

GI Tract – Mouth

GI Tract should be called

Teeth –

Salivary glands

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Amylase(Ptyalin) –

Lipase –

Bolus –

Swallowing –

Peristalsis –

Esophagus

- **The upper 1/3 is under**
- **The lower 2/3's is under**

GI Tract Mouth

GI Tract should be called the alimentary canal. Because the alimentary canal covers everything, not just the stomach and intestines.

Teeth – Food goes in and the teeth break the food down via mastication and mixes with the saliva.

Salivary glands produce 4ml/min of a water solution for food lubrication and initial stages of digestion.

- Parotid – (IX)Glossopharyngeal
- Submaxillary – (VII) Facial
- Sublingual – (VII) Facial

Amylase(Ptyalin) – Breaks down starchs

Lipase – Begins the break down of triglyceride lipds into glycerol and fatty acids.

Bolus – term for food after being broken down and formed into swallowing-sized lumps.

Swallowing occurs in the oral and laryngeal pharynx, which runs from the level of the hard pallet around C6, which is the start of the esophagus.

Peristalsis – the movement of the bolus, and the movement the rest of the way to the anus.

Esophagus

- **The upper 1/3 is under** voluntary control
- **The lower 2/3's is under** involuntary control

Stomach

Stomach Functions:

Major digestive juice in the stomach is:

The stimulation of gastric acid is in two phases.

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In the large intestines

The four states of ingested food and in which part of the GI tract they are found:

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Bacteria in the LI also synthesize –

Stomach

Stomach Functions: churns the bolus and mixes it with gastric fluid. This turns it into Chyme.

Major digestive juice in the stomach is: gastric acid which contains pepsin which digests protein.

The stimulation of gastric acid is in two phases.

- Cephalic Phase – ANS at the thought/sight/smell of food will start the secretion of gastric fluids.
- Gastric Phase when food enters the mouth and reaches the stomach, additional secretion activity takes place and the bolus gets turned into chyme.

Most of the digestion and absorption of food takes place in the SI. The trip thru the SI takes about 4 hours (it varies by book)

In the large intestines the body completes the absorption of water and a minimal amount of other nutrients which changes the chyme into feces.

The four states of ingested food and in which part of the GI tract they are found:

- Food – Mouth
- Bolus – Mouth -> Stomach
- Chyme – Stomach -> End of Small Intestines
- Feces – Large Intestine to defecation.

Bacteria in the LI also synthesize – Vitamin K.

SI and Accessory Organs

The SI (and mouth/stomach – to a limited extent)

Pancreas produces enzymes that

SI produces enzymes

The accessory organs of the GI Tract are:

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SI and Accessory Organs

The SI (and mouth/stomach – to a limited extent) secrete digestive enzymes that break down larger molecules into small molecules that can be absorbed. These digestive enzymes are also produced in the pancreas and delivered to the SI at the duodenum.

Pancreas produces enzymes that breakdown the largest molecules into smaller molecules (Disaccharides, etc)

SI produces enzymes that break down smaller molecules into the smallest size molecules that can be absorbed thru the intestinal walls

The accessory organs of the GI Tract are:

- Liver
- Gall Bladder
- Pancreas
- Various Intestinal Glands and structures located along the entire length of the GI tract. (Appendix, etc...)

Pancreas and Liver

Pancreas is divided into:

Exocrine pancreas –

Endocrine pancreas -

The protein digestive enzymes are release by the pancreas -

The liver's job is

The liver:

The liver's only digestive function:

Bile's function:

Pancreas and Liver

Pancreas is divided into the exocrine and endocrine system.

- Exocrine means ducted
- endocrine means that it leaves the cells and goes directly into the blood stream.

Exocrine pancreas – digestive enzymes that break the larger molecules into smaller molecules

Endocrine pancreas - A number of different hormones with Insulin being the most important.

The protein digestive enzymes are release by the pancreas - in an inactive form. If they were active they would digest the pancreas itself.

The liver's job is to receive all the digested food stuffs by way of the hepatic portal system which runs from the esophagus almost all the way down to the anus, it takes venous blood leaving the GI tract and delivers it to the liver instead of the heart. Here the liver does what it has to do.

The liver breaks down and detoxifies everything that comes in.

The liver's only digestive function: The production of bile which is a breakdown product of bilirubin

Bile's function: emulsify lipids. That means to break the larger fat droplets into smaller droplets so that digestive enzymes can act on them. There are no digestive enzymes in bile.

