# Chapter 21

# Nutrition and Digestion

PowerPoint Lectures for

***Biology: Concepts & Connections*, Sixth Edition**

***Campbell, Reece, Taylor, Simon, and Dickey***



**Lecture by Richard L. Myers**

**Translated by Nabih A. Baeshen**

# OBTAINING AND PROCESSING FOOD

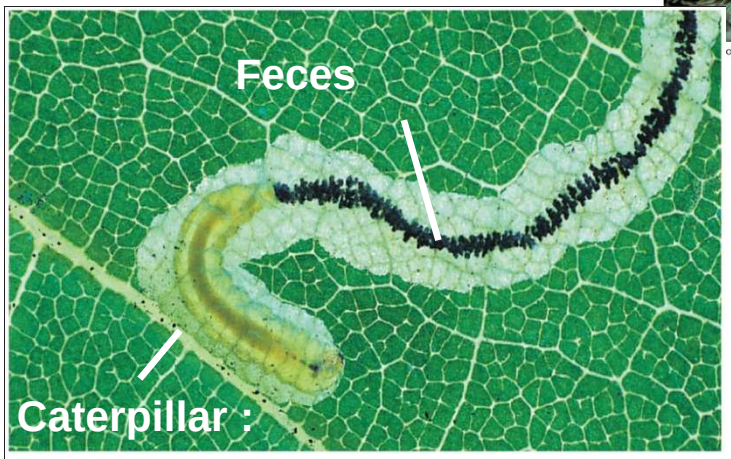
# 21.1 Animals ingest their food in a variety of ways

- Most animals have one of three kinds of diets
  - **Herbivores**, plant-eaters—cattle, snails, sea urchins
  - **Carnivores**, meat-eaters—lions, hawks, spiders
  - **Omnivores**, eating both plants and other animals—humans, roaches, raccoons, crows

# 21.1 Animals ingest their food in a variety of ways

- Animals obtain and ingest their food in different ways
  - **Suspension feeding**
  - **Substrate feeding**
  - **Fluid feeding**
  - **Bulk feeding**


**A suspension feeder**: a tube worm filtering food from the surrounding water through its tentacles.




**A substrate feeder**: a caterpillar eating its way through the soft green tissues inside an oak leaf.



**A fluid feeder:** a mosquito sucking blood.



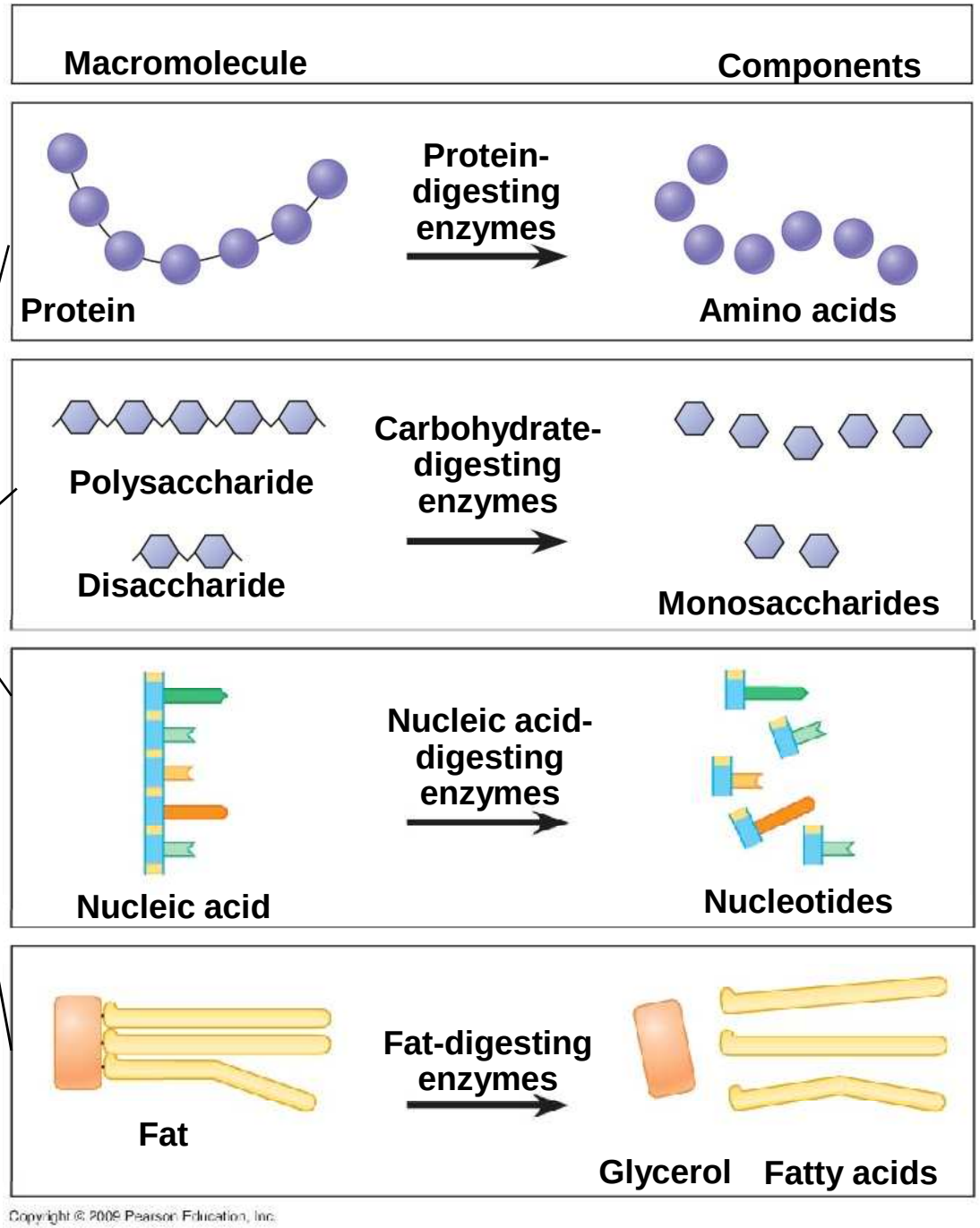
**A bulk feeder**: a grey heron preparing to swallow a fish head first and the rest next.

