VISWASS SCHOOL & COLLEGE OF NURSING

GNM 1ST YEAR

ANATOMY AND PHYSIOLOGY

UNIT-7

THE DIGESTIVE SYSTEM

LONG QUESTIONS AND ANSWERS

PREPARE BY: MS. AMRITA SINGH,
DEPARTMENT OF NURSING, VISWASS

1.A)Write down the meaning of metabolism? (2+8+5)

B)Discuss the carbohydrate metabolism.

C)Protein metabolism.

Metabolism

- Metabolism constitutes all the chemical reactions that occur in the body to provide the chemical energy essential for all cellular activities.
- Units of energy, energy balance and metabolic rate are briefly outlined below before considering the metabolic pathways used to release energy from absorbed nutrients.
- Metabolism involves two types of processes:
  - Catabolism:
    - Catabolic processes break down large molecules into smaller ones, releasing chemical energy, which is stored as adenosine triphosphate (ATP), and heat.
    - The heat generated maintains core body temperature at the optimum level for chemical activity (36.8^{0}C).
    - Excess heat is lost, mainly through the skin.
  - Anabolism:
    - This is building up, or synthesis, of large molecules from smaller ones and requires a source of energy, usually ATP.

Energy

- All body cells require energy to carry out their metabolic processes, including multiplication for replacement of worn-out cells, muscle contraction and synthesis of glandular secretions.
- The energy produced in the body may be measured and expressed in units of work (joules) or units of heat (kilocalories).
- A kilocalorie (kcal) is the amount of heat required to raise the temperature of 1 litre of water by 1 degree Celsius (1^0C).
- On a daily basis the body's collective metabolic process generate a total of about 3 million kilocalories.
- The nutritional value of carbohydrates, protein and fats eaten in the diet may be expressed in either kj per gram or kcal per gram.
- Energy balance is important, as it determines changes of body weight.
- Body weight remains constant when energy intake is equal to energy use.
- When intake exceeds requirement, body weight increases, which, when continual, will lead to obesity.
- Conversely, body weight decreases when nutrient intake does not meet energy requirements.

Carbohydrate metabolism

- Erythrocytes and neurones can use only glucose for fuel and therefore an adequate blood glucose level is needed to provide a constant energy source to these cells.
- Most other cells can also use other source of fuel.
- Digested carbohydrate, mainly glucose, is absorbed into the blood capillaries of the villi of the small intestine to the liver, where it is dealt with in several ways.
    - Glucose may be oxidised to provide the chemical energy, in the form of ATP, that is necessary for the considerable metabolic activity that takes place in the liver itself.
    - Some glucose may remain in the circulating blood to maintain normal blood glucose levels between 3.5 and 8 millimoles per litre (mmol/L) (63-144mg/100mL).

- Some glucose, if in excess of the above requirements, may be converted by the hormone insulin to the insoluble polysaccharide, glycogen, in the liver and the skeletal muscles.
- The formation of glycogen inside cells is a means of storing carbohydrate without upsetting the osmotic equilibrium.
- Before it can be used to maintain blood levels or to provide ATP, it must be broken down again into its constituent glucose units.
- Liver glycogen constitutes a store of glucose used for liver activity and for maintenance of the blood glucose level.
- Muscle glycogen stores provide the glucose required thyroxine are the main hormones associated with the breakdown of glycogen to glucose.
- Carbohydrate is excess of that required to maintain the blood glucose level and glycogen stores in the tissues is converted to fat and stored in the fat depots.

Carbohydrate and energy release:

- Glucose is broken down in the body, releasing energy, carbon dioxide and metabolic water.
- Catabolism of glucose occurs in a series of steps, with a little energy being released at each stage.
- The total no. of ATP molecules that may be generated from the complete breakdown of 1 molecule of glucose is 38, but for this to be achieved the process most occur in the presence of oxygen.
- In the absence of oxygen, this number is greatly reduced, the process is therefore much less efficient.

