I. Digestive System Background

A) Overview of the track

- The alimentary canal or gastrointestinal (GI) tract digests and absorbs food
- Alimentary canal - mouth, pharynx, esophagus, stomach, small intestine, and large intestine
- Accessory digestive organs - teeth, tongue, gallbladder, salivary glands, liver, and pancreas

B) Digestion, Absorption and Metabolism Overview:

- The GI tract is a "disassembly" line.
  * As large molecules are broken down, nutrients become more available to the body in each step of the digestive process.
  * Only small molecules can be absorbed. Most absorption is an active, controlled process.
  * Cells use AAs to make proteins. The organelles need ATP to power the production of proteins. Monosaccharides, especially glucose, will be oxidized to make ATP. Lipids are long-term energy storage. There are certain vitamins and minerals we need in our diet in order for our enzymes and other molecules to work properly. We need the building blocks of our genetic material so we can replicate it before mitosis.
- Proteins broken down to AAs in order to be absorbed. Absorption is via active transport with sodium.
- Complex carbos are broken down into (mostly) glucose and fructose to be absorbed. Glucose is absorbed actively with sodium. Fructose diffuses into the bloodstream.
- Lipids, which are fat soluble, can be absorbed directly, but many are broken down into FAs and glycogen to make them more water soluble.
- Vitamins are a diverse group, so their digestion and absorption are not easily summarized.
- Most necessary minerals are small and water soluble, so digestion and absorption is easy.
1) Basic Functional Concepts

- There are six essential Gastrointestinal Tract Activities:
  1. Ingestion - taking food into the digestive tract
  2. Propulsion - Peristalsis and Segmentation
  3. Peristalsis - waves of contraction and relaxation of muscles in the organ walls
  4. Digestion: Break things down
     * Mechanical digestion - chewing, mixing, and churning food
     * Chemical digestion - catabolic breakdown of food
  5. Absorption - movement of nutrients from the GI tract to the blood or lymph
  6. Defecation - elimination of indigestible solid wastes

2) Regulation

- Regulation of digestion involves:
  1. Mechanical and chemical stimuli - stretch receptors, osmolarity, pH and presence of substrate in the lumen.
  2. They initiate reflexes that begin nervous and hormonal controls.
     * Gut has control via Intrinsic endocrine glands (enteroendocrine) and neural reflexes.
     * These can activate or inhibit digestive glands
     * Also, cause mixing of lumen contents and move them along through tube.

- There are 2 types of neural control:
  1. Intrinsic control by local centers – Intrinsic (built into the system itself) nervous system.
     * Nerve plexuses near the GI tract initiate short reflexes, mediated by local enteric plexuses (“gut brain”)
  2. Extrinsic control by systems outside of the system - CNS centers influence over the system.
     * Long reflexes arising within or outside the GI tract
     * Involve CNS centers and extrinsic autonomic nerves.
3) Peritoneum and Peritoneal Cavity

- Peritoneum - serous membrane of the abdominal cavity:
  * Lubricates digestive organs
  * Allows them to slide across one another
  * Visceral Layer - covers external surface of most digestive organs
  * Parietal Layer - lines the body wall
  * Peritoneal cavity

- "Peritoneal organs" (intraperitoneal) - organs surrounded by peritoneum.

  Mesentery - double layer of peritoneum that provides:
  * Vascular and nerve supplies to the viscera
  * A means to hold digestive organs in place and store fat. Prevents TORSION ("twisting").

- Retroperitoneal organs - organs outside the peritoneum, adhered to body wall for extra protection.
  * Notice the membranes have simply "folded back", and are continuous, putting the organ in its own pocket.

By Dr. Johannes Sobotta [Public domain], via Wikimedia Commons
4) Blood Supply: Splanchnic Circulation

- Arteries and the organs they serve include:
  * Arterial: Celiac trunk and its branches: The common hepatic, splenic, and left gastric, feeding the spleen, liver, and stomach.
  * Also, Inferior and superior mesenteric, feeding the small and large intestines
  * Venous return: Hepatic portal circulation. All the veins leaving these organs dump into the Hepatic Portal vein, which takes blood to the liver for processing.

  Collects nutrient-rich venous blood from the digestive viscera

  Delivers this blood to the liver for metabolic processing and storage

II. Histology of the Alimentary Canal

- From esophagus to the anal canal the walls of the GI tract have the same four tunics:

  From the lumen outward they are the mucosa, submucosa, muscularis externa, and serosa.

  Each tunic has a predominant tissue type and a specific digestive function
A) Mucosa  
- Moist epithelial layer that lines the lumen of the alimentary canal  
- Its three major functions are:  
  1) Secretion of mucus  
  2) Absorption of the end products of digestion  
  3) Protection against infectious disease  
- Consists of three layers: a lining epithelium, lamina propria, and muscularis mucosae  
  
(i) Epithelial Lining  
* Consists of simple columnar epithelium and mucus-secreting goblet cells  
* The mucus secretions:  
  - Protect digestive organs from digesting themselves  
  - Ease food along the tract  
* Stomach and small intestine mucosa also contain:  
  - Enzyme-secreting cells  
  - Hormone-secreting cells (making them endocrine and digestive organs)  
  
(ii) Lamina Propria  
* Loose areolar and reticular connective tissue  
* Nourishes the epithelium and absorbs nutrients  
* Contains lymph nodes (part of MALT) important in defense against bacteria  
  
(iii) Muscularis Mucosae  
* Smooth muscle cells that produce local movements of mucosa  

B) Submucosa - dense connective tissue containing elastic fibers, blood and lymphatic vessels, lymph nodes, and nerves  

C) Muscularis externa - responsible for segmentation and peristalsis  

D) Serosa - the protective visceral peritoneum  
- Replaced by the fibrous adventitia in the esophagus  
- Retroperitoneal organs have both an adventitia and serosa  

III. Enteric Nervous System  
- Composed of two major intrinsic nerve plexuses  
  1) Submucosal nerve plexus - regulates glands and smooth muscle in the mucosa  
  2) Myenteric nerve plexus - Major nerve supply that controls GI tract mobility  
- Segmentation and peristalsis are largely automatic involving local reflex arcs  
  * Linked to the CNS via long autonomic reflex arc.