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# Concepts of Fitness and Wellness, 2nd Edition

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# Concepts of Fitness & Wellness

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# Concepts of Fitness and Wellness

Scott Flynn, Jonathan Howard, Lisa Jellum, Althea Moser

## Table of Contents

1. Healthy Behaviors
2. Fitness Principles
3. Cardiorespiratory Fitness
4. Muscular Fitness
5. Flexibility
6. Body Composition
7. Nutrition
8. Weight Management
9. Stress
10. Cardiovascular Disease
11. Cancer
12. Substance Use and Abuse
13. Sexually Transmitted Infections



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# Healthy Behaviors and Wellness

## Objectives:

- Define the nine dimensions of wellness
  - Identify health problems in the United States
  - Identify the behaviors that promote wellness
  - Behavior Modification: how change occurs, barriers to change, and how to successfully overcome barriers and make lasting lifestyle changes
- 

## Why Study Wellness?

As most college students do, you have probably set goals. Obviously, your individual goals differ from those of your fellow classmates, but everyone's goals share one common attribute: their intention to improve individual wellbeing. However, there are as many ideas about how to do that as there are individuals. Do your goals involve making more money, achieving better health, improving your relationships? Holistic wellness involves all those aspects of life and more. This chapter explains the importance of overall wellness, which is about more than being physically and mentally healthy, free from illness and disease. In fact, the study of wellness incorporates all aspects of life. Achieving overall wellness means living actively and fully. People in this state exude confidence, optimism, and self-efficacy; they have the energy reserves to do what needs to be done today and to plan for a better tomorrow. The most effective and transformative goals are those designed to achieve the highest level of personal wellness.

## Dimensions of Wellness

Wellness is a familiar term, but what is its true definition? Is it simply the absence of disease? This chapter will define all the components of holistic wellness and describe the factors that contribute to not only a person's physical and mental health, but also their ability to develop, thrive, succeed, enjoy life, and meet challenges head on with confidence and resolve.

To achieve this type of overall wellness, a person must be healthy in nine interconnected dimensions of wellness: physical, emotional, intellectual, spiritual, social, environmental, occupational, financial, and cultural. A description of each dimension follows.

## The Nine Dimensions of Wellness

- *Physical Wellness*  
People who are physically well actively make healthy decisions on a daily basis. They eat a nutritionally balanced diet; they try to get an adequate amount of sleep, and they

visit the doctor routinely. They make a habit of exercising three to five times per week; they have the ability to identify their personal needs and are aware of their body's limitations. They maintain positive interpersonal relationships and make healthy sexual decisions that are consistent with their personal values and beliefs.

- *Emotional Wellness*  
An emotionally well person successfully expresses and manages an entire range of feelings, including anger, doubt, hope, joy, desire, fear, and many others. People who are emotionally well maintain a high level of self-esteem. They have a positive body-image and the ability to regulate their feelings. They know where to seek support and help regarding their mental health, including but not limited to, seeking professional counseling services.
- *Intellectual Wellness*  
Those who enjoy intellectual wellness engage in lifelong learning. They seek knowledge and activities that further develop their critical thinking and heighten global awareness. They engage in activities associated with the arts, philosophy, and reasoning.
- *Spiritual Wellness*  
People who can be described as spiritually well have identified a core set of beliefs that guide their decision making, and other faith-based endeavors. While firm in their spiritual beliefs, they understand others may have a distinctly

different set of guiding principles. They recognize the relationship between spirituality and identity in all individuals.

- *Social Wellness*  
A socially well person builds healthy relationships based on interdependence, trust, and respect. Those who are socially well have a keen awareness of the feelings of others. They develop a network of friends and co-workers who share a common purpose, and who provide support and validation.
- *Environmental Wellness*  
An environmentally well person appreciates the external cues and stimuli that an environment can provide. People who have achieved environmental wellness recognize the limits to controlling an environment and seek to understand the role an individual plays in the environment.
- *Occupational Wellness*  
An occupationally well person enjoys the pursuit of a career which is fulfilling on a variety of levels. This person finds satisfaction and enrichment in work, while always in pursuit of opportunities to reach the next level of professional success.
- *Financial Wellness*  
Those who are financially well are fully aware of their current financial state. They set long- and short-term goals regarding finances that will allow them to reach their personal goals and achieve self-defined financial success.

- **Cultural Wellness**  
Culturally well people are aware of their own cultural background, as well as the diversity and richness present in other cultural backgrounds. Cultural wellness implies understanding, awareness and intrinsic respect for aspects of diversity. A culturally well person acknowledges and accepts the impact of these aspects of diversity on sexual orientation, religion, gender, racial and ethnic backgrounds, age groups, and disabilities.<sup>1</sup>

For more information on the nine dimensions of wellness, click on the link below:

[Nine Dimensions of Wellness](#)

To watch a video about the nine dimensions of wellness, click on the following link:

[Video on the Nine Dimensions of Wellness](#)

## Health Problems in the United States

Americans today experience health problems that people who lived 100 years ago did not encounter. What are the factors that account for these health problems that have arisen over the past 100 years? Most health problems faced by people in the U.S. are chronic diseases that are preventable and caused by everyday choices and unhealthy lifestyles.

The link below provides more information about the leading causes of death in the United States:

[Leading Causes of Death](#)

To see a 2014 chart that shows the leading cause of death by age group, click on the link below:

[Leading Cause of Death by Age Group](#)

In the video linked below, you will learn about the determinants of health as outlined by Healthy People 2020. Healthy People 2020 is a federal advisory committee comprised of non-federal, independent subject matter experts who gather data and provide advice on how to promote health and prevent disease in America:

[Healthy People 2020 and Determinants of Health](#)

The link below is to Healthy People 2020's website, which contains data and technical information about this organization's objectives:

[Healthy People 2020 Website](#)

## Behaviors That Promote Wellness

Bad habits are hard to break, but choosing to eat healthier and exercise more provides benefits that go far beyond a more ideal body weight and shape. Being physically fit can stave off many of the diseases and medical conditions discussed in the previous section, including heart disease,

the number 1 killer in America. Exercise reduces stress and eases depression. Healthier employees are also more productive. Being physically fit nurtures the mind, body, and spirit and is the cornerstone of wellness. The links below provide information about behaviors within your control that contribute to an improved quality of life and increased wellness.

[Six Behaviors That Contribute to Wellness](#)

[Lifestyle Choices and Their Effect on Wellbeing](#)

[Behaviors that Contribute to Wellness Presentation](#)

## Behavior Modification

Making permanent lifestyle changes is one of the greatest challenges a person can face. This section will explore how changes to behavior occur, the psychological barriers that hamper efforts to change, and tips for making lasting change.

### How Changes in Behavior Occur

**The Transtheoretical Model**, also called the **Stages of Change Model**, was developed by James Prochaska and Carlo DiClemente in the late 1970s. Considered the dominant model for describing how behavior changes occur, it evolved through studies examining the experiences of smokers who quit on their own and comparing them with the experiences of those requiring further treatment. The goal of those studies was to understand why some people were capable of quitting on their own. It was determined that people quit smoking if they were ready

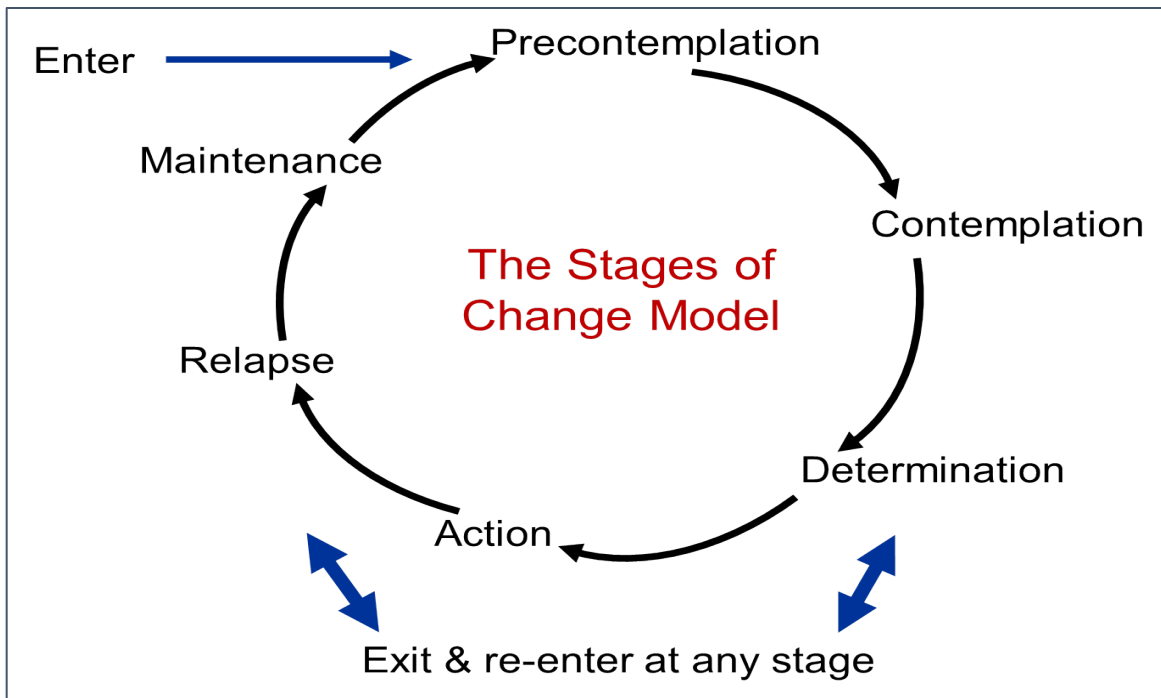
to do so. Thus, the Transtheoretical Model (TTM) focuses on the decision-making of the individual and is a model of intentional change. The TTM operates on the assumption that people do not change behaviors quickly and decisively. Rather, change in behavior, especially habitual behavior, occurs continuously through a cyclical process. The TTM is not a theory but a model; different behavioral theories and constructs can be applied to various stages of the model where they may be most effective.

The TTM posits that individuals move through six stages of change: precontemplation, contemplation, preparation, action, maintenance, and termination. Termination was not part of the original model and is less often used in application of stages of change for health-related behaviors. For each stage of change, different intervention strategies are most effective at moving the person to the next stage of change and subsequently through the model to maintenance, the ideal stage of behavior.

### Six Stages of Change:

- *Stage 1: Precontemplation*  
In this stage, people do not intend to take action in the foreseeable future (defined as within the next 6 months). People are often unaware that their behavior is problematic or produces negative consequences. People in this stage often underestimate the pros of changing behavior and place too much emphasis on the cons of changing behavior.





- **Stage 2: Contemplation**  
In this stage, people are intending to start the healthy behavior in the foreseeable future (defined as within the next 6 months). People recognize that their behavior may be problematic, and a more thoughtful and practical consideration of the pros and cons of changing the behavior takes place, with equal emphasis placed on both. Even with this recognition, people may still feel ambivalent toward changing their behavior.
- **Stage 3: Preparation (Determination)**  
In this stage, people are ready to take action within the next 30 days. People start to take small steps toward the behavior change, and they believe changing their behavior can lead to a healthier life.
- **Stage 4: Action**  
In this stage, people have recently changed their behavior (defined as within the last 6 months) and intend to keep moving forward with that behavior change. People may exhibit this by modifying their problem behavior or acquiring new healthy behaviors.
- **Stage 5: Maintenance**  
In this stage, people have sustained their behavior change for a while (defined as more than 6 months) and intend to maintain the behavior change going forward. People in this stage work to prevent relapse to earlier stages.
- **Stage 6: Termination**  
In this stage, people have no desire to return to their unhealthy behaviors and are sure they will not relapse. Since this is rarely reached, and people tend to stay in the maintenance stage, this stage is

often not considered in health promotion programs.

To progress through the stages of change, people apply cognitive, affective, and evaluative processes. Ten processes of change have been identified, with some processes being more relevant to a specific stage of change than other processes. These processes result in strategies that help people make and maintain change.

### **Ten Processes of Change:**

1. *Consciousness Raising*  
Increasing awareness about the healthy behavior.
2. *Dramatic Relief*  
Emotional arousal about the health behavior, whether positive or negative arousal.
3. *Self-Reevaluation*  
Self-reappraisal to realize the healthy behavior is part of who they want to be.
4. *Environmental Reevaluation*  
Social reappraisal to realize how their unhealthy behavior affects others.
5. *Social Liberation*  
Environmental opportunities that exist to show society is supportive of the healthy behavior.
6. *Self-Liberation*  
Commitment to change behavior based on the belief that achievement of the healthy behavior is possible.

7. *Helping Relationships*  
Finding supportive relationships that encourage the desired change.
8. *Counter-Conditioning*  
Substituting healthy behaviors and thoughts for unhealthy behaviors and thoughts.
9. *Reinforcement Management*  
Rewarding the positive behavior and reducing the rewards that come from negative behavior.
10. *Stimulus Control*  
Re-engineering the environment to have reminders and cues that support and encourage the healthy behavior and remove those that encourage the unhealthy behavior.

### **Limitations of the Transtheoretical Model**

Limitations of the model include the following:

- The theory ignores the social context in which change occurs, such as socioeconomic status and income.
- The lines between the stages can be arbitrary with no set criteria of how to determine a person's stage of change. The questionnaires that have been developed to assign a person to a stage of change are not always standardized or validated.
- No clear sense exists for how much time is needed for each stage, or how long a person can remain in a stage.

- The model assumes that individuals make coherent and logical plans in their decision-making process when this is not always true.

The Transtheoretical Model provides suggested strategies for public health interventions to address people at various stages of the decision-making process. Using strategies suggested by TTM can result in interventions that are more effective because they are tailored for a specific group of people. In other words, the interventions involve a message or program component that has been specifically created for a target population's level of knowledge and motivation. The TTM encourages an assessment of an individual's current stage of change and accounts for relapse in people's decision-making process.<sup>2</sup>

For more information about TTM, especially as it relates to exercise, click on the link below:

[TTM for Behavior Change](#)

One of the most effective tools for changing behavior is goal setting. The links below provide information on how to set goals effectively to achieve greater success in goal attainment.

[Goal Setting Info from Oregon State University's Academic Success Center](#)

[One Step at a Time Goal Achievement](#)

[Video on S.M.A.R.T. Goals](#)

[Making S.M.A.R.T. Goals Activity](#)

## Lifestyle Modification Barriers

Dr. James M. Olson, a psychology professor at the University of Western Ontario, London, has identified several psychological barriers that commonly prevent people from taking action, even when inaction poses a threat to their health. These barriers occur during 3 stages of behavior modification: admission of the problem, initial attempts to change, and long-term change as outlined below:

- *Barriers to Admission of the problem*  
The first step in lasting change is admitting a problem exists. People often fail to change behavior that poses a risk to their health because they deny a risk exists, trivialize their personal risk, feel invulnerable, make a faulty conceptualization, (i.e., they attribute early warning signs to a benign cause), or experience debilitating emotions when contemplating preventative measures.
- *Barriers to Initial Attempts to Change*  
At this stage, people acknowledge the need to change but struggle to accomplish their goals. This failure is a result of lack of knowledge, low self-efficacy (the belief in one's own ability to succeed at change), and dysfunctional attitudes.
- *Barriers to long-term change*  
Just because a person has experienced success in changing a behavior, that doesn't mean the change is permanent. Barriers to

long-term change include cognitive and motivational drift (diminishing enthusiasm for the need to change), lack of perceived improvement, lack of social support, and lapses.

To read more about these barriers to change, including strategies for overcoming these barriers, read Dr. Olson's entire article linked below:

### [Psychological Barriers to Behavior Change](#)

A presentation on overcoming barriers to change by the National Institute for Health and Clinical Excellence (NHS) is linked below:

### [Overcoming Barriers to Change](#)

## **Fostering Wellness in Your Life**

You are once again feeling motivated to eat better, exercise more, drink less caffeine or make any number of the positive lifestyle changes you have been telling yourself you want to make. You have tried before—probably declaring another attempt as a New Year's resolution—but without experiencing much success. Making a lifestyle change is challenging, especially when you want to transform many things at once. This time, think of those changes not as a resolution but as an evolution.

Lifestyle changes are a process that take time and require support. Once you are ready to make a change, the difficult part is committing and following through. So do your research and make a plan that will prepare you for success. Careful planning means setting small goals and taking things one step at a time.

Here are five tips from the American Psychological Association (APA) that will assist you in making lasting, positive lifestyle and behavior changes:

- *Make a plan that will stick.*  
Your plan is a map that will guide you on this journey of change. You can even think of it as an adventure. When making your plan, be specific. Want to exercise more? Detail the time of day when you can take walks and how long you will walk. Write everything down, and ask yourself if you are confident that these activities and goals are realistic for you. If not, start with smaller steps. Post your plan where you will most often see it as a reminder.
- *Start small.*  
After you've identified realistic short-term and long-term goals, break down your goals into small, manageable steps that are specifically defined and can be measured. Is your long-term goal to lose 20 pounds within the next five months? A good weekly goal would be to lose one pound a week. If you would like to eat healthier, consider as a goal for the week replacing dessert with a healthier option, like fruit or yogurt. At the end of the week, you will feel successful knowing you met your goal.
- *Change one behavior at a time.*  
Unhealthy behaviors develop over the course of time, so replacing unhealthy behaviors with healthy ones requires time. Many people run into problems when they try to change too much too fast. To

improve your success, focus on one goal or change at a time. As new healthy behaviors become a habit, try to add another goal that works toward the overall change you are striving for.

- *Involve a buddy.*  
Whether it be a friend, co-worker or family member, someone else on your journey will keep you motivated and accountable. Perhaps it can be someone who will go to the gym with you or someone who is also trying to stop smoking. Talk about what you are doing. Consider joining a support group. Having someone with whom to share your struggles and successes makes the work easier and the mission less intimidating.
- *Ask for support.*  
Accepting help from those who care about you and will listen strengthens your resilience and commitment. If you feel overwhelmed or unable to meet your goals on your own, consider seeking help from a psychologist. Psychologists are uniquely trained to understand the connection between the mind and body, as well as the factors that promote behavior change. Asking for help does not mean a lifetime of therapy; even just a few sessions can help you examine and set attainable goals or address the emotional issues that may be getting in your way.

## Start with “Why?”

Making changes in habitual behavior requires a deep and abiding belief that change is needed. Your desire to change may be motivated by personal goals, or it may be the result of the impact your improved wellness will have on those you love. Nietzsche said, “He who has a strong enough *why* can bear almost any *how*.”

Once you have a compelling reason to change, develop a plan and commit to that plan. If you experience a moment of weakness, do not waste time on self-condemnation. Revisit your compelling reason and reaffirm your commitment to change. The health, peace, and sense of wellbeing inherent in the highest level of your own personal wellness is more than worth the effort required to change.

For more information about making permanent lifestyle changes, go to the APA website linked below:

[Lifestyle Changes That Last](#)

## Assessing Your Personal Lifestyle Behaviors

Complete the following lab. Please print, complete, and submit the evaluation linked below to D2L.

[Lifestyle Evaluation Lab](#)

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<sup>1</sup>Auburn University. Division of Student Affairs.

<sup>2</sup>Boston University School of Public Health

## *Terminology Checklist:*

**Health-** Absence of disease

**Wellness-** optimal state of mind and body

**Behavior Modification-** the alteration of behavioral patterns through specific techniques

**Transtheoretical Model-** the theory of the stages of change for behavior change

**Goal Setting-** the process of identifying something that you want to accomplish and establishing measurable goals and timeframes

**Barriers-** something that stands in the way of you achieving your goals

## *Test Your Knowledge*

1. Health is defined as
  - a. Having health insurance
  - b. Absence or presences of disease or injury
  - c. Absence or presence of optimal wellness
  - d. Not having to see a doctor
  
2. Health and Wellness mean the same thing
  - a. True
  - b. False
  
3. Which of the following is the least likely to affect a college student's wellness?
  - a. Retirement income
  - b. School
  - c. Screen time
  - d. Drugs
  
4. Before changing your behavior, what must you do first?
  - a. Find help
  - b. Learn where resources are located that will help you change your behavior
  - c. Nothing you just start changing your behavior
  - d. Pick a behavior that you want to change
  
5. Visualization is
  - a. Picturing a pro-con list
  - b. Seeing yourself laying on the beach
  - c. Seeing yourself accomplish a goal
  - d. Picturing yourself falling asleep
  
6. What is the first step in the transtheoretical model?
  - a. Relapse
  - b. Precontemplation
  - c. Action
  - d. Preparation

Answers: 1.B, 2.B, 3.A, 4.D, 5.C, 6.B



# Fitness Principles

By Scott Flynn

## Objectives:

- Describe the origins of exercise
  - Define physical activity and exercise
  - Discuss principles of adaptation to stress
  - Provide guidelines for creating a successful fitness program
  - Identify safety concerns
- 

## Exercise: Not a Passing Fad

The benefits of physical activity and exercise are universally recognized—and have been for far longer than one might think. Our Paleolithic ancestors regularly engaged in physical activity to survive. However, rather than chasing after a soccer ball to win a game or taking a leisurely stroll down a tree-lined path, they “worked out” by chasing after their next meal. For them, no exercise meant no food. How’s that for a health benefit?

With the advent of sedentary agriculture some 10,000 years ago, that same level of peak performance was no longer necessary. As our ancestors continued to devise more advanced means of acquiring food, physical activity declined. It wasn’t until the fourth century BCE, that the Greek physician Herodicus, recognized the importance of being physically active outside of a hunter-gatherer society. He practiced gymnastic medicine, a branch of Greek medicine that relied on vigorous exercise as a treatment. During that same time period, Hippocrates, who is often referred to as the Father of Modern Medicine, asserted, “If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health.” In the 12 century CE, the Jewish philosopher Rabbi Moses ben Maimon, a

physician to the Sultan of Egypt, stated, “Anyone who lives a sedentary life and does not exercise, even if he eats good foods and takes care of himself according to proper medical principles, all his days will be painful ones and his strength will wane.” The 15<sup>th</sup> century theologian and scholar Robert Burton went so far as to declare that *not* exercising, or “idleness” as he referred to it in his widely read tome, *The Anatomy of Melancholy*, was the “bane of body and mind.” Burton also warned that the lack of exercise was the sole cause of melancholy (the name given depression at that time) and “many other maladies.” Burton claimed that idleness was one of the seven deadly, as well as “the nurse of naughtiness,” and the “chief author of mischief.” For Burton, exercise was not only essential for good health, but a means of avoiding eternal damnation.

By the 16<sup>th</sup> century, the benefits of exercise were widely accepted, at least among the wealthy and the educated, who had access to leisure. During this time period, H. Mercurialis defined exercise as “the deliberate and planned movement of the human frame, accompanied by breathlessness, and undertaken for the sake of health or fitness.” This definition is still widely used today.

Beyond the physical health benefits, there are affective benefits associated with group games

and activities. Ancient Mayans organized the first team game called the Ball Game. It consisted of two teams trying to get a ball through a hoop mounted approximately 23 feet on a wall. The rules were to get the ball through the hoop using certain parts of the body. In some cases the captain of the losing team gave himself as a human sacrifice to the winning team, an act that was believed by the Mayans to be a vital part of prosperity.

American Indians are thought to have founded the modern game of lacrosse, as well as other stick games. Lacrosse, which received its name from French settlers, was more than a form of recreation. It was a cultural event used to settle disputes between tribes.



Figure 1. Ball Players. George Catlin. Date unknown.

The outcome of the game, as well as the choosing of teams, was thought to be controlled supernaturally. As such, game venues and equipment were prepared ritualistically.

## From Ancient History to Modern Times

In retrospect, the perceived benefits of exercise have changed very little since Herodotus or the American Indians. Mounting research supports historical assertions that exercise is vital to sustaining health and quality of life. Culturally, sports play a huge role in growth and development of youth and adults. Physically,

there is indisputable evidence that regular exercise promotes healthy functioning of the brain, heart, and the skeletal and muscular systems. Exercise also reduces risk for chronic diseases, such as cancer, diabetes, and obesity. Regular exercise can even improve emotional health and overall wellbeing.

## What are Physical Activity and Exercise?

**Physical activity** is defined as any movement carried out by skeletal muscle that requires energy and is focused on building health. Health benefits include improved blood pressure, blood-lipid profile, and heart health. Acceptable physical activity includes yard work, house cleaning, walking the dog, or taking the stairs instead of the elevator. Physical activity does not have to be done all at once. It can be accumulated through various activities throughout the day. Although typing on a phone or laptop or playing video games does involve skeletal muscle and requires a minimal amount of energy, the amount required is not sufficient to improve health.

Despite the common knowledge that physical activity is tremendously beneficial to one's health, rates of activity among Americans continue to be below what is needed. According to the Center for Disease Control (CDC), only 1 in 5 (21%) of American adults meet the recommended physical activity guidelines from the Surgeon General. Less than 3 in 10 high school students get 60 minutes or more of physical activity per day. Non-Hispanic whites (26%) are more active than their Hispanic (16%) and Black counterparts (18%) as is the case for males (54%) and females (46%). Those with more education and those whose household income is higher than poverty level are more likely to be physically active.<sup>1</sup>

The word *exercise*, although often used interchangeably with the phrase *physical activity*, denotes a sub-category of physical

activity. **Exercise** is a planned, structured, and repetitive movement pattern intended to improve fitness. As a positive side-effect, it significantly improves health as well. Fitness improvements include the heart's ability to pump blood, increased muscle size, and improved flexibility.

## Components of Health-Related Fitness

In order to carry out daily activities without being physically overwhelmed, a minimal level of fitness is required. To perform daily activities without fatigue, it is necessary to maintain health in five areas: cardiorespiratory endurance, muscular strength and endurance, flexibility, and body composition. These five areas are called the components of health-related fitness. Development of these areas will improve your quality of life, reduce your risk of chronic disease, and optimize your health and well-being. Each of these 5 areas will be explored in depth at a later time. Below is a brief description of each.

- **Cardiorespiratory endurance**  
Cardiorespiratory endurance is the ability to carry out prolonged, large muscle, dynamic movements at a moderate to high level of intensity. This relates to your heart's ability to pump blood and your lungs' ability to take in oxygen.
- **Muscular strength**  
Muscular strength is the ability of the muscles to exert force over a single or maximal effort.
- **Muscular endurance**  
Muscular endurance is the ability to exert a force over a period of time or repetitions.

- **Flexibility**  
Flexibility is the ability to move your joints through a full range of motion.
- **Body Composition**  
Body composition is the relative amount of fat mass to fat-free mass.

As previously stated, these areas are significant in that they influence your quality of life and overall health and wellness.

## Skill-Related Components of Fitness

In addition to the 5 health-related components, there are 6 skill-related components that assist in developing optimal fitness: speed, agility, coordination, balance, power, and reaction time. Although important, these areas do not directly affect a person's health. A person's ability to perform ladder drills (also known as agility drills) is not related to his/her heart health. However, coordination of muscle movements may be helpful in developing muscular strength through resistance training. As such, they may indirectly affect the 5 areas associated with health-related fitness. Skill-related components are more often associated with sports performance and skill development.

## Principles of Adaptation to Stress

The human body adapts well when exposed to stress. The term *stress*, within the context of exercise, is defined as an exertion above the normal, everyday functioning. The specific activities that result in stress vary for each individual and depend on a person's level of fitness. For example, a secretary who sits at a desk all day may push his/her cardiorespiratory system to its limits simply by walking up

several flights of stairs. For an avid runner, resistance training may expose the runner's muscles to muscular contractions the athlete is not accustomed to feeling. Although stress is relative to each individual, there are guiding principles in exercise that can help individuals manage how much stress they experience to avoid injury and optimize their body's capacity to adapt. Knowing a little about these principles provides valuable insights needed for organizing an effective fitness plan.

## Overload Principle

Consider the old saying, "No pain, no gain." Does exercise really have to be painful, as this adage implies, to be beneficial? Absolutely not. If that were true, exercise would be a lot less enjoyable. Perhaps a better way to relay the same message would be to say that improvements are driven by stress. Physical stress, such as walking at a brisk pace or jogging, places increased stress on the regulatory systems that manage increased heart rate and blood pressure, increased energy production, increased breathing, and even increased sweating for temperature regulation. As these subsequent adaptations occur, the stress previously experienced during the same activity, feels less stressful in future sessions. As a result of the adaptation, more stress must be applied to the system in order to stimulate improvements, a principle known as the **overload principle**.

For example, a beginning weightlifter performs squats with 10 repetitions at 150 pounds. After 2 weeks of lifting this weight, the lifter notices the 150 pounds feels easier during the lift and afterwards causes less fatigue. The lifter adds 20 pounds and

continues with the newly established stress of 170 pounds. The lifter will continue to get stronger until his/her maximum capacity has been reached, or the stress stays the same, at which point the lifter's strength will simply plateau. This same principle can be applied, not only to gain muscular strength, but also to gain flexibility, muscular endurance, and cardiorespiratory endurance.

## FITT

In exercise, the amount of stress placed on the body can be controlled by four variables: **F**requency, **I**ntensity, **T**ime (duration), and **T**ype, better known as FITT. The FITT principle, as outlined by the American College of Sports Medicine (ACSM) falls under the larger principle of overload.

## Frequency and Time

Each variable can be used independently or in combination with other variables to impose new stress and stimulate adaptation. Such is the case for frequency and time.

Frequency relates to how often exercises are performed over a period of time. In most cases, the number of walking or jogging sessions would be determined over the course of a week. A beginner may determine that 2–3 exercise sessions a week are sufficient enough to stimulate improvements. On the other hand, a seasoned veteran may find that 2–3 days is not enough to adequately stress the system. According to the overload principle, as fitness improves, so must the stress to

ensure continued gains and to avoid plateauing.

The duration of exercise, or time, also contributes to the amount of stress experienced during a workout. Certainly, a 30-minute brisk walk is less stressful on the body than a 4-hour marathon.

