**U8L1 NOTES: INTRODUCTION** (web notes)

Background Information

*Digestion*: Includes both the physical and chemical processes that
_____________________________________________________________________.

*Absorption*: The entrance of these molecules across the gut lining (especially across
microvilli which are the tiny finger-like projections of the small intestine).
- Only certain substances can be absorbed:
  a.  
  b.  
  c.  
  d.  

*Elimination (defecation)*: All components except those mentioned above
_____________________________________________________________________.

*Chemical Digestion*: Chemical breakdown of food
-  

*Physical Digestion*: - Physical breakdown of good
  - Increases surface area so enzymes can work on them
U8L2 NOTES: DIGESTIVE SYSTEM (web notes and video)

Structures of the Digestive System

1. Oral Cavity (mouth) - Storage place for food while it is being ___________. Place where __________ is mixed with food.

2. Lips - _______________ in oral cavity and help direct _______________ ________________.

3. Teeth - _______________ (breaks food into smaller pieces to create more surface area for enzymes to work on)

4. Salivary Glands - Produce saliva for _______________ _______________ _______________.

5. Tongue - _______________ and pushes chewed food to the ________________.

6. Pharynx - Back of the throat where ________________ cavities join. This is where ________________ occurs.

7. Epiglottis - Flap of tissue, which ________________ keeping food from entering the ________________.

8. Esophagus - ________________. Food is transported through this tube from the mouth to the stomach by peristalsis.

a. **Swallowing** - A reflex action - Usually performed **automatically**. Food enters the ______________ because the air passages are blocked. The opening to the nose is covered by the ________ palate. The glottis (opening to the larynx and windpipe) is covered by the epiglottis. No __________ occurs. If it does, choking may occur.
b. **Peristalsis** - Rhythmical contraction of the ________________, pushing food along. Smooth muscle cause the contraction. Peristalsis also occurs all along the ________________ tract.

9. Cardiac Sphincter (esophageal sphincter) - Band of ____________ which closes off the top part of the stomach to prevent food from being regurgitate into the esophagus.

10. Stomach - J-shaped organ which ________________________________ food. The churning helps ________________ digest food, which creates more surface area and results in a mushy liquid called ________________. The chemical digestion of ________________ beings here.

**Control of Gastric (Stomach) Secretions** (Especially after eating a protein-rich meal);

a. Gastrin - Is a hormone produced by the ________________ enters the blood stream and later stimulate the upper part of the stomach to stimulate gastric glands to produce ________________. HCl and pepsinogen react with each other to produce ________________. ________________ chemically digests ________________ to ________________.

HCl can burn the gut lining so a ________________ is produced to prevent this from happening. If a portion of the gut is burned it is called an ________________.

**Be sure that you understand how the structure of the stomach facilitates digestion**
11. Pyloric Sphincter - Band of muscle which closes off the _______________ of the stomach and only allows small amounts (~1 teaspoon) of _______________ ________________.

12. Duodenum - First __________ of the small intestine. Enzymes from both the _______________ digest all 3 food groups here (chemical digestions). _______________ _______________ _______________ _______________ _______________ _______________ emulsifies fat.

13. Pancreas – Produces _______________ _______________ (the sodium bicarbonate is required to neutralize the acidic chyme which has a pH of about 2 such that it brings the pH of the small intestine to about 8.5 so that its enzymes are not denatured)

14. Gall Bladder - _______________ which is secreted into the small intestine from here.

15. Liver - ________________________________________ which is then stored in the gall bladder.

16. Small Intestine - Final digestion and absorption of _______________ _______________ _______________.
Control of Intestinal Secretions:

The duodenal wall produces ________________, the most important of which are **secretin** and **CCK** (_________________________) in response to the presence of acidic _____________. Secretin stimulates release of ________________ ________________ from the pancreas. CCK stimulates the release of ________________ ________________.

Acid, especially HCl, stimulates the release of ________________ ________________, while partially digested protein and fat stimulate the release of ________________.

Small Intestine is about 7m long - first 25 cm (10”) is the duodenum

a. Duodenum: ________________________________
   ____________________________ (from a pH of about 2 to a pH of about 8.5)

Other Pancreatic Juices:

i. ________________________________
   ________________________________ breaks down ________________

ii. ________________________________ breaks down ________________ to ________________.

iii. ________________________________ breaks down ________________, after bile has ________________

b. Remainder of Small Intestine is responsible for the final digestion of ________________ from intestinal juices made from millions of digestive glands along the intestinal wall.

i. ________________________________ breaks down ________________ to ________________

ii. ________________________________ breaks down ________________ to ________________

Main function of the small intestine though, is the ________________ of nutrient molecules. (A.A., glucose, fatty acids, and glycerol) Other ________________ (similar to maltose) are digested in the ________________ by their own enzymes. (e.g., lactase aids in lactose digestion, which is sugar in milk)
Absorption in the Small Intestine

The small intestine is specialized for absorption in that:

a. The small intestine is long with ____________________
   (folded walls)

b. The walls of the small intestine have ____________ (finger-like
   projections along the walls). The villi themselves have tiny
   __________________ on columnar epithelial cells.

