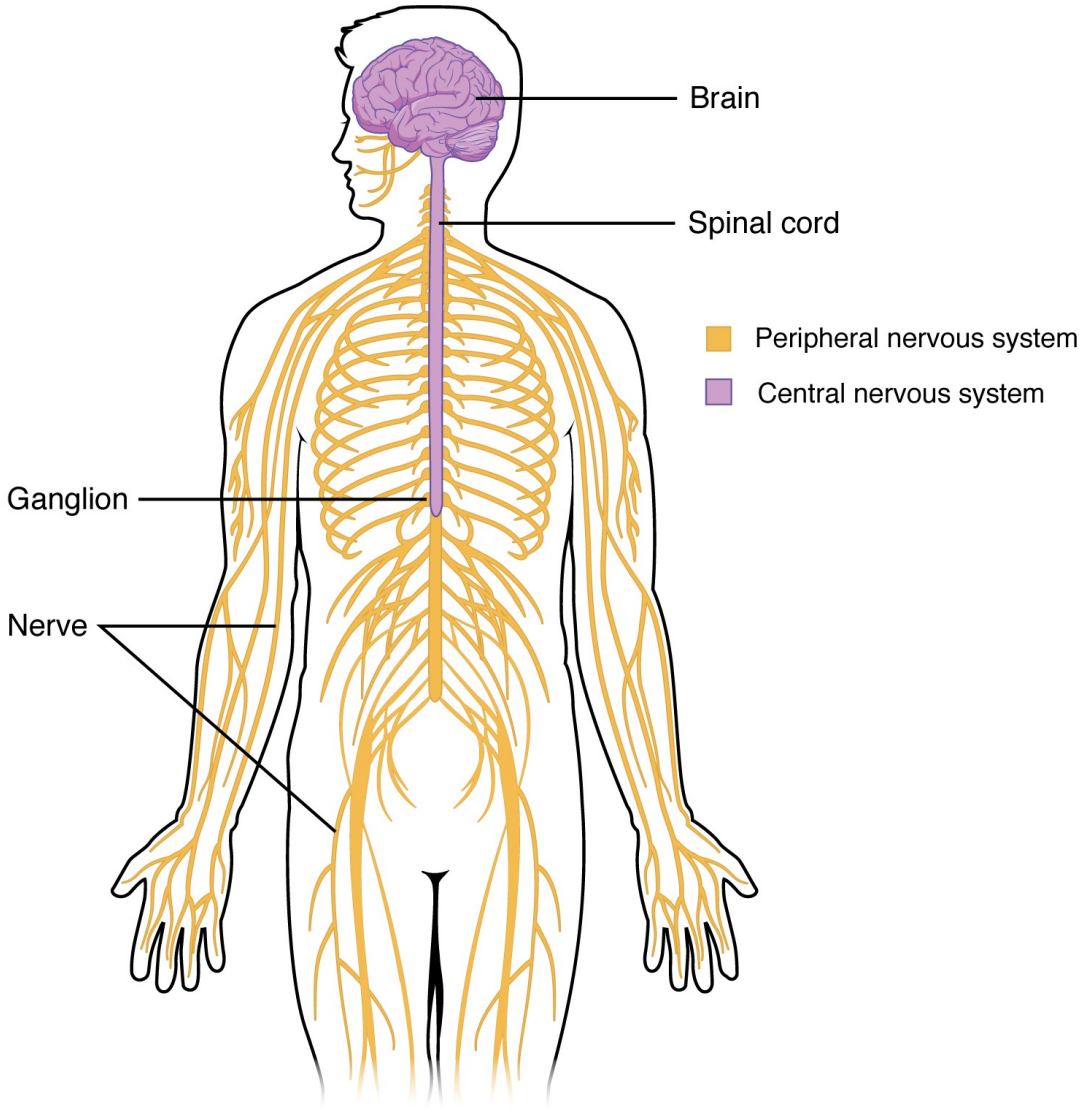
The Heart and Blood Vessels

SHERNORISE DAVIDSON

OVERVIEW:

The circulatory system is one of the fascinating bodily systems we have. It not only transports blood around the body continuously to ensure its survival, but it does so without the need for constant brain monitoring and adjustment. The circulatory system's role is to transport oxygenated blood from the heart to vital tissues and organs and take the deoxygenated blood with waste to the excretory organs to dispose of it. Internal arteries, capillaries, and veins make up the circulatory system, which helps create an extensive network of circulation networks throughout the body.

Circulatory System



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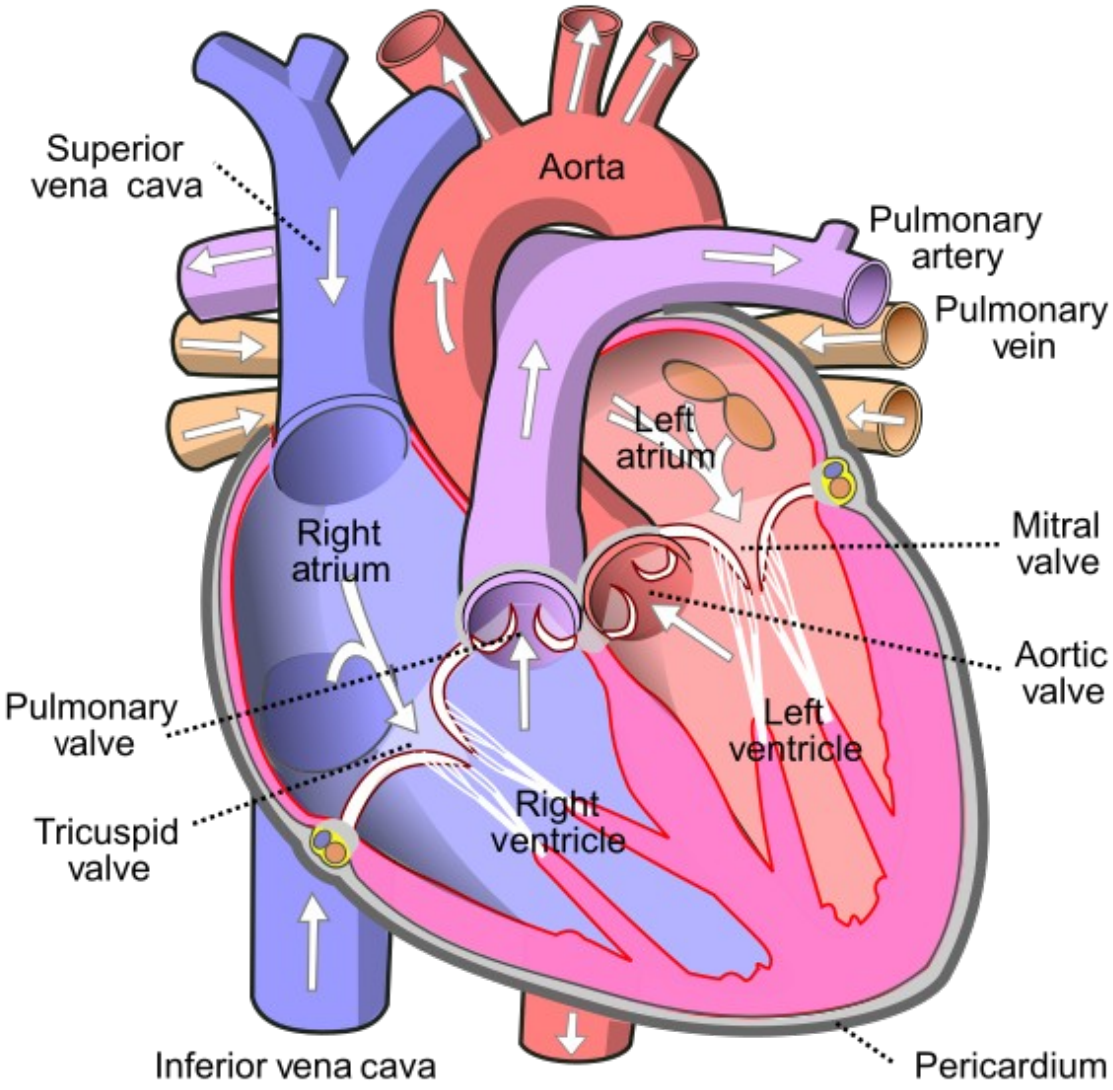
The Heart

