Fitness

- Depends on physical activity and exercise
- Regular physical activity
  - Promotes health
  - Reduces risk of developing many diseases
    - Heart disease
    - Cancer
    - Stroke
    - Diabetes
    - Hypertension
Benefits of Fitness

- Restful sleep
- Nutritional health
- Optimal body composition
- Optimal bone density
- Resistance to infectious diseases
- Low incidence of anxiety & depression
- Low risk for some types of cancer
- Strong circulation & lung function
- Low risk of cardiovascular disease
- Low risk of type 2 diabetes
- Strong self image
Benefits of Fitness

- Physical Activity Guidelines for Americans
  - Minimum amount of aerobic physical activity
    - Intensity of activity
    - Extensive health benefits
- Develop and maintain fitness
  - Cardiorespiratory endurance
  - Body composition
  - Strength & flexibility
Physical Activity Pyramid

DO SELDOM—Limit sedentary activities.
- Watch TV or movies
- Leisure computer time

2–3 DAYS/WEEK—Engage in strength and flexibility activities and enjoy leisure activities often.
- Sit-ups, push-ups
- Stretching exercises such as yoga
- Strength training such as weight lifting
- Leisure activities such as canoeing, dancing, golfing, horseback riding, bowling

4–6 DAYS/WEEK—Engage in moderate or vigorous activities regularly.
- Aerobic activities such as running, biking, swimming, roller-blading, rowing, cross-country skiing, kickboxing, power walking, dancing, jumping rope
- Sports activities such as basketball, soccer, volleyball, tennis, football, racquetball, softball

EVERY DAY—Be as active as possible.
- Use the stairs
- Walk or bike to class, work, or shops
- Scrub floors, wash windows
- Walk your dog
- Mow grass, rake leaves, turn compost, shovel snow, tend garden
- Wash and wax your car
- Play with children

NOTE: Tips for increasing physical activity every day can be found at mypyramid.gov.
### Guidelines for Physical Fitness

**TABLE 14-2 Guidelines for Physical Fitness**

<table>
<thead>
<tr>
<th>Type of Activity</th>
<th>Cardiorespiratory</th>
<th>Strength</th>
<th>Flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic activity</td>
<td>Resistance activity</td>
<td>Stretching activity</td>
<td></td>
</tr>
<tr>
<td>that uses large-</td>
<td>that is performed at</td>
<td>that uses the major</td>
<td></td>
</tr>
<tr>
<td>muscle groups and</td>
<td>a controlled speed and</td>
<td>muscle groups</td>
<td></td>
</tr>
<tr>
<td>can be maintained</td>
<td>through a full</td>
<td></td>
<td></td>
</tr>
<tr>
<td>continuously</td>
<td>range of motion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>5 to 7 days per week</td>
<td>2 or more nonconsecutive days per week</td>
<td>2 to 7 days per week</td>
</tr>
<tr>
<td>Intensity</td>
<td>Moderate (equivalent to walking at a pace of 3 to 4 miles per hour)(^a)</td>
<td>Enough to enhance muscle strength and improve body composition</td>
<td>Enough to develop and maintain a full range of motion</td>
</tr>
<tr>
<td>Duration</td>
<td>At least 30 minutes</td>
<td>8 to 12 repetitions of 8 to 10 different exercises (minimum)</td>
<td>2 to 4 repetitions of 15 to 30 seconds per muscle group</td>
</tr>
<tr>
<td>Examples</td>
<td>Running, cycling, swimming, inline skating, rowing, power walking, cross-country skiing, kickboxing, jumping rope; sports activities such as basketball, soccer, racquetball, tennis, volleyball</td>
<td>Pull-ups, push-ups, weight lifting, pilates</td>
<td>Yoga</td>
</tr>
</tbody>
</table>

\(^a\)For those who prefer vigorous-intensity aerobic activity such as walking at a very brisk pace (\(>6.5\) mph) or running (\(>6\) mph), a minimum of 20 minutes per day, 3 days per week is recommended.

