



## BI 121 Lecture 6

- I. Announcements** Data + Flashdrive for today's lab! Q?  
If you want notebook to study for Exam I on Oct 25th, turn in prior lecture next Tuesday, Oct 18<sup>th</sup>. Sample Exam Q.
- II. Nutritional Physiology in the News** Pondering Paleo Nutrition  
*Action Health Letter*, Marlene Zuk, U Minnesota + Shake the salt habit! *UC Berkeley Newsletter*. → Drink Your Calories? *PEBB Identifying Nutrition Quackery*, Kleiner & Monaco
- III. Nutrition Connections** DC Mod 2, Sizer & Whitney (S&W) Sci Lib
  - A. Diet & endurance? What's the best path to losing weight?
  - B. Low-carbohydrate dieting? What about fasting?
  - C. Balanced approach, Dr. Sacks [AHA NPAM Council](#)
- IV. Gastrointestinal Physiology** DC Module 3 pp 17-23, LS ch 15+
  - A. GI = Donut? GI secretions: What? Where? Why? LS p 438
  - B. How is the gut controlled?
  - C. Organ-by-organ review A&P LS tab 15-1 pp 440-1 +...
  - D. Zymogen? = Inactive precursor LS fig 15-9 p 452...
  - E. Accessory organs? Pancreas, Liver, Recycling! pp 457-63
  - F. Small intestine? Ulcers? LS fig 15-20,15-22 pp 467-8  
<http://www.cdc.gov/ulcer> *Beyond the Basics* LS p 456
  - G. Large intestine? LS fig 15-24 pp 472-4

# Lab 3: Nutritional Analyses via 2 Programs



+



**DietOrganizer**  
\* Easy to use diet software

<https://www.supertracker.usda.gov/>

***In Lab Today!***

# Sample Exam I Questions

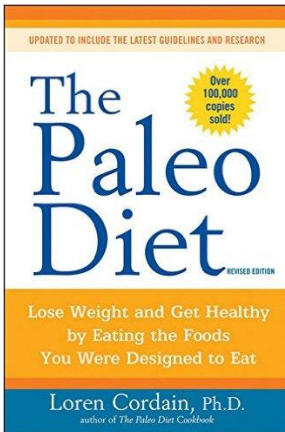
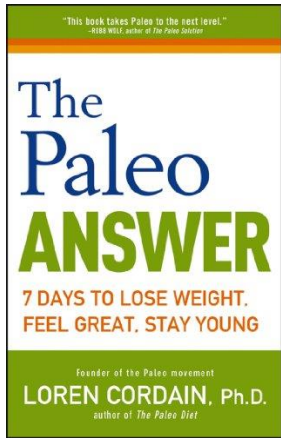
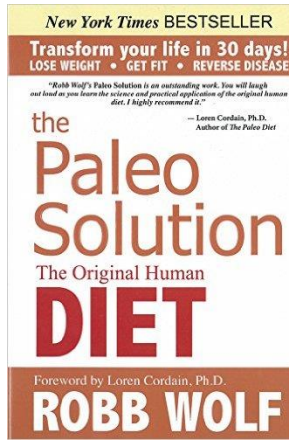
**Sample 1.** What is *human physiology*? (+2) How does it differ from *human anatomy*? (+2)

**Sample 2.** Give 2 *examples* of when *positive feedback* may occur normally in the human body. (+4)

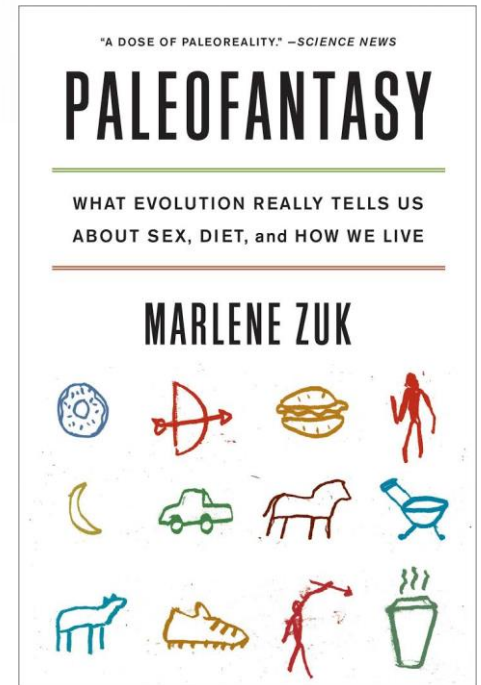
**Sample 3.** *Cells* are progressively organized into

- organs, systems, tissues, then the whole body
- tissues, organs, systems, then the whole body
- systems, tissues, organs, then the whole body
- None of the above are correct.

# Pondering Paleo?

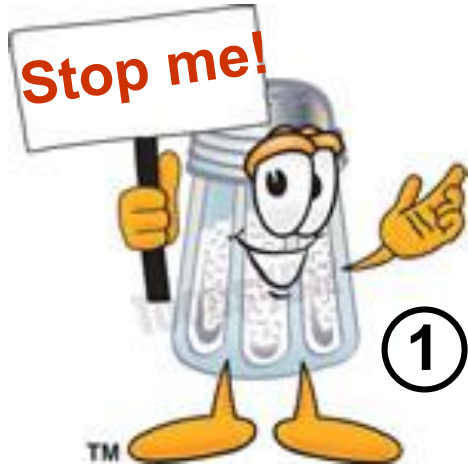


**Evolutionary Biologist  
Behavioral Ecologist  
U Minnesota**



<http://www.nutritionaction.com/daily/how-to-diet/pondering-paleo/>

# More Reasons to Shake the Salt Habit



- ① ↓ blood vessel vasodilation w/in 30 min by ingesting 1500 mg Na+!
- ② ↑ Ca<sup>2+</sup> excretion ↑ bone loss, risk of osteoporosis & fractures.
- ③ May directly impair kidney function & ↑ risk of kidney stones.
- ④ GI cancer risk, inflammation?

I'm outta here!!



# Macronutrients & Micronutrients Essential for Life

## Macronutrients

H<sub>2</sub>O/Water

➔ 1<sup>o</sup> Carbohydrates

➔ 2<sup>o</sup> Fats/Triglycerides/Lipids

➔ 3<sup>o</sup> Proteins

## Micronutrients

Vitamins (A, D, E, K; C + B)

Minerals (K<sup>+</sup>, Na<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>,  
Fe<sup>2+</sup>, Zn<sup>2+</sup>,...)

## Sample Food Sources

Water, other drinks, fruits  
& vegetables

Grains, vegetables, fruits,  
dairy products

Meats, full-fat dairy  
products, oils

Meats, legumes, dairy  
vegetables

**NB: Need only minute quantities!**

Vegetables, vegetable oils,  
fruits, citrus, grains, dairy

Fruits, vegetables, grains,  
nuts, dairy, meats,  
processed foods

➔ **Energy nutrients = yield ATP**



# US Modifications to 1992 Food Pyramid 2005

Fats, oils, and sweets

Use sparingly

↑ "good" fats!

↓ saturated & trans fats!

KEY

● Fat (naturally occurring and added)

▼ Sugars (added)

Milk, yogurt,  
and cheese  
group

2-3 servings

3 or more!

Vegetable  
group

3-5  
servings

5 or more!

Meat, poultry, fish,  
dry beans, eggs,  
and nuts group

2-3 servings

e.g. fish, nuts

Fruit group

2-4 servings

4 or more!

Bread,  
rice, and pasta  
group

6-11  
servings

1/2 whole grain

Regular Physical Activity: Exercise! Exercise!!

# *Dietary Guidelines for Americans 2005*

## *Food Guidance System*

Hooray!



1. ↑ emphasis on ↓ kcal + ↑ exercise.
2. 9-A-Day! 4 fruit + 5 vegetable servings.
3.  $\geq 3$  of 6 whole grains  $\longrightarrow$   $\frac{1}{2}$  whole grains!
4. 3 servings of dairy, eg 3 c fat-free milk.
5. ↓ saturated + trans fats + ↑ unsaturated/  
“good” fats, eg  $\Omega$ -3 fish, walnuts.
6. Drink in moderation if at all.
7. Practice food safety.



# *MyPlate launched June 2, 2011*

2. Focus on fruits.  
Whole fruit preferable to juice, but any fruit counts!  
Fill  $\frac{1}{2}$  your plate with fruits & vegetables!



3. Make at least  $\frac{1}{2}$  of your grains whole grains!

5. Get your calcium-rich foods. Buy skim or 1% milk. Go easy on cheese!

1. Vary your veggies.  
Fill  $\frac{1}{2}$  your plate with fruits & vegetables!

4. Go lean with protein. Keep protein to  $< \frac{1}{4}$  plate! Nuts, beans, peas, seeds, poultry, lean meat, seafood,...

## ***Diet & Health Guidelines for Cancer Prevention***

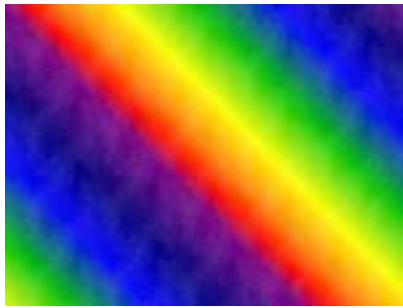
- 1. Choose a diet rich in variety of plant-based foods.**
- 2. Eat plenty of vegetables & fruits.**
- 3. Maintain a healthy weight & be physically active.**
- 4. Drink alcohol only in moderation, if at all.**
- 5. Select foods low in fat & salt.**
- 6. Prepare & store food safely.**

**And always, remember...**

**Do not smoke or use tobacco in any form.**



***American Institute for Cancer Research (AICR)***



# *Eating the Rainbow Hawaiian Style!!*



Your plate should be the size of a Frisbee, not a manhole cover.

When it comes to colorful foods, Fruit Loops don't count.

A surprising number of people get 1/5 of their calories from sodas or other liquids.

If you look at the label & need a chemistry degree to read it, put the item back on the shelf!



