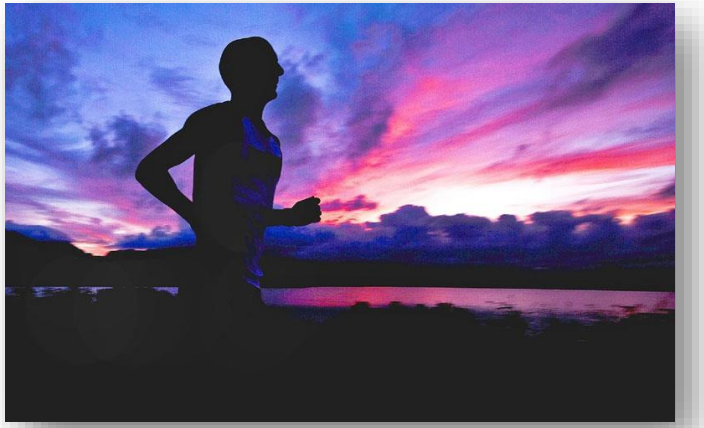
Fitness

Chapter 14

Fitness



- Dependent on minimum amount of physical activity/exercise:
  - Body movement, muscle contraction, increased energy expenditure
- 20% of US adults meet physical activity guidelines
- Regular physical activity
  - Promotes health (even 10 minutes/day)
  - Reduces chronic disease risk
  - Benefits: dose-response

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Benefits of Fitness

- Restful sleep
- Improved body composition
- Improved bone density
- Resistance to infectious diseases
- Lower incidence of anxiety and depression
- Lower chronic disease risk
- Strong circulation and lung function
- Strong self image
- Longevity
- Higher quality of life in old age
- Increased strength, endurance, flexibility

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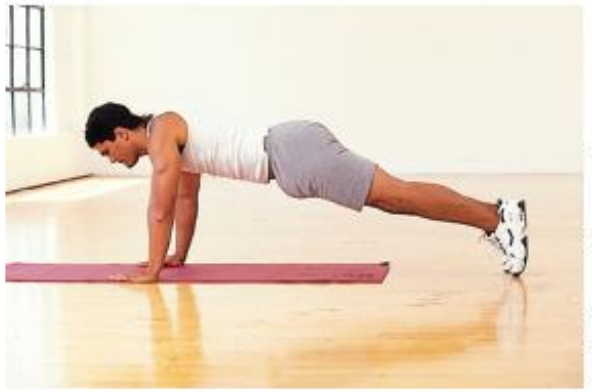
Levels of Physical Activity

TABLE 14-1 Levels of Physical Activity Intensity Compared

Level of Intensity	Breathing and/or Heart Rate	Perceived Exertion (on a Scale of 0 to 10)	Talk Test	Energy Expenditure	Walking Pace
Light	Little to no increase	<5	Able to sing	<3.5 kcal/min	<3 mph
Moderate	Some increase	5 or 6	Able to have a conversation	3.5 to 7 kcal/min	3 to 4.5 mph
Vigorous	Large increase	7 or 8	Conversation is difficult or "broken"	>7 kcal/min	>4.5 mph

SOURCE: Centers for Disease Control and Prevention, www.cdc.gov/physicalactivity/everyone; updated March 30, 2011.

TABLE 14-2 ACSM Guidelines for Physical Fitness

	Cardiorespiratory	Strength	Flexibility
	 Steve Cole/PhotoDisc/Getty Images	 David Hanower Photography	 David Hanower Photography
Type of Activity	Aerobic activity that uses large-muscle groups and can be maintained continuously	Resistance activity that is performed at a controlled speed and through a full range of motion	Stretching activity that uses the major muscle groups
Frequency	5 to 7 days per week	2 to 3 nonconsecutive days per week	2 to 7 days per week
Intensity	Moderate (equivalent to walking at a pace of 3 to 4 miles per hour)[a]	Enough to enhance muscle strength and improve body composition	Enough to feel tightness or slight discomfort
Duration	At least 30 minutes per day	2 to 4 sets of 8 to 12 repetitions involving each major muscle group	2 to 4 repetitions of 15 to 30 seconds per muscle group
Examples	Running, cycling, dancing, swimming, inline skating, rowing, power walking, cross-country skiing, kickboxing, water aerobics, jumping rope; sports activities such as basketball, soccer, racquetball, tennis, volleyball	Pull-ups, push-ups, sit-ups, weightlifting, pilates	Yoga

