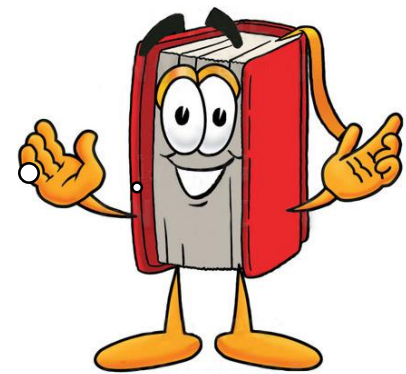


*Hey – I'll be ready
because I book it!!*



BI 121 Lecture 6

- I. Announcements** Next session Q? ~1/2 review, then Exam I.
Fun Lab 3 Nutrition after Exam I! Q?
- II. Nutrition News + Connections** Be a whiz at healthy grilling!
American Institute for Cancer Research, Grilling Quiz!
Dietary Guidelines for Americans 2015-2020, Blue Zones?
- III. Digestion Connections** LS ch 15, DC Module pp 17-23
 - A. Histology of the gut LS fig 15-2, 15-3 p 442-3
 - B. Stomach protein digestion + zymogens? LS fig 15-7, 15-9
 - C. Accessory organs: Pancreas & Liver + Recycling!
LS pp 457-63
 - D. Small intestine? Ulcers? LS fig 15-20, 15-22 pp 467-8
<http://www.cdc.gov/ulcer> Beyond the Basics LS p 456
 - E. Summary of chemical digestion LS tab 15-5 p 466
 - F. Large intestine? LS fig 15-24 pp 472-4

Be a Whiz at Healthy Grilling

Summertime is grilling time for Americans. Unless you take some simple precautions, however, grilling food can raise the risk of cancer. Take this multiple-choice quiz to see if you know the dos and don'ts of grilling for great taste and good health. Questions may have more than one correct answer.

1. Grilling can raise cancer risk because:

- A. The grill is usually dirty.
- B. Flies and pollution from the air can land on the food.
- ✓ C. Red meat, poultry or seafood can form carcinogenic compounds called heterocyclic amines (HCAs) when exposed to high heat. HCAs can damage the DNA of our genes, beginning the process of cancer development.
- ✓ D. Fat from red meat, poultry and seafood can drip, creating a cancer-causing substance called polycyclic aromatic hydrocarbons (PAHs). Smoke and flare-ups deposit the PAHs back on the meat.

2. What are the best choices for grilling?

- ✓ A. Vegetables and fruits because they don't form HCAs.
- ✓ B. Vegetables because natural phytochemicals in them stimulate enzymes that can convert HCAs to an inactive form that is easily eliminated from the body.
- ✓ C. Lean meats, like skinless chicken and fish, because they drip less fat.
- ✓ D. Small portions of red meat, like kebabs, because they cook fast.

3. A marinade can decrease carcinogens that form during grilling up to 96 percent because:

- A. It acts as a barrier, keeping flames from directly touching the meat.
- B. Typical marinade ingredients, like vinegar, citrus juices and olive oil, have special protective powers.
- ✓ C. Scientists aren't sure why.

4. If you decide to grill meat, which simple cooking adjustment(s) will reduce the formation of carcinogens?

- ✓ A. Covering the grill with punctured aluminum foil.
- ✓ B. Turning the gas down or waiting for charcoal to become low-burning embers.
- ✓ C. Raising the grilling surface.

- ✓ D. Placing meats to the side of the heat source.

5. Flipping meat every minute can also reduce the formation of carcinogens for the following reason(s):

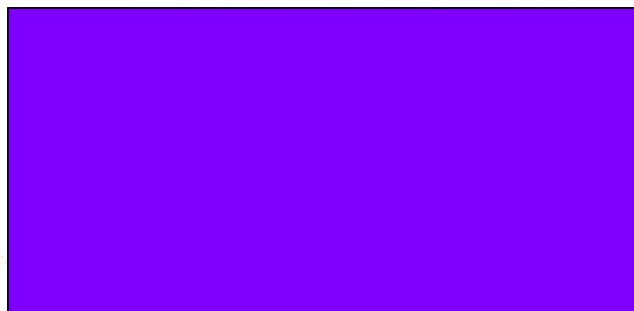
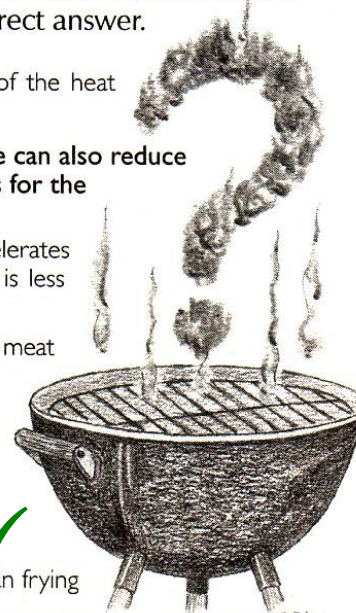
- A. Turning the meat often accelerates the cooking process, so there is less exposure to heat.
- B. Flipping propels HCAs off the meat into the air.
- ✓ C. Charring is less likely.

6. Safer methods of cooking meat than grilling include:

- ✓ A. Microwaving
- ✓ C. Stewing
- ✓ B. Roasting
- D. High-heat pan frying

7. If you decide to grill red meat, to limit cancer risk you should eat no more in a day than what amount?

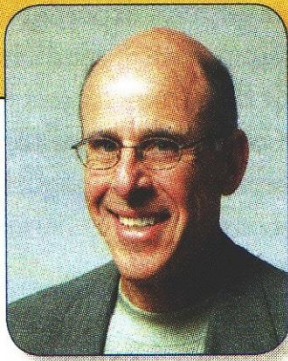
- A. 22 ounces
- C. 10 ounces
- B. 1 pound
- ✓ D. 3 ounces



FREEFACTS ▶ For more information about safe grilling, order a free copy of AICR's brochure, "The Facts About Grilling." Check box 4 on the Free Information Request card, or contact AICR national headquarters.

American Institute for Cancer Research (AICR) Healthy Grilling Quiz Summary

1. **Marinade, marinade, marinade!** By doing so, you can decrease carcinogens formed during grilling by $\leq 96\%$!
2. **Cover the grill with aluminum foil,** turn gas down or wait for low-burning embers, cook to the side.
3. **Best choices for grilling include vegetables and fruits** (no HCAs + enzymes to inactivate HCAs!), and lean meats (e.g., fish & skinless chicken ↓ PAHs).
4. **Flip meat every minute** to reduce charring & remove charred portions prior to eating.
5. **To limit cancer risk, eat no more than 3 oz grilled red meat in a day!** Cook small portions/kebabs.



John Swartzberg, M.D.
Chair, Editorial Board

WHO says to cut down on meat?

When I saw the headlines in October that meat was linked to cancer, I braced myself for the inevitable brouhaha. The news was that the International Agency for Research on Cancer (IARC), part of the World Health Organization (WHO), concluded that processed meats like hot dogs, bacon, and ham almost certainly increase the risk of colorectal cancer—by 18% per daily serving—and that red meat probably does as well.

But we've heard about this link many times before. Over the past 20 years, many observational studies have found that people who regularly eat red or processed meats have higher rates of several cancers, notably of the colon and rectum. And lab studies have shown that compounds formed when meat is processed (that is, smoked, salted, or cured) or cooked at high temperatures can cause cancer in animals or cells. All that research served as the basis of the IARC conclusions. But even in 2007 the World Cancer Research Fund, another key group of experts, concluded that there was "convincing" evidence that these meats increase the risk of colorectal cancer. And since 2002, WHO has advised people to moderate their consumption of processed meat, as do the still-pending 2015 Dietary Guidelines for Americans.

What elicited the most heated reaction in the press and blogosphere and especially from the meat industry was the fact that the IARC put processed meats in its Group 1—"carcinogenic to humans"—which includes tobacco smoking and asbestos. (It put red meats in Group 2A—"probably carcinogenic.") The IARC clearly explained that this classification merely indicates the strength of the evidence that something causes cancer, not the *degree* of risk. In fact, it said that the increased risk

from red or processed meat is "small" for individuals, though potentially important for public health since so many people eat meat.

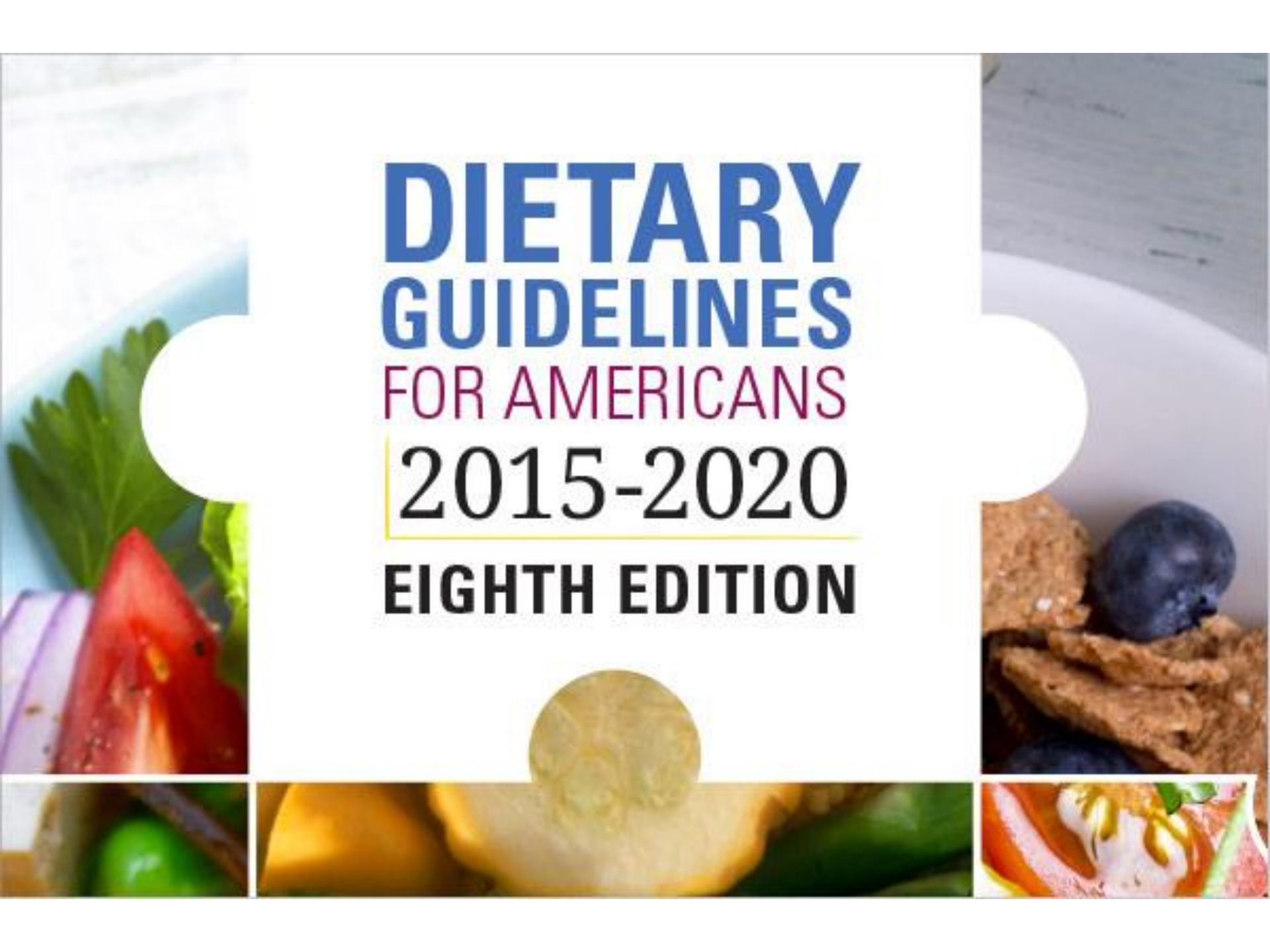
What about that 18% increase in risk? The IARC estimated that for every serving of processed meat (just under 2 ounces) or red meat (3½ ounces) eaten daily for years, the lifetime risk of colorectal cancer goes up by about 18%. But this is what's known as relative risk, which can be misleading. For instance, the lifetime risk of developing colorectal cancer in the U.S. is about 5%. An 18% increase does not mean $5\% + 18\% = 23\%$, but rather $5\% + (18\% \text{ of } 5\%) = 6\%$. That means one extra case of colorectal cancer per 100 meat eaters. In contrast, smoking increases the lifetime risk of lung cancer by roughly 2,000%—from about 1 per 100 people to about 20 per 100. So while IARC may classify both processed meat and smoking as Group 1 carcinogens, there's no comparison in their risks.