Diagram of the human heart



Note. By Eric Pierce. 2020, June 2, image found on Wikimedia Commons.

The epicardium, myocardium, and endocardium are the three layers that make up the heart. The endocardium is a lining that covers the inner wall of the heart. The cardiac muscle cells that make up the intermediate layer and the bulk of the heart wall make up the myocardium. The epicardium is part of the pericardium which is the outer layer of cells. The pericardium surrounds and shields the heart, allowing for powerful pumping while also keeping the heart in place to avoid friction between the heart and other tissues.

The primary role of the heart is to pump blood throughout the body. The heart is split into four chambers: the right atrium, right ventricle, left atrium and left ventricle with a septum to separate each. Each chamber includes a valve that contracts and relaxes to aid blood flow and prevent it from rushing back into the preceding chamber. When the blood first enters the heart's right atrium from the superior and inferior vena cava, which are veins that carry deoxygenated blood from the upper and lower body to the heart, the atrium contracts, squeezing the blood past the tricuspid valve, a type of atrioventricular valve, into the right ventricle. The right ventricle will then contract, forcing blood through a semilunar valve called the pulmonary valve into the pulmonary artery, where the blood then travels to the lungs.

The blood flows via capillaries in the lungs across the one-cell thick walls of the alveoli, or air sacs, where oxygen diffuses into the blood and is captured by the haemoglobin compound in red blood cells. As a waste, carbon dioxide diffuses into the alveoli, causing the blood to become oxygen-rich or oxygenated. This oxygenated blood returns to the heart through the pulmonary vein, which pushes the blood past the open mitral valve and into the left ventricle when the left atrium contracts. The left ventricle then contracts, emptying itself of oxygenated blood via the aortic valve and sending it into the aorta, the body's largest artery, which then transports it all over the body again.

It's important to note that this is a cycle, with the same blood being recycled while moving between oxygenated and deoxygenated forms.

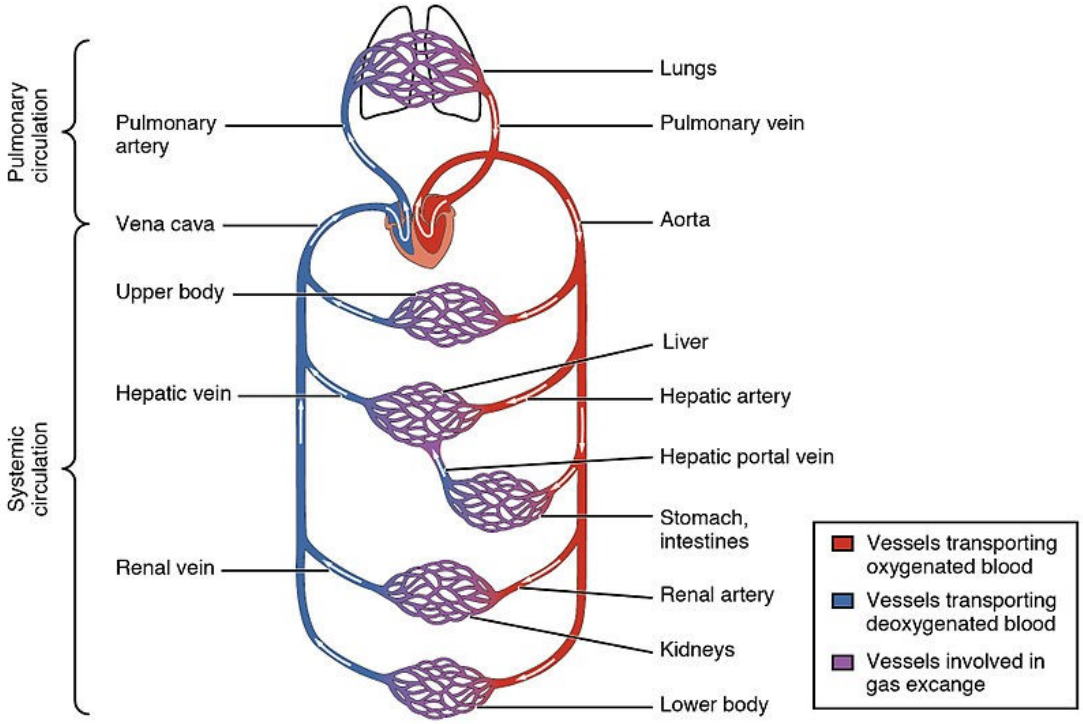
Fun Fact!