[a]For those who prefer vigorous-intensity aerobic activity such as walking at a very brisk pace (>4.5 mph) or running (≥5 mph), a minimum of 20 minutes per day, 3 days per week is recommended.
SOURCE: American College of Sports Medicine position stand: Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults—Guidance for prescribing exercise, *Medicine and Science in Sports and Exercise* 43 (2011): 1334–1359; W. L. Haskell and coauthors, Physical activity and public health: Updated recommendation for adults from the American College of Sports Medicine and the American Heart Association, *Medicine & Science in Sports & Exercise* 39 (2007): 1423–1434.

Developing Fitness

- Body adaptation: better performance with repetition
- Overload principle = incremental increases:
  - Frequency
  - Intensity
  - Time
  - Lead to body system improvements
    - Hypertrophy: protein synthesis → gain muscle tissue
  - Be cautious not to overuse/cause injury

Components of Fitness

- Daily activity requirements
- Healthy body weight and body composition
- Components:
  - Flexibility
  - Muscle strength and endurance
  - Cardiorespiratory endurance (heart and lungs)
  - Body composition (build lean tissue, reduce adipose tissue)

Cardiorespiratory Endurance

- Time a person can remain active with elevated heart rate
- Aerobic activity enhances capacity of heart, lungs, and blood
  - Deliver oxygen to cells (fuels brain and body functions!)
  - Remove waste from cells
- Process:
  - Heart becomes stronger → pumps more blood per beat → fewer beats necessary to move blood (heart rate slows)
    - Lower blood pressure, improved circulation, etc.
    - Avg resting heartrate = 70 beats/minute; conditioned resting heartrate = 50

Balanced Fitness Program

- Varied level of intensity
- Varied types of activity:
  - Aerobic
  - Resistance
  - Stretching
- Activities you enjoy doing

Energy Systems

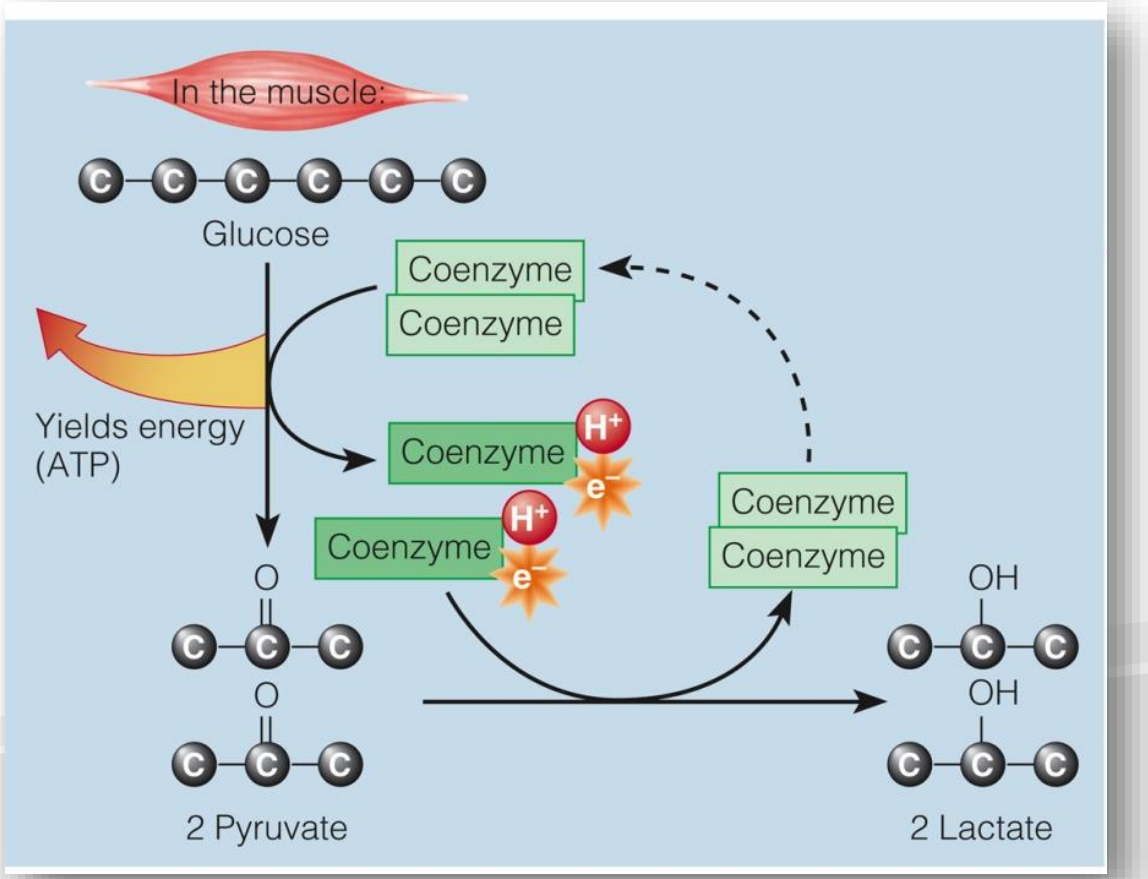
- Adenosine triphosphate (ATP)
  - Energy to powers cell activities (instant)
  - Small amounts in all body tissues, all the time
  - ATP molecule splits, energy is released:
    - Heat
    - Muscle contractions
  - Major energy systems enable muscle cells to regenerate ATP during activity:
    - Phosphagen system
    - Lactic acid system
    - Aerobic system

