UNITED STATES MARINE CORPS
FORCE FITNESS READINESS CENTER
THE BASIC SCHOOL
24191 GILBERT ROAD
QUANTICO, VIRGINIA 22134

STUDENT OUTLINE

BIOMECHANICS AND KINESIOLOGY II

FFIC1045

FORCE FITNESS INSTRUCTOR COURSE

M02MN1T

APPROVED BY: LtCol (Ret) Shusko, J. C. DATE: 20190426 INT:_____

LEARNING OBJECTIVES

a. TERMINAL LEARNING OBJECTIVES

(1) Given a unit to train, supervise injury prevention, to increase a Marine and units readiness. (0919-TRNG-2004s)

b. ENABLING LEARNING OBJECTIVES

(1) Without the aid of reference, identify biomechanics concepts without error. (0919-TRNG-2004ae)

(2) Without the aid of reference, identify the biomechanics of the foot and ankle without error. (0919-TRNG-2004af)

(3) Without the aid of reference, identify the phases of gait without error. (0919-TRNG-2004ag)

(4) Without the aid of reference, identify the biomechanics of the knee without error. (0919-TRNG-2004ah)

(5) Without the aid of reference, identify the biomechanics of the hip without error. (0919-TRNG-2004ai)

(6) Without the aid of reference, identify the biomechanics of the lumbar spine without error. (0919-TRNG-2004aj)

(7) Without the aid of reference, identify the biomechanics of the elbow without error. (0919-TRNG-2004ak)

(8) Without the aid of reference, identify the biomechanics of the shoulder without error. (0919-TRNG-2004al)

INTRODUCTION: Before understanding functional movements (combination of joint movement), it is important to understand the role of the individual joint. The Force Fitness Instructor will be better able to identify poor movement and prevent injury through a better understanding of this information.

1. BIOMECHANICS CONCEPTS.

a. Friction. Friction is the force that results from the resistance of two objects moving against one another. Depending on the sport, we may desire increased or decreased friction. In running, we depend on the friction forces between our feet and

the ground so we may exert force against the ground and propel forward. When friction is reduced, we are more likely to slip. To determine the amount of friction forces, we must consider both forces pressing against each other and coefficient of friction (depends on hardness and surface texture).

b. Balance. A body or object is said to be in equilibrium when a) the sum of the forces acting on it is equal to zero and also the sum of the torques acting on it is equal to zero. In other words, there are no unbalancing forces or torques. On the other hand, coaches and motor performance experts interpret balance as a condition in which a body or object is not linearly or angularly moving. It is stationary. In reference to the human body, if it is not "falling over" it is said to be in balance (e.g., a gymnast maintaining a handstand).

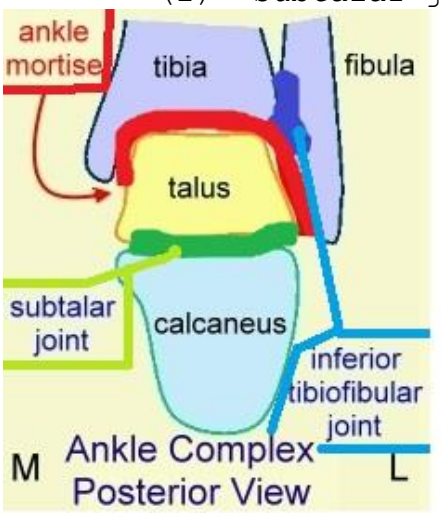
c. Stability. Stability is a quality relating to the degree to which a body resists being upset or moved. The major factors that affect a person's stability are: the area of the base of support, the relation of the line of gravity to the edge of the base, the height of the center of gravity, and the mass of the person.

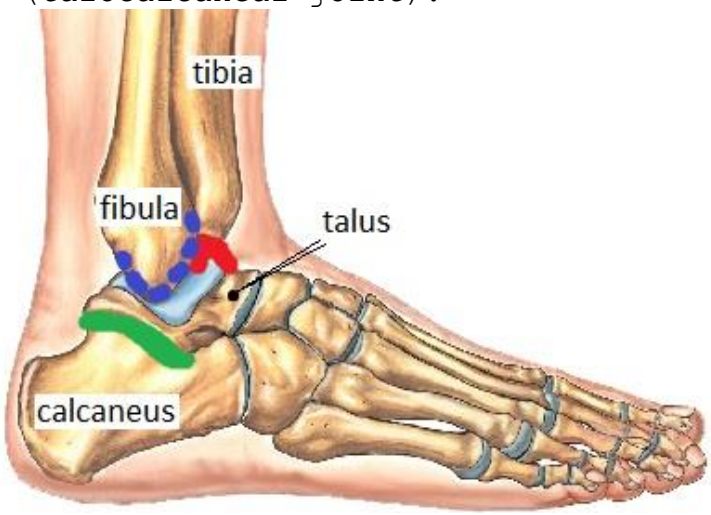
2. BIOMECHANICS OF THE FOOT AND ANKLE.

a. Joints. There are many joints of the ankle and foot, we will examine the most popular joints of the ankle.

