Chapter 11

11.1 Physical Activity and Fitness

- **Physical activity** – any muscle movement that increases energy expenditure
- **Leisure-time physical activity** – any activity unrelated to a person's occupation
  - For example, hiking, walking, biking
  - Includes **exercise** – purposeful, planned physical activity
- The components of physical fitness are achieved through three types of exercise
  - Aerobic exercise
  - Resistance training
  - Stretching
- **Physical fitness** – the ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and meet unforeseen emergencies
  - The components of physical fitness are
    - Cardiorespiratory fitness
    - Musculoskeletal fitness
    - Flexibility
    - Body composition

Table 11.1: Components of Fitness

Fitness Component	Recommended Intake
Cardiorespiratory	Examples of Activities that Improve Fitness in Each Component Aerobic-type activities, such as walking, running, swimming, cross-country skiing
Musculoskeletal fitness:	Resistance training, weight lifting, calisthenics, sit-ups, push-ups
Muscular strength	Weight lifting or related activities using heavier weights with few repetitions
Muscular endurance	Weight lifting or related activities using lighter weights with more repetitions
Flexibility	Stretching exercises, yoga
Body composition	Aerobic exercise, resistance training

11.2 Physical Activity and Chronic Disease

- Regular physical activity
  - Reduces the risk of heart disease, stroke, and high blood pressure
  - Reduces the risk of obesity
  - Reduces the risk of type 2 diabetes
  - May reduce the risk of colon cancer
  - Reduces the risk of osteoporosis

Figure 11.1: Health Benefits of Physical Activity

11.3 Physical Activity and Most Americans

- Despite the clear benefits of regular physical activity,
  - 79.9% of U.S. adults do not perform sufficient physical activity
  - 23.7% of U.S. adults admit to doing no leisure-time physical activity at all

Table 11.2: Rates of Physical Activity in the United States

Nutrient	Functions	Suggested Intake
Energy	Supports exercise, activities of daily living, and basic body functions	Depends on body size and the type, intensity, and duration of activity For many female athletes: 1,800 to 3,500 kcal/day For many male athletes: 2,500 to 7,500 kcal/day
Carbohydrate	Provides energy, maintains adequate muscle glycogen and blood glucose; high complex carbohydrate foods provide vitamins and minerals	45–65% of total energy intake Depending on sport and gender, should consume 6–10 g of carbohydrate per kg body weight per day
Fat	Provides energy, fat-soluble vitamins, and essential fatty acids; supports production of hormones and transport of nutrients	20–35% of total energy intake
Protein	Helps build and maintain muscle; provides building material for glucose; energy source during endurance exercise; aids recovery from exercise	10–35% of total energy intake 1.2-2.0 g per kg body weight
Water	Maintains temperature regulation (adequate cooling); maintains blood volume and blood pressure; supports all cell functions	Consume fluid before, during, and after exercise Consume enough to maintain body weight Consume at least 8 cups (64 fl. oz) of water daily to maintain regular health and activity Athletes may need up to 338 liters (170 fl. oz) every day; more is required if exercising in a hot environment
B-vitamins	Critical for energy production from carbohydrate, fat, and protein	May need slightly more (one to two times the RDA) for thiamin, riboflavin, and vitamin B_6
Calcium	Builds and maintains bone mass; assists with nervous system function, muscle contraction, hormone function, and transport of nutrients across cell membrane	Meet the current RDA: 14–18 years: 1,300 mg/day 19–50 years: 1,000 mg/day 51–70 years: 1,000 mg/day (men): 1,200 mg/day (women) 71 and older: 1,200 mg/day
Iron	Primarily responsible for the transport of oxygen in blood to cells; assists with energy production	Consume at least the RDA: Males: 14–18 years: 11 mg/day 19 and older: 8 mg/day Females: 14–18 years: 15 mg/day 19–50 years: 18 mg/day 51 and older: 8 mg/day

11.4 Designing a Sound Fitness Program

- For a sound fitness program:
  - Start by assessing your current level of fitness
  - Identify your personal fitness goals
  - Make your program varied, consistent, and fun
  - Appropriately overload your body
  - Include a warm-up and cool-down period
  - Start out slowly and gradually build up the time you spend each day until you reach 30 minutes

11.5 Sound Fitness Program

- A sound physical fitness program meets your personal fitness goals
- An individual's fitness program may vary depending on whether he or she is
  - Training for athletic competition
  - Working toward cardiorespiratory fitness
  - Trying to maintain overall health
- A sound physical fitness program is fun
- An individual's fitness program should focus on what he or she enjoys
  - Outdoor activities
  - Social recreation
- A sound physical fitness program includes variety and consistency
- Variety can be achieved by
  - Combining aerobic exercise, resistance training, and stretching
  - Combining indoor and outdoor exercises
  - Taking different routes when walking or jogging
  - Including entertainment such as music
  - Participating in different activities each week
- A sound physical fitness program appropriately overloads the body

Overload principle – put additional physical demands on the body to improve fitness

- Too much physical exertion is not recommended
- The FITT principle can be used to determine appropriate overload

11.6 The FITT Principle

Frequency: the number of activity sessions per week

- Desired frequency varies with fitness goals

Intensity: the amount of effort expended or how difficult the activity is to perform

- Desired intensity may be based on maximal heart rate

Time of activity: how long each session lasts

Type of activity: the range of activities engaged in to promote health and physical fitness

	Frequency	Intensity	Time and Type
Cardiorespiratory fitness 	At least 30 minutes most days of the week	50–70% maximal heart rate for moderate intensity; 70–85% maximal heart rate for vigorous intensity	At least 30 consecutive minutes Choose swimming, walking, running, cycling, dancing, or other aerobic activities
Muscular fitness 	2–3 days per week	70–85% maximal weight you can lift	1–3 sets of 8–12 lifts for each set A minimum of 8–10 exercises involving the major muscle groups such as arms, shoulders, chest, abdomen, back, hips, and legs, is recommended.
Flexibility 	2–4 days per week	Stretching through full range of motion	For stretching, perform 2–4 repetitions per stretch. Hold each stretch for 15–30 seconds. Or try yoga, tai chi, or other flexibility programs.

