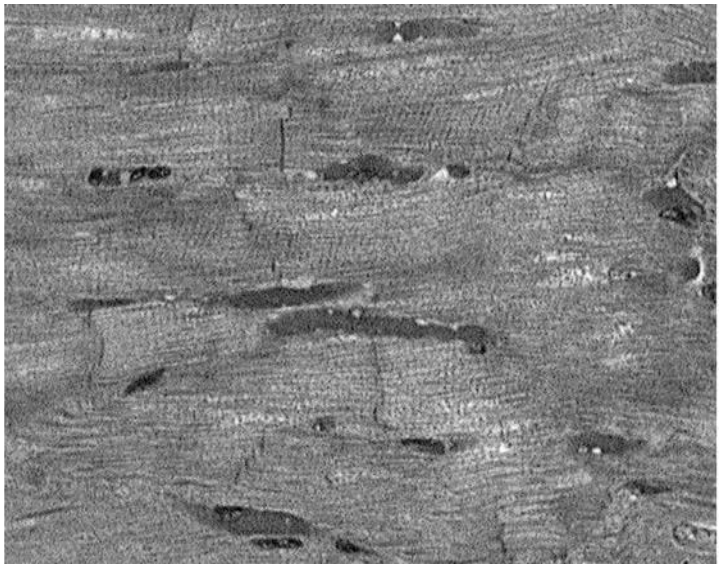
CARDIOVASCULAR TISSUES, HEART AND EMBRYOLOGY LAB

It is important to note that many of slides are composed of more than one tissue, as an organ is made up of various tissues. The Cardiovascular system is made up of the heart, blood vessels and accessory organs. Each of these is made up of various other tissues. For instance, the heart has striated cardiac muscle tissue in the myocardium, simple squamous endothelium as the endocardium, connective tissue, and adipose tissue.

Striated Cardiac Muscle tissue is branching, striated, and can have one or two nuclei. These cells branch and interact with other myocardiocytes via intercalated discs. Intercalated Disks are made up of Desmosomes (a circular plaque connected with adjacent cell via cadherins with interlocking intermediate filament). Adjacent to the Desmosomes are Gap junctions. Gap Junctions are made of Conexions for cell-to-cell communication (a direct cytoplasm connection).

These cells are like striated skeletal muscle cells in that they have the sarcomere arrangement of thin and thick filaments. Unlike Striated skeletal muscle, Striated Cardiac Muscle have more mitochondria. This makes them less tolerant to hypoxia. Also, the SR of myocardiocyte is smaller than what is found in striated skeletal muscle so the striated cardiac muscle is more dependent on extracellular Calcium (Ca). Still, T tubules that enter the Z line to carry the electrical messages are present. This tissue makes the muscular layer of the heart known as the Myocardium.

1. Draw what is seen in a slide of Striated Cardiac Muscle, label the intercalated discs.



2. What part of the heart is formed by Striated Cardiac Muscle tissue?

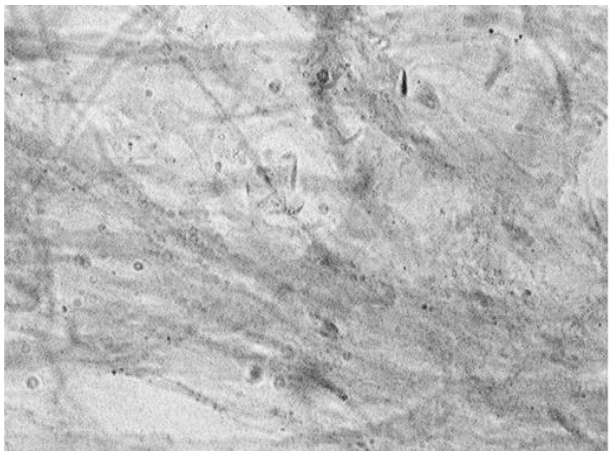
3. Draw an intercalated disc labeling a gap junction and a desmosome.

Around the Myocardium is the pericardium which is formed from different types of tissues. The outer layer, called the fibrous pericardium, is made of Dense Irregular connective tissue. This is followed by the Serous Pericardium that is made by two different layers divided by a cavity. The outer layer of the pericardium is composed of a fibrous outer layer which is over a layer of areolar tissue (loose irregular connective tissue) which is over a layer of simple squamous endothelium.

The Parietal pericardium is separated from the visceral pericardium (which can also be called the epicardium) by a cavity called the pericardial cavity. The pericardium is filled with a serous fluid. After the cavity, you reach the visceral pericardium, which is simple squamous endothelium that lies over adipose tissue that lines the outside of the heart. Adipose tissue is an energy source in areas with high oxygen supply.