Although independent of one another, frequency and time are often combined into the blanket term, **volume**. The idea is that volume more accurately reflects the amount of stress experienced. This can be connected to the **progression principle**. For example, when attempting to create a jogging plan, you may organize 2 weeks like this:

- Week 1: three days a week at 30 minutes per session
- Week 2: four days a week at 45 minutes per session

At first glance, this might appear to be a good progression of frequency and time. However, when calculated in terms of volume, the aggressive nature of the progression is revealed. In week 1, three days at 30 minutes per session equals 90 minutes of total exercise. In week two, this amount was doubled with four days at 45 minutes, equaling 180 minutes of total exercise. Doing too much, too soon, will almost certainly lead to burnout, severe fatigue, and injury. The progression principle relates to an optimal overload of the body by finding an amount that will drive adaptation without compromising safety.

## Type of Exercise

Simply put, the type of exercise performed should reflect a person's goals. In cardiorespiratory fitness, the objective of the exercise is to stimulate the cardiorespiratory system. Other activities that accomplish the same objective include swimming, biking, dancing, cross country skiing, aerobic classes, and much more. As such, these activities can be used to build lung capacity and improve cellular and heart function.

However, the more specific the exercise, the better. While vigorous ballroom dancing will certainly help develop the cardiorespiratory system, it will unlikely improve a person's 10k time. To improve performance in a 10k, athletes spend the majority of their time training by running, as they will have to do in the actual 10k. Cyclists training for the Tour de France, spend up to six hours a day in the saddle, peddling feverishly. These athletes know the importance of training the way they want their body to adapt. This concept, called the **principle of specificity**, should be taken into consideration when creating a training plan.

In this discussion of type and the principle of specificity, a few additional items should be considered. Stress, as it relates to exercise, is very specific. There are multiple types of stress. The three main stressors are metabolic stress, force stress, and environmental stress. Keep in mind, the body will adapt based on the type of stress being placed on it.

Metabolic stress results from exercise sessions when the energy systems of the body are taxed. For example, sprinting short distances requires near maximum intensity

and requires energy (ATP) to be produced primarily through anaerobic pathways, that is, pathways not requiring oxygen to produce ATP. Anaerobic energy production can only be supported for a very limited time (10 seconds to 2 minutes). However, distance running at steady paces requires aerobic energy production, which can last for hours. As a result, the training strategy for the distance runner must be different than the training plan of a sprinter, so the energy systems will adequately adapt.

Likewise, force stress accounts for the amount of force required during an activity. In weightlifting, significant force production is required to lift heavy loads. The type of muscles being developed, fast-twitch muscle fibers, must be recruited to support the activity. In walking and jogging, the forces being absorbed come from the body weight combined with forward momentum. Slow twitch fibers, which are unable to generate as much force as the fast twitch fibers, are the type of muscle fibers primarily recruited in this activity. Because the force requirements differ, the training strategies must also vary to develop the right kind of musculature.

Environmental stress, such as exercising in the heat, places a tremendous amount of stress on the thermoregulatory systems. As an adaptation to the heat, the amount of sweating increases as does plasma volume, making it much easier to keep the body at a normal temperature during exercise. The only way to adapt is through heat exposure, which can take days to weeks to properly adapt.

In summary, to improve performance, being specific in your training, or training the way you want to adapt, is paramount.

## Intensity

Intensity, the degree of difficulty at which the exercise is carried out, is the most important variable of FITT. More than any of the other components, intensity drives adaptation. Because of its importance, it is imperative for those beginning a fitness program to quantify intensity, as opposed to estimating it as hard, easy, or somewhere in between. Not only will this numeric value provide a better understanding of the effort level during the exercise session, but it will also help in designing sessions that accommodate individual goals.

How then can intensity be measured? Heart rate is one of the best ways to measure a person's effort level for cardiorespiratory fitness. Using a percentage of maximum lifting capacity would be the measure used for resistance training.

## Rest, Recovery, and Periodization

For hundreds of years, athletes have been challenged to balance their exercise efforts with performance improvements and adequate rest. The **principle of rest and recovery (or principle of recuperation)** suggests that rest and recovery from the stress of exercise must take place in proportionate amounts to avoid too much stress. One systematic approach to rest and recovery has led exercise scientists and athletes alike to divide the progressive fitness training phases into blocks, or periods. As a result, optimal rest and recovery can be achieved without

overstressing the athlete. This training principle, called **periodization**, is especially important to serious athletes but can be applied to most exercise plans as well. The principle of periodization suggests that training plans incorporate phases of stress followed by phases of rest.

Training phases can be organized on a daily, weekly, monthly, and even multi-annual cycles, called micro-, meso-, and macrocycles, respectively. An example of this might be:

Week	Frequency	Intensity	Time	Type
1	3 days	40% HRR	25 min	walk
2	4 days	40% HRR	30 min	walk
3	4 days	50% HRR	35 min	walk
4	2 days	30% HRR	30 min	other

As this table shows, the volume and intensity changes from week 1 to week 3. But, in week 4, the volume and intensity drops significantly to accommodate a designated rest week. If the chart were continued, weeks 5-7 would be “stress” weeks and week 8 would be another rest week. This pattern could be followed for several months.

Without periodization, the stress from exercise would continue indefinitely eventually leading to fatigue, possible injury, and even a condition known as **overtraining syndrome**. Overtraining syndrome is not well understood. However, experts agree that a decline in performance resulting from psychological and physiological factors cannot be fixed by a few days’ rest. Instead, weeks, months, and sometimes even years are required to overcome the symptoms of overtraining syndrome. Symptoms include the following:

- weight loss
- loss of motivation
- inability to concentrate or focus
- feelings of depression
- lack of enjoyment in activities normally considered enjoyable
- sleep disturbances
- change in appetite

## Reversibility

Chronic adaptations are not permanent. As the saying goes, “Use it or lose it.”

The **principle of reversibility** suggests that activity must continue at the same level to keep the same level of adaptation. As activity declines, called **detraining**, adaptations will recede.

In cardiorespiratory endurance, key areas, such as  $VO_{2max}$ , stroke volume, and cardiac output all declined with detraining while submaximal heart rate increased. In one study, trained subjects were given bed rest for 20 days. At the end of the bed rest phase,  $VO_{2max}$  had fallen by 27% and stroke volume and cardiac output had fallen by 25%. The most well-trained subjects in the study had to train for nearly 40 days following bed rest to get back into pre-rest condition. In a study of collegiate swimmers, lactic acid in the blood after a 2-minute swim more than doubled after 4 weeks of detraining, showing the ability to buffer lactic acid was dramatically affected.<sup>2</sup>

Not only is endurance training affected, but muscular strength, muscular endurance, and flexibility all show similar results after a period of detraining.

## Individual Differences

While the principles of adaptation to stress can be applied to everyone, not everyone responds to stress in the same way. In the HERITAGE Family study, families of 5 (father, mother, and 3 children) participated in a training program for 20 weeks. They exercised 3 times per week, at 75% of their  $VO_{2max}$ , increasing their time to 50 minutes by the end of week 14. By the end of the study, a wide variation in responses to the same exercise regimen was seen by individuals and families. Those who saw the most improvements saw similar percentage improvements across the family and vice versa. Along with other studies, this has led researchers to believe individual differences in exercise response are genetic. Some experts estimate genes to contribute as much as 47% to the outcome of training.

In addition to genes, other factors can affect the degree of adaptation, such as a person's age, gender, and training status at the start of a program. As one might expect, rapid improvement is experienced by those with a background that includes less training, whereas those who are well trained improve at a slower rate.

## Activity Guidelines

Below are links to the physical activity guidelines provided by the US Department of Health and Human Services and the American College of Sports Medicine (ACSM). As you review these recommendations, notice how closely they follow the FITT pattern described earlier in the chapter.

[NIH Recommendations for Physical Activity](#)

[ACSM Recommendations on Quantity and Quality of Exercise](#)

## Fitness Guidelines

The recommendations linked above pertain to physical activity only. While they can be applied to fitness, more specific guidelines have been set to develop fitness. As stated previously, physical activity is aimed at improving health; exercise is aimed at improving health and fitness. These guidelines will be referenced often as each health-related component of fitness is discussed.

## Creating a Successful Fitness Plan

Often, the hardest step in beginning a new routine is simply starting the new routine. Old habits, insufficient motivation, lack of support, and time constraints all represent common challenges when attempting to begin a new exercise program. Success, in this case, is measured by a person's ability to consistently participate in a fitness program and reap the fitness benefits associated with a long-term commitment.

## Think Lifestyle

Beginning a fitness program is a daunting task. To illustrate the concept of lifestyle, consider attendance at fitness centers during the month of January. Attendance increases dramatically, driven by the number 1 New Year's resolution in America: losing weight. Unfortunately, as time



marches on, most of these new converts do not. By some estimates, as many as 80% have stopped coming by the second week in February. As February and March approach, attendance continues to decline, eventually falling back to pre-January levels.

Why does this occur? Why aren't these new customers able to persist and achieve their goal of a healthier, leaner body? One possible explanation: patrons fail to view their fitness program as a lifestyle. The beginning of a new year inspires people to make resolutions, set goals, as they envision a new and improved version of themselves. Unfortunately, most of them expect this transformation to occur in a short period of time. When this does not happen, they become discouraged and give up. Returning to teen level weight and/or fitness may be an alluring, well-intended goal, but one that is simply unrealistic for most adults. The physical demands and time constraints of adulthood must be taken into consideration for any fitness program to be successful. Otherwise, any new fitness program will soon be abandoned and dreams of physical perfection fade, at least until next January.

Like any other lifestyle habit, optimal health and fitness do not occur overnight. Time and, more importantly, consistency, drive successful health and fitness outcomes. The very term *lifestyle* refers to changes that are long term and become incorporated into a person's daily routine. Unlike many fad diets and quick fixes advertised on television, successful lifestyle changes are also balanced and reasonable. They do not leave you feeling depressed and deprived after a few days. Find a balance between what you want to achieve and what you are realistically able to do. Finally, you must do

more than simply change your behaviors. You must also modify your mental perception to promote long-term health. Find a compelling reason for incorporating healthier behaviors into your daily routine.

The steps below will guide you through this process. Before beginning a fitness program, you should understand the safety concerns associated with exercise.

### **Safety First: Assessing Your Risk**

The physical challenges of beginning a new exercise program increase the risk of injury, illness, or even death. Results from various studies suggest vigorous activity increases the risk of acute cardiac heart attacks and/or sudden cardiac death.<sup>3</sup> While that cautionary information appears contradictory to the previously identified benefits of exercise, the long-term benefits of exercise unequivocally outweigh its risks. In active young adults (younger than 35), incidence of cardiac events are still rare, affecting 1 in 133,000 in men and 1 in 769,000 in women. In older individuals, 1 in 18,000 experience a cardiac event.<sup>4</sup>

Of those rare cardiac incidents that do occur, the presence of preexisting heart disease is the common thread, specifically, atherosclerosis. **Atherosclerosis** causes arteries to harden and become clogged with plaque, which can break apart, move to other parts of the body, and clog smaller blood vessels. As such, it is important to screen individuals for risk factors associated with heart disease before they begin an exercise program.

The American College of Sports Medicine recommends a thorough pre-screening to identify any risk of heart disease. The 7

major risk factors associated with increased risk of heart disease are identified below.<sup>5</sup>

- *Family history*  
Having a father or first-degree male relative who has experienced a cardiac event before the age of 55, or a mother or first-degree female relative who has experienced a cardiac event before age 65, could indicate a genetic predisposition to heart disease.
- *Cigarette smoking*  
The risk of heart disease is increased for those who smoke or have quit in the past 6 months.
- *Hypertension*  
Having blood pressure at or above 140 mm/Hg systolic, 90 mm/Hg diastolic is associated with increased risk of heart disease.
- *Dyslipidemia*  
Having cholesterol levels that exceed recommendations (130 mg/dL, HDL below 40 mg/dL), or total cholesterol of greater than 200 mg/dL increases risk.
- *Impaired fasting glucose (diabetes)*  
Blood sugar should be within the recommended ranges.
- *Obesity*  
Body mass index greater than 30, waist circumference of larger than 102 cm for men and larger than 88 cm for women, or waist to hip ratio of less than 0.95 men, or less than 0.86 women increases risk of heart disease.

- *Sedentary lifestyle*  
Persons not meeting physical activity guidelines set by US Surgeon General's Report have an increased risk of heart disease.

In addition to identifying your risk factors, you should also complete a Physical Activity Readiness Questionnaire (PAR-Q) before beginning an exercise program. The PAR-Q asks yes or no questions about symptoms associated with heart disease. Based on your responses on the PAR-Q, you will be placed into a risk category: low, moderate, high.

- Low risk persons include men younger than 45, and women younger than 55, who answer no to all of the PAR-Q questions and have one or no risk factors. Although further screening is a good idea, such as getting physician's approval, it isn't necessary.
- Moderate risk persons are men of or greater than 45, women 55 or those who have two or more risk factors. Because of the connection between cardiac disease, the seven risk factors, and risk during exercise, it is recommended you get a physician's approval before beginning an exercise program.
- High risk persons answer yes to one or more of the questions on the PAR-Q. Physician's approval is required before beginning a program.

Once you have determined your ability to safely exercise, you are ready to take the next steps in beginning your program. Additional safety concerns, such as where

you walk and jog, how to be safe during your workout, and environmental conditions, will be addressed at a later time.

As you review the remaining steps, a simple analogy may help to better conceptualize the process.

Imagine you are looking at a map because you are traveling to a particular location and you would like to determine the best route for your journey. To get there, you must first determine your current location and then find the roads that will take you to your desired location. You must also consider roads that will present the least amount of resistance, provide a reasonably direct route, and do not contain any safety hazards along the way. Of course, planning the trip, while extremely important, is only the first step. To arrive at your destination, you must actually drive the route, monitoring your car for fuel and/or malfunction, and be prepared to reroute should obstacles arise.

Preparing yourself for an exercise program and ultimately, adopting a healthier lifestyle, requires similar preparation. You will need to complete the following steps:

- *Assess your current fitness*  
Where are you on the map?
- *Set goals*  
What is your destination's location?
- *Create a plan*  
What route will you choose?
- *Follow through*  
Start driving!

## **Assess Your Condition**

To adequately prepare, you will need to take a hard look at your current level of

fitness. With multiple methods of assessing your fitness, you should select the one that most closely applies to you. Obtaining a good estimate will provide you a one-time glance at your baseline fitness and health and provide a baseline measurement for gauging the efficacy of your fitness program in subsequent reassessments.

Assessments are specific to each health-related component of fitness. You will have the opportunity to assess each one in the near future.

## **Set Goals**

Using the map analogy, now that you know your current location, you must determine your destination and the best route for getting there. You can start by setting goals. In his bestselling book, *The 7 Habits of Highly Effective People*, author Stephen Covey suggests you should “Begin with the end in mind.”<sup>7</sup> While Covey’s words may not be directly aimed at those seeking to complete a fitness program, his advice is useful to anyone making a significant lifestyle change. To be successful, you must develop a clear vision of your destination. Setting specific goals about how you want to feel and look, increases your chances of success. Without specific goals to measure the success of your efforts, you could possibly exceed your target and believe you failed.

The art of setting goals includes stating them in a clearly defined and measurable way. Consider exactly what you would like to accomplish, make certain your goals can be measured, and establish a reasonable timeframe in which to achieve your goals.

Goals that meet these guidelines are referred to as S.M.A.R.T. goals.

- **S**pecific  
Be as specific and detailed as possible in creating your goal.
- **M**easurable: If your goal cannot be measured, you will not know when you have successfully completed the goal.
- **A**ttainable  
Consider whether you have the resources—such as time, family support, and financial means—to obtain your goal.
- **R**ealistic  
While your goal should be challenging, it should not exceed reasonable expectations.
- **T**imeframe  
Set a deadline to accomplish your goal.

A well-stated goal contains all of the SMART components listed above. Take a look at the well-stated example below:

I will improve my 12-minute distance by 10% within 2 months of the first assessment.

Note, all the ingredients of a well-stated goal are present. It is specific (improve 12-minute distance by 10%), measurable (10% improvement), attainable and realistic (the degree of improvement is reasonable in that time frame), and includes a time frame (a clear deadline of 2 months).

Less effective goals would be stated like this:

- I will run farther next time I assess my fitness.
- I want to jog faster.

- I will lose weight

And a common one:

- I will exercise 3 days a week at 60% max heart rate for 45 minutes per session for 2 months.

At a closer glance, none of these examples contain all of the ingredients of a well-stated goal. How can “faster” be measured? “Farther” is not specific enough, nor is “lose weight.” In the last example, this is not a goal at all. It is a plan to achieve a goal that has not been stated.

In the end, setting up well-stated goals will give you the best chance to convert good intentions into a healthier lifestyle.

To complete this step, write down 2-3 personal goals, stated in the SMART format, and put them in a place you will see them frequently.

## Create a Plan

Once you know exactly what you want to achieve, generate a strategy that will help you reach your goals. As you strategize, your goal is to determine the frequency, the intensity, and the duration of your exercise sessions. While doing this, it is imperative to keep in mind a few key principles.

First, use your goals as the foundation for your program. If your goal is related to weight loss, this should drive the frequency, duration, and intensity of your daily workouts as these variables will influence your body’s use of fat for fuel and the number of calories burned. If you feel more interested in improving your speed, you will

need to dedicate more workout time to achieving those results.

Another key principle is the importance of safety. The importance of designing a program that is safe and effective cannot be overstated. You can minimize any risks by relying on the expert recommendations of the US Department of Health and Human Services and the American College of Sports Medicine previously outlined and linked [here](#). These highly reputable organizations have conducted extensive research to discover the optimal frequency, intensity, and duration for exercise.

## Follow Through

Once you have assessed your current fitness levels, set goals using the SMART guidelines, and created your personalized fitness plan, you should feel very proud of yourself! You have made significant progress toward achieving a healthier lifestyle. Now is when the “rubber hits the road.” (Literally so, if your plan includes walking or jogging.) Now that you have invested time and energy to develop a thoughtful, well-designed fitness program, it is time to reap the returns of good execution. The assessment, planning and preparation are really the hardest parts. Once you know what to do and how to do it, success is simply a matter of doing it.

Unfortunately, the ability to stick with a program proves difficult for most. To prevent getting derailed from your program, identify barriers that may prevent you from consistently following through. One of the most common challenges cited is a shortage of time. Work schedules, school, child care, and the activities of daily

living can leave you with little time to pursue your goals. Make a list of the items that prevent you from regularly exercising and then analyze your schedule and find a time for squeezing in your exercise routine. Regardless of when you schedule your exercise, be certain to exercise consistently. Below are a few additional tips for achieving consistency in your daily fitness program:

- *Think long term; think lifestyle.*  
The goal is to make exercise an activity you enjoy every day throughout your life. Cultivating a love for exercise will not occur overnight and developing your ideal routine will take time. Begin with this knowledge in mind and be patient as you work through the challenges of making exercise a consistent part of your life.
- *Start out slowly.*  
Again, you are in this for the long haul. No need to overdo it in the first week. Plan for low intensity activity, for 2–3 days per week, and for realistic periods of time (20–30 minutes per session).
- *Begin with low Intensity/low volume.*  
As fitness improves, you will want to gradually increase your efforts in terms of quantity and quality. You can do this with more time and frequency (called volume) or you can increase your intensity. In beginning a program, do not change both at the same time.
- *Keep track.*  
Results from a program often occur slowly, subtly, and in a very anti-climactic way. As a result,

participants become discouraged when immediate improvements are not visible. Keeping track of your consistent efforts, body composition, and fitness test results and seeing those subtle improvements will encourage and motivate you to continue.

- *Seek support.*  
Look for friends, family members, clubs, or even virtual support using apps and other online forums. Support is imperative as it provides motivation, accountability, encouragement, and people who share a common interest, all of which are factors in your ability to persist in your fitness program.
- *Vary your activities from time to time.*  
Your overall goals are to be consistent, build your fitness, and reap the health benefits associated with your fitness program. Varying your activities occasionally will prevent boredom. Instead of walking, play basketball or ride a bike. Vary the location of your workout by discovering new hiking trails, parks or walking paths.
- *Have fun.*  
If you enjoy your activities, you are far more likely to achieve a lasting lifestyle change. While you cannot expect to be exhilarated about exercising every day, you should not dread your daily exercise regimen. If you do, consider varying your activities more, or finding a new routine you find more enjoyable.

- *Eat healthier.*  
Nothing can be more frustrating than being consistent in your efforts without seeing the results on the scale. Eating a balanced diet will accelerate your results and allow you to feel more successful throughout your activities.

## Additional Safety Concerns

As activity rates among Americans increase, specifically outdoor activities, safety concerns also rise. Unfortunately, the physical infrastructure of many American cities does not accommodate active lifestyles. Limited financial resources and de-emphasis on public health means local and state governments are unlikely to allocate funds for building roads with sidewalks, creating walking trails that surround parks, or adding bike lanes. In addition, time constraints and inconvenience make it challenging for participants to travel to areas where these amenities are available. As a result, exercise participants share roads and use isolated trails/pathways, inherently increasing the safety risks of being active.

A key principle in outdoor safety is to recognize and avoid the extremes. For example, avoid roads that experience heavy traffic or are extremely isolated. Avoid heavy populated areas as well as places where no one is around. Do not exercise in the early morning or late at night, during extreme cold or extreme heat. To minimize safety risks during these types of environmental conditions, do not use headphones that could prevent you from hearing well and remaining alert, do not exercise alone, prepare for adequate

hydration in the heat, and use warm clothing in extreme cold to avoid frostbite. Extreme conditions require extra vigilance on your part.

A second key principle, whether outdoor or indoor, is to simply use common sense. While this caveat seems obvious, it gets ignored far too often. Always remember the purpose of your exercise is for enjoyment and improved health. If these objectives could be compromised by going for a run at noon in 95-degree heat, or lifting large amounts of weight without a spotter, you should reconsider your plan. Before exercising in what could be risky conditions, ask yourself, “Is there a safer option available?”

Lastly, be aware of the terrain and weather conditions. Walking or jogging on trails is a wonderful way to enjoy nature, but exposed roots and rocks present a hazard for staying upright. Wet, muddy, or icy conditions are additional variables to avoid in order to complete your exercise session without an accident.

The document linked below from the University of Texas at San Antonio Police Department outlines specific safety tips that will help you stay safe in your activities.

[Safety Tips for Runners, Walkers, and Joggers](#)

## **Environmental Conditions**

When exercising outdoors, you must consider the elements and other factors that could place you at increased risk of injury or illness.

## **Heat-Related Illness**

Heat-related illnesses, such as heat cramps, heat exhaustion, and heat stroke, contributed to 7,233 deaths in the United States between 1999 and 2009. A 2013 report released by the Center for Disease Control stated that about 658 deaths from heat-related illnesses occurred every year which account for more deaths than tornadoes, hurricanes, and lightning combined. Of those deaths, most were male, older adults.<sup>8</sup>

The number one risk factor associated with heat-related illness is hydration, the starting point of all heat-related illness. Unfortunately, sweat loss can occur at a faster rate than a person can replace with fluids during exercise, especially at high intensities. Even when trying to hydrate, ingestion of large amounts of fluids during exercise can lead to stomach discomfort. What does this mean? Hydration must begin before exercise and must become part of your daily routine.

Several practical methods of monitoring hydration levels can assist in preventing illness. One simple method, while not full proof, is to simply monitor the color of your urine. In a hydrated state, urination will occur frequently (every 2–3 hours) and urine will have very little color. In a dehydrated state, urination occurs infrequently in low volume and will become more yellow in color.

Another simple method involves weighing yourself before and after a workout (see lab). This is a great way to see firsthand how much water weight is lost during an exercise session primarily as a result of sweat. Your goal is to maintain your pre- and post-body weight by drinking fluids during and after the workout to restore

what was lost. This method, when combined with urine-monitoring, can provide a fairly accurate assessment of hydration levels.

The best preventative measure for maintaining a hydrated state is simply drinking plenty of water throughout the day. In previous years, recommendations for the amount of water to drink were a one size fits all of about 48–64 oz. per day, per person. In an effort to individualize hydration, experts now recommend basing fluid intake on individual size, gender, activity levels, and climate. Generally, half an ounce (fluid ounces) to 1 ounce per pound of body weight is recommended.<sup>9</sup> For a 150-pound individual, this would mean 75–150 ounces of water per day! While there is still considerable debate over the exact amounts, no one disputes the importance of continually monitoring your hydration using one of the techniques described previously. Insufficient hydration leads to poor performance, poor health, and potentially serious illness.

It should be noted that electrolyte “sport” drinks, such as Gatorade and PowerAde, are often used to maintain hydration. While they can be effective, these types of drinks were designed to replace electrolytes (potassium, sodium, chloride) that are lost through sweating during physical activity. In addition, they contain carbohydrates to assist in maintaining energy during activities of long duration. If the activity planned is shorter than 60 minutes in duration, water is still the recommended fluid. For activities beyond 60 minutes, a sports drink should be used.

## Cold-Related Illnesses

Much like extremely hot environmental conditions, cold weather can create conditions equally as dangerous if you fail to take proper precautions. To minimize the risk of cold-related illness, you must prevent the loss of too much body heat. The three major concerns related to cold-related illnesses are hypothermia, frost-nip, and frost bite.

As with heat-related illness, the objective of preventing cold-related illness is to maintain the proper body temperature of between 98.6 and 99.9 degrees Fahrenheit. If body temperature falls below 98.6 F, multiple symptoms may appear, indicating the need to take action. Some of those symptoms include:

- shivering
- numbness and stiffness of joints and appendages
- loss of dexterity and/or poor coordination
- peeling or blistering of skin, especially to exposed areas
- discoloration of the skin in the extremities

When walking or jogging in the cold, it is important to take the necessary steps to avoid problems that can arise from the environmental conditions.

- *Hydration is key.*  
Cold air is usually drier air, which leads to moisture loss through breathing and evaporation. Staying hydrated is key in maintaining blood flow and regulating temperature.
- *Stay dry.*  
Heat loss occurs 25x faster in water than on dry land. As such, keeping



shoes and socks dry and clothing from accumulating too much sweat will allow for more effective body temperature regulation.

- *Dress appropriately.*  
Because of the movement involved, the body will produce heat during the exercise session. Therefore, the key point is to direct moisture (sweat) away from the skin. This is controlled most effectively by layering your clothing. A base layer of moisture-wicking fabric should be used against the skin while additional layers should be breathable. This will channel moisture away from the skin, and any additional layers of clothing, without it becoming saturated in sweat. If exercising on a windy day, use clothing that protects from the wind and is adjustable so you can breathe.
- *Cover the extremities.*  
Those parts of the body farthest away from the heart (toes, fingers, and ears) tend to get coldest first. Take the appropriate steps to cover those areas by using gloves, moisture-wicking socks, and a winter cap to cover your head.

## Terminology Checklist

**Physical activity:** any activity that requires skeletal muscle and requires energy aimed at improving health.

**Exercise:** a subset of physical activity that is planned and structured aimed at improving fitness.

**Health related components of fitness:** types of activities dedicated to improving physical fitness categorized as cardiorespiratory endurance, muscular strength and endurance, flexibility, and body composition.

**Skills related components of fitness:** types of activities dedicated to improving physical skills categorized as speed, agility, coordination, balance, power, and reaction time.

**Principles of adaptations to stress:** guidelines related to managing the application of stress during physical activity/exercise.

**Overload Principle:** a principle of adaptation to stress suggesting the amount of stress applied during exercise must exceed a threshold level to stimulate adaptation.

**Volume:** the term used to describe “how much” stress is being applied by combining the duration and frequency of exercise.

**Progression principle:** a principle relating to how much additional stress that can safely be introduced to gradually improve fitness without risking injury or overuse.

**Specificity:** the principle of stress suggesting activities should be closely centered around the primary outcome goal, i.e. train the way you want to adapt.

**Reversibility:** the principle that adaptations to stress can be lost over time if training is modified or stopped.

**Principle of rest and recovery:** the concept that adaptation not only requires overload but also requires rest to avoid oversteering the body.

**Periodization:** a method of organizing workouts into blocks or periods. These cycles consist of work/stress periods and rest periods.

**Overtraining syndrome:** a condition of chronic stress from physical activity affecting the physical and psychological states of an individual or athlete.

**Detraining:** the act of no longer training at all or decreasing the amount of training.

## Test Your Knowledge

1. The term exercise refers to physical activity that is:
  - a. Discontinuous and unplanned but designed to improve fitness
  - b. Planned, structured, and repetitive designed to improve fitness
  - c. Not a contributor to physical fitness
  - d. Random and unstructured
2. Which of the following is NOT considered a skill-related fitness component?
  - a. Coordination
  - b. Flexibility
  - c. Balance
  - d. Agility
3. During the initial phase of an exercise program, a beginner should:
  - a. Begin slowly, exercising at a low intensity and gradually increasing volume
  - b. Keep intensity high, exercise at the high end of the target heart rate range
  - c. Perform short but intense bouts of activity
  - d. Exercise 5-7 days per week
4. The body's ability to adapt to gradual increases in the amount of exercise is the principle of:
  - a. Overload
  - b. Specificity
  - c. Reversibility
  - d. Assessment
5. The amount of overload needed to maintain or improve one's fitness level is NOT determined by:
  - a. Time (duration)
  - b. Intensity
  - c. Frequency
  - d. Specificity
6. Another term used for organizing your training into phases or cycles is:
  - a. Specificity
  - b. Skill training
  - c. Periodization
  - d. Overload

Key  
1. b  
2. b  
3. a  
4. a  
5. d  
6. c

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# Cardiorespiratory Fitness

## Objectives:

- Define the cardiovascular and respiratory system
  - Describe how the cardiorespiratory system works
  - Identify the benefits of cardiorespiratory fitness
  - What is the importance of this system?
  - Identify methods for assessing and improving the CR system
- 

## What is the cardiovascular and respiratory system?

Imagine for a moment climbing to the top of Mt. Everest, a challenging feat very few have accomplished. In the process, you gradually ascend from base camp, which sits at about 17,500 feet above sea level, to the peak at over 29,000 feet. At this elevation, the pressure of oxygen is so low, you struggle to take in a satisfying breath. Although you strive to breathe deeply, you are unable to get enough air. Your heart rate increases and you might even develop nausea and a headache. Unless your body has a chance to acclimate itself to higher elevations or you gain access to supplemental oxygen, your symptoms will persist or worsen.