Since the ventricles must build up a significant pressure that causes the blood to travel against gravity into the arteries and eventually across the body, the ventricles' walls are heartbeat more muscular than the atrium's walls since the atrium works with gravity as the blood merely flows to the chamber below.

Circulation Networks

There are three types of circulatory networks: pulmonary circulation, systemic circulation, and portal circulation. The valves at the ends of each heart chamber divide blood flow into two types: pulmonary circulation, which transports oxygen and carbon dioxide throughout the body; and systemic circulation, which transports vital tissues within the body.

2101 Blood Flow Through the Heart



Note. By OpenStax College – Anatomy & Physiology. 2013, December 14, illustration found on Commons Wikimedia.

In research from Lednev and Fikiet (2018), although veins may seem blue through the skin at times, this is not because the blood is blue. Bright red is the oxygen-rich blood that passes through the arteries and capillaries. After delivering oxygen to the tissues, the blood becomes dark red as it returns to the heart via the veins. The blue colour can be attributed to the low-energy light, red, being absorbed by the veins, leaving only high-energy (blue) light to be reflected.

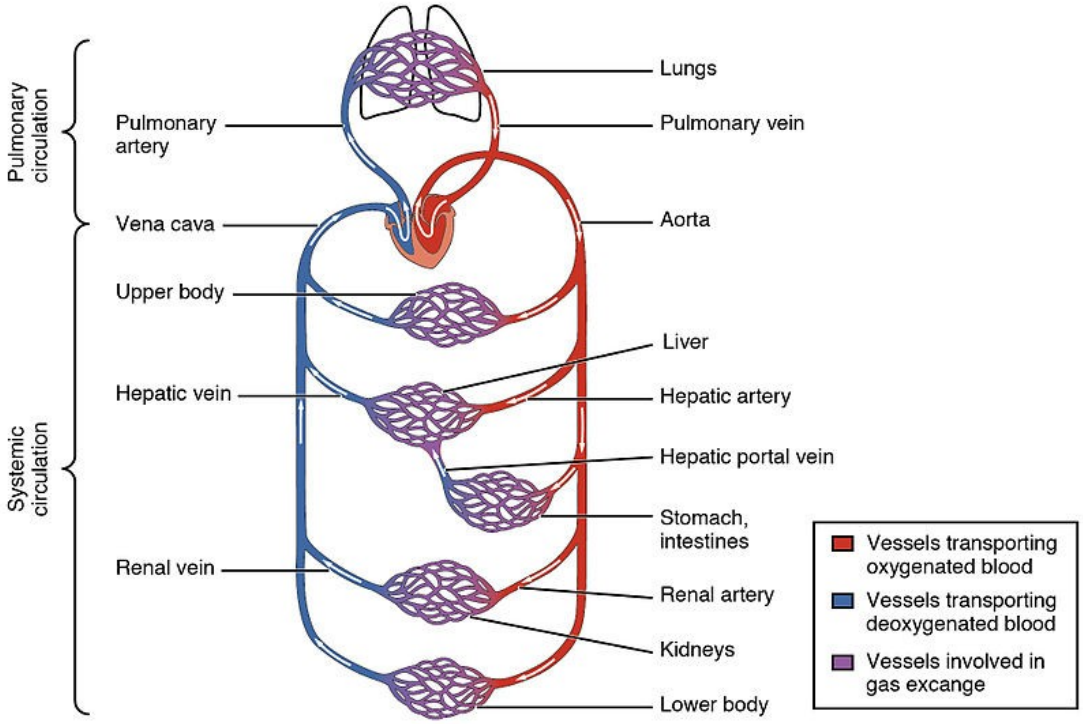
Systemic Circulation

Systemic circulation transports blood from the heart to the rest of the body, ensuring that all tissues receive enough blood flow. This blood is called oxygenated blood because it has a high concentration of nutrients and oxygen. The systemic circulation pathway begins with the delivery of blood from the left ventricle through the arteries that take it away from the heart to the arterioles and then to the capillaries in the tissues, where nutrients and oxygen are exchanged for carbon dioxide and waste.

Systemic circulation is divided into two parts: coronary and renal circulation. The coronary circulation delivers oxygenated blood to the heart muscle, whereas the renal circulation transports oxygen-poor and nutrient-rich blood away from the kidneys to satisfy other bodily requirements.

Pulmonary Circulation

Illu pulmonary circuit



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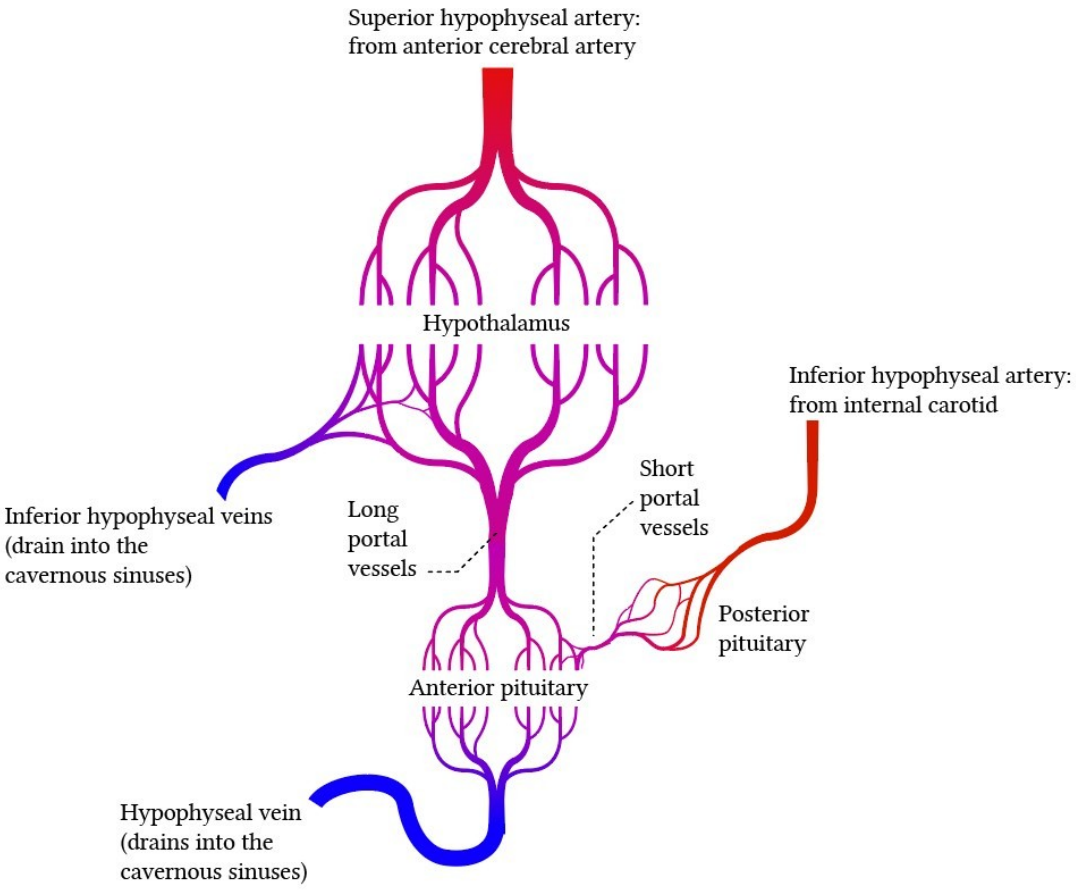
Pulmonary circulation is the movement of blood from the heart to the lungs and back again. It carries deoxygenated blood to the lungs, where it absorbs oxygen and excretes carbon dioxide. The oxygenated blood then returns to the heart.

