Dietary Fats

- Dietary fat is the nutrient of greatest concern to the American Heart Association because of the association of certain types of fat with coronary heart disease.
- Dietary fat is an important energy source for endurance-type sport events.

What are the different types of dietary fats?

- Lipids of interest
  - Triglycerides
  - Cholesterol
  - Phospholipids
- Specific fatty acids
  - Essential fatty acids
  - Omega-3 fatty acids
- Specific forms of cholesterol
- Specific types of phospholipids
What are triglycerides?

• An ester of glycerol (alcohol) and 3 fatty acids

Types of fatty acids

What are some common foods high in fat content?

• Fat exchange
  – Oils, butter, margarine
• High-fat meat exchange
  – Sausages, hot dogs, cheese
• Milk exchange
  – Whole milk
### Table 5.3

<table>
<thead>
<tr>
<th>Food Item</th>
<th>Calories</th>
<th>Grams of Fat</th>
<th>Percentage of Calories</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 ounces whole milk</td>
<td>150</td>
<td>8</td>
<td>48%</td>
</tr>
<tr>
<td>1 ounce cheddar cheese</td>
<td>115</td>
<td>9</td>
<td>70%</td>
</tr>
<tr>
<td>1 tablespoon peanut butter</td>
<td>95</td>
<td>8</td>
<td>76%</td>
</tr>
<tr>
<td>1 doughnut</td>
<td>100</td>
<td>5</td>
<td>48%</td>
</tr>
</tbody>
</table>

**Figure 5.4** Reading labels helps locate hidden fat. Who would think that Wieners (hot dogs) can contain about 85 percent of energy content as fat? Looking at the hot dog itself does not suggest that almost all its energy content comes from fat, but the label shows otherwise. Do the math: 120 x 0.85 = 102 or 85 percent.
### How do I calculate the percentage of fat Calories in a food?

#### TABLE 3.1: Calculation of the percentage of Calories in a food that are derived from fat

<table>
<thead>
<tr>
<th>Method A: Direct from label</th>
<th>Method B: From food composition tables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpreting serving</td>
<td>Interpreting serving</td>
</tr>
<tr>
<td>Calories in 100g (as given)</td>
<td>Calories in 100g (as given)</td>
</tr>
<tr>
<td>Fat in 100g (as given)</td>
<td>Fat in 100g (as given)</td>
</tr>
<tr>
<td>Percentage of Calories</td>
<td>Percentage of Calories</td>
</tr>
<tr>
<td>in fat</td>
<td>in fat</td>
</tr>
</tbody>
</table>

**Method A: Direct from label**

1. Interpreting serving:
   - Calories in 100g (as given) = 100
   - Fat in 100g (as given) = 20 grams
   - Percentage of Calories in fat = (20 / 100) * 100 = 20%

**Method B: From food composition tables**

1. Interpreting serving:
   - Calories in 100g (as given) = 100
   - Fat in 100g (as given) = 20 grams
   - Percentage of Calories in fat = (20 / 100) * 100 = 20%
What are fat substitutes?

- Fat substitutes are designed to produce the taste and texture of fat, but without the Calories.
- May be manufactured from carbohydrate, protein and fats and may contain 0-5 Calories per gram.
- Some examples:
  - Oatrim
  - Simplesse
  - Salatrim
  - Olestra

What is cholesterol and what foods contain cholesterol?

- Cholesterol is not a fat, but a sterol.
- Cholesterol is not an essential nutrient, essential meaning necessary in the diet.
- Cholesterol may be manufactured in the liver.
What are phospholipids?
• Comparable to triglycerides

What foods contain phospholipids?
• Rich in eggs, liver, wheat germ, peanuts and other fat containing foods
• Not an essential nutrient
• Your body can make all the phospholipids it needs

How much fat and cholesterol do we need in the diet?
• We need fat for three reasons
  – To provide energy needs
  – To provide essential fatty acids
  – To provide essential fat-soluble vitamins
**Dietary fat: Dietary Reference Intakes**

- **Total fat**
  - An AMDR of 20-35% of daily energy intake
  - No RDA, AI or UL have been set, but diets greater than 35% total fat are not recommended
- **Saturated fatty acids and trans fatty acids**
  - No RDA, AI, or UL have been developed
  - Health professionals recommend maximum of 7-10% of daily energy needs