(1) Talocrural (inferior tibia, fibula, and superior of talus).

(2) Subtalar joint (talocalcaneal joint).





b. Range of Motion. The ankle motion allows a person the ability to run, jump, and cut on a variety of surfaces.

(1) Plantarflexion, dorsiflexion, inversion, eversion, supination, pronation.

c. Muscles. While there are several muscles that control the ankle, we will focus on three main muscles of the ankle.

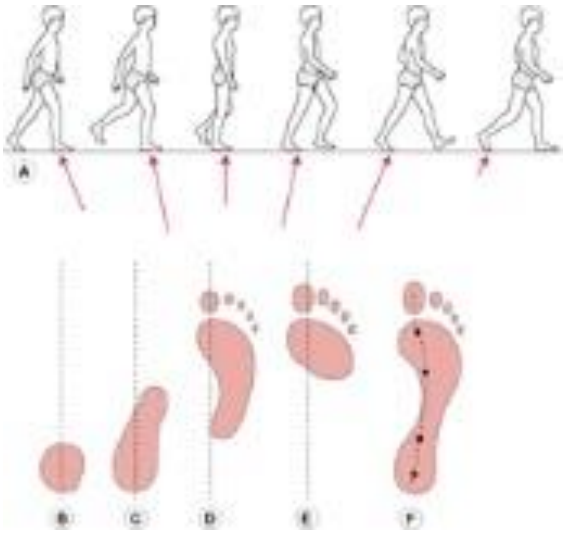
(1) Gastrocnemius: The gastrocnemius muscle crosses the knee joint slightly and assists with knee flexion. It's main action is plantarflexion of the foot.

(2) Soleus: The soleus muscle is deep to the gastrocnemius and plantar flexes the foot.

(3) Peroneus group: Peroneal muscles originate at the head of the fibula bone, attach to the lateral side of the foot (base of 5th), and the primary function is eversion of the ankle.

d. Gait. Gait is the pattern in which someone is walking. There are many biomechanical changes that can change strength, performance, and efficiency.

(1) Phases of gait: Heel strike, mid-stance, push off, and swing phase are the basic components. Normal gait starts with a heel strike slightly on the lateral side of the heel. Weight is then transferred to the arch during mid-stance and then weight is transferred to the big toe during push off. While the foot is in the air and not in contact with the ground, this is the swing phase.



e. Applied Foot Mechanics. Many injuries can result from poor foot and ankle mechanics. This may occur from a number of variable such as injury or anatomical variance.

(1) Things to look for: While diagnosis is beyond the scope of the FFI, it's important to recognize unusual patterns and refer them to the appropriate personnel. The FFI may notice odd wear patterns on shoes/boots. There may be inefficient movement about the ankle or hips. Finally, the side length or uneven sound of foot strikes may be noticed.

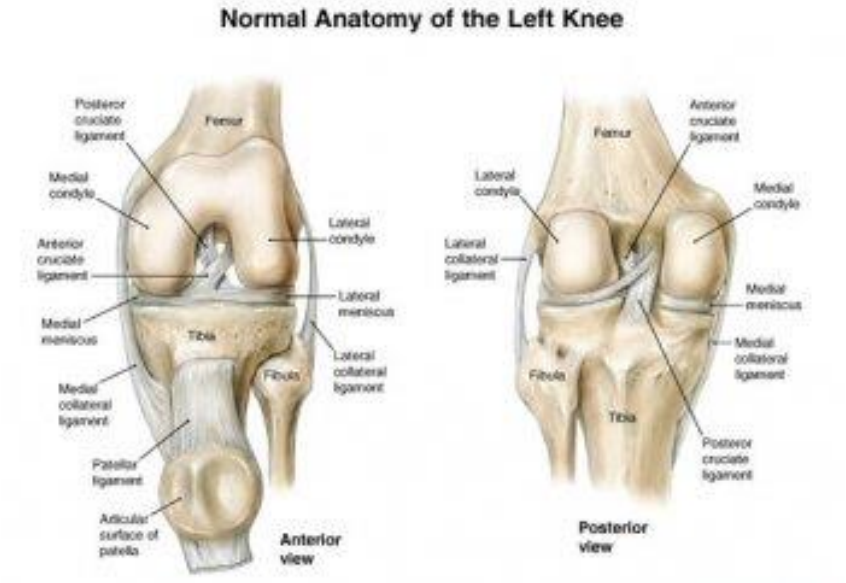
(2) Heel lift: During the squat or lunge technique it is important to have good flexibility in the ankle. Daily wear of combat boots may predispose flexibility in the foot and ankle.

