Chapter 12

Nutritional Strategies and Ergogenic Aids

Slide Show developed by:
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What You Will Learn…

1. The basic physiologic concepts concerning nutritional strategies and ergogenic aids.

2. The basic terminology related to nutritional strategies and ergogenic aids believed to enhance exercise performance.

3. The basic strategies to improve exercise performance and recovery.

4. The illegal and the legal methods that could enhance exercise performance.
Specific Nutritional Strategies

- Ingestion of carbohydrates
- Carbohydrate loading
- Glycogen replenishment
- Prevention of iron deficiency
- Protein supplementation
- Vitamin supplementation
- Balanced nutrition
  - Prevention of the female athletic triad
- Energy drinks
- Rehydration strategies
Introduction to Nutritional Strategies and Ergogenic Aids

• According to U.S. Food & Drug Administration at least 50% of U.S. general population has reported using dietary supplements

• Dietary supplements include:
  • Vitamins/Minerals
  • Amino acids (AA)
  • Herbs or botanicals
  • Metabolites/constituents/extracts
  • Combination of any of these ingredients
Introduction to Nutritional Strategies and Ergogenic Aids

- **Ergogenic aids** are substances, devices, or strategies to improve an individual’s energy use, production, or recovery.

- Examples of ergogenic aids include:
  - Stretching
  - Weight training
  - Visualization
  - Anabolic steroid use
  - Nutritional & vitamin supplementation
  - Blood doping
Introduction to Nutritional Strategies and Ergogenic Aids

• Studies have reported that 76-100% of athletes in many sports use dietary supplements and/or ergogenic aids to enhance their exercise performances.

• As an exercise leader, you should be concerned with:
  1. How these products affect exercise performance, negatively or positively.
  2. What negative side effects they may cause?
  3. Whether supplement is considered legal or illegal to use in regulated sport competitions.
Specific Nutritional Strategies to Enhance Exercise Performance

Some nutritional strategies that might be used to enhance exercise performance include:

1. CHO ingestion for homeostasis during prolonged steady-state exercise
2. CHO loading or glycogen loading before starting prolonged exercise
3. Recovery from prolonged exercise & glycogen uptake/replenishment/storage; tissue repair & maintenance of immune system after prolonged exercise
Nutritional Strategies (Cont.)

4. Prevention of iron deficiency exercise training for prolonged performance

5. Protein (AA) supplementation and/or vitamin supplementation

6. Understanding & combating medical consequences of female athletic triad

7. Energy drinks for combating fatigue or to increase performance

8. Rehydration drinks for prevention of heat cramps, heat stress, heat stroke, & death
Carbohydrates Can Be Ingested to Improve Exercise Performance

- CHO stores of body
  - Finite
- In fasted state their depletion represents
  - One limiting factor for prolonged exercise
- Muscular fatigue is linked to:
  - Amount of glycogen (CHO) stored in muscle
- When CHO stores are exhausted
  - Physical activity of muscle cannot continue
Carbohydrates Can Be Ingested to Improve Exercise Performance

• Development of even moderate hypoglycemia
  • May contribute to glycogen depletion by accentuating exercise-induced increases in release of glucagon & catecholamines

• These hormonal changes
  • Accelerate glycogen breakdown

• What may occur?
  • Self-propagating cycle that is triggered during prolonged exercise by diminished glycogen stores
    • Reduction of blood glucose (sugar)
Carbohydrates Can Be Ingested to Improve Exercise Performance

• What can you do to break this self-propagating cycle?
  • Supplement with ingested glucose

• Metabolic window (timing for replenishing)
  • Begins within 45 min after exercise

• Studies report that a delay in nutrient supplementation of up to 3 hours can dramatically decrease important anabolic activities including glycogen storage & protein balance

• In addition, duration & intensity of exercise will determine contribution of ingested glucose to exercise metabolism
Figure 12.1 Percentage of Fat and Carbohydrate Used as Exercise Intensity Increases

(a) $\text{CHO} = \text{carbohydrate}$

$\dot{V}O_2 \text{ max} = \text{maximum oxygen consumption}$
Figure 12.1 Absolute Fat and Carbohydrate Oxidation
Figure 12.2 Percentage of Fat and Carbohydrate Used as Exercise Duration Increases
Factors That Determine Gastrointestinal Absorption of Ingested Carbohydrate

- Ingested glucose is readily available during submaximal exercise.