- **Cis-monounsaturated fatty acids**
  - No RDA, AI or UL developed
  - Some health professionals suggest these are good fats
- **Cis-polyunsaturated fatty acids**
  - Omega-6 fatty acids
    - Linoleic acid is an essential fatty acid (17 g for adult males)
  - Omega-3 fatty acids
    - Alpha-linolenic acid is an essential fatty acid (1.6 g for adults)
- **Cholesterol**
  - 300 mg daily, or 100 mg/1,000 Calories

---

**TABLE 5.4** Daily allowance for grams of fat and saturated fat, and milligrams of cholesterol

<table>
<thead>
<tr>
<th>Total Calories</th>
<th>Fat Calories</th>
<th>Grams of fat</th>
<th>Grams of saturated fat</th>
<th>mg of cholesterol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000</td>
<td>300</td>
<td>33</td>
<td>11</td>
<td>100</td>
</tr>
<tr>
<td>1,500</td>
<td>450</td>
<td>50</td>
<td>16</td>
<td>150</td>
</tr>
<tr>
<td>2,000</td>
<td>600</td>
<td>66</td>
<td>22</td>
<td>200</td>
</tr>
<tr>
<td>2,500</td>
<td>750</td>
<td>83</td>
<td>27</td>
<td>250</td>
</tr>
<tr>
<td>3,000</td>
<td>900</td>
<td>100</td>
<td>33</td>
<td>300</td>
</tr>
</tbody>
</table>

*Based upon a diet containing 30 percent of Calories as fat with 100 milligrams of cholesterol per 1,000 Calories.
Possible problems with excessive dietary fat

• Health
  – May be linked to heart disease
  – May be linked to obesity

• Sports
  – May displace carbohydrates in the diet
  – May lead to excess caloric intake and weight gain
  – May cause gastrointestinal distress as part of a pregame meal

Fat: Metabolism and Function
How does dietary fat get into the body?

• About 98 percent of dietary fat consists of triglycerides
• About 2 percent consists of phospholipids and cholesterol
• Bile salts and lipases digest dietary lipids into free fatty acids (FFA), glycerol, cholesterol, and phospholipids
• Absorbed into intestinal cell; form a chylomicron, which enters the lymphatic system
• Some fatty acids (MCTs) go directly to the liver
What happens to the lipid once it gets into the body?

- Circulate in the body as chylomicrons
- Lipids deposited in body cells for storage as triglycerides
  - Fat or adipose cells
  - Muscle cells (IMTG – Intramyocellular triacylglycerol)
- Liver continues to modify the composition of the lipoproteins
What are the different types of lipoproteins?

- **Very low-density lipoproteins**
  - Mainly triglycerides; deliver FFA and glycerol to cells

- **Low-density lipoproteins**
  - Mainly cholesterol; delivers cholesterol to cells
  - Small dense LDL of health concern

- **High-density lipoproteins**
  - Mainly protein; delivers cholesterol from cells to liver

- **Lipoprotein (a)**
  - Similar to LDL; high density range

*Figure 5.8*
Can the body make fat from protein and carbohydrate?

What are the major functions of the body lipids?

- Structure
  - Lipids in all cell membranes
  - Fat depots as insulators
- Metabolic regulation
  - Essential FFA involved in intracellular metabolic pathways
  - Cholesterol is part of some hormones
  - Adipose cells produce adipokines (adipocytokines), such as leptin, that influence metabolic processes
  - Eicosanoids possess local hormone-like properties
- Energy source
Fat as an energy source

- Fat produces energy only by aerobic processes
- Fat provides about 60% of energy at rest
- Triglycerides yield
  - Glycerol, which goes to the liver
  - FFA, which may be oxidized for energy
- Ketones
  - By-products of excess fatty acid metabolism
  - May be used for energy in cells
How much total energy is stored in the body as fat?

- Fat is an efficient form of energy storage
  - 9 Calories per gram
  - Very little water content
- Total amount of stored fat energy varies, but approximately 80,000 to 100,000 Calories in the average adult male with normal body fat
- Most fat is stored in the adipose cells; about 2,500-2,800 fat Calories are stored in the muscle cells

Fats and Exercise
Are fats used as an energy source during exercise?

