

DIGESTION MECHANISM OF VARIOUS NUTRIENTS IN POULTRY

By

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Digestion

1

- Mechanical and chemical breaking down

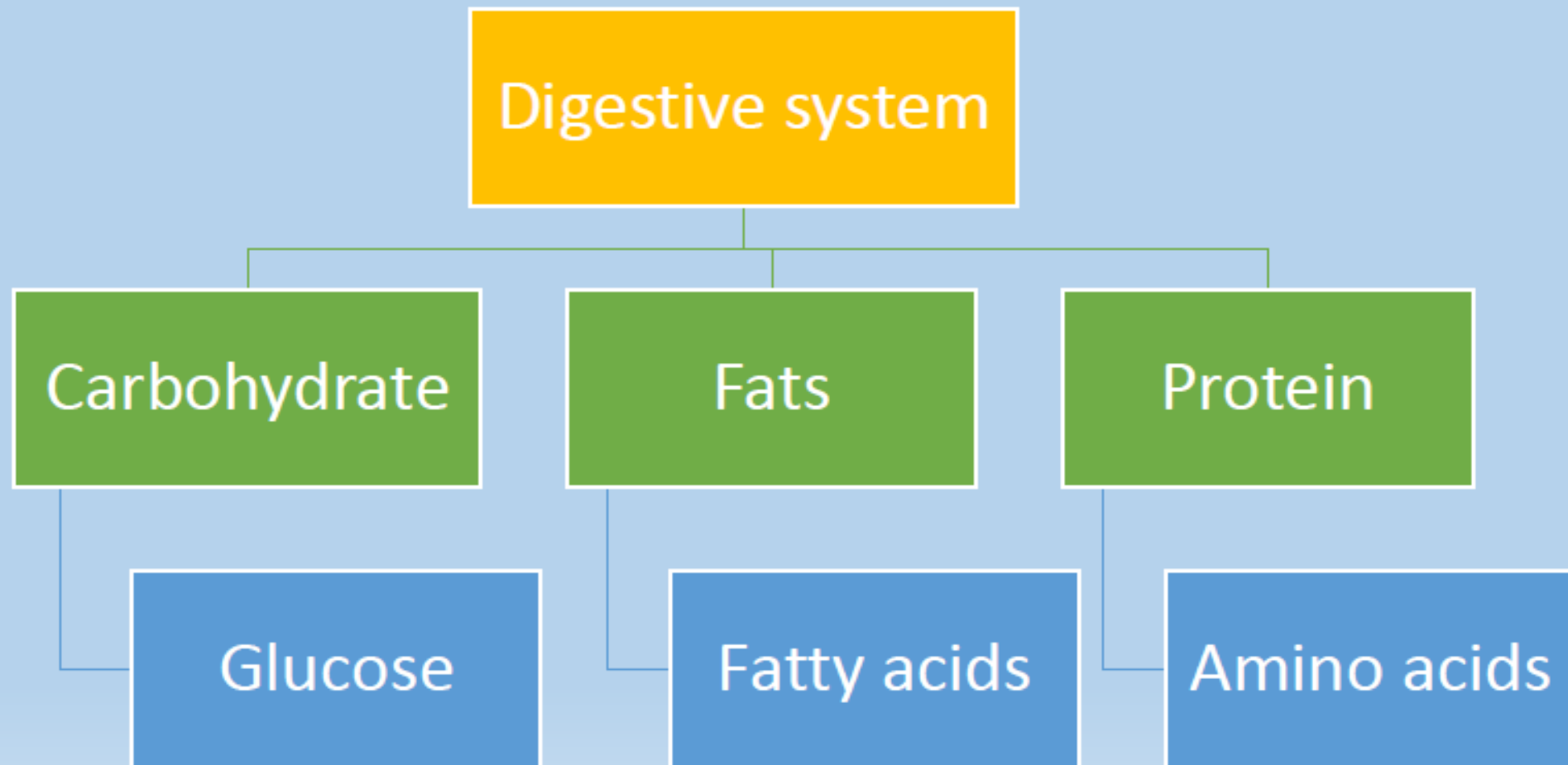
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- food into smaller components

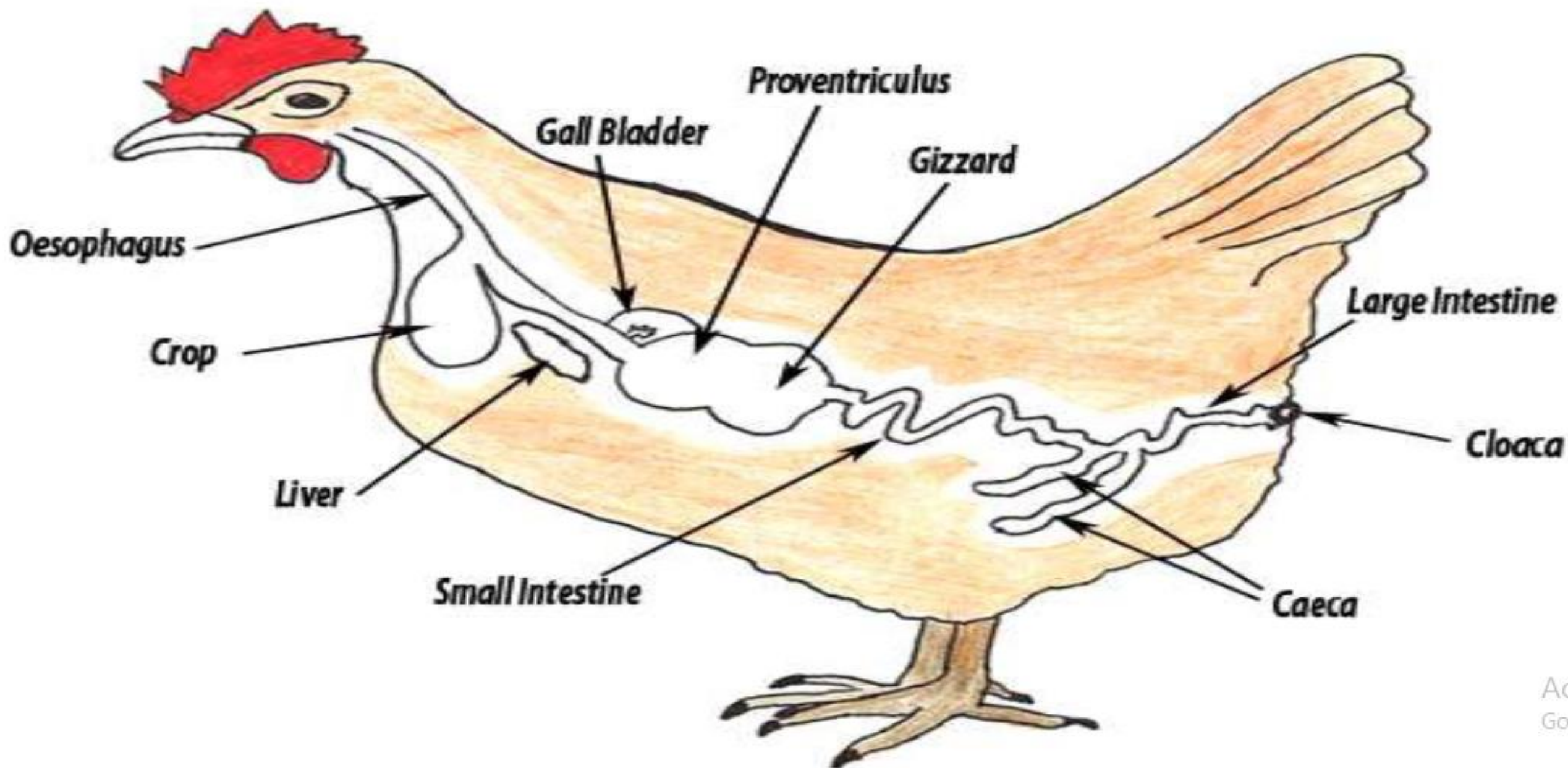
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- to a form that can be absorbed, for instance, into a blood stream

