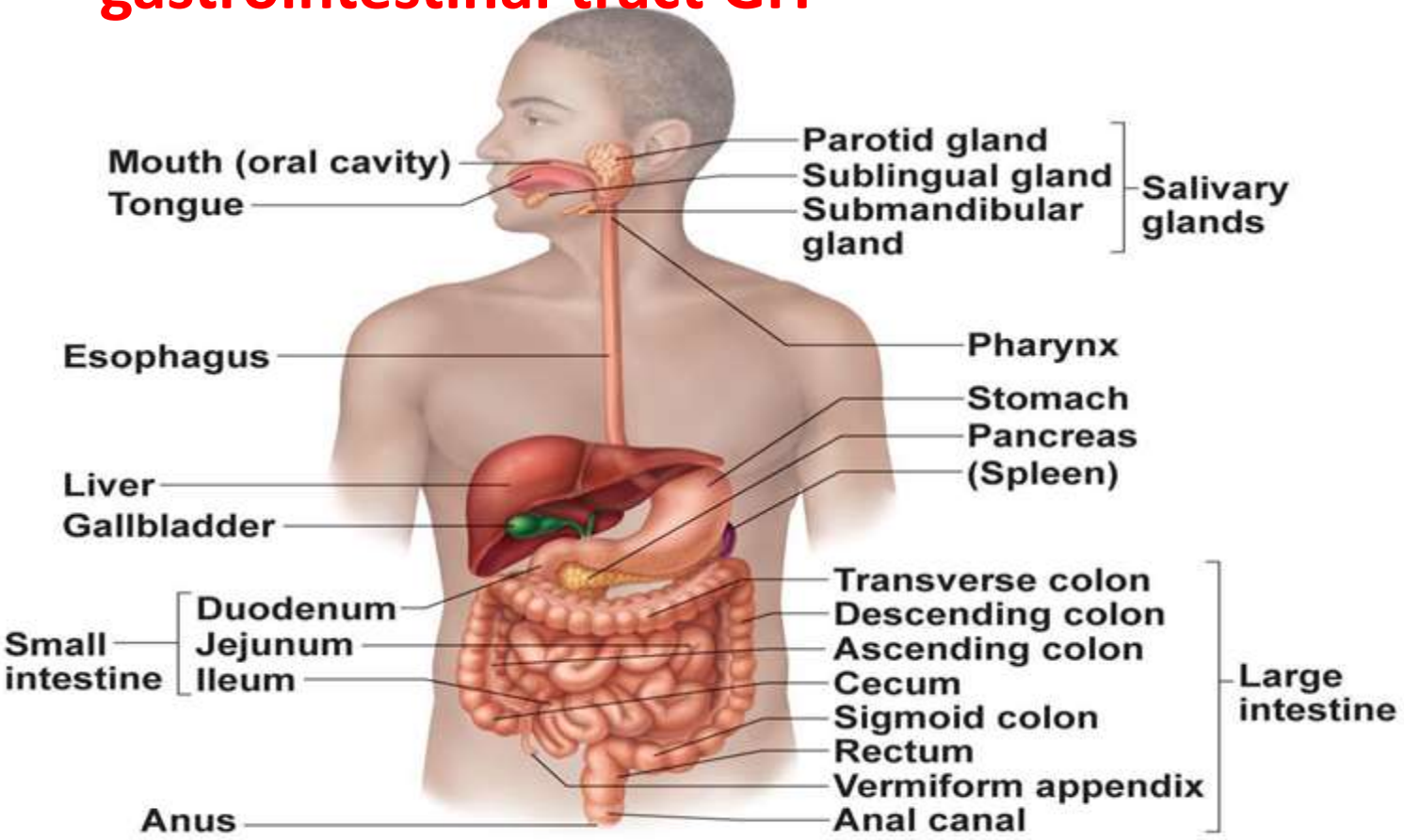
Digestive system
or alimentary tract or
gastrointestinal tract GIT



Digestive System Functions

1. Ingestion
2. Digestion: break down of large particles of food
   - mechanical digestion
   - chemical digestion
3. Propulsion
   - peristalsis
   - segmentation
4. Secretion:
   - digestive enzymes
   - hormones
5. Absorption:
   - from external environment into internal environment
   - across mucosa
6. Elimination of wastes (defecation)

The Digestive System

Purpose: to convert food particles into simpler micromolecules that can be absorbed into the bloodstream and used by the body

Major Organs and their Functions:

Mouth – to chew and grind up food

-- saliva also begins the chemical breakdown

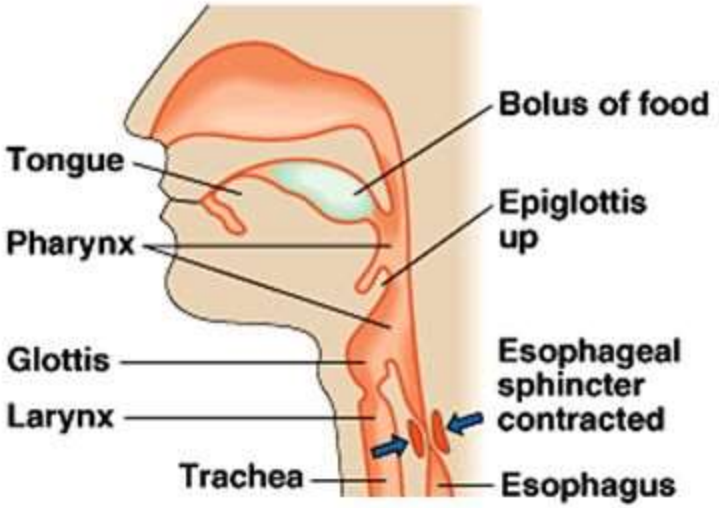
Esophagus – pipe connecting mouth to stomach

Stomach – secretes an extraordinarily strong acid (pH = 2) that leads to breakdown of food

-- once the food is broken down in the stomach and mixed with digestive juices, it is called **chyme**

Mouth

- Functions
  - mechanical digestion
    - teeth
      - break up food
  - chemical digestion (saliva)
    - amylase enzyme
      - digests starch
    - mucus
      - protects soft lining of digestive system
      - lubricates food for easier swallowing
    - buffers
      - neutralizes acid to prevent tooth decay
    - anti-bacterial chemicals
      - kill bacteria that enter mouth with food



Mouth: the oral cavity and its adnexa are organized for prehension, mastication and deglutition of food.

-dog and cat utilize teeth and forelimbs for prehension.

-horse utilize lips as prehensile organ to move food into mouth and grasped with incisors.
-bovine utilize tongue for prehensile as the lips have limited motility and upper incisors teeth are absent.

-sheep and goat utilize the tongue, incisors and lips.
-pigs utilize the incisor, tongue and movement of hand.

Mastication: rhythmic movement of mandible through these actions food is broken into small particles which are then mixed with saliva and prepared for swallowing.

-Carnivores: commonly swallow food after little mixing with saliva.

- Horse: masticate food prior to swallowing.

-ruminants (herbivores):do not masticate food until it is regurgitated.

-ominiovores: (human and monkey) masticated completely before swallowing.

Saliva: is a complex aqueous mixture of the products of all salivary gland contain variety of organic and inorganic substances (99% water, Na, K, albumin, globulin, urea, uric acid).


The salivary glands are exocrine glands, glands with ducts, that produce saliva and pour their secretion in the oral cavity
Major (Paired)
Parotid
Submandibular
Sublingual
Minor
Those in the Tongue, Palatine Tonsil, Palate, Lips and Cheeks

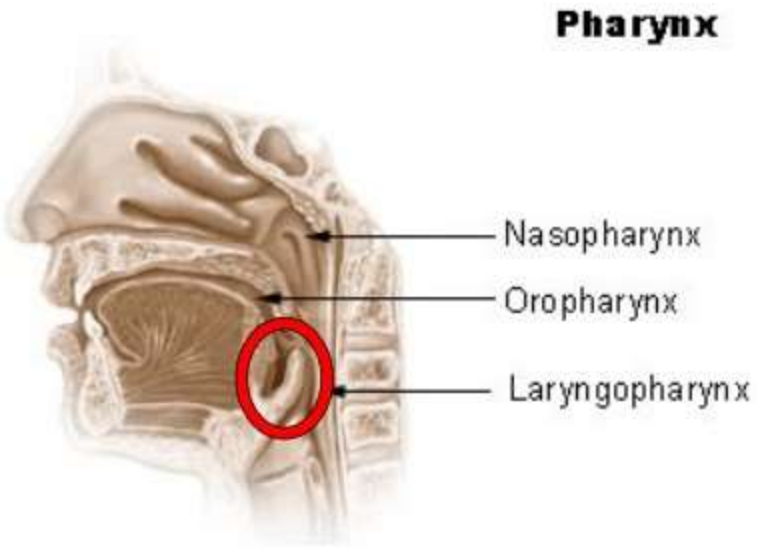
Salivary Gland Secretion

Two types of secretory cells are found in salivary glands:

- **Mucous cells**—secrete **mucin**, which forms mucus upon hydration
- **Serous cells**—secrete a watery fluid containing ions, lysozyme, and salivary **amylase**

Pharynx Function

- Passageway for air and food
- **Epiglottis** is fold of tissue that determines the pathway
- Food movement continues to esophagus via peristalsis.



Deglutition :(swallowing)

Following mastication of food with saliva formed into bolus which swallowed.

