LIPIDS/FATS

6

Dr. Preston Mercer, FACN
College of Public Health
Community and Family Health
pmercer@usf.edu

Learning Objectives

- Classify fats according to their chemical composition and distinguish between saturated and unsaturated, monounsaturated and polyunsaturated, cis and trans, and omega-3, -6, and -9 fatty acids
- Describe the digestion, absorption, transportation, and storage of fat
- Explain the metabolism of fat, including mobilization, transportation, uptake, activation, translocation, and oxidation as well as ketosis and the effect it may have on training

© Cengage Learning 2015

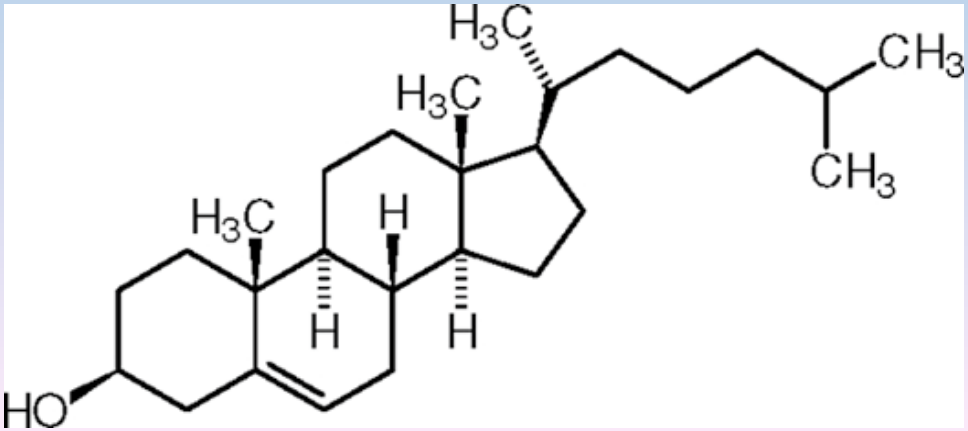
Learning Objectives

- Describe how the body uses fat to fuel exercise
- State fat recommendations for athletes and calculate the amount of fat needed daily
- Identify sources of dietary fat and assess an athlete's dietary fat intake
- Evaluate dietary supplements related to fat metabolism

© Cengage Learning 2015

Introduction

- Fat
  - Dietary intake
    - There are health risks associated with too much and too little
  - Member of lipids class of compounds
    - Triglycerides (fats and oils)
    - Phospholipids
    - Sterols



Roles of Body Fat

- Lipids: provide energy
- Adipose tissue
  - Fat-storing cells; also secretes hormones
  - Fat stored in fat cells
    - Supplies 60 percent of the body's ongoing energy needs during rest
  - Fat embedded in muscle
    - Along with glycogen, provides energy to muscle

TABLE 4-1 The Functions of Fats in the Body

- *Energy stores.* Fats are the body's chief form of stored energy.
- *Muscle fuel.* Fats provide much of the energy to fuel muscular work.
- *Padding.* Fat pads inside the body cavity protect the internal organs from shock.
- *Insulation.* Fats insulate against temperature extremes by forming a fat layer under the skin.
- *Cell membranes.* Fats form the major material of cell membranes.
- *Raw materials.* Fats are converted to other compounds, such as hormones, bile, and vitamin D, as needed.

