# Instructor's Guide to Accompany *Foundation in Kinesiology and Biomechanics*

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# Introduction to the Text

*Foundation in Kinesiology and Biomechanics* and its associated learning materials provide students with a comprehensive study of human body movement. The text views movement as it truly occurs—in functional patterns with synergic involvement of the trunk and joints, rarely in isolation. Rather than focusing on rote memorization of muscle attachments (these are included at the end of each section for reference), the materials concentrate on how muscles work in various positions and what factors influence movement and function. The materials allow the students to achieve a solid conceptual foundation in the study of movement, thus providing them with the background needed for the study of movement impairments and rehabilitation. The focus of this book and its associated materials is to provide the learner with a solid understanding of human kinesiology at a level that provides enough information for students to grasp the concepts of how the deficits in human movement that can occur either from injury or disease lead to limitations and dysfunctions in movement.

## Overview of Textbook Features

The first four chapters of the text discuss general concepts related to kinesiology that can apply to various parts of the body. The subsequent chapters focus on various body segments and joints and begin with an overview of the anatomy of the area with an emphasis on structures that can influence the movement of a joint when injured or diseased, producing pain and dysfunction. An important concept emphasized throughout the text is the fact that joints rarely move in isolation. For example, the ankles, knees, hips, spine, and even the arms and head all play a role in standing up in a safe and efficient manner. The chapters following the anatomy section focus on the specific kinesiology concepts associated with that body part and the important factors to consider in order to achieve efficient movement.

Each chapter contains *Clinical Connections* segments, which discuss various injuries or conditions that can influence expected joint movement, often producing pain and dysfunction. The chapters end with a case study describing a person who has experienced injury to the body segment studied in the chapter. The student is prompted to think beyond the kinesiology concepts learned in the chapter and to speculate on how involvement of the structures may affect movement. The chapters include discussion questions to be used to stimulate thinking beyond the textual information. Such discussions can show students the necessity of understanding how joints function before learning about how injury or disease can cause malfunction. Unless they understand healthy movement, students won't be able to apply treatment interventions to regain optimal movement and function. This is the sort of critical thinking skill required for students to move beyond memorizing muscle insertions to improving the lives of their patients.

## Overview of Davis*Plus* Resources

Additional resources are available for instructors at http://davisplus.fadavis.com/. Suggestions for incorporating these resources into classwork and assignments are provided throughout this instructor's guide.

- Lecture PowerPoints—Customizable PowerPoint slides to support lectures.
- Image files—Figures from the book for use in PowerPoints and assignments.

## Introduction to Kinesiology in Action

*Kinesiology in Action* is a customizable, interactive, online learning environment offering students and instructors various multimedia resources to support learning of complex concepts. Within this environment, instructors can design classes, monitor student progress, and assign quantitative and qualitative student assessment activities to students enrolled in their classes. All assignments are tracked in the platform's gradebook, which can be exported to an institution's learning management system (such as Blackboard, Angel, and CourseWorks), if desired.

*Kinesiology in Action* gives students an opportunity for active learning, as part of a class or independently. Many of the activities provide immediate feedback on student progress and performance. Using this format adds more value to kinesiology classes by engaging students in the participatory, information-sharing Web culture to which they are accustomed. Sharing knowledge, as well as acquiring skills and competencies, are no longer limited to the classroom. Now students can independently participate in an active community of learning, deepening their understanding of kinesiology.

As an instructor, you recognize that kinesiology courses are foundations for physical therapist and physical therapist assistant (PTA) students, providing them with the language of human movement and creating a bridge between the basic sciences and clinical management. Because kinesiology appears early in the curriculum, students require a straightforward approach to observing, evaluating, and understanding human movement. They must integrate anatomy, surface anatomy palpation, muscle function, alignment, kinematics, and the mechanical concepts of human movement presented in texts and lectures. Students need to examine the material frequently in their own time and at their own pace using a comfortable, accessible format. *Kinesiology in Action* will help advance these skills in the context of physical therapy patient/client management. Using recommendations from this guide, you can integrate content into lectures and create assignments to foster elements of remembering and understanding, applying and analyzing, as well as evaluating human movement.

## Incorporating *Kinesiology in Action* Into Your Course

Each lesson of *Kinesiology in Action* includes some or all of the following activities and features, which can be either automatically graded by the platform or submitted to instructors for qualitative feedback. A digital version of the book chapter text is also available to view within each lesson. Students can easily reference and interact with the text to review any concepts they have not yet mastered.

### Pretest

Pretests consist of 10 multiple-choice questions to gauge the students' preexisting knowledge and identify areas of weakness. The intent of the pretest is to prepare the students for learning by linking to the reading. These questions include foundational anatomy and kinesiology questions that address fivecritical components: medical terminology, review of anatomical structures, arthrology, osteokinematics, and arthrokinematics.

#### *Suggestions for Use*

BEFORE CLASS: INDEPENDENT REVIEW OR FLIPPED CLASSROOM

- Test the students' knowledge retention prior to the unit. By grading this Pretest, it ensures that students will review the readings, whether or not you choose to use this component as part of your course grade. Credit for flipped classroom participation may represent a small portion of the course grade.
- Students can be required to define or write out answers to anything that was marked as incorrect on their Pretest to ensure requisite comprehension of topics.

AT THE END OF YOUR LECTURE OR DIDACTIC COMPONENT

- Students can retake the Pretest after the lecture is completed. Doing so provides you with feedback regarding student learning immediately following presentation of the material. This also helps students to determine their own "muddiest" thinking, leading to a better post-lecture review.
- Challenging concepts identified by the Pretest results can be used as discussion forum topics for students to further explore concepts or as a subsequent laboratory component.

### Practice Activities

If your students take anatomy concurrently with kinesiology, these activities serve to connect the two courses and reinforce the salient structures for kinesiology. If your curriculum places anatomy and kinesiology in subsequent semesters, these activities provide you with a safeguard that students are ready for advanced learning.

- **Labeling**—The user labels various illustrations by clicking and dragging the labels to the appropriate location. Students can work along with their textbooks and classroom or virtual models to develop the requisite knowledge of important structures.
- **Hotspot Identification**—For these activities, the user is presented with an image and is prompted to click on the area identified in the clue. This activity can be used to identify specific structures and locations of injuries.
- **Flash Cards**—This ungraded activity provides an opportunity for students to review terminology and key concepts before taking the Posttest.

### *Suggestions for Use*

BEFORE CLASS FOR A FLIPPED CLASSROOM ACTIVITY

- Labeling and Hotspot Activities challenge students to identify structures important to joint movement and function. Review and assessment of knowledge prior to the class will facilitate learning as the course adds additional structural, biomechanical, and functional information.
- Bundle this activity with the Pretests for greater integration of the chapter's information prior to class. By taking the Pretest first and then completing the related Practice Activities, students will continue to explore foundational anatomy and its application to movement.

DURING CLASS

- ***In lecture:*** Ask students to come to the front of the class and complete Labeling or Hotspot activities, which can be projected to the rest of the class.
- ***In lab:*** Assign students a list of important structures, bony landmarks, muscle attachments, and so on, that they must actively identify on models and skeletons.

AFTER CLASS

- Have students use the flash cards to review key terms and concepts from the lesson in preparation for the Posttest.

## Text Generation

For this open-ended, short-answer activity, users are given a prompt to which they respond by typing in an answer into the field provided. Many of these activities include images of complex postures and movements that students are required to analyze and apply principles of kinesiology to the patient/client situation. The Text Generation Activity develops students' critical thinking about biomechanics through the integration of postures and movements found in daily living. The questions reinforce chapter materials and require students to use the information as one would in a clinical situation.

Recommended answers to these activities are provided in a separate section of this Instructor's Guide. To extend the activity, you can ask questions that integrate other regional issues, biomechanical constraints, and functional demands linked to aging, injury, and interventions.

### *Suggestions for Use*

BEFORE CLASS FOR A FLIPPED CLASSROOM ACTIVITY

- These more challenging questions can be given before class for students to stimulate their thinking about the application of key concepts necessary for movement function as well as rehabilitation. Topics can be revisited during the in-class session.

DURING CLASS

- ***In lecture:*** Students can complete the activities in real time, and the instructor can be assured that all students are participating by tracking who has submitted answers. When courses have shorter, multiple-class sessions, this activity could be incorporated at the end of the first session for "out-of-class thinking" or used in a subsequent session as an application of basic concepts from the previous session.

  The instructor can lead a discussion in which the students must defend the answers by citing concepts from the text that support their decision making. Working through these linked

activities may lead to further exploration of the serial installments of the case studies found within the chapters. These activities would match high-level learning objectives found in course syllabi and also promote clinical reasoning skills aimed at patient care.

- ***In lab:*** Have students participate in small-group discussions in which one group member replicates the activity or posture mentioned in the Text Generation Activity prompt. The students can use the assignment to foster clinical reasoning by justifying their decisions based on the scenario presented. You may also consider incorporating the image associated with the Text Generation Activity into a clinical case study to promote application of principles to the patient/client management model.

AFTER CLASS

- These activities lend themselves perfectly to out-of-class assignments. Students can view the activities and complete questions generated by the site as well as those provided by the instructor to promote learning beyond the classroom.
- Consider assigning the generation activities to the discussion board, where students post their rationales for their answer choices. Requiring all students to respond outside of class time allows the instructor to view how all students conceptualize the information and apply it to specific situations.

## Critical Thinking

This activity incorporates video of a certain skill or pathology. The user answers a "decision point" question based on the video introduction. The user then views the concluding video and answers follow-up questions. This is an activity for students to visualize concepts in context and practice applying their background knowledge. The student must apply kinesiology in a patient/client situation. Students can review rationales explaining correct responses after completing the activity to receive immediate feedback.

### *Suggestions for Use*

BEFORE CLASS: INDEPENDENT REVIEW FOR FLIPPED CLASSROOM

- Assign the reading ahead of class and ask students to review the video and complete the questions associated with the video. This assignment facilitates reading and heightens understanding prior to the class session. Review the students' results via the *Kinesiology in Action* gradebook, and use this information to structure class time to meet learning needs and achieve optimal results.
- Have students review key movements prior to class. Then play the videos at the beginning of the class to highlight key concepts from the textbooks. This approach allows for more class time to be spent on higher levels of learning, such as application, analysis, and evaluation.

DURING CLASS

- ***In lecture:*** As you move through the course materials, direct students to watch the video(s) and answer the question(s). This active learning within the classroom engages students and adds to topical discussions. Consider posing your own questions based on the videos to promote understanding of different but related situations. Alternately, ask the students to view the video(s) and complete the question(s) at the end of class to obtain feedback regarding student

learning immediately following presentation of the material. This end-of-session activity encourages students to review materials outside of the classroom.

- ***In lab:*** The critical thinking activities can be assigned as small-group discussion topics to foster clinical reasoning. Have students explain the kinematics observed in the video and apply the information in clinical case studies or as part of the patient/client management model. Consider expanding this activity to incorporate the additional videos from the video library tab.

AFTER CLASS

- You may choose to assign the video to confirm that students understand the material covered during the lecture. Tracking student progress via the gradebook provides valuable information that can guide whether additional content review is needed in class at the start of the next lecture in the context of a discussion board topic.
- Have students review the Critical Thinking Videos and other clips in the video library as homework to develop their knowledge and skills.

## Palpation Practice Activities

### *Suggestions for Use*

DURING CLASS

- ***In lecture:*** During the lecture, stop after each section and have students palpate the structures covered during each portion of the lecture.
- ***In lab:*** Have students locate the landmarks and muscle groups outlined for each chapter.

AFTER CLASS

- Post the practice activities as a discussion board topic. Have students practice the techniques with each other, post their findings, and comment on what they find challenging about the process.

## Posttest

Similar to the Pretests, the Posttests consist of 10 multiple-choice questions to assess understanding of key topics from the lessons. This activity reinforces learning and provides instructors with data from the online grading system to determine content areas that may need further review.

### *Suggestions for Use*

This set of questions is good for students to consider independently following the unit to self-assess their areas of strength and areas requiring further review. They can be used in class or as homework. Review graded answers to determine student comprehension of materials and to decide which concepts may need to be reviewed.

## Discussion Forum

Students can access the discussion forum to view and respond to posted topics. You select the thread title and its description. You can also attach a file, if required as part of the message. Students reply to the thread and activity, which you monitor and moderate. You can create group assignments within the discussion forum.

### *Suggestions for Use*

Recommended as an out-of-class assignment, these forums allow for peer interaction and provide opportunities to develop clinical reasoning and decision-making skills beyond formal classroom sessions.