- Fat energy sources
  - Plasma chylomicrons and triglycerides: minor source
  - Adipose cell triglycerides
    - Hormone-sensitive lipase released FFA
    - Increases serum FFA for delivery to muscle
  - Muscle cell triglycerides
    - HSL releases FFA
- Use during exercise
  - Serum FFA into muscles is increased during exercise
  - Epinephrine stimulates FFA release from muscle triglycerides

FFA use during exercise
Fat use during exercise

- Mild exercise @ 25% VO\textsubscript{2max}
  - About 80% or energy may come from fat
  - Most serum FFA come from the adipose tissue
- More intense exercise up to 65% VO\textsubscript{2max}
  - Muscle triglycerides become increasingly important
- High-intensity exercise = 85% VO\textsubscript{2max}
  - Carbohydrate is more important and fat use drops to
    =25% as muscle glycogen becomes the main source
  - In general, FFA oxidation decreases as carbohydrate oxidation increases with increases in exercise intensity

<table>
<thead>
<tr>
<th>Table 5.1 Fat energy sources during exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma chylomicrons</td>
</tr>
<tr>
<td>Plasma VLDL</td>
</tr>
<tr>
<td>Plasma FFA</td>
</tr>
<tr>
<td>Muscle FFA</td>
</tr>
</tbody>
</table>

Note: With high-intensity exercise, 65 percent VO\textsubscript{2max} or higher, total fat oxidation falls.

Fat Use during Endurance Exercise

- Plasma FFA are the preferred source of energy during rest and are used during mild exercise (25-45% VO\textsubscript{2max}); all 65% VO\textsubscript{2max} about 90 percent of energy is derived from fat, and about 20 percent from carbohydrate
- Plasma FFA use decreases as exercise intensity increases to 65% VO\textsubscript{2max}
- Muscle FFA used sparingly during mild exercise, but use increases as exercise intensity increases to 65% VO\textsubscript{2max}
- Carbohydrate becomes major source as exercise intensity increases, particularly above 65% VO\textsubscript{2max}, while total fat oxidation decreases
Fat use during exercise:
Suggested limiting factors
- Inadequate FFA mobilization from adipose tissue
- Limited transport of FFA into the muscle cell
- Suboptimal metabolism of intramuscular FFA
- Increased carbohydrate oxidation may inhibit fat oxidation

Fat use during exercise:
Dietary effects
- Carbohydrate intake decreases fat oxidation
  - Increased insulin may inhibit lipolysis
- Carbohydrate intake will help optimize endurance exercise performance
- As carbohydrate levels diminish and FFA use increases, exercise performance is usually impaired

Does gender or age influence the use of fats as an energy source during exercise?
- Gender
  - Some studies report females may oxidize more fat than males during submaximal exercise
  - Other research notes no difference in carbohydrate or fat metabolism during exercise in equally trained subjects
- Age
  - Younger children use more fat during submaximal exercise than do teenagers
  - Children may have low activity of glycolytic enzymes
  - Adult-like use of fat and carbohydrate during exercise is similar once children pass puberty
What effect does exercise training have on fat metabolism during exercise?

- Endurance training induces adaptations that enhance fat utilization and aerobic exercise performance
  - Increased expression of genes in the skeletal muscle that increase enzymic capacity for fat oxidation
  - Increased muscle triglyceride storage
    - Increased insulin sensitivity facilitates FFA entry to muscle
    - Increased FFA transporters in the muscle cell membrane
  - Increased sensitivity of muscle and adipose cells to epinephrine
  - Increased transport of plasma FFA into muscle during exercise

Fats and Endurance Performance

- Endurance training induces adaptations that enhance fat utilization and aerobic exercise performance
  - Increased expression of genes in the skeletal muscle that increase enzymic capacity for fat oxidation
  - Increased muscle triglyceride storage
    - Increased insulin sensitivity facilitates FFA entry to muscle
    - Increased FFA transporters in the muscle cell membrane
  - Increased sensitivity of muscle and adipose cells to epinephrine
  - Increased transport of plasma FFA into muscle during exercise

### Table 5.6
Possible mechanisms associated with the increased use of fat as an energy source during aerobic endurance exercise following exercise training.

- Increased blood flow and utilization to the muscle, delivering more plasma FFA.
- Increased muscle triglyceride content, possibly associated with increased insulin sensitivity.
- Increased sensitivity of both adipose and muscle cells to epinephrine, resulting in increased FFA release to the plasma and within the muscle from triglycerides.
- Increased number of fatty acid transporters in the muscle cell membrane to move fatty acids from the plasma into the muscle cell.
- Increased ability to use lipolysis as an energy source.
- Increased number and size of mitochondria and associated oxidative enzymes for processing of activated FFA.
- Increased activation of PPAR and transport across the mitochondrial membrane.
- Increased activity of oxidative enzymes.
Fats: Ergogenic Aspects

- Strategies or supplements proposed to be ergogenic
  - Fat loading
  - Fasting
  - Medium-chain triglycerides (MCTs)
  - Glycerol
  - Phospholipids
  - Omega-3 fatty acids
  - Carnitine
  - Hydroxycitrate (HCA)
  - Conjugated linoleic acid (CLA)
  - Caffeine

What is fat loading?

