Digestive System

Digestion

Digestion – is breakdown of complex food molecules like starch into smaller molecules like glucose that can pass through the cell membranes of intestine and get absorbed into blood.

Digestive functions include Ingestion, physical processing, digestion, secretion, absorption and excretion.

Digestive System

Digestive system has 2 main components.
A) Alimentary canal or GI tract
B) Associated organs – teeth, tongue, salivary glands, liver and pancreas.

Alimentary canal: is a long coiled tube starting with mouth and ending at anus.

Histology of alimentary canal

GI tract is formed of 4 major parts. Starting from outside to inner side:-

Serosa: or serous membrane is formed of Squamous epithelium and a small amount of connective tissue.

Muscularis Externa: is formed of external longitudinal and inner circular smooth muscles.

Submucosa: is areolar connective tissue having blood and lymphatic vessels in it.

Mucosa: or mucous membrane is formed of 3 parts. It is the innermost layer of intestine. It helps in secretion and absorption.

Increase in Surface Area in Intestine

3 structures increase surface area for absorption of digested food in intestine.

Plicae – circular folds in intestine
Villi – finger like multicellular projections on plicae
Microvilli – finger like projections of cell membrane of cells on villi.

GI Movements

Peristalsis is pushing forward of food from one part of GI tract to next.
Segmentation is a local to and fro movement that churns food, mixes enzymes with food.
Parasympathetic ANS regulates movements by stimulating contractions in muscularis externa.

Tongue

Tongue is muscular organ and tastes food. It has 2 types of projections = papillae over it.
1. Fungiform – mushroom shaped
2. Vallate – larger mushroom shaped

These papillae bear taste buds.

Tongue is attached with muscles to Hyoid bone.

It bears a lingual frenulum on inferior side.

Mouth = Oral Cavity

Mouth = oral cavity is outlined by lips – anterior; cheeks – lateral; tongue inferior; palate - superior.

Tongue lies at the floor of oral cavity. Mouth is continuous with posterior oropharynx. Anterior roof of oral cavity is Hard Palate formed of bones – palatine processes of maxilla and palatines.

Chewing = Mastication: as we put food into mouth teeth cut it and grind into smaller morsels.

Tongue moves food around and mixes saliva to soften and bind food. Mastication has dual voluntary and involuntary control. It means we can chew food by conscious effort = voluntary or by reflex action = involuntary.
Salivary Glands

**Salivary Glands**: 3 pairs of salivary glands open with their ducts into mouth and secrete major amount of Saliva. Parotid glands lie, below skin, in front of auricles

**Functions**:
- Moistens food
- Cleans mouth
- Dissolves food to be tasted and impacted
- Contains enzymes to digest starch.

**Teeth**

**Teeth**: are fixed in alveoli in Maxilla – upper jaw and mandible – lower jaw. Each half jaw has 2 incisors – cutting teeth; 1 canine – tearing teeth; 2 premolars – smaller chewing teeth; and 3 molars – larger chewing teeth. **Permanent teeth** are 32 – (i 2/2, c 1/1, pm 2/2, m 3/3) X 2, in adult humans.

**Deciduous teeth** = milk teeth = baby teeth are 20 and include 2 incisors, 1 canine and 2 molars in each half of jaw. Usually incisors and canines have single root, premolars have 2 roots and molars have 3 roots. Infection or impaction in roots give tooth pain and need Root Canal Treatment. Canines and 3rd molar teeth = wisdom teeth are vestigial = nonfunctional in humans.

**Structure of Tooth**

**Tooth**: is formed of bone and is yellow in color. It is covered by white **Enamel** = ivory, the hardest substance in human body.
- **Crown** is the exposed part of tooth.
- Part of tooth embedded in jaw bone is **Root**.
- A narrow part of tooth, **Neck** joins crown and root. Neck is covered by gum = gingiva.
- **Gingivitis** is infection of gums by bacteria.

**Esophagus**

**Esophagus** is about 10” long and passes through neck, thorax and diaphragm and immediately enters stomach.

Esophagus is lined by **Adventitia** – a coarse, dry connective tissue that fixes it to surrounding organs.

**Pharynx** – is the throat. Soft Palate forms the roof. It lacks any bone support. Its posterior part hangs freely, the Uvula. It has 3 parts:
- **Nasopharynx**: nasopharynx is superior pharynx continuous with nasal cavity. **Pharyngeal tonsils** do not allow microorganisms to auditory tubes that open into nasopharynx. Food does not enter nasopharynx.
- **Oropharynx** is the middle pharynx and is posterior continuity of mouth. Air and food cross their paths in it. **Palatine and lingual tonsils** lie in this part.
- **Laryngopharynx** is inferior pharynx and larynx and esophagus open into it.

**Swallowing of food**

Swallowing is initiated by tongue. Saliva gets mixed with food during chewing and makes a solid ball = **Bolus**. Tongue blocks mouth. Uvula blocks nasopharynx. Larynx moves up and epiglottis covers it. Skeletal muscles of esophagus open and Bolus is pushed into esophagus. **Swallowing is controlled by a Reflex action.**

**Stomach**

Stomach is highly distensible curved tube 6-10” in length. When empty hardly wider than colon but when full can hold 1 gallon or 4L of food and can extend up to pelvis. It has 4 main parts.
- A) Cardiac region lies around cardiac opening. A sphincter muscle guards the opening and allows food to enter stomach from esophagus.
- B) Fundus is dome shaped upper part tucked below diaphragm.
C) Body is the main middle part.
D) Pylorus is the funnel shaped part that opens into small intestine. A sphincter guards pyloric orifice and allows only small amount of food to enter duodenum.