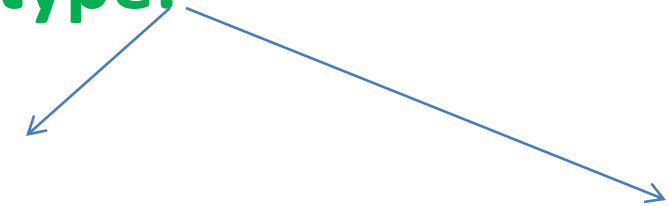
Deglutition is divided into three stage but physiologically it is continuous.

1.oral stage: first stage: the period of time during which the food bolus pass from oral cavity into pharynx. This stage voluntary.

2.pharyngeal stage: second stage: the food bolus passes through the pharynx to esophagus. this stage is involuntary.

3.esophygeal stage: third stage passes through esophagus to stomach. this stage is involuntary.

According to stomach the animal divided into two type;



Simple stomach animals

Horse,dog,cat,human

ruminant
(multiple or complex)

cow,sheep,goat,dears,buffalo

STOMACH

- Partially digested food leaves the esophagus and enters the stomach.
- The stomach is a large, hollow organ.
- One function of the stomach is to store food. This allows you to go many hours between meals.
- The stomach is like a balloon. It can stretch when filled.
- An adult stomach can hold about 2 L of food and liquid.

The simple stomach divided into three area:

1.cardiac region:(area between esophagus and stomach)contain cardiac gland secret mucin (mucopolysaccharide) from muco neck cell, facilitate the enterance of bolus to stomach and coat and protect the stomach mucosa from digestive enzyme and HCL.

2.fundic region:major portion and proper gland the main part of stomach contain fundic gland which contain specialized cells:

a. Parietal cell or oxyntic cell:

secret Hcl also produce intrinsic factor combine with vitamin B12 .

function of Hcl:

1.play important role in digestion.

2.provide suitable environment for protein digestion.

3.disinfectant against infection.

b.chief or peptic cell or zymogen:

secret pepsinogen (inactive) ⟶ pepsin (active)

*pepsin: enzyme for protein digestion.

*rennin (milk coagulation in newborn to provide adequate time for digestion.

*casein(milk protein) $\xrightarrow[Ca]{\text{rennin}}$ coagulate material

*gastric lipase for lipid digestion.

3.pyloric region: area between stomach and duodenum secret mucin.

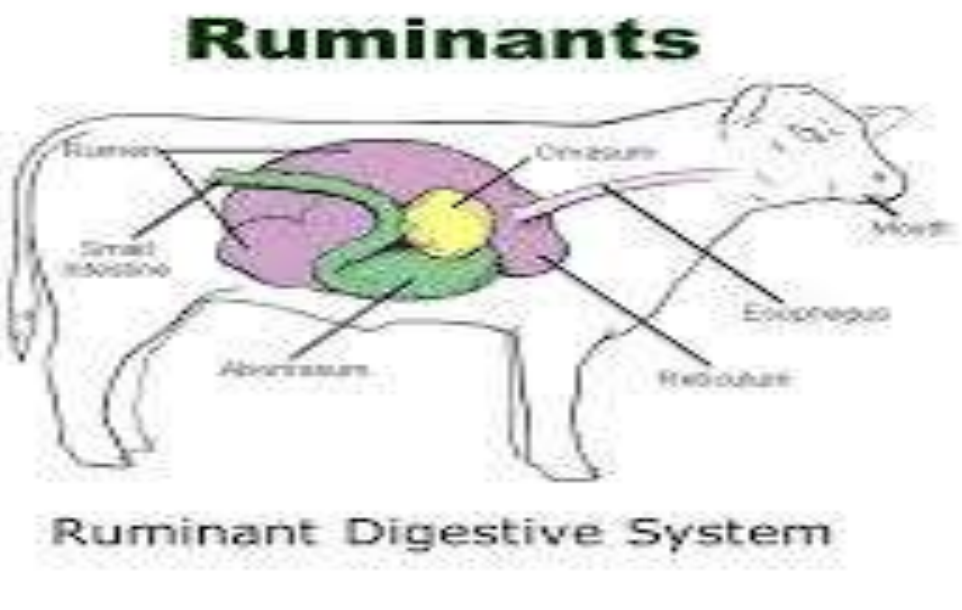
Stomach of ruminant: **4chambers**

1.rumen

2.reticulum **distention of esophagus**

3.omasum.

4.abomasum (proper stomach)



Ruminant contain (esophageal groove) extend from esophagus to omasum, composed from two fold, by closure of these two folds the milk directly pass to omusum to prevent fermentation of milk by rumen microbes (normal active in new born).

Rumen:80%

The digestion of cellulose, carbohydrate and some proteins by anaerobic bacteria and protozoa which converted it to energy.

The result of digestion lead to gases formation co2,CH4,N,O2,H2 which removed by eructation or belching.

