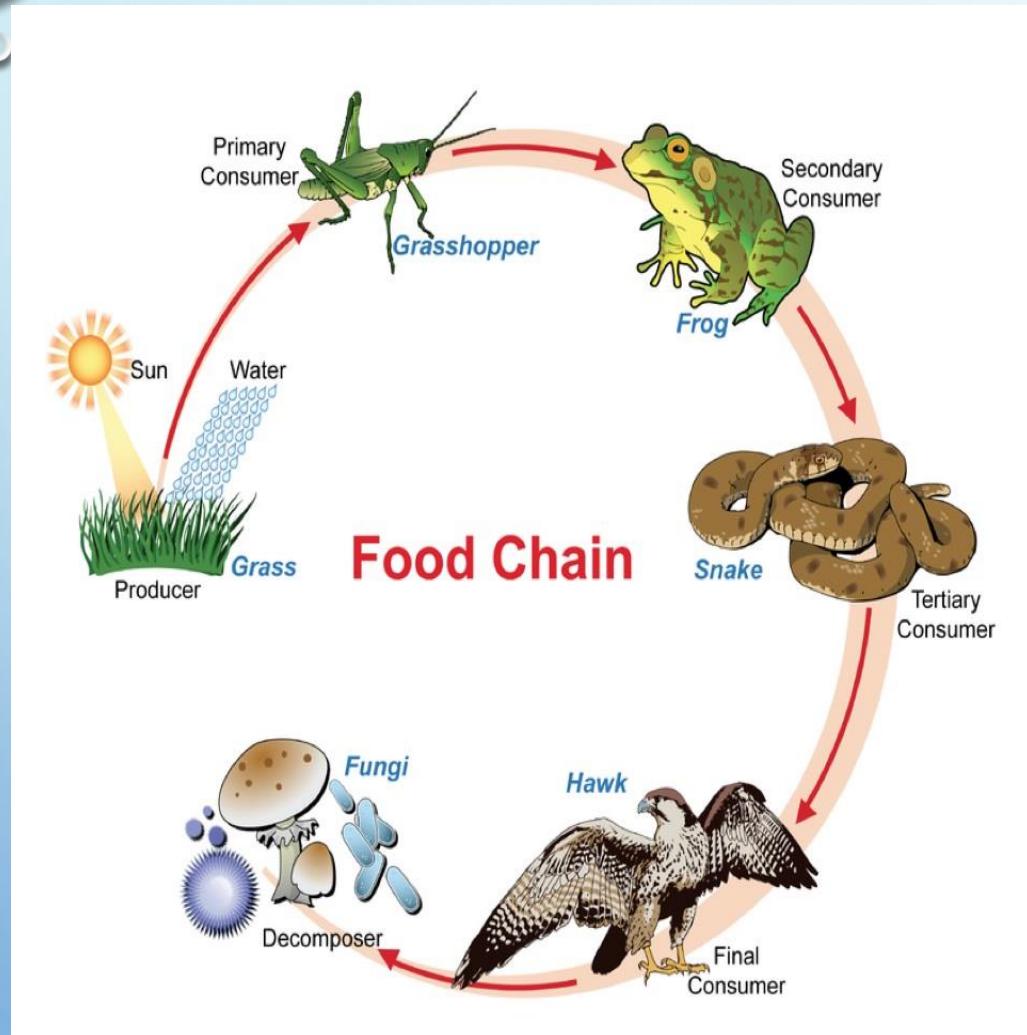


# **HETEROTROPHIC NUTRITION**

**ORGANISMS OBTAIN NUTRIENTS FROM ALREADY MADE  
ORGANIC COMPOUNDS FROM OTHER ORGANISMS**

# **EXAMPLES INCLUDE:**

- MAINLY CHEMOHETEROTROPHIC ORGANISMS
  - HOLOZOITS
  - PARASITES
  - SAPROHYTES
  - COMMENSALS
  - INSECTIVOROUS PLANTS
- PHOTOHETEROTROPHS
  - PURPLE NON-SULPHUR BACTERIA



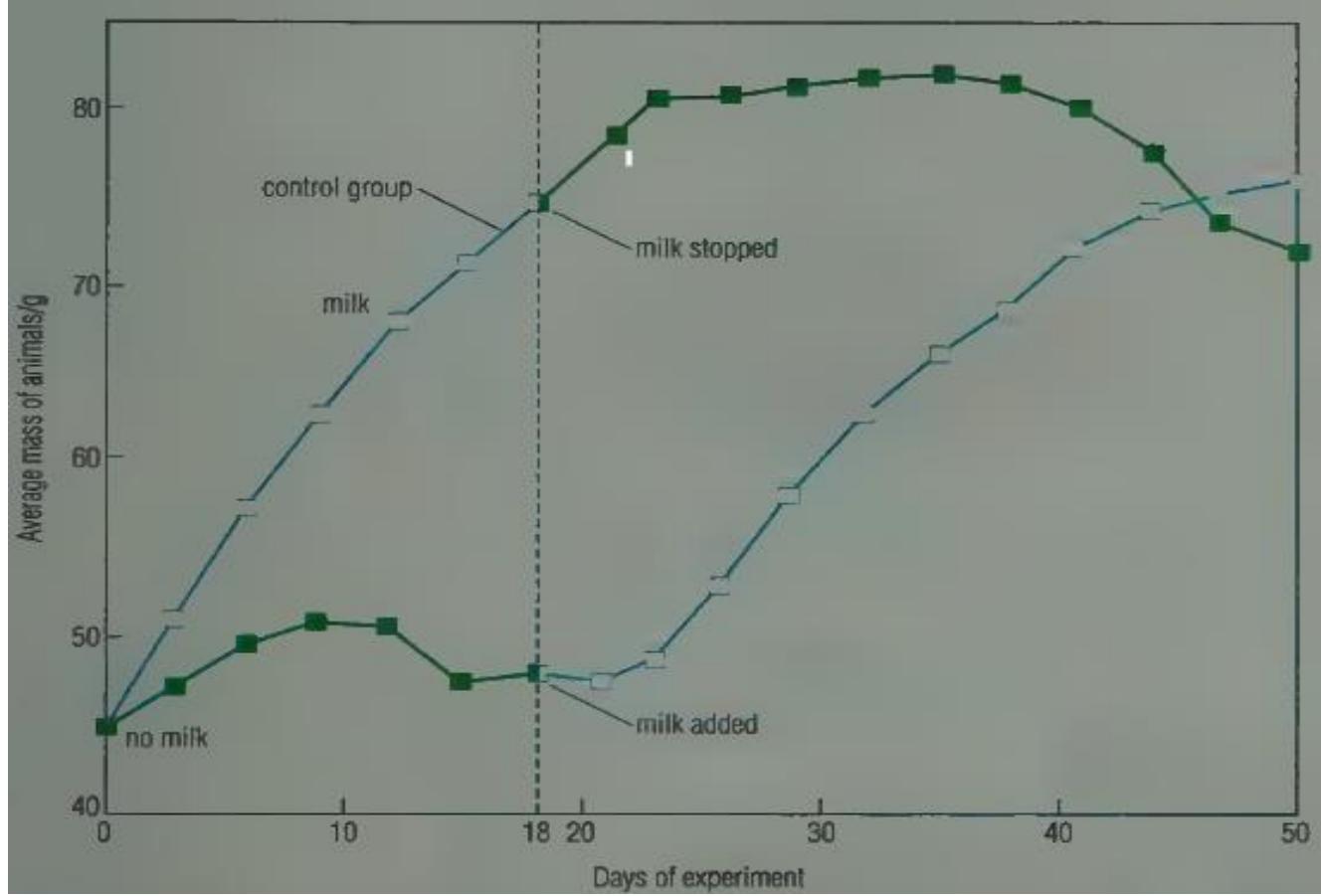
- SUCH ORGANISMS ARE UNABLE TO MAKE THEIR OWN FOOD
  - CONSUMERS.
  - ANIMALS, INSECTIVOROUS PLANTS, FUNGI AND SOME BACTERIA.

**ECOLOGICALLY REFERRED TO AS  
CONSUMERS**

# **ASSIGNMENT**

- 1. WHAT IS MEANT BY THE TERMS “FOOD” AND “BALANCED DIET”?**
- 2. STATE THE COMPONENTS OF THE BALANCED DIET;  
STATING CLEARLY THE ROLE OF EACH IN THE BODY**
- 3. STATE THE GENERAL IMPORTANCE OF FOOD IN  
ORGANISMS**

# MILK



- THE ONLY FOOD IN THE FIRST DAYS IN THE LIFE OF A MAMMAL
- IT IS SUFFICIENT BECAUSE IT CONTAINS ALL NUTRIENTS NEEDED FOR PROPER GROWTH
- HOWEVER; IT IS INSUFFICIENT TO ADULT MAMMALS DUE TO SHORTAGE OF IRON AND ROUGHAGES
- YOUNG MAMMALS STORE ENOUGH IRON IN THE LIVER BEFORE BIRTH

# **FORMS OF HETEROTROPHIC NUTRITION**

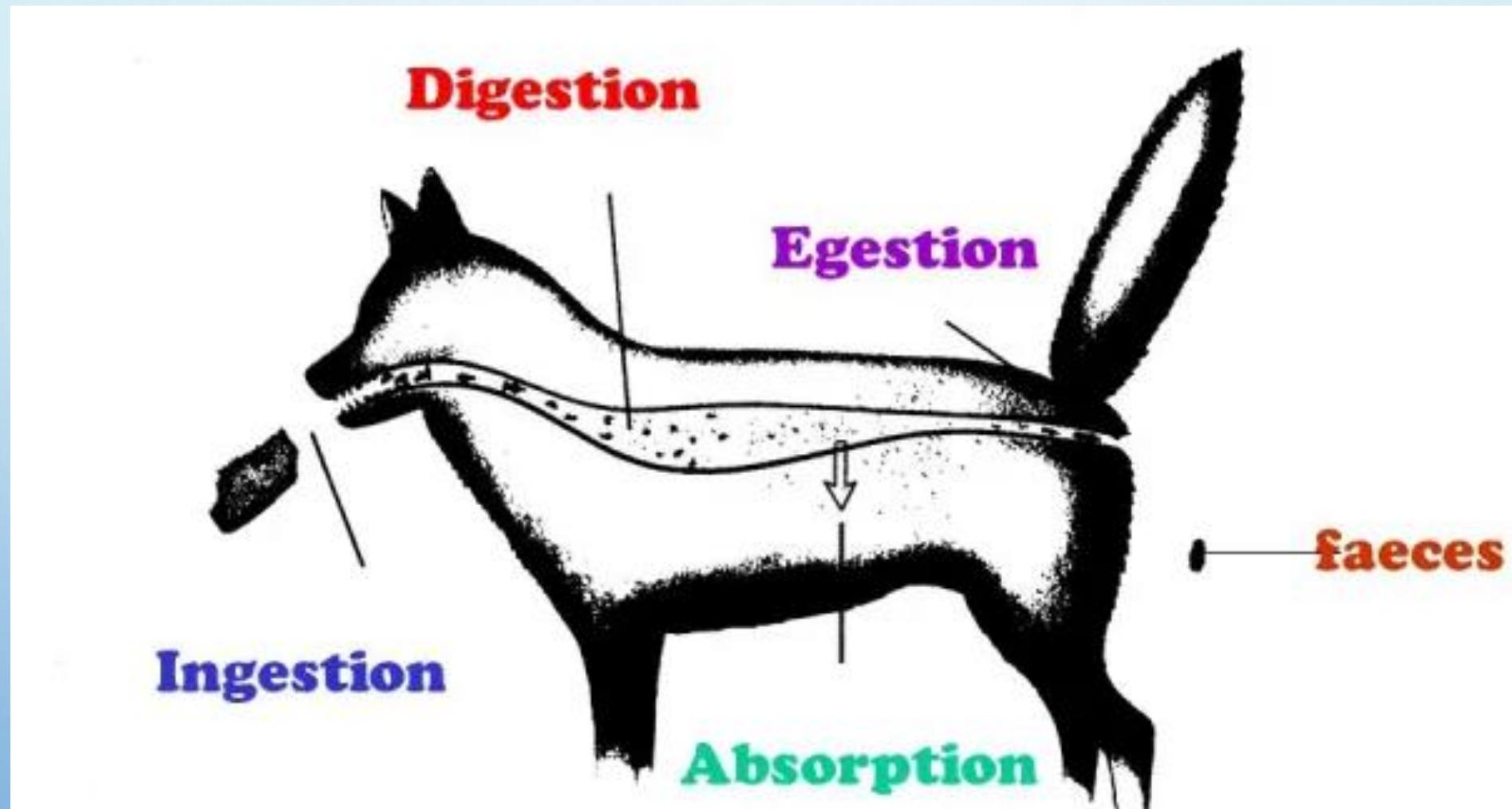
- **HOLOZOIC NUTRITION**
- **SAPROPHYTISM**
- **SYMBIOSIS – MUTUALISM, COMMENSALISM & PARASITISM.**

# HOLOZOIC NUTRITION

THE INTAKE OF SOLID FOOD BROKEN DOWN INTO

SMALLER PARTICLES WHICH ARE ABSORBED

- SPECIALIZED DIGESTIVE TRACT



# STAGES INVOLVED

- **INGESTION:** THE INTAKE OF SOLID FOODS INTO THE BODY THROUGH THE MOUTH
- **DIGESTION:** THE BREAKDOWN OF FOOD INTO SMALLER ABSORBABLE PARTICLES.
- **ABSORPTION:** PROCESS BY WHICH SOLUBLE PRODUCTS OF DIGESTION PASS FROM THE GUT INTO THE BLOOD STREAM.
- **ASSIMILATION:** - THE PROCESS BY WHICH ABSORBED FOOD IS UTILIZED BY THE BODY.
- **EGESTION:** ELIMINATION OF UNDIGESTED FOOD MATERIAL FROM THE BODY THROUGH ANUS

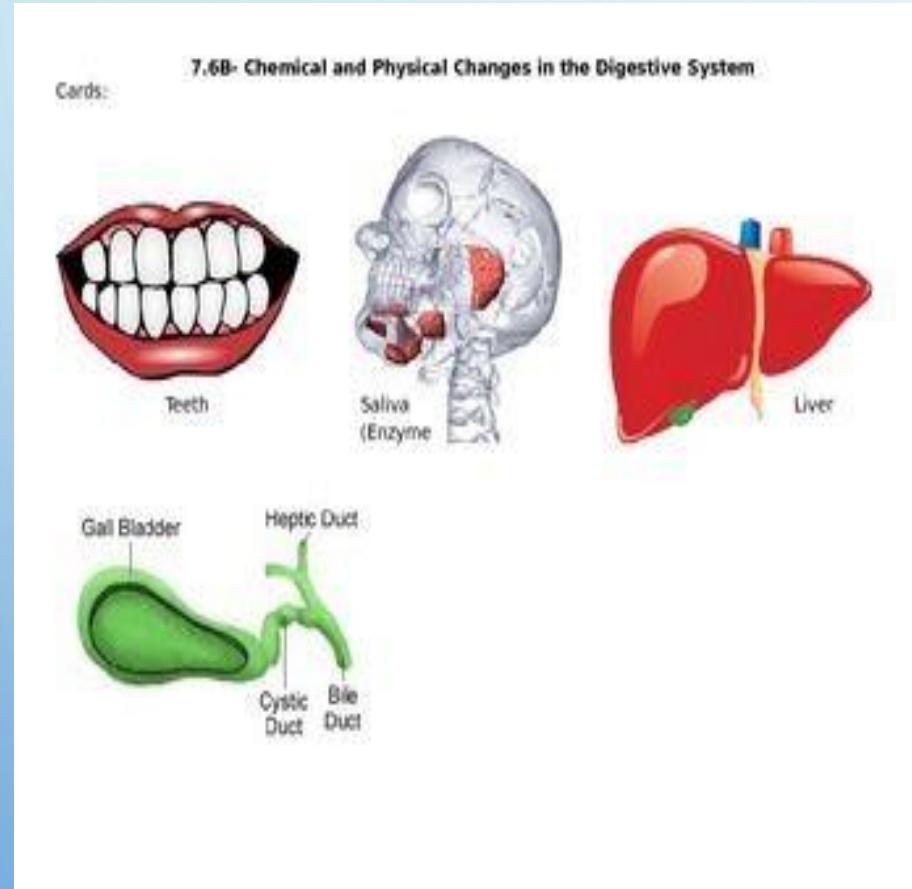
## **ACCORDING TO THE NATURE OF FOOD .....**

- **HERBIVORES**; THESE FEED ENTIRELY ON PLANT MATERIAL.
  - **GRAZERS** - COWS, ANTELOPES ETC.
  - **BROWSERS** - GOATS AND GIRAFFES
- **CARNIVORES**; THESE FEED ON FLESH. - LION, CAT, CHEETAH
- **OMNIVORES**; THESE FEED ON BOTH PLANTS AND ANIMALS
  - MAN AND PIGS

# DIGESTION IN MAN

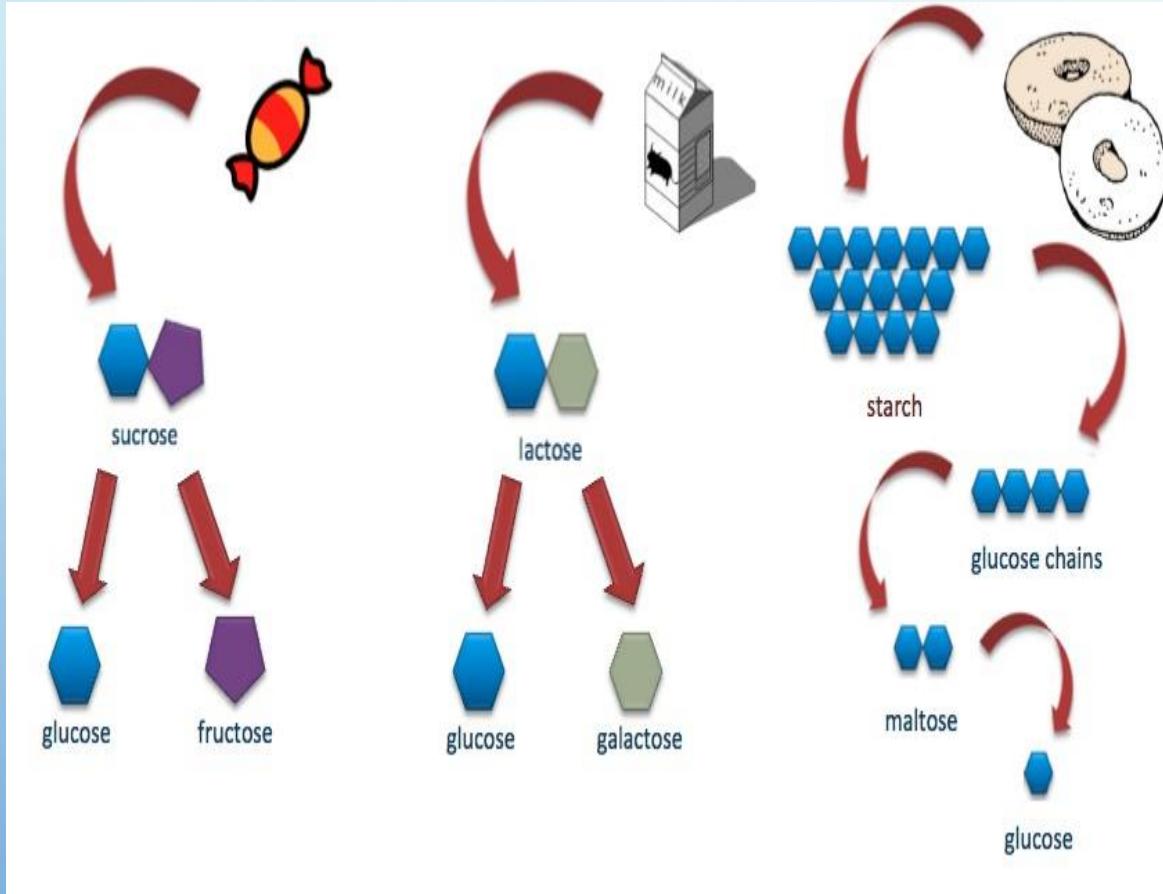
*THE PROCESS BY WHICH FOOD IS BROKEN DOWN INTO SMALLER  
SOLUBLE PARTICLES THAT CAN BE ABSORBED INTO THE BODY*

# TYPES OF DIGESTION



- **PHYSICAL DIGESTION - BREAKDOWN OF FOOD WITHOUT CHANGE IN THE CHEMICAL NATURE**
  - INCREASING THE SURFACE AREA
- **IT INVOLVES:**
  - **MASTICATION – BY TEETH**
  - **EMULSIFICATION - BY BILE SALTS**
  - **RHYTHMIC CONTRACTION OF MUSCLES.**

# CHEMICAL DIGESTION

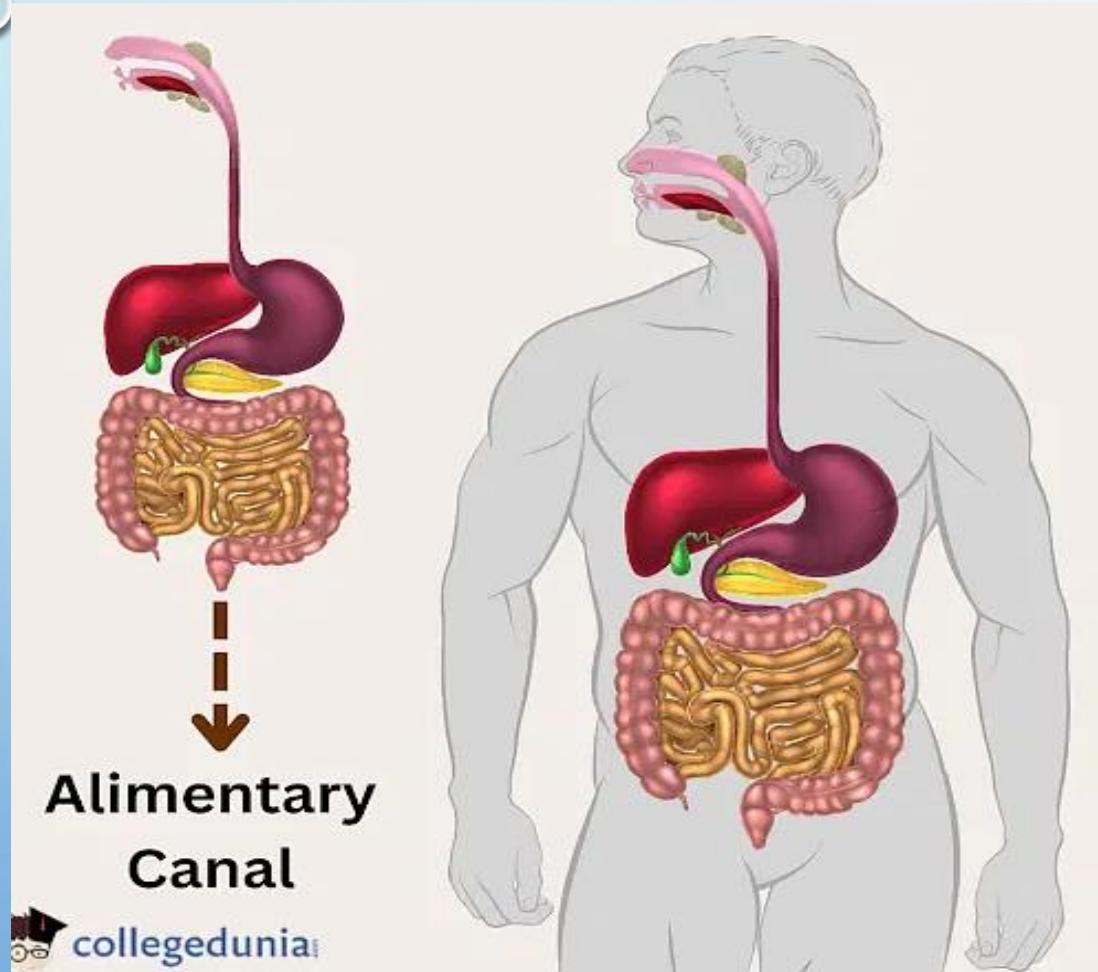


- THE BREAKDOWN OF FOOD INTO SMALLER PARTICLES WITH CHANGE IN THE CHEMICAL NATURE
- IT OCCURS BY MEANS OF ENZYMES

# THE HUMAN DIGESTIVE SYSTEM

**COMPRISED OF THE ALIMENTARY CANAL AND ASSOCIATED  
ORGANS**

# THE ALIMENTARY CANAL



- A MUSCULAR TUBE RUNNING FROM THE MOUTH TO THE ANUS OF AN ORGANISM.
- IT IS A SITE FOR DIGESTION AND ABSORPTION OF FOOD

## **ASSOCIATED ORGANS INCLUDE ....**

- LIVER
- GALL BLADDER
- PANCREAS
- SALIVARY GLANDS
- TONGUE
- TEETH

## The digestive tract:

## Accessory organs:

### 1. Mouth

Site of mechanical and chemical processing  
(tongue manipulates food so that teeth can chew food; saliva digests carbohydrates)



