THE GASTROINTESTINAL TRACT

MOTILITY AND SECRETION

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INTRODUCTION

- The gastrointestinal tract also known as the alimentary canal is the digestive system of an organism with its' associated organs
- Few studies have addressed the specifically or systematically the question of whether motility and secretion within the GIT are linked and if so by what mechanisms

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- Increased motor activity of the stomach is frequently associated with increased acid and pepsin secretion.
- Similarly , an increase in small intestine motility is accompanied by elevated fluid and electrolyte secretion.
- The GIT produces both endocrine and exocrine secretions, hormones are produced by cells of ductless endocrine glands and are liberated into the blood stream

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- Unlike endocrine secretions, the output of an exocrine gland does not ooze out into the circulation but generally flows through a duct into a body cavity as the mouth, gut, nasal passage, or urinary tract that is in continuity with the exterior
- Exocrine secretions consist of aqueous mixtures rather than single species of molecule.

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- The newly synthesized products of the secretory glands are usually packaged into granules in the Golgi apparatus.
- The granules are membrane-bound vesicles distinguished from smaller synaptic vesicles of neural tissue by their larger and less uniform size.
- Enzyme containing secretory granules are known as zymogen granules.

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- In the alimentary canal, these mixtures typically consist of water, ions, enzymes, and mucus.

An exocrine gland typically consist of an invaginated epithelium of closely packed cells lining a blind cavity called the acinus.

The acinus connects to a small duct that, in turn connects to a larger duct leading to the lumen of the digestive canal

- The way in which the granules are released into the acinus depends on the animal group and tissue. The are four known means of secretion:
- In halocrine secretion, the entire acinar cell is cast off and lyses to released its contents. This occurs in some insects and molluscan exocrine tissues
- In apocrine secretion, the epical portion of the acinar cell, which contains the secretory material, is sloughed off, and the cell then reseals at its apex. This occurs in mollusks
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- In merocrine secretion, the epical portion of the acinar cell pinches off, and this portion, containing the secretory products, breaks open in the acinus. Arthropod and annelid exocrine glands utilize this method
- Exocytosis; this entails the fusion of the membranes surrounding secretory vesicles with the cell membrane so that the contents are expelled from the cell.

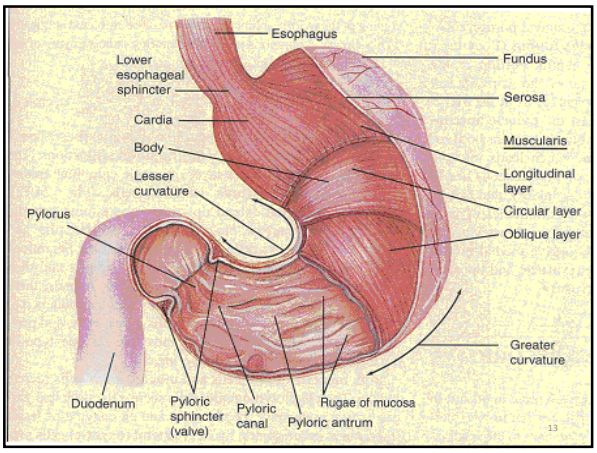
- In every case investigated, this process is regulated by level of intracellular free Calcium.
- Exocytosis appears to be the mechanism for secretion in all exocrine and endocrine cells in which the secretory product is stored in vesicles
- Once the primary secretory products are free in the acinar lumen, they generally become secondarily modified in the secretory duct to produce the final secretory juice.

