

## CHAPTER No. 11

### DIGESTION

The process in which large and complex molecules are broken down into small and simple molecules in the alimentary canal with the help of enzymes and accessory glands (liver and pancreas) is called Digestion. Digestion begins in the mouth and is completed in the Small intestine.

The chewing process known as mastication is dependent upon powerful muscles Masseter and Temporalis.

The small rounded ball-like structure formed in the mouth from food is called Bolus.

Taste buds are present on Tongue which select the food on the basis of its taste.

Three pairs of salivary glands are present in the mouth which are Exocrine in nature.

Parotid, sub-mandibular and sub-lingual are the types of Salivary gland.

Largest salivary gland is parotid gland which is present in the mouth near to the ear.

Salivary glands release saliva which consists of  $\text{NaHCO}_3$ , salivary amylase or ptyalin and Maltase.

$\text{NaHCO}_3$  releases  $\text{CO}_2$  and kills germs, so it is Antiseptic in nature.

Salivary amylase or ptyalin convert Starch or Glycogen into maltose and its pH is 6.7 - 7.

Salivary maltase convert maltose into 2-units of glucose and its pH is 6.1-6.8.

Protein and lipids cannot be digested in the mouth while small amounts of Carbohydrate are digested in the mouth.

Sub-lingual gland is also called Ebner's gland and releases lingual lipase.

The opening of the larynx is called Glottis.

Lid or operculum called Epiglottis is the type of elastic cartilage which prevents food from entering the larynx.

The Soft palate, the back of the roof of the mouth, closes off the nasal cavity during swallowing.

The swallowing procedure is regulated by nerves in the Medulla oblongata and pons.

The bolus is passed into the esophagus by automatic constrictions of the Pharynx.

Choking is a reflex action when food or liquid passes into the trachea, it involves a sudden forceful expulsion of air through the larynx.

Food travels from the mouth to the stomach in about 4 to 8 seconds.

The digestive tract is surrounded by both circular and longitudinal smooth muscle that allows for rhythmic Contractions or peristalsis.

The stomach is the part where Physical and chemical breakdown of food really begins.

Chyme is formed in the stomach.

An empty stomach has a volume of approximately 50ml, but typically after a meal its capacity expands to about 1 liter of food and may expand to hold as much as 4 liters.

Stomach is "J" shape.

Stomach is divided into 4 regions including cardiac region or esophageal region, fundus, body (central and largest region) and pylorus region.

The wall of the stomach is lined with millions of gastric glands which together secrete 400-800ml of gastric juice at each meal.

Cardiac sphincter or esophageal sphincter prevents the backward flow of chyme and is present between Stomach and esophagus.



The stomach consisted of Three types of muscles circular muscle, longitudinal muscle and oblique muscle.

Small intestine walls are covered in wrinkles called Rugae which are themselves covered in millions of fingers like projections called Villi.

Villi is further consisted of Microvilli.

The lacteal of villi which is the part of lymphatic system absorb Fats.

The blood vessels receive other nutrients and transport them via the Hepatic portal vein to the liver.

Large intestine consist of 4-regions the caecum, colon, rectum and anal canal.

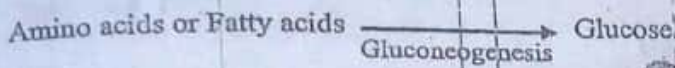
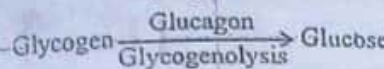
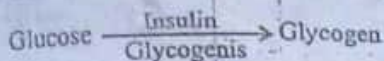
The term colon is sometimes used to describe the Entire large intestine.

Ileocecal valve is present between small intestine and large intestine.

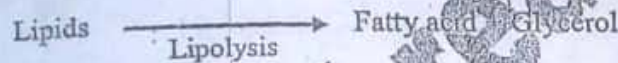
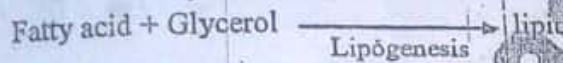
The colon is the longest segment of Large intestine.