In fact, IARC cited estimates that 34,000 cancer deaths per year worldwide can be attributed to diets high in processed meat. In contrast, tobacco causes nearly 2 million cancer deaths per year.

I should add that I don't think it has been clearly established that meat causes cancer. Proving that foods cause or help prevent cancer is difficult for many reasons. Notably, the observational studies upon which the IARC classifications were largely based can only find associations—they cannot prove cause and effect.

That said, there are plenty of other reasons to moderate your intake of red meats and limit processed ones. There's strong evidence linking them to cardiovascular disease and a variety of other disorders, though it's not clear which compounds in them are the possible culprits. What's more, eating more plant-based foods and less meat is better for the planet, resulting in less greenhouse gas production.

And there's a far surer way to reduce the risk of colorectal cancer than tinkering with your diet: Get screened.



**DIETARY
GUIDELINES**
FOR AMERICANS
2015-2020
EIGHTH EDITION

Dietary Guidelines for Americans 2015-2020

Released January 7, 2016

A healthy eating pattern includes:

- **Variety of vegetables** from all subgroups: dark green, red & orange, legumes, starchy & other
- **Fruits**, especially whole fruits
- **Grains**, at least half of which are whole grains
- **Fat-free or low-fat dairy**, including milk, yogurt, cheese &/or fortified soy beverages
- **Variety of protein foods** including seafood, lean meats & poultry, eggs, legumes & nuts, seeds & soy products
- **Oils** (healthy)

A healthy eating pattern limits:

- **Saturated fats** & **trans fats**, added **sugars** & **sodium**
- **Balance calories with physical activity** to manage weight.

<http://health.gov/dietaryguidelines/2015/>

The World's Longest-Lived People!

○ Blue Zones! ○



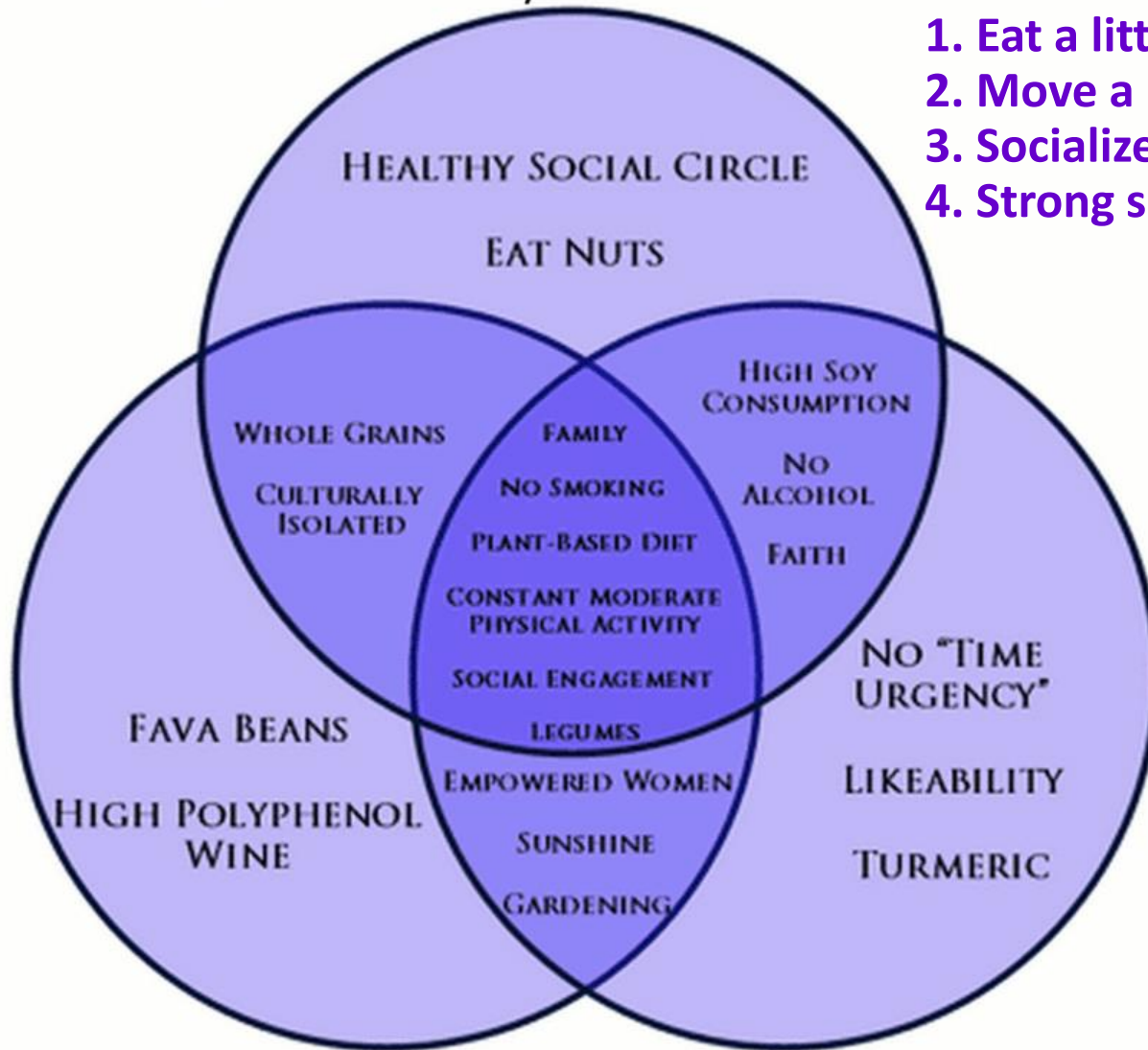
<https://www.cbsnews.com/news/blue-zones-do-people-who-live-in-certain-areas-live-longer/>, Aug 2013.

Buettner, D. *National Geographic*, Nov 2005.