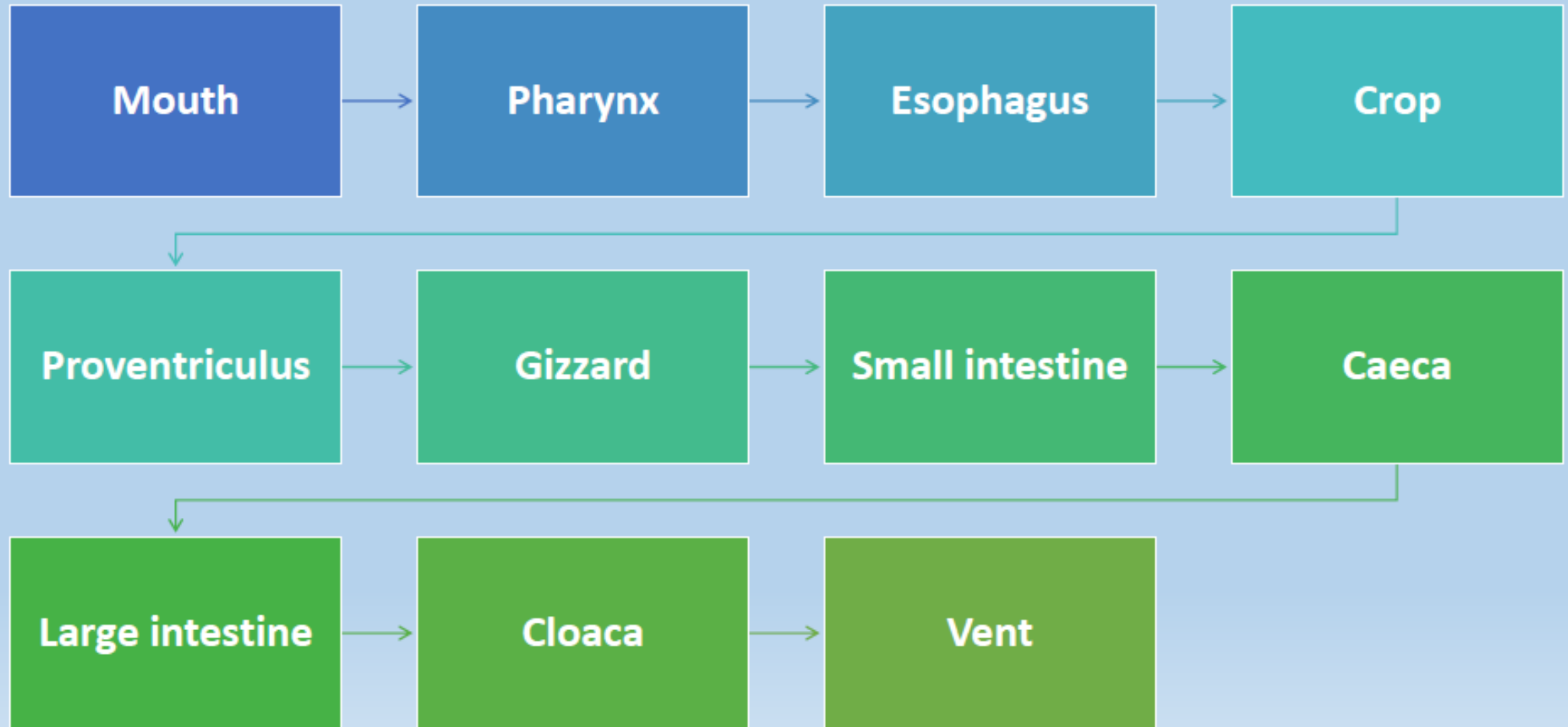
Responsible for the breakdown of complex non absorbable components like;

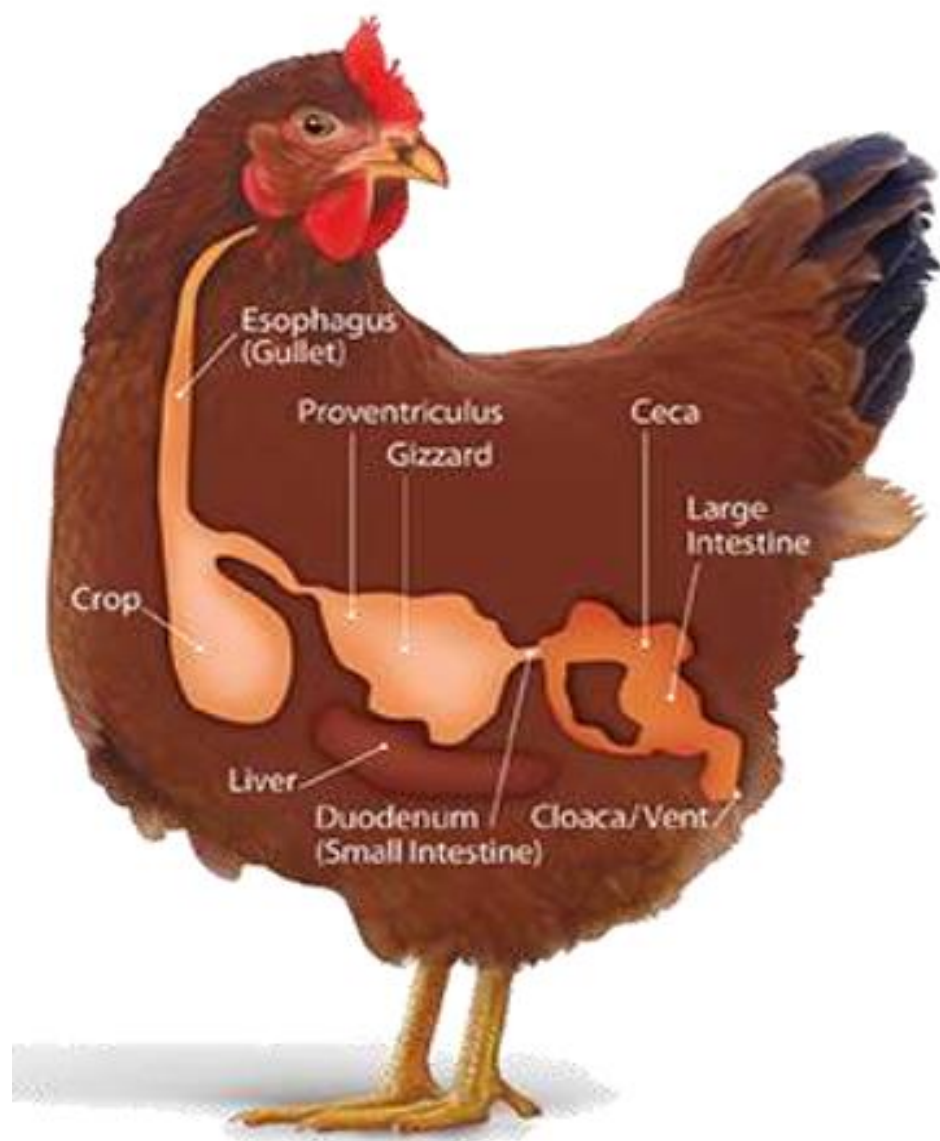


The Digestive System of a Chicken



Digestive system is divided into following parts





Mouth

- Saliva and digestive enzymes are added
- Does not have teeth to chew its feed

Pharynx

- Common passage way for feed and air
- It is divided into two parts: Esophagus; Larynx