© Cengage Learning

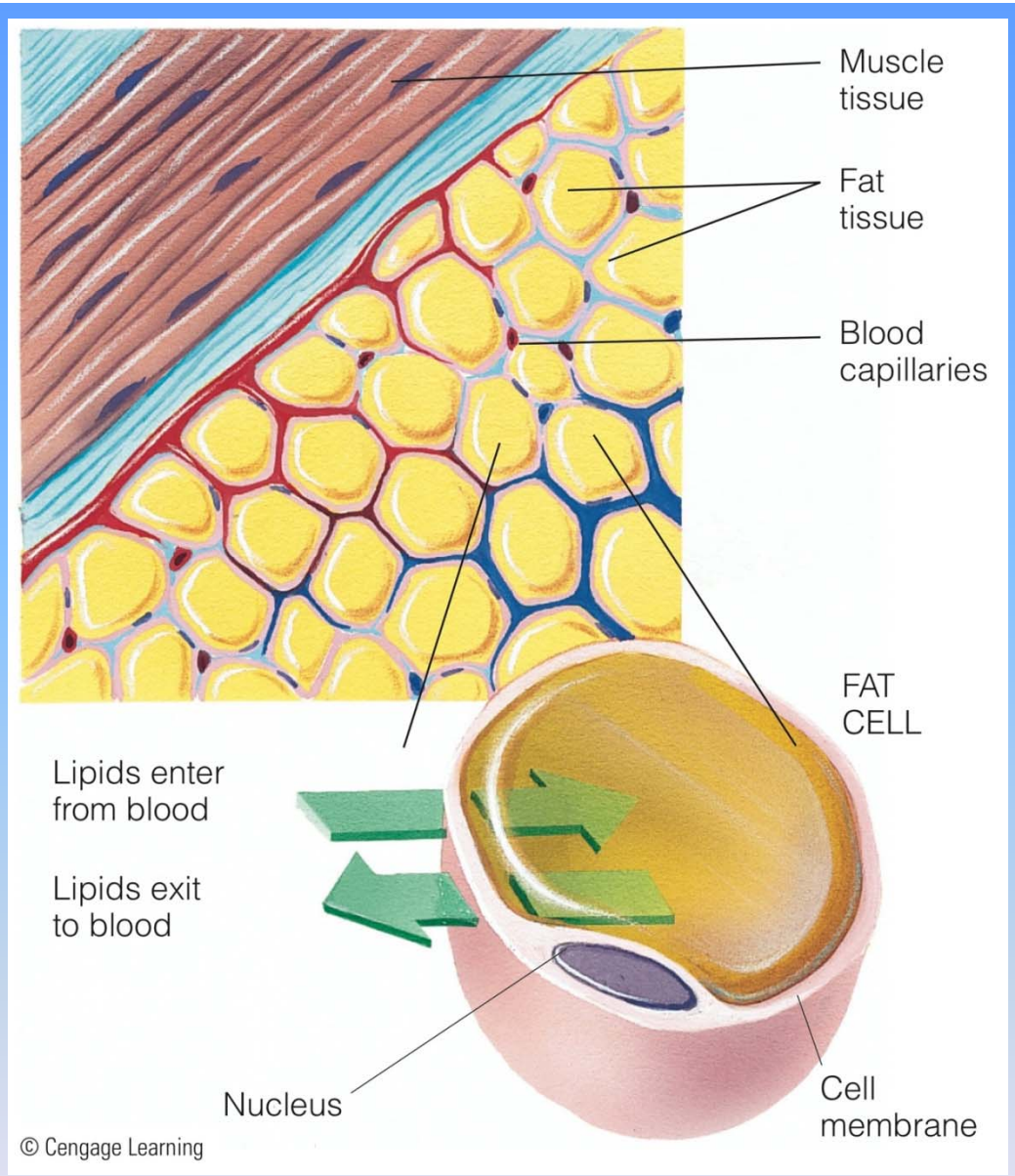

Muscle tissue
Fat tissue
Blood capillaries
FAT CELL
Lipids enter from blood
Lipids exit to blood
Nucleus
Cell membrane
© Cengage Learning

TABLE 4-2 The Lipid Family

Triglycerides (fats and oils)

- Glycerol (1 per triglyceride)
- Fatty acids (3 per triglyceride)
  - Saturated
  - Monounsaturated
  - Polyunsaturated
    - Omega-6
    - Omega-3