(3) Pronated foot: During lifting techniques, especially with heavy weight, there may be a tendency for the foot to pronate. The Olympic weight lifting shoe provides a solid counter platform. Running shoes are designed for cushion and flexibility.

3. BIOMECHANICS OF THE KNEE.

a. Joints. There are three joints of the knee, we will review the tibiofemoral joint.

(1) Tibiofemoral joint: The tibiofemoral joint holds critical ligaments and cartilage of the knee.



b. <u>Range of Motion</u>. The main motions of the knee are flexion and extension.

(1) <u>Flexion and extension</u>: The range of motion of the knee is about 0 deg to 140 deg.

c. <u>Muscles</u>. There are several muscles that cross the knee joint, we will focus on the main knee flexors and extensors.

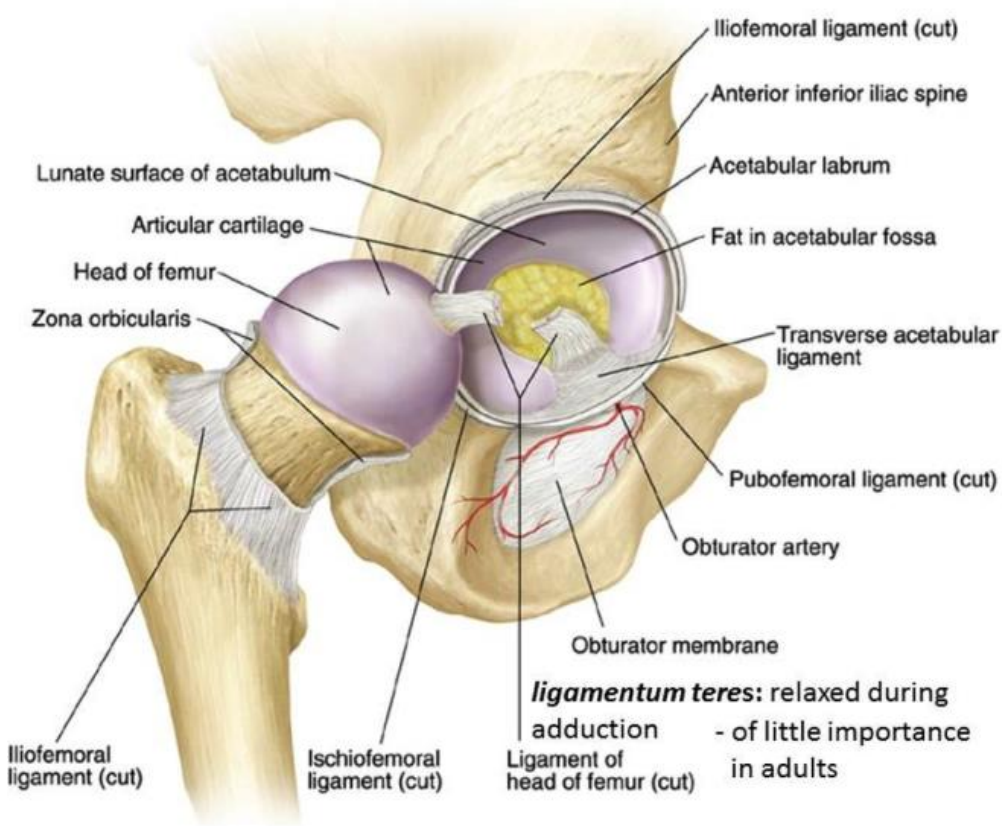
(1) <u>Quadriceps</u>: The quadriceps muscle group encompasses 4 major muscles of the anterior thigh and its main function is knee extension. Some of the muscle fibers cross the hip and can assist in hip flexion.

(2) <u>Hamstrings</u>: The hamstring muscle group consists of 3 major muscle groups. The main function of the hamstrings are knee flexion and hip extension.