Phosphagen System

- Creatine Phosphate (CP)
  - Stored in muscles
  - Immediately released
  - Splits anaerobically
    - Releases phosphate
    - Replenishes ATP supplies
  - Quick energy: supplies last for ~10 seconds
  - Produced during rest
    - Reversal of process that occurs during activity

Lactic Acid System

- Anaerobic glycolysis
  - Primary glucose source: glycogen stores in muscle cells
  - Glucose → pyruvate → lactate
- Produced after CP is used up
  - Supplies last up to 3 minutes
  - Fuels high-intensity, short duration activity



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Aerobic System

- Prolonged demands (sustained activity)
- Carbohydrates, fats and some amino acids broken down
  - Produce uninterrupted supply of ATP
  - Factors influencing type/proportions of fuel used:
    - Dietary availability (storage)
    - Conditioning (conditioned muscles use less glycogen and more fat)
    - Intensity and duration of activity:
      - Anaerobic activities (high intensity, short duration) rely more on glucose
      - Endurance activities (low-moderate intensity, long duration) rely more on fats

Energy Systems & Fuels

TABLE 14-4 Primary Fuels Used for Activities of Different Intensities and Durations

Activity Intensity	Activity Duration	Energy System	Preferred Fuel Source	Oxygen Needed?	Activity Example
Extreme	5 to 10 sec	Phosphagen system	ATP-CP (immediate availability)	No	100-meter sprint, shot put, golf or baseball bat swing, tennis or volleyball serve
Very high	20 sec to 2 min	Lactic acid system	ATP from carbohydrate (anaerobic glycolysis)	No	400-meter run, 100-meter swim, gymnastic routine
High	2 min to 20 min	Aerobic system	ATP from carbohydrate (glycolysis and TCA cycle)	Yes	Cycling, swimming, running
Moderate	> 20 min	Aerobic system	ATP from fat (fatty acid-oxidation and TCA cycle)	Yes	Hiking

NOTE: All energy systems function at all times, but depending on the intensity of the activity and the conditioning of the athlete, one system will predominate at any given time.