Figure 11.2: Using the FITT Principle

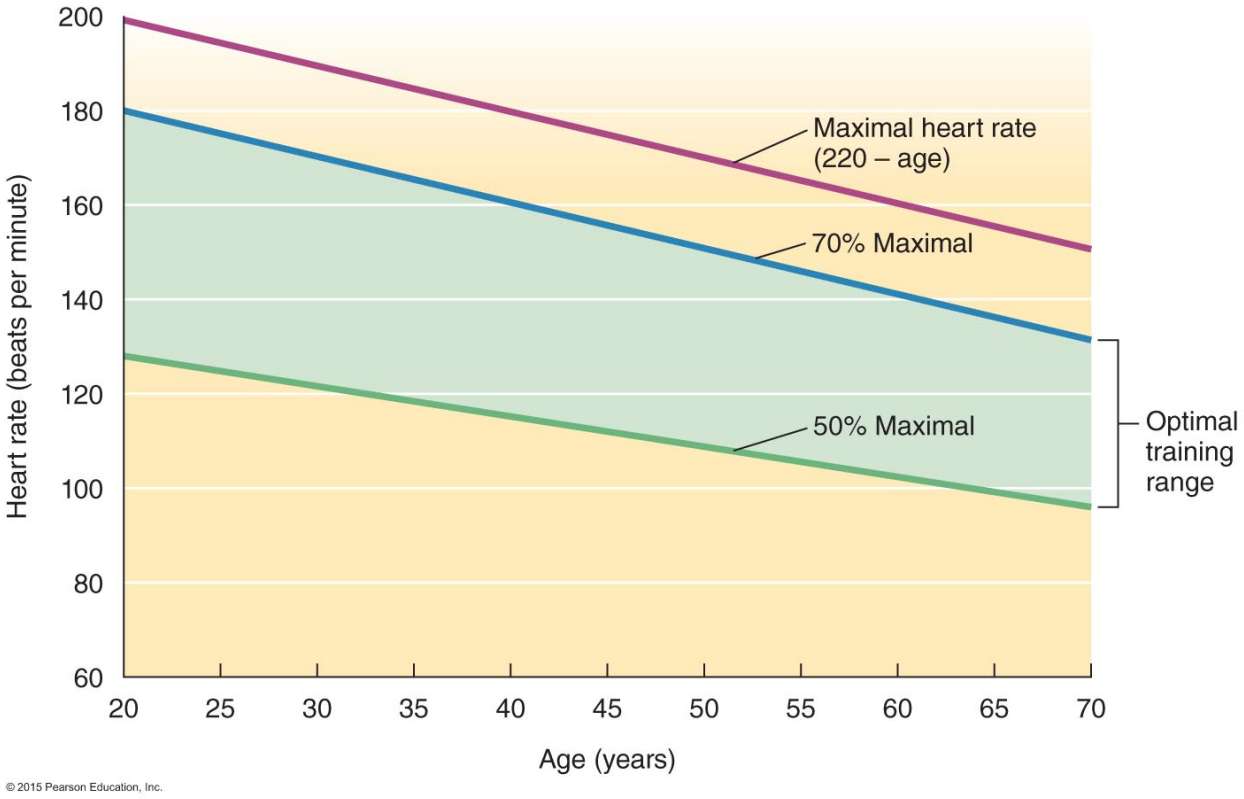

Figure 11.3: Maximal Heart Rate Training Chart

11.7 Sound Fitness Program

A sound physical fitness program includes a warm-up period and a cool-down period

11.7.1 Warm-Up

- Should be brief (5 to 10 minutes), gradual, and sufficient to increase muscle and body temperature
- Includes aerobics, calisthenics, and stretching
- Enhances flexibility and helps prepare you psychologically for the activity to come

11.7.2 Cool-down

- Should be gradual
- Includes some of the same activities as in the exercise session, along with stretching
- Assists in preventing injury and may help reduce muscle soreness

11.8 Fuel for Physical Activity

- The common currency for energy in the body is adenosine triphosphate, or ATP
- After depleting ATP stores, muscles turn to other energy sources
  - Creatine phosphate (CP) stores energy that can be used to generate ATP
    - Creatine phosphate can be broken down to support the regeneration of ATP for enough energy for 3–15 seconds of maximal physical effort

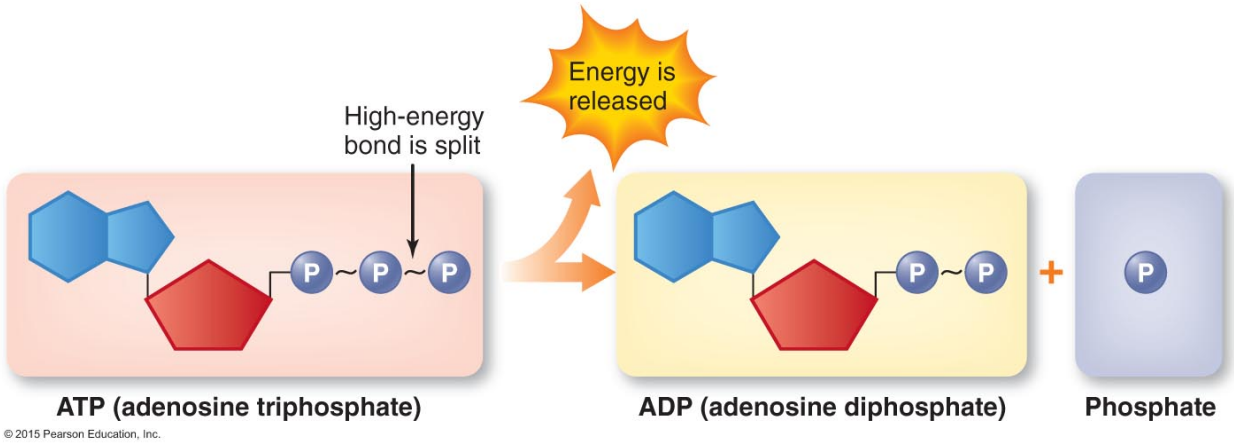

Figure 11.4: Adenosine Triphosphate (ATP)

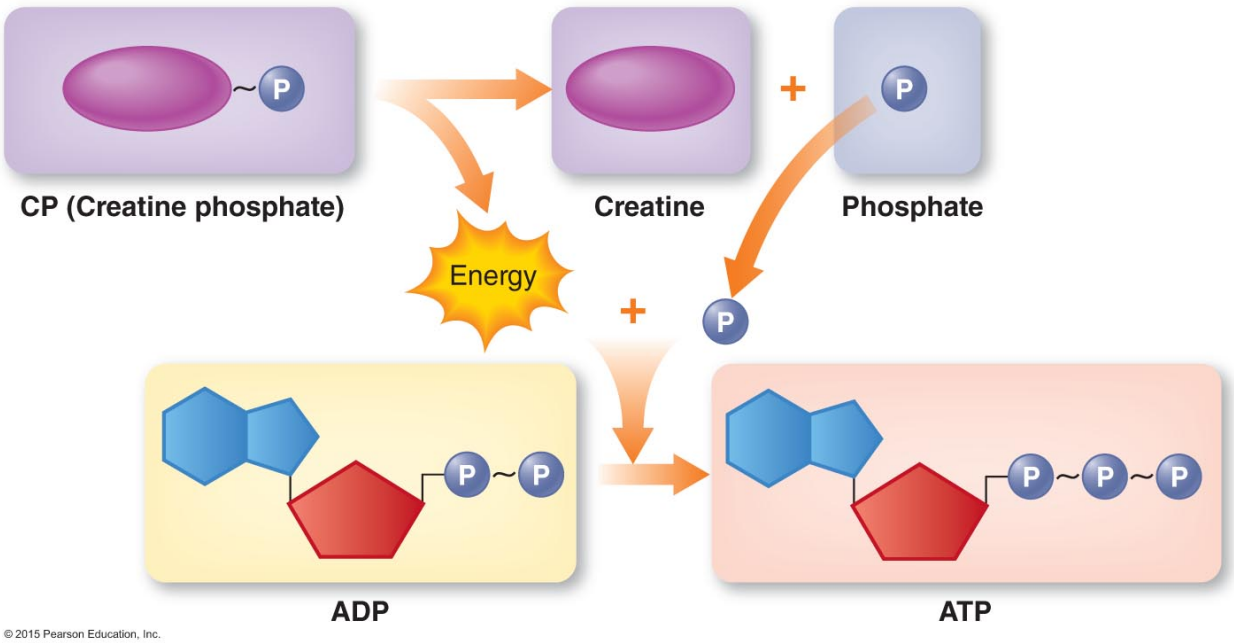

Figure 11.5: Creatine Phosphate (CP)