# 21.2 Overview: Food processing occurs in four stages

## نظرة شاملة: يتم التعامل مع الطعام ومعالجته في اربعة مراحل

- Food is processed in four stages
  - **Ingestion**
  - **Digestion**
  - **Absorption**
  - **Elimination**

- **Mechanical digestion** breaks food down into smaller pieces
- **Chemical digestion** breaks down large organic molecules into their components



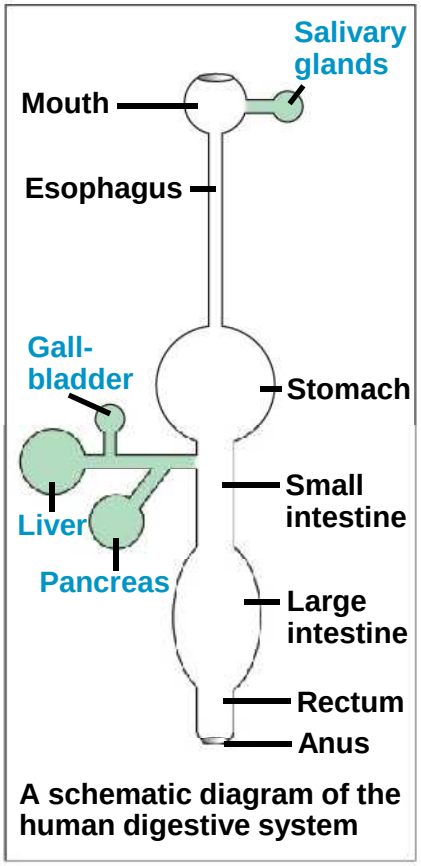
# 21.3 Digestion occurs in specialized compartments

- Sponges digest food in vacuoles
- Cnidarians and flatworms have a gastrovascular cavity with a single opening, the mouth
- Most animals have an alimentary canal with
  - **Mouth**
  - **Anus**
  - **Specialized regions**