- Theoretical mechanism to help delay onset of fatigue
  - Elevated serum FFA levels and muscle triglyceride levels
  - Increase the percentage use of fat as an energy source during exercise
  - Spare the use of muscle glycogen

Acute fat loading

- Acute high-fat diets
  - Infuse a lipid solution with heparin
  - Ingest a high-fat (60-90% fat) meal prior to exercise
  - Ingest a high-fat diet for 1-2 days prior to exercise

- Research findings
  - Acute high-fat diets do not enhance aerobic endurance performance
  - Some research indicates consuming a high-fat diet for 1-2 days may impair performance in high-intensity exercise tasks
Chronic fat loading

• Chronic high-fat diets
  – Ingest a high-fat (40-70%) diet for 1-3 weeks
  – Some studies provided high-carbohydrate meals prior to testing
• Research findings from studies and reviews with trained individuals

Chronic fat loading

– Results from several studies of an ergogenic effect
  • Increased exercise time to exhaustion at moderate intensity
  • Faster time in cycling time trial
  • Greater fat utilization and sparing of muscle glycogen
  • Suggest performance at 60-80 % VO₂max may be improved in distance cyclists and runners

Chronic fat loading

– Results from studies of no ergogenic effect
  • No effect on cycling time to exhaustion
  • No effect on cycling time trial (100 kilometers)
  • In several studies, there was greater fat utilization and sparing of muscle glycogen
  • In several studies, performance time was better with the high-fat diet, but not statistically significant
High Fat Diets – The Bottom Line

- Chronic high-fat diets
  - Overall, research findings are equivocal but generally indicate that a chronic high-fat diet does not enhance aerobic endurance performance
  - Endurance performance can, at best, only be maintained on such diets as compared to high-carbohydrate diets
  - Endurance athletes may adapt to high-fat diets, but training becomes more psychologically stressful
  - Some studies suggest high-fat diets impair endurance performance
  - Diets containing 20-30 percent of energy from fat appear to be reasonable for endurance athletes

Will fasting help improve my performance?

- Fasting for 24 hours may increase serum FFA availability
- However, fasting may impair
  - Carbohydrate availability
  - Endurance exercise performance
- Fasting may be used in weight-control sports, and effects are discussed in chapter 10

Can the use of medium-chain triglycerides improve endurance performance?

- Theory as an ergogenic aid
  - Rapid absorption into portal circulation
  - Rapid uptake by mitochondria in muscle cells
  - May be oxidized at a rate similar to exogenous glucose
Ergogenic effects of MCTs:
Research findings
- Most studies with MCT supplementation, either consumed separately or combined with carbohydrate, have not shown enhanced performance in endurance exercise tests
- MCT supplementation does not appear to spare use of muscle glycogen
- Several studies have shown impaired performance with MCT supplementation
- MCT supplementation may also cause gastric distress in some individuals and impair performance

Is the glycerol portion of triglycerides an effective ergogenic aid?
- Theory as an ergogenic aid
  - Exogenous glycerol may be converted to glucose and be an efficient energy source during exercise
- Research findings
  - Glycerol does not affect endurance performance
  - The rate of conversion by the liver may be too slow

Are phospholipid dietary supplements effective ergogenic aids?
- Theory as an ergogenic aid
  - Phosphatidylcholine (lecithin)
    - Contains choline for formation of acetylcholine
    - Contains phosphates, which may be ergogenic
  - Phosphatidylserine
    - Optimal functioning of neuronal cells; may affect hormonal responses to exercise favorably
    - May serve as an antioxidant to prevent muscle damage
    - May help promote optimal balance of calcium in muscle cells
Ergogenic effect of phospholipids: Research findings

- Phosphatidylcholine
  - Early studies with poor control showed ergogenic effects
  - Later research, although limited, found no ergogenic effects

Ergogenic effect of phospholipids: Research findings

- Phosphatidylserine
  - Little to no effect on muscle tissue damage
  - A recent study by the same research group have shown improved performance in a cycling test to exhaustion
  - Research findings are preliminary and more research is recommended

Why are omega-3 fatty acids suggested to be ergogenic, and do they work?