Within each villus are ________________________ and small lymph
vessel called a ____________________ which absorbs fluids and
returns it to the veins later on.

Absorption occurs across the walls of each villus by active transport (uses
energy). ______________ and __________________________.

________________________________________. _________________
________________________________________________________________

**Be sure you understand how the structure of the small intestine facilitates its function**
17. Appendix - Found at ______
_______________________
_______________________
_______________________
-unknown function in humans

18. Large Intestine (colon) - absorption of ____________ from undigested food.

   a. The large intestine usually contains a large population of _________________.
   These organisms live off any substances that were not digested earlier. When they break down these substances, they give off ____________
   ________________ that cause the characteristic odor of feces.

   b. Some vitamins, Amino Acids, and other growth substances required by the body (Growth factors), are produced by _________________.
   The growth factors spill out into this gut and are absorbed by the gut lining. E. coli helps us metabolize what our bodies were unable to thereby providing us with a vital service.

19. Rectum - Enlarged portion of the _______. Undigested food is _________________.

20. Anal Sphincter (anus) - Bands of muscle which allow undigested wastes to _________________.

YOU SHOULD WATCH THE STRUCTURES OF THE DIGESTIVE SYSTEM VIDEO AND SUMMARY VIDEO BEFORE PROCEEDING ANY FURTHER!
Carbohydrate Digestion:

**SALIVARY AMYLASE** - ________________________________
- Acts on __________________ to break it into many molecules of maltose.
- Maltose is later broken down in the system to ____________________.

**PANCREATIC AMYLASE** - Also acts on ________________________________
- Occurs in the ____________________, but is produced by the pancreas.

**MALTASE** - Produced in the ________________________________.
- Converts ________________________________.

\[ \text{maltase} \quad \text{+} \quad \text{maltose} \quad \rightarrow \quad \text{maltase} \]

Protein Digestion:

**PROTEASES** - ________________________________.
- There are two types of proteases:
  a. **Pepsin** - Produced by the ________________________________
  b. **Trypsin** - Produced by the ________________________________.

\[ \text{pepsin/trypsin} \quad \text{+} \quad \text{pepsin/trypsin} \quad \rightarrow \quad \text{pepsin/trypsin} \]

**PEPTIDASES** - Break down peptides into ____________________________.
- Produced by the ________________________________.

\[ \text{peptidases} \quad \text{+} \quad \text{peptidases} \quad \rightarrow \quad \text{peptidases} \]

YOU SHOULD WATCH THE CARBOHYDRATE DIGESTION VIDEO AND THE PROTEIN DIGESTION VIDEO BEFORE PROCEEDING ANY FURTHER!
Lipid/Fat Digestion

**BILE** - Produced by the ____________________
- Stored in the ________________________________
- Breaks down fat in the ________________________ into fat droplets
- **not an enzyme, but rather an emulsifier**
- **EMULSIFICATION**: The ______________________ of fats to fat droplets by bile.

NOTE: A person who has had his/her gall bladder removed will have trouble digesting fatty foods. The gall bladder stores bile for use at the proper time during the digestive process.

Bile

LIPASE - Produced by the ____________________
- Breaks down fat droplets into glycerol and ____________________________

Lipase

Nucleic Acid Digestion

**NUCLEASE** – produced by the ________________________________
- works in the ________________________________
- breaks down RNA and DNA into ________________________________

**NUCLEOSIDASES** – produced by the ________________________________
- works in the ________________________________
- breaks down ____________________________________________

YOU SHOULD WATCH THE LIPID DIGESTION VIDEO BEFORE PROCEEDING ANY FURTHER!
### Digestive Enzymes Summary Table