**SOURCE:** P. Rath, *Honolulu Advertiser*, Sept 11, 2008 citing D. Chong & N. Kerr.



**5 times per wk?  $\equiv$  106,600 calories/yr  $\equiv$   $\pm$  30.5 lb fat/yr**



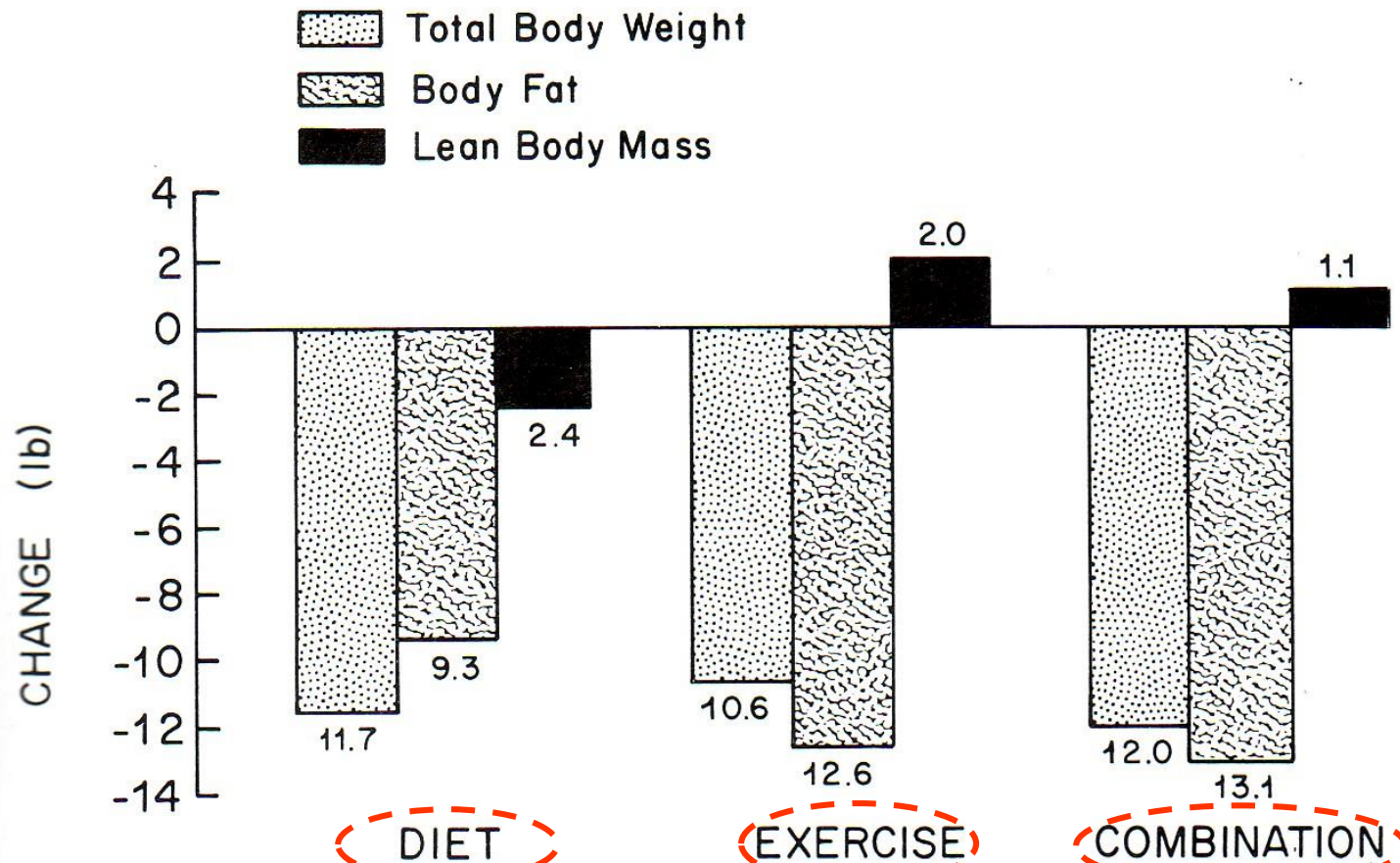
Starbucks  
Cinnamon  
Dolce Latte,  
whipped cream  
Venti (20 oz.)

**410 calories**

Jogging | **50 min.**



**Better  
choices!**



**Figure 4-9.** Changes in body weight, body fat, and lean body weight for diet, exercise, and combination groups. (From Zuti W. B., and Golding, L. A.: Comparing diet and exercise as weight reduction tools. *Phys. Sportsmed.* 4:49-53, 1976.)

**NB: Each group 500 kcal deficit/day, 16 weeks**



***Exercise is better than dieting in lowering body fat & preserving muscles!***



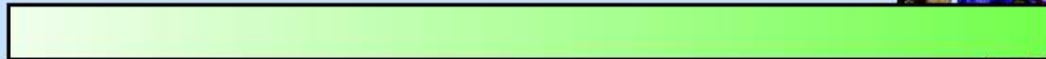
# Dietary Composition & Physical Endurance

eg, Atkins!

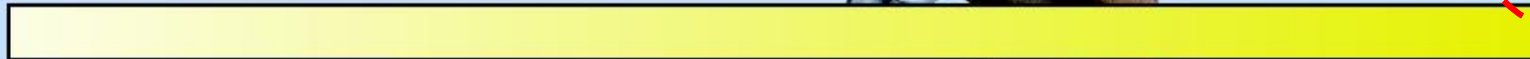
High-fat diet



Normal mixed diet



High-carbohydrate diet



**~ 1/3 endurance!**

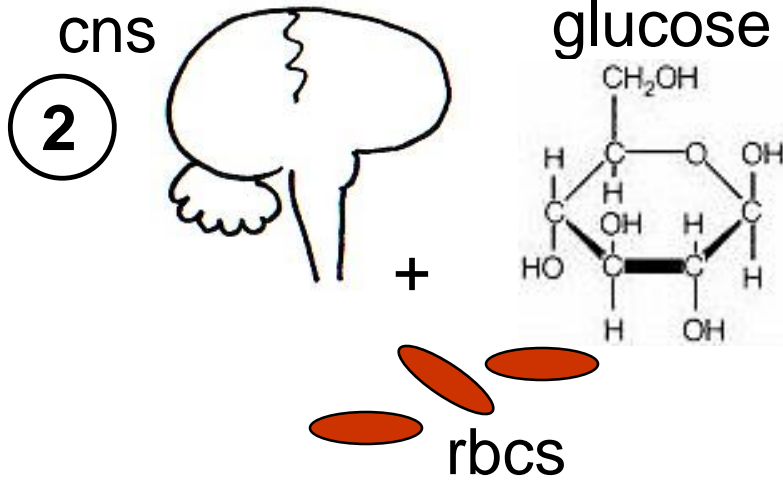
Maximum endurance time:

57 min

114 min

167 min





# Negative Effects of Low Carbohydrate

1



- ① ↑ fatigue/exhaustion central & peripheral!
- ② ↓ glucose – brain+spinal cord, rbcs thrive upon.
- ③ ↓ variety which reduces intake of phytochemicals, vitamins, minerals & fiber.
- ④ ↑ risk of respiratory infections.

4



+ gall stones,  
↓ thermoregulation...



# ***We're better at storing fat vs carbohydrate!***

**Dietary Fat**



**3 % Kcal**

**Body Fat**



**23 % Kcal**

**Dietary  
Carbohydrate**



**To Help Lower Body Wt & %Fat  
EXERCISE!! +*Minimize* These!!**



**FAT            9 Kcal/g**

**ETOH          7 Kcal/g**

**CARB         4 Kcal/g**

**PRO           4 Kcal/g**

**NB:    *Minimize* not *Eliminate!*  
*Moderation* not *Abstinence!!***

***I'm not sure I believe you!  
Why can't I just starve to  
lose weight?***



**TOTAL FAST =**  
**No Energy Nutrients**  
**(No Carbohydrates, Fats**  
**or Proteins)**

**ONLY**

- 1. Water**
- 2. Vitamins**
- 3. Minerals**

# 60-day Fast???

Lost 60 lb!! Wow!!

Yet

26 lb Water

20 lb Lean Body Mass

14 lb Fat

Fat <  $\frac{1}{4}$  total wt loss!

>  $\frac{3}{4}$

***You can lose weight by  
starving – but it's mostly  
water & muscle! Also, there  
can be complications!***



# **Potential Complications of Total Fasting**

**Nausea, diarrhea, persistent vomiting,  
postural hypotension, nutritional  
deficiencies, menstrual irregularities,  
and...sudden death.**

## **Positive Aspect??**

**General loss of appetite within  
first 2 days, maintained  
throughout fasting period.**



# Council on Nutrition, Physical Activity and Metabolism (NPAM) Spring 2009



## Dietary Carbohydrate, Fat and Protein in Weight-Loss Diets: A Report and Insider's Reflections on the Pounds Lost Trial

Frank M. Sacks, MD

**W**ell-controlled studies of energy-reduced diets conducted in controlled environments showed that the macronutrient composition of the diet did not affect weight loss (1). Nonetheless, theories persisted that specific macronutrients would be superior for weight loss. For example, the traditional paradigm for low-fat, high-carbohydrate diets was based on the lower energy density of carbohydrate compared to fat, and the metabolic efficiency of converting dietary fat to body fat (2). Indeed strict vegetarians sustain lower body weight for

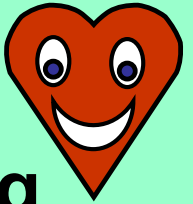
that Mediterranean diets were superior to low-fat diets for weight loss (5,6). Others claimed that a radically different approach that used low-carbohydrate, high-fat, and high-protein foods could produce weight loss without attention to reducing intake because of the satiety of protein-rich foods. Low-carbohydrate diets succeeded in the first few months with more rapid weight loss than low-fat diets but by one year, none of the trials found that weight loss on low-carbohydrate

*Continued on page 26*



years on low-fat diets (3). However, meaningful differences in body weight usually were not achieved in population-based trials of conventional low-fat diets (4). Thus, higher-fat, Mediterranean-style diets were proposed to be better for long-term weight loss because of their variety and satisfaction. Two trials found

## ***Dr. Sacks' Conclusions:***



**We conclude that healthful diets with varying emphases on carbohydrate, fat & protein levels can all achieve clinically meaningful weight loss & maintenance of weight loss over a 2-yr period. The results give people who need to lose weight the flexibility to choose a diet that they can stick with, as long as it's heart healthy. Such diets can also be tailored for individuals based on their personal & cultural preferences & in this regard may have the best chance for long-term success.**

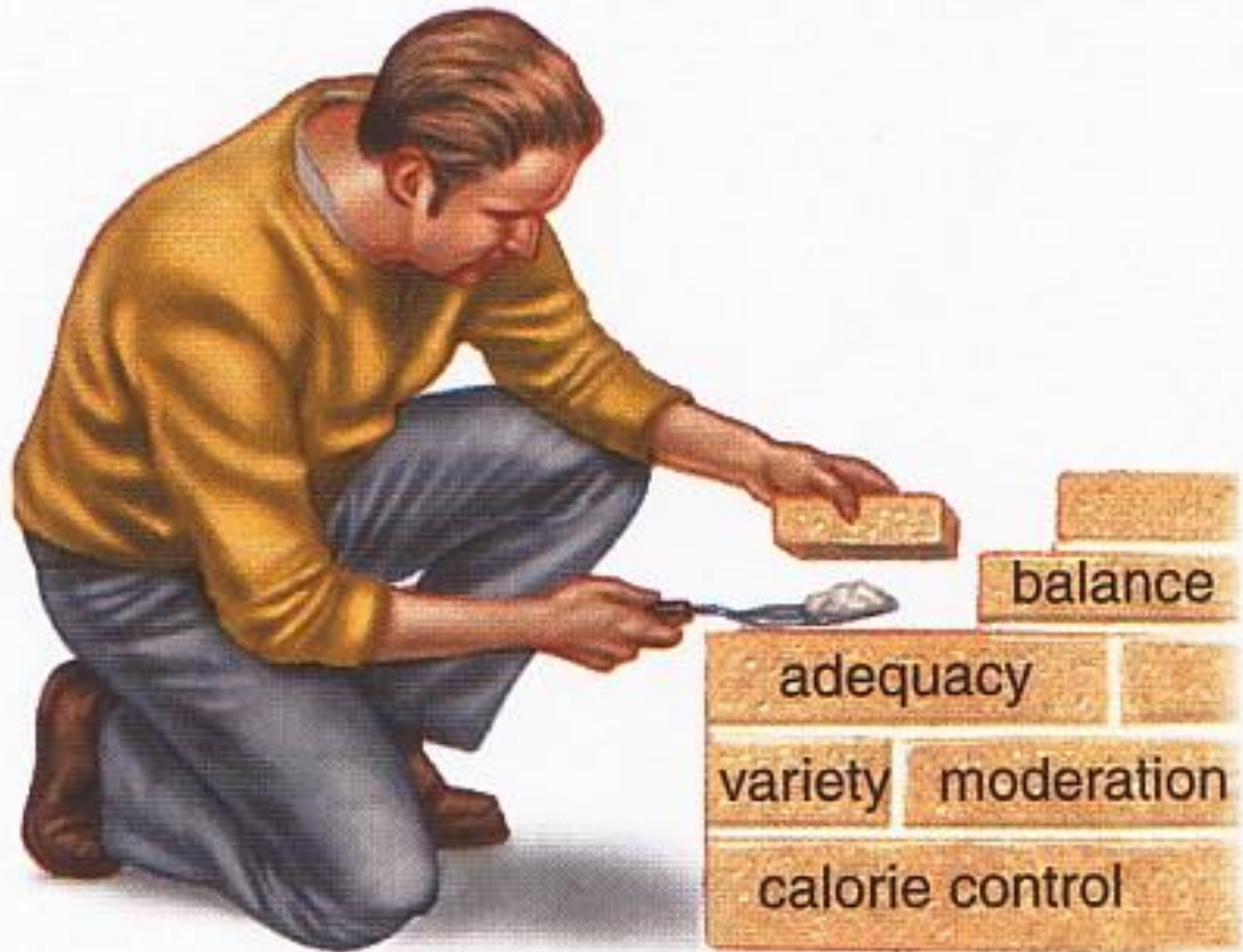
***US Dietary Recommended Intakes (DRI)  
Committee Acceptable Macronutrient  
Distribution Ranges (AMDR)!***