- Theory as an ergogenic aid
  - May increase blood flow and O2 delivery
  - RBC membrane less viscous; easier blood flow
  - Produce eicosanoids that induce vasodilation
  - May also increase secretion of human growth hormone
  - One of the theories of the Zone Diet
**Ergogenic effects of omega-3 fatty acids: Research findings**
- Non peer-reviewed studies found improved performances with Eicomax, a sport dietary supplement
- Results from well-controlled, peer-reviewed scientific research indicate omega-3 fatty acids do not affect energy metabolism during exercise.
- Studies also report no ergogenic effect on aerobic endurance performance.
- Some research suggests omega-3 fatty acids may help reduce bronchoconstriction in athletes with exercise-induced asthma.

**Can carnitine supplements enhance fat metabolism and exercise performance?**
- Theory as an ergogenic aid
  - L-carnitine may help increase a specific enzyme that facilitates transport of long-chain fatty acids into mitochondria and increase fat oxidation. Carnitine may also increase blood flow.
  - Carnitine may be beneficial to endurance athletes by increasing fat oxidation and sparing muscle glycogen.
  - Carnitine supplementation has increased endurance in patients with peripheral vascular disease.
  - Carnitine dietary supplements have also been marketed for weight loss.
  - Carnitine may facilitate the oxidation of pyruvate, which may reduce production of lactic acid during exercise.

**Ergogenic effect of carnitine: Research findings**
- Supplementation may increase plasma levels, but not muscle concentration of carnitine.
- No effect on fat oxidation.
- Acute supplementation does not improve performance.
- No effect on lactic acid energy system or related performance.
- No effect on VO2max or aerobic performance.
- Does not reduce body fat.
- L-carnitine is safe, but D-carnitine may be toxic.
- Carnitine/tartrate: Antioxidant effect of tartrate.
Can hydroxycitrate (HCA) enhance endurance performance?

- Theory as an ergogenic aid
  - Modify citric acid cycle metabolism to promote fatty acid oxidation
- Research findings
  - Available research is limited, but findings indicate no effect on fat metabolism during exercise in either sedentary or endurance-trained cyclists

Can conjugated linoleic acid (CLA) enhance exercise performance?

- Theory as an ergogenic aid
  - Marketed as a means to decrease body fat and increase lean muscle mass in resistance-trained athletes
- Research findings
  - Research with trained athletes is limited, but indicates CLA supplementation has no effect on body fat, muscle mass, or strength tests in resistance-trained athletes
  - Effects on health are discussed later in this chapter

What’s the bottom line regarding the ergogenic effects of fat-burning diets or strategies?

- Increasing the use of fat as a fuel during exercise does not appear to increase endurance exercise capacity
- Athletes should not attempt to increase the amount of fat in their diet
- Recommendations suggest athletes should consume about 20-30% of daily energy needs as fat
- High-fat diets may impair exercise performance
Caffeine

- Original theory
  - Enhance oxidation of FFA and spare muscle glycogen
  - Enhance aerobic endurance exercise performance

Dietary Fats and Cholesterol: Health Implications

- Dietary fat as a risk factor for chronic diseases may be associated with the amount and type of fat. There are good fats and bad fats
- Chronic diseases associated with excess dietary fat
  - Coronary heart disease
  - Obesity
    - Diabetes
    - High blood pressure
  - Certain forms of cancer
- Key point: Avoid diets that are very low and very high in fat

How does cardiovascular disease develop?

- A number of cardiovascular diseases
  - Coronary heart disease
  - Stroke
  - Hypertensive disease
  - Rheumatic heart disease
  - Congenital heart disease
Coronary heart disease (CHD)
Coronary artery disease (CAD)

- Disease of the coronary arteries

Coronary heart disease

- Arteriosclerosis
- Atherosclerosis
  - Associated with formation of plaque

Coronary heart disease

- Increased plaque may lead to coronary occlusion or coronary thrombosis (clot) that will induce ischemia, or a decrease blood flow to the heart muscle
- Angina, or pain, may be an indicator of decreased blood flow to the heart muscle
- If blood flow decrease is severe, myocardial infarct, or death of heart muscle, will occur
Cool Website

- www.Americanheart.org/riskassessment

- Use this questionnaire to assess your risk of developing coronary heart disease. Knowing your cholesterol levels and blood pressure is helpful, but not required. Some information about risk factors is also presented.
How do the different forms of serum lipids affect the development of atherosclerosis?