These are the sensations many people with cardiovascular or respiratory illnesses, such as asthma, chronic bronchitis, or mild cardiovascular disease, experience on a daily basis. Climbing up a flight of steps may leave them gasping for air, as would walking briskly or even breathing in cold air. Regardless of the cause, being unable to take in sufficient air can create a sense of panic and cause serious physical discomfort.

From this simple example, hopefully, you feel an appreciation for the simple act of breathing and ensuing satisfaction that comes with each life-sustaining breath. For most people, unless they engage in strenuous physical activity sufficient to get them breathing hard, their **cardiovascular and respiratory system** (heart, blood vessels, and lungs) operates efficiently enough to go relatively unnoticed. However, does that mean their cardiorespiratory (CR) system is functioning at optimal capacity? Or, could it be operating at a minimum level and experiencing problems that go undetected? This chapter defines cardiorespiratory fitness, examines the benefits of a healthy CR system, and explores how to effectively assess and improve the CR system.

## The Benefits of Good Cardiorespiratory Health

The link below provides a list of specific benefits:

- [List of Benefits](#)

The article linked below describes how exercise protects against Cardiovascular Disease (CVD):

- [Preventing CVD](#)

## How the CR System Works

The cardiorespiratory system operates to obtain and circulate vital compounds throughout the body—specifically, oxygen and nutrients, such as food energy, vitamins, and minerals. Both oxygen and nutrients, which are imperative for cellular energy production, must be taken in from the lungs and digestive system. Because the heart and lungs are so interlocked in this process, the two systems are often labeled together as the cardiorespiratory system. Without a healthy respiratory system, the body would struggle to bring in enough oxygen, release carbon dioxide (the chemical waste product of cellular metabolism) and eliminate unwanted particles that enter the respiratory tract when inhaling. Without a healthy heart, transporting oxygen from the lungs and nutrients from the digestive system to the body's cells would be impossible. If the health of the CR system were compromised enough, survival would be impossible. Additionally, both must be healthy or the function of one or the other will be compromised.

Below are several videos explaining how the cardiovascular and respiratory systems operate and function together:

- [The CR System and Exercise](#)

- [How the Cardiovascular System Works](#)
- [Respiratory System Explained in Detail](#)

## The CR System and Energy Production

Clearly the cardiovascular and respiratory systems function as one, but why is the CR system so important? What makes the distribution of oxygen throughout the body so vital to existence? The answer is simple: ENERGY. While oxygen in and of itself does not contain any energy (**calories**), it does combine with fuel extracted from food once it has been introduced into the cell to help produce **adenosine triphosphate (ATP)**. ATP is the basic form of cellular energy found in the body. Because the body stores very little ATP, it must constantly be regenerated. For this reason, people must continue eating and breathing to live.

Within the context of fitness, the purpose of the cardiorespiratory system is not only to produce energy but to also adapt in a way so that energy production can be optimized. For example, a high school cross country runner wants to be fit enough to compete in the state cross country meet. Unfortunately, this athlete's current mile times are 6 minutes per mile. In other words, that is the maximum work rate possible for this athlete. However, the goal is to improve to 5 minutes per mile, or improve the maximum work rate. To do so, more energy must be produced. According to the principles of adaptation, it is possible for this athlete to become more efficient at producing energy, enabling him to run a

mile in less time. An example of this adaptation comes from the world record mile time of 3 minutes and 43 seconds. The world record marathon time (26.2 miles) is 2 hours, 2 minutes, and 52 seconds. That equates to 4 minutes and 41 seconds per mile over the 26-mile course. That is some serious ATP production!

## Oxidative Energy System (Aerobic)

As oxygen and nutrients are delivered to the cells, they are utilized to produce ATP. The workhorses of the cell for oxidative metabolism are the **mitochondria**. This form of energy production is contingent on the ability of the CR system to deliver oxygen and nutrients and the cell's ability to process that oxygen. Because of the importance of oxygen in this particular energy-producing pathway, it is called the oxidative energy system, or **aerobic system**.

Oxidative energy production is the primary means of ATP production during rest and for activities that last for 2 minutes or longer. Although other forms of energy production assist in ATP production at any given time, long duration exercise sessions rely on this aerobic pathway. Also, in contrast to other forms of ATP production, the oxidative energy system uses both carbohydrates and fats for fuel sources.

**To consider:** What activities would emphasize development of this energy pathway?

## Immediate/Explosive Energy System

While the oxidative system is the primary source of ATP production, it does require a few minutes for the system to begin operating at full capacity during exercise. How then could the body immediately produce enough energy to perform a strenuous activity, such as sprinting 50 meters? Clearly, another energy system must drive ATP production. The immediate or explosive energy system utilizes the storage of **creatine phosphate (CP)** and the storage of **adenosine diphosphate**, which is stored in very small amounts, to generate ATP. When needed, this energy system provides enough ATP to sustain a short-duration, explosive activity, approximately 10–20 seconds or less. Once CP is depleted, other energy systems must assist in the ATP generating process.

## Non-Oxidative or Anaerobic Energy System

As the name implies, the **non-oxidative energy system** does not require oxygen to generate ATP. Instead, the cells where the ATP is produced require **glucose** (carbohydrates that have been broken down) as the fuel source. Like the immediate energy system, this system is associated with high intensity and short duration movements. While it is possible for some elite athletes to maintain exercise at “anaerobic” levels for several minutes, even they will eventually fatigue as a result of the non-oxidative system's ability to sustain

ATP production for events lasting longer than approximately 2 minutes.

As glucose is processed to produce ATP, the natural byproduct of this process, lactic acid, also begins to accumulate. The result of excessive lactic acid accumulation contributes to muscle fatigue, making it impossible to continue exercise at a high intensity.

## Energy Systems Combine

It is important to understand that energy systems do not operate in a compartmental fashion, but rather operate simultaneously, each carrying some of the burden of ATP production. For example, a professional soccer player would spend most of the match “cruising” at a light/moderate intensity level, thus primarily utilizing the oxidative energy system. However, during the match, he or she may sprint for several hundred meters, utilizing the explosive and non-oxidative system, or he or she may jump, requiring use of the explosive system. Thus, both energy systems are utilized simultaneously throughout the match. To improve performance, this player would need to develop the energy system which is utilized the most during the match.

## Changes in the CR System

An improvement in CR functioning, or fitness level, requires adaptation of the system. Remember, the point is to more effectively generate ATP so more work can be accomplished. In order to process more oxygen and deliver more oxygenated blood

to the cells, the overall system must undergo changes to make this possible. Here is a list of adaptations that occur to the CR system as a result of consistent aerobic exercise:

- Resting heart rate may decrease. The average resting heart rate hovers around 70–75 beats per minute. Elite athletes may have resting heart rates in the high 30s. Generally, resting heart rate may decrease by approximately 10 beats per minute with chronic exercise.
- Pulmonary adaptations, such as increased **tidal volume** (the amount of oxygen entering the lungs with each breath) and increased **diffusion capacity** (the amount of oxygen that enters the blood stream from the lungs). This allows for more oxygen to enter the pulmonary circulation en route to the left side of the heart.
- The heart muscles, specifically the left side of the heart, increase in size making it possible to contract more forcefully. As a result, more blood can be pumped with each beat meaning more oxygen can be routed to the systemic circulation.
- More oxygen is delivered and transported into the cells where ATP production can occur. This is called the **arterial-vein difference** ( $a\text{-}V_{O_{2\text{diff}}}$ )

These changes in the system are not permanent because of a process known as the **principle of reversibility**. Following a period of inactivity, the benefits from chronic aerobic exercise will be reversed.

## Assessing CR Fitness

To adequately prepare for starting a personal fitness program, it is important to first assess your current level of fitness. There are multiple methods for assessing a person's level of fitness. Each of the walking/jogging assessments discussed here attempts to estimate a key physiological marker of the heart's and lungs' functioning capacity and maximal oxygen consumption. **Maximal oxygen consumption**, or  $VO_{2\max}$ , measures the body's maximum ability to take in and utilize oxygen, which directly correlates to overall health and fitness. A good estimate of  $VO_{2\max}$  provides a one-time glance at a person's health and fitness level and a baseline measurement for reassessment at future dates to gauge improvements.

Some of the most common walking/jogging assessments used to estimate  $VO_{2\max}$  include the 12-Minute Walk, 1.5-Mile Run/Walk Test, 3-Minute Step Test, and 1-Mile Walk Test. Unfortunately, these field assessments, although practical and inexpensive, only provide estimations. More accurate assessments require a lab-based  $VO_{2\max}$  test using equipment that measures the volume of oxygen and carbon dioxide being moved in and out of the air passages during exercise. Although this test is more accurate, the expense and availability make it impractical for most. Unlike the lab test, the field assessments are relatively cost free, user-friendly and require very little expertise to conduct or perform. In addition, the key point of the assessment is measuring differences rather than absolute values, and the field tests accurately meet that objective.

Information on how to safely perform these assessments will be provided at the end of this chapter.

## Measuring Heart Rate

Those starting the  $VO_{2\max}$  assessments must first measure their heart rate, an important component used in the calculations.

Here is a video describing how to determine heart rate:

- [How to check your pulse](#)

## Creating a Plan to Develop CR Fitness

Once the assessments have been completed, the next step is to develop a plan for maintaining or improving your current level of fitness. This fitness plan should include activities that are safe and adapted to meet your personal goals. Once these fitness goals have been identified, the principles of adaptation to change can be utilized to achieve those goals. These principles include **specificity**, targeting specific areas in a workout, and **overload**, the practice of increasing exertion as the body adapts to ensure continued gains in fitness levels. Specifically, you need to apply the FITT principle (**F**itness, **I**ntensity, **T**ime, and **T**ype) described in detail in the previous chapter, "Fitness Principles":

- **Frequency:** 3–5 days per week for healthy adults.
- **Intensity:** moderate to vigorous intensity, which equals 40–85% of



heart rate reserve, or 55–90% of percentage of max heart rate. (More information about intensity will be provided later.)

- **Time/duration:** 20–60 minutes per session or accumulation of 150 minutes per week. Sessions must be continuous for 10 minutes or more.
- **Type/mode:** Use large muscle groups and exercises specific to cardiorespiratory exercise.

Click on the link below for ACSM’s latest recommendations on the quantity and quality of exercise for adults:

- [ACSM's Official News Release](#)

## Measuring Intensity

Intensity may be the most important aspect of the FITT principle. Engaging in a “cardio” program that does not stress the CR system to the recommended levels will be ineffective. Engaging in a program that overstresses the system can lead to injury and pose unnecessary risks. So how do you know if you are in the right range?

Heart rate is one of the best ways to measure effort level. Walking and jogging increase a person’s heart rate. Based on the function of the heart, this is no surprise. The heart rate directly correlates with the amount of oxygen being taken in by the lungs. As activity increases in intensity, oxygen demands increase and so does heart rate.

Because of this relationship, heart rate can be used in the design of an effective walking and jogging program by creating

target heart rate zones. Heart rate zones represent an intensity range—a low end heart rate and a high end rate—within which a person’s heart rate would fall during a walking or jogging session.

The first step in determining your **target heart rate (THR)**, is to determine your **maximum heart rate (MHR)**, both measured in beats per minute (bpm). Generally, MHR is estimated to be your age subtracted from 220 beats per minute. In other words, your heart rate should theoretically stop increasing once it reaches the calculated maximum. While helpful, it is not uncommon to see variances in the laboratory tested maximum heart rate versus the calculated method.

The next step in calculating THR is to calculate a specific percentage of your MHR. This is done using two different methods. Keep in mind, finding the THR is the objective in both methods, even though slightly different numbers are used.

The first method, called Max Heart Rate Method, is more commonly used.

### Max Heart Rate Method

1. Calculate MHR;  
 $MHR = 220 - \text{age}$ .
2. Calculate high and low THR by plugging in a percentage range. In this example, 60 and 80% are being used.  
 $MHR \times .60 = THR_{\text{Low}}$   
 $MHR \times .80 = THR_{\text{High}}$
3. The resulting low and high THR numbers represent the range, or target intensity.

The target intensity signifies an optimal training zone for that particular walking or

jogging session. By keeping the heart rate within that range, you will drive adaptation specific to that intensity. By using real, but random numbers, and plugging them into the above equation this becomes apparent.

Female, aged 20:

1.  $MHR = 220 - 20$   
 $MHR = 200 \text{ bpm}$
2.  $THR_{low} = 200 \times .60$   
 $THR_{low} = 120 \text{ bpm}$   
 $THR_{high} = 200 \times .80$   
 $THR_{high} = 160 \text{ bpm}$
3.  $THR = 120 - 160 \text{ bpm}$

To achieve her self-established goals, the female in the example above will need to stay within the range of 120 and 160 bpm. If her efforts are intense enough that she begins to exceed 160 bpm during her session, or easy enough that her heart rate falls below 120 bpm, she would need to change her intensity mid-session to get the optimal results.

### The Karvonen Formula or Heart Rate Reserve Method

1. Calculate MHR;  $MHR = 220 - \text{age}$ .
2. Determine your **resting heart rate (RHR)**.
3. Find the **heart rate reserve (HRR)**;  
 $HRR = MHR - RHR$
4. Calculate high and low THR by plugging in a percentage range and then adding in the RHR. In this example, 60 and 80% are being used.  
 $THR_{low} = HRR \times .60 + RHR$   
 $THR_{high} = HRR \times .80 + RHR$
5. The resulting low and high THR numbers represent the range, or target intensity.

Clearly, the Karvonen formula requires a few more steps, specifically, the incorporation of the resting heart rate. Using the same female in the example above, along with a randomly selected RHR, the THR looks like this:

1.  $MHR = 220 - 20$   
 $MHR = 200$
2.  $RHR = 72 \text{ bpm}$  (randomly selected)
3.  $HRR = MHR - RHR$   
 $HRR = 200 - 72$   
 $HRR = 128$
4.  $THR_{low} = HRR \times .60 + RHR$   
 $THR_{low} = 128 \times .60 + 72$   
 $THR_{low} = 149 \text{ bpm}$   
 $THR_{high} = HRR \times .80 + RHR$   
 $THR_{high} = 128 \times .80 + 72$   
 $THR_{high} = 174 \text{ bpm}$
5.  $THR = 149 - 174 \text{ bpm}$

A comparison of the two methods, reveals that the low and high end of the Karvonen formula is much higher than the Max Heart Rate method, even though the exact same percentages have been used. If the female in this example used the Karvonen Formula, she would find herself at a much higher intensity, especially at the low end of the range (120 vs. 149 bpm). How can this be? Aren't these formulas supposed to have the same objective?

While it is true that both equations are used to estimate a target heart rate range, only the Karvonen Formula takes into account the RHR, the lowest possible heart rate that can be measured for that individual. The Max Heart Rate method assumes the lowest heart rate possible is "0," a number to be avoided if at all possible! Because of the difference between 0 and the maximum heart rate, the calculated percentages result in a much lower number. In terms of

accuracy, the Karvonen method is superior. It simply is a better representation of true target ranges.

## Other Ways to Determine Intensity

Since not everyone owns a heart rate monitor, other methods of determining exercise intensity have been developed. One particular method, called the **rating of perceived exertion (RPE)**, uses subjective measurement to determine intensity. The method is as simple as asking the question, Overall, how hard do I feel I am working? The answer is given based on a scale of 6 to 20 with 6 being almost no effort and 20 being maximum effort. Studies have indicated that when subjects are asked to exercise at a moderate or heavy intensity level, subjects can accurately do so, even without seeing their heart rate. As a result, using the RPE scale can be an effective way of managing intensity.

The original RPE scale or **Borg Scale**, designed by Dr. Gunnar Borg, was developed to mimic generalized heart rate patterns. The starting and ending point of the scale are less intuitive than a typical scale of 1-10. By design, the 6 represents a resting heart rate of 60 bpm and the 20 an exercise heart rate of 200 bpm, a beat count someone might experience at maximum effort. Over time, a modified Borg Scale was developed using a simple 1–10 scale, with 1 being resting effort and 10 being maximum effort. Even though the modified scale is more intuitive, the traditional scale is still used more frequently.

Walking and jogging not only benefit physical health, but many enjoy the social benefits realized by exercising with friends. When walking or jogging with friends, intensity can easily be measured by monitoring your ability to carry on a conversation. With the **Talk Test**, if you are only able to say short phrases or give one word responses when attempting to converse during an exercise session, this would suggest you are working at a high enough intensity that your breathing rate makes conversation difficult. Certainly, if you can speak in full sentences without getting winded, the intensity would be very light. Just like RPE, the Talk Test is yet another way to subjectively measure intensity, which can then be correlated with heart rates.

## Cardiorespiratory Fitness Assessment

Follow the link below to the course lab in which you will be assessing your current level of cardiorespiratory fitness. You will be using the lab labeled:

- [Assessing Your Cardiorespiratory Fitness Level](#)

## Terminology Checklist

**Cardiorespiratory system:** The term used to describe the relationship between the cardiovascular system (heart and blood vessels) and respiratory system (lungs).

**Calorie:** A term used to describe food energy. Scientifically, it is the amount of energy needed to raise one kilogram of

water, 1 degree Celsius. More accurately, it is one kilocalorie.

**Adenosine Triphosphate (ATP):** The basic unit of energy used by the cells.

**Aerobic energy system:** The term used to describe the way cells produce ATP. In this case, the cells require oxygen to assist in ATP production.

**Mitochondria:** The area (organelle) of the cell where ATP is produced.

**Creatine phosphate:** a compound found in the cells and used by the immediate energy system that can be used to produce ATP.

**Non-oxidative energy system:** a term used to describe the way cells produce ATP. In this case, cells do not require oxygen to produce ATP.

**Glucose:** The simplest form of sugars found in the blood.

**Tidal volume:** The amount of air measured during inspiration or expiration.

**Diffusion capacity:** The amount of air that is transferred from the lungs to the blood.

**Arterial-vein difference ( $a\text{VO}_{2\text{diff}}$ ):** The difference between the oxygen found in arterial blood and venous blood.

**Principle of Reversibility:** The fitness principle describing how fitness is lost while detraining.

**Maximal oxygen consumption ( $\text{VO}_{2\text{max}}$ ):** The maximum amount of oxygen the body can take in and utilize.

**Specificity:** A fitness principle describing how fitness improvements or adaptations to exercise stress are specific to the type of training that is performed.

**Overload:** The fitness principle describing how adaptation to exercise stress is driven by progressively increasing the workload during training.

**Target Heart Rate (THR):** A term describing heart rate zones that represent an intensity range—a low end heart rate and a high end rate—used as a guide for exercise intensity.

**Max heart rate (MHR):** The maximum number of beats per minute the heart can contract.

**Resting Heart Rate (RHR):** The minimum number of beats per minute the heart contracts.

**Heart Rate Reserve (HRR):** The difference between the maximum heart rate and the resting heart rate. This term is also used to describe a method for calculating target heart rate.

**Rating of Perceived Exertion (RPE):** A self-assessment used during exercise used to estimate the intensity of the work being performed. The scale used, called the Borg Scale, ranges from 6 to 20.

**Talk-test:** A self-assessment used during exercise to estimate the intensity of the work being performed. The assessment is based on the degree of breathlessness observed while attempting to talk during exercise.

Test Your Knowledge

1. Which of the following is one of the primary functions of the cardiorespiratory system?
  - a. To transport oxygen
  - b. To pick up waste products
  - c. To transport nutrients
  - d. All of the above are functions of the cardiorespiratory system.
2. Cardiorespiratory endurance is developed best by activities that:
  - a. Involve continuous rhythmic movements of large muscle groups.
  - b. Alternate between brief periods of maximal exertion and rest.
  - c. Gently extend joints beyond their normal range of motion.
  - d. Involve working with weights or resistance.
3. Maximal oxygen consumption ( $VO_{2max}$ ) is:
  - a. The body's maximum ability to take in and utilize oxygen
  - b. The velocity of oxygen flowing through the blood
  - c. Solely determined by genetics
  - d. Very difficult to predict
4. The non-oxidative energy system could provide energy for up to:
  - a. Maximum of 10 second or less
  - b. Up to 2 minutes
  - c. As long as needed
  - d. Up to 5 minutes
5. Adenosine triphosphate (ATP) is defined as:
  - a. The building block of proteins
  - b. The stored form of sugar
  - c. The simplest form of carbohydrate in the blood
  - d. The basic form of energy used by the cells.

Answer key:

1. D
2. A
3. A
4. B
5. D

# Muscular Strength and Endurance

## Objectives:

- Describe muscular structure and function
  - Identify types of muscles
  - Describe an effective resistance exercise program
  - Assess your muscular strength and endurance
  - Understand the dangers of supplements
- 

Muscles are used for movement in the body. The largest portion of energy expenditure in the body happens in muscles while helping us perform daily activities with ease and improving our wellness. Muscular strength is the amount of force that a muscle can produce one time at a maximal effort, and muscular endurance is the ability to repeat a movement over an extended period of time. Resistance training is the method of developing muscular strength and muscular endurance, which in turns improves wellness. This chapter explores many ways to resistance train. However, achieving the best muscular performance requires the assistance of a trained professional.

For more information on muscular fitness and endurance, please click on the link below:

[Muscular Strength and Endurance](#)

## Muscular Physiology

Muscles are highly specialized to contract forcefully. Muscles are powered by muscle cells, which contract individually within a

muscle to generate force. This force is needed to create movement.

There are over 600 muscles in the human body; they are responsible for every movement we make, from pumping blood through the heart and moving food through the digestive system, to blinking and chewing. Without muscle cells, we would be unable to stand, walk, talk, or perform everyday tasks.

### Types of Muscle

There are three types of muscle:

- *Skeletal Muscle*  
Responsible for body movement.
- *Cardiac Muscle*  
Responsible for the contraction of the heart.
- *Smooth Muscle*  
Responsible for many tasks, including movement of food along intestines, enlargement and contraction of blood vessels, size of pupils, and many other contractions.

## Skeletal Muscle Structure and Function

Skeletal muscles are attached to the skeleton and are responsible for the movement of our limbs, torso, and head. They are under conscious control, which means that we can consciously choose to contract a muscle and can regulate how strong the contraction actually is. Skeletal muscles are made up of a number of **muscle fibers**. Each muscle fiber is an individual muscle cell and may be anywhere from 1 mm to 4 cm in length. When we choose to contract a muscle fiber—for instance we contract our bicep to bend our arm upwards—a signal is sent from our brain via the spinal cord to the muscle. This signals the muscle fibers to contract. Each nerve will control a certain number of muscle fibers. The nerve and the fibers it controls are called a **motor unit**. Only a small number of muscle fibers will contract to bend one of our limbs, but if we wish to lift a heavy weight then many more muscle fibers will be recruited to perform the action. This is called muscle fiber recruitment.

Each muscle fiber is surrounded by connective tissue called an external lamina. A group of muscle fibers are encased within more connective tissue called the endomysium. The group of muscle fibers and the endomysium are surrounded by more connective tissue called the perimysium. A group of muscle fibers surrounded by the perimysium is called a muscle fasciculus. A muscle is made up of many muscle fasciculi, which

are surrounded by a thick collagenous layer of connective tissue called the epimysium. The epimysium covers the whole surface of the muscle.

Muscle fibers also contain many mitochondria, which are energy powerhouses that are responsible for the aerobic production of energy molecules, or ATP molecules. Muscle fibers also contain glycogen granules as a stored energy source, and **myofibrils**, which are threadlike structures running the length of the muscle fiber. Myofibrils are made up of two types of protein: 1) Actin myofilaments, and 2) myosin myofilaments. The actin and myosin filaments form the contractile part of the muscle, which is called the sarcomere. Myosin filaments are thick and dark when compared with actin filaments, which are much thinner and lighter in appearance. The actin and myosin filaments lie on top of one another; it is this arrangement of the filaments that gives muscle its striated or striped appearance. When groups of actin and myosin filaments are bound together by connective tissue they make the myofibrils. When groups of myofibrils are bound together by connective tissue, they make up muscle fibers.

The ends of the muscle connect to bone through a tendon. The muscle is connected to two bones in order to allow movement to occur through a joint. When a muscle contracts, only one of these bones will move. The point where the muscle is attached to a bone that moves is called the **insertion**. The point where the muscle is attached to a bone that remains in a fixed position is called the **origin**.

## How Muscles Contract

Muscles are believed to contract through a process called the **Sliding Filament Theory**. In this theory, the muscles contract when actin filaments slide over myosin filaments resulting in a shortening of the length of the sarcomeres, and hence, a shortening of the muscle fibers. During this process the actin and myosin filaments do not change length when muscles contract, but instead they slide past each other.

During this process the muscle fiber becomes shorter and fatter in appearance. As a number of muscle fibers shorten at the same time, the whole muscle contracts and causes the tendon to pull on the bone it attaches to. This creates movement that occurs at the point of insertion.

For the muscle to return to normal (i.e., to lengthen), a force must be applied to the muscle to cause the muscle fibers to lengthen. This force can be due to gravity or due to the contraction of an opposing muscle group.

Skeletal muscles contract in response to an electric signal called an **action potential**. Action potentials are conducted along nerve cells before reaching the muscle fibers. The nerve cells regulate the function of skeletal muscles by controlling the number of action potentials that are produced. The action potentials trigger a series of chemical reactions that result in the contraction of a muscle.

When a nerve impulse stimulates a motor unit within a muscle, all of the muscle fibers controlled by that motor unit will contract. When stimulated, these muscle fibers contract on an all-or-nothing basis. The all-

or-nothing principle means that muscle fibers either contract maximally along their length or not at all. Therefore, when stimulated, muscle fibers contract to their maximum level and when not stimulated there is no contraction. In this way, the force generated by a muscle is not regulated by the level of contraction by individual fibers, but rather it is due to the number of muscle fibers that are recruited to contract. This is called muscle fiber recruitment. When lifting a light object, such as a book, only a small number of muscle fibers will be recruited. However, those that are recruited will contract to their maximum level. When lifting a heavier weight, many more muscle fibers will be recruited to contract maximally.

When one muscle contracts, another opposing muscle will relax. In this way, muscles are arranged in pairs. An example is when you bend your arm at the elbow: you contract your bicep muscle and relax your tricep muscle. This is the same for every movement in the body. There will always be one contracting muscle and one relaxing muscle. If you take a moment to think about these simple movements, it will soon become obvious that unless the opposing muscle is relaxed, it will have a negative effect on the force generated by the contracting muscle.

A muscle that contracts, and is the main muscle group responsible for the movement, is called the agonist or prime mover. The muscle that relaxes is called the antagonist. One of the effects that regular strength training has is an improvement in the level of relaxation that occurs in the opposing muscle group. Although the agonist/antagonist relationship changes, depending on which



muscle is responsible for the movement, every muscle group has an opposing muscle group.

Below are examples of agonist and antagonist muscle group pairings:

AGONIST (Prime Mover)	Antagonist
<b>Latimus Dorsi</b> (upper back)	<b>Deltoids</b> (shoulder)
<b>Rectus Abdominus</b> (stomach)	<b>Erector Spinae</b> (back muscles)
<b>Quadriceps</b> (top of thigh)	<b>Hamstrings</b> (back of thigh)
<b>Gastrocnemius</b> (calf)	<b>Tibialis Anterior</b> (front of lower leg)
<b>Soleus</b> (below calf)	<b>Tibialis Anterior</b> (front of lower leg)

Smaller muscles may also assist the agonist during a particular movement. The smaller muscle is called the synergist. An example of a synergist would be the deltoid (shoulder) muscle during a press-up. The front of the deltoid provides additional force during the press-up; however, most of the force is applied by the pectoralis major (chest). Other muscle groups may also assist the movement by helping to maintain a fixed posture and prevent unwanted movement. These muscle groups are called fixators. An example of a fixator is the shoulder muscle during a bicep curl or tricep extension.

### Types of Muscular Contraction

- *Isometric*  
This is a static contraction where the length of the muscle, or the joint angle, does not change. An example is pushing against a stationary object

such as a wall. This type of contraction is known to lead to rapid rises in blood pressure.

- *Isotonic*  
This is a moving contraction, also known as **dynamic contraction**. During this contraction the muscle fattens, and there is movement at the joint.

### Types of Isotonic Contraction

- *Concentric*  
This is when the muscle contracts and shortens against a resistance. This may be referred to as the lifting or positive phase. An example would be the lifting phase of the bicep curl.
- *Eccentric*  
This occurs when the muscle is still contracting and lengthening at the same time. This may be referred to as the lowering or negative phase.

### Muscle Fiber Types

Not all muscle fibers are the same. In fact, there are two main types of muscle fiber:

- *Type I*  
Often called slow-twitch or highly-oxidative muscle fibers
- *Type II*  
Often called fast-twitch or low-oxidative muscle fibers

Additionally, Type II muscle fibers can be further split into Type IIa and Type IIb. Type IIb fibers are the truly fast twitch fibers, whereas Type IIa are in between slow and fast twitch. Surprisingly, the characteristics of Type IIa fibers can be strongly influenced by the type of training undertaken. Following a period of endurance training, they will start to strongly resemble Type I fibers, but following a period of strength training they will start to strongly resemble Type IIb fibers. In fact, following several years of endurance training they may end up being almost identical to slow-twitch muscle fibers.

### **Type I (Slow-Twitch Muscle Fibers)**

Slow-twitch muscle fibers contain more mitochondria, the organelles that produce aerobic energy. They are also smaller, have better blood supply, contract more slowly, and are more fatigue resistant than their fast-twitch brothers. Slow-twitch muscle fibers produce energy, primarily, through aerobic metabolism of fats and carbohydrates. The accelerated rate of aerobic metabolism is enhanced by the large numbers of mitochondria and the enhanced blood supply. They also contain large amounts of myoglobin, a pigment similar to hemoglobin that also stores oxygen. The myoglobin provides an additional store of oxygen for when oxygen supply is limited. This extra oxygen, along with the slow-twitch muscle fibers' slow rate of contraction, increases their endurance capacity and enhances their fatigue resistance. Slow-twitch muscle fibers are recruited during continuous exercise at low to moderate levels.