Enzymes secreted in the oral cavity

The enzyme secreted in the oral cavity is salivary α-amylase which is a component of saliva secreted by the salivary glands

HORMONES AND ENZYMES SECRETED IN THE STOMACH

Enzyme or Hormone	Site of secretion	Site of action	Substrate acted upon	Products of action
Pepsinogen-pepsin	stomach	stomach	proteins	Large peptides
Gastrin	stomach	Secretory cells and muscles of stomach	stomach	HCl production and secretion; stimulates gastric motility



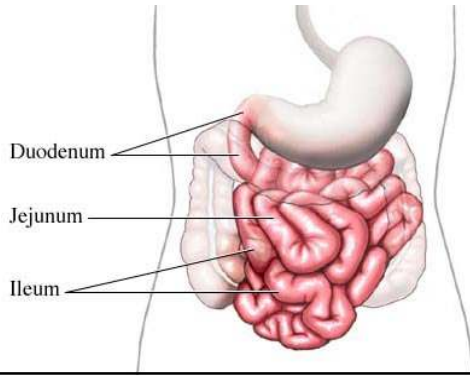
HORMONES SECRETED IN THE SMALL INTESTINE

HORMONE	TISSUE OF ORIGIN	TARGET TISSUE	PRIMARY ACTION	STIMULUS TO SECRETION
Secretin	Duodenum	Pancrease; secretory cells and muscles of stomach	Water and NaHCO3 secretion; inhibits gastric motility	Food and strong acid in stomach and small intestine
Gastric inhibitory peptide	Upper small intestine	Gastric mucosa and musculature	Inhibits gastric secretion and motility	Monosaccharides and fats in duodenum
Enteroglucagon	Duodenum	Jejunum, pancrease	Inhibits motility and secretion	Carbohydrates in duodenum
Somatostatin	Small intestine	Stomach, pancrease, intestine	Inhibits HCl secretion, pancreatic secretion, intestinal motility	

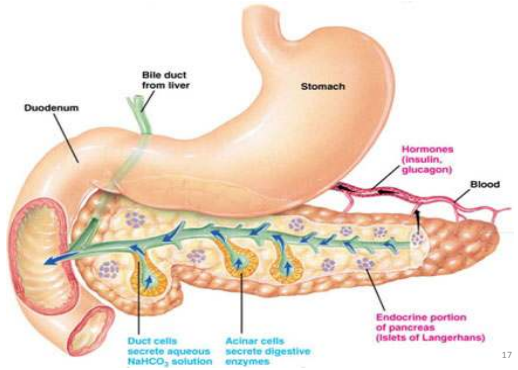
ENZYMES SECRETED IN THE SMALL INTESTINE.

ENZYME	SITE OF ACTION	SUBSTRATE ACTED UPON	PRODUCTS OF ACTION
Peptidases	Small intestine	Oligopeptides	Amino acids
Nucleosidases	Small intestine	Nucleosides	Sugars, purines, pyrimidines
Nucleotidases	Small intestine	Nucleotides	Nucleosidases, phosphoric acid
Enterokinase	Small intestine	Trypsinogen	Trypsin

DIAGRAM OF THE SMALL INTESTINE



ENZYMES SECRETED IN THE PANCREAS



- In addition to the endocrine secretion of the pancreas- insulin from the islets of Langerhans, the pancreas contains exocrine tissues that produces several digestive secretions that enter the small intestine through the pancreatic ducts. The pancreatic enzymes include

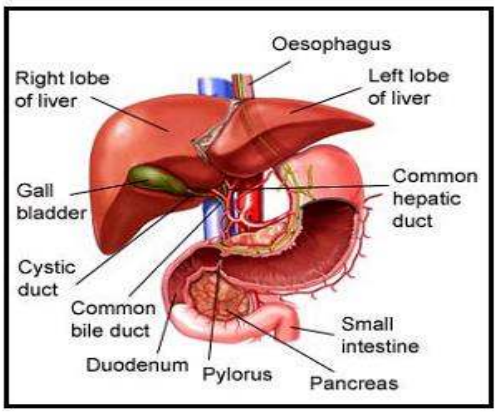
ENZYME	SITE OF SECRETION	SITE OF ACTION	SUBSTRATED ACTED UPON	PRODUCTS OF ACTION
Pancreatic α-amylase	Pancreas	Small intestine	Starch	Disaccharides
Trypsinogen	"	Small intestine	Proteins	Large peptides
Cymotrypsin	"	"	"	"
Elastase	"	"	Elastin	"
Lipase	"	"	Triglycerides	Monoglycerides, fatty acids, glycerol

