AN INTRODUCTION TO CIRCULATORY SYSTEMS*

I. THE CIRCULATION -- An Overview

A. Introduction:

1. Functions of a circulation.

a. The primary function of any circulation is to provide a means around the constraint of diffusion. As we have seen, this constraint is greatest in cases of:

(i) large size (anything bigger than a small cell),

(ii) where little of the organism's surface acts as an exchange surface with the environment, and

(iii) where processes (whatever they may be) need to occur at a high rate.

b. The types of functions that circulations typically perform are many -- some are important on a moment-to-moment basis and if disrupted may result in speedy death or injury while others can be suspended for considerable periods of time.

(i) Nutrient functions (broadly construed):

(a) respiratory gas transport

(b) movement of fuels

(c) Movement of wastes

(ii) Support Function -- transmittal of force in hydraulic and hydrostatic skeletons

(iii) Heat transfer

(iv) Coordination and Control: (transmission of hormones and other chemical messengers)

(v) Movement of elements of the immune system

(vi) Signal function: behavioral -- in some cases, dilation of blood vessels of certain areas serves as a signal.

c. In different tissues the amount of circulation and its pattern varies. Furthermore, as we have seen earlier with muscles, they can also vary in the same tissue at different times.

2. Functional elements of a Circulatory System:

a. The central element of any circulation is a liquid tissue called **blood or hemolymph** depending on the type of circulation (see box below). The degree to which blood or hemolymph is a true tissue (whether or not it is significantly cellularized) varies considerably with the type of animal although it always contains the largest proportion of cells when some of these cells are involved in respiratory gas transport. In circulations such as those of arthropods where cells are not involved with gas transport (either because trachea are used or because hemocyanin is the carrier and it is not found in cells) there are far fewer cells and most of these are associated with clotting, formation of connective tissues, and immunity.

b. **Pumps**: these create a pressure gradient to cause convective movements. There are a number of types that will be discussed after the circulation has been introduced.

c. **Vascular System**: the system of tubes and sinuses through which the circulating fluids move.

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d. **Lymph or Intracellular Fluid**: the fluids that bathe all cells in the body; the lymph is produced by fluid that leaves the vascular system and then returns via specialized ducts.