<table>
<thead>
<tr>
<th>Enzyme</th>
<th>Glandular Source</th>
<th>Site of Action and pH</th>
<th>Substrate or food acted upon</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salivary Amylase</td>
<td>Salivary Glands (Mouth)</td>
<td>Mouth neutral (7)</td>
<td>Starch</td>
<td>Maltose</td>
</tr>
<tr>
<td>Pepsin</td>
<td>Gastric Glands (Stomach)</td>
<td>Stomach acidic (3.5)</td>
<td>Proteins</td>
<td>Peptides</td>
</tr>
<tr>
<td>Pancreatic Amylase</td>
<td>Pancreas</td>
<td>Small Intestine basic (7.5)</td>
<td>Starch</td>
<td>Maltose</td>
</tr>
<tr>
<td>Trypsin</td>
<td>Pancreas</td>
<td>Small Intestine basic (7.5)</td>
<td>Protein</td>
<td>Peptides</td>
</tr>
<tr>
<td>Lipase</td>
<td>Pancreas</td>
<td>Small Intestine basic (7.5)</td>
<td>Fat Droplets</td>
<td>Glycerol and fatty acids</td>
</tr>
<tr>
<td>Nuclease</td>
<td>Pancreas and small intestine</td>
<td>Small Intestine basic (7.5)</td>
<td>Nucleic Acids (DNA &amp; RNA)</td>
<td>Nucleotides</td>
</tr>
<tr>
<td>Peptidases</td>
<td>Small Intestine</td>
<td>Small Intestine basic (7.5)</td>
<td>Peptides</td>
<td>Amino Acids</td>
</tr>
<tr>
<td>Maltase</td>
<td>Small Intestine</td>
<td>Small Intestine basic (7.5)</td>
<td>Maltose</td>
<td>Glucose</td>
</tr>
<tr>
<td>Nucleosidases</td>
<td>Small Intestine</td>
<td>Small Intestine basic (7.5)</td>
<td>Nucleotides</td>
<td>Base, Sugar, Phosphate</td>
</tr>
</tbody>
</table>
Insulin and Glucagon

1. Insulin - _______________
   - Production by _______________
   - Secreted when _______________
   - Causes ________________
   - To take up and store excess glucose as Glycogen.
   - Also promotes synthesis of ________________
   - ***LOWERS BLOOD SUGAR LEVEL***

2. Glucagon - ________________
   - Secreted when blood sugar concentration ________________
   - Causes liver and muscles to break down ________________
   - Stops ________________
   - ***RAISES BLOOD SUGAR LEVEL***

Pancreas is called both an Exocrine and an Endocrine organ.
- Exocrine - __________________________________________
- Endocrine - __________________________________________

Six Major Functions of the Liver

1. Destroys old red blood cells and ___________________________ to a product in bile.

2. Produces Bile that is ___________________________
   Duodenum where it emulsifies fat.
3. Store Glucose as Glycogen after eating, and _______________________________ between eating to maintain the glucose concentration of the blood.

4. Produces Urea from the breakdown of amino acids (______________________) 

5. Makes Blood Proteins from _______________________.

6. Detoxifies the blood by removing _____________________________ __________________ (converting them to harmless substances).

***The liver is an essential organ***

What to Know….  
**Be sure you know the structures and functions of each part of the digestive system, all the enzymes including where they are produced, the substrate they work on, and the product produced, how insulin and glucagon regulate blood sugar levels and finally, know all 6 functions of the liver**

Summary of 3 Key Classes of Biological Molecules

<table>
<thead>
<tr>
<th>Food group</th>
<th>Elements present</th>
<th>Chemical structure</th>
<th>Function</th>
<th>Examples of foods rich in this group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>Carbon (C) Hydrogen (H) Oxygen (O)</td>
<td>Glucose Maltose Starch</td>
<td>“Fuel food” provides energy for daily activities e.g. movement, fighting illnesses.</td>
<td>Cornflakes Bread Pasta Jam</td>
</tr>
<tr>
<td>Proteins</td>
<td>Carbon (C) Hydrogen (H) Oxygen (O) Nitrogen (N)</td>
<td>Protein: Made of polypeptides: Themselves made of amino-acids:</td>
<td>For growth and repair of cells</td>
<td>Lean meat Egg white Cheese</td>
</tr>
<tr>
<td>Fats/Oils</td>
<td>Carbon (C) Hydrogen (H) Oxygen (O)</td>
<td>Made of two types of smaller molecules: glycerol and fatty acids</td>
<td>Energy store, heat insulation</td>
<td>Butter, oil, oily fish</td>
</tr>
</tbody>
</table>
1. Label the diagram below of the digestive system with the following terms (15 marks):