Figure 11.6: Energy Balance

- Metabolism of glucose
  - Anaerobic (without oxygen) breakdown of glucose yields two ATP molecules
    - Lactic acid is produced

- Aerobic (with oxygen) breakdown of glucose yields 36–38 molecules of ATP
  - CO_2 and H_2O are produced

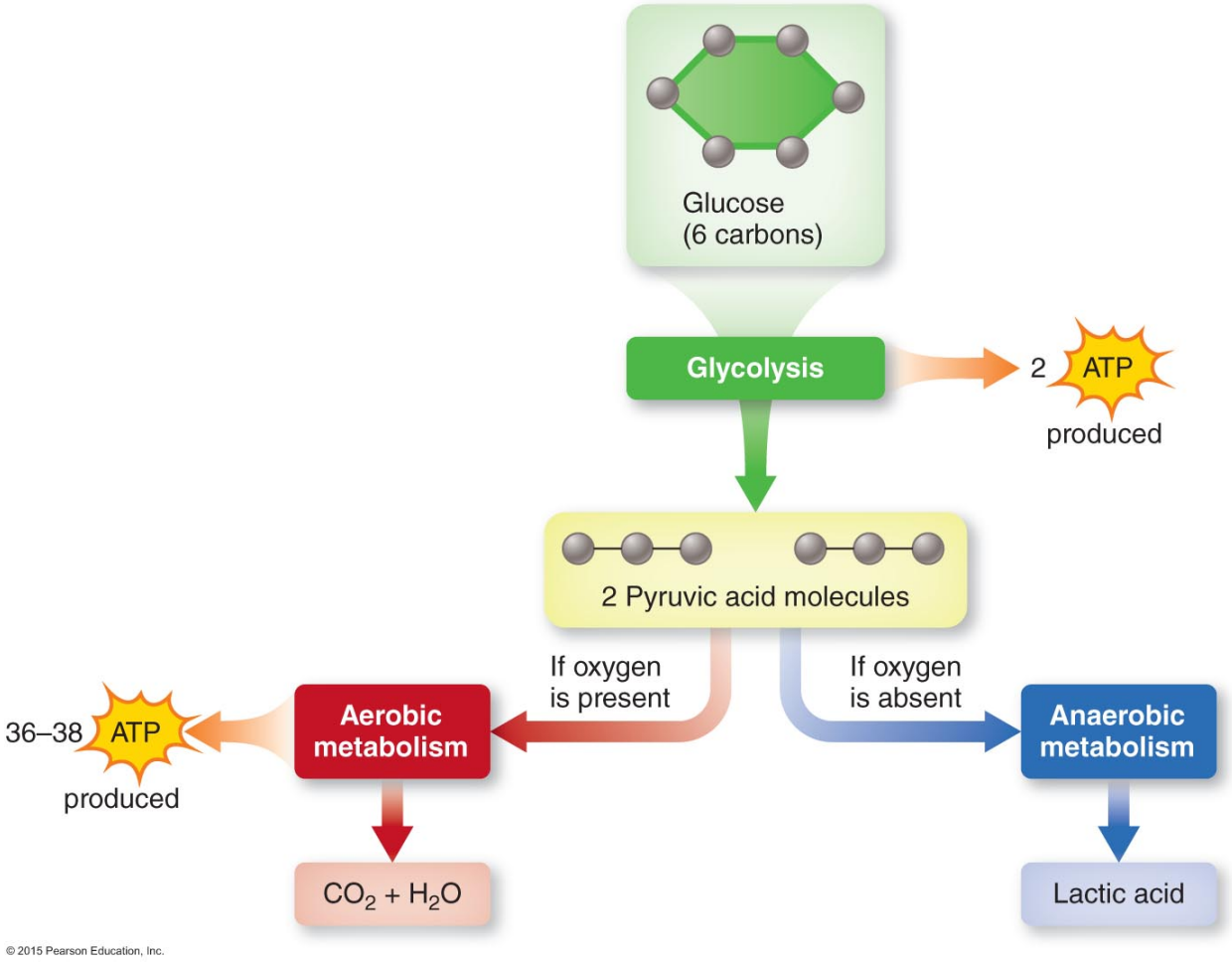

Figure 11.7: Metabolism of Glucose

- Stored triglycerides (fats) can be metabolized to generate ATP
  - For low-intensity exercise
  - For exercise of long duration
  - A very abundant energy source, even in lean people
  - Provides more than two times the energy per gram as carbohydrate
- Carbohydrates and fats can both be used as energy sources for the production of ATP
  - Carbohydrates are mostly used for high-intensity activity
  - Fats are used for low-intensity exercise
- Proteins (amino acids) are not a major fuel source for exercise

