LABORATORY 14 - CIRCULATORY SYSTEM

OBJECTIVES:

LIGHT MICROSCOPY - Recognize and distinguish between different categories of vessels and the layers that form them (tunica intima, media and adventitia): A) arteries, large (elastic) and medium (muscular); B) veins, large and medium; C) microvascular system, small arteries and arterioles, small veins and venules, capillaries, lymphatic vessels. Recognize different regions and structures of the heart and the layers that can be distinguished.

ELECTRON MICROSCOPY: Recognize different types of vessels, the different layers that form them (tunica intima, media and adventitia) and the tissue and cells from which they are composed.

ASSIGNMENT FOR TODAY'S LABORATORY:

GLASS SLIDES

SL 85 Medium artery and vein
SL 184 Aorta (elastic tissue stain)
SL 31 Aorta
SL 52 Large vein (Inferior vena cava)
SL 87 Large vein (Portal vein)
SL 14, 15B 24, 96 Small arteries and veins, arterioles venules and capillaries
(SL 14 was fixed with arteriole pressure maintained)
SL 77 (Lymph Node) Lymphatic vessels
SL 63 Heart
SL 88 Right ventricle and pulmonary artery
SL 30 Aorta and/or pulmonary artery and ventricle
SL 64 Purkinje fibers

POSTED ELECTRON MICROGRAPHS

S-38 Arteriole
S-40 Arteriole
S-42 Capillary
#19 Blood vessel
#19B Blood vessel
Lab 14 Posted EMs

HISTOLOGY IMAGE REVIEW - available on computers in HSL
Chapter 9, Circulatory System
Frames: 567-626

SUPPLEMENTARY ELECTRON MICROGRAPHS

Rhodin, J. A.G., An Atlas of Histology
Copies of this text are on reserve in the HSL.
Circulatory system pp. 190 - 208

I. **GROSS VESSELS**. Compare the structure of arteries and veins of similar size with regard to: thickness, composition of the three tunics of the vessels (intima, media, adventitia). Also look for adjacent nerves.

A. MEDIUM (MUSCULAR) ARTERIES AND MEDIUM VEINS

1. Medium Artery and Vein - SL 85 - H and E (J. 11-2, 11-7, 11-19; W. 8.10, 8.22) - Study and compare the structure of the medium-sized artery and vein (low, med). In which structure is the smooth muscle in the media more organized (red arrows, media of artery; blue arrows, media of vein)?

2. Within the artery observe the internal elastic lamina (blue arrows). There may be a less prominent external elastic lamina, as well. Are there elastic fibers within the tunica media?

B. LARGE (ELASTIC) ARTERIES

1. AORTA - SL 184 (W. 8.9) - (elastic tissue stain). Three sections are included in this slide. In the section in the middle locate the aorta and observe the distribution of elastic lamellae. What function do they serve? (Do not confuse the folds (between red arrows) in the section with the elastic lamellae.)

2. AORTA - (H and E) Compare to slide 184. The elastic laminae are bright pink and refractile (blue arrows). In the adventitia small vessels (vasa vasorum) and nerves (nervi vasorum) are evident. The vasa vasorum supply circulation to both the adventitia and the outer regions of the tunica media.

C. LARGE VEINS.

1. Inferior Vena Cava - SL 52 (low, med). Also, study other blood vessels of different sizes.

2. Portal Vein - SL 87. Both the inferior vena cava and the portal vein have smooth muscle bundles in the tunica adventitia (within blue circles). What is the orientation of the muscle in the tunica adventitia? Can you suggest a possible function for this organization of the muscle?

II. **THE MICROVASCULAR SYSTEM**

Because of the relatively small size of this class of vessels, and because vessels on different slides have a range of characteristics due to tissue type and preparation technique, it is often difficult to definitively identify vessels belonging to this category. This is especially true when one falls into the trap of trying to identify a single vessel on a slide in isolation. Therefore, it is crucial that you compare the histological features of a vessel you are trying to identify to a nearby vessel of approximately the same size. Under these conditions, you will find it much easier to compare features such as luminal diameter and content, wall thickness, smooth muscle content, presence of valves and elastic lamina, etc.. When one can do this successfully, identification of arterioles, venules, capillaries, and lymphatic channels is fairly trivial. Be comforted in knowing that exam images and slides will have neighboring vessels for comparison.

From the lecture notes and text, determine the structural features that distinguish various categories and identify examples on each of the following slides:

A. The microvascular system includes small arteries and veins as well as arterioles, venules, and capillaries. Numerous examples of these vessels occur on the following slides - SL 14 (scan, med 1, med 2 (blue arrows, venule), high 1, high 2 (arteriole). (Note: This slide was fixed with high pressure maintained in the arterioles, therefore, you will likely need to focus on the presence or absence of the internal elastic lamina to make your determination.), 15B (high 1, high 2 (blue arrow, venule; red arrow, arteriole), high 3). 24 (med, high), 96 (high 1, high 2) (J.

