UNIT - V

DATE

Cardiovascular system

Cardio - Heart Vascular - Blood vessels

→ The cardiovascular system consist of heart & blood vessels. It is mainly a transport system.
→ It transport respiratory gases, nutrients & excretory products to various part of the body.

Anatomy of the heart :-

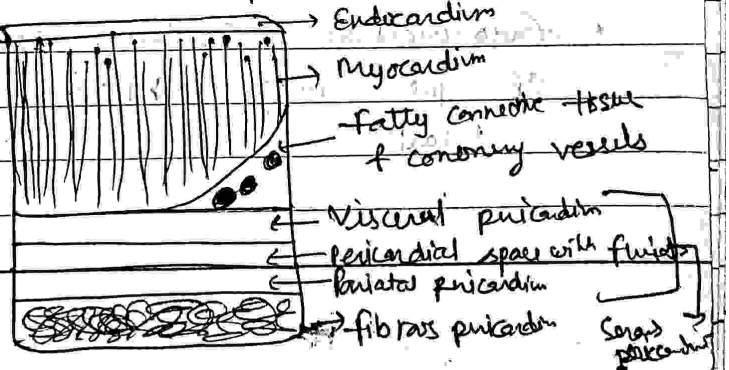
- Heart is a roughly cone-shaped hollow muscular organ. It is about 10 cm long & is about the size of the owner's fist.
- The average weight is 250 gm in adult females & 300 gm in adult males.

Position :-

- Heart lie in the thoracic cavity in the space b/w the lungs & behind the sternum. Two thirds of the heart is on the left side.
- The apex is about 9cm to the left of the midline at the level of 5th intercostal space, i.e, a little below the nipple and lightly nearer the midline. The base extends to the level of the 2nd rib.

Structure :-

1) The heart wall :- Heart wall is composed of three layer of tissue :-
   i) pericardium
   ii) myocardium
   iii) Endocardium



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① Pericardium → The pericardium is the outer most layer and is made up of sac

1) outer 2) Inner sac

- fibrous → Consists of fibrous tissue, it is the outer sac
- Serous → A continuous double layer of serous membrane.

1) fibrous pericardium → Composed of tough, inelastic, dense irregular connective tissue. It prevents overstreching of the heart and provides protection and hold the heart at particular position.