- gall bladder
- large intestine
- epiglottis
- rectum
- duodenum/small intestine
- salivary gland
- esophagus
- stomach
- pancreas
- tongue
- teeth
- appendix
- bile duct
- small intestine
- liver
2. Describe the key functions for each of the following structures (18 marks):

a. mouth

b. tongue

c. teeth

d. salivary glands

e. pharynx

f. epiglottis

g. esophagus
h. cardiac sphincter

i. stomach

j. pyloric sphincter

k. duodenum

l. liver

m. gall bladder

n. pancreas
3. Identify the key digestive enzymes that are produced by each of the following glands/organs (15 marks, 0.5 mark for each blank filled in correctly):

a. The salivary glands produces ______________________________ which works in the mouth at pH _____ to break _________________________ down into _________________________.

b. The stomach produces ______________________________ which works in the stomach at pH _____ to break _________________________ down into _________________________.

c. The pancreas produces ______________________________ which works in the small intestine at pH _____ to break proteins down into _________________________.

d. The pancreas produces ______________________________ which work in the small intestine at pH _____ to break lipids down into _________________________ and 3 _________________________.

o. appendix

p. large intestine (colon)

q. rectum

r. anus
e. The pancreas and small intestine produce______________________________ which work in the small intestine at pH _____ to break nucleic acids down into_________________________.

f. The pancreas produces______________________________ which works in the small intestine at pH _____ to break carbohydrates (starches) down into_________________________.

g. The small intestine produces______________________________ which works in the small intestine at pH _____ to break maltose down into_________________________.

h. The pancreas produces______________________________ which works in the small intestine at pH _____ to break peptides down into_________________________.

i. The pancreas produces______________________________ which works in the small intestine at pH _____ to break nucleotides down into_________________________.

4. Identify the following components produced by the pancreas (6 marks):

a. Three key digestive enzymes:
   i. _________________________________
   ii. _________________________________
   iii. _________________________________

b. Two key hormones that regulate blood sugar levels
   i. _________________________________ (released when blood sugar is too high)
   ii. _________________________________ (released when blood sugar is too low)

c. One compound key for regulate pH within the small intestine:
   i. _________________________________

5. Compare and contrast the terms exocrine and endocrine. (3 marks)
6. Please describe the effects of:
   
   a. glucagon on the body (2 marks)

   b. insulin on the body (3 marks)

7. Describe how fats are emulsified, digested and absorbed in the small intestine. (3 marks)

8. Draw and label a villus. Indicate which nutrients are absorbed by the blood vessels and which are absorbed by the lacteals. (6 marks)

9. Describe three key functions of the large intestine. (3 marks)
10. Label the diagram below of the digestive system with the following terms (15 marks):

- gall bladder
- large intestine
- epiglottis
- rectum
- duodenum/small intestine
- salivary gland
- esophagus
- stomach
- pancreas
- tongue
- teeth
- appendix
- bile duct
- small intestine
- liver

Diagram:

1. teeth
2. epiglottis
3. liver
4. gall bladder
5. bile duct
6. large intestine
7. appendix
8. salivary gland
9. tongue
10. esophagus
11. stomach
12. duodenum
13. pancreas
14. small intestine
15. rectum
11. Describe the key functions for each of the following structures (18 marks):

a. Mouth = ingestion of food, mechanical digestion via teeth and tongue, chemical digestion of starches via salivary amylase

b. Tongue = mechanical digestion of food, moves food to back of pharynx for swallowing, taste buds

c. Teeth = mechanical digestion of food (grinding)

d. Salivary glands = provides moisture in form of saliva to make food easier to swallow, releases salivary amylase which begins chemical digestion of starch, helps to produce a moist ball of food called a bolus

e. Pharynx = region at back of throat where food and air must cross pathways to go down the appropriate "tubes" (food down esophagus, air down trachea)

f. Epiglottis = structure that closes of glottis (opening of trachea) preventing food from entering lungs during swallowing

g. Esophagus = muscular tube that moves food from mouth to stomach via peristalsis

h. Cardiac sphincter = circular muscle between trachea and stomach that opens to allow food into stomach but closes to prevent food and acid from coming back up the esophagus

i. Stomach = J-shaped muscular organ that stores food (typically expands to 1 L but can go up to 4 L); churns to perform mechanical digestion; produces hydrochloric acid to kill bacteria, begin denaturing proteins such that they are more accessible to enzymes and to activate pepsin; produces a soupy/acidic food mixture called chyme

j. Pyloric sphincter = circular muscle between stomach and small intestine that opens and closes to allow chime to enter the small intestine

k. Duodenum = ~ first 30 cm of small intestine, accepts secretions from the pancreas that include enzymes begin digestion of proteins, nucleic acids, carbohydrates and lipids (trypsin, nucleases, pancreatic amylase and lipases respectively); produces and secretes enzymes that continue digestion of proteins, nucleic acids and carbohydrates (nucleosidases, peptidases and maltase, respectively)

