# DIGESTION III

## I. DEFINITIONS

**ingestion** = eating
**mechanical digestion** = grinding of food by teeth and mixing of food by peristalsis
**chemical digestion** = enzymatic breakdown of large organic molecules into sub-units
**extracellular digestion** = chemical digestion that takes place outside of cells (i.e. in the lumen of the digestive tract)
**intracellular digestion** = chemical digestion that occurs inside cells (in lysosomes)

## II. CHEMICAL DIGESTION -summarized in **Table I in manual**

- we will now look at the chemical digestion of all the major organic molecules

### A. Carbohydrates (starch, glycogen)

- digestion of starch (a polysaccharide) to maltose (a disaccharide) starts in the mouth ) using **salivary amylase** ⇒ digests about 3% of the starch
- salivary amylase continues to act for about 15 minutes until it is inactivated by hydrochloric acid in the stomach
- in the duodenum of the small intestine:
  - **(i) pancreatic amylase** (from pancreas) completes the breakdown to maltose
  - **(ii) maltase (**from cells in the intestinal wall) digests maltose into glucose ( a monosaccharide)
- the disaccharides lactose and sucrose can also be digested into monosaccharides; the enzymes (lactase and sucrase) are produced by the cells of the small ntestine
- monosaccharides can then be: **Biochemistry Handout Fig 19.13**; i.e. Fig 24.20 (T11/T12)
  - (i) absorbed by cells lining small intestine
  - (ii) transported from the cells into capillary networks
  - (iii) sent to the liver via the hepatic portal system

### B. Proteins - see manual Table 1 for summary

- digestion involves 2 general types of enzymes:
  - **(i) endopeptidases** break proteins into fragments by breaking internal chem. bonds
  - **(ii) exopeptidases** break down fragments by removing single amino acids from end
- cells lining the stomach secrete an inactive enzyme called **pepsinogen**
- HCl converts pepsinogen into active **pepsin** (an endopeptidase)
- pepsin begins the digestion of protein in the acid pH of the stomach
- 2 other endopeptidases (**trypsin** & **chymotrypsin** from pancreatic juice) continue digestion in the alkaline pH of the small intestine
- there are also 2 exopeptidases that act in the small intestine
  - **(i) carboxypeptidase** (from pancreatic juice) that removes amino acids from the carboxy (COOH) end of protein fragments
  - **(ii) amino peptidase** (secreted by intestinal cells) that remove amino acids from the amino ($NH_3$) end of protein fragments
- single amino acids are absorbed into capillaries of the hepatic portal system and are trans ported to the liver just like monosaccharides: **Biochemistry Handout Fig 19.13**

**C. Fats - see summary in Table I of manual**

- digestion involves **3 lipase enzymes:**
  - **(i) lingual lipase** is made by salivary glands, is activated by stomach acid, and can remove only one fatty acid
  - **(ii) gastric lipase**, made by cells lining the stomach, can remove 1 or 2 fatty acids
  - **(iii) pancreatic lipase** acts in the small int. and completes the digestion of fats to monglyceride and fatty acids
- for pancreatic lipase to act efficiently, **bile** must emulsify fat globules into tiny droplets
- end products of lipase are fatty acids and monoglycerides which are absorbed into cells lining the small intestine
- once inside the cells:
  - (i) the final fatty acids are removed from the monoglycerides
  - (ii) glycerol and fatty acids are made back into fats
  - (iii) fats, phospholipids & cholesterol are coated with soluble proteins = **chylomicrons**
- the chylomicrons enter small lymphatic vessels called lacteals located in the center of villi
  - see **Biochemistry Handout Fig 19.13**
- lacteals drain into larger lymphatic vessels that eventually join with the bloodstream at the left sub-clavian vein

## III. Control of the Secretion of digestive Juices

**A. Nervous Control** (fast and short-acting response)

- sight, smell, hearing of food prep and even thought of food stimulates cerebrum
  ⇒ impulse to stomach to produce gastric juice (HCl, mucous, pepsinogen)
- food in mouth stimulates taste buds
  ⇒ impulse to cerebrum
  ⇒ impulse to stomach to produce gastric juice and pancreas to produce pancreatic juice (alkaline fluid with enzymes)

**B. Hormonal Control** (slow and long-acting response) **Manual Figs 3 & 4**

**(i) Gastrin**

- produced by ductless (endocrine) glands of the **stomach** when stimulated by the presence of **protein-containing food**
- enters blood capillaries and circulates to other types of cells lining the stomach
- causes cells to secrete **gastric juice**

**(ii) Secretin**

- produced by endocrine glands of the **small intestine** when stimulated by the presence of **acidic food** (chyme) in the duodenum
- enters blood capillaries and goes to pancreas
- causes production of **pancreatic juice** (alkaline fluid with enzymes)

**ADDITIONAL CHAPTER 24 TEXTBOOK QUESTIONS TO TRY:**

Tortora 11th OR 12th ed.: Self-Quiz Questions 1 & 14 (b-h & k) and Fig. Questions 24.18 & 24.1
Tortora 10th ed: Self-Quiz Questions 3 & 14 (b-h); Fig Questions. 24.23 & 24.1
Martini 8th ed: Chapter 24 Review Questions 1, 9, 13 & 19