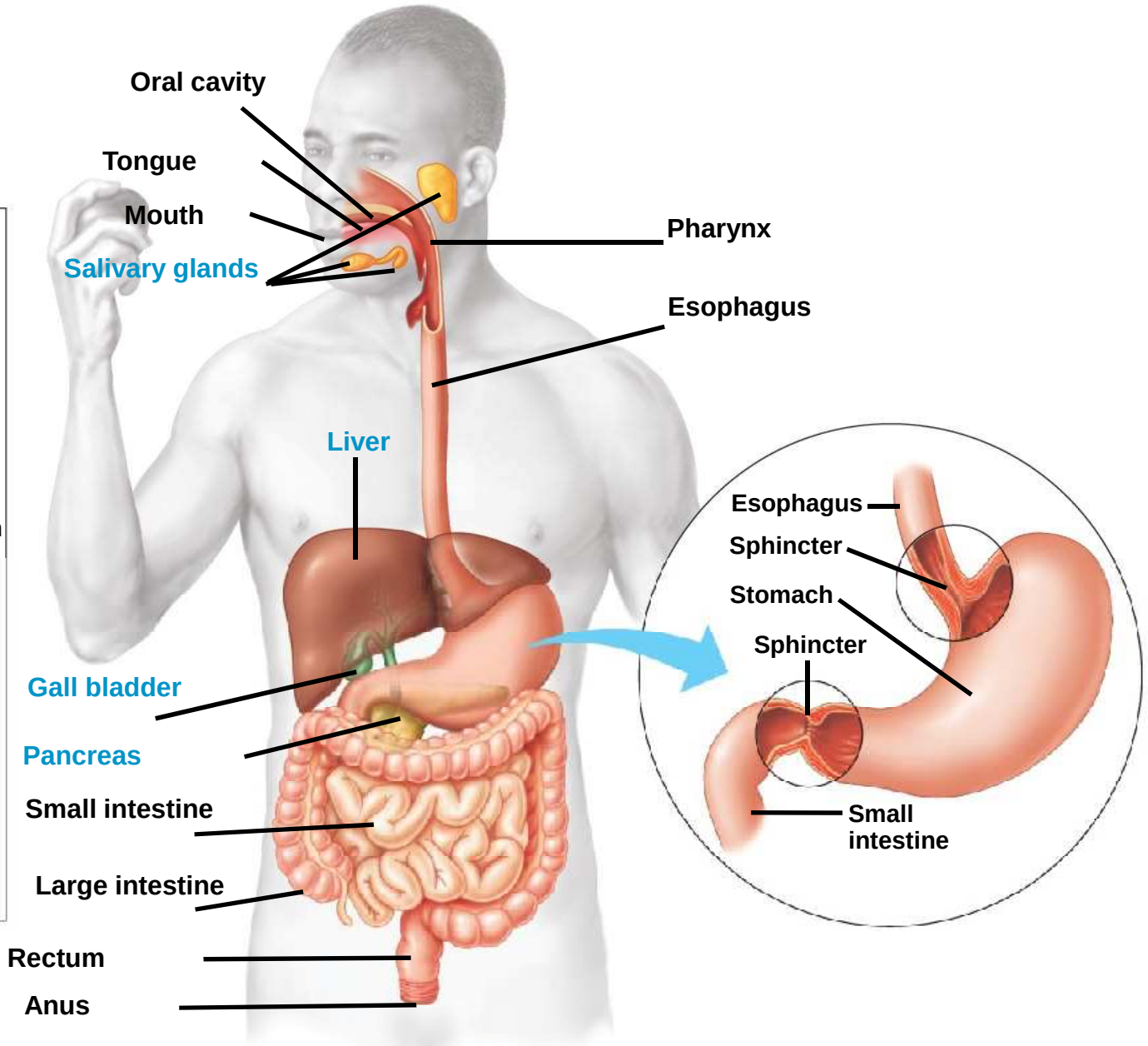
# HUMAN DIGESTIVE SYSTEM

# 21.4 The human digestive system consists of an alimentary canal and accessory glands

- Alternating waves of contraction and relaxation by smooth muscle in the walls of the canal move food along in a process called **peristalsis**
- **Sphincters** control the movement of food into and out of the stomach .
- **1-pyloric sphincter(**at the base of the stomach**)**
  - Regulates the passage of food from the stomach to the small intestine
- **2- The cardiac sphincter (**lower esophageal sphincter **)**
  - Limits the upward movement of acids into the esophagus




A schematic diagram of the human digestive system




# The human digestive system

# 21.5 Digestion begins in the oral cavity

- Teeth break up food,and functions of saliva

  1-moistens food

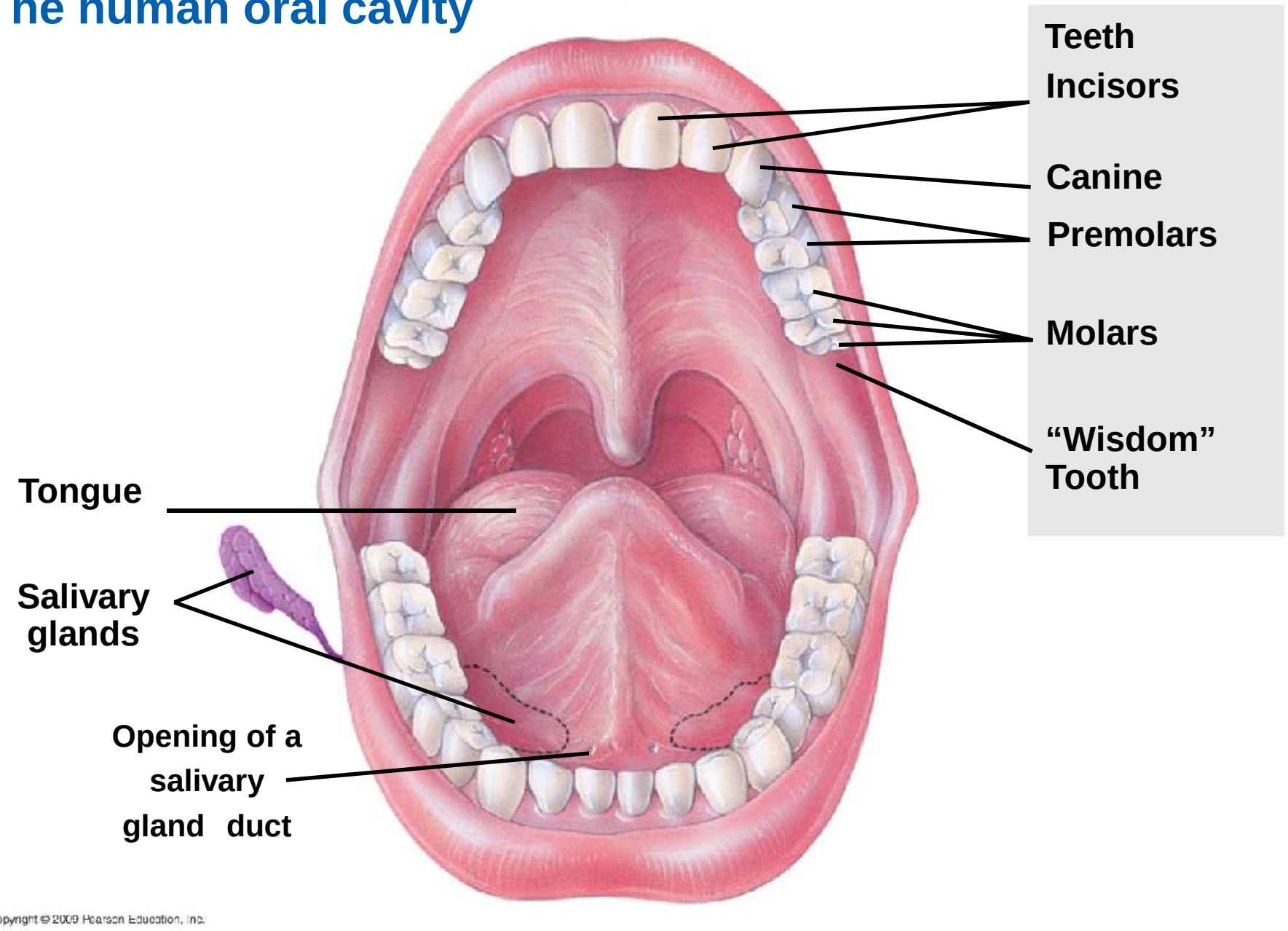
  2- Salivary enzymes begin the hydrolysis of **starch**