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Glucose Use During Physical Activity

- Glucose: stored in liver and muscles as *glycogen*
- During exertion
  - Liver breaks down glycogen → glucose released into bloodstream
  - Muscles use blood glucose *and* muscle stores of glycogen
    - Muscles fatigue when glycogen is depleted (~2000 kcalories of energy = 20 mile run)
- Glycogen storage depends on:
  - Dietary carbohydrate intake
    - High-carbohydrate diets = more glycogen stores = enhanced endurance
  - Intensity of activity
    - Moderate = slow glycogen use (muscles also draw from fatty acid stores)
    - Intense = rapid glycogen use

Glucose Use During Physical Activity

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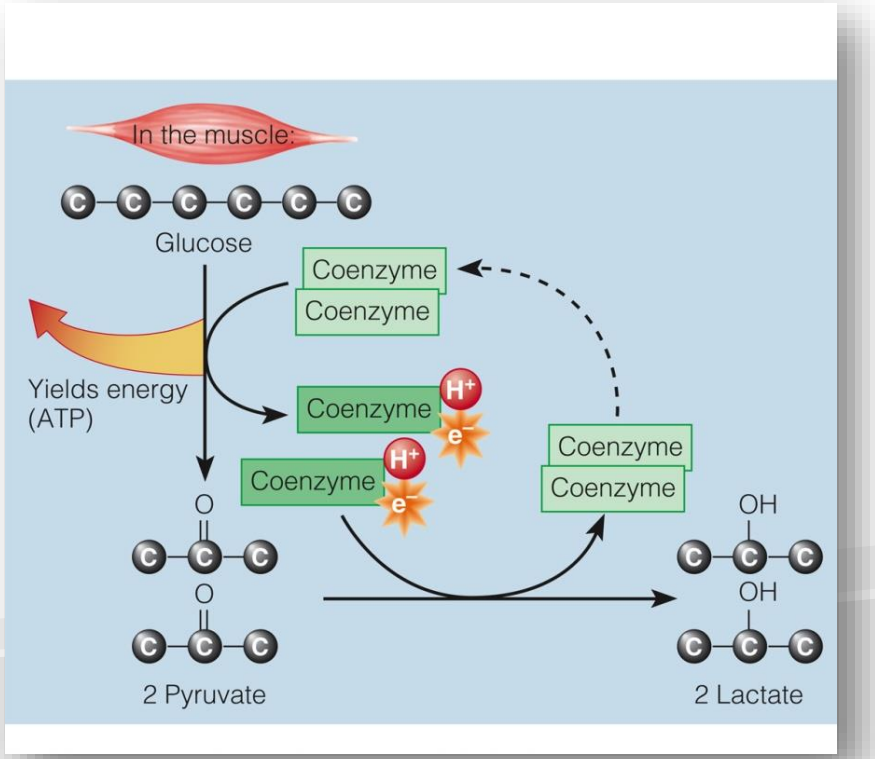
Glucose Use During Physical Activity

- Lactate
  - Glycolysis produces pyruvate rapidly → exceeds capacity of mitochondria to accept H and electrons
  - Accumulating pyruvate "picks up" H → becomes lactate
  - Lactate accumulates in muscles
    - Intense activity can only be maintained for 1-3 minutes
    - Feel the burn!