– 1–6% of energy needs during exercise

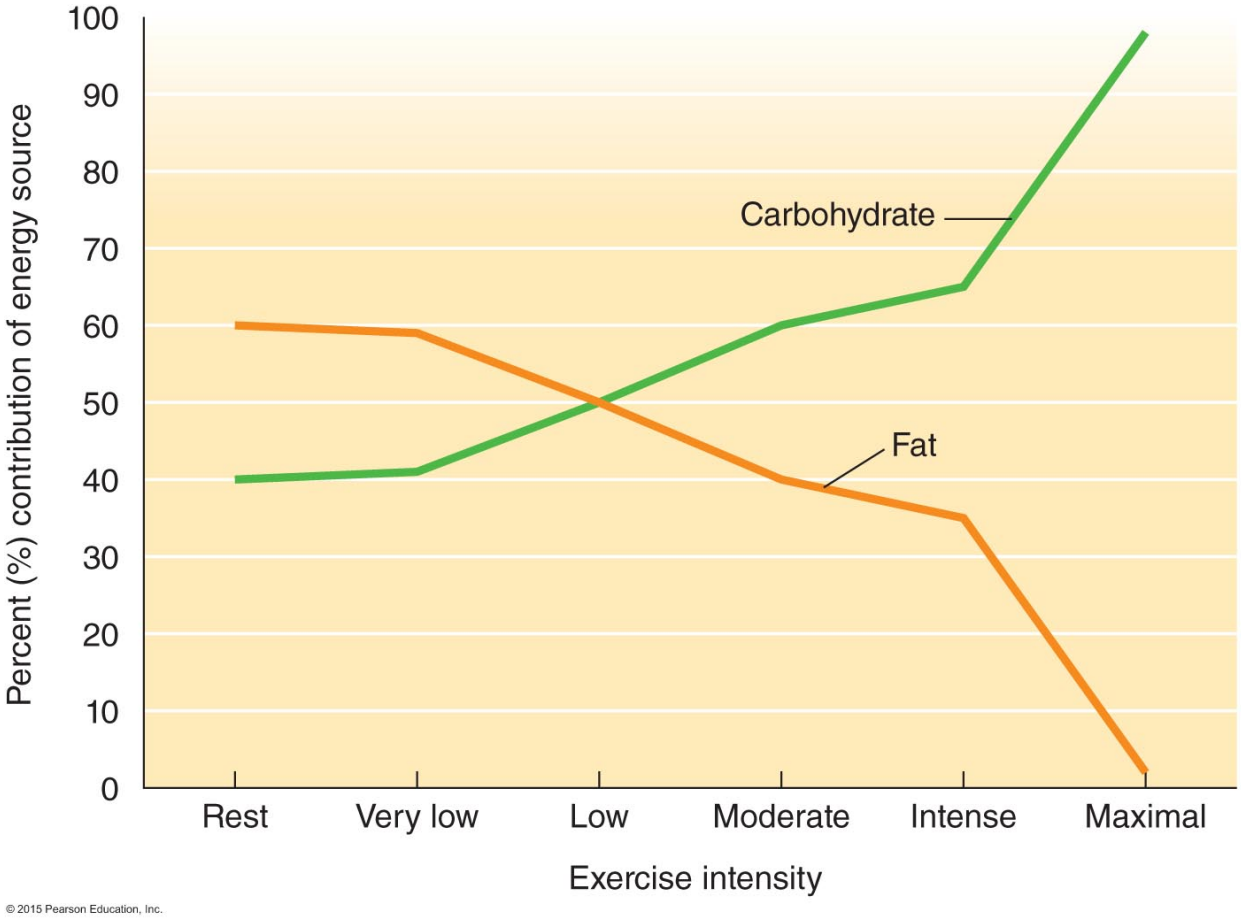

Figure 11.8: Fat and Carbohydrate Contributions

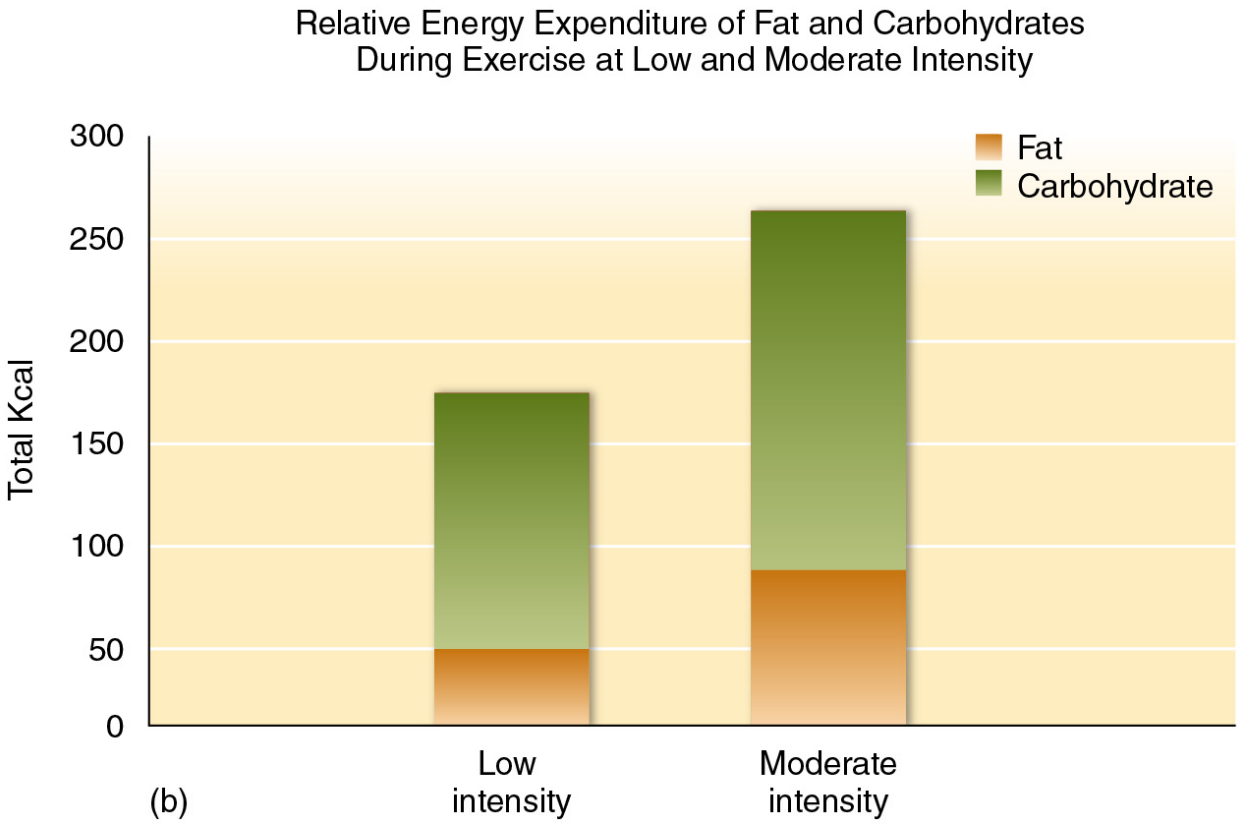

Figure 11.9: Fat and Carbohydrate Contributions (cont.)

11.9 Energy Needs for Physical Activity

- Energy needs
  - Energy needs may be higher for athletes
  - Different energy needs for males and females
  - Depend on body size
  - Depend on the type, intensity, and duration of physical activity

Table 11.3: Nutrients for Vigorous Physical Activity

Nutrient	Functions	Suggested Intake
Energy	Supports exercise, activities of daily living, and basic body functions	Depends on body size and the type, intensity, and duration of activity For many female athletes: 1,800 to 3,500 kcal/day For many male athletes: 2,500 to 7,500 kcal/day
Carbohydrate	Provides energy, maintains adequate muscle glycogen and blood glucose; high complex carbohydrate foods provide vitamins and minerals	45–65% of total energy intake Depending on sport and gender, should consume 6–10 g of carbohydrate per kg body weight per day
Fat	Provides energy, fat-soluble vitamins, and essential fatty acids; supports production of hormones and transport of nutrients	20–35% of total energy intake
Protein	Helps build and maintain muscle; provides building material for glucose; energy source during endurance exercise; aids recovery from exercise	10–35% of total energy intake 1.2-2.0 g per kg body weight
Water	Maintains temperature regulation (adequate cooling); maintains blood volume and blood pressure; supports all cell functions	Consume fluid before, during, and after exercise Consume enough to maintain body weight Consume at least 8 cups (64 fl. oz) of water daily to maintain regular health and activity Athletes may need up to 338 liters (170 fl. oz) every day; more is required if exercising in a hot environment
B-vitamins	Critical for energy production from carbohydrate, fat, and protein	May need slightly more (one to two times the RDA) for thiamin, riboflavin, and vitamin B_6
Calcium	Builds and maintains bone mass; assists with nervous system function, muscle contraction, hormone function, and transport of nutrients across cell membrane	Meet the current RDA: 14–18 years: 1,300 mg/day 19–50 years: 1,000 mg/day 51–70 years: 1,000 mg/day (men): 1,200 mg/day (women) 71 and older: 1,200 mg/day
Iron	Primarily responsible for the transport of oxygen in blood to cells; assists with energy production	Consume at least the RDA: Males: 14–18 years: 11 mg/day 19 and older: 8 mg/day Females: 14–18 years: 15 mg/day 19–50 years: 18 mg/day 51 and older: 8 mg/day

