

DIGESTION AND ABSORPTION OF NUTRIENTS

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SCO9B750

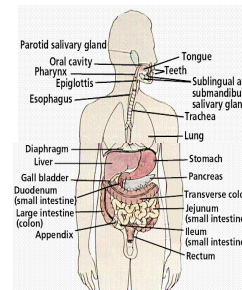
OUTLINE

- Introduction.
- Mammalian digestive system.
- Sugar/amino acid assimilation across the intestinal epithelium.
- Fats digestion and assimilation.
- Processing absorbed nutrients.
- Unique features of the vertebrate digestive system.

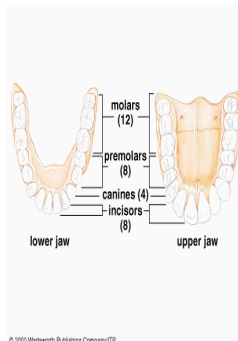
INTRODUCTION.

- **Digestion** is the process by which food is physically and chemically broken down into molecules that can be adsorbed by body cells (Gerald Audesirk and Teresa audesirk, 1993).
- Evolutionary trends in vertebrates.
 - Fish:
 - Amphibians e.g. toad:
 - Mammals e.g. man:
- Generalizations about the digestive system.
 - Food broken down physically and chemically.
 - Intermittent intake of food.
 - Food movement by peristalsis.

MAMMALIAN DIGESTIVE SYSTEM. The human digestive system.



- **The role of the mouth; chewing and moistening of food.**



- **Salivary glands** -- moisten food and secrete **salivary amylase** (an enzyme that begins the breakdown of starch into smaller disaccharide and monosaccharide units) and lingual lipase (starts the digestion of triglycerides into fatty acids and monoglycerides)

SUMMARY OF DIGESTION OF THE MOUTH

STRUCTURE	ACTIVITY	RESULT
Cheeks and lips	Keep food between teeth during mastication.	Food is uniformly chewed.
Tongue	Move tongue from side to side and in and out.	Food maneuvered for mastication, shaped into bolus and maneuvered for deglutition (swallowing)
-Extrinsic muscles		
-Intrinsic muscles	Alter shape of the tongue	Deglutition and speech.
Taste buds	Serve as receptors for food stimulus.	Secretion of saliva stimulated by nerve impulses from taste buds to salivary nuclei in brain stem to salivary gland.
Glands	Secrete lingual lipase	Breaks down triglycerides into fatty acids and monoglycerides.
Buccal glands	Secrete saliva	Lining of mouth and pharynx moistened and lubricated.
Salivary glands	Secrete saliva	Lining of mouth and pharynx moistened and lubricated. Saliva softens, moistens and dissolves food, cleanses mouth and teeth, salivary amylase splits polysaccharides into smaller fragments.
Teeth	Cut, tear and pulverize food.	Solid food reduced to smaller particles for swallowing.

The role of the stomach; breakdown of food, protein digestion.

-Epithelial cells line inner surface of the stomach, and secrete gastric juice containing hydrochloric acid (HCL), pepsinogen, and mucus; ingredients important in digestion.

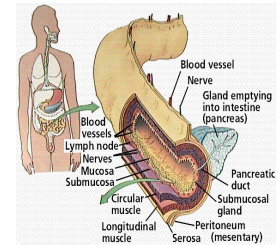
- Epithelial cells secrete mucus that forms a protective barrier between the cells and the stomach acids.

The role of the small intestine.

• Final digestion of proteins, carbohydrates and fats that have not yet been digested occurs here.

• Villi have cells that produce intestinal enzymes which complete the digestion of peptides and sugars.

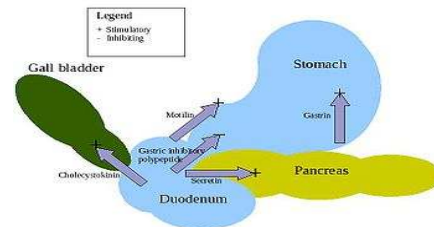
• Structure and details of the small intestine (Gary A Thibodeau and Kevin T. Patton, 1999).