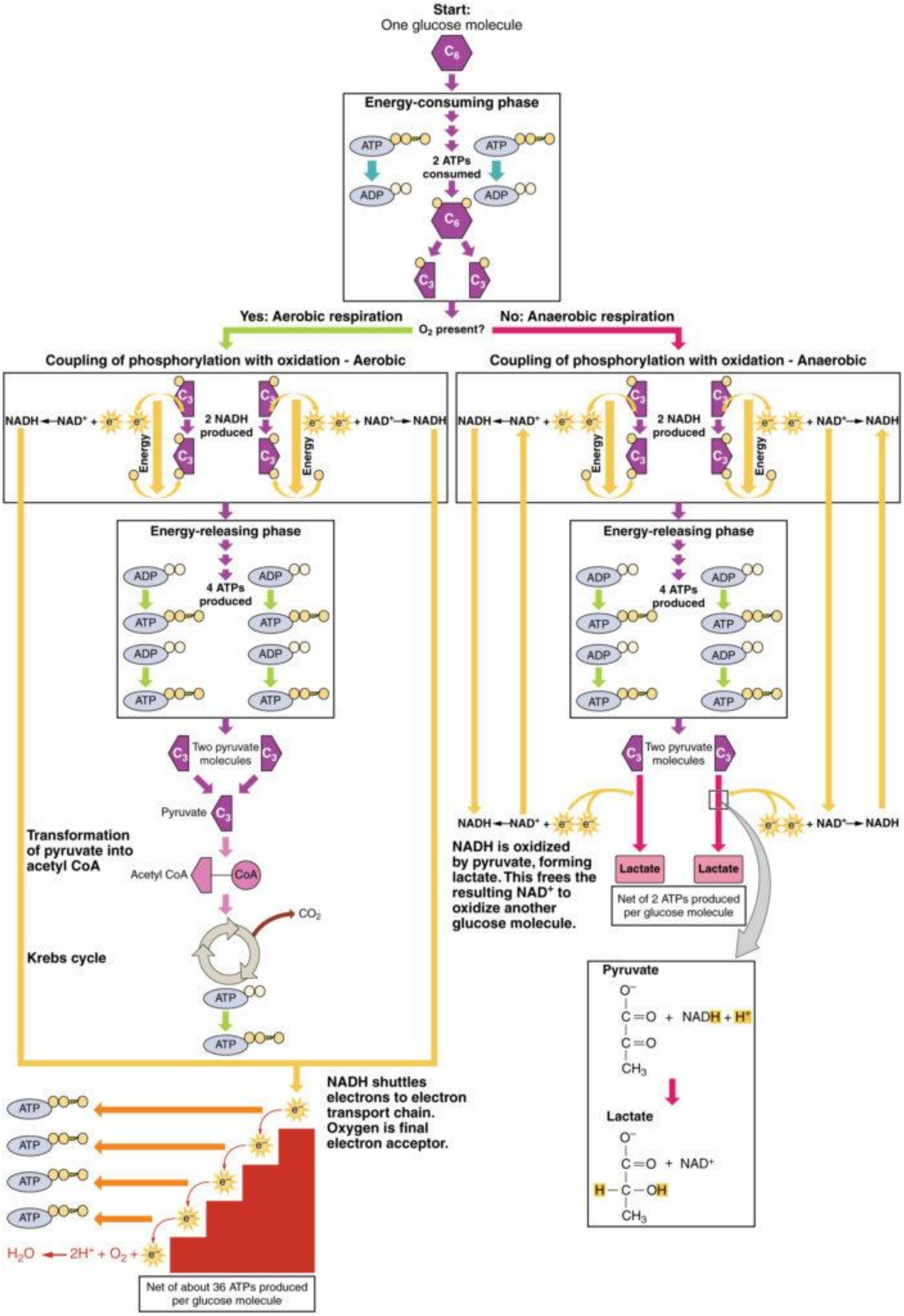
Anaerobic respiration

- When oxygen is limited or absent, pyruvate enters an anaerobic pathway.
- In these reactions, pyruvate can be converted into lactic acid. In addition to generating an additional ATP, this pathway serves to keep the pyruvate concentration low so glycolysis continues, and it oxidizes NADH into the NAD+ needed by glycolysis.

- In this reaction, lactic acid replaces oxygen as the final electron acceptor. Anaerobic respiration occurs in most cells of the body when oxygen is limited or mitochondria are absent or nonfunctional.
- This is an effective pathway of ATP production for short periods of time, ranging from seconds to a few minutes.
- The lactic acid produced diffuses into the plasma and is carried to the liver, where it is converted back into pyruvate or glucose via the Cori cycle.

Aerobic Respiration

- In the presence of oxygen, pyruvate can enter the Krebs cycle where additional energy is extracted as electrons are transferred from the pyruvate to the receptors NAD+, GDP, and FAD, with carbon dioxide being a “waste product”.
- The NADH and FADH2 pass electrons on to the electron transport chain, which uses the transferred energy to produce ATP.
- As the terminal step in the electron transport chain, oxygen is the **terminal electron acceptor** and creates water inside the mitochondria.



Fats of the end products of carbohydrate metabolism:

Lactic acid:

- Some of the lactic acid produced by anaerobic catabolism of glucose may be oxidised in the cells to carbon dioxide and water but first it must be changed back to pyruvic acid.
- If complete oxidation does not take place, lactic acid travels to the liver in the circulating blood, where it is converted to glucose and may then take any of the pathways open to glucose.

Carbon dioxide:

- This is excreted from the body as a gas by the lungs.

Metabolic water :

- This is added to the considerable amount of water already present in the body.
- Excess is created in the urine by the kidneys.

Protein metabolism:

- Dietary protein consists of a number of aminoacids.
- About 20 amino acids have been named and 9 of these are described as essential because they can not be synthesizedin the body.
- The others are non essential amino acids because they can be synthesized by many tissues.
- The enzymes involved in this process are called transminases.
- Digestion breaks down dietary protein into its constituents amino acids in preparation for absorption into the blood capillaries of the villi in the small intestine.

Amino acid pool:

- The bodies capacity for storing amino acids is very limited and excess amino acids are deaminated in the liver.
- A small pool of amino acids is available to body cells to draw on when they need to synthesis their own materials.

Sources of amino acids:

- Exogenous: these are derived from dietary protein.

- Endogenous: these are obtained from the breakdown of existing body proteins. in adult about 80-100 gm of protein are broken down and replaced each day.

Source of aminoacids:

- Deamination: Amino acids not needed by the body of broken down, or deaminated, mainly in the liver. The nitrogenous part, the amino groupis converted to ammonia and then combined with carbon dioxide, forming urea, which is excreted in the urine. The remaining part is used to provide energy.
- Excretion: The faeces contains a considerable amount of protein within cells shed from the lining of the alimentary tract.

Amino acids and energy release:

- Amino acids are potential fuel molecules that are used by the body only when other energy sources are low.
- To supply the amino acids for use as fuel, in extreme situations, the body breaks down muscles, its main protein source.

2) A) Discuss the process of digestion & absorption. **(7+5+3)**

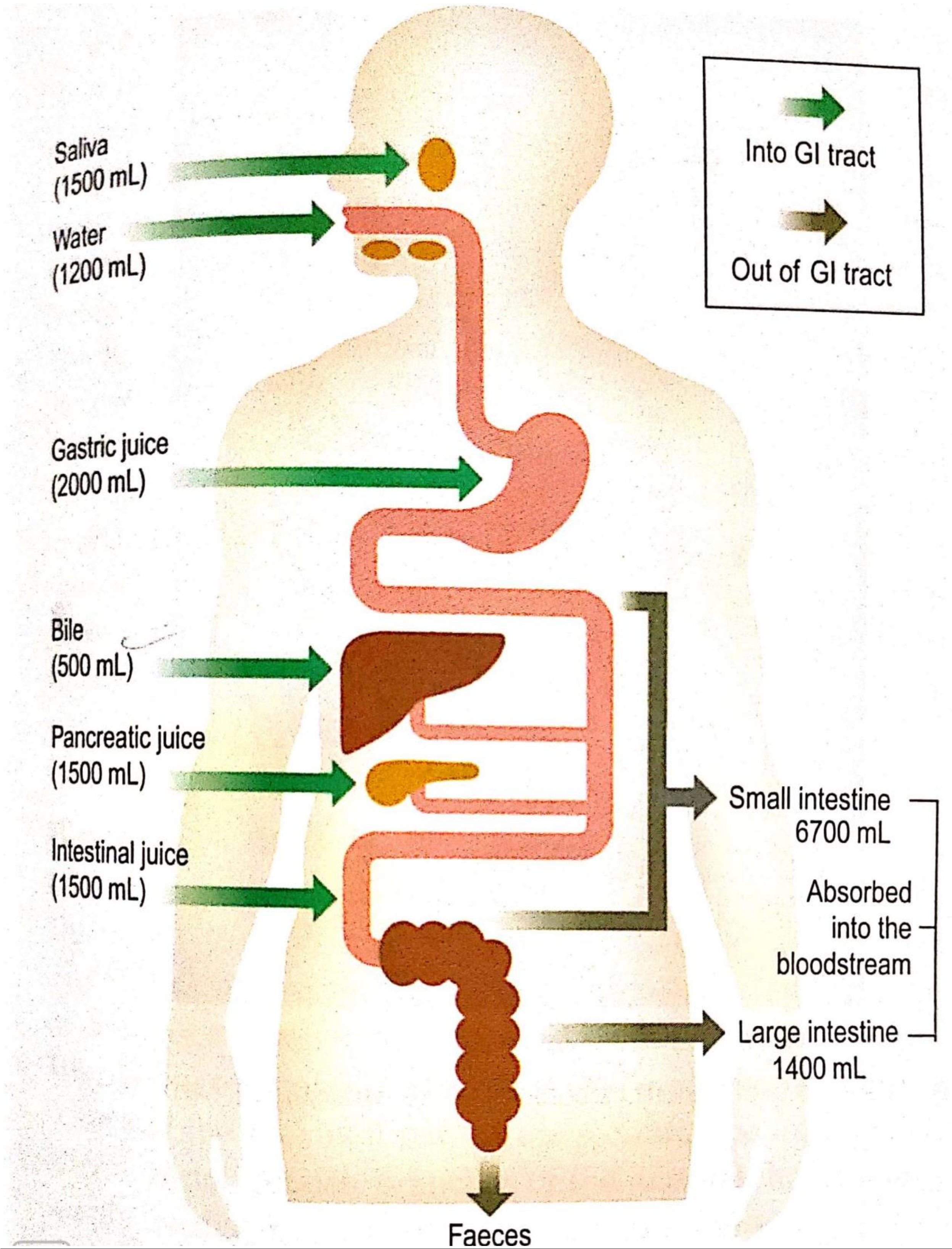
B) Write the function of bile and how it helps to digestion in small intestine.