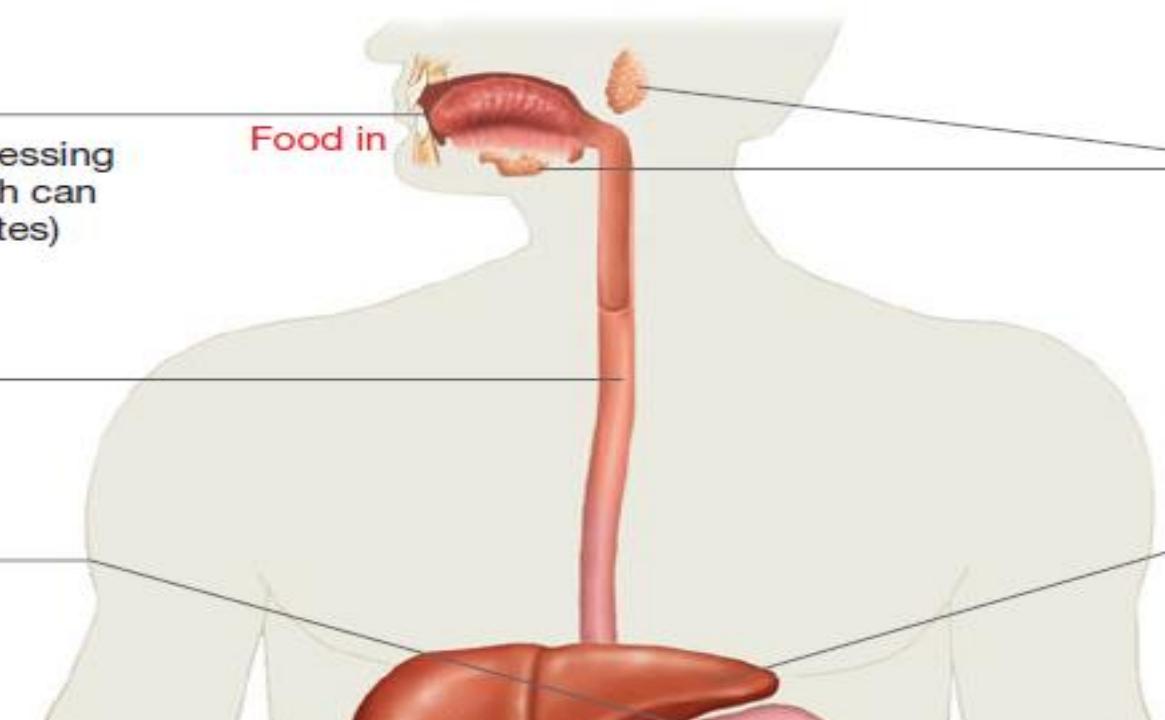
**Salivary glands**  
Secrete enzymes that digest carbohydrates; supply lubricating mucus

### 2. Esophagus

Transports food

### 3. Stomach

Site of mechanical and chemical processing (digests proteins)

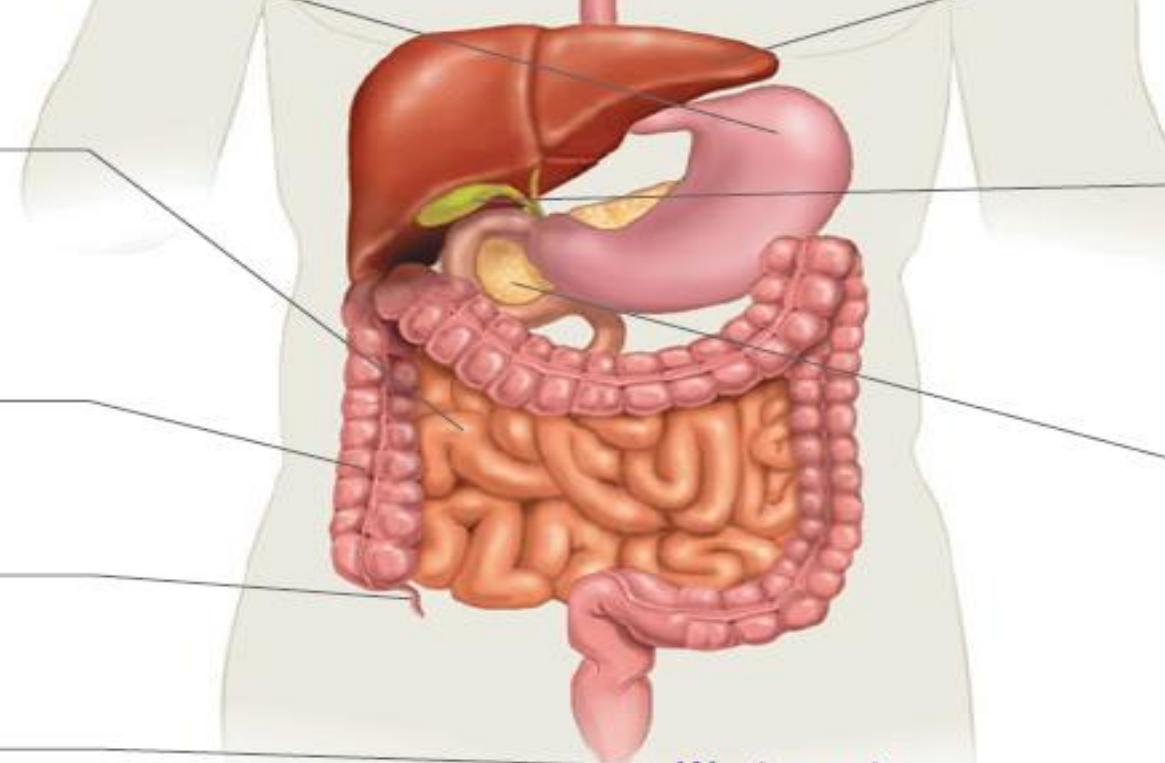


## Liver

Secretes molecules that aid in fat digestion

### 4. Small intestine

Site of chemical processing and absorption (digests proteins, fats, carbohydrates; absorbs nutrients and water)



## Gallbladder

Stores secretions from liver; empties into small intestine

### 5. Large intestine

Absorbs water and forms feces; contains symbiotic bacteria

## Pancreas

Secretes enzymes and other materials into small intestine

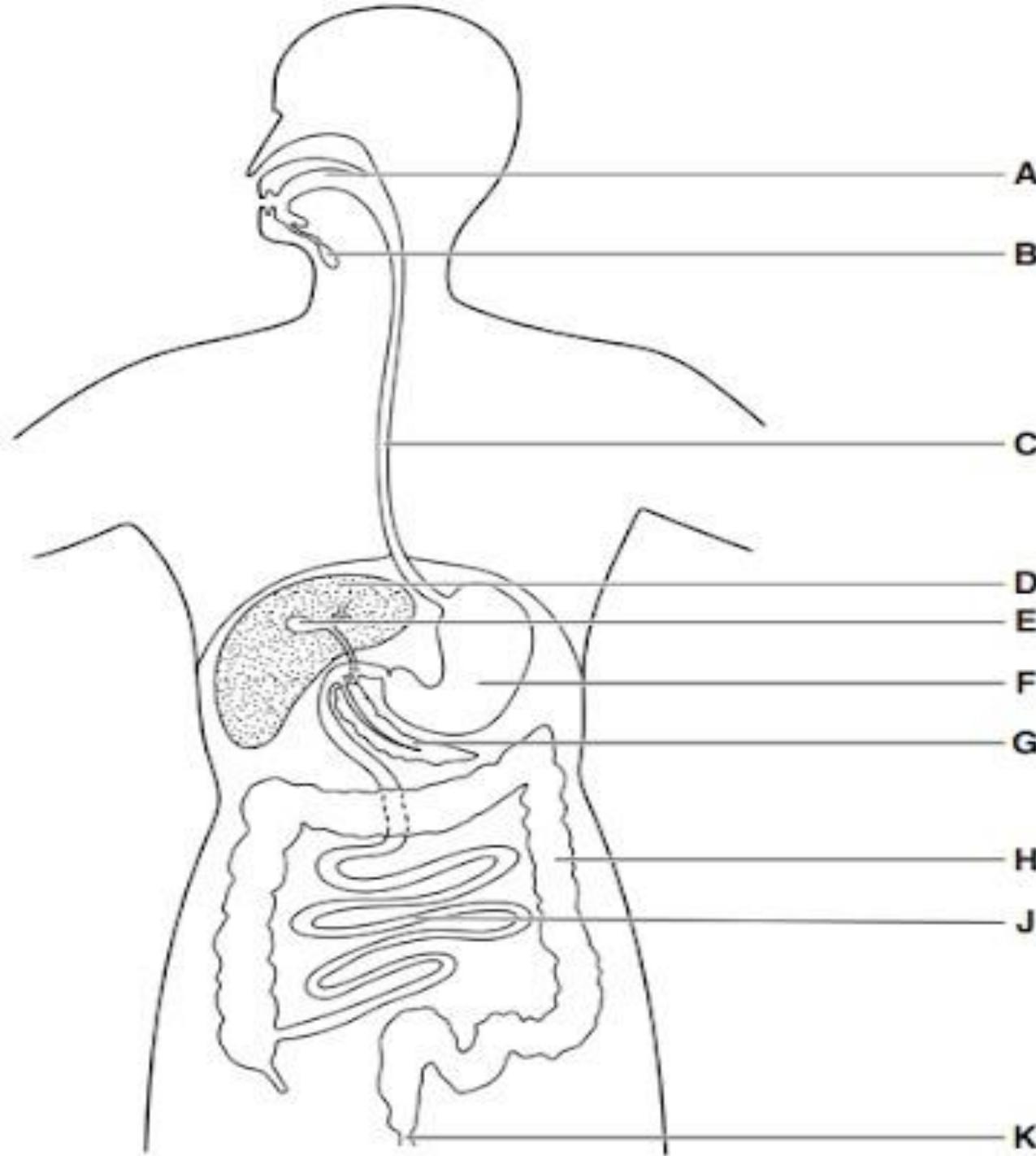
### 6. Appendix

Contains immune tissue; harbors symbiotic bacteria

### 7. Anus

Eliminates feces

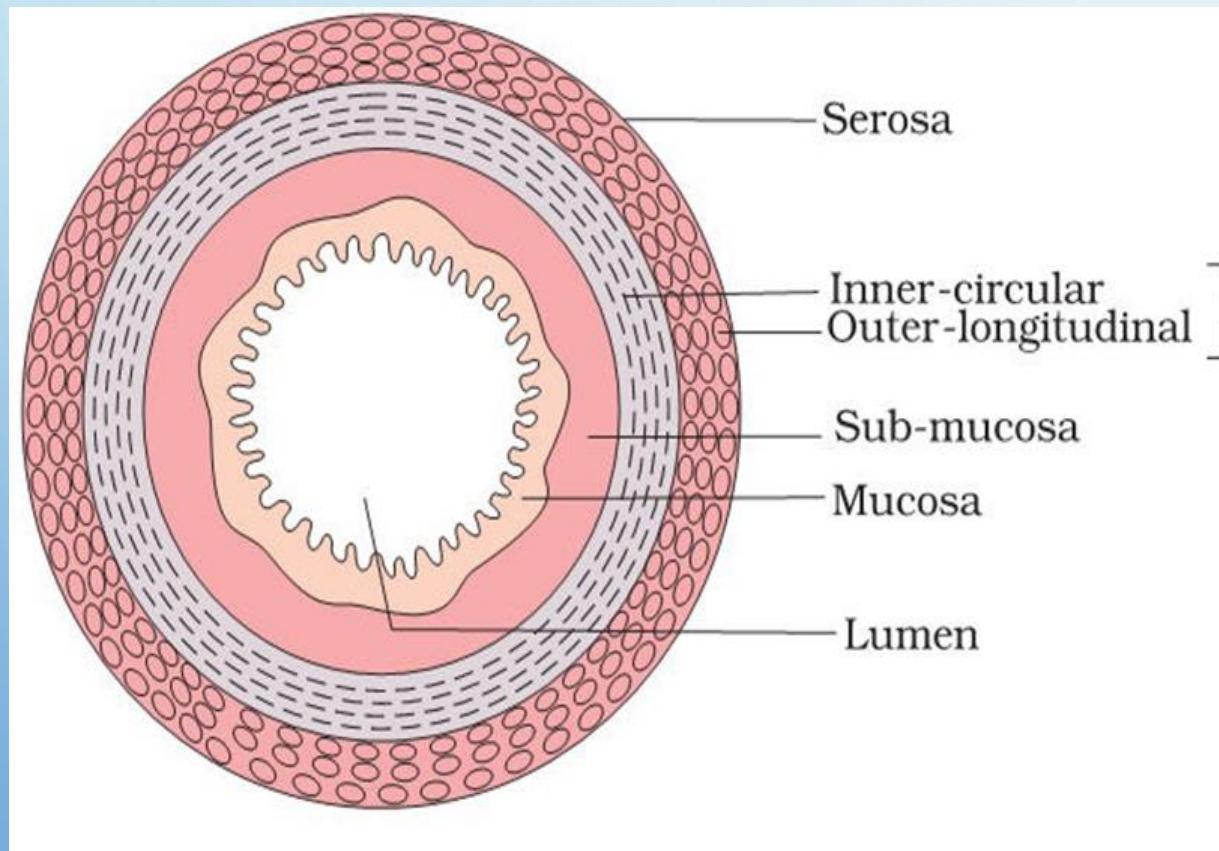
Wastes out



# **CROSS SECTION THROUGH THE ALIMENTARY CANAL**

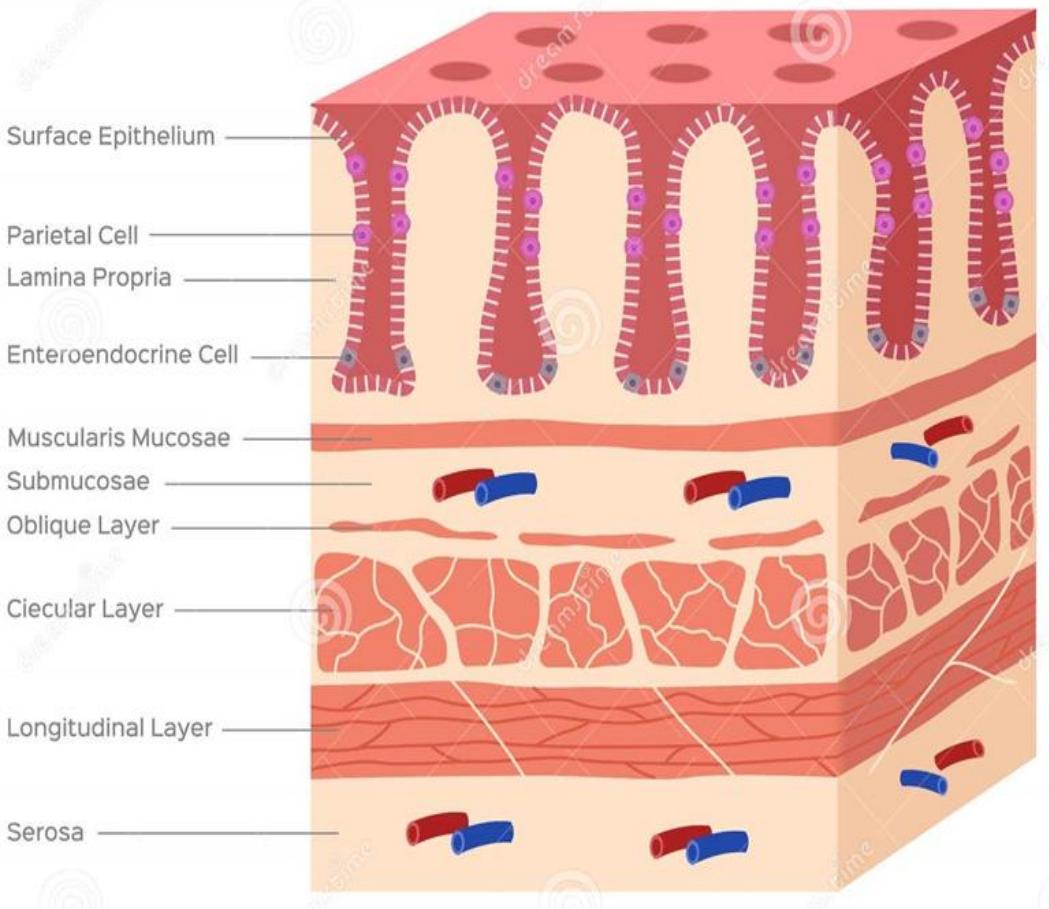
***FOUR DISTINCT LAYERS***

**....VARY IN THICKNESS AND COMPOSITION**

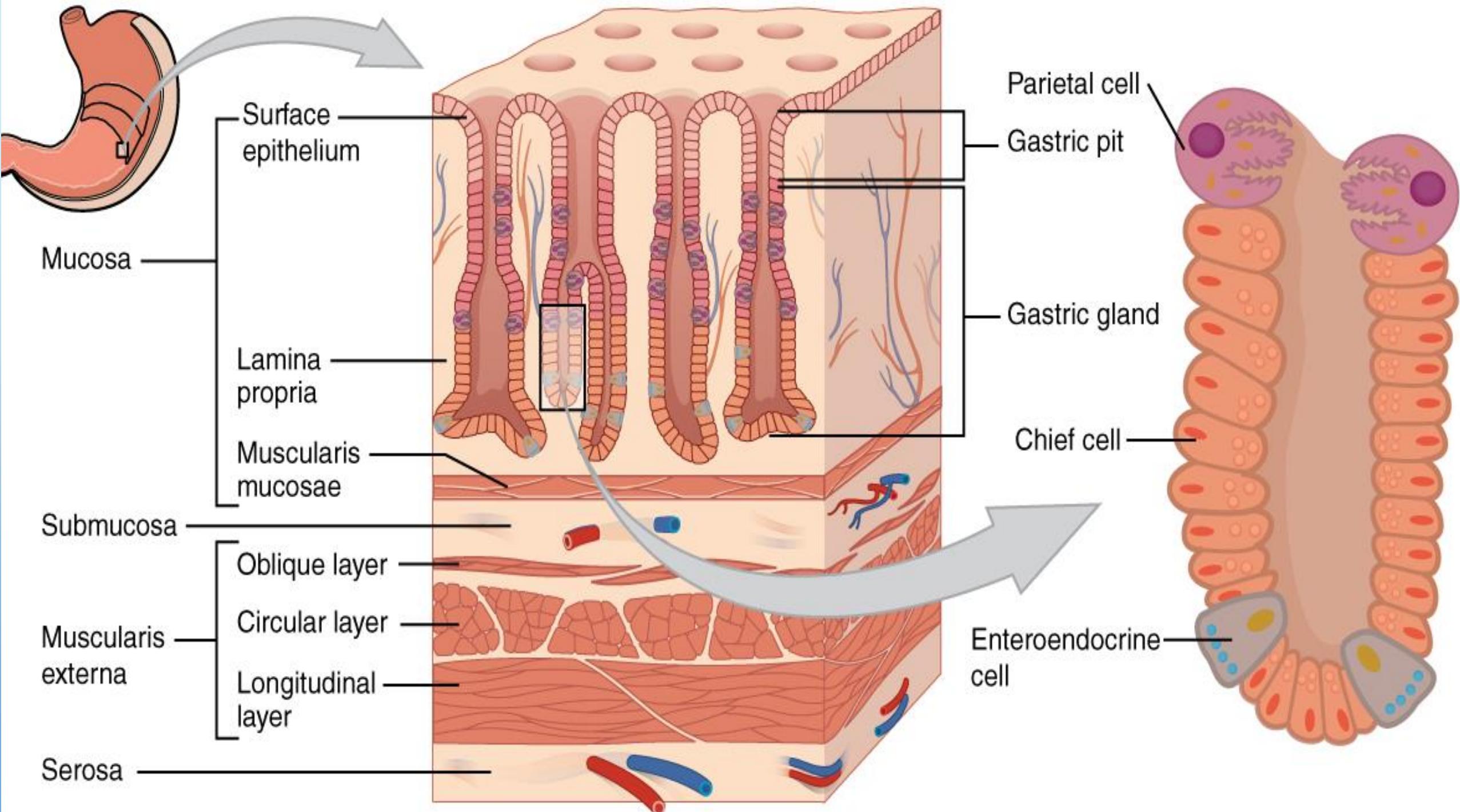


- MUCOSA
- SUBMUCOSA
- MUSCULARIS EXTERNA
- SEROSA

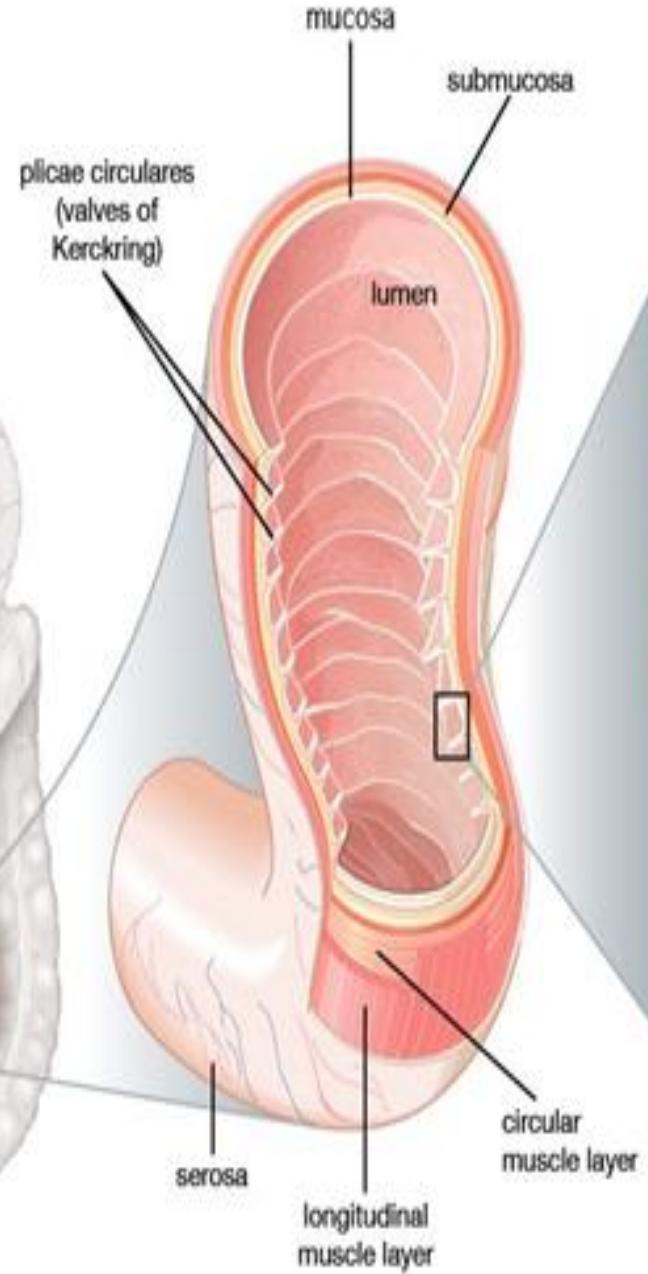
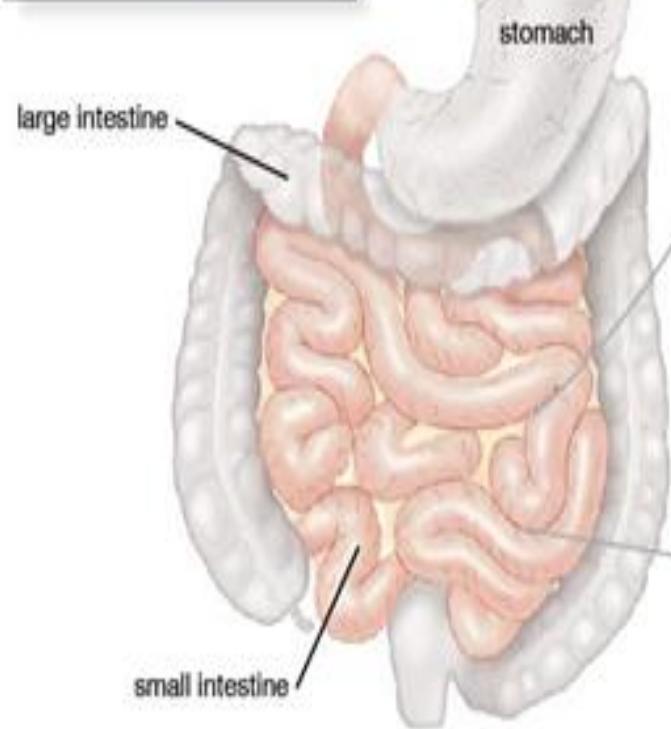
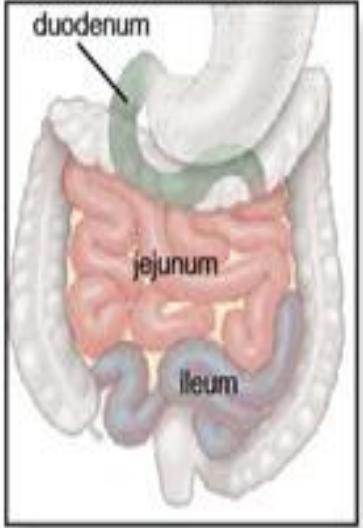
# THE MUCOSA