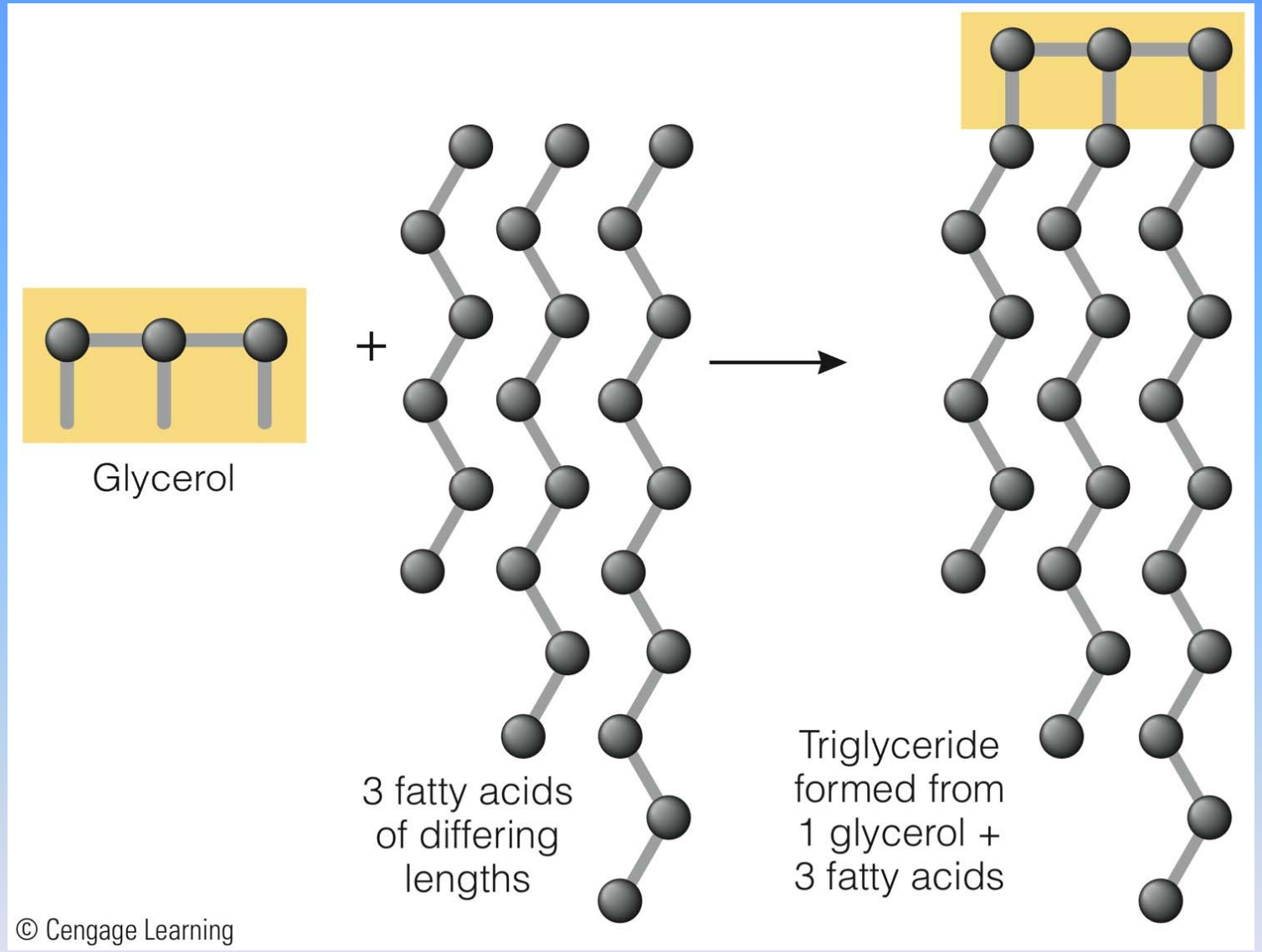
Phospholipids (such as the lecithins)

