Applied Anatomy and Physiology for Manual Therapists

Detailed Outline and Resources for Lesson Planning

Every teacher's lesson plan is different due to a number of variables including content, class length, personal teaching style, students' needs, available resources, and materials. This ancillary has been created to provide you with a detailed outline of the contents of *Applied Anatomy and Physiology for Manual Therapists* by chapter. Additional resources available to you through LWW as well as suggestions for presentation, learning exercises, and group activities are listed to help you put together an engaging and effective lesson plan for your class.

Chapter 6 — The Skeletal Muscle System

Learning Objectives:

Upon completion of this chapter, the student will be able to:

1. Give several examples of how knowledge of the muscular system is applied in manual therapy practice.
2. List and describe the key characteristics and functions of skeletal muscle.
3. Name and locate the major parts of a skeletal muscle.
4. Name and describe the distinguishing characteristics between fascia and tendons.
5. Describe the microscopic arrangement of a skeletal muscle fiber.
6. Name the parts of a motor unit and explain the role of each in muscle contraction.
7. Explain the key physiologic principles that govern the function of skeletal muscle, including sliding-filament mechanism, all-or-none response, threshold stimulus, and motor unit recruitment.
8. List and explain the three major types of muscle contraction.
9. Explain the three primary mechanisms of producing energy for muscle contraction.
10. Explain muscle fatigue and oxygen debt.
11. Name and describe the different types of fiber arrangements found in muscles of the body.
12. Name and describe the four major roles muscles play in creating and controlling movement.
13. Explain how muscles get their names.

14. Describe the general location of the major muscles and the prime function(s) of each.
15. Describe common skeletal muscle system changes associated with exercise and aging and explain their implications for manual therapy practices.

Detailed Outline	Obj	Text pages	PPt slides	S&RG	Additional Resources and Sample Activities
Characteristics and functions of skeletal muscle ● List and describe the characteristics of skeletal muscle: ○ Excitable ○ Contractile ○ Extensible ○ Elastic ● List and explain the functions of skeletal muscle: ○ Movement of body parts ○ Posture ○ Stabilization of joints ○ Production of heat	2	118	1-4	Ex 1	Have students form pairs and explain the different characteristics of muscle to one another to be sure they can distinguish each.
Structure of skeletal muscle ● Each skeletal muscle is an organ comprised of muscle tissue and fibrous connective tissue ● Describe the macroanatomy of a muscle (Fig 6-1): ○ Epimysium covers the entire muscle ○ Perimysium divides the muscle into fascicles (bundles of muscle cells/fibers) ○ Endomysium covers each individual muscle fiber ○ Muscle belly ○ Tendons ● Describe the microanatomy of a skeletal muscle fiber (Fig 6-2): ○ Multinucleated ○ Lots of mitochondria ○ Sarcolemma = plasma membrane of fiber ○ Sarcoplasm = cytoplasm ○ Sarcoplasmic reticulum = ER ○ Myofibrils = cylindrical organelles composed of	3,5	118-119	5-7	Ex 2,4; GrA 1	Provide a blank diagram of a muscle (S&RG Ch 6, Ex 2) for students to color and label as part of their note-taking. Build a model of a skeletal muscle using Red Vines for muscle fibers and elastic wrap for the different layers of fascia.