M Poulain & Coworkers. *Experimental Gerontology*, Sep 2004

Loma Linda, United States

1. Eat a little bit better!
2. Move a little bit more!
3. Socialize more!
4. Strong sense of purpose!



Sardinia,
Italy

Okinawa,
Japan

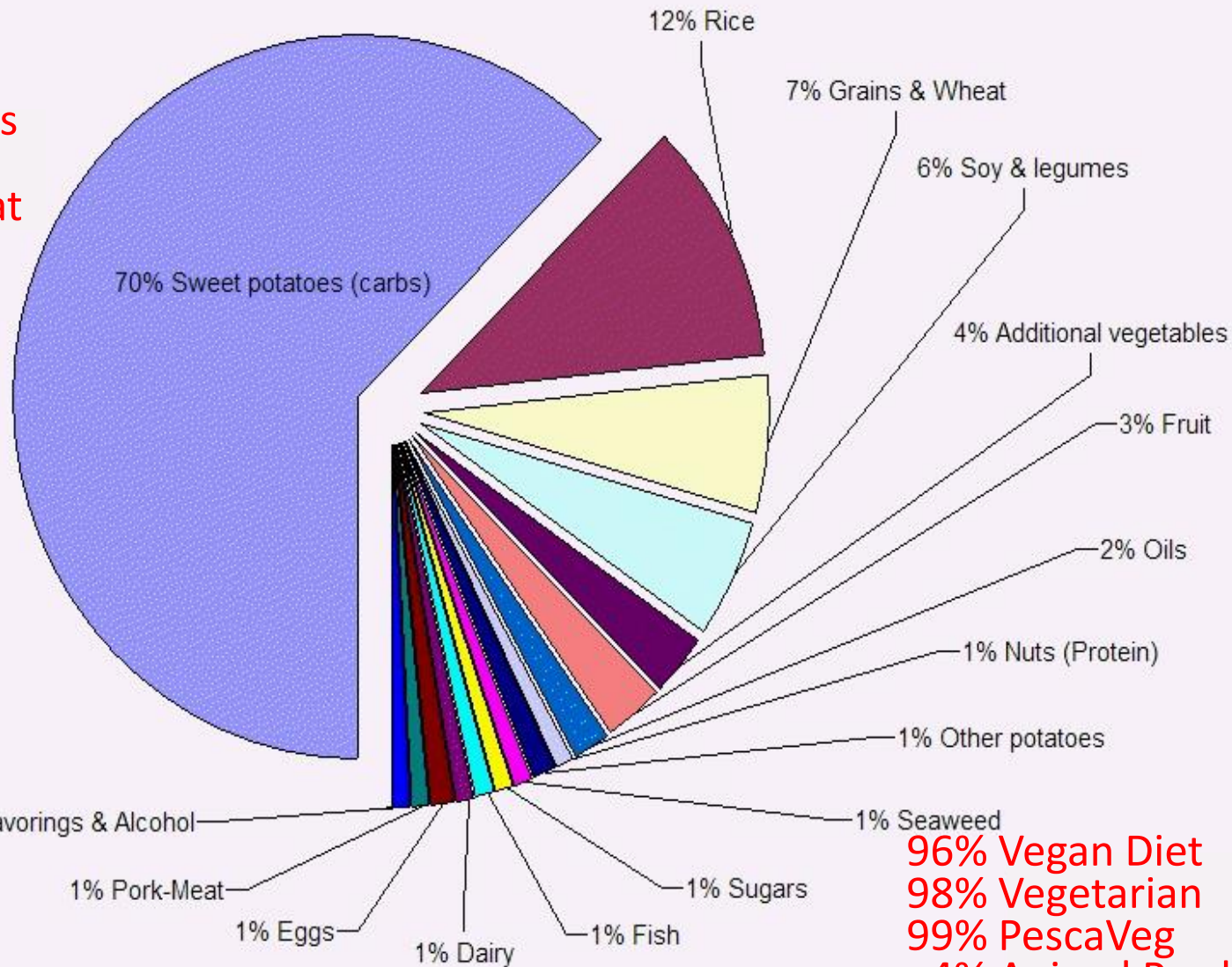
https://en.wikipedia.org/wiki/Blue_Zone

<https://bluezones.com/>

<http://www.sciencedirect.com/science/article/pii/S0531556504002141>

OKINAWA LONGEVITY DIET

- 70% Sweet Potatoes
- 12% Rice
- 7% Grains & Wheat
- 6% Soy & legumes
- 4% Additional vegetables
- 3% Fruit
- 2% Oils
- 1% Nuts (Protein)
- 1% Other potatoes
- 1% Seaweed
- 1% Sugars
- 1% Fish
- 1% Dairy
- 1% Eggs
- 1% Pork-Meat
- 1% Flavorings & Alcohol



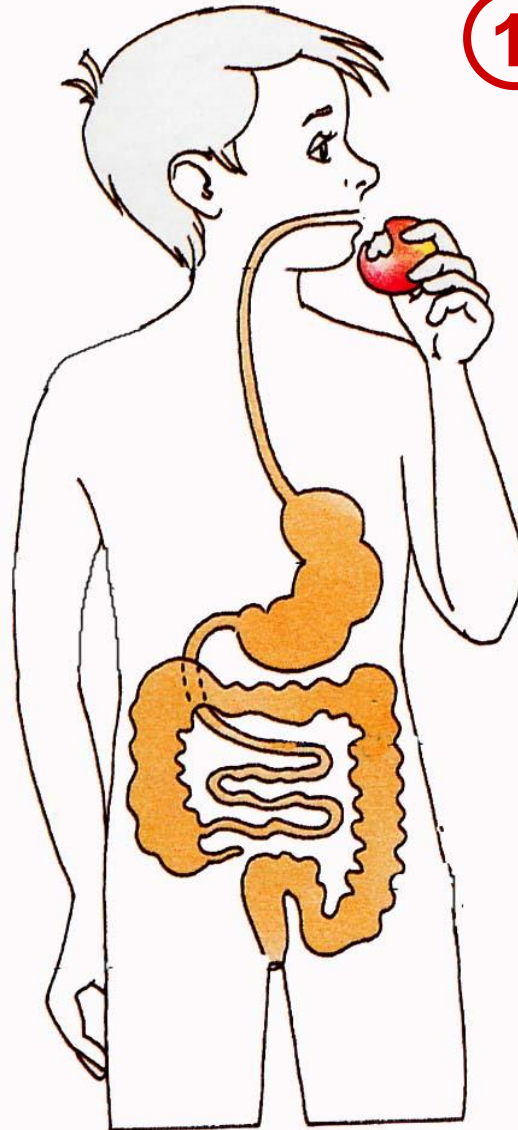
85% Carbohydrates
 9% Protein
 6% Fat
 85-10-5
 1785 Calories

96% Vegan Diet
 98% Vegetarian
 99% PescaVeg
 <4% Animal Prod
 <1% Fish
 <1% Meat-Pork

SCIENTIFIC STUDY: "The Diet of the World's Longest-Lived People and Its Potential Impact on Morbidity and Life Span"
 JOURNAL: Annals of the Academy of Sciences - Volume 1114: 434-455 (2007).

Note: These are the Actual Food Measurements of the Centenarians, not the diet of All island Okinawans or the ones who died, but the ones who lived.

Digestion Steps



① Ingestion

② Mechanical Digestion

③ Chemical Digestion

④ Peristalsis

⑤ Absorption

⑥ Storage

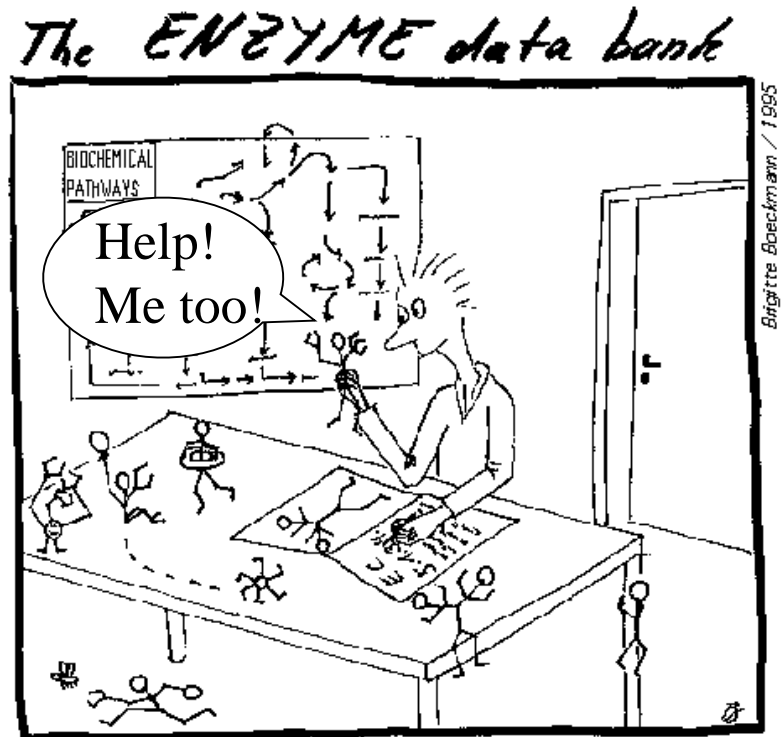
⑦ Defecation

Hydrolysis of Energy Nutrients

Hi gang!!
You need me
for digestion!!



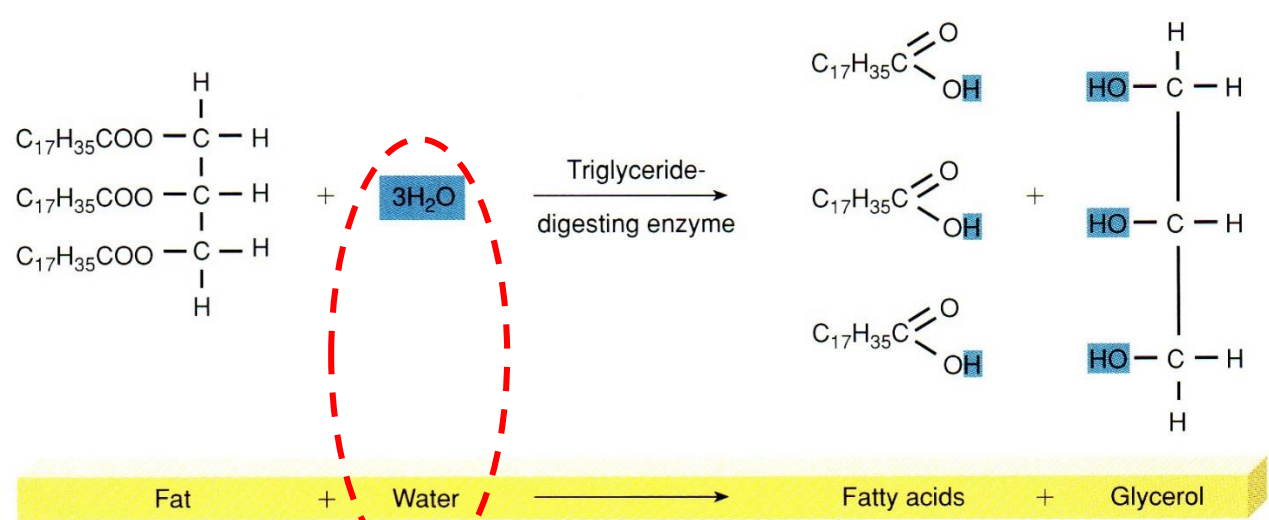
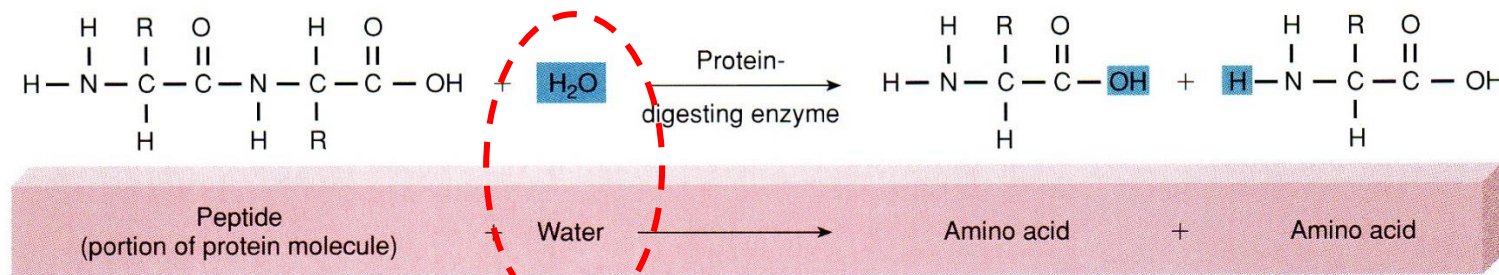
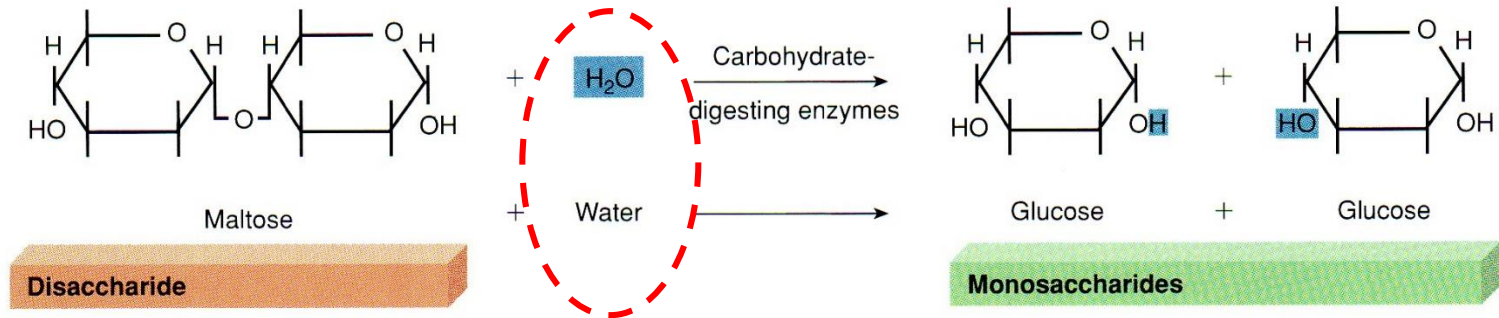
+