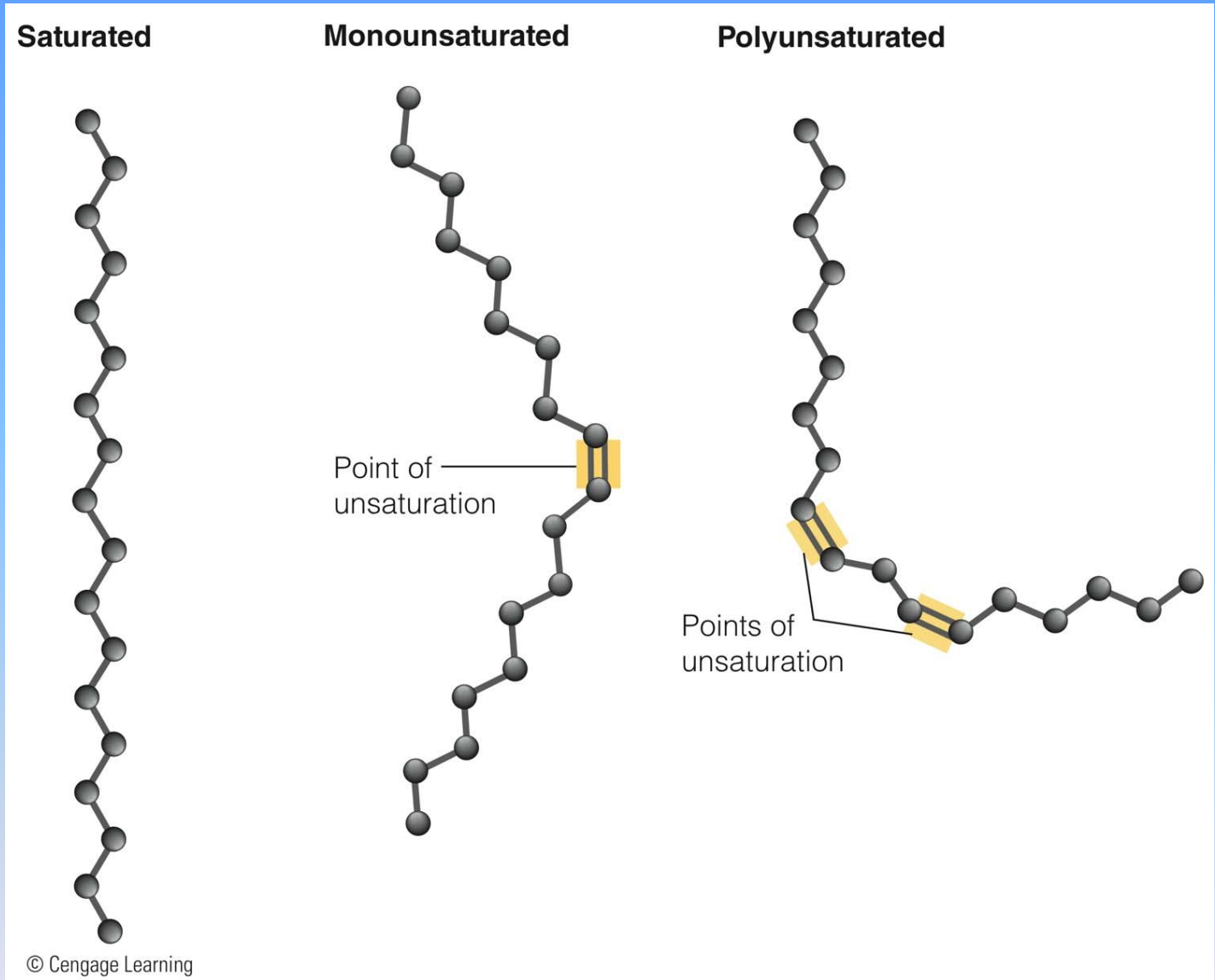
Sterols (such as cholesterol)