<b><u>Energy Nutrient</u></b>	<b><u>% Total Calories</u></b>
<b>Carbohydrate</b>	<b>45-65%</b>
<b>Fat</b>	<b>20-35%</b>
<b>Protein</b>	<b>10-35%</b>

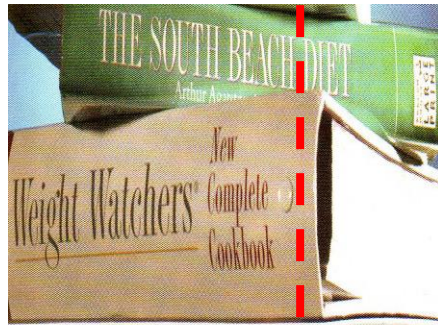
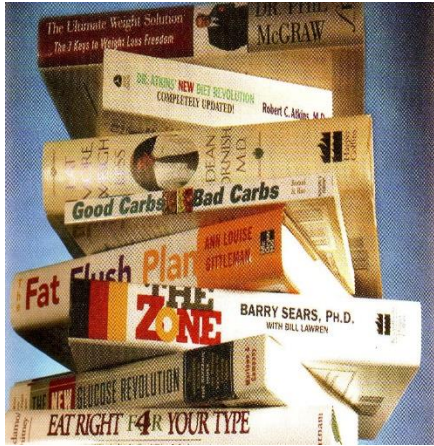
# Emphasize ABCs + Variety & Moderation!



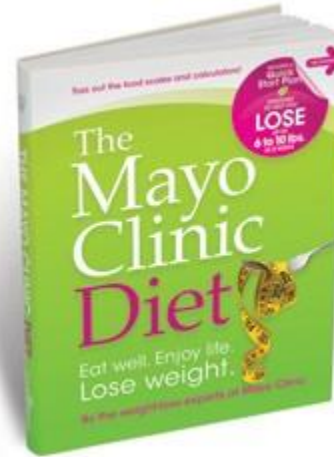
*All of these factors help to build  
a nutritious diet.*



**NOT PEER-REVIEWED =  
TRADE BOOKS**



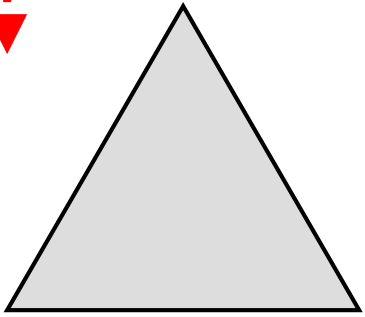
**PEER-REVIEWED =  
TEXTS →  
RESEARCH**



**AHA + DASH +  
MAYO CLINIC** 



**LOWER  
CARBOHYDRATE**



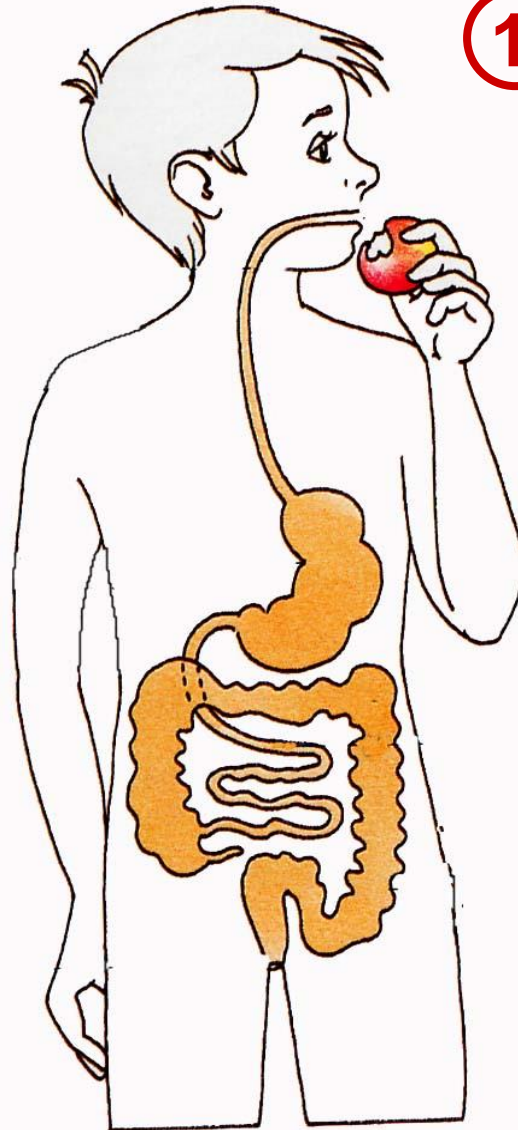
**LOWER  
FAT**



**ELIMINATE CALORIES  
or FOOD GROUPS  
ENCOURAGE FASTING**

**ADEQUACY  
BALANCE  
CONSISTENCY  
& MODERATION**

# Digestion Steps



- ① Ingestion
- ② Mechanical Digestion
- ③ Chemical Digestion
- ④ Peristalsis
- ⑤ Absorption
- ⑥ Storage
- ⑦ Defecation

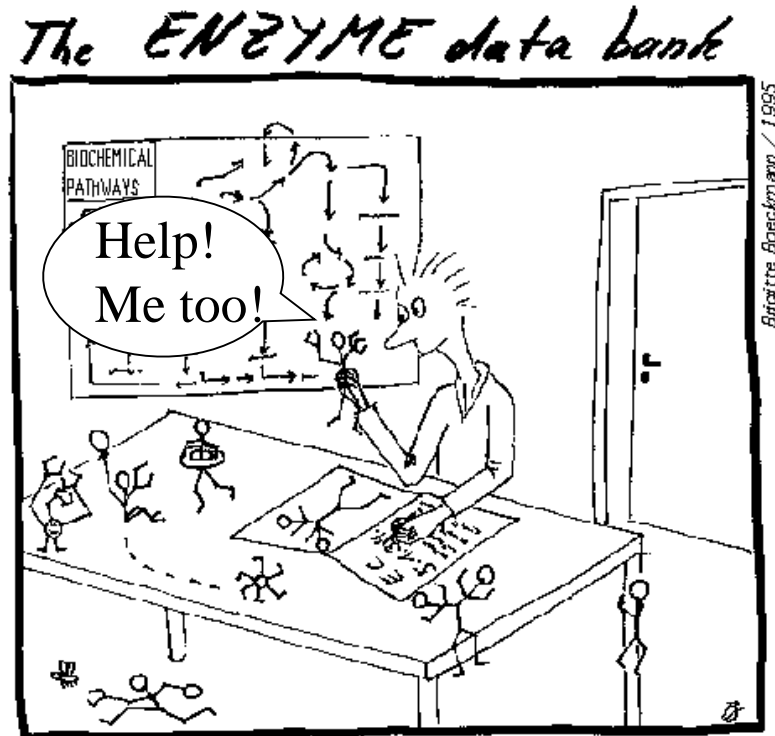
**SOURCE:** Dr. Eugene Evonuk, 1989. cf. L Sherwood, 2012 pp 437-8.

# Hydrolysis of Energy Nutrients

Hi gang!!  
You need me  
for digestion!!



+

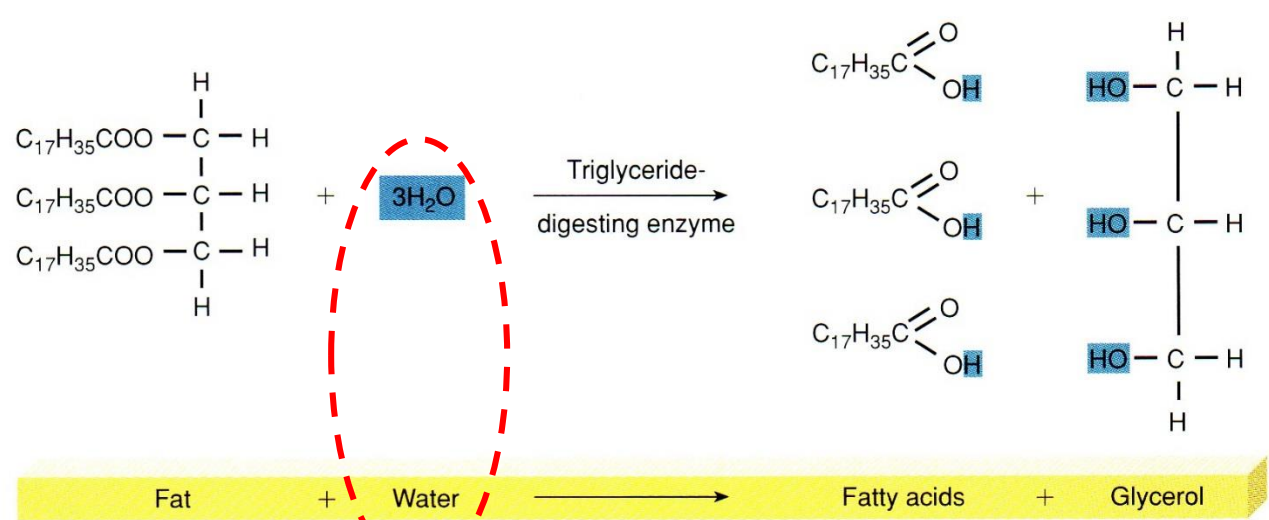
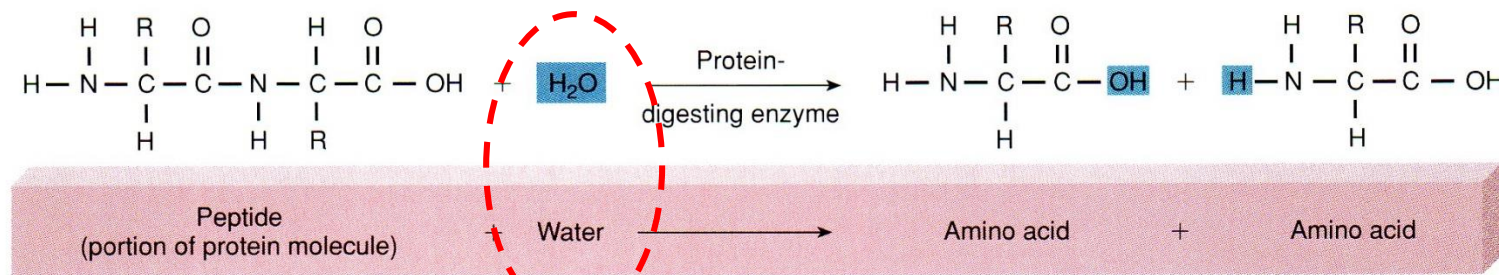
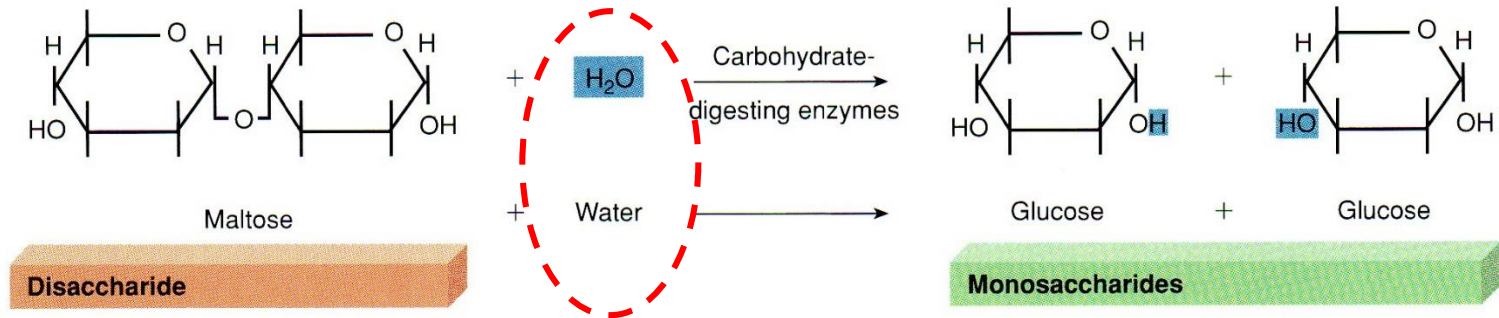