Esophagus

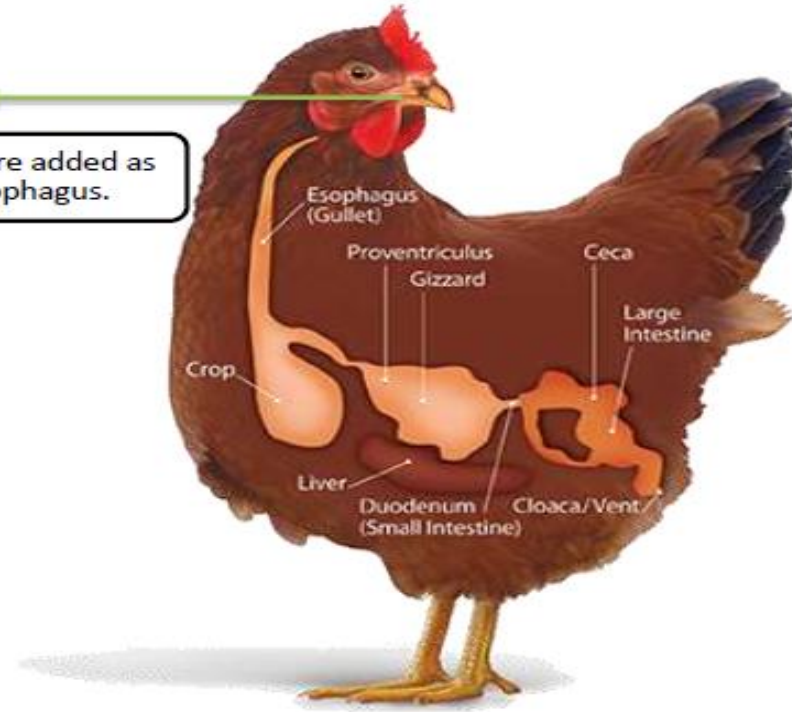
- Transports food from the mouth to the stomach
- Major secretion is mucous

Organs and Functions

The Mouth

Mouth:
It all starts here.

A small bit of saliva and digestive enzymes are added as the food moves from the mouth into the esophagus.

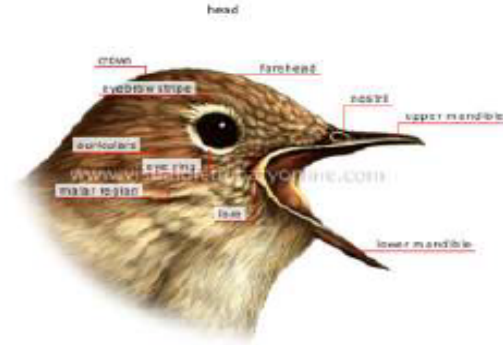


Mouth

- Saliva and digestive enzymes are added
- Does not have teeth to chew its feed

Mouth (beak) is made up of:

1. Upper mandible
 - attached with skull
 - non-movable part of beak
2. Lower mandible
 - It is the movable part of beak



- The chicken does not have teeth to chew its feed.

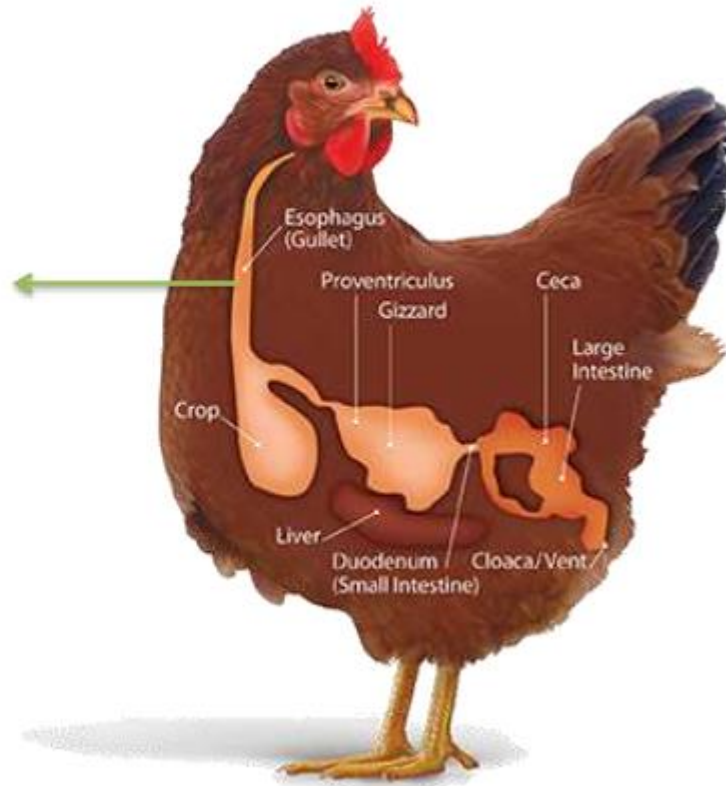
- The roof of mouth is made up of hard palate that is divided by a long narrow slit in the center that is opened to the nasal passage.
- The soft palate is absent in chicken.



The Esophagus

Esophagus:

Transports food from the mouth to the stomach.



Esophagus

- Transports food from the mouth to the stomach
- Major secretion is mucous

Description

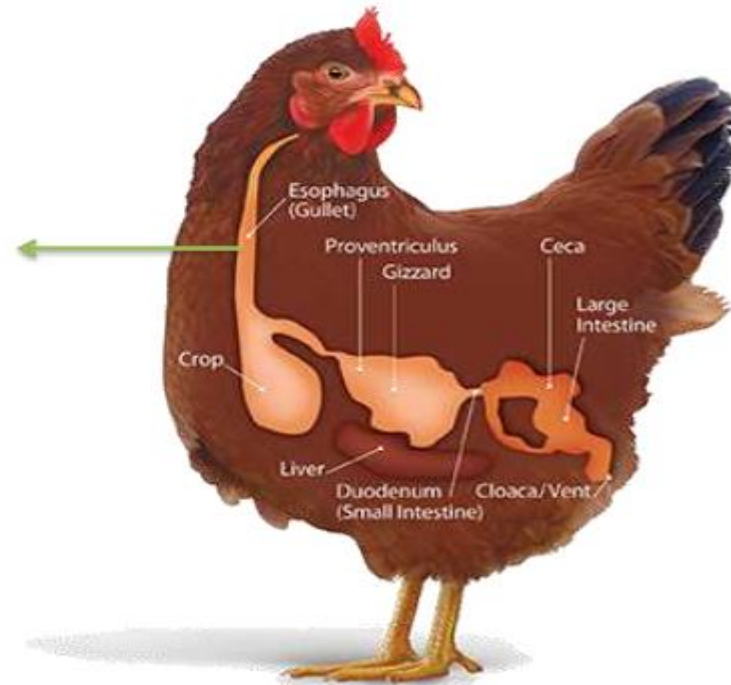
Esophagus is a tube like structure that extends from mouth to Proventriculus.