  3-Buffers neutralize acids

  4-Antibacterial agents kills some bacteria ingested with food

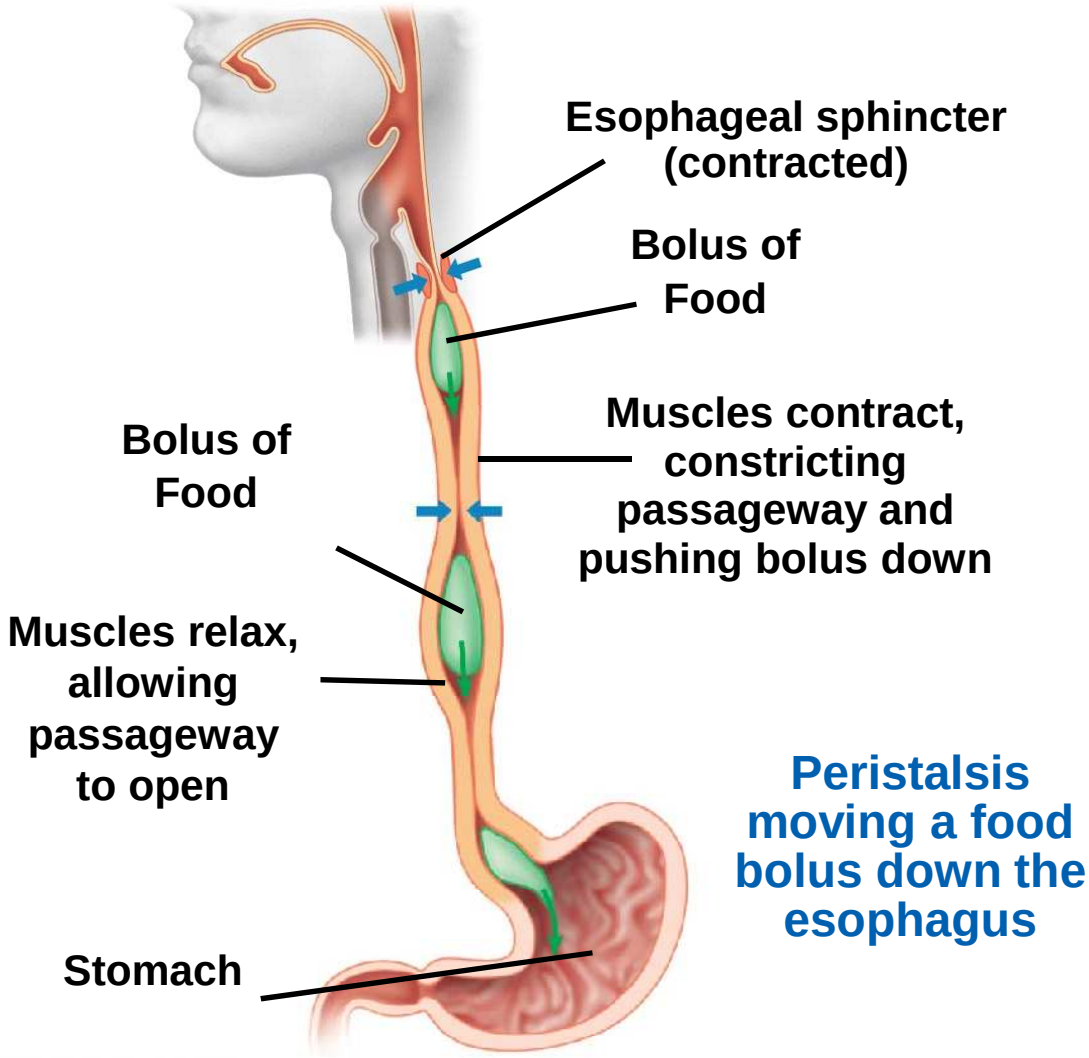
- The tongue tastes, shapes the bolus of food, and moves it toward the pharynx

# The human oral cavity



# 21.6 After swallowing, peristalsis moves food through the esophagus to the stomach

- **The trachea** conducts air to the lungs
- **The esophagus** conducts food from the pharynx to the stomach
- **Pharynx is the common passage for food and air**






Copyright © 2009 Pearson Education, Inc.

