

ZOO 4377L - VERTEBRATE MORPHOLOGY LAB

LAB 12: CIRCULATORY SYSTEM

Name: _____ SSN: _____

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Next Week's Assignment: Walker & Homberger - Chapter 12 (*Excretory and Reproductive Systems*): pp. 395-411, 413-430; read the small print and skim the large print sections.

Preparation: Walker & Homberger - Chapter 11 (*Circulatory Systems*); read the small print and skim the large print sections.

Background

In many small invertebrates, all the cells of the body are in close proximity to a fluid environment that provides adequate exchange of gases with their surroundings. Vertebrates, however, are larger and not all cells are within diffusible distance of the external environment. As a result, vertebrates have a complex circulatory system which functions to transport gases, nutrients, and waste to and from every cell throughout the body. Almost every living cell within a vertebrate lies within 100 μm of a capillary. The circulatory system is grossly divided into two components, the **cardiovascular system** and the **lymphatic system**. The cardiovascular system is responsible for blood circulation and consists of the **heart, arteries, veins, capillaries, and blood**. The lymphatic system collects fluid which has seeped from the cardiovascular system into surrounding tissue spaces and returns it to the cardiovascular system. The accumulated lymph, unlike blood, receives no cardiac pressure and thus relies on general muscular activity and weak lymph musculature for transport. The development of the circulatory system in an embryo closely mimics the phylogeny of the vertebrate circulatory system. It is the first organ system to become functional in the embryo. The fate of the ancestral **aortic arches** (the blood vessels that supply the visceral arches) is of particular interest since these form the so-called "great vessels" in the tetrapods.

Today's Lab

In today's lab we will take a very comparative approach to the circulatory system. You will need to dissect the circulatory system of both your cat and shark. In addition you will dissect a sheep heart. You will recall that the cat and shark are latex-injected so that the arteries should be readily apparent. The sheep's heart will be used to study the internal anatomy of the heart. As always, you will be responsible for knowing all structures which appear in **bold** for next week's quiz.

- ? What is the difference between a portal and systemic vein? [Hint: Read pages 337-378.]
- ? Functionally, what distinguishes an artery from a vein? [Hint: Think in terms of the direction of blood flow; see. page 339] Does oxygenation of the blood have anything to do with it?
- ? What is a [venous] sinus? Sinus is Latin for a cavity, channel or hollow. Thus, there are many types of anatomical sinuses (e.g., paranasal sinuses, aortic sinuses, venous sinuses, intestinal sinuses, bony sinuses, etc.), the term being used to describe any enlargement; the term does not refer to any specific type of tissue.

- ? What is an [vascular] anastomosis? [**Hint:** Read p. 339.]. Anastomosis is Greek for “*to furnish with a mouth*” and refers to any communication (direct or indirect) between two tubular structures; again, this term is not tissue specific (e.g., vascular, intestinal, uretal, etc.).

I. SHARK CIRCULATORY SYSTEM.

Follow the basic plan in W & H, but their directions are much more in depth than we need to go. Instead, use the structures you need to identify as a guide, and locate them using W & H. **Start with pages 301-302 in Chapter 10 to open up the pericardial cavity.** Then proceed to the pages in Chapter 11 identified below

Identify:

Heart (p. 341; Figs. 11-3, 11-4 and 11-12):

sinus venosus
atrium
ventricle
conus arteriosus

Veins (p. 346-7; Fig. 11-5):

common cardinal veins
 posterior cardinal sinus
 anterior cardinal sinus
coronary veins

Arteries (p. 348-350; Figs. 11-4, 11-9)

ventral aorta
afferent branchial arteries
efferent branchial arteries
dorsal aorta
carotid artery

- ? Using your text (Figures 11.3, 11.5 and 11.9) as a guide, diagram the flow of blood through the shark's circulatory system, starting with the cardinal sinuses and ending with the dorsal aorta (and including the chambers of the heart). For each structure, note whether the blood is oxygenated or deoxygenated. This can be done on the back of your handout or on a separate page..

II. MAMMALIAN CIRCULATORY SYSTEM

Material: Cat and sheep heart

Again, use W & H for their directions and pictures, but use the list below as a guide. Be forewarned that there is a lot of variability among individuals in the appearance of the circulatory system. Why do you suppose this is so?

Identify:

External heart and associated vessels (pp. 369-373); both cat and sheep heart.

right atrium
auricle

cranial vena cava
 caudal vena cava
 right ventricle
 pulmonary trunk
 ligamentum arteriosum
 pulmonary arteries
 left atrium
 pulmonary veins
 left ventricle
 aorta

Arteries and veins cranial to heart (pp. 373-377); cat only.