Pancreatic and Enteric Enzymes

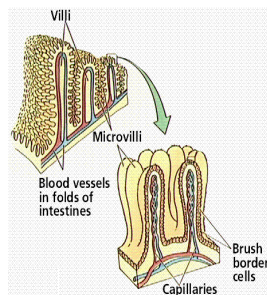
- Pancreatic amylase- converts starch to maltose and α -dextrin.
- Trypsin. Converts Proteins to Peptides.
- Chymotrypsin, converts Proteins to Peptides.
- Elastase (activated form proelastase), converts Protein to Peptides.
- Carboxypeptidase -converts terminal amino acids at carboxyl (acid) end of peptides to Peptides and amino acids
- Pancreatic lipase-converts Triglyceride (fats-and oils) that have been emulsified by bile salt to fatty acids and monoglycerides-
- Dipeptidase- converts Dipeptide to amino acids.
- phosphatases- converts nucleotides to nitrogenous bases pentoses and phosphates

Hormonal control of pancreatic secretion.



Brush Border

- The absorptive epithelial cells synthesize several digestive enzymes called brush border enzymes and insert them in the plasma membrane of the microvilli.
- Among brush border enzymes are four carbohydrate-digesting enzymes called α -dextrinase, maltase, sucrase and lactase; protein digesting enzymes called peptidases (aminopeptidases and dipeptidases) and two types of nucleotide-digesting enzymes called nucleotidases and phosphatases.

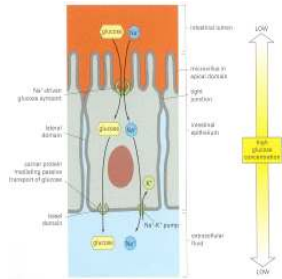


SUGAR/AMINO ACID ASSIMILATION ACROSS THE INTESTINAL EPITHELIUM.

- The bases from the breakdown of sugars are absorbed by active transport. Active transport is the movement of molecules and ions against their concentration gradient, from lower to higher concentrations. The process requires the expenditure of cellular energy obtain from ATP.
- E.g. the Na^+/K^+ pump- which transports 2K^+ into the cell and 3Na^+ out of the cell.
 - If Na^+ is not continually pumped out, the gradient would rapidly be lost, and cells would swell and burst. An important feature of this mechanism is that ATP hydrolysis and ion transport are tightly coupled—ATP is not hydrolyzed unless the ions are transported

Membrane Transport of glucose and the Electrical Properties of Membranes (Bruce et al, 2002)

- Glucose is cotransported (symport) with Na. The Na⁺ gradient driving the glucose symport is maintained by a Na⁺ pump in the basal and lateral plasma membrane domains, which keeps the internal concentration of Na⁺ low.
- prevent solutes from crossing the epithelium between cells, allowing a concentration gradient of glucose to be maintained across the cell sheet, and they also serve as diffusion barriers within the plasma membrane

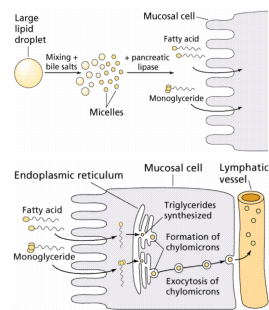


Importance of Na⁺ uptake in water absorption

- The greater absorption of water at the villous tips result from an elevated concentration of Na⁺ near the upper end of the villous lumen. There are two reasons for this concentration gradient. First, most of the active absorption of Na⁺ takes place across absorptive cell located at the tip of each villous. Secondly, the organization of the circulation within the villus leads to further concentration of NaCl at the upper end of the villous lumen because of a **counter current** mechanism, arterial blood flowing towards the villous tip picks up Na⁺ from the Na⁺ enriched blood leaving the villus in a descending venule. The "short circulation" of sodium in this manner recirculates and concentrates it in the villous tip, promoting osmotic flow of water from the intestinal lumen into the villous.