## Video Library

Videos and animations are available for students to enhance learning of key concepts. PTA students tend to need support in visualizing various concepts and body motions. The variety of videos for each lesson allows the instructor to develop the student's knowledge of normal and abnormal movement through visual inspection. Depending on your curriculum, some assessment videos may be too advanced for individuals beginning a program, but they may become relevant later in the PTA program. The animations focus on foundational joint range-of-motion concepts and are an excellent reference for PTA students throughout their coursework.

### *Suggestions for Use*

The videos and animations may be assigned as part of a flipped classroom model, whereby the in-class time serves as a discussion of the key concepts presented in the video. Alternatively, you may choose to have students view the videos and animations during structured lecture or laboratory sessions to facilitate understanding.

## Sample Schedule

| Week | Lecture Topic | Assigned Textbook Chapter(s) | Associated *Kinesiology in Action* Assignments |
|---|---|---|---|
| 1 | • Directional terms<br>• Planes of motion<br>• Axis of rotation<br>• Movement terminology<br>• Forces<br>• Center of mass<br>• Base of support<br>• States of equilibrium<br>• Stress-strain relationship<br>• Vectors<br>• Torques<br>• Force couples | Chapter 1: Principles of Kinesiology and Biomechanics | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Flash cards |
| 2 | • Joint cellular composition<br>• Joint structural components<br>• Joint classifications<br>• Osteokinematics<br>• Arthrokinematics | Chapter 2: Structure and Function of Joints | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Flash cards |
| 3 | • Muscle action terminology<br>• Muscle structure<br>• Types of muscle contractions<br>• The motor unit<br>• Muscle architecture<br>• Muscle length-tension relationships<br>• Active and passive insufficiency<br>• Force-velocity relationship<br>• Neural structures and motor output<br>• Muscle changes related to aging and inactivity | Chapter 3: Structure and Function of Muscles | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Flash cards<br>• Videos |
| 4 | • Newton's laws of motion<br>• Static and dynamic equilibrium<br>• Mass, force, and acceleration<br>• Ground reaction forces<br>• Work-energy relationships<br>• Lever systems<br>• Mechanical advantage | Chapter 4: Additional Biomechanical Principles | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Flash cards |

| Week | Lecture Topic | Assigned Textbook Chapter(s) | Associated *Kinesiology in Action* Assignments |
|---|---|---|---|
| | • Anatomical pulleys | | |
| 5 | • Spinal structures<br>• Spinal curves<br>• Spinal kinematics<br>• Regional spinal characteristics<br>• Spinal muscles<br>• Stabilization and alignment | Chapter 5: Structure and Function of the Spine | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Flash cards<br>• Palpation practice<br>• Videos |
| 6 | • Structures of the thorax<br>• Ventilation<br>• Kinematics during ventilation<br>• Muscles of ventilation<br>• Ventilation system changes related to aging and disease | Chapter 6: Structure and Ventilation Function of the Thorax | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Flash cards<br>• Palpation practice<br>• Videos |
| 7 | • Temporomandibular joint structures<br>• Mandibular movement<br>• Muscles<br>• Temporomandibular joint dysfunction related to aging and disease | Chapter 7: Temporomandibular Joint | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Flash cards<br>• Videos |
| 8 | • Shoulder complex structures<br>• Sternoclavicular joint structures and kinematics<br>• Acromioclavicular joint structures and kinematics<br>• Scapulothoracic joint structures and kinematics<br>• Glenohumeral joint structures and kinematics<br>• Coracoacromial arch<br>• Shoulder complex kinematics<br>• Scapulothoracic joint muscles<br>• Glenohumeral joint muscles<br>• Functional deficits in the shoulder complex | Chapter 8: Structure and Function of the Shoulder Complex | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Critical thinking<br>• Flash cards<br>• Palpation practice<br>• Videos |
| 9 | • Elbow complex structures<br>• Humeroulnar and humeroradial joints | Chapter 9: Structure and Function of the Elbow Complex | • Pretest/Posttest<br>• Labeling<br>• Hotspots |

| Week | Lecture Topic | Assigned Textbook Chapter(s) | Associated *Kinesiology in Action* Assignments |
|---|---|---|---|
| | • Kinematics<br>• Carrying angle<br>• Proximal and distal radioulnar joint kinematics<br>• Elbow complex muscles<br>• Muscle recruitment during functional activities | | • Text generation<br>• Critical thinking<br>• Flash cards<br>• Palpation practice<br>• Videos |
| 10 | • Wrist complex structures<br>  ○ Carpal tunnel<br>  ○ Kinematics<br>  ○ Muscles<br>• Hand complex structures<br>  ○ Hand arches<br>  ○ Kinematics<br>  ○ Muscles<br>• Tenodesis<br>• Flexor tendon sheath pulley system<br>• Extensor mechanism<br>• Functional position<br>• Prehension<br>• Grips<br>• Pinches | Chapter 10: Structure and Function of the Wrist and Hand Complex | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Critical thinking<br>• Flash cards<br>• Palpation practice<br>• Videos |
| 11 | • Hip complex structures<br>• Femur angle of inclination<br>• Femoral torsion<br>• Joint structures<br>• Center edge angle<br>• Acetabular anteversion angle<br>• Kinematics<br>  ○ Osteokinematics<br>  ○ Lumbopelvic rhythm<br>• Arthrokinematics<br>• Hip complex muscles | Chapter 11: Structure and Function of the Hip Complex | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Critical thinking<br>• Flash cards<br>• Palpation practice<br>• Videos |
| 12 | • Knee structures<br>  ○ Bony structures<br>  ○ Joint structures<br>  ○ Menisci<br>  ○ Bursae<br>  ○ Capsule and ligaments | Chapter 12: Structure and Function of the Knee | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Critical thinking<br>• Flash cards |

| Week | Lecture Topic | Assigned Textbook Chapter(s) | Associated *Kinesiology in Action* Assignments |
|---|---|---|---|
| | ○ Medial and lateral collateral ligaments<br>○ Anterior and posterior cruciate ligaments<br>• Kinematics<br>○ Osteokinematics<br>○ Q-angle<br>○ Medial and lateral (axial) rotation<br>• Arthrokinematics<br>• Screw-home mechanism<br>• Muscles<br>• Influence of hip position on knee function | | • Palpation practice<br>• Videos |
| 13 | • Bony structures<br>• Joint structures<br>• Osteokinematics<br>• Arthrokinematics<br>• Foot arches<br>• Muscles<br>• Functional performance of the foot | Chapter 13: Structure and Function of the Ankle and Foot Complex | • Pretest/Posttest<br>• Labeling<br>• Hotspots<br>• Text generation<br>• Critical thinking<br>• Posttest<br>• Flash cards<br>• Palpation practice<br>• Videos |
| 14 | • The gait cycle<br>• Spatial descriptors of gait<br>• Temporal descriptors of gait<br>• Center of mass displacement during gait<br>• Joint kinematics during gait<br>• Muscle activity during gait<br>• Atypical gait patterns | Chapter 14: The Kinesiology of Gait | • Pretest/Posttest<br>• Labeling<br>• Text generation<br>• Critical thinking<br>• Posttest<br>• Flash cards<br>• Videos |

# Chapter 1: Principles of Kinesiology and Biomechanics

Begin the study of human movement by first discussing universal terms to describe various types of movement and the directions and planes in which they occur. It is important to emphasize the way body segments move in relationship to each other and how this movement determines their function and how tasks are accomplished. Discuss how external forces such as those from gravitational forces and friction must be overcome by internal forces generated by the musculoskeletal system to determine whether or not movement will occur. Throughout this course it is important to emphasize how alignment and forces can either foster healing and increase function or cause injury and produce dysfunction. Such knowledge provides a foundation on which to build rehabilitation concepts and principles.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

1.1 Identify the directional location of sites using universal descriptors.
1.2 Demonstrate movement in the three cardinal planes, and identify the axes around which the movement occurs.
1.3 Describe movement directions, and explain the concept of degrees of freedom of movement.
1.4 Discern the differences between linear, angular, and general motion.
1.5 Illustrate the concepts of open and closed kinematic chain movement, and identify examples of these types of movement that occur in daily activities.
1.6 Discuss types of forces, and understand how internal and external forces can work to provide movement, stability, or dysfunction.
*1.7 Explain the concepts of vector forces in terms of their magnitude and direction.*
*1.8 Outline the components of torques, and understand the relationship between forces, moment arms, and the torques they produce.*
1.9 Define the concept of force couples in human motion.

## Key *Kinesiology in Action* Activities by Topic

- Labeling: Directional terms, planes of motions, movement terminology
- Hotspots: Forces and axis of rotation
- Generation: Stress-strain relationship, torques, force couples

## Additional Resources

- Chapter 1 PowerPoint
- Chapter 1 images

# Chapter 2: Structure and Function of Joints

This chapter discusses the general composition and overall function of joints. The specific joint function of each body segment is covered in detail in subsequent chapters. It is important for the student to understand the cellular and structural components of joints, the classification of joints, and the general concepts related to the osteokinematic and arthrokinematic concepts of joint movement before beginning the study of the specific joints of the human body.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

2.1 Discuss the various functions of the skeletal system.
2.2 Differentiate between the axial and the appendicular skeleton.
2.3 Describe the types of cellular components that form joint structures.
2.4 Discuss structures found in the different types of joints in terms of their tissue composition and role in the stability and mobility of the joint.
2.5 Classify types of joints according to their structure, movement, and function.
*2.6 Compare and contrast osteokinematic and arthrokinematic movement.*
*2.7 Explain the concepts of arthrokinematic movement and the mechanics of roll, glide, spin, and concave-convex patterns of motion.*
2.8 Analyze the concepts of closed-packed and open-packed positions and end-feel patterns.
2.9 Identify the adverse effects of immobilization on joint structures.

## Key *Kinesiology in Action* Activities by Topic

- Labeling: Axial and appendicular skeleton, types of joints
- Hotspots: Components of joints
- Generation: Open- and closed-chain motion, arthrokinematics, osteokinematics, effects of forces on joints

## Additional Resources

- Chapter 2 PowerPoint
- Chapter 2 images

# Chapter 3: Structure and Function of Muscles

This chapter begins with an overview of the general structural and mechanical properties of skeletal muscles. It covers the interrelationship between these muscle structures and the nervous system and identifies factors that influence the speed and force of muscle contractions. The responsiveness of the neuromuscular system, muscle fiber types, muscle length, and joint angles all are contributing factors to the quantity and quality of the contraction produced. This introduction to the characteristics and general function of skeletal muscle provides a background for the study of individual muscle groups in subsequent chapters. Understanding skeletal muscle structures and their function creates a foundation for insight into how muscles can facilitate recovery and optimal function or how they can contribute to injury and dysfunction.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

3.1 Choose the appropriate terms to explain the various roles of skeletal muscles during human movement.
3.2 Describe the cellular components of muscle tissue and their function during muscle activation.
3.3 Demonstrate the different types of muscle contractions, and compare and contrast them in terms of force produced.
3.4 Summarize the anatomical composition and physiological function of the motor unit.
3.5 Identify the various types of muscle architecture and fiber types, and relate each to their potential for generating force and movement.
3.6 Name the various connective tissue structures found in muscles, and define their role in generating force, providing structure, and resisting stretch.
3.7 Discuss the relationship between muscle length and speed of contraction and their ability to produce tension.
*3.8 Compare and contrast active and passive muscle insufficiency.*
3.9 Outline the neural structures involved with motor output, including the sensory receptors specific to muscle tissue.
3.10 Analyze the changes in the muscular system associated with aging and inactivity.

