تَنوير

BIOLOGY

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File Title : Chapter 41 part 3

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صدق الله العظيم

Biology : chapter 41, part III

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Secretions of the Small Intestine

- The epithelial lining of the duodenum produces several digestive enzymes
- Enzymatic digestion is completed as peristalsis moves the chyme and digestive juices along the small intestine
- Most digestion occurs in the duodenum; the jejunum and ileum function mainly in absorption of nutrients and water

Absorption in the Small Intestine

it is the longest part in the digestive system

① (folded & coiled)

- The small intestine has a huge surface area, due to **villi** ② and **microvilli** ③ that are exposed to the intestinal lumen

to volume ratio

How?

① + ② + ③

② interial wall of the small intestine has circular folds

③ structures on surface of the simple epithelial cells (Brush Border)

- The enormous microvillar surface creates a brush border that greatly increases the rate of nutrient absorption

As A result: increase the efficiency of absorption

- Transport across the epithelial cells can be passive or active depending on the nutrient

ei: water, by osmosis

-fruktose: facilitated diffusion

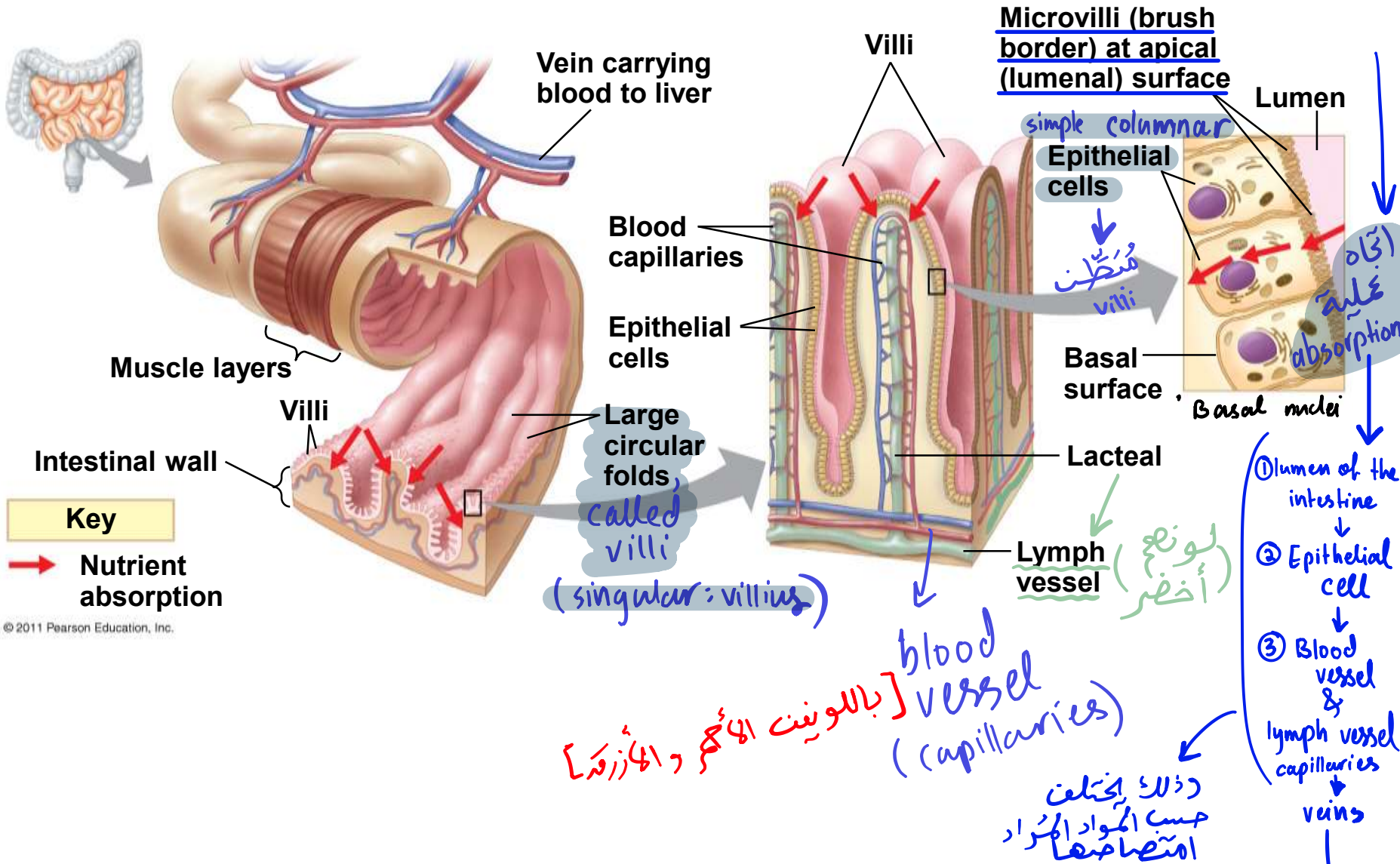
* passively *

Fructose moves by facilitated diffusion from lumen of S. I to epithelial cells. Then, exits the basal surface, absorbed into microscopic blood vessels or capillaries at core of each villus.

* actively * ⇝ كمية أكبر إلى الدم

• AA's, small peptides, vitamins & most glucose are pumped against concentration gradient into epithelial cells of villus, this active transport allow much more absorption of nutrients than passive transport.

Figure 41.13


Vein carrying blood to liver
Muscle layers
Villi
Intestinal wall
Large circular folds, called villi
(singular: villus)
Key
Nutrient absorption
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Villi
Microvilli (brush border) at apical (lumenal) surface
Lumen
simple columnar Epithelial cells
Blood capillaries
Epithelial cells
Basal surface
Basal nuclei
Lacteal
Lymph vessel
blood vessel (capillaries)
①lumen of the intestine
② Epithelial cell
③ Blood vessel & lymph vessel capillaries
veins

- **Capillaries &veins carry nutrients-rich blood away from villi all converge into Hepatic portal vein(lead directly to liver).**

hepatic portal vein
– to the liver –
to adjust the blood
heart
Body parts

  - The **hepatic portal vein** carries nutrient-rich blood from the capillaries of the villi to the liver, then to the heart
  - The liver regulates nutrient distribution, interconverts many organic molecules, and detoxifies many organic molecules
  - **From liver, blood travels to heart, then to other tissues & organs.**
    - **This arrangement serves 2 main functions:**

    1.Allows liver to regulate distribution of nutrients to rest of body.

    2. Liver can remove toxic sub. (drugs) Before blood circulates broadly.

Blood vessel directly ← كل عكس باقي المواد التي تذهب إلى /heart ← 2 large veins عند منطقة الرقبة ← large lymph vessels ← تذهب إلى lacteal

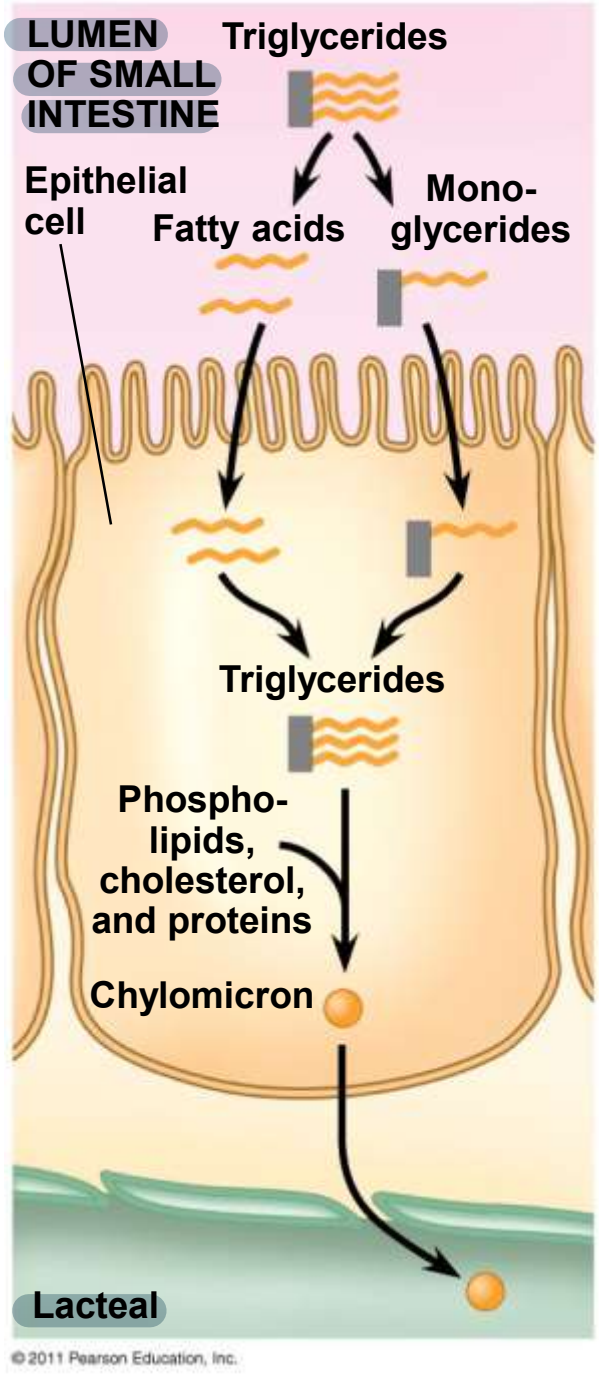
- Most nutrients leave intestine through bloodstream, but fats take different pathway.

