Chapter 11 – The Heart



https://www.pinterest.com/pin/165788830009278918/

Heart Facts

- About the size of your fist
- Lies in the Mediastinum
- Widest portion called the base (sits behind 2nd rib)
- Point at bottom = apex
 - points towards the left











Figure 11.1c Location of the heart within the thorax.



Functions

- Pumps blood in one direction
- Keeps oxygen rich and oxygen poor blood separate
- Supplies blood pressure
- Supplies every cell in the body with blood

The Cardiovascular System

- The Heart
 - Located in the mediastinum
- Blood Vessels
 - Pulmonary
 Circuit
 - Systemic
 Circuit



Coverings of the Heart

- Deep to Superficial
 - Visceral pericardium
 - Pericardial fluid
 - Parietal pericardium
 - Fibrous pericardium
 - (anchors heart to mediastinum)





3 layers of the heart wall

- Deep to superficial
 - <u>Endocardium</u>: lines the heart chambers
 Made of endothelium
 - <u>Myocardium</u>: actual cardiac (heart) muscle
 - <u>Epicardium</u> = outermost layer
 visceral pericardium



Chambers of the Heart

- Superior Chambers
 - Receiving chambers
 - Right Atrium
 - Left Atrium
- Inferior Chambers
 - Discharging chambers
 - Right Ventricle
 - Left Ventricle



Figure 11.5 Anatomical differences in right and left ventricles.



The Heart: Valves

- Allow blood to flow in only one directionFour valves
 - Atrioventricular valves between atria and ventricles
 - Bicuspid/Mitral valve left side of heart
 - Tricuspid valve –right side of heart
 - Semilunar valves between ventricle and artery
 - Pulmonary semilunar valve
 - Aortic semilunar valve

Heart Valves

- AV valves
 - Anchored in place by chordae tendineae ("heart strings")
 - Open during heart relaxation and closed during ventricular contraction
- Semilunar valves
 - Closed during heart relaxation but open during ventricular contraction
- These valves open and close in response to pressure changes in the heart

Division between Rt. & Lf Heart

• Pulmonary Circuit (Right Atrium & Ventricle)

• Intraventricular Septum

• Systemic Circuit (Left Atrium & Ventricle)

Right Heart

- Right Atrium receives oxygen poor blood from 3 veins
 - 1. Superior Vena Cava
 - 2. Inferior Vena Cava
 - 3. Coronary Sinus
- Rt. Atrium pumps blood into the Right Ventricle through a valve = Atrioventricular valve (AV)
 - Rt. AV valve is called the TRICUSPID VALVE

Tricuspid Valve – 3 flaps



Right Heart

- Blood enters Rt Ventricle
- Out the rt. ventricle via the Semilunar Valve (pulmonary semilunar)
- Into the pulmonary trunk
- Pulmonary trunk splits to the Rt. & Lf. Pulmonary arteries
- Pulmonary arteries to the lungs



Left Heart

- Oxygen rich blood back to the heart from the lungs in the Pulmonary Veins
- Into the Left Atrium
- Into the Left Ventricle thru Bicuspid Valve
 - Mitral Valve



Left Heart

- Blood is forced (thick wall muscle) out of the left ventricle thru the Semilunar Valve (aortic semilunar)
- Aorta
 - first branch to the coronary arteries
 - Nourish the heart itself
 - Branches to rest of the body





Operation of Heart Valves

Operation of the AV valves

- Blood returning to the heart fills atria, putting pressure against atrioventricular valves; the atrioventricular valves are forced open
- (2) As the ventricles fill, atrioventricular valve flaps hang limply into ventricles
- 3 Atria contract, forcing additional blood into ventricles
- Ventricles contract, forcing blood against atrioventricular valve cusps
- 2 Atrioventricular valves close
- 3 Chordae tendineae tighten, preventing valve flaps from everting into atria

Figure 11.(4a)



AV valves open



(b)

Operation of the semilunar valves



As ventricles contract and intraventricular pressure rises, blood is pushed up against semilunar valves, forcing them open



Semilunar valve open

As ventricles relax, and intraventricular pressure falls, blood flows back from arteries, filling the cusps of semilunar valves and forcing them to close



Semilunar valve closed

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Slide 11 10

Heart Sounds

- Through the stethoscope, the beating of the heart that we hear is from the closing of the valves
- First sound = lub
 - Closing of both AV valves (tricuspid and bicuspid) when blood fills the ventricles.
- Second sound = dub
 - Closing of both semilunar valves after blood has been expelled from the ventricles.
- Any extra sounds (murmurs) heard are due to leaky valves

Valve Pathology

- Incompetent valve = backflow and re-pump
- Stenosis = stiff= heart workload increased
- May be replaced

Coronary Circulation

- Blood supply directly to the heart tissue
- From aorta to lf. and rt. coronary branches
- After feeding the heart
- Blood supply returns to rt. Atrium via the coronary sinuses