## Key *Kinesiology in Action* Activities by Topic

- Labeling: Components of muscle tissue, sensory structures associated with motor output
- Hotspots: Muscle architecture
- Generation: Active and passive insufficiency, force couples, motor units, relationship between speed of contraction and generation of forces

### Video Library Clips

- Active insufficiency
- Passive insufficiency

## Additional Resources

- Chapter 3 PowerPoint
- Chapter 3 Images

# Chapter 4: Additional Biomechanical Principles

In the study of kinesiology, students must be familiar with concepts related to biomechanics. The concepts related to Newton's laws of motion, forces, levers, mechanical advantage, and mechanical systems tend to be difficult concepts for students to understand. Emphasize that understanding of these concepts will enhance their understanding of human motion. For students who have not previously studied general physics concepts, this information can be unfamiliar to them. Relating these concepts to ideas already familiar to students will facilitate their understanding. Combining the information presented in this chapter with the concepts in previous chapters provides a solid foundation for analyzing movement, considering mechanisms of injury, and applying rehabilitation concepts to promote function and recovery.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

*4.1 Explain Newton's laws of inertia, acceleration, and action-reaction and how they apply to human motion.*
*4.2 Compare and contrast static and dynamic equilibrium.*
*4.3 Discuss the concept of acceleration.*
*4.4 Define moment of inertia.*
*4.5 Describe how mass and force influence acceleration of an object.*
*4.6 Discuss ground reaction forces in terms of action and reaction.*
*4.7 Explain the relationship between work and energy using the concepts of potential and kinetic energy.*
*4.8 Relate the concept of power to human movement.*
*4.9 Describe the concepts of first-class, second-class, and third-class levers, and give examples of these systems in the human body.*
*4.10 Demonstrate the concepts of mechanical advantage.*
*4.11 Identify anatomical pulleys in the musculoskeletal system and explain their role in increasing mechanical advantage of muscles.*

## Key *Kinesiology in Action* Activities by Topic

- Labeling: acceleration and deceleration muscle contractions, lever systems
- Hotspots: lever systems
- Generation: moment arms, internal and external forces, torques

## Additional Resources

- Chapter 4 PowerPoint
- Chapter 4 images

# Chapter 5: Structure and Function of the Spine

Instruction in the course now turns to the components of the human body involvement with human movement, beginning with the central trunk. Emphasize the importance of the spine's function—both mobility for functional movement of the human body and stability required for vertical support of the torso during movement of the extremities. While reviewing the anatomy of the spine, connect the structures to the concepts of how the spine transmits and absorbs forces between the upper and lower extremities while protecting the spinal cord. When reviewing the regional differences, emphasize how these differences contribute to function and movement in the region and predispose the region to injury or dysfunction when subjected to excessive forces or malalignment.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

5.1 Discuss the general purpose and function of the spine.
5.2 Describe the primary and secondary spinal curves.
5.3 Name and describe the general features of a vertebra in terms of its bony structures, ligaments, and joints.
5.4 Discuss the specific curves, bony and ligament structures, kinematics, and muscle function for the cervical, thoracic, lumbar, and sacral spinal regions.
*5.5 Explain the role muscles play in spine stabilization in terms of deep stabilizers and primary movers.*
*5.6 Understand how malalignment of specific spinal areas affects postural alignment of other areas.*

## Key *Kinesiology in Action* Activities by Topic

- Labeling: spinal curves, vertebral components, spinal ligaments, spinal motions
- Hotspots: vertebral component
- Generation: spinal postural deviations, limitations in spinal movement and function, movement of spine and spinal structures during functional movement
- Critical thinking: lumbar-pelvic rhythm

### Video Library Clips

- Normal Lumbar Motion
- Alterations to Lumbopelvic Mobility
- Squat vs. Stoop Lifting
- Thoracic Spine and Rib Cage Breathing
- Vertebral Column Assessment
- Vertebral Column Assessment: Lumbar-Pelvic Rhythm
- Palpation Tutorial: Thoracic Region in Supine Position
- Palpation Tutorial: Thoracic Region in Prone Position
- Palpation Tutorial: Lumbar Spine
- Palpation Tutorial: Posterior Pelvic Region
- Palpation Tutorial: Pelvis in the Standing Position

- Palpation Tutorial: Posterior Cervical Spine
- Palpation Tutorial: Anterior Pelvis
- Animation: Neck (Pivot Joint): Flexion, Extension, and Hyperextension
- Animation: Neck (Pivot Joint): Lateral Flexion
- Animation: Neck (Pivot Joint): Rotation
- Animation: Trunk: Flexion, Extension, Hyperextension
- Animation: Trunk: Lateral Flexion
- Animation: Trunk: Rotation

## Additional Resources

- Chapter 5 PowerPoint
- Chapter 5 images
- Palpation practice activities (see Appendix A of this instructor's guide)

# Chapter 6: Structure and Ventilation Function of the Thorax

In Chapter 5 students were introduced to the posterior bony and connective tissue structures that form the articulations between the 12 thoracic vertebrae and each rib. This chapter examines the anterior articulations and the role anterior and posterior structures play in ventilation. Chapter 5 explained the role of trunk muscles in movement of the spine. In this chapter, the discussion focuses on how these same muscles function as muscles of ventilation. For efficient ventilation that meets the respiratory needs of the body, there must be adequate mobility of the bony components of the thorax and optimal activation of the respiratory muscles to move the thorax.

For this chapter, emphasize to students the needed mobility and expansion of the thorax in each direction in order to have adequate efficient ventilation. Point out how restrictions in the noncontractile structures and dysfunction in the contractile muscles can lead to inadequate ventilation, decreased functional capacity, and secondary complications and disease. By connecting the typical kinesiology and biomechanics to the atypical, students gain insight into the importance of first understanding typical functions.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

6.1 Outline the bony structures that form the thorax.
6.2 List the joints formed between the thoracic vertebrae and the sternum and their associated ligaments.
*6.3 Discuss the four lung volumes and determine the combination of lung volumes that define the various lung capacities.*
6.4 Explain the muscle mechanics involved in ventilation.
6.5 Identify and compare the muscles involved in quiet ventilation and forced inspiration.
6.6 Discuss additional inspiratory muscles and their function.
6.7 Identify the muscles involved in forced expiration.
6.8 Explain the age-related changes that can occur in the respiratory system.

## Key *Kinesiology in Action* Activities by Topic

- Labeling: thoracic structures, lung volumes, and lung capacities
- Hotspots: thoracic structures
- Generation: thoracic motion during ventilation, comparing normal ventilation to ventilation with chronic obstructive pulmonary disease (COPD), abnormal postures and ventilation

### Video Library Clips

- Thoracic Spine and Rib Cage Breathing
- Thoracic Kyphosis: Effects on Rib Expansion and Vital Capacity

## Additional Resources

- Chapter 6 PowerPoint
- Chapter 6 images
- Palpation practice activities (see Appendix A of this instructor's guide)

# Chapter 7: Structure and Function of the Temporomandibular Joint

Although students may be least familiar with the temporomandibular (TM) joint compared to other joints in the body, it is important for them to study and understand its function. The TM joint is one of the most frequently used joints: It is used during chewing, swallowing, and speaking.

When reviewing the anatomy, emphasize how the two distinct articulations of the joint are interdependent and are further divided by a disc in each joint. The disc divides each joint into upper and lower articulations. Ultimately, this complex structure forms four distinct articulations that move congruently to allow the jaw to move in various planes and directions and withstand large compressive loads as it accomplishes the functional activities of eating, swallowing, and talking. The joint functions as a combination hinge and plane joint.

After students have an understanding of the joint's function, introduce how it is subject to malalignment, abnormal stresses, and injury that can result in oral dysfunction and head, neck, and jaw pain. Postural malalignment, pathology, and aging can adversely affect the joint. Although students may further study the dysfunction of the joint in other courses, an introduction at this point in their studies stresses the importance of first understanding typical motion and function.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

7.1 Compare the bone and disc structures of the TM joint with those of other synovial joints, and discuss how the differences in the TM joint improve the function of the joint.

7.2 Discuss the attachments of the intra-articular disc of the TM joint, and explain how the disc enhances joint function.

7.3 Identify the ligaments associated with the TM joint, and explain their role in stabilizing the joint.

7.4 Demonstrate the osteokinematic movements that occur at the TM joint: depression, elevation, protrusion, retrusion, and lateral excursion.

*7.5 Explain the arthrokinematic motions that must occur during each of the osteokinematic movements to achieve full-range, symptom-free movement.*

7.6 Specify the muscles that are responsible for each of the movements that occur at the TM joint.

7.7 Discuss common causes of TM joint dysfunction, and describe populations at risk for TM joint dysfunction.

## Key *Kinesiology in Action* Activities by Topic

- Labeling: muscles and structures of the TM joint
- Hotspots: mandibular movement, structures of the TM joint
- Generation: arthrokinematics and osteokinematics of the TM joint

### Video Library Clips

- TMJ Normal Motions
- TMJ Deviations

## Additional Resources

- Chapter 7 PowerPoint
- Chapter 7 images
- Palpation practice activities (see Appendix A of this instructor's guide)

# Chapter 8: Structure and Function of the Shoulder Complex

When beginning the study of the joints in the extremities, students need to understand that joints rarely function in isolation independent of other joints. Although the components of the upper extremity are presented in separate chapters, it is imperative for the student to understand that without the contribution of each section of the upper extremity, the function of the entire arm can be impaired. Opening and closing the hand around an object is of little use if the elbow and shoulder cannot function to reach for the object. The proximal shoulder complex must also provide a stable base on which the distal segments can move and manipulate objects. In this chapter, draw attention to how the function of the sternoclavicular, acromioclavicular, and scapulothoracic joints contribute to optimal function of the glenohumeral joint.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

8.1 Describe the bony and soft tissue structures and significant landmarks that form the shoulder complex.

*8.2 Discuss the osteokinematic and arthrokinematic functions of each joint in the shoulder complex and explain how these joints work in synergy to produce optimal movement of the complex.*

8.3 Explain how the coracoacromial arch and subacromial space might be involved in shoulder impingement.

*8.4 Analyze the movement of each joint in the shoulder complex to explain shoulder complex kinematics.*

8.5 Incorporate the role of the individual shoulder complex muscles into a discussion of shoulder complex kinematics.

8.6 Compare and contrast the structures involved in static versus dynamic stabilization of the glenohumeral joint.

8.7 Describe how shoulder complex muscle weakness, postural malalignment, or both can contribute to shoulder complex dysfunction.

## Key *Kinesiology in Action* Activities by Topic

- Labeling: muscles of the shoulder complex
- Hotspots: scapular motion, shoulder complex ligaments
- Generation: synergistic muscles producing scapular motion, open- and closed-chain scapular motion, arthrokinematic and osteokinematic motion of the glenohumeral joint
- Critical thinking: shoulder assessment (glenohumeral joint), shoulder biomechanics

### Video Library Clips

- Shoulder Elevation
- Scapula Instability
- Adhesive Capsulitis
- Shoulder Assessment: Glenohumeral Joint
- Shoulder Biomechanics
- Palpation Tutorial: Anterior Shoulder

- Palpation Tutorial: Scapula
- Animation: Shoulder (Ball-and-Socket Joint): Flexion, Extension, Hyperextension
- Animation: Shoulder (Ball-and-Socket Joint): Circumduction

## Additional Resources

- Chapter 8 PowerPoint
- Chapter 8 images
- Palpation practice activities (see Appendix A of this instructor's guide)

# Chapter 9: Structure and Function of the Elbow Complex

This chapter studies the structures and functions of the elbow complex, which consists of the humeroradial and humeroulnar joints and the proximal and distal radioulnar joints. During instruction, emphasize how the elbow complex functions to position the hand in space so that it can accomplish a multitude of tasks ranging from intrinsic fine motor manipulations to powerful grips. Discuss how the elbow lengthens the arm for reaching and shortens the arm to enable the hand to bring objects to the face (such as for eating and grooming). By adding a rotational component of motion, the elbow complex provides a means for the hand to function in all planes. Finally, bring attention to the function of the elbow complex as it stabilizes the arm so that the wrist and hand can generate a strong grasp and links the function of the shoulder to the hand.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

9.1 Describe the bony and soft tissue structures that make up the joints of the elbow complex.

*9.2 Discuss the osteokinematic and arthrokinematic motions that occur at each joint of the elbow complex.*

9.3 Explain the carrying angle of the elbow joint.

9.4 Explain the law of parsimony and how it relates to the recruitment of the elbow extensor muscles.

*9.5 Name the muscles associated with the elbow complex and describe their function in terms of isolated movement and as a synergist or stabilizer during various motions of the elbow complex.*

9.6 Describe the role of elbow complex muscles during common functional activities.

## Key *Kinesiology in Action* Activities by Topic

- Labeling: bony landmarks, muscles
- Hotspots: ligaments, cubital valgus and varus
- Generation: function of the triceps and active and passive insufficiency, arthrokinematics of the elbow joint in open- and closed-chain motion
- Critical thinking: elbow range of motion: passive tension of triceps with shoulder positioning, elbow strength: biceps strength with shoulder positioning: active vs. passive insufficiency

### Video Library Clips

- Normal Elbow Motion
- Elbow Limitations and Compensations
- Elbow Range of Motion: Passive Tension of Triceps with Shoulder Positioning
- Elbow Strength: Biceps Strength with Shoulder Positioning: Active vs. Passive Insufficiency
- Palpation Tutorial: Anterior Elbow
- Palpation Tutorial: Posterior Elbow
- Animation: Elbow (Hinge Joint): Flexion, Extension
- Animation: Elbow (Hinge Joint): Rotation

## Additional Resources

- Chapter 9 PowerPoint
- Chapter 9 images
- Palpation practice activities (see Appendix A of this instructor's guide)

# Chapter 10: Structure and Function of the Wrist and Hand Complex

Chapter 10 begins the study of the wrist complex and the hand. Emphasize to students that the function of the wrist, whether acting as a stabilizer or as a mover, affects the position and function of the hand. Because many of the muscle tendons that move the hand and fingers cross the wrist, their ability to generate power, lengthen when additional range of motion is needed, or produce fine intrinsic motion is influenced by the position of the wrist. Understanding of general concepts, such as the lateral origin of wrist extensors versus the medial origin of flexors and the role these muscle groups play in stabilizing the wrist during power grips, will prepare the student for understanding dysfunction of these muscles and the effects on gripping.

