Mechanisms and Characteristics
Of Sports Trauma

I. MECHANICAL INJURY: Force of mechanical energy is that which changes the state of rest or uniform motion of matter. When a force applied to any part of the body results in a harmful disturbance in function and or structure, a mechanical injury is said to have been sustained

A. Tissue Properties: Tissues have relative abilities to resist a particular load. The stronger the tissue, the greater magnitude of load it can withstand.
B. Tissue properties are described according to the following:
   1. load: outside force or forces acting on tissue.
   2. Stress: the internal reaction or resistance to an external load
   3. Strain: extent of deformation of tissue under loading
   4. Viscoelastic: any material whose mechanical properties vary depending on rate of load. Human tissue is viscoelastic, it has both viscous and elastic properties
   5. Yield point: elastic limit of tissue
   6. Mechanical failure: elastic limit of tissue is exceeded, causing tissue to break

C. three tissue mechanical stresses that lead to sports injuries
   1. tension: force that pulls or stretches tissue. Stretching beyond the yield point leads to rupturing of soft tissue or fracturing of a bone. Examples of these are sprains, strains, and avulsion fractures
   2. compression: force that, with enough energy, crushes tissue. When the force can no longer be absorbed, injury occurs. Arthritic changes, fractures and contusions are commonly caused by compression force
   3. shearing: force that moves across the parallel organization of the tissue. Injury occurs once shearing has exceeded the inherent strength of a tissue. Blisters, rips, abrasions, or vertebral disk injuries are examples

II. BENDING STRESS: Caused by a combination of tension and compression. Usually associated with long bones

III. SOFT TISSUE TRAUMA: Soft tissue or nonbony tissue, falls generally under the category of noncontractile and contractile. Noncontractile tissues are skin, joint capsules, ligaments, fascia, cartilage, dura matter, and nerve roots. Connective tissue are those structures that are part of the muscle, its tendon or bony insertion

IV. SKIN INJURIES

A. Anatomical characteristics: the skin is the external covering of the body. It represents the body's largest organ system and essentially consists of two layers, the epidermis and dermis. The skin because of its makeup can be easily traumatized (injured)
B. Injurious mechanical forces: forces are friction or rubbing, scraping, compression or pressure, tearing, cutting and penetrating
C. **Wound classification:** wounds are classified according to the mechanical force that causes them

1. **Friction blisters:** continuous rubbing over the surface of the skin causes a collection of fluid below or within the epidermal layer called blister
2. **Abrasions:** common conditions in which the skin is scraped against a rough surface. The epidermis and dermis are worn away, exposing numerous blood capillaries
3. **Skin bruise:** a blow that compresses or crushes the skin surface and produces bleeding under the skin, the condition is identified as a bruise or contusion
4. **Laceration:** wound in which the flesh has been irregularly torn
5. **Skin avulsion:** skin that is torn by the same mechanism as a laceration to the extent that tissue is completely ripped from its source
6. **Incision:** wound which the skin has been sharply cut
7. **Puncture wound:** object penetrates the skin

V. **SKELETAL MUSCLE INJURIES:** High percentage of sports injuries

A. **Anatomical characteristics**

1. **three basic types:**
   a. smooth
   b. cardiac
   c. striated
2. **the type that is most often affected in sports is the striated or skeletal
3. **the Muscle group is separated into 3 basic parts**
   a. the muscle
   b. the muscle tendon junction
   c. the tendon
4. **the tendon is very resilient to injuries.** The bone, and muscle properties will fail before the tendon will

B. **Muscle injury classification**

1. **Acute muscle injuries: 2 categories**
   a. **CONTUSION:** received by a sudden traumatic blow to the body