# 21.8 The stomach stores food and breaks it down with acid and enzymes

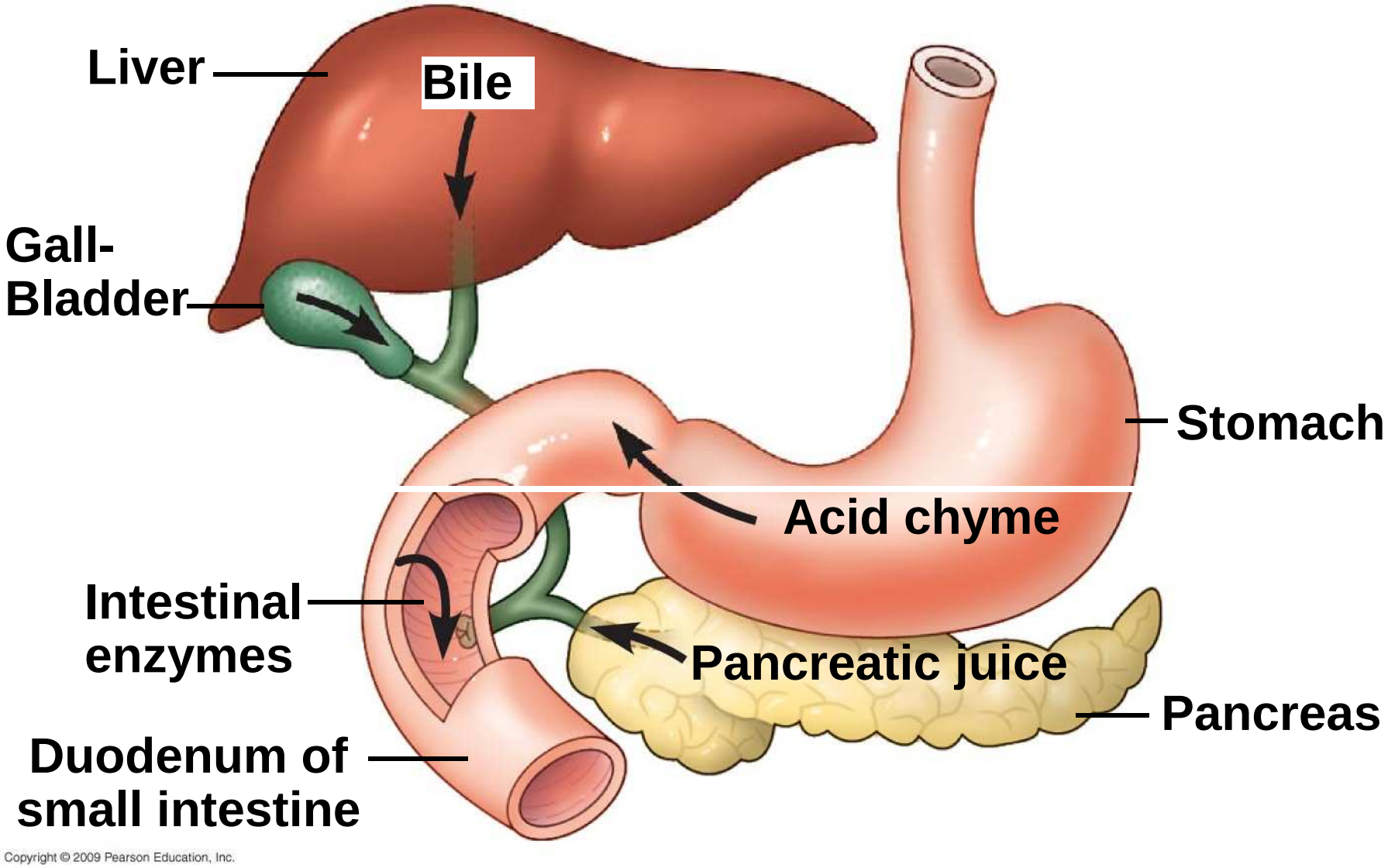
- **Acid**
  - pH 2
  - **Parietal cells** secrete hydrogen and chloride ions, which combine to make HCl
  - Acid kills bacteria and breaks apart cells in food
- **Pepsinogen and HCl produce pepsin**
  - Pepsin production activates more pepsinogen production—**positive feedback**
  - **Pepsin** begins the chemical digestion of **proteins**
  - Acidic gastric juices mix with food to produce **acid chyme**

# 21.8 The stomach stores food and breaks it down with acid and enzymes

- **What prevents the gastric juices from digesting the walls of the stomach**?
  - Mucus helps protect against HCl and pepsin
  - New cells lining the stomach are produced about every 3 days

# 21.10 The small intestine is the major organ of chemical digestion and nutrient absorption

- Small intestine is named for its smaller diameter—it is about 6 meters long
- **Alkaline pancreatic juice** neutralizes acid chyme and **pancreatic enzymes** digest food
- **Bile**, **made** in the liver and **stored** in the gall bladder, **emulsifies** fat for attack by pancreatic enzymes
- Enzymes from cells of the **intestine continue digestion**





The small intestine and related digestive organs

## TABLE 21.10 ENZYMATIC DIGESTION IN THE SMALL INTESTINE

| | | | | |
|---|---|---|---|---|
| **Carbohydrates** | | | | |
| Starch | Pancreatic amylase → | Maltose (and other disaccharides) | Maltase, sucrase, lactase, etc. → | Monosaccharides |
| **Proteins** | | | | |
| Polypeptides | Trypsin, chymotrypsin → | Smaller polypeptides | Aminopeptidase, carboxypeptidase, dipeptidase → | Amino acids |
| **Nucleic acids** | | | | |
| DNA and RNA | Nucleases → | Nucleotides | Other enzymes → | Nitrogenous bases, sugars, and phosphates |
| **Fats** | | | | |
| Fat globules | Bile salts → | Fat droplets (emulsified) | Lipase → | Fatty acids and glycerol |

# 21.10 The small intestine is the major organ of chemical digestion and nutrient absorption

- Surface area for absorption is increased by
  - Folds of the intestinal lining
  - Fingerlike villi
- Nutrients pass across the epithelium and into blood
- Blood flows **to the liver** where nutrients are **processed** and **stored**

# 21.11 One of the liver's many functions is processing nutrient-laden blood from the intestines

- **Blood from the digestive tract drains to the liver**
- **The liver performs many functions**