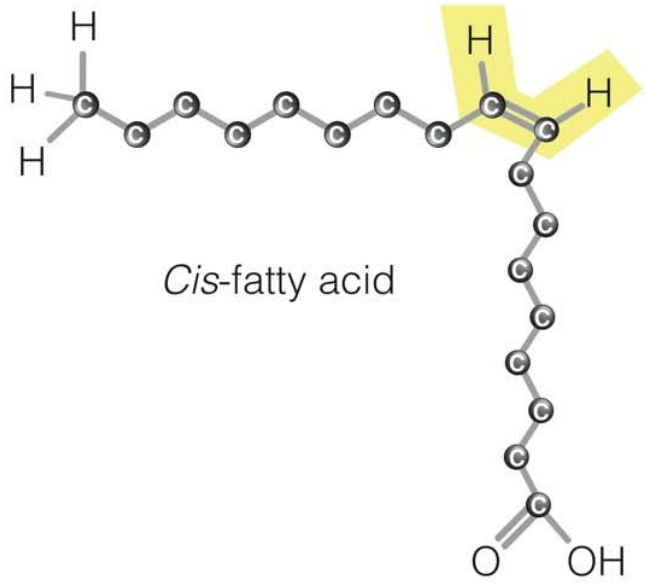
© Cengage Learning

The Chemist's View of Lipids

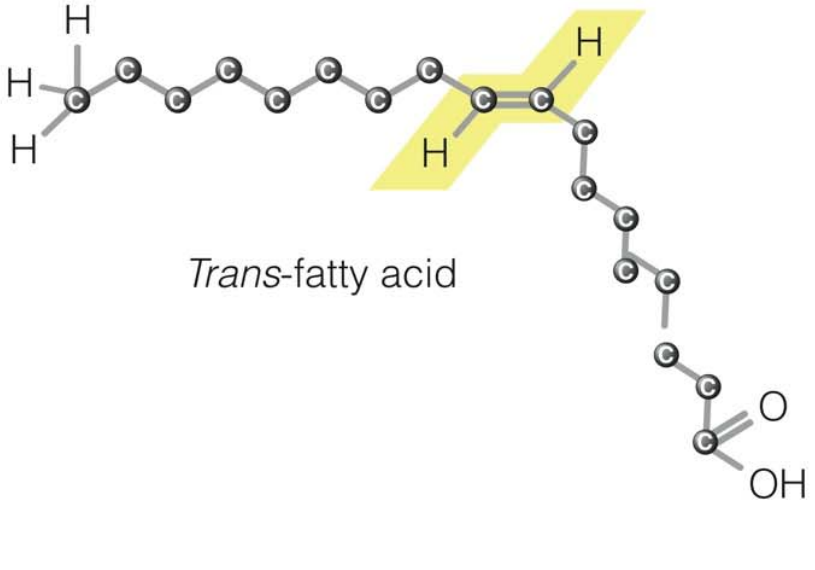
- Triglycerides
  - Predominant form of lipids
  - Three fatty acids attached to a glycerol "backbone"
- Fatty acids
  - Differ in chain length and degree of saturation
  - What is the difference between a saturated fatty acid and an unsaturated fatty acid?


Glycerol
+
3 fatty acids of differing lengths
Triglyceride formed from 1 glycerol + 3 fatty acids
© Cengage Learning


Saturated
Monounsaturated
Polyunsaturated
Point of unsaturation
Points of unsaturation
© Cengage Learning



Cis-fatty acid



Trans-fatty acid

© Cengage Learning

*BHA is butylated hydroxyanisole; BHT is butylated hydroxytolvene.

The Chemist's View of Lipids

CAN YOU TELL BY LOOKING?

- Comparison of three fats
  - Lard (from pork): most saturated ▸ hardest
  - Chicken fat: less saturated ▸ somewhat soft
  - Safflower oil: most unsaturated ▸ liquid
- Stability
  - Why are polyunsaturated fatty acids most susceptible to becoming rancid?

The Chemist's View of Lipids (cont'd.)

- Stability
  - Methods manufacturers protect fat-containing products from rancidity
    1. Seal products airtight and refrigerate
    2. Add antioxidants, e.g., BHA and BHT
    3. Hydrogenate products

The Chemist's View of Lipids (cont'd.)

- Hydrogenation
  - Advantages: protects against oxidation and alters texture
  - What are the disadvantages?
- Essential fatty acids
  - Linoleic acid: omega-6 fatty acid
  - Linolenic acid: omega-3 fatty acid

The Chemist's View of Lipids (cont'd.)

- Phospholipids: class of lipids
  - Food sources: eggs, soybeans, peanuts, etc.
  - Lecithin and other phospholipids
    - Constituents of cell membranes
    - Emulsifiers in the body
    - Some generate signals in cells

The Chemist's View of Lipids (cont'd.)

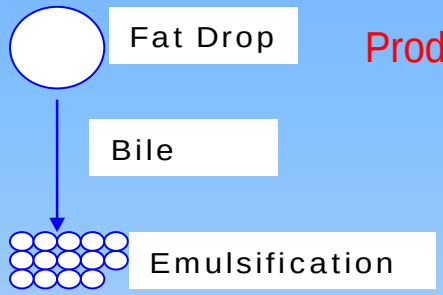
- Sterols
  - Large, complex molecules
    - Interconnected rings of carbon
    - Cholesterol, vitamin D, and sex hormones
  - Cholesterol
    - Obtained in foods as well as made by the liver

Digestion of Lipids

Mouth - None

Stomach - Gastric Lipase

Small Intestine - Bile Salts
Pancreatic Lipase
Cholesterol Lipase
Lecithinase



Products: Glycerol
FFA
Mono - Di - Glycerides
Cholesterol
Cholesterol Esters (Bile)