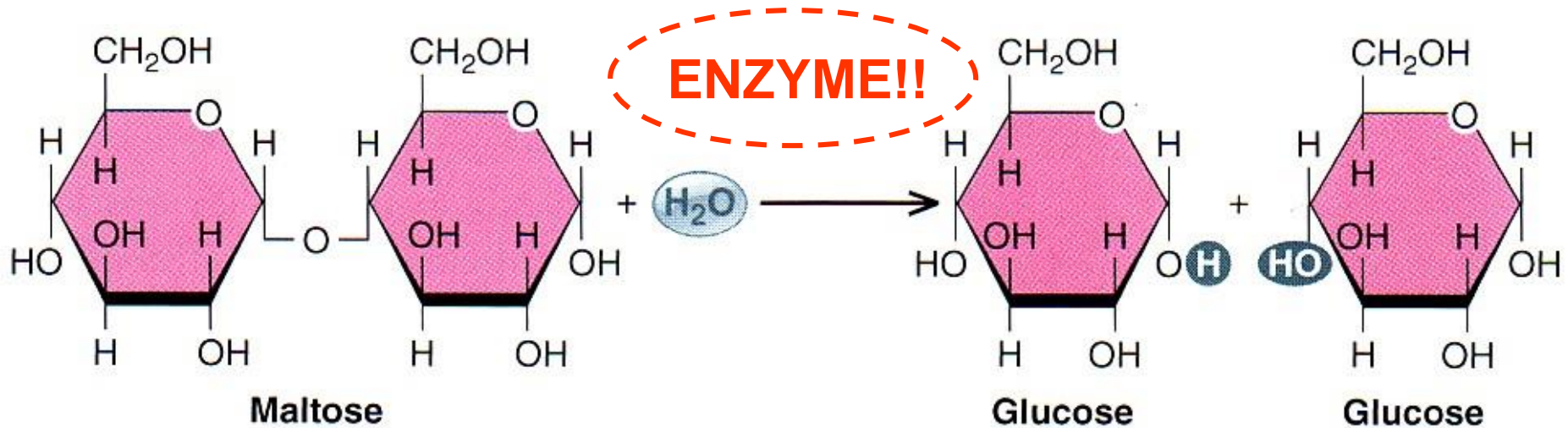
H₂O

+

Enzyme



What's missing?

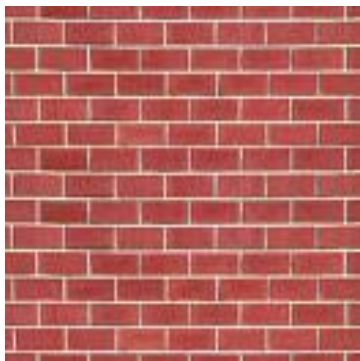


● **FIGURE 15-1** An example of hydrolysis. In this example, the disaccharide maltose (the intermediate breakdown product of polysaccharides) is broken down into two glucose molecules by the addition of H₂O at the bond site.

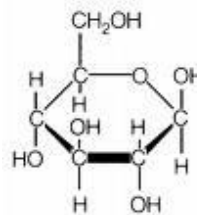
Polymer to Monomer (Many to One)



...Central-linking theme!!