Blood Flow

- All arteries branch
 FROM the aorta
- All veins branch INTO the Superior and Inferior Vena Cava





Gas Exchange



Rt. Atrium

Tricuspid Valve

Rt. Ventricle

Pulmonary Semilunar Valve

Pulmonary Trunk

Pulmonary Arteries

Lungs

Gas Exchange

Pulmonary Veins

Left Atrium



Pulmonary Gas Exchange



Left Atrium

Systemme

Bicuspid Valve (Mitral Valve)

Left Ventricle

Aortic Semilunar Valve

Aorta

Arteries

Heart and Body Tissues

Gas Exchange

Body Veins

Superior/Inferior Vena Cava

Systemic Circulation



Conduction System of the Heart

- Intrinsic conduction system: heart contracts automatically
- Heart beats about 2.5 billion times in a lifetime
- About 5 liters of blood is recycled in a heart beat!



Conduction System...

SA node (Sinoatrial node):

- Near upper posterior wall of the right atrium
- Pacemaker of the heart
- Initiates heartbeat and the atria contract



Sinoatrial node fires, action potentials spread through atria which contract



Conduction System... AV node (Atrioventricular node):

- Near the base of the right atrium
- By the interatrial septum
- Receives input from the SA node
- Passes it to the AV bundle (bundle of His)


Conduction system...

AV bundle (Bundle of His)

- In the interventricular septum
- To Body From Lungs From Cungs 1 Sinus node 2 Atria-right & left 3 AV node 3 Ventricles-right & left
- Transfers signal to the Purkinjee fibers

Purkinjee fibers

- In the ventricular walls
- Signal causes ventricular contraction
- Intercalated discs (gap junctions)
- Pass signal to every cardiac cell





Pig Heart Dissection

<u>https://www.youtube.c</u>
 <u>om/watch?v=FN7aVXEk</u>
 <u>Fzg</u>



Heart Attach Video

• [Discovery Channel] Body Story -Episode 3 - The Beast Within



Now, on to the Cardiac Cycle...

- All the events that occur in one heartbeat
- Average Heart Rate about 70-75 beats/minute
 Range 60-100 beats/minute
- Both sides of the heart contract together
- Contraction is initiated by the SA Node



Cardiac Cycle – one complete heartbeat

- **Systole:** Contraction of the heart muscle
- First, both atria contract
- Then, both ventricles contract
- **Diastole:** Relaxation of the heart muscle
- Both atria relax
- Followed by the relaxation of both ventricles







DIA ST OLE

SYST OLE

Atrial Systole: Phase 1

- Both atria contract
- Ventricles are relaxed
- Blood enters both ventricles through the open AV valves
- Semilunar (pulmonary and aortic) stay closed
- AV valves (tricuspid and bicuspid) close Atrial systole ends

First heart sound - lub

Lasts about = 0.15 sec



Ventricular Systole: Phase 2

- Both ventricles contract
- Both atria are relaxed at this time
- Blood is pushed into the aorta & pulmonary trunk through the semilunar valves
- Semilunar valves close
 Second heart sound dub
- Takes about 0.30 sec



Atrial and Ventricular Diastole: Phase 3

- Both Atria and Ventricles are relaxed
- Blood returns to the right atrium via venae cavae (SVC and IVC)
- Blood returns to the left atrium via pulmonary veins
- Blood also flows passively into the ventricles
- Both AV valves are open
- Both semilunar valves are closed
- Takes about 0.40 seconds
- https://www.youtube.com/watch?v=5tUWOF6wEnk



Cadiac Output (CO)

• CO - Volume of blood pumped out of each ventricle in one minute

 Stroke Volume (SV) – amt of blood pumped by each ventricle in one contraction (about 70mL)

• Heart Rate – about 75 beats/min

Cardiac Output

- CO depends on heart rate and stroke volume
 CO = HR X SV
- 75 beats/min x 70mL/beat

• CO = 5250mL/min – 5.25 L/min

Cardiac Output

- CO of an average human = 5.25 L/minute
- This equals the total blood volume in our bodies!
- Can be affected by changes in heart rate or SV

https://www.youtube.com/watc h?v=bUW-2GHfX64



Figure 11.9 Influence of selected factors on cardiac output.