- Effectiveness with which ingested glucose enters blood is determined, in part, by time ingested glucose spends in gastrointestinal (GI) tract, or its “transit time”.

- Longer transit time:
  - The greater is the time available for GI absorption.

- Rate of gastric emptying into small intestine is a key factor in determining transit time.

- Exercise causes an increase in GI transit time and may counterbalance reduction in blood flow to gut allowing efficient nutrient absorption.
Factors That Determine Gastrointestinal Absorption of Ingested Carbohydrate

• Availability of ingested CHO depends on:
  • Composition of CHO
  • Quantity of CHO
  • Exercise parameters such as:
    • Work intensity
    • Duration
    • Modality
Factors That Determine Gastrointestinal Absorption of Ingested Carbohydrate

• One way to increase CHO amount that enters blood from gut is to increase mass of ingested glucose

• Although effective in increasing absolute amount of glucose
  • Fraction of ingested glucose that is made available for metabolism is actually decreased

• Why? More glucose remains in GI tract

• It is important to recognize that CHO ingestion may result in a decrease in plasma glucose which is counterproductive to work performance

• Typically occurs if glucose ingestion precedes exercise by about 45 min

• Causes onset of exercise to coincide with peak postprandial [insulin]
Factors That Determine Gastrointestinal Absorption of Ingested Carbohydrate

- The ingestion of glucose polymers (commercial sports drinks) has been frequently used during exercise.

- Basis for consuming this form of sugar:
  - Osmolarity of ingested solution will be reduced.
  - Decreasing the movement of water & electrolytes into GI tract.
Factors That Determine Gastrointestinal Absorption of Ingested Carbohydrate

- Once in small intestine
  - Glucose polymers are rapidly hydrolyzed to free glucose & absorbed in this form
- Therefore, on absorption from GI tract they are metabolized with same efficiency as that of ingested glucose
- Sucrose ingestion has been used as a source of substrate during exercise with similar effectiveness to ingested glucose
- Why?
  - Hydrolysis of sucrose leads to entry of glucose into circulation
# Composition of Selected Beverages

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Serving Size (oz)</th>
<th>Energy (kcal)</th>
<th>CHO (g)</th>
<th>CHO (source)</th>
<th>CHO (%)</th>
<th>Cations (mg)</th>
<th>Caffeine (mg)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrate</td>
<td>8</td>
<td>55</td>
<td>10</td>
<td>HFCS</td>
<td>4</td>
<td>Na⁺: 91</td>
<td>0</td>
<td>5.1% glycerol; some vitamin C</td>
</tr>
<tr>
<td>Gatorade Original Thirst Quencher</td>
<td>8</td>
<td>50</td>
<td>14</td>
<td>Sucrose syrup; glucose-fructose syrup</td>
<td>6</td>
<td>Na⁺: 110</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Gatorade Endurance Formula</td>
<td>8</td>
<td>50</td>
<td>14</td>
<td>Sucrose syrup; glucose-fructose syrup</td>
<td>6</td>
<td>Na⁺: 200</td>
<td>0</td>
<td>Some calcium and magnesium</td>
</tr>
<tr>
<td>Accelerade</td>
<td>8</td>
<td>80</td>
<td>14</td>
<td>Sucrose, maltodextrin, fructose</td>
<td>6</td>
<td>Na⁺: 133</td>
<td>0</td>
<td>Some magnesium, vitamin C, E; 5 g protein</td>
</tr>
<tr>
<td>All Sport Body Quencher</td>
<td>8</td>
<td>60</td>
<td>16</td>
<td>HFCS</td>
<td>7</td>
<td>Na⁺: 55</td>
<td>0</td>
<td>Vitamin C; some B vitamins</td>
</tr>
<tr>
<td>POWERade</td>
<td>8</td>
<td>64</td>
<td>17</td>
<td>HFCS, glucose polymers</td>
<td>7</td>
<td>Na⁺: 53</td>
<td>0</td>
<td>Some B vitamins</td>
</tr>
</tbody>
</table>

## Carbohydrate-electrolyte beverages (4–7% carbohydrate)

- Hydrate
- Gatorade Original Thirst Quencher
- Gatorade Endurance Formula
- Accelerade
- All Sport Body Quencher
- POWERade