Functions

1. It helps carry feed from mouth towards Proventriculus.
2. Secretes mucous for lubrication.

The Esophagus

Esophagus:
Transports food from the mouth to the stomach.



Crop

- Responsible for the storage of feed
- Little digestion with salivary amylase

PROVENTRICULUS

- Glandular stomach or true stomach
- Responsible for the production of gastric juice

Gizzard

- Muscular Stomach or Ventriculus
- Crushing and grinding the feed particle

Gizzard

- Muscular Stomach or Ventriculus
- Crushing and grinding the feed particle

Gizzard

Description

- Also called muscular stomach or ventriculus.
- It is made up of two pairs of powerful muscles capable of crushing and grinding the feed particle, which act as the bird's teeth.
- (The tunica muscularis of gizzard is made up of two layers of smooth muscles, inner circular & outer longitudinal)

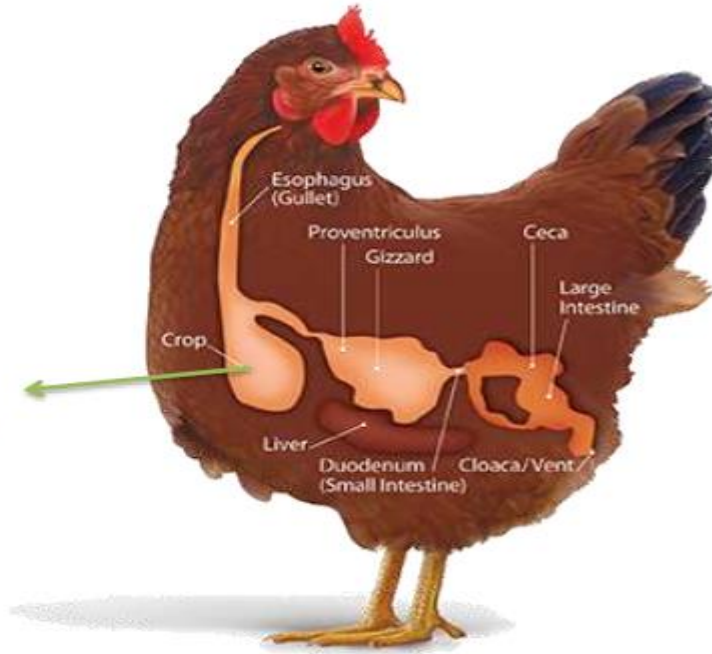
Functions

1. It performs powerful muscular contraction, which ultimately leads to crushing and grinding of feed particles.
2. This process is aided by the presence of grit or rocks present in the gizzard.
3. The gizzard performs 2-5 contractions per minute according to the consistency of the feed particle!!!!!!

The Crop

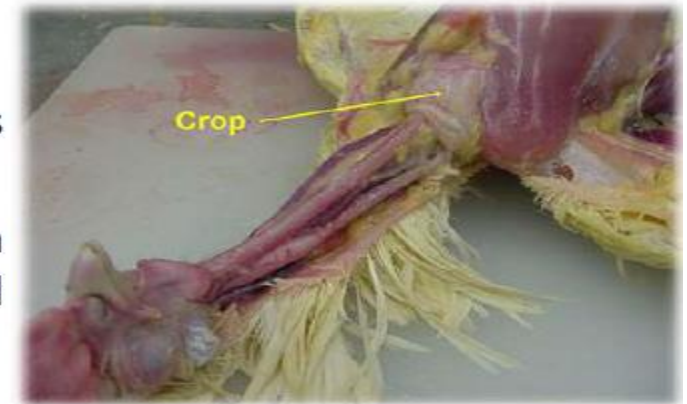
Crop:
A pouch in the esophagus used to store food temporarily before moving it on to the stomach.

Feed can remain for up to 12 hours



Description

- Crop is the extension of esophagus located in the neck region.
- Cropectomy has no effect on growth rate of ad-libitum fed chickens.



Functions:

1. Storage of feed, so, when the proventriculus or gizzard is empty the feed by pass the crop.
2. Little digestion takes place with the action of salivary amylase.
 - 1) Amylase activity at this site comes from either salivary secretions, intestinal reflux, or plant and/or bacterial sources.
 - 2) Starch is hydrolyzed within the crop where it can either be absorbed, converted to alcohol, lactic or other acids

Proventriculus

Stomach:

Principally the organ where food is broken into smaller units. It has two parts:

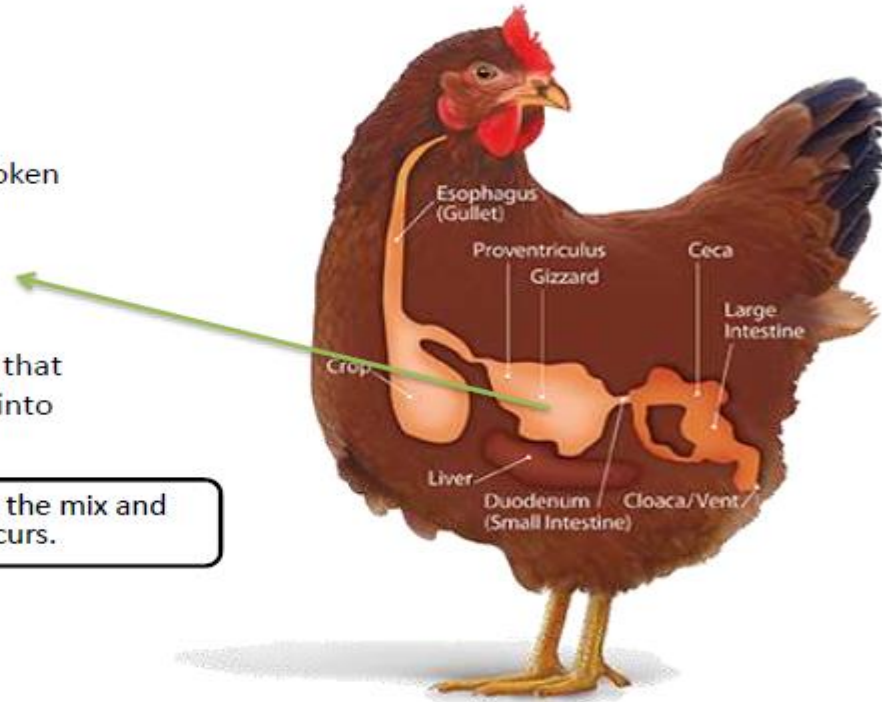
1. Proventriculus

For storage

2. Gizzard

Is a muscular part of the stomach that uses grit to grind grains and fiber into smaller particles.

Digestive enzymes are added to the mix and physical grinding of the food occurs.