***note; increase gases in rumen lead to bloat.**

Reticulum: smallest one direct contact with diaphragm.
Omusum: folded.
Abomasums: proper stomach.

Rumination or regurgitation:

Normal process in ruminant begin within the first week of age(return of rumen continent to the mouth for re mastication). The rumination combined with physiological activity like closure of epiglottis, contraction of diaphragm which lead to change in thoracic pressure and squeeze of rumen continent to oral cavity.

***note: occur 3-9hr/day**
depend upon food nature:
Herb lead to increase rumination.
Concentrated (grain) decrease rumination.

Regulation of gastric secretion:

There are three phases of gastric secretion depending upon region from which stimuli arise:

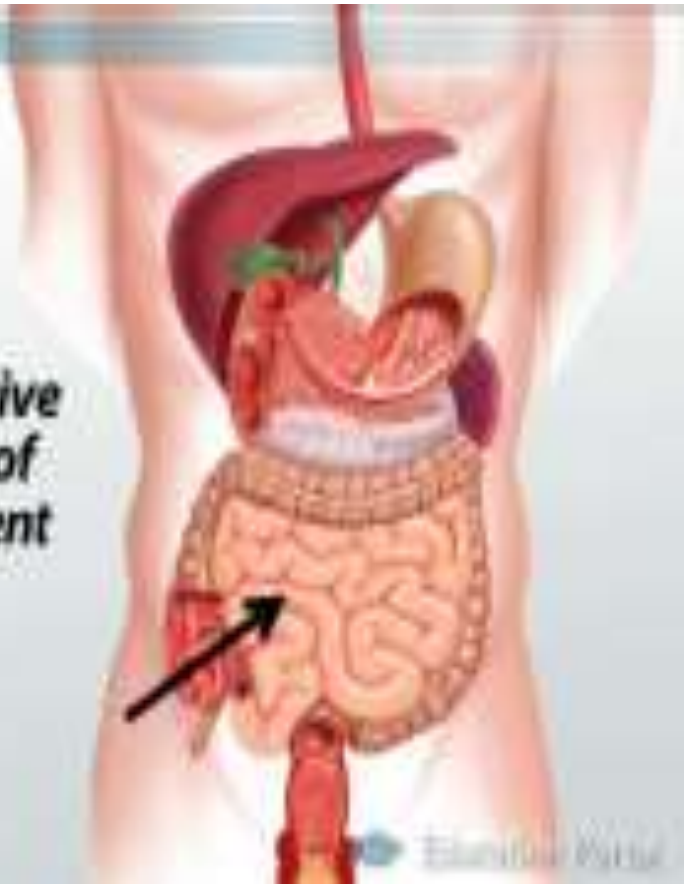
1.cephalic phase or psychic phase: presence of food in mouth,smell,thought,vision,hear.

2.gastric phase: distention of stomach, due to presence of food.

3.intestinal phase: presence of food material within small intestine.

Small Intestine

the section of your digestive tract where the majority of food digestion and nutrient absorption takes place

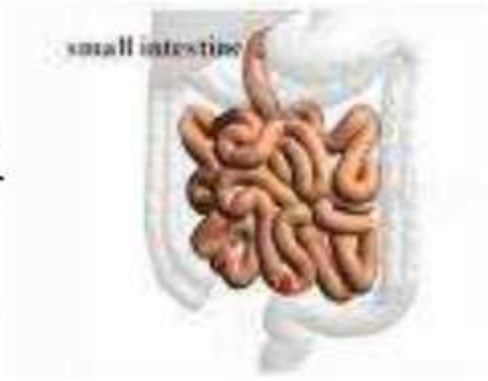


Small intestine

- Function
  - chemical digestion
    - major organ of digestion & absorption
  - absorption through lining
    - over 6 meters!
    - small intestine has huge surface area = 300m^2 (~size of tennis court)
- Structure
  - 3 sections
    - duodenum = most digestion
    - jejunum = absorption of nutrients & water
    - ileum = absorption of nutrients & water

