Anatomy of the Circulatory System

The Heart – Anatomy

is one of first organ systems to appear in developing embryo
→ heart is beating by 4th 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