H<sub>2</sub>O

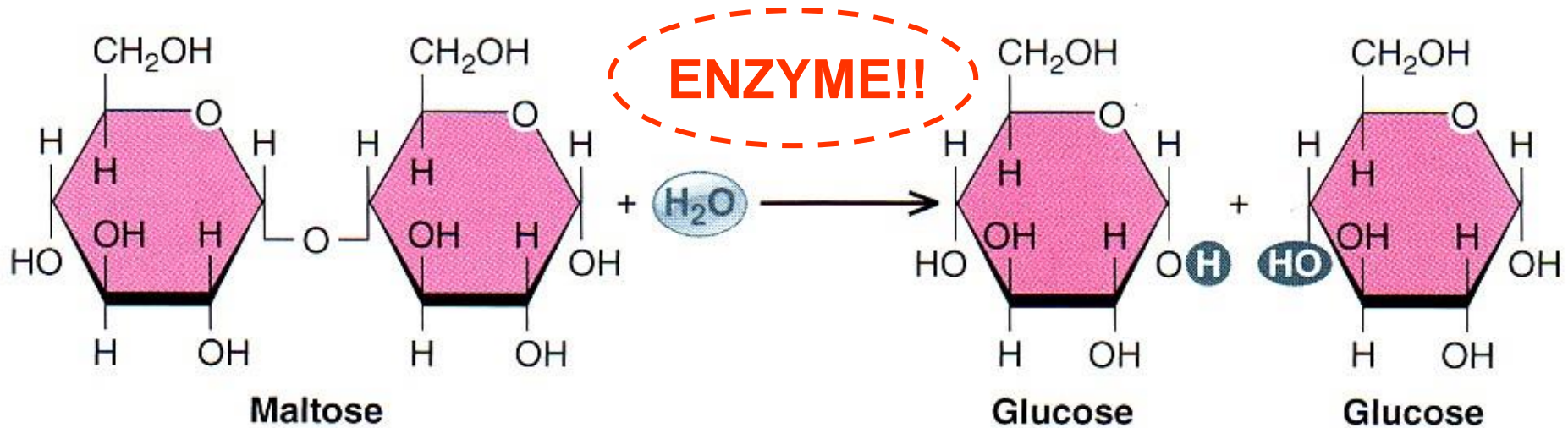
+

Enzyme





# What's missing?

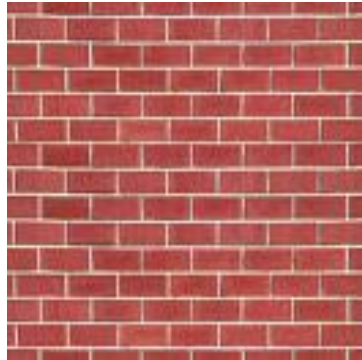


● **FIGURE 15-1** An example of hydrolysis. In this example, the disaccharide maltose (the intermediate breakdown product of polysaccharides) is broken down into two glucose molecules by the addition of H<sub>2</sub>O at the bond site.

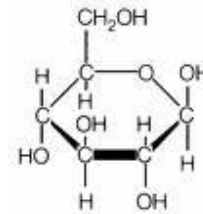
# Polymer to Monomer (Many to One)



...Central-linking theme!!

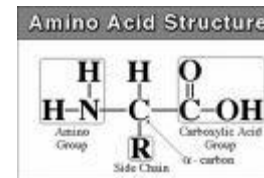


Carbohydrate

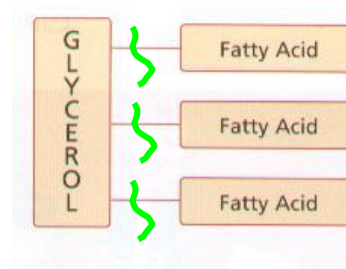
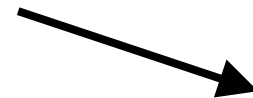


Glucose

Protein  
+  
Fat

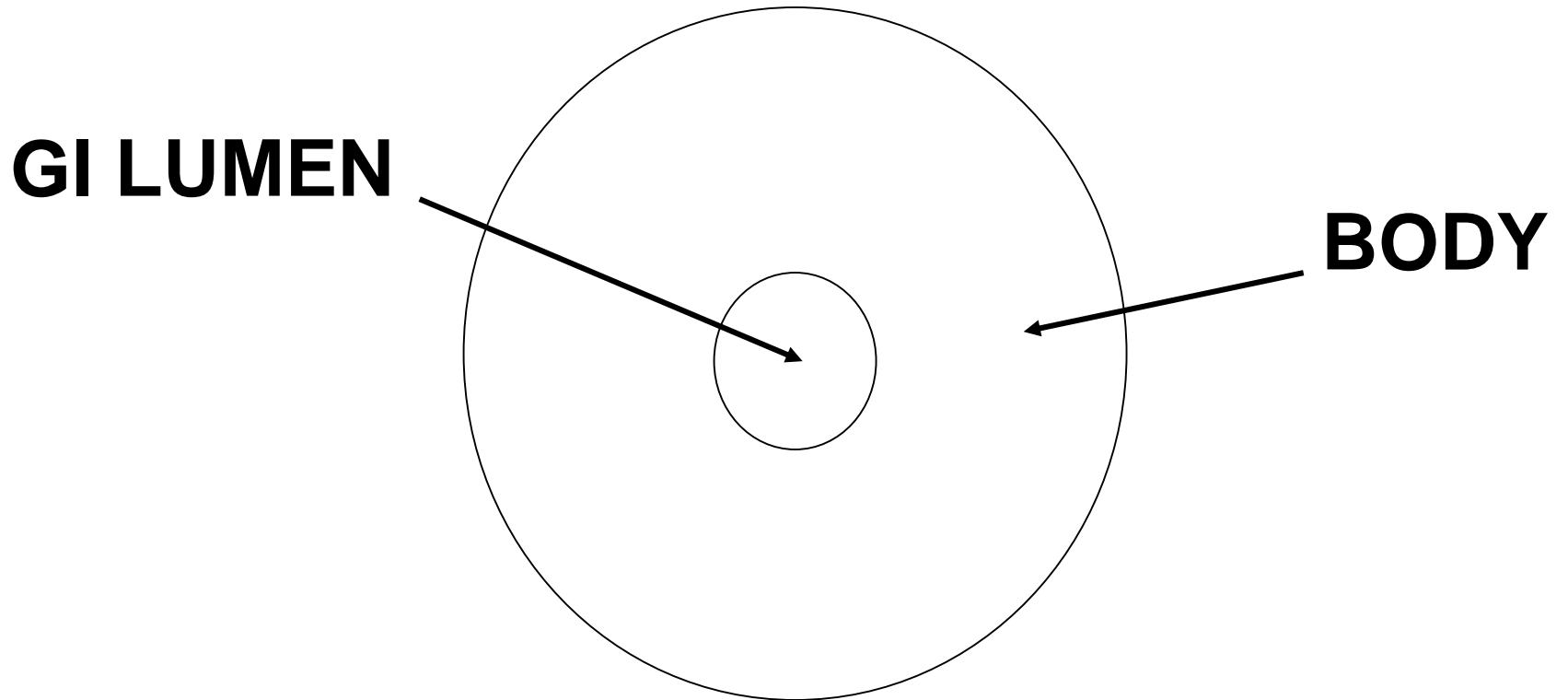


Amino Acids



Fatty Acids  
+  
Glycerol

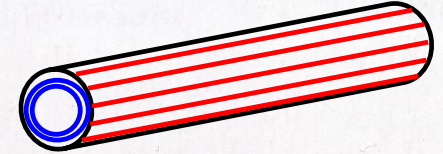
# GI-DONUT ANALOGY



# ***Common Control Mechanisms***

- 1. Local (autoregulation)**
- 2. Nervous (rapidly-acting)**
- 3. Hormonal (slower-acting/  
reinforcing)**

**Longitudinal → Shortens L**



**Circular → ↓d or Width**

Body wall

Serosa

Submucosa

Duct of large accessory digestive gland (i.e., liver or pancreas) emptying into digestive-tract lumen