**Stomach**

Stomach wall has innermost oblique muscles in addition to outer longitudinal and inner circular muscles of rest of alimentary canal. It helps in mechanical action of churning and mixing the food by continuous contractions and relaxations of stomach muscles. It helps in mixing gastric juices with food.

Food is changed to a creamy paste = Chyme inside stomach by combined mechanical (churning) and chemical action of enzymes.

**Gastric Glands**

Gastric glands lie at the base of gastric pits in the stomach mucosa. Most cells in gastric gland secrete Pepsinogen. Single large cells open into gastric glands and secrete concentrated HCl acid. HCl acid change inactive protein digesting enzyme Pepsinogen → Pepsin.

A large number of mucous glands open into stomach and secrete mucous. Mucous is protective to stomach mucosa.

**Small Intestine**

Small intestine is formed of 3 parts. A) Duodenum B) Jejunum and C) ileum. It is the main site of digestion and absorption of food. It is hanging by fan shaped mesentery from posterior body wall. Small Intestine is about 20 feet in cadaver = dead body but only about 6-13 feet in living human due to muscle tone.

Duodenum: It has intestinal glands that secrete complete digestive juice that digests all 4 types of food requiring digestion – carbohydrates, lipids, proteins and nucleic acids. Bile duct from liver and pancreatic duct open into duodenum.

Jejunum and ileum

Jejunum: is the middle part of small intestine. Jejunum means ‘empty’ because it gets empty after death of human.

Ileum: is the last part of small intestine and opens into large intestine at ileocecal valve. Ileum means ‘coiled’. Both jejunum and ileum are coiled.

**Large Intestine**

Large Intestine: is wider than small intestine but shorter in length – about 5 feet. It is formed of 5 parts. A) Cecum B) Appendix C) Colon D) Rectum and E) Anal Canal.

Cecum: is reduced in humans due to omnivore diet.

Appendix: is a small twisted worm like extension of cecum. It is rich in lymphatic tissue. Sometimes it creates trouble due to overgrowth of enteric bacteria in it. In some patients needs surgical removal = Appendicitis.

Colon: is the largest part of large intestine and frames the jejunum and ileum. Its parts include a) ascending colon b) transverse colon c) descending colon and d) S-shaped sigmoid colon that opens into rectum.

No digestion takes place in large intestine. It harbors a large number of enteric bacteria that help in disposal of toxic by-products of digestion and increase the bulk of feces. Water is absorbed here to solidify the feces. It also stores feces.

Colon also absorbs bile salts and vitamins.

Rectum and anal canal

Rectum: is short. We get the feeling to pass feces on entering rectum.

Anal Canal: is the last part and opens out through anus. Anus is guarded by 1 voluntary and 1
involuntary sphincter muscles. Undigested food and bacteria pass out through anus as feces.

**Pancreas**

Pancreas extends laterally from duodenum and is partially covered by stomach. It is about 6” long and is formed of pinkish soft tissue. It has 3 parts – head, body and tail.

Head lies in the C of duodenum and tail ends against spleen.

Exocrine function – secretes digestive enzymes and pH buffers through pancreatic duct into duodenum.

Endocrine function – secretes insulin and glucagon hormones to regulate absorption of glucose and amino acids.

**Liver**

Liver: is the largest gland in human body. It occupies the right upper quadrant in abdomen and lies inferior to diaphragm and mostly covered by rib cage.

Lobes of liver: traditionally liver is divided into 4 lobes. 2 prominent lobes are larger Right lobe and smaller Left lobe.

Gall Bladder stores and concentrates bile. It releases bile through bile duct.

Bile is waste of liver metabolism. It has bile salts and bile pigments in it. Bile salts/pigments help in digestion and absorption of fats.

Recap 1 Digestive System

1. Humans have ---deciduous = milk teeth and # of---permanent teeth.
2. -----pairs of salivary glands secrete saliva into ------------
3. Esophagus carries food to -------
4. Stomach sends food to -------
5. Colon absorbs ------- produced by bacteria.
6. Distal end of the alimentary canal is -------------. 
7. Bile is stored and concentrated in -------
8. Bile salts increase surface area of fats by emulsification .
9. --------are absorbed by lacteal lymphatic capillaries.
10. Glucose and amino acids are absorbed into -------

Recap 2 Digestive System

1. Digestion of carbohydrates start in ------------
2. Digestion of proteins start in ------------
3. Digestion of lipids and nucleic acids start in ------------
4. Stomach secretes the hormone -------- on arrival of food
5. Gastric glands secrete ---------acid and enzyme ---------
6. HCl activates pepsinogen into ---------------
7. Pancreas secretes its enzymes through --------duct into ------------
8. Pepsin is part of --------juice and trypsin is part of --------juice
9. Pepsin or trypsin break proteins into -------------
10. Peptidases break peptides into ------------- 
11. Lipase acts on lipids and break into ------