The rectum is the final part of the Large intestine.

The liver is one of the most important and Largest organ in the human body.

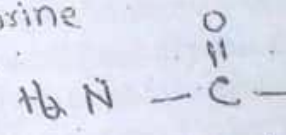
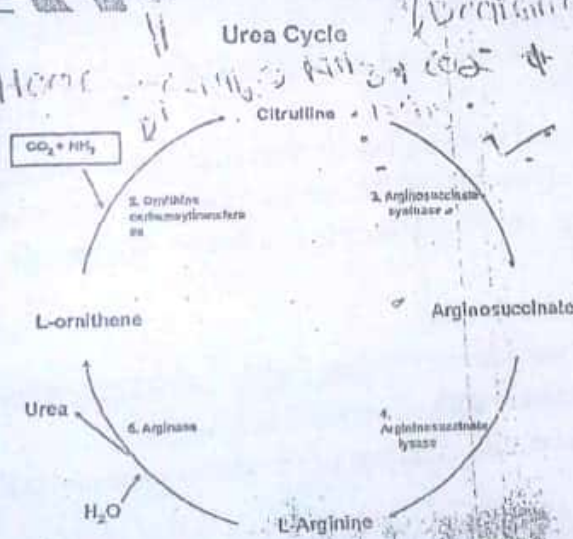


Hepatocytes are the Bile secreting liver cells



Animal fats are stored in Adipose tissues of skin. *→ make side*

Urea cycle or ornithine cycle occur in liver in which Ammonia is converted into urea.

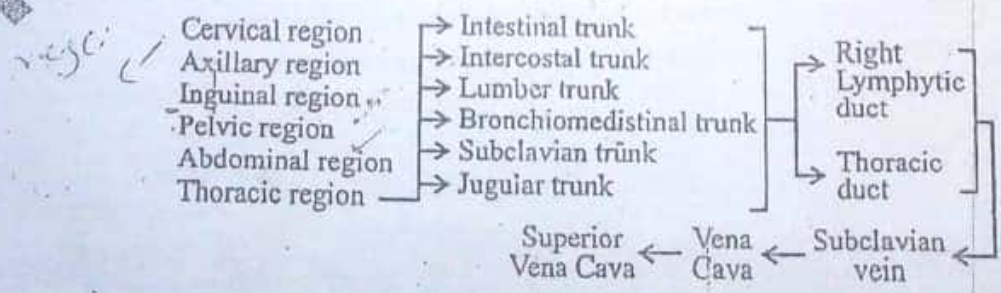


The removal of Amino ( $\text{NH}_2$ ) group from amino acid to produce ammonia is called Deamination