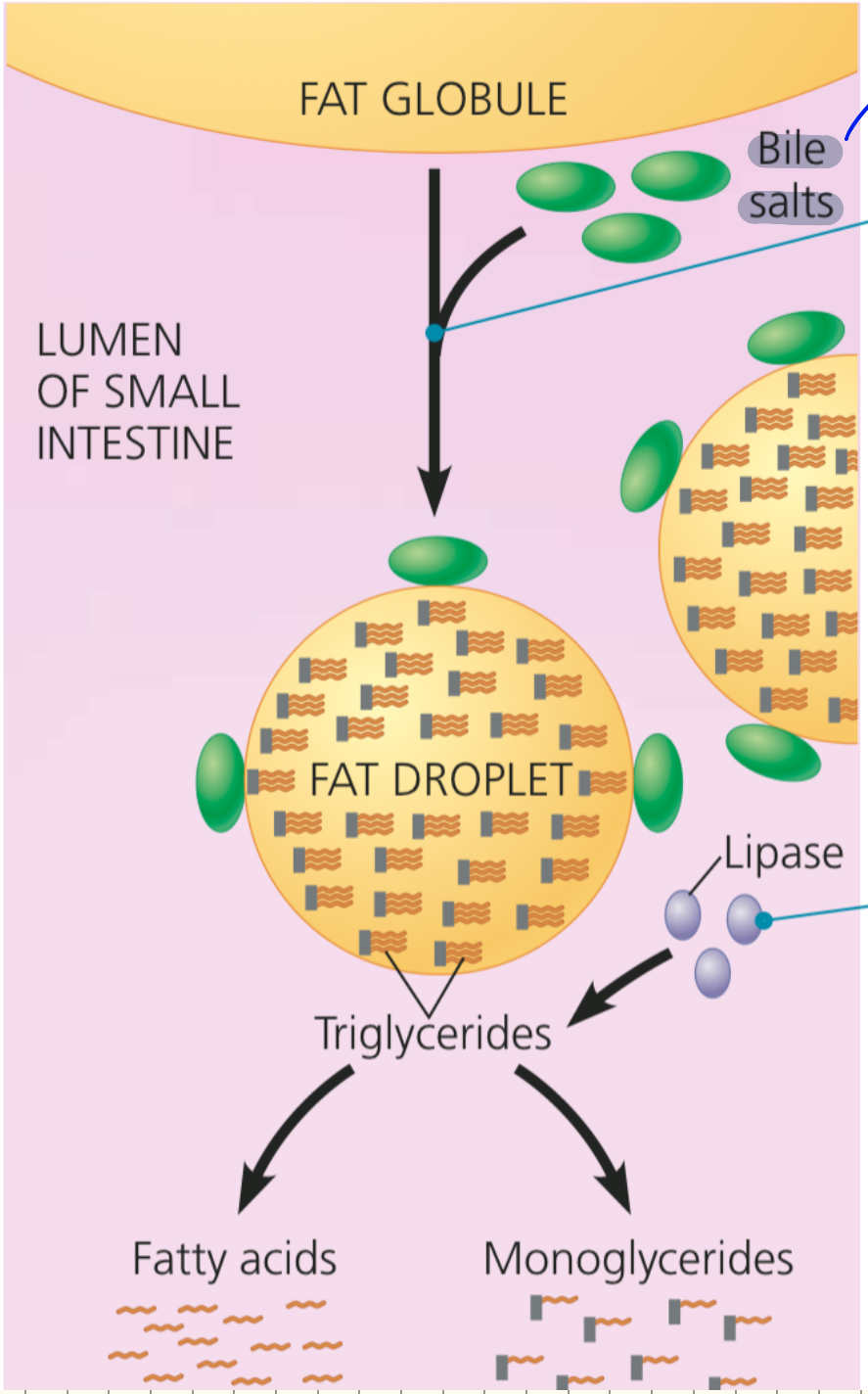
• In lumen,fat mol.exposed on fat droplets are hydrolysed by lipase to F.A's and monoglycerids.

- Epithelial cells absorb fatty acids and monoglycerides and recombine them into triglycerides
- These fats are coated with phospholipids, cholesterol, and proteins to form water-soluble **chylomicrons**
- Chylomicrons are transported into a lacteal, a lymphatic vessel in each villus
- Lymphatic vessels deliver chylomicron-containing lymph to large veins that return blood to the heart

Figure 41.14

Absorption of Fats [which are hydrophobic]:





يأتي من liver ومخزن في gall-bladder

1 In the lumen of the small intestine, bile salts break up large fat globules into fat (or oil) droplets, increasing exposure of triglycerides (fat molecules) on the surface to hydrolysis (step 2).

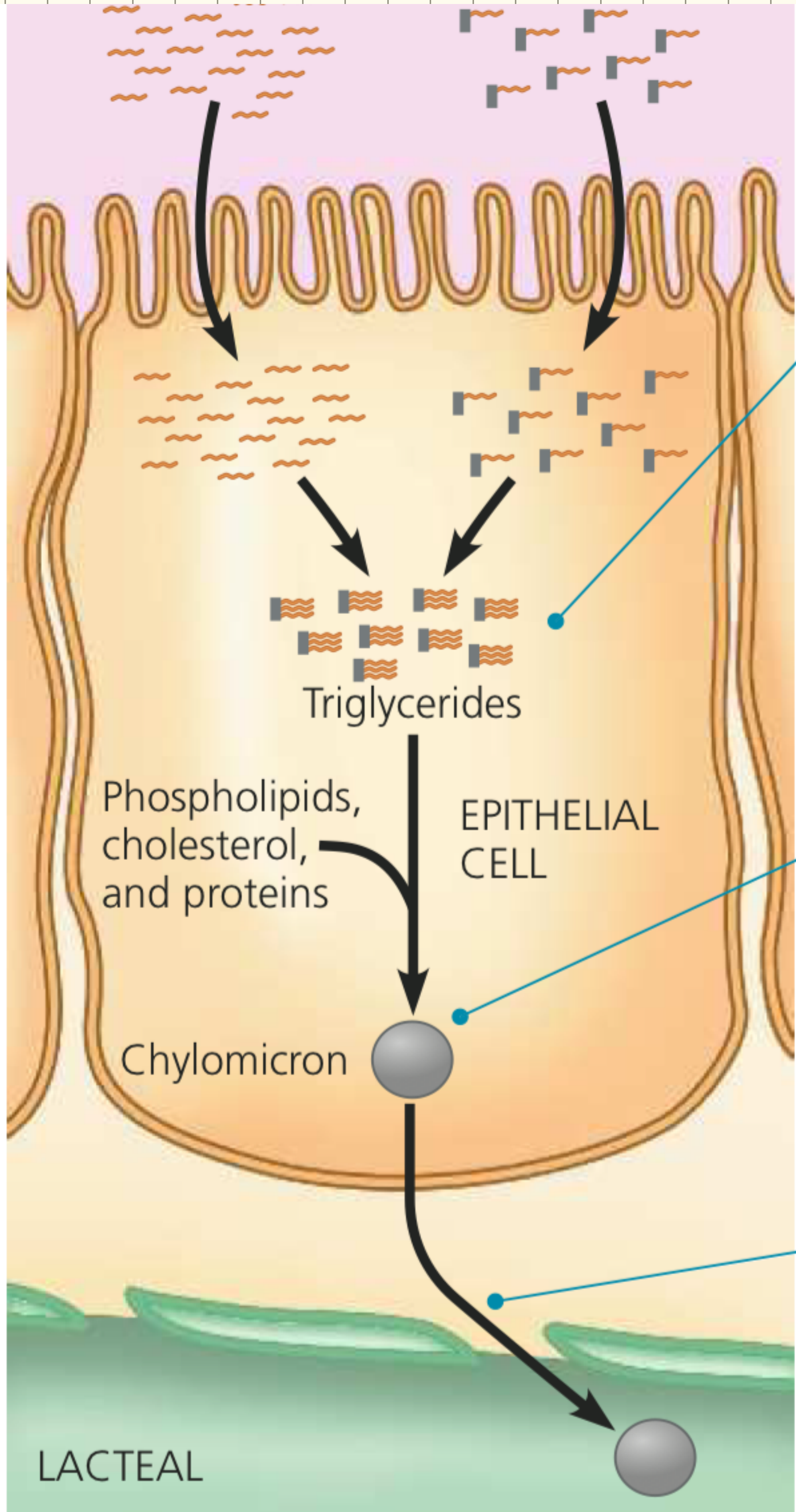
→ العملية تسمى emulsification

2 During enzymatic hydrolysis, the enzyme lipase breaks the exposed triglycerides down to fatty acids and monoglycerides.

أصغر أجزاء الكبيرة not polymers

lipase enzyme: produced by pancreas → to small intestine

- they can diffuse across the membrane



*they enter by simple diffusion

3 After diffusing into epithelial cells, monoglycerides and fatty acids are re-formed into triglycerides. (Some glycerol and fatty acids pass directly into capillaries.)

4 The triglycerides → fat soluble are incorporated into particles called chylomicrons → water soluble. (1) Phospholipids and (2) proteins on the surface make chylomicrons water-soluble.
+(3) cholestrol

5 Chylomicrons leave epithelial cells by exocytosis and enter lacteals, where they are carried away by the lymph and later pass into large veins that lead directly to the heart.