Summary So Far

Based on what we have said so far, where does the processing of digestion start for:

- Carbs
- Lipids
- Proteins

Summary So Far

Based on what we have said so far, where does the processing of digestion start for:

- Carbs - mouth
- Lipids – mouth, but mostly in duodenum.
- and proteins – Stomach

Intestinal Layers

Notable Layers of the Intestines:

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Intestinal Layers

Notable Layers of the Intestines:

- Epithelial Cells - We have specialized epithelial cells whose jobs are to create or absorb specific substances.
- Muscularis Mucosa - Just beneath the epithelial cell layer is the muscularis mucosa which is a thin layer of muscle tissue that can contract and change the surface for secretion or absorption.
- Circular Muscles – There is a double layer of muscles along the small and large intestines. The inner layer is a circular muscle layer that can contract to decrease the diameter of segments of the lumen.
- Longitudinal Muscles – That's the outer layer that shortens the lengths of the segments of the GI tract. You combine these last two layers' movements and get both mixing and peristalsis (movement). The movement is like two steps forwards, and one step back.

Enteric Nervous System

The intestinal tract has it's own

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The GI tract is also enervated by the ANS.

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PSNS –

SNS –

Vagovagal reflex means –

The vagus nerve is

Enteric Nervous System

The **intestinal tract has it's own** enteric nervous system just as the heart has its' own nervous system. There are two sets of nerves. Their jobs are to integrate and coordinate the motility, secretory, and endocrine functions of the GI tract.

- Submucosal plexus (aka Meissner's plexus) - secretion/absorption/flow of blood.
- Myenteric plexus (aka Auerbach's plexus) - Motility – the outer layer of muscles. Long and circular muscles. The myenteric is the more superficial of the two.

The **GI tract is also enervated by** the ANS.

- The PSNS is via the CN X Vagus and sacral outflow (S2-S4)
- The SNS is from the spinal chord levels T8 through L2

PSNS – excitatory in digestion. It speeds it up.

SNS – usually inhibitory in digestion.

Vagovagal reflex means – the reflex path that contains both afferent and efferent fibers.

The vagus nerve is both afferent and efferent.

Major Hormones of the GI Tract

There are four major hormones that are released by –

There hormones are produced by –

These four hormones have specific –

The four are:

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Major Hormones of the GI Tract

There are four major hormones that are released by the cells in the GI mucosa.

There hormones are produced by endocrine cells in the Gi tract, enter into the Heptic portal system and reach the general circulation

These four hormones have specific physiologic action of target cells. Essentially they let the GI tract down the line know what is coming it's way.

The four are:

- Gastrin – More Acid
- Cholecystokinin – More Bile
- Secritin – More Bicarb
- **Gastric Inhibitory Peptide (GIP) – More Insulin**

Gastric Hormone Details

Gastrin

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Cholecystokinin (CCK)

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Secretin

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Gastric Inhibitory Peptide (GIP)

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Gastric Hormone Details

Gastrin is a hormone secreted in response to small peptides and AA in the stomach and stretching of the stomach. (More acid)

- Increase H⁺ secretion by gastric parietal cells (increase acidity of the stomach) By causing gastric parietal cells to make acid. (The major cell in the stomach that produces acid – parietal cells)
- Stimulates the growth of the gastric mucosa.

Cholecystokinin (CCK) Again stimulated by the presence of small peptides/AA and the presence of fatty acids. (More bile)

- Stimulates the gall bladder and relaxes the sphincter of Oddi
- Stimulates the pancreas to release of digestive enzymes
- Stimulates growth of the exocrine pancreas
- Inhibits gastric emptying which means it tells the stomach to work on the material a little longer.

Secretin is stimulated by the presence of H⁺ in the duodenum and fatty acids in the duodenum. (More bicarb)

- Stimulates the pancreas to secrete bicarbonate (a base) also stimulates pancreatic growth
- Stimulates the liver into secreting more H₂O and bicarbonate, and increases bile production.
- Inhibits H⁺ secretion by the gastric parietal cells

Gastric Inhibitory Peptide (GIP) which is the only one of the four that is stimulated by the presence of not only AA, FA's and peptides, but also the presence of carbohydrates. (More insulin)

- Stimulates insulin release by the pancreas
- Inhibits H⁺ production by the gastric parietal cells

Paracrines and Neurocrines of the GI Tract

Paracrine –

Paracrines associated with the GI tract:

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Neurocrine:

Neurocrines that are synthesized by the GI tract:

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Paracrine and Neurocrines of the GI Tract

Paracrine – stimulates something close by.

Paracrines associated with the GI tract:

- Somatostatin – secreted by cells throughout the GI tract in response to H^+ in the GI tract, It inhibits the release of all GI hormones.
- Histamine – secreted by mast cells in the gastric mucosa. Increases gastric secretion.

Neurocrine: A substance, generally a neurotransmitter, produced by a nerve cell that also functions as a hormone.