Water Soluible Micelles

Intestinal Wall → Chylomicrons

Portal → Liver
Glyceros
Shortchain
FA 4-6

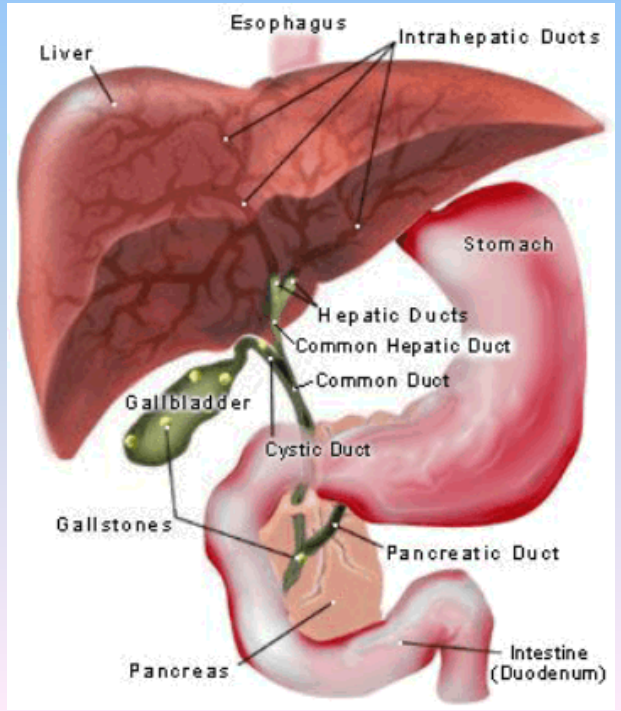
Chylomicrons → Systemic Circulation

Liver → Lipoprot. VLDL → Systemic Circulation

Dietary Lipid
95% Triglyceride

The Chemist's View of Lipids (cont'd.)

- Cholesterol
  - Leaves liver by two routes:
    1. Incorporated into bile, stored in the gallbladder, and delivered to the intestine
    2. Via the bloodstream to all the body's cells



Health Effects and Recommended Intakes of Fats

- Diet high in saturated fats or *trans* fats
  - Increased risk of cardiovascular disease
  - Greater-than-average chances of some cancers
  - An increasing waistline often increases blood triglycerides

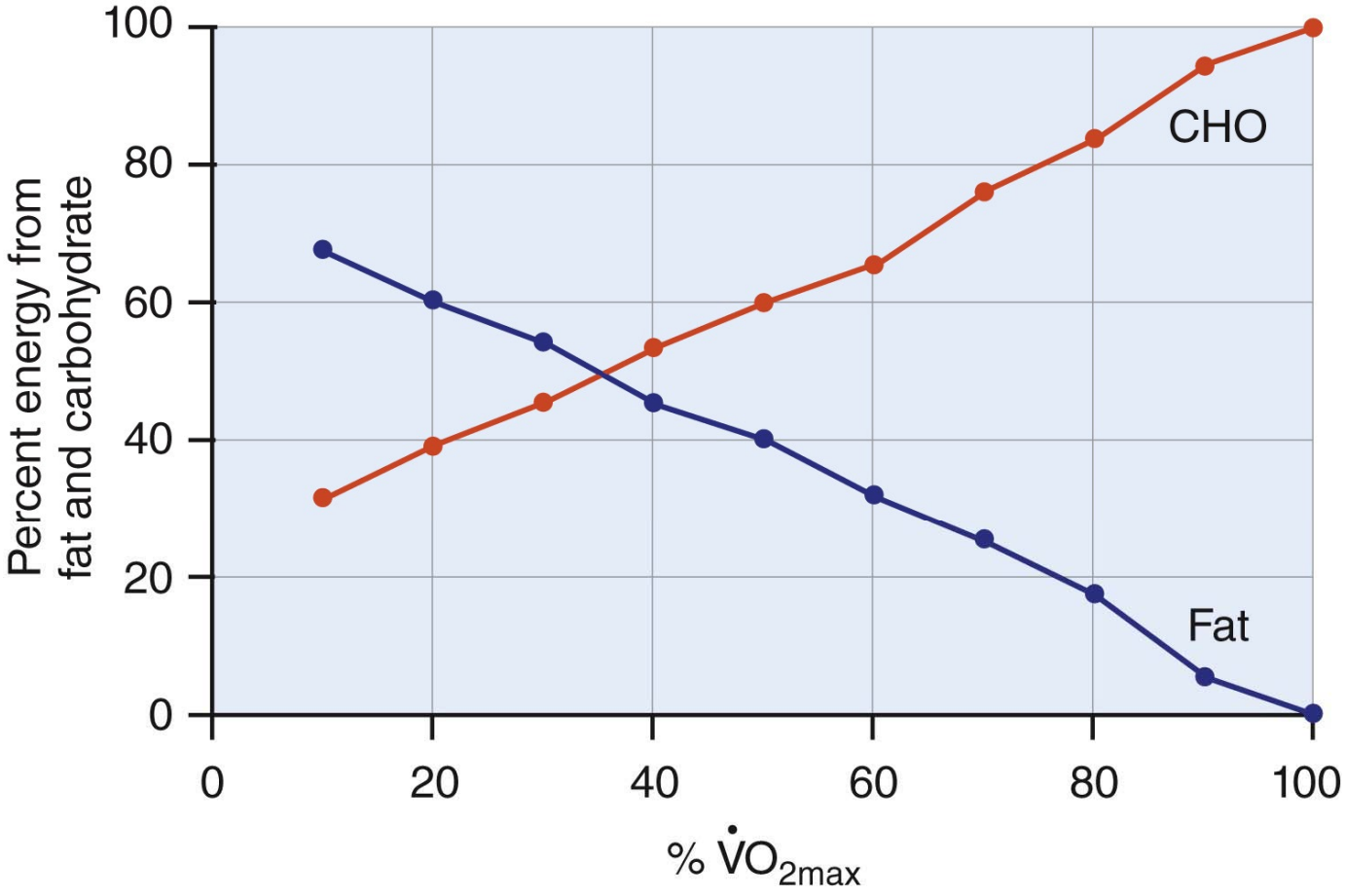
Health Effects and Recommended Intakes of Fats (cont'd.)