myofilaments ○ Myofilaments are organized in repetitive overlapping pattern forming sarcomeres ▪ Myosin (thick filament) ▪ Actin (thin filament) ▪ A bands (dark areas) ▪ I bands (light areas) ▪ Z lines (separate one sarcomere from another)					
Connective tissue components of skeletal muscle ● Disorganized (fascia) and organized (tendon) fibrous c.t. components found in muscles ● All these tissues have high number of collagen fibers made of the protein tropocollagen ● Ground substance is a viscous gel ● Define and describe fascia (Fig 6-3): ○ Includes epi-, peri-, endomysium ○ Fibers are widely spaced by ground substance in a multidirectional arrangement ○ Can withstand repeated bouts of multi-directional stresses ○ All layers actually contiguous ○ Function to attach skin to the muscles, compartmentalize muscle into fascicles, hold fibers together, lubricate fibers and fascicles, and transfer the force of contraction to the bones ● Define and describe tendon and aponeurosis (Fig 6-4): ○ Attach muscles to bone ○ Contain tightly packed parallel collagen fibers ○ Strong to withstand internal force of muscle contraction ○ Locate and describe transitional zones ▪ Tenoperiosteal junction ▪ Musculotendinous junction	4	119-122	8-10	Ex 1,3; GrA 1	Provide time for students to compare and contrast fascia and tendons. Ask them to share their thoughts and create a Venn diagram (S&RG Ch 6, Ex 3) together to track their responses.
Physiology of muscle contraction ● Describe the sliding filament mechanism (Fig 6-5):	7	122-123	11	Ex 1,5; GrA 1	Build a moving example of the sliding filament mechanism. Have some people serve as myosin filaments and others serve as actin filaments. Give the myosin

○ Requires stimulation by nervous system ○ Involves the sarcomeres (smallest units of contraction) ○ Stimulation causes: ▪ Stored Ca^{2+} to be released into sarcoplasm ▪ Ca^{2+} exposes binding sites on actin ▪ Myosin binds to actin, forming cross-bridges ▪ ATP used to detach myosin, which flips to next binding site (sliding) ▪ Stimulus removed and ATP used to pump Ca^{2+} out of sarcoplasm ● Describe the length-strength ratio					filaments sticks or bolsters to attach and "row past" the actin filaments.
Stimulating muscle contraction ● Interface between the nervous and muscular system is the motor unit ● Define and describe the motor unit (Fig 6-6): ○ Neuromuscular junction ○ Motor end plate ○ Neurotransmitters ● Physiologic principles of contraction include: ○ Threshold stimulus ○ All-or-none response ○ Graded response/motor unit recruitment	6,7	123	12	Ex 1,5; GrA 1	Ask students to think of analogies, stories, songs, or poems for the physiologic principles. For example, the threshold could be the threshold of a room or building where something they really want resides. If they get in (reach the threshold), they get it all; if they don't step over the threshold, they get none. Give them time to be creative. Use video animation of muscle contraction to show the parts and function of the NMJ.
Energy for muscle contraction ● Contraction requires ATP ● Some ATP is stored in the muscle, but only enough for a few seconds ● Describe the 3 ways to produce ATP for contraction: ○ Direct phosphorylation using creatine phosphate (Fig 6-7) ○ Anaerobic cellular metabolism (Fig 6-8), also called glycolysis ○ Aerobic cellular metabolism (Fig 6-8), also called Krebs or citric acid cycle (define myoglobin) ● Define muscle fatigue and list possible causes: ○ Lack of O_2	9,10	123-126	13-16	Ex 1,6,7	Provide students a blank diagram of the methods of energy production (S&RG Ch 6, Ex 6) to color and fill out as you lecture and review the information. Provide a table for them to complete (S&RG Ch 6, Ex 7) or have them create a mind map to organize the key information about energy production for muscle contraction.