       1. can range from superficial to deep tissue compression and hemorrhage
   2. a hematoma (blood tumor) is formed by the pooling of blood which becomes encapsulated by a connective tissue membrane.
   3. A contusion can penetrate to the skeletal structures, causing a bone bruise
   4. The extent to which an athlete may be hampered by this condition depends on the location of the bruise and the force of the bruise
   5. The following characteristics are typical in cases of severe contusions:
     a. the athlete reports being struck a hard blow
     b. the blow causes pain and a transitory paralysis caused by pressure on and shock to the motor and sensory nerves (transitory means temporary)
     c. palpation often reveals a hard area
     d. ecchymosis or tissue discoloration may take place
b. **STRAINS**: a stretch tear or rip in the muscle or adjacent tissue such as fascia or muscle tendon

1. a strain can be classified into 1, 2, or 3rd degree strains and they range from minute separation to complete tendinous avulsion or muscle rupture
   a. 1st degree: local pain, which is increased by tension, minor loss of strength, mild swelling, ecchymosis, and local tenderness
   b. 2nd degree: same characteristics as 1st degree by with moderate signs and symptoms and impaired muscle function
   c. 3rd degree: signs and symptoms are severe, with a loss of function, and commonly a palpable defect in the muscle

2. the highest incidence of muscle strains in sports are hamstrings, gastrocs, quads, hip flexor, spinalis group of the back, deltid, and rotator cuff group

2. **TENDON INJURIES**
   a. tendons are organized in bundles surrounded by a gelatinous material that decreases friction
   b. tendon attaches muscle to bone
   c. because the tendon is twice as strong as the muscle the injury usually occurs in the muscle belly, musculotendonous junction or bony attachment

3. **MUSCLE CRAMPS AND SPASMS**
   a. muscle cramps and spasm lead to muscle and tendon injuries
      1. a cramp is a painful involuntary contraction
         a. cramps have been attributed to lack of water and electrolytes in relation to muscle fatigue
      2. a reflex reaction caused by trauma of the musculoskeletal system is commonly called a spasm
   3. there are 2 basic types of cramps or spasms
      a. tonic: rigid muscle contraction that last over a period of time
      b. clonic: alternating involuntary muscular contraction and relaxation in quick succession

4. **OVEREXERTION MUSCLE PROBLEMS**: Four specific indicators of possible overexertion are, acute muscle soreness, muscle stiffness, delayed muscle soreness and muscle cramping
   a. **Acute-onset muscle soreness**: related to an impedance of circulation, causing muscular ischemia (lack of iron). Lactic acid and potassium collect in the muscle and stimulate pain receptors
   b. **Delayed-onset muscle soreness**: increases in intensity for 2 to 3 days and then decreases in intensity until it has completely disappeared in 7 days
      1. eccentric contractions cause most muscle soreness
      2. ways to decrease soreness is a warm-up and cooldown
   c. **Muscle stiffness**: does not produce pain
   d. **Muscle cramps**: most common is tonic
5. CHRONIC MUSCLE INJURIES
   a. Myositis/fascitis: inflammation of muscle tissue
   b. Tendonitis: swelling and pain that move with the tendon
   c. Tenosynovitis: inflammation of the synovial sheath surrounding the tendon
   d. Bursitis: fluid filled sac found in places where friction might occur.
       Predominately located between bony prominence and muscle or tendons
   e. Ectopic calcification: (myositis ossificans) deep muscle contusion cause bone to calcify and grow into the muscle
   f. Atrophy and contracture:

VI. SYNOVIAL JOINTS: A joint in the human body is defined as the point where two bones join together. A joint must also transmit forces between participating bones.
A. ANATOMICAL CONSIDERATIONS:
   1. the joint consists of cartilage and fibrous connective tissue
   2. joints are classified as:
      a. immovable
      b. slightly immovable
      c. freely movable (these joints are also called synovial articulations)
         1. these types are more susceptible to trauma
   3. Anatomical characteristics of the synovial articulations consist of four features:
      a. have a capsule or ligaments
      b. synovial membrane
      c. articular cartilage
      d. synovial cavity (joint space)
      e. in addition to these four there are muscles, nerve, and blood supply