4. <u>BIOMECHANICS OF THE HIP</u>.

a. <u>Joints</u>. The hip joint is one of the most stable and protected joints in the human body.

(1) Acetabulum



b. <u>Range of Motion</u>. A large range of motion allows for greater/stronger contraction for movement.

(1) Flexion, extension, abduction, adduction, internal rotation, external rotation, and circumduction. The hip joint has several motions; it has great range of motion and high stability.

c. <u>Muscles</u>. Muscles of the hip serve mainly for propulsion. Some of the strongest muscles of the body cross the hip joint.

(1) <u>Iliopsoas</u>: The iliopsoas muscle group flexes the hip

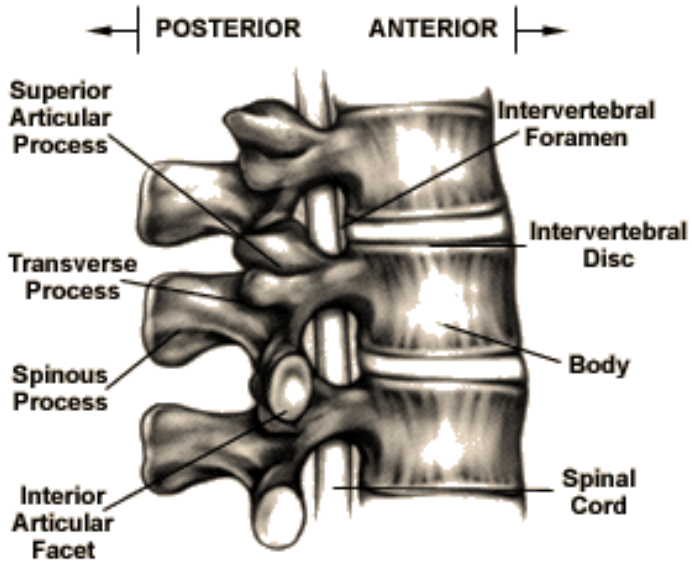
(2) <u>Tensor Fascia Latae(TFL)</u>: The TFL is located on the side of the hip and functions as a hip abductor. The TFL distal tendon is commonly known as the iliotibial band.

(3) <u>Gluteus maximus</u>: The gluteus maximus is one of three gluteus muscles. This is the strongest muscle of the body and primarily serves as hip extension.

5. BIOMECHANICS OF THE LUMBAR SPINE.

a. Joints. There are 3 major regions of the vertebrae: cervical, thoracic, and lumbar. The lumbar vertebrae are the largest and thickest because they support the entire upper body weight. The lumbar spine vertebrae are stacked upon each other on cartilaginous discs.

(1) Levels: Lumbar joints are typically named by the 2 bones that are adjacent. For example: the first lumbar vertebrae on top of the second lumbar vertebrae is called L1-L2.



b. Range of Motion. The range of motion of lumbar vertebrae pivots on the intervertebral disc. The motion of each vertebrae is typically not measured, it is typically graded in total motion of that segment.

(1). The vertebrae individually have small motions, however, as a group they are able to create large motion. The motions are flexion, extension, side bending, and rotation

c. Muscles. There are a number of muscles that act on back motion. The motion depends on if both muscle groups contract together (flexion or extension) or if one side only contracts (side bending).

(1) Back extensors: There are several groups of muscles that run the length of the spine. In a combined contraction they extend the spine and in a unilateral contraction rotation

will occur. Main muscles to identify are the latissimus dorsi, trapezius, and erector spinae muscle group.