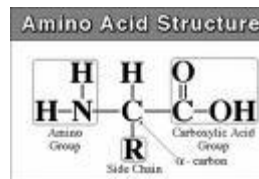


Carbohydrate

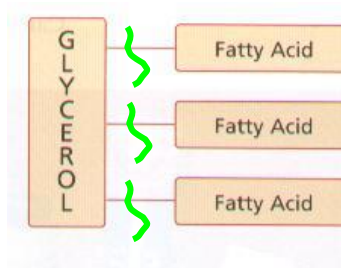


Glucose

Protein
+
Fat

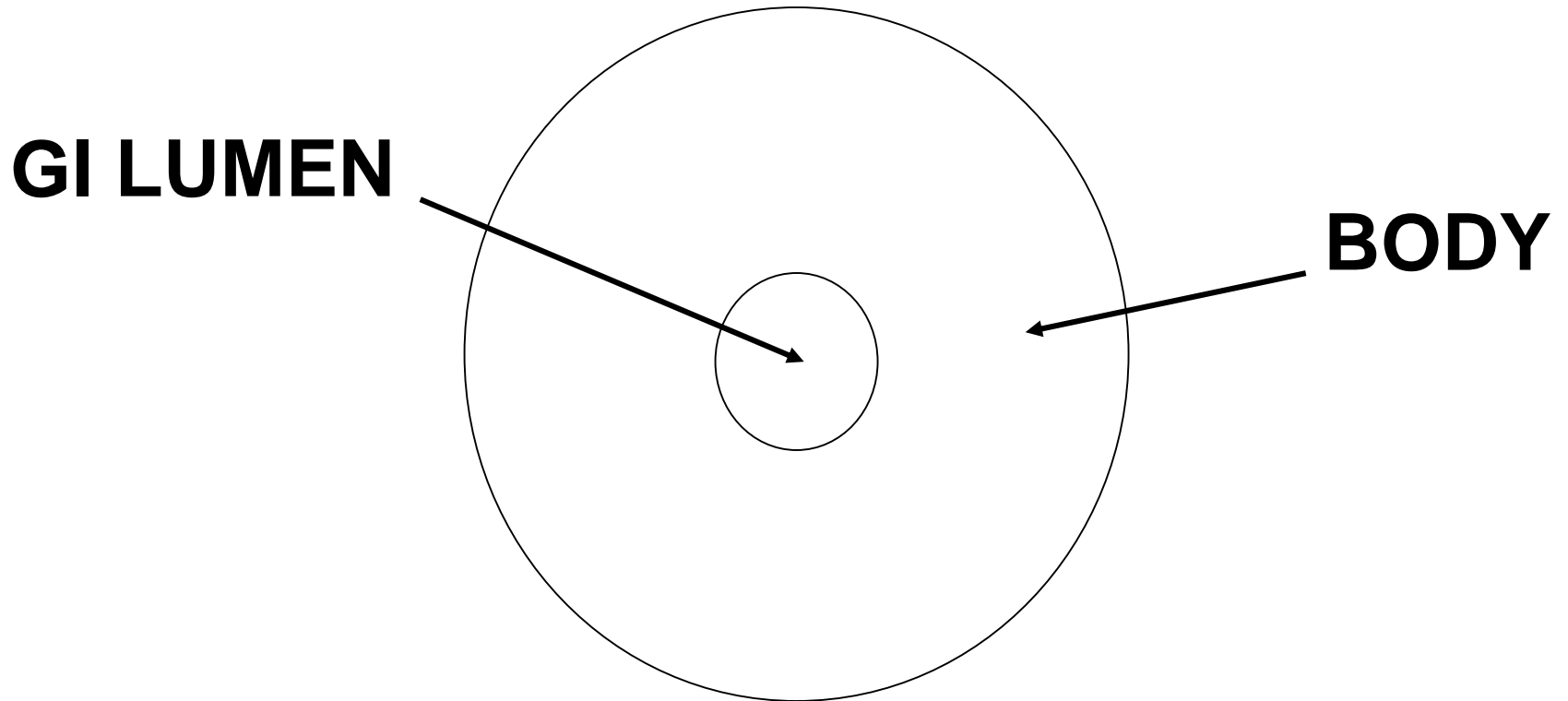


Amino Acids



Fatty Acids
+
Glycerol

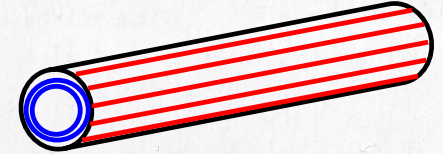
GI-DONUT ANALOGY



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

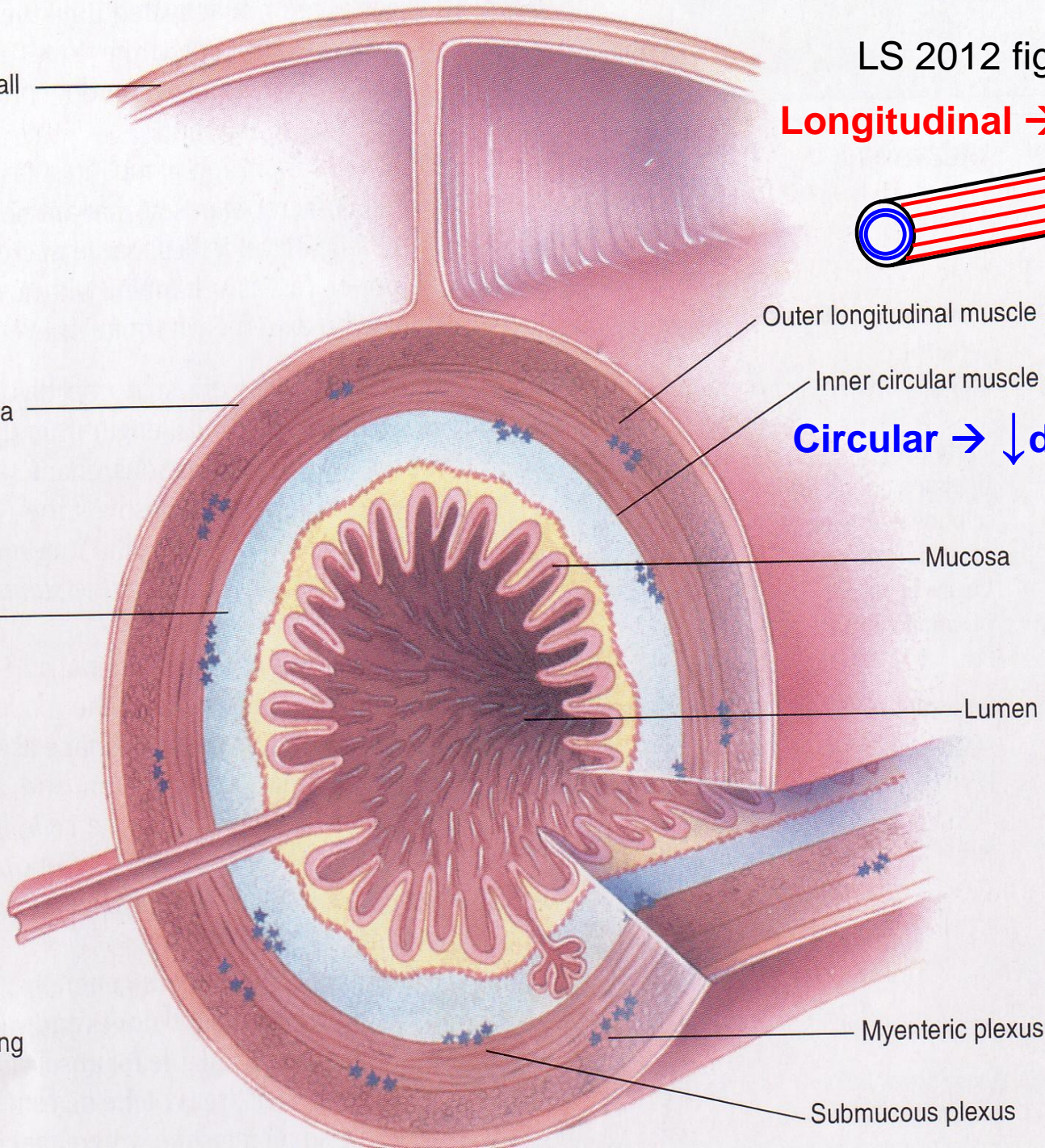
Muscularis externa

Mucosa

Lumen

Myenteric plexus

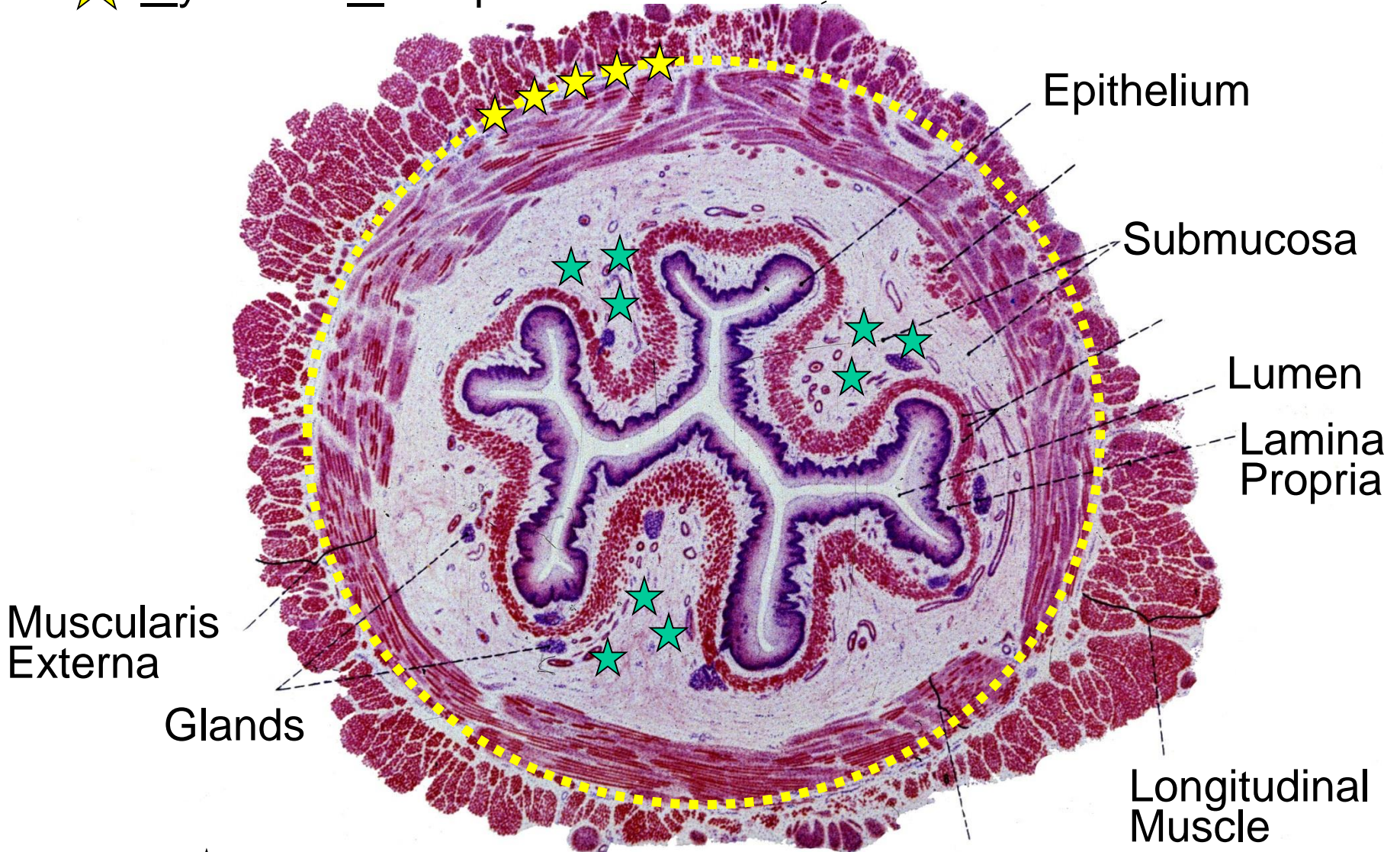
Submucous plexus



★ Myenteric motor plexus!

Serosa

cf: G&H fig 62-2



Epithelium

Submucosa

Lumen

Lamina Propria

Muscularis Externa

Glands

Longitudinal Muscle

Circular Muscle

★ Meissner's sensory & secretory plexus!

H Howard 1990

Gut Secretions

Secretion

Release Site

1. Mucus

into GI Lumen

2. Enzymes

into GI Lumen

3. H₂O, acids, bases+

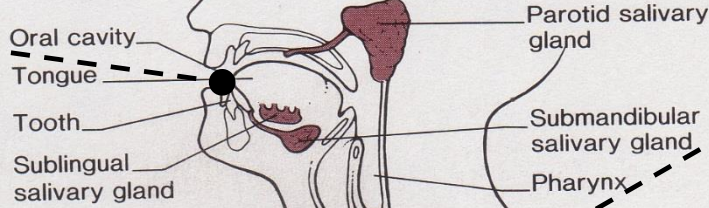
into GI Lumen

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

Esophagus

3. Stomach

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

Stomach

5. Pancreas

Secretion mucus +
 NaHCO_3 + enzymes
enzymatic digestion:
carbohydrate, fat, protein