C)Explain the function of gastric juice.

A) process of digestion:

- Digestion begins even before you put food into your mouth. When you feel hungry, your body sends a message to your brain that it is time to eat.
- Sights and smells influence your body's preparedness for food. Smelling food sends a message to your brain. Your brain then tells the mouth to get ready, and you start to salivate in preparation for a delicious meal.
- Once you have eaten, your digestive system breaks down the food into smaller components. Another word for the breakdown of complex molecules into smaller, simpler molecules is "catabolism". To do this, catabolism functions on two levels, mechanical and chemical.

- Once the smaller particles have been broken down, they will be absorbed into the blood and delivered to cells throughout the body for energy or for building blocks needed for cells to function.
- Digestion involves two processes.
    - physical
    - Chemical
- Physical:
    - During the physical process, the food is mixed and moved throughout the
    - gastrointestinal tract. This process is also referred to as motility and the partially digested food is propelled by the wave-like action called peristalsis.
    - Ring-like muscular valves called sphincters prevent the back flow of partially digested food and digestive juices.
    - There are sphincters between the esophagus and stomach (esophageal sphincter), between the stomach and small intestine (pyloric sphincter) and small intestine and colon (ileocecal sphincter).
- Chemical:
    - The chemical process of digestion involves the release of water, acid, bicarbonate and enzymes to be mixed with the food to further break it down into smaller subunits.
    - Chemical breakdown starts in the mouth where enzymes break down complex carbohydrate. In the stomach, water and acid are released to begin the breakdown of protein.
    - A mucus lining protects the stomach from the corrosive acid. The mixture, also known as chyme, enters the small intestine where bicarbonate is introduced to neutralize the acid and enzymes are added to break chemical bonds.
    - Most small intestine digestive enzymes are produced in the pancreas.



Process of absorption:

- Absorption of nutrients from the small intestine through the enterocytes occurs by several processes.
    - Diffusion
    - Osmosis
    - Facilitated diffusion
    - Active transport
- Water moves by osmosis; small fat soluble substances, and others are generally transported inside the villi by other mechanisms.
- Monosaccharides and amino acids are actively cotransported with sodium ions into the blood capillaries in the villi.
- Fatty acids and glycerol, are able to diffusion into the lacteals and are transported along lymphatetic vessels to the thoracic duct, where they enters the circulation.
- A small numbers of proteins and other large substances are absorbed uncharged.
- Other nutrients, such as vitamins, mineral salts and water, are also absorbed from the small intestine into the blood capillaries.
- Fat soluble vitamins are absorbed into the lacteals along with fatty acids and glycerol.
- Vitamin B_{12} combines with intrinsic factors in the stomach and is actively absorbed in the terminal ileum.
- The surface area through which absorption takes place in the small intestine is greatly increased by the circular folds of mucos membrane and by the very large number of villi and microvilli present.
- It has been calculated that the surface area of the small intestine is about five timesthat of the whole body surface.
- Large amounts of fluid enter the alimentary tract each day. Of this only about 1500 ml is not observed by the small intestine and passes into the large intestine.

B)<u>function of bile</u>

- **<u>Bile</u>**
    - Bile, secreted by the liver, is unable to enter the duodenum, then the hepatopancreatic sphincter is closed; it therefore passes from the hepatic duct along the cystic duct to the gallbladder, where it is stored.

- Bile has a pH around 8 and between 500 & 1000 ml is secreted daily. It consist of
  - Water
  - Mineral salts
  - Mucus
  - Bile salts
  - Bile pigments, mainly bilirubin
  - Cholesterol

Function:

- Emulsification of fats in the small intestine-bile salt
- Making cholesterol and fattyacids soluble, enabling their absorption along with the fat soluble vitamins-bile salt
- Excretion of billirubin(a waste product from the breakdown of red blood cells), most of which is in the form of stercobilin.

Release from gallbladder :

- After a meal duodenum secrets the hormone secretin and CCK during the intestinal phase of gastric secretion.
- They stimulate contraction of the gallbladder and relaxation of the hepatopancreatic sphincter, expelling both bile and pancreatic juice through the duodenal papilla into the duodenum.
- Secretion is markedly increased when chime entering the duodenum contains a high portion of fat.

Chemical digestion in enterocytes:

- Most of the digestive enzymes in the small intestine are contained in the enterocytes of the epithelium that covers the villi.
- Digestion of carbohydrate, protein and fat is completed by direct contact between these nutrients and the enterocytes.
- By these contact between these nutrients and the microvilli and within the enterocytes.
- Alkaline intestinal juice(ph 7.8-8.0) assist in raising the pH of intestinal contents to between 6.5 and 7.5.the enzymes that complete chemical digestion of food at the surface of the enterocytes are;
  - Peptidases

- Lipase
- Sucrose

- Peptidase such as trypsin break down polypeptides into smaller peptides and amino acids.
- Peptidase are secreted in an inactive form from the pancreas and must be activated by enterokinase in the duodenum.
- The final stage of breakdown of all peptides to amino acids takes place at the surface of the enterocytes.
- Lipase completes the digestion of carbohydrate by splitting disaccharides such as sucrose, maltose and lactose into monosaccharides at the surface of the enterocytes.