Aminopeptidases	"	"	Large peptides	Oligopeptides
Nucleases	"	"	Nucleic acid	Nucleotides
Carboxypeptidases	"	"	Large peptides	Small peptides

THE LIVER

- The vertebrate liver does not produce digestive enzymes, but provides bile, a fluid essential for digestion of fats. Bile consists of water and a weakly basic mixture of cholesterol, lecithin, inorganic salts, bile salts and bile acids
- Bile is stored in the gallbladder

- Bile serves three functions
- First, its high alkalinity is important for terminal stages of digestion after the high acidity provided by the gastric juice
- Second, the bile salts help disperse fat for digestion.
- Third, the bile carries with it water-insoluble waste substances removed from the bloodstream by the liver, such as hemoglobin pigments, steroids, and drugs



CONTROL OF DIGESTIVE SECRETION

- So far very little is known about the control of digestive secretions in invertebrates. Filter feeders evidently maintain a steady secretion while they continuously feed. Other invertebrates secrete enzymes in response to the presence of food in the alimentary canal, but precise control mechanisms remain obscure owing to the lack of intensive investigation and to the formidable variety of invertebrate types.

- Among vertebrates, the primary stimulus for secretion of digestive juices in a given part of the digestive tract is the presence of food or, in some instances, elsewhere in the tract.

The presence of food stimulates sensory endings, which leads to the reflex activation of autonomic efferents that activate or inhibit motility and exocrine secretion.

Appropriate food molecules also directly stimulate epithelial endocrine cells by contact with receptors of endocrine cells

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Causing reflex secretion of the GI hormones into local secretion. These reflexes permit secretory organs separate from the alimentary canal proper, such as the liver and pancreas, to be properly coordinated with digestive needs of food passing along the GIT.

NB. None of these mechanisms is under simple voluntary control

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The properties of two types of control, hormonal and neural, employed in each part of the alimentary canal are related to the length of time food is normally present there.

e. g. salivary secretion is very rapid and entirely under involuntary neural control;

gastric secretions are under hormonal as well as neural control;

and intestinal secretions are slower and are primarily under hormonal control.

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Gastrointestinal secretion is largely under the control of GI peptide hormones secreted by endocrine cells of the gastric and intestinal mucosa.

Several of these hormones turn out to be identical to neuropeptides that act as transmitters in the central nervous system.

This suggests that the generic machinery for producing these biologically active peptides has been put in use by cells of the both the CNS and the GIT.

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SUMMARY OF THE REGULATION OF DIGESTIVE SECRETIONS

Secretion	Nervous Regulation	Chemical Regulation
Saliva	Presence of food in mouth or sight of food; parasympathetic impulses along 7th and 9th cranial nerves	None
Gastric juice	Sight or smell of food; parasympathetic impulses along 10th cranial nerves	Gastrin—produced by the G cells of the gastric mucosa when food is present in the stomach
Bile Secretion by the liver	None	Secretin—produced by the enteroendocrine cells of the duodenum when chyme enters

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Contraction of the gallbladder	None	Cholecystokinin—produced by the endocrine cells of the duodenum when chyme enters
Enzyme pancreatic juice	None	Cholecystokinin—from the duodenum
Bicarbonate pancreatic juice	None	Secretin—from the duodenum
Intestinal juice	Presence of chyme in the duodenum; parasympathetic impulses along 10th cranial nerves	None

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SUMMARY

- The motility of the vertebrate digestive tract depends on the coordinated activity of the longitudinal and circular layers of smooth muscle.
- Peristalsis occurs when a ring of circular contraction proceeds along the gut preceded by a region in which the circular muscles are relaxed.

- The parasympathetic innervations stimulates motility, whereas sympathetic innervations stimulates motility.
- Secretion of digestive juices as well as the motility of smooth muscle are under neural and endocrine control.
- All GI hormones are peptides.

THANKS FOR YOUR KIND ATTENTION