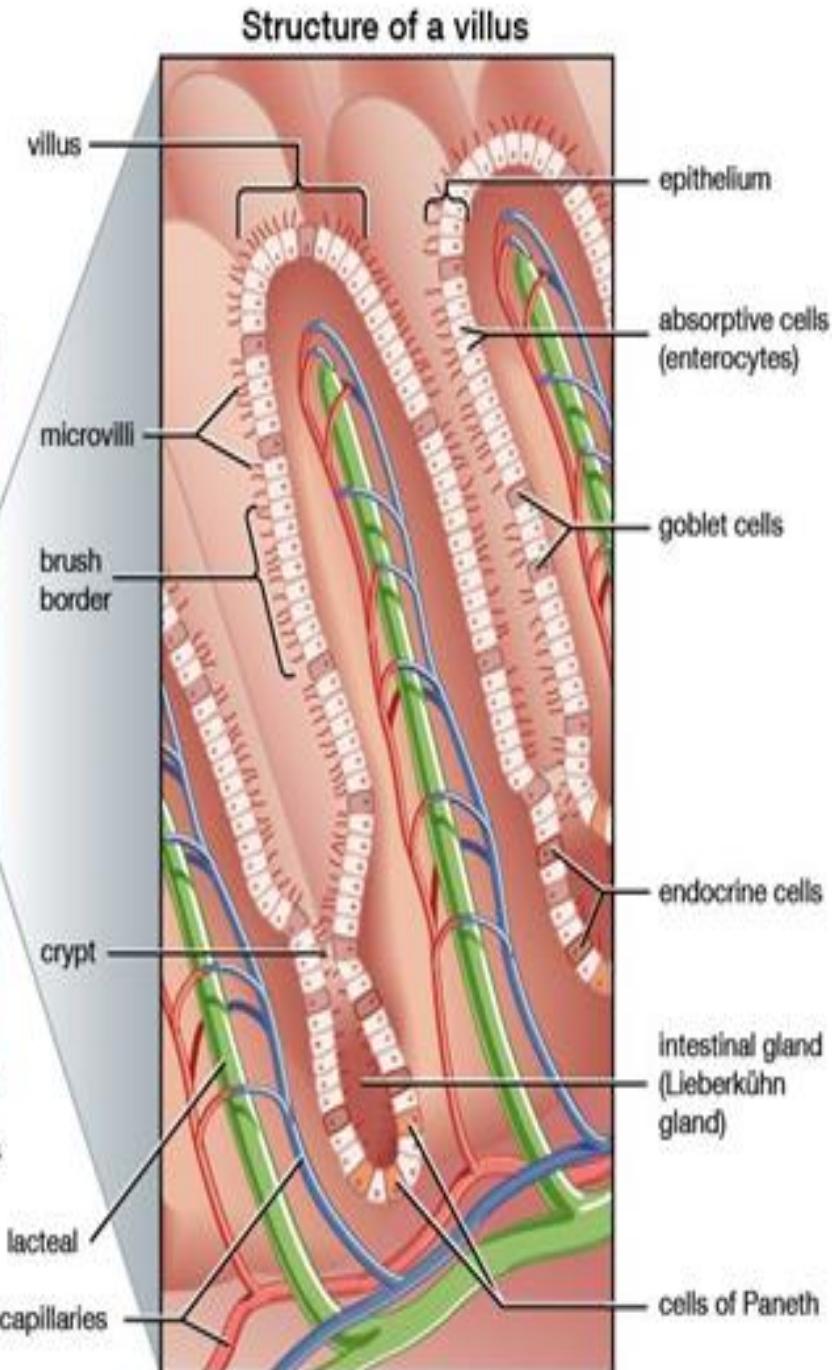
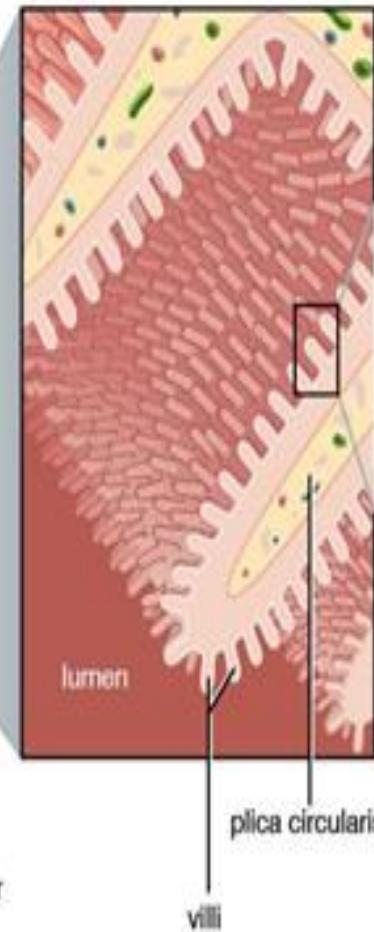
- INNERMOST LAYER
- MAINLY COMPOSED OF GLANDULAR EPITHELIUM
  - SECRETES MUCUS AND ENZYMES.
- IN THE OESOPHAGUS – NON KERATINISED STRATIFIED EPITHELIUM-PROTECTION.
- IN THE ILEUM – NUMEROUS MICROVILLI
  - SURFACE AREA.



## Regions of the small intestine



## Enlargement of plicae circulares



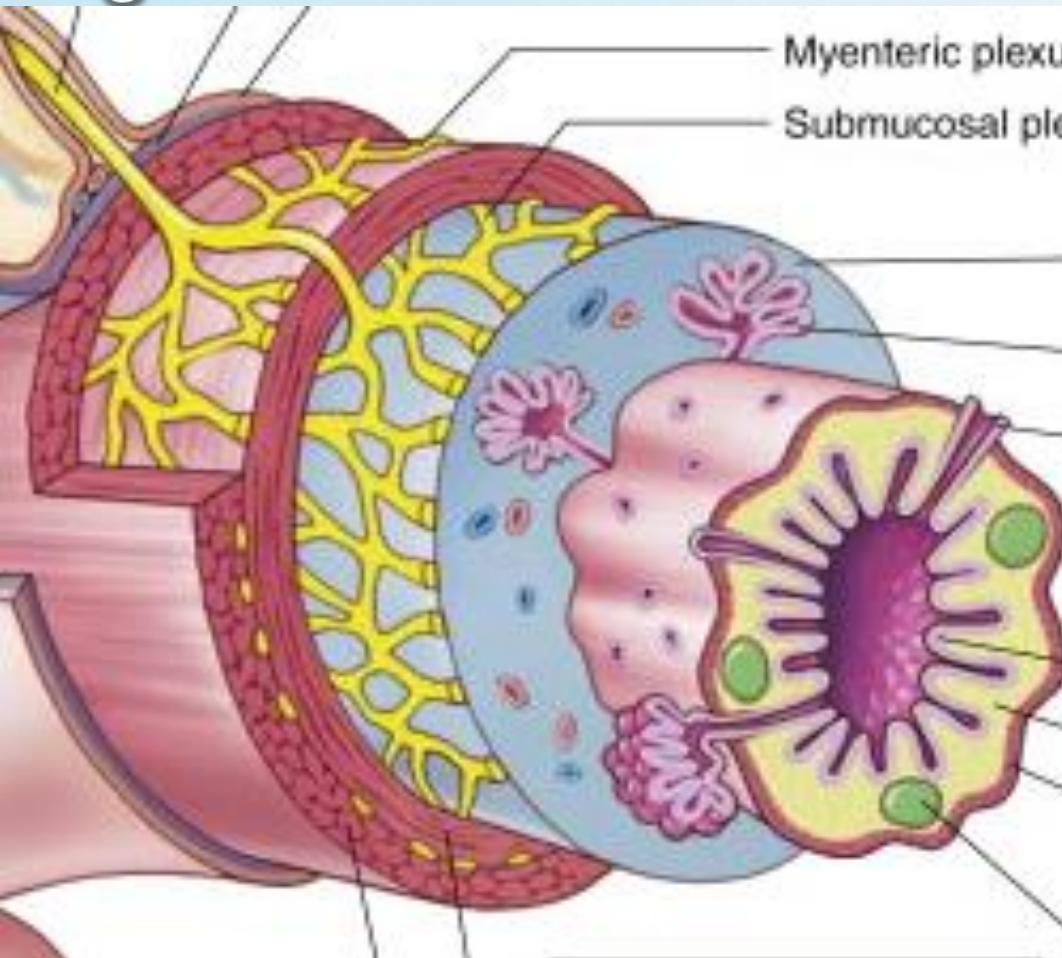
- **ALSO MUCOSA .....**

- **LAMINA PROPRIA** – A LAYER OF CONNECTIVE TISSUE  
BENEATH THE MUCOSAL EPITHELIUM
  - CONTAINING BLOOD VESSELS AND LYMPHATIC VESSELS.
- **MUSCULARIS MUCOSA** – A THIN LAYER OF SMOOTH  
MUSCLES

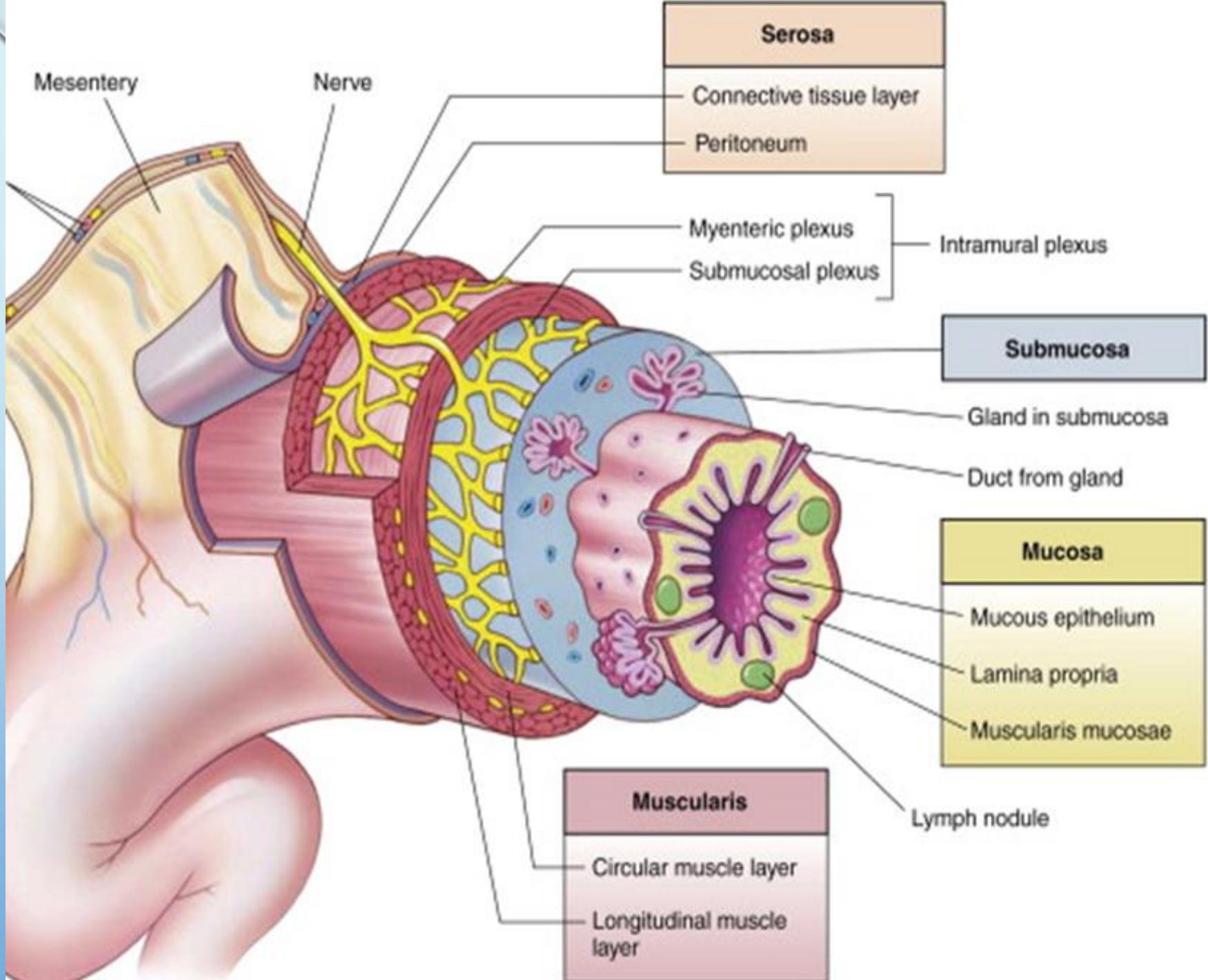
# **ROLES OF THE MUCOSA**

- PRODUCES MUCUS WHICH LUBRICATES FOOD AND PROTECTS THE GUT FROM SELF-DIGESTION
- SITE FOR ABSORPTION OF FOOD.
  - THIN, VILLI, MICROVILLI AND BLOOD CAPILLARIES
- CONTAINS BLOOD AND LYMPHATIC VESSELS WHICH TRANSPORT ABSORBED FOOD
- PRODUCES DIGESTIVE ENZYMES WHICH BREAKDOWN FOOD

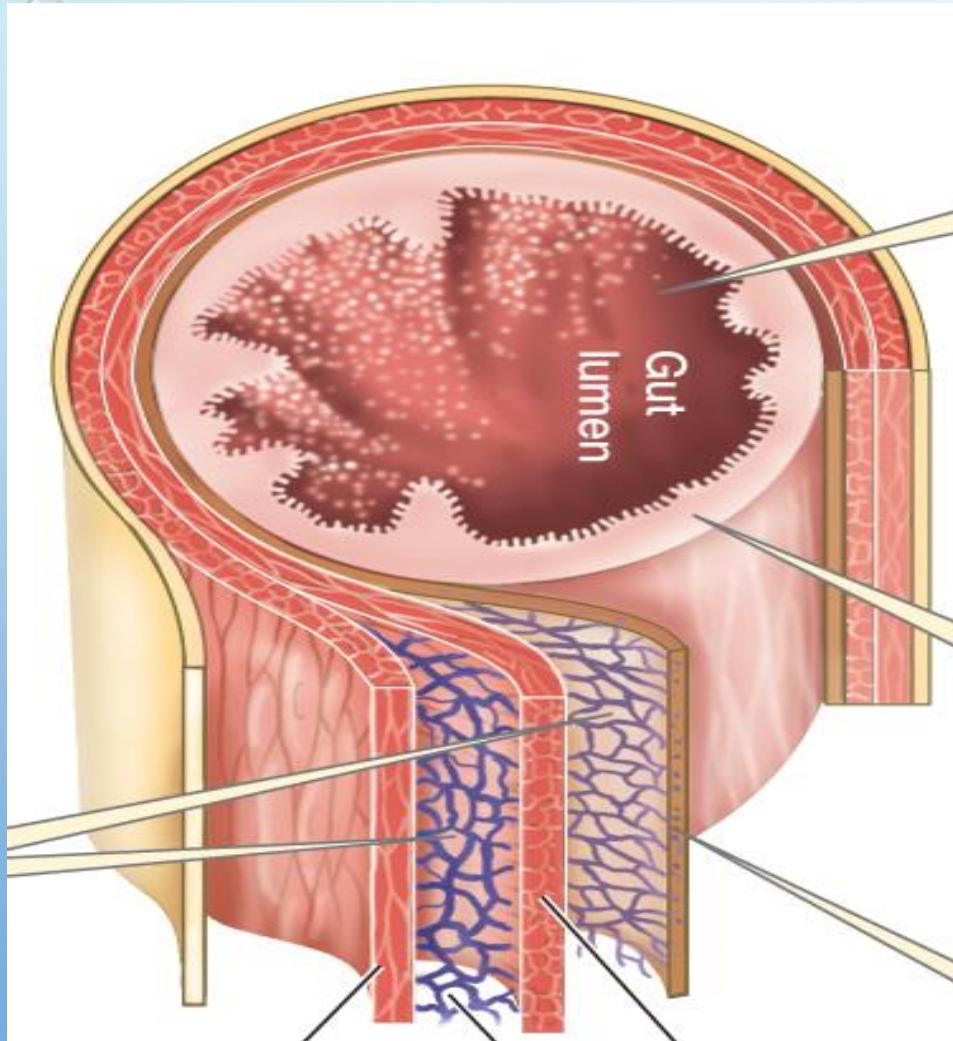
# THE SUBMUCOSA



- A THIN LAYER OF CONNECTIVE TISSUE FOUND JUST BELOW THE MUCOSA.
- COLLAGEN AND ELASTIC FIBRES.
- NERVES - COORDINATE MUSCULAR MOVEMENTS OF THE GUT
- BLOOD AND LYMPHATIC VESSELS - TRANSPORT ABSORBED FOOD.
- BRUNNER'S GLANDS – MUCUS



# MUSCULARIS EXTERNA

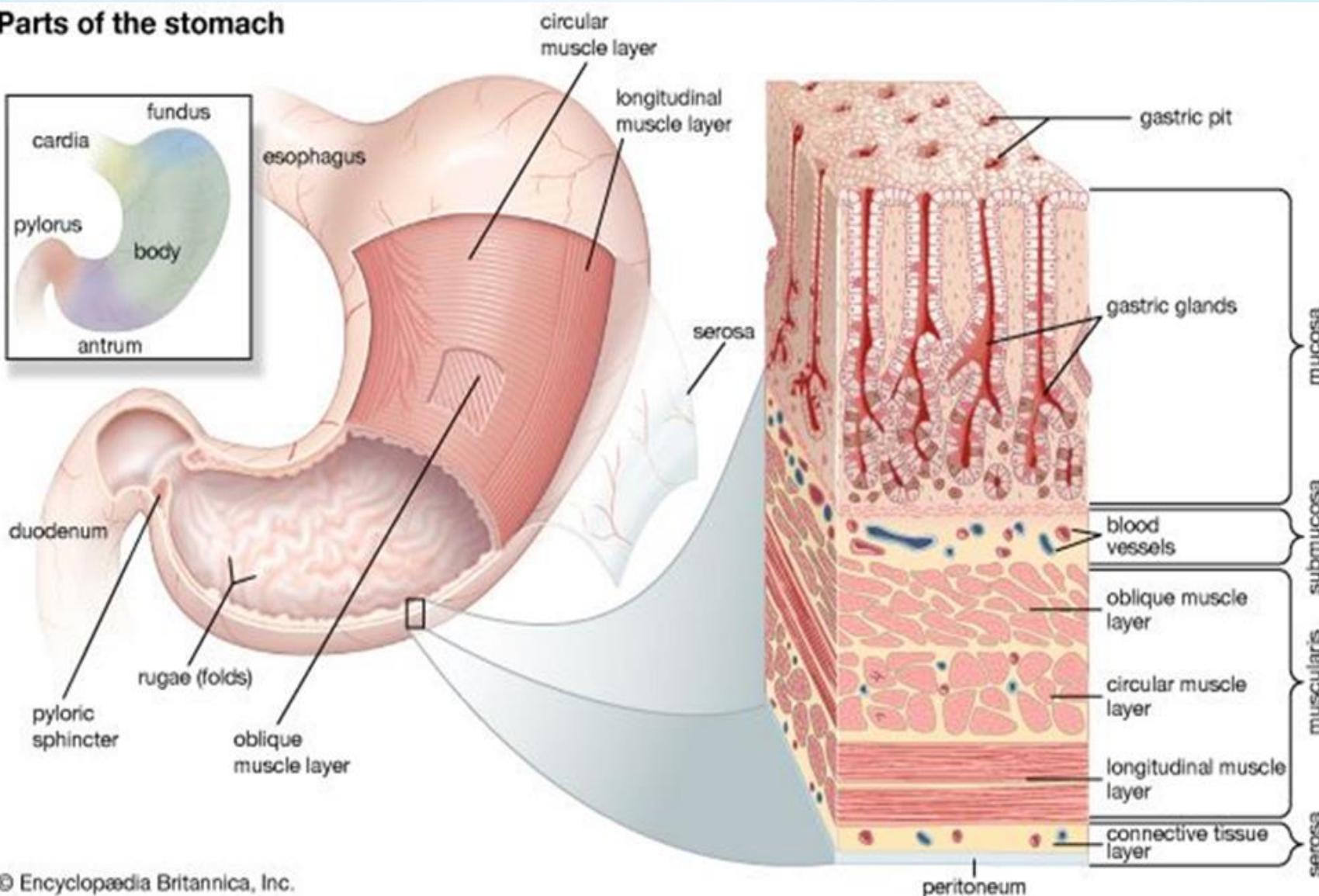


- A LAYER OF SMOOTH MUSCLES – CONTROLS PERISTALSIS
  - INNER LAYER OF CIRCULAR
  - OUTER LAYER OF LONGITUDINAL
- COORDINATED BY THE A.N.S.
- CIRCULAR MUSCLES THICKEN AT SPHINCTERS – CONTROL FOOD MOVEMENT

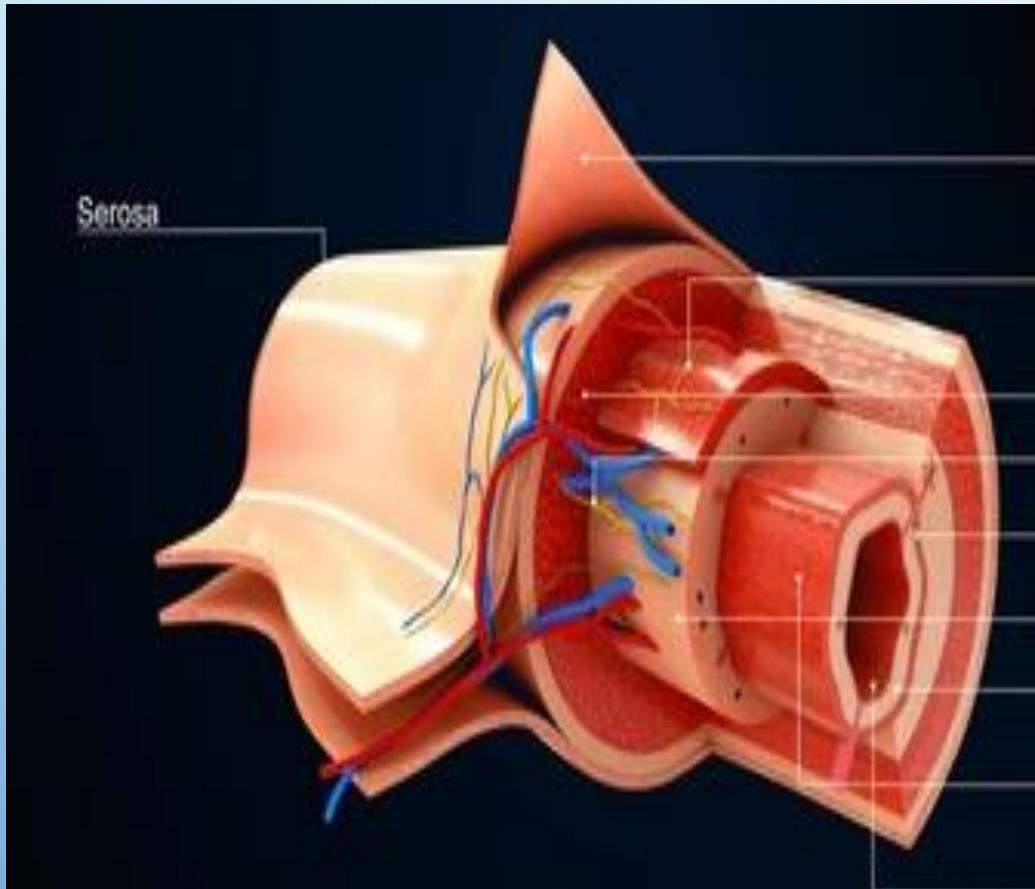
## NB:

- BETWEEN THE CIRCULAR LAYER AND SUBMUCOS IS THE **MEISSNER'S PLEXUS** – CONTROLS SECRETION OF MATERIALS
- BETWEEN THE CIRCULAR AND THE LONGITUDINAL LAYERS OF MUSCLE IS THE **AUERBACH'S PLEXUS** – CONTROLS PERISTALSIS
  - BOTH NERVE NETS ARE PARTS OF THE ANS.
- MUSCULARIS EXTERNA OF THE STOMACH HAS A THIRD LAYER **OBLIQUE OF SMOOTH MUSCLES** ON THE INSIDE

## Parts of the stomach



# SEROSA

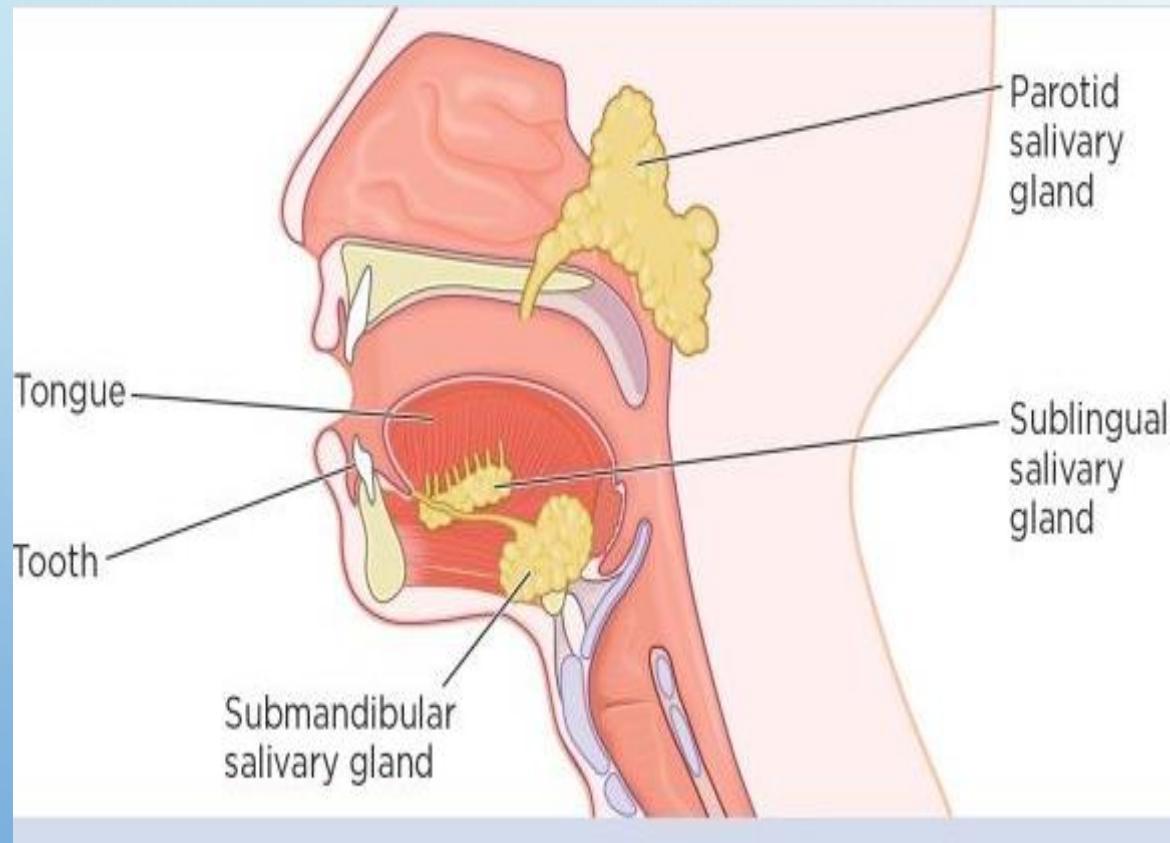


- THE OUTERMOST LAYER COMPOSED OF FIBROUS CONNECTIVE TISSUE
- **PERITONEUM (OUTERMOST LINING)** CONSTITUTES THE MESENTERIES.
  - MOIST TO MINIMIZE FRICTION
  - FIRMLY SUSPENDS THE GUT ONTO THE BODY WALL

# **PARTS OF THE DIGESTIVE SYSTEM**

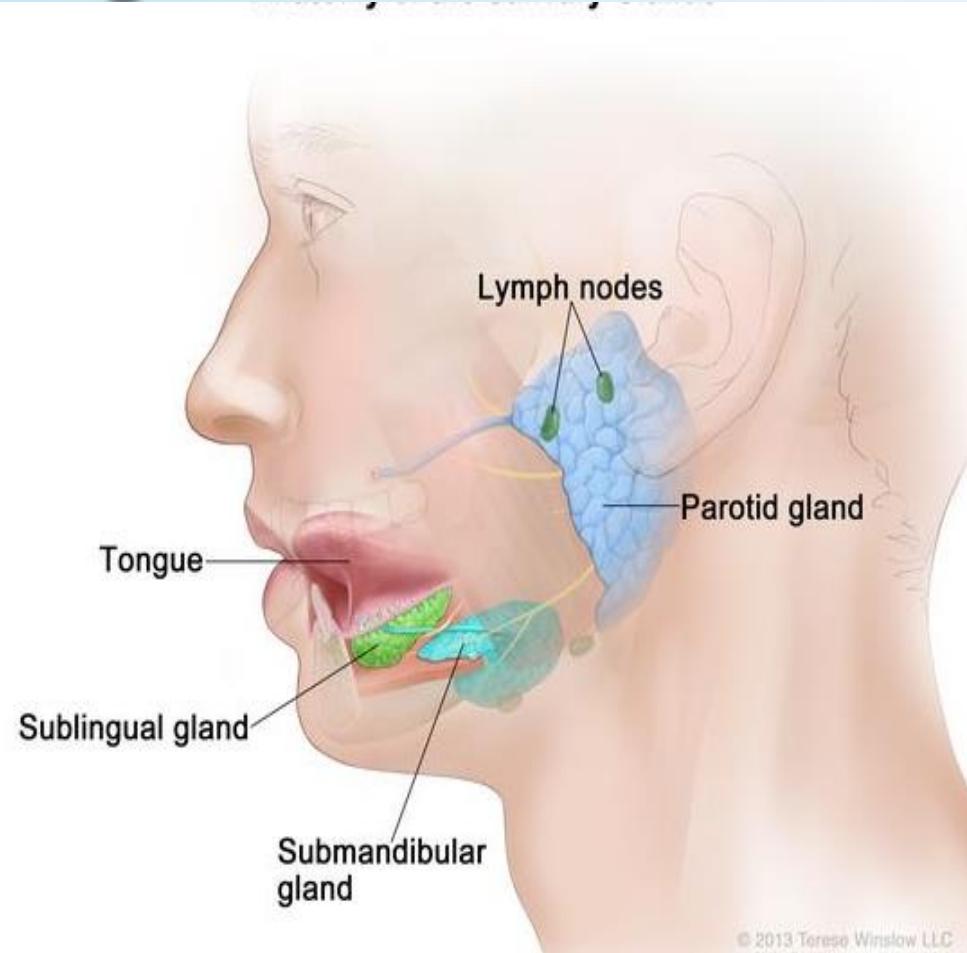
**..... AND FUNCTION**

# THE MOUTH



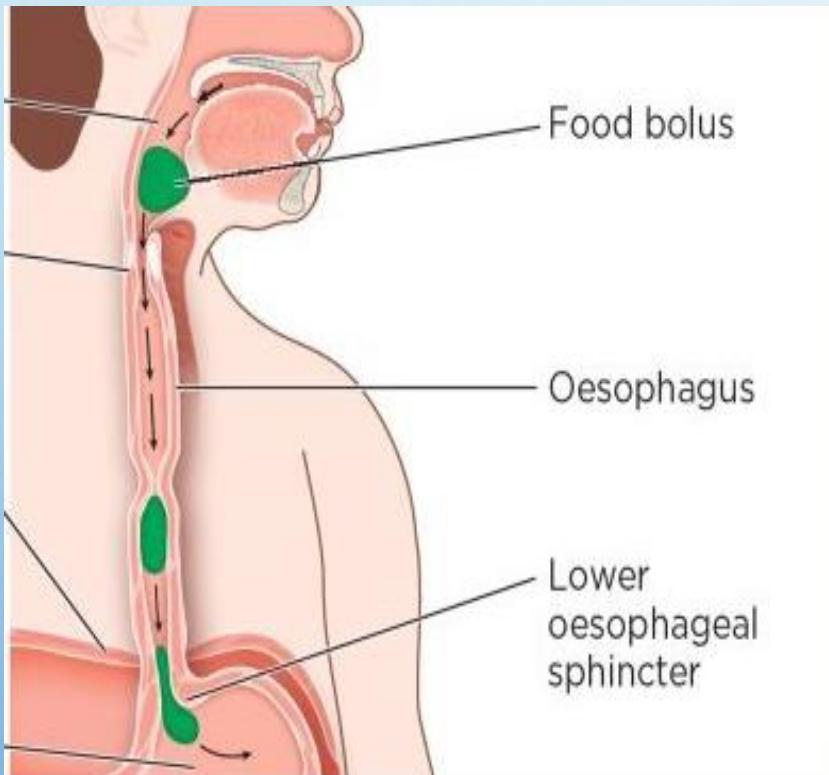
- CONTAINS TEETH, SALIVARY GLANDS AND THE TONGUE.
- TEETH - PHYSICAL DIGESTION
- TONGUE - MIXES FOOD WITH SALIVA
  - TASTING OF FOOD
  - INITIATES SWALLOWING

# SALIVARY GLANDS



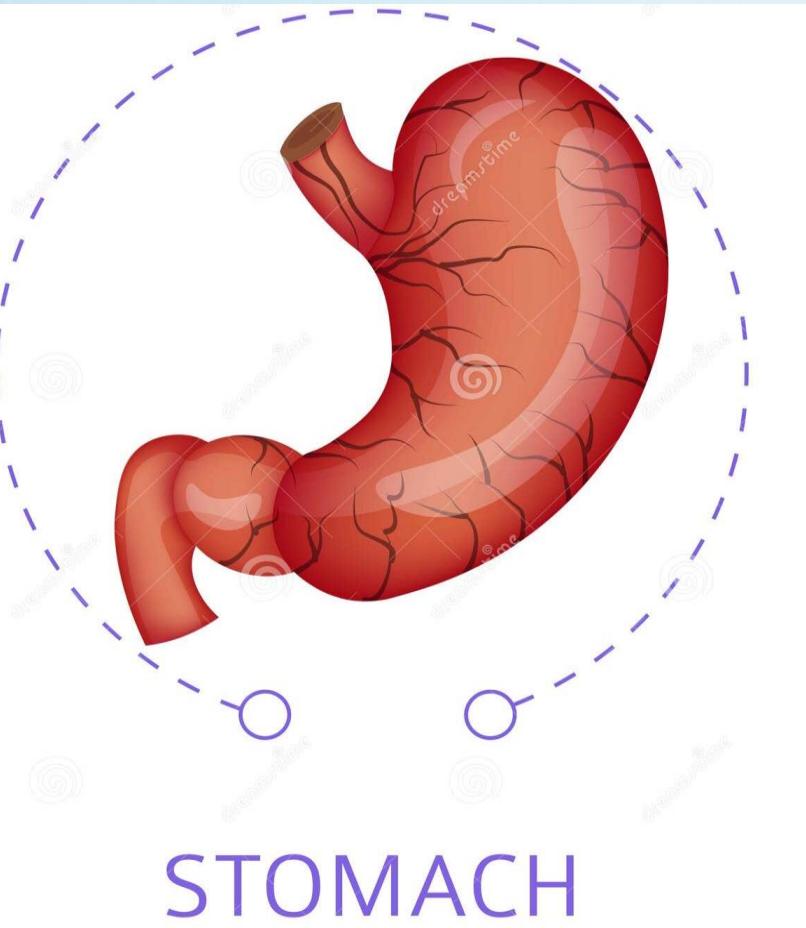
- PRODUCE SALIVA;
  - CONTAINS SALIVARY AMYLASE .....
  - COOLS OR WARMS UP FOOD
  - MUCUS STICKS FOOD PARTICLES TOGETHER
- LUBRICATES SWALLOWING
- ANTI-BACTERIAL ENZYMES
- SALTS MAINTAIN PH

# OESOPHAGUS

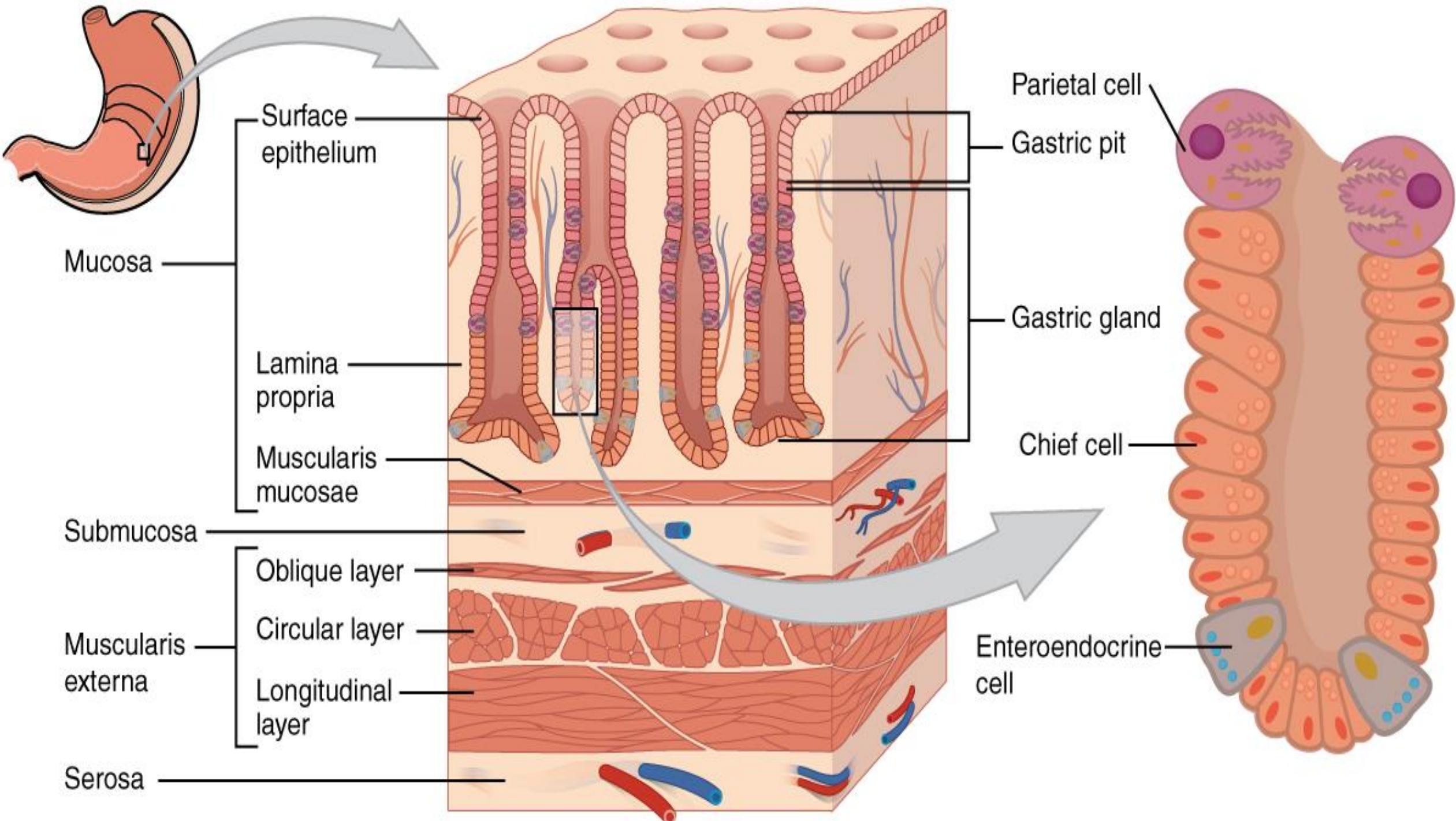


- A MUSCULAR TUBE THAT CONNECTS THE MOUTH TO THE STOMACH
- CIRCULAR AND LONGITUDINAL MUSCLES CONTRACT ALTERNATELY TO PUSH FOOD IN A WAVE-LIKE MOTION - **PERISTALSIS**

# THE STOMACH

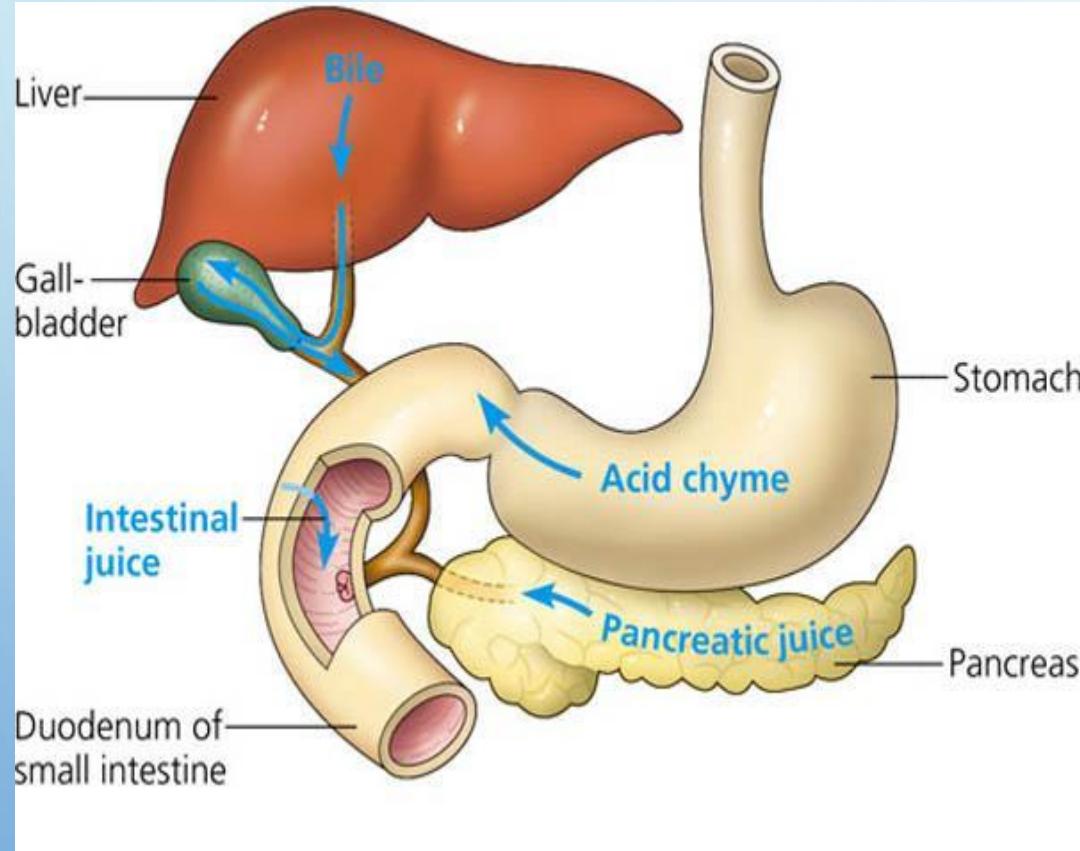


- J-SHAPED MUSCULAR BAG
  - FOOD STORAGE AND DIGESTION
  - PHYSICAL DIGESTION DUE TO RHYTHMIC CONTRACTIONS OF THE WALLS
  - CHEMICAL DIGESTION - ENZYMES IN GASTRIC JUICE
  - GASTRIC GLANDS/PITS



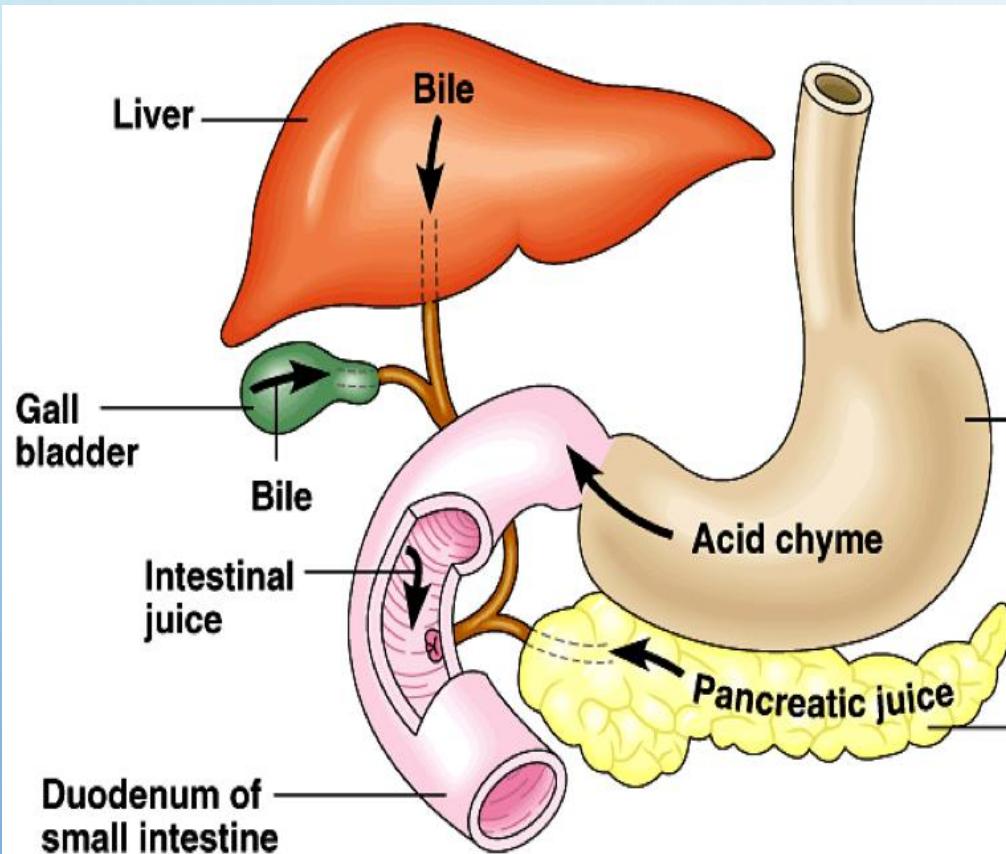
<b>Secretion</b>	<b>Secreted by</b>	<b>Function</b>
Mucus	Goblet cells	Protects stomach walls from Hydrochloric acid and self-digestion
Hydrochloric Acid	Oxyntic/Parietal Cells	<ul style="list-style-type: none"> <li>- Activates pepsinogen to pepsin; provides an acidic pH</li> <li>- Activates prorennin to rennin</li> <li>- Kills bacteria in food</li> </ul>
Pepsinogen	Chief/Peptic/Zymogen cells	<ul style="list-style-type: none"> <li>Activated to pepsin which</li> <li>- Hydrolyses proteins to polypeptides</li> <li>- Activates the remaining pepsinogen</li> </ul>
Prorennin	Chief cells	Activated to rennin which coagulates caseinogen in milk to insoluble casein