Developing Fitness

- Goals
  - Meet everyday demands of life
  - Reasonable body weight & body composition

- Components
  - Flexibility
  - Muscle strength and endurance
  - Cardiorespiratory endurance
Developing Fitness

- Principles of conditioning
  - Overload principle
    - Frequency
    - Intensity
    - Time
  - Body’s response to physical activity
    - Hypertrophy vs. atrophy
    - Work different muscle groups from day to day
- Make sure it is safe to start a program
Developing Fitness

- Minimizing risk of overuse injuries
  - Be active all week
  - Use proper equipment and attire
  - Use proper form
  - Include warm-up and cool-down activities
  - Challenge your strength and endurance a few times a week
  - Pay attention to body signals
- Work out wisely
Cardiorespiratory Endurance

- Length of time a person can remain active with an elevated heart rate
- Enhances capacity of heart, lungs, and blood
  - Deliver oxygen
    - Aerobic
    - VO₂ max
  - Remove waste
- Mind and body benefit
Cardiorespiratory Endurance

- Cardiorespiratory conditioning
  - Aerobic workouts improve heart and lung activities
    - Enhanced oxygen delivery
    - Slower heart rate
    - Breathing is more efficient
    - Circulation improves
    - Blood pressure falls
Cardiorespiratory Endurance

- Cardiorespiratory conditioning
  - Activity sustained for 20 minutes or more
    - Use most of large-muscle groups
    - Intensity must elevate heart rate
  - Perceived effort
    - Still able to talk comfortably
Delivery of Oxygen by the Heart & Lungs to the Muscles

1. The respiratory system delivers oxygen to the blood.

2. The circulatory system carries oxygenated blood throughout the body.

3. The muscles and other tissues obtain oxygen from the blood and release carbon dioxide into it.

4. The blood carries the carbon dioxide back to the lungs.

Air ($O_2$, $CO_2$), other gases
Cardiorespiratory Endurance

- Muscle conditioning
  - Fit muscles use oxygen efficiently
    - Reduces heart’s workload
    - Burns fat longer

- Balanced fitness program
  - Level of intensity varies
  - Activities you enjoy doing
  - Addresses all aspects of fitness
Resistance Training

- **Purpose**
  - Build muscle mass
  - Develop and maintain muscle strength, muscle power, and muscle endurance
- **Benefits for prevention of chronic diseases**
- **Maximize and maintain bone mass**
- **Improve posture & reduce risk of back injury**
- **Strength vs. power vs. endurance**
Energy Systems and Fuels to Support Activity

- Adenosine triphosphate (ATP)
  - Small amounts in all body tissues all the time
  - Delivers energy instantly
  - Chemical force for muscle contraction
    - Mechanical movement
    - Heat
Energy Systems and Fuels to Support Activity

- Creatine phosphate (CP)
  - Stored in the muscles
  - Break down begins before ATP pools dwindle
  - Split anaerobically
    - Release phosphate
    - Replenish ATP supplies
  - Produced during rest
Energy Systems and Fuels to Support Activity

- Energy-yielding nutrients
  - Prolonged demands of sustained activity
  - Breakdown produces ATP
    - Muscles use a mixture of fuels
  - Factors influencing fuel use
    - Diet, intensity & duration of activity, training
  - Anaerobic activities – glucose
  - Endurance activities – fats
# Fuels Used for Activities of Different Intensities & Durations

<table>
<thead>
<tr>
<th>Activity Intensity</th>
<th>Activity Duration</th>
<th>Preferred Fuel Source</th>
<th>Oxygen Needed?</th>
<th>Activity Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme</td>
<td>8 to 10 sec</td>
<td>ATP-CP (immediate availability)</td>
<td>No (anaerobic)</td>
<td>100-yard dash, shot put</td>
</tr>
<tr>
<td>Very high</td>
<td>20 sec to 3 min</td>
<td>ATP from carbohydrate (lactate)</td>
<td>No (anaerobic)</td>
<td>¼-mile run at maximal speed</td>
</tr>
<tr>
<td>High</td>
<td>3 min to 20 min</td>
<td>ATP from carbohydrate</td>
<td>Yes (aerobic)</td>
<td>Cycling, swimming, or running</td>
</tr>
<tr>
<td>Moderate</td>
<td>More than 20 min</td>
<td>ATP from fat</td>
<td>Yes (aerobic)</td>
<td>Hiking</td>
</tr>
</tbody>
</table>

*All levels of activity intensity use the ATP-CP system initially; extremely intense short-term activities rely solely on the ATP-CP system.*
Glucose Use During Physical Activity