Students can become overwhelmed with the anatomical detail and biomechanics of the hand. Emphasize that the hand is a multifaceted structure designed to perform intrinsic prehension or gross powerful grasps. It can generate forces that exceed 100 lb or gently hold delicate objects as it performs work activities or assists with fine motor activities of daily living, such as feeding and dressing. The hand also functions as a sensory organ, providing the brain with information about the shape and texture of objects, the temperature of its surroundings, and other characteristics of the environment. The final accomplishments of the hand are interdependent on the stability and position provided by the trunk, shoulder, elbow, and wrist.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

10.1 Describe the bony structures that make up the wrist complex and the hand.
10.2 Name the joints of the wrist complex and hand.
10.3 Demonstrate the osteokinematic motions of the wrist and hand, and list typical ranges of motion for each joint.
10.4 List the major ligaments and connective tissue structures of the wrist and hand, and discuss their function in terms of stability and the movements they limit.
10.5 Describe the structures that form the carpal tunnel and the structures that traverse through the tunnel.
10.6 Compare the structure and function of the three arches of the hand.
*10.7 Discuss the function of the individual muscles of the wrist and hand and their synergistic action during finger and thumb activities and during functional use of the hand.*
10.8 Demonstrate the tenodesis action of the hand, and describe its mechanism of action and how it can be used to assist with grasp.
10.9 Explain the flexor tendon pulley system and the extensor mechanism of the hand.
10.10 Discuss the use and purpose of the types of power grasps and prehension.

## Key *Kinesiology in Action* Activities by Topic

- Labeling: carpal and hand bones and joints, structures forming the carpal tunnel, motions of the wrist, motions of the thumb
- Hotspots: wrist flexors and extensor muscles
- Generation: influence of wrist position on grip strength, arthrokinematics of the wrist
- Critical thinking: active/passive insufficiency vs. functional position, tenodesis

### Video Library Clips

- Gripping Tasks Power
- Gripping Tasks Precision
- Gripping with Rheumatoid Arthritis
- Active/Passive Insufficiency vs. Functional Position of the Hand
- Tenodesis
- Palpation Tutorial: Wrist
- Palpation Tutorial: Carpal Bones of the Wrist
- Animation: Wrist (Condyloid Joint): Abduction and Adduction
- Animation: Wrist (Condyloid Joint): Flexion, Extension, Hyperextension
- Animation: Thumb (Saddle Joint): Flexion and Extension
- Animation: Thumb (Saddle Joint): Opposition
- Animation: Hands and Fingers: Abduction and Adduction
- Animation: Hands and Fingers: Flexion, Extension, Hyperextension

## Additional Resources

- Chapter 10 PowerPoint
- Chapter 10 images
- Palpation practice activities (see Appendix A of this instructor's guide)

# Chapter 11: Structure and Function of the Hip Complex

As with previous chapters, begin the study of the hip complex by reviewing the anatomy. The textbook chapter begins by discussing that the hip joint is composed of the head of the femur and the acetabulum of the pelvis. It is a ball-and-socket joint of stability because an extensive joint capsule, the labrum, and the ligaments reinforce its deep socket. Then the information moves to the functions of the hip as it provides an axis for the trunk and pelvis to move on the lower extremity as a person leans forward in a sitting position. It provides the range of motion and strength to move the body upward in standing up from a sitting position. With the study of the actions of muscles associated with the hip, point out how the hip joint plays a major role in functional activities, such as walking, negotiating stairs, running, and lifting and carrying loads. Conclude the discussion of the hip complex by introducing how hip muscular weakness, dysfunction, or both can adversely affect a person's balance and overall safety and how hip pathology or trauma can result in pain and major disability of the entire body.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

11.1 Describe the bony and connective tissue structures related to the hip joint and relate these structures to muscle attachments and joint function.
11.2 Discuss the normal angle of inclination of the femur and the conditions of coxa valgus and coxa varus.
11.3 Define femoral torsion in terms of anteversion and retroversion.
11.4 Define the function of the acetabular structures, and explain how their alignment affects hip joint stability and mobility.
*11.5 Discuss the open- and closed-chain osteokinematics and arthrokinematics of the hip joint in femur-on-pelvis and pelvis-on-femur movement.*
11.6 Identify the muscles of the hip joint, and describe their function as primary and secondary movers.
*11.7 Explain how changes in hip position can alter the function of specific hip muscles.*

## Key *Kinesiology in Action* Activities by Topic

- Labeling: bony components of the pelvis and femur, angles of inclination, femoral torsion
- Hotspots: ligaments and muscles associated with the hip joint
- Generation: analysis of a squat in terms of muscle recruitment and alignment, active and passive insufficiency of hip muscles, hip adductors augmenting hip flexion and extension
- Critical thinking: assessment, stability control, hip-pelvis kinematics

### Video Library Clips

- Hip Motion Normal
- Hip Motion with Squat
- Sit to Stand with Hip Weakness
- Single Limb Stance with Hip Weakness
- Hip Assessment: Stability Control
- Hip Assessment: Hip-Pelvis Kinematics
- Palpation Tutorial: Hip in Prone Position

- Palpation Tutorial: Hip in Side-lying Position
- Palpation Tutorial: Hip in Supine Position
- Animation: Hip (Ball-and-Socket Joint): Abduction and Adduction
- Animation: Hip (Ball-and-Socket Joint): Flexion, Extension, Hyperextension
- Animation: Hip (Ball-and-Socket Joint): Internal and External Rotation

## Additional Resources

- Chapter 11 PowerPoint
- Chapter 11 images
- Palpation practice activities (see Appendix A of this instructor's guide)

# Chapter 12: Structure and Function of the Knee

When beginning the study of the knee joint, emphasize how the joint links the feet to the hips and functions to provide stability and mobility. Its function is interdependent on the proximal and distal joints of the leg for most functional activities, including transitioning from one position to another, such as when moving from sitting to standing and during walking and running.

The knee joint is a biaxial modified hinge joint that moves in the sagittal plane during flexion and extension and in the horizontal plane during medial and lateral rotation. Students must understand this component of rotation if they are to later understand the rotational component that commonly results in injuries to knee structures.

Students tend to quickly grasp how the joint functions in an open-chain movement during activities such as the swing phase of walking or kicking a ball, but they also need to understand how the joint functions in a closed-chain fashion—when the body is moving from sitting to standing or negotiating stairs or when it is in the stance phase of walking and running. When the knee is supporting body weight, it undergoes tremendous compression stresses and requires sufficient stability to support that weight. Because of the design of the knee joint, where there is minimal interlocking of joint surfaces, the stability of the joint comes primarily from the ligaments, intra-articular menisci, and large muscles that surround the joint. An understanding of the knee joint, its structures, and its kinematics provides the background necessary to appreciate the mechanisms of injury to the knee joint and the concepts related to therapeutic interventions.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

12.1 Describe the bony structures related to the knee joint and relate these structures to muscle attachments and joint function.
12.2 Discuss how the patella functions to increase the efficiency of the quadriceps muscle.
12.3 Explain the function of the menisci of the knee and relate injuries of the menisci to the degeneration of joint surfaces.
12.4 Outline the major ligaments of the knee and discuss their function in terms of stability and motion restriction.
12.5 Demonstrate both open- and closed-chain osteokinematics of the knee.
12.6 Describe typical patterns of patellar tracking and factors that influence the tracking, including the Q-angle.
*12.7 Discuss the arthrokinematics of the knee joint in tibia-on-femur and femur-on-tibia movement.*
*12.8 Define the screw-home mechanism of the knee.*
*12.9 Discuss the location and function of the knee muscles, and explain how their function is influenced by the position of the hip.*

## Key *Kinesiology in Action* Activities by Topic

- Labeling: structures of the knee joint, genu valgum, genu varus, genu recurvatum, knee ligaments
- Hotspots: menisci and ligaments of the knee

- Generation: hip and knee muscle activation during functional activities, patellofemoral forces with activities and positions, arthrokinematics
- Critical thinking: assessment, joint interaction with the knee, patellar motion

### Video Library Clips

- Double and Single Limb Stance and Squat
- Weakness or Limitation of Joint Consistent with Knee Pathology (ACL)
- Knee Assessment: Joint Interaction with the Knee
- Knee Assessment: Patellar Motion
- Palpation Tutorial: Knee
- Animation: Knee (Hinge Joint): Flexion and Extension

## Additional Resources

- Chapter 12 PowerPoint
- Chapter 12 images
- Palpation practice activities (see Appendix A of this instructor's guide)

# Chapter 13: Structure and Function of the Ankle and Foot Complex

When beginning the study of the ankle and foot complex, emphasize that the primary function of this complex is to provide a link between the body and the ground that is stable yet mobile and adaptable to various surfaces before becoming more rigid during locomotion. The foot must be pliable enough to conform to uneven surfaces during early stance while walking. It then needs to absorb ground reaction forces and translate body weight forces while maintaining whole-body stability during the stance phase of gait. As the limb is ready for push-off, the foot must become a rigid lever to help thrust the body forward. During the swing phase of gait, when the limb is moving forward, activation of the ankle and foot prevents the foot from scraping the ground.

Before beginning the study of the ankle and foot, clarify the regions of the ankle and foot. The term *ankle* is used to describe the talocrural joint, which is the articulation between the distal tibia and fibula and the talus. The *foot* refers to all of the joints distal to the ankle. The talus, calcaneus, navicular, cuneiforms, and cuboid bones make up the *tarsus* area of the foot and are called tarsal bones. The foot is divided into three regions: the rearfoot, the midfoot, and the forefoot. The rearfoot comprises the talus and calcaneus. The midfoot comprises the tarsal bones (navicular, three cuneiforms, and cuboid). The forefoot refers to the five metatarsals and 14 phalanges. The large great toe has two phalanges, and the four lesser toes have three. The dorsal surface refers to the top of the foot, whereas the plantar surface is the bottom of the foot.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

13.1 Describe the bony and connective tissue structures that make up the ankle and foot joints.
13.2 Identify the motion that each of the major ligaments in the ankle and foot limits.
13.3 Name the ligaments that are particularly prone to injury, and explain why in each case.
13.4 Discuss the kinematics of each joint in the ankle and the foot.
13.5 Describe the three arches of the foot and their function during weight-bearing activities.
*13.6 List the muscles that act on the ankle and foot joints, and describe their actions in open- and closed-chain activities.*
*13.7 Describe the motions of pronation and supination at the talocrural, subtalar, and transverse tarsal joints of the ankle and foot.*

## Key *Kinesiology in Action* Activities by Topic

- Labeling: muscles and ligaments of the ankle and foot
- Hotspots: bony structures of the ankle and foot
- Generation: motion of the subtalar joint in standing
- Critical thinking: subtalar closed-chain pronation

### Video Clip Library

- Normal Motion of Foot and Ankle in Stance
- Normal Motion of the Foot and Ankle with Sit-to-Stand/Step Ups
- Functional Tasks with Ankle Limitations
- Subtalar Closed-Chain Pronation and the Effects on the Knee

- Palpation Tutorial: Lateral Border of the Foot
- Palpation Tutorial: Medial Border of the Foot
- Animation: Ankle (Hinge Joint): Flexion and Extension
- Animation: Foot (Gliding Joint): Eversion and Inversion
- Animation: Toes: Flexion, Extension, Abduction, and Adduction

## Additional Resources

- Chapter 13 PowerPoint
- Chapter 13 images
- Palpation practice activities (see Appendix A of this instructor's guide)

# Chapter 14: The Kinesiology of Gait

Each of the previous chapters of this text presents concepts related to human movement or examines the individual joints of the body and how they move. Now the functional activity that can require the movement or stabilization of nearly every joint in the body is introduced to the student—walking. Whether a person is walking and talking at the same time, turning the head to look at an object while walking, or simply moving from place to place, the human body attempts to perform this function of gait in the safest, most efficient manner. Walking is an activity in which a person repeatedly loses and regains balance. The process begins as the body leans forward in a potential fall that is prevented by recovering balance as the foot moves forward to a new position. While walking, the body moves from one point to another by this repetitive and alternating placement of the feet to counter the forward displacement of the body. Begin your discussion of this chapter by introducing the components of the gait cycle. Then study the movement of various joints during walking and explore how the muscles work together to produce walking. Conclude with a brief examination of common atypical gait patterns that result from the dysfunction of various body systems.