Description

- Also called glandular stomach or true stomach.
- It is a specialized enlargement of the gullet just before entry into the gizzard.

PROVENTRICULUS

- Glandular stomach or true stomach
- Responsible for the production of gastric juice

Functions:

- Production of gastric juice;
 - Gastric juice is made up of the proenzyme known as **pepsinogen** and **hydrochloric acid**, both are produced by oxyntico-peptic cells.
 - Gastric juice produced in response to protein content in diet.
 - Acid secretion of chickens is high relative to mammals.
 - Amylolysis occurs in the crop, it is not evident in the ventriculus.

Small intestine

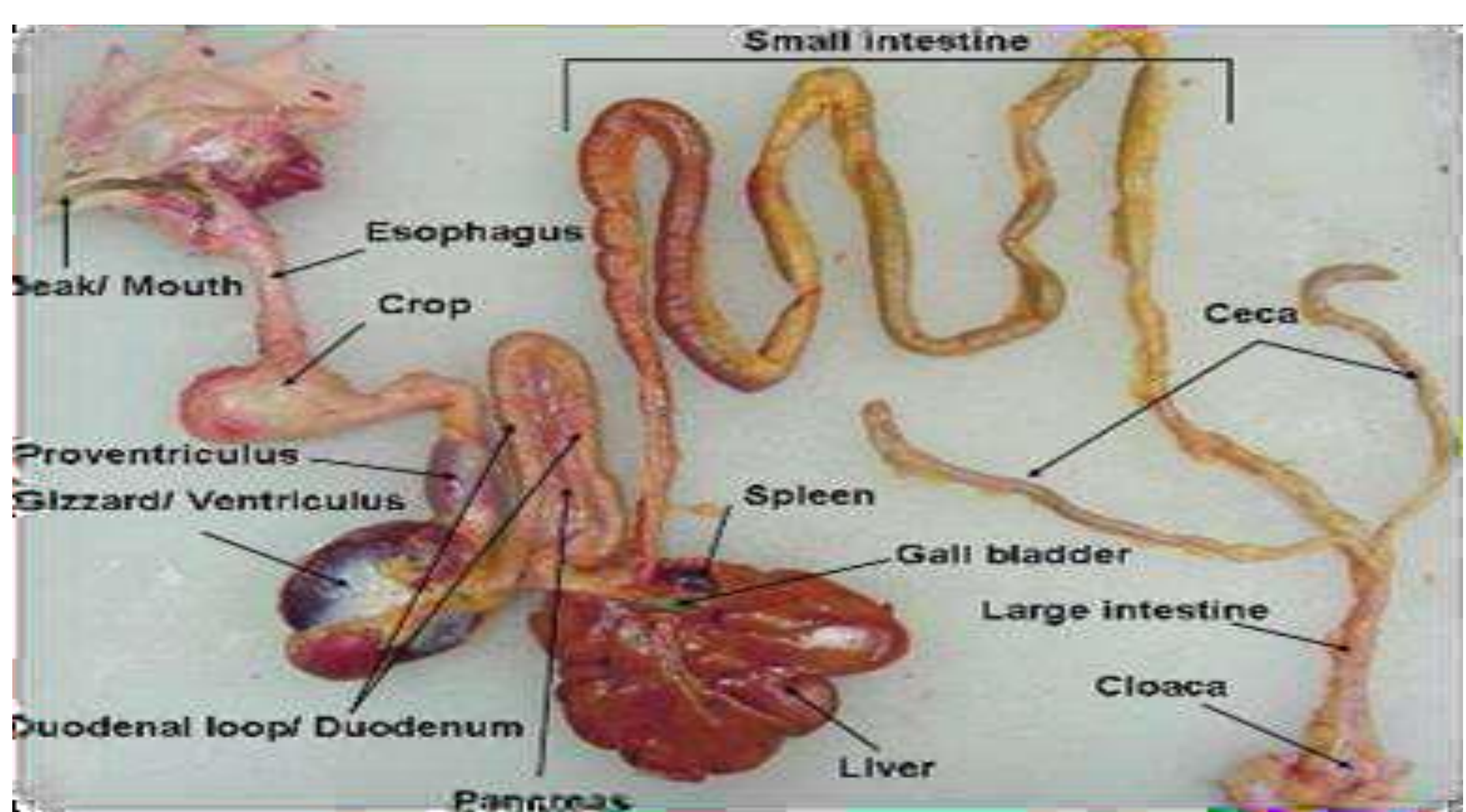
- 3 parts. **1-Duodenum** **2-Jejunum** **3-Ileum**
- Digestion by intestinal juice, pancreatic juice & bile

Caeca

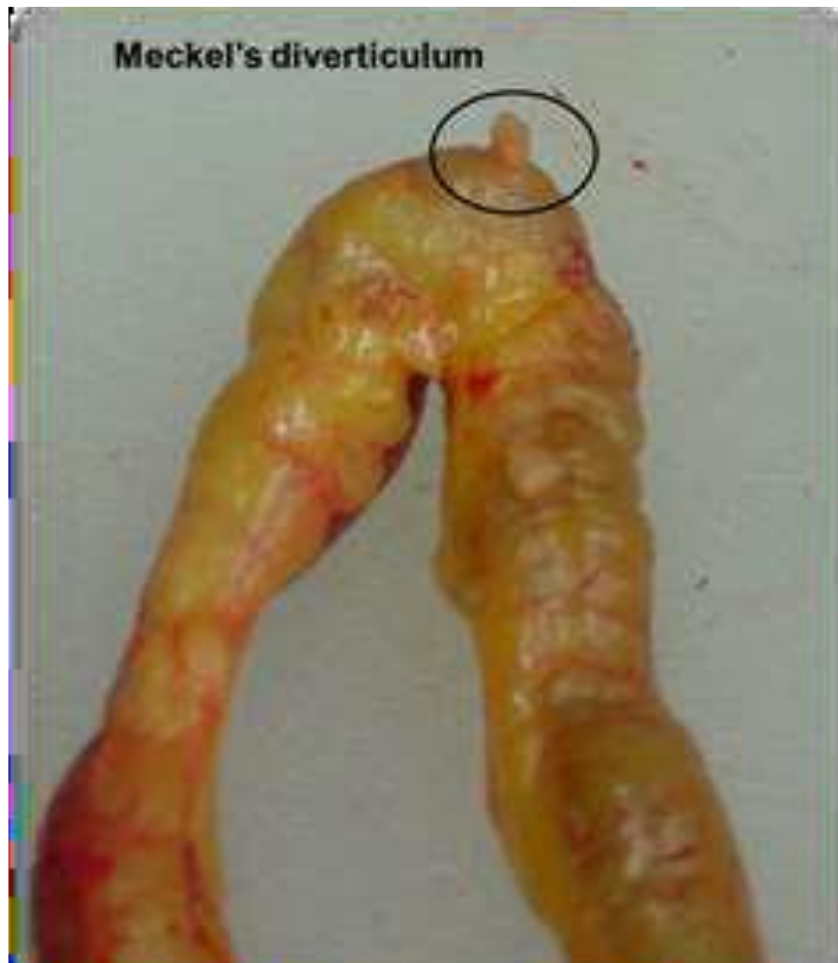
- 2 blind pouches b/w small intestine & large intestine
- Digestion with the help of bacterial action

Large Intestine

- Smaller as compared to small intestine and caecum
- Maintain water balance by water absorption.