# THE DUODENUM



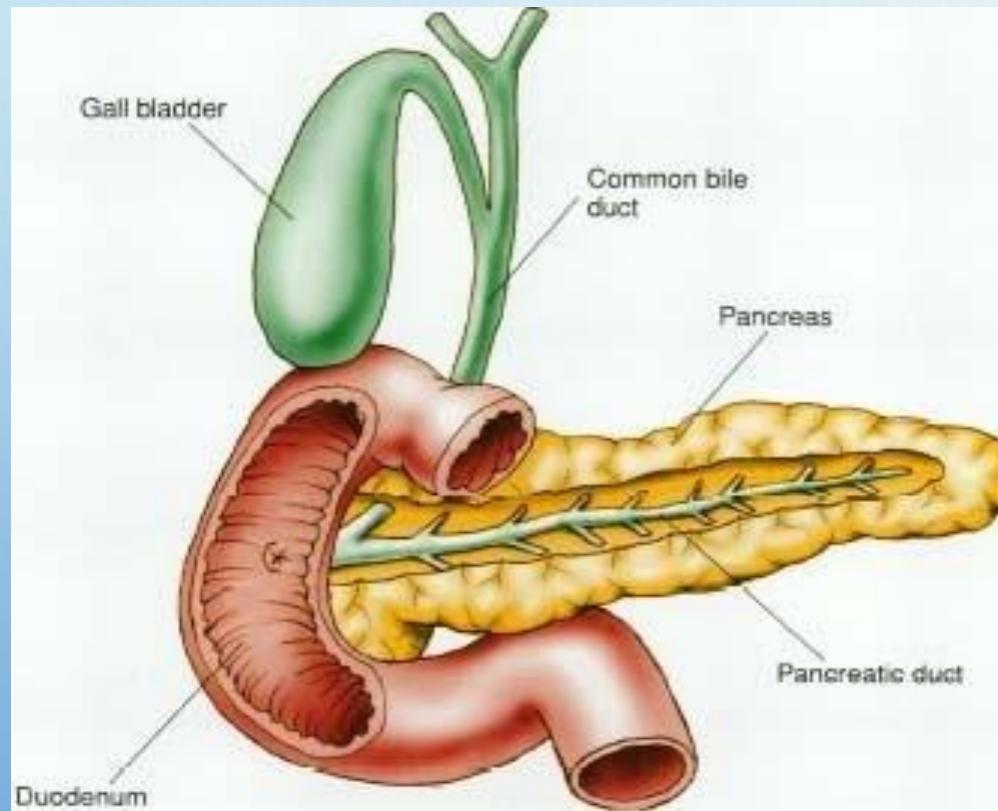
- CHEMICAL DIGESTION
  - BILE FROM THE GALL BLADDER
  - PANCREATIC JUICE FROM THE PANCREAS

# BILE



- A GREEN SECRETION FORMED BY LIVER CELLS; STORED IN THE GALL BLADDER.
- BILE SALTS - EMULSIFY FATS
- MINERAL SALTS - NEUTRALIZE THE ACIDIC FOOD CHYME.
- PROVIDES ALKALINE PH

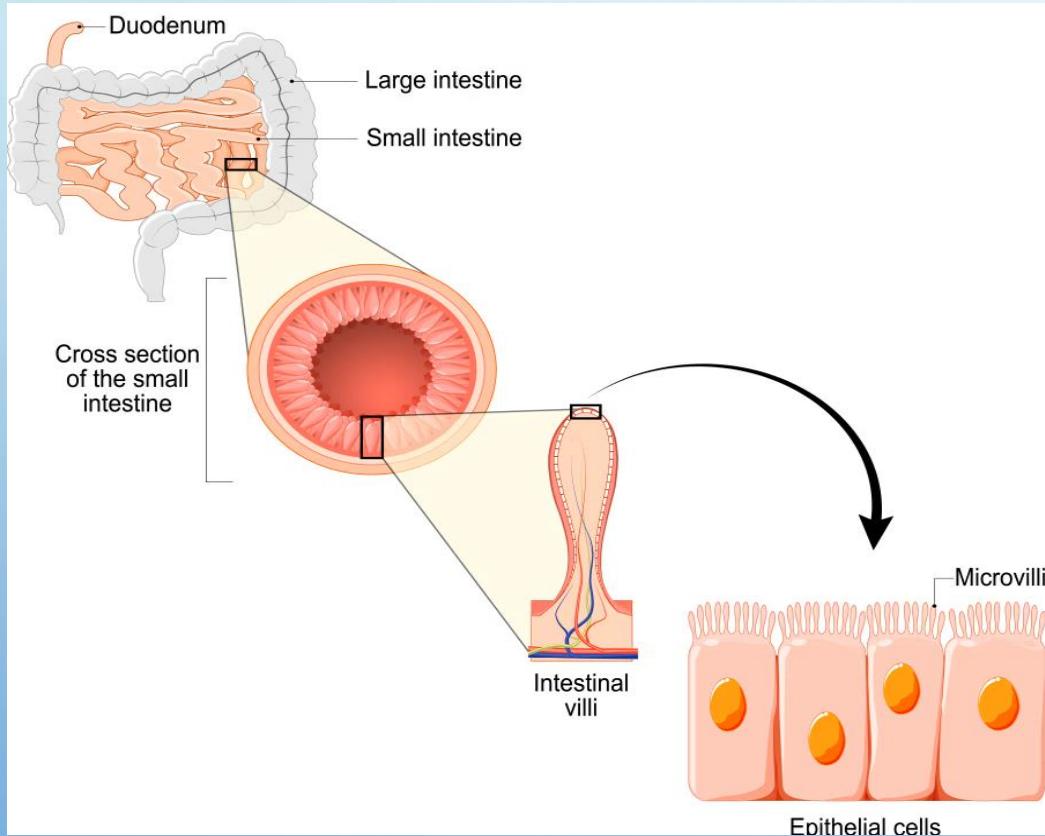
# PANCREATIC JUICE



- PRODUCED BY THE PANCREAS.
- PANCREATIC TRYPSIN
- CHYMOTRPSIN
- CARBOXYPETIDASE
- PANCREATIC AMYLASE
- PANCREATIC LIPASE
- NUCLEASE

<b>Active component</b>	<b>Function</b>
Pancreatic Trypsin	<ul style="list-style-type: none"><li>• Activates remaining Trypsinogen</li><li>• Chymotrypsinogen to chymotrypsin</li><li>• Breaks down proteins to Peptides</li></ul>
Chymotrypsin	Proteins and peptides to amino acids
Carboxypeptidase	Peptides to amino acids
Pancreatic Amylase	Breaks down starch to maltose
Pancreatic Lipase	Lipids to Fatty acids and Glycerol
Nuclease	Breaks down nucleic acids to nucleotides

# ILEUM



- DIGESTION FINALIZED; END PRODUCTS ABSORBED.
- WALLS RELEASE AN INTESTINAL JUICE - **SACCUS ENTERICUS.**
  - CONTAINS SEVERAL ENZYMES
  - LONG AND COILED; ADAPTED FOR ABSORPTION

# COLON



- IT IS WHERE WATER IS ABSORBED
- MUTUALISTIC BACTERIA – B & K
- UNDIGESTED FOOD CONTINUES TO THE RECTUM BEFORE BEING PASSED OUT THROUGH ANUS (EGESTION).

# THE PROCESS OF FOOD DIGESTION IN MAN

- IN THE MOUTH, PHYSICAL DIGESTION OCCURS BY THE CHEWING ACTION OF TEETH (**MASTICATION**).
- IT IS MIXED WITH SALIVA FROM SALIVARY GLANDS, CONTAINING SALIVARY AMYLASE, WHICH BREAKS DOWN STARCH TO MALTOSE – **CHEMICAL DIGESTION**.
- FOOD IS ROLLED INTO A BOLUS BY THE TONGUE AND PUSHED DOWN THE GULLET; TO THE STOMACH – **PERISTALSIS**.

## **IN THE STOMACH,**

- PHYSICAL DIGESTION - RHYTHMIC CONTRACTION
- WALLS OF THE STOMACH (GASTRIC GLANDS) - RELEASE GASTRIC JUICE
  - HYDROCHLORIC ACID; ACTIVATES PEPSINOGEN INTO PEPSIN; PROVIDES AN ACIDIC PH
  - PEPSIN CATALYSES THE BREAK DOWN OF PROTEINS INTO PEPTIDES.

## IN THE DUODENUM

- BILE (GALL BLADDER):
  - BILE SALTS - NEUTRALIZE THE ACIDIC FOOD CHIME
  - PROVIDES ALKALINE PH SUITABLE FOR PANCREATIC ENZYMES
  - EMULSIFY FATS INTO FAT DROPLETS.
- PANCREATIC JUICE (FROM PANCREAS):
  - PANCREATIC AMYLASE, TRYPSIN AND LIPASE

Pancreatic enzyme	Substrate	Products
Pancreatic trypsin	Proteins and peptides	Amino acids
Pancreatic amylase	Starch	Maltose
Pancreatic lipase	Fats/lipids	Fatty acids and glycerol

## **IN THE ILEUM**

- PRESENCE OF FOOD STIMULATES RELEASE OF AN INTESTINAL JUICE - **SACCUS ENTERICUS**
- CONTAINS ENZYMES WHICH PRODUCE THE END PRODUCTS OF DIGESTION FORMING A MILKY EMULSION CALLED CHYLE

<b>Enzymes</b>	<b>Substrate</b>	<b>Products</b>
Sucrase	Sucrose	Glucose and fructose
Maltase	Maltose	Glucose and glucose
Lactase	Lactose	Glucose and galactose
Peptidase	Polypeptides	Amino acids
Lipase	Lipids	Fatty acids and glycerol

- THE END PRODUCTS OF DIGESTION ARE ABSORBED INTO BLOOD;  
TRANSPORTED TO OTHER PARTS OF THE BODY.
- REMAINING MIXTURE CONTINUES TO THE COLON WHERE  
ABSORPTION OF WATER AND MINERAL SALTS TAKES PLACE.
- THE UN DIGESTED FOOD MATERIAL IS TEMPORARILY STORED IN THE  
RECTUM AND PASSED OUT OF THE BODY THROUGH ANUS.

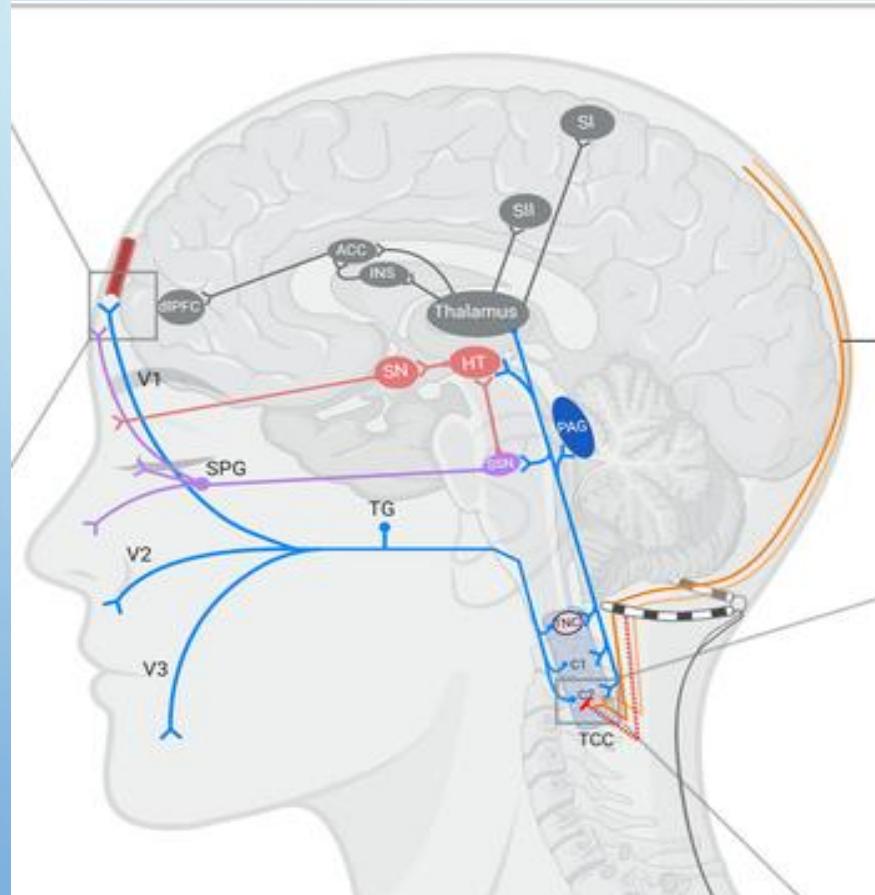
**NB**

THE COLON CONTAINS A LARGE POPULATION OF  
MUTUALISTIC BACTERIA LIKE E.COLI WHICH SYNTHESISE  
VITAMINS B AND K - ALSO ABSORBED INTO BLOOD.

# **CONTROL OF DIGESTION**

- ***SECRETION OF GUT ENZYMES SHOULD BE SYNCHRONIZED WITH PRESENCE OF FOOD TO MINIMIZE WASTAGE OF SUCH PROTEINS AND ENERGY; AND PREVENT DAMAGE DUE TO SELF-DIGESTION.***
- ***BOTH NERVOUS AND ENDOCRINE SYSTEM.***

# IN THE MOUTH

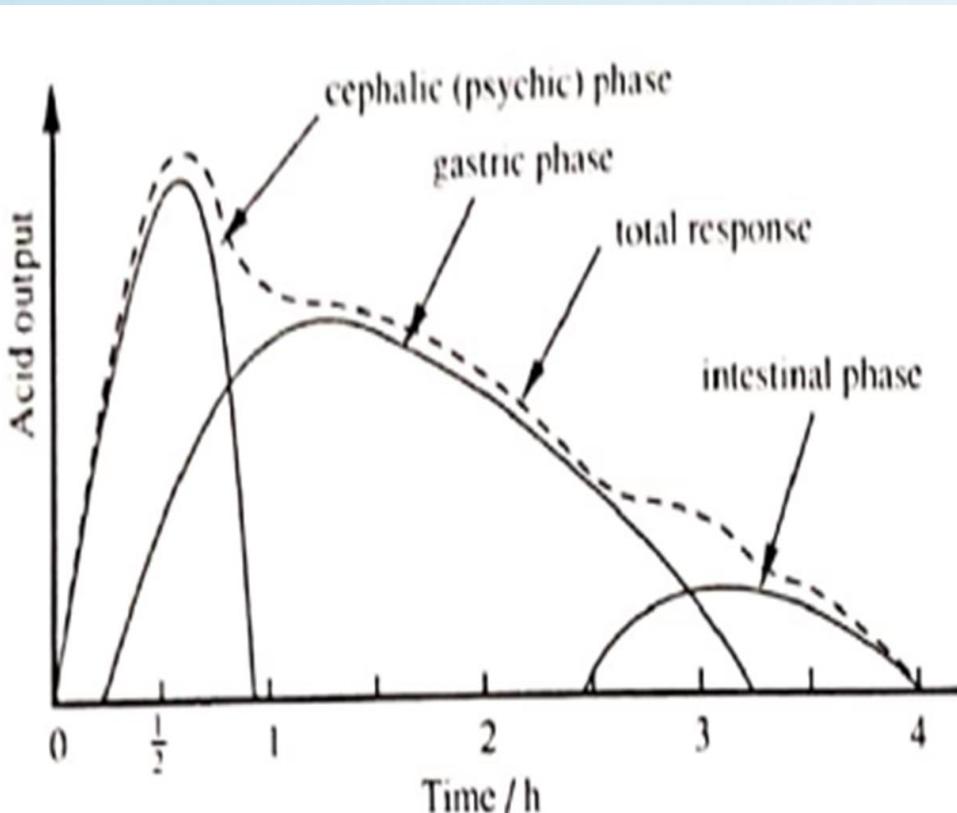


- ONLY NERVOUS CONTROL
- RAPID AND SHORT-LIVED
- FOOD SPENDS LITTLE TIME

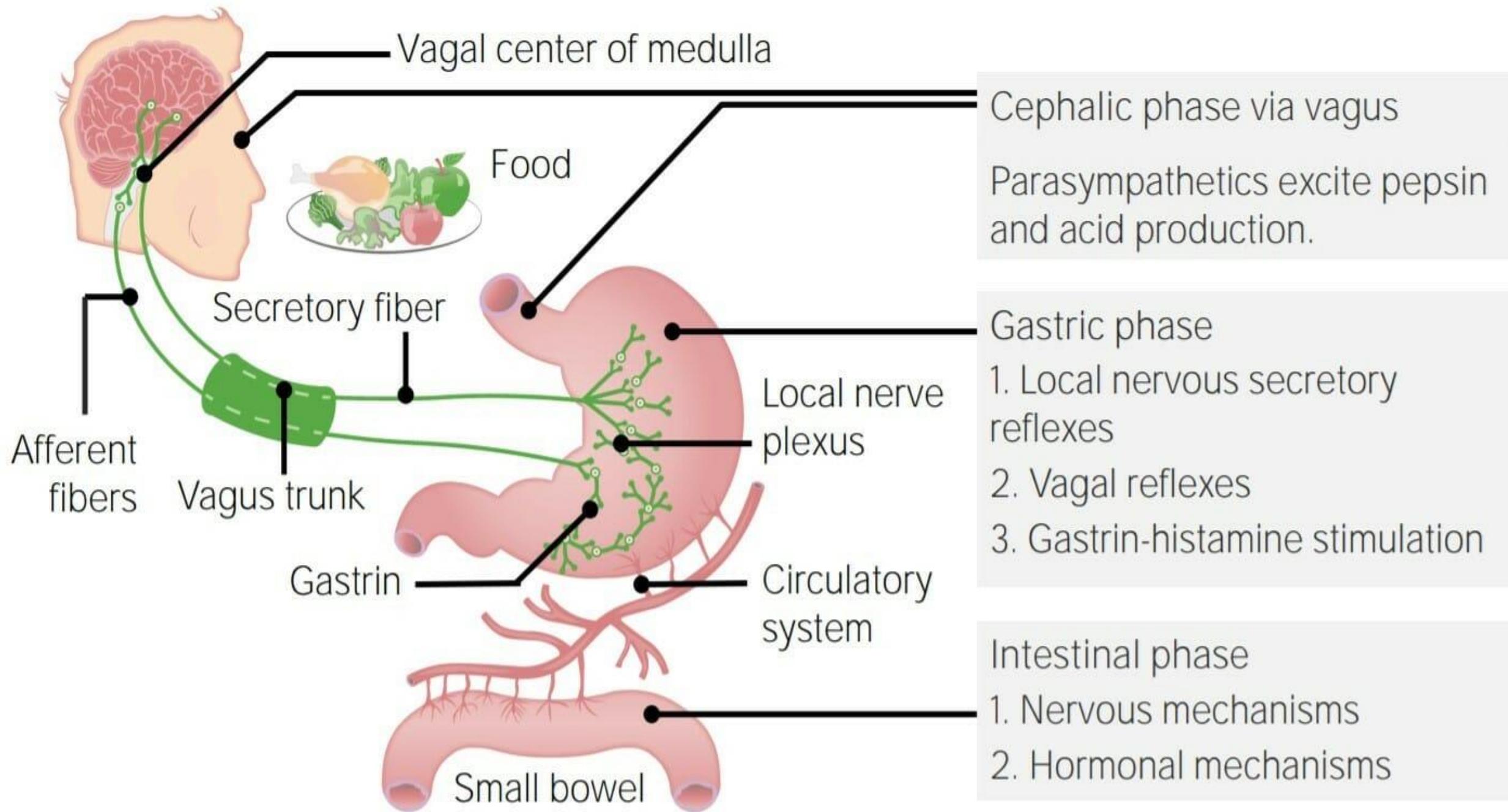
## **...SUMMARY**

- THOUGHT, SMELL OR SIGHT OF FOOD INITIATES AN UNCONDITIONED REFLEX; IMPULSES ARE SENT VIA SENSORY NEURONS TO THE BRAIN; SENDS IMPULSES VIA MOTOR NEURONS TO SALIVARY GLAND - SECRETE OF SALIVA.
- PRESENCE OF FOOD STIMULATES THE TASTE BUDS, SEND IMPULSES TO THE BRAIN; STIMULATES SALIVARY GLANDS TO SECRETE SALIVA - CONDITIONED REFLEX

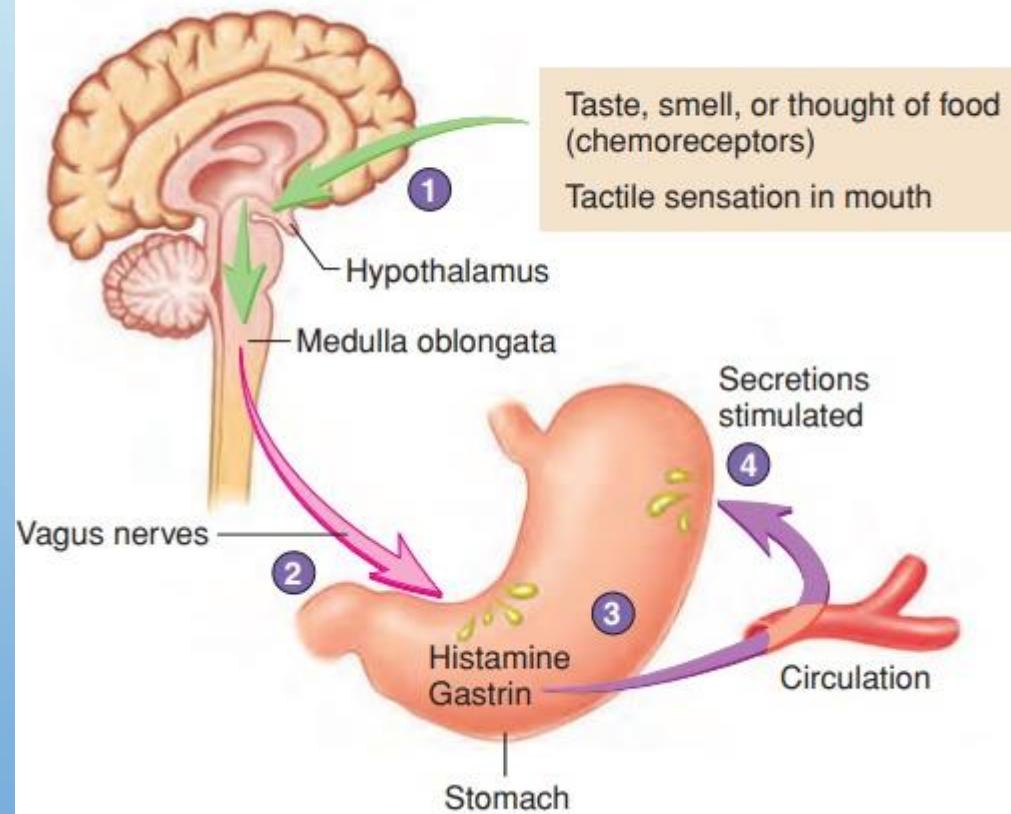
# IN THE STOMACH



- CONTROL OF GASTRIC JUICE SECRETION OCCURS IN THREE PHASES
  - CEPHALIC PHASE
  - GASTRIC PHASE
  - INTESTINAL PHASE
- NERVOUS AND HORMONAL CONTROL

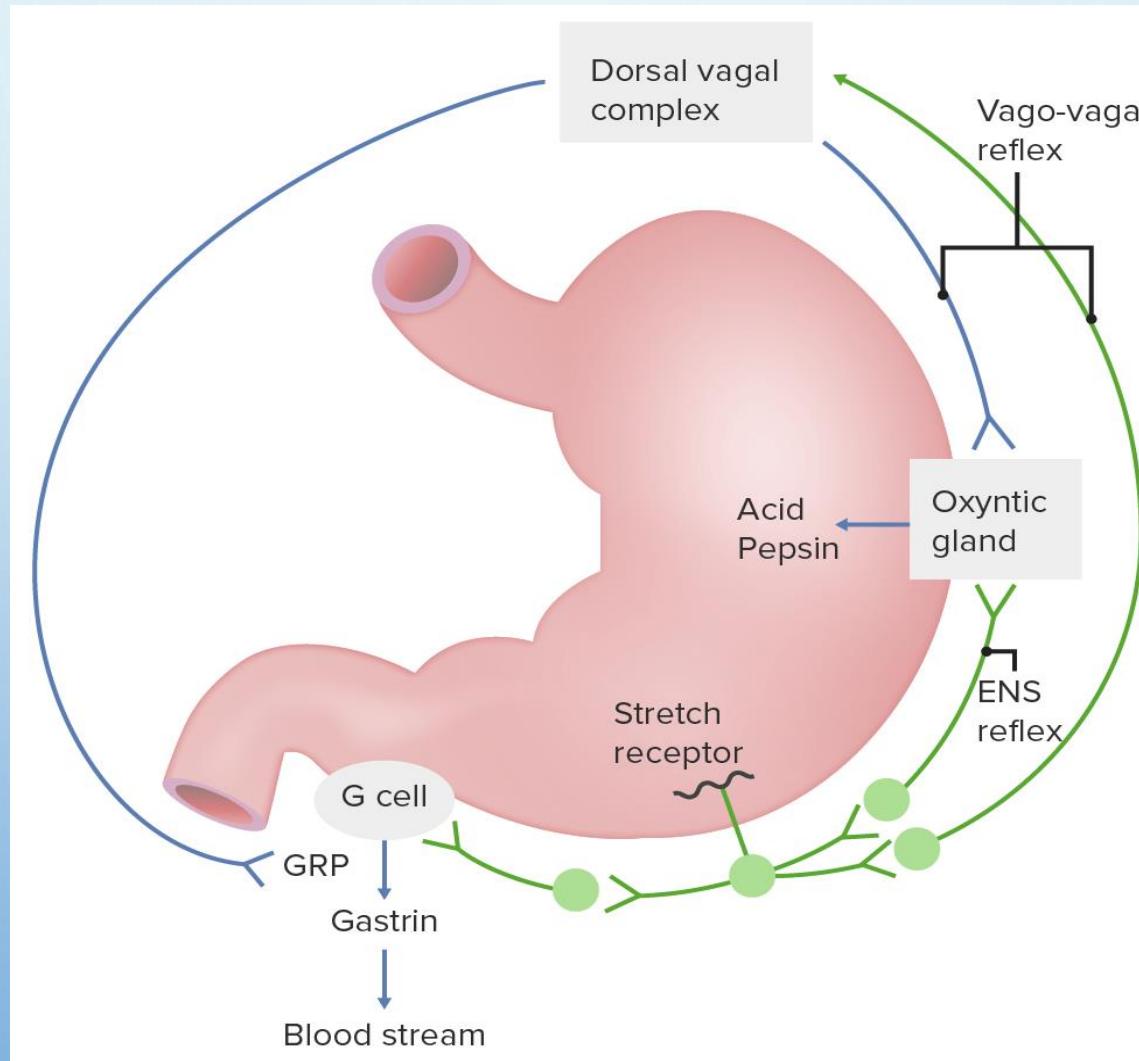


# CEPHALIC PHASE



- PURELY NERVOUS
- SIGHT, SMELL OR TASTE OF FOOD INITIATES IMPULSES SENT VIA SENSORY NERVES TO THE BRAIN; SENDS IMPULSES VIA THE VAGUS NERVE; TO GASTRIC GLANDS, STIMULATING RELEASE OF GASTRIC JUICE + HYDROCHLORIC ACID
- PREPARING THE STOMACH FOR RECEIVING FOOD
- LASTS ABOUT 1 HOUR