## Learning Outcomes

*Italicized learning outcomes indicate topics students may find most challenging.*

After reading this chapter, the learner will be able to:

14.1 Describe the components of the gait cycle, including the events that occur during the stance and swing phases of gait.
14.2 List the spatial parameters used to measure step length, stride length, and step width.
14.3 Record the temporal parameters used to measure cadence and step time.
14.4 Discuss the factors that influence walking speed.
*14.5 Explain the movement of the pelvis, hip, knee, ankle, foot, trunk, and arms during the various components of the gait cycle.*
*14.6 Identify when major lower extremity muscle groups are activated during the gait cycle.*
14.7 Recognize atypical gait patterns.

## Key *Kinesiology in Action* Activities by Topic

- Labeling: phases of gait, spatial descriptors of gait
- Generation: gait characteristics, abnormal gait
- Critical thinking: gait assessment, knee-ankle-foot orthoses, impact of ankle-foot orthoses on gait

### Video Library Clips

- Normal Alignment Resting Posture
- Alignment with Scoliosis
- Normal Gait Cycle Sagittal View (Full Body)
- Normal Gait Cycle (Ankle Focus)
- Normal Gait Cycle (Knee Focus)
- Normal Gait Cycle (Hip Focus)
- Normal Gait Cycle (Trunk and Upper Body Focus)
- Normal Gait Cycle Frontal Plane Motion
- Gait Using One Crutch

- Gait Using Two Crutches
- Musculoskeletal Impairments Gait
- Knee-Ankle-Foot Orthosis (KAFO) Use in Individuals with Midthoracic Spinal Cord Injury
- Forward Head Posture: Effects on Cervical Spine Range of Motion
- Gait Assessment: Ascending Stairs
- Ankle Locked at Neutral Plantar Flexion (PF)/Dorsiflexion (DF) and the Impact on Mid-Stance to Late Stance
- Ankle Locked at Neutral PF/DF and the Impact on Push-off
- Ankle AFO Allowing DF but Preventing PF and the Impact on Gait
- Ankle Locked at Neutral PF/DF and the Impact on Initial Contact through Foot Flat

## Additional Resources

- Chapter 14 PowerPoint
- Chapter 14 images

# Appendix A: Palpation Practice Activities

Use these practice activities for selected lessons in class, as a discussion board topic, or as a group activity. Consider having students view the palpation tutorial videos in the video library before practicing.

## Lesson 5: Cervicothoracic and Lumbar Spine

### Activity #1

- Place your hand on the back of the skull to palpate the occipital bone.
- Now move your fingers to the small prominence at the center of the bone to palpate the occipital protuberance.
- Move your fingers along the midline of the spine to palpate the spinous processes in each region of the spine. The C7 spinous process is the most prominent in the cervical spine. It is easily palpated and often more prominent with neck flexion.
- Move your fingers lateral to the spinous processes (right and left) to palpate the transverse processes.

### Activity #2

Palpate each of the following muscles.

#### *Sternocleidomastoid*

- Palpate the anterior surface of the neck between the sternal end of the clavicle and the mastoid process.

#### *Scalenes*

- Palpate the lateral surface of the neck between the sternocleidomastoid and the upper trapezius.

#### *Rectus abdominis*

- Palpate the midline of the anterior trunk.

#### *External and Internal Obliques*

- Palpate each side of the anterior trunk. Internal obliques are deep to external oblique muscles.

#### *Transverse abdominis*

- Place the fingertips medial and inferior to the anterior superior iliac spines of the pelvis. Activate the muscle with the “drawing in” maneuver of bringing the umbilicus in toward the spine.

#### *Erector spinae*

- Palpate the posterior aspect of the trunk at each spinal level. It is difficult to differentiate each group.

## Lessons 6 and 7: Thoracic Cavity and Temporomandibular Joint

### Activity #1

- Palpate the structure just anterior to the external auditory meatus—the tragus.
- Now move just anterior to the tragus to palpate the mandibular condyle.
- Open and close your mouth to feel this structure move.
- See whether you can feel the difference between rolling and gliding.
    - Open slightly with your tongue on the roof of your mouth to feel rolling.
    - Protract or laterally deviate your mandible to feel gliding.
- From the condyle, move inferiorly along the mandibular ramus until it changes direction at the angle of the mandible.
- While palpating the angle of the mandible, clench your teeth together.
    - Do you feel a muscle contract?
    - What muscle is it?

### Activity #2

- Palpate the angled inferior border of your right and left rib cage. Move superiorly along the inferior border until they meet in the midline. Here you will find the xiphoid process.
- Move superiorly to palpate the body of the sternum.
- Continue palpating superiorly along the sternum until you feel a horizontal line—the manubriosternal joint at the level of the second rib and then the manubrium above this joint.
- Put your hands on your upper chest above the nipple level. Take a deep breath to feel the ribs' "pump-handle" motion, which will feel like the ribs are elevating and moving anteriorly.
- Place your hands on your lateral rib cage near the lower half of your rib cage. Take a deep breath and notice the bucket handle motion of the ribs, which feels like the ribs are elevating and moving laterally.

## Lesson 8: The Shoulder Complex

### Activity #1

Palpate the borders and bony landmarks of the scapula on a colleague.

- Locate the superior angle and vertebral border of the scapula on the posterior trunk. The medial border begins at approximately the level of T2 and runs inferiorly to T7.
- At the distal end of the scapula, place your fingers on the inferior angle of the scapula. It is the inferior medial point of the scapula where the vertebral and axillary borders meet.
- From the inferior angle run your fingers along the axillary border—the lateral edge of the scapula.
- Move your fingers superiorly along the lateral edge of the scapula to the flattened acromion process area that articulates with the clavicle.
- From the acromion process, move your fingers slightly inferiorly and medially along the bony ridge called the scapular spine. It runs from the acromion toward the vertebrae.
- On the anterior surface locate the coracoid process inferior to the acromioclavicular joint and deep to the pectoralis major muscle.

### Activity #2

Palpate bony landmarks of the humerus.

- Place your fingers inferiorly to the acromion process on the anterior surface while laterally rotating the humerus to palpate the head of the humerus.
- With your fingers in the same area, medially rotate the humerus to feel the greater tubercle move under your fingers.
- Place your fingers medial to the greater tubercle while laterally rotating the humerus to feel the lesser tubercle.
- Place your fingers between the greater and lesser tubercle to feel the bicipital (intertubercular) groove.

### Activity #3

Palpate each one of the rotator cuff muscles on a colleague.

#### *Supraspinatus*

- In prone, find the spine of the scapula.
- Roll superiorly into the supraspinatus fossa.
- Follow the supraspinatus under the acromion to the distal attachment at the greater tubercle of the humerus.
- Resist shoulder abduction to confirm.

#### *Infraspinatus*

- In prone, find the spine of the scapula.
- Roll inferiorly into the infraspinatus fossa.
- Follow the infraspinatus laterally to the greater tubercle of the humerus.
- Resist shoulder external rotation to confirm.

### *TERES MINOR*

- In prone, with the arm over the side of the table, identify the inferior angle of the scapula and follow the lateral border superiorly toward the axilla.
- When at the superior portion of the lateral border of the scapula, slide laterally onto the infraspinatus.
- Resist shoulder external rotation to confirm.

### *SUBSCAPULARIS*

- In side-lying, flex the shoulder to 90 degrees.
- Slide your thumb into the axilla between the ribs and the scapula.
- Flex your thumb to ease into the subscapular fossa and palpate the subscapularis.
- Resist shoulder internal rotation to confirm.

## Lesson 9: The Elbow Complex

### Activity #1

- With your elbow in extension, identify the epicondyles of the humerus and the olecranon of the ulna. Note how the three structures are in a straight line.
- What happens to this alignment with elbow flexion? Why does this happen?
- Does the alignment of these structures change with pronation or supination? Why or why not?

### Activity #2

- With your elbow flexed, place your fingers on the lateral aspect of the forearm distal to the elbow joint to palpate the head of the radius while supinating and pronating the forearm.
- What arthrokinematic motion is occurring at the radial head during supination and pronation of the forearm?

## Lesson 10: The Wrist and Hand Complex

### Activity #1

Practice this sequence to palpate the carpal bones.

#### *Proximal row—scaphoid, lunate, triquetrum, pisiform*

- **Scaphoid:** Begin at the radial styloid and slide your finger distally and slightly posteriorly, reaching the hollow space between the extensor pollicis longus and brevis.
- **Lunate:** Slide laterally from the scaphoid onto the lunate; you will know you are on the lunate if you feel the bone move anteriorly with wrist extension.
- **Triquetrum:** Slide laterally again onto the triquetrum. You will know you are on the triquetrum if you are immediately distal to the ulnar styloid. If you abduct the wrist, the triquetrum protrudes, and when you adduct the wrist, it will disappear.
- **Pisiform:** Find the distal medial joint line of the wrist and move slightly distally and onto the pea-shaped projection.

#### *Distal row—trapezium, trapezoid, capitate, hamate*

- **Trapezium:**
  - Option 1: Locate the scaphoid and move distally along the first ray.
  - Option 2: Identify the first metacarpal and move proximally onto the trapezium.
- **Trapezoid:**
  - Option 1: Locate the scaphoid and move distally along the second ray.
  - Option 2: Identify the second metacarpal and move proximally to the trapezoid.
- **Capitate:**
  - Option 1: Locate the lunate and move distally along the third ray.
  - Option 2: Identify the third metacarpal and move proximally to the capitate.
- **Hamate:**
  - Option 1: Locate the triquetrum and move distally along the fourth and fifth rays.
  - Option 2: Identify the space between the fourth and fifth metacarpals and move proximally onto the hamate. On the anterior surface, if you locate the pisiform, move slightly distally on an angle toward the index finger and onto the hook of the hamate.

## Activity #2

Identify the medical epicondyle of the elbow. Now trace the path of each of the wrist flexor muscles.

### *Flexor carpi radialis*

- With the forearm in supination, resist wrist flexion.
- Identify the most lateral tendon at the wrist; this is the flexor carpi radialis (FCR).
- Confirm that you are on the FCR by recruiting it to abduct the wrist.
- Now trace this tendon back to the medial epicondyle.

### *Palmaris longus*

- With the forearm in supination, resist wrist flexion.
- Identify the second tendon from the lateral side of the wrist; this is the palmaris longus. (Take note that some people do not have a palmaris longus.)
- Trace this tendon back to the medial epicondyle.

### *Flexor digitorum*

- With the forearm in supination, place your fingers in the middle of the wrist, just proximal to the joint line.
- Wiggle the fingers like you are playing the piano; the tendon that is moving is the flexor digitorum.
- Trace this tendon back to the medial epicondyle.

### *Flexor carpi ulnaris*

- With the forearm in supination, resist wrist flexion.
- Identify the most medial tendon at the wrist; this is the flexor carpi ulnaris (FCU).
- Confirm that you are on the FCU by recruiting it to adduct the wrist.
- Trace this tendon back to the medial epicondyle.

## Activity #3

Identify the lateral epicondyle of the elbow. Now trace the path of each of the wrist extensor muscles.

### *Extensor carpi radialis longus (ECRL)*

- With the forearm in pronation, resist wrist extension.
- Identify the ECRL at the lateral epicondyle of the humerus.
- Confirm that you are on the ECRL by having the wrist extend toward the thumb side of the hand.

### *Extensor carpi radialis brevis (ERCB)*

- With the forearm in pronation, resist wrist extension.
- Confirm that you are on the ECRB by palpating the tendon on the dorsal surface of the wrist proximal to the third metacarpal.

### *Extensor carpi ulnaris (ECU)*

- With the forearm in pronation, resist wrist extension with ulnar deviation.
- Confirm that you are on the ECU by palpating the tendon on the dorsal surface of the wrist between the ulnar styloid process and the fifth metacarpal.