- Fats and heart health
  - High LDL: increased likelihood of fatal heart attack or stroke
    - Promotes cholesterol uptake in the blood vessel walls
  - High HDL: lower disease risk
  - *Trans* fats: raise LDL and lower HDL

Health Effects and Recommended Intakes of Fats (cont'd.)

- Dietary Guidelines for dietary cholesterol
  - Healthy people: less than 300/day
  - People with or at high risk of heart disease: less than 200 mg/day
- Monosaturated fat (olive oil)
  - May prevent heart disease
- Omega-6 and omega-3 fats
  - Lower total cholesterol and LDL

Fat Oxidation During Exercise



CHO = carbohydrate

$\dot{V}O_{2max}$ = maximum oxygen consumption

© Cengage Learning. All Rights Reserved.

6.6 Fat Recommendations for Athletes

- Total energy (kcal) need
  - Macronutrient balance
    - Higher CHO/protein intake typically means lower fat intake
    - Severe restriction of fat intake not recommended
  - Often expressed as a % of total energy intake
    - 20 to 35% total caloric intake
  - May be expressed on g/kg body weight basis
    - ~1.0 g/kg daily
    - May need to be as high as 3.0 g/kg (ultra-endurance athletes)

© Cengage Learning 2015

Fat Recommendations for Athletes

- Adjusting fat intake to achieve energy deficits
  - Reducing body fat may result in improved performance
  - Fat intake is typically reduced since reductions to CHO or protein intakes may be detrimental to performance
  - Athletes may consume a short-term, low fat diet to achieve body composition goals
  - The fat intake of a bodybuilder will vary depending on the training cycle

© Cengage Learning 2015

Inadequate Fat Intake Can Negatively Affect Training, Performance, and Health

- Effects of an inadequate fat intake on training, performance, and health
  - Inadequate replenishment of intramuscular fat stores
  - Inability to manufacture sex-related hormones
  - Decline in high-density lipoprotein cholesterol (HDL-C)
  - Inadequate fat-soluble vitamin intakes

© Cengage Learning 2015

Translating Fat Recommendations to Food Choices

- Many athletes fail to consume an appropriate amount of fat
- Certain unsaturated fatty acids may help to reduce heart disease risk
- Excess saturated fat intake should be avoided

© Cengage Learning 2015

Summary

- Fat is the most energy-dense nutrient found in food
- The predominant fat in food and in the body is the triglyceride
- Fat absorption, digestion, transportation, and metabolism are slow and complicated
- The main sites of fat storage are adipocytes, liver, and muscle cells
- Fat is the primary energy source at rest and during low-intensity activity

© Cengage Learning 2015

Summary

- Athletes find that their diets tend to be relatively lower in fat than the typical American diet
- Caution should be used when restricting fat because athletes can reduce the fat in their diets too much

© Cengage Learning 2015