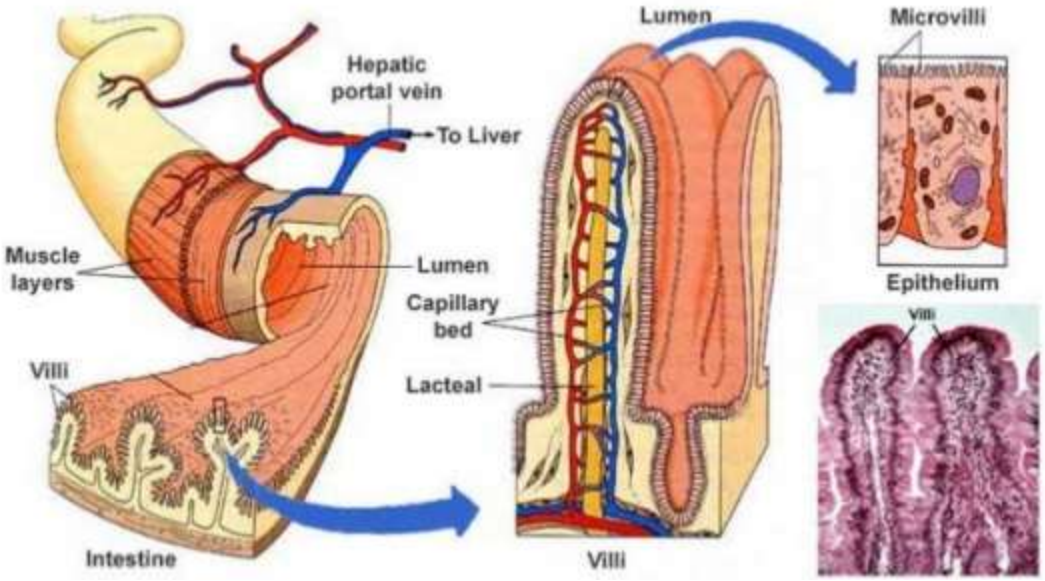
Small Intestine

- Most **chemical digestion** takes place here.
- Simple **sugars** and **proteins** are absorbed into the inner lining.
- **Fatty acids** and **glycerol** go to lymphatic system.
- Lined with villi, which increase surface area for absorption, one cell thick.



Absorption by Small Intestines

- Absorption through villi & microvilli
  - finger-like projections
  - increase surface area for absorption



The large intestine composed from:

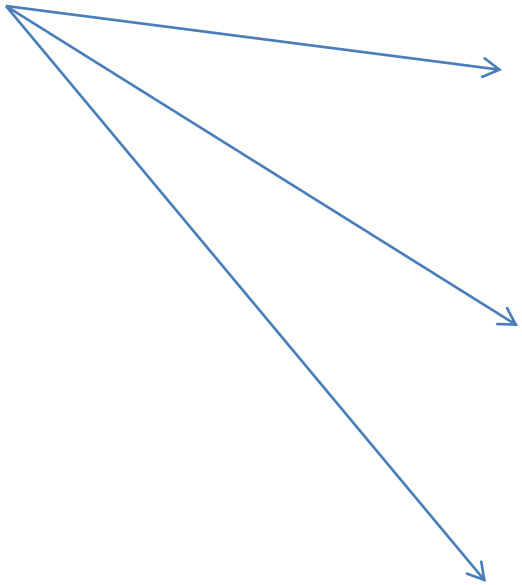
1.cecum: blind ended pouch from which extends the appendix(small finger like project having no known essential function.

The function of cecum in horse for digestion and absorption like rumen in cow,goat and sheep contain microbes.

The appendix

- It's a small tube attached to the **cecum**.
- Originally it was thought that there was no function of the **appendix**, however doctors now believe that it plays an important role in fetus and adolescent development. The **appendix** releases hormones and endocrine cells as well as it is involved in the production of good bacteria in the **intestines**.

2.colon ;which divided into:



asending

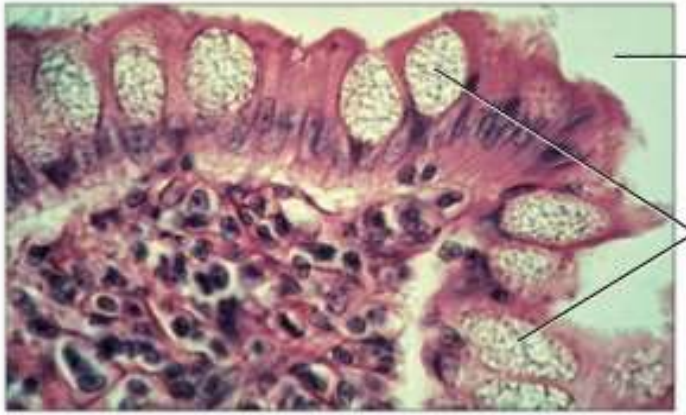
Transverse

desending

3.rectum:straight segment ends in anus.

Functions of the Large Intestine

- The large intestine:
  - Has little or no digestive function
  - Absorbs water and electrolytes
  - Secretes mucus
  - Houses intestinal flora
  - Forms feces
  - Carries out defecation