4. Knowing that the sac around the heart is called the Pericardium what would you call the cavity within the pericardium?
5. Draw what you would see in a slide of this Simple squamous endothelium?

6. Draw what you would see in a slide of Areolar tissue labeling the elastic fibers and collagen fibers. What cells make this tissue?



7. Define cardio, myo, and peri.

Taking blood away from the heart are the Arteries and the veins bring blood back to the heart. If one looks at a slide of an artery and vein one can see the three layers: the tunica interna, tunica muscularis (smooth muscle layer), and tunica externa. When comparing the size difference between the tunica muscularis of the artery and vein we find that the artery is larger than that of the Veins. Should one inspect the lumen of the vein you will find that the vein is larger than the concomitant artery.

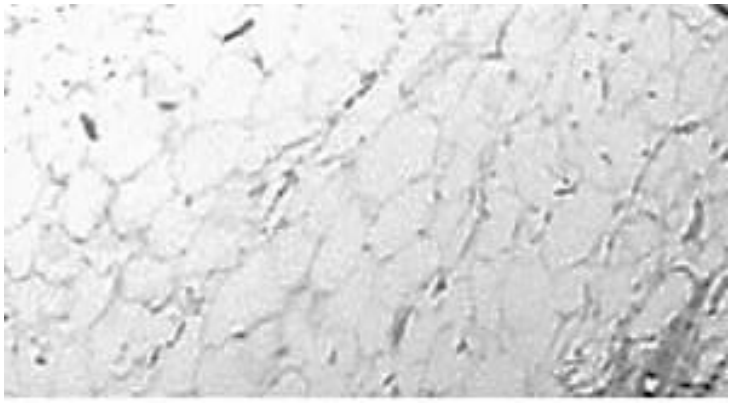
Each layer of the vessels is composed of different types of tissues. The Tunica Intima, innermost layer is composed of Simple Squamous Endothelium. The Tunica Muscularis is composed of smooth muscle and the Tunica Externa is composed of a special type of connective tissue called elastic tissue. It is composed of collagen and elastic

fibers. While most tissues in the arteries and veins, it is important to look at the specialized contractile tissue withing the walls of the vessels. This is Smooth Muscle which, unlike striated skeletal and striated cardiac muscles do not have stripes. While the maintain similar proteins, they are not arranged in sarcomeres. The cells of Smooth muscle also do not fuse so will have only one nucleus per cell and depending on the class of Smooth muscle have gap junctions to help them contract as a unit. This tissue also tends not to have as many mitochondria

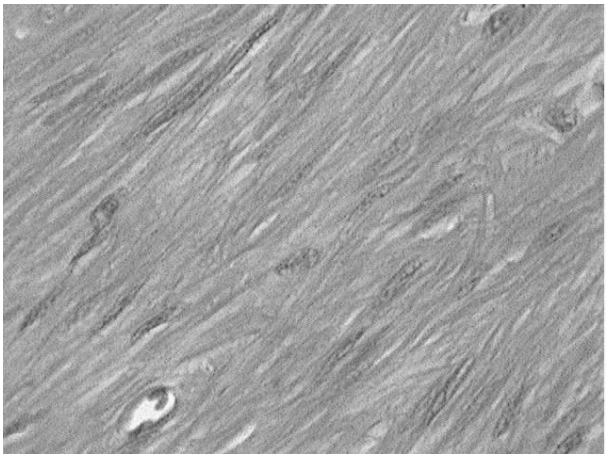
The Large arteries branch to medium sized arteries to small arteries. Each time the arteries get smaller, there is more areas for the blood to spread out leading to a drop in pressure. This means that the tunica muscularis can and does get progressively get smaller. The small arteries become arterioles which end up having the one or two layers of smooth muscle. This progression to smaller vessels continues until it reaches the capillaries. As the capillaries are where gas exchange takes place, the tissue left is ideal to allow diffusion and osmosis to proceed. In essence, at the capillaries, remain a layer of simple squamous endothelium.