Meckel's diverticulum



Cloaca

- Bulbous/enlarged area located at the end of large intestine
- Common sewer

Vent

- External opening of the cloaca
- Its size is variable

ACCESSORY DIGESTIVE GLANDS

Salivary Glands

Pancreas

Liver

Salivary glands

Production of saliva

Secretions ranges from 7 to 25 ml

Pancreas

Produces a pancreatic juice

Proteolytic
Lipolytic
CH₂O splitting
Nucleolytic

Liver

Detoxification
Store house

Activates and inactivates protein & peptide hormone

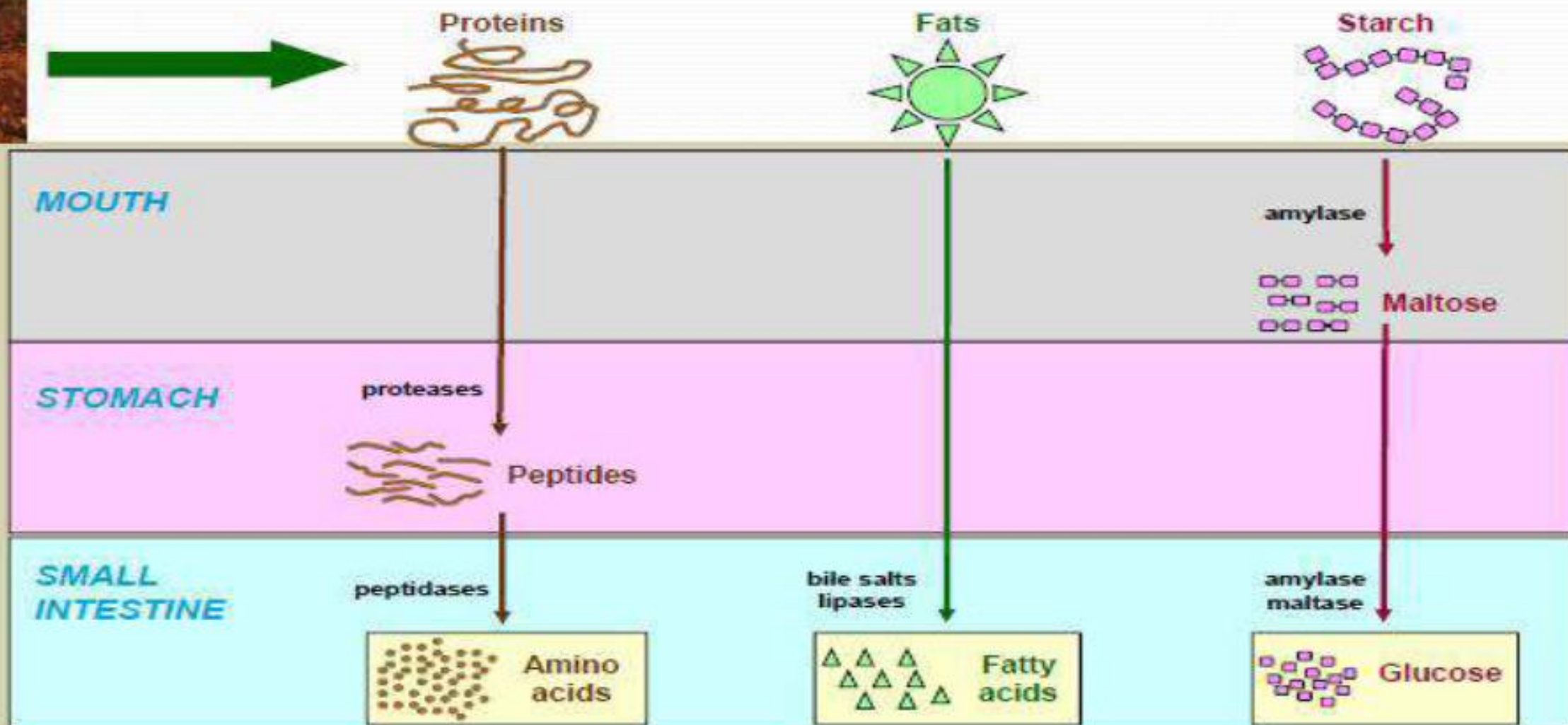
DIGESTIVE ENZYME ACTIVITY

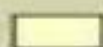
Location	ph	Enzyme	Substrate	Product
Mouth	7.0-7.5	Saliva (Amylase)	Lubricates feed Starch Dextrin	Dextrin Glucose
Crop	4.5	Mucus	Soften feed	
Gizzard and Proventriculus	2.5	HCL	Lower digesta pH, initiates protein cleavage	
		Pepsin	proteins	Polypeptides
		Lipase	triglyceride	Fatty acids, monoglycerides
Duodenum	6.0-6.8	Amylase	Starch, dextrin	Maltose, glucose
		Trypsin, chymotrypsin and esterase	Proteins, peptides	Peptides and amino acids
		Carboxypeptidases collagenase	Peptides collagen	Amino acids, peptides

DIGESTIVE ENZYME ACTIVITY

Duodenum		Lipase	Fats	Fatty acids, monoglycerides, diglycerides
		Cholesterol esterase	Cholesterol esters	Fatty acids, cholesterol
Jejunum	5.8-6.8	Maltase and isomaltase	Maltose, isomaltose	Glucose
		Sucrase	sucrose	Glucose, fructose
		Lactase	lactase	Glucose, Galactose
		Polynucleotidase Peptidases	Nucleic acids peptides	Mononucleotides mononucleotides
Ceca	5.7-5.9	Microbial activity	Cellulose, polysaccharides Starches, sugars	Volatile fatty acids Vit. K, B vitamins

Digestive Process in Poultry



 = main site of absorption

Carbohydrates

Digestion Mechanism of Carbohydrates

- Amylase enzyme which initiates starch digestion
- Mostly digestion occur in jejunum

- Alpha amylase hydrolysed 1,4 linkages on both sides
- Maltose is cleaved by maltase and isomaltase

- Sucrase hydrolyses sucrose
- Milk derived CH_2O are hydrolysed by lactase to glucose and galactose

Gross Energy digestible energy metabolizable energy of starch and sugars

Carbohydrate	Gross	Digestible	Metabolizable
Starch	3750	3550	3350
Glucose	3430	3400	3330
Maltose	3600	3390	3250
Fructose	3000	2875	2750
Sucrose	3950	3875	3750

Proteins

Digestion Mechanism of Proteins

No digestion in mouth & Proventriculus is 1st site

HCL & Pepsin play major role in digestion

Proventriculus & gizzard major sites

Most protein in
the feed are
quite resistant to
attack by
enzymes

Must be
denatured

3D
structure of protein
Is broken into single
structure

Normal crude protein contents and digestibilities of common poultry feed stuff

Feed stuff	CP	Iliac digestibility (%)			
		CP	lys	met	cys
Corn	18	82-86	81	91	85
Wheat	12	78-82	81	87	87
Barley	10	70-82	78	79	81
sorghum	10	62-72	78	89	83
Peanut meal	49	88-91	83	88	78
Soybean meal	46	83-87	91	92	82
Cottonseed meal	43	61-76	67	73	73