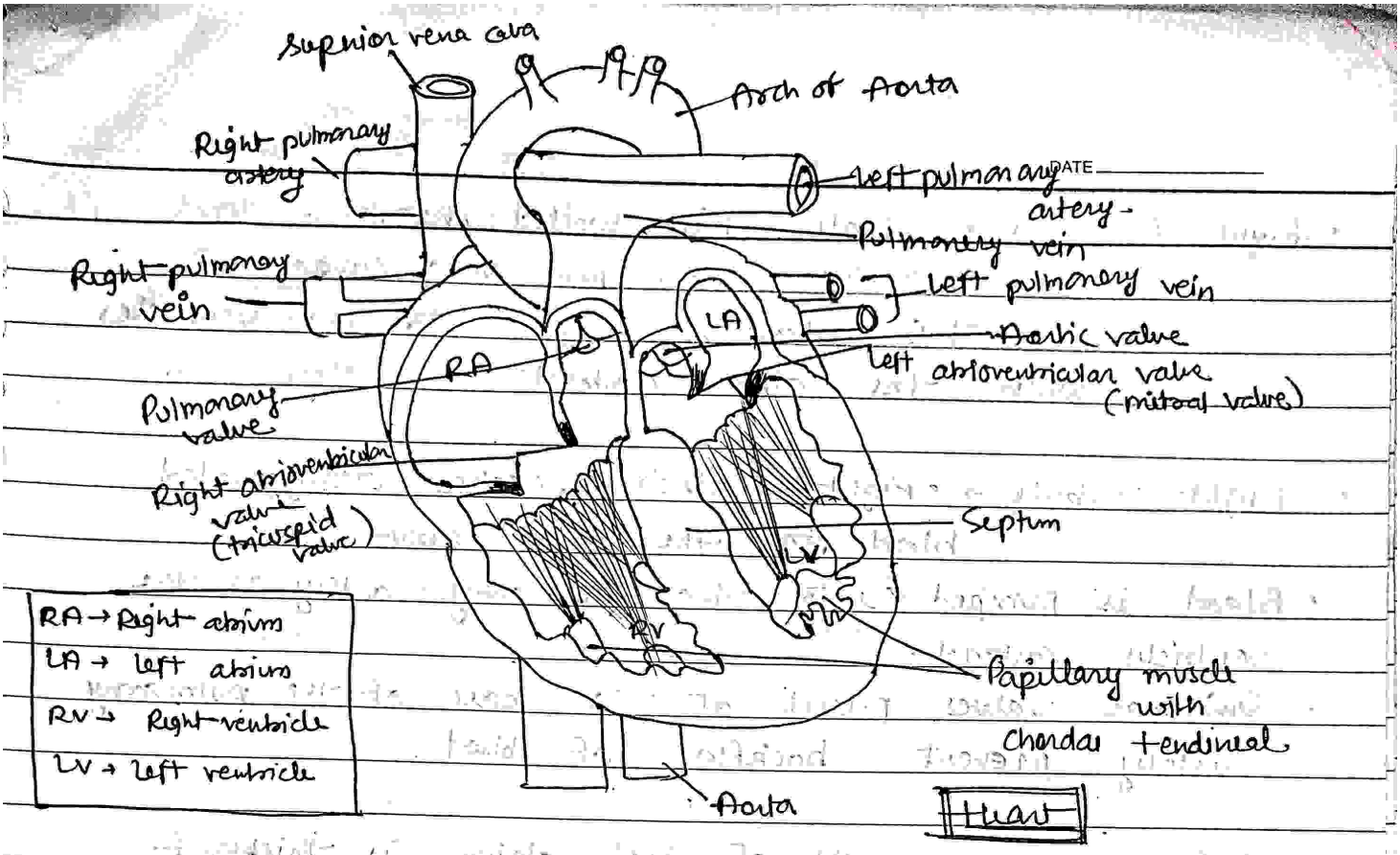
2) Serous pericardium → It is a thinner, more delicate membrane that forms a double layer around the heart. The outer parietal layer of Serious pericardium also called as epicardium (external layer of heart wall).

- Space b/w perietal & viseral layer filled with the pericardial fluid which is ~~sere~~ secreated by serous membrane & the space is called as pericardial cavity.

② Myocardium (middle layer) → Made up of cardiac muscle & makes up the bulk of heart & It is responsible for pumping action.

③ Endocardium (Inner layer) → It is the inner layer of myocardium & consist of thin layer of endothelial cells.

- It provides smooth thin lining for the chamber of hearts & covers the valves of hearts.
- Endocardium continues with the endothelial lining of the large blood vessels attached to the heart.



Heart

Chambers of heart:-

- Heart is made up of four chamber, two chamber on the right side & two chamber on the left side
- Right & left sides of the heart act as two separate pumps.
- Left sides of heart much larger work load than the right side of the heart. Also the wall of left ventricle have thick as compain to right ventricle
- Right ventricle pumps blood only to lungs (pulmonary circulation)
- left ventricle pumps blood to all other parts of the body i.e, (systemic circulation).

Chamber of the heart

Two superior chambers	Two inferior chambers
Right Atrium	left atrium
Right ventricle	left ventricles

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• Right Atrium → • small, thin walled chamber.
• Receives blood from vena cavae
• the blood is pumped into the ventricles when the atria contract