• Total cholesterol (Lower is better)
• LDL-cholesterol (Lower is better)
• HDL-cholesterol (Higher is better)
• Triglycerides (Lower is better)
• Cholesterol ratios
  – TC/HDL: 4.5 is average risk; lower is better
  – LDL/HDL: 3.5 is average risk; lower is better

**TABLE 5.8** Serum lipid factors associated with increased risk of atherosclerosis

<table>
<thead>
<tr>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>High levels of total cholesterol</td>
</tr>
<tr>
<td>High levels of LDL-cholesterol</td>
</tr>
<tr>
<td>High levels of dense form of LDL-cholesterol</td>
</tr>
<tr>
<td>High levels of HDL-cholesterol</td>
</tr>
<tr>
<td>High levels of abnormal lipoprotein, lipoprotein (a)</td>
</tr>
<tr>
<td>High levels of apolipoprotein B</td>
</tr>
<tr>
<td>High levels of triglycerides</td>
</tr>
<tr>
<td>Low levels of HDL-cholesterol</td>
</tr>
<tr>
<td>Low levels of LDL-cholesterol</td>
</tr>
<tr>
<td>Low levels of apolipoprotein A-I</td>
</tr>
</tbody>
</table>

Conversion: mmol/L to mg/dL

• Total, LDL-, and HDL-cholesterol
  – Multiple mmol/L by 38.67
• Triglycerides
  – Multiple mmol/L by 88.57
National Cholesterol Education Guidelines:
Fasting levels in mg/dl

• Total cholesterol
  – Less than 200: Desirable
  – 200-239: Borderline high
  – 240 or above: High

• LDL-cholesterol
  – Less than 100: Optimal
  – 100-129: Near optimal
  – 130-159: Borderline high
  – 160-189: High
  – 190 and above: Very high

• HDL-cholesterol
  – Less than 40: Low
  – 160 or above: Protective
National Cholesterol Education Guidelines: Fasting levels in mg/dl

- Triglycerides
  - Less than 150: Normal
  - 151-199: Borderline high
  - 200-499: High
  - 500 and above: Very high

Can I reduce my serum lipid levels and possibly reverse atherosclerosis?

- Research suggests for each 1% reduction in serum LDL-cholesterol, there is a 1% reduction in risk of coronary heart disease
- Healthier lifestyle
  - Diet
  - Exercise
- Drugs
  - Statins
National serum cholesterol guidelines: Use of drugs

<table>
<thead>
<tr>
<th>Risk Category</th>
<th>Target LDL (mg/dl)</th>
<th>Take drugs if LDL is</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Less than 160</td>
<td>190 or higher</td>
</tr>
<tr>
<td>Moderate</td>
<td>Less than 130</td>
<td>160 or higher</td>
</tr>
<tr>
<td>Moderately high</td>
<td>Less than 130 (optional goal 100)</td>
<td>130 or higher</td>
</tr>
<tr>
<td>High</td>
<td>Less than 100 (optional goal 70)</td>
<td>100 or higher</td>
</tr>
</tbody>
</table>

What should I eat to modify my serum lipid profile favorably?

- Diet guidelines have been developed by a variety of health professional groups
  - National Cholesterol Education Program
  - American Heart Association
  - National Institutes of Health
  - National Heart, Lung, and Blood Institute
  - DASH diet
  - OmniHeart diet
Dietary recommendations to reduce the risk of CHD

• 1. Adjust caloric intake to achieve and maintain ideal body weight

• 2. Reduce the total amount of fats in the diet
   – May reduce fat content to 20% or less of energy
   – Do not replace fats with refined carbohydrates

• 3. Reduce the amount of saturated fat to less than 7 percent of dietary Calories
   – Eat more plant foods
   – Choose lean meat, fish, and poultry

<table>
<thead>
<tr>
<th>Hamburger (4 ounces)</th>
<th>% fat</th>
<th>Calories</th>
<th>Grams of fat</th>
<th>Grams of saturated fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular</td>
<td>25</td>
<td>331</td>
<td>28</td>
<td>10.7</td>
</tr>
<tr>
<td>Lean</td>
<td>15</td>
<td>243</td>
<td>17</td>
<td>6.6</td>
</tr>
<tr>
<td>Extra lean</td>
<td>9</td>
<td>155</td>
<td>5.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Extra lean</td>
<td>3</td>
<td>136</td>
<td>4.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Dietary recommendations to reduce the risk of CHD

4. Reduce the consumption of trans fats and, comparable to saturated fat, keep dietary intake as low as possible.
   - Combined total of saturated and trans fat intake should not exceed 10% of daily caloric intake
   - Check food labels for trans fats
     • Food label may list 0 grams if less than 0.5 gram
     • Eating multiple servings could increase trans fat intake
   - Eat at trans fat-free restaurants