8. What type of tissue would you find in a capillary?

9. Draw what is seen in a slide of adipose tissue



10. Look at a slide of smooth muscle and draw it below and label the nuclei.



Differences between arteries and veins:

Structure	**Tissue**	**Arterial version**	**Venous version**
Tunica intima	Simple squamous endothelium	Has an internal elastic membrane	Has valves
Tunica muscularis	Smooth muscle	Thicker	Thinner
Tunica externa	Elastic tissue	thinker	

11. On the image provided label the artery and vein as well as the structures from the previous table:

12. With regards to the lumen which had a larger one arteries or veins?

13. Which has a larger smooth muscle wall?

Basic Cardiovascular embryology:

By day eight after fertilization, the embryo has implanted, and the trophoblast have begun to invade the endometrial lining forming a connection between the embryo and the endometrium called an umbilical stock. Then, by week five, the embryo and yolk sac are found inside the amnionic sac. The placenta, formed from the trophoblast and mesoderm, sends finger-like projections called Chorionic villi deep into the uterus looking for blood supply. By week ten, the umbilical stock is the umbilical cord and now holds a vein (from uterus to fetus) and two artery (from fetus to uterus) to gain nutrients from mother and drop off metabolic waste. At about the same time, some of the neural crest cells migrate within the heart tube to begin to form an electrical conduction system which will make sure the heart beats independently from any nervous stimulation.

Near week two, there is a group of mesodermal cells begin to form two tubes near the pharynx that grow and migrate caudally ventral tube, a sac forms that will become the pericardial sac. The sac will surround the two heart tubes which will fuse to form one heart with bulges by week three. Nearest to the Pharynx are two Truncus arteriosus which connect to the ventricle which then connects inferiorly to the two primordial atria. These Atrium are attached inferiorly to two vessels. The primitive heart tube tends to move fluid from caudal to cranial in a one directional circular loop.

In week four, the ventricle begins to grow faster than the rest of the heart to move caudally as the Atrium migrates cranially. The two vessels coming off the truncus arteriosus, cranial to the ventricle, become the right and

left aortic arches. These two arches will become the majority of the body's arteries. The two vessels coming to the Atrium become the Sinus Venosus which will become the veins of the body.

The now two chambered heart continues to develop leading to the external separation of the atria to form a right and left bulge which do not have a true division inside but develop veins to drain the blood into the heart. By week five, the three chambered heart has a truncus arteriosus, which is attached to the ventricle, with two trunks within it, the Aorta and the Pulmonary trunk. After week five, cells from the top of the atrium, grow migrating towards the ventricle which will form the first interatrial septum called the septum premium. Once formed, some cells in the middle of the septum premium go through apoptosis (cell death) to leave a hole within the atrium which is called the foramen ovalis Next cells from the area between the atrium and ventricle migrate towards the atrium for form a flap called the septum Segundum so that the heart has valve allowing blood to move from the right atrium to the left.

The truncus arteriosus then splits and the two vessels rotate so that the aorta is on the left side of the ventricle and the pulmonary trunk is on the right side of the ventricle. Once the great vessels, pulmonary trunk and aorta are in the correct place, a septum between the ventricle develops leading a right and left ventricle where the Right ventricle pumps to the lungs and the left ventricle will pump to the body.

Once the heart develops, blood from the body, including the placenta, will enter the right Atrium via the veins, then be pumped into the right ventricle and left atrium (via the foramen ovalis). From the right ventricle, blood will be pumped though the pulmonary trunk to the pulmonary veins, to the lungs. Blood will enter the left atrium from the lungs via the pulmonary veins and from the right atrium via the foramen ovalis. Blood from the left atrium will be pumped to the left ventricle which will then pump the blood out to the rest of the body via the aorta and arteries. Blood will return to the heart via the Veins.

14. Why might cardiovascular development be evidence for evolution?
15. What would happen if the Great vessels did not split from the Truncus arteriosus?
16. What would occur if the pulmonary trunk and aorta did not move to their respective locations?
17. What shunts blood from the right atrium to the left atrium?
18. How many vessels should be found in an umbilical cord?

As oxygen and nutrients are coming from maternal blood, it is important that certain structures exist that will disappear from a free-living human. The first is the foramen ovalis, the second is an artery between the aorta and the pulmonary trunk called the ductus venosum sending blood from the pulmonary trunk to the Aorta. The last important vessel present in utero which has to close is the shunt between the Umbilical vein (coming from mother to fetus) to the largest inferior vein of the body that drains directly into the right atrium called the Inferior vena cava. The vessel between the umbilical vein and the Inferior vena cava is called the Ductus venosus.

Under normal development, when the first breath of life occurs, the ducts all close. When the foramen ovalis closes it becomes the fossa ovalis and when the Ductus Venosus and Arteriosus close they are called the Ligamentum Venosum and Arteriosum respectively.

19. In a normal baby, why do the Ductus venosus and arteriosus have to close?
20. If the truncus arteriosus did not split, why is it important that the shunts remain open?
21.