## Lightly sweetened waters with vitamins added

- Propel Fitness Water
- Vitamin water

## Soft drinks

- Coca Cola
- Pepsi
- Mountain Dew

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Serving Size (oz)</th>
<th>Energy (kcal)</th>
<th>CHO (g)</th>
<th>CHO (source)</th>
<th>CHO (%)</th>
<th>Cations (mg)</th>
<th>Caffeine (mg)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propel Fitness Water</td>
<td>8</td>
<td>10</td>
<td>3</td>
<td>Sucrose syrup</td>
<td>1</td>
<td>Na⁺: 35</td>
<td>0</td>
<td>Some B vitamins; may have added calcium; contains sucralose*</td>
</tr>
<tr>
<td>Vitamin water</td>
<td>8</td>
<td>50</td>
<td>13</td>
<td>Fructose</td>
<td>5.5</td>
<td>Na⁺: 0</td>
<td>0</td>
<td>Vitamins A, C, and some B vitamins; lutein</td>
</tr>
<tr>
<td>Coca Cola</td>
<td>8</td>
<td>97</td>
<td>27</td>
<td>HFCS</td>
<td>11</td>
<td>Na⁺: 33</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Pepsi</td>
<td>8</td>
<td>100</td>
<td>27</td>
<td>HFCS and/or sugar</td>
<td>11</td>
<td>Na⁺: 25</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Mountain Dew</td>
<td>8</td>
<td>110</td>
<td>31</td>
<td>HFCS, orange juice concentrate</td>
<td>13</td>
<td>Na⁺: 50</td>
<td>37</td>
<td></td>
</tr>
</tbody>
</table>
## More beverages...

### Fruit juices

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Calories</th>
<th>Sodium (mg)</th>
<th>Potassium (mg)</th>
<th>Ingredients</th>
<th>Naturally occurring vitamins and minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange juice</td>
<td>11</td>
<td>15</td>
<td>450</td>
<td>Sucrose, fructose, glucose</td>
<td>Naturally occurring vitamins and minerals</td>
</tr>
<tr>
<td>Unsweetened apple juice</td>
<td>11.5</td>
<td>8</td>
<td>296</td>
<td>Primarily fructose, some glucose and sucrose</td>
<td>Naturally occurring vitamins and minerals</td>
</tr>
</tbody>
</table>

### Energy drinks

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Calories</th>
<th>Sodium (mg)</th>
<th>Potassium (mg)</th>
<th>Ingredients</th>
<th>Naturally occurring vitamins and minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMP Energy Drink</td>
<td>12.5</td>
<td>65</td>
<td>71</td>
<td>HFCS and/or sugar</td>
<td>Some B vitamins, taurine, ginseng</td>
</tr>
<tr>
<td>Red Bull</td>
<td>11</td>
<td>200</td>
<td>80</td>
<td>Sucrose, glucose, glucuronolactone</td>
<td>Some B vitamins</td>
</tr>
<tr>
<td>Rock Star Energy Energy</td>
<td>13</td>
<td>40</td>
<td>80</td>
<td>HFCS</td>
<td>Some B vitamins, taurine, herbs (for example, milk thistle, ginseng, ginkgo)</td>
</tr>
<tr>
<td>SoBe Adrenaline Rush</td>
<td>15</td>
<td>115</td>
<td>86</td>
<td>HFCS</td>
<td>Vitamin C; 50 mg ginseng</td>
</tr>
<tr>
<td>Venom Energy Drink</td>
<td>11.5</td>
<td>10</td>
<td>100</td>
<td>HFCS</td>
<td>Vitamin C, some B vitamins, taurine, bee pollen, ginseng</td>
</tr>
</tbody>
</table>

### Other

<table>
<thead>
<tr>
<th>Beverage</th>
<th>Calories</th>
<th>Sodium (mg)</th>
<th>Potassium (mg)</th>
<th>Ingredients</th>
<th>Naturally occurring vitamins and minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extran</td>
<td>42</td>
<td>20</td>
<td>50</td>
<td>Glucose syrup</td>
<td>Concentrated CHO source for ultradistance events</td>
</tr>
</tbody>
</table>
Effect of Carbohydrate Ingestion on Body Fuel Stores

- CHO ingestion is accompanied by hormonal & metabolic changes that impact fuel supply to working muscle.
- CHO ingestion usually slows rate of decline of circulating glucose that generally occurs with prolonged exercise
  - Leads to overt increase in circulating glucose.
- At least two important endocrine changes accompany an increase in glucose availability:
  1. Exercise-induced decline in insulin & increase in glucagon are reduced or eliminated altogether reducing glucose from the liver.
  2. Higher insulin level will suppress both mobilization of non-esterified fatty acids (NEFA) from adipose tissue and glucose from the liver.
Effect of Carbohydrate Ingestion on Body Fuel Stores