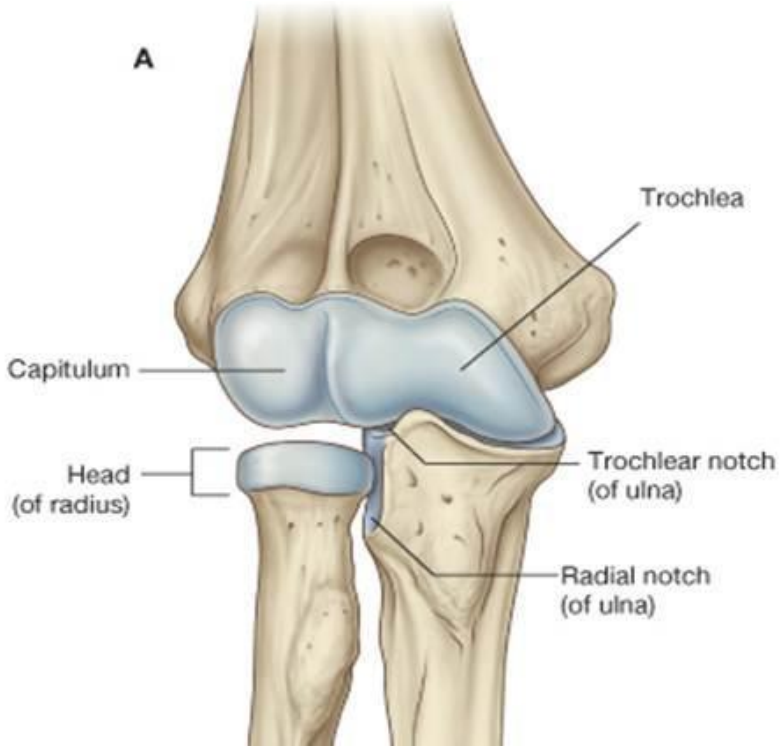
(2) Abdominals. The rectus abdominis is the most recognized of the abdominal muscle group, commonly referred to as the "6" or "8" pack. In a combined contraction, they flex the spine, in a unilateral contraction rotation will occur. The oblique muscle group's primary function is rotation.

6. BIOMECHANICS OF THE ELBOW.

a. Joints. The elbow joint is a complex joint that functions as a fulcrum for the forearm responsible for positioning the hand in space.

(1) Humeroulnar. The humeroulnar joint is the classic hinge joint of the elbow. It allows for flexion and extension of the elbow.

(2) Radioulnar. The radioulnar joint allows for pronation and supination of the hand and wrist.



b. Range of Motion.

(1) The range of motion for the elbow are: flexion, extension, supination, and pronation. The elbow has a large

range of motion for flexion as in a bicep curl. The pronation and supination allow for rotation, like turning a door handle.

c. Muscles.

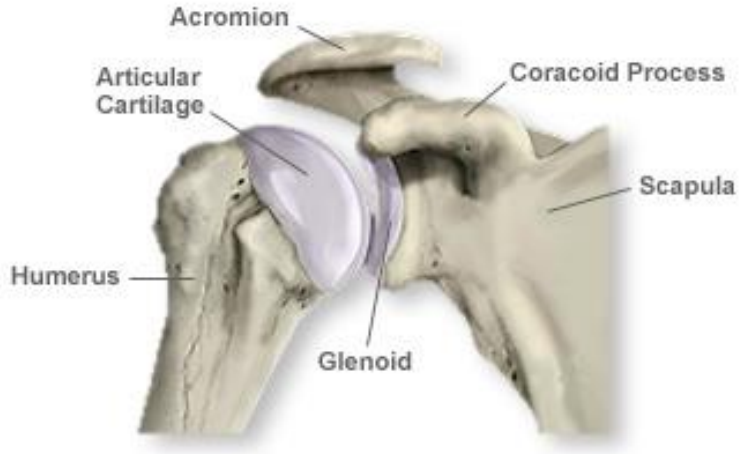
(1) Biceps brachialis: The biceps muscle, which has two heads, crosses the elbow joint and shoulder. The main function is elbow flexion. The muscle can assist in shoulder flexion.

(2) Triceps: The triceps muscle, which has three heads, crosses the posterior elbow joint. The main function is elbow extension. The muscle can assist in shoulder extension.

7. BIOMECHANICS OF THE SHOULDER.

a. Joints. The shoulder links the upper extremity to the trunk and acts in conjunction with the elbow to position the hand in space for efficient motion.

(1) Glenohumeral: The main shoulder joint is the glen humeral joint and is a classic ball and socket. The joint is deepened by a cartilage ring on the glenoid.



b. Range of Motion. An absence of bony constraints allows a wide range of motion at the expense of stability.

(1) The shoulder has a large amount of range of motion but lacks stability. The motions for the shoulder are: flexion, extension, rotation, abduction, adduction, and circumduction.

c. Muscles. Beyond ligaments, the muscle of the shoulder serve as protection and increases stability. While there are

many muscles that control shoulder joint motion, we will review the less known group, the rotator cuff.

(1) Rotator cuff: There are many muscles that control the motions at the glen humeral joint. The rotator cuff is the most important group for the overhead athlete. The group of muscles are: Supraspinatus, Infraspinatus, Teres Minor, Subscapularis (SITS).

SUMMARY: The Force Fitness Instructor now has an understanding of the different tissues of the body and how exercise can affect its structure and composition. As muscle moves the limb or extremity, the Instructor can further apply their knowledge to joint motions of the body.

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