

## Understandings:

### 1. Explain artery.

- Arteries are the vessels that deliver the blood away from the heart to the whole body. Therefore, it has to endure high pressure. This naturally leads to a thicker muscle and elastic tissues.

Otherwise, diverging sacks such as aneurysm might occur that may eventually burst.

ALL organs have an artery because they need to be supplied with blood. Kidney have renal artery, liver have hepatic artery and heart have coronary artery etc.

### 2. Outline the structure of artery.

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We need to know four structures.

Starting from the inside and out:

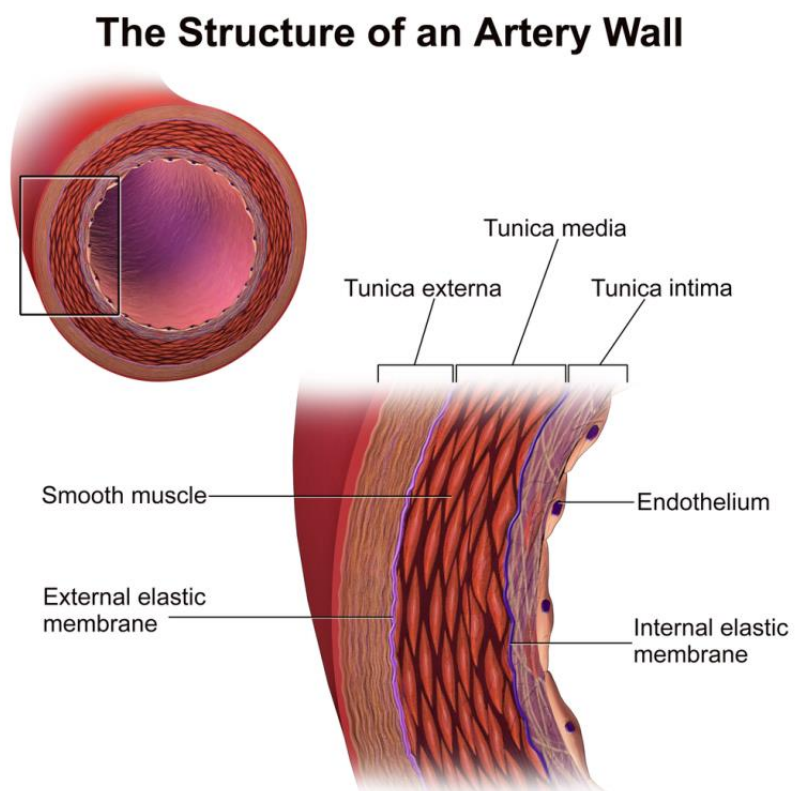
1. Lumen, which is the hollow space.
2. Tunica intima, which is a smooth endothelium, which is a single layer of cells.

DO NOT confuse this with epithelium. "Thelium" just means cell layer. Depending on the prefix, the location is different. Epi as in epilogue means over or after hence cell layer is on the outer part, just like epithelial cells on the villi.

3. Tunica media is thick and contains smooth muscle and elastic fibers.

Difference between smooth muscle and skeletal muscle is smooth muscle is involuntary, while skeletal is the muscle that enables skeletal and joint movement hence voluntary.

4. Tunica externa, a very tough layer of connective tissue. A connective tissue is a tissue that separates, connects and supports an organ from another organ. In this case, the function would be support.



### 3. Explain arterial blood pressure.

- Pressure is highest right at the heartbeat. This phase is called the systolic phase, and its pressure is called systolic pressure. This makes the arteries stretch slightly.

When the stretched muscles and fibers contract, its pressure is worked upon the blood and therefore squeezes the blood further, saving energy for the heart. This is called diastolic pressure and it is slightly lower, but not too low due to the blood that fills the lumen.

When the size of vessels alters, we name it vasoconstriction and vasodilation. These are usually affected by the brain and hormones.

	When body is cold (incl. blood temperature)	When body is warm (incl. blood temperature)
<b>In terms of blood arterioles</b>	Vasoconstriction: "Vaso" means vessel and constriction is obviously when it contracts. This makes the blood unable to closely reach the skin surface and reduce heat loss.	Vasodilation: Dilation means weakening, thus this makes the blood easier to go closer to the surface and transfer thermal energy of blood out to the surface.

### 4. Explain capillaries.

- These are basically sites where the exchange of gas and nutrients take place between the blood and the tissues. To maximize gas exchange, there are certain characteristics they have adapted.