### **Type IIb (Fast-Twitch Low-oxidative Muscle Fibers)**

These fibers are larger in size, have a decreased blood supply, have smaller mitochondria and less of them, contract more rapidly, and are more adapted to produce energy anaerobically (without the need for oxygen) than slow-twitch muscle fibers. Their reduced rate of blood supply, together with their larger size and fewer mitochondria, makes them less able to produce energy aerobically, and are therefore, not well suited to prolonged exercise. However, their faster rate of contraction, greater levels of glycogen, and ability to produce much greater amounts of energy anaerobically make them much more suited to short bursts of energy. Because of their greater speed of contraction and reduced blood supply, they are far less fatigue resistant than slow-twitch fibers, and they tire quickly during exercise.

### **Numbers of Slow and Fast-Twitch Fibers**

The number of slow and fast-twitch fibers contained in the body varies greatly between individuals and is determined by a person's genetics. People who do well at endurance sports tend to have a higher number of slow-twitch fibers, whereas people who are better at sprint events tend to have higher numbers of fast-twitch muscle fibers. Both the slow twitch and fast-twitch fibers can be influenced by training. It is possible through sprint training to improve the power generated by slow twitch fibers, and through endurance training, it is possible to increase the

endurance level of fast-twitch fibers. The level of improvement varies, depending on the individual, and training can never make slow-twitch fibers as powerful as fast-twitch, nor can training make fast-twitch fibers as fatigue resistant as slow-twitch fibers.

## **Cardiac Muscle Structure and Function**

Cardiac muscle cells are only found in the heart. They are elongated and contain actin and myosin filaments, which form sarcomeres; these join end to end to form myofibrils. The actin and myosin filaments give cardiac muscle a striated appearance. The striations are less numerous than in skeletal muscle. Cardiac muscles contain high numbers of mitochondria, which produce energy through aerobic metabolism. An extensive capillary network of tiny blood vessels supply oxygen to the cardiac muscle cells. Unlike the skeletal muscle cells, the cardiac cells all work as one unit, all contracting at the same time. In short, the sinoatrial node at the top of the heart sends an impulse to the atrioventricular node, which sends a wave of polarization that travels from one heart cell to another causing them all to contract at the same time.

## **Smooth Muscle Structure and Function**

Smooth muscle cells are variable in function and perform numerous roles within the body. They are spindle shaped and smaller than skeletal muscle and contain fewer actin and myosin filaments. The actin and myosin filaments are not organized into

sarcomeres, so smooth muscles do not have a striated appearance. Unlike other muscle types, smooth muscle can apply a constant tension. This is called smooth muscle tone. Smooth muscle cells have a similar metabolism to skeletal muscle, producing most of their energy aerobically. As such, they are not well adapted to producing energy anaerobically.<sup>1</sup>

For more information on muscle physiology, click on the links below:

[Skeletal Muscle Physiology](#)

[Fast Twitch versus Slow Twitch](#)

[Actin and Myosin: the Romeo and Juliet of Muscle Cells](#)

[Skeletal Muscles](#)

## **Resistance Exercise Programing**

Designing a resistance exercise program can seem like a daunting task. However, the basics are very simple. The table below provides instructions for designing an effective resistance exercise program.



## Resistance Exercise Program

<b>F</b>	Frequency of Exercise	How Often	Beginner	2–3 days per week Full-body workout of all 6 body areas 48–72 hours of rest in-between workouts	
			Intermediate to High	4–5 days per week; often perform split workouts (example: Monday and Thursday, work chest, shoulders, triceps, abdominals; Tuesday and Friday, work back, legs, biceps) 48–72 hours of rest in-between workouts	
<b>I</b>	Intensity of Exercise	How Hard	Beginner	60%–70% of maximum strength	
			Intermediate to High	70%–90% of maximum strength	
<b>T</b>	Time of Exercise	–How many reps –How many sets –How much time between sets	Beginner	1–3 Sets 8–12 repetitions	30 sec to 1 minute
			Intermediate to High	Endurance – 12–20+ Reps 2–3 Sets	30 sec to 1 minute
				Strength – 2–6 Reps 3–5 Sets	2 to 5 minutes
<b>T</b>	Type of Exercise	Which Exercises	Weight machines, free weights, resistance tubing, medicine ball, own body weight		

**Note:** Specificity Principle — you must work each muscle group to have strength gains in that particular part of the body.

### Recommendations for Resistance Training Exercise

- *Perform a minimum of 8 to 10 exercises that train the major muscle groups.*
  - Workouts should not be too long. Programs longer than one hour are associated with higher dropout rates.
  - Choose more compound, or multi-joint exercises, which involve more muscles with fewer exercises.
- *Perform one set of 8 to 12 repetitions to the point of volitional fatigue.*
  - More sets may elicit slightly greater strength gains, but additional improvement is relatively small.
- *Perform exercises at least 2 days per week.*
  - More frequent training may elicit slightly greater strength gains, but additional improvement is relatively small.

- since progress is made during the recuperation between workouts.
- 2-10% increase in load if one to two repetitions over the desired number
- *Adhere as closely as possible to the specific exercise techniques.*
  - *Perform exercises through a full range of motion.*
    - Elderly trainees should perform the exercises in the maximum range of motion that does not elicit pain or discomfort.
  - *Perform exercises in a controlled manner.*
  - *Maintain a normal breathing pattern.*
  - *If possible, exercise with a training partner.*
    - Partners can provide feedback, assistance, and motivation.
  - *Training frequency*
    - 2-3 days per week for novice and intermediate training
    - 4-5 days per week for advanced training
  - *Novice training*
    - 8-12 repetition maximum (RM)
  - *Intermediate to advanced training*
    - 1-12 RM using periodization\* (strategic implementation of specific training phases alternating between phases of stress and phases of rest)
    - eventual emphasis on heavy loading (1-6 RM)
    - at least 3-min rest periods between sets
    - moderate contraction velocity
    - 1-2 s concentric, 1-2 s eccentric

### **Position Stand on Progression Models in Resistance Training for Healthy Adults<sup>2</sup>**

- *Both concentric and eccentric muscle actions*
- *Both single and multiple joint exercises*
- *Exercise sequence*
  - large before small muscle group exercises
  - multiple-joint exercises before single-joint exercises
  - higher intensity before lower intensity exercises
- *When training at a specific RM load*

\*For more information on using periodization for weight training, click on the link below:

#### [Periodization for Weight Training](#)

- *Hypertrophy training*
  - 1-12 RM in periodized fashion, with emphasis on the 6-12 RM zone
  - 1- to 2-min rest periods between sets
  - moderate contraction velocity
  - higher volume, multiple-set programs

- *Power training* (two general loading strategies):
  - **Strength training**
    - use of light loads
    - 30-60% of 1 RM
    - fast contraction velocity
    - 2-3 min of rest between sets for multiple sets per exercise
    - emphasize multiple-joint exercises especially those involving the total body
  - **Local muscular endurance training**
    - light to moderate loads
    - 40-60% of 1 RM
    - high repetitions (> 15)
    - short rest periods (< 90 seconds)

Recommendations should be viewed within the context of an individual's target goals, physical capacity, and training status.

## Six Types of Resistance Training

Each type of resistance training benefits muscles in a different way. While these types of resistance training are not new, they could be unique sources of resistance that you have not considered in your quest to add muscle to your frame. Using these forms of resistance alone, in combination with one another, or in combination with the more traditional resistance apparatus, can enable you to diversify your efforts to produce valuable and improved results.

In each type of training, you may use an apparatus to create an environment for resistance. The uniqueness of these sources is found in the way they are implemented. You might use a dumbbell for a particular

exercise in some of these alternative resistance methods, but the way you use the resistance through a range of motion may be altogether different.

- *Dynamic Constant Training*  
As the name suggests, the most distinctive feature of dynamic constant training (DCT) is that the resistance is constant. A good example of DCT occurs when you use free weights or machines that do not alter resistance, but redirect it instead. The emphasis shifts to different planes along the muscle group being worked. When you work on a shoulder-press machine, for example, the resistance remains constant over the entire range of motion. It is identical from the bottom of the movement to the top and back down again. Only the direction of the resistance varies. The resistance redirects itself through the arc and then redirects itself again when the shoulders let the weight come back down to the starting position.
- *Dynamic Progressive Training*  
In dynamic progressive training (DPT), resistance increases progressively as you continue to exercise. DPT is often used as a rehabilitative measure and offers the sort of resistance that builds gradually while remaining completely within the control of the person using it. Equipment includes rubber bands and tubing, springs, and an apparatus controlled by spring-loaded parts. They are low-cost items that are easily accessible and can be used anywhere. Though

commonly employed for rehabilitation of torn ligaments, joints, muscles, and broken bones, it is also convenient for travelers on either vacation or business trips. When combined with traditional forms of resistance, this training creates a better-balanced program and provides the muscles with a welcome alternative from time to time.

- *Dynamic Variable Training*

This form of resistance exercise takes up where dynamic constant training leaves off. Whereas DCT employs constant resistance, never varying to accommodate the body's mechanics, DVT can be adapted to the varying degrees of strength of a muscle group throughout a range of motion. Though very few machines succeed in this goal, a few have come close.

Hammer Strength equipment emphasizes common fixed areas of resistance. However, the Strive line of equipment has been able to give the user much more choice in resistance levels during an exercise. Strive equipment uses the DVT principle most effectively because it allows the user to increase resistance at the beginning, middle or end of the range of motion. If your joints are stronger at the end of a movement (the top) or the beginning (the bottom), you can set the resistance accordingly. The Strive line is the most flexible yet of all gym equipment designed to adhere to the DVT principle. It lets you tailor-make your workouts

based on your body's mechanics.

- *Isokinetic Training*

In isokinetic training (IKT), the muscle is contracted at a constant tempo. Speed determines the nature of this resistance training, not the resistance itself; however, the training is based on movement carried out during a condition of resistance. IKT can be performed with the body's own weight.

In isokinetic training, resistance is steady while velocity remains constant. For example, isokinetics are at work with any machine that is hydraulically operated. The opposing forces mirror each other throughout the range of motion. A good example would be pressing down for triceps on a hydraulic machine and having to immediately pull up (the resistance is constant in both directions) into a biceps curl while maintaining the same speed. IKT often involves opposing body parts. Trainers can use a variety of apparatus with their clients to achieve isokinetic stasis between muscle groups.

- *Isometric Training*

Familiar to most people, isometric training (IMT) is an excellent way to build strength with little adverse effect on joints and tendons commonly associated with strength training and lifting heavy weights. Though it appears simple in comparison to traditional resistance training, IMT should not be underrated in its effectiveness. IMT is a method in which the force of

contraction is equal to the force of resistance. The muscle neither lengthens nor shortens. You may be wondering how any training occurs without lengthening and shortening the muscles. In IMT, the muscles act against each other or against an immovable object.

Isometric training is what you see swimmers do when they press their hands against a solid wall, forcing all their bodyweight into the wall. Another common IMT exercise is pressing the hands together to strengthen the pectorals and biceps. Pressing against the wall can involve muscles in the front deltoid, chest and biceps. Isometric training has been proven very effective for gaining strength, but this method usually strengthens only the muscles at the point of the isometric contraction. If the greatest resistance and force are acting upon the mid-portion of the biceps, that is where most of the benefit will occur. A comprehensive isometric routine can serve to increase strength in certain body parts.

- *Isotonic Training*  
This method demands constant tension, typically with free weights. Though this approach may sound a lot like dynamic constant training, it differs because it does not necessarily redirect the resistance through a range of motion, but rather, keeps tension constant as in the negative portion of an exercise. Complete immobility of the muscle being worked is required. For example, in the preacher curl, the

biceps are fixed against the bench. They lift (positive), then release the weight slowly downward (negative), keeping the same tension on the muscles in both directions. This is one reason that free-weight exercise is considered the best form of isotonic training. Merely lifting a dumbbell or barbell, however, is not necessarily enough to qualify as isotonic. The true essence of isotonic training is keeping resistance constant in both the positive and negative portions of each repetition.

### **Exercise Order for Resistance Training**

The general guidelines for exercise order when training all major muscle groups in a workout is as follows:

- Large muscle group exercises (i.e., squat) should be performed before smaller muscle group exercises (i.e., shoulder press).
- Multiple-joint exercises should be performed before single-joint exercises.
- For power training, total body exercises (from most to least complex) should be performed before basic strength exercises. For example, the most complex exercises are the snatch (because the bar must be moved the greatest distance) and related lifts, followed by cleans and presses. These take precedence over exercises such as



the bench press and squat.

- Alternating between upper and lower body exercises or opposing (agonist–antagonist relationship) exercises can allow some muscles to rest while the opposite muscle groups are trained. This sequencing strategy is beneficial for maintaining high training intensities and targeting repetition numbers.
- Some exercises that target different muscle groups can be staggered between sets of other exercises to increase workout efficiency. For example, a trunk exercise can be performed between sets of the bench press. Because different muscle groups are stressed, no additional fatigue would be induced prior to performing the bench press. This is especially effective when long rest intervals are used.<sup>3</sup>

## Resistance Training Conclusion

The most effective type of resistance-training routine employs a variety of techniques to create a workout program that is complete and runs the gamut, from basic to specialized. Learning different methods of training, different types of resistance, and the recommended order can help you acquire a balanced, complete physique. That does not mean that these training methods will help everybody to win

competitions, but they will help you learn how to tune in to your body and understand its functions through resistance and movement. This knowledge and understanding develops a valuable skill, allowing you to become more adept at finding what works best for you on any given day.

For additional information on resistance exercises, click on the links below:

[Exercise and Muscle Directory](#)

[Muscular Strength and Endurance Activity](#)

## Supplements

Many active people use nutritional supplements and drugs in the quest for improved performance and appearance. Most of these substances are ineffective and expensive, and many are dangerous. A balanced diet should be your primary nutritional strategy.

Below are links that provide additional information about the use of supplements during exercise:

[Benefits and Side Effects of Steroid Use](#)

[Claims versus actual effects of performance aids](#)

## Terminology Checklist:

**Muscles-** organ in the body that causes movement

**Skeletal Muscle-** Responsible for body movement

**Cardiac Muscle-** Responsible for the contraction of the heart

**Muscle Fiber-** individual muscle cell

**Motor unit-** a nerve controlling a group of muscle fibers

**Myofibrils-** which are threadlike structures running the length of the muscle fiber

**Insertion-** point where the muscle is attached to a bone that moves

**Origin-** point where the muscle is attached to a bone that remains in a fixed position

**Action Potential-** the electrical current that cause a muscle to contract

**Sliding Filament Theory-** the theory of how our muscles move

**Dynamic contraction-** muscle movements that cause bodily movements

**Repetition-** One movement pattern

**Set-** a group of repetitions

**Periodization-** Breaking resistance training into different training phases

**Strength-** the maximal amount a force that can produced one time

**Hypertrophy-** muscle fibers getting bigger

**Atrophy-** muscle fibers getting smaller

**Isokinetic-** muscle is contracted at a constant tempo

**Isometric-** muscle contraction cause no bodily movement

## Test Your Knowledge

1. What is the best way to assess muscular endurance?
  - a. Repetition maximum test
  - b. 1-repetition maximum test
  - c. 12 minute swim
  - d. sit and reach
  
2. Static muscular strength exercise are ones where no movement occurs?
  - a. True
  - b. False
  
3. Concentric movement refers to
  - a. Muscles lengthening
  - b. Muscles staying the same length
  - c. Muscles shortening
  - d. Muscles going thru a full range of motion
  
4. Proper technique in resistance exercise helps all the following except
  - a. Better muscular improvements
  - b. Less risk for injury
  - c. Makes exercising safer
  - d. Makes you look better
  
5. Which of the following is not needed in order to be safe while doing resistance exercises?
  - a. Working out in a mirror
  - b. Using proper technique
  - c. Using spotters
  - d. Not working out when injured

Answers: 1.A, 2.A, 3.C, 4.D, 5.A

## References

<sup>1</sup>Information pulled from [www.strengthandfitnessuk.com](http://www.strengthandfitnessuk.com)

<sup>2</sup>(ACSM 2002)

<sup>3</sup>Information is from the National Strength and Conditioning Association and LiveStrong.org

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# Flexibility

## Objectives:

- Define flexibility
- Examine the benefits of flexibility
- Identify ways to increase flexibility
- Create an effective stretching program
- Assess your own flexibility

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## What is flexibility?

One of the five health-related components of fitness is flexibility. Flexibility relates to the ability to move a joint through its full range of motion (ROM). Developing a complete fitness program requires taking time to emphasize this component by stretching. Unfortunately, as the American Council on Exercise points out, “Most people neglect flexibility training, limiting freedom of movement, physical and mental relaxation, release of muscle tension and soreness, and injury prevention.”<sup>1</sup>

Perhaps the reason it is so easy for people to overlook flexibility is because its benefits, while significant, are felt more than seen. However, failing to address this component of fitness can have serious consequences, especially as a person ages. Without flexibility, everyday tasks, such as sweeping the floor or even getting out of bed, become difficult. A reduced mobility of joints increases the risk of injury during an exercise routine, as well as the risk of occasional and chronic back pain. This chapter will provide a greater understanding of this vitally important component of a complete fitness program

and demonstrate why flexibility shouldn't be overlooked.

## Types of Flexibility

Flexibility is classified into two types: static and dynamic.

- *Static flexibility*  
This type of flexibility is a measure of the limits of a joint's overall range of motion. It is measured by stretching and holding a joint in the position of its maximum range while using a measuring instrument to quantify that range. To achieve the maximum range, **passive forces**, the force generated from an external source, are required.
- *Dynamic flexibility*  
This type of flexibility is a measure of overall joint stiffness during movement. Unlike static flexibility, dynamic flexibility requires active force production, or your own muscles contracting. Because quantifying “stiffness,” is difficult, dynamic flexibility is measured more subjectively. Assessment is based on

how easy or difficult it is to perform certain tasks, such as swinging a tennis racket, climbing steps, or getting in and out of a car.

The aim of any good stretching program is to improve both static and dynamic flexibility so that normal ROM can be achieved. The definition of *normal* in this context is one developed from population studies that measured various areas of the body and established an average degree of movement for a particular joint.

## Benefits of Flexibility and Stretching

Regular stretching provides many benefits, the most important of which is simple: flexibility provides freedom of movement and the ability to complete activities with greater ease.

### Healthy Joints and Pain Management

As many as 26 percent of all adults report pain and stiffness in joints. That number increases dramatically with age, and women are more likely to develop joint symptoms.<sup>2</sup> For adults, arthritis is one of the most common conditions, with 54% of people 75 years and older having been diagnosed with arthritis.<sup>3</sup> Regular exercise, including regular stretching, is essential for people with arthritis to maintain function and manage joint pain. Even for those not affected by joint conditions, stretching

increases joint mobility and function, and decreases joint stiffness and pain.

Imbalances in the muscles can cause discomfort and pain. For example, if the front of a person's thighs and hips gets too tight from a lack of flexibility, the tension will pull on the hips, where the muscles are attached. The result is the pelvis may be pulled forward and cause greater sway in your lower back. This affects posture and can eventually lead to pain and stiffness in the neck, shoulders, and lower back. Stretching all major muscle groups and joint areas regularly promotes good alignment and balance.

### Muscle Relaxation and Stress Relief

Staying in one position for long periods of time, repetitive movements, and other everyday stressors can result in stiff muscles and knots, also called trigger points. Regular stretching decreases anxiety, blood pressure, and breathing rate, which help to relax muscles and aches and pains related to neuromuscular tension (stress). Flexibility has also been prescribed successfully to treat dysmenorrhea, which is painful menstruation. It also relieves muscle cramps that can occur during exercise or participation in sports.

### Other Benefits

In addition to the benefits listed above, research has documented additional benefits that provide good reasons for maintaining a routine of stretching:

- *Increased blood flow*  
Blood carries vital nutrients and oxygen to muscles and tissues. Stretching increases blood flow to the muscles being stretched, which helps them recover from exercise faster.<sup>4</sup>
- *Reduced risk of developing future lower back pain*  
Although research is still inconclusive, most experts agree that muscle fitness and stretching exercises reduce the risk of developing lower back pain by counteracting the natural loss in muscle and connective tissue elasticity that occurs with aging.

## Flexibility and Aging

For many college students, maintaining long-term flexibility is not a concern. For young adults, bending over to tie their shoes is painless. Walking around campus with a backpack requires minimal effort. However, ROM declines with age. Simple activities like rotating the head and neck to glance over the shoulders, getting in and out of a vehicle, or carrying groceries can become painful. Therefore, flexibility is critical in maintaining a high quality of life throughout the aging process.

## The Inactivity-Mobility Cycle

Anyone who has suffered an injury and had to wear a splint, cast, or brace to immobilize a joint knows how important mobility is to overall health. Unfortunately,

*Flexibility*

when the joints' ROM becomes restricted by arthritis or other injuries, activity declines. As activity declines, the ROM continues to diminish as a result of inactivity, and a vicious cycle ensues. A simple stretching program can help alleviate this problem and break the cycle.

## Improving Range of Motion

Joint ROM results from a combination of factors, which are classified as either internal or external. Internal structures relate to the physical structures of body materials and tissue. External factors are non-structural and include gender, age, excess fat mass, muscle mass, environmental temperature, and restrictions in clothing or equipment.

Internal factors include joint structure/joint mechanics and the connective and soft tissue surrounding the joint. Because muscular actions, such as muscular contractions and stretching, are controlled by the nervous system, another internal factor can be attributed to the neuromuscular system and how the stretching and tension is managed.

## Joint Structure

A joint is defined as a location on the skeletal system where two or more bones intersect and interact. For example, the humerus (upper arm) intersects with the radius and ulna (lower arm) at the point of the elbow. The bony formation of each joint structurally limits its ROM. For example, the shoulder joint, which is structurally a ball-

in-socket joint, can rotate in multiple directions, giving it a wide range of motion. However, the knee joint is a modified hinge joint, which is limited to essentially a forward-backward direction of movement.

Additionally, ROM may be limited by excessive fat mass or even large muscle mass surrounding a particular joint. Although the amount of muscle mass and fat mass surrounding a joint can be altered by diet and activity levels, joint structure is permanent. As a result, little can be done to improve flexibility in this area.

Not only is range of motion related to the joint structure, but flexibility exercises are joint-specific. Stretching the hamstring will not improve flexibility in the shoulders. Likewise, flexibility in the shoulders may be excellent while fingers or ankles remain “stiff.” As such, a complete and effective stretching program includes multiple stretches for various joints.

## Connective and Muscle Tissue

Joints are surrounded and connected by muscles, tendons, ligaments, and skin. The head of the humerus fits into a small cavity to create the shoulder joint. However, those bones cannot remain in that position without the muscles, tendons, and ligaments that keep the joint tight and hold it in place. In addition, muscle tissue is surrounded with connective tissue, primarily collagen and elastin. As a joint moves through its normal range of motion, all of this soft tissue must stretch to accommodate the movement. Therefore, static and dynamic flexibility is probably

most limited by the flexibility of the surrounding soft tissue, specifically the connective tissue.

While the exact biomechanics of how flexibility is changed is not well understood, they do appear to be related to the elastic and plastic properties of the connective tissue. **Elasticity** is defined as the ability to return to resting length after **passive stretching** (i.e., elastic recoil). Like a spring, soft tissues stretch and then recoil to their resting position. **Plasticity** is the tendency to assume a greater length after passive stretching (i.e., plastic deformation). Stretching that spring composed of soft tissues will change its resting position to a new longer length. The goal of a flexibility program is to repeatedly overload the elastic properties of the muscle to elicit plastic deformation over time. Experts suggest that a slow, sustained stretch for 30–90 seconds is necessary to produce chronic plastic deformation.

## Neuromuscular System

Modern cars come equipped with a central computer and sensors to troubleshoot problems with the vehicle. Sensors in the engine monitor temperature. Sensors on the wheels gauge tire pressure while sensors in the gas tank alert the driver when fuel is low. Much like a car, our bodies are equipped with sensors, called **proprioceptors**, that help us manage movement and prevent injury.

Muscles have two specific types of proprioceptors that determine the length and tension of the muscle. These



proprioceptors are called muscle spindles and Golgi tendon organs (GTOs).

Muscle spindles lie parallel to the regular muscle and help determine the length of muscles when they are being stretched. When a muscle is stretched, it sends signals to the central nervous system causing the stretched muscle to contract. This resistance to the stretch, called the **myotatic** or **stretch reflex** is generated by the nervous system's reflexive stimulus sent to the stretching muscle. That same signal also causes the antagonist, or opposing muscle to relax, called **reciprocal inhibition**. As such, when the upper thigh (quadriceps) are stretched, the hamstrings (antagonist to the quadriceps) relax.

The GTOs are located near the **musculotendon junction**, the end points of the muscle, and relay messages to the central nervous system regarding muscle lengthening and tension of the muscle. When activated, these signals will override the stretch reflex causing a sudden relaxation of the stretching muscle. This is called **autogenic inhibition** or the **inverse myotatic reflex**. This inhibitory reflex can only occur after the muscle has been stretched for 5 seconds or longer. This is why, to effectively stretch, movements must be sustained for long, slow increments of time. Otherwise, the resistance encountered from the stretch reflex will not be overridden and lengthening cannot occur. Whether signaling the muscles to contract or relax, the neuromuscular system manipulates the stretched muscle, presumably as a protective mechanism to prevent injury.

## Improving Flexibility

Research has identified multiple stretching techniques that aid in improving ROM. Regardless of the specific technique or specific mode used, each technique can be performed using either active or passive mode. **Active stretching**, also called unassisted stretching, is done individually without an external stimulus. **Passive stretching**, or assisted stretching, is when a partner or trainer is used as the stimulus in the stretching exercise. Both modes are effective and can be applied to each of the techniques described below.

### Static Stretching

The technique most commonly prescribed and used to improve flexibility is the static stretch. A static stretch involves slow, gradual, and controlled movements. The muscle group is stretched toward the end of the joint's ROM until the point of mild discomfort is reached. Once that point is reached, the stretch is held in a "static" position for 30 to 90 seconds. After the prescribed time, the stretch can be repeated. Common ways in which static stretching is applied would be performing Yoga routines or stretching after a workout or an athletic event. Some of the major advantages of static stretching are as follows: 1) It is generally considered safe (see [Stretches to Avoid](#)); 2) It is simple to perform; and 3) It is effective at increasing ROM. The only major disadvantage comes from doing it too much, which can reduce strength and may make joints unstable. Of

course, this potential risk applies to all of the techniques.

## **Ballistic Stretching**

Ballistic stretching involves forceful bouncing or ball-like movements that quickly exaggerate the joint's ROM without holding the position for any particular duration. This type of stretching involves dynamic movements like those done by athletes during sports events. In that regard, ballistic stretching is seen as being very specific to and beneficial for athletes. However, one criticism of ballistic stretching is that because of the short duration of the stretch and the forceful nature of ballistic movements, the muscular contraction from the stretch reflex may cause muscle soreness or even injury. For that reason, many coaches regard ballistic stretching as unsafe. Also, many researchers contend that it is less effective at improving ROM. Nonetheless, the American College of Sports Medicine (ACSM) still recommends ballistic stretching as one method to effectively increase flexibility.

## **Dynamic Stretching**

Ballistic stretching is a form of dynamic stretching. However, when referring to dynamic stretching routines, most fitness professionals are referring to dynamic movements that do not involve forceful bouncing motions. Instead, dynamic stretching, in this context, suggests performing exaggerated sports movements in a slower, more controlled manner. For example, a sprinter may use several

*Flexibility*

exaggerated stride lengths before a race to improve hip ROM.

An advantage of dynamic stretching is its ability to target and improve dynamic flexibility, which in turn may improve performance. A disadvantage comes from the movements involved, which often require good balance and coordination. Since mastering the correct form requires time and a certain level of athleticism, dynamic stretching may not be suitable for certain populations.

## **Proprioceptive Neuromuscular Facilitation (PNF) Stretching**

This type of exercise usually involves a partner. The partner will passively stretch the person's muscle. This movement is immediately followed by an isometric muscle contraction against resistance. This contraction is then followed by another passive stretch. This type of stretch is also named contract-relax stretch because of the sequence of movements involved. Other types of PNF stretching involve contract-relax-antagonist contraction, also describing the sequence of movements involved but adding an additional step.

As the name of the technique implies, PNF stretching emphasizes the natural interaction of the proprioceptors with the muscles to increase the ROM during the stretch. Remember that during the stretch, the muscle spindles cause two responses: the stretch reflex and the reciprocal inhibition (the relaxing of the antagonist muscle). After 5 seconds, the GTOs then override the muscle spindle's signals

causing autogenic inhibition. Because the muscle is relaxed, it can be stretched more easily. To reiterate, the stretch either uses the activity of the antagonist muscle to get the target muscle to relax or the target muscle itself relaxes as a result of the contraction of the antagonist muscle.

While many experts assert that PNF stretching is the most effective technique, studies that compare static and PNF stretching are inconclusive. Regardless, it does appear to be very effective at increasing static flexibility. Some disadvantages to PNF are that it generally requires a knowledgeable partner, it is somewhat complicated, and it can cause soreness as a result of the contractions.

## Creating an Effective Stretching Program

The ACSM has made specific recommendations on how to design a flexibility program (click [here](#) to view). However, before examining these recommendations in depth, you should first evaluate your current flexibility status by assessing various joints' ROM. Specifically, performing the sit-and-reach test will assess your hamstring and lower back flexibility while using a goniometer can be used to assess your ankles, knees, hips, neck and shoulders. Instructions on how to perform these assessments will follow later.

## Setting Goals

Once you determine which of your joints are the most and least flexible, you can set some realistic goals to improve or maintain your ROM. Be specific when you set goals. Instead of just saying, "I want to increase my flexibility," identify the specific area of the body you intend to improve. You will also want to make sure your goal can be measured. A better way to state your goal is, "I will improve my sit-and-reach score by 4 cm by the end of the semester." Notice this goal, as stated, includes a specific area, is measurable, and includes a deadline. By stating your goal properly, you will increase the likelihood of achieving it.

