

HEART & PERIPHERAL CIRCULATION

General Structure of the Heart

1. four-chambered muscular pump
2. two separate circuits
 - = complete separation of oxy/deoxygenated blood
 - = each side of heart has atrium + ventricle
3. Inter-atrial, Inter-ventricular, atrio-ventricular septa
4. base of the heart = attachment of large veins
5. apex of the heart = ventricles

Myocardium - cardiac muscle cells

1. cardiac muscle cells are branched
2. intercalary discs relay action potentials = *syncytia*
3. intercalary discs are strong = meshwork

Coverings of the Heart

1. **Myocardium**: muscular mass of the heart
 - a. layer- thickness varies depending upon location
 - b. atrial & ventricular walls are separate functional units
2. **Endocardium**: innermost layer that lines the chambers
 - a. elastic and collagenous fibers
 - b. covers the surfaces of chambers and valves
3. **Epicardium**: (aka: visceral pericardium!) outer layer
 - a. blood vessels and lymphatics
4. **Parietal pericardium**: double layered membrane:
 - a. inner layer: thin serous membrane
 - reflects onto heart surface = visceral pericardium
5. **Pericardial sac**: double layered membrane:
 - a. inner layer: thin parietal pericardium
 - b. outer layer:
 - attaches to diaphragm, sternum, vertebral column
 - lateral walls = parietal pleura

Chambers & valves of the heart

Right atrium

- superior & inferior vena cava, coronary sinus
- pectinate muscles
- right atrio-ventricular valve (aka: tricuspid = 3 cusps)

Right ventricle

- right atrioventricular valve (aka: tricuspid = 3 cusps)
- papillary muscles, chordae tendineae
- trabeculae carneae
- pulmonary (right) semilunar valve (3 cusps)
- pulmonary trunk

Left atrium

- 4 pulmonary veins
- pectinate muscles
- left atrioventricular valve (aka: bicuspid/mitral = 2 cusps)

Left ventricle

- left atrioventricular valve (aka: bicuspid/mitral = 2 cusps)
- papillary muscles, chordae tendineae
- trabeculae carneae
- left (aortic) semilunar valve (3 cusps)
- aorta

So...How do each of these valves function?

Coronary valves:

1. insure one-way flow of blood through heart
2. bad seal? = back-flow (regurgitation)
3. regurgitation reduces heart efficiency
4. regurgitation = gurgling/fluttering sound = 'murmur'
5. most common problems found in A/V valves

Mitral valve prolapse: failure of chords/papillary muscles to properly stabilize the bicuspid valve = heart murmur

Function of the heart

Systole: contraction of the myocardium

Diastole: relaxation of the myocardium

1. atrial systole injects blood into ventricles
2. ventricles fill which causes AV-valves to start closing
3. atrial diastole
4. ventricular systole injects blood into aorta/pulmonary a.
5. AV-valves to slam shut - ('lubb' - sound)
6. back pressure in Aorta/pulmonary trunk builds up
7. semilunar valves to slam shut ('dupp' - sound)
8. ventricular diastole

Electrical system of the heart

Sino-atrial (SA) node:

1. located in the wall of the right atrium
2. pacemaker (nodal) cells responsible for heart rate

Atrio-ventricular (AV) node:

1. located at the junction between the atria & ventricles

Conducting cells:

1. interconnect the two nodes

AV bundle (bundle of His):

1. runs through inter-ventricular septum
2. passes from AV-node, branching out to the ventricles

Purkinje fibers:

1. continue from AV-bundle, spread through myocardium

Control of heart rate:

1. SA-node = heart initiates its own heartbeat
2. 'base-line' heart rate:
 - a. slowed by parasympathetic ANS - (acetylcholine)
 - b. accelerated by sympathetic ANS - (norepinephrine)

Some Clinical Terminology

Heart murmur - mechanical failure of a heart valve

Bradycardia - slower than normal heart rate

Tachycardia - faster than normal heart rate

Pericardial cavity - space btw. parietal & visceral pericardia

Pericarditis - inflammation of the pericardia

Cardiac tamponade - pericardial sac fills with blood - strangulates heart with each successive beat

Coronary ischemia - restriction of blood supply to the heart

Infarction (infarct) - localized cell death from lack of oxygen

Myocardial infarction (MI - heart attack)

- localized cell death due to lack of O₂ in myocardium

Angina pectoris

- referred pain that radiates to the arms, chest, and back

Peripheral Circulation

Blood vessels - 3 layers

1. *Tunica interna* - thin endothelium
2. *Tunica media* - smooth muscle
3. *Tunica externa* - CT sheath around outside of vessel

Three types of vessels

Arteries: carry blood from the heart to the tissues

Appearance: round, thick walls

Tunica interna: internal elastic membrane

Tunica media: thick muscle layer

Tunica externa: collagen and elastic fibers

Veins: return blood to the heart from the tissues

Appearance: flattened, thin walls

Tunica interna: smooth walls, no elastic membrane

Tunica media: thin muscle layer

Tunica externa: collagen and few elastic fibers

Lymphatics: returns lymph (interstitial fluid) to heart

= VERY thin-walled vessels

Categorize BV's by size

Heart > elastic a. > muscular a. > arteriole > **CAPILLARY**

CAPILLARY > venule > medium-sized v. > large v. > heart

Control of blood flow through arteries

Tunica media - smooth muscle adjusts BV diameter

- *vasoconstriction* of a vessel (decrease in diameter)
- *vasodilation* of a vessel (increase in diameter)

So.....

Fight/Flight response

- constriction of most arteries (increase BP)
- dilation of cap. beds in muscles (increase O₂ delivery)
- restriction of blood supply to gut (redistribute blood)

Rest and digest response

- redistribute blood to gut (increase food adsorption)
- dilation of cap. beds in gut (increase delivery of blood)

Where is all the blood?

1. heart & lungs @ 15%
2. brain, arteries, & muscular capillaries @ 20%
3. skin, gut, liver, veins @ 65%

Some simple rules to keep in mind:

- 1) arteries lead AWAY from the heart
- 2) veins lead TOWARD the heart
- 3) BV's often named after nearby bones (*iliac, femoral*)
- 4) (if not #3) then BV's named by 'region' (*axillary*)
- 5) arteries branch into smaller and smaller arteries
- 6) veins combine into larger and larger veins

Venous drainage of skin/limbs:

- superficial v. deep veins
- large veins have 'valves'

Some terminology concerning vasculature...

Embolus: drifting blood clot in the circulation

Thrombus: stationary blood clot within a blood vessel.

Embolism: blockage due to the blood clot

Cerebrovascular accident (CVA = stroke)

Arteriosclerosis: abnormal thickening/rigidity of arteries

Aneurysm: bulge in weakened arterial wall

Varicose veins: swollen veins distorted by valve failure

Hemorrhoids: varicose veins of the rectum & anus

Edema: abnormal accumulation of fluid in peripheral tissues