Capillaries have many branches and are only one layer of cells, endothelium. The capillary wall (endothelium) is very permeable and therefore plasma can leak out and travel through the tissues. Tissues absorb necessities through diffusion or active transport and then the fluid comes back. The diameter is small so it can reach all cells. Only one red blood cell is able to squeeze through to maximize diffusion.

However, note that permeability differs depending on the type of target tissue and the need of nutrients at an instant.

### 5. Explain vein.

- The veins are the vessels after the capillaries. These contain the deoxygenated blood with all nutrients taken. Pressure is also low; therefore veins are wider and thinner.

How does it travel? Well, it does that by its own contraction, acting like a pump and also skeletal muscles. Thus exercising helps the vein's blood flow better.

## 6. Explain the role of valves in veins.

- The pressure drops after blood has passed capillaries. Thus valves are essential in the vein to stop backflow. Continuous circulation of blood is vital.

## 7. State that there are two separate circulations in the body.

- The capillaries of a mammal are too thin to withstand high pressure. Thus once the blood is deoxygenated, it cannot travel to the lungs on its own. Thus, it travels back to the heart and the heart will pump into the lungs.

We therefore have two circulations: systemic circulation – the circulation to the body – and pulmonary circulation – the circulation to the lungs.

## 8. Explain what the sinoatrial node does.

- Sinoatrial node is a group of muscle cells in the right atrium that contracts on its own, a.k.a. myogenic.

They do not need any input from the brain! Awesome. The cells somehow know that they should contract at even pace, around 1 beat/second.

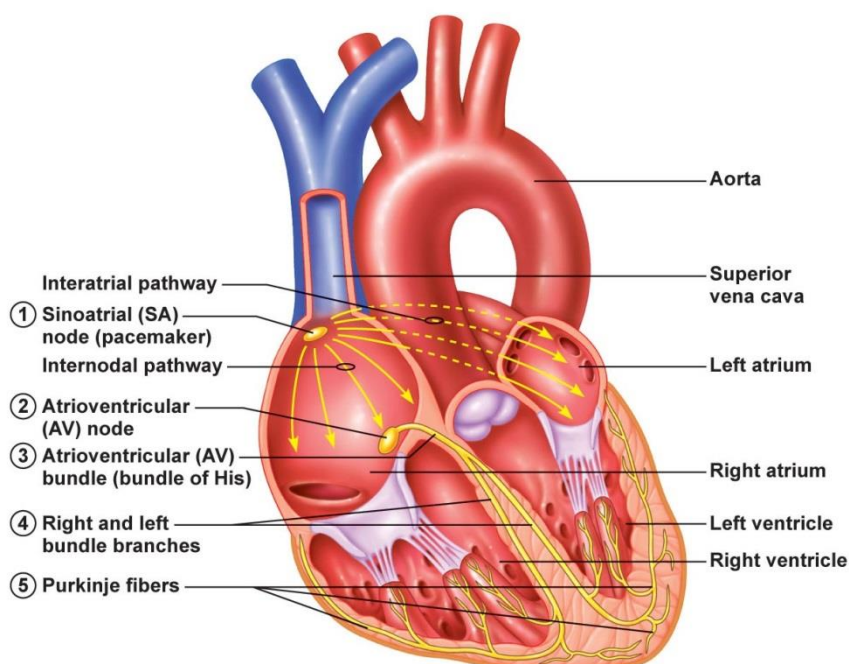
## 9. State sinoatrial node is a pacemaker.

- Since sinoatrial node is the initiator of the heartbeat, they are also a pacemaker. Some people have defects on this node. In that case, their node is replaced by an artificial sinoatrial node that serves the same function.

## 10. Explain atrial and ventricular contraction.

- Okay, we know that sinoatrial node is the pacemaker, but how does this small bundle of myogenic cells reach to the ventricles and the atria?

When sinoatrial nodes contract they also send out electrical signals.



These signals reach the atria and makes them contract, making the blood flow to the ventricle.

Now, approximately 0.1s later, the signal reaches atrioventricular nodes that contract and send electrical signals through a bundle of fibers, called Purkinje fibers.

This makes the ventricle contract. It is unbelievable how sophisticated our heart is.

### 11. Explain how heart rates can be changed.

- Nerves stimulates whether the heart should pump faster or not. There are two types of autonomic nerves that are attached to the pacemaker. Cardiac depressor nerve, the one that tells the heart to slow down, and cardiac accelerator nerve, the one that tells the heart to speed up.