* علاقة هضم وامتصاص الدهون هي الأطول: وهذا يُفسِّر سبب الشعور في الشبع مدة طويلة بعد تناولها

Fats:
(1) Enters by: simple diffusion
(2) leaves by: active exocytosis

In addition to absorbing nutrients, the small intestine recovers water and ions. • Typically all but 0.1 L of the water is reabsorbed in the intestines, with most of the recovery occurring in the small intestine. (90%)

nutrients بعد حركة ال

• - There is no mechanism for active transport of water. Instead, water is reabsorbed by osmosis when sodium and other ions are pumped out of the lumen of the intestine. to the blood

+ الماء تتحرك بعد حركة ال nutrients / وحركة الماء تتم بعملية osmosis

Absorption in the Large Intestine

- The **colon** of the l**arge intestine** is connected to the small intestine
- The **cecum** aids in the fermentation of plant material and connects where the small and large intestines meet
- The human cecum has an extension called the **appendix**, which plays a very minor role in immunity

a finger shaped extension of the human cecum, is thought to serve as a reservoir for symbiotic microorganisms

Human Anatomy: Intestines

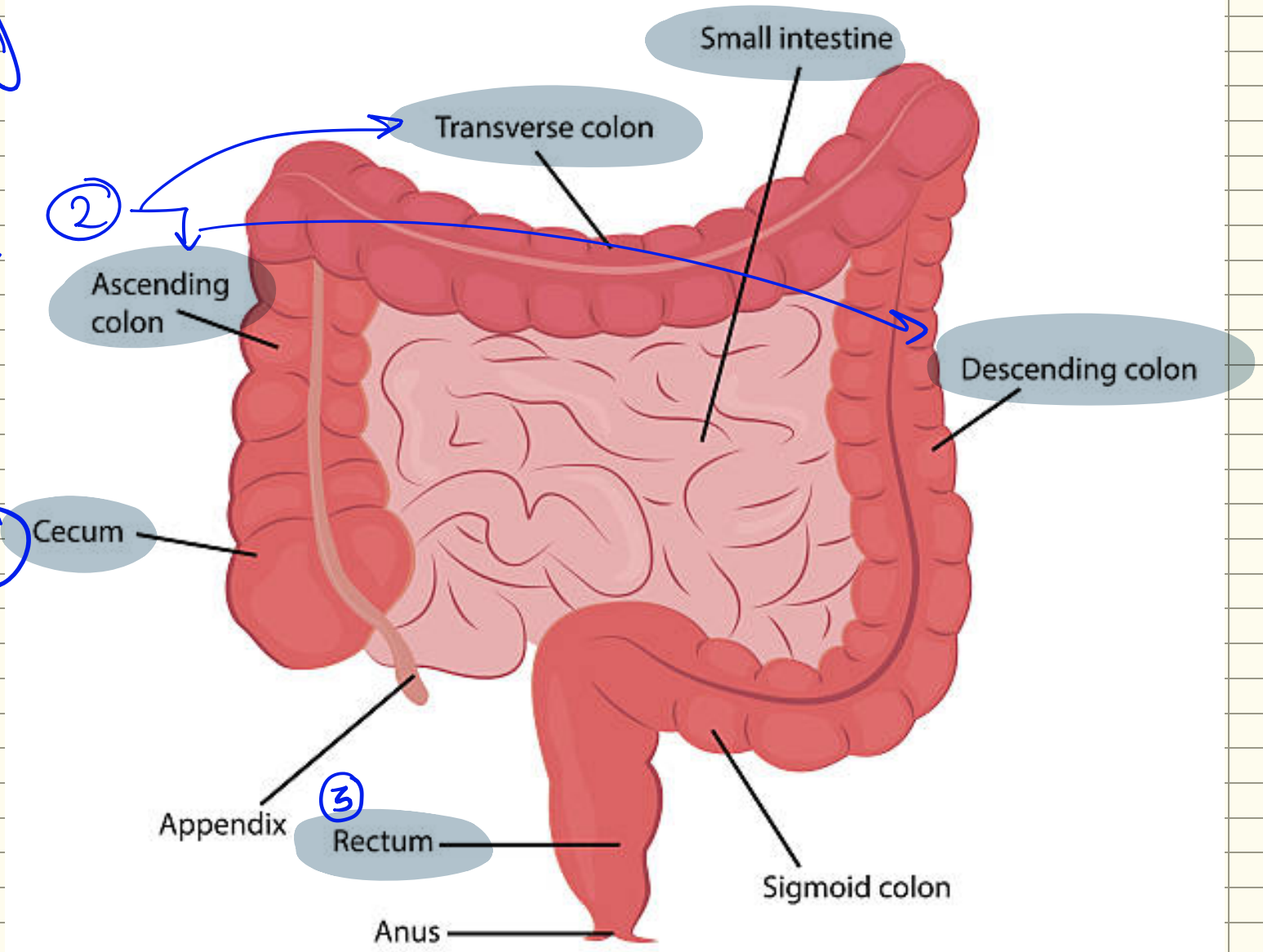
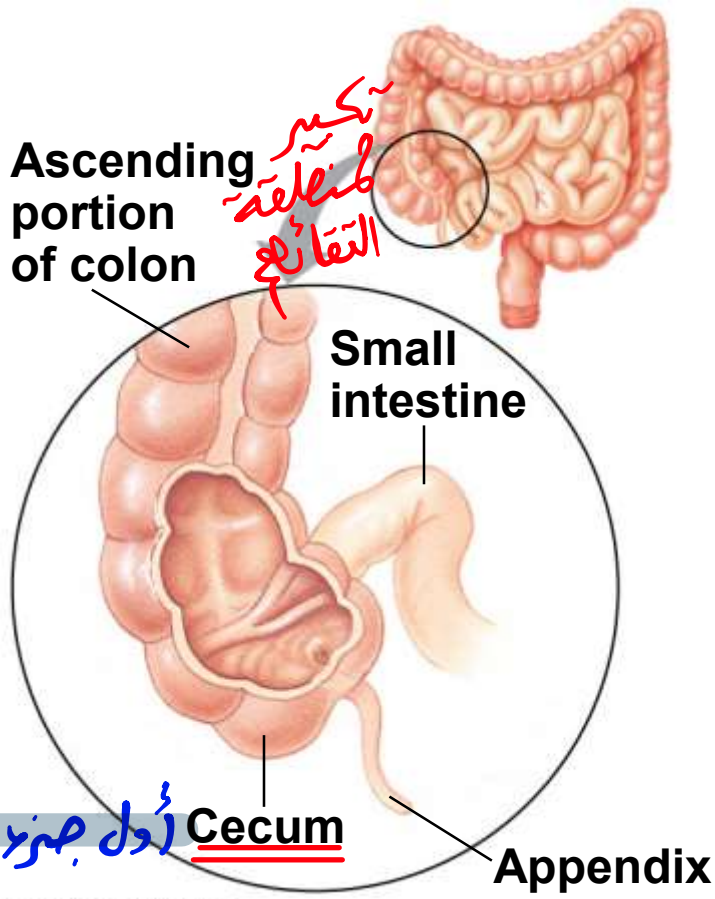


Figure 41.15



The alimentary canal ends with the large intestine, which includes the colon, cecum, and rectum. The small intestine connects to the large intestine at a T-shaped junction The appendix.

One arm of the T is the
1.5-m-long colon, which leads to the rectum and anus. The other arm is a pouch called the cecum.

تحتوي مجموعة من البكتيريا التي تفرز الأنزيمات المسؤولة عن هضم السيليلوز

The cecum is important for fermenting ingested material, especially in animals that eat large amounts of plant material. → contains cellulose, which we can't digest
Compared with many other mammals, humans have a small cecum.

أمّا عند الـ herbivores يكون أطول

- A major function of the colon is to recover water that has entered the alimentary canal and began in the S.I,(90%) by **osmosis**.
- The colon houses bacteria (e.g., Escherichia coli) which live on unabsorbed organic material: produce gases ; methane & hydrogen sulfide. some produce vitaminsK, biotin & folic acid)
- **Feces**, including undigested material, cellulosic fibers and bacteria, become more solid as they move through the colon.