Fats & fatty acids

Digestion mechanism of fats and fatty acids

No hydrolysis in the upper elementary tract

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graph LR; A[No hydrolysis in the upper elementary tract] --> B[Limited acid catalysed hydrolysis in proventriculus and gizzard]; B --> C["Digestion & absorption usually occur in small intestine By lipase"]
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Limited acid catalysed hydrolysis in proventriculus and gizzard

Digestion & absorption usually occur in small intestine
By lipase

Digestion mechanism of fats and fatty acids

Secretion from very early age, this activity increases very rapidly from 1st 3 weeks

Fat digestion is enhanced by emulsification

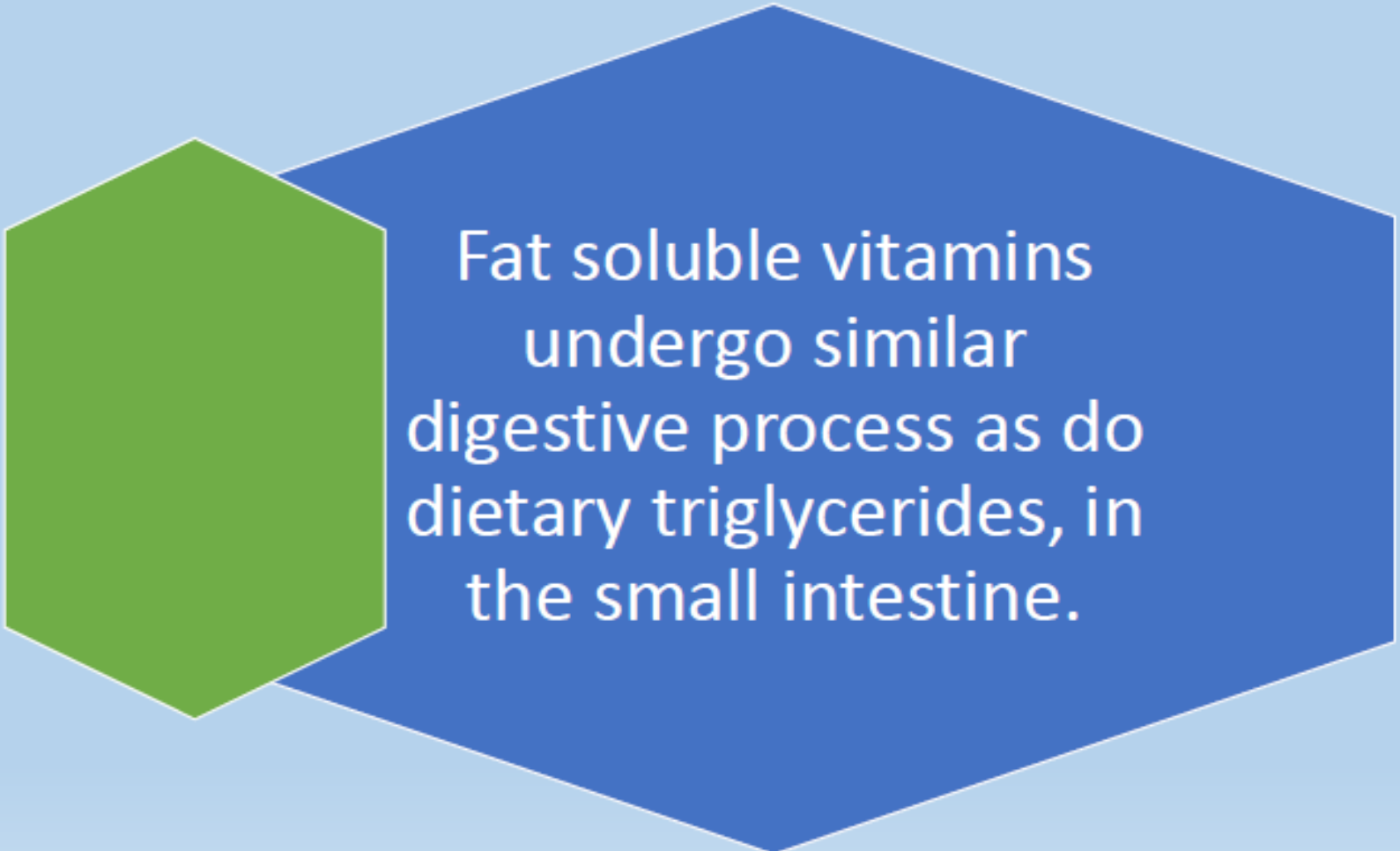
Bile salts & lipase play major role

Digestibility values of various fatty acid

Fatty acids	no. of carbon	Digestibility (%)	
		3-4 weeks	>8 weeks
Lauric	12:0	65	-
Myristic	14:0	25	29
Palmitic	16:0	2	12
Stearic	18:0	0	4
Oleic	18:1	88	94
Linoleic	18:2	91	95