Pancreas

Liver

Gallbladder

Duodenum

Large intestine

Small intestine

Anal canal

Rectum

4. Liver-Gall Bladder

Emulsification =
detergent action of bile
+ secretion

6. Small Intestine

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

Liver

Gallbladder

Duodenum

Large intestine

Small intestine

Anal canal

Rectum

7. Large Intestine

Dehydration
secretion + absorption
storage + peristalsis

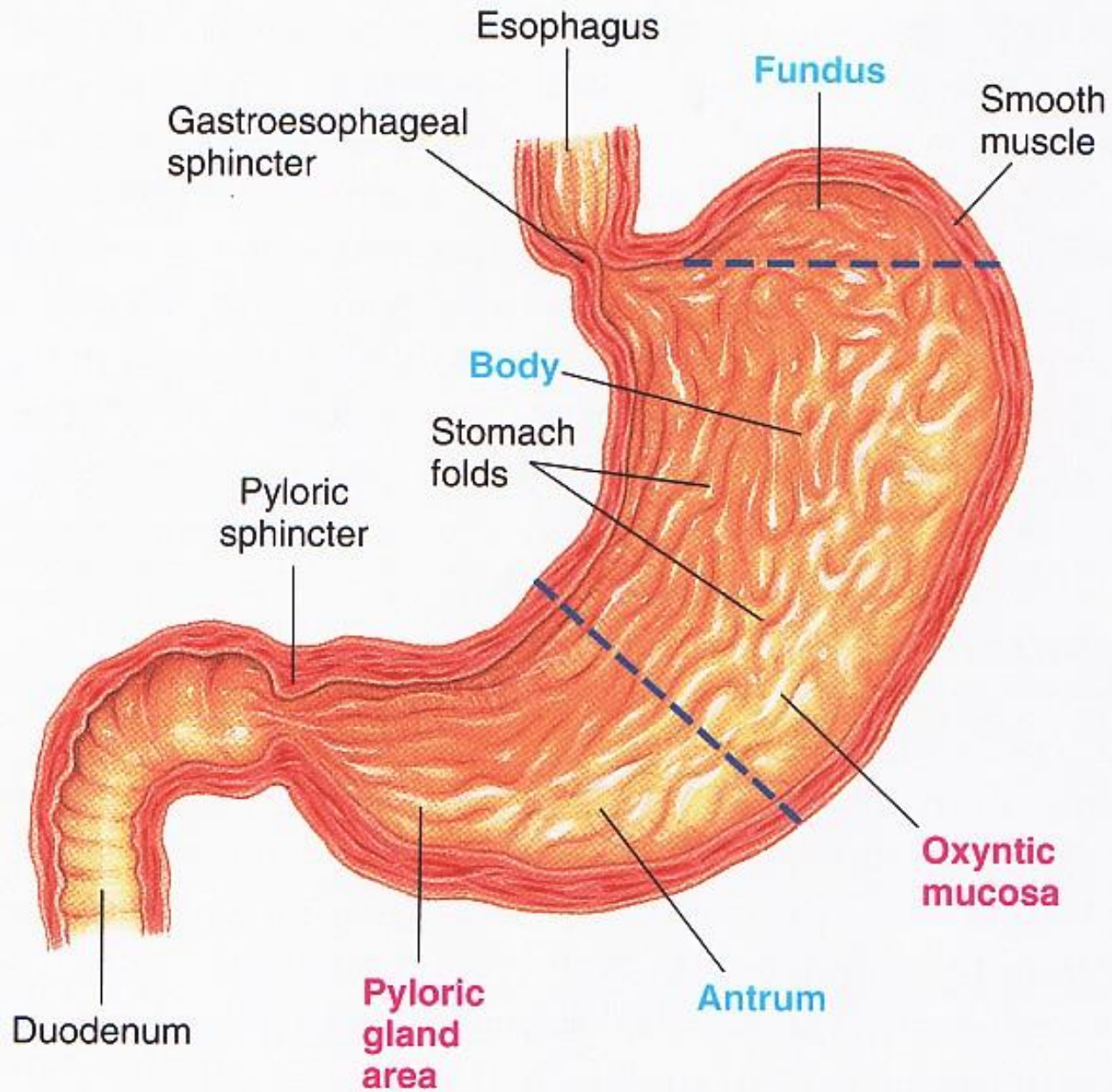
Large intestine

Small intestine

Anal canal

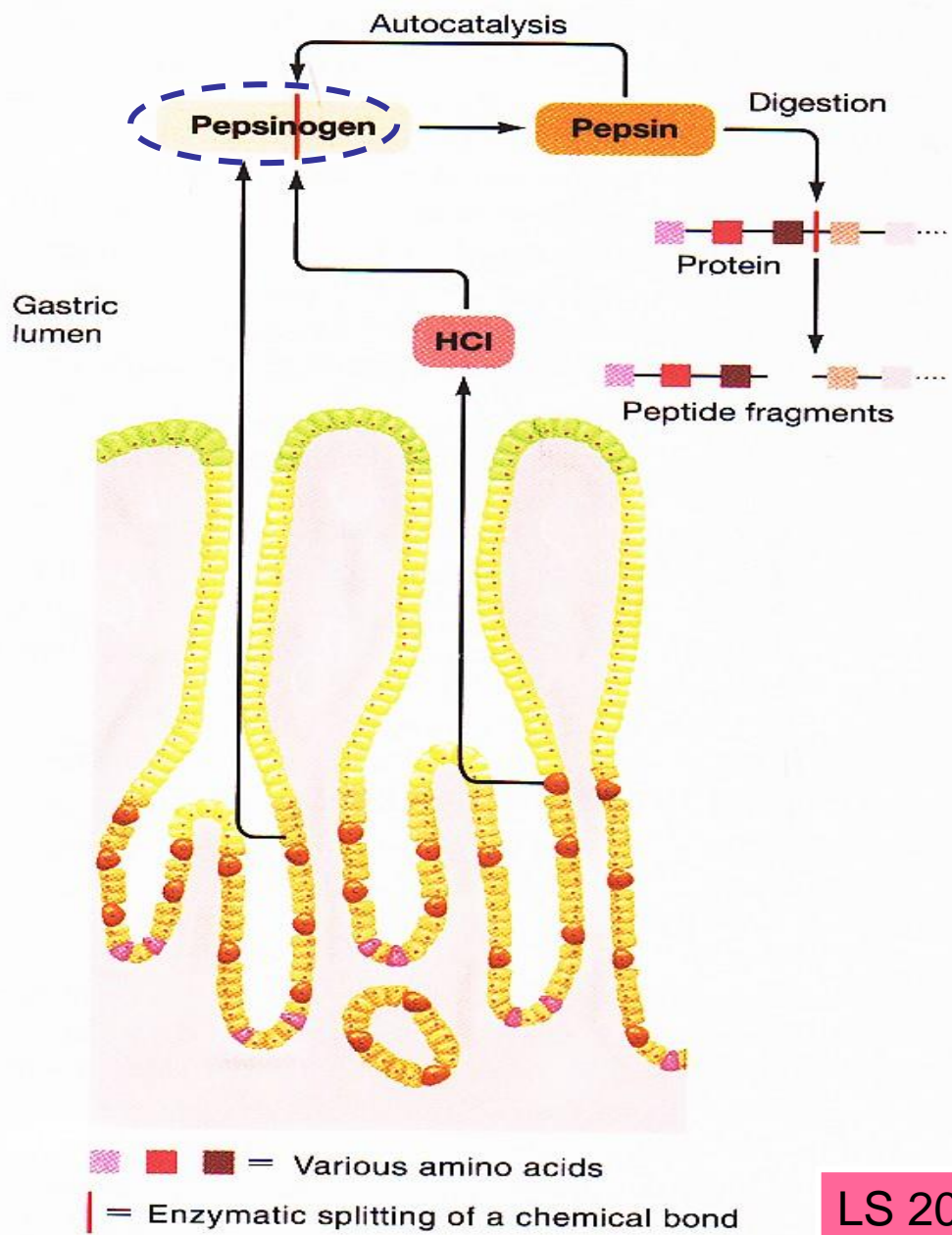
Rectum

Where does
enzymatic
digestion of
protein
begin?



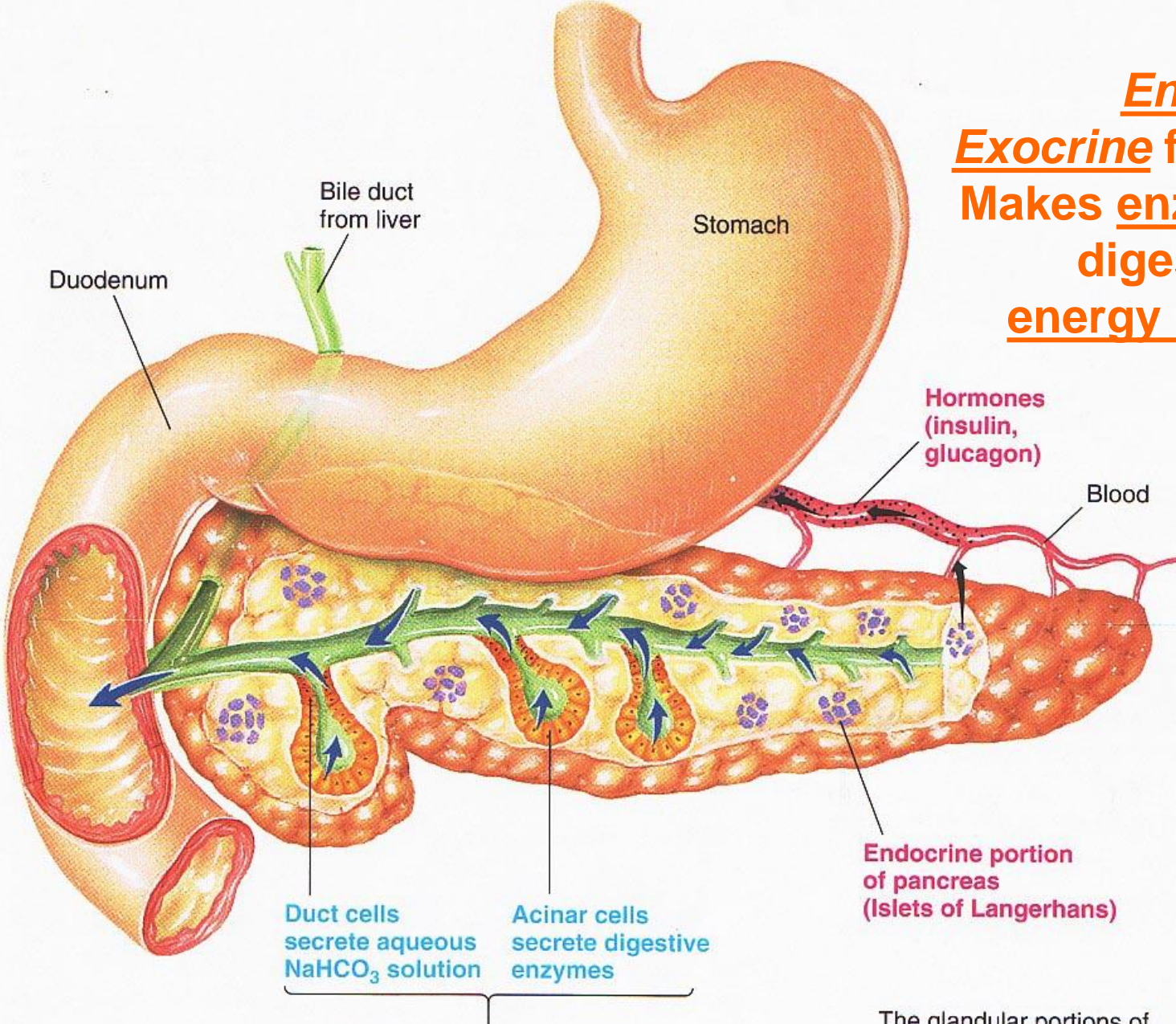
● **FIGURE 15-7**

**Zymogen =
an inactive
precursor**



Why is the
pancreas so
unique?

