included at the end of these *Teacher Information Pages* – these versions of the images include guiding questions and expected student responses to help you facilitate the activity.
5. Discuss the key points and guiding questions indicated on the teacher version of each blood vessel image with your class. Be sure to relate the structure of each type blood vessel to its function.
6. The teacher should copy the *Blood Flow Mat* onto a transparency and using an overhead projector, trace the image onto a large bed sheet, shower curtain, or butcher paper.
7. Cut out and laminate the *Character Cards* and *Glucose Disk*.



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8. Students will participate in a simulation demonstrating how the blood vessels, heart, lungs, and body cells work together.
9. Following instructions on their *Student Data Pages*, students will answer questions that will help them to model the movement of oxygen, carbon dioxide, nutrients, and byproducts through the three blood vessels. Since this is a whole group activity, take advantage of being able to “freeze” the action and discuss important points during the simulation.
10. Be sure to monitor so that students are modeling the correct movements. An answer key for the questions on the *Student Data Pages* follows this *Teacher Information Section*.
11. Student observations will be written in student organizers or on the *Student Data Page*.

Modifications:

Students can work in pairs or individually when working on the graphic organizer.

If you do not want to use the organizer, students can draw a diagram and label the layers. The students can then describe the structure and function of each of the vessel layers.

When students are looking at pictures of the blood vessels you can discuss them together as a class.

Extensions:

Students and/or teacher can bring in materials for the organizer to model each of the layers. (Example: elastic for elastic layer in media or netting for the epithelial layer.)

Activity References Used:

Li, John K-J. (2000). *The Arterial Circulation: Physical Principles and Clinical Applications*. New Jersey: Human Press.

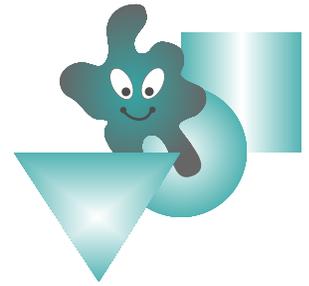
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