11-1 , 11-12, 11-13, 11-14, 11-15, 11-17,11-8 to 11-11; W. 8.12, 8.14, 8.15). By looking at several slides you will see many vessels sectioned in different orientations.

B. In SL 24 (med [green arrows] high) compare the structure of lymphatic vessels (J. 11-23, 11-24; W. 8.25, 8.26) and (J. 11-18; W. 8.19, 8.20) venules. The lymphatic vessels will be found adjacent to the lymph node (large, dark staining, cellular structure). Also, study SL 77 for lymphatics.

C. Electron microscope – Study the ultrastructural features of arteriole. Note the various types of capillaries demonstrable by the electron microscope (J. 11-13 to 11-15; W. 8.15, 8.16).

III. **HEART**

A. ATRIUM AND VENTRICLE - SL 63 Masson's Trichrome - C.T. elements stain green. Note: (1) the differences between the thickness of myo- and endocardium (blue arrows, endocardium; red arrows, myocardium) in the atrium and ventricle; (2) the cardiac muscle extending into the adventitia of a pulmonary vein (1, blue arrow , 2); (3) the A.V. valve; (4) the annulus fibrosus (within green circle) which is found where the atrium, ventricle and valve meet.

B. RIGHT VENTRICLE AND PULMONARY ARTERY - SL 88,. image from SL 88 (W. 8.1). Note pulmonary valve, the sinus (or space) behind the valve, and annulus fibrosus (red arrow, valve; blue arrow, sinus; green circle, annulus fibrosus).

C. AORTA AND/OR PULMONARY ARTERY AND VENTRICLE - SL 30 (scan, low) - (orcein stain for elastic fibers) Observe the "origin" of the vessels from the annulus fibrosus, also any other distribution of elastic tissue present.

D. PURKINJE FIBERS - SL 64 (scan, low) (J. 11-22; W. 8.6). In this section a large triangular mass of muscle is stained red. On one edge, a small strand of tissue is pulled away from the main part. Purkinje fibers may be found in this strand. Compare the cytology of these cells with those of regular cardiac muscle. What is their function? The orientation of this section is not known precisely.

E. Electron microscope - Review features of cardiac muscle.

Note about valves for the exam ***– For this course, you should definitely be able to differentiate between atrioventricular and semilunar valves based on the tissues that flank these structures. (the former is between atrial and ventricular tissue, and the later is between ventricular tissue and elastic arteries) However, you do NOT have to differentiate between the two atrioventricular valves (bicuspid vs. tricuspid), and you will NOT need to distinguish between the two semilunar valves (aortic vs. pulmonary). Of course, you will need to do this in the Gross Anatomy lab. For our course, simply stating atrioventricular valve or semilunar valve is sufficient. You may specifically name the valve (e.g. tricuspid, pulmonary) as long as your name is a possibility based on what is on the slide.***

OBJECTIVES FOR LABORATORY 14: CIRCULATORY SYSTEM

1. Using the light microscope or digital slides, identify:

    - Vessel types
        - Large (elastic) arteries
        - Medium (muscular) arteries
        - Small arteries and Arterioles
        - Capillaries
        - Venules
        - Medium veins
        - Large veins
        - Lymphatic vessels
    - Structures within each vessel
        - Tunics
            - Tunica intima
            - Tunica media
            - Tunica externa (adventitia)
        - Elastic laminae
            - Internal elastic laminae
            - External elastic laminae
        - Cell types
            - Fibroblasts
            - Smooth muscle cells
            - Pericytes
            - Endothelial cells
    - Heart
        - Layers
            - Endocardium
            - Myocardium
            - Epicardium
                - Coronary vessels
                - Pulmonary veins
        - Ventricles
        - Atria
        - Atrioventricular valves
        - Semilunar valves
        - Annulus fibrosus
        - Purkinje fibers

2. On electron micrographs, identify:

    - Types of vessels (note focus on smaller vessels here)
        - Small arteries and arterioles
        - Capillaries
            - Continuous capillaries
            - Fenestrated capillaries
            - Continuous sinuses (continuous sinusoids)
            - Fenestrated sinuses (fenestrated sinusoids)
            - Discontinuous sinusoids
        - Venules
    - Structures - see Tunics, Elastic laminae, and Cell types listed above.
        - Pinocytotic vesicles
        - Basal laminae

REVIEW

1. What is an arteriovenous anastomosis? What is its function?

2. Name one similarity and one difference between A-V and semi-lunar valves.

3. What connective tissue separates the atrium from the ventricles? What important structure passes through this connective tissue?

4. In slide #64 you saw Purkinje fibers in the subendocardium. Name other structures that participate in the regulation of heartbeat.

5. Review the ultrastructure of the three types of capillaries especially with regard to the correlations that may be made between the structure of the wall and their function in transcapillary exchange in different tissues and organs.