Outer longitudinal muscle

Inner circular muscle

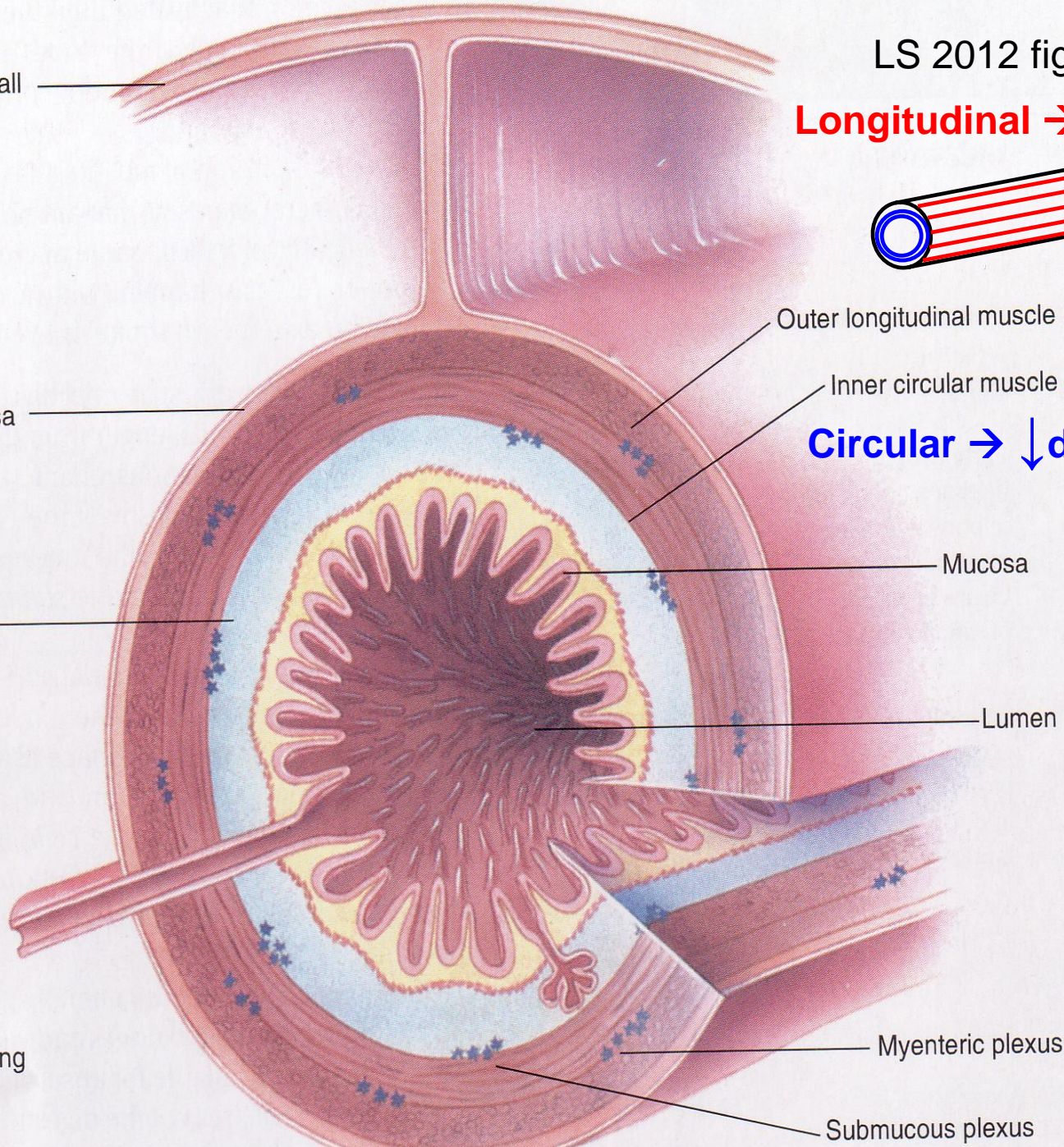
Muscularis externa

Mucosa

Lumen

Myenteric plexus

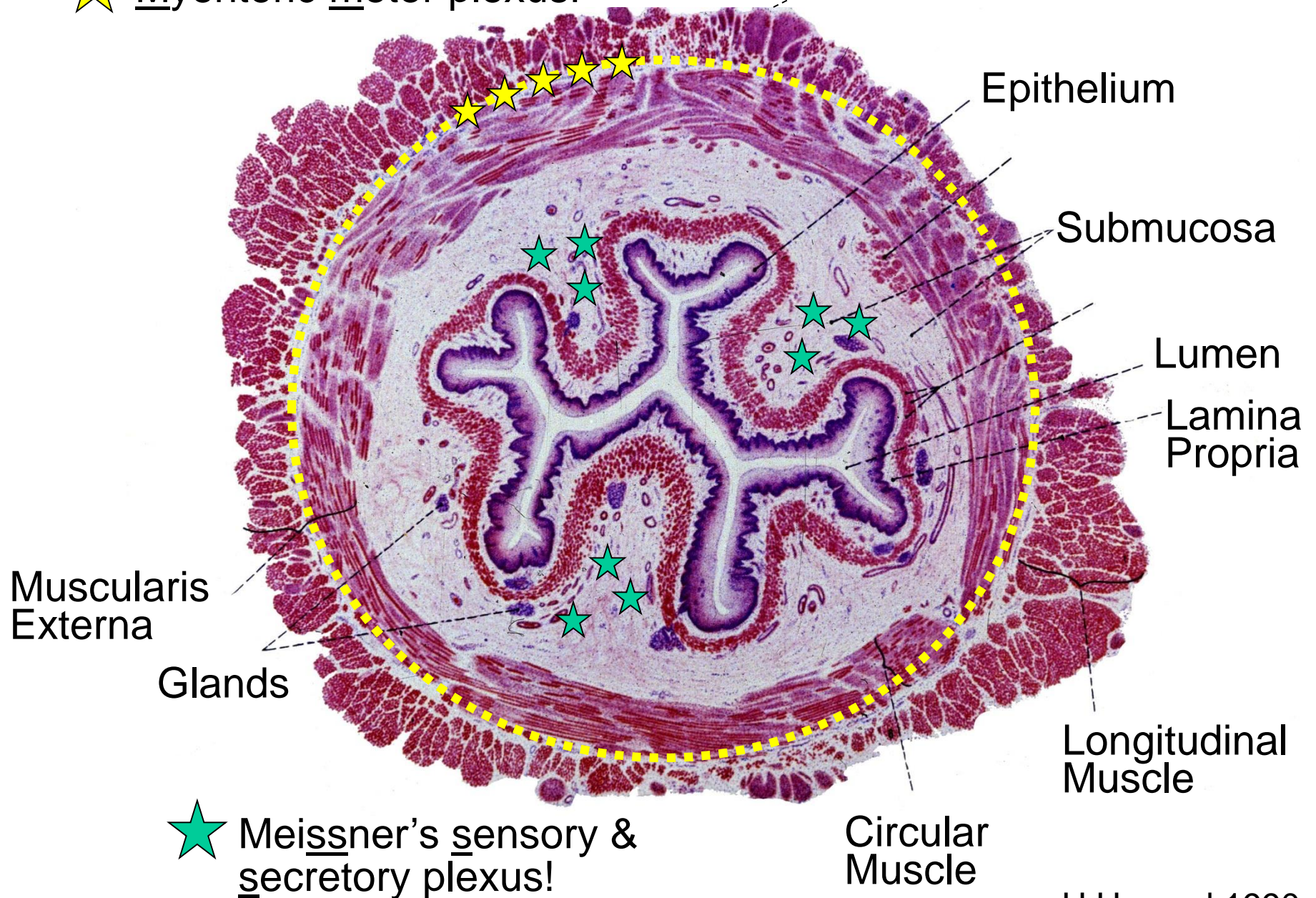
Submucous plexus



★ Myenteric motor plexus!

Serosa

cf: G&H fig 62-2



★ Meissner's sensery & secretory plexus!

# ***Gut Secretions***

## ***Secretion***

## ***Release Site***

**1. Mucus**

**into GI Lumen**

**2. Enzymes**

**into GI Lumen**

**3. H<sub>2</sub>O, acids, bases+**

**into GI Lumen**

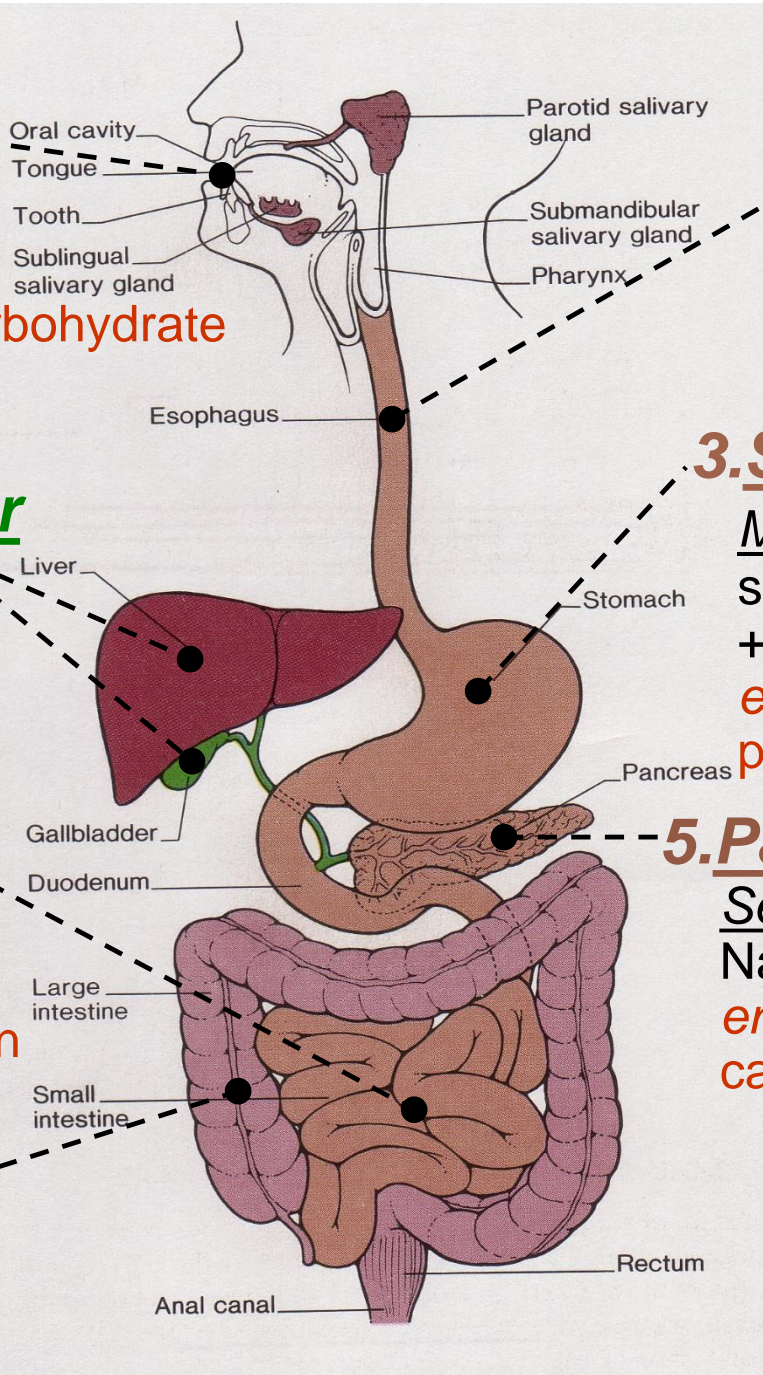
**4. Hormones**

**into Blood**



# 1. Mouth

Ingestion entry way  
salivary gland secretion  
mucus + enzymes  
enzymatic digestion: carbohydrate  
mastication = chewing  
deglutition = swallowing



# 2. Esophagus

Rapid transit  
peristalsis  
secretion mucus

# 3. Stomach

Mixing peristalsis  
secretion mucus + HCl  
+ enzymes  
enzymatic digestion:  
protein + butter fat!

# 5. Pancreas

Secretion mucus +  
NaHCO<sub>3</sub> + enzymes  
enzymatic digestion:  
carbohydrate, fat, protein