## Applying the FITT Principle

As mentioned previously, the ACSM has made recommendations for designing a flexibility program based on the FITT Principle (**F**requency, **I**ntensity, **T**ime and **T**ype). As the ACSM recommends, your flexibility program should include multiple stretching exercises that target all major joints, including the neck, shoulders, elbows, wrists, trunk, hips, knees, and ankles.

After selecting your exercises, follow the recommendations below when performing your routine:

- *Frequency*  
Stretch a minimum of 2-3 days per week, ideally 5-7 days per week.

- *Intensity*  
Stretch to the point of tightness or mild discomfort.
- *Time (duration of each stretch)*  
Stretch for a minimum of 10 seconds for very tight muscles with an emphasis on progressing to 30-90 seconds. Complete two to four repetitions of each stretch.
- *Type (mode)*  
Select the technique that best suits your circumstances: static, dynamic, ballistic, or proprioceptive neuromuscular facilitation.

## When to Stretch

Although stretching can be done any time, the ACSM traditionally recommends that flexibility training be incorporated into the warm up or cool down phase of an exercise session. Recent studies suggests that stretching before an exercise session will compromise the force-producing capabilities of muscles and should be avoided. Therefore, it is recommended that stretching be restricted to *after* the warm-up or workout, when the temperature of the body and muscles has increased. Additional evidence pertaining to this concept shows that applying heat packs for 20 minutes to increase muscle temperature can increase hamstring flexibility more so than 30 seconds of static stretching. These findings confirm that temperature also plays a significant role in muscle ROM.

Additional information about improving your flexibility and balance can be found by clicking on the link below:

[Improving Flexibility and Balance](#)

## Stretching Safely

In addition to warming up your muscles before performing stretching exercises, additional precautions can be taken to ensure the safety of your routine. When muscles are stretched quickly and forcefully, the stretch reflex can be activated. This creates significant tension because the muscle fibers will not only be stretching but also attempting to contract. As mentioned previously, this is one of the reasons ballistic stretching may not be suitable for everyone. To avoid this, stretch slowly and in a controlled fashion while holding the stretch for 10 seconds or more.

## Stretches to Avoid

Research indicates that some stretches are **contraindicated**, which means they are not recommended because they provide little to no benefit and may cause injury. A list of stretches to avoid, as well as safer, alternate stretches, can be found by clicking on the link below. However, this is not a comprehensive list of potentially risky stretches. To avoid injury, it is important to consider personal limitations before performing a stretch exercise.

[Contraindicated Stretches](#)

# Assessing Your Flexibility

## Laboratory Exercises

The first step in creating a successful flexibility program is to assess your own flexibility. Follow the link below for instructions on how you can perform these assessments. The sections you may find most helpful include sections 5.1, 5.2, and 5.3.

[Assessment Exercises](#)

## Terminology Checklist

**Static Flexibility:** the outermost limit of a stretched muscle measured while holding a stretch in place. This can also refer to a technique used to improve the outermost limit of a stretched muscle performed by holding stretches for 15-60 seconds.

**Dynamic Flexibility:** the relative degree of ease a muscle can move through a normal range of motion. This can also refer to a technique used to improve static flexibility and ease of motion done by performing exaggerated movements.

**Elasticity:** the ability of the muscle to return to its resting length after being stretched.

**Plasticity:** the tendency of a muscle to assume a greater length after stretching.

**Proprioceptors:** sensors within muscles that send feedback to the central nervous system conveying muscular length and tension. The two primary sensors related to

flexibility are Golgi Tendon Organs (GTO's) and muscle spindles.

**Joint Structure:** the fixed arrangement of a joint that is a determining factor for range of motion. An example would be ball-in-socket joint or modified hinge joint.

**Myotatic Reflex:** a reflexive stimulus of the muscle to contract as a muscle is being stretched.

**Reciprocal Inhibition:** the principle that when one muscle is stimulated to contract the opposing muscle is will relax.

**Autogenic Inhibition:** an inhibitory reflex that allows one sensor in the muscle to override the signals of another sensor. Also called the inverse myotatic reflex.

**Active stretching:** a mode for stretching that is unassisted or involves no internal stimulus.

**Passive stretching:** a mode for stretching that uses an external source such as a partner or gravity to assist in the movements.

**Ballistic stretching:** a technique used to improve range of motion performed by gently bouncing back and forth to stretch and relax the muscle.

**Proprioceptive Neuromuscular Facilitation (PNF):** a technique used to improve range of motion performed by a sequence of stretching and contracting muscles. These sequences target the neuromuscular structures to facilitate relaxation of reflexive activity.

## Test Your Knowledge

1. Experts, such as the American College of Sports Medicine, recommend performing flexibility exercises:
  - a. A minimum of 2-3 days p/week
  - b. At least 1-2 days p/week
  - c. Ideally, 5-7 days p/week
  - d. Both a and c
2. The best time to perform stretching exercises is:
  - a. After a warm-up or after a workout session
  - b. Immediately before all high-performance activities.
  - c. To the point of pain
  - d. While holding one's breath.
3. The technique of stretching that emphasizes contracting followed by relaxing a muscle is called:
  - a. Ballistic
  - b. Dynamic
  - c. PNF
  - d. Passive
4. The key objective of performing flexibility exercises is to:
  - a. Increase elasticity and plasticity of the muscles
  - b. Improve body composition
  - c. Release toxins that accumulate in the blood
  - d. Improve lung capacity
5. The stretching technique most often recommended by experts for general fitness is:
  - a. Dynamic
  - b. Ballistic
  - c. PNF
  - d. Static

- Key:
1. D
  2. A
  3. C
  4. A
  5. D

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## Additional Readings

BIOMECHANICS OF STRETCHING

<http://medind.nic.in/jau/t06/jaut06p3.pdf>

# Body Composition

By Scott Flynn

## Objectives:

- What is body composition?
  - How does body composition affect a person's health?
  - What are the health risks and costs associated with overweight and obesity?
  - What is the significance of body fat distribution?
  - What is Body Mass Index (BMI) and why is it important?
- 

## Body Weight versus Body Composition

According to surveys, the top reason American females exercise is for weight control. For males, the top reason is to improve muscle tone while weight control ranks as the fourth most important reason.<sup>1</sup> Levels of attractiveness based on weight and visible musculature are significant points of emphasis in American culture. As such, individuals with well-toned muscles and low body weight are marketed as *superior* within the context of attractiveness, financial success, and multiple other traits. Unfortunately, this emphasis, as seen in mainstream media, can result in unrealistic ideals and potentially harmful behaviors, such as eating disorders.

Unlike the mainstream outlets, which focus on the association between fat levels and physical attractiveness, this chapter focuses on the health-related consequences related to good and bad body composition. **Body composition** is defined as the body's relative amount of fat-free mass (FFM) and fat mass (FM) and is generally expressed as

a percentage of total body weight. FFM includes bones, muscles, ligaments, body fluids and other organs, while FM is limited to fat tissue.

## The Importance of Measuring Body Composition Rather Than Just Tracking Body Weight

Tracking weight can be helpful, but body composition measurements help separate a person's actual weight from the weight that could be unhealthy.

For example, an individual who weighs 200 pounds and has 8% body fat, such as an athlete, only carries around 16 pounds of FM. However, a 200-pound person who has a sedentary lifestyle and a body composition of 20%, carries 40 pounds of FM. Weight alone, in this case, does not distinguish between FFM and FM and would suggest both individuals have similar health. As body fat percentage increases, the potential for various diseases also increases significantly.



## Diseases Associated with Excessive Body Fat

According to the National Institute of Health (NIH), a wide array of diseases can be linked to excessive body fat.<sup>2</sup> Some of them are:

- Type II Diabetes Mellitus
- Hypertension
- Cancer
- Cerebrovascular Disease (Stroke)
- Cardiovascular Disease
- Metabolic Syndrome
- Lung Disorders
  - Sleep Apnea
  - Asthma
- Musculoskeletal Diseases
  - Osteoarthritis
  - Gout
- Gallbladder Disease
- Pancreatitis
- Non-Alcohol Fatty Liver Disease
- Dementia
- Psychological Problems and Quality of Life
- Kidney Disease
- Pregnancy Problems

An explanation of how being overweight relates to each disease (those highlighted) can be viewed by clicking on the following link.

- [NIH-Explanation of Disease Risk Associated with Overweight](#)

## How Much Fat is Needed?

Fat is a necessary component of daily nutrition. It is needed for healthy cellular

function, energy, cushioning for vital organs, insulation, and for food flavor.

Fat storage in the body consists of two types of fat: essential and nonessential fat. **Essential fat** is the minimal amount of fat necessary for normal physiological function. For males and females, essential fat values are typically considered to be 3% and 12%, respectively. Fat above the minimal amount is referred to as **nonessential fat**. It is generally accepted that an overall range of 10-22 percent for men and 20-32 percent for women is considered satisfactory for good health. A body composition within the recommended range suggests a person has less risk of developing obesity-related diseases, such as diabetes, high blood pressure, and even some cancers.

A woman's essential fat range is naturally greater than a man's because of fat deposits in breasts, uterus and sex-specific sites. In both males and females, non-essential fat reserves can be healthy, especially in providing substantial amounts of energy.

Excessive body fat is categorized by the terms overweight and obesity. These terms do not implicate social status or physical attractiveness, but rather indicate health risks. **Overweight** is defined as the accumulation of non-essential body fat to the point that it adversely affects health. According to the American College of Sports Medicine (ACSM), the threshold for being characterized as overweight is having a body composition of FM greater than 32% and 19% for females and males, aged 20-39, respectively.<sup>3</sup>

**Obesity** is characterized by excessive accumulation of body fat and can be

defined as a more serious degree of being overweight. Classifications of obesity begin at body composition of FM greater than 39% and 25% in females and males ages 20-39, respectively. <sup>4</sup>

## Other Health Risks

Diseases are not the only concern with an unhealthy body fat percentage. Several others are listed below.

- *Performance of physical activity*  
An important component of a healthy lifestyle and weight management is regular physical activity and exercise. To the contrary, those who live a sedentary lifestyle will find it more difficult to maintain a healthy body weight or develop adequate musculature, endurance, and flexibility. Unfortunately, additional body weight makes it more difficult to be active because it requires more energy and places a higher demand on weak muscles and the cardiovascular system. The result is a self-perpetuating cycle of inactivity leading to more body weight, which leads to more inactivity.
- *Emotional wellness*  
Studies indicate obesity is associated with a 25% increase in anxiety and mood disorders, regardless of age or gender. Other studies suggest increases in BMI significantly increase the incidence of personality disorders and anxiety and mood disorders. Additional studies have been able to associate a higher

incidence of psychological disorders and suicidal tendencies in obese females compared with obese males.<sup>5</sup>

- *Pre-mature death*  
The association between obesity and diseases, such as cancer, CVD, and diabetes, suggests that people with more body fat generally have shorter lifespans. The Center for Disease Control (CDC) estimates up to 365,000 deaths each year can be linked with obesity, representing nearly 15% of all deaths. Other studies have tied the Years of Life Lost to body mass index measurements, estimating anywhere from 2 to 20 years can be lost, depending on ethnicity, age at time of obese classification, and gender.<sup>6</sup>
- *Economic impact*  
The physical harm caused by obesity and overweight is mirrored by its economic impact on the health care system. The CDC has estimated the medical costs to be about \$147 billion in 2008, which includes preventative, diagnostic, and treatments. Overweight and obesity also contribute to loss of productivity at work through absenteeism and *presenteeism*, defined as being less productive while working. The annual nationwide productive costs fall within the range of from \$3.38 to \$6.38 billion.<sup>7</sup>

## Body Fat Distribution

Body composition measurements can help determine health risks and assist in creating an exercise and nutrition plan to maintain a healthy weight. However, the presence of unwanted body fat is not the only concern associated with an unhealthy weight. Where the fat is stored, or fat distribution, also affects overall health risks.

Non-essential fat is primarily stored in **adipose tissue**, or fat cells, located on the surface of the body and surrounding the body's organs. Surface fat, located just below the skin, is called **subcutaneous fat**. Fat that lies deeper in the body surrounding the body's organs is called **visceral fat**. Unlike subcutaneous fat, visceral fat is more often associated with abdominal fat. Researchers have found that excessive belly fat decreases insulin sensitivity, making it easier to develop type II diabetes. It may also negatively impact blood lipid metabolism, contributing to more cases of cardiovascular disease and stroke in patients with excessive belly fat.<sup>8</sup>

Body fat distribution can easily be determined by simply looking in the mirror. The outline of the body, or body shape, would indicate the location of where body fat is stored. Abdominal fat storage patterns are generally compared to the shape of an apple, called the **android shape**. This shape is more commonly found in males and post-menopausal females. In terms of disease risk, this implies males and post-menopausal females are at greater risk of developing health issues associated with excessive visceral fat. Individuals who experience chronic stress tend to store fat in the abdominal region.

A pear-shaped body fat distribution pattern, or **gynoid shape**, is more commonly found in pre-menopausal females. Gynoid shape is characterized by fat storage in the lower body such as the hips and buttocks. This shape may be connected to females' child-bearing abilities as enzymes associated with fat-storage and mobilization are activated during certain times of pregnancy and post-partum.

Besides looking in the mirror to determine body shape, people can use an inexpensive tape measure to measure the diameter of their hips and waist. Many leading organizations and experts currently believe a waist circumference of 40 or greater for males and 35 or greater for females significantly increases risk of disease.<sup>9</sup>

In addition to measuring waist circumference, measuring the waist and the hips and using a waist-to-hip ratio (waist circumference divided by the hip circumference) is equally effective at predicting body fat-related health outcomes. According to the National Heart, Lung, and Blood Institute, a ratio of greater than 0.82 for females and 0.94 for males is associated with a higher risk of developing heart disease, diabetes, and hypertension.<sup>10</sup>

## Body Mass Index

In addition to body composition and waist/hip circumferences, measuring body mass has also been used as an effective method to assess health risks. **Body mass index (BMI)** is a measurement of

height (m<sup>2</sup>) and weight (kg) suggesting that a person's body's weight should be proportional to his or her height. For example, based on the BMI scale, a female with a height of 5'6" should not weigh more than 155 lbs. If her weight exceeded 155 lbs., she would be categorized as "overweight."

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m}^2\text{)}}$$

Among several criticisms, the BMI method has been faulted for not distinguishing between FM and FFM, since only the overall weight is taken into account. For athletes, who may be more massive as a result of larger muscles, this criticism holds true. For example, a professional football player who weighs 215 pounds and stands at 6'3" would have the exact same BMI as a relatively sedentary arm-chair quarterback who also weighs 215 pounds with the same height. This discrepancy also exists when applying BMI to the senior population. As age increases, muscle mass declines. Seniors who have experienced years of muscle mass decline but increased body fat may maintain a constant weight despite having a very different body composition.

Other criticisms of using BMI as a health risk assessment tool include its failure to take age or gender into account. As discussed previously, females naturally have more body fat yet are classified in the same context as males. Because this measurement is so widely used by physicians, patients continue to express concerns about the validity of BMI as an indication of fatness.

Regardless of the criticisms, BMI as used for the general population, has been shown to

be a reasonable predictor of health outcomes. At its core, it is not intended to be an estimate of body composition, i.e., measure FM and FFM. Instead, it is intended to be used as an estimate of healthy/unhealthy levels of body fat. When used as a means of tracking weight changes over time it can be a valuable tool in predicting health and for recommending lifestyle modifications.<sup>11</sup>

## How to Measure Body Composition

Multiple methods exist to estimate body composition. Remember, body composition is the ration of FM and FFM used to help determine health risks. Of the other methods already mentioned (waist, waist-to-hip ratio, and BMI), none provide estimates of body composition but do provide measurements of other weight-related health markers, such as abdominal fat. Experts have designed several methods to estimate body composition. While they are not flawless, they do provide a fairly accurate representation of body composition. The most common are:

- *Hydrostatic Weighing (Underwater Weighing)*  
At one time, hydrostatic weighing (also and maybe more accurately called **hydrodensitometry**) was considered the criterion for measuring body composition. Many other methods are founded on this model, in one form or another. This method attempts to measure the density of the body by applying Archimedes' principle:

density = mass/volume. The mass and volume components are measured by using dry weight and then weight while being submerged in a water tank. Since fat is less dense than muscle tissue, a person with more body fat will weigh less in the water than a similar person with more lean mass. Using the measurements, the density can be determined and converted into body fat percentage. With a small margin of error (around 1-2%) this method is very accurate. Unfortunately, the expense and practicality of building and maintaining a water tank limits access for most. Also, for those with a fear of water, this would obviously not be the preferred method.

- *Dual Energy X-Ray Absorptiometry (DEXA)*

Replacing underwater weighing as the new “gold standard,” is DEXA. While underwater weighing accurately compartmentalizes FM and FFM, DEXA adds a third compartment by using low-radiation X-rays to distinguish bone mineral. This addition slightly increases the accuracy of DEXA by eliminating some of the guess work associated with individual differences, such as total body water and bone mineral density.

Originally, DEXA scanners were designed to determine and help diagnose bone density diseases. As a result, they can be found in many physicians’ offices. However, a full body scan, which takes only a few minutes, is all that is needed to also determine body fat percentage.

Major disadvantages to this method are its high cost and the need for a well-trained professional to operate the equipment and analyze the results.

- *Air Displacement (Plethysmography)*

A good alternative to more expensive methods, air displacement determines body density using the same principle as underwater weighing, by measuring mass and volume. Clearly, the main difference is that mass and volume are being determined by air displacement rather than water displacement. Using a commercial device (the Bod Pod is most commonly referenced), a person sits in a chamber that varies the air pressure allowing for body volume to be assessed. Air displacement provides a viable alternative for those with a fear of water.

Like many other methods, the expense, availability, and training of personnel Air Displacement requires limit accessibility. Additionally, its accuracy is slightly less than underwater weighing.

- *Bio-electrical Impedance Analysis (BIA)*

BIA takes a slightly different approach to measuring FFM. The premise behind BIA is that FFM will be proportional to the electrical conductivity of the body. Fat-tissue contains little water, making it a poor conductor of electricity; whereas, lean tissue contains mostly

water and electrolytes, making it an excellent conductor. BIA devices emit a low-level electrical current through the body and measure the amount of resistance the current encounters. Based on the level of impedance, a pre-programmed equation is used to estimate body fat percentage.

The most accurate BIA devices use electrodes on the feet and hands to administer the point-to-point electrical current. The margin of error for these devices falls in the range of 3–5%. Portable or handheld BIA devices that only measure lower or upper body conductivity have a higher margin of error (4–8%).

Because BIA devices primarily measure hydration, circumstances that may influence hydration status at the time of measurement must be taken into account. Recent exercise, bladder content, hydration habits, and meal timing can cause wide measurement variations and influence accuracy. However, this method is generally inexpensive, often portable, and requires limited training to use, making it a very practical option.

- ***Skinfold Analysis***  
Skinfold analysis is a widely used method of assessing body composition because of its simplicity, portability, and affordability. It is also fairly accurate when administered properly. Margins of error are about 4–7%, depending on the quality of the skinfold calipers and skill of the administrator/technician. The

assumption of skinfold measurement is that the amount of subcutaneous fat is proportionate to overall body fat. As such, a technician pinches the skin at various sites and uses calipers to measure and record the diameter of the skin folds. These numbers can then be plugged into an equation to generate an estimate of body fat percentage.

The proportionality of subcutaneous fat and overall body fat depends on age, gender, ethnicity, and activity rates. As such, technicians should use the skinfold technique specific to the equation that accounts for those variables to improve accuracy.

## **Weighing in on the U.S.**

Despite the well-known health concerns implicated in overweight and obesity and the availability of multiple methods for assessment and tools to improve body composition, current trends in the United States and around the world are moving in the wrong direction. The unprecedented number of obese Americans has led experts to label it an epidemic, much like they would a disease in a developing country. According to the CDC, the number of American adults (>20 years) that fall into the overweight classification based on BMI are 70.7%. Of those, 37.9% fall within the obese classification. In 1962, the overweight and obesity rates for adults in the U.S. were 32% and 13%, respectively. In other words, overweight trends have more than doubled and obesity rates have almost tripled over the past 50+ years.<sup>12</sup>

Of more concern are the increasing number of obese children ages 6-11 and adolescents ages 12-19, amounting to 17.4% and 20.6%, respectively.<sup>13</sup> While those numbers have stabilized over the past decade, this has led to a dramatic increase in insulin resistance, a form of diabetes formerly known as adult onset diabetes.

With such a diverse population in the U.S. and with an understanding of how BMI is calculated, it is only natural to question the high number of overweight and obese citizens based on BMI alone. However, it is generally believed this is an accurate portrayal of weight status. In a study attempting to compare BMI measurements to actual body fat percentage, it was determined that the total number of obese citizens may be underestimated, and its current prevalence may be worse than is currently being reported.

## What Can Be Done?

With the available tools to identify health risks associated with body fat, anyone concerned about their health should gather as much data about body composition and body fat distribution as possible. Compiling multiple measurements and analyzing them provides a better idea of a person's current health status and will help determine the next course of action. For example, BMI alone can be beneficial. But when combined with waist circumference, a greater understanding of risk can be achieved. Likewise, when combining BMI and waist circumference with body fat percentage, an ideal conclusion of health status can be made.

In the lab accompanying this chapter, you will be guided through the process of assessing your BMI, waist circumference, waist-to-hip ratio, and body fat percentage.

The next course of action is to set goals and formulate a plan to get to a healthy range of weight and body fat percentage. Where weight loss is needed, the plan should include a balance of calorie restriction and physical activity/exercise. This might also include tracking your current eating and activity habits. More specific information on weight management strategies will be discussed in a later chapter.

## Low Body Composition

Because more people experience excess body fat, the focus up to this point has been on health concerns related to overweight and obesity. However, fat is an essential component to a healthy body, and in rare cases, individuals have insufficient fat reserves, which can also be a health concern. The range of essential body fat for males is 3-5% and 8-12% for females. Attempting to, or intentionally staying in those ranges, through excessive exercise or calorie restriction is not recommended. Unfortunately, low body fat is often associated with individuals struggling with eating disorders, the majority of whom are females.

The main concern of low body fat relates to the number and quality of calories being consumed. Foods not only provide energy but also provide the necessary nutrients to facilitate vital body functions. For example, low amounts of iron from a poor diet can result in anemia. Potassium deficiencies can

cause hypokalemia leading to cardiovascular irregularities. If adequate calcium is not being obtained from foods, bone deficiencies will result. Clearly, having low body fat, depending on the cause, can be equally as detrimental to health as having too much.

The health concerns most often linked to low body fat are:

- Reproductive disorders
  - Infrequent or missing menstrual cycles
- Respiratory disorders
- Immune System disorders
- Circulatory disorders
- Premature death

In some cases, despite attempts to gain weight, individuals are unable to gain the pounds needed to maintain a healthy weight. In these cases, as in the case of excess fat, a holistic approach should be taken to determine if the low levels of body fat are adversely affecting health. These individuals should monitor their eating habits to assure they are getting adequate nutrition for their daily activity needs. Additionally, other lifestyle habits should be monitored or avoided, such as smoking, which may suppress hunger.

Additional reading on low body fat and its impact can be found on the Livestrong.com website, on this page: [At what body fat percent do you start losing your period?](#)

## Terminology Checklist

**Body Composition:** The measurement of the body's proportion of fat mass to fat free mass.

**Fat Mass:** The amount of fat tissue in the body often expressed as a percentage of total body mass.

**Fat Free Mass (FFM):** not fat tissue in the body such as bones, muscles, ligaments, and blood.

**Essential Fat:** the amount of fat needed for vital body functions.

**Non-essential fat:** the amount of fat that exceeds the necessary fat needed for vital body functions. This fat is considered energy storage.

**Overweight:** the accumulation of non-essential body fat to the point that it adversely affects health.

**Obesity:** is characterized by excessive accumulation of body fat and can be defined as a more serious degree of being overweight.

**Adipose Tissue:** another term for fat. More specifically it is loose connective tissue composed of adipocytes.

**Subcutaneous fat:** fat tissue stored below the skin's surface.

**Visceral Fat:** fat tissue stored around central organs.

**Android shape:** a body shape used to help characterize body fat distribution in which fat is stored in the abdominal region. The



android shape is also called the “apple” shape.

**Gynoid shape:** a body shape used to help characterize body fat distribution in which fat is stored in the hips, buttocks, and thighs. It is also called the pear shape.

**Body Mass Index (BMI):** an index based on concept that weight and height should be proportionate. It is calculated by dividing weight by the height squared (weight/height<sup>2</sup>).

**Hydrodensitometry:** This method attempts to measure the density of the body by using water displacement.

**Dual Energy X-ray Absorbtiometry (DEXA):** A method of measuring body composition that uses low energy x-rays that also measure bone density.

**Air Displacement Plethysmography:** A method of measuring body composition that measures the density of the body by using air displacement.

**Bio-electrical impedance analysis (BIA):** A method of measuring body composition by emitting a small electrical current through the body and using the amount of resistance encountered by this current to predict body fat content.

**Skinfold Analysis:** A method of measuring body composition by measuring the diameter of pinched skin at various sites on the body.

## Test Your Knowledge

1. The key to healthy body composition is to:
  - a. Emphasize short-term weight loss
  - b. Focus on lifestyle changes
  - c. Emphasize diet only
  - d. Set unrealistic goals
2. The people who tend to gain weight in the hip area have a higher incidence of coronary heart disease than those people who gain weight in the abdominal area.
  - a. True
  - b. False
3. The “Bod Pod” estimates percent body fat by using:
  - a. Low energy x rays
  - b. Water displacement
  - c. Air displacement
  - d. Electrical current
4. Essential body fat is best described as:
  - a. Fat essential to look good
  - b. Fat essential for body functioning
  - c. Fat used as energy storage
  - d. Fat used to cushion organs
5. Which of the following methods for measuring body composition would be considered most accurate?
  - a. DEXA
  - b. Skin folds
  - c. BIA
  - d. Plethysmography

### Answer Key

1. B
2. B
3. C
4. B
5. A

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# Nutrition

## Objectives:

- Summarize the basics of nutrition
- Define macronutrients and micronutrients
- Categorize and describe the body's sources of energy
- Analyze intake of nutrition and make appropriate changes

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## The Basics

Nutrition can be defined as the science of the action of food, beverages, and their components in biological systems. A nutrient is a compound that provides a needed function in the body. Nutrients can be further classified based on the amount needed in the body. **Macronutrients** are the nutrients the body needs in larger amounts. **Micronutrients** are also important nutrients, but ones the body needs in smaller amounts.

Macronutrients	Micronutrients
Carbohydrate	Vitamins
Protein	Minerals
Lipids	
Water	

## Macronutrients

- *Carbohydrates*  
The word *carbohydrate* literally means "hydrated carbon," or carbon with water. Thus, it is no surprise that carbohydrates are made up of carbon, hydrogen, and oxygen. Sucrose (table sugar) is an example of a commonly consumed carbohydrate. Some dietary

examples of carbohydrates are whole-wheat bread, oatmeal, rice, sugary snacks/drinks, and pasta.

- *Proteins*  
Like carbohydrates, proteins are comprised of carbon, hydrogen, and oxygen, but they also contain nitrogen. Several dietary sources of proteins include nuts, beans/legumes, skim milk, egg whites, and meat.
- *Lipids*  
Lipids consist of fatty acids, triglycerides, phospholipids, and sterols (cholesterol). Lipids are also composed of carbon, hydrogen, and oxygen. Some dietary sources of lipids include, oils, butter, and egg yolks.
- *Water*  
Water is made up of hydrogen and oxygen and is the only macronutrient that provides no energy.

## Micronutrients

- *Vitamins*  
These compounds are essential for normal physiologic processes in the body.
- *Minerals*  
Minerals are the elements (think periodic table) that are essential for normal physiologic processes in the body.

## Calories (Food Energy)

Food energy is measured in kilocalories (kcal), commonly referred to as calories. Although technically incorrect, this terminology is so familiar that it will be used throughout this course. A kilocalorie is the amount of energy needed to raise 1 kilogram of water 1 degree Celsius. A food's kilocalories are determined by putting the food into a bomb calorimeter and determining the energy output: Energy = Measurement of Heat Produced. Below is a picture of a bomb calorimeter and a link to a video showing how one is used.

<https://www.youtube.com/watch?v=YXo9B2AbH0s>

The number of kilocalories per gram for each nutrient is shown below:

Nutrient	Energy (kcal/g)
Carbohydrate	4
Protein	4
Lipids	9
Water	0
Vitamins	0
Minerals	0

As the table above illustrates, only carbohydrates, protein, and lipids provide energy. However, there is another dietary energy source that is not a nutrient—alcohol. To emphasize, alcohol is *not* a nutrient, but it does provide 7 kilocalories of energy per gram.

Knowing the number of calories in each nutrient allows a person to calculate/estimate the amount of calories contained in any food consumed.

## Carbohydrates

Carbohydrates have become, surprisingly, quite controversial. Some people passionately extol the merits of carbohydrates, while others berate them as nutritional assassins. However, it is important to understand that carbohydrates are a diverse group of compounds that have a multitude of effects on bodily functions. Thus, trying to make blanket statements about carbohydrates is not a good idea.