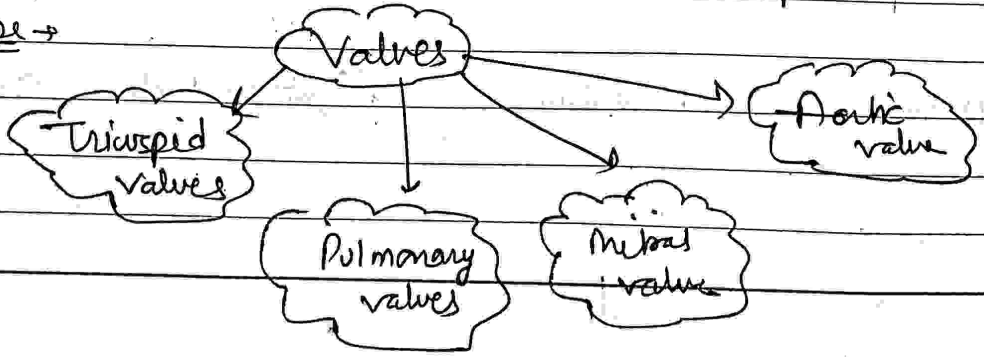
• Right ventricle → • Right ventricle receives deoxygenated blood from the right atrium
• Blood is pumped into the pulmonary artery as the ventricles contract.
• Semilunar valves present at the base of the pulmonary artery prevent backflow of blood.

• Left Atrium → • Wall of left atrium is thicker & It is smaller than right atrium.
• Oxygenated blood from the lungs is collected by the left atrium
• It opens into the left ventricle

• Left ventricle → • Collects oxygenated blood from left atrium.
• When the left ventricle contracts, blood pumped into the aorta.
• The muscular walls of the left side is much thicker than that of the right.

• Valves of the hearts → Valves are located within the chambers of the hearts
• Valves control the direction of blood flow

Type →



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1) Tricuspid valve →

- It is an atrioventricular valve situated b/w the atria & ventricle
- Controls the opening b/w right atrium & right ventricle

ii) Mitral Valve →

→ It is an anteioventricular valve situated b/w the atria & ventricle

→ Controls the opening b/w the left atrium & left ventricle

iii) Pulmonary valve (Pulmonic valve) →

→ It is a semilunar valve which controls the blood leaving the heart.

→ Situated b/w the right ventricle and the pulmonary valve.

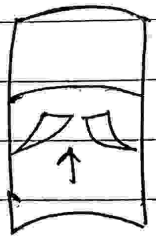
→ Control the flow of blood from the right ventricle

→ Prevents blood flow back to the right ventricle as it relaxes.

iv) Aortic valve →

→ It is semilunar valve which controls the blood leaving the heart.

→ Control blood flow b/w left atrium & the aorta



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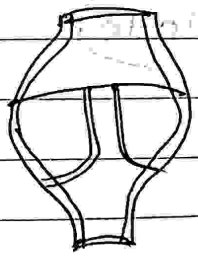

(Closed)

Blood flow through heart

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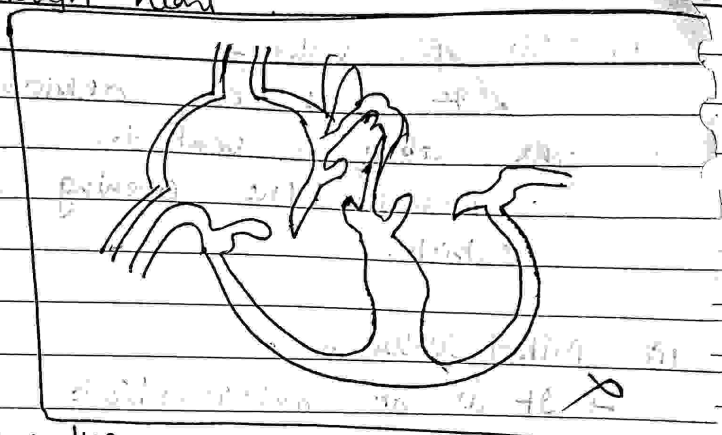

Veins → Inferior & Superior Vena Cava → Right atrium → Tricuspid valve → Right ventricle → Pulmonary semilunar valve → Pulmonary arteries → Lungs → Pulmonary veins (Right & left) → Left atrium → Mitral valve → Left ventricle → Aortic semilunar valve → Aorta → Arteries → Capillaries → Veins