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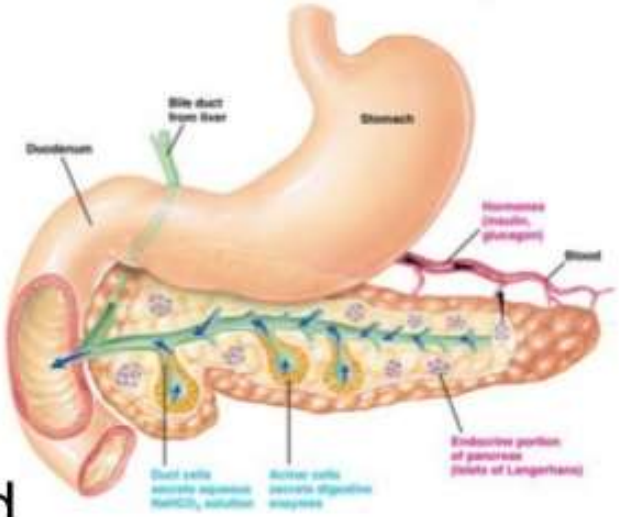
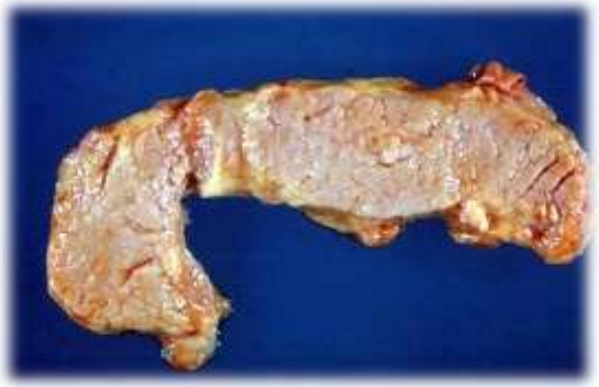
Pancreas: dual function

- Produces ***pancreatic fluid*** that breaks down all categories of food
- Pancreatic fluid is secreted into the duodenum
- The alkaline fluid introduced neutralizes acidic chyme
- <u>Endocrine products</u>:
  - Insulin
  - Glucagons

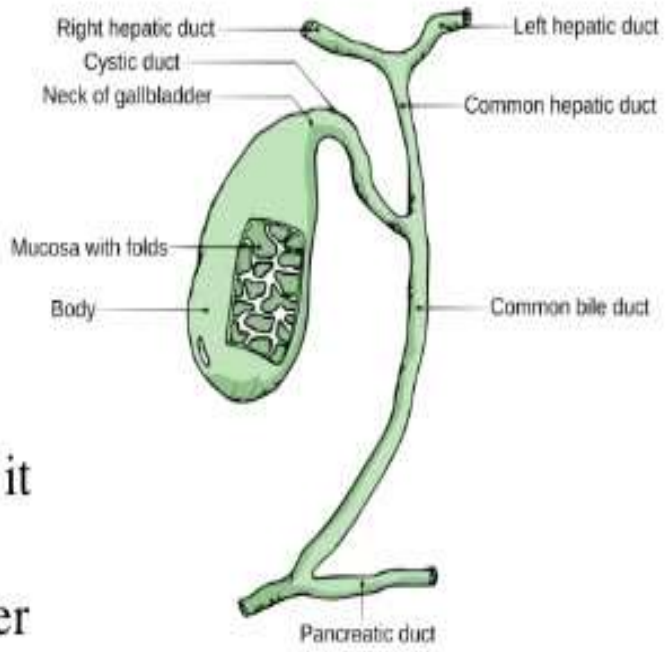




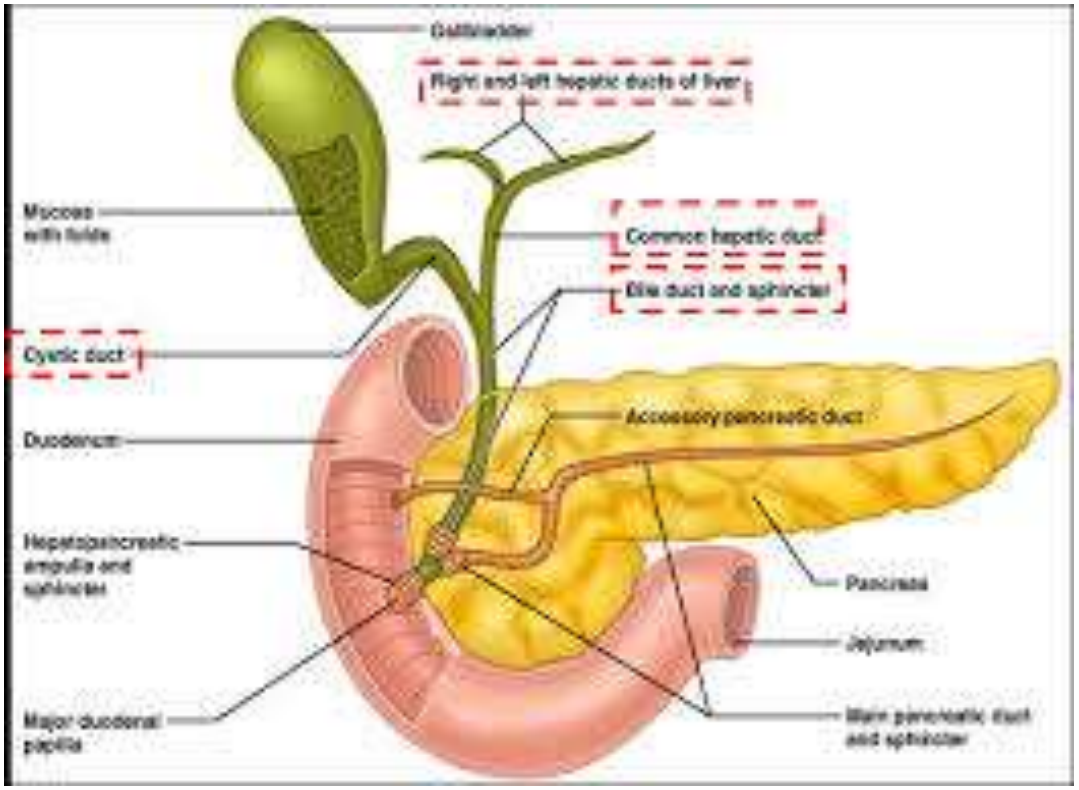
The removal of pancreas lead to difficult in lipid digestion, the feces in this state is fatty and mud color (steatorrhea).