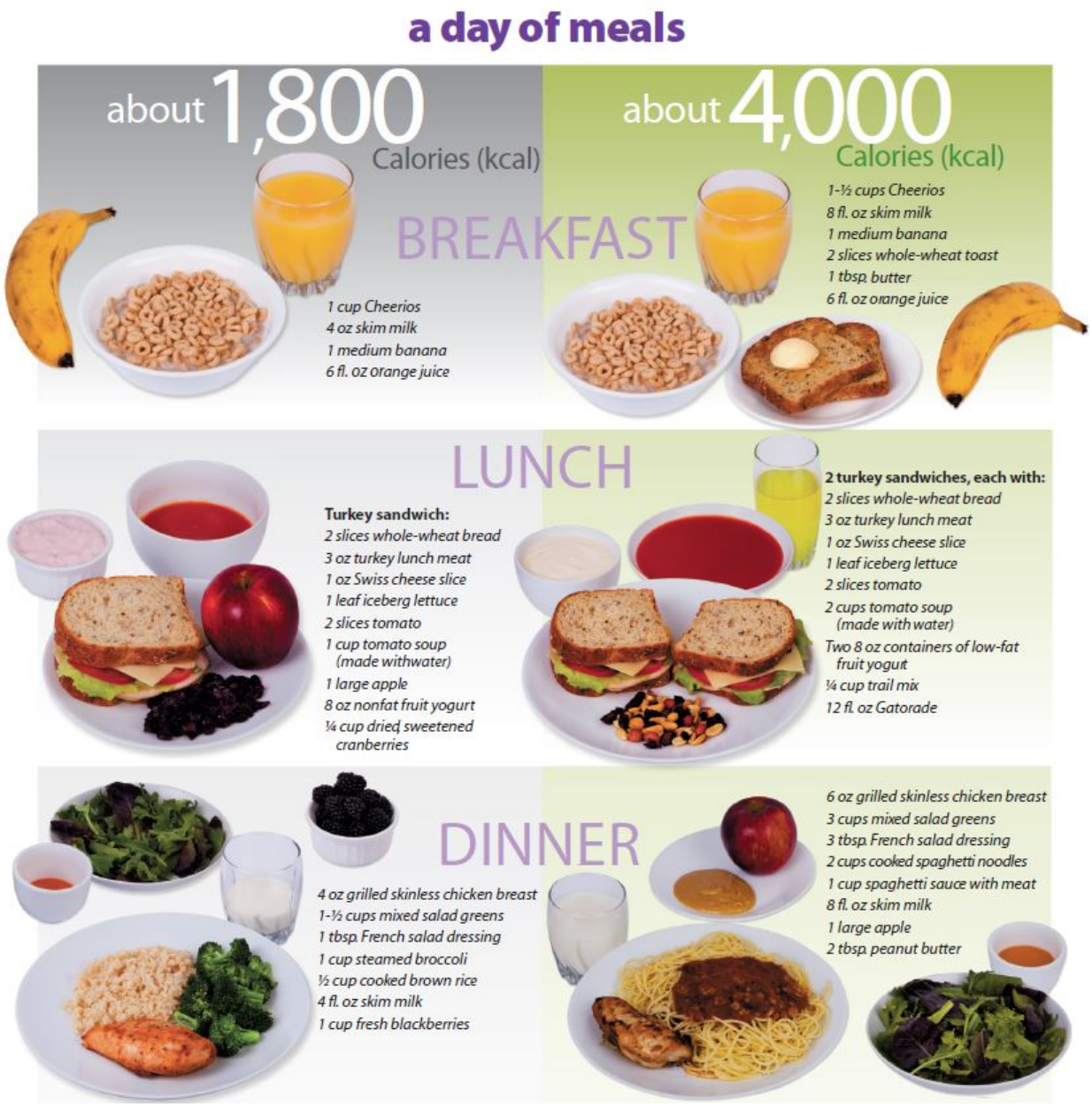

Figure 11.10: Eating for Athletes

11.10 Carbohydrate Intake for Physical Activity

- Athletes should consume carbohydrate within the AMDR of 45–65% of total energy intake
- Athletes should consume a daily carbohydrate intake of 6–10 grams per kg body weight to optimize glycogen stores
- Good sources are fiber-rich, less-processed foods such as whole grains, cereals, vegetables, and juices