l. Liver = multiple body functions, but with respect to digestion, produces bile necessary to emulsify lipids (a form of mechanical digestion so that they can be accessed by enzymes for chemical digestion
m. gall bladder = stores and concentrates bile, if there is too much cholesterol in the blood it will be added to bile and then precipitate out in the gall bladder leading to the painful condition of gallstones which may necessitate the removal of the gall bladder

n. pancreas = exocrine (enzyme) functions include producing pancreatic juices that contain bicarbonate ions (to neutralize acidic chyme so that it does not harm the small intestine), trypsin which digests proteins, salivary amylase which digests carbohydrates, nuclease which digest nucleic acids and lipase which digest lipids (fats and oils); endocrine (hormone) functions include releasing glucagon when glucose blood levels are low and insulin when blood glucose levels are high

o. appendix = once thought to be a vestigial organ (non-functional remnant of evolution) it appears that it may serve as a "safe room" for commensal bacteria when the body is under attack by harmful bacteria

p. large intestine (colon) = absorption of salt, water and vitamins, storage of waste (feces), elimination of waste (defecation)

q. rectum = specific area of colon that store feces until the appropriate time for defecation; contains nerves necessary for trigger and delaying the defecation response

r. anus = exit point for elimination of waste (feces) from the body

12. Identify the key digestive enzymes that are produced by each of the following glands/organs (15 marks, 0.5 mark for each blank filled in correctly):

   a. The salivary glands produces ________________ which works in the mouth at pH ~ 7 to break ________________ down into ________________.

   b. The stomach produces ________________ which works in the stomach at pH ~ 2 to break ________________ down into ________________.

   c. The pancreas produces ________________ which works in the small intestine at pH ~ 7.5 to break proteins down into ________________.

   d. The pancreas produces ________________ which work in the small intestine at pH ~ 7.5 to break lipids down into ________________ and ________________.

   e. The pancreas and small intestine produce ________________ which work in the small intestine at pH ~ 7.5 to break nucleic acids down into ________________.

Page 21 of 23
f. The pancreas produces **pancreatic amylase** which works in the small intestine at pH 7.5 to break carbohydrates (starches) down into **maltose**.

g. The small intestine produces **maltase** which works in the small intestine at pH 7.5 to break maltose down into **glucose**.

h. The pancreas produces **peptidase** which works in the small intestine at pH 7.5 to break peptides down into **amino acids**.

i. The pancreas produces **nucleosidases** which works in the small intestine at pH 7.5 to break nucleotides down into **sugar, base**.

13. Identify the following components produced by the pancreas (6 marks):

   a. Three key digestive enzymes:
      i. **pancreatic amylase**
      ii. **trypsin**
      iii. **lipases**

   b. Two key hormones that regulate blood sugar levels
      i. **insulin** (released when blood sugar is too high)
      ii. **glucagon** (released when blood sugar is too low)

   c. One compound key for regulate pH within the small intestine:
      i. **bicarbonate**

14. Compare and contrast the terms exocrine and endocrine. (3 marks)

   = exocrine refers to the release/secretion of enzymes into nearby structures
   = endocrine refers to the release of hormones (chemical messengers) into the blood, these hormones can influence nearby or more distant organs

15. Please describe the effects of:

   a. glucagon on the body (2 marks)
      = glucagon is release by the pancreas when blood glucose levels fall causing the liver to convert glycogen to glucose which is then added to the blood such that blood glucose levels return to a homeostatic level

   b. insulin on the body (3 marks)
      = insulin is by the pancreas when blood glucose levels are too high causing cells to transport glucose from the blood into the cell and causing liver cells to convert the glucose to glycogen for storage

16. Describe how fats are emulsified, digested and absorbed in the small intestine. (3 marks)

   = bile is released from liver/gall bladder into small intestine where its bipolar nature helps lipids to interact with water (bile has a charge, polar head that readily interacts
with water and a non-charge, non-polar tail that readily interacts with non-polar lipids at thus, it acts as a sort of mediator between water and lipids), emulsification of lipids increase their surface area and accessibility such that lipases (from the pancreas) can begin chemical digestion such that glycerol and fatty acids are produced, glycerol and fatty acids are then absorbed by the lacteals of the villi of the small intestine in a rather complicated process that is not detailed in biology 12.

17. Draw and label a villus. Indicate which nutrients are absorbed by the blood vessels and which are absorbed by the lacteals. (6 marks)

18. Describe three key functions of the large intestine. (3 marks)
   - Absorb salt, water and vitamins
   - Storage of waste (feces)
   - Elimination of waste (defecation)