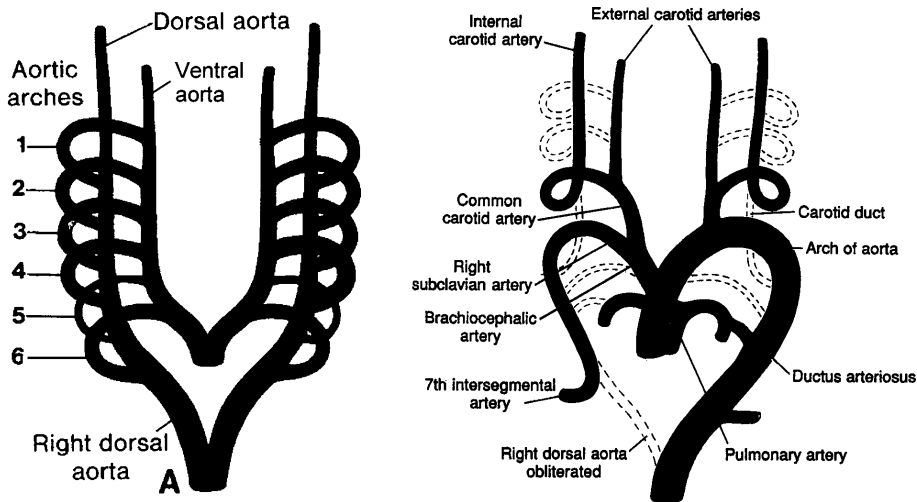
subclavian veins
 external jugular veins
 internal jugular veins
 brachiocephalic veins
 brachiocephalic artery
 common carotid arteries
 subclavian arteries (note L/R asymmetry)

Arteries and veins caudal to heart (pp. 381-383); cat only.

descending aorta (note numerous branches to various visceral organs)
 renal arteries
 renal veins

Embryonic/phylogenetic origin of the great arterial vessels

Superficially, the branchial arteries and the systemic vessels to which they give rise in the shark bear little resemblance to great vessels seen in the cat. However, as described on pp. 376 and 377 of your dissector, the major arteries of the cat are derived from an embryonic arrangement of mammalian aortic arches which is virtually identical to that of the shark branchial arteries. Using your text and the figures supplied below (Sadler 12-34A, 12-35) as a guide, please list the embryonic/phylogenetic origin of each of the adult structures listed below. This exercise will take some time so you should first continue on to the dissection of the sheep heart.



adult structureembryonic origin

ascending aorta (origin of arch)

aortic arch

descending aorta

pulmonary trunk

pulmonary arteries

ligamentum (ductus) arteriosum

brachiocephalic artery

right subclavian artery

left subclavian artery

common carotid arteries

internal carotid arteries

external carotid arteries

Internal heart (sheep heart) (pp. 389-392)

Instead of that described in the dissector, you may wish to use the following dissection to examine the internal structures of the heart: Carefully remove the fat from the apex of the heart taking care not to damage the vessels. Determine the aorta and pulmonary trunk and look for the ligament arteriosum connecting them. With a pair of scissors, open the pulmonary trunk and extend the incision into the right ventricle, cutting to its base. From this cut, open the right atrium by cutting across the atrioventricular ostium and extending the cut up through the cranial vena cava. Repeat the procedure for the left ventricle and atrium starting from the aorta. Lastly, see if you can find the coronary arteries arising from the base of the aorta; this may take some doing.

great vessels:**aorta****pulmonary trunk****caudal and cranial vena cavae****pulmonary vv****right atrium****interatrial septum****fossa ovalis**

entrance of coronary sinus (left cranial vena cava)

openings of venae cavae

pectinate muscle

right ventricle**tricuspid (right atrioventricular) valve****papillary muscle****chordae tendinae****cusps (flaps)****interventricular septum**

trabeculae carnae

pulmonary valve

semilunar valves

left atrium

opening of pulmonary veins

pectinate muscle

left ventricle

bicuspid (left atrioventricular) valve

papillary muscle

chordae tendinae

cusps (flaps)

interventricular septum

trabeculae carneae

aortic valve

semilunar valves

coronary arteries

- ? Why is the wall of the left ventricle thicker than that of the right? Why are the walls of the atria thinner than the ventricles?

- ? Among the great vessels, why are the walls of the arteries thicker than the walls of the veins?

- ? Why do the coronary arteries arise from the aorta rather than the pulmonary trunk?

- ? What is the function of the ligamentum arteriosum in the adult? In the fetus?

- ? What foramen ovale marks the position of what structure in the fetus? What was its function?

- ? Starting with the venae cavae and ending with the aorta (and including the chambers of the heart), diagram the flow of blood through the cat's circulatory system. For each structure, note whether the blood is oxygenated or deoxygenated.