- Insulin will stimulate glucose transport at working muscle
  - A process that may also be increased by reduction in non-esterified fatty acids [NEFA]
  - Suppresses muscle glycogen breakdown
- Glucose ingestion reduces liver glycogen breakdown during exercise
  - Inhibits gluconeogenesis during prolonged exercise
Effect of Carbohydrate Ingestion on Body Fuel Stores

• Liver & muscle glucose uptake after ingestion of CHO are both increased after exercise

• Improved ability of liver & muscle to extract glucose from blood is due, in part, to an increase in insulin sensitivity after exercise

• Glucose taken up by liver is largely used to replenish tissue glycogen stores

• Glycogen replenishment, which takes 24-48 hr, is facilitated after exercise by the increased capacity for intestinal glucose absorption of ingested glucose
What is Carbohydrate Loading?

(a) $\text{CHO} = \text{carbohydrate}$

$\text{g/kg/d} = \text{grams per kilogram body weight per day}$

(b) $\text{CHO} = \text{carbohydrate}$

$\text{min} = \text{minute}$

$\text{km} = \text{kilometer}$
Optimizing Recovery

• Following challenges must be achieved to optimize recovery from exhaustive exercise so that one can engage in high-intensity regular, daily, vigorous activities:
  • Replace fluid/electrolyte
  • Stimulate insulin release within 20-45 min after exercise
  • Increase & maintain muscle blood flow in recovery
  • Replenish glycogen stores
  • Initiate tissue repair & stimulate protein synthesis
  • Minimize muscle damage while stimulating immune system
Fluid/electrolyte replacement

- Water by itself is not good enough!
- Consume .3 to .5 grams of sodium chloride per liter of water
- This maintains drive to drink
- Reduces urine loss and promotes rapid fluid replacement
- Need to replace 125 to 150% of water lost to fully rehydrate
Glycogen replenishment

- Considerations—significantly decreased after 1 and 1/2 hours of high intensity exercise, requires 24 hours to replenish.
- Consume 1.2 to 1.5 grams of CHO per Kg body weight (154 lbs = 70 kg = 84 to 105 grams) and .3 to .5 grams of protein per Kg body weight (154 lbs = 70 kg = 21 to 35 grams).
- Consume carbs/protein (meal or fluids) immediately post (within 30 minutes) and every 2 hours afterwards.
Initiation of tissue repair

- Considerations—prevent protein degradation
- Increased protein synthesis
- Insulin and amino acids can work together to increase protein synthesis and stimulate tissue repair
- Insulin can also slow protein degradation
- Consuming a CHO/PRO (2.5 to 1 ratio) supplement immediately post-exercise will reduce protein breakdown, increase protein synthesis, and produce a net positive protein balance. This will result in a faster training adaptation
Monitoring Diet Can Help Prevent Iron Deficiency Anemia

- Iron deficiency anemia
  - Severe depletion of iron stores that reduces [Hb]
- Iron deficiency (with or without anemia) affects more females than males because of
  - the relatively lower intakes of iron-rich foods
  - the high iron losses through menstruation
- Men can also become iron deficient especially if they are vegetarian and they do not address their dietary iron needs
Monitoring Diet

- Who is most vulnerable to iron deficiency anemia?
  - Adolescent girls

- Why?
  - Some are vegetarians & do not select good dietary sources of iron (fortified cereals, legumes, nuts, & seeds)

- What are signs of iron deficiency anemia?
  - Lethargy & decreased aerobic performances because of decreased hemoglobin (Hb)

- What should an exercise leader do?
  - Encourage those with early signs to see personal physician who can test their blood Hb & ferritin levels
Vitamin Supplementation

- In general, active individuals who eat well balanced meals
  - Need no vitamin supplementation
- However, some individuals who do not have a well-balanced eating plan
  - Can balance their nutrient intake by consuming an inexpensive daily vitamin supplement that does not negatively affect exercise performance
Vitamin Supplementation

- Antioxidant vitamin supplementation (vitamin C, vitamin E, and beta-carotene)
  - Has been advocated by some sports nutritionists for those who exercise in extreme environmental conditions
    - Heat
    - Cold
    - Altitude
Female Athlete Triad