Hep  
↓ prevent  
Thrombosis

- ⇒ Low pressure baroreceptors also known as cardiopulmonary or Volume receptor.
- ⇒ Thrombus is a Greek word which means Blood clot.
- ⇒ The disorder in which a person generates a thrombus in a vessel is called Thrombosis.
- ⇒ Risk of thrombosis increases in certain conditions like atrial fibrillation, heart valve replacement, & recent heart attack.
- ⇒ Detached blood clot circulating in blood or any solid, liquid or gaseous part circulating in the blood is called Embolus. *→ if in brain → stroke*
- ⇒ The term embolus was coined by Rudolph Carl Virchow in 1848.
- ⇒ When thrombus block coronary artery is called Coronary thrombosis. *(cause angina)*
- ⇒ The artery which carry oxygenated blood from aorta to the muscles of heart is called Coronary Artery.
- ⇒ Deposition of LDL (Low density lipoprotein) or cholesterol due to which the wall of artery thick is called Atherosclerosis. *(7 times increase due to hyper lipemia)*
- ⇒ Hyperlipidemia, hypertension and cigarette smoking together increase risk Seven time of Atherosclerosis.
- ⇒ Arteriosclerosis is any hardening, stiffening or loss of elasticity of arterioles due to age.
- ⇒ Which one of the ventricle fail to develop due to genetical problem is called Hypoplasia.
- ⇒ When Foramen Ovale fail to block the interauricular septa is called Blue baby or cyanosis.
- ⇒ About 90-95% of hypertension is essential hypertension or primary hypertension.
- ⇒ Primary hypertension has no Medical cause.
- ⇒ Cushing syndrome is a disorder in which both adrenal glands can overproduce the Harmon cortisol.
- ⇒ Severe chest pain radiating from left side of body is the indication of heart attack is called Angina pectoris or Angina.
- ⇒ Heart performance test is called Angiography.
- ⇒ When stent is inserted to remove the thrombus to start the continuity of blood is called Angioplasty.
- ⇒ When heart lung machine or cardiopulmonary bypass is used in open heart surgery is called On pump surgery.
- ⇒ When heart lung machine or cardiopulmonary bypass is not used in open heart surgery is called Off pump surgery.
- ⇒ First lymphatic duct from liver was discovered by Olaus Rudbeck. *angiography*
- ⇒ Lymphatic duct system was confirmed by Thomas Bartholin in whole body. *Heart performance test.*
- ⇒ Infection of lymph node is called Hodgkin's disease.
- ⇒ Spreading of cancerous cells through lymphatic system is called Metastasis.
- ⇒ Largest lymphatic organ is Spleen.
- ⇒ There are about 100 lymph nodes are present in neck region.
- ⇒ Lymph nodes are present in six areas of body.





Those blood vessels which carry oxygenated blood is called arteries except Pulmonary artery which carry deoxygenated blood from heart to the lungs.

Those blood vessels which carry deoxygenated blood is called veins except Pulmonary vein which carry oxygenated blood from heart to the lungs.

The diameter of arterioles is 3µm-10µm.

The diameter of capillaries is 7.5µm.

The diameter of venules is 8µm - 100µm.

Pre-capillary sphincter is present in capillaries made up of smooth muscles which prevent the backward flow of blood.

Blood vessel arteries is consisted of Three layers, Tunica externa, Tunica media, Tunica intima having areolar tissue, elastic fibers and squamous epithelium.

Vasoconstriction and vasodilation is the important function of Arteries.

Largest blood vessels (Aorta + Vena cava) have a blood vessel to receive oxygenated blood is called vessel of the vessel or Vasa vasorum.

Most of the volume of blood is contained in Veins.

It has been estimated that an adult human being has some 60,000 miles of capillaries with a total surface of some 800 - 1000m<sup>2</sup> (an area greater than three tennis courts).

Human body have 5 liter blood whose PH is 7.4.

Organ	At Rest	During Exercise
Heart	250 ml/minute	750 ml/minute
Kidneys	1200 ml/minute	600 ml/minute
Skeletal muscles	1000 ml/minute	12500 ml/minute
Skin	400 ml/minute	1900 ml/minute
Viscera	1400 ml/minute	600 ml/minute
Brain	750 ml/minute	750 ml/minute
Other	600 ml/minute	400 ml/minute
Total	5600 ml/minute	17500 ml/minute

Systolic blood pressure which is felt during the ventricular contraction.

Diastolic blood pressure which is felt during ventricular relaxation.

The normal blood pressure of human body is 120/80.

Name of Vessel	Systole B.P	Diastolic B.P	B.P
Aorta	120	80	120/80
Arteries	102	60	
Arterioles	60	45	
Capillaries			40
Venules			20
Veins			10
Vena cava			0

Blood pressure is detected by Baroreceptor in blood vessel.

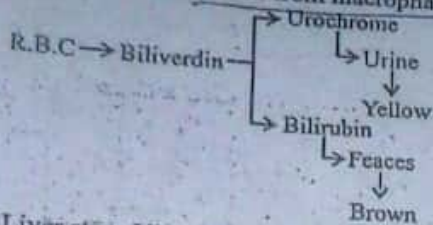
The Low pressure baroreceptors are involved with the regulation of blood volume.