5. Substitute monounsaturated fatty acids (MUFAs) for saturated fats and simple, refined carbohydrates
   - Monounsaturated oils: Olive, canola
   - The Mediterranean diet
     • Rich in olive oil
     • Also rich in vegetables, whole grains, and seafood
   - The AHA approves of diets rich in MUFAs provided they
     • they are used to replace saturated fats in the diet
     • that caloric intake is in balance
   - There is a qualified health claim for olive oil

6. Consume adequate amounts of polyunsaturated fatty acids (PUFAs)
   - Essential fatty acids found in vegetable oils, nuts
     - Linoleic fatty acid (omega-6)
     - Alpha-linolenic fatty acid (omega-3)
   - Other omega-3 fatty acids
Omega-3 fatty acids

- Omega-3 fatty acids
  - Eicosapentaenic acid (EPA)
  - Docosahexaenic acid (DHA)
- Found mainly in fish

**TABLE 5.11**

| Grams of EPA and DHA in fish per 3-ounce edible fish portion and in fish oils per gram of oil |
|---|---|---|
| > 1 gram/3 ounces | 0.5-1.0 gram/3 ounces | < 0.5 gram/3 ounces |
| Herring | Halibut | Codfish |
| Oysters, Pacific | Omega-3 concentrate* | Cod |
| Salmon, Atlantic, farmed | Salmon, sockeye | Cod liver oil* |
| Salmon, Atlantic, wild | Trout | Crab |
| Salmon, chinook | Tuna, fresh | Flounder/Sole |
| Sardines | Tuna, white, canned in water | Haddock |
| | | Lobster |
| | | Oysters, Eastern |
| | | Scallops |
| | | Shrimp |
| | | Tuna, light, canned in water |

Omega-3 fatty acids:

**EPA and DHA**

- Epidemiological research indicates populations that consume diets rich in fish have a lower incidence rate of CHD
- Theory underlying health effects of EPA and DHA
  - Help to form eicosanoids (local hormones) that affect metabolism and gene expression
Omega-3 fatty acids: EPA and DHA

Experimental research has suggested a number of possible mechanisms underlying health benefits of omega-3 fatty acids:
- Reduce serum triglycerides
- Increase HDL-cholesterol
- Prevent clot formation
- Decrease platelet aggregation
- Improve vascular tone
- Decrease blood viscosity
- Optimize blood pressure
- Promote anti-inflammatory activity
- Decrease abnormal heart rhythms

Omega-3 fatty acids: EPA and DHA

- Experimental research findings are equivocal regarding a cardio protective effect of omega-3 fatty acid supplementation
- Some reviews note that epidemiological evidence favors risk reduction, while experimental studies do not. People who eat more fish may engage in other healthy behaviors
- Conversely, several meta-analyses indicate eating more fish and omega-3 fatty acids lowers mortality from cardiovascular disease

Omega-3 fatty acids: AHA Scientific Statement

- Key points of the AHA statement on fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease
- Eat fish, particularly fatty fish, at least twice a week
- Eat plant foods rich in alpha-linolenic fatty acid
- Individuals who have high serum triglycerides may benefit from a fish oil supplement of 2-4 grams of EPA and DHA daily
Caveats on eating fish

- Some types of fish contain mercury (methylmercury)
  - Shark
  - Swordfish
  - King mackerel
  - Ahi tuna (Sushi)
- Mercury may harm the nervous system and impair neurodevelopment in the fetus or in young children
- Other fish, such as farmed salmon, may contain environmental contaminants

Fish and Health

- In general, the benefits of fish outweigh the risks
- Caution is recommended for some
  - Women of childbearing age
    - Limit intake of large, predatory fish
    - Eat no more than 12 ounces of other fish per week
    - Limit light tuna to 3 cans, white to 1 can per week
  - Pregnant women should avoid canned tuna entirely
  - Young children should follow similar precautions
  - Adults should eat a wide variety of fish; local fish if possible

Fish and Health

- Select fresh, local seafood when available
- Recommendations from the Consumers Union

<table>
<thead>
<tr>
<th>Daily</th>
<th>Several times a week</th>
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<tbody>
<tr>
<td>Salmon</td>
<td>Flounder</td>
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<td>Tilapia</td>
<td>Sole</td>
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<td>Pollock</td>
<td>Herring</td>
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<td>Clam</td>
<td>Crab</td>
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<td>Crawfish</td>
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Fish oil supplements

- Some health professionals recommend 500-1,300 mg daily of EPA and DHA combined, but mainly from fish.
- American Heart Association
  - Recommends individuals with heart disease obtain EPA and DHA from fish, about one gram a day.
  - Consult with your physician if you want to obtain EPA and DHA from supplements.
- Typical 1,000 mg fish capsule contains 300 mg of EPA (180 mg) and DHA (120 MG).
- Quality and safety of supplements may be questionable.