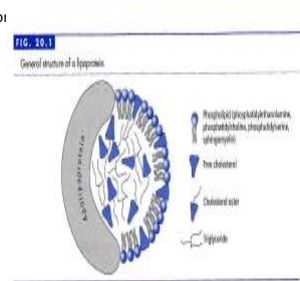
FAT DIGESTION AND ASSIMILATION.

- Most fats are absorbed as free fatty acids and 2-monoglycerides, but a small fraction is absorbed as free glycerol and as diglycerides.
- Once across the intestinal barrier, they are reformed into triglycerides and packaged into chylomicrons or liposomes, which are released into the lacteals, the capillaries of the lymph system and then into the blood. Eventually, they bind to the membranes of hepatocytes, adipocytes or muscle fibres, where they are either stored or oxidized for energy.



Fat Digestion And Assimilation Con't

- The liver acts as a major organ for fatty acid treatment, processing chylomicron remnants and liposomes into the various lipoprotein forms.
- VLDL's carry lipids synthesized by the liver to body cells
- LDL's carry cholesterol around the body
- HDL's carry cholesterol from the body back to the liver for breakdown and excretion.



PROCESSING ABSORBED NUTRIENTS

Functions of the liver.

- The liver has a multitude of important and complex functions. Some of these functions are to:
 - Manufacture (synthesize) proteins, including albumin (to help maintain the volume of blood) and blood clotting factors
 - Synthesize, store, and process (metabolize) fats, including fatty acids (used for energy) and cholesterol
 - Metabolize and store carbohydrates, which are used as the source for the sugar (glucose) in blood that red blood cells and the brain use
 - Form and secrete bile that contains bile acids to aid in the intestinal absorption (taking in) of fats and the fat-soluble vitamins A, D, E, and K.
 - Eliminate, by metabolizing and/or secreting, the potentially harmful biochemical products produced by the body, such as bilirubin from the breakdown of old red blood cells and ammonia from the breakdown of proteins.

The liver and associated organs and their connections to the digestive system



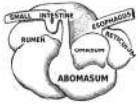
Unique features of the vertebrate digestive system

- Functions to break down food into molecules small enough to absorb, or pass across digestive membrane.
- The following are certain tasks that the D.S must generally accomplished (Gerald Audesirk and Teresa audesirk, 1993).
- Ingestion: The food must be brought into the D.T through the mouth.
- Mechanical Breakdown: The physical breakdown of food particles into smaller pieces.
- Chemical Breakdown: The food particle must be exposed to a variety of digestive enzymes and other digestive fluids that cause large molecules to be broken down into smaller subunits.
- Absorption; the small molecules must be transported out of the D.T and into cells.
- Elimination; ingested material must be expelled from the body.

Ruminant digestive system

Fiber, especially cellulose and hemi-cellulose, is primarily broken down into the volatile fatty acids, acetic acid, propionic acid and butyric acid in these chambers (the reticulo-rumen) by microbes: (bacteria, protozoa, and fungi

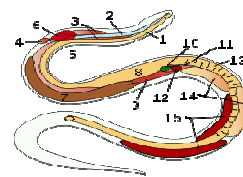
Ruminant Digestive system



Intermittent feeding in snakes

- In the wild, feeding intervals for rattlesnakes and big constrictors range from a few weeks to a few months. Pregnant female rattlesnakes will normally go one and a half years without eating; snakes in zoos have refused food for over two years. In other words, snakes swallow huge meals, digest them at leisure, and then wait a long time before eating again. Thus the snake's intestine has to be designed so that it can be called upon unpredictably, at short notice, to have a big load of digestive work dumped on it, and then do nothing for a long time until the dinner gong sounds again." 1 oesophagus, 2 trachea, 3 tracheal lungs, 4 rudimentary left lung, 5 right lung, 6 heart, 7 liver, 8 stomach, 9 air sac, 10 gallbladder, 11 pancreas, 12 spleen, 13 intestine, 14 testicles, 15 kidneys.

Anatomy of a snake.



THANKS FOR LISTENING.

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