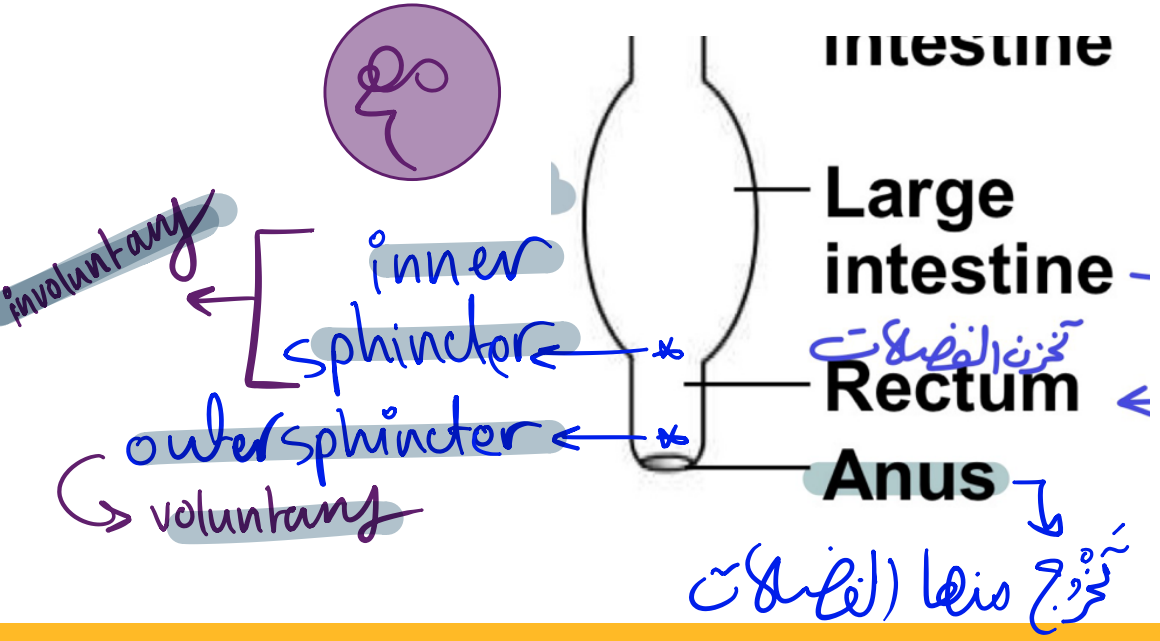
بكتريا نافعة وجود في القولون

تعيش symbiotic relationship

هي تتغذى / واحنا شو نستفيد؟

+ تسهل عملية خروج الفضلات

- Feces are stored in the **rectum** until they can be eliminated through the anus
- Two sphincters between the rectum and anus control bowel movements



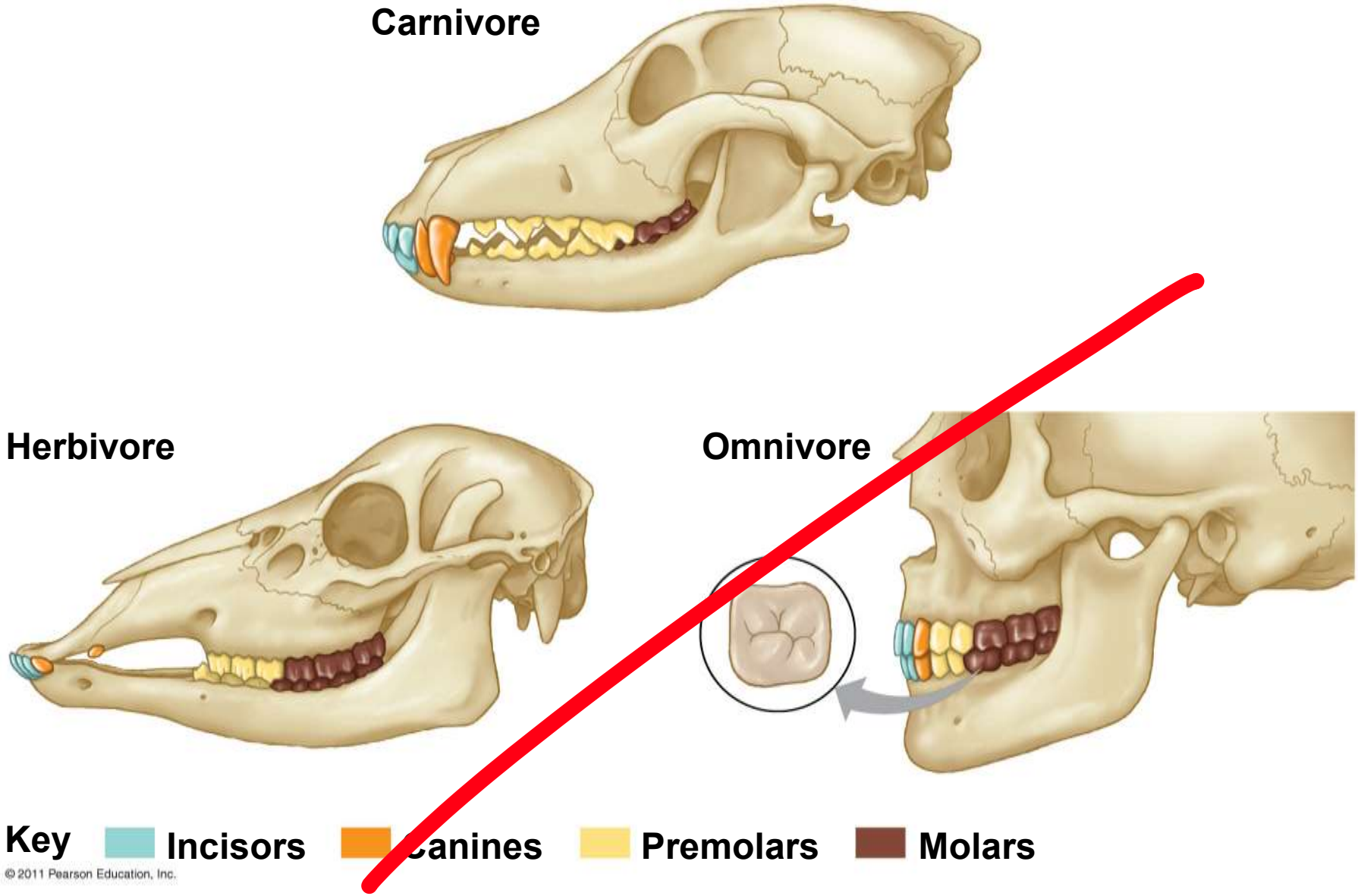
Concept 41.4: Evolutionary adaptations of vertebrate digestive systems correlate with diet

- Digestive systems of vertebrates are variations on a common plan
- However, there are intriguing adaptations, often related to diet

Dental Adaptations

- Dentition, an animal's assortment of teeth, is one example of structural variation reflecting diet
- The success of mammals is due in part to their dentition, which is specialized for different diets
- Nonmammalian vertebrates have less specialized teeth, though exceptions exist
  - For example, the teeth of poisonous snakes are modified as fangs for injecting venom

Figure 41.16



Stomach and Intestinal Adaptations

- Many carnivores have large, expandable stomachs
- Herbivores and omnivores generally have longer alimentary canals than carnivores, reflecting the longer time needed to digest vegetation

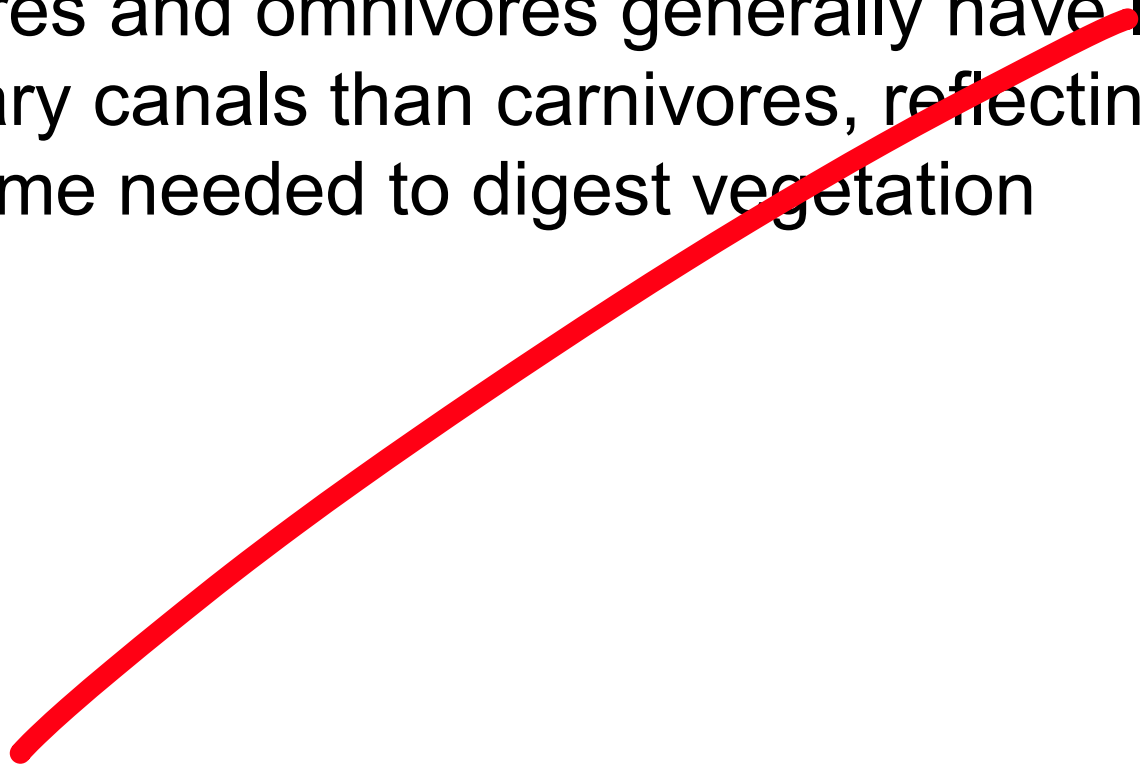
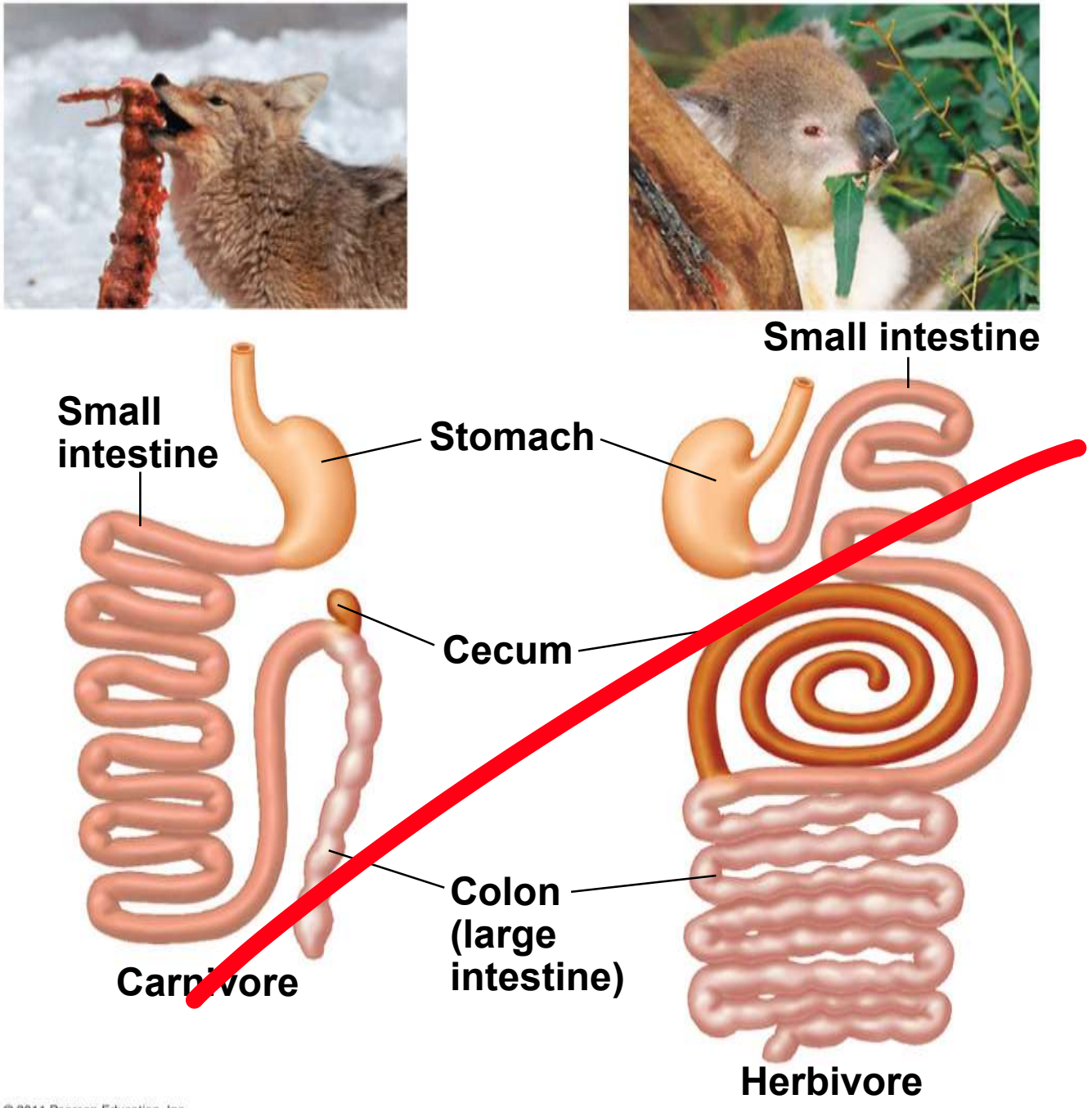