I	left p. veins
II	" P. artery
III	Right P. artery
IV	Superior Vena Cava
V	inferior vena cava

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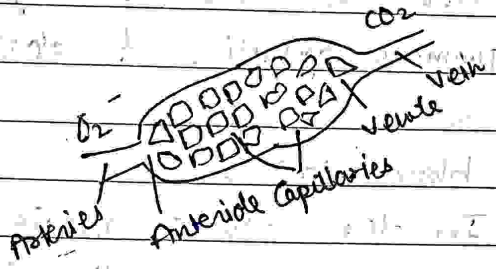
Blood Vessels

- Vascular System → Blood circulates inside close transport.
  - The structure of arteries & veins.
  - The heart pump blood into vessels that vary in structure size & function.

Blood vessels

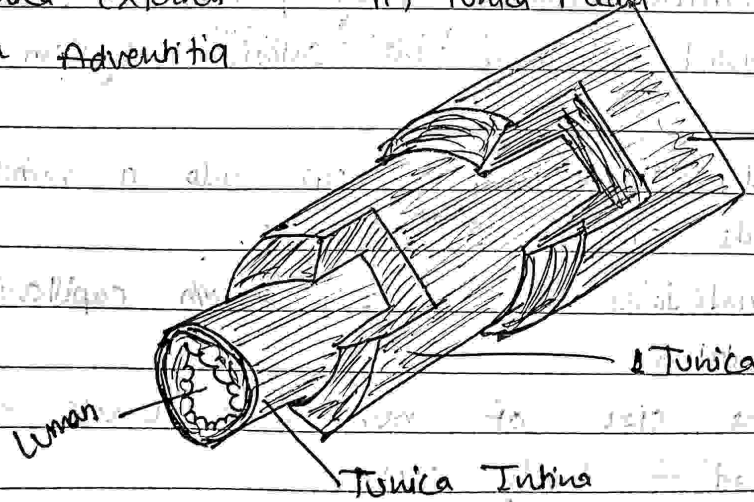
i) Arteries
ii) Veins
iii) Arterioles
iv) Venules
v) Capillaries



Anatomy of Blood vessels → Blood vessels from a closed tubular structure that permits blood to flow from the heart to all the living cells of the body & then back to the heart.

- The walls of arteries and veins are composed of three layers or tunics.

i) Tunica External or Adventitia
ii) Tunica Media
iii) Tunica Interna



[Internal Structure of Artery & Veins]

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I) Tunica external or Adventia
The outermost layer is composed of loose connective tissue.

II) Tunic Media → The middle layer of is composed of smooth muscle. The tunica media of arteries has variable amount of elastic fibers.

III) Tunica Interna → The innermost layer, is composed of simple squamous epithelium & elastic fibers composed of elastin.

Types of blood vessels

I) Arteries → In the tunica media of large arteries, there are numerous layers of elastic fibers b/w the smooth muscles & cells.

- The large arteries expand when the pressure of the blood rises as a result of the heart contraction.

Small arteries are less elastic than the large arteries.

II) Arterioles → Arterioles are less elastic than the large arteries & have thicker of smooth muscle and having size of near about 10 to 100 um.

- Arterioles have narrow lumina, they provide the greatest resistance to blood through the arterial system.

III) Capillaries → Small arterioles break up into a number of minut vessels called as capillaries.

- Blood flow from arterioles to venules through capillaries is called microcirculation.
- They are the size of nutrients & waste exchange b/w the blood & body cells.

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VI) Veins:- Veins are the vessels that carry blood from capillaries back to the heart.

- The blood is delivered from microscopic vessels called venules into progressively larger vessels that empty into the larger veins.
- Veins are thinner because they have less muscle elastic in tunica media.