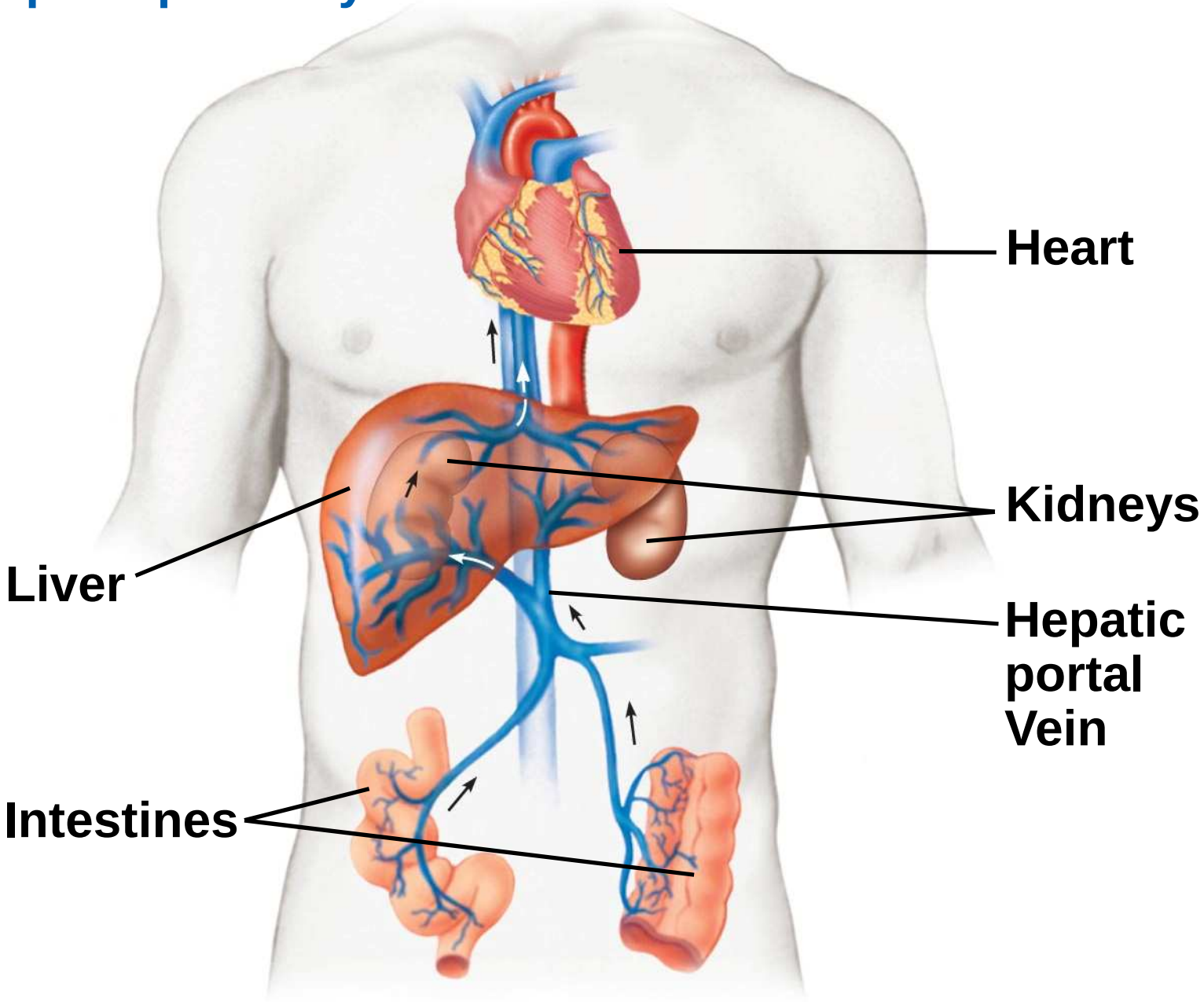
1-Glucose in blood is **converted** to glycogen and stored in the liver

2-Liver **synthesizes** many proteins including blood clotting proteins and lipoproteins that transport fats and cholesterol