Control of secretion:

Mechanical stimulation of the intestinal glands by chime in believed to be the main stimulus for the secretion of intestinal juice, although hormones may also be involved.

C)function of gastric juice:

Gastric juice:

About 2litres of gastric juice are secreted daily by specialised secretory glands in the mucosa. It consist of:

- Water
- Mineral salts
- Mucus secreted by mucous neck cells in the glands and surface mucous cells on the stomach surface
- Hydrochloric acid } secreted by parietal cell
- Intrinsic factor { in the gastric glands
- Inactive enzyme precursors-pepsinogens secreted by chief cells in the glands.

Functions of gastric juice:

- Water further liquefies the food swallowed.
- Hydrochloric acid:
  - Acidifies the food and stops the action of salivary amylase
  - Kills ingested microbes
  - provides the acid environment needed for the action of pepsins.

- Pepsinogens are activated to pepsins by hydrochloric acid and by pepsins already present in the stomach.
- Intrinsic factor is necessary for the absorption of vitamin B_{12} from the ileum.
- Mucus prevents mechanical injury to the stomach wall by lubricating the contents. It is also prevent chemical injury by acting as a barrier between the stomach wall and the highly corrosive gastric juice; hydrochloric acid is present in potentrially damaging concentration and pepsin would digest the gastric tissues.

3)a) draw a labelled diagram of digestive system. (5+6+4)

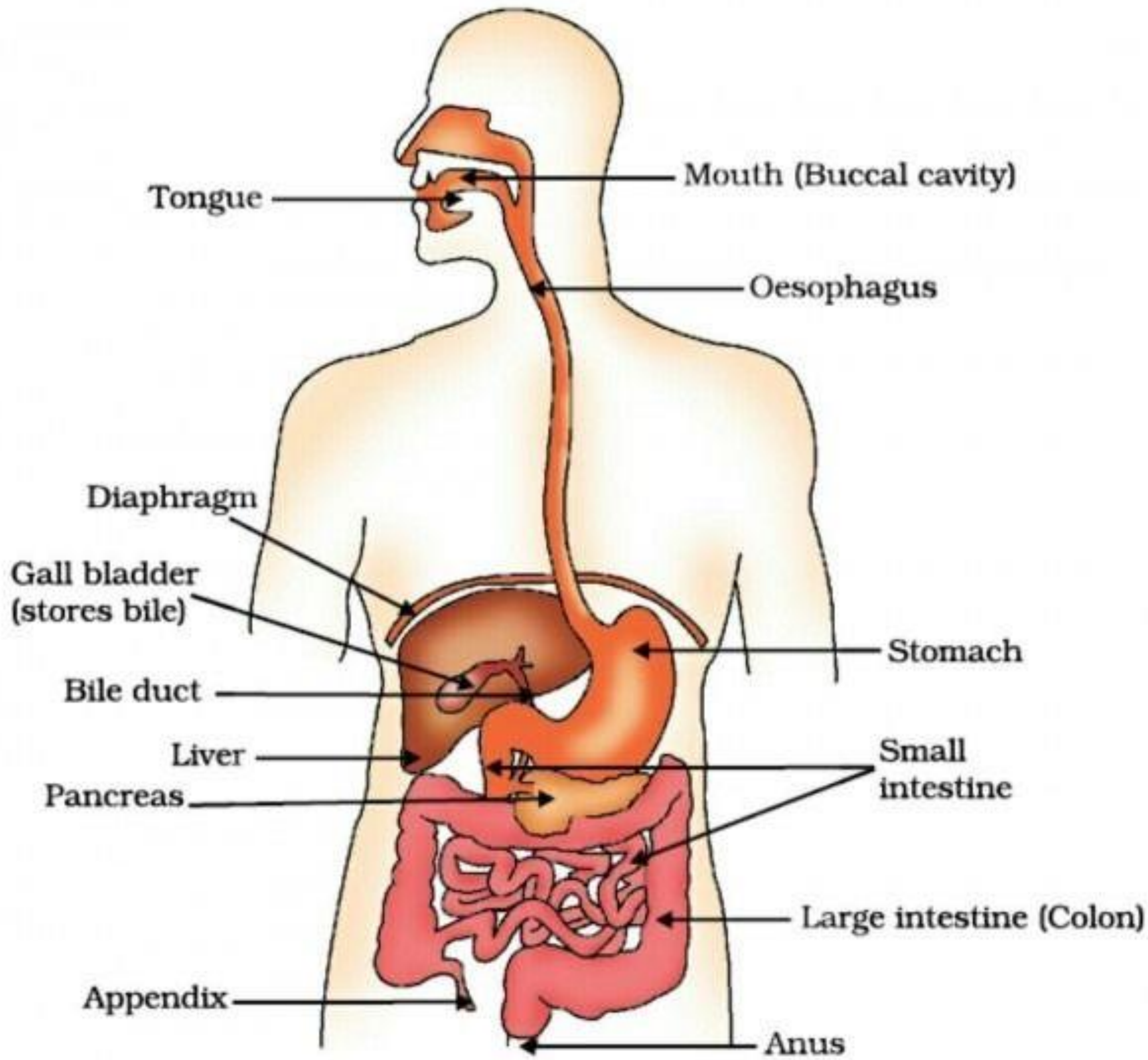
b)Describe the structure and function of Stomach.

c)write down the composition and functions of gastric juice.

A) Digestive system

The digestive system described the alimentary canal, its accessory organs and a variety of digestive process that prepare food eaten in the diet for absorption.

- It is also known as the gastrointestinal (GI) tract, this is essentially a long tube through which food passes.
- It commences at the mouth and terminates at the anus.
- And in adults is around 5 metres in length.
- The various organs along its length have different functions, although structurally they are remarkable. The parts are
    - Mouth
    - Pharynx
    - Oesophagus
    - Liver
    - Gall bladder
    - Stomach
    - Small intestine
    - Large intestine
    - Rectum
    - Anal canal



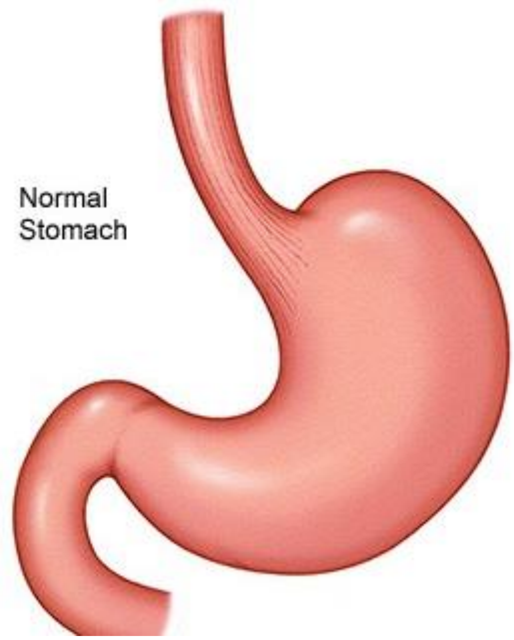
(Labelled diagram of digestive system)

B) Structure and function of stomach

Stomach:

- Stomach is a J-shaped dilated portion of the alimentary tract situated in the epigastric, umbilical and left hypochondrial region of the abdominal cavity.