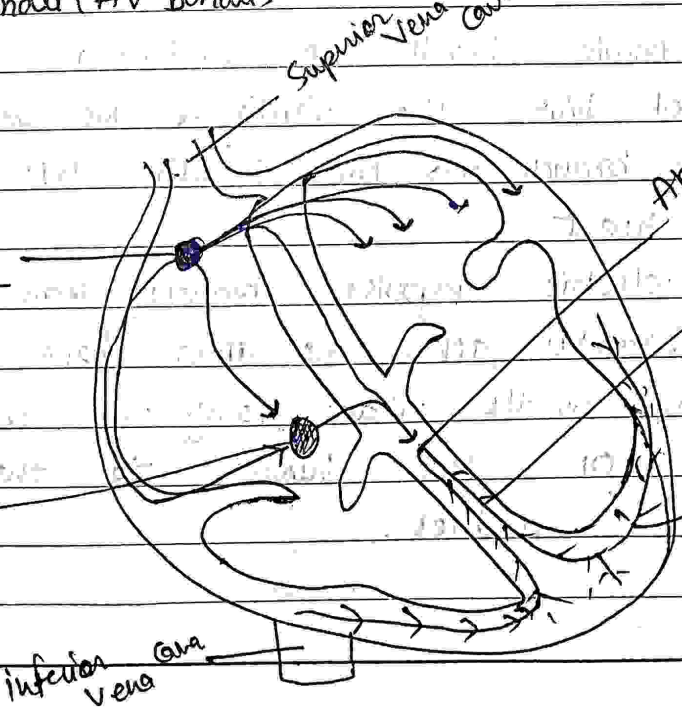
V) Venules → The venules help to carry blood from capillaries & deliver to vein. Group of capillaries within a tissue reunite to form small veins called venules.

CONDUCTING SYSTEM OF THE HEART

A system available in the heart which is responsible for the rhythmic contraction & conduction of impulses in the heart.

The impulse conduction system of the heart consist of four structures:-

i) Sinoatrial node (SA node)
ii) Atrioventricular node (AV node)
iii) Atrioventricular bundle (AV bundle)
iv) Purkinje fibers.



[Conducting system of heart]

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I) Sinoatrial node (SA node) →

- The SA node is located in the wall of right atrium near the superior vena cava (SVC) opening.
- Specialized muscle fibers that make up this structure unique in that they can continually & rhythmically send impulses (signals to contract) without any stimulation from the nervous system. This means that the SA node is said to be self exciting.
- This is also why the SA node is said to be pacemaker of the heart.
- Impulse from the SA node are then calculated across the atria from right to left.

II) Atrioventricular Node (AV node) →

The AV node located in the right side of atrial wall just below the opening of superior vena cava.

- The electrical impulse is carried from the SA node & the AV node is stimulated.
- The AV node delay the path of the impulses from the SA node reaches the AV node.

III) Atrioventricular bundle (AV bundle) →

- Located b/w the Atria & the ventricles.
- fibres branch into two, bundle left & right side of the heart

→ The electric impulse travels from the AV node to the bundle branches after the atria have contracted & emptied.

→ The AV bundle than carry the impulse down the centre of the heart to the right and left ventricles.

Purkinje fibres →

- located at the end of the AV bundle at the base of the heart.
- the purkinje fibres are responsible for the contraction of the ventricles & the papillary muscle tips.

Cardiac Output

- Cardiac output is defined as the amount of blood pumped out of each ventricle per minutes.
- Cardiac output is expressed in two forms →
  1) stroke volume
  2) Minute volume

Unit → Litre(ml)/min

CO = SV × HR

Cardiac output [ml/min] = Stroke volume (ml/beat) × Heart Rate (beat/min)

- Average heart rate = 70 bpm
- Average stroke volume = 70 - 80ml/beat
- Average cardiac output = 5000 ml/min.