## Lesson 11: The Pelvis and Hip

### Activity #1

Palpate the bony landmarks of the pelvis and hip.

- Place your hands on the top margins of the pelvis to palpate the iliac crests.
- With your hands on the iliac crests, move them posteriorly and medially to the "dimples" on each side to palpate the posterior superior iliac spine (PSIS).
- Move inferiorly from the PSIS to palpate the protuberance, which is the posterior inferior iliac spine (PIIS).
- Have a partner flex the hip, while you move your fingers up the posterior thigh to the ischial tuberosity. It is the large protuberance on the inferior buttock.
- Place your hands on the iliac crests. Move them anterior and medially to palpate the protuberance of the anterior superior iliac spine (ASIS). The projection inferior to the ASIS is difficult to palpate because it is deep to muscle—the anterior inferior iliac spine (AIIS).
- Place your fingers on the proximal lateral femur and palpate the protuberance that rolls under your fingers as the femur is rotated medially and laterally.

### Activity #2

While supine, locate the following muscles.

#### *Iliopsoas*

- Palpate deep and just distal to the inguinal ligament.

#### *Rectus femoris*

- Move laterally to the iliopsoas to the AIIS and follow to the patellar tendon.

#### *Sartorius*

- Palpate the ASIS and distally as the muscle descends inferiorly and medially crossing diagonally across the thigh.

#### *Adductor group*

- Palpate on the medial aspect of the thigh; it may be difficult to delineate each specific muscle.

## Lesson 12: The Knee

### Activity #1

Palpate the bony landmarks of the knee.

- Above the knee joint space, trace the femoral shaft inferiorly to palpate the bony prominence of the medial femoral condyle on the medial aspect of the femur.
- Move your fingers immediately below the joint space to palpate the medial tibial condyle.
- Repeat the tracing of the femoral shaft inferiorly on the lateral aspect of the femur to palpate the lateral femoral condyle before crossing the joint line to the lateral tibial condyle.
- Move laterally to the lateral tibial condyle to palpate the head of the fibula.
- From the lateral tibial condyle move your fingers medially to the mid-shaft of the tibia to palpate the tibial tuberosity.
- Locate the patella on the anterior aspect of the knee superior to the tibial tuberosity in the patellar tendon.

### Activity #2

- In supine, locate the vastus lateralis on the lateral portion of the thigh and follow to the patellar tendon.
- In supine, locate the vastus medialis on the medial portion of the thigh and follow to the patellar tendon.

### Activity #3

Follow the path of each of the muscles.

- In prone, locate the ischial tuberosity and move distally. This is the common tendon of the hamstrings.
- On the lateral aspect of the posterior femur is the biceps femoris.
- Resist knee flexion while palpating laterally to confirm proper identification.

#### *Semitendinosus*

- In prone, locate the ischial tuberosity and move distally. This is the common tendon of the hamstrings.
- On the medial aspect of the posterior femur are the semitendinosus and semimembranosus. The semitendinosus is the more superficial of the two muscles and has a very long tendon.

#### *Gracilis*

- The gracilis is medial to the semitendinosus.
- The proximal attachment of the gracilis is the pubic tubercle; it blends in with the semitendinosus and sartorius to attach to the proximal medial shaft of the tibia as a common tendon—the pes anserinus tendon.

#### *Sartorius*

- The sartorius is medial to the gracilis and wraps around from the anterior surface of the femur.
- It begins at the ASIS and blends with the semitendinosus and gracilis to attach to the proximal medial shaft of the tibia as a common tendon—the pes anserinus tendon.

### *Semimembranosus*

- In prone, locate the ischial tuberosity and move distally. This is the common tendon of the hamstrings.
- On the medial aspect of the posterior femur are the semitendinosus and semimembranosus. The semimembranosus is deep to the semitendinosus.

## Lesson 13: The Ankle and Foot Complex

### Activity #1

Palpate the bony landmarks of the ankle.

- Follow the fibular shaft inferiorly to the bony prominence of the lateral malleolus.
- Follow the tibial shaft inferiorly to the bony prominence of the medial malleolus.
- Bisect the medial and lateral malleolus to locate the talus.
- Cup the heel on the posterior aspect of the foot to locate the calcaneus.

### Activity #2

Practice palpating the five tarsals.

#### *Navicular*

- Identify the medial and lateral malleoli; the bone between the malleoli is the talus.
- Move medially and distally onto the navicular bone.
- Confirm that you are on the navicular bone by resisting plantar flexion and inversion.
- The navicular is the attachment of the posterior tibialis.

#### *Cuboid*

- The cuboid has six surfaces; it is similar to the hamate of the wrist.
- Identify the styloid process of the fifth metatarsal and follow the lateral border of the foot proximally onto the cuboid bone.

#### *Medial cuneiform*

- From the navicular bone, move distally along the medial border of the foot to the medial cuneiform.
- Confirm that you are on the medial cuneiform by continuing distally to the first metatarsal.

#### *Intermediate cuneiform*

- From the medial cuneiform, move laterally to the intermediate cuneiform.
- Confirm that you are on the intermediate cuneiform by continuing distally to the second metatarsal.

#### *Lateral cuneiform*

- From the intermediate cuneiform, move laterally to the lateral cuneiform.
- Confirm that you are on the lateral cuneiform by continuing distally to the third metatarsal.

### Activity #3

- Locate the posterior aspect of the lower leg in the upper-third region to palpate the gastrocnemius.

- Palpate the tibialis posterior, flexor hallucis longus, and flexor digitorum longus tendons posterior and inferior to the medial malleolus.
- Locate the tibialis anterior along the anterior lateral aspect of the tibia and its tendon as it crosses anteriorly on the medial aspect of the ankle.
- Palpate fibularis longus and fibularis brevis posterior and inferior to the lateral malleolus.

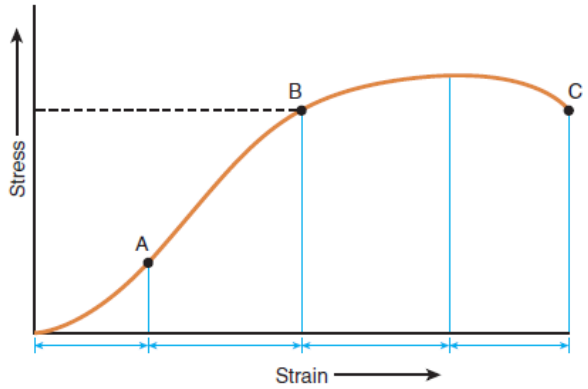
# Appendix B: Recommended Answers to Generation Exercises

Use these answers as a guide for grading your students' responses to the generation exercises.

## Lesson 1: Principles of Kinesiology and Biomechanics

### Exercise #1

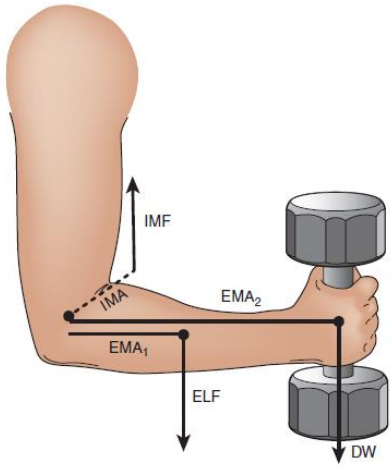
This figure shows a stress-strain curve for connective tissue.




- What is the region between point A and point B called? *Elastic region*
- When a stretch is applied to the hamstring muscles and the stretch (stress) falls within the region between point A and point B, will there likely be a change in the hamstring length and flexibility when the stretch (stress) is removed? *The stress applied to the hamstrings between these two points will most likely not produce a change in muscle length and flexibility. The muscle can show characteristics of creep, in which the length increases during the application of stress but returns to its original shape after the stress is removed.*
- What happens to the tissue at point C when the stress-strain on the tissue reaches this level? *When connective tissue has reached the ultimate yield point due to the stress applied, tissue failure occurs, resulting in structural damage to the tissue.*
- A person sustains a lateral ankle sprain that results in ligament microtears. Where on the stress-strain curve would the strain of the ligament structures have occurred? *Point C on the curve, which represents the ultimate yield point of the tissue*

## Exercise #2

This figure shows the internal force produced by the biceps muscle (IMF) and the external force produced by the weight of the arm (ELF) and the dumbbell (DW). IMA is the internal moment arm and EMA1 and EMA2 are the external moment arms.

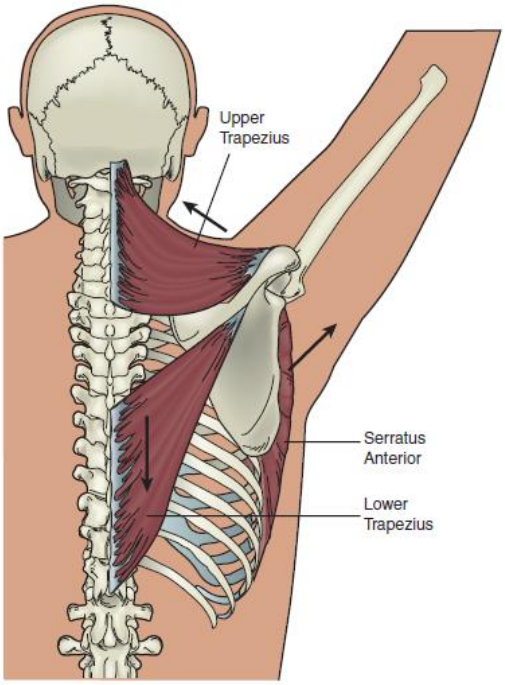



IMA = 0.25 ft
EMA1 = 0.8 ft
ELF = 5 lb
EMA2 = 1.5 ft
DW = 5 lb

- How much force will the biceps muscle need to generate to maintain the elbow in the static position shown in the diagram?
  IMF × IMA = EMA1 × ELF + EMA2 × DW
  IMF × 0.25 ft = 0.8 ft × 5 lb + 1.5 ft × 5 lb
  IMF × 0.25 ft = 4 ft lb + 7.5 ft lb
  IMF × 0.25 ft = 11.5 ft lb
  IMF = 11.5 ft lb/0.25 ft
  IMF = 46 lb
- How much force does the biceps muscle (IMF) need to generate to increase elbow flexion while lifting the weight? Greater than *46 lb*

## Exercise #3

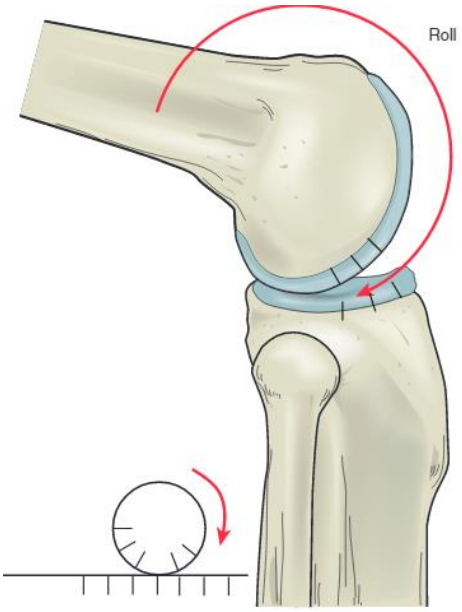
The figure represents active shoulder flexion, with the scapula upwardly rotating as the upper and lower trapezius and serratus anterior muscles work as a force couple.




- If the scapula did not rotate due to a malfunction of the force couple muscles, how would the scapular component of the shoulder joint change? *The glenoid fossa, which is the portion of the scapula that forms one side of the shoulder joint, would not stay aligned with the head of the humerus.*
- How might this scapular dysfunction interfere with arm movement? *The arm would not be able to elevate through the full range of motion because the motion of the head of the humerus would be limited by the acromion of the scapula.*

## Lesson 2: Structure and Function of Joints

### Exercise #1

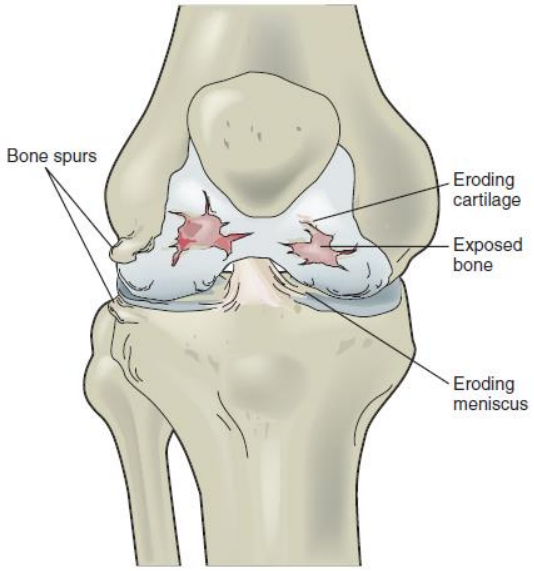



The figure represents movement of the femur on the tibia. Use the figure to answer the following questions.