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

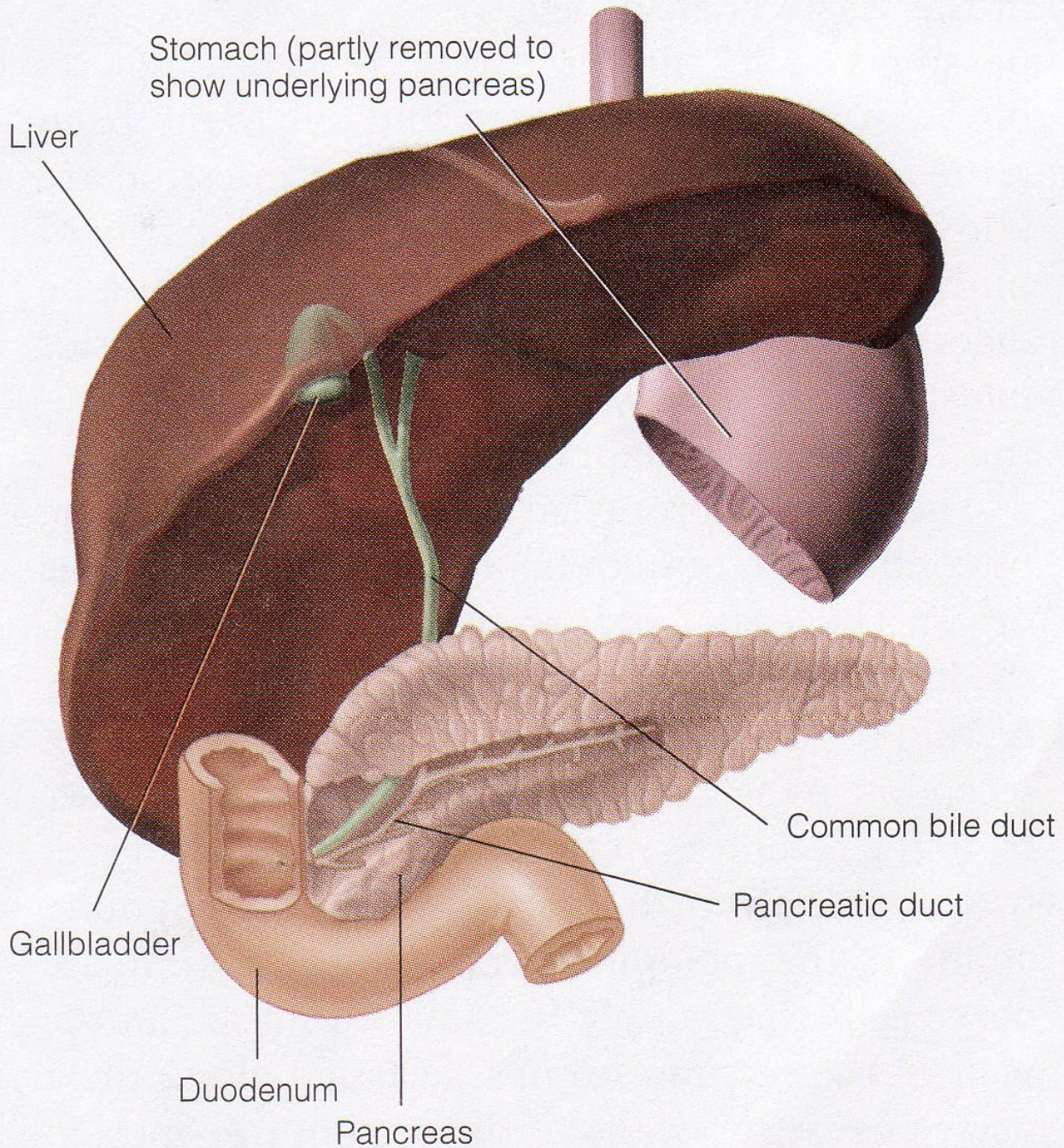


LS 2012 fig 15-11 p 457

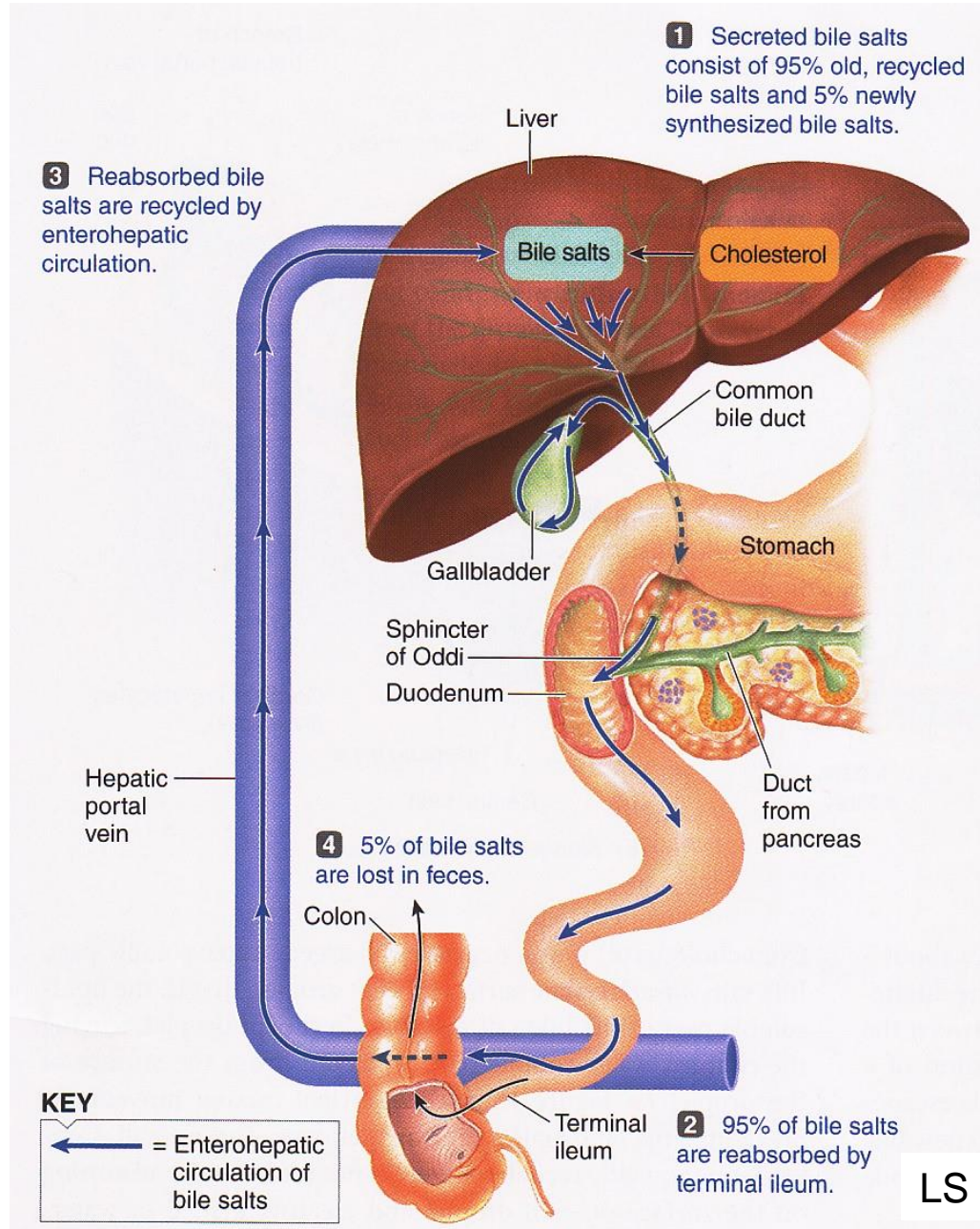
Exocrine portion of pancreas (Acinar and duct cells)

The glandular portions of the pancreas are grossly exaggerated.

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

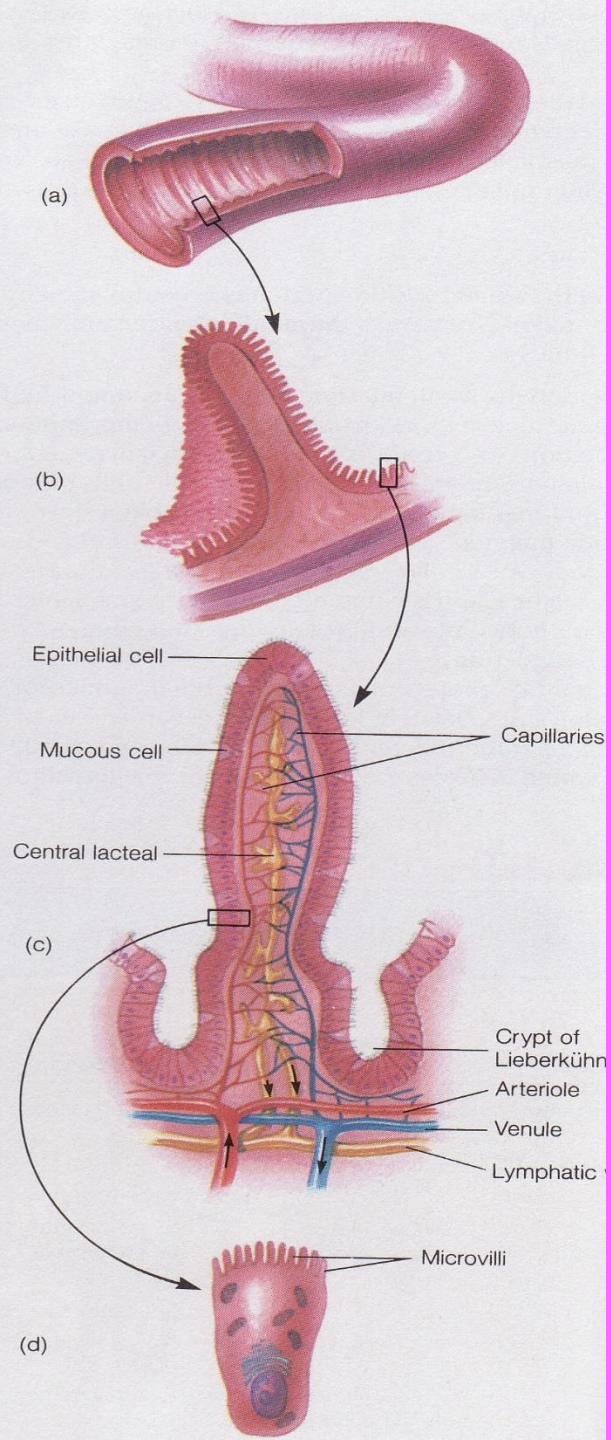


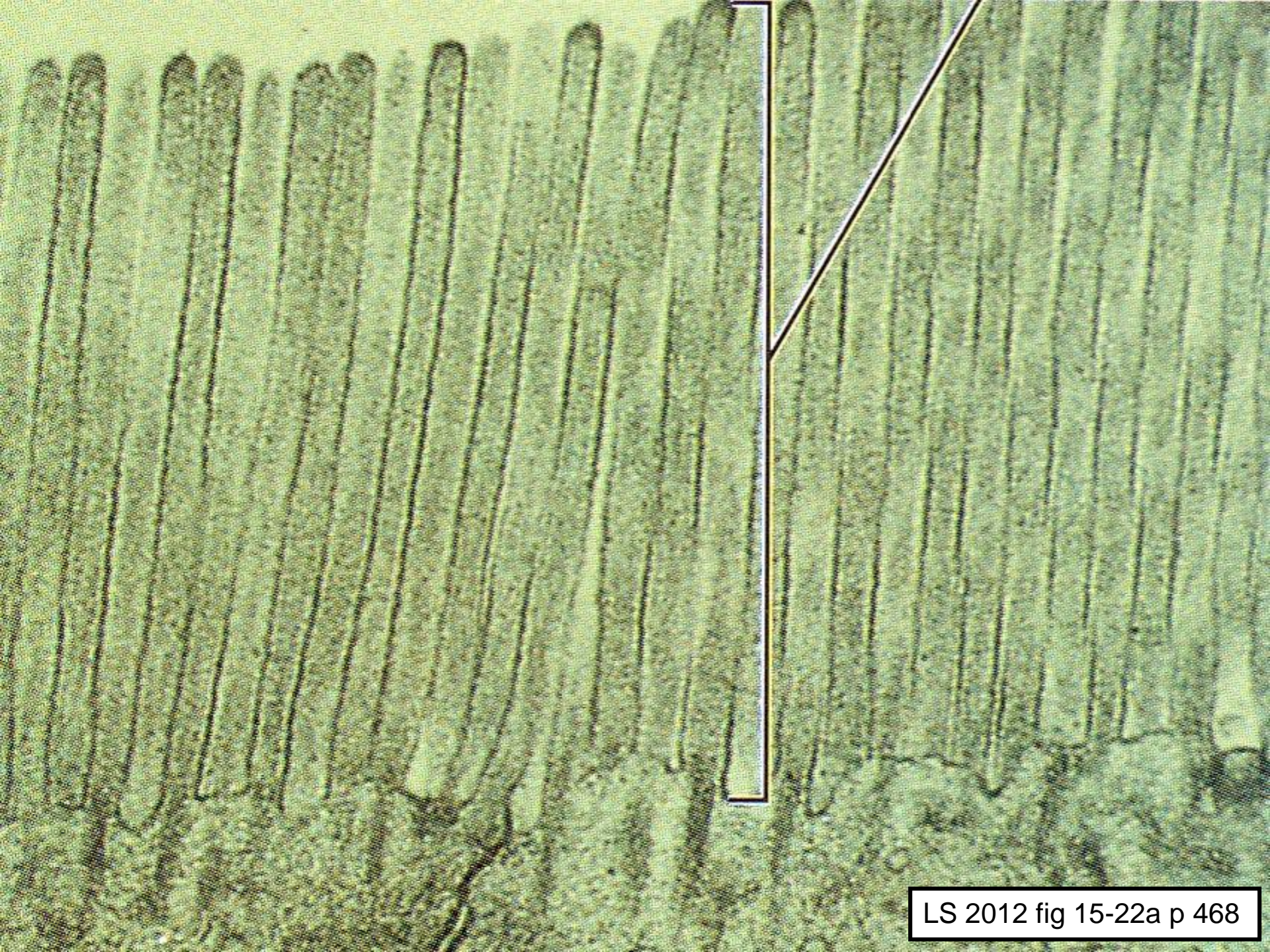
Liver: Amazing Recycling of Bile Salts!