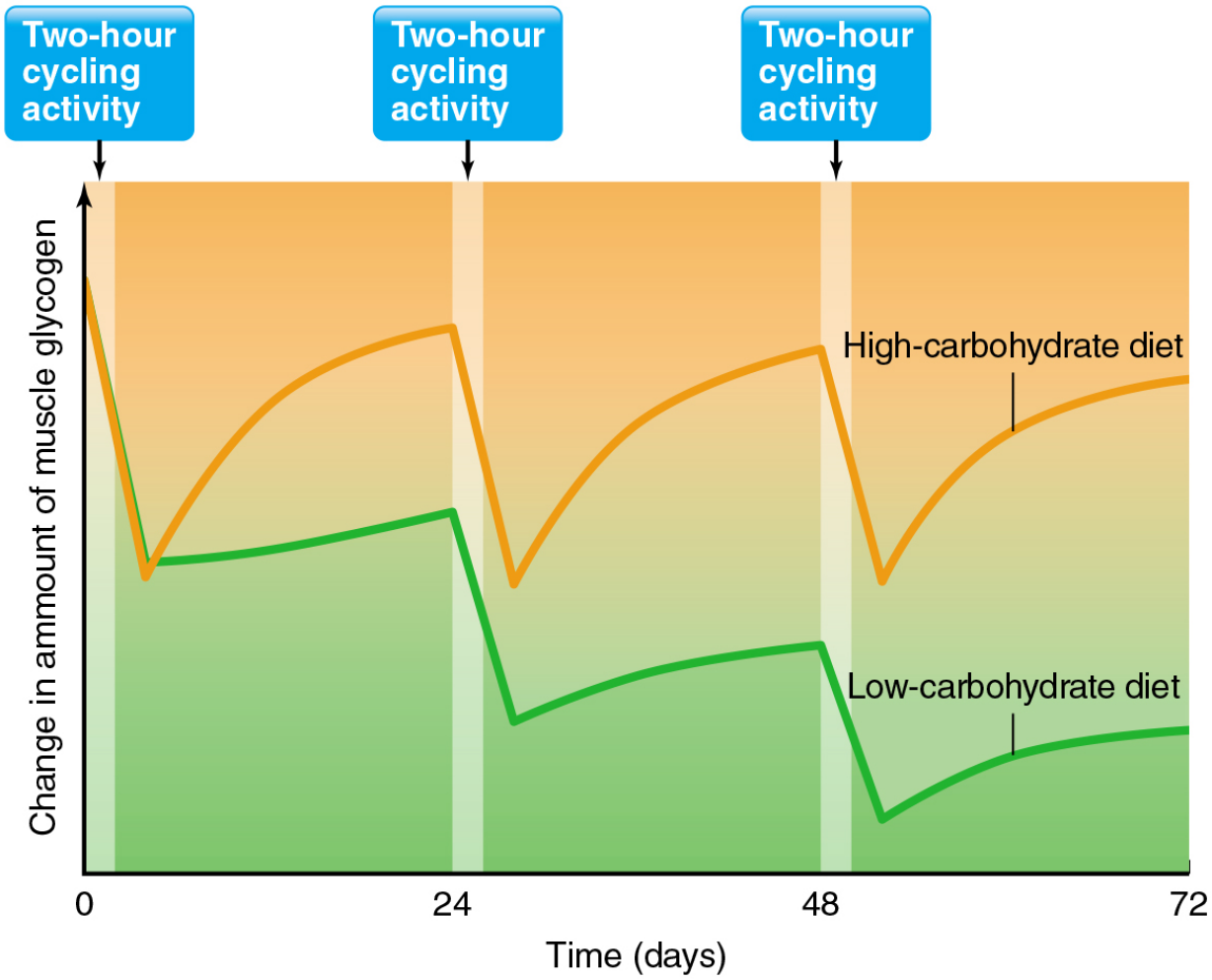

Figure 11.11: Carbohydrates and Muscle Glycogen Stores

Table 11.4: Carbohydrate and Total energy in Various Foods

Food	Amount	Carbohydrate (g)	Energy from Carbohydrate (%)	Total Energy (kcal)
Sweetened applesauce	1 cup	50	97	207
Large apple with	1 each	50	82	248
saltine crackers	8 each			
Whole-wheat bread	1-oz slice	50	71	282
with jelly	4 tsp.			
and skim milk	12 fl. oz			
Spaghetti (cooked)	1 cup	50	75	268
with tomato sauce	$\frac{1}{4}$ cup			
Brown rice (cooked)	1 cup	100	88	450
with mixed vegetables	$\frac{1}{2}$ cup			
and apple juice	12 fl. oz			
Grape-Nuts cereal	$\frac{1}{2}$ cup	100	84	473
with raisins	$\frac{3}{8}$ cup			
and skim milk	8 fl. oz			
Clif Bar (chocolate chip)	2.4 oz	43	75	230
Meta-Rx (fudge brownie)	100 g	41	41	400
Power Bar (chocolate)	1 bar	45	75	240
PR Bar Ironman	1 bar	22	44	200

Source: Data adapted from Manore, M. M., N. L. Meyer, and J. L. Thompson. 2009. Sport Nutrition for Health and Performance, 2nd ed. Champaign, IL: Human Kinetics.

- Carbohydrate loading, or glycogen loading, involves altering training and carbohydrate intake so that muscle glycogen storage is maximized
  - May benefit athletes competing in marathons, distance swimming, cross-country skiing, and triathlons
  - Does not always improve performance
  - Can lead to adverse side effects

Table 11.5: Carbohydrate Loading Guidelines

Days Prior to Event	Exercise Duration (in minutes)	Carbohydrate Content of Diet (g per kg body weight)
6	90 (at 90% max effort)	5 (moderate)
5	40 (at 70% max effort)	5 (moderate)
4	40 (at 70% max effort)	5 (moderate)
3	20 (light training)	10–12 (high)
2	20 (light training)	10–12 (high)
1	Rest	10–12 (high)
Day of race	Competition	Pre-competition food and fluid

Sources: Current Trends in Performance Nutrition, by Marie Dunford. Copyright © 2005 by Human Kinetics, Champaign, IL. Reprinted with permission; and American College of Sports Medicine, Academy of Nutrition and Dietetics, and Dietitians of Canada. 2016. Nutrition and Athletic Performance. Joint Position Statement. Medicine and Science in Sports and Exercise 48(3):543-568.

11.11 Fat Intake for Physical Activity

- Fat intake of 20–35% of total energy intake is generally recommended for both athletes and non-athletes, with less than 10% as saturated fat
- Fat provides energy, fat-soluble vitamins, and essential fatty acids
  - Inadequate levels can prove detrimental to training and performance

11.12 Protein Intake for Physical Activity

- Protein intakes suggested for active people range from 1.2 to 2.0 grams per kg of body weight
- High-quality sources include lean meats, poultry, fish, eggs, low-fat dairy products, legumes, and soy products

11.13 Fluid Intake for Physical Activity

- Fluids
  - Enable the body's primary cooling mechanism, evaporative cooling
  - Are necessary to prevent dehydration and heat-related illnesses
- Fluid intake is critical for physically active people

- Drink fluids before, during, and after exercise
- Consume enough to maintain body weight
- Training in hot environments requires careful attention to water intake

11.14 Fluid Intake and Physical Activity

- Heat production during exercise can increase 15 to 20 times compared to inactivity
- The body cools itself through evaporative cooling, but heat illness can occur with dehydration
  - Heat syncope
  - Heat cramps
  - Heat exhaustion

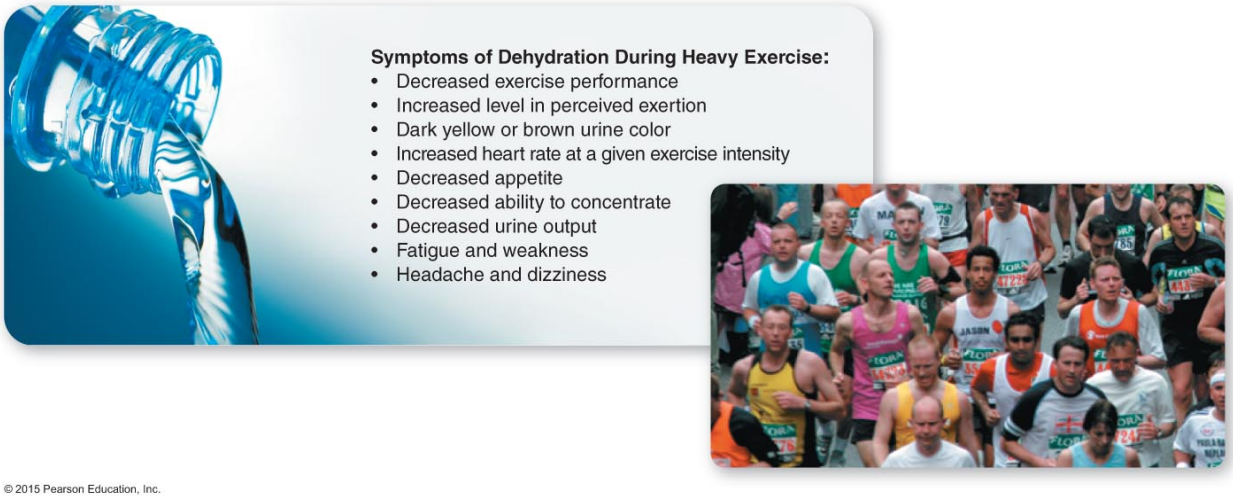

Figure 11.12: Dehydration Symptoms

Table 11.6: Guidelines for Fluid Replacement

Activity Level	Environment	Fluid Requirements (liters per day)
Sedentary	Cool	2–3
Active	Cool	3–6
Sedentary	Warm	3–5
Active	Warm	5–10

Before Exercise or Competition

- Drink adequate fluids during the 24 hours before event; should be able to maintain body weight.
- Slowly drink about 0.17 to 0.34 fl. oz per kg body weight of water or a sports drink in the 2 to 4 hours prior to exercise or event to achieve urine that is pale yellow in color while allowing sufficient time for excretion of excess fluid prior to exercise.
- Consuming beverages with sodium and/or small amounts of salted snacks at a meal will help stimulate thirst and retain fluids consumed.

