# **The Circulatory System**

# Lec.10 Histology

### **The Circulatory System**

### includes both

- 1. blood vascular system
- 2. lymphatic vascular system

### **blood vascular system**

- 1. The heart, an organ whose function is to pump the blood.
- 2. The arteries, a series of efferent vessels that become smaller as they branch, and whose function is to carry the blood, with its nutrients and oxygen, to the tissues.
- 3. The capillaries, the smallest blood vessels, constituting a complex network of thin tubules that branch profusely in almost every organ and through whose walls the interchange between blood and tissues takes place.
- 4. The veins, which result from the convergence of capillaries into a system of larger channels that continue enlarging as they approach the heart, toward which they convey the blood to be pumped again.

## The lymphatic vascular system

- The lymphatic vascular system, begins with the lymphatic capillaries, which are closed-ended tubules that merge to form vessels of steadily increasing size; these vessels terminate in the blood vascular system emptying into the large veins near the heart.
- One of the functions of the lymphatic system is to return the fluid of the tissue spaces to the blood.
- The internal surface of all components of the blood and lymphatic systems is lined by a single layer of a squamous epithelium, called endothelium.

# Heart

- The heart is a muscular organ that contracts rhythmically, pumping the blood through the circulatory system.
- The right and left ventricles pump blood to the lungs and the rest of the body respectively; right and left atria receive blood from the body and the pulmonary veins respectively.

- The walls of all four heart chambers consist of three major layers or tunics:
- 1. the internal endocardium
- 2. the middle myocardium
- 3. and the external epicardium

### The endocardium

 The endocardium consists of a single layer of squamous endothelial cells on a thin layer of loose connective tissue containing elastic and collagen fibers as well as some smooth muscle cells.



## The myocardium

- The myocardium is the thickest of the tunics and consists of cardiac muscle.
- The myocardium is much thicker in the ventricles than in the atria.

# the epicardium

 The heart is covered externally by simple squamous epithelium (mesothelium) supported by a thin layer of connective tissue that constitutes the epicardium.

### **Structure of Blood Vessels**

Blood vessels are composed of the following layers, or tunics

- 1. The tunica intima has one layer of endothelial cells supported by a thin subendothelial layer of loose connective tissue with occasional smooth muscle cells.
- 2. The tunica media, the middle layer, consists chiefly of concentric layers of helically arranged smooth muscle cells.
- 3. The tunica adventitia or tunica externa consists principally of type I collagen and elastic fibers. This adventitial layer is gradually continuous with the stromal connective tissue of the organ through which the blood vessel runs.



### **Large Elastic Arteries**

- Large elastic arteries help to stabilize the blood flow. The elastic arteries include the aorta and its large branches. Freshly dissected, they have a yellowish color from the elastin in the media.
- The intima is thicker than the corresponding tunic of a muscular artery.
- The media consists of elastic fibers and a series of concentrically arranged, perforated elastic laminae whose number increases with age (there are about 40 in the newborn, 70 in the adult).
- The tunica adventitia is relatively underdeveloped.

#### **Muscular Arteries**

- The muscular arteries can control blood flow to organs by contracting or relaxing the smooth muscle cells of the tunica media.
- The intima has a very thin subendothelial layer and the internal elastic lamina,.
- The tunica media may contain up to 40 layers of more prominent smooth muscle cells.
- The adventitia consists of connective tissue. Lymphatic capillaries, vasa vasorum, and nerves are also found in the adventitia and these structures may penetrate to the outer part of the media

#### **Arterioles**

- Muscular arteries branch repeatedly into smaller and smaller arteries, until reaching a size with only two or three medial layers of muscle.
- The smallest arteries branch as arterioles, which have one or two smooth muscle layers and indicate the beginning of an organ's microvasculature where exchanges between blood and tissue fluid occur.
- The subendothelial layer is very thin,
- the elastic laminae are absent and the media is generally composed of circularly arranged smooth muscle cells. In both small arteries and arterioles,
- the tunica adventitia is very thin.

### **Capillaries**

- The capillaries are often referred to as exchange vessels, since it is at these sites that O<sub>2</sub>, CO<sub>2</sub>, substrates, and metabolites are transferred from blood to the tissues and from the tissues to blood.
- They are composed of a single layer of endothelial cells rolled up in the form of a tube.
- The average diameter of capillaries varies from 5 to 10 μm and their individual length is usually not more than 50 μm.

### Venules

- The transition from capillaries to venules occurs gradually.
- The immediate **postcapillary venules** are similar structurally to capillaries, These venules converge into larger **collecting venules** which have more contractile cells.
- With greater size the venules become surrounded by recognizable tunica media with two or three smooth muscle layers and are called muscular venules.

#### Veins

- Blood entering veins is under very low pressure and moves toward the heart by contraction of the tunica media and external compressions from surrounding muscles and other organs.
- Valves project from the tunica intima to prevent back-flow of blood.
- Most veins are small or medium veins with diameters less than one centimeter.
- Such veins are usually located in parallel with corresponding muscular arteries.
- The intima usually has a thin subendothelial layer and the media consists of small bundles of smooth muscle
- The collagenous adventitial layer is well-developed.

- large veins have a well-developed tunica intima, but the tunica media is relatively thin, with few layers of smooth muscle and abundant connective tissue.
- The adventitial layer is thick in large veins and frequently contains longitudinal bundles of smooth muscle.

### Lymphatic Vascular System

- In addition to blood vessels, the body has a system of thin-walled endothelial channels that collect excess interstitial fluid from the tissue spaces and return it to the blood.
- This fluid is called lymph; unlike the blood, it flows in only one direction, toward the heart.
- The lymphatic capillaries originate in the various tissues as thin, closed-ended vessels that consist of a single layer of endothelium and an incomplete basal lamina.