- The stomach has a dilated structure and functions as a vital digestive organ. In the digestive system the stomach is involved in the second phase of digestion.
- the stomach is located between the oesophagus and the small intestine. It secretes digestive enzymes and gastric acid to aid in food digestion

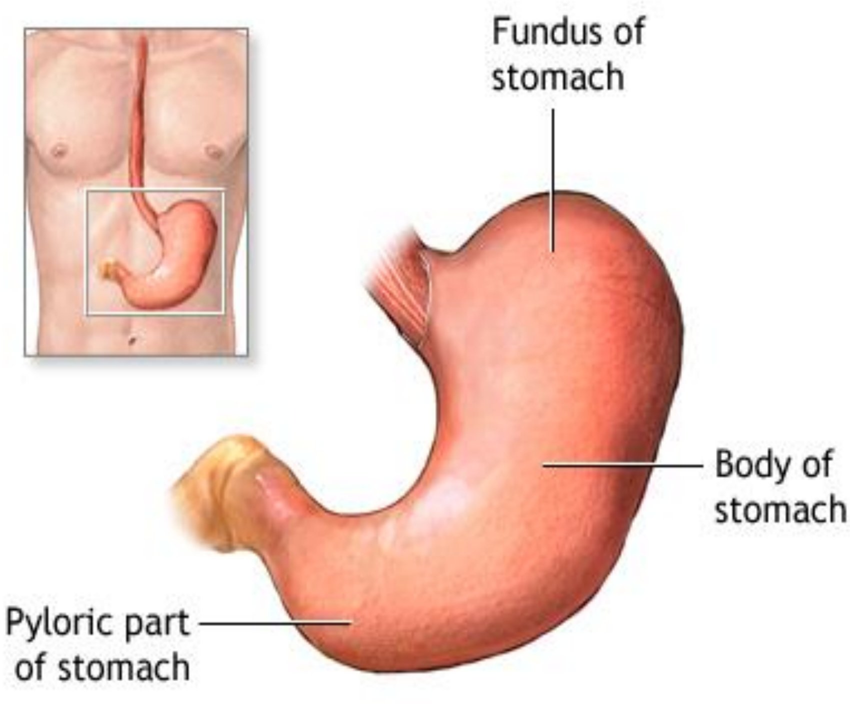


Organs associated with the stomach:

- Anteriorly- left lobe of liver and anterior abdominal wall.
- Posteriorly- abdominal aorta, pancreas, spleen, left kidney and adrenal gland.
- Superiorly- Diaphragm, oesophagus, and left lobe of liver
- Inferiorly- transverse colon and small intestine
- To the left- diaphragm and spleen.
- To the right- liver and duodenum.

Structure:

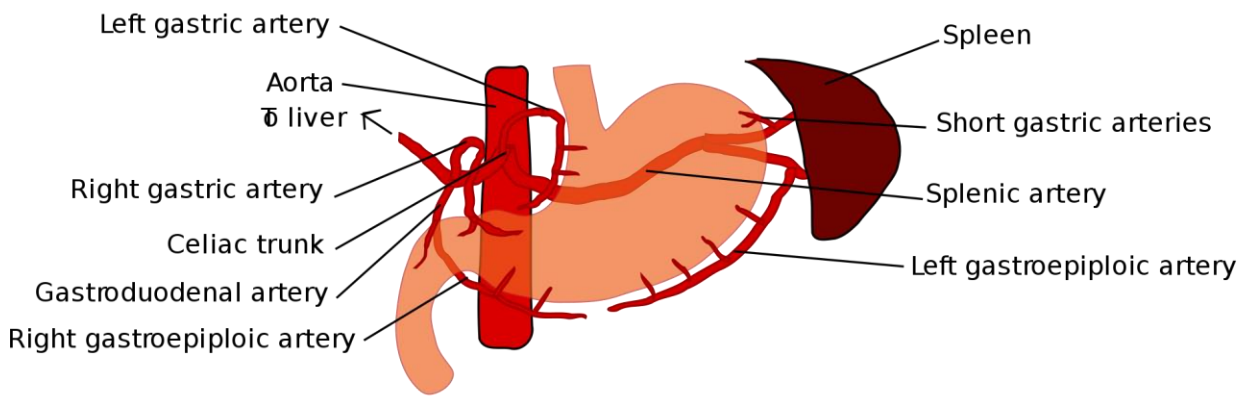
- The stomach is continuous with the oesophagus at the lower oesophageal sphincter and with the duodenum at the pyloric sphincter, it has two curvature.
- The lesser curvature is short, lies on the posterior surface of the stomach and is the downward continuation of the posterior wall of the oesophagus.
- Just before the pyloric sphincter it curves upward to complete the J shape.
- Where the oesophagus joins the stomach the anterior region angles acutely upwards, curves downwards forming the greater curvature and then slightly upward towards the pyloric sphincter.
- The stomach is divided into 3 regions.
    - The fundus
    - The body
    - The pylorus



Blood supply:

- Arterial supply to the stomach is by the left gastric artery, a b ranch of the coeliac artery, the right gastric artery and the gastroepiploic arteries.

➢ Venous drainage is through veins of into the portal vein.



Gastric juice and functions of stomach:

- ➢ Stomach size varies with the volume of food it contains, which may be 1.5 litres or more in an adult.
- ➢ After a meal food accumulates in the stomach in layers, the last part of the meal remaining in the fundus for some time.
- ➢ Mixing with the gastric juice takes place gradually and it may be some time before the food is sufficiently acidified to stop the action of salivary amylase.
- ➢ The gastric muscle generates a churning action that breaks down the bolus and mixes it with gastric juice.

Secretion of gastric juice:

- ➢ There is always a small quantity of gastric juice present in the stomach, even when it contains no food. This is known as fasting juice.
- ➢ Secretion reaches its maximum level about 1 hour after a meal, then declines to the fasting level after about 4 hours.
- ➢ These are **three phases** of secretion of gastric juice:
    - Cephalic phase**:** This flow of juice occurs before food reaches the stomach and is due to reflex stimulation of the vegus nerves, initiate by the sight, smell, taste or thought of food.
    - Gastric phase: When stimulated by the presence of food, the enteroendocrine cells in the pylorus and duodenum secrets the hormone gastrin directly into the circulating blood.