- Combination of interrelated conditions like
  - Disordered eating
  - Amenorrhea (absence or cessation of menstruation)
  - Increased risk of osteoporosis

- Affects women (& some men) in
  - Dance, gymnastics, wrestling, figure skating, endurance running, & cheerleading (flyers)

- Why? To be successful, these physical activities & sports often require participants to
  - Train excessively hard
  - Maintain extremely low %BF
  - Maintain high ratios of strength to LBM
Female Athlete Triad

Eating Disorder
- Restrictive dieting (inadequate energy and nutrient intake)
- Overexercising
- Weight loss
- Lack of body fat

Osteoporosis
- Loss of calcium from bones

Amenorrhea
- Diminished hormones
Amenorrhea

- Amenorrhea is common among premenopausal women.
- Secondary amenorrhea (absence of 3-6 consecutive menstrual cycles) can be associated with excessive training, depleted body fat, low body weight, & inadequate nutrition.
- Loss of body fat has been linked to reduced storage of estrogen precursors, resulting in:
  - Amenorrhea
  - Subsequent bone demineralization.
Energy Drinks

- Typically loaded with high fructose corn syrup and caffeine (see lower part of Table 12.1)
  - All contain caffeine as most active ingredient
    - Too much caffeine = numerous adverse effects related to “caffeinism”
    - FDA recommended limit is 5 g caffeine per 12 oz of fluid
    - Nausea, diarrhea, indigestion, irregular heart rhythms, irregular respiration, lightheadedness, jitteriness, & frequent urination
  - Although some research supports caffeine to enhance endurance by stimulating use of FA & sparing glycogen utilization
Energy Drinks

- Many energy drinks
  - Contain as much as 4x recommended caffeine dosage
  - Vary greatly in other ingredients from brand to brand

- Overconsumption of energy drinks (& caffeine)
  - Can inhibit exercise by causing
    - Dehydration, cramping, fatigue, sleeplessness, & nervousness
Heat Cramping Can Be Prevented

• Muscle cramping is a result of:
  • Muscle fatigue
  • Salt loss
  • Na+/K+ imbalance
  • Dehydration

• Active clients who
  • Sweat heavily
  • Cover their clothes with Na+
    • May be at greater risk for muscle cramping
Heat Cramping Can Be Prevented

- Clients who cramp
  - Often lose a lot of Na+ while working out
  - May avoid dietary salt for health reasons
  - They do not realize they need more in their diets

- You can help prevent cramping in your higher risk athletic clients by:
  - Encouraging them to drink water before, during, and after exercise
  - Avoid caffeinated and high fructose sugary beverages
  - Stretch before exercise
  - Consume a balanced diet
Common Ergogenic Aids and Exercise

- Anabolic steroids (Testosterone)
- Human growth hormone (HGH)
- Protein & amino acid (AA) supplementation
- Creatine
- Ephedrine
- Hi-lo altitude training
- Other ergogenic aids
Anabolic Steroids

- Derived from testosterone
- Ingestion with exercise promotes
  - Male characteristics, increases muscle mass, & decreases recovery time from vigorous exercise
- Anabolic steroids are
  - Illegal & are designed for medical use only
- In US, state & federal laws prohibit possession, delivering, or administering anabolic steroids
## Examples and Sources of Anabolic Steroids

<table>
<thead>
<tr>
<th><strong>Examples</strong></th>
<th><strong>Sources</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Testosterone</td>
<td>Physicians</td>
</tr>
<tr>
<td>Oxandrolone</td>
<td>Pharmacists</td>
</tr>
<tr>
<td>Oxymesterone</td>
<td>Dentists</td>
</tr>
<tr>
<td>Methyltestosterone</td>
<td>Sport coaches</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Methandienone</td>
<td>Athletic trainers</td>
</tr>
<tr>
<td>Fluoxymesterone</td>
<td>Conditioning coaches</td>
</tr>
<tr>
<td>Nandrolone</td>
<td>Conditioning coaches</td>
</tr>
<tr>
<td>Androstenedione (Andro)</td>
<td>Conditioning coaches</td>
</tr>
<tr>
<td>Trenbolone</td>
<td>Conditioning coaches</td>
</tr>
</tbody>
</table>