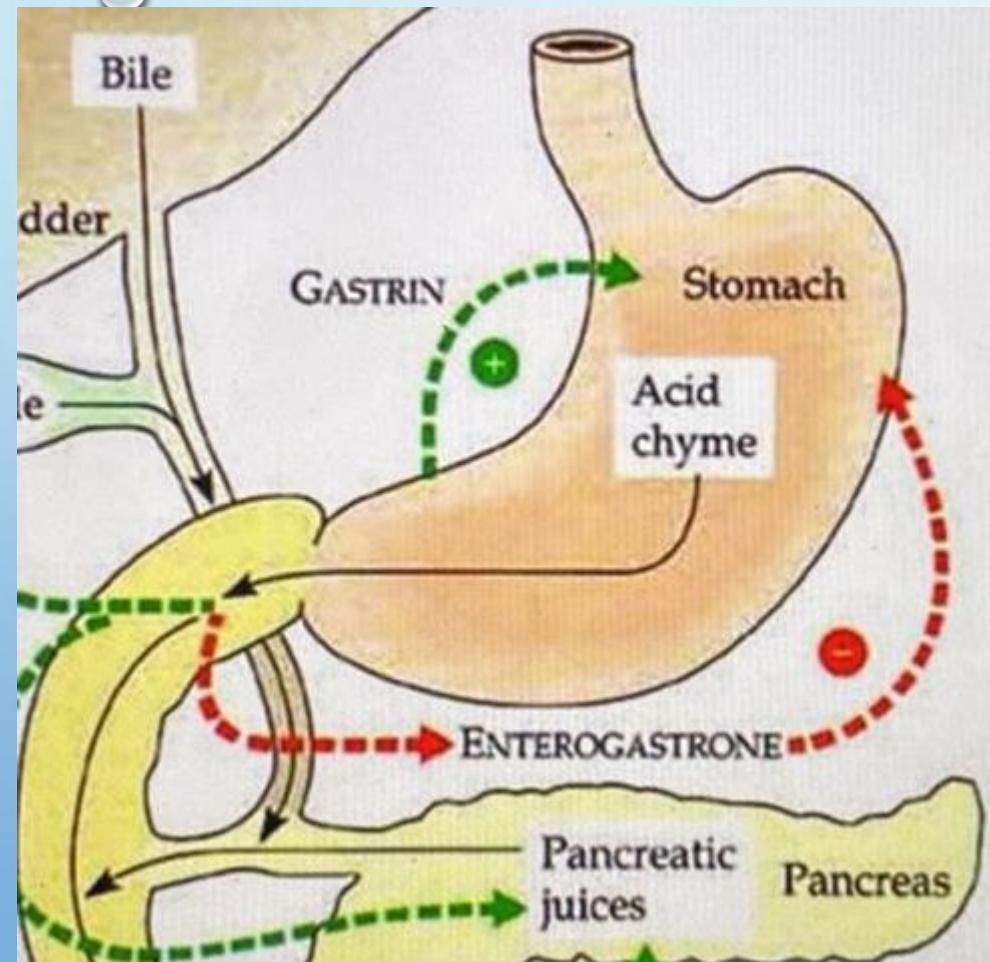
# GASTRIC PHASE



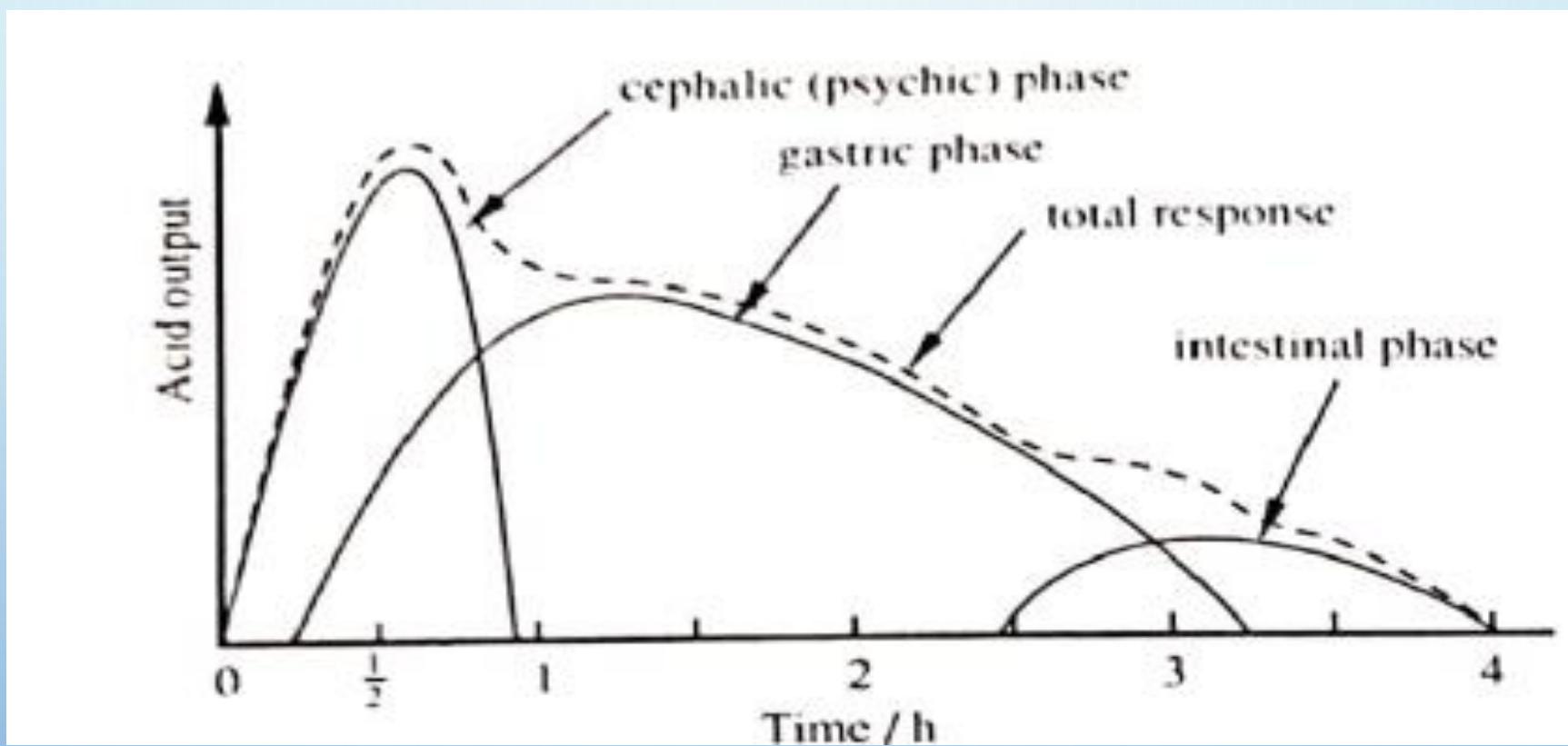
## ... SUMMARY

- NERVOUS AND HORMONAL
- FOOD DISTENDS THE STOMACH WALLS;
  - STIMULATES STRETCH RECEPTORS; SEND IMPULSES TO THE SUBMUCOSA (MEISSNER'S PLEXUS); SENDS IMPULSES TO GASTRIC GLANDS; STIMULATING RELEASE OF GASTRIC JUICE
  - STIMULATES ENDOCRINE CELLS IN THE MUCOSA TO RELEASE OF GASTRIN INTO BLOOD; TO GASTRIC GLANDS STIMULATING RELEASE OF GASTRIC JUICE.
- THIS PHASE LASTS FOR ABOUT 4 HOURS.

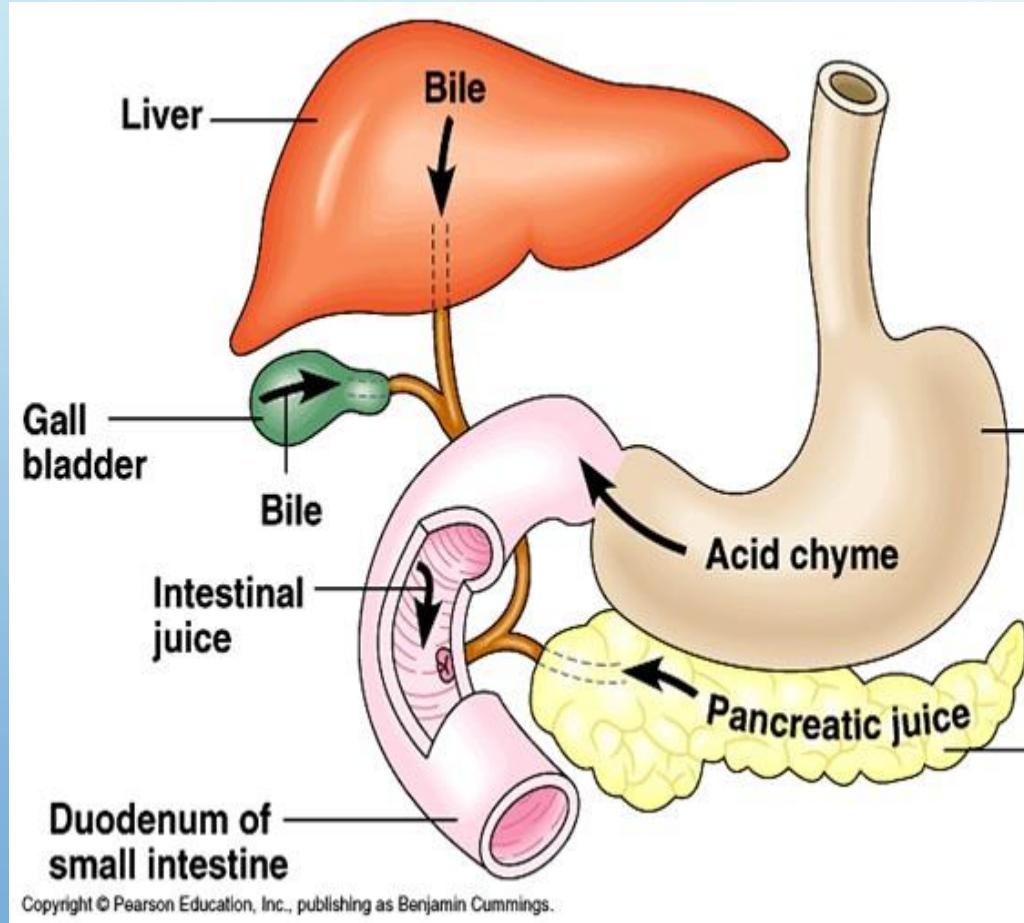
# INTESTINAL PHASE



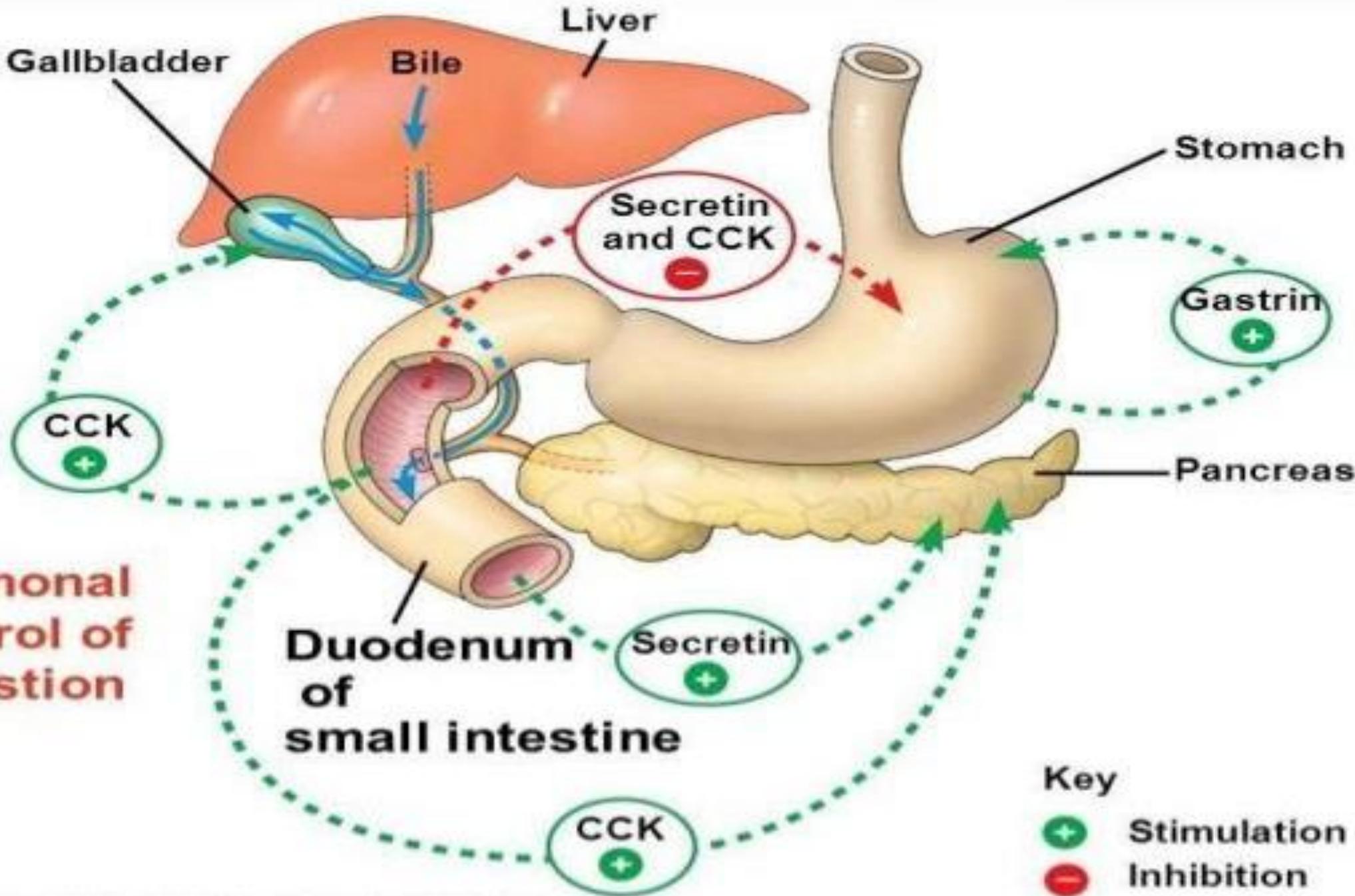
- OCCURS IN THE DUODENUM
- NERVOUS AND HORMONAL
- ACID IN FOOD STIMULATES IMPULSES TO THE BRAIN; INHIBITS FURTHER RELEASE OF ACIDIC GASTRIC JUICE
- FATS IN FOOD STIMULATE RELEASE OF ENTEROGASTRONE HORMONE; INHIBITS RELEASE OF GASTRIC JUICE; SLOWS DOWN STOMACH EMPTYING.



# IN THE DUODENUM



- IN THE DUODENUM TWO HORMONES;
  - SECRETIN
  - CHOLECYSTOKININ (PANCREOZYMIN)
- CONTROL RELEASE OF BILE AND PANCREATIC JUICE



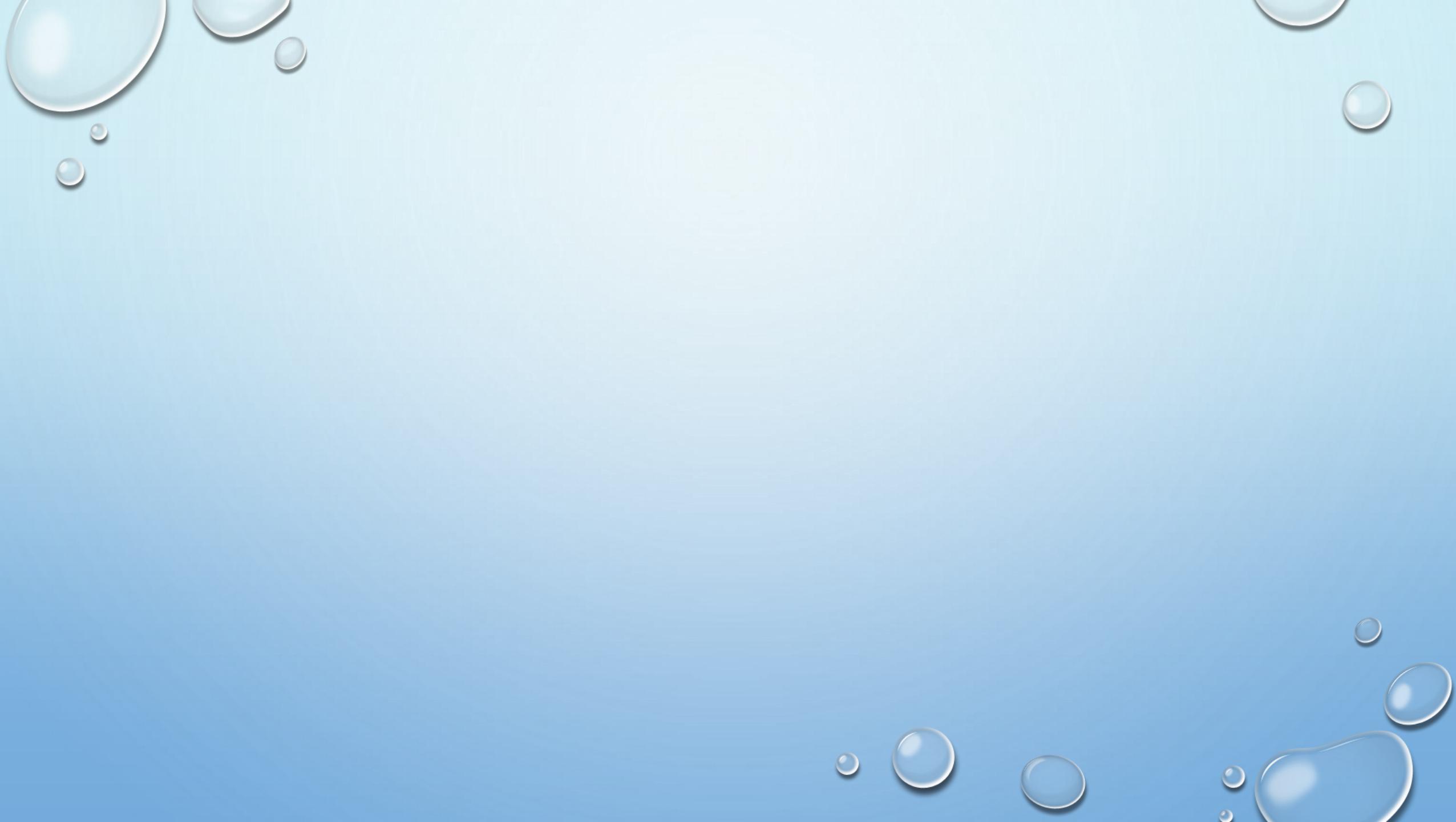
- FOOD IN THE DUODENUM STIMULATES RELEASE OF **SECRETIN** AND **CHOLECYSTOKININ** FROM THE WALLS
- SECRETIN IS RELEASED IN RESPONSE TO **ACID** IN FOOD
  - STIMULATES SYNTHESIS OF **BILE** IN THE LIVER
  - FLOW OF **BICARBONATE** IONS IN PANCREATIC JUICE.
- CHOLECYSTOKININ IS RELEASED IN RESPONSE TO PARTLY DIGESTED **FATS** (AND PROTEINS)
  - STIMULATES SYNTHESIS OF **ENZYMES** IN PANCREATIC JUICE
  - CONTRACTION OF THE GALL BLADDER TO RELEASE BILE

## **IN THE ILEUM**

**PRESENCE OF FOOD IN THE ILEUM STIMULATES RELEASE OF**

**IN INTESTINAL JUICE WHICH CONTAINS ENZYMES THAT**

**PRODUCE THE END PRODUCTS OF DIGESTION.**



# **ABSORPTION AND ASSIMILATION OF FOOD**

MONOSACCHARIDES, MINERAL SALTS AND AMINO ACIDS  
ARE ABSORBED BY A COMBINATION OF DIFFUSION AND  
ACTIVE TRANSPORT INTO EPITHELIAL CELLS; THEN DIFFUSE  
INTO THE BLOOD CAPILLARIES.