Gastrin, circulating in the blood that supplies the stomach, stimulates the gastric gland to produce more gastric juice.

- Intestinal phase: When the partially digested contents of the stomach reach the small intestine, two hormones secretin and cholecystokinin, are produced by endocrine cells in the intestinal mucosa. They slow down the secretion of gastric juice and reduce gastric motility.

Functions of stomach:

- Temporary storage-allow time for the digestive enzymes, pepsins, to act.
- Chemical digestion-pepsin break proteins into polypeptides.
- Mechanical breakdown
- Limited absorption-water, alcohol and some lipid-soluble drugs.
- Non-specific defence against microbs
- Preparation of iron for absorption
- Production and secretion of intrinsic factor
- Regulation of the passage of gastric contents into the duodenum
- Secretion of the hormonegastrin.

C)composition and function of gastric juice

Gastric juice:

About 2litres of gastric juice are secreted daily by specialised secretory glands in the mucosa. It consist of:

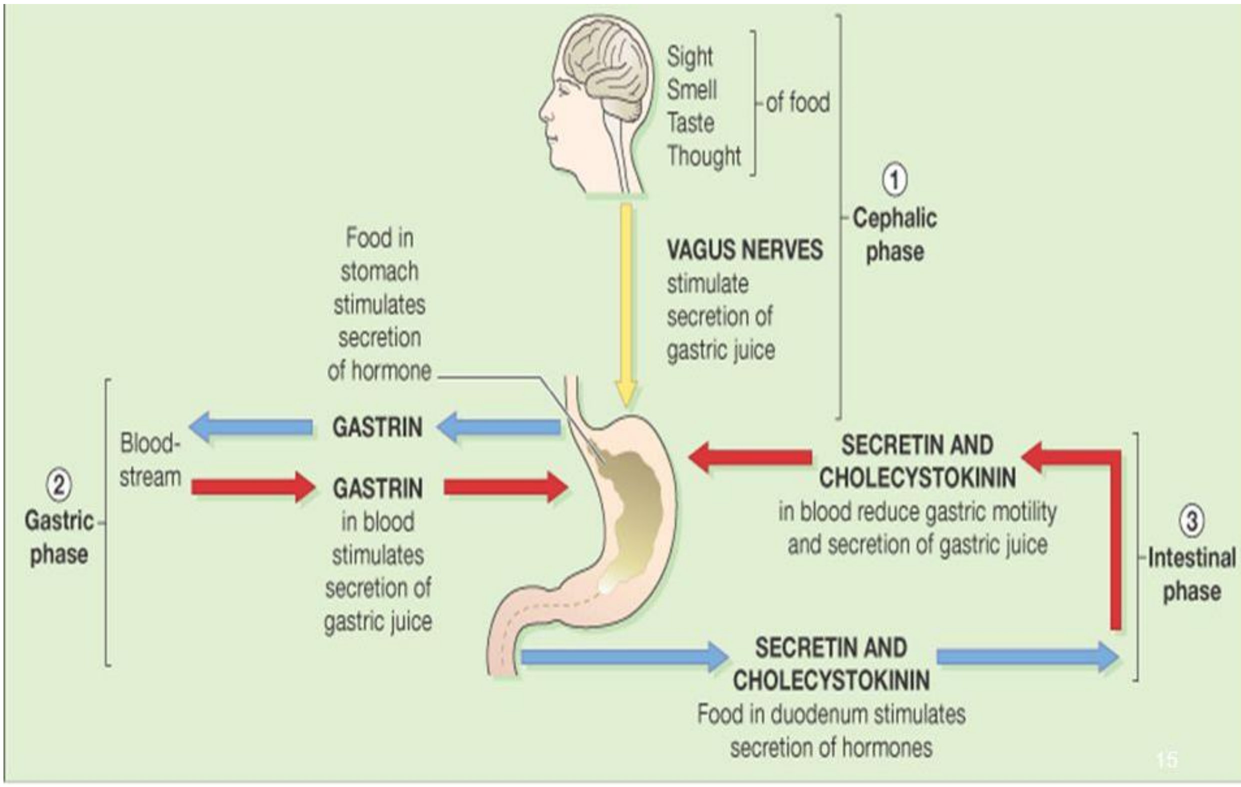
- Water
- Mineral salts
- Mucus secreted by mucous neck cells in the glands and surface mucous cells on the stomach surface
- Hydrochloric acid } secreted by parietal cell
- Intrinsic factor { in the gastric glands
- Inactive enzyme precursors-pepsinogens secreted by chief cells in the glands.

Functions of gastric juice:

- Water further liquefies the food swallowed.
- Hydrochloric acid:
  - Acidifies the food and stops the action of salivary amylase
  - Kills ingested microbes
  - provides the acid environment needed for the action of pepsins.
- Pepsinogens are activated to pepsins by hydrochloric acid and by pepsins already present in the stomach.
- Intrinsic factor is necessary for the absorption of vitamin B_{12} from the ileum.
- Mucus prevents mechanical injury to the stomach wall by lubricating the contents. It is also prevent chemical injury by acting as a barrier between the stomach wall and the highly corrosive gastric juice; hydrochloric acid is present in potentrially damaging concentration and pepsin would digest the gastric tissues.

Secretion of gastric juice:

- There is always a small quantity of gastric juice present in the stomach, even when it contains no food. This is known as fasting juice.
- Secretion reaches its maximum level about 1 hour after a meal, then declines to the fasting level after about 4 hours.
- These are **three phases** of secretion of gastric juice.
  - Cephalic phase
  - Gastric phase
  - Intestinal phase



4)A)Discuss the structure and function of intestines. (8+7)

B)Describe the digestion takes place in the small intestine.