The High pressure baroreceptor are involved with the regulation of blood pressure.



⇒ The liver plays a vital role in Detoxification.

⇒ Kupffer cells modified from macrophage help in detoxification.



⇒ Liver store Vitamins B, A, D, E, K, minerals like Iron and Copper.

⇒ The liver synthesizes bile which is important for Fat digestion or help in the Emulsification of fats.

⇒ Bile is stored in the gall bladder.

⇒ Pancreas can be divided into Three regions, the head, the body and the tail.

⇒ Pancreatic duct is also called Duct of wirsung.

⇒ Pancreatic juice empties from pancreas into the duodenum through Ampulla of Vater.

⇒ Bile duct is also called Hepatic duct.

⇒ Bile duct and pancreatic duct collectively called hepatopancreatic duct or Sphincter of oddi.

⇒ Pancreas is consist of Exocrine and Endocrine gland.

⇒ One million small clusters of cells called Islets of Langerhans are present in pancreas.

⇒ 80-90% of pancreas is consisted of Exocrine gland (Acinar cells and associated ducts).

⇒ 2% of pancreas is consisted of Endocrine gland.

⇒ Twenty to forty acinar cells join into a unit called the acinus.

⇒ Acinar cells secrete the digestive enzyme.

⇒ In each acinus another type of cells called Centroacinar cells are present which are responsible for fluid and electrolyte secretion by the pancreas.

⇒ The contents of acinus drain into small intercalated duct and then to interlobular duct from where it passes into Pancreatic duct.

⇒ Interlobular ducts contribute to fluid and electrolyte secretion along with the Centroacinar cells.

⇒ Islets of Langerhans cells consist of alpha cells which secrete Glucagon, beta cells which secrete Insulin, delta cells which secrete Somatostatin and F cells secrete pancreatic polypeptide.

⇒ Pancreatic juice is Alkaline in nature.

⇒ 500-800ml of pancreatic fluid is secreted per day.

⇒ Pancreatic juice consist of pancreatic amylase or Ptyalin, lipase, and trypsinogen.

⇒ Amylase, lipase and protease of pancreas is collectively called Isozymes.

⇒ Isozymes are synthesized in the endoplasmic reticulum of the acinar cells and are packaged in the Zymogen granules.

⇒ Amylase is the only digestive enzyme secreted by the pancreas in an Active form.

⇒ PH of amylase is 7.

⇒ Starch and glycogen is converted into glucose by Amylase.

⇒ PH of lipase is 7-9.

⇒ Enterokinase converts trypsinogen to Trypsin.

⇒ Secretin is to be the first hormone which is to be discovered.



Secretin functions as a type of fire man, it is released in response to acid in the small intestine and stimulates the Pancreas and Bile duct to release a flood of bicarbonate which Neutralize the acid. Destruction of the gastric or intestinal mucosal lining of the stomach by HCl is a direct cause of peptic ulcer.

Infection with the bacterium Helicobacter pylori is thought to play an important role in causing both gastric and duodenal ulcers.

About 60% of peptic ulcers are caused by Helicobacter pylori.

The inflammation of the stomach lining is called Gastritis.

Obesity refers to an increase in total body Fats.

Multiply your weight in pounds by 705, divide by your height in inches, divide this number by your height in inches a second time.

Underweight person BMI → below 18.5

Normal BMI → 18.5 to 24.9

Overweight BMI → 25 to 29.9

Obese BMI → 30 to 39.9

Morbidly obese → above 40

Bulimia nervosa is an eating disorder in which a person may eat a lot of food at once and then try to get rid of the food by vomiting, using laxatives or sometimes over exercising.

Bulimia nervosa and anorexia nervosa is Psychiatric disorders.

Being eating of high carbohydrate foods usually in secret is the symptoms of Bulimia nervosa.