## **THE RELEVANCE OF ACTIVE TRANSPORT ....**

- FASTER
- MORE EFFECTIVE – MORE NUTRIENTS ABSORBED REGARDLESS OF THE CONCENTRATION GRADIENT
- UNIDIRECTIONAL – NUTRIENTS STRICTLY FROM THE GUT INTO THE BODY

# LIPIDS

- FATTY ACIDS AND GLYCEROL DIFFUSE INTO EPITHELIAL CELLS; COMBINE INTO LIPIDS
- COMBINE WITH PROTEINS TO FORM WATER-SOLUBLE LIPOPROTEIN DROPLETS (**CHYLOMICRONS**); PASS INTO LACTEALS BY **EXOCYTOSIS**.
- CARRIED INTO LYMPHATIC VESSELS AND EVENTUALLY INTO BLOOD VIA THE SUBCLAVIAN VEIN.
- THE LIPIDS ARE HYDROLYSED BY A PLASMA LIPASE INTO FATTY ACIDS AND GLYCEROL WHICH ARE TAKEN UP BY BODY CELLS

# **ASSIMILATION OF DIGESTED FOOD**

- **SUGARS/GLUCOSE - CARBOHYDRATES**
- IN THE LIVER, CARBOHYDRATES ARE
  - BROKEN DOWN BY RESPIRATION TO PROVIDE ENERGY
  - CONVERTED INTO GLYCOGEN FOR STORAGE
  - CONVERTED INTO FATS FOR STORAGE IN FAT TISSUES

## AMINO ACIDS - FROM PROTEINS

- FORMATION OF NEW PROTEINS - ENZYMES AND HORMONES
- REPAIR AND BUILD UP NEW BODY CELLS
- EXCESS ARE DEAMINATED IN THE LIVER;
  - CARBOHYDRATES – RESPIRED OR STORED AS GLYCOGEN
  - AMMONIA – CONVERTED TO UREA – LOST IN URINE

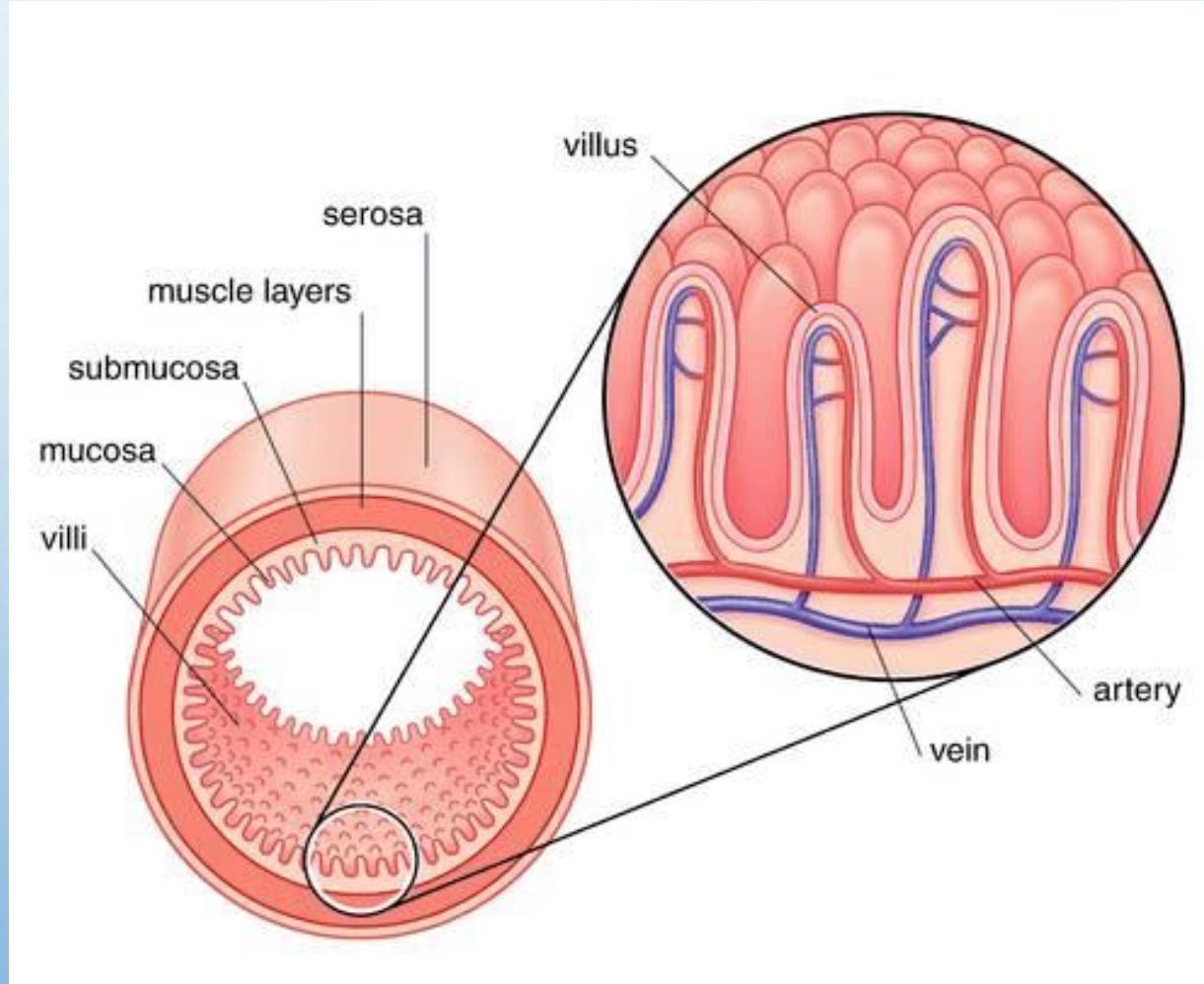
## **FATTY ACIDS AND GLYCEROL – FROM LIPIDS**

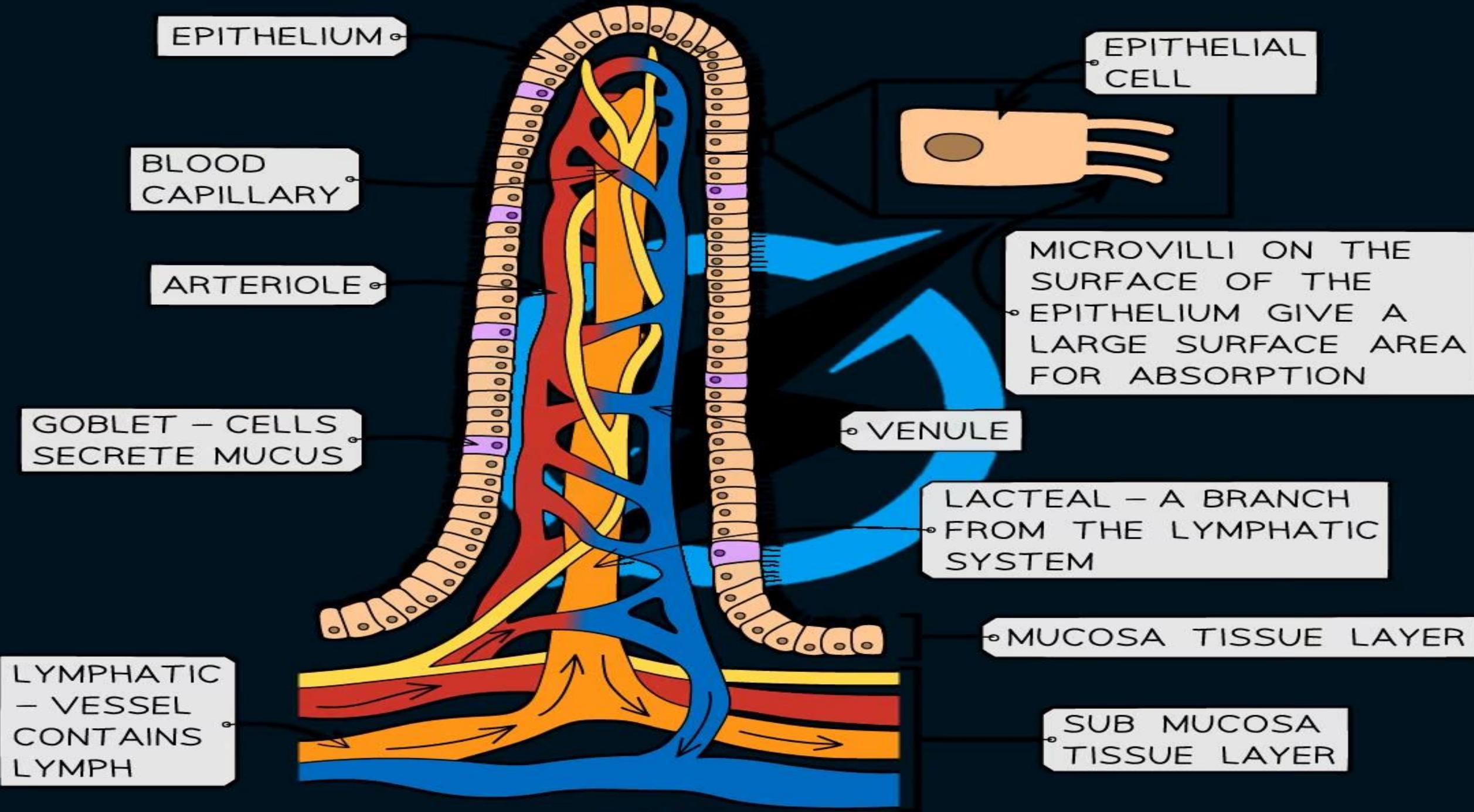
- STORED INTO FAT TISSUES ...
- BROKEN DOWN BY RESPIRATION TO PRODUCE ENERGY
- USED TO FORM NEW LIPIDS.
- FORMATION OF BODY STRUCTURES LIKE CELL MEMBRANES  
AND HORMONES.

## **ADAPTATIONS OF THE ILEUM FOR ABSORPTION**

- LONG - LARGE SURFACE AREA FOR ABSORPTION.
- THIN EPITHELIUM - TO REDUCE THE DIFFUSION DISTANCE
- NUMEROUS VILLI - INCREASE THE SURFACE AREA
- NUMEROUS BLOOD CAPILLARIES - TRANSPORT FOOD
- NETWORK OF LACTEALS - ABSORB AND DISTRIBUTE FATS
- NUMEROUS MITOCHONDRIA - PROVIDE ENERGY

# DIAGRAM OF VILLUS





# COMPARING HERBIVORES AND CARNIVORES

! **WOW!**

**Snails have the most teeth of any animal. They have thousands of tiny teeth lined up in rows.**

## Lion

Their teeth may be made for killing, but male lions let the females do most of the hunting. When the lionesses catch a meal, such as a zebra, the male lion always eats first.



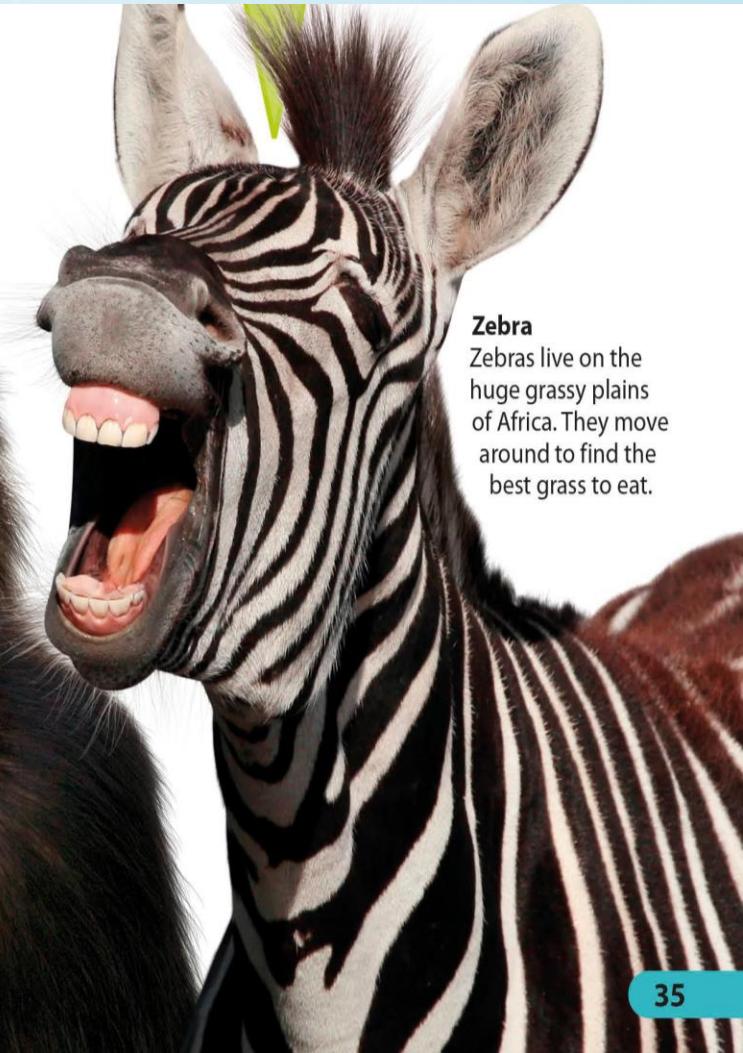
## Chimpanzee

Humans and chimpanzees are related. They both have 32 teeth, but chimpanzees have larger canine teeth than humans.

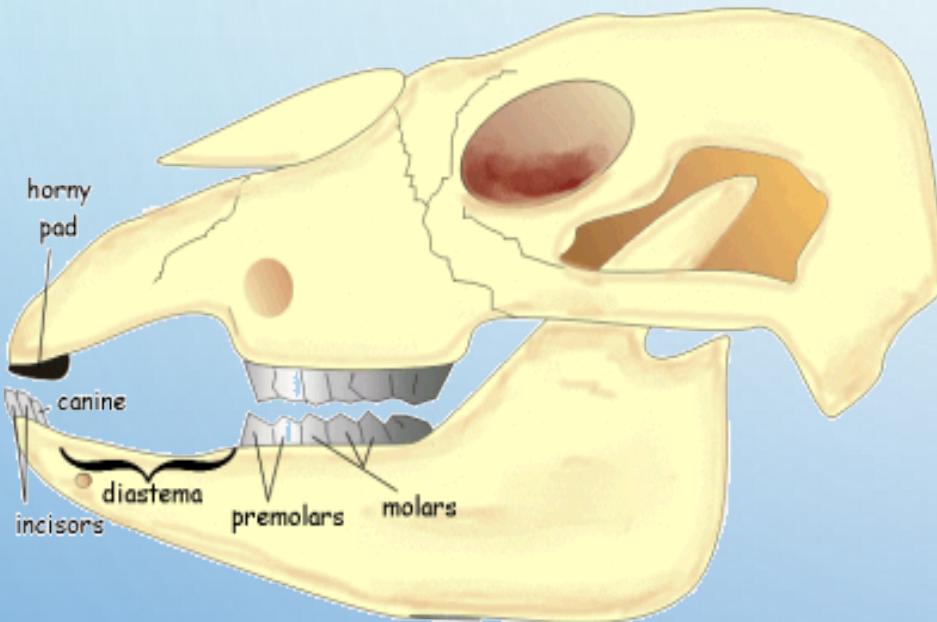


## Zebra

Zebras live on the huge grassy plains of Africa. They move around to find the best grass to eat.



# HERBIVORES

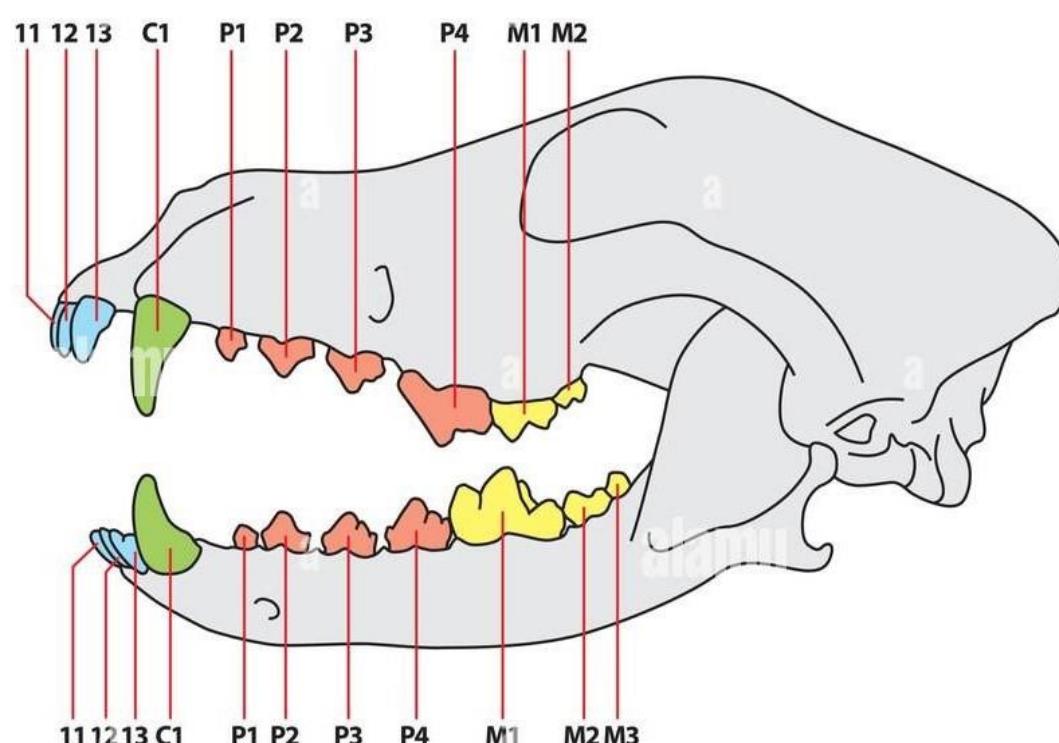


- LACK INCISORS IN THE UPPER JAW, CREATING A HARD PELLET AGAINST WHICH GRASS IS HELD DURING GRAZING.
- CANINES ARE ABSENT – DIASTEMA; EASY MANIPULATION OF GRASS BY THE TONGUE
- MOLARS AND PREMOLARS ARE BROAD WITH PROMINENT CUSPS AND RIDGES FOR GRINDING OF VEGETATION

**...CONT.**

- TEETH GROW CONTINUOUSLY IN LIFE...
- THEIR JAWS ARE LOOSELY SUSPENDED - LATERAL MOVEMENT.
- THE TONGUE IS LONGER AND MORE MUSCULAR TO GATHER GRASS
- LONGER DIGESTIVE TRACTS – CELLULOSE DIGESTION TAKES LONG
- MUTUALISTIC BACTERIA WHICH RELEASE CELLULASE. THESE ARE FOUND IN THE RUMEN AND PROMINENT CAECA.

# CARNIVORES



- LARGE, SHARP POINTED AND CURVED CANINES TO CATCH, KILL AND TEAR PREY.
- INCISORS ARE SMALL AND POINTED TO CUT FLESH
- THEY HAVE STRONG SERRATED CARNASSIAL TEETH FOR CRUSHING BONES AND SCRAPE FLESH FROM BONES

**...CONT.**

- LARGER STOMACHS TO ACCOMMODATE LARGER VOLUMES OF FOOD - FEED LESS FREQUENTLY
- SHORTER DIGESTIVE TRACTS BECAUSE MEAT MAINLY CONSISTS OF PROTEINS - EASILY DIGESTED.
- JAW MUSCLES ARE STRONG; ALLOWING ONLY VERTICAL MOVEMENT; WITH A WIDER GAPE TO EASILY CAPTURE PREY



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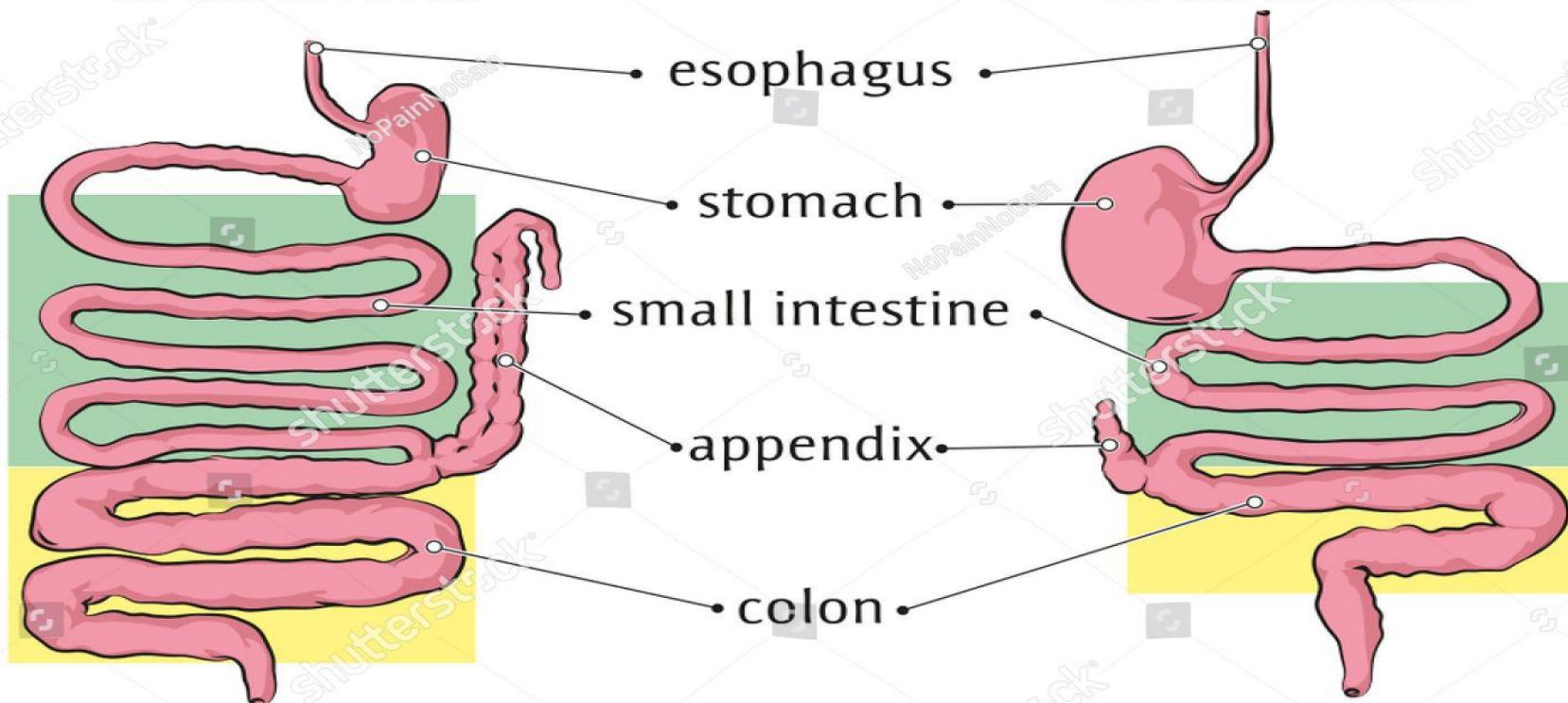
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**Digestive system  
in herbivores**