○ Decreased Ca^{2+} supply ○ Depletion of glycogen or other fuels ○ Lactic acid or ADP build-up ○ Insufficient release of neurotransmitter ● Define oxygen debt					
Types of muscle contraction ● All contractions: ○ Produce tension or pulling force at the muscle's attachments ○ Cause bunching or broadening of the muscle belly ○ May or may not produce shortening ● Define and describe the types of muscle contraction: ○ Tonic ○ Isometric (Fig 6-9) ○ Isotonic (Fig 6-9) ▪ Concentric ▪ Eccentric ○ Non-productive contractions ▪ Twitch or tic ▪ Fasciculation ▪ Tetanic	8	126-128	17-21	Ex 1; GrA 1	Review the difference between motor tone and muscle tone and relate to the practice of manual therapy. Refer students to the Pathology Alert: Muscle Cramps and Spasms. Discuss the application of this information to their practice of manual therapy.
Movement and muscle assignments ● Define origin and insertion (terms relate to function of the muscle) ● Describe lever systems: ○ Key components (fulcrum, resistance, force) ○ List and explain categories (Fig 6-10) ○ Identify mechanical rules of lever systems ▪ Muscle must originate and insert on different bones and creates movement in the joint(s) crossed ▪ Force of contraction pulls on the insertion ▪ Location and angle at which the muscle crosses the joint determine the specific movement produced ● Define and describe muscle architecture (Fig 6-11 and 6-12):	11,12	128-135	22-30	Ex 8,9,11; GrA 1	You may choose to skip information on lever systems, movement roles/assignments, and/or ROM, especially if you teach in a curriculum with a separate musculoskeletal anatomy or kinesiology course. Discuss practical application of muscle architecture information for the practice of manual therapy (importance of knowing fiber direction). Discuss practical application of ROM information for the practice of manual therapy. Practice performing PROM, AROM, and RROM with a classmate as if they are a client. Be sure they do PROM to feel and understand the different types. See S&RG Ch 6, GrA 3 for ideas.

○ Define and provide examples of parallel muscles (Fig 6-13A) ▪ Fusiform ▪ Circular ▪ Triangular ○ Define and provide examples of pinnate muscles (Fig 6-13B) ▪ Unipennate ▪ Bipennate ▪ Multipennate ● Define and describe each muscle role: ○ Agonist (prime mover) ○ Antagonist (define and relate to reciprocal inhibition) ○ Synergist ○ Stabilizer (fixator) ● Define and describe types of ROM: ○ PROM (end feel) ○ AROM ○ RROM					
Major muscles of the body ● List and provide examples of themes among muscle names: ○ Size (ex. magnus) ○ Shape (ex. rhomboids) ○ Function (ex. flexor digitorum) ○ Fiber direction (ex. obliques) ○ General location (ex. abdominis) ○ Origin or insertion (ex. SCM) ○ Number of origins (ex. biceps) ● Name and locate major muscles of the body (may include origin, insertion, action(s)): ○ Head and face (Fig 6-14 and Table 6-1) ○ Neck (Fig 6-15 and 6-16, plus Table 6-2) ○ Chest and abdomen (Fig 6-17 through 6-19, plus Table 6-3) ○ Paraspinals (Fig 6-20 and Table 6-4) ○ Back (Fig 6-21 and 6-22, plus Table 6-5) ○ Brachium (Fig 6-23 and Table 6-6)	13,14	135-159	31-49	Ex 10-13; GrA 1-4	Much of this information may be taught within a musculoskeletal anatomy or kinesiology course. Check out the S&RG for a variety of ways to review this information, including coloring, making models, making charts, using flashcards, and playing games like "Jeopardy" or sculpting statues. Note that innervations for the muscles are provided in Appendix B. Use Acland video 3.1.7 (3.1.7 Paravertebral muscles) to show the muscles of the paraspinal group and/or video 1.1.7 (1.1.7 Muscles passing from the scapula to the humerus) to show details of the rotator cuff.

○ Forearm (Fig 6-23 and Table 6-7) ○ Pelvic girdle (Fig 6-24 and 6-25, plus Table 6-8) ○ Thigh (Fig 6-24 and 6-25, plus Table 6-9) ○ Leg (Fig 6-26 through 6-28, plus Table 6-10)					
Exercise, aging, and the muscular system ● Identify common changes in the skeletal system related to exercise: ○ Muscle hypertrophy ○ Increased vascularity ● Identify common changes in the skeletal system related to aging: ○ Muscle atrophy ○ Dehydration changes connective tissue components ○ Decreased flexibility and stiffness ○ Diminished strength and endurance ○ Slowing of reflexes ○ Changes in muscle and motor tone	15	156, 160	50		Discuss with students how these changes may affect their manual therapy treatments when working with physically active clients. Discuss with students how these changes may affect their manual therapy treatments when working with the elderly.