Anorexia is an emotional disorders that focuses on food, but actually an attempt to deal with perfectionism and a desire to control things by strictly regulation Food and Weight.

People with anorexia have an extreme fear of gaining Weight.

The primary sign of anorexia nervosa is severe Weight loss.

Food poisoning is the type of intestinal condition is characterized by sudden illness caused by eating food or drinking liquids contaminated by a toxin or infectious organisms.

Clostridium, botulinum bacterium (botulism) causes muscle weakness and Paralysis.

Listeriosis may cause flu like symptoms and lead to Meningitis.

Food poisoning is caused by staphylococci, E-coli, salmonella and campylobacter.

Infection of the blood is called Septicemia.

Pain or discomfort in the upper abdomen that is not associated with a structural abnormality is called Dyspepsia.



Circulation

There are Two types of circulatory system, blood circulatory system also called cardiovascular system and Lymphatic system.

Cardiovascular system is the type of closed circulatory system.

Lymphatic system is the type of Open circulatory system.

Cardiovascular system or blood circulatory system consists of Heart, Artery, Capillaries and Vein.

The study about heart is called Cardiology. — uni nucleate

Heart is made up of Myogenic muscle or cardiac muscle which is striated or striated in nature.

Heart work day and night Untiringly.

Human heart is consisted of 4 chambers, 2 Auricle and 2 ventricles.

Auricles are thin and smaller in size.

Ventricles are thick and larger in size.

The shape of the human heart is Conical.

Heart is prevented from over extension by inelastic double membrane is called Pericardium membrane. — prevent from over extension

The space between heart and pericardium membrane is called Pericardium cavity.

Pericardium fluid is present in between heart and pericardium membrane which lubricates the heart to ease the movement and protect the heart from any mechanical injury.

Interauricular wall or septa is present between two auricles while interventricular wall or septa is present between two ventricles.

Tricuspid valve is present between Right Auricle and Right Ventricle. →

Bicuspid valve or Mitral valve is present between left auricle and left ventricle. →

Right Auricle receive deoxygenated blood from vena cava (superior vena cava collect deoxygenated blood from upper part of the body and inferior vena cava collect deoxygenated blood from the lower part of the body).

Cardiac cycle complete in 0.8 second.

→ Auricle relax (diastole) = 0.3 second

→ Auricle contract (systole) = 0.1 second

→ Ventricle relax (diastole) = 0.1 second

→ Ventricle contract (systole) = 0.3 second

One complete systole (contractions) and diastole (relaxation) of heart is called Cardiac cycle.

Pulse rate of normal adult is 72 beat per minute.

1 minute = 60 seconds

$$\frac{60}{72} = \boxed{0.8 \text{ second}}$$

Lub (first sound) is produced by closing of the AV valves (Bi and Tricuspid valve) during the contraction of the ventricle in systole.

The Dub (second sound) is produced by closing of the semilunar valve in the beginning of diastole.

When heartbeat, it poured 85 mL blood into Aorta.

The speed of flow of blood fluctuates from 425 cm/sec in the aorta to about less than 1mm/minute in capillaries.

AV-node (Atrio-ventricular node) is also called Relay station.



allow chyme into small intestine and is present between stomach and Duodenum (small intestine).

Gastric juice of stomach consist of HCl, pepsinogen and Mucous.

Pepsinogen is inactive form of pepsin which help in the digestion of Protein.

Mucous labelled the wall of stomach and protect it from the side effect of HCl and Pepsin.

Stomach is Sterile having no parasite or pathogens due to the presence of HCl which is Antiseptic in nature.

Stomach consist of 6-types of cells.

G-cells of stomach release Gastrin which stimulate gastric juice and stimulate acid.

D-cells release Somatostatin which inhibit Acidity.

Chief cells or zymogen cells release Gastric lipase and Pepsinogen (Inactive form of pepsin which digest protein).

Enterochromaffin cells release histamine which Stimulate acid.