* Cardiac output varies widely with the level of activity of the body

factor affecting Cardic output :-

- Heart rate → ↑HR → ↑CO.
- force of contraction → ↑ contraction → ↑ SV → ↑ CO
- Blood volume → ↑ BV → ↑ CO

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- factor affect HR (heart rate)

Autonomic innervation
Hormans
fitness levels
Age
} HR

- factor Affecting stroke volume (SV)

Heart size
fitness level
Gender
Contractility
Duration of contraction
Preload / After load
} Stroke volume = EDV - ESV

Cardiac output = HR X SV

Stroke volume → stroke volume is the volume of blood pumped outp of each ventricle pir beat/contraction.

- As the stroke volume increases the cardiac output also increase
- stroke volume depends upon
  - End diastolic volume (EDV)
  - Contractility

SV = EDV - ESV

The stroke volume for each ventricle are generaly equal both being approx. 70 ml in healthy 70 kg man.

Regulation of stroke volume →

- Regulation by three variables →
  - End diastolic volume
  - Total ruiphural resistance
  - Contractibility.

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(a) End diastolic Volume [EDV]
- → volume of blood in the ventricle at the end of diastole.
- → sometime called preload
- → stroke volume increase with ↑ EDV

(b) Total peripheral Resistance → frictional resistance in the arteries.
- Inversely related to stroke volume
- called after load.

(c) Contractibility → • Strength of ventricular Contraction.
- stroke volume ↑ with contractibility.

Ejection fraction (EF) – % age of the EDV i.e ejected / cardiac cycle

$$\text{Stroke volume} = EDV - ESV$$

$$EF\% = (SV/EDV) \times 100$$

Normal ejection fraction is about 50–65 %.

- Venous Return → End diastolic volume is controlled by factors that affect venous returns–
  - Total volume
  - venous pressure (driving force for blood return)
- Veins have high Compliance – stretch more at a given pressure than arteries (veins have thinner walls)
- Veins are capacitance vessels – 2/3 of the total blood volume is in veins.
- They hold more blood than arteries but maintain lower pressure.

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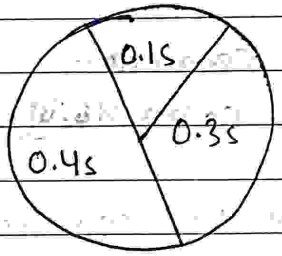
Cardiac Cycle

It is a complete cycle of event in the heart from the bigining of one heart beat to the bigining of the next.

- Cardiac muscle differ from all other muscles of the body.
- Heart muscle has its own built in mechanism for bringing about contraction & relaxation.

Stages of Cardiac Cycle →

Talking 74 bpm as an example, each cycle lasts about 0.8 of a second



i) 0.1s → Atrial systole
ii) 0.3s → Ventricle systole
iii) 0.4s → Complete diastole

Total period of 1 cycle = 0.8 s

I) Atrial Systol → It is a contraction of the heart muscle (myocardia) of the left & right atria.

- As the atria contract, the BP in each atrium increases, forcing additional blood into ventricles. The additional flow of blood is called atrial kick.

II) Ventricular Systole → It is the contraction of the muscle of the left or right ventricles.

III) Comple diastole → After contraction of the ventricle there is complete cardiac distal, a period of 0.4 sec, when the atrias & ventricles are relaxed.

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Regulation of Blood Pressure

- **Blood pressure** → It is defined as the lateral pressure exerted by blood vessels the blood pressure which is normally expressed is arterial blood pressure.
- It has two parts :—
  1) Systolic blood pressure
  2) Diastolic blood pressure

Normal range → 120/80 mm Hg

- **Systolic Blood Pressure** → It is the maximux blood pressure. This occurs during the systole of the heart. (Range 100 - 120 m Hg).
- It refers to phase of ventricular contraction.

- **Diastolic blood pressure** → It is the minimum pressure. It occurs during the diastole of the heart. (Range 60 - 80 mm Hg).
- It refers to phase of ventricles relaxation.

Pulse pressure → It is the difference b/w systolic & digstolic (It is nearly 40 mm Hg).

factor that affecting blood pressure

1) Blood volume
2) Cardiac output
3) Elasticity of blood vessels
4) Diamiter of the lumen of blood vessels
5) Viscosity of blood

Measurement of blood pressure: (Auscultatory method)

It is usually measured by an instrument called **sphigmomanometer**.