# 4. Liver-Gall Bladder

Emulsification =  
detergent action of bile  
+ secretion

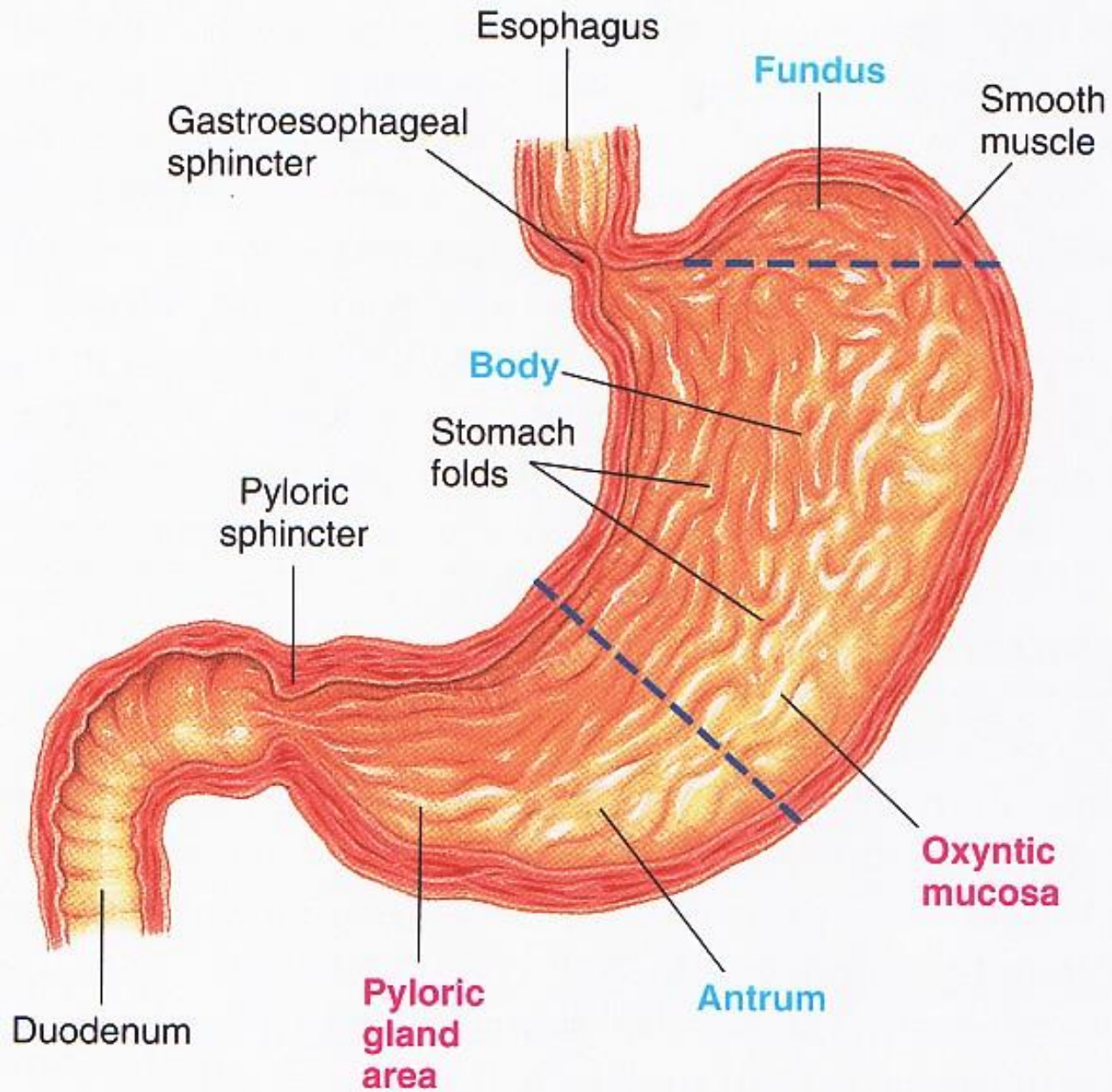
# 6. Small Intestine

Absorption  
Secretion mucus  
+ enzymes  
enzymatic digestion:  
carbohydrate, fat, protein  
Peristalsis

# 7. Large Intestine

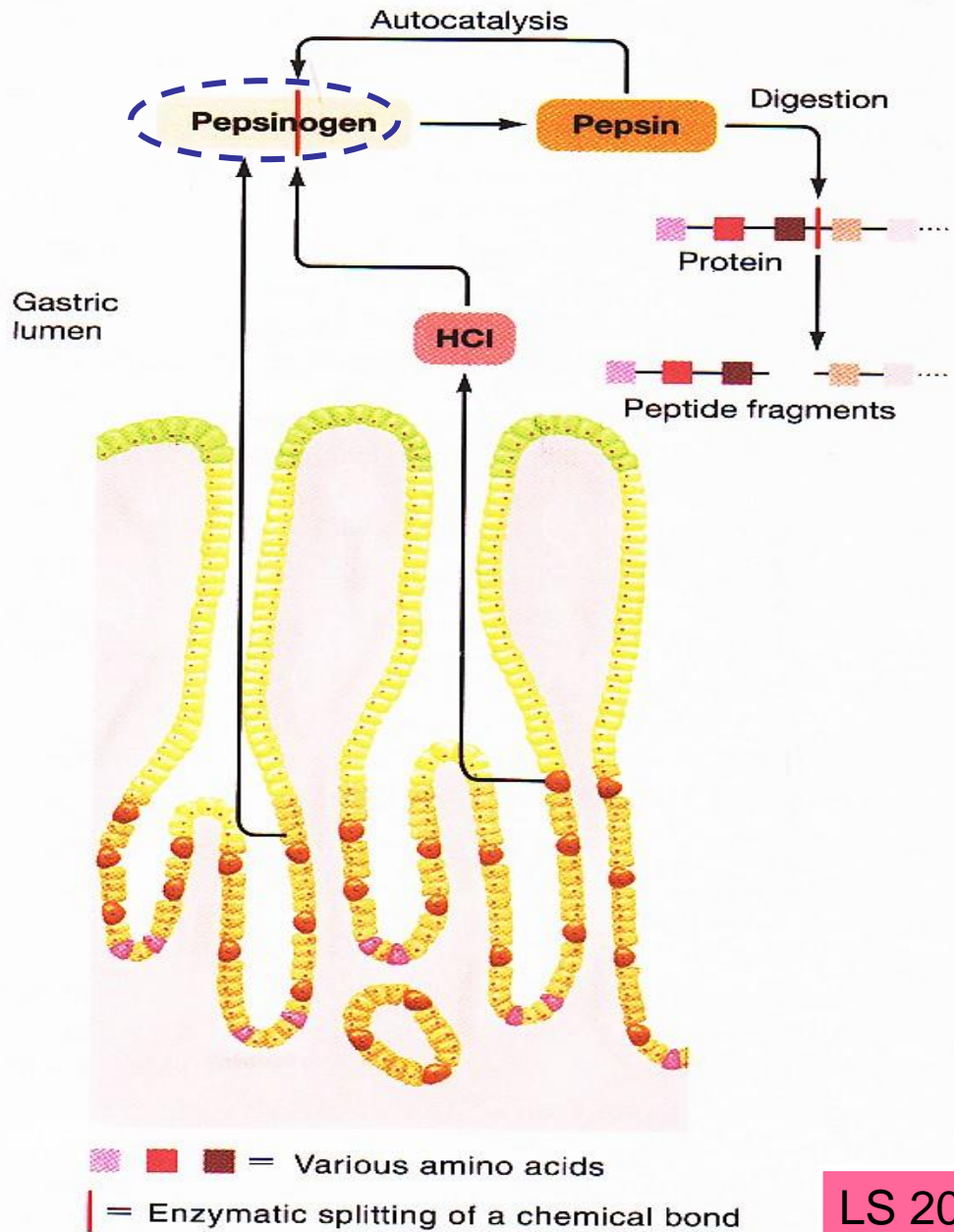
Dehydration  
secretion + absorption  
storage + peristalsis

Where does  
enzymatic  
digestion of  
protein  
begin?



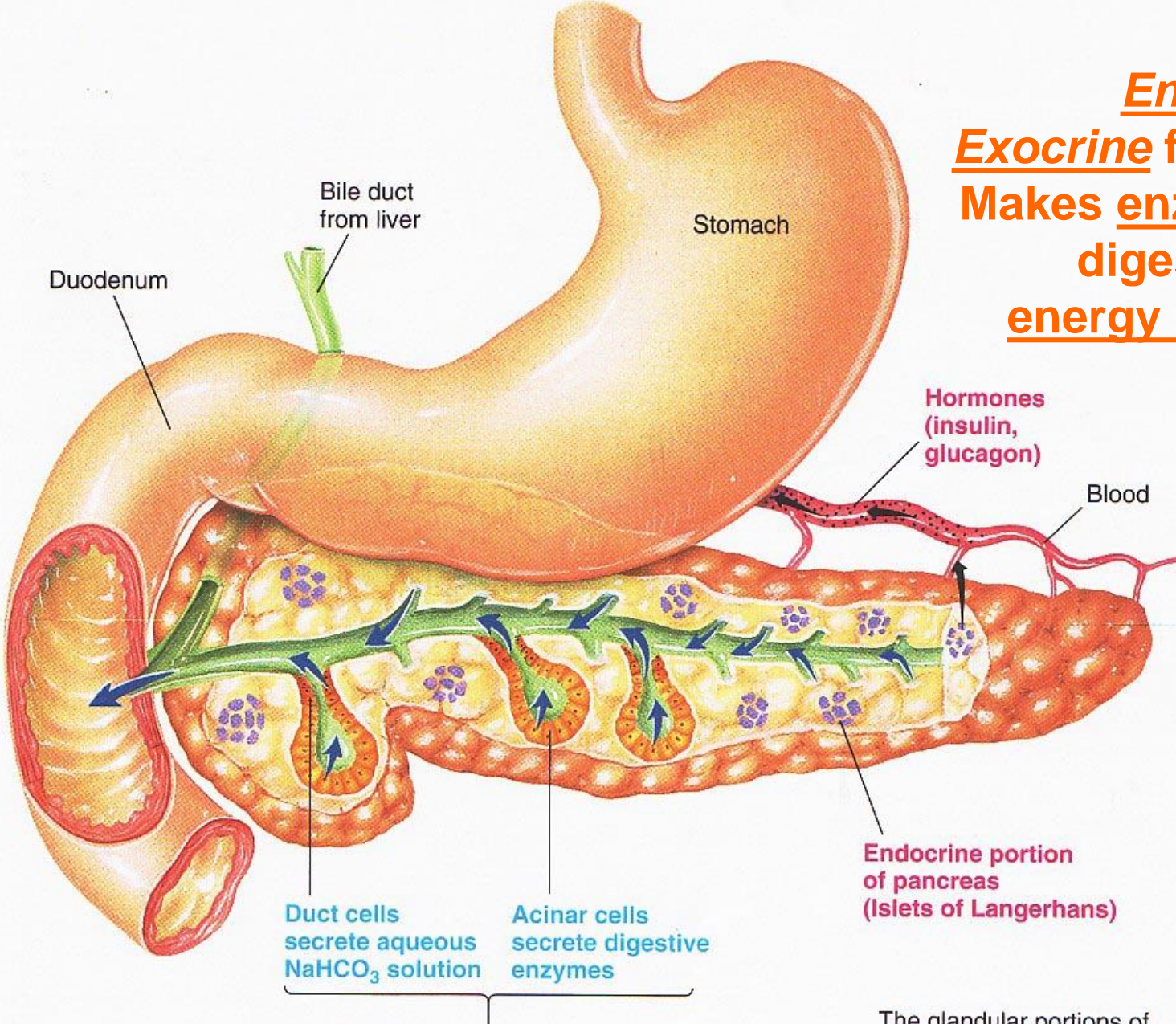
● **FIGURE 15-7**

**Zymogen =  
an inactive  
precursor**



Why is the  
*pancreas* so  
unique?