## My Plate

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On average, a person needs 1500 to 2000 calories per day to sustain (or carry out) daily activities. The total number of calories needed by one person is dependent on their body mass, age, height, gender, activity level, and the amount of exercise per day. If exercise is regular part of one's day, more calories are required. As a rule, people underestimate the number of

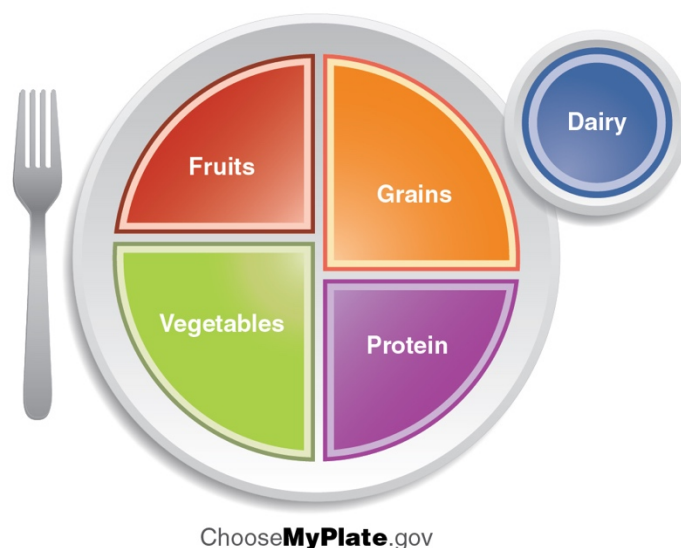
calories ingested and overestimate the amount they burn through exercise. This can lead to ingestion of too many calories per day. The accumulation of an extra 3500 calories adds one pound of weight. If an excess of 200 calories per day is ingested, one extra pound of body weight will be gained every 18 days. At that rate, an extra 20 pounds can be gained over the course of a year. Of course, this increase in calories could be offset by increased exercise. Running or jogging one mile burns almost 100 calories.

The type of food ingested also affects the body's metabolic rate. Processing of carbohydrates requires less energy than processing of proteins. In fact, the breakdown of carbohydrates requires the least amount of energy, whereas the processing of proteins demands the most energy. In general, the amount of calories ingested and the amount of calories burned determines the overall weight. To lose weight, the number of calories burned per day must exceed the number ingested. Calories are in almost everything you ingest, so when considering calorie intake, beverages must also be considered.

To help provide guidelines regarding the types and quantities of food that should be eaten every day, the USDA has updated their food guidelines from MyPyramid to MyPlate. They have put the recommended elements of a healthy meal into the context of a place setting of food. MyPlate categorizes food into the standard six food groups: fruits, vegetables, grains, protein foods, dairy, and oils. The accompanying website gives clear recommendations regarding quantity and type of each food that you should consume each day, as well as identifying which foods belong in each

category. The accompanying graphic (Figure) gives a clear visual with general recommendations for a healthy and balanced meal. The guidelines recommend to “Make half your plate fruits and vegetables.” The other half is grains and protein, with a slightly higher quantity of grains than protein. Dairy products are represented by a drink, but the quantity can be applied to other dairy products as well.

MyPlate



The U.S. Department of Agriculture developed food guidelines called MyPlate to help demonstrate how to maintain a healthy lifestyle.

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## High-Fructose Corn Syrup

Food manufacturers are always searching for cheaper ways to produce their products. One extremely popular method for reducing costs is the use of high-fructose

corn syrup as an alternative to sucrose. High-fructose corn syrup is approximately 50% glucose and 50% fructose, which is the same as sucrose. Nevertheless, because increased consumption of high-fructose corn syrup has coincided with increased obesity in the United States, a lot of controversy surrounds its use.

Alternative sweeteners are simply alternatives to sucrose and other mono- and disaccharides that provide sweetness.

Below are several links that provide additional information about glucose, corn syrup, and sugar.

The New York Times article linked below discusses the growing popularity of sugar compared to high fructose corn syrup:

["Sugar is Back on Food Labels, This Time as a Selling Point"](#)

The website linked below provides a wealth of information about all things sweet, such as corn syrup, sugar substitutes, sugar supplements, and granulated fructose.

### [Corn Syrup](#)

The article linked below explains why the Corn Refiners Association has asked for permission to change the name of high fructose corn syrup to corn sugar and why the US Food and Drug Administration rejected that request:

["No New Name for High Fructose Corn Syrup"](#)

## Protein

Protein is another major macronutrient that, like carbohydrates, consists of small repeating units. But instead of sugars, proteins are made up of amino acids.

Proteins can be classified as either complete or incomplete. Complete proteins provide adequate amounts of all nine essential amino acids. Animal proteins, such as meat, fish, milk, and eggs, are good examples of complete proteins. Incomplete proteins do not contain adequate amounts of one or more of the essential amino acids. For example, if a protein does not provide enough of the essential amino acid leucine it would be considered incomplete. Leucine would be referred to as the **limiting amino acid** because there is not enough of it for the protein to be complete. Most plant foods are incomplete proteins, with a few exceptions, such as soy. The table below shows the limiting amino acids in some plant foods.

*Self Magazine's* Nutrition Data website is a useful resource for determining protein quality and identifying complementary proteins. To use the site, go to [www.nutritiondata.com](http://www.nutritiondata.com), type the name of the food you want information on in the search bar and hit Enter. When you have selected your food from the list of possibilities, you will be given information about this food. Included in this information is the Protein Quality section. This will give you an amino acid score and a figure that illustrates which amino acid(s) is limiting. If your food is an incomplete protein, you can click "Find foods with a complementary profile." This will take you to a list of dietary

choices that will provide complementary proteins for your food.

The chapter linked below is from a book published by the National Academies of Sciences, Engineering, and Medicine and provides an exhaustive examination of the role protein and amino acids play in human health.

[Protein and Amino Acids](#)

## Fat

There is neither bad nor good cholesterol, despite the common use of these descriptions in reference to LDL and HDL, respectively. Cholesterol is cholesterol. HDL and LDL contain cholesterol but are actually lipoproteins that will be described later. It is not necessary to include cholesterol in your diet because our bodies have the ability to synthesize the required amounts. The figure below gives you an idea of the cholesterol content of a variety of foods.

<http://www.webmd.com/cholesterol-management/foods-to-avoid-for-high-cholesterol>

## Fiber

The simplest definition of fiber is indigestible matter. Indigestible means that it survives digestion in the small intestine and reaches the large intestine. There are the three major fiber classifications:

- *Dietary fiber*  
This type of fiber contains both nondigestible carbohydrates and

lignin and is always intrinsic and intact in plants.

- *Functional fiber*  
This type of fiber contains nondigestible carbohydrates only and can be isolated, extracted, or synthesized. Functional fiber can be from plants or animals and produces beneficial physiological effects in humans.
- *Total Fiber*  
Fiber that contains both dietary fiber and functional fiber.

## Vitamins

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**Vitamins** are organic compounds found in foods and are a necessary part of the biochemical reactions in the body. They are involved in a number of processes, including mineral and bone metabolism, and cell and tissue growth, and they act as cofactors for energy metabolism. The B vitamins play the largest role of any vitamins in metabolism ([Table](#) and [Table](#)).

You get most of your vitamins through your diet, although some can be formed from the precursors absorbed during digestion. For example, the body synthesizes vitamin A from the  $\beta$ -carotene in orange vegetables like carrots and sweet potatoes. Vitamins are either fat-soluble or



water-soluble. Fat-soluble vitamins A, D, E, and K, are absorbed through the intestinal tract with lipids in chylomicrons. Vitamin D is also synthesized in the skin through exposure to sunlight. Because they are carried in lipids, fat-soluble vitamins can accumulate in the lipids stored in the body. If excess vitamins are retained in the lipid stores in the body, hypervitaminosis can result.

Water-soluble vitamins, including the eight B vitamins and vitamin C, are absorbed with water in the gastrointestinal tract. These vitamins move easily through bodily fluids, which are water based, so they are not stored in the body. Excess water-soluble vitamins are excreted in the urine. Therefore, hypervitaminosis of water-soluble vitamins rarely occurs, except with an excess of vitamin supplements.

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are stored in the skeleton and necessary for the hardening of bones. Most minerals are ionized, and their ionic forms are used in physiological processes throughout the body. Sodium and chloride ions are electrolytes in the blood and extracellular tissues, and iron ions are critical to the formation of hemoglobin. There are additional trace minerals that are still important to the body's functions, but their required quantities are much lower.

Like vitamins, minerals can be consumed in toxic quantities (although it is rare). A healthy diet includes most of the minerals your body requires, so supplements and processed foods can add potentially toxic levels of minerals. [Table](#) and [Table](#) provide a summary of minerals and their function in the body.

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## Minerals

**Minerals** in food are inorganic compounds that work with other nutrients to ensure the body functions properly. Minerals cannot be made in the body; they come from the diet. The amount of minerals in the body is small—only 4 percent of the total body mass—and most of that consists of the minerals that the body requires in moderate quantities: potassium, sodium, calcium, phosphorus, magnesium, and chloride.

The most common minerals in the body are calcium and phosphorous, both of which



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# Weight Management

By Lisa Jellum

## Objectives:

- Discuss how to manage weight through diet
- Provide steps for starting a weight loss plan
- Reinforce the importance of physical activity in weight management
- Explain how to keep the weight off

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The majority of Americans are unhappy with their current weight. Almost everyone would like to lose at least 5 pounds. A growing percentage of Americans are carrying enough excess weight to put them at risk for many diseases and even death. Few people, however, know enough about their own bodies to successfully manage their weight. Anyone planning to start a weight loss program should begin by carefully considering the following factors:

- How many calories are being consumed daily?
- How many calories are being expended?
- How much fluids are being consumed?
- How well are electrolytes being managed?

## Weight Management Through Diet

Achieving one's ideal weight can be a real challenge. But like most endeavors in life, knowledge is power. The more people know about their diet, the better equipped they will be to manage their weight. Most people

focus on the number of calories consumed. However, it is also important for them to know how many macronutrients are in the foods they eat. The most effective way to do this is performing a 10-day nutritional intake analysis. These analyses are best done on consecutive days to account for the habitual ebb and flow of one's daily food intake.

Remaining healthy during any weight loss program is paramount. Fad diets that promise quick results do not consider the effects of rapid weight loss on the body. Restricting weight loss to 1 to 2 pounds a week is a far healthier approach. Slow weight also prevents the body from burning lean muscle since the body can only burn a certain amount of fat in a week. Dieters who experience steady declines in weight are more likely to keep the weight off. The term "diet" is often synonymous with strict routines that require drastic changes in one's eating habits. In reality, the term "diet" simply describes the intake of food.

To lose weight, dieters need a clear understanding of how weight loss occurs. One pound of fat loss is going to require a reduction in caloric intake of 3,500 calories. When viewed in terms of daily food intake,

to lose a pound a week, a dieter needs to reduce their daily food intake by 500 calories a day:  $3,500 \text{ calories} / 7 \text{ days} = 500 \text{ calories per day}$ . To successfully lose 2 pounds per week, that reduction would have to be doubled to 1,000 calories per day. Attempting to lose 2 pounds or more per week would require a calorie reduction too drastic to be maintained and too restrictive to be healthy. Thus the recommendation of combining diet and exercise is the most effective method for experiencing weight loss. Subtracting 500 calories of food intake and exerting 500 calories in exercise will provide that same 1000 calorie reduction, but in a manner that is far easier to maintain, and certainly more enjoyable.

No matter what your weight loss goal is, even a modest weight loss, such as 5 to 10 percent of your total body weight, is likely to produce health benefits, such as improvements in blood pressure, blood cholesterol, and blood sugars.<sup>1</sup>

## Getting Started with Weight Loss

The Centers for Disease Control and Prevention (CDC) recommends following the step-by-step guide published on its website, on this page: [Healthy Weight: Losing Weight. Getting Started](#). The same information is also reprinted below:

### Step 1: Make a commitment.

Making the decision to lose weight, change your lifestyle, and become healthier is a big step to take. Start simply by making a commitment to yourself. Many people find it helpful to sign a written contract committing to the process. This contract may include things like the amount of

weight you want to lose, the date you would like to lose the weight by, the dietary changes you will make to establish healthy eating habits, and a plan for getting regular physical activity.

Writing down the reasons why you want to lose weight can also help. It might be because you have a family history of heart disease, or because you want to see your kids get married, or simply because you want to feel better in your clothes. Post these reasons where they serve as a daily reminder of why you want to make this change.

### Step 2: Take stock of where you are.

Consider talking to your health care provider. He or she can evaluate your height, weight, and explore other weight-related risk factors you may have. Ask for a follow-up appointment to monitor changes in your weight or any related health conditions.

Keep a "food diary" for a few days, in which you write down everything you eat. By doing this, you become more aware of what you are eating and when you are eating. This awareness can help you avoid mindless eating.

Next, examine your current lifestyle. Identify things that might pose challenges to your weight loss efforts. For example, does your work or travel schedule make it difficult to get enough physical activity? Do you find yourself eating sugary foods because that is what you buy for your kids? Do your coworkers frequently bring high-calorie items, such as doughnuts, to the workplace to share with everyone? Think through things you can do to help overcome these challenges.

Finally, think about aspects of your lifestyle that can help you lose weight. For example, is there an area near your workplace where you and some coworkers can take a walk at lunchtime? Is there a place in your community, such as a YMCA, with exercise facilities for you and child care for your kids?

### **Step 3: Set realistic goals.**

Set some short-term goals and reward your efforts along the way. If your long-term goal is to lose 40 pounds and to control your high blood pressure, some short-term eating and physical activity goals might be to start eating breakfast, taking a 15-minute walk in the evenings, or having a salad or vegetable with supper.

Focus on two or three goals at a time.

Great, effective goals are —

- Specific
- Realistic
- Forgiving (less than perfect)

For example, "Exercise more" is not a specific goal. But if you say, "I will walk 15 minutes, 3 days a week for the first week," you are setting a specific and realistic goal for the first week.

Remember, small changes every day can lead to big results in the long run. Also, remember that realistic goals are achievable goals. By achieving your short-term goals day by day, you will feel good about your progress and be motivated to continue. Setting unrealistic goals, such as losing 20 pounds in 2 weeks, can leave you feeling defeated and frustrated.

Being realistic also means expecting occasional setbacks. Setbacks happen when you get away from your plan for whatever reason—maybe the holidays, longer work

hours, or another life change. When setbacks happen, get back on track as quickly as possible. Also, take some time to think about what you would do differently if a similar situation happens, to prevent setbacks.

Keep in mind everyone is different—what works for someone else might not be right for you. Just because your neighbor lost weight by taking up running, doesn't mean running is the best option for you. Try a variety of activities: walking, swimming, tennis, or group exercise classes, to see what you enjoy most and can fit into your life. These activities will be easier to stick with over the long term.

### **Step 4: Identify resources for information and support.**

Find family members or friends who will support your weight loss efforts. Making lifestyle changes can feel easier when you have others you can talk to and rely on for support. You might have coworkers or neighbors with similar goals, and together you can share healthful recipes and plan group exercise. Joining a weight loss group or visiting a health care professional, such as a registered dietitian, can help.

### **Step 5: Continually "check in" with yourself to monitor your progress.**

Revisit the goals you set for yourself in Step 3, and evaluate your progress regularly. If you set a goal to walk each morning but are having trouble fitting it in before work, see if you can shift your work hours or if you can get your walk in at lunchtime or after work. Evaluate which parts of your plan are working well and which ones need tweaking. Then rewrite your goals and plan accordingly.

If you are consistently achieving a particular goal, add a new goal to help you continue on your pathway to success.

Reward yourself for your successes!

Recognize when you are meeting your goals and be proud of your progress. Use non-food rewards, such as a bouquet of freshly picked flowers, a sports outing with friends, or a relaxing bath. Rewards help keep you motivated on the path to better health.<sup>2</sup>

## The Importance of Physical Activity in Maintaining a Healthy Weight

On its website, the CDC explains the importance of including physical activity as part of any weight loss program. You can find information about the benefits of physical activity, recommended levels of physical activity, and the number of calories burned during common activities by clicking on this link to webpage: [Healthy Weight: Physical Activity for a Health Weight](#). That same information is reprinted below.

### Why is physical activity important?

Regular physical activity is important for good health, and it is especially important if you are trying to lose weight or to maintain a healthy weight.

- When losing weight, more physical activity increases the number of calories your body uses for energy or "burns off." The burning of calories through physical activity, combined with reducing the number

of calories you eat, creates a "calorie deficit" that results in weight loss.

- Most weight loss occurs because of decreased caloric intake. However, evidence shows the only way to maintain weight loss is to be engaged in regular physical activity.
- Most importantly, physical activity reduces risks of cardiovascular disease and diabetes beyond that produced by weight reduction alone.

Physical activity also helps to—

- Maintain weight.
- Reduce high blood pressure.
- Reduce risk for type 2 diabetes, heart attack, stroke, and several forms of cancer.
- Reduce arthritis pain and associated disability.
- Reduce risk for osteoporosis and falls.
- Reduce symptoms of depression and anxiety.

### How much physical activity do I need?

When it comes to weight management, people vary greatly in how much physical activity they need. Here are some guidelines to follow:

**To maintain your weight.** Work your way up to 150 minutes of moderate-intensity aerobic activity, 75 minutes of vigorous-intensity aerobic activity, or an equivalent mix of the two each week. Strong scientific evidence shows that physical activity can help you maintain your weight over time. However, the exact amount of physical activity needed to do this is not clear since it varies greatly from person to person. It is

possible that you may need to do more than the equivalent of 150 minutes of moderate-intensity activity a week to maintain your weight.

**To lose weight and keep it off.** You will need a high amount of physical activity unless you also adjust your diet and reduce the amount of calories you are eating and drinking. Getting to and staying at a healthy weight requires both regular physical activity and a healthy eating plan. What do moderate- and vigorous-intensity mean?

**Moderate:** While performing the physical activity, if your breathing and heart rate is noticeably faster but you can still carry on a conversation, it is probably moderately intense.

Examples include:

- Walking briskly (a 15-minute mile).
- Light yard work (raking/bagging leaves or using a lawn mower).

- Light snow shoveling.
- Actively playing with children.
- Biking at a casual pace.
- 

**Vigorous:** If your heart rate is increased substantially, and you are breathing too hard and fast to have a conversation, it is probably vigorously intense.

Examples include:

- Jogging/running.
- Swimming laps.
- Rollerblading/inline skating at a brisk pace.
- Cross-country skiing.
- Most competitive sports (football, basketball, or soccer).
- Jumping rope.<sup>3</sup>

**The table on the next page provides a list of common physical activities and the average calories expended during those activities.**





<b>Calories Used per Hour in Common Physical Activities</b>		
Moderate Physical Activity	Approximate Calories/30 Min. for a 154 lb. Person <sup>1</sup>	Approximate Calories/Hr. for a 154 lb. Person <sup>1</sup>
Hiking	185	370
Light gardening/yard work	165	330
Dancing	165	330
Golf (walking and carrying clubs)	165	330
Bicycling (<10 mph)	145	290
Walking (3.5 mph)	140	280
Weight lifting (general light workout)	110	220
Stretching	90	180
Vigorous Physical Activity	Approximate Calories/30 Min. for a 154 lb. Person <sup>1</sup>	Approximate Calories/Hr. for a 154 lb. Person <sup>1</sup>
Running/jogging (5 mph)	295	590
Bicycling (>10 mph)	295	590
Swimming (slow freestyle laps)	255	510
Aerobics	240	480
Walking (4.5 mph)	230	460
Heavy yard work (chopping wood)	220	440
Weightlifting (vigorous effort)	220	440
Basketball (vigorous)	220	440

1. Calories burned per hour will be higher for persons who weigh more than 154 lbs. (70 kg) and lower for persons who weigh less.

Source: Adapted from [Dietary Guidelines for Americans 2005, page 16, Table 4.](#)

## Keeping the Weight Off

On its website the CDC admonishes that permanent weight loss is a result of making changes to eating habits that become a long-term part of a healthier lifestyle. You may access that section on their website by clicking [Healthy Weight: Improving Your Eating Habits](#). It is also reprinted below.

## Reflect, Replace, Reinforce: A process for improving your eating habits

- Create a list of your eating habits. Keeping a food diary for a few days, in which you write down everything you eat and the time of day you ate it, will help you uncover your habits. For example, you might discover that you always seek a sweet snack

to get you through the mid-afternoon energy slump. Use this [diary](#) to help. It's good to note how you were feeling when you decided to eat, especially if you were eating when not hungry. Were you tired? Stressed out?

- Highlight the habits on your list that may be leading you to overeat. Common eating habits that can lead to weight gain are:
  - Eating too fast
  - Always cleaning your plate
  - Eating when not hungry
  - Eating while standing up (may lead to eating mindlessly or too quickly)
  - Always eating dessert
  - Skipping meals (or maybe just breakfast)
- Look at the unhealthy eating habits you have highlighted. Be sure you have identified all the triggers that cause you to engage in those habits. Identify a few you would like to work on improving first. Don't forget to pat yourself on the back for the things you are doing right. Maybe you almost always eat fruit for dessert, or you drink low-fat or fat-free milk. These are good habits! Recognizing your successes will help encourage you to make more changes.
- Create a list of "cues" by reviewing your food diary to become more aware of when and where you are "triggered" to eat for reasons other than hunger. Note how you are typically feeling at those times. Often an environmental "cue," or a particular emotional state, is what

encourages eating for non-hunger reasons.

- Common triggers for eating when not hungry are:
  - Opening up the cabinet and seeing your favorite snack food.
  - Sitting at home watching television.
  - Before or after a stressful meeting or situation at work.
  - Coming home after work and having no idea what's for dinner.
  - Having someone offer you a dish they made "just for you!"
  - Walking past a candy dish on the counter.
  - Sitting in the break room beside the vending machine.
  - Seeing a plate of doughnuts at the morning staff meeting.
  - Swinging through your favorite drive-through every morning.
  - Feeling bored or tired and thinking food might offer a pick-me-up.

Circle the "cues" on your list that you face on a daily or weekly basis. Going home for the Thanksgiving holiday may be a trigger for you to overeat, and eventually, you want to have a plan for as many eating cues as you can. But for now, focus on the ones you face more often.

Ask yourself these questions for each "cue" you have circled:

Is there anything I can do to avoid the cue or situation? This option works best for cues that don't involve others. For example, could you choose a different route to work to avoid stopping at a fast food restaurant on the way? Is there another place in the break room where you can sit so you are not next to the vending machine?

For things I cannot avoid, can I do something differently that would be healthier? Obviously, you cannot avoid all situations that trigger your unhealthy eating habits, like staff meetings at work. In these situations, evaluate your options. Could you suggest or bring healthier snacks or beverages? Could you offer to take notes to distract your attention? Could you sit farther away from the food so it won't be as easy to grab something? Could you plan ahead and eat a healthy snack before the meeting?

Replace unhealthy habits with new, healthy ones. For example, in reflecting upon your eating habits, you may realize that you eat too fast when you eat alone. So, make a commitment to share a lunch each week with a colleague, or have a neighbor over for dinner one night a week. Other strategies might include putting your fork down between bites or minimizing other distractions (i.e., watching the news during dinner) that might keep you from paying attention to how quickly—and how much—you are eating.

Here are more ideas to help you replace unhealthy habits:

Eat more slowly. If you eat too quickly, you may "clean your plate" instead of paying attention to whether your hunger is satisfied.

Eat only when you are truly hungry instead of when you are tired, anxious, or feeling an emotion besides hunger. If you find yourself eating when you are experiencing an emotion besides hunger, such as boredom or anxiety, try to find a non-eating activity

to do instead. You may find a quick walk or phone call with a friend helps you feel better.

Plan meals ahead of time to ensure that you eat a healthy well-balanced meal. Reinforce your new, healthy habits and be patient with yourself. Habits take time to develop. It doesn't happen overnight. When you do find yourself engaging in an unhealthy habit, stop as quickly as possible and ask yourself: Why do I do this? When did I start doing this? What changes do I need to make?

Be careful not to berate yourself or think that one mistake "blows" a whole day's worth of healthy habits. You can do it! It just takes one day at a time!<sup>4</sup>

## References:

1. Need CDC source for benefits of losing 5 to 10 percent of body weight.
2. CDC's step by step guide.  
[https://www.cdc.gov/healthyweight/losing\\_weight/getting\\_started.html](https://www.cdc.gov/healthyweight/losing_weight/getting_started.html). Format according to APA style guide.
3. CDC's page on physical activity. Format according to APA style guide.
4. CDC's page on improving your eating habits. Format according to APA style guide.
- 5.

# Stress

## Objectives:

- Define stress
  - Describe the effects of stress on wellbeing
  - Identify effective strategies for managing stress
  - Assess your own levels of stress
- 

In today's fast-paced society, most people complain about being stressed. However, when they use the term *stress*, they rarely know its true meaning. The word carries many negative connotations and is associated with an unpleasant or traumatic event. As such, people mistakenly believe that stress is simply the nervousness and tension experienced prior to, during, or after a negative event. In fact, the effects of stress are physiological, emotional, *and* psychological.

Additionally, not all levels of stress are detrimental. The stress athletes experience right before a big game or college students feel right before an exam can enhance focus and increase their ability to concentrate. Stress is either good or bad depending on how long it persists and how it is perceived by the individual.

This chapter will provide a deeper understanding of what stress is and provide effective strategies for managing stress.



*Anxiety. By Edvard Munch. 1894.*

## What Is Stress and How Does It Affect Wellness?

Stress is defined as the body's physical, mental, and emotional response to a particular stimulus, called a **stressor**. This adaption/coping-response helps the body prepare for challenging situations. It is the level of a person's response to a stressor that determines whether the experience is positive or negative. As a hardworking college student, you may feel as if you know the meaning of stress all too well. You may dream of a future where the demands on your time are diminished, so you can escape the high levels of stress you are feeling now. Unfortunately, regardless of

their situation, everyone experiences stress on a regular basis. The good news is, not all stress is bad! Small levels of stress can enhance cognitive brain function. Stress may provide the motivation and concentration you need to write an essay, practice a speech, or prepare for a job interview. For most people, these types of stressors are manageable and not harmful. Stressors that have the potential for harm include the sudden loss of a loved one, the unexpected ending of a romantic relationship, or the unfair demands of an unreasonable boss.

## Defining Stress

Stress, then, is more than simply the tension and apprehension generated by problems, obstacles, or traumatic events. Stress is the body's automatic response ([physical](#), mental, and [emotional](#)) to any stressor. It is a natural and unavoidable part of life, and it can be empowering and motivating, or harmful and potentially dangerous.

For more information on stress click on the links below:

[What is Stress?](#)

[Understanding and Dealing with Stress](#)

Below is a video on stress.

[What is stress and what causes it?](#)

## Effects of Stress on Wellness

As stated previously, not all stress is bad. In fact, the stress associated with riding a roller coaster, watching a scary movie, or scaling a cliff can enhance these experiences. Regardless of whether the stress experienced is negative or positive, the effects on the body are identical. When a person senses that a situation demands action, the body responds by releasing chemicals into the blood. The hypothalamus signals the adrenal glands to release a surge of hormones that include adrenaline and cortisol. The physiological effects of those chemicals—enhanced focus, quicker reaction time, and increased heart rate, energy, and strength—are quite beneficial when faced with a potentially dangerous situation that is temporary.

Unfortunately, most of the stressors people face—work, school, finances, relationships—are a part of everyday life, and thus, inescapable. Experiencing ongoing, unavoidable stress can result in some very unpleasant and harmful effects, both mental and physical. Chronic stress can cause upset stomach, headaches, sleep problems, and heart disease. It can also cause depression, anxiety, and even memory loss.

To watch a video that describes the effects of stress in detail, click on the link below:

[How Stress Affects Your Body and Mind](#)

## What Are the Strategies for Managing Stress?

Although stress in everyday life is unavoidable, there are ways to cope with it that will minimize or eliminate its harmful effects.

The Anxiety and Depression Association of America (ADAA) provides a list of effective strategies for coping with stress. That document is linked here: [Tips: Coping Strategies](#). For your convenience, it is also reprinted below with the ADAA's permission.

When you are feeling anxious or stressed, these strategies will help you cope:

- **Take a time-out.** Practice yoga, listen to music, meditate, get a massage, or learn relaxation techniques. Stepping back from the problem helps clear your head.
  - **Eat well-balanced meals.** Do not skip any meals. Do keep healthful, energy-boosting snacks on hand.
  - **Limit alcohol and caffeine,** which can aggravate anxiety and trigger panic attacks.
  - **Get enough sleep.** When stressed, your body needs additional sleep and rest.
  - **Exercise daily** to help you feel good and maintain your health. Check out the [fitness tips](#) below.
  - **Take deep breaths.** Inhale and exhale slowly.
  - **Count to 10 slowly.** Repeat, and count to 20 if necessary.
  - **Do your best.** Instead of aiming for perfection, which isn't possible, be proud of however close you get.
- **Accept that you cannot control everything.** Put your stress in perspective: Is it really as bad as you think?
  - **Welcome humor.** A good laugh goes a long way.
  - **Maintain a positive attitude.** Make an effort to replace negative thoughts with positive ones.
  - **Get involved.** Volunteer or find another way to be active in your community, which creates a support network and gives you a break from everyday stress.
  - **Learn what triggers your anxiety.** Is it work, family, school, or something else you can identify? Write in a journal when you're feeling stressed or anxious and look for a pattern.
  - **Talk to someone.** Tell friends and family you're feeling overwhelmed, and let them know how they can help you. Talk to a physician or therapist for professional help.
  - **Get help online.** [Lantern](#) offers online programs guided by professional coaches to help you turn healthy anxiety management into a habit. *(Sponsored)*
    - [Listen to podcasts on a wide range of topics](#)
    - [Watch recorded webinars on topics ranging from how to worry less, coping with panic attacks, treatments for children, and helping suicidal families, and many more.](#)

### Fitness Tips: Stay Healthy, Manage Stress

To receive the greatest benefits from exercising, try to include at least 2½ hours

of moderate-intensity physical activity (e.g., brisk walking) each week, 1¼ hours of a vigorous-intensity activity (such as jogging or swimming laps), or a combination of the two.

- **5 X 30:** Jog, walk, bike, or dance three to five times a week for 30 minutes.
- **Set small daily goals** and aim for daily consistency rather than perfect workouts. It is better to walk every day for 15–20 minutes than to wait until the weekend for a three-hour fitness marathon. Lots of scientific data suggests that frequency is most important.
- **Find forms of exercise** that are fun or enjoyable. Extroverted people often like classes and group activities. People who are more introverted often prefer solo pursuits.
- **Distract yourself** with an iPod or other portable media player to download audiobooks, podcasts, or music. Many people find it is more fun to exercise while listening to material they enjoy.
- **Recruit** an “exercise buddy.” It is often easier to stick to your exercise routine when you have to stay committed to a friend, partner, or colleague.
- **Be patient** when you start a new exercise program. Most sedentary people require about four to eight weeks to feel coordinated and sufficiently in shape so that exercise feels easier.