- It consists of a mercury manometer, cuff & hand pump the cuff is tied around the cubital fossa of the individual.
- Then the hand pump is pressed so the air inflated in the cuff.

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- When the cuff is fully inflated air pressure is more than blood pressure.
- So blood flow in the branchial artery is completed obstructed. Now the hand pump is slowly released till the time the appeard of the 1st sound is heard (By means of stethoscope put in cubital fossa).
- The manometric reading is now noted. This reading is the systolic BP.
- later the hand pump is slowly released till the time the sound become louder & louder later it stops.
- The manometer reading is noted when the sound disappeard.
- This reading is the diastolic blood pressure.

Conbal of blood Pressure → Blood pressure is conbal by two ways →

→ Short-term Conbal
→ long term Conbal

- Short term Conbal → On a moment to moment basic. which mainly involves the baro receptor reflex. as also called chemoreceptors & circulating harmons.

- long term Conbal → which involves regulation of blood volume by the kidney & the Renin-angiotensin as aldosterone system.

Baroreceptors These are nerve ending sensitivity to pressure changes within the vessels, situated in the arch of the aorta & in the Carotid sinuses.

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Rises in B.P. in aortic arch & carotid sinuses

↓

Stimulation of baroreceptors

↓

↑ in the input to the CVC (cardiovascular centre)

↓

↑ parasympathetic nerve activity to heart

↓

Vasodilation

↓

fall in Systolic BP

↓

↓ BP in aortic arch & carotid sinuses

↓

Deactivation of barreceptors

↓

↓ output to CVC

↓

↓ ↑ parasympathetic Nerve activity to heart

↓

↑ HR & ↑ force of contraction

↓

Vaso constriction

↓

↑ Systemic BP

Baroreceptor control the BP it called Baroreceptor reflex

Chemoreceptor

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Chemoreceptor

- Nerve endings situated in the carotid & aortic bodies. They are primarily involves in control of respiration.
- They are sensitive to change the level of CO_2, O_2 & acidity of the blood pH.
- Input to the CVS influences its output only when severe distribution of respiratory function occurs as when arterial BP falls to less than 80 mm Hg

↑ [H⁺]
↓ pCO_2 → Chemoreceptor → CVC → ↑ Stroke volume, ↑ Heart rate, ↓ Vasoconstriction → ↑BP
↓ PO_2

↓ H^+
↓ PCO_2 → Chemoreceptors → CVC → ↓ Stroke vol., ↓ HR, ↓ Vasoconstriction → ↓ BP
↓ PO_2

Hormonal Regulation

1) Epinephrine / Nor-epinephrine

Ep/NE —Release→ ↑CO by ↑HR & force of contraction.

11) Antidiuretic Hormone (ADH)

Hypothalmus —Released from posterior pituitary→ ↓BP —ADH→ Causes vasoconstriction

↑BP → Also called vasopression.

LONG TERM — DATE

— Renin Angiotensin - Aldosterone (RAA) system

Dehydration, Na^+ defeciency

↓

↓in blood vol. → ↓ in BP → Juxtaglomerular cell of kidney

↓

↑ Renin

↓

Angiotensinogen ← liver

↓

↑ Angiotensin - I

↓

↑ Angiotensin - II

lung — ACE - Angiotensin Converting enzyme

Vasoconstriction of arterioles

↓

BP ↑ until it returns to normal

Adrenal Cortex ← ↑K^+ in extracellular fluid

↓

↑ Aldosterone

↓

In kidney ↑Na^+ & H_2O reabsorption

&

↑ secretion of K^+ & H^+ in to Urine

↓

↑ Blood Volume

RAAS

Pulse

- Pulse is a wave of distension & elongation felt in an artery wall each time the left ventricle ejects blood into the system
- Each contraction of the left ventricle forces about 60 - 80 milliliters of blood through the already full

DATE

full aorta & into the asterial system.