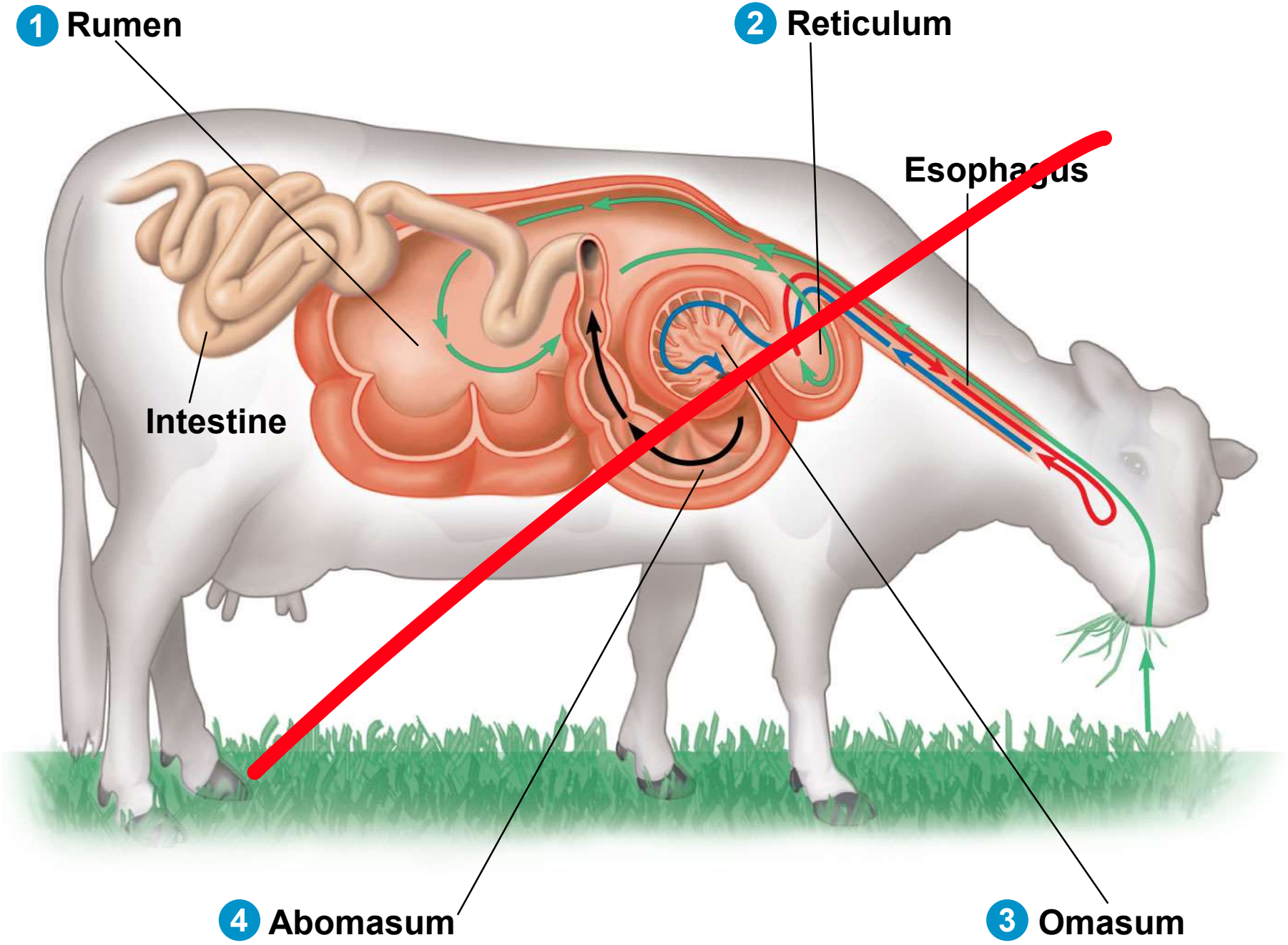
Figure 41.17



Mutualistic Adaptations

- Many herbivores have fermentation chambers, where mutualistic microorganisms digest cellulose
- The most elaborate adaptations for an herbivorous diet have evolved in the animals called **ruminants**

Figure 41.18



Concept 41.5: Feedback circuits regulate digestion, energy storage, and appetite

- The intake of food and the use of nutrients varies with an animal's diet and environment

كما ويوجد جهازين مسؤولين عن عملية ال control-
1)nervous system.
2)endocrine system.

negative feedback for regulation
of what?
①digestion
②energy storage
③appetite

Regulation of Digestion

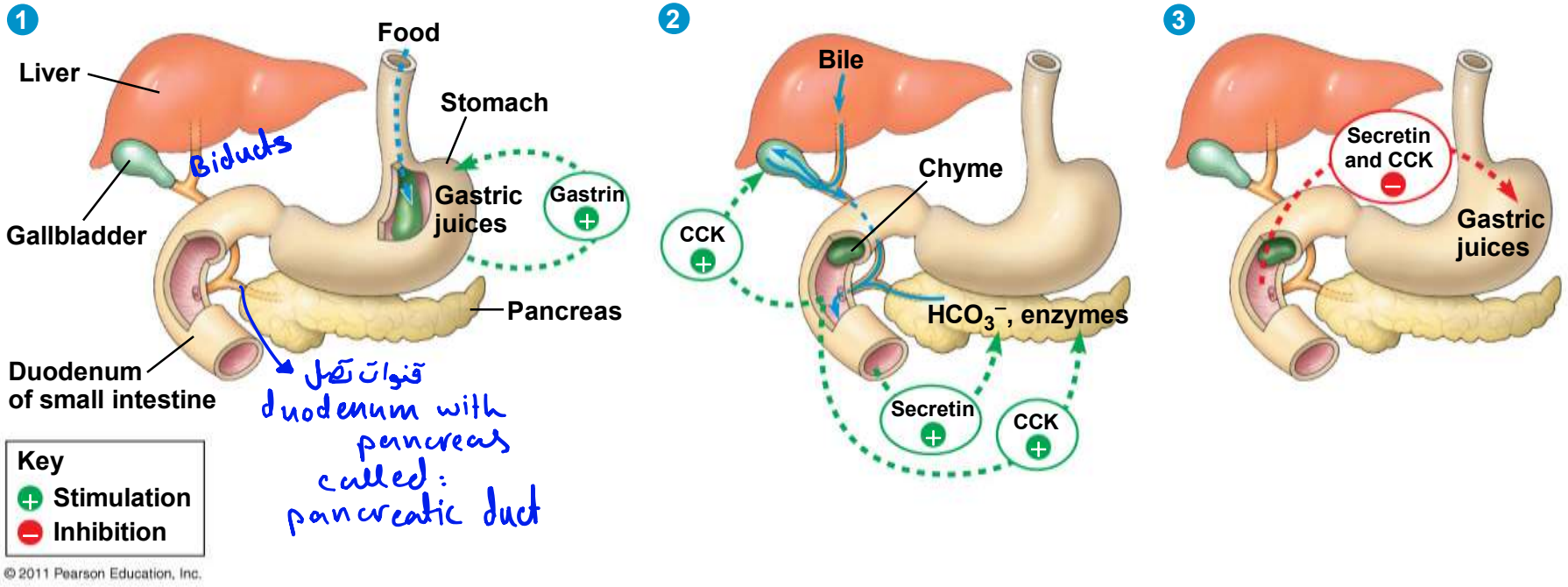
1. Each step in the digestive system is activated as needed **(as food reaches a new compartment)**
3. The enteric division of the nervous system helps to regulate the digestive process
4. The endocrine system also regulates digestion through the release and transport of hormones
2. **The arrival of food triggers secretions that promote next stage in chemical digestion &muscular contractions along alimentary canal.**