Portal Circulation

portal vein



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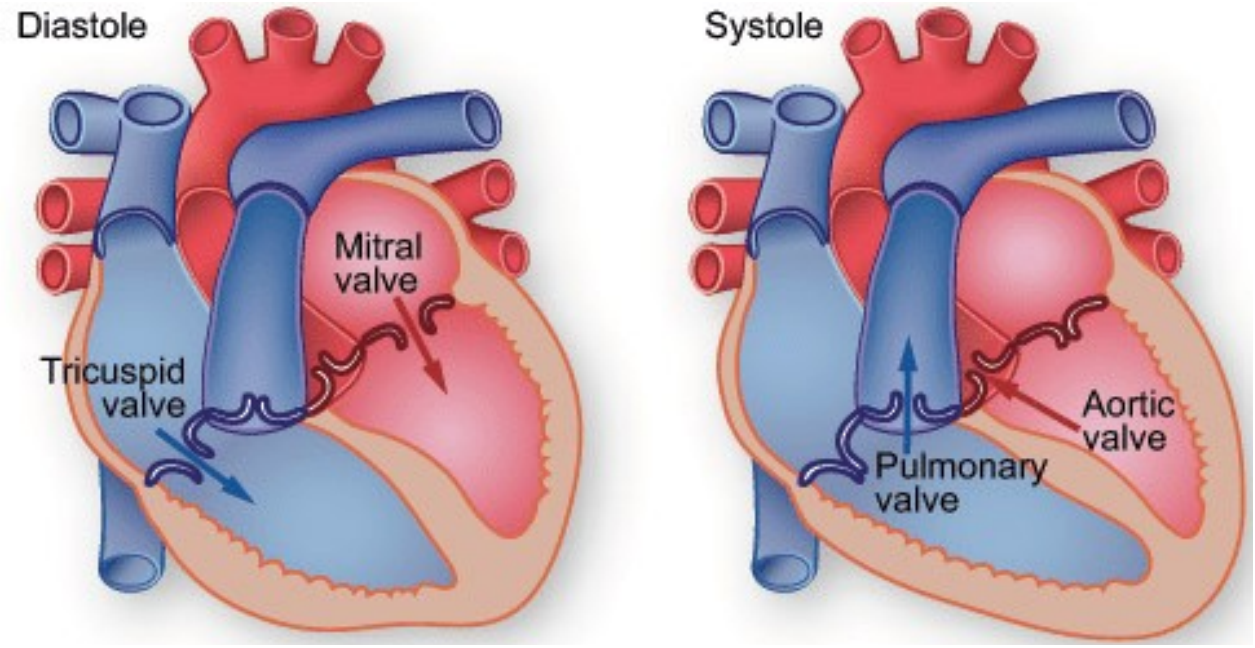
A portal circulation is made up of linking portal veins, which are a network of vessels that flow between linked capillaries. It allows the liver to eliminate any potentially toxic compounds processed before the blood enters the main blood circulation, which is regulated by systemic circulation. Hepatic portal, placental, and renal circulations are examples, as are some sections of the lymphatic circulation (Dean et al., 2004).

The Cardiac Cycle

Systole and diastole phases



Note. By Ashkan Jamali. 2017, February, illustration found on ResearchGate.

The cardiac cycle is a sequence of contractions and relaxations of the atria and ventricles that pump blood throughout the body. The cardiac cycle is divided into two phases: diastole and systole. They happen when the heart pumps blood via a system of blood vessels that transports blood to every region of the body.

Systole

The heart contracts and pushes blood out during systole. The time interval between the first and second heart sounds of the cardiac cycle is when the ventricles of the heart contract (the sequence of events in a single heartbeat). The effects of systole endure for around two seconds, although they linger for several minutes.

Diastole

The heartbeat's relaxation phase occurs when the heart muscles relax and the chambers fill with blood. This is the time when the ventricles recover to their regular size and tension after a heartbeat. The lengthier of the two stages, diastole, allows the heart to rest between contractions.

Systolic blood pressure is the first number, or "top," while diastolic blood pressure is the second number, or "bottom." Systolic blood pressure is the force acting on the arteries while the heart pushes blood through them, and diastolic blood pressure is the force acting on the arteries as the heart rests between beats. Blood pressure should be between 90/60 and 120/80 as a general rule. Blood pressure of 140/90 or greater is considered high. Low blood pressure is defined as a reading of 90/60 or below. Even if your diastolic number is reasonable (less than 80), if your systolic measurement is 120-129, you may have high blood pressure (Ambardekar, 2008).