Pulse main point :-

i) Temporatartery
ii) facial artery
iii) common carotid artery
iv) Branchial artery
v) Radial artery
vi) femoral artery
vii) behind knee (Popiteal artery)
viii) Posterior tibial artery
ix) Dorsalis pedis artery

An average of 60-80 is common at rest. Information that may be obtained from the pulse includes:-

- The rate at which the heart is beating.
- The regularity of the heart beat - the intervals b/w beats should be equal.
- The volume or strength of the beat - It should be possible to compress the artery with moderate pressure stopping the flow of blood.
- The tension - Artery wall should feel soft & pliant under the fingers.

ECG Electro Cardiogram

ECG is define as "recording of electrical activity of heart on a graph paper or Graphical representation of electrical activity of heart.

- The machine which is used to record the electrical activity of heart is electro-Cardio graph.

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a) ECG Machine
b) Power lab

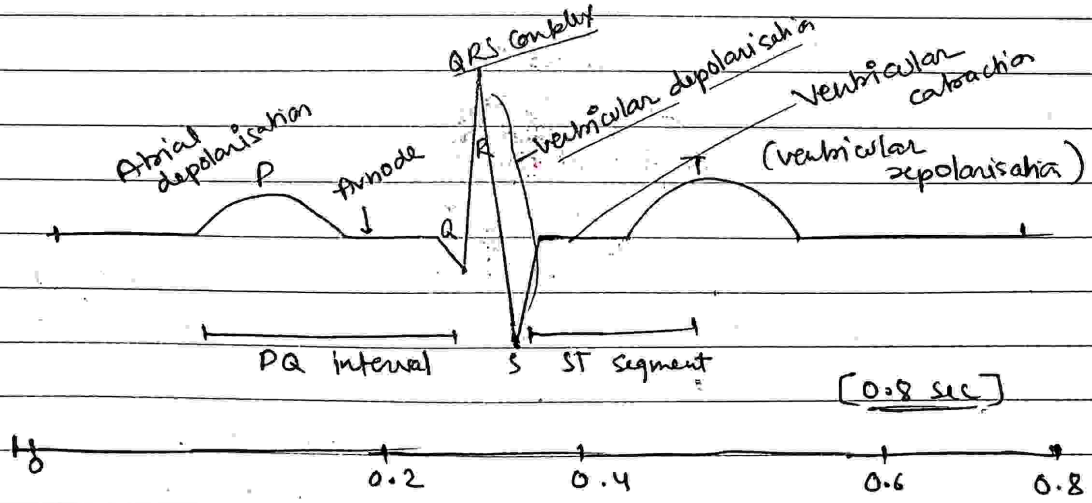
⇒ The graph on which this electrical activity is recorded is called ECG.

Parts & Segment of ECG :-

1) P wave → Small upward deflection on ECG, it represents atrial depolarisation of SA node.

2) QRS Complex → Second wave correspond to downward deflection continues as large upright triangular wave and ends as a downward wave. It represents the ventricular depolarization.

3) T wave → Corresponds to ventricular repolarization i.e. a dome shaped upward deflection. It occurs just as the ventricles are starting to relax. T wave is smaller & wider than QRS Complex because of repolarisation occurs more slowly than depolarization. During the plateau phase it give straight line in ECG.



The ECG described above originates from the SA node is known as Sinus Rhythm.

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Diseases of Heart

i)

Congestive heart failure → Condition in which the heart does not pump the blood properly to meet the normal demands.

ii) Cardiac Arrhythmia → It is a group of condition in which heart beat is irregular, to fast or to slow

- Tachy cardia — fast above 100 beats/min.
- Brady Cardia — slow below 60 beats/min.

ii) Hypertension → A long term medical condition in which blood pressure in arteries is persistently elevated.

i) Hypotension → low blood pressure especially in arteries of systemic circulation.

) Mycardial Infarction →

When blood flow stops to a part of heart causing damage of heart muscle