The Skeletal System

The Rigid Framework of the Body
The Skeletal System

- The bones, joints, cartilage, and ligaments
- **The Skeleton**
  - Axial Skeleton
    - Skull, vertebrae, and ribs
  - Appendicular Skeleton
    - Shoulder girdle, pelvis, and extremities
Figure 10.1 The axial and appendicular skeletons together form the adult human skeleton.
Mechanical Function of the Skeletal System

- An arrangement of rigid links (bones) connected at joints to allow specific body movements
- Muscles attached to bones provide forces that may cause changes in the positions of bones relative to each other
  - The skeletal system provides the long levers that enable movement
Levers

- Bones are the levers of the human body
- All levers have an axis of rotation
- Three Types of Levers
  - 1st class lever
  - 2nd class lever
  - 3rd class lever
Relative locations of the applied force, the resistance, and the fulcrum, or axis of rotation, determine lever classifications.
Joints

- Definition
  - “Any place where two bones meet or join”

- Function
  - Keep bones together
  - control the motion allowed between bones
    - Act as axes of rotation for the lever system
  - transfer forces between bones
Synovial Joints

- Bones connected by ligaments
- Separated by a joint cavity that encloses the space between the bones
- Highly mobile joints
- Examples
  - Most of the joints of the appendicular skeleton
  - Wrist, elbow, shoulder, ankle, knee, and hip
Synovial Joints

- Six Subclassifications
  - Gliding
  - Hinge
  - Pivot
  - Ellipsoidal
  - Saddle, and
  - Ball and socket
Gliding Joints

- Articulations are flat and small
- Sliding planar movements (no rotations)
- Examples
  - intercarpal (wrist),
  - intertarsal (ankle), and
  - acromioclavicular (shoulder girdle)
Hinge Joints

- **Uniaxial**
  - Allow only one degree of freedom of movement

- **Movements**
  - Flexion/extension
    - Medial/Lateral Axis
    - Sagittal Plane

- **Examples**
  - humeroulnar (elbow)
  - tibiofemoral (knee)
  - talotibial and talofibular (ankle)
Pivot Joints

- **Uniaxial**
  - Allow only one degree of freedom of movement

- **Movements**
  - Pronation/Supination
    - Longitudinal axis
    - Transverse plane

- **Examples**
  - Radioulnar joints
    - Pronation/Supination
Ellipsoidal Joints

- **Biaxial**
  - Two degrees of freedom
- **Movements**
  - Flexion/extension
    - Medial/Lateral Axis
    - Sagittal Plane
  - Abduction/adduction
    - Anterior/Posterior Axis
    - Frontal Plane
- **Examples**
  - radiocarpal (wrist)
Saddle Joints

- Biaxial
  - Two degrees of freedom

- Movements
  - Flexion/extension
    - Medial/Lateral Axis
    - Sagittal Plane
  - Abduction/adduction
    - Anterior/Posterior Axis
    - Frontal Plane

- Example
  - First carpometacarpal joint (at the base of the thumb)
Ball and Socket Joints

- Triaxial
  - Three degrees of freedom
- Movements
  - Flexion/extension
    - Medial/Lateral Axis
    - Sagittal Plane
  - Abduction/adduction
    - Anterior/Posterior Axis
    - Frontal Plane
  - Internal/external rotation
    - Longitudinal axis
    - Transverse plane
- Examples
  - glenohumeral (shoulder)
  - hip joint
Synovial Joints

- Structure of Synovial Joints
  - Articular Capsule
    - Sleeve of ligamentous tissue
    - Forms a joint cavity
  - Synovial Membrane
    - Inner surface lining of the articular capsule
    - Secretes synovial fluid, which fills the joint cavity
Synovial Fluid

- **Lubricant**
  - reduces friction
- **Nutrient**
  - nourishes the articular cartilage which has no blood supply
- **Cleanser**
- **Hydrostatic shock absorber**
Synovial Joints

- Structure of Synovial Joints
  - Articular Cartilage
    - Two Types
      - Hyaline Cartilage and Fibrocartilage
    - Improve the bone-to-bone fit at the joint
      - increasing the joint's stability and
      - reducing pressure when the joint is loaded
    - Reduce friction and prevents wear
    - Provide some shock absorption
Articular Cartilage

- **Hyaline Cartilage**
  - Thin layer of cartilage that covers the articulating ends of the bones

- **Fibrocartilage**
  - Disc or partial disc of fibrocartilage that separates the articulating surfaces of the bones
  - The bearing surfaces between moving bones
Synovial Joints

- Instability of Synovial Joints
  - Definition of Instability
    - Rotations of the bones in planes other than those defined by the degrees of freedom of movement for the joint, or
    - Movement of the articulating surfaces away from each other through
      - shear dislocation (sliding laterally) or
      - traction dislocation (pulling apart)
Synovial Joints

- Reducing Instability of Synovial Joints
  - Increasing Shear Stability
    - Bone-on-Bone Compression
      - Increases friction
    - Reciprocal convex and concave shapes of the articulating ends of bones
      - Tighter the bone-to-bone fit and
    - Articular Cartilage
      - Improve Bone-to-Bone fit
    - Fibrocartilage
      - Produce convex regions to aid in resisting shear
Synovial Joints

- Reducing Instability of Synovial Joints
  - Increasing Tension Stability
    - Ligaments and tendons provide the tensile forces to resist traction dislocations
Synovial Joints

- Flexibility of Synovial Joints
  - The angular range of motion in the planes in which the joint is designed to move
- Factors that Limit Flexibility
  - Articulating Bones
    - The shapes of the articulating bones may limit range of motion
    - Example: Olecranon process
  - Ligaments
    - Shortening and/or twisting of ligaments can limit range of motion
Synovial (Diarthrodial) Joints

- Factors that Limit Flexibility
  - Bulkiness of Soft Tissues
    - Examples: a person with larger muscles or large amounts of fatty tissue
  - Friction within the Joint
    - Any wearing or damage to the articular cartilage increases joint friction
    - Example: arthritis