A)structure and function of intestines:

Small intestine:

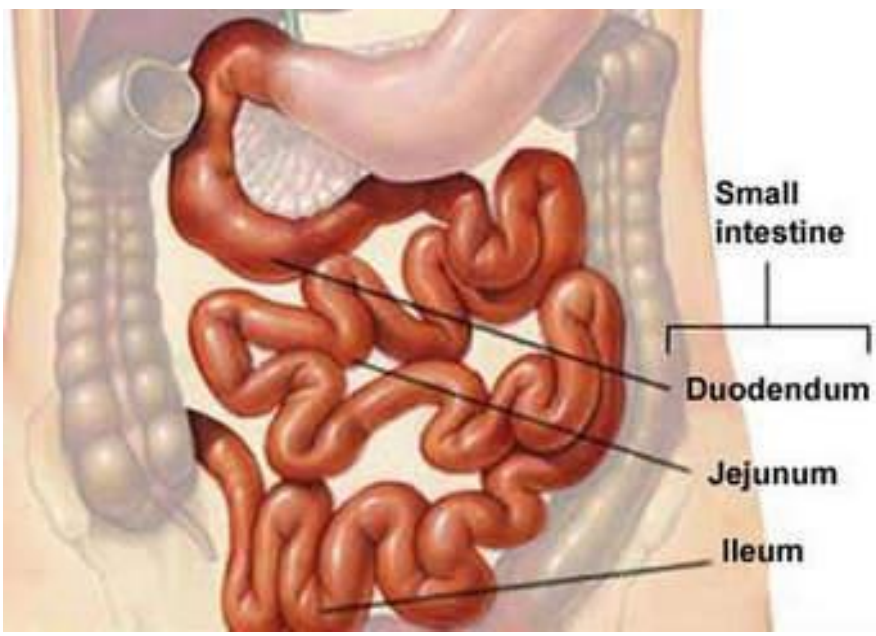
- The small intestine is continuous with the stomach at the pyloric sphincter.
- The small intestine is about 2.5 cm in diameter and a little over 5 metres long; it leads into the large intestine at the ileocaecal valve.
- It lies in the abdominal cavity, surrounded by the large intestine.
- In the small intestine the chemical digestion of food is completed and absorption of most nutrients takes place.
- The small intestine is comprise of three continuous parts.
    - Duodenum

- Jejunum
- Ileum

➢ Duodenum: This is about 25 cm long and curves around the head of the pancreas. Secretion from the gallbladder and pancreas merge in a common structure-the hepatopancreatic ampula-and enter the duodenum at the duodenal papilla. The duodenal papilla is guarded by a ring of smooth muscle, the hepatopancreatic sphincter.

➢ Jejunum: this is the middle section of small intestine and is about 2 metres long.

➢ Ileum: The terminal section is about 3 metres long and ends at the ileocaecal valve, which controls the flow of material from the ileum to the caecum, the first part of the large intestine, and prevents backflow.



Peritoneum:

➢ The mesentery, a double layer of peritoneum, attaches the jejunum and ileum to the posterior abdominal wall.

- The attachment is quite short in comparison with the length of the small intestine; it is therefore fan-shaped.
- The large blood vessels and nerves lie on the posterior abdominal wall and the branches to the small intestine pass between the two layers of the mesentery.

Mucosa:

- The surface area of the small intestine mucosa is greatly increased by permanent circular folds, unlike the rugae of the stomach . are not smoothed out when the small intestine is distended. They promote mixing of chyme as it passes along.
- The villi are tiny finger like projections of the mucosal layer into the intestinal lumen, about 0.5-1mm long.
- This covering consist of columnar epithelial cells, or enterocytes, with tiny microvilli on their free border.

Blood supply:

- The superior mesenteric artery supplies the whole of the small intestine.
- Venous drainage is by the superior mesenteric vein, which joins other veins to form the portal vein.
- The portal vein contains a high concentration of absorbed nutrients; this blood passes through the liver before entering the hepatic veins and ultimately, the inferior venacava.

Intestinal juice:

- About 1500 ml of intestinal juice are secreted daily by the glands of the small intestine.
- It is slightly basic and consist of water, lubricating mucus and bicarbonate to nutralise gastric acid.

Functions:

- Onward movement of its contents by peristalsis, which is increased by parasympathetic stimulation.
- Secretion of intestinal juice, also increased by parasympathetic stimulation

- Completion of chemical digestion of carbohydrates, protein and fats in the enterocytes of the villi.
- Protection against infection by microbes that have survived the antimicrobial action of the hydrochloric acid in the stomach, by both solitary and aggregated lymph follicles.
- Secretion of the hormones CCK and secretin.
- Absorption of nutrients.

Large intestine:

- The large intestine is about 1.5 metres long, beginning at the caecum in the right iliac fossa and terminating at the rectum and anal canal.
- Its lumen is about 6.5 cm in diameter, larger than that of the small intestine. It forms an arch round the coiled-up small intestine.
- For descriptive purposes the large intestine is divided into the **caecum, colon, rectrum and anal canal.**

Caecum;

- This is the first part of the large intestine.
- It is a dilated region that has a blind end inferiorly and is continuous with the ascending colon superiorly.
- Just below the function of the two, the ileocaecal valve opens from the ileum.
- The vermiform appendix is a fine tube, closed at one end, which leads from the caecum.
- It is about 8-9 cm long and has the same structure as the walls of the large intestine but contains more lymphoid tissue.
- The appendix has no digestive function but can cause significant problems when it becomes in flamed.

Colon;

The colon has four parts, which have the same structure and functions

- The ascending colon passes upwards from the caecum to the level of the liver, where it curves acutely to the left at the hepatic flexure to become the transverse colon.

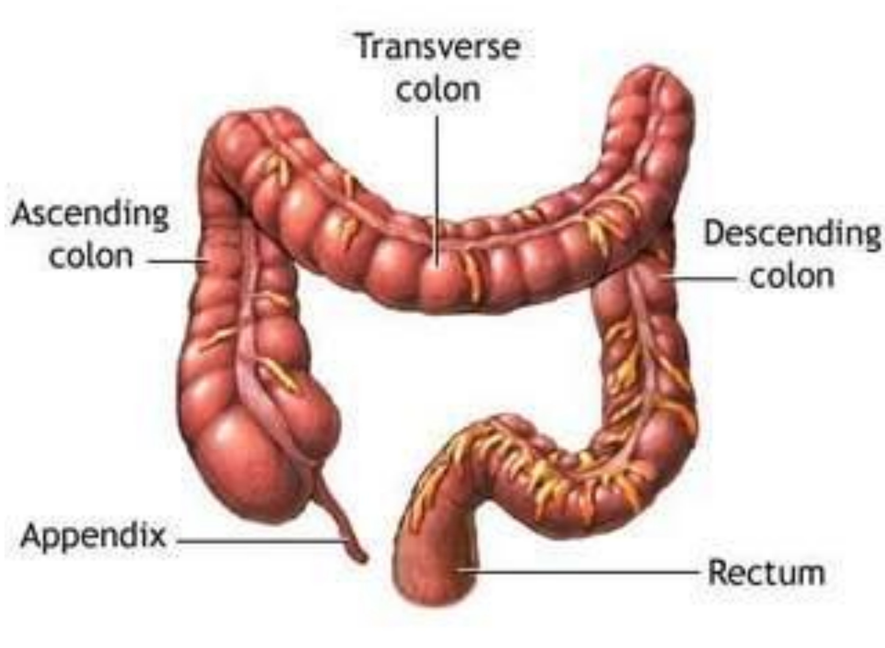
- The transverse colon extends across the abdominal cavity in front of the duodenum and the stomach to the area of the spleen, where it forms the splentic flexure and curves acutely downwards to become the descending colon.
- The descending colon passes down the left side of the abdominal cavity, then curves towards the midline. At the level of the iliac crest is known as the sigmoid colon.
- The sigmoid colon is an S-shaped curve in the pelvic cavity that continuous downwards to become the rectum.