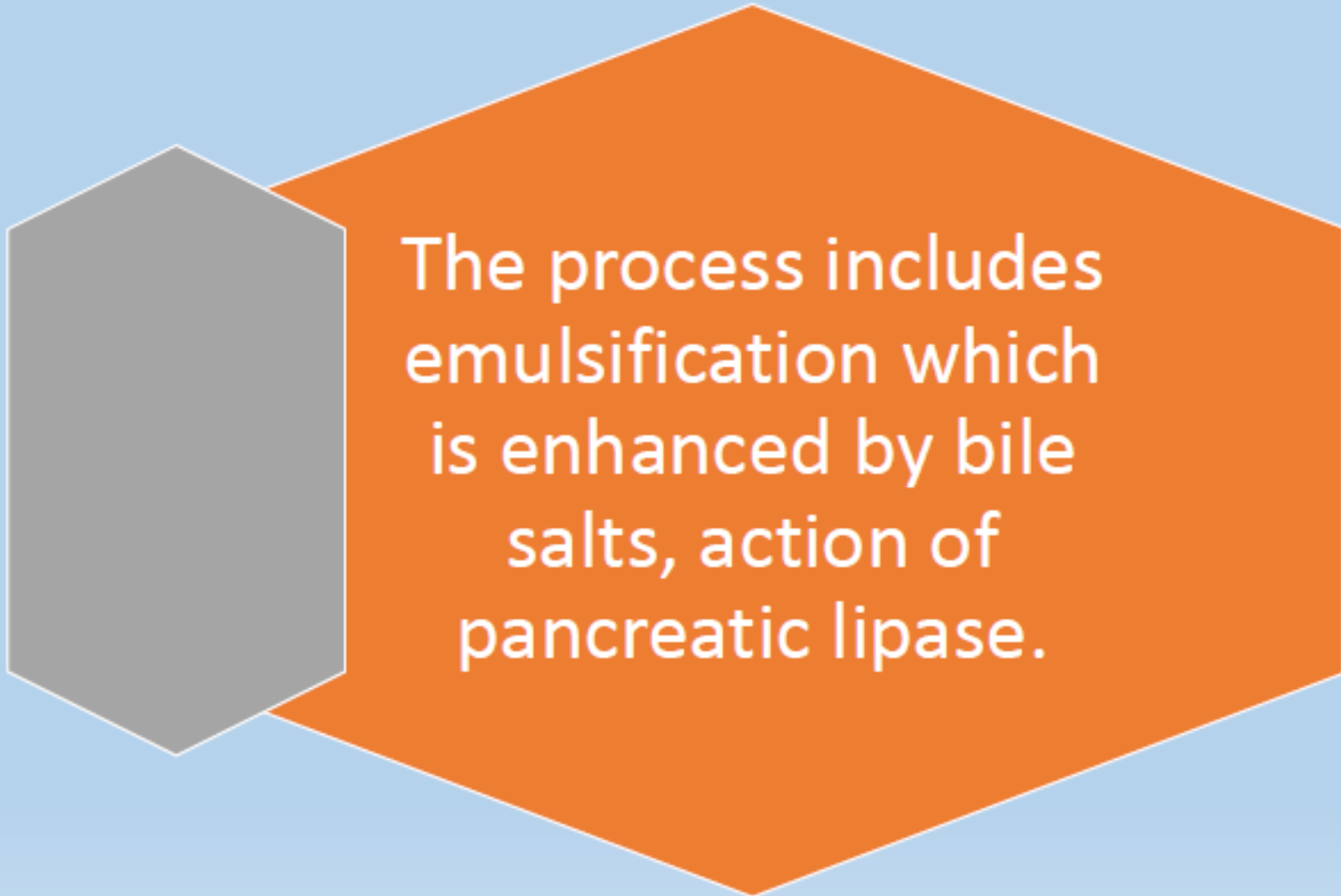
Vitamins

Digestion mechanism of Vitamins



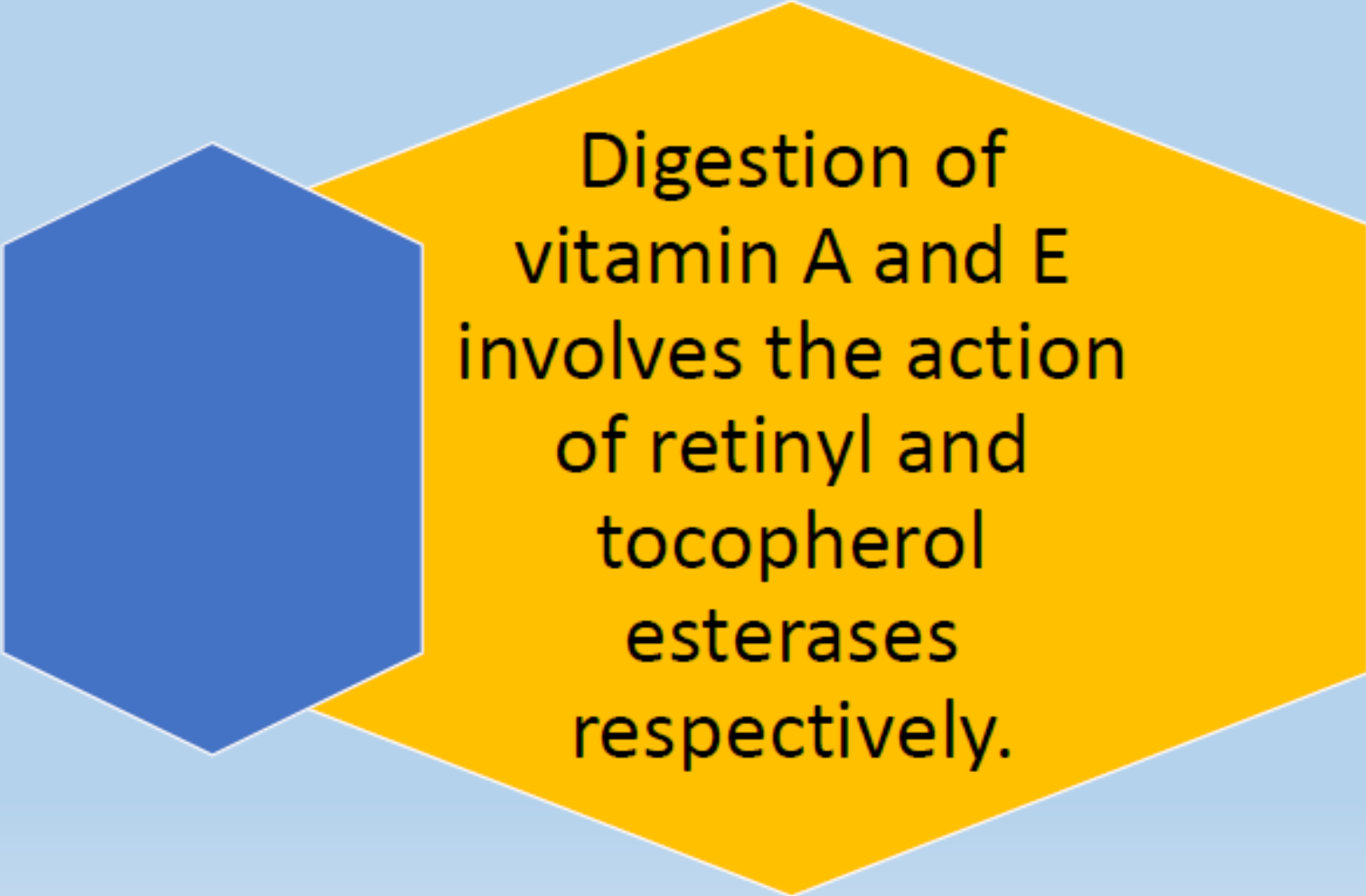
Fat soluble vitamins undergo similar digestive process as do dietary triglycerides, in the small intestine.

Digestion mechanism of Vitamins



The process includes emulsification which is enhanced by bile salts, action of pancreatic lipase.

Digestion mechanism of Vitamins



Digestion of vitamin A and E involves the action of retinyl and tocopherol esterases respectively.

Digestibilities of Vitamins

Digestibility of vitamins

Digestibility %

Vit. A

40-70

Vit. D3

50-66

Vit. E

10-25

Vit. K

50%

Niacin

85%

Feed enters crop whole and undergoes a bacterial fermentation

contain a large bacterial community which break down indigested plant material



Crop

Duodenum

Proventriculus

Lining secretes acid-low pH environment

Gizzard

Site of mechanical grinding of feed
Low pH environment
Sets rate of passage through GIT:

Hard pellets or a large grist size require more grinding; rate of passage is slowed.
Fine textured mash or poor quality pellets require less grinding; rate of passage is faster



Ileum

Jejunum

Small Intestine (SI)

Digesta from gizzards is mixed with bile salts and digestive enzymes in the SI
Major site of chemical digestion and nutrient absorption
High surface area due to villi and microvilli

Caeca

Rectum and Cloaca



Colon

Little absorption and digestion occur
After leaving the colon, the fecal pellet passes into the cloaca where it is mixed with uric acid and expelled via the vent.

Mechanism of Hunger

There are two systems or centers located in the brain or liver which controls the feeding behavior of animals

1. Satiety center
2. Appetite center

Satiety Center

- It is located in the liver of the chicken, while in other animals it is located in the brain.
- This center is also known as glucostatiey Centre.
- Level of glucose in the blood activates and stimulates the satiety center leading to cessation of feed in take.

Appetite Center

- The stimulation of this Centre results in feed intake or hunger.
- This centre is stimulated by low concentration of glucose in the blood. This is located in the brain.