**Endocrine + Exocrine functions; Makes enzymes for digesting all 3 energy nutrients!**

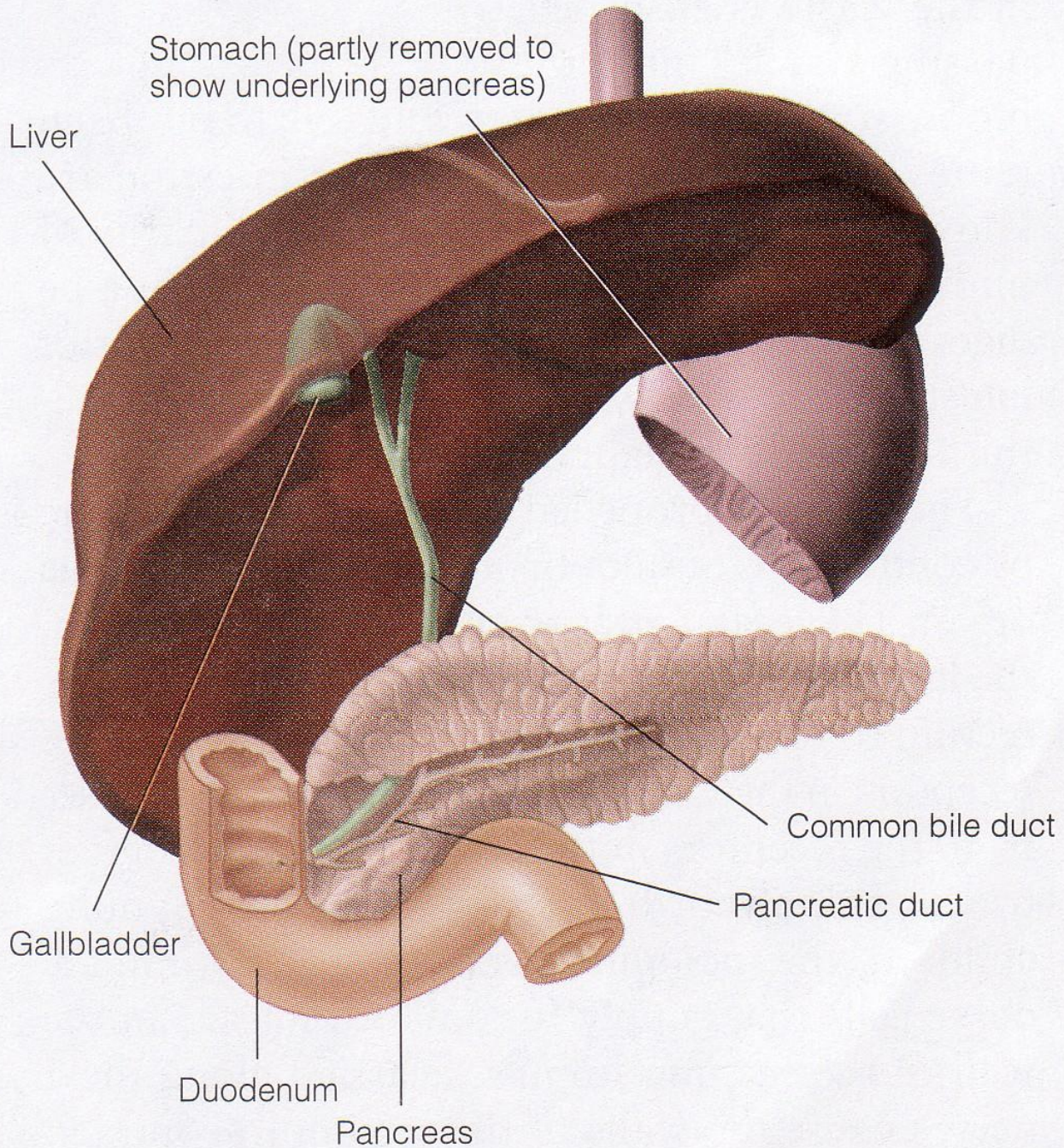


LS 2012 fig 15-11 p 457

**Exocrine portion of pancreas (Acinar and duct cells)**

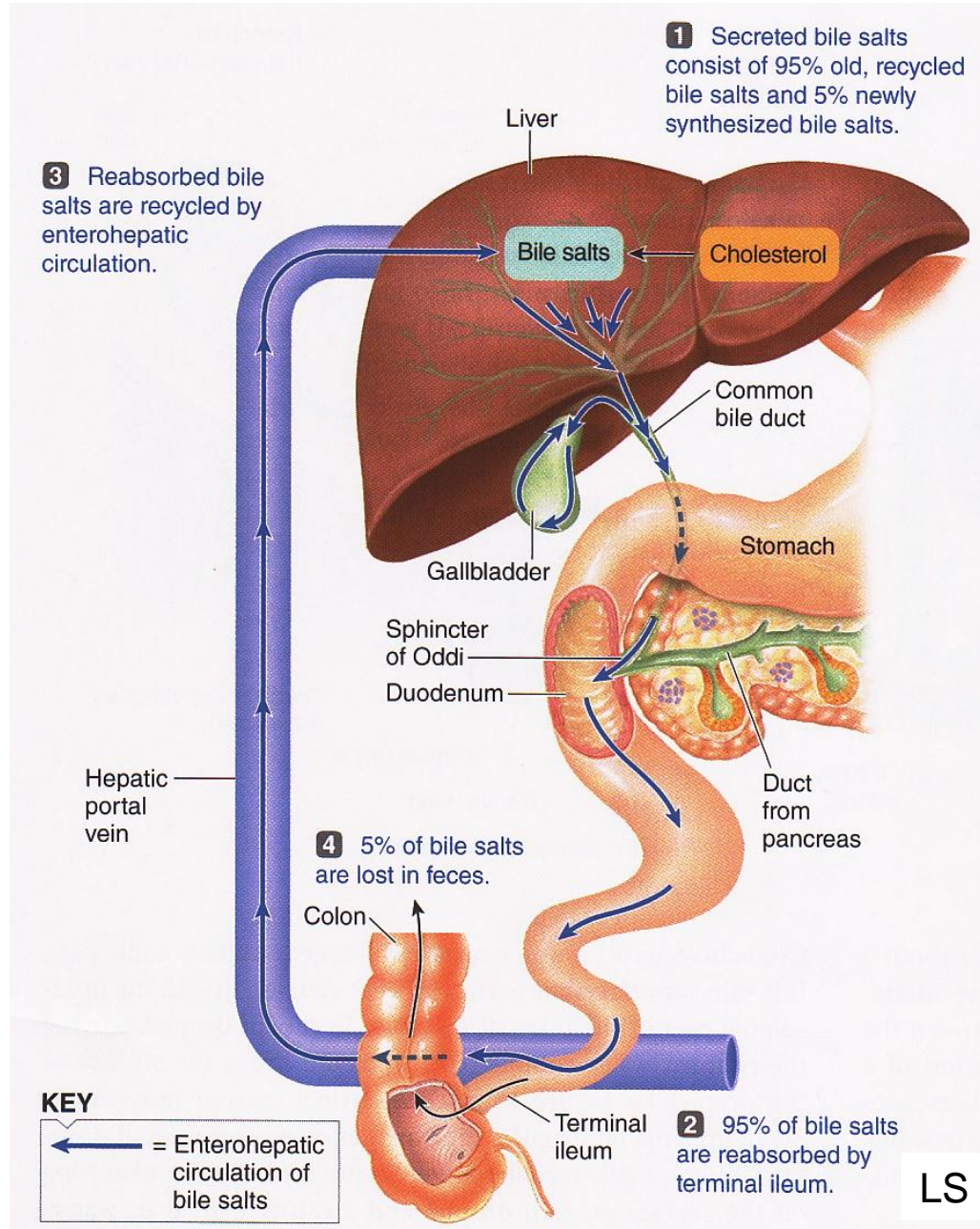
The glandular portions of the pancreas are grossly exaggerated.

**What are other  
accessory organs  
of digestion, that is,  
off-shoots of the  
primary tube?**



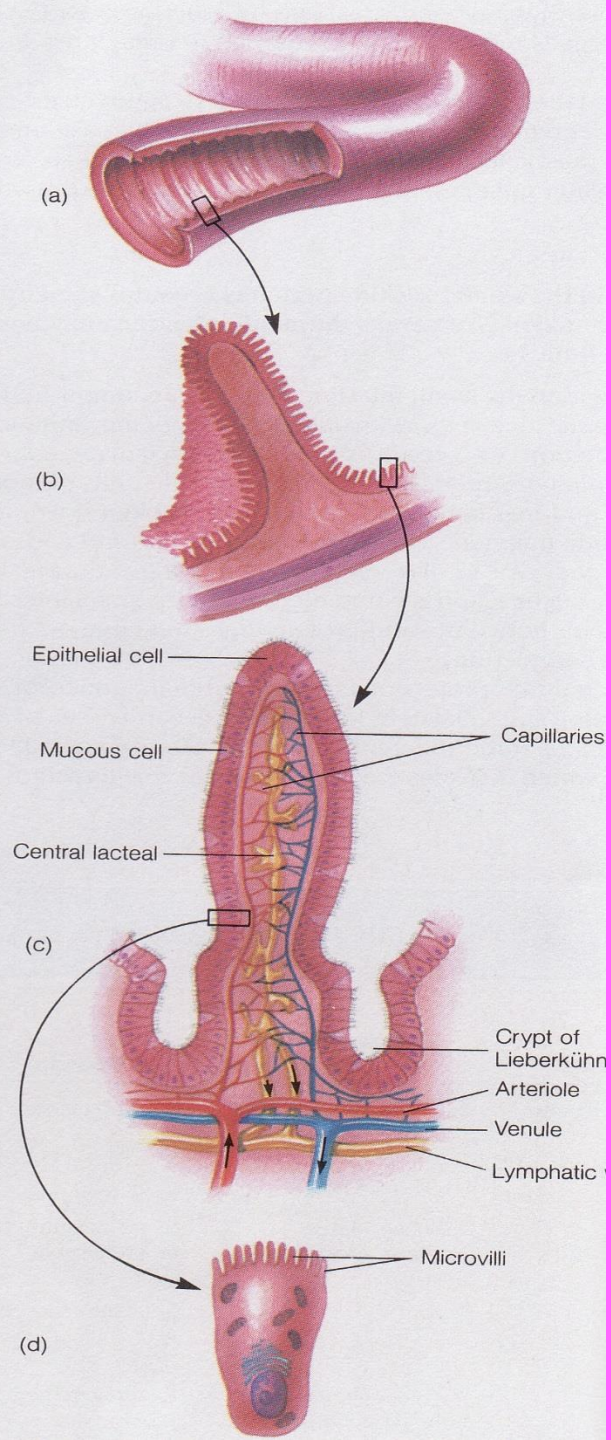


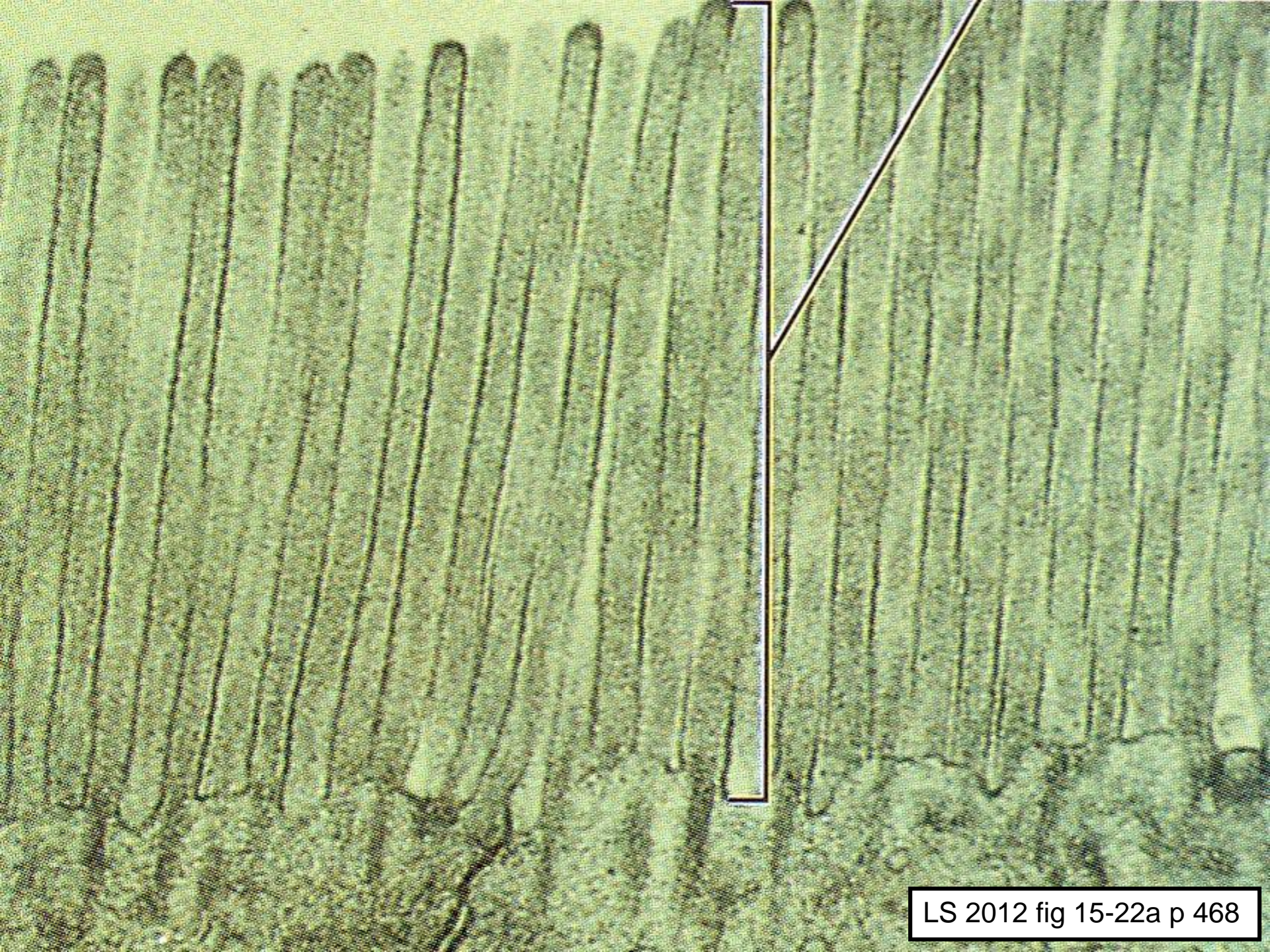
# Liver: Amazing Recycling of Bile Salts!