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetrahydrogestrinone (THG)</td>
<td>Veterinarians</td>
</tr>
<tr>
<td>Dehydroepiandrosterone (DHEA)</td>
<td>Physical therapists</td>
</tr>
<tr>
<td>Mesterolone</td>
<td>Nutrition consultants</td>
</tr>
<tr>
<td>Danazol</td>
<td>Nutrition consultants</td>
</tr>
<tr>
<td>Stanozolol</td>
<td>Nutrition consultants</td>
</tr>
<tr>
<td>Clostebol</td>
<td>Nutrition consultants</td>
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</table>

*Table: Examples and Sources of Anabolic Steroids.*
## Examples of Oral and Injectable Steroids

<table>
<thead>
<tr>
<th>Steroid</th>
<th>Oral</th>
<th>Injectable</th>
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</thead>
<tbody>
<tr>
<td>Testosterone cypionate</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Nandrolone decanoate</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Stanozolol</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Methandienone</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mesterolone</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Boldenone undecylenate</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Tetrahydrogestrinone (THG) (may also be a gel or injectable)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Methyltestosterone</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Methenolone acetate</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Methenolone enanthate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oxandrolone</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Androstenedione (Andro)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Clostebol acetate</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Fluoxymesterone</td>
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<td>X</td>
</tr>
<tr>
<td>Danazol</td>
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<td>X</td>
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<tr>
<td>Oxymetholone</td>
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<td>X</td>
</tr>
<tr>
<td>Dehydroepiandrosterone (DHEA)</td>
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</tr>
<tr>
<td>Norethandrolone</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Drostanolone propionate</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Oxymesterone</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Trenbolone acetate</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
## Side Effects and Adverse Reactions to Steroids

<table>
<thead>
<tr>
<th>Mind</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Extreme aggression with hostility (&quot;steroid rage&quot;); mood swings; anxiety; dizziness; drowsiness; unpredictability; insomnia; psychotic depression; personality changes, suicidal thoughts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Face and Hair</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Swollen appearance; greasy skin; severe, scarring acne; mouth and tongue soreness; yellowing of whites of eyes (jaundice)</td>
</tr>
<tr>
<td>- In females, male-pattern hair loss and increased growth of face and body hair</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voice</th>
</tr>
</thead>
<tbody>
<tr>
<td>- In females, irreversible deepening of voice</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chest</th>
</tr>
</thead>
<tbody>
<tr>
<td>- In males, breathing difficulty, breast development</td>
</tr>
<tr>
<td>- In females, breast atrophy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heart</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Heart disease; elevated or reduced heart rate; heart attack; stroke; hypertension; increased low-density lipoprotein; reduced high-density lipoprotein</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Abdominal Organs</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Nausea; vomiting; bloody diarrhea; pain; edema; liver tumors (possibly cancerous); liver damage, disease, or rupture leading to fatal liver failure; kidney stones and damage; gallstones; frequent urination; possible rupture of aneurysm or hemorrhage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Blood</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Blood clots; high risk for blood poisoning; those who share needles risk contracting HIV (the AIDS virus) or other disease-causing organisms; septic shock (from injections)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reproductive System</th>
</tr>
</thead>
<tbody>
<tr>
<td>- In males, permanent shrinkage of testes; prostate enlargement with increased risk for cancer; sexual dysfunction; loss of fertility; excessive and painful erections</td>
</tr>
<tr>
<td>- In females, loss of menstruation and fertility; permanent enlargement of external genitalia; fetal damage, if pregnant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Muscles, Bones, and Connective Tissues</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Increased susceptibility to injury with delayed recovery times; cramps; tremors; seizure-like movements; injury at injection site</td>
</tr>
<tr>
<td>- In adolescents, failure to grow to normal height</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Fatigue; increased risk for cancer</td>
</tr>
</tbody>
</table>
# Common Signs Associated with Steroid Abuse

<table>
<thead>
<tr>
<th>Men</th>
<th>Women</th>
<th>Both Men and Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baldness</td>
<td>Growth of facial hair</td>
<td>Jaundice (yellowing of skin)</td>
</tr>
<tr>
<td>Development of breasts</td>
<td>Deepened voice</td>
<td>Swelling of feet and ankles</td>
</tr>
<tr>
<td>Impotence</td>
<td>Breast reduction</td>
<td>Rapid lean muscle weight gain (25–40 pounds)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bad breath</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mood swings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nervousness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trembling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Acne (back of arms)</td>
</tr>
</tbody>
</table>
Human Growth Hormone (HGH)

- Hormone produced by
  - Anterior pituitary gland
  - Initially used in 1950s to help children with growth retardation problems