Additional strategies for coping with stress are linked below:

[The Single Most Important Thing You Can Do for Stress](#)

[Stress Management](#)

[10 Tips to Manage Stress](#)

Below is a link to a video on stress:

[How to Reduce Stress and Anxiety](#)

To hear the world’s most relaxing sound (according to research), click on the link below:

[World's Most Relaxing Sound](#)

## Assess Your Stress Level

Are you more or less stressed than your peers? The website linked below contains a stress test. On the website, scroll down to the “Quiz: Are You Stressed?”

[How Stressed Are You?](#)

Below is a link to the Lab for this chapter on stress. Please be certain to get a PDF of your results and submit it in D2L:

[Lab for Chapter on Stress](#)



## **Terminology Checklist:**

**Stress-** the body's physical, mental, and emotional response to a particular stimulus

**Stressor-** Something that causes stress

**Eustress-** Good Stress

**Distress-** Bad stress

**Adrenalin-** a hormone secreted by the adrenal glands, especially in conditions of stress, increasing rates of blood circulation and breathing

## Test Your Knowledge

1. The stage of stress where the stressor can cause death or health problems
  - a. Alarm
  - b. Resistance
  - c. Exhaustion
  - d. Relapse
2. Which of the following does not occur when the body first encounters stress
  - a. Heart rate increase
  - b. Breathing increase
  - c. Increased sweating
  - d. Faster digestion
3. What hormone is most likely to be released when stress is encountered
  - a. Testosterone
  - b. Adrenaline
  - c. Estrogen
  - d. Leptin
4. The immune system becomes stronger when a stress is first encounters
  - a. True
  - b. False
5. Stress can cause all of the following except
  - a. Headaches
  - b. Insomnia
  - c. Muscle cramps
  - d. Upset stomach
6. Stress can lead to some mental concerns
  - a. True
  - b. False

Answers: 1.C, 2.D, 3.B, 4.A, 5.C, 6.A

# Cardiovascular Disease

By Lisa Jellum

## Objectives:

- Define cardiovascular disease
- Identify the types of cardiovascular disease
- Identify risk factors that predispose for heart disease and stroke
- Assess personal risk of Cardiovascular Disease

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## What Is Cardiovascular Disease?

Cardiovascular disease (CVD) generally refers to conditions that involve narrowed or blocked blood vessels. The term is often used interchangeably with heart disease. However, heart disease is just one type of cardiovascular disease. Other types of CVD include stroke, high blood pressure, angina (chest pain), and rheumatic heart disease. This chapter will focus on heart disease and strokes.

### Heart Disease

Heart disease is a disorder of the blood vessels that can lead to heart failure. This disorder can be congenital and/or the result of lifestyle. Most people associate heart disease with heart attacks. A heart attack, also known as a **myocardial infarction**, happens when an artery becomes blocked, preventing oxygen and nutrients from getting to the heart. When a person is experiencing a heart attack, they will have crushing chest pains, profound shortness of

breath, left arm pain, radiating jaw pain or middle back pain. These signs and

symptoms indicate that a person should seek immediate medical assistance.

Click on the link below for more information about how to recognize and respond to a heart attack victim:

- [Recognizing and Responding to a Heart Attack](#)

Other types of heart disease include:

- Coronary artery disease: damage or disease in the heart's major blood vessels
- High blood pressure: A condition in which the force of the blood against the artery walls is too high.
- Cardiac Arrest: Sudden, unexpected loss of heart function, breathing, and consciousness.
- Congestive heart failure: A chronic condition in which the heart does not pump blood as well as it should.
- Arrhythmia: Improper beating of the heart, whether irregular, too fast, or too slow.
- Peripheral artery disease: A circulatory condition in which

narrowed blood vessels reduce blood flow to the limbs.

- Congenital heart disease: An abnormality in the heart that develops before birth.

Many people believe incorrectly that heart disease can be cured with surgery and medication. This is a myth. Heart disease is a lifelong condition. Although procedures, such as bypass surgery, can increase blood flow to the heart, the arteries remain damaged. Additionally, this condition will steadily worsen without major lifestyle changes.

## Combating America's Number 1 Killer

Heart disease remains the leading cause of death in America, and in most other countries worldwide. However, the death toll from this disease has been declining steadily for decades, falling 60% since its peak in the mid 1960s. In addition, the death rate from stroke, the third most common cause of death, has declined by about 75 percent since the early 1960s (NIH, 2017). The death rates from these diseases have fallen as awareness about the devastating effects of smoking, high cholesterol, high blood pressure, and obesity has increased. Researchers believe that heart disease in America will continue to decline if more people begin to eat healthier diets, exercise more, and stop smoking.

Click on the link below to watch a video about the study in the 1960s that first revealed the root causes of heart disease:

- [The Hidden Epidemic: Heart Disease in America](#)

## Stroke

Strokes are the fifth leading cause of death and a leading cause of disability in the United States. This type of CVD affects the arteries leading to the brain and blood vessels within the brain. A stroke occurs when a blood vessel that carries oxygen and nutrients to the brain is either blocked by a clot or ruptures. When that happens, part of the brain cannot get the blood and oxygen it needs and as a result, brain cells begin to die.

A stroke that occurs as the result of a blockage is called an **ischemic stroke**. A **hemorrhagic stroke** is the result of a rupture and accounts for only 20% of all strokes.

**The Cincinnati Stroke Scale provides early warning signs of a stroke:**

- **F = Face:** Is one side of the face drooping down?
- **A = Arm:** Can the person raise both arms, or is one arm weak?
- **S = Speech:** Is speech slurred or confusing?
- **T = Time:** If the conditions listed above are present call 9-1-1 immediately! Time is critical!

## What Causes CVD?

The 4 conditions listed below, all of which are beyond a person's control, can be linked to cardiovascular disease:

- *Age*  
There is a strong correlation between CVD and age. As a person ages, the risk for CVD increases also. Although, with males, the risk seems to be when they are younger and females seem to be at higher risk post-menopausal.
- *Sex*  
Males have a higher risk for CVD, especially at younger ages. Women experience higher risk later in their lives. Click on the link below to learn more about The Heart Truth Program, a program focused on raising awareness about women's risk for heart disease and ways for reducing that risk:

[The Heart Truth Program](#)

- *Race*  
African Americans have the highest risk factor for CVD.
- *Family History/ Race*  
A person's genes can be one of the strongest predictors of CVD, but also has the smallest correlation to CVD overall.

The 4 conditions listed below are also linked to cardiovascular disease but *are* within a person's power to change:

- *Tobacco use*  
The strongest predictor of CVD is the use of tobacco. The use of tobacco accounts for 30% of CVD risk. There is a significant reduction in risk for those who do not use tobacco.
- *Obesity*

Those that have a BMI greater than 30 have a higher than normal risk than those that do not have a BMI greater than 30. "The "obesity epidemic" experienced by the United States over the past several decades threatens to reverse important progress against heart disease.

- *Diet*  
CVD can be correlated to high intake of saturated fat and cholesterol. Risk of dietary cholesterol intake can be correlated to atherosclerosis.
- *Diabetes*  
This condition is viewed as seriously as any of the other factors, such as smoking, high blood pressure, and high blood cholesterol, that a person can control. In fact, those with Type II diabetes have the same level of risk for a heart attack as those who have already had a heart attack.

## Personal Risk Assessment

### What Is Your Number?

The following screening tests are used to assess a person's risk for developing CVD

- *Lipoprotein Profile*  
**What:** A blood test that measures total cholesterol, LDL "bad" cholesterol, HDL "good" cholesterol, and triglycerides (another form of fat in the blood). The test is given after a 9- to 12-hour fast.

**Why:** To find out if you have any of the following: high blood cholesterol (high total and LDL cholesterol), low HDL cholesterol, or high triglyceride levels. All affect your risk for heart disease.

**When:** All healthy adults should have a lipoprotein profile done at least once every 5 years. Depending on the results, your doctor may want to repeat the test more frequently.

- *Blood Pressure*

**What:** A simple, painless test using an inflatable arm cuff.

**Why:** To find out if you have high blood pressure (also called hypertension) or prehypertension. Both are risk factors for heart disease.

**When:** At least every 2 years, or more often if you have high blood pressure or prehypertension.

- *Fasting Plasma Glucose*

**What:** The preferred test for diagnosing diabetes. After you have fasted overnight, you will be given a blood test the following morning.

**Why:** To find out if you have diabetes or are likely to develop the disease. Fasting plasma glucose levels of 126 mg/dL or higher in two tests on different days mean that you have diabetes. Levels between 100 and 125 mg/dL mean that you have an increased risk of developing diabetes and may have prediabetes. Diabetes is an important risk factor for heart disease and other medical disorders.

**When:** At least every 3 years, beginning at age 45. If you have risk factors for diabetes, you should be

tested at a younger age and more often.

## Online Risk Calculator

If you know your cholesterol levels and your blood pressure, you can use one of the calculators linked below to assess your risk of developing cardiovascular disease:

[American College of Cardiology Risk Calculator](#)

[Framingham Heart Study Risk Calculator](#)



# Cancer Development

By Althea K. Moser

## Objectives:

- Define cancer and how cancer arises
  - Describe different types of cancer
  - Identify cancer risks and methods for cancer prevention
  - Assess personal cancer risk
- 

## What Is Cancer?

Cancer is the name given to a collection of related diseases in which the body's cells begin to divide without stopping and spread into surrounding tissues.

Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally, human cells grow and divide to form new cells as the body needs them. When cells grow old or become damaged, they die, and new cells take their place.

When cancer develops, however, this orderly process breaks down. As cells become more and more abnormal, old or damaged cells survive when they should die, and new cells form when they are not needed. These extra cells can divide without stopping and may form growths called **tumors**.

Many cancers form solid tumors, which are masses of tissue. Cancers of the blood, such as leukemias, generally do not form solid tumors.

Cancerous tumors are **malignant**, which means they can spread into, or invade,

nearby tissues. In addition, as these tumors grow, some cancer cells can break off and travel to distant places in the body through the blood or the lymph system and form new tumors far from the original tumor.

Unlike malignant tumors, **benign tumors** do not invade nearby tissues. However, some benign tumors can be quite large. When removed, they usually do not grow back, whereas malignant tumors sometimes do. Unlike most benign tumors elsewhere in the body, benign tumors in the brain can be life threatening.

## How Cancer Arises

Cancer is a genetic disease—that is, it is caused by changes to genes that control the way our cells function, especially how they grow and divide.

Genetic changes that cause cancer can be inherited. They can also be the result of errors that occur as cells divide or environmental exposures that cause damage to **DNA**, the molecules inside cells that carry genetic information and pass it on from one generation to the next. Cancer-causing environmental exposures include



substances, such as the chemicals in tobacco smoke; and radiation, such as ultraviolet rays from the sun.

Each person's cancer has a unique combination of genetic changes. As the cancer continues to grow, additional changes will occur. Even within the same tumor, different cells may have different genetic changes.

In general, cancer cells have more genetic changes, such as mutations in DNA, than normal cells. Some of these changes may be the result of the cancer, rather than its cause.

## Cancer Statistics

Cancer severely impacts Americans and societies throughout the world. Cancer statistics describe what happens in large groups of people and provide a picture in time of the burden of cancer on society. Statistics indicate how many people are diagnosed with and die from cancer each year, the number of people who are currently living after a cancer diagnosis, and the average age at diagnosis. They also reveal differences among groups defined by age, sex, racial/ethnic group, geographic location, and other categories.

Although statistical trends are usually not directly applicable to individual patients, they are essential for governments, policymakers, health professionals, and researchers to understand the impact of cancer on the population and to develop strategies to address the challenges that cancer poses to society. Statistical trends are also important for measuring the

success of efforts to control and manage cancer.

## Statistics at a Glance: The Burden of Cancer in the United States

- In 2016, an estimated 1,685,210 new cases of cancer will be diagnosed in the United States, and 595,690 people will die from the disease.
- The most common cancers in 2016 are projected to be breast cancer, lung and bronchus cancer, prostate cancer, colon and rectum cancer, bladder cancer, melanoma of the skin, non-Hodgkin lymphoma, thyroid cancer, kidney and renal pelvis cancer, leukemia, endometrial cancer, and pancreatic cancer.
- The number of new cases of cancer (**cancer incidence**) is 454.8 per 100,000 men and women per year (based on 2008–2012 cases).
- The number of cancer deaths (**cancer mortality**) is 171.2 per 100,000 men and women per year (based on 2008–2012 deaths).
- Cancer mortality is higher among men than women (207.9 per 100,000 men and 145.4 per 100,000 women). It is highest in African American men (261.5 per 100,000) and lowest in Asian/Pacific Islander women (91.2 per 100,000) per year (based on 2008–2012 deaths).

- The number of people living beyond a cancer diagnosis reached nearly 14.5 million in 2014 and is expected to rise to almost 19 million by 2024.
- Approximately 39.6 percent of men and women will be diagnosed with cancer during their lifetimes (based on 2010-2012 data).
- In 2014, an estimated 15,780 children and adolescents, aged from 0 to 19, were diagnosed with cancer and 1,960 died of the disease.
- National expenditures for cancer care in the United States totaled nearly \$125 billion in 2010 and could reach \$156 billion in 2020.

The following video explores cancer incidence and mortality through 2020:

[Incidence and Mortality 2020](#)

## Types of Cancer

There are more than 100 types of cancer. Types of cancer are usually named for the organs or tissues where the cancers form. For example, lung cancer starts in cells of the lung and brain cancer starts in cells of the brain. Cancers may also be described by the type of cell that formed them, such as an epithelial cell or a squamous cell.

Some types of cancer are:

### Breast Cancer

The breast is made up of glands called **lobules** that can make milk and thin tubes

called ducts that carry the milk from the lobules to the nipple. Breast tissue also contains fat and connective tissue, lymph nodes, and blood vessels.

The most common type of breast cancer is ductal carcinoma, which begins in the cells of the ducts. Breast cancer can also begin in the cells of the lobules and in other tissues in the breast. Ductal carcinoma in situ is a condition in which abnormal cells are found in the lining of the ducts but have not spread outside the duct. Breast cancer that has spread from where it began in the ducts or lobules to surrounding tissue is called **invasive breast cancer**. In inflammatory breast cancer, the breast looks red and swollen and feels warm because the cancer cells block the lymph vessels in the skin.

In the United States, breast cancer is the second most common cancer in women after skin cancer. It can occur in both men and women, but it is rare in men. Each year there are about 100 times more new cases of breast cancer in women than in men.

Some screening tests for breast cancer include:

- *Clinical breast exams and regular breast self-exams*  
Routine examinations of the breasts by health care providers or by women themselves have not been shown to reduce deaths from breast cancer. However, if a woman or her health care provider notices a lump or other unusual change in the breast, it is important for her to get it checked out.

The following link explains how to perform a Breast Self-Exam:

### [Breast Self-Exam \(BSE\)](#)

- *Mammography*  
This screening method for breast cancer has been shown to reduce mortality from the disease among women aged from 40 to 74, especially those aged 50 or older.
- *Breast MRI*  
This imaging test is often used for women who carry a harmful mutation in the *BRCA1* gene or the *BRCA2* gene; such women have a high risk of developing breast cancer, as well as increased risk for other cancers.

## Cervical Cancer

The cervix is the lower, narrow end of the **uterus**, the organ where a fetus grows. The cervix leads from the uterus to the vagina, also known as the **birth canal**.

The main types of cervical cancer are squamous cell carcinoma and adenocarcinoma. Squamous cell carcinoma begins in the thin, flat cells that line the cervix. Adenocarcinoma begins in cervical cells that make mucus and other fluids.

Long-lasting infections with certain types of human papillomavirus (HPV) cause almost all cases of cervical cancer. Vaccines that protect against infection with these types of HPV can greatly reduce the risk of cervical cancer.

Screening tests:

- *Pap test and human papillomavirus (HPV) testing*

Having a Pap test to check for abnormal cells in the cervix, or a test to check for HPV, can find cells that may become cervical cancer. These cells can be treated before cancer forms. Testing is generally recommended to begin at age 21 and to end at age 65, as long as recent results have been normal.

Cervical cancer can usually be cured if it is found and treated in the early stages.

## Colorectal Cancer

Colorectal cancer is cancer that starts in the colon or rectum. The colon and the rectum are parts of the large intestine, which is the lower part of the body's digestive system. During digestion, food moves through the stomach and small intestine into the colon. The colon absorbs water and nutrients from the food and stores waste matter called **stool**. Stool moves from the colon into the rectum before it leaves the body.

Most colorectal cancers are **adenocarcinomas**, cancers that begin in cells that make and release mucus and other fluids. Colorectal cancer often begins as an abnormal colon growth called a **polyp**, which may form on the inner wall of the colon or rectum. Some polyps may develop into cancer over time. Finding and removing polyps can prevent colorectal cancer.

Colorectal cancer is the third most common type of cancer in men and women in the United States.

Screening tests:

- *Colonoscopy, sigmoidoscopy, and high-sensitivity fecal occult blood tests (FOBTs)*

Deaths from colorectal cancer have decreased with the use of colonoscopies and fecal occult blood tests, which check for blood in the stool. Colonoscopy and sigmoidoscopy also help prevent colorectal cancer because they can detect polyps that can be removed before they develop into cancer. Expert groups generally recommend that people who are at average risk for colorectal cancer have screening beginning at age 50 through age 75.

## Lung Cancer

Most lung cancer diagnoses are either non-small cell lung cancer or small cell lung cancer, depending on the way the cells look under a microscope. Non-small cell lung cancer is much more common than small cell lung cancer.

Most cases of lung cancer are caused by smoking. Lung cancer is the leading cause of death from cancer in the United States.

For most patients with lung cancer, current treatments do not cure the cancer.

Screening test:

- *Low-dose helical computed tomography*

This test, which is used to screen for lung cancer, has been shown to reduce lung cancer deaths among heavy smokers aged from 55 to 74.

## Prostate Cancer

The prostate gland makes fluid that forms part of semen. The prostate lies just below the bladder in front of the rectum. It surrounds the **urethra**, the tube that carries urine and semen through the penis and out of the body.

Prostate cancer is the most common cancer in men in the United States, after skin cancer, and the second leading cause of death. Prostate cancer occurs more often in African-American men than in white men. African-American men with prostate cancer are more likely to die from the disease than white men with prostate cancer.

Almost all prostate cancers are adenocarcinomas, cancers that begin in cells that make and release mucus and other fluids. Prostate cancer often has no early symptoms. Advanced prostate cancer can cause men to urinate more often or have a weaker flow of urine, but these symptoms can also be caused by benign prostate conditions.

Prostate cancer usually grows very slowly. Most men with prostate cancer are older than 65 years and do not die from the disease. Finding and treating prostate cancer before symptoms occur may not improve a patient's health or help him live longer. Men are advised to consult their doctor about their risk of prostate cancer and whether they need screening tests.

Screening test:

- *PSA test*

This blood test, which is often done along with a digital rectal exam, is

able to detect prostate cancer at an early stage. However, expert groups no longer recommend routine PSA testing for most men because studies have shown that it has little or no effect on prostate cancer deaths and leads to overdiagnosis and overtreatment.

## Skin Cancer

Skin cancer is the most common type of cancer. It usually forms in skin that has been exposed to sunlight but can occur anywhere on the body.

Skin consists of several layers. Skin cancer begins in the **epidermis**, or outer layer, which is made up of squamous cells, basal cells, and melanocytes.

There are several different types of skin cancer. Squamous cell and basal cell skin cancers are sometimes called nonmelanoma skin cancers.

Nonmelanoma skin cancer usually responds to treatment and rarely spreads to other parts of the body.

Melanoma is more aggressive than most other types of skin cancer. Unless melanoma is diagnosed early, it is likely to invade nearby tissues and spread to other parts of the body. The number of cases of melanoma increases each year. Only 2 percent of all skin cancers are melanoma, but it causes the most deaths from skin cancer.

Screening test:

- *Skin exams*  
Doctors often recommend that people who are at risk for skin cancer examine their skin regularly or have a health care provider do so. Such exams have not been shown to decrease the risk of dying from skin cancer, and they may lead to overtreatment. However, people should be aware of changes in their skin, such as a new mole or a change to an existing mole, and report these to their doctor promptly.

## Testicular Cancer

The testicles are two glands inside the **scrotum**, a sac of loose skin below the penis. The testicles make sperm and the hormone testosterone.

Testicular cancer is the most common cancer in men aged from 15 to 34 years. The two main types of testicular tumors are seminoma and nonseminoma. Nonseminomas tend to grow and spread more quickly than seminomas.

The most common sign of testicular cancer is a lump or swelling in the testicle. Most testicular cancers can be cured, even if they are diagnosed at an advanced stage.

Treatment for testicular cancer can cause infertility by decreasing the amount of sperm made by the body. Men who want to have children may want to use sperm banking to store sperm before they begin treatment.

Screening test:

- *There is no standard or routine screening test for testicular cancer.* Most often, testicular cancer is first found by men themselves, either by chance or during self-exam. Sometimes the cancer is found by a doctor during a routine physical exam.

The following video explains how to perform a testicular self-exam:

### [Testicular Self-Exam](#)

## Leukemia

Leukemia is cancer of the blood cells. Most blood cells form in the bone marrow. In leukemia, immature blood cells become cancer. These cells do not work the way they should and crowd out the healthy blood cells in the bone marrow.

Different types of leukemia depend on the type of blood cell that becomes cancer. For example, lymphoblastic leukemia is a cancer of the **lymphoblasts**, white blood cells that fight infection. White blood cells are the most common type of blood cell to become cancer. But **red blood cells**, cells that carry oxygen from the lungs to the rest of the body, and **platelets**, cells that clot the blood, may also become cancerous.

Leukemia occurs most often in adults older than 55 years, but it is also the most common cancer in children younger than 15 years.

Leukemia can be either acute or chronic. Acute leukemia is a fast-growing cancer that usually gets worse quickly. Chronic leukemia is a slower-growing cancer that

gets worse slowly over time. The treatment and prognosis for leukemia depend on the type of blood cell affected and whether the leukemia is acute or chronic.

## Lymphoma

Lymphoma is cancer that begins in cells of the lymph system. The lymph system is part of the immune system, which helps the body fight infection and disease. Because lymph tissue is found all through the body, lymphoma can begin almost anywhere.

The two main types of lymphoma are Hodgkin lymphoma and non-Hodgkin lymphoma (NHL). These can occur in both children and adults. The treatment and probability of a cure depend on the stage and the type of lymphoma.

## Risk Factors for Cancer

It is usually impossible to know why one person develops cancer and another does not. But research has shown that certain risk factors may increase a person's chances of developing cancer. There are also factors—called protective risk factors, or just protective factors—that are linked to a lower risk of cancer.

Cancer risk factors include exposure to chemicals or other substances, as well as certain behaviors. They also include circumstances that people cannot control, like age and family history. A family history of certain cancers can be a sign of a possible inherited cancer syndrome.

Most cancer risks, as well as protective factors, are initially identified in epidemiology studies. In these studies, scientists look at large groups of people and compare those who develop cancer with those who do not. These studies may show that those who develop cancer are more or less likely to behave in certain ways, or to be exposed to certain substances, than those who do not develop cancer.

On their own, such studies cannot prove that a behavior or substance causes cancer. For example, the finding could be a result of chance, or the true risk factor could be something other than the suspected risk factor. But findings of this type sometimes get attention in the media, and this can lead to false beliefs about how cancer starts and spreads.

When many studies all point to a similar association between a potential risk factor and an increased risk of cancer, and when a possible mechanism exists that could explain how the risk factor could actually cause cancer, scientists can be more confident about the relationship between the two.

Although some risk factors can be avoided, others—such as growing older—cannot. Limiting exposure to avoidable risk factors may lower a person’s risk of developing certain cancers.

Some of the most studied risk factors for cancer are listed below.

## **Age**

Advancing age is the most important risk factor for cancer overall, and for many specific types of cancer. According to the

most recent statistical data from the National Cancer Institute’s Surveillance, Epidemiology, and End Results program, the median age of a cancer diagnosis is 66 years. This means that half of cancer cases occur in people below this age and half in people above this age. One-quarter of new cancer cases are diagnosed in people aged from 65 to 74.

But the disease can occur at any age. For example, bone cancer is most frequently diagnosed among people under age 20, with more than one-fourth of cases occurring in this age group. And 10 percent of leukemias are diagnosed in children and adolescents under 20 years of age, whereas only 1 percent of cancer overall is diagnosed in that age group.

## **Alcohol**

Drinking alcohol can increase a person’s risk of cancer of the mouth, throat, esophagus, larynx (voice box), liver, and breast. The more a person consumes alcohol, the higher his or her risk. The risk of cancer is much higher for those who drink alcohol and also use tobacco.

Doctors advise people who drink to do so in moderate amounts. The federal government’s Dietary Guidelines for Americans defines moderate alcohol drinking as up to one drink per day for women and up to two drinks per day for men.

It has been suggested that certain substances in red wine, such as resveratrol, have anticancer properties. However, no

evidence exists that drinking red wine reduces the risk of cancer.

## **Cancer-Causing Substances in the Environment**

Cancer is caused by changes to certain genes that alter the way our cells function. Some of these genetic changes occur naturally when DNA is replicated during the process of cell division. But others are the result of environmental exposures that damage DNA. These exposures may include substances known as **carcinogens**, any substance that causes cancer, such as the chemicals in tobacco smoke; and radiation, such as ultraviolet rays from the sun.

People can avoid some cancer-causing exposures, such as tobacco smoke and the sun's rays. But others are harder to avoid, especially if they are found in the air, water, and food, or the materials people use to do their jobs. Scientists are studying which exposures may cause or contribute to the development of cancer. Understanding which exposures are harmful, and where they are found, may help people avoid them.

Simply because a substance has been designated as a carcinogen, however, that does not mean that the substance will necessarily cause cancer. Many factors influence whether a person exposed to a carcinogen will develop cancer, including the amount and duration of the exposure and the individual's genetic background.

## **Diet**

Many studies have looked at the possibility that specific dietary components or **nutrients** are associated with increases or decreases in cancer risk. Studies of cancer cells in the laboratory and of animal models have sometimes provided evidence that isolated compounds may be carcinogenic, or have anticancer activity.

But with few exceptions, studies of human populations have not yet shown definitively that any dietary component causes or protects against cancer. Sometimes the results of **epidemiologic** studies, which compare the diets of people with and without cancer have indicated that people with and without cancer differ in their intake of a particular dietary component.

However, these results show only that the dietary component is associated with a change in cancer risk, not that the dietary component is responsible for, or causes, the change in risk. For example, participants with and without cancer could differ in other ways besides their diet, and it is possible that some other difference accounts for the variance in cancer risk.

## **Hormones**

Estrogens, a group of female sex hormones, are known human carcinogens. Although these hormones have essential physiological roles in both females and males, they have also been associated with an increased risk of certain cancers. For instance, taking combined menopausal hormone therapy (estrogen plus progestin, which is a synthetic version of the female hormone progesterone) can increase a woman's risk of breast cancer. Menopausal hormone therapy with estrogen alone



increases the risk of endometrial cancer and is used only in women who have had a hysterectomy.

A woman who is considering menopausal hormone therapy should discuss the possible risks and benefits with her doctor.

Studies have also shown that a woman's risk of breast cancer is related to the estrogen and progesterone made by her ovaries, known as endogenous estrogen and progesterone. Being exposed for a long time and/or to high levels of these hormones has been linked to an increased risk of breast cancer. Increases in exposure can be caused by starting menstruation early, going through menopause late, being older at first pregnancy, and never having given birth. Conversely, having given birth is a protective factor for breast cancer.

## Obesity

People who are obese may have an increased risk of several types of cancer, including cancers of the breast (in women who have been through menopause), colon, rectum, esophagus, kidney, pancreas, gallbladder, and the lining of the uterus, called the **endometrium**.

Conversely, eating a healthy diet, being physically active, and maintaining a healthy weight may reduce the risk of some cancers. These healthy behaviors also lessen the risk of other illnesses, such as heart disease, type II diabetes, and high blood pressure.

## Sunlight

The sun, sunlamps, and tanning booths all give off ultraviolet (UV) radiation. Exposure to UV radiation causes early aging of the skin and skin damage that can lead to skin cancer.

People of all ages should limit the amount of time they spend in the sun, especially between mid-morning and late afternoon, and avoid other sources of UV radiation, such as tanning beds. It is important to keep in mind that UV radiation is reflected by sand, water, snow, and ice and can go through windshields and windows.

The best way to lessen UV damage when spending time in the sun is to wear long sleeves, long pants, a hat with a wide brim, and sunglasses with lenses that absorb UV radiation. Sunscreen with a sun protection factor (SPF) of at least 15 may help prevent skin cancer but does not work as well as staying out of the sun and wearing protective clothing.

## Tobacco

Tobacco use is a leading cause of cancer and of death from cancer. People who use tobacco products, or are regularly exposed to environmental tobacco smoke (called **secondhand smoke**), have an increased risk of cancer because tobacco products and secondhand smoke have many chemicals that damage DNA.

Tobacco use causes many types of cancer, including cancer of the lung, larynx, mouth, esophagus, throat, bladder, kidney, liver, stomach, pancreas, colon and rectum, and

cervix, as well as acute myeloid leukemia. People who use smokeless tobacco, such as snuff or chewing tobacco, have increased risks of cancers of the mouth, esophagus, and pancreas.

No level of tobacco use is safe. People who use any type of tobacco product are strongly urged to quit. People who quit smoking, regardless of their age, have substantial gains in life expectancy compared with those who continue to smoke. Also, quitting smoking at the time of a cancer diagnosis reduces the risk of death.

## Cancer Prevention Overview

Cancer prevention is action taken to lower the chance of getting cancer. In addition to the physical problems and emotional distress caused by cancer, the high costs of care are also a burden to patients, their families, and to the public. Preventative measures can lower the number of new cases and cancer deaths, and reduce the burden of cancer on society.