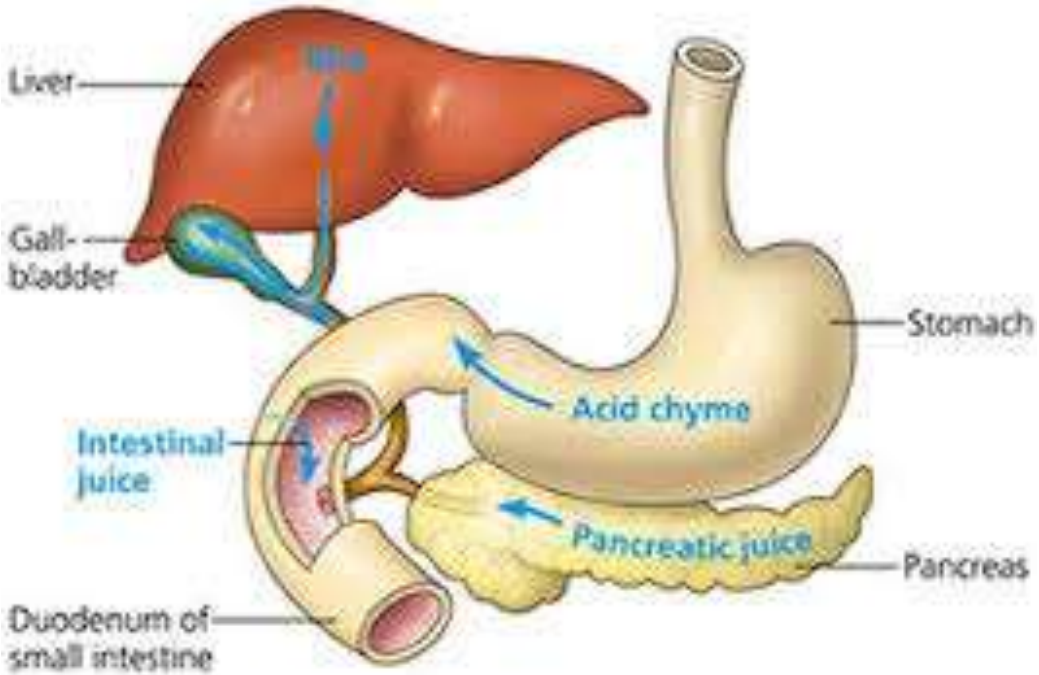
GALL BLADDER FUNCTION

- Thin-walled green muscular sac about 10 cm long, about the size of a **kiwi fruit**.
- **Stores bile** that is not immediately needed for digestion.
- When gall bladder fills with bile, it expands.
  - Contraction of muscularis layer ejects bile into the **common bile duct**.
- When small intestine is empty, **sphincter of Oddi** closes.



*__Gallstones__ are cholesterol that have crystallized within the gall bladder.


Gallbladder
Right and left hepatic ducts of liver
Mucosa with folds
Common hepatic duct
Bile duct and sphincter
Cystic duct
Accessory pancreatic duct
Duodenum
Hepatopancreatic ampulla and sphincter
Pancreas
Jejunum
Major duodenal papilla
Main pancreatic duct and sphincter


Liver
Bile
Gall-
bladder
Stomach
Acid chyme
Intestinal
juice
Pancreatic juice
Pancreas
Duodenum of
small intestine

What is the liver?

- The liver is a vital organ with many important functions.