Heart Rate

- Regulated by the cardioregulatory center
 Located in medulla oblongata
- Controlled by the autonomic nervous system
- Parasympathetic nervous system
 Slows heart rate via vagus nerve
- Sympathetic nervous system
 - Increases heart rate



Measuring HR: Pulse



EKG (ECG)

- Electrocardiogram
- Records the electrical activity of the myocardium (layer with the heart muscle)



EKG (ECG)

- P wave: Atrial depolarization
 - impulse started at the SA node travels down the atria (atria are about to contract)
- QRS complex: Ventricular depolarization
 - Followed by the excitation of Purkinjee fibers
 - Ventricles are about to contract
- T wave: ventricular repolarization

- Ventricles are about to relax



Arrhythmias

Bradycardia

HR of fewer than 60 beats/minute

Tachycardia

HR of more than 100 beats/minute

Fibrillation

 Rapid uncoordinated beating https://www.youtube.com/watch?v=v3b-YhZmQu8



Blood Vessels

• TUNICS = layers of tissue

LUMEN = where blood flows



BLOOD VESSELS

3 layers – Tunics (except capillaries)

- Innermost layer = Tunica intima
 - epithelial tissue
- Middle layer = Tunica media
 - Connective tissue (elastic and collagen fibers) & smooth muscle
- Outermost layer = Tunica externa or adventitia

 irregular connective tissue,
 containing both elastic
 and collagenous fibers



Figure 11.10b Structure of blood vessels.



Arteries VS.

Veins

- Carry blood away from the heart
- Small arteries = arterioles
- largest arteries are about as thick as a thumb
- Blood rich in oxygen
 - Except pulmonary arteries
- Flows under high pressure (highest in aorta because close to left Ventricle)

- carry the blood to the heart
- smallest veins = venules
- Blood low in oxygen
 Except in pulmonary veins
- Thin walls
- Flows under low pressure (lowest in Vena Cava furthest from left. Ventricle)
- Contains valves in the lumen



Figure 11.20 Blood pressure in various areas of the cardiovascular system.



Capillaries

- Thin and fragile
- One epithelial cell thick
- exchange of oxygen and carbon dioxide takes place through the thin capillary wall.
- RBCs inside the capillary release their oxygen which passes through the wall and into the surrounding tissue
- Tissue releases its waste products which passes through the wall and into the red blood cells
- Capillary networks capillary beds
 - Blood flow through the capillary bed = microcirculation

Capillaries

- Capillary beds consist of two types of vessels:
 - 1. Vascular shunt
 - 2. True capillaries
- Entrances to capillary beds are guarded by precapillary sphincters
- Exchanges with tissue cells occur across walls of true capillaries
- When precapillary sphincters are closed, blood bypasses the local area via the vascular shunt





Fetal Circulation

- Exchange of O₂ and CO₂ takes place in the placenta
- Umbilical vein is O₂ –rich blood
 - Travels towards the heart of the fetus via the mother and placenta
- Umbilical veins leads to the ductus venosus which allow blood to enter the fetal inferior vena cava then into the rt. atrium



Fetal Circulation from the Rt Atrium

- Right atrium Right ventricle pulmonary arteries lungs
 - Only about 10% of the blood flow enters the pulmonary circuit.

OR

 Rt. atrium directly into the left atrium through a detour
 Foramen ovale (oval hole)



Fetal Circulation from the Rt Atrium

 Right Atrium - right ventricle - pulmonary trunk directly into – aorta via a shunt called the ductus arteriosus, Superior Aorta



After Birth

- Umbilical cord is cut
- Baby takes first breath
- Lungs inflate with oxygen
- Rush of oxygen rich blood from lungs into the left atrium causes a flap to cover the foramen ovale

Major Vessels of the Body

 you will need to learn the major arteries and veins of the body and which vessels supply which areas of the body – Please refer to the Blood Vessels Color plate.


Systemic Arterial System



Arteries of the Chest and Upper Extremity





Veins with Valves

 Some veins contain valves – prevent blood from flowing backwards











Venous System of the Trunk and Upper Limb



Aging and the Cardiovascular System

- Arteriosclerosis
- Atherosclerosis
- Hypertension
- Stroke
- Myocardial Infarction
- Congestive Heart Failure



Atherosclerosis



- Buildup of fatty plaques in the walls of blood vessels.
- Causes usually high cholesterol diet (LDL's)

Arteriosclerosis

- Stiffening/hardening of the arteries
- Due to high blood pressure over time/smoking/diet/ atherosclerosis



Blood pressure is the measurement of force applied to artery walls





Hypertension

- When a person's blood pressure is elevated at all times (140/90 is considered high)
- Caused by stress, diet, inactivity, smoking,

salt, alcohol, genetics



Myocardial Infarction/Heart Attack

- Damaged heart tissue due to blockage in the coronary arteries interrupting blood flow to the heart muscle cells
- Caused by high bp, atherosclerosis, poor diet (LDL's), alcohol, diabetes



Stroke

- Disturbance of blood flow to the brain usually because of a blocked or burst artery
- Caused by smoking, poor diet, hypertension, diabetes, advanced age





Hemorrhage/blood leaks into brain tissue



Clot stops blood supply to an area of the brain

Congestive Heart Failure

- The heart stops pumping because the heart muscles have been weakened by a previous attack, virus, or high blood pressure
- Diabetes/alcohol aggravate situation



Keeping your Heart Healthy!

- Don't smoke
- Get active
- Eat a healthy diet (limit fats)
- Maintain a healthy weight
- Get regular check-ups

