Digestive System

I. Introduction
   I. Tube from mouth to anus, 30 ft. long
   II. Greatest portion below diaphragm
   III. Function: digestion and absorption

II. Cross section through the coelom (body cavity) and digestive tube
   I. Lumen = hollow opening of a duct or tube
   II. Mucous membrane = absorption, secretion
      i. Columnar epithelium = stomach, small and large intestine
      ii. Stratified squamous = non-keratinized, mouth esophagus, rectum

III. Submucosa: areolar connective tissue rich in blood vessels and nerve endings

IV. Muscle: function - propel food and other materials through the tube
    i. Circular layer inner layer
    ii. Longitudinal layer outer layer
    iii. Transverse or oblique layer (in stomach only)

V. Visceral peritoneum - peritoneal layer of digestive tube

III. Buccal Cavity
   I. Lips - orbicularis oris muscle (striated) covered layering to mucous membrane
   II. Cheeks - buccinator muscle aids in mastication
   III. Tongue - striated muscle
      i. Highly movable - limited by lingual frenulum
      ii. Mucous membrane - covers free surface
      iii. Papillae
         1. Filiform ridges (thread like) - tactile sense
         2. Fungiform (mushroom shaped) - taste buds on these
         3. Vallate papillae - posterior 1/3 of tongue, v-shaped, few in number
      iv. Tongue function - taste, mastication, speech, deglution (swallowing)

IV. Teeth - read

V. Oral roof
   i. Hard palate - covered with mucous membrane, palatine bone and palatine process of maxilla
   ii. Soft palate - striated muscle covered by mucous membrane
   iii. Uvula - read location and function
   iv. Functions: aid in swallowing, mastication, speech

VI. Salivary Glands
   i. Parotid, Submandibular, sublingual, and minor glands
   ii. Locations and function (secretion)
   iii. Saliva - mucin, water, salivary amylase

IV. Pharynx
   I. Nasopharynx - above and behind soft palate
      i. Posterior nares
      ii. Eustachian tubes
      iii. Adenoids or pharyngeal tonsils
   II. Oropharynx
      i. Below soft palate and posterior to buccal cavity
ii. Palatine tonsils - located between glossopalatine arch and pharyngopalatine arch
iii. Function: guide food and air to laryngopharynx

III. Laryngopharynx
i. Epiglottis - fold of cartilage and mucous membrane to guide food to esophagus and air into trachea

V. Esophagus
I. Structure
i. Muscular tube 10 inches long
ii. Secretion - mucous, no enzymes
iii. Upper third striated muscle, middle third transition from striated to smooth muscle, lower third smooth muscle

II. Function: connects laryngopharynx with stomach

III. Process of swallowing
i. Stage 1 = mouth, tongue thrust upward along hard then soft palate: bolus of food thrown into pharynx
ii. Stage 2 = air passage shut off (clang of epiglottis), food "grabbed" by constrictors of the oropharynx and forced into esophagus (constrictors are striated, but involuntary control)
iii. Stage 3 = food moved by peristalsis

VI. Stomach
I. Location: below diaphragm and liver in Epigastric and left hypochondriac region of abdomen
II. Gross anatomy

III. Muscle layers
i. Longitudinal - outer
ii. Circular - middle
iii. Oblique - innermost

IV. Histology
i. Mucous membrane - simple columnar epithelium which is bent into folds called rugae
ii. Gastric pits
iii. Mucous cells
iv. Parietal cells
v. Chief cells or zymogenic cells

V. Function
i. Gastric juice consist of mucous, HCl (parietal cells), pepsinogen (pepsin)
ii. Activation of pepsin, a protease
iii. Gastric lipase
iv. Mixing
v. Storage

VI. Secretion of gastric juice
i. Cephalic phase - sight, smell, taste, thought of food, stimulates 25-30% of gastric secretion
ii. Gastric phase - mechanical stimulus of food, chemical stimulus of protein fragments, gastrin (hormone) produced in pylorus and secreted to blood,
spread to brain via CVS, fundus, stimulates further secretion of gastric juice, 75% of secretion of gastric juice is of this type

iii. Intestinal phase - chyme has entered duodenum but gastric juice still is produced in the stomach

VII. Emptying of stomach
i. Gradual process
ii. Significance

VIII. Terms associated with stomach
i. Gavage tube = tube to stomach
ii. Gastrostomy = artificial opening to stomach
iii. Nausea = characterized by upset feeling, salivation, weakness, perspiration
iv. Vomiting = intense reverse peristalsis of stomach musculature
v. Gastric lavage = washing of stomach
vi. Gastric analysis = hypersecretion, hyosecretion, achlorhydria

VII. Small Intestine
I. Introduction
i. Site of digestion and absorption
ii. 2.5 cm x 600 cm (1 in x 20 feet)
iii. Duodenum - 25 cm (10 inches)
iv. Jejunum 8 feet
v. Ileum 12 feet

II. Modifications of small intestine
i. Circular folds
ii. Villi - capillaries and lymph vessels
iii. Microvilli - increased absorptive area
iv. Intestinal glands or crypts of lieberkuhn secrete enzymes
v. Lymph tissue - below epithelium of mucosa
vi. Duodenal glands - most numerous near pylorus, secretion of mucous, protective function

