TISSUE RESPONSE TO INJURY

I. THE INFLAMMATORY RESPONSE: This response can be acute or chronic. Acute inflammation has a short onset and short duration. Chronic has a long onset and long duration.

A. Acute inflammation: Three phases: acute, repair, and remodeling
   1. Phase I: Acute phase:
      a. initial body response
      b. first three to four days
      c. reaction designed to
         1. protect,
         2. localize,
         3. rid the body of some injurious agent in preparation for healing and repair
      d. main causes of inflammation are trauma, chemical agents, thermal extremes, and pathogenic organisms
      e. cellular death occurs from the trauma
      f. after trauma death of tissue may be caused by lack of oxygen
   g. R.I.C.E. SHOULD BE USED TO DETER DEATH
   h. VASCULAR RESPONSE
      1. FIRST HOUR: Before the initial signs of inflammation occur the body
         VASOCONSTRICTS (DECREASE IN THE DIAMETER OF A BLOOD VESSEL)
      2. At this time coagulation begins to seal broken vessels and is followed by activation of chemical influences
      3. SECOND HOUR: VASODILATION: increase in the diameter of a blood vessel.
         a. this leads to swelling (edema)
         b. dilation also causes exudate of plasma and concentration of red blood cells
         c. the cell walls become more permeable (permit passage of a substance through a vessel wall) from higher to lower pressure
   i. CELLULAR RESPONSE:
   j. CHEMICAL MEDIATORS:
      1. HISTAMINE: Causes dilation and cell permeability
      2. SEROTONIN: Causes vasoconstriction
      3. BRADYKININ: Increases permeability and causes pain
   k. BLEEDING AND EXUDATE: The extent of fluid in the injured area is highly dependent on the extent of damaged vessels and the permeability of the intact vessel.
   2. PHASE II: REPAIR PHASE: (HEALING)
      a. Follow inflammatory phase (48-72 hours to approximately 6 weeks)
      b. This phase occurs why the area has become clean through the removal of cellular debris, erythrocytes, and the clot.
      c. Tissue repair is accomplished through three process
         1. resolution: there is little tissue damage and normal restoration
2. formation of granular tissue, occurs if resolution is delayed
3. regeneration: replacement of tissue by the same tissue
d. granulation tissue is scar tissue: the proximity of the injury determines the amount of granular tissue produced
e. the granulation phase has 2 types of healing
   1. Primary healing: low scar tissue, healing occurs with the opposing tissues being close together
   2. Secondary healing: gap in injury causing scar tissue
f. REGENERATION:

3. **PHASE III: REMODELING PHASE** (rehabilitation)
   a. overlaps that of repair
   b. first 3 to six weeks are characterized by increase production of scar tissue and increased strength of its fibers
   c. strength of scar tissue continues to increase from three months to two years

B. CHRONIC INFLAMMATION
1. Chronic inflammation is swelling that last for months to years.
2. It results from repeated microtrauma and overuse

II. **SOFT-TISSUE HEALING**: All tissues of the body can be defined as soft tissue except for bone.
   ♦ The human body has four types of soft tissue:
      1. epithelial tissue: skin and the lining of vessels, organs
      2. connective tissue: tendons, ligament, cartilage, fat, blood vessels and bone
      3. muscle:
      4. nervous tissue: brain, spinal cord, and nerves

A. **CARTILAGE HEALING**:
1. Articular cartilage has limited capacity to heal
2. Cartilage has little to no direct blood supply

B. **LIGAMENT HEALING**:
1. undergoes the three phases of acute, repair, and remodeling
2. full ligament healing with scar maturation may take as long as twelve months

C. **SKELETAL MUSCLE HEALING**
1. Repair on the same pattern as the three phases but must have rehabilitation strengthening exercises in a progressive manner

D. **NERVE HEALING**:
1. Nerve cells do not regenerate
2. Regeneration can take place within a nerve fiber.
3. The closes the injury is to the nerve cell the more difficult regeneration becomes
III. MODIFYING SOFT-TISSUE HEALING: Healing process is unique in each athlete. Different tissue vary in their ability to heal as well. EX. Cartilage. Age and nutrition may also affect healing. Also health conditions may affect healing.