- Is the movement open-kinematic-chain movement or closed-kinematic-chain movement? *The figure illustrates closed-kinematic-chain movement because the tibia is stationary and the femur is moving on the distal segment.*
- In what directions are the arthrokinematic motions of rolling and gliding occurring? *Rolls anteriorly and glides posteriorly*
- What osteokinematic motion is occurring at the joint? *Knee extension*
- In what plane and around what axis is the motion occurring? *Sagittal plane; frontal axis*
- What functional activity requires this specific type of movement at the knee joint? *Moving from sitting to standing during which the distal segments—the feet and lower limb—are stationary while the proximal femur moves the knee into extension*

### Exercise #2

The figure displays degenerative changes that can occur at the knee joint in response to stresses.

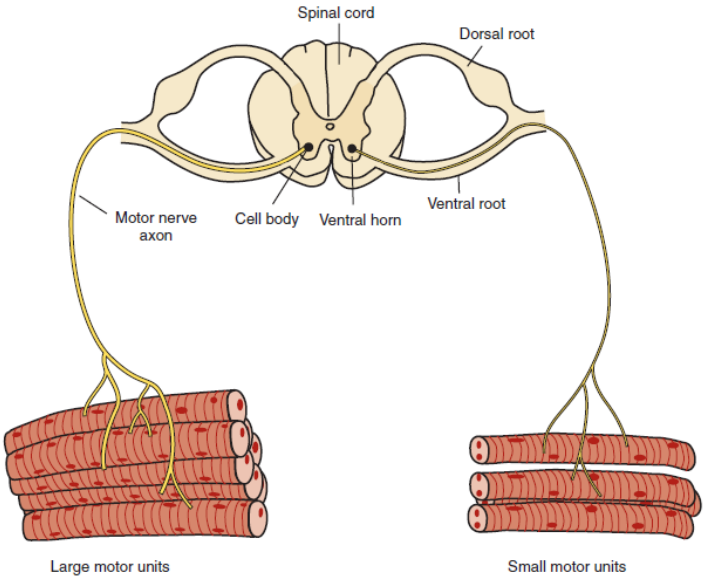



- What type of external forces could contribute to the erosion of the cartilage and meniscus? *Compression forces due to increased body weight can contribute to this type of damage. A sudden external torsion force could result in injury to the meniscus. Excessive friction between joint surfaces, often due to increased compression of the two surfaces, could also play a role. It is not likely that a distraction or elongation force would be involved.*
- What is the likelihood that these structures will heal? Why or why not? *Because of the poor blood supply of the structures, there is a high probably that they will not heal. Severe damage to the articular cartilage of the knee can often result in the need for a surgical total knee replacement. Often the damaged portion of the meniscus must be surgically removed.*
- Why will the exposed bone likely increase the amount of pain experienced by the person who has this condition? *Articular cartilage itself is aneural in comparison to the periosteum around the underlying bone. The bony surface with its increased innervation will transmit pain impulses to the brain.*

## Lesson 3: Structure and Function of Muscles

### Exercise #1

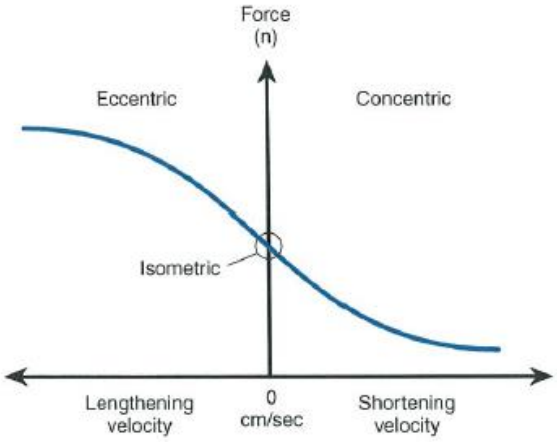
The figure represents large and small motor units. Use the figure to answer the following questions.




- Which type of motor unit is MOST LIKELY recruited for lifting heavy loads? What type of muscle fibers are MOST LIKELY being recruited? *Large motor units; type II muscle fibers*
- Which type of motor unit would MOST LIKELY be recruited in the fingers when playing the piano? *Small motor units*
- Which motor unit tends to recruit type I fibers for holding the trunk erect in sitting? *Small motor units*

## Exercise #2

The graph depicts the relationship between speed of contraction and ability to produce force. Use the graph to answer the following questions.




- What happens to the ability of a muscle to generate a force during a concentric contraction as the speed of contraction increases? How would this concept apply to instructions you would give to someone who is lifting weights to increase strength? *During a concentric contraction, the ability to generate force decreases as speed increases. People exercising to increase strength should slow the speed of contraction during concentric work. They should slowly lift the amount of weight (below any symptom provocation) that challenges the movement.*
- As the speed slows to the point the muscle is isometrically contracting, compare the force it can generate to the force generated by a concentric contraction. *Typically, muscles are able to generate a greater force during an isometric contraction compared to a concentric contraction.*
- How does increased speed affect the ability of a muscle to generate force during an eccentric contraction? How would this concept apply to instructions you would give to someone who is lifting weights to increase strength? *Eccentric muscle contractions are able to increase force as the speed of contraction increases until a point where there is a plateau of force. People exercising to increase strength need to increase the speed of the eccentric portion of the activity compared to the concentric portion.*

## Exercise #3

Watch the Active Insufficiency video in the video library. Use the demonstration in the video clip to answer the following question.

- How does the wrist position affect the grip strength when using a hammer to produce a large force? *Holding a hammer (or any object) with a power grip requires the wrist to be in a position of slight extension. As the wrist moves into flexion, the wrist extensors are over-lengthened and cannot produce the muscle force that can be produced when the muscles are at an optimal length. The wrist extensors become actively insufficient as the wrist is positioned in flexion.*

### Exercise #4

Watch the Passive Insufficiency video in the video library. Use the demonstration in the video clip to answer the following question.

- How could a person with paralysis of the fingers use passive insufficiency to grip and release an object? *Using the concept of passive insufficiency, during wrist extension the finger flexors are stretched over the wrist and fingers. As the finger flexor tendons stretch, they become passively insufficient and can no longer lengthen. The fingers begin to flex, not due to an active contraction of the finger flexors, but due to them being unable to passively be stretched further. A person who does not have the ability to grasp an object such as a hairbrush by activating finger flexor muscles can actively extend the wrist causing the finger flexors to be stretched over the wrist and fingers. As they become passively insufficient, the finger flexors will passively flex the fingers around the handle of the brush.*

## Lesson 4: Additional Biomechanical Principles

### Exercise #1

A. B.

Taking into account moment arms and internal and external forces, follow the directions below and answer the following questions.

- Identify the knee joint axis, the moment arm of the quadriceps, and the moment arm of the lower limb and cuff weight in each photograph.
- Which photograph displays the longest moment arm for the lower limb and cuff weight? *A.*
- Which placement of the cuff weight will require more force from the quadriceps to move it? *A.*
- Which placement of the cuff weight will be easier for the person to lift the weight? *B.* Why? *The moment arm of the external force is shorter; therefore, the total force the quadriceps will need to overcome is less.*
- To strengthen the quadriceps, which placement of the cuff is optimal if all other conditions are in place to promote strengthening of the quadriceps? *A.*

## Lesson 5: Structure and Function of the Spine

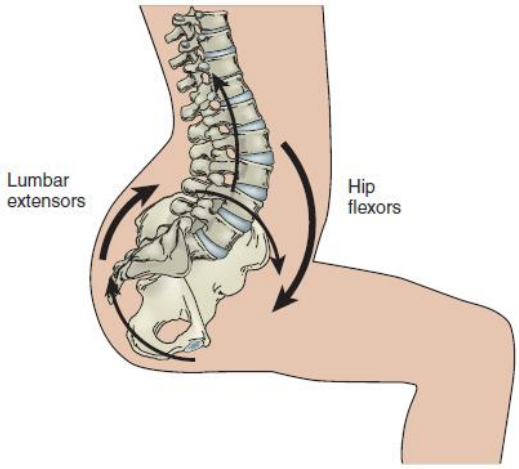
### Exercise #1

Analyze the posture of the person in the photo when answering the following questions.

- What is the term for the position and posture of the head and neck? *Forward head posture*
- What head and neck muscles may need strengthening to improve head and neck posture? *Deep occipital flexors and cervical extensors*
- What is the position of the thoracic spine? *Excessive thoracic kyphosis*
- What thoracic muscles may need strengthening to improve spinal posture? *Thoracolumbar trunk extensors*

### Exercise #2

If a person maintained the posture in the image over a period of time:




- What is the posture of the lumber spine? *The lumbar spine is in extension with an excessive lumbar lordosis.*
- Will the lumbar spine become tight in flexion or extension? *The lumbar spine will become tight in extension. The lumbar extensor muscles and soft tissue will need to be stretched.*

- How does this position affect the abdominal muscles? *The anterior abdominal muscles will be over-lengthened, become weaker, and will require strengthening to correct this excessive lumbar lordosis.*

### Exercise #3

Watch the Vertebral Column Assessment video in the video library. Then answer the questions below.

- What functional activities may be hindered for the person with this limited range of motion? *Looking over the shoulder when driving a car, turning the head to move the eyes to see an object rather than turning the entire trunk to see the object.*
- Why did the therapist focus treatment on improving the arthrokinematic motion of the atlanto-axial joint? *The arthrokinematic motion of a joint must be obtained before a joint can perform the osteokinematic motion of the joint. The atlas must be able to spin around the axis in order to obtain cervical rotation. This joint function is essential for cervical rotation because the majority of cervical rotation occurs at this joint.*

### Exercise #4

Watch the video Squat vs. Stoop Lifting in the video library, and answer the following questions.

- During a squat lift, what is the position of the spine? *The spine is extended.*
- During a squat lift, what is the direction disc material is MOST LIKELY to be directed? *The disc material will move in an anterior direction away from peripheral nerve roots.*
- During a stoop lift, what is the position of the spine? *The spine is flexed.*
- During a stoop lift, what is the direction disc material is MOST LIKELY to be directed? *The disc material will move in a posterior direction toward peripheral nerve roots.*

## Lesson 6: Structure and Ventilation Function of the Thorax

### Exercise #1

- How does the "bucket-handle" movement of the ribs affect inspiration? *As the ribs move up and outward during inspiration, the intrathoracic volume is increased. This increased volume results in decreased pressure compared to the pressure in the external environment atmosphere. Because gasses move from higher pressures to lower pressures, the air moves from the external environment into the lungs.*
- If the rib cage became immobile, what influence might these restrictions have on the person's ability to perform daily activities such as bathing, dressing, or going up and down steps? *Without the ability to expand the rib cage, the intrathoracic volume would not increase as much and the amount of airflow into the lungs would be decreased. Muscles and organs would not have the oxygen needed to perform tasks at the rate and intensity that could be done in a healthy state. This thoracic cage immobility would decrease the ability to expire appropriate volumes of air resulting in an increase in residual lung volumes. This would also hinder ventilation and decrease the amount of oxygen available for activities.*

### Exercise #2

Compare and contrast the ventilation of a healthy person and someone with chronic obstructive pulmonary disease (COPD). *In healthy ventilation, the diaphragm contracts and descends along with thoracic and abdominal expansion. These motions increase the intrathoracic volume and decrease its*

*pressure to facilitate airflow into the lungs. With COPD, the diaphragm tends to be flat and is unable to descend. The abdomen is pulled up and inward, which does not allow an increase in intrathoracic volume. The person attempts to increase lung volume by moving the upper ribs up and out.*

### Exercise #3

Watch the video titled Thoracic Kyphosis: Effects on Rib Expansion and Vital Capacity in the video library. Then answer the following questions.

- What lung volumes are the thoracic kyphotic posture MOST LIKELY to adversely affect? *The thoracic kyphosis compresses the rib cage and reduces the expansion of the lungs. Tidal volume and inspiratory reserve volume are likely to be reduced because there is decreased room for expansion of the lungs during inspiration.*
- How will these reduced volumes influence the functional abilities of the individual? *With the decrease in inspiratory lung volumes, the amount of oxygen available during each respiration for organ and muscle function will be reduced. The individual will need to increase the respiration rate to achieve adequate ventilation. This increased workload will increase the energy expenditure for a given activity.*

## Lesson 7: Structure and Function of the Temporomandibular Joint

### Exercise #1

Watch the TMJ Deviations video in the video library and review the image shown to answer the following questions.