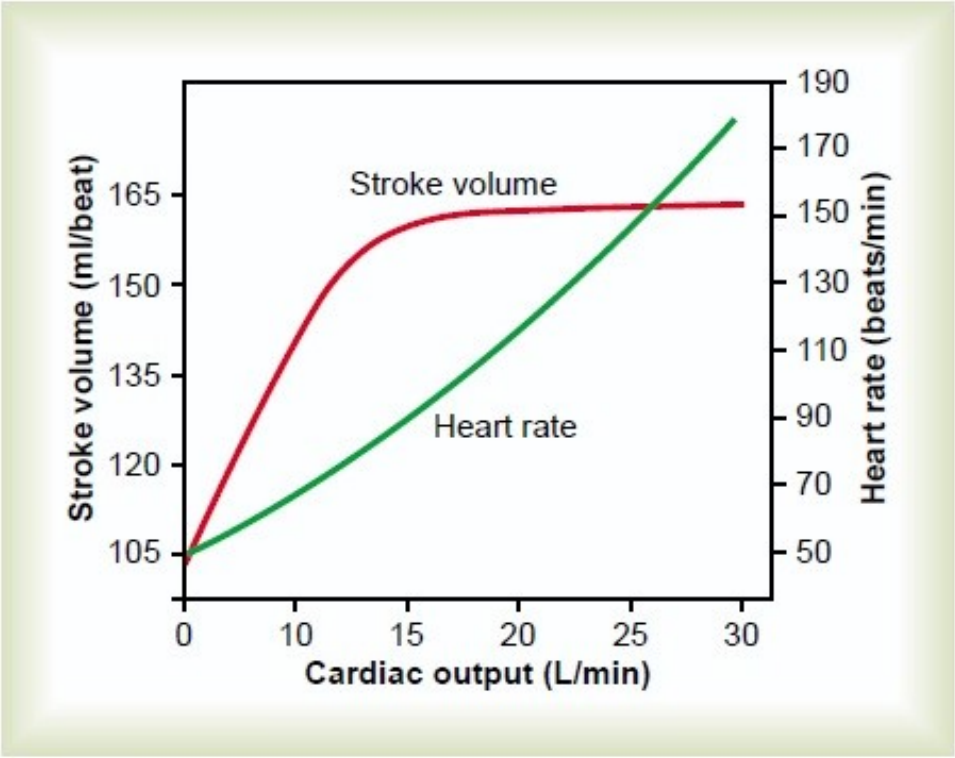
Heartbeat

The heartbeat is automatically triggered by a specific tissue in the heart called the sinoatrial (SA) node, which is located near the right atrial wall. The SA node acts as a pacemaker by releasing spontaneous electrical charges, forcing the two atria to contract in sync, resulting in a beat. The heartbeat goes to a second node, the atrioventricular (AV) node, which is situated between the right atrium and the right ventricle, where it stops before spreading to the ventricle walls. Blood is pumped into the arteries with each heartbeat, causing their walls to expand and constrict. As a result, one cycle of expansion and contraction is referred to as a pulse.

Stroke Volume

The stroke volume is the amount of blood expelled during ventricular contraction, or the amount of blood pumped out of the heart by each ventricle during one contraction. The stroke volume is proportional to the number of times the heart beats each minute. At rest, each contraction does not empty the heart chambers. They fill and empty faster during exercising because the heart contracts more vigorously (O'Keefe & Singh, 2021).

Approximate stroke volume output and heart rate at different levels of cardiac output in a marathon athlete



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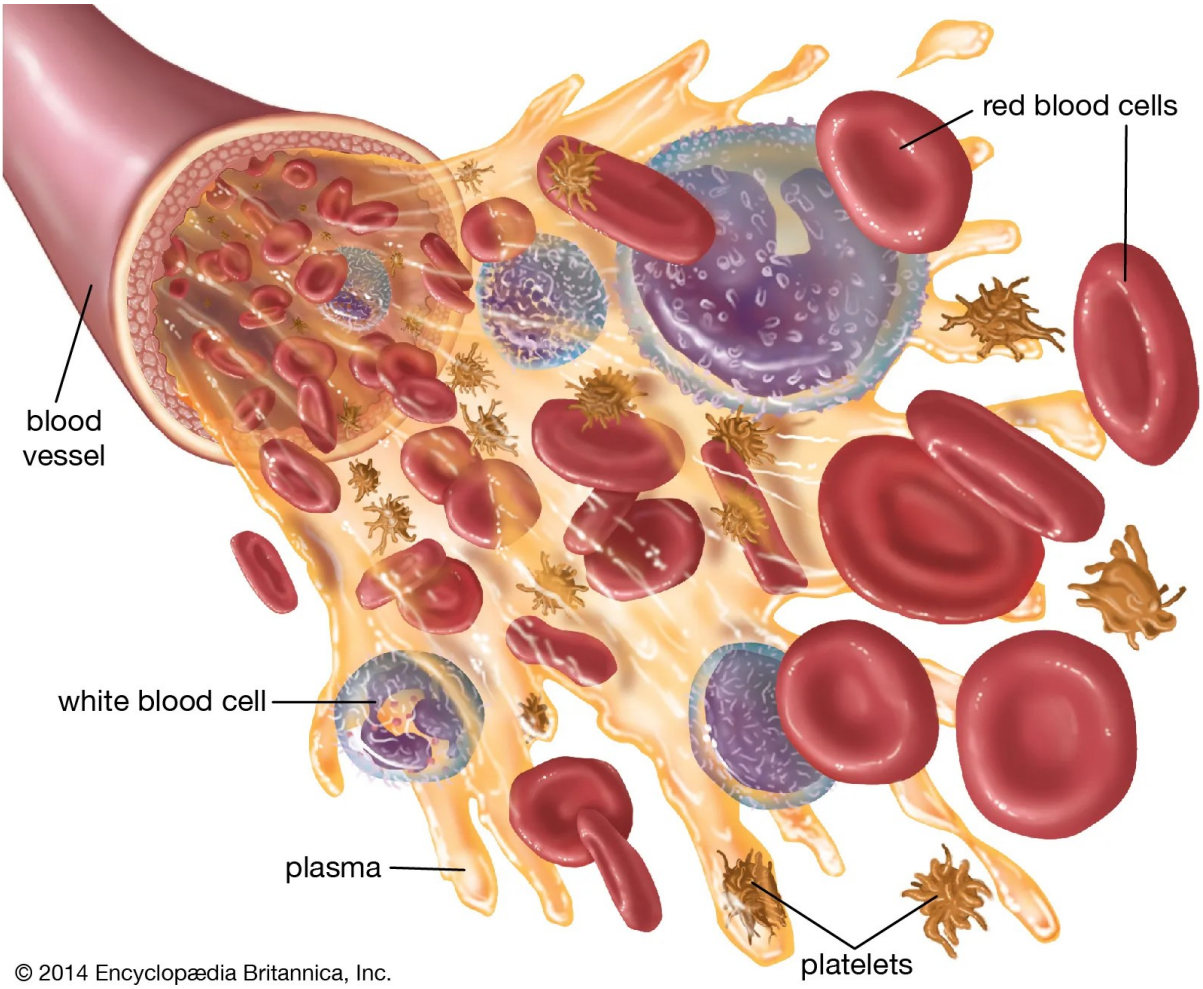
The value of noting the stroke volume is important since it may be proven that the stroke volume increases by monitoring the heart rate during activity. Consider stretching an elastic band... the more you stretch it, the tighter it becomes. Similarly, during muscular contraction, the heart fibres are stretched further, causing not only the veins to squeeze tighter, forcing more blood into the heart, but also the heart's ventricles to contract more powerfully, raising the stroke volume.