<u>Rectum</u>

This is a slightly dilated section of the large intestine and is about 13cm lomg. It leads from the sigmoid colon and terminates in the anal canal.

<u>Anal canal</u>

- This is a short passage about 3.8cm long in the adult and leads from the rectum to the exterior.
- Two muscular sphincters control the anus; the internal sphincter, consisiting of smooth muscle, is under the control of the autonomic nervous system, and the external sphincter, formed by skeletal muscle, is under voluntary control.



Strucure

- The arrangement of the longitudinal muscle fibres is modified in the caecum and colon.
- They do not form a continuous layer of tissue but are instead collected into three strips, called taeniae coli, which run lengthways along the caecum and colon.
- They stop at the junction of the sigmoid colon and the rectum.
- As these longitudinal strips of the muscle tissue are slightly shorter than than the total length of the caecum and colon, they give it a puckered appearance.
- In the rectum the longitudinal muscle fibres spread out as in the basic structure and this layer therefore completely surrounds the rerctum and the anal canal.
- The anal sphinmcters are formed by thickening of the circular muscle layer.

Blood supply;

Arterial supply

- This is mainly by the superior and inferior mesenteric arteries.
- The superior mesenteric artery supplies the caecum, ascending colon and most of the transverse colon.
- The inferior mesenteric artery supplies the remainder of the colon and the promixal part of the rectum,
- The middle and inferior rectal arteries, branches of the internal iliac arteries, supply the distal section of the rectum and the anus.

Venous drainage

- This is the mainly by the superior and inferior mesenteric veins which drain blood from the parts supplied by arteries of the same names.
- These veins join the splenic and gastric veins to form the portal vein.
- Veins drainig the distal part of the rectum and the anus join and the internal iliac veins, meaning that blood from this region returns directly to the inferior venacava, bypassing the liver and portal circulation.

Functions

Absorption

- This contents of the ileum that pass through the ileocaecal valve into the caecum are still fluid, even though a large amount of water has been absorbed in the small intestine.
- In the large intestine, absorption of water, by osmosis, continues until the familiar semisolid consistency of faeces is achieved.
- Minerals salts, vitamins and some drugs are also absorbed into blood capillaries from the large intestine.

Microbial activity

- The large intestine is heavily colonized by certain types of bacteria, which synthesise vitamin K and folic acid.
- They include *Escherichia coli,Enterobacter aerogenes, Strepptococcus faecalis* and *Clostridium perfringens.*

Mass movement

- The large intestine does not exhibit peristaltic movement as do other parts of the digestive tract**.**

Defaecation

- The rectum is usually empty, but when a mass movement forces the content of the sigmoid colon into the rectum the nerve ending in its wall are stimulated by stretch.

B)digestion takes place in the small intestine

- When acid chime passes into the small intestine it is mixed with pancreatic juice, bile and intestinal juice, and is in contact with the absorptive enterocytes of the villi.
- The digestion of all nutrients is completed:
  - Carbohydrate are broken down to monosaccharides
  - Proteins are broken down to amino acids.
  - Fats are broken down to fatty acid and glycerol.
- <u>Pancreatic juice:</u>
- Pancreatic juice is secreted by the exocrine pancreas and enters the duodenum at the duodenal papilla. It consist of:
  - Water

- Mineral salts
- Enzymes
    - ✓ Amylase
    - ✓ Lipase
    - ✓ Nucleases that digest the nuclic acids, DNA and RNA
- Inactive enzyme precursors including:
    - ✓ Trypsinogen
    - ✓ Chymotrypsinogen

➢ Pancreatic juice is basic(alkaline, pH-8) because it contains significant quantities of bicarbonate ions, which are basic (alkaline)in solution.

➢ When acid stomach contents enter the duodenum they are mixed with pancreatic juice and bile, and the ph is raised to between 6 and 8.

Functions

Digestion of protein:

➢ Typsinogen and chymotrypsinogen are inactive enzyme precursors activated by enterokinase, an enzyme is the microvilli, which converts them into the active proteolytic enzymes trypsin and chymotrypsin.

➢ These enzymes break polypeptide down into tripeptide, dipeptide and amino acid.

➢ It is important for them to be produced as inactive precursors and they are activated only on their arrival in the duodenum; otherwise they would digest the pancreas.

Digestion of carbohydrate:

➢ Pancreatic amylase converts all digestible polysaccharides(starches) not acted on by salivary amylase to disaccharides.

Digestion of fats:

➢ Lipase converts fats to fatty acids and glycerol.

➢ To aid the action of lipase, bile salt emulsify fats, i.e. reduce the size of the globules, increasing their surface area.

Control of secretion :

- The secretion of pancreatic juice is stimulated by secretin and CCK, produced by endocrine cells in the walls of the duodenum.
- The presence in the duodenum of acid chime from the stomach stimulates the production of hormones.

- Bile
  - Bile, secreted by the liver, is unable to enter the duodenum, then the hepatopancreatic sphincter is closed; it therefore passes from the hepatic duct along the cystic duct to the gallbladder, where it is stored.
  - Bile has a pH around 8 and between 500 & 1000 ml is secreted daily. It consist of
    - Water
    - Mineral salts
    - Mucus
    - Bile salts
    - Bile pigments, mainly bilirubin
    - Cholesterol

Function:

- Emulsification of fats in the small intestine-bile salt
- Making cholesterol and fattyacids soluble, enabling their absorption along with the fat soluble vitamins-bile salt
- Excretion of billirubin(a waste product from the breakdown of red blood cells), most of which is in the form of stercobilin.

Release from gallbladder :

- After a meal duodenum secrets the hormone secretin and CCK during the intestinal phase of gastric secretion.
- They stimulate contraction of the gallbladder and relaxation of the hepatopancreatic sphincter, expelling both bile and pancreatic juice through the duodenal papilla into the duodenum.
- Secretion is markedly increased when chime entering the duodenum contains a high portion of fat.

Control of secretion:

Mechanical stimulation of the intestinal glands by chime in believed to be the main stimulus for the secretion of intestinal juice, although hormones may also be involved.