Scientists are studying ways to prevent cancer, including the following:

- avoiding or controlling factors known to cause cancer
- improving diet and adopting a healthier lifestyle
- finding precancerous conditions early
- incorporating chemoprevention: the use of medicines that treat precancerous conditions or prevent cancer from starting

## Cancer Treatment

Patients and their doctors must choose from a plethora of cancer treatments. The types of treatment a patient receives depend on the type of cancer a person has and how advanced it is. Some people with cancer will have only one treatment. But most people have a combination of treatments, such as surgery with chemotherapy and/or radiation therapy. They may also undergo immunotherapy, targeted therapy, or hormone therapy.

Clinical trials are also an option for some patients. Clinical trials are research studies that involve people. Understanding what they are and how they work can help patients decide if taking part in a trial is a good option.

When seeking treatment for cancer, patients have a lot to learn and consider. It is normal for them to feel overwhelmed and confused. Talking with their doctor and learning all they can about their treatment options, including clinical trials, can help them make a decision they feel good about.

## Assessing Your Personal Risk of Cancer

Complete the following Lab to assess your personal risk of cancer, and submit it per your instructor's directions:

[Assess Your Risk of Cancer](#)

## Terminology Checklist:

**Cancer:** The name given to a collection of related diseases in which the body's cells begin to divide without stopping and spread into surrounding tissues.

**Malignant:** Cancerous tumors that can spread into or invade nearby tissues.

**Benign:** Tumors that do not invade nearby tissues.

**Carcinogens:** Any substance that causes cancer, such as the chemicals in tobacco smoke; and radiation, such as ultraviolet rays from the sun.

**Breast cancer:** Cancer that starts in the cells and/or tissues of the breast. It can occur in both men and women.

**Cervical cancer:** Cancer that starts in the cells of the cervix. Long-lasting infections with certain types of human papillomavirus (HPV) cause almost all cases of cervical cancer.

**Colorectal cancer:** Cancer that starts in the colon or rectum.

**Lung cancer:** Most lung cancer diagnoses are either non-small cell lung cancer or small cell lung cancer, depending on the way the cells look under a microscope. Most cases of lung cancer are caused by smoking.

**Prostate cancer:** Almost all prostate cancers are adenocarcinomas, cancers that begin in cells that make and release mucus and other fluids.

**Skin cancer:** Skin cancer is the most common type of cancer. It usually forms in skin that has been exposed to sunlight but can occur anywhere on the body.

**Testicular cancer:** Testicular cancer is the most common cancer in men aged from 15 to 34 years.

## Test Your Knowledge:

1. Benign tumors in the breast can be life threatening. T F
2. The population who statistically have the highest deaths from cancer are:
  - a) Caucasian women
  - b) African-American men
  - c) Pacific Islander women
  - d) Caucasian men
3. Cancer of the lung, larynx (voice box), mouth, esophagus, throat, pancreas, as well as acute myeloid leukemia are often the result of:
  - a) alcohol abuse
  - b) exposure to UV radiation
  - c) tobacco use
  - d) hormonal imbalances
4. Leukemia is cancer of the \_\_\_\_\_.
5. A \_\_\_\_\_ can check for abnormal cells in the cervix.

**Answers:** 1. F, 2. B, 3. C, 4. Blood cells, 5. Pap Test

### Source:

The website of the National Cancer Institute (<https://www.cancer.gov>)

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# Substance Use and Abuse

By Althea K. Moser

## Objectives:

- Address addiction and risk factors for addiction
  - Define types of drugs, possible health effects, and treatment options
  - Explore the abuse of alcohol, nicotine, e-cigarettes, and prescription drugs and their role in addiction
  - Assess personal risk for substance use and abuse
- 

## Drug Abuse and Addiction

### What is drug addiction?

Addiction is defined as a chronic, relapsing brain disease that is characterized by compulsive drug seeking and use, despite harmful consequences. It is considered a brain disease because drugs change the brain by changing its structure and how it works. These brain changes can be long-lasting and can lead to the harmful behaviors seen in people who abuse drugs.

Addiction is a lot like other diseases, such as heart disease. Both disrupt the normal, healthy functioning of the underlying organ, have serious harmful consequences, and are preventable and treatable, but if left untreated, can last a lifetime.

### Why do people use drugs?

In general, people begin taking drugs for a variety of reasons:

- *To feel good*

Most abused drugs produce intense feelings of pleasure. This initial sensation of euphoria is followed by other effects, which differ depending on the type of drug used. For example, with stimulants such as cocaine, the “high” is followed by feelings of power, self-confidence, and increased energy. In contrast, the euphoria caused by opiates, such as heroin, is followed by feelings of relaxation and satisfaction.

- *To feel better*  
Some people who suffer from social anxiety, stress-related disorders, and depression begin abusing drugs in an attempt to lessen feelings of distress. Stress can play a major role in initial drug use, continuing drug abuse, or relapse in patients recovering from addiction.
- *To do better*  
Some people feel pressure to chemically enhance or improve their cognitive or athletic performance, which can play a role in initial experimentation and continued

abuse of drugs, such as prescription stimulants or anabolic/androgenic steroids.

- *To satisfy their curiosity and "because others are doing it"*  
In this respect, adolescents are particularly vulnerable because of the strong influence of peer pressure. Teens are more likely than adults to engage in risky or daring behaviors to impress their friends and express their independence from parental and social rules.

### **If taking drugs makes people feel good or better, what's the problem?**

When they first use a drug, people may perceive what seem to be positive effects. They may also believe that they can control their use. However, drugs can quickly take over a person's life. Over time, if drug use continues, other pleasurable activities become less pleasurable and taking the drug becomes necessary for the user just to feel *normal*. They may then compulsively seek and take drugs even though doing so causes tremendous problems for themselves and their loved ones. Some people may start to feel the need to take higher or more frequent doses, even in the early stages of their drug use. These are the telltale signs of an addiction.

Even relatively moderate drug use poses dangers. Consider how a social drinker can become intoxicated, get behind the wheel of a car, and quickly turn a pleasurable activity into a tragedy that affects many lives.

### **Is continued drug abuse a voluntary behavior?**

The initial decision to take drugs is typically voluntary. However, with continued use, a person's ability to exert self-control can become seriously impaired; this impairment in self-control is the hallmark of addiction. Brain imaging studies of people with addiction show physical changes in areas of the brain that are critical to judgment, decision making, learning and memory, and behavior control. Scientists believe that these changes alter the way the brain works and may help explain the compulsive and destructive behaviors of addiction.

### **Why do some people become addicted to drugs while others do not?**

As with any other disease, vulnerability to addiction differs from person to person, and no single factor determines whether a person will become addicted to drugs. In general, the more **risk factors** a person has, the greater the chance that taking drugs will lead to abuse and addiction. **Protective factors**, on the other hand, reduce a person's risk of developing addiction. Risk and protective factors may be either environmental, such as conditions at home, at school, and in the neighborhood, or biological, for instance, a person's genes, his or her stage of development, and even a person's gender or ethnicity.

Risk and Protective Factors for Drug Abuse and Addiction	
Risk Factors	Protective Factors
Aggressive behavior in childhood	Good self-control
Lack of parental supervision	Parental monitoring and support
Poor social skills	Positive relationships
Drug experimentation	Academic competence
Availability of drugs at school	School anti-drug policies
Community poverty	Neighborhood pride

### What environmental factors increase the risk of addiction?

- Home and family*  
The influence of the home environment, especially during childhood, is a very important factor. Children with parents or older family members who abuse alcohol or drugs or engage in criminal behavior, have an increased risk of developing their own drug problems.
- Peers and school*  
Friends and acquaintances can have an increasingly strong influence during adolescence. Drug-using

peers can sway even those without risk factors to try drugs for the first time. Academic failure or poor social skills can put a child at further risk for using or becoming addicted to drugs.

### What biological factors increase risk of addiction?

- Genetics*  
Scientists estimate that genetic factors account for between 40 and 60 percent of a person’s vulnerability to addiction. This includes the effects of environmental factors on the function and expression of a person’s genes. A person’s stage of development and other medical conditions a person may have are also factors. Adolescents and people with mental disorders are at greater risk of drug abuse and addiction than the general population.
- Dramatic changes in brain development that occur during adolescence*  
One of the brain areas still maturing during adolescence is the prefrontal cortex—the part of the brain that enables us to assess situations, make sound decisions, and keep our emotions and desires under control. The fact that this critical part of the adolescent brain is a work in progress puts teenagers at increased risk for making poor decisions, such as trying drugs or continuing to take them. Also, introducing drugs during this period of development may cause brain changes that have

profound and long-lasting consequences.

### What other factors increase the risk of addiction?

- *Early use*  
Although taking drugs at any age can lead to addiction, research shows that the earlier a person begins to use drugs, the more likely he or she is to develop serious problems. This increased risk may reflect the harmful effects that drugs can have on the developing brain. It may result from a mix of early social and biological vulnerability factors, including unstable family relationships, exposure to physical or sexual abuse, genetic susceptibility, or mental illness. Still, the fact remains that early use is a strong indicator of problems ahead, including addiction.
- *Method of administration*  
Smoking a drug or injecting it into a vein increases its addictive potential. Both smoked and injected drugs enter the brain within seconds, producing a powerful rush of pleasure. However, this intense “high” can fade within a few minutes, taking the abuser down to lower, more normal levels. Scientists believe this starkly felt contrast drives some people to repeated drug usage in an attempt to recapture the fleeting pleasurable state.<sup>1</sup>

## Types of Drugs, Possible Health Effects, and Treatment Options

Click on the link below and review the information on commonly abused drugs. Make sure to explore the material, including possible health effects and treatment options when applicable, for the following substances:

- Alcohol
- GHB
- Inhalants
- Marijuana
- Methamphetamine
- Cocaine
- Heroin
- LSD
- MDMA/Molly
- Tobacco

- [Commonly Abused Drugs](#)

## Alcohol, Nicotine, e-cigarettes, and Prescription Drugs

Click on the following links to learn more about alcohol and alcohol abuse:

- [Alcohol Abuse FAQs](#)
- [College Drinking](#)

Click on the following link for information about nicotine addiction:

- [Nicotine Addiction](#)



Watch the video linked below to learn about the consequences of teens using e-cigarettes:

- [Teens and E-cigarettes](#)

Watch the video linked below to learn more about prescription drug abuse in teens:

- [Prescription Drug Abuse in Teens](#)

## Assessing Your Personal Risk Factors for Substance Use and Abuse:

Complete **one** of the following Labs to assess your personal risk factors for substance use and abuse. Choose the Lab most relevant for you. Submit the Lab per your Instructor's directions.

If you drink alcohol complete the following Lab:

1. [Alcohol Use Lab](#)

If you smoke cigarettes, complete the following Lab:

2. [Cigarette Use Lab](#)

## Terminology Checklist:

**Addiction:** Addiction is defined as a chronic, relapsing brain disease that is characterized

by compulsive drug seeking and use, despite harmful consequences.

**Cocaine:** A powerfully addictive stimulant drug made from the leaves of the coca plant native to South America.

**GHB:** A depressant approved for use in the treatment of narcolepsy, a disorder that causes daytime "sleep attacks."

**Heroin:** An opioid drug made from morphine, a natural substance extracted from the seed pod of various opium poppy plants.

**Inhalants:** Solvents, aerosols, and gases found in household products such as spray paints, markers, glues, and cleaning fluids; also nitrites (e.g., amyl nitrite), which are prescription medications for chest pain

**LSD:** A hallucinogen manufactured from lysergic acid, which is found in ergot, a fungus that grows on rye and other grains.

**Marijuana:** Marijuana is made from the hemp plant, *Cannabis sativa*. The main psychoactive (mind-altering) chemical in marijuana is delta-9-tetrahydrocannabinol, or THC.

**MDMA (Ecstasy / Molly):** A synthetic, psychoactive drug that has similarities to both the stimulant amphetamine and the hallucinogen mescaline.

**Methamphetamine:** An extremely addictive stimulant amphetamine drug.<sup>2</sup>

## Test Your Knowledge:

1. Scientists estimate that genetic factors account for between 25-50 percent of a person's vulnerability to addiction. T F
2. A standard drink of beer in the US measures 12 ounces T F
3. Loss of smell is a long-term possible health effect of using:
  - a) GHB
  - b) Heroin
  - c) LSD
  - d) Cocaine
4. List three symptoms that people may experience when withdrawing from tobacco and nicotine.
5. List three factors that may influence how a person reacts to alcohol.

**Answers:** 1. F, 2. T, 3. D

4. Any three of the following choices:
  - Anxiety
  - Irritability
  - Headache
  - Hunger
  - Cravings for cigarettes and other sources of nicotine
5. Any three of the following choices:
  - Age
  - Sex.
  - Race or ethnicity.
  - Physical condition (e.g. weight, fitness level).
  - Amount of food consumed before drinking.
  - How quickly the alcohol was consumed.
  - Use of drugs or prescription medicines.
  - Family history of alcohol problems

**Source:**

National Institute on Drug Abuse  
National Institutes of Health  
U.S. Department of Health and Human Services

(<https://www.drugabuse.gov/publications/drugs-brains-behavior-science-addiction/preface>)

(<https://www.drugabuse.gov/drugs-abuse/commonly-abused-drugs-charts>)

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# Sexually Transmitted Diseases/Infections (STDs/STIs)

By Althea K. Moser

## Objectives:

- Define STDs, explain how they are transmitted, and identify the most common STDs/STIs
  - Identify the incidence, prevalence, and cost of STIs in the United States
  - Learn prevention techniques and treatment options
  - Develop a personal plan for STI prevention
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## What are STDs?

The following information about STDs is published by the Office of Disease Prevention and Health Promotion on the website Healthy People.gov., and is found on the page "[Sexually Transmitted Diseases](#)":

STDs refer to more than 25 infectious organisms that are transmitted primarily through sexual activity. STD prevention is an essential primary care strategy for improving reproductive health.<sup>1</sup> Despite their burdens, costs, and complications, and the fact that they are largely preventable, STDs remain a significant public health problem in the United States. This problem is largely unrecognized by the public, policymakers, and health care professionals. STDs cause many harmful, often irreversible, and costly clinical complications, such as:

- Reproductive health problems
- Fetal and perinatal health problems
- Cancer

- Facilitation of the sexual transmission of HIV infection<sup>2</sup>

## How are STDs Transmitted?

Ejaculation does not have to occur for an STD/STI to be passed from person to person. Sharing contaminated needles used to inject drugs or using contaminated body piercing and tattooing equipment also can transmit some infections, such as HIV or hepatitis B and C.

Anyone who has had or is having sexual intercourse or oral sex, or who has participated or is participating in sex play, is at risk for acquiring an STD/STI

Fortunately, it is possible for a person to decrease his or her risk by having protected sex and knowing his or her STD/STI status and that of his or her partner.

Still, the Centers for Disease Control and Prevention (CDC) estimates nearly 20 million new cases of these reportable STDs/STIs (gonorrhea, chlamydia, syphilis) occur each year in the United States—

almost half of them among young people 15 to 24 years of age.<sup>1</sup>

While not the most common STD/STI, HIV/AIDS is one of the most devastating and most well known. Recent data from the CDC indicate that 1.1 million Americans have HIV<sup>2</sup>:

- One in five is unaware that they have the virus.
- Approximately 50,000 Americans become infected with HIV each year.
- 15,529 people with AIDS died in 2010.

Click on the following link to learn more about reported STDs in the United States:

[CDC Fact Sheet](#)

## What are the Most Common Types of STIs?

The following information about the most common STIs is published by the US Department of Health and Human Services and found on the NIH's website on the page "[What are some types of sexually transmitted diseases or sexually transmitted infections \(STDs/STIs\)?](#)":

Approximately 20 different infections are known to be transmitted through sexual contact. Here are descriptions of some of the most common and well known:

### Chlamydia

Chlamydia<sup>1</sup> (pronounced *kla-MID-ee-uh*) is a common STD/STI caused by the bacterium *Chlamydia trachomatis*. Chlamydia can be

transmitted during vaginal, oral, or anal sexual contact with an infected partner. While many individuals will not experience symptoms, chlamydia can cause fever, abdominal pain, and unusual discharge of the penis or vagina.

In women, whether or not they are having symptoms and know about their infection, chlamydia can cause pelvic inflammatory disease (PID). In PID, the untreated STD/STI progresses and involves other parts of the woman's reproductive system, including the uterus and fallopian tubes. This progression can lead to permanent damage to the woman's reproductive organs. This damage may lead to ectopic pregnancy (in which the fetus develops in abnormal places outside of the womb, a condition that can be life-threatening) and infertility.

Additionally, if the woman is pregnant, her developing fetus is at risk, because chlamydia can be passed on during her pregnancy or delivery and could lead to eye infections or pneumonia in the infant. If chlamydia is detected early, it can be treated easily with an antibiotic taken by mouth.

### Gonorrhea

Gonorrhea<sup>2</sup> (pronounced *gon-uh-REE-uh*) is caused by the bacterium *Neisseria gonorrhoeae*, which can grow rapidly and multiply easily in the warm, moist areas of the reproductive tract. The most common symptoms of gonorrheal infection are a discharge from the vagina or penis and painful or difficult urination.

As with chlamydial infection, the most common and serious complications of gonorrhea occur in women and include

pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and the potential spread to the developing fetus if acquired during pregnancy. Gonorrhea also can infect the mouth, throat, eyes, and rectum and can spread to the blood and joints, where it can become a life-threatening illness.

In addition, people with gonorrhea can more easily contract HIV, the virus that causes AIDS. HIV-infected people with gonorrhea are also more likely to transmit the virus to someone else.<sup>3</sup>

### **Genital Herpes**

Genital herpes<sup>4</sup> is a contagious infection caused by the herpes simplex virus (HSV). There are two different strains, or types, of HSV: herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2). Both can cause genital herpes, although most cases of genital herpes are caused by HSV-2.<sup>5</sup> When symptomatic, HSV-1 usually appears as fever blisters or cold sores on the lips, but it can also infect the genital region through oral-genital or genital-genital contact. Symptomatic HSV-2 typically causes painful, watery skin blisters on or around the genitals or anus. However, substantial numbers of people who carry these viruses have no or only minimal signs or symptoms. Neither HSV-1 nor HSV-2 can be cured, and even during times when an infected person has no symptoms, the virus can be found in the body's nerve cells. Periodically, some people will experience outbreaks in which new blisters form on the skin in the genital area; at those times, the virus is more likely to be passed on to other people. Pregnant women, especially those who acquire genital herpes for the first time

during pregnancy, may pass the infection to their newborns, causing life-threatening neonatal HSV, an infection affecting the infant's skin, brain, and other organs.<sup>6</sup>

### **HIV/AIDS**

HIV, or the human immunodeficiency virus,<sup>7</sup> is the virus that causes AIDS (acquired immunodeficiency syndrome). HIV destroys the body's immune system by killing the blood cells that fight infection. Once HIV destroys a substantial proportion of these cells, the body's ability to fight off and recover from infections is compromised. This advanced stage of HIV infection is known as AIDS.

People whose HIV has progressed to AIDS are very susceptible to opportunistic infections that do not normally make people sick and to certain forms of cancer. AIDS can be prevented by early initiation of antiretroviral therapy in those with HIV infection. Transmission of the virus primarily occurs during unprotected sexual activity and by sharing needles used to inject intravenous drugs, although the virus also can spread from mother to infant during pregnancy, delivery, and breastfeeding.

In 2013, NIH-supported researchers reported that a 2-year-old child who was born with HIV and was treated starting in the first few days of life has had her HIV infection go into remission. This appears to be the first case of functional cure of HIV.

### **Human Papillomavirus (HPV)**

HPV<sup>8</sup> is the most common STD/STI. More than 40 HPV types exist, and all of them can infect both men and women. The types of HPVs vary in their ability to cause genital warts; infect other regions of the body, including the mouth and throat; and cause cancers of the cervix, vulva, penis, and mouth.

Although no cure exists for HPV infection once it occurs, regular screening with a Pap smear test can prevent or detect at an early stage most cases of HPV-caused cervical cancer. (A Pap smear test involves a health care provider taking samples of cells from the cervix during a standard gynecologic exam; these cells are examined under a microscope for signs of developing cancer). A newly available vaccine protects against most (but not all) HPV types that cause cervical cancer. The American Academy of Pediatrics recommends this vaccine for school-aged boys and girls.<sup>9</sup>

## Syphilis

Syphilis<sup>10</sup> infections, caused by the bacterium *Treponema pallidum*, are passed from person to person during vaginal, anal, or oral sex through direct contact with sores, called chancres. Between 2001 and 2009, the Centers for Disease Control and Prevention (CDC) data show that the syphilis rate increased each year. Those people at highest risk for syphilis include men having sex with both men and women and people residing in the south.<sup>10</sup> The first sign of syphilis is a chancre, a painless genital sore that most often appears on the penis or in and around the vagina. Beyond being the first sign of a syphilis infection, chancres make a person two to five times more likely to contract an HIV infection. If

the person is already infected with HIV, chancres also increase the likelihood that the virus will be passed on to a sexual partner.<sup>3</sup> These sores typically resolve on their own, even without treatment. However, the body does not clear the infection on its own, and, over time, syphilis may involve other organs, including the skin, heart, blood vessels, liver, bones, and joints in secondary syphilis. If the illness is still not treated, tertiary syphilis can develop over a period of years and involve the nerves, eyes, and brain and can potentially cause death.

Expectant mothers harboring the bacterium are at an increased risk of miscarriage and stillbirth, and they can pass the infection on to their fetuses during pregnancy and delivery. Infants that acquire congenital syphilis during pregnancy may suffer from skeletal deformity, difficulty with speech and motor development, seizure, anemia, liver disease, and neurologic problems.

## Bacterial Vaginosis

Bacterial vaginosis<sup>11</sup> is a common, possibly sexually transmitted, vaginal infection in women of reproductive age. While it is healthy and normal for a vagina to have bacteria, just like the skin, mouth, or gastrointestinal (GI) tract, sometimes changes in the balance of different types of bacteria can cause problems.

Bacterial vaginosis occurs when problematic bacteria that are normally present only in small amounts increase in number, replace normal vaginal lactobacilli bacteria, and upset the usual balance. This situation becomes more likely if a woman douches frequently or has new or multiple sexual

partners. The most common sign of a bacterial vaginosis infection is a thin, milky discharge that is often described as having a "fishy" odor. However, some women will have no symptoms at all.

Regardless of symptoms, having bacterial vaginosis increases the risk of getting other STDs/STIs and is also associated with pelvic inflammatory disease (PID), an infection of the female reproductive organs, including the uterus and the fallopian tubes (which carry eggs to the uterus), and postoperative infections. Preterm labor and birth are also possibly more common in women with bacterial vaginosis.

### Trichomoniasis

Trichomoniasis<sup>12</sup> (pronounced *trik-uh-muh-NAHY-uh-sis*) infection is caused by the single-celled protozoan parasite *Trichomonas vaginalis* and is common in young, sexually active women. The parasite also infects men, though less frequently. The parasite can be transmitted between men and women as well as between women whenever physical contact occurs between the genital areas. Although *Trichomonas* infections do not always cause symptoms, they can cause frequent, painful, or burning urination in men and women as well as vaginal discharge, genital soreness, redness, or itching in women. Because the infection can occur without symptoms, a person may be unaware that he or she is infected and continue to re-infect a sexual partner who is having recurrent signs of infection. As with bacterial STDs/STIs, all sexual partners should be treated at the same time to avoid re-infection.

NICHHD-sponsored research has shown that during pregnancy, *Trichomonas* infection is associated with an increased risk of premature birth and infants with low birth weight. Moreover, infants born to mothers with *Trichomonas* infection are more than twice as likely as infants born to uninfected women to be stillborn or to die as newborns.<sup>13</sup>

### Viral Hepatitis

Viral hepatitis is a serious liver disease that can be caused by several different viruses, which can be transmitted through sexual contact.

- Hepatitis A virus (HAV) causes a short-term or self-limited liver infection that can be quite serious, although it does not result in chronic infection. While there are other ways the virus can be transmitted, HAV can be spread from person to person during sexual activity through oral-rectal contact. Vaccination can prevent HAV infection.<sup>13</sup>
- Hepatitis B virus (HBV) causes a serious liver disease that can result in both immediate illness and lifelong infection leading to permanent liver scarring (cirrhosis), cancer, liver failure, and death. HBV spreads through both heterosexual and homosexual contact as well as through contact with other bodily fluids, such as blood, through shared contaminated needles used for injecting intravenous (IV) drugs, tattooing, and piercing. Pregnant women with HBV can transmit the



virus to their infants during delivery. HBV infection is preventable through vaccination.<sup>1</sup>

- Hepatitis C virus (HCV) can cause an immediate illness affecting the liver, but it more commonly becomes a silent, chronic infection that leads to liver scarring (cirrhosis), cancer, liver failure, and death. HCV is most commonly transmitted through sharing needles or exposure to infected blood. However, it can spread through sexual contact or from mother to fetus during pregnancy and delivery. There is no vaccine for HCV, and treatments are not always effective.<sup>15</sup> [2]

## What is the Incidence, Prevalence, and Cost of STIs?

Click on the following link to learn more about the incidence, prevalence, and cost of STIs in the United States:

[The Prevalence, Incidence, and Cost of STIs in the US](#)

## Prevention Techniques for STIs/STDs

Click on the following link to learn how to prevent STIs:

[How You Can Prevent STDs](#)

## STI Treatment Options:

The following information about the most common STIs is published by the US Department of Health and Human Services and found on the NIH's website on the page "[What are the treatments for sexually transmitted diseases and sexually transmitted infections \(STDs/STIs\)?](#)":

STDs/STIs caused by bacteria, yeast, or parasites can be treated with antibiotics. These antibiotics are most often given by mouth (orally). However, sometimes they are injected or applied directly to the affected area. Whatever the infection, and regardless of how quickly the symptoms resolve after beginning treatment, the infected person must take all of the medicine prescribed by the health care provider to ensure that the STD/STI is completely treated.

Although treatments, complications, and outcomes vary among viral STDs/STIs depending on the particular virus (HIV, genital herpes, human papillomavirus, hepatitis, or cytomegalovirus), health care providers can provide treatments to reduce the symptoms and the progression of most of these illnesses. For example, medications are available to limit the frequency and severity of genital herpes outbreaks while reducing the risk that the virus will be passed on to other people.

Individuals with HIV need to take special antiretroviral drugs that control the amount of virus they carry. These drugs, called *highly active antiretroviral therapy*, or HAART,<sup>1</sup> can help people live longer,

healthier lives. If a woman with HIV becomes pregnant, these medicines also can reduce the chance that her fetus or infant will get the infection. Being tested and treated for STDs/STIs is especially important for pregnant women because some STDs/STIs may be passed on to their infants during pregnancy or delivery. Testing women for these STDs/STIs early in their pregnancy is important, so that steps can be taken to help ensure delivery of a healthy infant. The necessary treatment will depend on the type of STD/STI involved.

## Developing a Personal Plan for STI Prevention

Complete the following lab to develop a personal plan for STI prevention. Submit the Lab per your Instructor's directions.

[Plan for Change: Preventing STIs](#)

## Helpful Resources

[GHC's Student Support Services](#)

[How to Get Tested](#)  
[Georgia Department of Public Health](#)

[Lesbian and Bisexual Health](#)

## Terminology Checklist:

**STDs:** More than 25 infectious organisms that are transmitted primarily through sexual activity.<sup>1</sup>

**Chlamydia:** Chlamydia<sup>1</sup> (pronounced *kla-MID-ee-uh*) is a common STD/STI caused by the bacterium *Chlamydia trachomatis*.

**Gonorrhea:** Gonorrhea<sup>2</sup> (pronounced *gon-uh-REE-uh*) is caused by the bacterium *Neisseria gonorrhoeae*, which can grow rapidly and multiply easily in the warm, moist areas of the reproductive tract.

**Genital Herpes:** Genital herpes<sup>4</sup> is a contagious infection caused by the herpes simplex virus (HSV). There are two different strains, or types, of HSV: herpes simplex virus type 1 (HSV-1) and type 2 (HSV-2). Both can cause genital herpes, although most cases of genital herpes are caused by HSV-2.<sup>5</sup>

**HIV & AIDS:** HIV, or the human immunodeficiency virus,<sup>7</sup> is the virus that causes AIDS (acquired immunodeficiency syndrome). The advanced stage of HIV infection is known as AIDS.

**Human Papillomavirus (HPV):** HPV<sup>8</sup> is the most common STD/STI. More than 40 HPV types exist, and all of them can infect both men and women.

**Syphilis:** Syphilis<sup>10</sup> infections, caused by the bacterium *Treponema pallidum*, are passed from person to person during vaginal, anal, or oral sex through direct contact with sores, called chancres.

**Bacterial vaginosis:** Bacterial vaginosis<sup>11</sup> is a common, possibly sexually transmitted, vaginal infection in women of reproductive age.

**Trichomoniasis:** Trichomoniasis<sup>12</sup> (pronounced *trik-uh-muh-NAHY-uh-sis*) infection is caused by the single-celled protozoan parasite *Trichomonas vaginalis* and is common in young, sexually active women.

## Test Your Knowledge:

1. AIDS is always the end result for people with HIV. T F
2. There will always be symptoms present if a person has an STD. T F
3. \_\_\_\_\_ can develop over a period of years and involve the nerves, eyes, and brain and can potentially cause death.
  - a) Tertiary syphilis
  - b) HIV
  - c) Human Papillomavirus (HPV)
  - d) Hepatitis C virus (HCV)
4. List 3 clinical complications of STDs.
5. List 3 ways that you can prevent STDs.

**Answers:** 1. F, 2. F, 3. A

4. Any 3 from the chapter including:
  - Reproductive health problems
  - Fetal and perinatal health problems
  - Cancer
  - Facilitation of the sexual transmission of HIV infection
5. Any 3 from the chapter including:
  - Abstinence
  - Vaccination
  - Reduce Number of Sex Partners
  - Mutual Monogamy
  - Use Condoms

## References by Section:

### Sexually Transmitted Diseases

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### How many people are affected by or at risk for a sexually transmitted disease or sexually transmitted infection (STD/STI)?

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### What are the Most Common Types of STIs?

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## **STI Treatment Options**

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