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

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

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
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?

**TABLE 4-2 The Lipid Family**

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triglycerides (fats and oils)</td>
<td>Glycerol (1 per triglyceride)</td>
</tr>
<tr>
<td>• Fatty acids (3 per triglyceride)</td>
<td>Saturated</td>
</tr>
<tr>
<td></td>
<td>Monounsaturated</td>
</tr>
<tr>
<td></td>
<td>Polyunsaturated</td>
</tr>
<tr>
<td></td>
<td>Omega-6</td>
</tr>
<tr>
<td></td>
<td>Omega-3</td>
</tr>
<tr>
<td>Phospholipids (such as lecithins)</td>
<td>Sterols (such as cholesterol)</td>
</tr>
</tbody>
</table>

**Diagram:**

- Illustration of saturated, monounsaturated, and polyunsaturated fatty acids.

*Omega-3 is a type of polyunsaturated fatty acid. DHEA is dehydroepiandrosterone.*
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

Dietary Lipid
95% Triglyceride

Mouth
- None

Stomach
- Gastric Lipase

Small Intestine
- Bile Saliva
  Pancreatic Lipase
  Cholesterol Esterase (Ble)

Bile Salts
Pancreatic Lipase
Cholesterol

Chylomicrons
Liver

Lipoproteins
VLDL

Portal Vein
Dietary Cholesterol
FA 4
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
• 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)
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

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

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

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

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