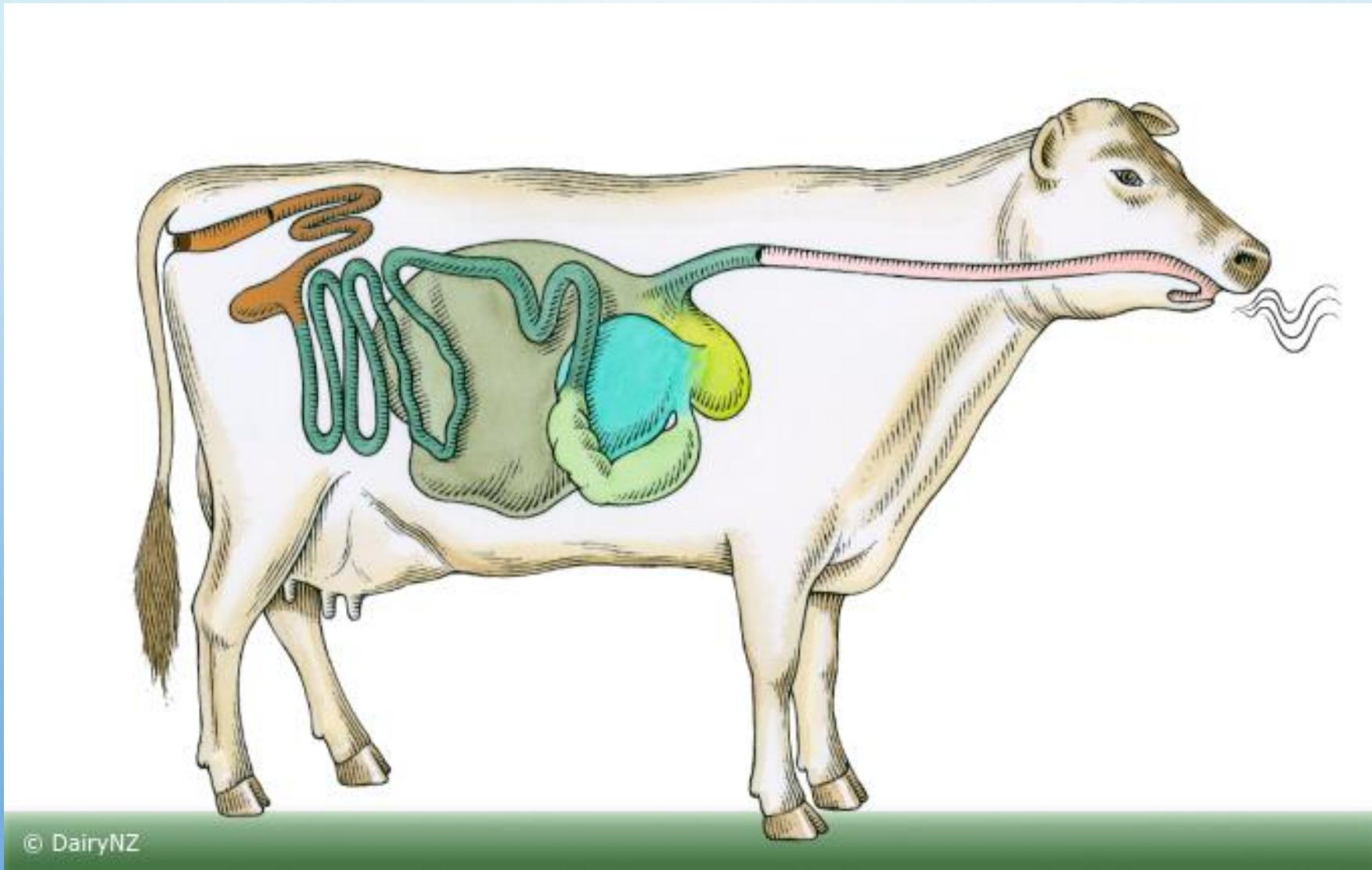
**Digestive system  
in carnivores**



# **OMNIVORES**

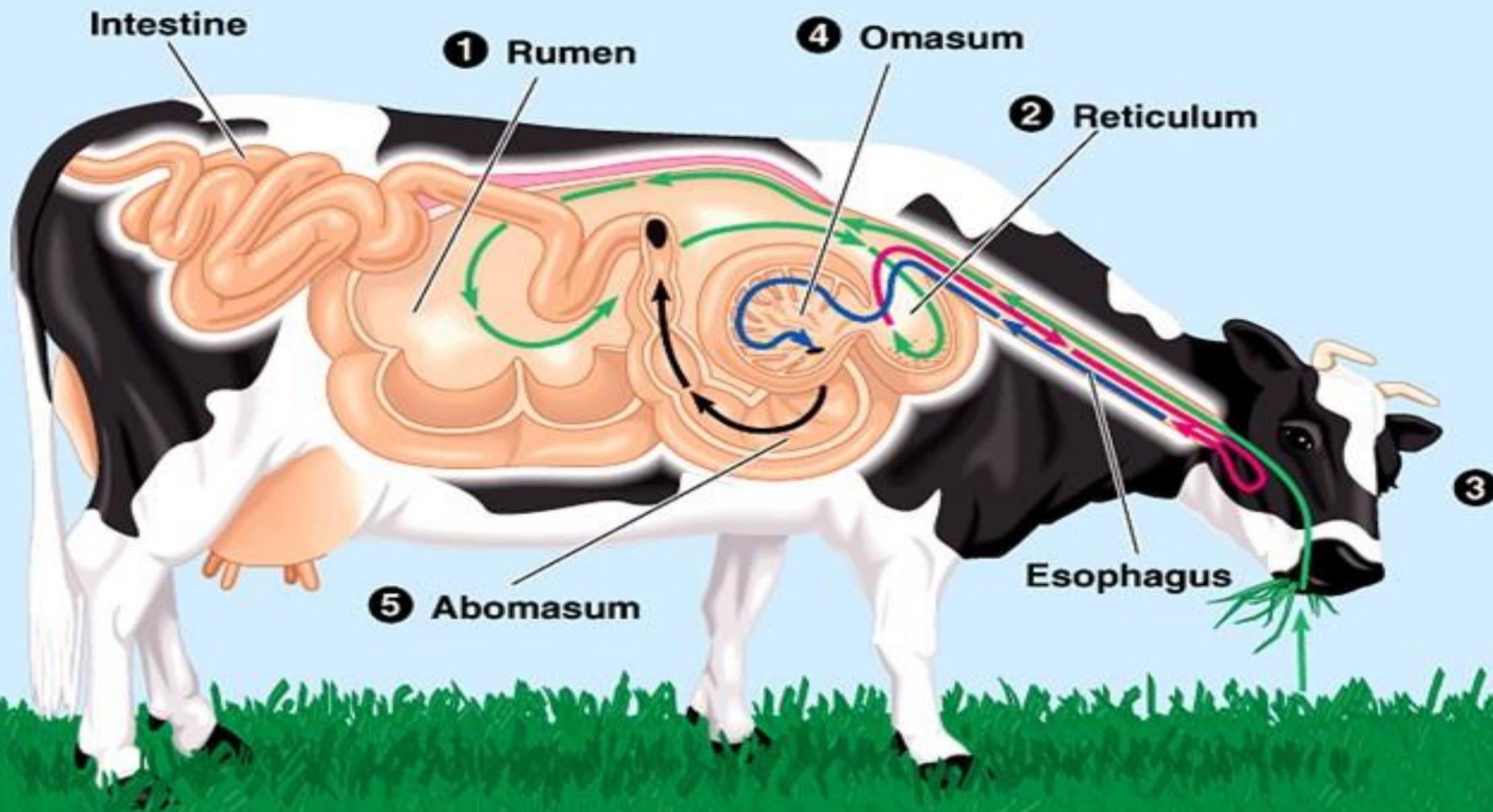
- OMNIVORES HAVE THE LEAST SPECIALIZED DENTITION  
BECAUSE THEY FEED ON BOTH MEAT AND VEGETATION
- MODERATE SIZE OF THE STOMACH
- MODERATE LENGTH OF THE DIGESTIVE TRACT
  - MAN, CHIMPANZEE, HEDGEHOG, PIG

# RUMINANT DIGESTIVE SYSTEM



# RUMINANTS...

- ANIMALS THAT CHEW CUD.
  - CATTLE, GOATS, SHEEP, ANTELOPES ...
- GUT CONSISTS OF A STOMACH WITH FOUR CHAMBERS:
  - RUMEN (POUCH), RETICULUM, OMASUM AND ABOMASUM
  - THE RUMEN IS THE FIRST AND LARGEST CHAMBER; WHERE PARTLY CHEWED GRASS IS STORED.

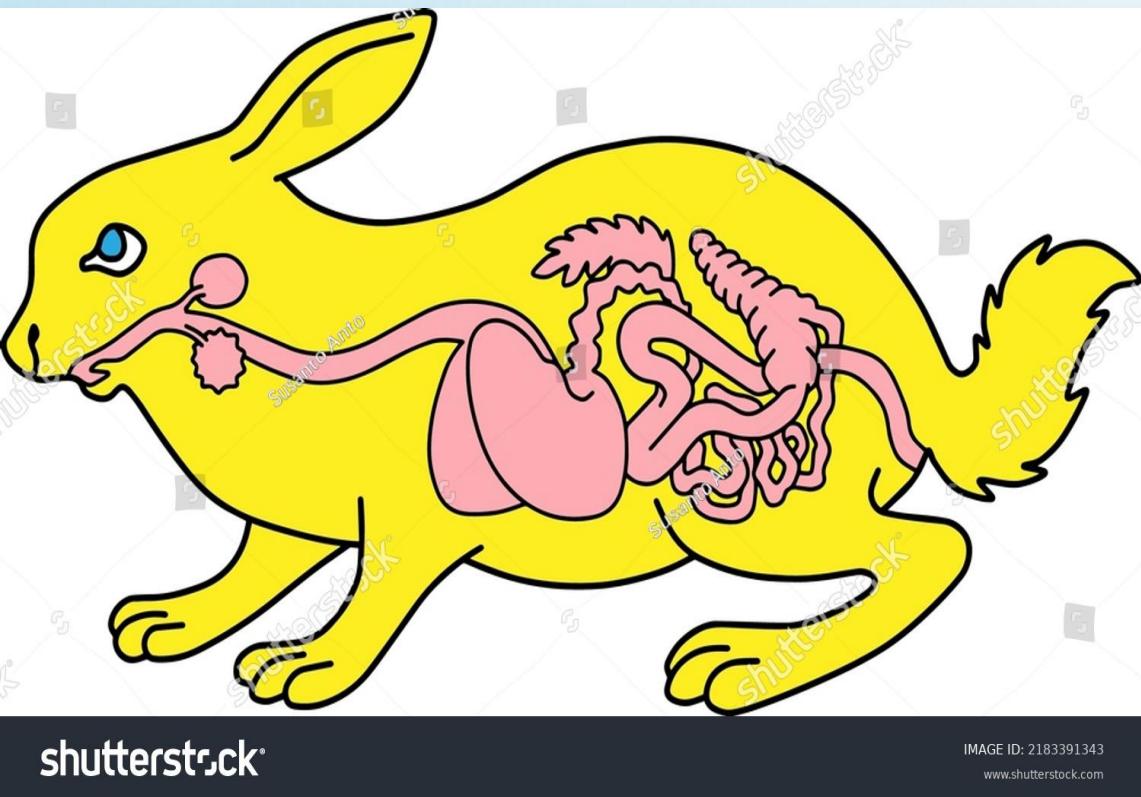


- IN THE MOUTH, GRASS IS PARTLY CHEWED BY TEETH; MIXED WITH LARGE AMOUNTS OF SALIVA (NO ENZYMES); SWALLOWED INTO THE RUMEN.
- IN THE RUMEN, MUTUALISTIC BACTERIA RELEASE CELLULASE; BREAKS DOWN CELLULOSE TO GLUCOSE; ANAEROBICALLY FERMENTED TO FORM ORGANIC ACIDS (ABSORBED INTO BLOOD), CARBON DIOXIDE AND METHANE (BELCHED OUT THROUGH MOUTH)
- THE BACTERIA ALSO SYNTHESISE VITAMINS AND PROTEINS (FROM AMMONIUM SALTS) WHICH ARE ABSORBED.

**...CONT.**

- FERMENTED FOOD PASSES TO THE RETICULUM; ROLLED INTO BALLS (CUD); REGURGITATED INTO THE MOUTH FOR PROPER CHEWING; AND SWALLOWED INTO THE OMASUM.
- THIS HAS PARALLEL LEAF-LIKE COMPARTMENTS WHERE WATER IS ABSORBED, BEFORE FOOD PASSES TO THE ABOMASUM.
- GASTRIC JUICE IS SECRETED FROM THE WALLS OF THE ABOMASUM, PEPSIN BREAKS DOWN PROTEINS TO PEPTIDES.
- DIGESTION CONTINUES AND PRODUCTS OF DIGESTION ARE ABSORBED IN THE ILEUM.

## IN NON RUMINANTS



- LIKE RABBITS AND HORSES, MUTUALISTIC BACTERIA OCCUR IN THE CAECUM AND LARGE INTESTINE
- PRODUCTS OF BACTERIAL FERMENTATION ARE LOST IN FAECES.
- THESE ORGANISMS INGEST THEIR FAECES TO ABSORB THESE NUTRIENTS
  - COPROPHAGY.

**NB:**

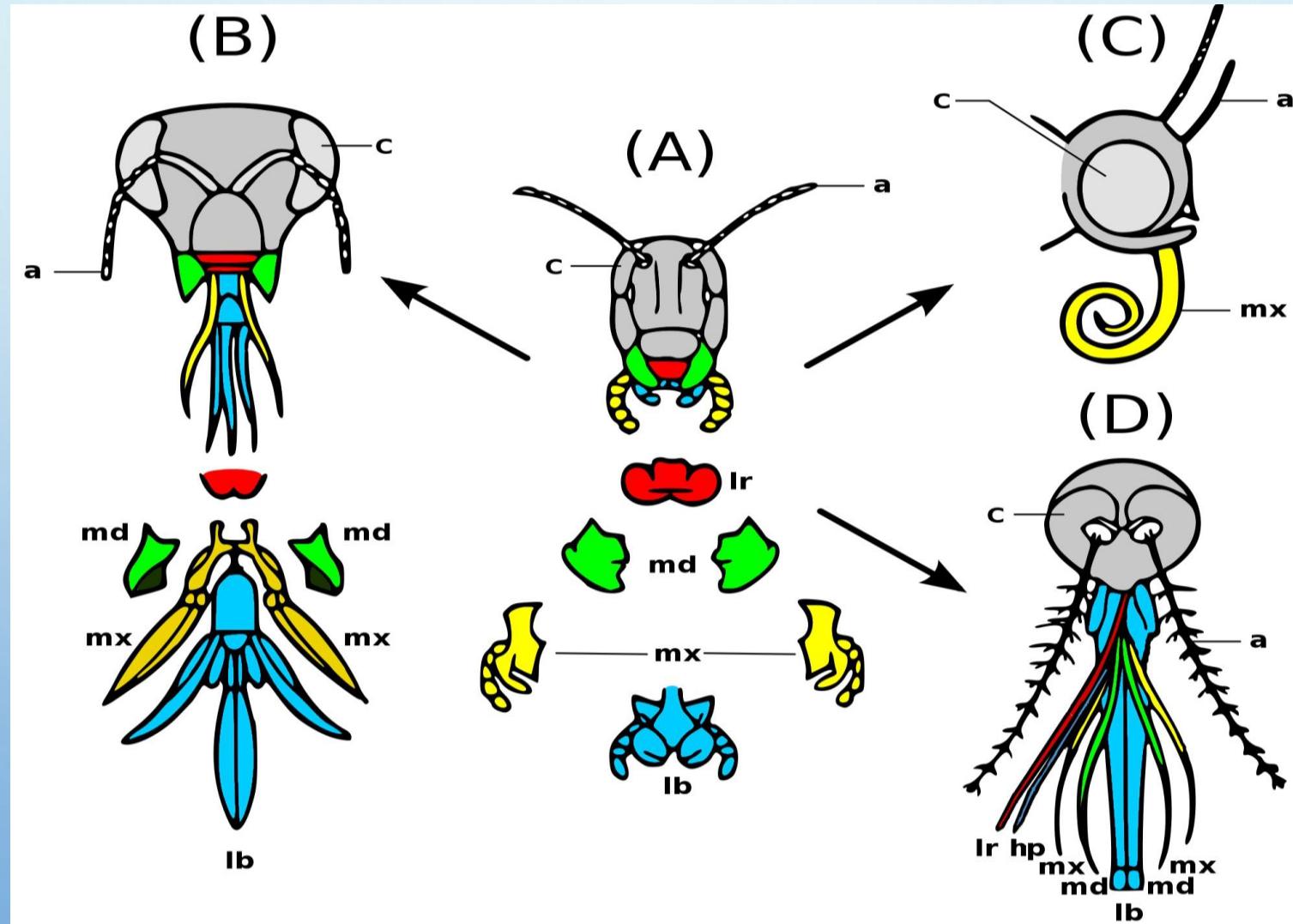
CELLULASE-SECRETING BACTERIA ARE ALSO PRESENT IN  
DIGESTIVE TRACTS OF TERMITES TO ENABLE THEM DIGEST  
CELLULOSE IN WOOD.

# **FEEDING IN INSECTS**

**INSECTS UTILIZE A WIDE RANGE OF FOOD SUBSTRATES.**

**THEIR MOUTH PARTS ARE MODIFIED ACCORDING TO THE FOOD  
SUBSTRATE UTILIZED**

# INSECT MOUTH PARTS



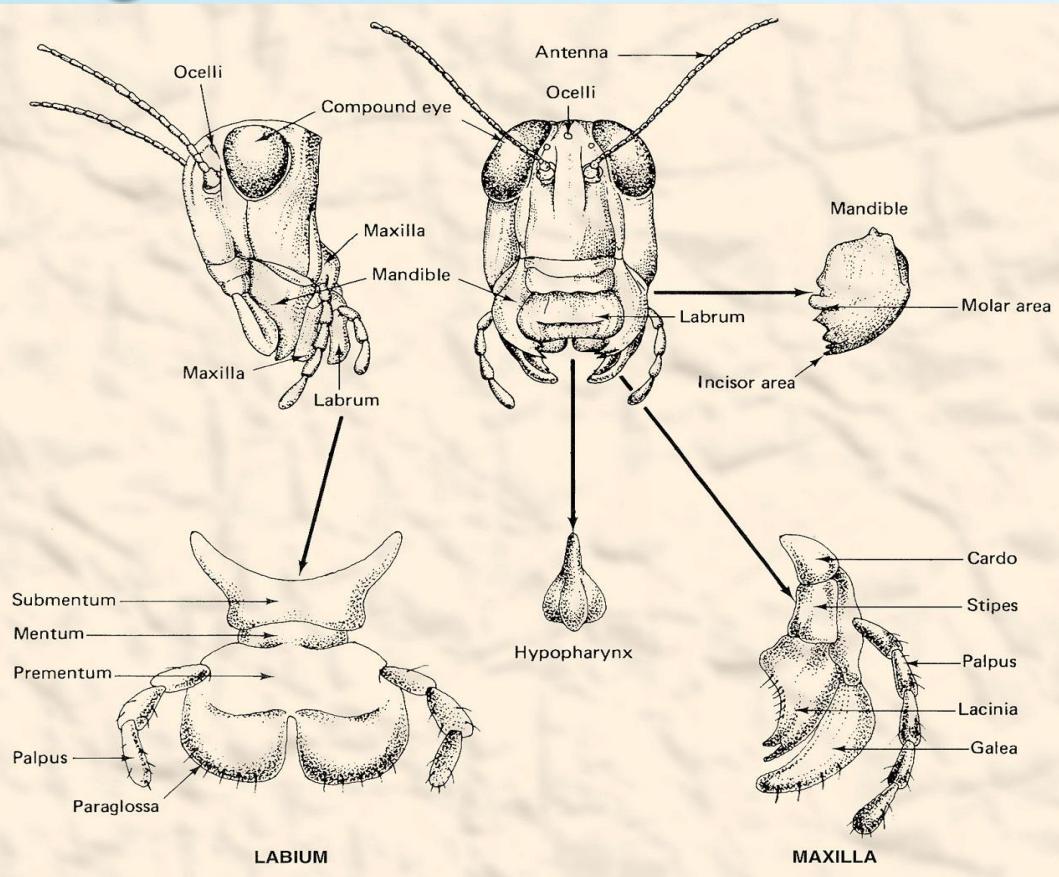
# **GENERALLY ...**

- LABIUM – LOWER LIP
- LABRUM – UPPER LIP
- MANDIBLES – A PAIR OF CUTTING DEVICES
- MAXILLAE – A PAIR OF STRUCTURES THAT HOLD AND MANIPULATE FOOD DURING CHEWING
- SEGMENTED EXTENSIONS CALLED PALPS – SMELL AND TASTE

## **DEPENDING ON THE FOOD SUBSTRATE ...**

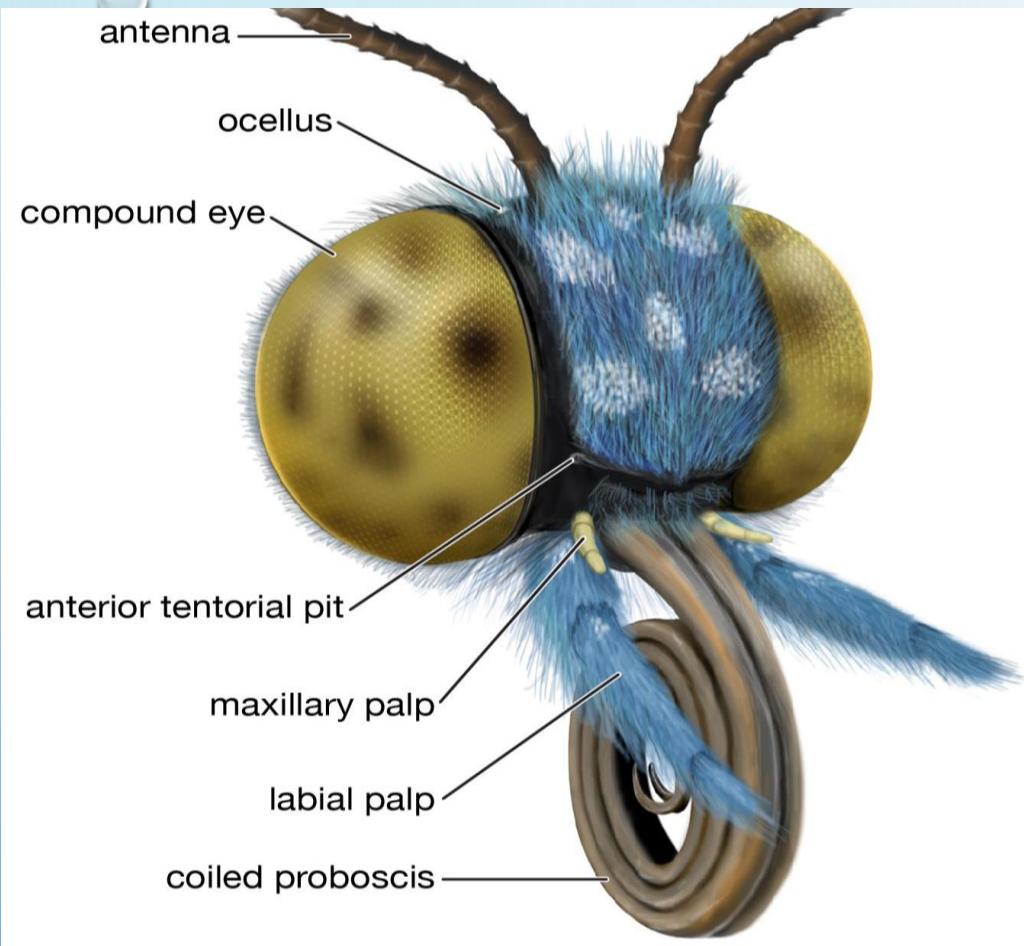
- BITING/CUTTING
- SUCKING
- PIERCING AND SUCKING

# BITING/CUTTING



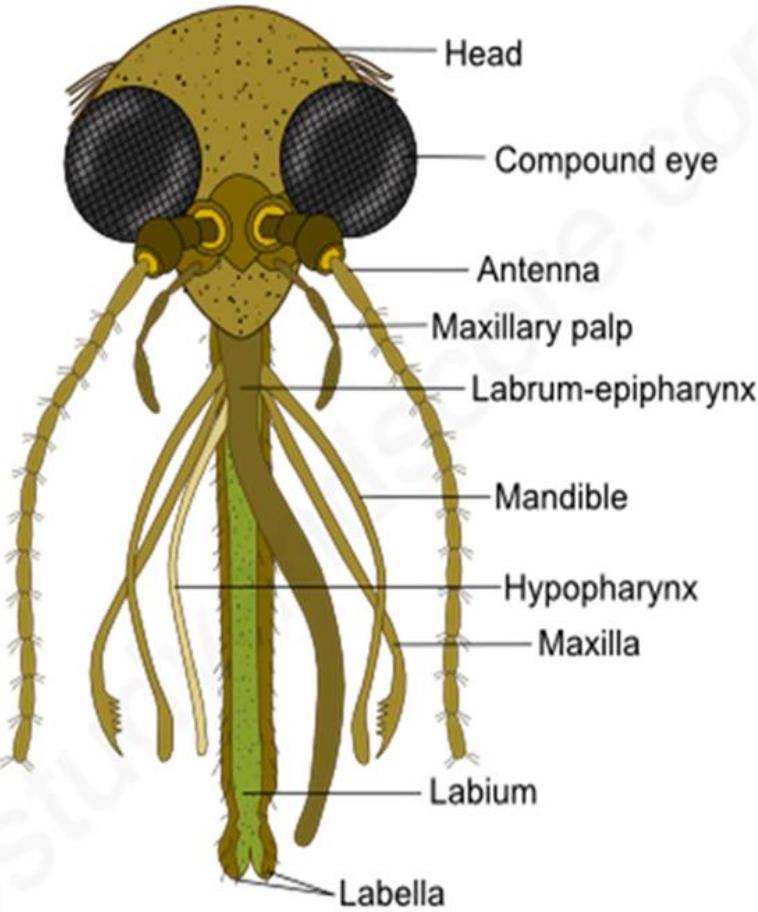
- LEAST SPECIALIZED MOUTH PARTS
- MAINLY FEED ON PLANT MATERIAL (PESTS)
- GRASS HOPPERS, LOCUSTS, COCKROACHES ...
- STRONG MANDIBLES WITH A SHARP SERRATED EDGE FOR CUTTING FOOD INTO SMALLER PARTICLES

# SUCKING



- FEED ON FLUIDS
- BUTTER FLIES, HOUSEFLIES.
- MAXILLAE ARE LONG, MODIFIED INTO C-SHAPED STRUCTURES THAT JOIN TO FORM THE **PROBOSCIS**.
- MANDIBLES ARE ABSENT AND PALPS ARE LESS DEVELOPED

## PIERCING AND SUCKING



- PARASITIC INSECTS LIKE MOSQUITOES AND APHIDS

- LABIUM, LABRUM AND MANDIBLES ARE MODIFIED INTO SHARP PIERCING STYLETS ...

- A LONG PROBOSCIS FOR SUCKING FLUIDS

# APHIDS



- APHIDS ARE COMMON PLANT PARASITES THAT SUCK NUTRIENTS FROM PHLOEM.
- THEY ARE ALSO VECTORS THAT IN THE PROCESS SPREAD VIRAL INFECTIONS BETWEEN PLANTS.



# INSECTIVOROUS PLANTS



PLANTS THAT FEAST ON ANIMALS  
INSECTIVOROUS PLANTS

- ADAPTED TO TRAP AND DIGEST INSECTS FOR NUTRIENTS.
- MAINLY GROW IN NITROGEN-POOR SOILS
- THEIR LEAVES TRAP INSECTS, RELEASE DIGESTIVE ENZYMES WHICH BREAKDOWN THE INSECT EXTRACELLULARLY
- SOLUBLE PRODUCTS ARE ABSORBED INTO THE PLANT BODY FOR ASSIMILATION
  - VENUS FLY TRAP, PITCHER PLANTS AND DESMODIUM

# THE END

GOOD LUCK @MOSES.B