Hormones also control the rate of the heart. Adrenaline that is secreted from adrenal glands and transported via the blood will speed up the heart rate, e.g. when you are stressed.

Medulla is the one that controls both nerve stimuli and hormones. It is located in a part of the brain stem and is connected to the spinal cord. What further stimulate the medulla are our peripheral nerves.

The variables that stimulate a response are blood pressure, pH (dissolved carbon dioxide that can form carbonic acid) and oxygen concentration.

Having low blood pressure, low pH and low oxygen concentration will initiate the cardiac accelerator nerve.

Having high will cause the opposite.

### 12. Explain what epinephrine is and its role.

- Epinephrine = adrenaline = hormone. This is mentioned above.

#### Extra notes

- What is the composition of blood?

First of all, blood is what we call fluid tissue, since it is an ensemble of cells that carry out the same function –transporting oxygen and nutrients – it is considered to be a tissue, a fluid tissue.

If we were to put blood in a centrifuge, it will be separated into these substances:

On top (the least dense part), we will find plasma covering about 55% of the whole. Of the plasma, 90% is water!!! 8% is protein (includes antibodies, and other proteins) and 2% is hormones, nutrients and other various substances.

On the second layer, there will be the leucocytes (white blood cells) together with thrombocytes (platelets) covering about 1% of the blood. WBCs are cells that are produced from the bone marrow and they are the immune system of our body. There are two types of WBCs: phagocytes and lymphocytes. Phagocytes are non-specific immunities that engulf pathogens and lymphocytes are specific immunities that produce antibodies.

Platelets are also cells (without nucleus) that prevent the blood from clotting.

On the last layer, there will be erythrocytes (red blood cells) covering 45%. RBCs are cells without nucleus and bunch of hemoglobin that transports the oxygen throughout the body.

### Extra notes

- What are the things that the blood does?

Remember that blood transports NACHOUH.

Nutrients (e.g. glucose)

Antibodies

Carbon dioxide

Hormones

Oxygen

Urea

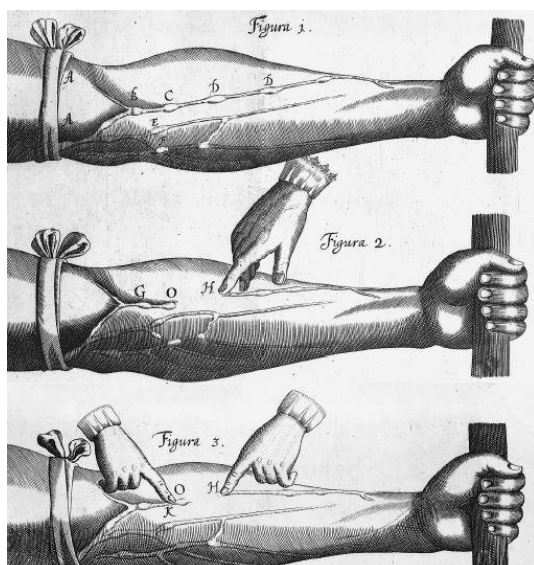
Heat (not a molecule, unlike all the others)

## Applications and Skills:

**1. Explain how William Harvey discovered that the heart was acting as a pump for circulation.**

- He was an intelligent guy that discovered key things about circulation:

1. He discovered circulation of blood. I.e. blood is reused and travels in circulation.
2. Unidirectional.
3. Blood was not absorbed by the body. It merely acts as a transport system.
4. Existence of capillaries.



## 2. Explain what an atherosclerosis is.

- Yes, we once again come across Latin and these complex terminologies that should only be found in Jurassic Park movies.

But hey, we are smart so we need to know this.

First of all, we need to know what arteriosclerosis is. Arterio refers to arteries and we know what those are. Sclerosis is Latin for "hardening". So, arteriosclerosis is when arteries become thick and stiff.

