

# Anatomy of the Circulatory System

## The Heart – Anatomy

is one of first organ systems to appear in developing embryo  
→ heart is beating by 4<sup>th</sup> week

study of heart = **cardiology**

about size and shape of closed fist

beats >100,000 x's/day (~103,680b/d)(~3 Billion times in a lifetime)

we are more aware of our heart than most other internal organs

heart lies in **mediastinum**, behind sternum

broad superior border of heart = **base**

lower border of heart (= **apex**) lies on diaphragm

heart is enclosed in its own sac, = **pericardium**  
(=**pericardial sac**)(parietal pericardium) composed of tough fibrous  
outer layer and inner serous membrane

outer surface of heart is also covered with serous membrane (= visceral  
pericardium) (= **epicardium**) continuous with the pericardium

between the 2 membranes is **pericardial fluid** → lubrication

**pericarditis** = inflammation of pericardium,  
membranes become dry, each heartbeat becomes painful

### wall of heart:

**epicardium** = visceral pericardium  
thin & transparent serous tissue

**myocardium** = cardiac muscle cell  
most of heart  
branching, interlacing contractile tissue  
acts as single unit

**endocardium** = delicate layer of endothelial cells  
continuous with inner lining of blood vessels

interior of heart is subdivided into **4 chambers**:

**atria** = two upper chambers with auricles  
smaller, thinner, weaker

**ventricles** = two lower chambers  
larger, thicker, stronger  
left ventricle much larger and thicker than right ventricle

There are 4 major vessels attached to heart:

**2 arteries** (take blood away from heart):  
**aorta** - from left ventricle  
**pulmonary trunk** - from right ventricle

**2 veins** (bring blood back to heart):  
**vena cava** (superior & inferior)- to right atrium  
quickly splits into 2 pulmonary arteries  
**pulmonary veins** (4 in humans) - to left atrium

There are also 4 one-way valves that direct flow of blood through the heart in one direction:

## **2 Atrioventricular (AV) valves**

held in place by **chordae tendinae**

attached to **papillary muscles**  
→ prevent backflow (eversion)  
keeps valves pointed in direction of flow

**bicuspid** (Mitral) valve  
- separates left atrium and ventricle  
- consists of two flaps of tissues

**tricuspid** valve  
- separates right atrium and ventricle  
- consists of three flaps of tissues

## **2 Semilunar valves**

at beginning of arteries leaving the ventricles

**aortic SL valve** at beginning of aorta

**pulmonary SL valve** at beginning of pulmonary trunk

# Blood Vessels

blood flows in closed system of vessels  
over 60,000 miles of vessels (mainly capillaries)

## **arteries & arterioles**

– take blood away from heart to capillaries

## **capillaries**

-actual site of exchange

## **venules & veins**

– bring blood from capillaries back to heart

## **Histology of Vessels**

walls of arteries and veins consist of three layers:

- a. **Tunica Externa**
- b. **Tunica Media**
- c. **Tunica Interna**

### **a. Tunica Externa (= T. adventitia)**

outer loose connective tissue

often merges with that of neighboring blood vessels, nerves or other organs

anchors the vessel and provides passage for small nerves, lymphatic vessels and smaller blood vessels

### **b. Tunica Media**

middle, made mainly of smooth muscle with some elastic tissue and collagen fibers

strengthens vessel walls

→ prevent high pressure from rupturing them

allows **vasodilation** and **vasoconstriction**

usually the thickest

### **c. Tunica Interna (=T. Intima)**

inner endothelium

exposed to blood

normally repels formed elements to keep blood moving freely

when damaged or inflamed induce platelets or WBC's to adhere

**aneurysm** = a weak point in arterial wall forms, usually due to degeneration of the tunica media, atherosclerosis or hypertension. Is a bulging sac that may rupture or put pressure on nearby brain tissue, vessels or other passageways. Most common in abdominal aorta, renal arteries and circle of Willis

## **Types of Blood Vessels**

### **1. Arteries & Arterioles**

built to withstand the greatest pressure of the system

→ strong resilient walls,

→ thick layers of connective tissues

→ more muscular than veins

arteries and arterioles typically contain ~25% of all blood in circulation

### **2. Veins & Venules**

generally have a greater diameter than arteries but thinner walls, flaccid

→ more **compliant**

three layer are all thinner than in arteries

tunica adventitia is thickest of three

but not as elastic as arteries

little smooth muscle

~70% of all blood is in veins & venules

### **3. Capillaries:**

consist of only a single layer of squamous epithelium

= endothelial layer (=tunica intima)

## **Circulatory Routes**

simplest and most common route of blood flow:

heart→arteries→capillaries→veins→heart

arteries, capillaries and veins are arranged into **two circuits**:

**pulmonary**: heart → lungs → heart

rt ventricle→ pulmonary arteries (trunk)→lungs→pulmonary  
veins→left atrium

**systemic**: heart → rest of body → heart

left ventricle→aorta→body→vena cava→rt atrium

heart is a double pump

oxygen deficient blood in pulmonary vein and vena cava  
→ usually blue on models

## **Major Arteries and Veins**

### **Pulmonary Circuit:**

Arteries                      **pulmonary a.**

Veins                         **pulmonary v.**

### **Systemic Circuit:**

Arteries                      **aorta**  
                                    **ascending aorta**  
                                    **rt & lft coronary a.**  
                                    **aortic arch**  
                                    **brachiocephalic a.**  
                                    **common carotid a.**  
                                    **internal carotid a.**  
                                    **external carotid a.**  
                                    **subclavian a.**  
                                    **axillary a.**  
                                    **brachial a.**  
                                    **lft common carotid a.**  
                                    **lft subclavian a**  
**descending aorta**  
                                    **celiac trunk**  
                                    **superior mesenteric a.**  
                                    **renal a.**  
                                    **gonadal a.**  
                                    **inferior mesenteric a.**  
**common iliac a.**  
                                    **internal iliac a.**  
                                    **external iliac a.**  
                                    **femoral a.**

Veins:                         **superior vena cava**  
                                    **coronary v.**  
                                    **brachiocephalic v.**  
                                    **jugular v.**  
                                    **subclavian v.**  
                                    **axillary v.**  
                                    **brachial v.**

inferior vena cava  
hepatic v.  
hepatic portal v.  
superior mesenteric v.  
inferior mesenteric v.  
  
renal v.  
gonadal v.  
common iliac v.  
internal iliac v.  
external iliac v.  
femoral v.

## **Special Circulation Patterns**

### **1. Coronary Circulation (or Cardiac Circulation)**

heart needs an abundant supply of oxygen and nutrients  
→myocardium has its own supply of vessels

any interruption of blood flow can cause necrosis within minutes  
= **myocardial infarction**

R & L Coronary Artery branch from aorta just beyond aortic SL valve

most blood returns to heart through veins that drain into Right Atrium  
beneath entrance of Inferior Vena Cava

### **2. Hepatic Portal System**

veins from spleen, stomach, pancreas, gall bladder, and intestines

superior and inferior mesenteric merge to form hepatic portal vein

do not take blood directly to vena cava

instead take it to liver for "inspection"  
-phagocytic cells remove toxins  
-vitamins and minerals are stored

### **3. Circle of Willis**

7 separate arteries  
branching from the internal carotids and vertebral arteries

arterial anastomosis interconnects them to form a circle of connecting  
arteries at base of brain

→ more than one route for blood to get to brain