Blood

blood components diagram



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After discussing the circulatory system, it is time to move on to the most important aspect of it: blood. Blood is a continually flowing fluid that provides nutrition, oxygen, and waste elimination to the body. The blood is made up of red blood cells, also known as erythrocytes, which transport oxygen and nutrients, white blood cells, also known as leukocytes, which protect against foreign bodies that enter our bodies, plasma, which is a clear liquid that makes up 55% of blood and carries the solid cells, and platelets, which cause blood clots and aid in wound closure (Garraud & Tissot, 2018).

A, B, O, and AB are the four kinds of blood. This is due to the presence of two antigens, A and B, on the surface of red blood cells, as well as a protein called the Rh factor, which can be present,+, or absent,-, resulting in eight blood types: A+, A-, B+, B-, O+, O-, AB+, and AB-, according to Red Cross (n.d.). They also stated that in blood group A, there are A antigens on the red blood cells with anti-B antibodies in the plasma, B has B antigens with anti-A antibodies in the plasma, group O has no antigens, but both anti-A and anti-B antibodies in the plasma and blood group AB has both A and B antigens, but no antibodies.

Rh-negative blood is administered to Rh-negative individuals, while Rh-positive or Rh-negative blood is administered to Rh-positive people. As antibodies target antigens of the same kind, if one blood type carries a certain antigen, the other blood type receiving it cannot have the same antibody. As strange as that may appear, here's an example that could explain. Since people with blood type A have A type antigen in their red blood cells, they cannot donate to people with blood types B or O because they have antibody A, but they may donate to those with blood types AB and A because their antibodies are different. This would make blood types O and AB universal donors and acceptors, respectively.

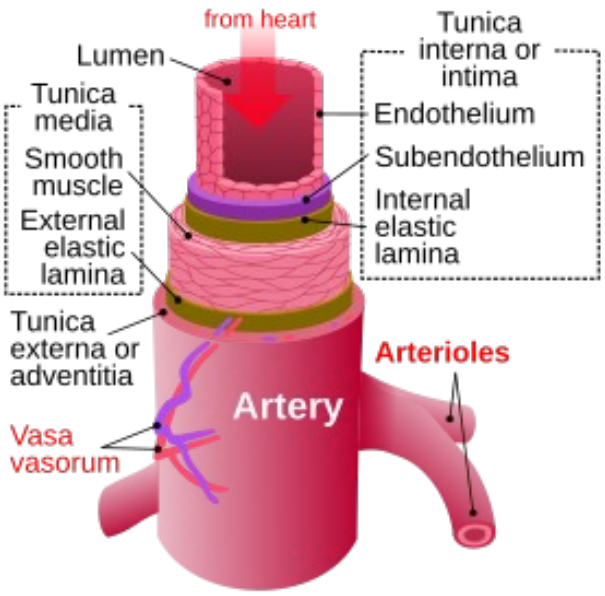
Blood Types And Transfusions				
Blood Type	**Antigens on Red Blood Cells**	**Antibodies in Plasma**	**Donations can be given to**	**Can receive donations from**
A	A	B	A, AB	A,O
B	B	A	B,AB	B,O
AB	A,B	-	AB	A,B,AB,O
O	-	A, B	A,B,AB,O	O

Blood Vessels

Blood vessels are pathways through which blood is delivered to bodily tissues. The body's blood vessels are classified into three types: arteries, capillaries, and veins. Each of these is extremely crucial in the circulation process.

Arteries

Diagram of an artery



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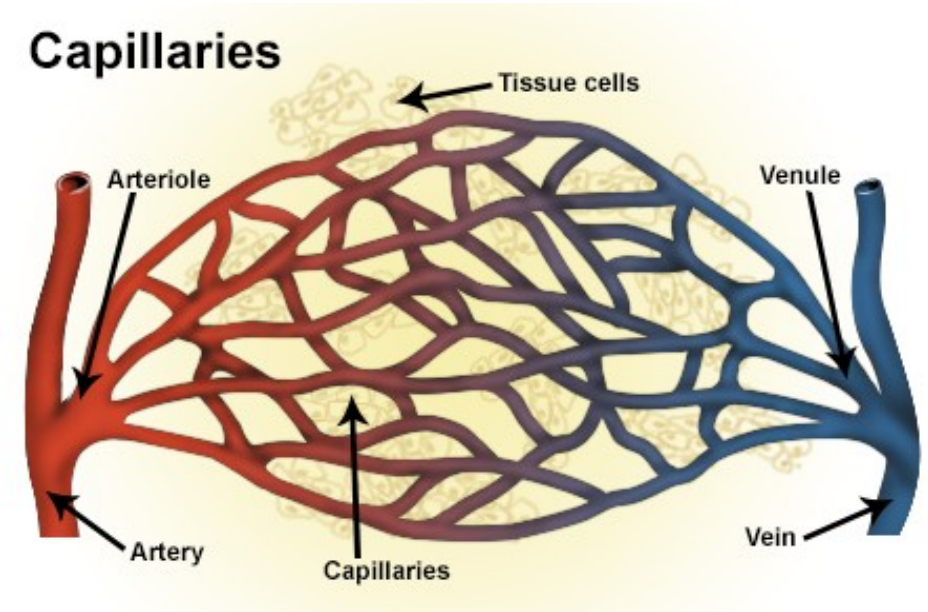
Arteries are muscular tubes lined with smooth tissue that transport oxygenated blood away from the heart. It also contains three layers: the tunica intima, which is lined with a smooth tissue called endothelium on the inside, the tunica media, which is a layer of muscle that allows arteries to bear high pressures from the heart, and the tunica externa or adventitia, which is the connective tissue that anchors arteries to neighbouring tissues. The aorta is the main artery, which branches into major arteries that provide blood to various limbs and organs. To reach deeper into the muscles and organs of the body, the major arteries divide into minor arteries and ultimately smaller vessels called arterioles.