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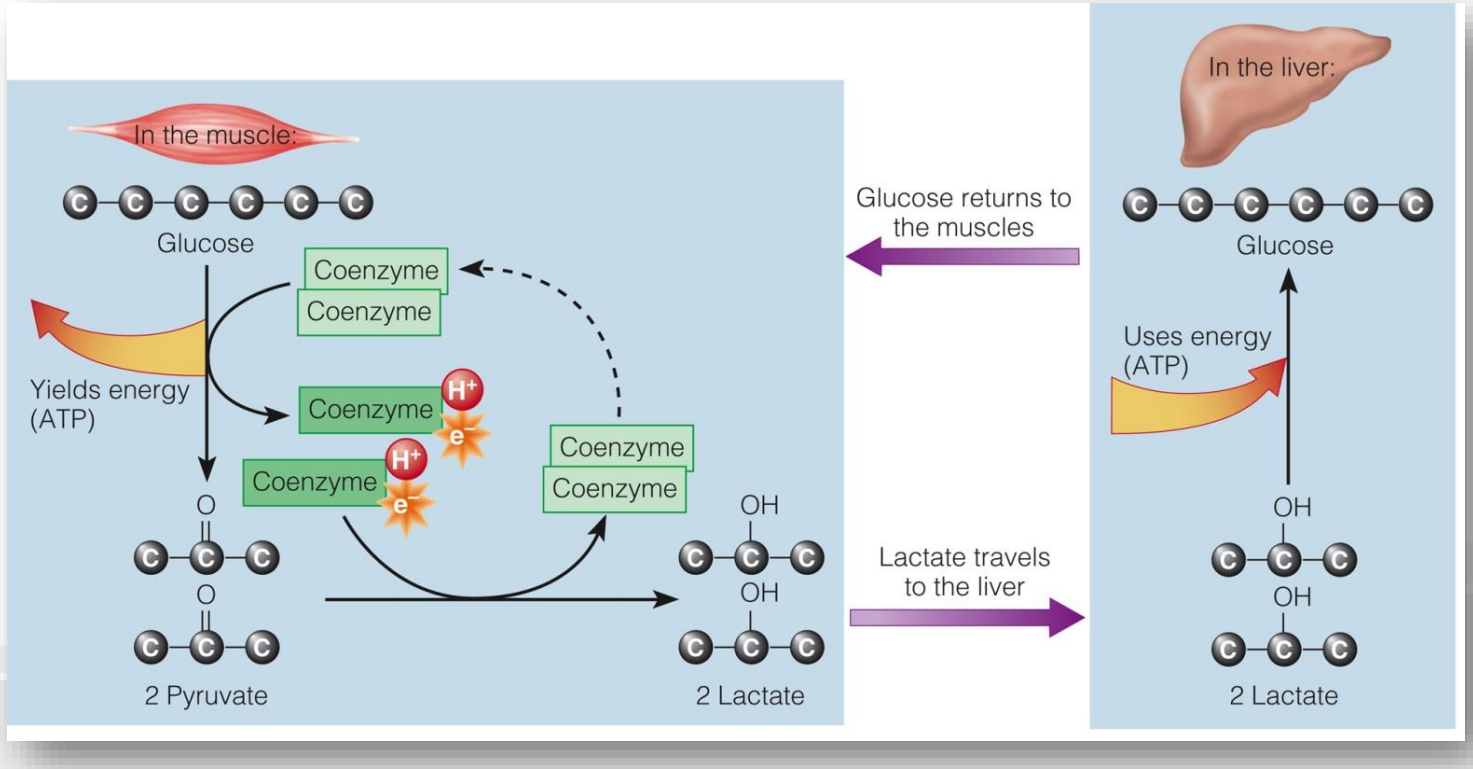
Glucose Use During Physical Activity

- Cori cycle:
  - Accumulated lactate leaves muscle, travels to liver
  - Liver enzymes convert lactate back into glucose to return to the muscles
  - Fuels additional activity



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Glucose Use During Physical Activity

- Duration and glycogen use
  - First ~20 minutes moderate activity = glycogen is main fuel
    - Muscles use glycogen stores, then liver empties glycogen stores
  - After 20 minutes, more fat is used for fuel
    - Glycogen use continues
    - Prolonged activity = blood glucose declines, muscle and liver glycogen stores = depleted
- Glucose depletion
  - Nervous system function nearly halts
  - To prevent depletion, athletes need carbohydrate-rich diets

Glucose Use During Physical Activity

- Glucose before activity
  - Glucose consumed ~3-4 hours before activity to “top off” stores
- Glucose during activity
  - 30-60 grams of carbohydrate/hour during endurance activities
  - Augment body glycogen stores and forestall exhaustion
- Glucose after activity (within 2 hours)
  - Replenish and enlarge glycogen stores

Fat Use During Physical Activity

- Recommendations for athletes: 20-35% of energy from fat
  - Same as Average Joe
- Body fat stores = important during physical activity
  - Provide 70,000+ kcalories of energy
  - Fatty acids from internal fat stores and under the skin
  - Areas with most fat to spare donate the most
    - May not appear "fattiest" on the body
  - Spot reducing doesn't work: fat cells release fatty acids into blood, not into nearby muscles
    - Blood delivers amount of fat each muscle needs