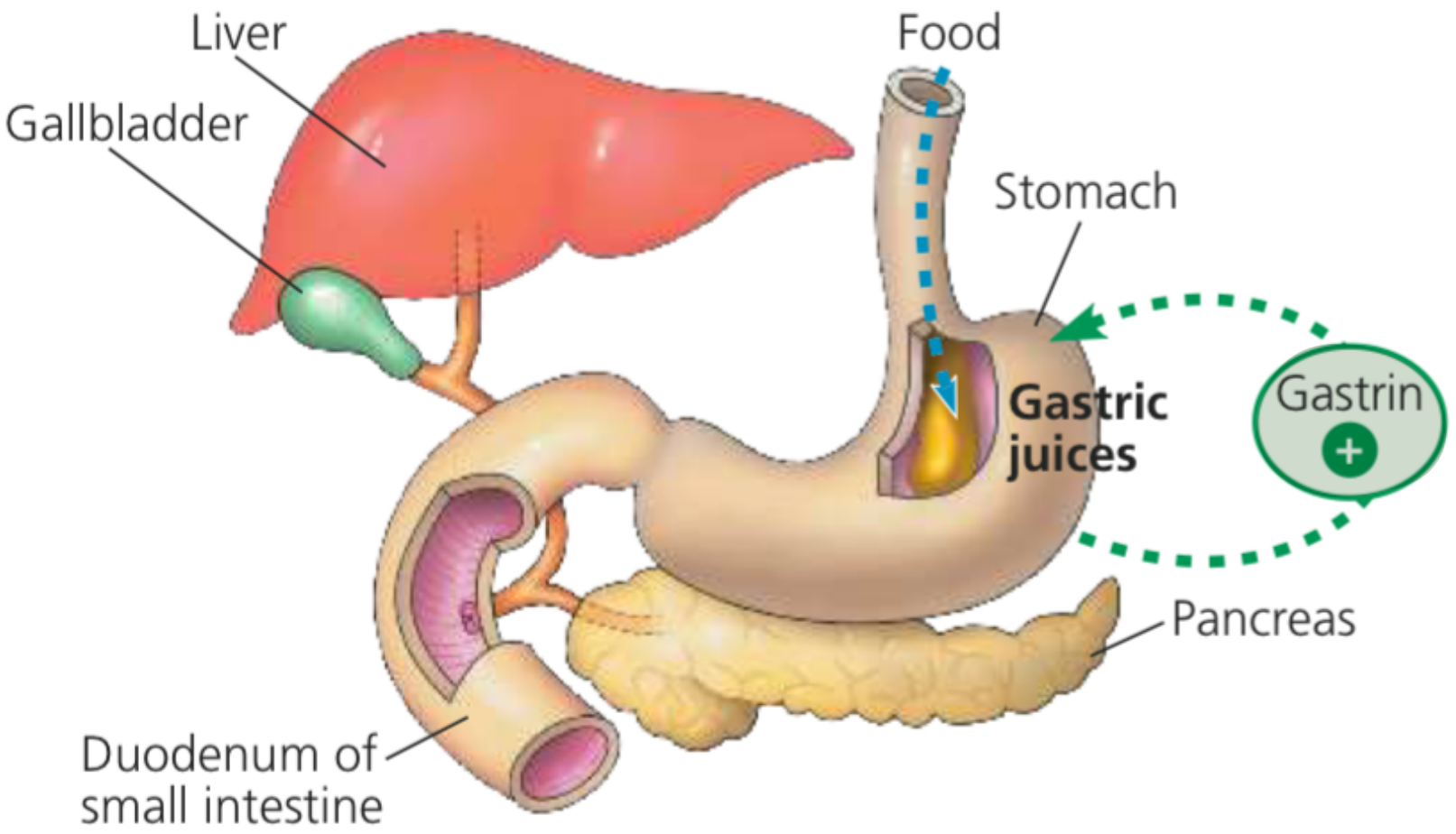
(nervous reflexes stimulate saliva release when food is in oral cavity)

(لبس ستوف الأكل يبدأ إفراز اللعاب)

Figure 41.19

What are the hormones that are secreted and have a role in digestion ?

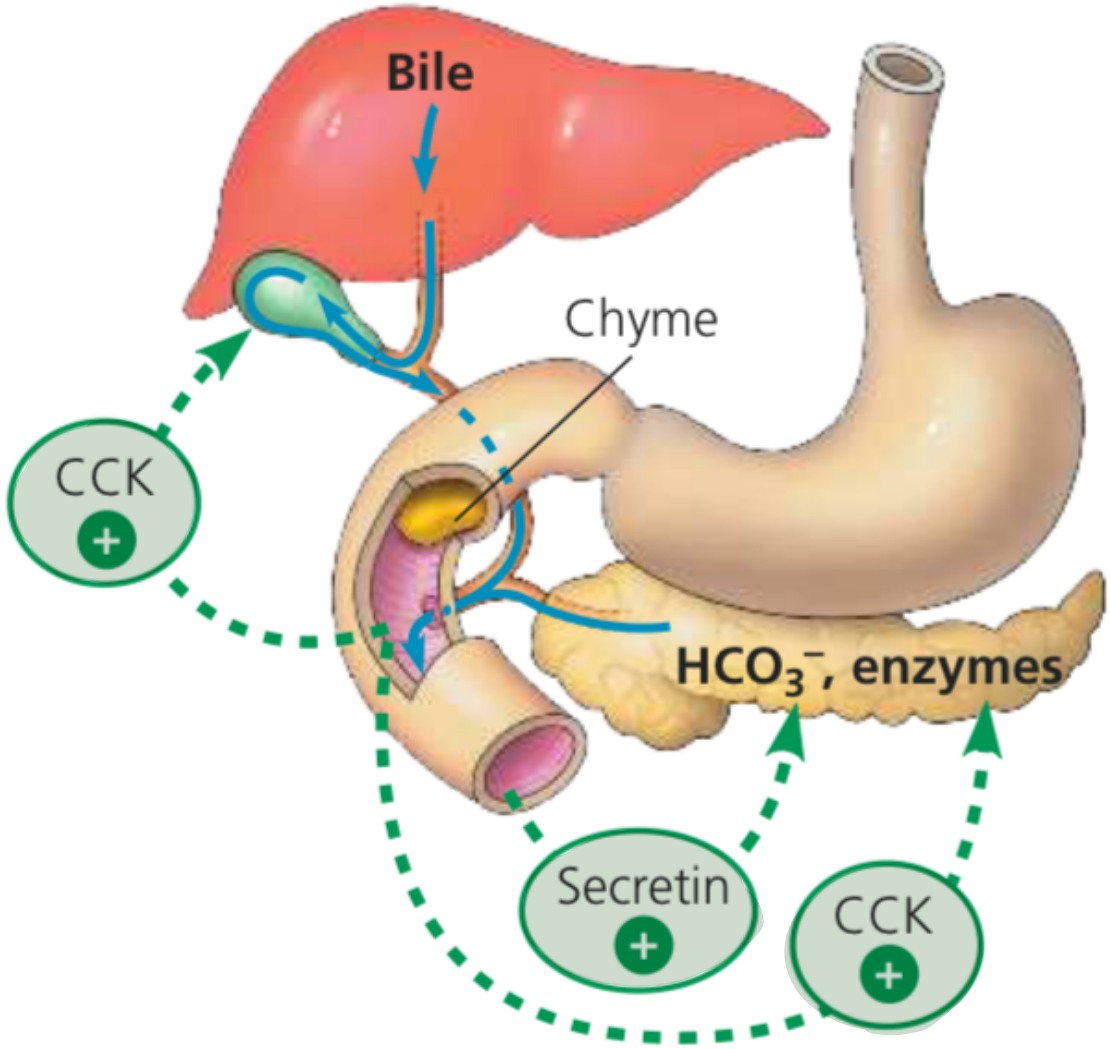




1 As food arrives at the stomach, it stretches the stomach walls, triggering release of the hormone *gastrin*. Gastrin circulates via the bloodstream back to the stomach, where it stimulates production of gastric juices.