- What is the osteokinematic motion occurring in the image? *Mandibular depression*
- What arthrokinematic motions must occur to achieve the osteokinematic motion? *The mandibular condyle rolls and glides anteriorly.*
- How would injury to the disc affect the arthrokinematic motions? *Without the mandibular condyle's ability to roll and glide anteriorly, the mandible would not be able to depress and open the mouth on the side of the disc injury. Rather than the mandible depressing in a vertical path, it would deviate to one side or not be able to open sufficiently. There would likely be pain and an audible clicking of the disc.*
- What functional activities may be hindered due to the disc injury? *Eating, talking, yawning*

## Lesson 8: Structure and Function of the Shoulder Complex

### Exercise #1

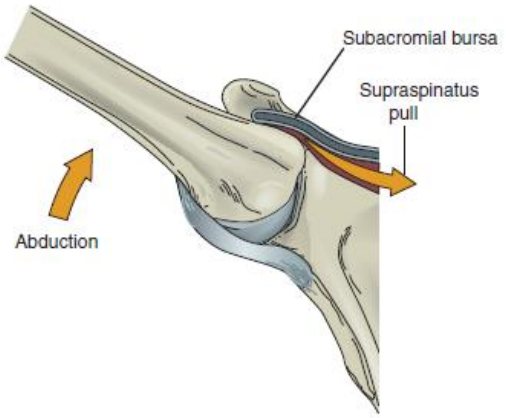
Watch the Shoulder Elevation video in the video library and answer the following questions.

- What is the primary movement of the scapulae to achieve shoulder elevation in the frontal plane (shoulder abduction)? *Upward rotation*
- What muscles work in synergy to produce this scapular movement? *Upper and lower trapezius and serratus anterior*
- If the serratus anterior muscle is weak, what position of the scapula would MOST LIKELY be noted? *Scapular winging*
- What is an open-chain movement that could be used to strengthen the serratus anterior? What is a closed-chain movement that could be used? *An open-chain movement that could be used is*

*scapular protraction. Closed-chain movements that could be used are wall or floor push-ups with elbows extended.*

### Exercise #2

Use the image shown to answer the following questions.




- What is the osteokinematic motion occurring in the image? *Glenohumeral (shoulder) abduction*
- What is the arthrokinematic direction of the roll of the humeral head needed to achieve the osteokinematic motion? *The humeral head must roll superiorly to achieve full range of humeral abduction without impinging structures in the subacromial space.*
- What is the arthrokinematic direction of the slide of the humeral head needed to achieve the osteokinematic motion? *The humeral head must glide inferiorly to achieve full range of humeral abduction without impinging structures in the subacromial space.*
- Name functional activities that MOST LIKELY require this motion at the shoulder. *Combing hair, reaching upward, sports-related activities*

## Lesson 9: Structure and Function of the Elbow Complex

### Exercise #1

- Identify the attachments of the triceps muscle. *Proximal attachments = long head – infraglenoid tubercle of the scapula, lateral head – posterior surface of proximal humerus, medial head – posterior surface of distal half humerus; distal attachments = olecranon process of the ulna.*
- Identify the three motions of the triceps muscle. *Extension of the shoulder, extension of the elbow, and the long head adducts the shoulder.*
- What is the position of maximal force generating capacity? Why? *Neutral shoulder with midrange elbow flexion; this is the optimal length-tension relationship for maximal triceps force production.*
- What is the position of active insufficiency? *Position in which the triceps is maximally shortened = full shoulder and elbow extension.*
- What is the position of passive insufficiency? *Position in which the triceps is maximally lengthened = full shoulder and elbow flexion.*

### Exercise #2

- Identify the surfaces of the elbow articulations. *Distal humerus and proximal ulna*
- Which joint partner is convex? Which in concave? *The humerus is convex, and the ulna is concave.*
- In open-chain flexion of the elbow, in which direction does the ulna glide on the humerus? *Anterior glide (concave on convex)*
- Does this change with closed-chain motions? If so, how? If not, why? *Yes. Due to reverse muscle action, the humerus moves on the ulna (convex on concave).*

## Lesson 10: Structure and Function of the Wrist and Hand Complex

### Exercise #1

Using a blood pressure cuff rolled up and inflated to 30 mm Hg, explore the strength of gripping with the wrist in varying degrees of flexion and extension. In what wrist position is the grip the greatest? Why? *Grip is greatest with wrist extension with ulnar deviation because of the length-tension relationship of the multi-articulate muscles of the wrist and hand. Wrist extension helps to take up the slack of the finger flexors to prevent active insufficiency.*

### Exercise #2

If an individual is lacking wrist extension after a radial fracture, which direction should a clinician glide the proximal carpals on the distal radius to enhance motion? Why? *Glide anteriorly because convex proximal carpals will glide posteriorly and roll anteriorly on concave distal radius.*

## Lesson 11: Structure and Function of the Hip Complex

### Exercise #1

- When lowering a box to the floor, what type of muscle action is being performed at the hips? *Eccentric hip extension*
- What muscles are responsible for this motion? *Gluteus maximus, biceps femoris, semitendinosus, and semimembranosus*
- Genu valgus is an undesirable component of a squat. What muscles of the hip are important to prevent genu valgus? *Hip external rotation (ER) is an effective way to control genu valgus. The muscles responsible for hip ER are gluteus maximus; superior fibers of the piriformis, obturator internus, and externus; gemellus superior and inferior; and posterior fibers of gluteus medius.*
- When performing a squat, how can you prevent excessive stress on the knees with increasing knee flexion? *Keep the knees behind the toes; if you are more concerned about reducing the stress on the hip, allowing the knees to pass anteriorly to the toes is acceptable.*

### Exercise #2

- Which muscle(s) become passively insufficient to prevent further hip flexion in this position? *The hamstrings, consisting of the biceps femoris, semimembranosus, and semitendinosus, are passively insufficient in this position.*
- How does this passive insufficiency increase as further hip flexion is attempted in this position? *The hamstrings become passively insufficient due to their two joint attachments. They attach on the ischial tuberosity of the pelvis and below the knee on the fibula and tibia. In the image, the muscles are stretched over the hip and over the knee joint.*

- What position would allow an increase in hip flexion? *Hip flexion would be increased if the distal attachments of the hamstrings were put on slack by flexing the knee.*
- What possible exercise could the model do on a regular basis to increase the amount of hip flexion available in this position? *By increasing the length of the hamstrings through a regular stretching program, the amount of hip flexion available with knee extension is most likely to increase the amount of hip flexion available in this position.*

### Exercise #3

- What function do adductor magnus and adductor longus perform as the right hip begins to move from the position shown into extension? *Adductor magnus and adductor longus become hip extensors as the hip moves from end-range flexion into extension.*
- What other muscles will likely activate to produce hip extension? *Gluteus maximus and the hamstrings provide hip extension during this activity.*
- Why is it possible for a runner to sustain inner-thigh muscle strains when running up hills? *During instances of heavy resistance, such as moving one's body weight up a hill during running, the adductor group assists with hip extension at the end range of hip flexion and assists with hip flexion at the end range of hip extension. This continuous work of the muscle group against heavy loads could result in muscle injury, especially for the untrained runner or one who runs with poor technique.*

## Lesson 12: Structure and Function of the Knee

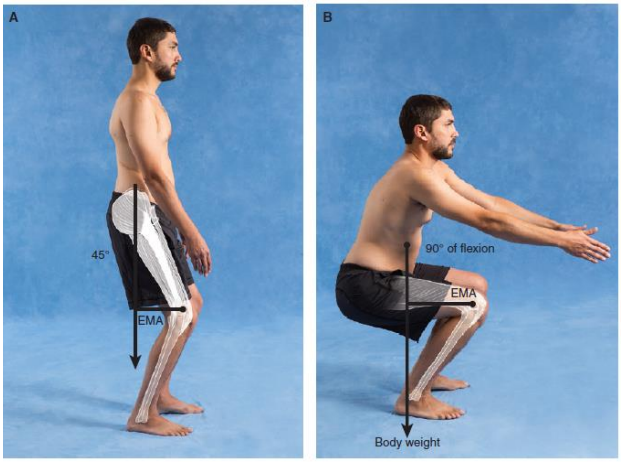
### Exercise #1

- An athlete had an anterior cruciate ligament reconstruction. The athlete has decreased knee flexion. Given the structure of the joint surfaces, in what direction should you glide the tibia to facilitate knee flexion? *In open kinetic chain, the concave tibia will roll and glide posteriorly on the femur for knee flexion. Gliding the tibia posteriorly will enhance knee flexion.*
- Does this change if the femur is mobilized on the tibia? *Yes. If the femur is moved on the tibia, the arthrokinematics are now convex on concave. That means the femur will roll posteriorly and glide anteriorly during closed kinetic chain knee flexion.*

Exercise #2

- What hip and knee muscles are activated to perform this functional movement? *The gluteus maximus and hamstrings are activated to extend the hips while the quadriceps extend the knee.*
- What type of contraction is being performed by the muscles producing the motion at the hip and knee? *The muscles are performing a closed-chain concentric contraction of hip and knee extension.*
- What arthrokinematic motions are occurring at the knee joint? *The femur is rolling anteriorly and gliding posteriorly. At terminal extension, the femur slightly medially rotates.*

Exercise #3




- Which position results in the greatest force into the patellofemoral joint? *Position B would produce the greatest force into the patellofemoral joint.*
- Why is there more force into the joint with the change in position? *As the knee increases in flexion, there is greater contact of the patella in the femoral groove. In addition, the moment arm of the quadriceps is increased with increased flexion, which results in an increase in the amount of torque force produced by the quadriceps.*

- If a person is experiencing infrapatellar discomfort, which position should MOST LIKELY be avoided during strengthening exercises? *Position B should be avoided because in this position the greatest amount of stress is applied to the patellofemoral joint.*

## Lesson 13: Structure and Function of the Ankle and Foot Complex

### Exercise #1

Given the common nature of lateral ankle sprains:

What is the common motion that would stress the lateral ligaments? *Talocrural inversion*

What additional motions would isolate the following ligaments?

- Anterior talofibular: *Most often injured with inversion and plantar flexion (e.g., stepping in a hole or on someone's foot)*
- Calcaneofibular: *Stabilizes the talus in the mortise; prevents inversion and dorsiflexion*
- Posterior talofibular: *Prevents inversion and dorsiflexion*

Palpate each of these ligaments, and perform the appropriate motions to stress each ligament.

### Exercise #2

An individual experienced an Achilles tendon injury and now presents with limited ankle dorsiflexion. What are the arthrokinematics that would be helpful to restore this motion? *The convex talus rolls anteriorly and slides posteriorly on the concave tibial mortise.*

### Exercise #3

Watch the Normal Motion of the Ankle and Foot in Stance video in the video library, and answer the following questions.

- Which motion of the calcaneus is associated with unlocking of the subtalar joint? *Calcaneal eversion is a component of pronation, which unlocks the subtalar joint.*
- What function of the foot does unlocking of the subtalar joint provide? *Unlocking the subtalar joint increases the mobility of the foot, allowing it to adapt to uneven and various terrains during the stance phase of walking.*
- What motion of the calcaneus is associated with locking of the subtalar joint? *Calcaneal inversion is a component of supination, which locks the subtalar joint.*
- What function of the foot does locking of the subtalar joint provide? *Locking the subtalar joint transforms the foot into a rigid lever that contributes to push-off of the foot and limb to propel the body forward during walking.*

## Lesson 14: The Kinesiology of Gait

### Exercise #1

- Name the phase of gait for the left lower extremity in the figure shown. *Heel strike or initial contact*
- Which muscles are acting eccentrically at the left ankle? *Ankle dorsiflexors*
- What is the moment of force at the left ankle? *Plantar-flexion moment*
- What type of contraction is occurring in the left quadriceps muscle? *Eccentric*

### Exercise #2

- Notice the brace on the person in the illustration shown. How might the brace help with gait at the ankle? *During swing phase, it can prevent plantar flexion of the ankle and thus stop the foot from dragging.*
- How might the brace help with gait at the knee? *It can prevent the knee from snapping into hyperextension during stance phase.*
- What kind of gait might this person demonstrate if he was not wearing the brace? *Steppage gait; circumduction may also occur.*