B. JOINT CAPSULE:
   1. Bones of the joint are held together by a cuff of fibrous tissue known as the capsule
   2. It consists of bundles of collagen and functions primarily to hold the bones together

C. LIGAMENTS
   1. Ligaments are sheets or bundles of collagen fibers that form a connection between two bones.
   2. Ligaments fall into 2 categories
      a. ones that are considered intrinsic (inside)
      b. ones that are considered extrinsic (outside)
   3. ligaments and capsules found in synovial joints are similar in composition to tendons; however in contrast they contain elastic fibers and collagen fibers that have a wavy, irregular and spiral configuration
   4. Ligaments attach bone to bone
   5. Ligaments are strongest in the middle and weakest at their ends.
6. A major factor in ligamentous injury is the viscoelastic tissue properties of ligaments and capsules. Viscoelasticity refers to the extensibility when loaded that is time dependent. Constant compression or tension causes ligaments to deteriorate, whereas intermittent compression and tension increases strength, especially at the bony attachment.

7. Ligaments act as a protective backups for the joint.

8. Primary protection of the joint occurs from the muscles and their tendons

D. **SYNOVIAL MEMBRANE AND SYNOVIAL FLUID**: Function as the lining and lubrication of the joint

E. **ARTICULAR CARTILAGE**:  
   1. Provides firm and flexible support  
   2. Cartilage has no direct blood or nerve supply  
   3. Acts as a cushion for bone ends

F. **ADDITIONAL SYNOVIAL JOINT STRUCTURES**  
   1. Fat  
   2. Articular disks  
   3. Nerve supply

G. **TYPES OF SYNOVIAL JOINTS**: Six types  
   1. Ball and Socket- allow all possible movement (shoulder, hip)  
   2. Hinge joints- allow only flexion and extension (elbow)  
   3. Pivot joints- permit rotations around an axis (cervical atlas and axis)  
   4. Ellipsoidal joints- (wrist joint)  
   5. Saddle shaped- (thumb)  
   6. Gliding joints- allow a small amount of gliding back and forth or sideways (finger)

H. **FUNCTIONAL SYNOVIAL JOINT CHARACTERISTICS**: Synovial joints differ in their ability to withstand trauma, depending on their skeletal, ligamentous and muscular organization. The table below provides a general guide to the strength of selected joints in terms of sports participation:

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<thead>
<tr>
<th>articulation</th>
<th>skeleton</th>
<th>ligaments</th>
<th>muscles</th>
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<td>strong</td>
<td>moderate</td>
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<tr>
<td>knee</td>
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I. **SYNOVIAL JOINT STABILIZATION**  
   1. Muscles are main stabilizer  
   2. Ligaments and capsular structures are highly important to joints

J. **ARTICULAR CAPSULE AND LIGAMENTS**  
   1. Articular cartilage have 3 basic functions  
      a. motion control: the shape of the cartilage determines the motion that will occur
K. SYNNOVIAL JOINT TRAUMA
   1. A major factor in joint injuries is the viscoelastic tissue properties of ligaments and capsules

L. SYNNOVIAL JOINT INJURY CLASSIFICATION
   1. ACUTE JOINT INJURIES
      a. SPRAINS: one of the most common and disabling injuries seen in sports, is a traumatic joint twist that results in stretching or total tearing of the stabilizing connective tissues
         1. when a joint is forced beyond its normal anatomical limits, microscopic and gross tears occur
      2. SPRAINS ARE GRADED IN THREE LEVELS:
         a. Grade 1: characterized by some pain, minimum loss of function, mild point tenderness, little or no swelling and no abnormal motion when tested
         b. Grade 2: moderate pain, moderate loss of function, swelling, and slight to moderate loss of function
         c. Grade 3 (severe): extremely painful, major loss of function, severe instability, tenderness and swelling
         d. A grade 3 may also represent a subluxation that has been reduced spontaneously
      3. Blood and synovial fluid in the joint cavity during a sprain produces joint swelling, local temperature increases, pin or point tenderness and skin discoloration (ecchymosis)
      4. Because of their lack of blood supply ligaments and capsules heal slowly
      5. Because their nerve supply is great ligaments and capsule injuries are very painful
      6. The joints that are most vulnerable to sprains in sports are the ankles, knees, and shoulders