بالمعدة

أوّل هرمون يُفرَز من المعدة
وهدفه هو بالمعدة، لذلك يطلع ويرجع لحفز انتاج gastric juices



اذا الهرمون الزجبة على البنكرياس:

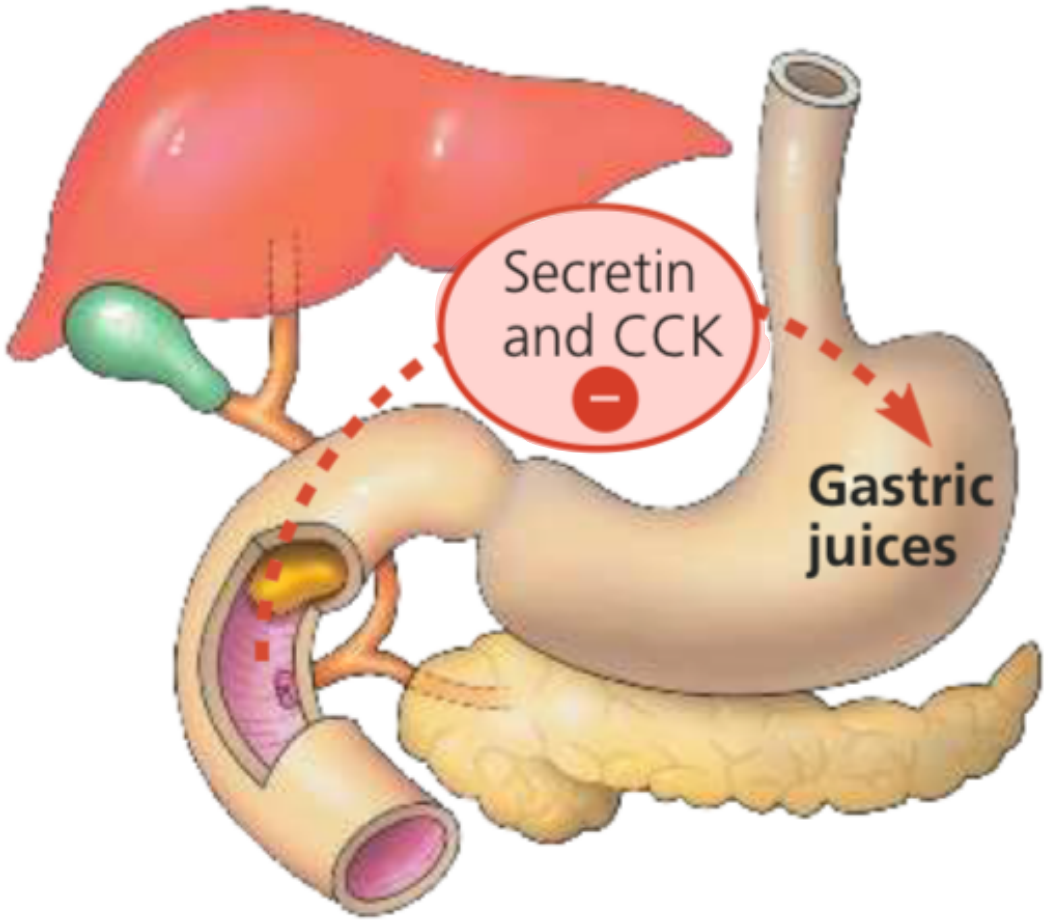
trypsin + chymotrypsin [inactive] released from pancreas, then go to duodenum [they are now activated because of high pH] & then they'll digest proteins

2 Chyme—an acidic mixture of partially digested food—eventually passes from the stomach to the duodenum. The duodenum responds by releasing the digestive hormones cholecystokinin and secretin. *Cholecystokinin (CCK)* stimulates the release of digestive enzymes from the pancreas and of bile from the gallbladder. *Secretin* stimulates the pancreas to release bicarbonate (HCO_3^-), which neutralizes chyme.

اذا الهرمون الزجبة على المعدة

goes out of the duodenum to the gallbladder, بدّه Bile بلشي افرزي
↳ goes to duodenum where fat digestion is completed

Secretin from duodenum → pancreas HCO_3^- → duodenum → increases pH



go back to the stomach, and say: يا معدة، خفضي إفرازاتك وخفضي عصارتك الهاضمة وذلك لإبطاء عملية هضم الدهون.

3 If the chyme is rich in fats, the high levels of secretin and CCK released inhibit peristalsis. This slows the movement of chyme and allows the more time-consuming digestion of fats to take place in the small intestine.

& secretion of digestive enzymes, thereby slowing digestion.

Regulation of Energy Storage

شو اللي بخلي الجسم يخزن الطاقة
و " " " " يستهلك طاقة
مخزنة؟

- The body stores energy-rich molecules that are not needed right away for metabolism
- In humans, energy is stored first in the liver and muscle cells in the polymer glycogen
- Excess energy is stored in adipose tissue, the most space-efficient storage tissue

في حالة الزيادة

في حالة النقصان

When fewer calories are taken in than are expended(heavy exercise or lack of food),human body expend ① liver glycogen first then ② muscle glycogen & ③ fat. Adipose tissue provides most of body store of energy.

أغلب عمليات تخزين واستهلاك الطاقة تبدأ بغلوكوز

Glucose Homeostasis

Glucose level in the body is controled by the pancreas

- Oxidation of glucose generates ATP to fuel cellular processes
- The hormones insulin and glucagon regulate the breakdown of glycogen into glucose (secreted by the pancreas)
- The liver is the site for glucose homeostasis
  - A carbohydrate-rich meal raises insulin levels, which triggers the synthesis of glycogen

in liver and muscles, also insulin triggers transport of glucose to body cells.

  - Low blood sugar causes glucagon to stimulate the breakdown of glycogen and release glucose

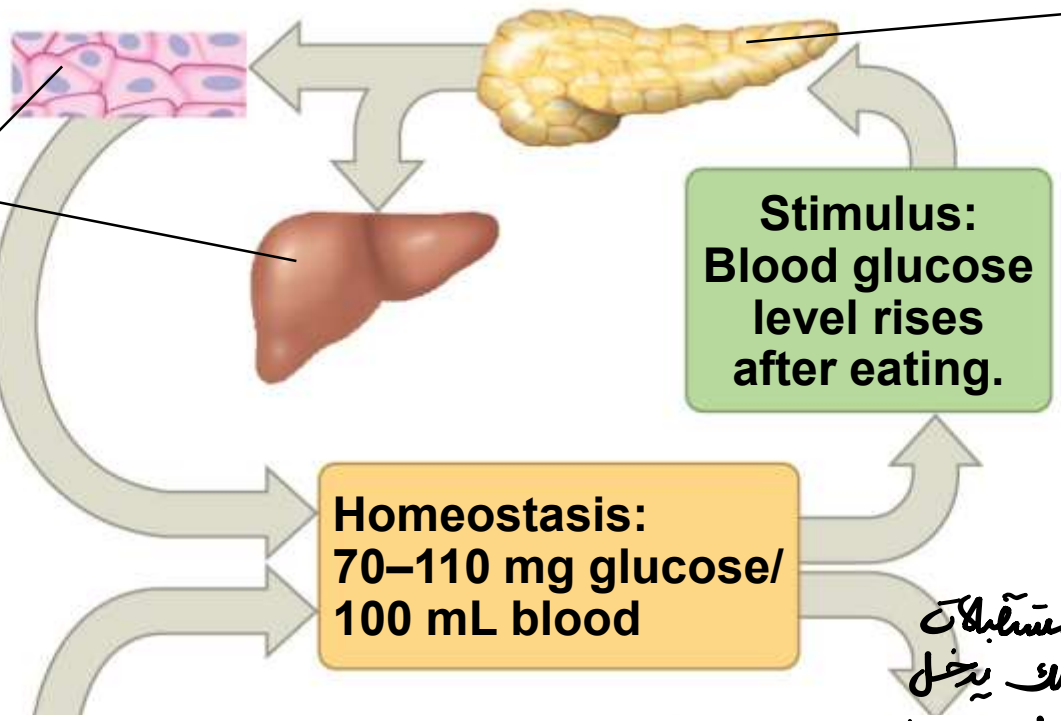
cells in the pancreas:

مسؤولين عن glucose homeostasis 70 → 110

- Alpha-cells : secretes glucagon
- Beta-cells : secretes insulin

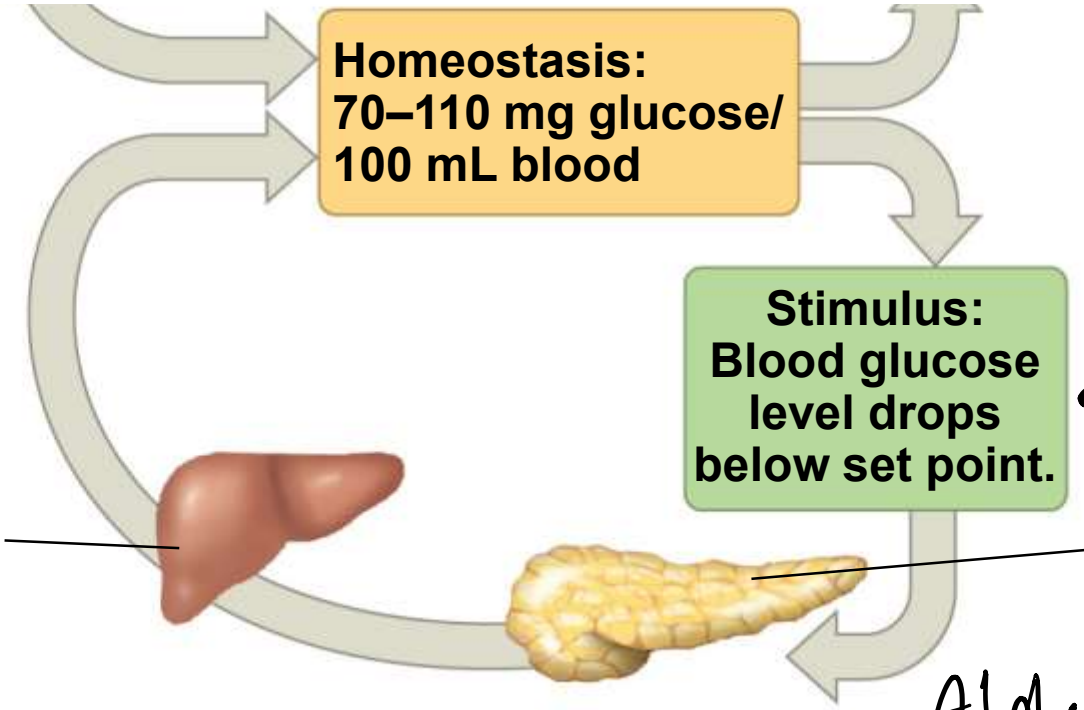
Their effect is antagonistic عكس بعض

Figure 41.20



السُّكّر
ارتفع السكر من
١١٠ ، خلايا
Bcells سوف تحفز
وتنتج الأنسولين
الذي يذهب للدم
١) يرتبط الأنسولين بالمستقبلات
على الخلايا، ونتيجة لذلك يدخل
الجلوكوز داخل الخلايا حتى يقل مستواه
في الدم
٢) يذهب إلى liver ويحفز عملية
تخزين السكر الزائد على شكل
غلايكوجين
glycogen synthesis

Figu



مستوى السكر انخفض أكثر من 70

Alpha cells will be stimulated

Diabetes Mellitus

• A number of disorders can disrupt glucose homeostasis with potentially serious consequences, especially for the heart, blood vessels, eyes, and kidneys. The best known and most prevalent of these disorders is diabetes mellitus.

B cells haven't released it

• The disease diabetes mellitus is caused by a deficiency of insulin or a decreased response to insulin in target tissues.

• The blood glucose level rises, but cells are unable to take up enough glucose to meet metabolic needs.

• Instead, fat becomes the main substrate for cellular respiration.

• There are two main types of diabetes mellitus: type 1 and type 2. Each is marked by high blood glucose levels, but with very different causes.

1- Type 1 Diabetes Also called insulin-dependent diabetes,

الأخطر

غالبا هذه الأمراض بسبب الزعل :)

• type 1 diabetes is an autoimmune disorder in which the immune system destroys the beta cells of the pancreas.

Type 1 diabetes, which usually appears during childhood, destroys the person's ability to produce insulin. Treatment consists of insulin injections, typically given several times daily. In the past, insulin was extracted from animal pancreases, but now human insulin can be obtained from genetically engineered bacteria, a relatively inexpensive source.

• Stem cell research may someday provide a cure for type 1 diabetes by generating replacement beta cells that restore insulin production by the pancreas.

2- Type 2 Diabetes Non-insulin-dependent diabetes

the most common

العامل الوراثي يزيد من احتمالية إصابته

-type 2 diabetes, is characterized by a failure of target cells to respond normally to insulin. Insulin is produced, but target cells fail to take up glucose from the blood, and blood glucose levels remain elevated. Although heredity can play a role in type 2 diabetes, excess body weight and lack of exercise significantly increase the risk of developing

& high weight

• More than 90% of people with diabetes have type 2.

• Many can control their blood glucose levels with regular exercise and a healthy diet; some require medications.

• Nevertheless, type 2 diabetes is the seventh most common cause of death in USA and a growing public health problem worldwide.

The resistance to insulin signaling in type 2 diabetes is sometimes due to a genetic defect in the insulin receptor or the insulin response pathway.

In many cases, however, events in target cells suppress activity of a otherwise functional response pathway.

One source of this suppression appears to be inflammatory signals generated by the innate immune system How obesity and inactivity relate to this suppression is being studied in both humans and laboratory animals.

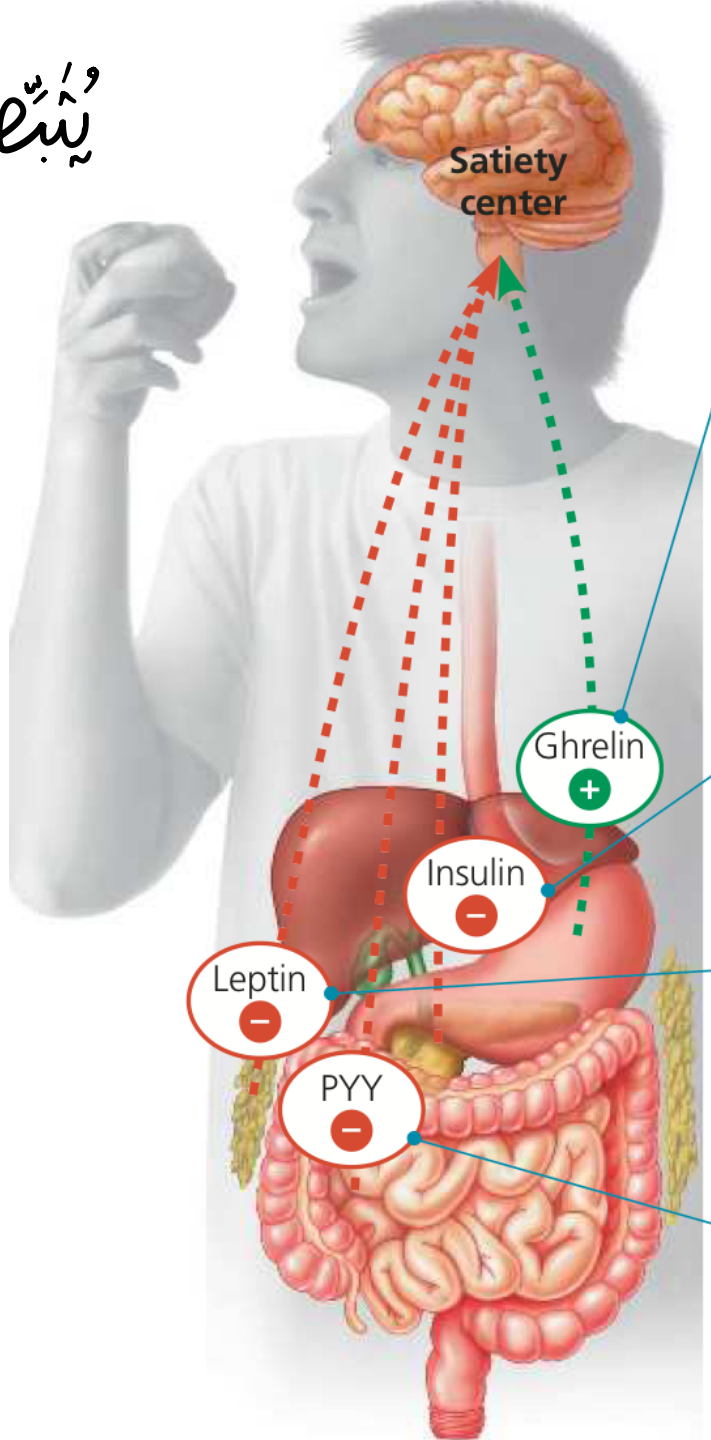
Regulation of Appetite and Consumption

- Overnourishment causes obesity, which results from excessive intake of food energy with the excess stored as fat
- Obesity contributes to diabetes (type 2), cancer of the colon and breasts, heart attacks, and strokes
- Researchers have discovered several of the mechanisms that help regulate body weight

These mechanisms control the storage and metabolism of fat.

Figure 41.21

suppress : يُثبّط



stimulates the appetite

Secreted by the stomach wall, **ghrelin** is one of the signals that triggers feelings of hunger as mealtimes approach. In dieters who lose weight, ghrelin levels increase, which may be one reason it's so hard to stay on a diet.

A rise in blood sugar level after a meal stimulates the pancreas to secrete **insulin**. In addition to its other functions, insulin suppresses appetite by acting on the brain.

Produced by adipose (fat) tissue, **leptin** suppresses appetite. When the amount of body fat decreases, leptin levels fall, and appetite increases.

The hormone **PYY**, secreted by the small intestine after meals, acts as an appetite suppressant that counters the appetite stimulant ghrelin.

يقلله / يقلل عكسه

- Hormones regulate long-term and short-term appetite by affecting a “satiety center” in the brain
- Studies on mice revealed that the hormone **leptin** plays an important role in regulating obesity
- Leptin is produced by adipose tissue and can help to suppress appetite

In addition to neuronal network functioning independently from CNS to regulate hormonal release and integrating digestive system.

- The problem of maintaining weight partly stems from our evolutionary past, when fat hoarding was a means of survival
- Individuals who were more likely to eat fatty food and store energy as adipose tissue may have been more likely to survive famines

The end of biology course