III. Digestion in small intestine
i. Bile
1. Green yellow fluid: water, bile salts, bilirubin, biliverdin, cholesterol, fatty acids, lecithin, inorganic salts
2. Only bile salts (cholesterol product) are important in digestion
3. Bile salts emulsify fats by reducing surface tension
4. Bile salts also important in absorption of fatty acids
5. Bile flow and production regulated by hormone secretion
6. Cholecystokinin regulates gall bladder emptying

ii. Pancreatic juice (pancreas is both an exocrine and endocrine gland), delivers the following to a duct system that leads to duodenum
1. Sodium bicarbonate - neutralization of acidic chyme is essential for pancreatic enzymes to work
2. Pancreatic amylase - splits polysaccharides to disaccharides (except cellulose)
3. Lipase - digests fats t three fatty acids and one glycerol
4. Proteases - digest proteins and/or polypeptides into dipeptides
a. Trypsinogen  
  b. Chymotrypsinogen  
  c. Inactive procarboxypeptidase  
  d. Enterokinase  

5. Nucleases  

iii. Intestinal juice  
  1. Enterokinase  
  2. Maltase  
  3. Lactase  
  4. Sucrase  
  5. Aminopeptidase  
  6. Dipeptidase  
  7. Nucleases  

IV. Absorption  
  i. Sugars - active transport  
  ii. Fatty acids and glycerol pass through mucosa with help of bile  
  iii. Amino acids - active transport  
  iv. Inorganic material  
    1. Sodium - by active transport  
    2. Chloride - by diffusion  
    3. Potassium - by diffusion  
    4. Calcium - diffusion aided by parathormone  
    5. Water - absorption function of large intestine  

VIII. Large Intestine  
  I. Gross anatomy  
  II. Muscle layers: taenia coli - longitudinal bands  
  III. Mucous membranes - no villi, goblet cells (mucous protection of intestine), intestinal glands  
  IV. Function;  
    i. No digestion - no enzymes  
    ii. Breakdown occurs due to action of E. coli and other bacteria  
      1. Fermentation of carbohydrates  
      2. Putrefaction of proteins  
        a. Phenol, indole, skatol = absorbed  
        b. H2S produced  
        c. NH3 produced  
        d. Vitamin K synthesized and absorbed - only practical source of vitamin K  
    iii. Entry to cecum at ileocecal valve is due to relaxation of the sphincter:  
        about 15 cc enters at a given time  
    iv. Danger of killing helpful bacteria  
    v. 8,000 ml/day absorbed  

V. Movement of fecal material  
  i. Pendular movements  
  ii. Segmentation movements  
  iii. Mass movements - propulsive, strongest in AM after a meal
iv. Stretch receptors in rectum and significance
v. Defecation - relaxation of internal and external sphincter, smooth muscle
   contraction of rectum - levatorani muscles (striated)

VI. Fecal material and diagnostic significance
i. Normal stool
ii. Abnormal stool colors
   1. White
   2. Black and/or tar like
   3. Red streaks
   4. White streaks and/or dots
   5. Diarrhea

VII. Terms
i. Ileostomy
ii. Colostomy

VIII. Hormones

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Stimulus</th>
<th>Route</th>
<th>Function</th>
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<tbody>
<tr>
<td>Gastrin</td>
<td>protein fragments</td>
<td>pylorus to fundus</td>
<td>greater gastric secretion</td>
</tr>
<tr>
<td>Enterogastrone</td>
<td>fats, fatty acids</td>
<td>duodenum to stomach</td>
<td>inhibits gastric secretion</td>
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<td>inhibits stomach muscle contractions</td>
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<tr>
<td>Secretin</td>
<td>acid chyme</td>
<td>duodenum to pancreas</td>
<td>stimulate sodium bicarbonate production in pancreas, stimulates bile secretion</td>
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<tr>
<td>Pancreozymin</td>
<td>acid chyme</td>
<td>duodenum to stomach</td>
<td>production of enzymes</td>
</tr>
<tr>
<td>Cholecystokinin</td>
<td>fats, fatty acids</td>
<td>duodenum to gall bladder</td>
<td>release of bile</td>
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DIGESTIVE HANDOUT
Students are responsible for the following terms for definition and location on acceptable
models, sheep head sections, and cat dissections.

1. mouth (buccal cavity)  43. villi
2. laryngopharynx       44. spleen
3. nasopharynx          45. greater curvature
4. oropharynx           46. lesser curvature
5. adenoids
6. tonsils
7. Eustachian tube orifice
8. nasal concha - superior, middle, inferior
9. hard palate
10. soft palate
11. glottis
12. epiglottis
13. trachea
14. larynx
15. esophagus
16. stomach
17. fundus
18. body
19. pylorus
20. pyloric sphincter
21. rugae
22. cardiac orifice
23. duodenum
24. jejunum
25. ileum
26. pancreas
27. pancreatic duct
28. liver
29. gall bladder
30. cystic duct
31. bile duct (common)
32. hepatic duct
33. ileocecal valve
34. cecum
35. appendix
36. ascending colon
37. transverse colon
38. descending colon
39. sigmoid colon
40. rectum
41. haustra
42. taenia coli