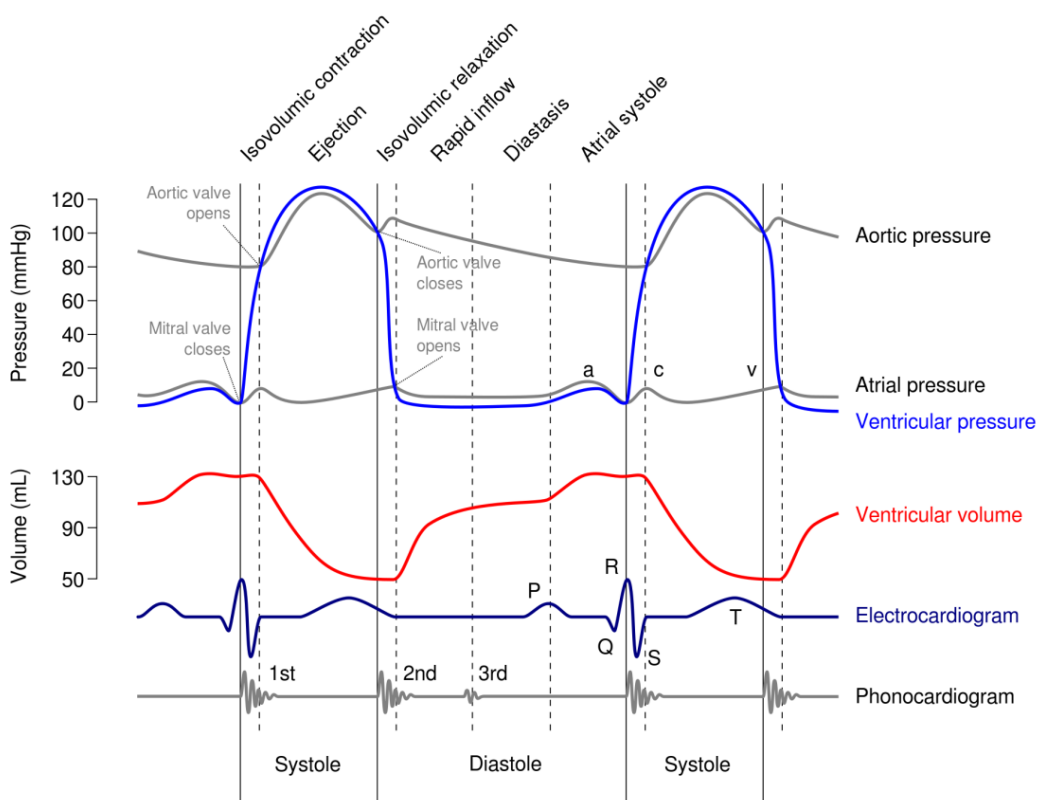
Atherosclerosis is one of the 5 types of arteriosclerosis. It is when a special fatty tissue called atheroma accumulates on the endothelium on arteries. The next question is how and why?

To answer how, it usually starts when there is damage on the endothelial cells (inner layer). Low density lipoproteins (contains fats and cholesterol) starts to get caught in this cleavage. Endothelial cells will call phagocytes for help. However, as the phagocytes consume, they get bigger and further block the arterial walls. In addition, smooth muscle cells move through the cleavage to additionally cover the lumen.

When this happens in the coronary artery, we call it coronary occlusion. When the heart cannot get its blood supply, it is fatal. This includes heart attack and stroke.

## 3. Explain the pressure changes in chambers of the heart and the aorta.

- In order for a blood to move and valves to open, the pressure of current place must exceed the pressure of destination.



Note that  
aortic valve =  
semilunar  
valve.

Mitral valve =  
atrioventricular  
valve.

Look at this  
diagram and  
think. Pay  
attention to  
the pressure  
part.

**4. Identify type of blood vessel from the structure of their walls.**

- There are significant characteristics for the artery, capillary and vein.

	Artery	Capillary	Vein
<b>Diameter of lumen</b>	Little more than 10micrometer	About 10micrometer	Wide
<b>Thickness of wall</b>	Thick	1 cell thin	Relatively thin
<b>Number of layers</b>	Tunica externa, media and intima	1 cell thin. Endothelial cells	Tunica externa, media and intima
<b>Muscle and fibers in the wall</b>	Abundant	None	A little
<b>Valves</b>	No valves	No valves	Valves

These structures make sense in terms of the pressure that each have to withstand and their function.

**5. Be able to recognize the chambers and valves of the heart.**

- This part is very easy. Atrium is the upper chambers, ventricles are the lower chambers.

The valves are tricuspid, pulmonary, mitral and aortic valves.

**TOK:**

**1. Our current understanding is that emotions are the product of activity in the brain rather than the heart. Is knowledge based on science more valid than knowledge based on intuition?**