Fat Use During Physical Activity

- Duration of activity
  - Epinephrine signals fat cells to break down stored triglycerides
  - Sustained, moderate activity:
    - Blood fatty acid concentration surpasses resting concentration → fat stores become major fuel source
- Intensity of activity
  - As intensity increases, less fat is used
    - Fat broken down by aerobic metabolism (oxygen needed to burn fat)

Protein Use ~~During~~ After Physical Activity

- Not a major fuel for physical activity
- Protein for muscle building
  - Synthesis of body proteins suppressed during activity
    - Recovery time after activity: accelerated protein synthesis
  - High-quality protein consumption → enhances muscle protein synthesis
  - Repeated anaerobic activity with slight overload triggers muscle protein synthesis → increased muscle mass/strength

InstaPoll

- What is the most important energy-yielding nutrient for athletes to consume?
  - Water
  - Protein
  - Fat
  - Carbohydrate

Nutrients to Support Activity

- Vitamins and minerals
  - Release energy (from foods)
  - Transport oxygen
  - Especially: Vitamin E; iron
- Supplements
  - Do not enhance performance of well-nourished people
- Deficiencies impede performance
- Water: necessary to avoid dehydration (loss of >2% body weight reduces muscles' capacity)
- Electrolytes

Electrolytes

- Electrolyte losses occur with sweat
  - Greatest in beginners
  - Training improves electrolyte retention
  - Replacement: regular foods or sports drinks (endurance activities)
- Hyponatremia
  - Loss of sodium + excessive liquid consumption
    - Blood sodium concentration becomes extremely low
  - Do not restrict salt in days before endurance activity

Hydration

- Hydrate before activity: prepare for losses
  - Drink extra fluid in the *days* before major event
  - Rehydrate during and after activity: replenish losses
- For most of us
  - Water
- For *endurance athletes*
  - Carbohydrate-containing beverages…

…A Note about Sports Drinks

- Marketing (multi-billion dollar industry)
- Sports drinks offer:
  - Fluid
  - Sodium (+ other electrolytes)
  - Good taste
  - **Glucose**
- Math practice!
  - Sugar: 4 grams = 1 tsp
  - How many tsp of added sugar in this? →
    - 8 ½ tsp! (WHO daily limit = 6 tsp)

Nutrition Facts

1 serving per container

Serving Size **20 fl oz (591 mL)**

Amount Per Serving

Calories **140**

	% Daily Value*
Total Fat 0g	**0%**
Sodium 270mg	**12%**
Total Carbohydrate 36g	**13%**
Total Sugars 34g	
Includes 34g Added Sugars	**69%**
Protein 0g	
Potassium 80mg	0%

Not a significant source of saturated fat, *trans* fat, cholesterol, dietary fiber, vitamin D, calcium, and iron.

*The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

WATER, SUGAR, DEXTROSE, CITRIC ACID, SALT, SODIUM CITRATE, MONOPOTASSIUM PHOSPHATE, GUM ARABIC, GLYCEROL ESTER OF ROSIN, NATURAL FLAVOR, YELLOW 5

Other Fluids (Incompatible with Physical Activity)

- Enhanced water
  - Neither healthy nor natural
  - Added sugar
  - Negligible vitamin and mineral content
- Caffeine
  - Stimulant
  - Excesses can hinder performance
- Alcohol
  - Negative effects: dehydration, loss of coordination, slow reaction time

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Recommendations for Physical Activity

- Water
  - Depleted most rapidly
  - Crucial to performance
- Nutrient-dense foods
- Carbohydrates
  - High carbohydrate intake = high availability
  - Intensive training: may need concentrated carbohydrates in addition to regular meals (dried fruit, nectars, etc.)
- Healthy fats
- Lean protein

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Before and After

- No single food improves skill, speed, or strength
- Pregame meal
  - Several hours before activity; light, digestible, carb-based, lots of fluids
- Recovery meal
  - Carbohydrate-rich food or beverages to enhance glycogen storage
  - High quality protein foods to stimulate protein synthesis