Neurocrines that are synthesized by the GI tract:

- Vasoactive Intestinal peptide (VIP) – homologous to secretin. Relaxes smooth muscle of the GI tract and stimulates bicarbonate and inhibits gastric H^+ secretion.
- Bombesin (GRP) – released from the vagus nerve, stimulates the release of gastrin.
- Enkephalins – secreted from nerves in the mucosa and smooth muscle of the GI tract. Stimulates contraction of GI smooth muscle and inhibits intestinal secretion of fluids and electrolytes.

Digestive Enzymes (Saliva, Gastric, SI, Bile)

Saliva Contains:

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Gastric acid contains:

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Small Intestines secrete:

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The bile produces in the liver and transported to the duodenum

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Digestive Enzymes (Saliva, Gastric, SI, Bile)

Saliva Contains:

- Amylase – in the digestive secretion saliva – begins the breakdown of starch molecules.

Gastric acid contains:

- pepsin that begins the breakdown of protein molecules (only works in an acid environment)
- we also have intrinsic factor that attaches to the B12 vitamin and protects it from gastric acid as it passes through the stomach.

Small Intestines secrete:

- Disaccharidases – breakdown disaccharides into monosaccharides
- Peptidases – breakdown small peptides. (a couple of amino acids stuck together)
- Amylase – breaksdown big carbohydrate molecules into smaller carbohydrate molecules (dissaccharide)
- Lipase – begins breakdown of lipids into smaller segments
Enterokinase (a substance, not an enzyme) - Activates Trypsinogen. Trypsinogen is produced by the pancreas. Activates the protein digesting enzymes that are produced by the pancreas.

The bile produces in the liver and transported to the duodenum

- has no digestive enzymes, instead it emulsifies the fat. Breaks down large fat droplets into smaller fat droplets.

Digestive Enzymes (Pancreas)

Exocrine pancreas produces the majority of the following enzymes

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- These work on protein molecules
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As a general statement digestive enzymes do what?

Digestive hormones –

Digestive Enzymes (Pancreas)

Exocrine pancreas produces the majority of the following enzymes

- Amylase – the majority is produced here. Breaks carbo's into disaccharides.
- These work on protein molecules
 - Three different enzymes that work on different types of peptide bonds. The bond between amino acids.
 - Trypsin
 - Chymotrypsin
 - Carboxypeptidase
- Lipase -works on lipids (triglycerides predominately)
- Cholesterol Esterase – breaks down cholesterol
- Ribonuclease – works on RNA
- Deoxyribonuclease – works on DNA

As a general statement digestive enzymes do what? - break down materials to be absorbed.

Digestive hormones – direct the GI tract as to the proper functions to take. It tells the GI tract what's coming down line.

Macronutrients

SI produces enzymes that break disaccharides into monosaccharides

Sucrase – breaks down sucrose (table sugar) into glucose and fructose.

Maltase – breaks down maltose (normally from carbohydrate breakdown) into two glucoses.

Lactase – breaks down lactose into glucose and galactose

These hexose sugars are now absorbed and taken to the liver where most of the fructose and galactose is converted to glucose. The absorption is both by active transport and facilitated diffusion. (carry molecule but no energy)

DNA and RNA are broken down by Ribonuclease and Deoxyribonuclease. And the pentose sugars and nitrogen bases are absorbed in a similar manner and taken to the liver (facilitated diffusion and active transport)

The bonds in protein are called peptide bonds.

Polypeptides and peptides are the terms for proteins as they are broken down....

The enzymes that break larger proteins into smaller proteins come from the pancreas.

Peptidases break the final peptide bonds into AA. They come from the small intestine. The absorption through the intestinal mucosa is entirely by active transport.

The breakdown of larger lipids into drops small enough to be acted upon by enzymes is called – emulsification.

This is done by bile in the duodenum,

The major lipids digested are triglycerides and phospholipids.

The enzyme lipase breaks these molecules into their components glycerol and fatty acids (if it is a triglyceride) plus a phosphorus-containing molecule if it is a phospholipid.

Most of these molecules are absorbed -go to the lipids

- cannot pass through the capillaries.
 - Chylomicrons
- by being coated by a thin layer of protein. (to help it travel through the system)

They do not go into the lymphatic system and are taken directly into the bloodstream, bypassing the hepatic portal system.

Metabolism is divided into two processes.

Anabolism – putting simple into complex.

Catabolism – putting complex into simple (or energy)

All ingested carbs are converted into glucose.

Carbs not needed for immediate energy needs are converted into glycogen and stored in the liver or converted to lipids and stored in the fat cells.

Energy from glucose catabolism is generated in three phases. They are:

Glycolysis – takes place in the cell cytoplasm.

Citric Acid Cycle – takes place in the matrix of the mitochondria.

Electron Transport System – Takes place on the inner walls of the mitochondria.