During Exercise or Competition

- Amount and rate of fluid replacement depend on individual sweating rate, exercise duration, weather conditions, and opportunities to drink.
- Drink sufficient fluids during exercise to replace sweat losses such that total fluid loss is less than 2% of body weight.

Following Exercise or Competition

- Consume about 3 cups of fluid for each pound of body weight lost.
- Fluids after exercise should contain water to restore hydration status and sodium to support rehydration.
- Consume enough fluid to permit regular urination and to ensure the urine color is very light or light yellow in color; drinking about 125–150% of fluid loss is usually sufficient to ensure complete rehydration.

In General

- Products that contain fructose should be limited, as these may cause gastrointestinal distress.
- Alcohol should be avoided, as it increases urine output and reduces fluid retention.

Source: American College of Sports Medicine, Academy of Nutrition and Dietetics, and Dietitians of Canada. 2016. Nutrition and Athletic Performance. Joint Position Statement. Medicine and Science in Sports and Exercise 48(3):543-568.

11.15 Micronutrient Intake for Physical Activity

- The requirements for some vitamins and minerals may be elevated in athletes
  - B-vitamins
  - Calcium
  - Iron
- Adequate intake of these nutrients can be met with a healthy, balanced diet and should not require supplementation

11.16 Ergogenic Aids

- **Ergogenic aids:** – substances used to improve exercise and athletic performance
  - Many of these products are not effective
  - Some of these products are dangerous
  - Reliable research and accurate information on these products are hard to find
- Ergogenic aids used to build muscles and increase strength include
  - Anabolic steroids
    - Effective but illegal; numerous serious side effects
  - Andro (androstenedione) and DHEA (dehydroepiandrosterone)
    - Precursors of testosterone
    - Not been shown to be effective
  - GHB (gamma-hydroxybutyric acid)
    - Severe side effects and some reported deaths
- Creatine
  - It may improve performance in sprint activities
  - It may be beneficial to increase strength gained during resistance exercise
  - Relatively minor side effects
  - Effects of long-term use are unknown
- Protein and amino acid supplements
  - Not been shown to be effective
- Ergogenic aids used to increase energy levels and optimize fuel use include
  - Caffeine

    - Increases fat use for energy during exercise
    - In energy drinks, associated with serious side effects in children, adolescents, and young adults
  - Ephedrine
    - Stimulant banned in the United States
    - Serious side effects and some reported deaths
    - Also known as ephedra and ma huang

- Ergogenic aids found to be ineffective include
  - Carnitine
    - Claimed to increase transport of fatty acids into the mitochondria so they can be used for energy
  - Chromium
    - Claimed to enhance insulin's action
  - Ribose
    - Claimed to increase work output and speed up recovery time

- One more ergogenic aid that may have beneficial effects:
  - Beta-alanine
    - Increases the production of carnosine
    - Supplementation may enhance a person's ability to perform short-term, high-intensity activity and may delay muscle fatigue
    - Several weeks of supplementation are needed to affect performance

11.17 In Depth: Disorders Related to Body Image, Eating, and Exercise

- Disordered eating
  - A variety of atypical eating behaviors that people use to achieve a lower body weight
    - Ex: going on a diet, refusing to eat fat
  - Eating disorder
    - A psychiatric condition that involves extreme body dissatisfaction and long-term eating patterns that negatively affect body functioning

11.17.1 Body Image

- Body image
  - A person's perception, feelings about, and critique of his or her body's appearance and functioning
- Body image can affect eating and exercise behaviors

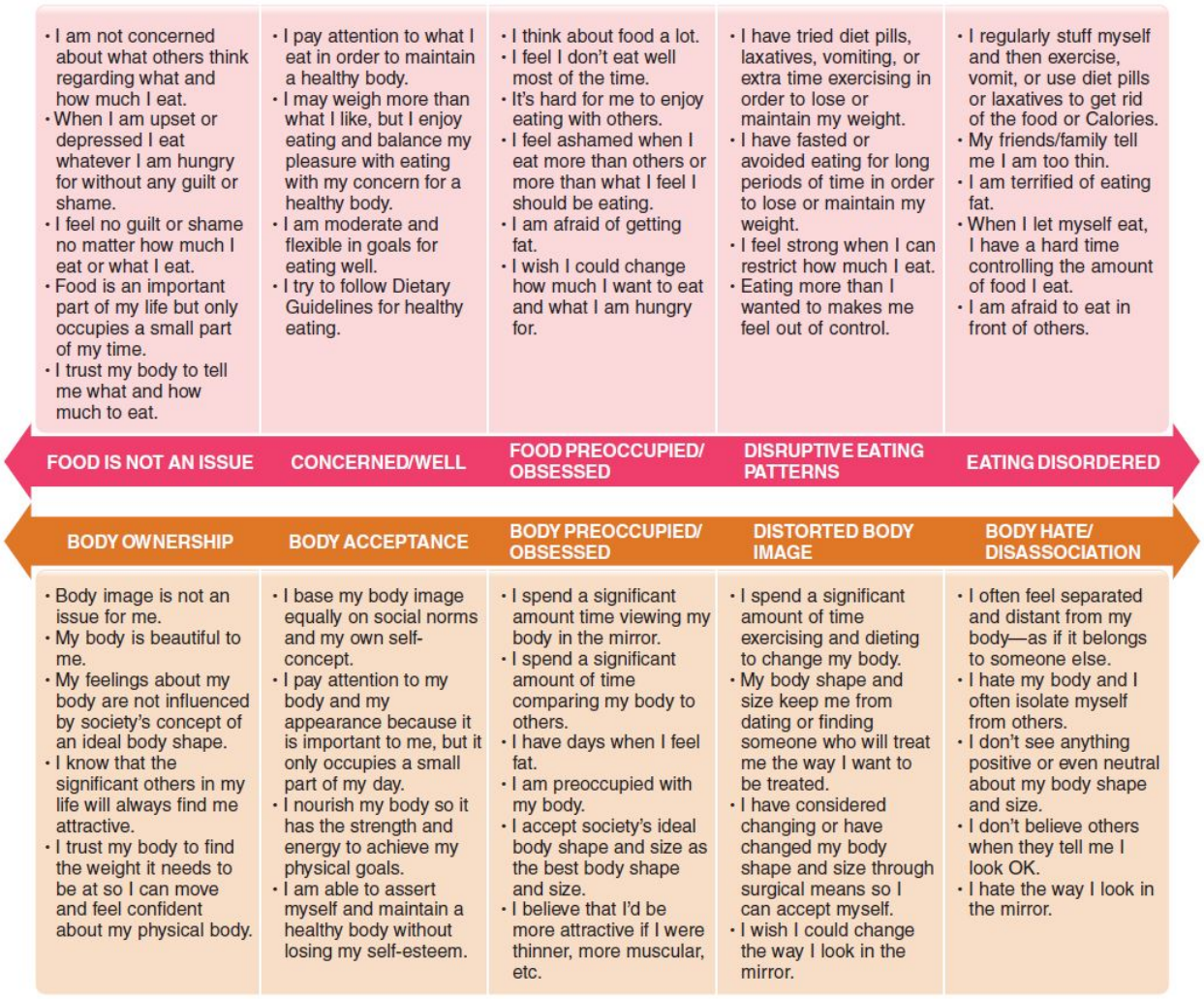

Figure 11.13: Body Image

11.17.2 Body Dysmorphic Disorder

- Body dysmorphic disorder (BDD) is a clinically diagnosed psychiatric disorder characterized by a disabling preoccupation with perceived defects in appearance
  - May affect up to 2.4% of the population