The liver

- removes harmful chemicals from the blood
- fights infection
- helps digest food
- stores nutrients and vitamins
- stores energy

Liver Functions

1. Carbohydrate metabolism
   - Polysaccharide stored in liver as glycogen
   - Converts glycogen, fructose, galactose, lactic acid, amino acids → glucose to ↑ blood glucose
2. Lipid metabolism
   - Produces cholesterol, triglycerides; makes bile
   - Makes lipoproteins for lipid transport
3. Protein metabolism
   - Remove NH_2 from amino acids → ammonia (NH_3) → urea → to kidneys (urine)
   - Synthesize most plasma proteins: albumin

Motility of GIT:

Gastric Motility

-Peristalsis

small intestine motility

- peristalsis
-segmentation
-pendular
-villi

large intestine motility

-peristalsis
-antiperistalsis
-saculation

Gastric motility(peristalsis):

this movement propel food forward along the tract(stimulus of single section of gut causes ring to move forward along the gut pushing any material in the gut ahead of contraction, this type occur in all segment of GIT but intensity and frequency vary from one part of tract to another.

In stomach is strong that is with 1-3 hr causes movement of food through stomach after meal.

In small intestine very weak require 3-10hr to move food .

In large intestine is very strong but lastly only a fraction of an hour out of each day to allow re absorption of all most all the electrolyte and water before expulsion of feces.

*the peristalsis movement is anal ward direction rather than up ward direction.

The peristalsis movement in stomach begin from cardiac region to pyloric region this for empty of stomach.

If the empty stomach remain for long time lead to hunger contraction.

Motility of small intestine:

1. peristalsis movement.
2. segmintation movement.
3. pendular movement.
4. villi movement.

Peristalsis movement:

The stimulus begin with the entrance of chyme to small intestine lead to distention → stimulation of mynetric plexus → contraction of circular smooth muscle of intestinal wall ahead of distention.

This weak movement provide adequate time for digestion and absorption.

Segmentation movement:

Special movement promote :

1.mixing food with GIT secretion(pancreas,Gall bladder).

2.promote attachment of chyme with intestinal wall for increase absorption.

3.promote intestinal blood and lymph flow.

This type of movement not affected the pushing the intestinal content but dividing the intestine into segments. In this way the chyme is chopped again and again.

Pendular movement(swinging):

Swinging the intestine back and forth (elongation and shorten) this movement mix chyme with GIT secretion , also increase absorption, not affected to push of intestinal content.

Villi movement:

Villi increase surface area of absorption, the contraction of villi is fast but relaxation is slowly is to empty its content to blood and lymph.

Motility of large intestine:

Generally the movement of large intestine is irregular and slowly. the main movement is

1.peristalsis: which is slowly but strong lastly only fraction of an hour out of each day. This allow for water and electrolyte re absorption. this movement propel lead to push the large intestine content to rectum.

2.antiperistalsis movement:

delay push of large intestinal content to rectum. This for increase re absorption of water and electrolytes before expulsion of feces.

3.sacculation movement: (equine)

similar to pendular movement of small intestine this movement for mixing and increase absorption.

Defication :

This reflex begin with stimulation of nerve receptor of rectum → spinal cord nerve impulses through the parasympathetic to colon and rectum contraction of colon and rectum and at the same time relaxation of internal and external muscle of sphincter this lead to expulsion of feces.

The deification is combined by contraction of abdominal muscle and diaphragm , closure of epiglottis for increase pressure inside intestinal cavity.

Nitrogen cycle in ruminant: or protein regeneration cycle

The result of protein digestion is amino acids.

The digestion of amino acids is urea.

The ruminant utilize urea for protein synthesis when protein is little in food.

Rumen contain microbes and protozoa which utilize urea by urease enzyme to ammonia and CO_2.

Decrease urea concentration inside rumen lead to transport of urea from blood circulation to rumen.

Sources of rumen nitrogen:

1.urea of parotid salivary gland.

2.blood.

3.food nitrogen.

Regulation of GIT process:

1.basic principle:

a.distention of GIT wall.

b.chyme osmolarity.

C.chyme acidity.

d.chyme concentration.

2.neural regulation:

parasympathetic and sympathetic.

3.hormonal regulation:

a.gastrin

b.secretin.

c.cholecystokinin.

Avian digestive system:

1.length of GIT is shorter in birds relative to animal.

2.bird lacks teeth and heavy jaw muscle which have been replaced with a light weighted beak.

3.food particles are swallowed whole and then reduced in size by ventricular or gizzard.
4.birds unlike mammals have no distinction between pharynx and mouth (oropharynx).
5.esophagus is divided into cervical and thoracic .

6.the cervical esophagus expanded to form crop.

7.stomach composed from two chamber:

a. proventicular (glandular) which site of acid secretion.

b.gizzard (muscularis)mechanical digestion.

8.ceca (cecum) at junction between ileum and rectum.

9.the rectum some time called colon.

10.cloaca common pathway instead of anus.

The cloaca contain3 opening of 3 systems(digestive,renal,reproductive).