Parietal cells or oxyntic cells release HCl and intrinsic factor.

Intrinsic factor bind with Ca<sup>++</sup> and Vitamin B12 to absorb in body.

Mucous cells release Mucus (which label the stomach walls) and bicarbonate.

Stomach wall absorb Iron Fe<sup>++</sup>, highly fat-soluble substances like alcohol and drugs like Aspirin and Ethanol.

Mechanism of secretion of gastric juice is controlled through Chemical control and nervous control.

Sometimes even the sight, smell, taste or hearing of delicious food stimulate the nervous system which orders for the secretion of small amount of gastric juices like watering of mouth, this is proved by the

experiment of Russian Pavlov. He cut the esophagus of a dog and left the cut end open to the outside, when he fed this dog the food of course never reached the stomach yet, the stomach resulted in the

secretion of about One fourth the normal of gastric juice.

Protein in the food stimulate gastrin.

Small intestine is consisted of Three segments, duodenum, jejunum and ileum.

The length of small intestine is 17 feet and its diameter is 3-4 cm.

The length of large intestine is 5 feet and diameter is 9-12 cm which is Three times greater than small intestine.

The small intestine is where most Chemical digestion take place.

In small intestine protein is converted into Amino acid, carbohydrate is converted into glucose and lipid, and glycerol is converted into fatty acid.

Small intestine release Maltase, Lactase, Sucrase which digest maltose, lactose and sucrose.

Bile from liver and pancreatic juice from pancreas is received by duodenum.

The word duodenum is derived from Latin word Duodenum Digitorum which mean Twelve fingers or inches, so its length is 10-12 inch.

Duodenum is roughly Horse shoe shaped.

Duodenum is divided into Four segments, superior, descending, horizontal and ascending duodenum.

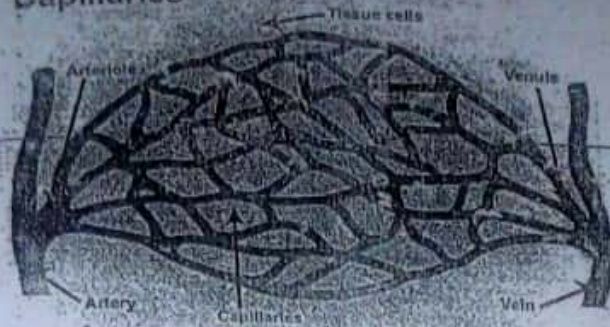
The length of Jejunum is 4-7 feet, where chemical breakdown of the food chyme is completed.

The term jejunum stems from the Latin jejunum meaning empty.

The stomach is consisted of Three layers serosa, mucosa and sub-mucosa.



Capillaries



The double membrane that surrounds heart is called pericardium  
 These membranes are slightly apart from one another having a space, this space is called pericardial cavity  
 The fluid in pericardial cavity is called pericardial fluid, which lubricates the heart to ease its movement and protect the heart from any mechanical injury

In human aorta is on the left side while in bird aorta is on the right

When natural pacemaker fails then artificial pacemaker is implanted near AV node  
 Both arteries and veins are made of same three layers but in arteries the middle layer is thicker than the middle layer of vein

pressure baroreceptors are present in aortic arch and in carotid sinuses of the left and right internal carotid arteries

High pressure baroreceptors present in aortic arch enable the examination of blood being delivered to all blood vessels via systemic arch

High pressure baroreceptors present in carotid arteries monitors the blood being delivered to brain

Low pressure baroreceptors have both circulatory and renal effects  
 The renal effects allow these low pressure receptors to change in the mean pressure in the system in long term.

The artery which carry oxygenated blood from aorta to the muscles of hearts is called coronary artery.