b. ACUTE SYNOVITIS:

c. SUBLUXATIONS, DISLOCATIONS, AND DIASTASIS
   1. Dislocations are second to fractures in terms of disabling the athlete
   2. The highest incidence of dislocations involves the fingers and the next is the shoulder
   3. Dislocations are classified into 2 classes:
      a. subluxations: joint relocates
      b. luxations: complete dislocation
   4. Diastasis: separation of two bones (ulna and radius in wrist)
   5. SEVERAL FACTORS IMPORTANT IN RECOGNIZING AND EVALUATING DISLOCATIONS:
      a. There is loss of limb function
b. Deformity is almost always apparent

c. Swelling and pint tenderness are immediately present

6. First time dislocations should always be considered and treated as a possible fracture

7. X-ray is always necessary with dislocations

2. CHRONIC JOINT INJURIES
   a. Osteochondrosis
   b. Traumatic arthritis
   c. Bursitis, capsulitis, synovitis

VII. SKELETAL TRAUMA
A. BONE FUNCTIONS
   1. BODY SUPPORT
   2. ORGAN PROTECTION
   3. MOVEMENT
   4. CALCIUM RESERVATION
   5. FORMATION OF BLOOD CELL

B. TYPES OF BONE: Bones are classified according to their shapes
   1. Flat bones: skull, ribs, and scapulae
   2. Irregular bones: vertebral column and the skull
   3. Short bones: wrist, ankle
   4. Long bones: the most commonly injured bones in sports, humerus, ulna, femur, tibia, fibula, and phalanges

C. BONE GROWTH: Important aspect to remember is the epiphyseal growth plate

D. BONE INJURIES:
   1. ANATOMICAL WEAK POINTS: Areas where bones change shape
      a. long bones that change shape gradually are less prone to injury
      b. bones that change shape suddenly are more prone to injury (clavicle)

E. LOAD CHARACTERISTICS
   1. Long bones can be stressed or loaded to fail by tension, compression, bending, twisting, and shearing
F. BONE TRAUMA CLASSIFICATION: Bone trauma can generally be classified as PERIOSTITIS, ACUTE FRACTURES, STRESS FRACTURES, AND EPIPHYSEAL CONDITIONS

1. PERIOSTITIS: inflammation of the covering of the bone. Caused mainly by contusions

2. Acute bone fractures:
   a. DEPRESSED FRACTURE: Occur mainly in flat bones such as the skull
   b. GREENSTICK FRACTURE: Incomplete breaks in the bone
   c. IMPACTED FRACTURE: Fall from a height, which causes a long bone to receive a force of such magnitude that the tissue is compressed
   d. LONGITUDINAL: Fracture that occurs along its length
   e. OBLIQUE: similar to spiral fractures; occurs when one end of the bone is fixed and the other experiences a twist
   f. SERRATED: Usually caused by a direct blow that causes sharp toothlike edges, very dangerous fracture because it tears other structures
   g. SPIRAL: S shaped separation
   h. TRANSVERSE: Fracture that occurs in a straight line
   i. COMMINUTED: Fragmented fracture
   j. COUNTRECOUP: Fracture occurs on the side opposite the point of trauma
   k. BLOWOUT FRACTURE: fracture occur to the wall of the eye orbit
   l. STRESS FRACTURE: fatigue type fractures

3. EPIPHYSEAL CONDITIONS:
   a. usually occur in the age range of 10 to 16

4. APOPHYSEAL INJURIES: OSGOOD SCHLATTER’S DISEASE