  - Equally common in males and females

- Muscle dysmorphia

  - Pathological pursuit of increased muscularity that causes individuals to engage in highly disordered eating behaviors

11.17.3 Contributing Factors

- Several factors may influence disorders related to body image, eating, and exercise

  - Genetics
  - Family environment
  - Anxiety, compulsivity, abnormal eating behaviors
  - Media
  - Social/cultural values
  - Other psychological disorders

11.17.4 Anorexia Nervosa

- A serious, potentially life threatening eating disorder that is characterized by self-starvation

- Self-starvation can lead to deficiencies in essential nutrients and energy required for the human body to function normally

- Signs and symptoms

  - Restrictive eating patterns
  - Eliminating food groups
  - Intense fear of weight gain
  - Amenorrhea (loss of menstrual cycle for 3 months or more)
  - Distorted body image

- Health risks:

  - Deficiency in total Calories and micronutrients
  - Body will be forced to use fat stores and lean tissue for energy
  - Reduction of non-vital bodily functions
  - Electrolyte imbalances
    * Can lead to heart failure or death

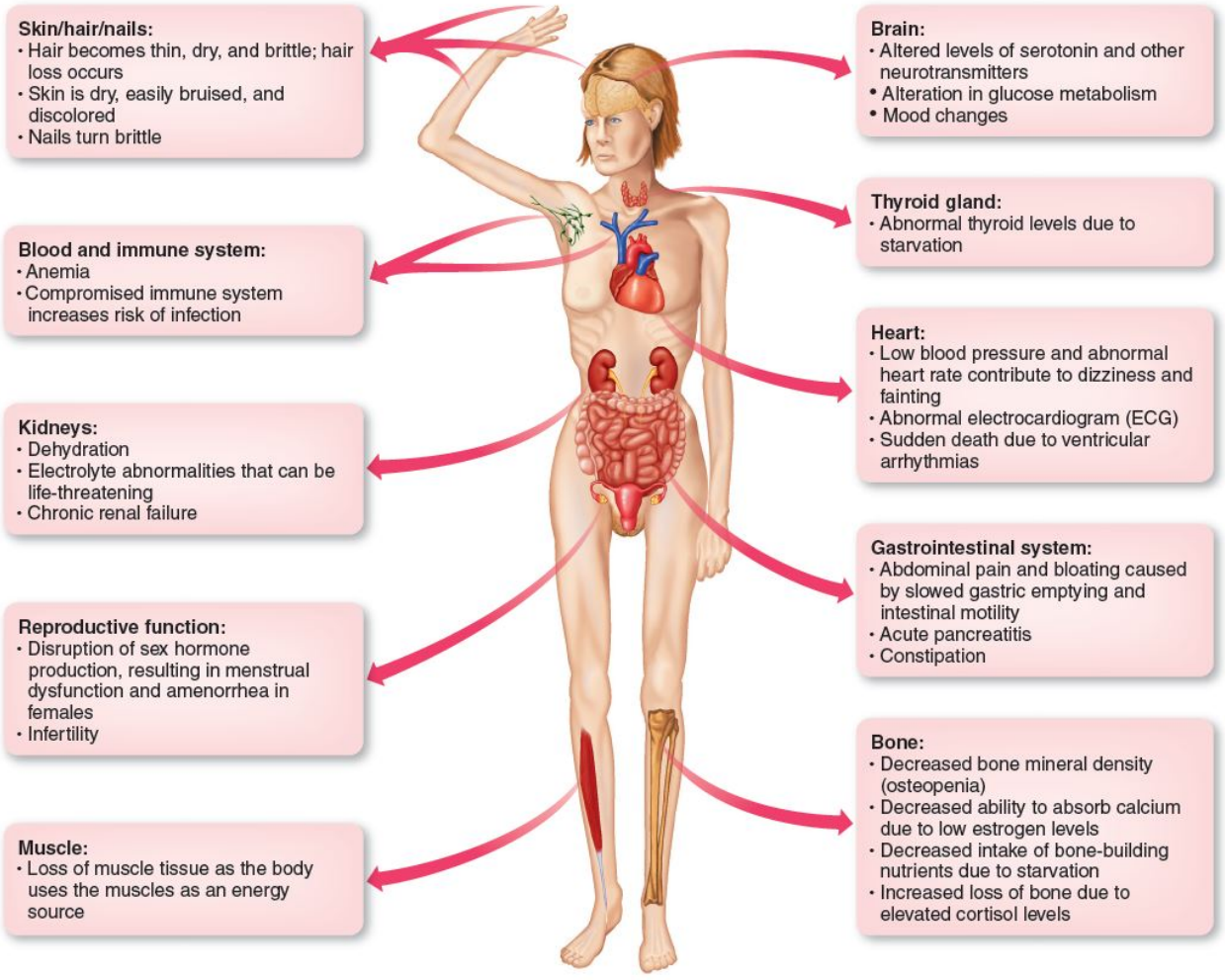

Figure 11.14: Anorexia Nervosa

11.17.5 Bulimia Nervosa

- Characterized by repeated episodes of binge eating and purging

  Binge eating: a consumption of a quantity of food that is large in size for the person and the amount of time in which the food is eaten

  Purging: compensatory behavior used to prevent weight gain. Methods include vomiting, laxative or diuretic abuse, enemas, fasting, and excessive exercise

- Signs and symptoms
  - Recurrent episodes of binge eating
  - Recurrent inappropriate compensatory behavior in order to prevent weight gain
  - Chronically inflamed and sore throat
  - Swollen glands in the neck and jaw

  - Worn tooth enamel

- Health risks
  - 3–5% of adult female population
  - 2% of adult male population
  - Increased risk of being overweight/obese due to increase in caloric consumption
  - Increased blood lipids
  - Low self-esteem
  - Depression

11.17.6 Night-Eating Syndrome

- A disorder characterized by intake of the majority of the days energy between 8 pm and 6 am
- Individuals with this disorder also experience mood and sleep disorders

11.17.7 Female Athlete Triad

- Syndrome that consists of three clinical conditions in some physically active females
  - Low energy availability
  - Amenorrhea
  - Low bone density
- Typically seen in female athletes who participate in activities that emphasize leanness