Capillaries

Capillaries network

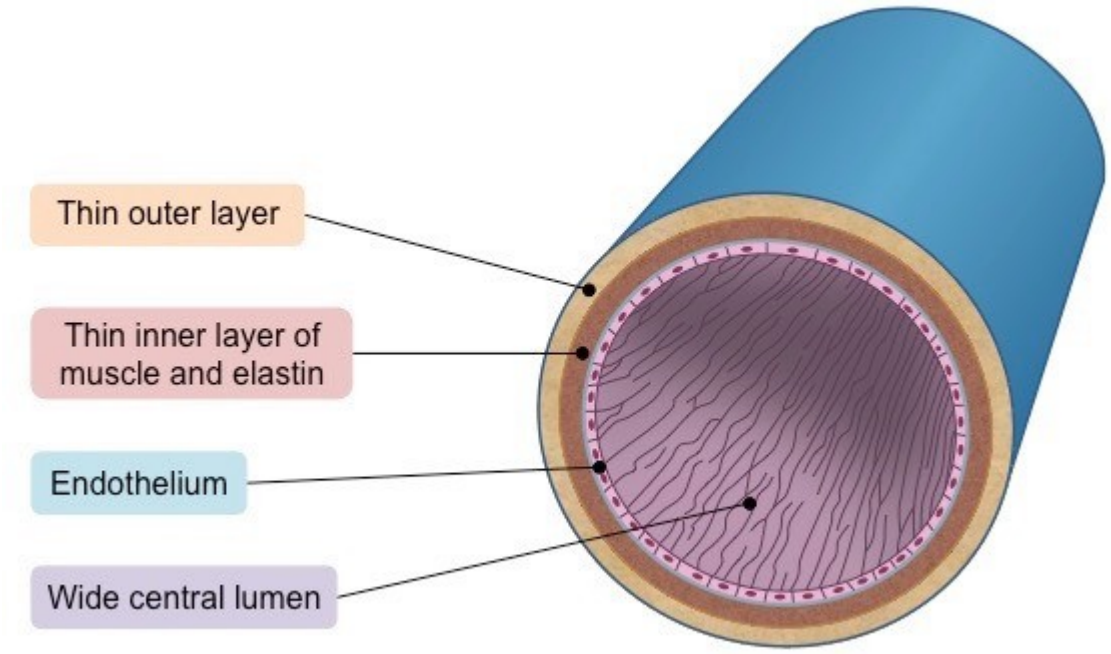


Note. 2017, December 6, image found on Commons Wikimedia.

Capillaries are the tiniest blood vessels, measuring around 5 micrometres in diameter, and forcing red blood cells to move in a single line through them. They are made up of only two layers of cells: endothelial cells on the inside and epithelial cells on the outside. Their role in the circulatory system entails the exchange of oxygen, nutrients carried in oxygenated blood of the arteries with carbon dioxide, and other waste transferred in veins via deoxygenated blood, inside physiological tissues such as muscles and lungs via diffusion and structural changes to the haemoglobin protein in the blood.

Veins

Structure of a Typical Vein



Note. By BioNinja.n.d., image found on BioNinja.

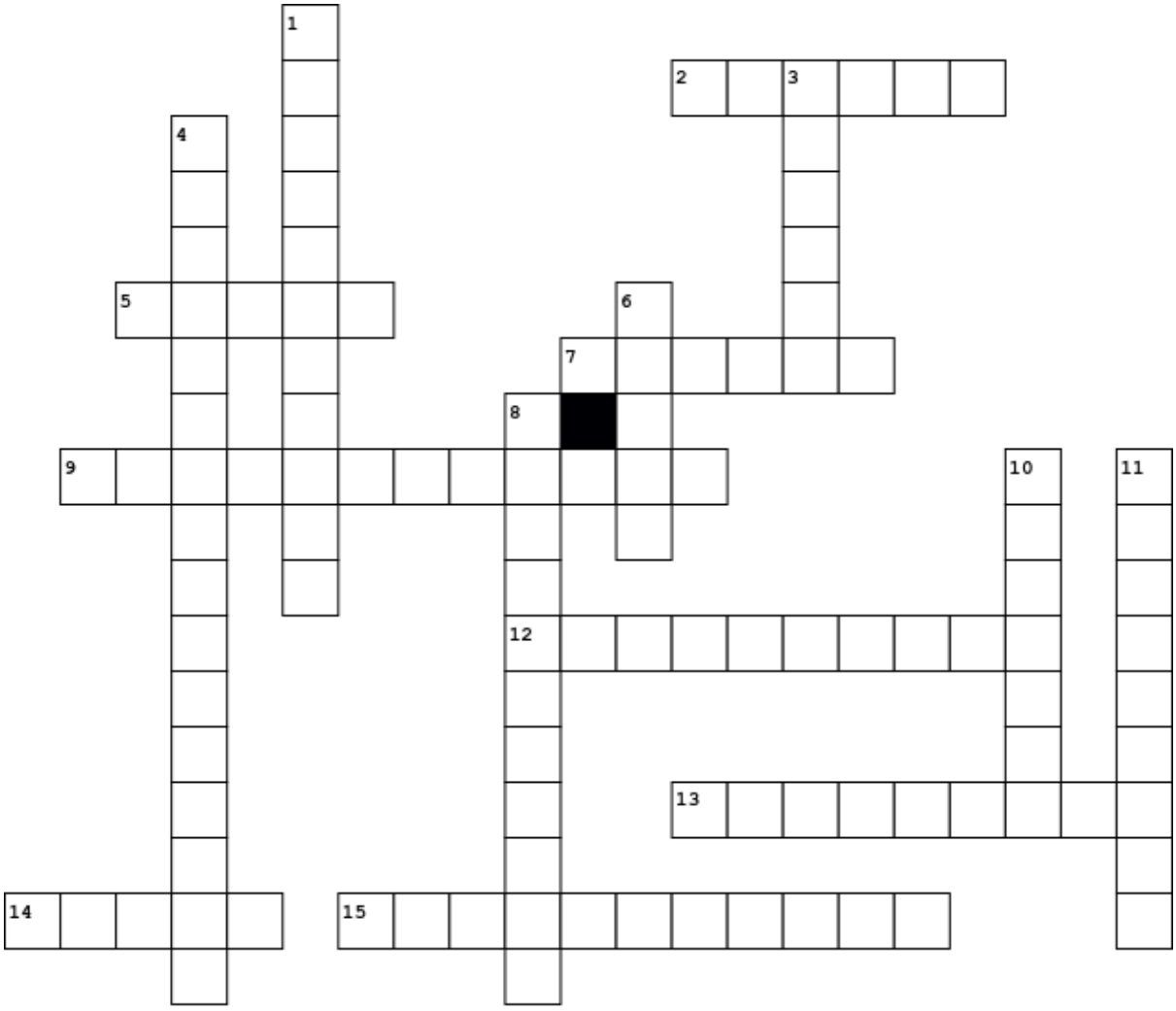
Veins are channels that carry blood back to the heart and have a layer of membranous tissue on the inside, a layer of thin bands of smooth muscle in the centre, and a layer of connective tissue on the outside. As the pressure and rate of flow are substantially lower, the veins have thinner walls. Veins also include valves to prevent blood from flowing backwards. Since veins must struggle against gravity to return blood to the heart, muscle contractions can aid in the return of blood to the heart. It should be noted that the major veins receive blood from the same organs and limbs as the major arteries do.(Ramasamy, 2017).