- **Exertion**
  - Liver breaks down glycogen
    - Release glucose into bloodstream
  - Muscles use glucose and stored glycogen
    - Muscle fatigue when glycogen is depleted

- **Glycogen storage**

- **Intensity of activity**
  - Impacts how long glycogen will last
The Effect of Diet on Physical Endurance

- Fat and protein diet: 57 min
- Normal mixed diet: 114 min
- High-carbohydrate diet: 167 min
Glucose Use During Physical Activity

- Lactate
  - Glycolysis exceeds capacity of mitochondria
  - Accumulating pyruvate is converted to lactate
    - Lactate does not cause fatigue
  - Lactate leaves muscle and travels to liver
  - Liver enzymes convert lactate back into glucose to return to the muscles
    - Cori cycle
Glucose Use During Physical Activity

- Duration of activity affects glycogen use
  - First 20 minutes or so of moderate activity
    - After 20 minutes, more and more fat is used for fuel
    - Glycogen use continues
  - Glucose depletion
    - Nervous system function
    - Guidelines to maximize glucose supply
Glucose Use During Physical Activity

- Glucose during activity
  - Foods and beverages consumed during activity
    - 30 to 60 grams of carbohydrate per hour during prolonged events
  - Glucose after activity
    - Enlarges glycogen stores
      - Within 2 hours of activity
      - High glycemic index
Glucose Use During Physical Activity

- Training affects glycogen storage
  - Adaptation to continual hard work
- Conditioned muscles rely less on glycogen
  - Rely more on fat for energy
- Trained muscles use oxygen more efficiently
  - More mitochondria
Fat Use During Physical Activity

- High-fat, low-carbohydrate diets
  - More fat used to fuel activity
    - Benefits are not consistently evident
  - May experience greater fatigue
  - Recommendations – 20 to 35% of energy from fat
- Body fat stores
Fat Use During Physical Activity

- Fat is liberated from internal fat stores and fat under the skin
  - Areas with most to spare, donate the most
    - Spot reducing
- Fatty acids released into blood
  - Blood delivers amount of fat each muscle needs
- Some body fat is essential
Fat Use During Physical Activity

- Duration of activity
  - Epinephrine
  - Sustained, moderate activity

- Intensity of activity
  - As intensity increases, less and less fat used

- Training
  - Adaptations that permit body to draw on fat for fuel
Protein Use During Physical Activity – and Between Times

- Not a major fuel for physical activity
- Used to build muscle and other lean tissue
  - To some extent, to fuel activity
- Protein is handled differently during activity and rest
Protein Use During Physical Activity – and Between Times

- Protein used in muscle building
  - Synthesis of body proteins suppressed during activity
    - Hours of recovery
  - High-quality protein consumption
    - Enhances muscle protein synthesis
- Repeated activity with slight overload
- Signaling of DNA and RNA
- Aerobic vs. anaerobic training
Protein Use During Physical Activity – and Between Times

- Used as fuel
  - Muscles speed up use of amino acid
  - 10% of total fuel during activity and rest

- Diet
  - Adequate energy and carbohydrate

- Intensity and duration
  - Protein needs are higher for endurance and strength athletes
Protein Use During Physical Activity – and Between Times

- **Training**
  - Higher degree of training, less protein used during activity

- **Protein recommendations**
  - Needs are greater for athletes in training
  - Need adequate carbohydrate intake
# Recommended Protein Intakes for Athletes

**Table 14-5** Recommended Protein Intakes for Athletes

<table>
<thead>
<tr>
<th></th>
<th>Recommendations (g/kg/day)</th>
<th>Protein Intakes (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Males</strong></td>
</tr>
<tr>
<td>RDA for adults</td>
<td>0.8</td>
<td>56</td>
</tr>
<tr>
<td>Recommended intake for power (strength or speed) athletes</td>
<td>1.2–1.7</td>
<td>84–119</td>
</tr>
<tr>
<td>Recommended intake for endurance athletes</td>
<td>1.2–1.4</td>
<td>84–98</td>
</tr>
<tr>
<td>U.S. average intake</td>
<td>102</td>
<td>70</td>
</tr>
</tbody>
</table>