For normal adult B.P. of 120/80 is hypertension

For women above the age of 45 B.P. of 160/95 is hypertension

For men of age above 45, B.P. of 140/95 is hypertension

B.P. increase with age b/c of loss of elasticity of blood vessels

Reduction of blood pressure by 5-6mmHg can decrease the risk of stroke by 40% and coronary heart disease by 15-20%, also reduces the likelihood of dementia heart failure and mortality

Angina is due to lack of blood supply to heart muscle

Angina is atherosclerosis of cardiac arteries

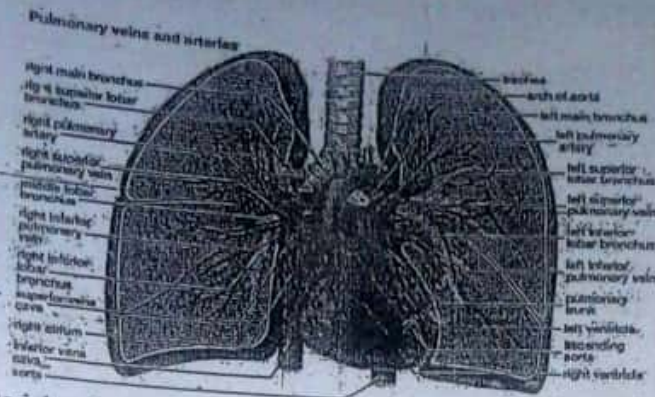
Lymphatic system does not have any pumping organ like heart to transport material but the activity of skeleton muscles, breathing and movement of viscera provide ample energy to move the fluid upward

embolism

Handwritten notes:

- Angioplasty
- stent (used in feet)
- open heart surgery
- cardiopulmonary bypass machine
- if not used off pump surgery
- saphenous vein in leg muscle

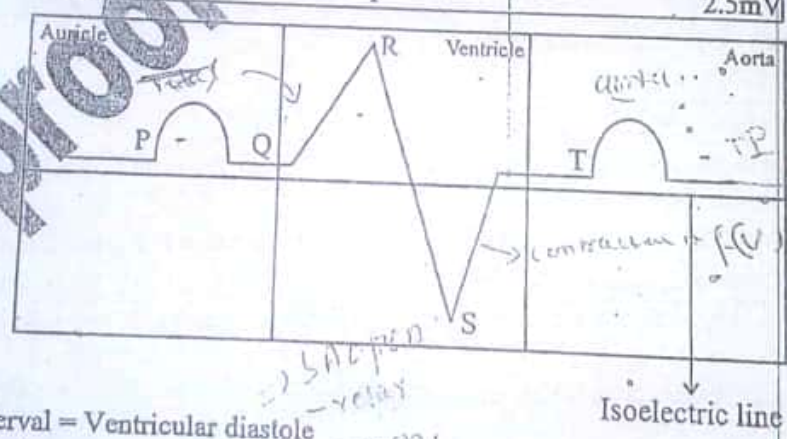




- ⇒ SA-node (Sino arterial node) is also called Pace maker.
- ⇒ Purkinje fibers were discovered in 1839 by Jan Evangelista Purkyně.
- ⇒ Purkinje fibers are the extension of the Autonomic nervous system.
- ⇒ The electrocardiogram is a medical device for recording the electrical activity of the heart.
- ⇒ When the overall electrical current of the heart goes towards a particular lead, it registers a Positive deflection (—▲—). *electrode -> positive*
- ⇒ Those electrical current that go away from the lead register a Negative deflection (—▼—).
- ⇒ Those which are at 90 degrees or perpendicular to the lead register "0" is seen as an Isoelectric line (—).

⇒ The rate of paper is 25mm/second using 2.5mV

Paper	Second	Voltage
1mm	0.04	0.1mV
5mm	0.2	0.5mV
10mm	0.4	1mV
20mm	0.8	2mV
25mm	1	2.5mV



- TP-Interval = Ventricular diastole
- P-wave = Atrial systole  $\Rightarrow$  AV open
- QR-Interval = End of Ventricular diastole  $\rightarrow$  relax
- RS-Interval = Ventricular systole  $\rightarrow$  contraction
- T-wave = Ventricular diastole