Fun Fact!

Vein walls are made up of three layers, just like artery walls, but they are thinner and less elastic than arterial walls because they do not have to endure high blood pressure, allowing veins to store a large percentage of the blood in circulation.

ACTIVITY 1:

Heart and Blood



Across

2. Woah, woah, woah! Keep separate, keep it moving! Imagine if I wasn't here keep oxygenated and deoxygenated away from each other in this room? You'd never live!
5. Whew! I'm always exercising! Pumping and pumping and pumping...

Down

1. You'd think that with the important role I play in carrying oxygen, people would stop calling me RBC and use my real name. What is it?
3. I have a 55% stake in the blood you know? Without me it could never flow anywhere!
4. Did you know my name is Latin?

7. You can say I'm a mooch because I only take but never give but is have any special antibodies to defend me!

9. Choo! Choo! All aboard! Hold your breath on this ride though, we don't have much air here!

12. Deep breath in and out... doesn't that feel nice? Glad you feel so, I could carry this for miles for you

13. I'm muscular and strong when compared to my brother my job needs to me to force blood quickly from one area to another

14. Halt! You can't go back so you must go on. Don't blame me, I'm just doing my job!

15. With all that pumping, it's a wonder we haven't exploded! Luckily the heart has me: their knight in shining armour! Not only do I protect them, I keep them in check!

I carry deoxygenated blood to the heart but my twin does the upper half

6. Ahhh! Why does everyone want me? They can't even share with me because of my antigens!

8. Mr.RBC seems to forget who does the real lifting around here...especially with all the shifting I have to do for the gases

10. Did you know that the heart is a muscle? I'm the one who laid the foundation.

11. You should see that I'm quite the artist! I spend all day patching away at the holes in skin and making scabs

ACTIVITY 2:

Circulation Networks

Name: _____

Date: _____

Match the word on the left side to its definition on the right side.

1. _____ circulation transports vital tissues within the body
2. _____ color of the veins through the skin
3. _____ colour of oxygen-rich blood
4. _____ blood with a high concentration of nutrients and oxygen
5. _____ coronary circulation deliver oxygenated blood to here
6. _____ movement of blood from the heart to the lungs
7. _____ Renal circulation is a form of this circulation
8. _____ blood carried to the lungs in pulmonary circulation

A. portal

B. liver

C. deoxygenated

D. dark red

E. heart

F. lungs

G. oxygenated

H. red

I. blue

J. pulmonary

K. bright red

L. systemic

ACTIVITY 3:

The Cardiac Cycle

Name: _____

Date: _____

Circle the correct answer for each question below.

1. **What happens when ventricular contraction begins?**

   A. The atrioventricular valves are opened

   B. The atrioventricular valves shut down

   C. The atrioventricular valves widens

   D. The atrioventricular valves open and close rapidly

2. **What is the cardiac cycle?**

   A. occurrences involving blood expelled from the artery and directed to the cardiac muscles

   B. blood discharged into the body from the capillaries

   C. blood discharged into the body from the capillaries

   D. occurrences involving the contraction and relationship of the cardiac muscles

3. **Which of the following is considered a normal blood pressure value?**

   A. 120/129

   B. 90/60

   C. 120/80

   D. 140/90

4. **What is one cycle of expansion and contraction referred to as?**

   A. Cardiac Output

   B. Pulse

   C. Ventricular Contraction

   D. Cardiac Cycle

5. **What is the relationship between the stroke volume and the number of times the heart beats per minute?**

   A. Proportional

   B. Inversely Proportional

Answer each question in the space provided.

6. **What are the two phases of the cardiac cycle?**

7. **What is the lengthier of the two stages of the cardiac cycle?**

8. **What does the sinoatrial or SA node act as?**

9. **What is located between the right atrium and the right ventricle?**

10. **What is the measurement of the force acting on the arteries while the heart pushes blood through them?**

_____

_____

https://myworksheetmaker.com/worksheet/133323/view/the-cardiac-cycle

ACTIVITY 4:

Blood Vessels

Name: _____

Date: _____

Fill in the blank with the missing word.

from	thick	tissues	narrow
larger	thinner	from	to
lower	blood	interior	differs
to	low	small	aorta
reducing	arterioles	exterior	backwards
great	valves	chambers	diffuse
higher			

1. Arteries transport blood under _____ pressure, thus their construction is built to handle it. Muscle and elastic tissue make up their _____ walls. As blood pulsates through them, the artery walls' flexibility permits them to expand and recoil. In comparison to veins, arteries have a _____ lumen. Arteries transport blood _____ the heart ___ the body's tissues at all times. The main artery, the _____, divides into major arteries that provide blood to numerous limbs and organs. The major arteries branch out into minor arteries and then smaller vessels called _____ to reach deeper into the body's muscles and organs.

2. Veins transport blood at _____ pressure, so their shape _____ from that of arteries. They have an inner layer of membranous tissue, a middle layer of thin bands of smooth muscle, and an outer layer of connective tissue. Veins also have _____ walls and a _____ lumen, which aids low-pressure blood flow by _____ resistance. There are also _____ in the veins that prevent blood from flowing _____. Blood is always carried ___ the heart through veins _____ the bodily tissues.

3. The lumen of a capillary is very _____ and is one-cell thick. Endothelial cells line the _____, and epithelial cells line the _____. This enables the effective exchange of chemicals, including oxygen, nutrients, carbon dioxide, and waste between the _____ and _____. Substances _____ through the capillary wall from _____ concentrations to _____ concentrations.

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