**NOTE:** Daily protein intakes are based on a 70-kilogram (154-pound) man and 55-kilogram (121-pound) woman.

Vitamins and Minerals to Support Activity

- Roles in supporting activity
  - Assist in releasing energy from fuels
  - Transport oxygen
- Supplements
  - Do not enhance performance of well-nourished people
    - Deficiencies
Vitamins and Minerals to Support Activity

- Vitamin E
  - Prolonged, high-intensity activity
    - Increases free radical production
    - Free radicals may be beneficial
  - Benefits
  - Sources
Vitamins and Minerals to Support Activity

- **Iron**
  - Deficiency particularly among active young women
  - Vegetarian athletes
  - Iron-deficiency anemia
    - Impairs performance
  - Sports anemia
    - Adaptive, temporary response
  - Recommendations for athletes
Fluids and Electrolytes to Support Activity

- Water loss
  - Sweating and breathing
  - Dehydration risk
- Temperature regulation
  - Hyperthermia
    - Heat stroke prevention
  - Hypothermia
    - Symptoms
Fluids and Electrolytes to Support Activity

- Fluid replacement via hydration
  - Hydrate before activity
    - Drink extra fluid in the days before event
  - Rehydrate during and after activity
- Fluids for everyday, active people
  - Plain, cool water
- Fluids for endurance athletes
  - Carbohydrate-containing beverages
## Hydration Schedule for Physical Activity

<table>
<thead>
<tr>
<th>When to Drink</th>
<th>Amount of Fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 to 3 hr before activity</td>
<td>2 to 3 c</td>
</tr>
<tr>
<td>15 min before activity</td>
<td>1 to 2 c</td>
</tr>
<tr>
<td>Every 15 min during activity</td>
<td>( \frac{1}{2} ) to 1 c (Drink enough to minimize loss of body weight, but don’t overdrink.)</td>
</tr>
<tr>
<td>After activity</td>
<td>2 c for each pound of body weight lost(^a)</td>
</tr>
</tbody>
</table>

\(^a\)Drinking 2 cups of fluid every 20 to 30 minutes after exercise until the total amount required is consumed is more effective for rehydration than drinking the needed amount all at once. Rapid fluid replacement after exercise stimulates urine production and results in less body water retention.

Fluids and Electrolytes to Support Activity

- Electrolyte losses and replacement
  - Losses occur with sweat
    - Greatest in beginners
  - Replacement
    - Regular foods or sports drinks
- Hyponatremia
  - Loss of sodium and excessive liquid consumption
Fluids and Electrolytes to Support Activity

- Sports drinks
  - Hydration is critical to optimal performance
    - Water is best for most people
  - Sport drinks offer the following
    - Fluid
    - Glucose
    - Sodium and other electrolytes
    - Good taste
Fluids and Electrolytes to Support Activity

- Enhanced water
  - Lightly flavored
  - Carbohydrates and electrolytes
- Caffeine
  - Excesses can hinder performance
    - Potentially dangerous
- Alcohol
  - Negative effects
Diets for Physically Active People

- **Water**
  - Thirst is a late signal of need
- **Nutrient density**
  - Vitamins, minerals, and energy
- **Carbohydrates**
  - Pregame meal
  - Intensive training
- **Protein**
Diets for Physically Active People

- Meals before and after competition
  - No single food improves skill, speed, or strength
  - Some kinds of foods support better performance
- Pregame meal
  - When, what, and how much?
- Postgame meal
  - Carbohydrate-rich food or beverages
Highlight 14

Supplements as Ergogenic Aids
Ergogenic Aids

- For most substances, research does not support claims
- Some supplements are contaminated
  - Health risks
- Difficult to distinguish valid claims from bogus ones
  - Research findings presented out of context
  - Facts are often exaggerated and twisted
## Ergogenic Aids