- HGH has been
  - Synthetically produced
  - Used/abused by those interested in enhancing
    - Speed
    - Strength
    - Power performances
Human Growth Hormone (HGH)

- Expensive
- Regular ingestion has been associated with
  - Cancer development in mice
- Taken in large quantities, HGH can:
  - Cause acromegaly
  - Lead to diabetes, thyroid disorders, heart disease, menstrual irregularities, diminished sex drive, & shortened life span
- Use of HGH is considered illegal unless prescribed by a physician for hormonal deficiencies
Protein and Amino Acid Supplementation

- Exercise scientists have estimated that protein contributes
  - Between 2 & 3% to a maximum of 10% of energy needs of exercising subjects in
    - Endurance activities or
    - High-intensity/high volume resistance training sessions

- Maximum daily protein requirement for athletes in training is between
  - 1.2-1.7 g/kg BM (0.55–0.77 g/lb)
Branch Chain Amino Acids (BCAA)

- Leucine, isoleucine, & valine
  - Serve as precursors for AA glutamine & alanine

- Isoleucine & valine are used as
  - Direct energy sources during intense exercise
  - May help prevent fatigue

- Leucine has been reported to help
  - Activate protein re-synthesis related to muscle growth

- Positive effects of BCAA are debatable
  - Many well-controlled studies have shown no effect on performance
beta-Hydroxy-beta-methylbutyrate (HMB)

• Metabolite of leucine

• Has been reported to:
  • Increase muscle size & strength

• Some research has also shown that HMB
  • Reduces muscle breakdown after exercise without side effects

• Effect of HMB supplementation also
  • Remains debatable
Whey Protein

- Popular protein supplement because it is
  - Processed from milk
  - Absorbed quickly
  - Easily digestible
  - High in BCAAs

- Whey protein is popular with athletes because
  - Inexpensive
  - Used in commercially available products to increase protein synthesis after exercise
Casein Protein

- Another AA
  - Processed from milk, but
  - It is slower acting (absorbed slower) than whey protein
- Both are often combined in protein supplement products to:
  - Take advantage of both their fast & slower absorption rates
Beta-Alanine

- Rate-limiting precursor of carnosine
  - Found in fast-twitch muscle
  - Accounts for about 10% of a muscle’s ability to buffer H+ ions (help maintain blood pH) during high-intensity exercise

- Has been shown in recent studies to:
  - Increase muscle carnosine content significantly
    - May offer athletes an alternative to using bicarbonate/citrate loading procedure to increase buffers for high-intensity exercise
  - Running 800-meter dash
Creatine

- Primarily associated with skeletal muscle & high-energy compound PCr
  - Can help enhance synthesis of ATP
- Oral creatine supplementation has become a
  - Common practice for strength & power athletes
  - It has been anecdotally reported that athletes as young as 9 & 10 yr are using creatine regularly
- Theoretically
  - Improves recovery time from high-intensity bouts of exercise
Creatine supplementation in combination with resistance training has been

- associated with gains in strength
- related to a gain in weight
  - Which may be good or bad depending on sport, but
  - Most of weight gain has been attributed to water retention in muscles

- May help vegetarians the most
- Why? - red meats are a prime source of creatine
- It appears that quality creatine can be purchased inexpensively at large supercenters
- A standard dosage of 2 g/day is enough to maximize the effects of creatine in most individuals
- It is a legal ergogenic aid
Ephedrine

- Pseudoephedrine, phenylpropanolamine, & herbal ephedrine (ma huang) are
  - Sympathomimetics
- These substances simulate sympathetic nervous system’s physiologic effects
  - Increased HR & BP
- Used as dietary supplements & ergogenic aids
  - Increase energy
  - Decrease appetite
  - Increase metabolism without exercise
Ephedrine

- Banned in regulated sports
- Has been associated with
  - Restlessness, nervousness, tachycardia, arrhythmias, hypertension, & even death
- A fundamental chemical in distilling of methamphetamine (speed)
  - FDA has required all medicines (decongestants) that contain ephedrine, pseudoephedrine, or phenylpropanolamine to be removed from over-the-counter shelves of drugstores & pharmacies
Hi-Lo Altitude Training

- Most recently accepted, yet controversial, training practices for endurance athletes
  - “Live high” at 7,000 feet or more
  - “Train low” at altitudes ≤ 4,000 feet
- Based on concept of increasing [erythropoietin] (EPO) in blood by ascending to altitude (increases RBC mass)
  - Stimulates natural RBC production
- Blood Doping
  - Transfusion, storage, & reinfusion of RBCs
  - Supplemental use of hormone EPO to increase RBC
## Other Ergogenic Aids