Conjugated linoleic acid (CLA)

- CLA is a polyunsaturated omega-6 fatty acid.
- It is found naturally in small amounts in dairy foods and beef.
- May have small effect on fat loss in obese individuals.
- However, the Consumers Union indicates CLA may impair glucose metabolism and promote inflammation, which are adverse health effects.

Dietary recommendations to reduce the risk of CHD

- 7. Reduce the amount of dietary cholesterol.
  - Some question the need to limit dietary intake of cholesterol.
  - A recent meta-analysis covering 17 studies concluded that the addition of 100 milligrams of dietary cholesterol per day would increase slightly the ration of total cholesterol to HDL-cholesterol.
  - Limiting cholesterol intake may be especially important for cholesterol responders, whose serum increases with intake.
  - Cholesterol levels on the DV are based on 300 mg/day.
  - The AHA recommends 300 mg/day, or 100 mg/1,000 kcal.
Dietary recommendations to reduce the risk of CHD

8. If you consume foods with artificial fats, do so in moderation
   - Fat substitutes are GRAS
   - Foods with olestra, such as potato chips, may cause intestinal cramps and loose stools when consumed in larger amounts
   - The ADA concludes fat substitutes may play a role in weight control, if they are part of a balanced diet and lower the total caloric content of the food
   - The American Diabetes Association indicates fat substitutes may help improve the serum lipid profile

9. Reduce intake of refined carbohydrates and increase consumption of plant foods high in complex carbohydrates and dietary fiber, particularly water-soluble fiber.
   - Refined sugar and starches can ↑ serum triglycerides
   - Legumes, oat products, and soy protein may ↓ serum cholesterol
   - Plant foods, such as almonds and oats, that contain sterols and stanols are known to ↓ serum cholesterol
     - 2 grams/day may ↓ total and LDL-cholesterol
     - Fortified foods available, such as Benecol (tub margarine)

10. Nibble food throughout the day
   - Research indicates that consuming the same amount of total Calories consumed throughout the day rather than in three concentrated meals at breakfast, lunch, and dinner would significantly reduce LDL-cholesterol
   - For some, it may be wise to avoid eating a high fat meal
     - It may impair blood vessel function
     - It may reduce the anti-inflammatory potential of HDL-cholesterol
     - It may significantly increase serum triglycerides and decrease blood flow through the heart
     - It could increase blood pressure responses to a stressful situation
Can exercise training also elicit changes in serum lipid profiles?

- Aerobic exercise may help reduce the morbidity and mortality of CHD
- The precise mechanism whereby exercise may help reduce the morbidity and mortality of CHD has not been identified
Exercise and CHD

- Possible beneficial mechanisms of exercise
  - Reduction in body fat and maintain a healthy weight
  - Reduction of blood pressure
  - Favorable effects on the serum lipid profile
    - Muscle membrane more insulin sensitive
      - Clears lipids from the blood
    - Modified activity of some enzymes
      - Hepatic lipase
      - Lipoprotein lipase

Exercise and CHD

- An acute bout of exercise may reduce risk factors for CHD
  - Reduce blood pressure
  - Reduce serum triglycerides
  - Increase HDL-cholesterol
  - Improve insulin sensitivity and glucose homeostasis

Exercise and CHD

- Chronic exercise training exerts favorable effects on the serum lipid profile in both males and females
  - Lower serum triglycerides (↓ 5-38 mg/dL)
  - Higher levels of HDL-cholesterol (↑ 2-8 mg/dL)
- However, exercise training may have little effect on
  - Total cholesterol
  - LDL-cholesterol
- Increased amounts of daily physical activity may confer additional benefits
- Some individuals may not respond and may need drugs to achieve a favorable lipid profile
Exercise and CHD

- Females who become amenorrheic with excessive exercise and low energy intake may have lower levels of estrogen, which could lead to ↓ HDL-cholesterol
- Expending about 500 Calories in moderate-intensity exercise 16 hours or less before a high fat meal will minimize adverse effects in the lipid profile
- One study has shown that highly trained endurance runners who increased their dietary fat to 40% or more of daily energy experienced no adverse effects on their serum lipid profiles

Exercise, diet and CHD

- Beneficial effects of exercise are additive to a diet low in total and saturated fat
- A low-fat diet will reduce total and LDL-cholesterol, but may also lower HDL-cholesterol
- Exercise may prevent or attenuate the decrease in HDL-cholesterol seen in low-fat diets