What is the major
function of the
small intestine?

Absorption!!







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



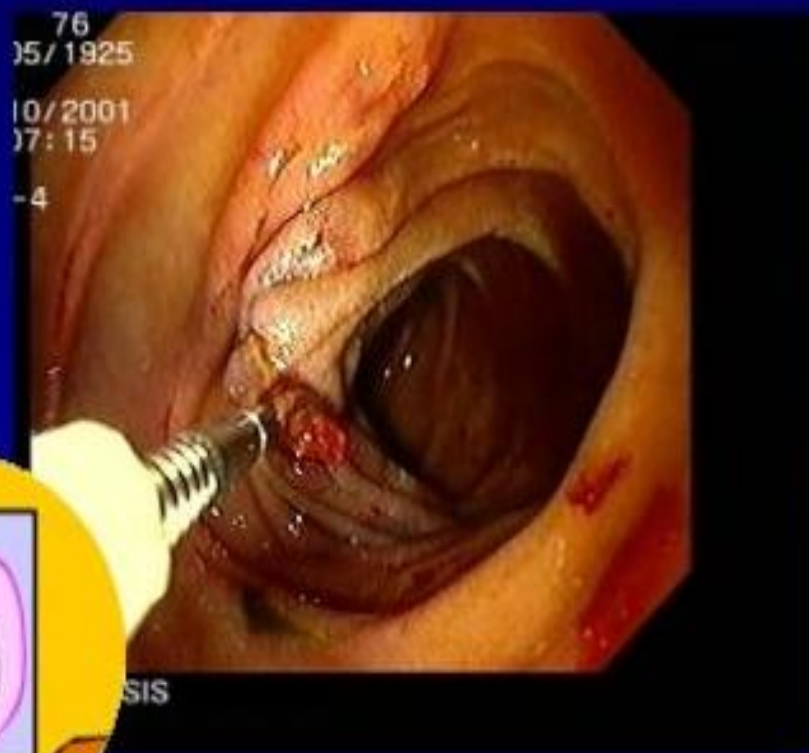
Ulcer Facts

- 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.

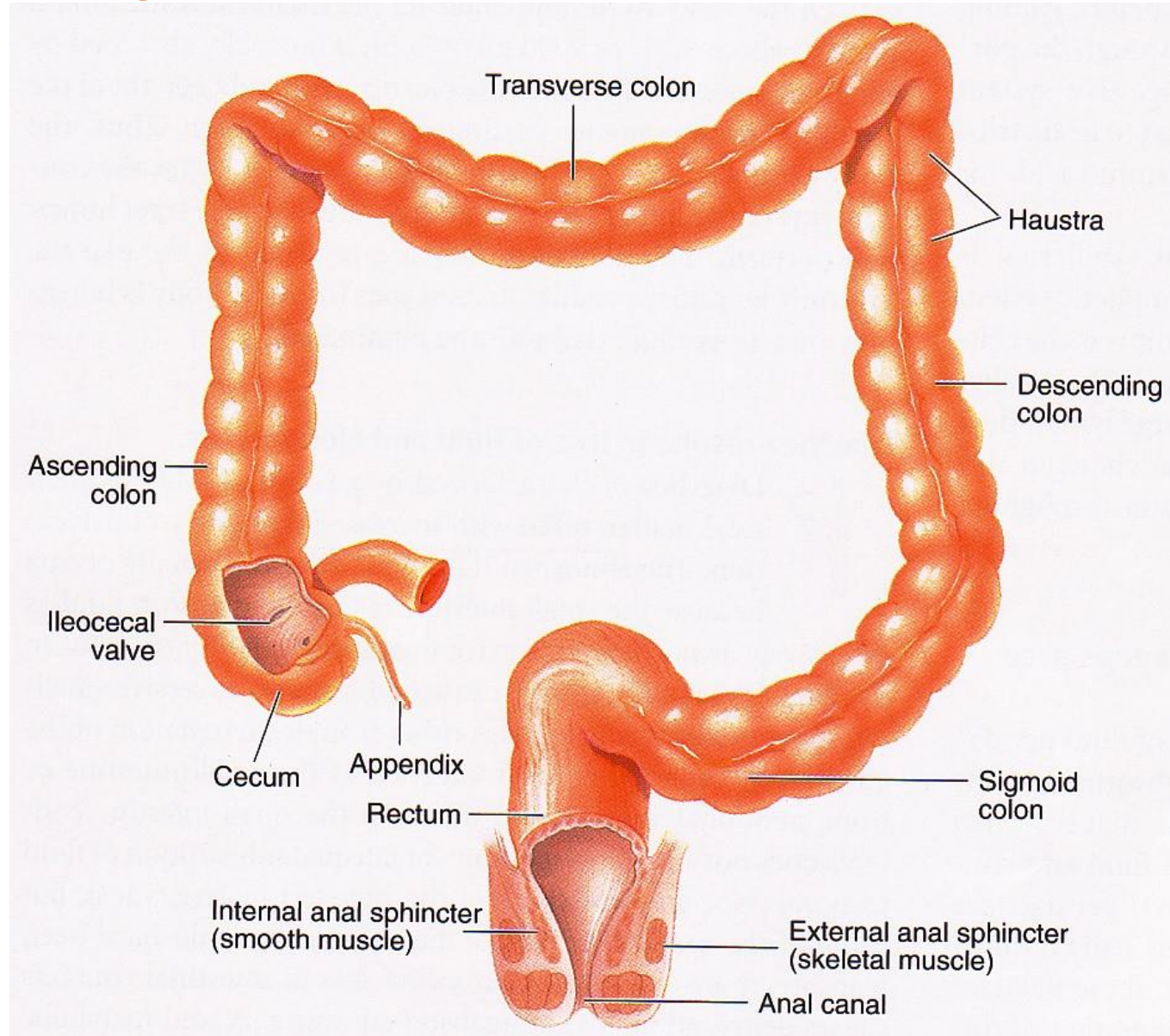
In the second photograph, a disposable metal clip is applied to the ulcer. The patient remained well and left hospital three days later.



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

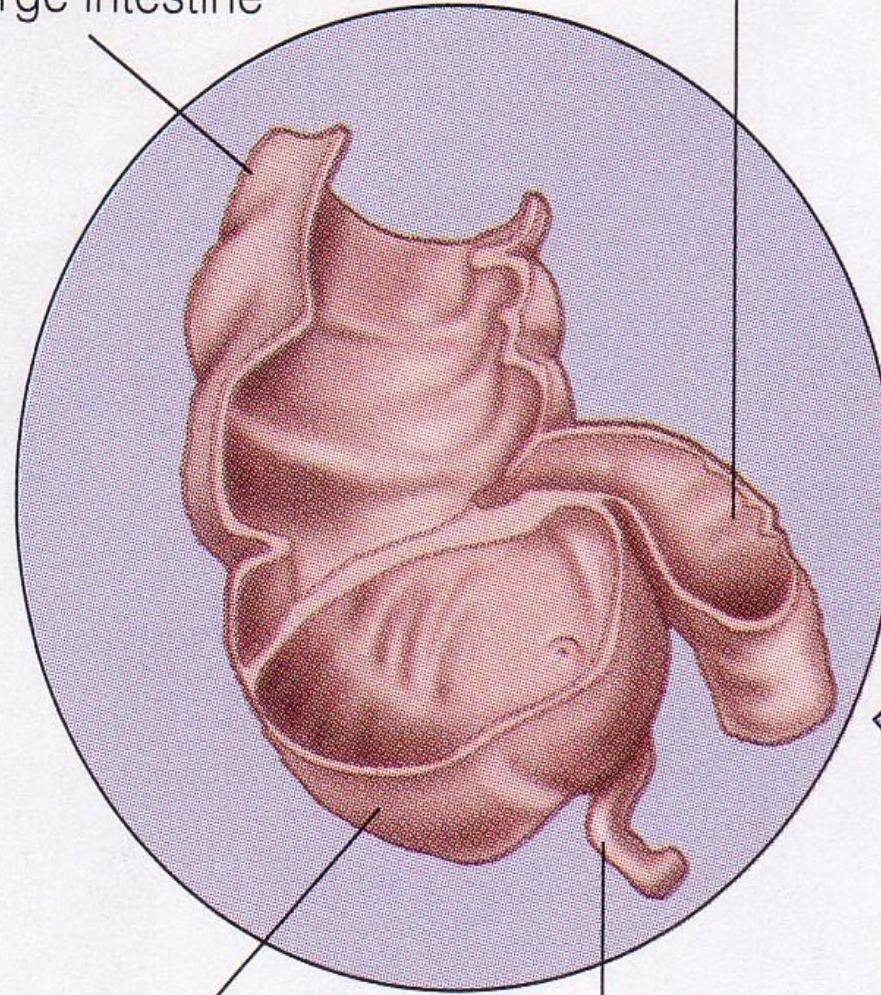
Nutrients	Enzymes for Digesting the Nutrients	Source of Enzymes	Site of Action of Enzymes	Action of Enzymes	Absorbable Units of the Nutrients
Carbohydrates	Amylase	Salivary glands	Mouth and (mostly) body of stomach	Hydrolyzes polysaccharides to disaccharides (maltose)	
		Exocrine pancreas	Small-intestine lumen		
	Disaccharidases (maltase, sucrase, lactase)	Small-intestine epithelial cells	Small-intestine brush border	Hydrolyze disaccharides to monosaccharides	Monosaccharides, especially glucose
Proteins	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
Fats	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