3-Liver **changes toxins** to less toxic forms

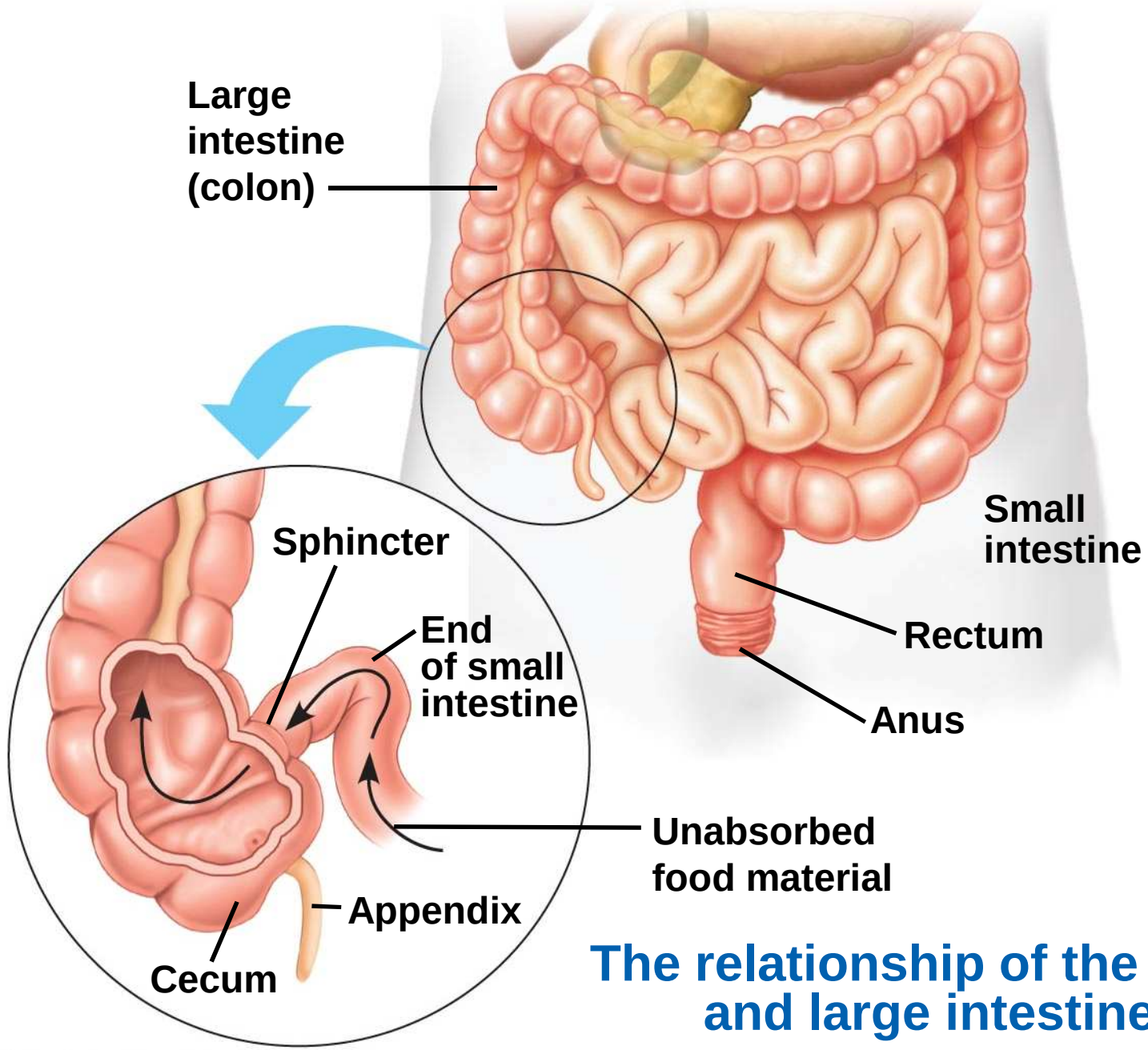
4-Liver produces **bile**

# The hepatic portal system.



# 21.12 The large intestine reclaims water and compacts the feces

- **Diarrhea** occurs when too little water is reclaimed
- **Constipation** occurs when too much water is reclaimed
- **Feces** are stored in the rectum
- **Colon bacteria** produce vitamins—biotin, vitamin K, B vitamins
- **Appendix**
  - Located **near the junction** of the small intestine and colon
  - Makes a minor contribution to immunity




**The relationship of the small and large intestine.**

# NUTRITION

# 21.14 Overview: A healthy diet satisfies three needs

- Fuel to power the body
- Organic molecules to build molecules
- **Essential nutrients**—raw materials that animals cannot make for themselves

# 21.15 Chemical energy powers the body

- Nutrients are oxidized inside cells to make ATP
- Proteins, carbohydrates, and fats are the main sources of calories
- **Basal metabolic rate** (**BMR**): energy a resting animal requires each day
- **Metabolic rate**: BMR plus the energy needed for physical activity
- Excess energy is stored as glycogen or fat

Our metabolic rates typically decrease throughout adulthood

# 21.16 An animal's diet must supply essential nutrients

- Essential nutrients cannot be made from any raw material
- **Undernourishment**—not enough calories
- **Malnourishment**—missing essential nutrients
- Animals cannot produce eight of the 20 amino acids named essential amino acids
- These eight amino acids must come from the diet

# 21.18 A healthy diet includes 13 vitamins and many essential minerals

- **Essential vitamins and minerals**
  - Required in minute amounts
  - Extreme excesses can be dangerous
  - Excess water-soluble vitamins can be eliminated in urine
  - Excess fat-soluble vitamins accumulate to dangerous levels in body fat

- **Minerals** are simple inorganic nutrients usually required in small amounts
  - Calcium and phosphorus are required in larger amounts
  - Most people ingest more salt than they need

# 21.22 CONNECTION: What are the health risks and benefits of weight loss plans?

- **Weight loss diets**
  - May help individuals lose weight
  - May have health risks leading to malnourishment
- Diets fail because people return to old eating habits
- The most effective diets combine
  - Increased exercise
  - Limited balanced diet of about 1200 calories per day

# 21.23 CONNECTION: Diet can influence cardiovascular disease and cancer

- A healthy diet may reduce the risk of cardiovascular disease and cancer
- Two main types of cholesterol
  - **LDL** : contributes to blocked blood vessels and higher blood pressure
  - **HDL :** tends to reduce blocked blood vessels
- Exercise increases HDL levels
- Smoking decreases HDL levels

# You should now be able to

1- Describe the four stages of food processing
2- Describe the main components of the human digestive tract and their functions

3- Explain how teeth and saliva help us swallow

4- Describe the Heimlich maneuver

5- Explain why the stomach does not digest itself

6- Describe the causes and treatment of heartburn, GERD, and gastric ulcers
7- Compare the structures and functions of the small and large intestines
8- Compare the digestive tracts of carnivores and herbivores
9- Distinguish between undernourishment and malnourishment
10- Describe the types of information found on food labels
11- Explain how a healthy diet and exercise promote good health

# Nutrition and Digestion التغذية و الهضم

| المصطلـــــــــــــــح | تعريف المصطلـــــــح |
|---|---|
| Obtaining And Processing Food | الحصول على الطعام وكيفية التعامل معه |
| Herbivores | اكلات الاعشاب |
| Carnivores | اكلات اللحوم |
| Omnivores | مزدوجة التغذية |
| Suspension Feeding | التغذية بالعوالق |
| Substrate Feeding | التغذية مما يحيط به ويعيش عليه |
| Fluid Feeding | التغذية بالسوائل |
| Bulk Feeding | التغذية بكتل ضخمة |
| Ingestion | التناول |
| Digestion | الهضم |
| Absorption | الامتصاص |
| Elimination | الطرد خارج الجسم |
| Mechanical Digestion | الهضم الالي |
| Chemical Digestion | الهضم الكيميائي |
| Cnidarians And Flatworms | الكنيداريات (الجوفمعويات قديم) و الديدان المفلطحة |
| Gastro Vascular Cavity | جوف معدي وعائي |
| Alimentary Canal | قناه هضمية |
| Human Digestive System | الجهاز الهضمي في الانسان |