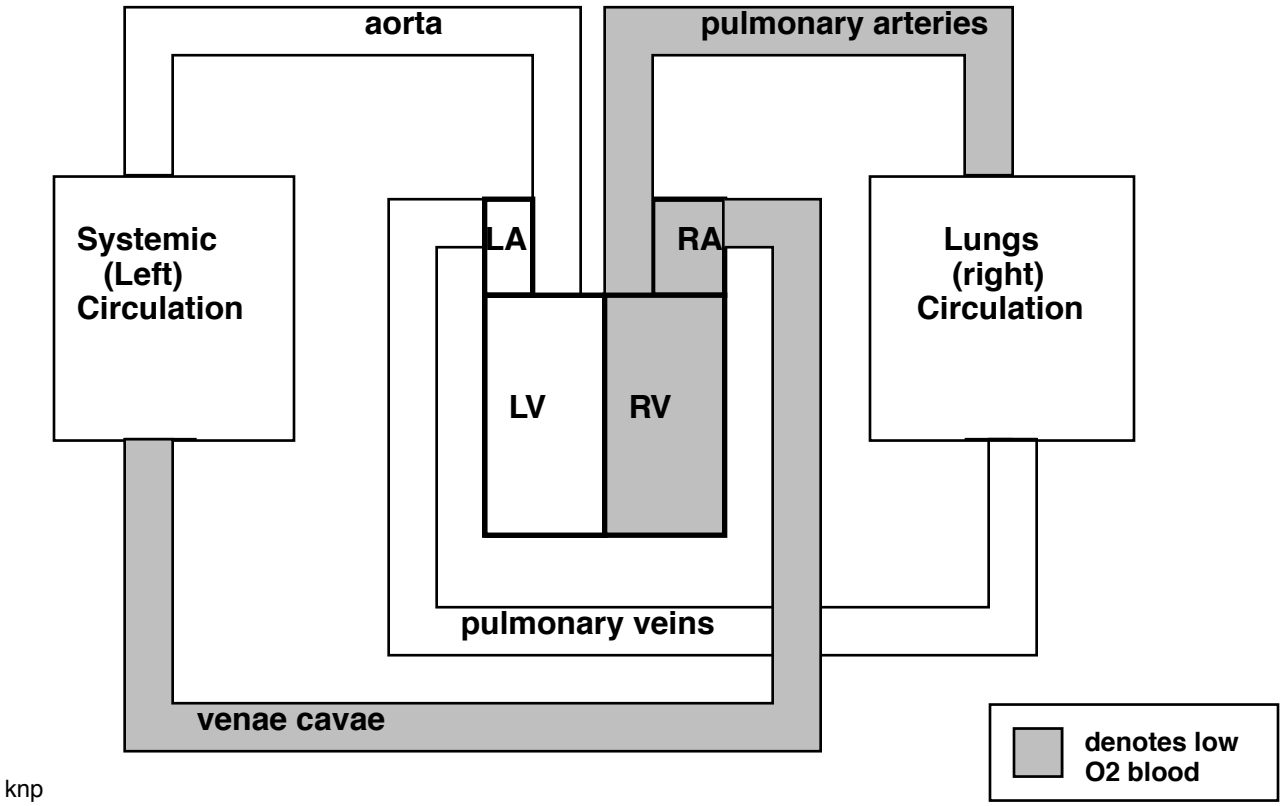
Note: there are two general types of vascular systems -- **opened** and **closed.** The principal distinction between the two rests in whether the exchange areas are small, thin closed vessels called capillaries (closed system) or are larger sinuses (opened). ***In closed circulations***, the fluid tissue flowing through the vascular system is termed **blood** -- fluid that flows outside of this system between cells and in specialized tubes but that is formed via a filtering process that occurs in the capillaries is termed **lymph**. By contrast, ***in open circulations***, the fluid vascular tissue is termed **hemolymph** and the distinction between the fluid that flows among the cells of the solid tissues and the fluid filling the definable vascular system is not very great except that certain components (oxygen transport proteins and/or oxygen transport cells) are not found in the intracellular fluid but remain in the exchange sinuses.

B. BASIC ANATOMY OF THE MAMMALIAN HEART AND CIRCULATION: these notes will be primarily concerned with the mammalian circulation. Thus, a brief understanding of its anatomy is vital; this will be made more detailed over the next few days.

1. Overall picture: We can regard the entire circulation as **two circulations:**

a. the **PULMONARY or RIGHT SIDE CIRCULATION** starts at the **RIGHT ATRIUM** where venous blood from all of the body except the lungs mixes, then moves through the **RIGHT VENTRICLE** and carries deoxygenated blood from the right ventricle via the **PULMONARY ARTERIES** (note that these arteries carry low oxygen "venous" blood) to the **LUNGS** where the blood is oxygenated and CO_2 is removed, it is then collected in the **PULMONARY VEINS** (note that these veins carry oxygenated blood) where they **return to the heart and end on the LEFT ATRIUM**.

b. the **SYSTEMIC or LEFT SIDE CIRCULATION** starts at the **LEFT ATRIUM**, where oxygenated blood ("arterial" blood) from the pulmonary veins mixes, proceeds through the main pumping chamber, the **LEFT VENTRICLE** out into the **AORTA** which is the main systemic artery in the body, then through the various circulations to the capillary beds that serve various tissues and the de-oxygenated ("venous") is then collected in the various systemic veins and is finally **returned to the right atrium and enters the right side circulation**.



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The next set of notes will provide you with the background in fluid dynamics that you will need to understand the circulation. We will then focus on the vascular system, next on the pumping elements and finally we will look at how the overall system is regulated in mammals.