What is the major  
function of the  
small intestine?

*Absorption!!*







<http://www.cdc.gov/ulcer/>



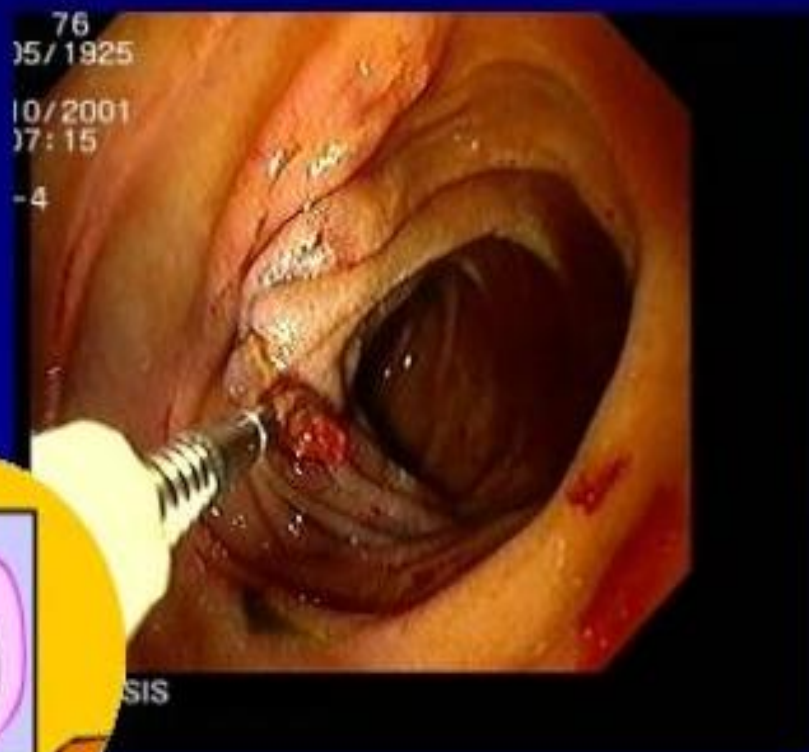
## Ulcer Facts

- Most ulcers are caused by an infection, not spicy food, acid or stress.
- The most common ulcer symptom is burning pain in the stomach.
- Your doctor can test you for *H. pylori* infection.
- Antibiotics are the new cure for ulcers.
- Eliminating *H. pylori* infections with antibiotics means that your ulcer can be cured for good.

# Clipping a Duodenal Ulcer

Peering through the pylorus into the duodenum, we see some blood and a vessel sticking out of the wall, just at the front edge of a small but deep ulcer.

In the second photograph, a disposable metal clip is applied to the ulcer. The patient remained well and left hospital three days later.

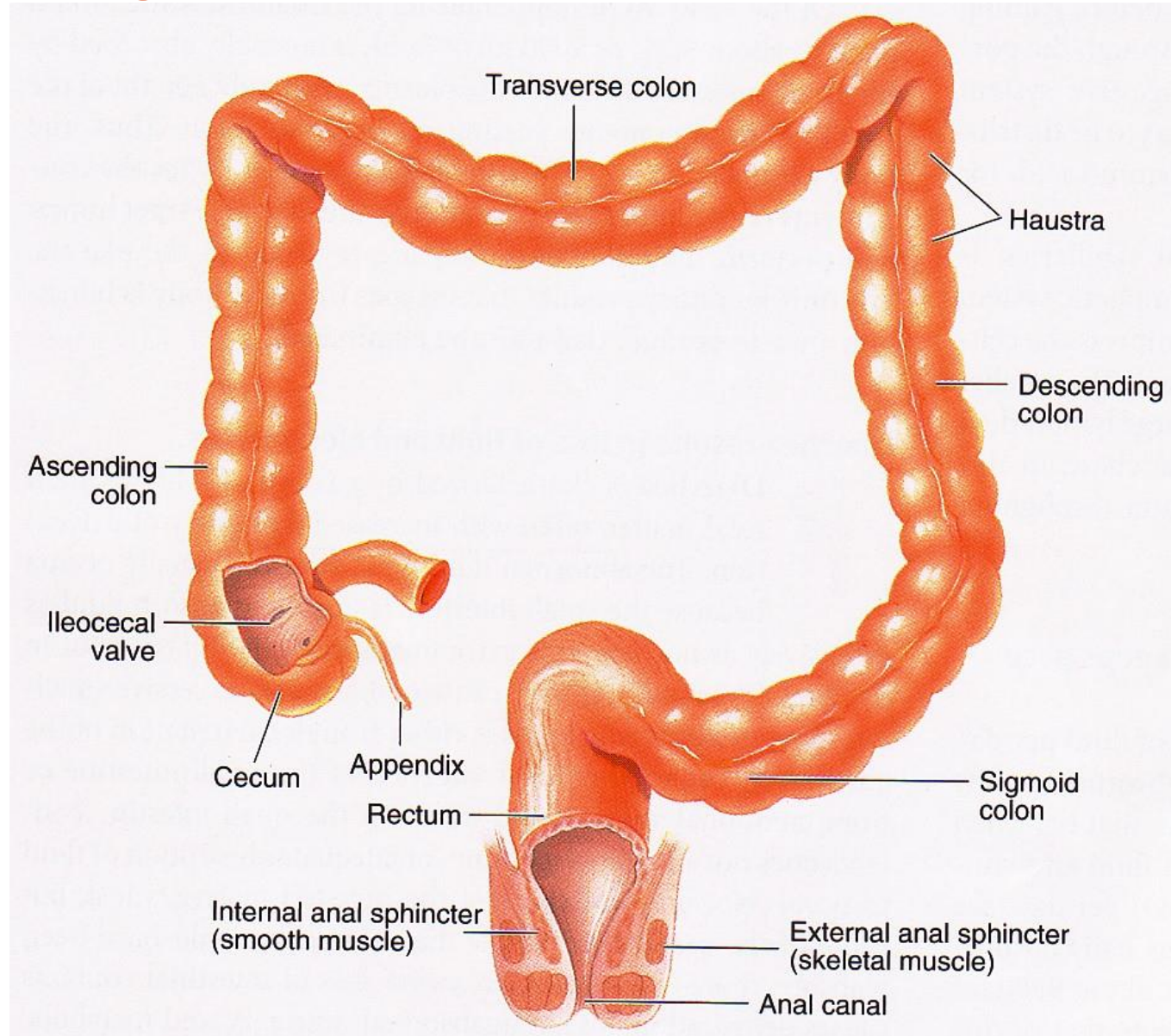




▲ **Table 15-5 Digestive Processes for the Three Major Categories of Nutrients**

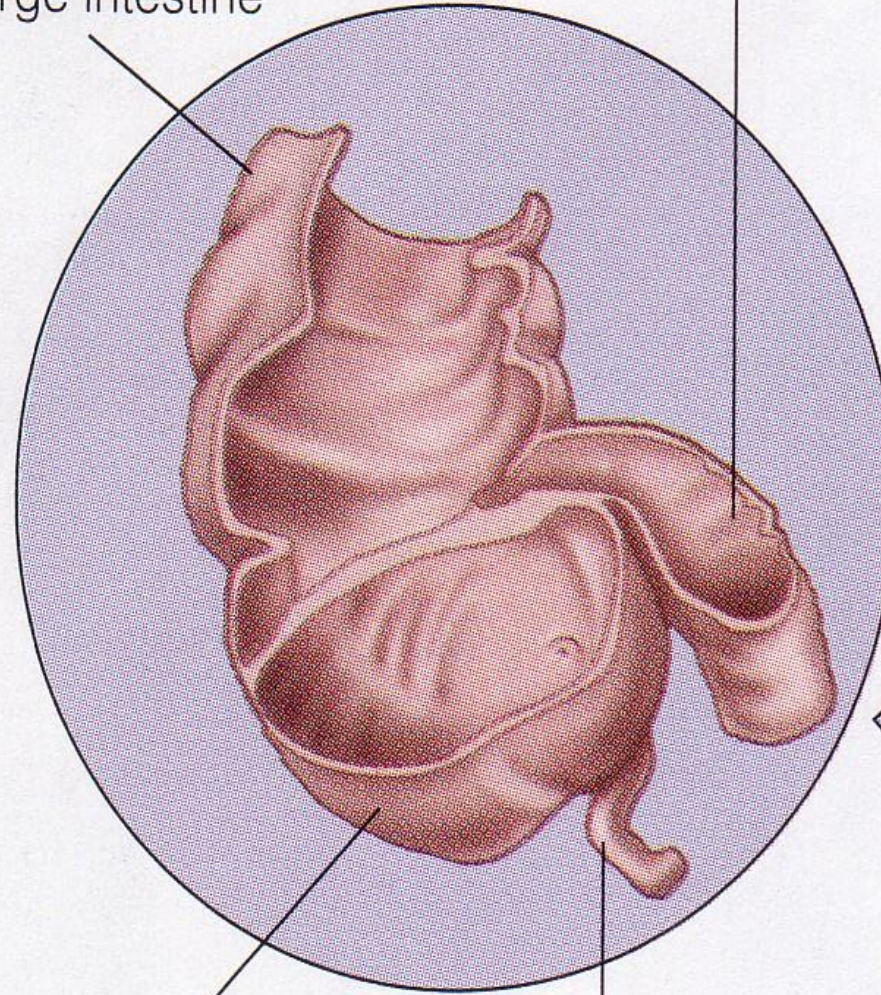
Nutrients	Enzymes for Digesting the Nutrients	Source of Enzymes	Site of Action of Enzymes	Action of Enzymes	Absorbable Units of the Nutrients
<b>Carbohydrates</b>	Amylase	Salivary glands	Mouth and (mostly) body of stomach	Hydrolyzes polysaccharides to disaccharides (maltose)	
		Exocrine pancreas	Small-intestine lumen		
	Disaccharidases (maltase, sucrase, lactase)	Small-intestine epithelial cells	Small-intestine brush border	Hydrolyze disaccharides to monosaccharides	Monosaccharides, especially glucose
<b>Proteins</b>	Pepsin	Stomach chief cells	Stomach antrum	Hydrolyzes protein to peptide fragments	
	Trypsin, chymotrypsin, carboxypeptidase	Exocrine pancreas	Small-intestine lumen	Attack different peptide fragments	
	Aminopeptidases	Small-intestine epithelial cells	Small-intestine brush border	Hydrolyze peptide fragments to amino acids	Amino acids
<b>Fats</b>	Lipase	Exocrine pancreas	Small-intestine lumen	Hydrolyzes triglycerides to fatty acids and monoglycerides	Fatty acids and monoglycerides
	Bile salts (not an enzyme)	Liver	Small-intestine lumen	Emulsify large fat globules for attack by pancreatic lipase	

# Large Intestine Structure & Function



Ascending  
portion of  
large intestine

Ileum  
of small  
intestine



Cecum

Appendix