A. MANAGEMENT CONCEPTS
1. DRUGS TO TREAT INFLAMMATION: Used to decrease vasodilatation
2. THERAPEUTIC MODALITIES: cold, heat, ultrasound, electric stim, tens
3. THERAPEUTIC EXERCISE:
   a. the focus of soft-tissue rehabilitation through exercise is pain-free movement, full-strength power, and full extensibility of muscles.
   b. The focus of ligament rehabilitation is pain free and have full strength and range of motion
   c. Immobilization is not always good for injuries

IV. FRACTURE HEALING: Fracture healing takes time, coaches, trainers, athletes must be patient

A. ACUTE FRACTURES OF THE BONE: Follows the same three phases that soft tissue does but is more complex
   ♦ In general acute fracture healing has 5 stages:
     1. hematoma formation
     2. cellular proliferation
     3. callus formation
     4. ossification
     5. remodeling

ACUTE FRACTURE HEALING
PHASE I: ACUTE PHASE
   ➢ TRAUMA
   ➢ HEMORRHAGE
   ➢ BONE DEATH
PHASE II: RAPAIR
   ➢ GRANULATION
   ➢ WOVEN BONE
   ➢ HARD CALLUS
PHASE III: REMODELING
   ➢ RESORPTION OF CALLUS
   ➢ TRABECULAR BONE
   ➢ BONE

A. HEMATOMA FORMATION:
   1. Acute inflammation usually last about four days
   2. A hematoma forms around the ends of the bone and a blood clot forms

B. CELLULAR FORMATION:
1. The hematoma begins organization of granular tissue and gradually builds a fibrous junction between the fractured ends.
2. These cells initially produce a fibrous callus, then cartilage, and finally a woven bone.

C. CALLUS FORMATION:
1. A soft callus is formed within 1-2 weeks but is an unorganized network of woven bone at the ends of the fracture and is later absorbed and replaced by bone.
2. At this soft callus stage and internal and external callus are produced
3. These calluses begin to immobilize the fracture site
4. In 3-4 weeks the HARD CALLUS starts to form internally first followed by the external callus.
5. The hard callus continues to grow up to 3 to 4 months.
6. The hard callus is a gradual connection of bone filament to the woven bone at the fracture ends

D. OSSIFICATION
1. Ossification occurs when the bone has been properly immobilized and the bone ends become crossed with the laying down of primary bone.
2. The calluses are absorbed by the osteoclasts (bone cells)
3. The fracture has been bridged and firmly united

E. REMODELING
1. Occurs after the callus has been resorbed and the new bone has been laid down
2. This can last up to years
3. The remodeling phase is considered complete when a fractured bone has been restored to its former shape or has developed a shape that can withstand imposed stresses

F. MANAGEMENT OF ACUTE FRACTURES
1. Bones must be immobilized completely until X-ray studies reveal that the hard callus has formed
2. ITEMS THAT MAY AFFECT THE HEALING PROCESS OF BONES:
   a. Poor blood supply (navicular bone)
   b. Poor immobilization
   c. Infection

G. HEALING OF STRESS FRACTURES
1. Healing of stress fractures is the same as acute fractures
2. It is important to understand that untreated stress fractures can lead to an acute fracture

V. PAIN
   ➢ MAJOR INDICATOR OF INJURY

A. NOCICEPTION
1. There are two basic nociceptors that deal with pain
   a. The type C fibers (slow fibers)
   b. The type A delta fibers (fast fibers)
2. The type C fibers can be compared to a slow train, they move impulses to the spinal cord at a rate of .5 to 2.0 meters per second
   a. these types of fiber carry the pain responses of dull aching type pain
3. The type A delta fibers can be compared to a fast train, they move impulses to the spinal cord at a rate of 5 to 30 meters per second
   a. this type of pain is acute in nature and has characteristics of sharp or stabbing

B. ENDOGENOUS ANALGESICS
   ➢ The body can produce its own pain reducers

C. PAIN CATEGORIES:
1. Fast versus slow pain:
   a. A fibers verses C fibers
2. Acute versus Chronic
   a. Acute pain is pain that is less than six months in duration
   b. Acute pain is when tissue damage occurs and serves as a warning
   c. Chronic pain has a duration longer than six months
3. Projected (referred pain)
   a. Occurs away from the injury site
   b. THREE TYPES OF REFERRED PAIN
      1. Myofascial pain (trigger points)
      2. Sclerotomic and dermatomic pain: bone, muscle, fascia, or skin areas supplied by a single nerve root
   c. these types of pain can cause depression, anxiety, fear anger
4. Variations in pain sensitivity
   a. pain modulation: because pain is a mixture of both physiological and psychological factors management can be a major challenge
   b. Pain assessment; very difficult:
      1. use a scale of 1 to 10
      2. use words like none, slight, mild, moderate, severe
   c. Pain treatment: must stop the pain-spasm-pain cycle
      1. heat and cold
      2. induced analgesia (TENS unit)
      3. The gate theory (heat, ice, tens, acupressure, acupuncture, counterirritants,