# Nutrition and Digestion التغذية و الهضم

| المصطلـــــــــــــــح | تعريف المصطلـــــــح |
|---|---|
| Alternating Waves | الموجات المتعاقبة |
| Contraction And Relaxation By Smooth Muscle | الانقباض والانبساط للعضلات الملساء |
| Peristalsis | الانقباضات التموجية |
| Sphincters | العضلات العاصرة |
| Digestive Chambers | القناة الهاضمة |
| Pyloric Sphincter | العضلة العاصرة البوابية |
| Salivary Enzymes | انزيمات اللعاب |
| Hydrolysis Of Starch | حلمأة |
| Buffers Neutralize Acids | تحييد ومعادلة الاحماض |
| Antibacterial Agents | المضادة للبكتريا |
| Shapes The Bolus Of Food | يشكل لقمة الطعام |
| Oral Cavity | الفمي للإنسان |
| Wisdom Tooth | سن العقل |
| Parietal Cells Secrete Hydrogen And Chloride Ions | خلايا جدار المعدة ايونات الهيدروجين و الكلور |
| Pepsinogen | انزيم الببسينوجين |

# Nutrition and Digestion التغذية و الهضم

| المصطلـــــــــــــــح | تعريف المصطلـــــــح |
|---|---|
| Hcl | حامض الهيدروكلوريك |
| Positive Feedback | استرجاع ايجابي |
| Acidic Gastric Juices | العصارة المعدية الحامضية |
| Acid Chyme | الكيموس الحامضي |
| Alkaline Pancreatic Juice Neutralizes Acid Chyme | العصارة البنكرياسية القاعدية بمعادلة الكيموس الحامضي |
| Bile | العصارة الصفراوية |
| Gall Bladder | الحوصلة الصفراوية |
| Surface Area For Absorption | مساحة سطح الامتصاص |
| Folds Of The Intestinal Lining | طيات بطانة الامعاء |
| Fingerlike Villi | خملات تشبه الاصابع |
| Glucose In Blood Is Converted To Glycogen | يتحول سكر العنب (الجلوكوز) الموجود في الدم الى نشا حيواني |
| Stored In The Liver | ويخزن في الكبد |
| Liver Synthesizes Many Proteins | يقوم ببناء البروتينات |
| Blood Clotting Proteins | بروتينات تجلط الدم |
| Lipoproteins That Transport Fats And Cholesterol | البروتينات الليبدية التي تقوم بنقل الدهون و الكلسترول |

# Nutrition and Digestion التغذية و الهضم

| تعريف المصطلـــــح | المصطلـــــــــــــح |
|---|---|
| يحول الكبد السموم الى هيئات اقل سمية | Liver Changes Toxins To Less Toxic Forms |
| ينتج الكبد العصارة الصفراوية | Liver Produces Bile |
| الاسهال | Diarrhea |
| القبض | Constipation |
| يخزن البراز في المستقيم | Feces Are Stored In The Rectum |
| بكتريا القولون تنتج الفيتامينات مثل البايوتين , فيتامين ك وفيتامينات ب | Colon Bacteria Produce Vitamins—Biotin, Vitamin K, B Vitamins |
| الزائدة الدودية | Appendix |
| التغذية | Nutrition |
| تتأكسد المواد الغذائية داخل الخلايا لإنتاج ثلاثي فوسفات الادينوسين | Nutrients Are Oxidized Inside Cells To Make ATP |
| المصادر الاساسية للسعرات الحرارية | Main Sources Of Calories |
| معدل الايض الاساسي | Basal Metabolic Rate (BMR) |
| نسبة ما يحتاجه الحيوان الساكن من الطاقة في اليوم | Energy A Resting Animal Requires Each Day |
| معدل الايض | Metabolic Rate |
| بالأنشطة الحيوية | Physical Activity |

# Nutrition and Digestion التغذية و الهضم

| المصطلـــــــــــــــح | تعريف المصطلـــــــح |
|---|---|
| Excess Energy Is Stored As Glycogen Or Fat | خزن الطاقة الفائضة على هيئة نشا حيواني او دهني |
| Undernourishment | قلة التغذية |
| Malnourishment | سوء التغذية |
| Essential Amino Acids | احماض امينية ضرورية |
| Diet | النظام الغذائي |
| Essential Vitamins And Minerals | الفيتامينات و المعادن الضرورية |
| Extreme Excesses | الزيادة المفرطة |
| Minerals | المعادن |
| Weight Loss Diets | الانظمة الغذائية لإنقاص الوزن |
| Most Effective Diets | نظام الحمية الاكثر تأثير |
| Increased Exercise | المزيد من التمارين الرياضية |
| Limited Balanced Diet | نظام حمية متوازن ومحدد |
| Cardiovascular Disease And Cancer | مخاطر الاصابة بامراض الاوعية القلبية والسرطان |
| Ldl | كلسترول منخفض الكثافة |
| Contributes To Blocked Blood Vessels | يساهم في انسداد الاوعية الدموية |
| Hdl | لكلسترول عالي الكثافة |
| Tends To Reduce Blocked Blood Vessels | يؤدي الى خفض نسبة انسداد الاوعية الدموي |