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Claims Related to Exercise</th>
<th>Evidence</th>
<th>Side Effects</th>
<th>Legality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>Ethanol beverage</td>
<td>Decreases anxiety, relaxes</td>
<td>No benefits</td>
<td>Yes, serious</td>
<td>Banned for some sports*</td>
</tr>
<tr>
<td>Amphetamines</td>
<td>Pep pills; central nervous system (CNS) stimulant</td>
<td>Increases arousal and decreases fatigue</td>
<td>Mixed, with some positive</td>
<td>Yes, serious</td>
<td>Illegal</td>
</tr>
<tr>
<td>Aspirin</td>
<td>Pain reliever</td>
<td>Decreases pain and muscle fatigue</td>
<td>Limited positive benefit</td>
<td>Yes, mild</td>
<td>Legal</td>
</tr>
<tr>
<td>Beta-blockers</td>
<td>Reduces heart rate and blood pressure</td>
<td>Decreases anxiety</td>
<td>Positive on motor function, but reduced aerobic function</td>
<td>Yes, serious</td>
<td>Banned by some sports bodies*</td>
</tr>
<tr>
<td>Beta-2 agonists</td>
<td>Relaxes bronchiolar smooth muscle</td>
<td>Increases lean muscle mass</td>
<td>Mixed with no effects from inhalers</td>
<td>Yes, mild</td>
<td>Banned unless prescribed</td>
</tr>
<tr>
<td>Branched-chain amino acids</td>
<td>Precursors for the amino acids</td>
<td>Decreases mental fatigue</td>
<td>Mixed to negative</td>
<td>Yes, mild</td>
<td>Legal</td>
</tr>
<tr>
<td>Caffeine</td>
<td>CNS stimulant</td>
<td>Increases muscle contractility, aerobic endurance, and increased fat metabolism</td>
<td>Lower versus higher amounts produce best benefits</td>
<td>Yes, serious</td>
<td>Banned by some sports bodies*</td>
</tr>
</tbody>
</table>

Table 12.6
## Other Ergogenic Aids (cont.)

<table>
<thead>
<tr>
<th>Ergogenic Aid</th>
<th>Description</th>
<th>Effect</th>
<th>Benefits</th>
<th>Risks</th>
<th>Legal Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnitine</td>
<td>Derived amino acid involved in energy production</td>
<td>Increases fat metabolism, spares glycogen</td>
<td>No benefits</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td>Chromium</td>
<td>Trace mineral</td>
<td>Increases lean muscle mass</td>
<td>No benefits unless deficient</td>
<td>None</td>
<td>Legal</td>
</tr>
<tr>
<td>Diuretics</td>
<td>Increase fluid excretion</td>
<td>Decreases body mass</td>
<td>Limited benefit (dehydration)</td>
<td>Yes, serious</td>
<td>Banned by some sports bodies*</td>
</tr>
<tr>
<td>Ephedrine</td>
<td>CNS stimulant</td>
<td>Increases energy level and delays fatigue</td>
<td>No benefit or limited</td>
<td>Yes, serious</td>
<td>Banned by many sports bodies*</td>
</tr>
<tr>
<td>Erythropoietin</td>
<td>Red blood cell stimulant</td>
<td>Increases aerobic capacity</td>
<td>Positive benefit</td>
<td>Yes, serious</td>
<td>Illegal</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Major mineral (electrolyte)</td>
<td>Enhances muscle growth</td>
<td>No benefits unless deficient</td>
<td>Yes, mild</td>
<td>Legal</td>
</tr>
<tr>
<td>Sodium bicarbonate</td>
<td>Baking soda</td>
<td>Buffer of lactic acid that delays fatigue</td>
<td>Positive benefit in events &lt;3 minutes in duration</td>
<td>Yes, mild to serious</td>
<td>Legal</td>
</tr>
<tr>
<td>Vitamin B&lt;sub&gt;12&lt;/sub&gt; (cyanocobalamin)</td>
<td>Coenzyme involved in metabolism</td>
<td>Increases energy production</td>
<td>Mixed to negative</td>
<td>None</td>
<td>Legal</td>
</tr>
</tbody>
</table>

*Table 12.6*
The End

Slide Show developed by:
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Professor of Public Health
Columbia College
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