### Table H14-1: Substances Promoted as Ergogenic Aids

<table>
<thead>
<tr>
<th>Dietary Supplement</th>
<th>Claims</th>
<th>Research Findings</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arginine (an amino acid)</td>
<td>Increases muscle mass</td>
<td>Ineffective</td>
<td>Generally well tolerated; may be harmful to people with heart disease</td>
</tr>
<tr>
<td>Boron (trace mineral)</td>
<td>Increases muscle mass</td>
<td>Ineffective</td>
<td>No adverse effects reported with doses up to 10 mg/day; should be avoided by those with kidney disease or women with hormone-sensitive conditions</td>
</tr>
<tr>
<td>Coenzyme Q10 (carrier in the electron transport chain)</td>
<td>Enhances exercise performance</td>
<td>Ineffective</td>
<td>Mild indigestion</td>
</tr>
<tr>
<td>Gamma-glycerol (plant sterol)</td>
<td>Increases muscle mass; mimics anabolic steroids without known side effects</td>
<td>Ineffective</td>
<td>No adverse effects reported with short-term use; no long-term safety studies</td>
</tr>
<tr>
<td>Ginseng (plant)</td>
<td>Enhances exercise performance</td>
<td>Ineffective</td>
<td>No adverse effects reported with moderate doses; large doses may cause hypertension, nervousness, sleeplessness, acne, edema, headache, and diarrhea; those with diabetes should be aware of hypoglycemic effects; should be avoided by those at risk for estrogen-related cancers, those with blood clotting issues, and pregnant or lactating women</td>
</tr>
<tr>
<td>Glycerol (a 3-carbon molecule that is part of triglycerides and phospholipids)</td>
<td>Improves hydration during exercise; regulates body temperature during exercise; enhances exercise performance</td>
<td>Inconsistent findings for improving hydration and regulating body temperature; ineffective for enhancing exercise performance</td>
<td>May cause nausea, headaches, and blurred vision; should be avoided by those with edema, congestive heart failure, kidney disease, hypertension, and other conditions that may be aggravated by fluid retention</td>
</tr>
<tr>
<td>HMB (beta-hydroxy-beta-methylbutyrate) (a metabolite of the branched-chain amino acid leucine)</td>
<td>Increases muscle mass and strength</td>
<td>Inconsistent findings</td>
<td>No adverse effects with short-term use and doses up to 76 mg/kg of body weight</td>
</tr>
<tr>
<td>Pyruvate (a 3-carbon sugar)</td>
<td>Enhances exercise endurance</td>
<td>Ineffective</td>
<td>No long-term safety studies; digestive problems with short-term use (&lt;3 weeks)</td>
</tr>
<tr>
<td>Ribose (a 5-carbon sugar)</td>
<td>Increases ATP production and enhances high-intensity exercise performance</td>
<td>Ineffective</td>
<td>Naturally generated in body; submitted to USDA to become Generally Recognized As Safe food additive (pending)</td>
</tr>
<tr>
<td>Royal jelly (produced by bees)</td>
<td>Enhances stamina and reduces fatigue</td>
<td>No studies on human beings to date</td>
<td>No adverse effects with doses up to 12 mg/day; should be avoided by those with a history of asthma or allergic reactions</td>
</tr>
<tr>
<td>Sodium bicarbonate (baking soda)</td>
<td>Reduces lactic acid and delays fatigue; enhances power and strength</td>
<td>May reduce lactic acid and muscle fatigue; more research is needed for definitive conclusions</td>
<td>Gastrointestinal distress including diarrhea, cramps, and bloating; should be avoided by those on sodium-restricted diets</td>
</tr>
</tbody>
</table>

Dietary Supplements

- **Carnitine**
  - Promoted as “fat burner”
  - Facilitates transfer of fatty acids across mitochondrial membrane
  - Good sources

- **Chromium picolinate**
  - Essential trace mineral
    - Involved in carbohydrate & lipid metabolism
  - Food sources
Dietary Supplements

- Complete nutrition supplements
  - Fall short of claims
- Creatine
  - Advertised as enhancing stores of CP in muscles
  - Performance enhancement
  - Safety is under question
  - Side effect of weight gain
Dietary Supplements

- Conjugated linoleic acid (CLA)
  - Naturally occurring polyunsaturated fatty acids
  - Effect of CLA supplements on body composition
- Caffeine
  - Benefits
  - Adverse effects
Hormonal Supplements

- Anabolic steroids
  - Derived from male sex hormone – testosterone
    - Development of male characteristics
    - Lean body mass
  - Use is banned
  - Risks associated with use
- Herbal alternatives
  - “Natural” does not mean “harmless”
Hormonal Supplements

- DHEA and androstenedione
  - Hormones made in the adrenal glands
    - Precursors for testosterone
  - Short-term side effects
  - Long-term effects
- Human growth hormone (hGH)
  - Acromegaly
  - Other effects