Chapter 8

The Skeletal System

Articulations

Lecture Presentation by
Steven Bassett
Southeast Community College

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Introduction

- Bones are designed for support and mobility
- Movements are restricted to joints
- Joints (articulations) exist wherever two or more bones meet
  - Bones may be in direct contact or separated by:
    - Fibrous tissue, cartilage, or fluid
Introduction

• Joints are classified based on:
  • Function
    • Range of motion
  • Structure
    • Makeup of the joint
Classification of Joints

• Joints can be classified based on their range of motion (function)
  • **Synarthrosis**
    • Immovable
  • **Amphiarthrosis**
    • Slightly movable
  • **Diarthrosis**
    • Freely movable
Classification of Joints

• Synarthrosis (Immovable Joint)
  • Sutures (joints found only in the skull)
    • Bones are interlocked together
  • Gomphosis (joint between teeth and jaw bones)
    • Periodontal ligaments of the teeth
• Synchondrosis (joint within epiphysis of bone)
  • Binds the diaphysis to the epiphysis
• Synostosis (joint between two fused bones)
  • Fusion of the three coxal bones
Figure 6.3c The Adult Skull

Major Sutures of the Skull
- Coronal suture
- Squamous suture
- Frontonasal suture
- Lambdoid suture
- External acoustic meatus
- Mastoid process
- Zygomatic arch
- Mental foramen
- Mental protuberance

Lateral view of the bones of the adult skull
- Superior temporal line
- Squamous suture
- Lambdoid suture
- Occipital bone
- Parietal bone
- Frontal bone
- Sphenoid
- Frontonasal suture
- Ethmoid
- Lacrimal groove of lacrimal bone
- Nasal bone
- Infra-orbital foramen
- Maxilla
- Zygomatic bone
- Zygomatic arch
- Temporal process of zygomatic bone
- Mental foramen
- Mental protuberance
- Coronal suture
- Supra-orbital foramen
- Frontal bone
- Parietal bone
- Squamous part of temporal bone
- Temporal process of temporal bone
- External acoustic meatus
- Mastoid process
- Styloid process
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<td>Fibrous Suture</td>
<td>A suture is a synarthrotic joint located only between the bones of the skull. The edges of the bones are interlocked and bound together at the suture by dense fibrous connective tissue.</td>
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Figure 5.3a Anatomy of a Representative Bone

The femur, or thigh bone, in posterior and sectional views. The femur has a diaphysis (shaft) with walls of compact bone and epiphyses (ends) filled with spongy bone. A metaphysis separates the diaphysis and epiphysis at each end of the shaft. The body weight is transferred to the femur at the hip joint. Because the hip joint is off center relative to the axis of the shaft, the body weight is distributed along the bone so that the medial portion of the shaft is compressed and the lateral portion is stretched.
Figure 7.10a The Pelvic Girdle
Classification of Joints

- Amphiarthroses (Slightly Movable Joints)
  - **Syndesmosis** (ligaments that connect two bones but limit their motion)
    - Between the radius and ulna
    - Between the tibia and fibula
  - **Symphysis** (bones are separated by a wedge or pad of cartilage)
    - Between the pubic bones of the two coxal bones
Table 8.1 Function and Structural Classification of Articulations

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Figure 7.7d The Radius and Ulna

**Anterior view of the radius and ulna**
Figure 7.11a The Pelvis (1 of 2)

Anterior view

- Pubic symphysis
- Ilium
- Pubis
- Ischium

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Classification of Joints

- **Diarthroses (Freely Movable Joints)**
  - Also called **synovial joints**
  - Typically found at the ends of long bones
  - Examples of diarthroses
    - Shoulder joint
    - Elbow joint
    - Hip joint
    - Knee joint
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Classification of Joints

• Synovial Joints
  • All synovial joints have six basic characteristics
    • A joint capsule
    • The presence of articular cartilages
    • A joint cavity with synovial fluid
    • A synovial membrane
    • Accessory structures (cartilage, ligaments, tendons, bursae)
    • Sensory nerves and blood vessels
Figure 8.1a Structure of a Synovial Joint

Components of Synovial Joints

- Joint capsule
- Synovial membrane
- Articular cartilages
- Joint cavity containing synovial fluid

Diagrammatic view of a simple articulation

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Figure 8.1b Structure of a Synovial Joint

A simplified sectional view of the knee joint

- Quadriceps tendon
- Patella
- Joint capsule
- Synovial membrane
- Joint cavity
- Articular cartilage
- Bursa
- Fat pad
- Meniscus
- Extracapsular ligament (patellar)
- Intracapsular ligament (cruciate)

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Classification of Joints

- Joints can be classified based on their histological structure
  - **Bony fusion** (fusion of the frontal bone)
  - **Fibrous joint** (skull sutures)
  - **Cartilaginous joint** (pubic symphysis)
  - **Synovial joint** (ball-and-socket joints and hinge joints)
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Classification of Joints

- Synovial Fluid
  - Lubricates the surfaces of the articular cartilages and reduces friction
  - Nourishes the chondrocytes by entering and exiting the articular cartilages due to the forces acting on the joint
  - Acts as a shock absorber
Classification of Joints

- Accessory Structures of Synovial Joints
  - Accessory structures are:
    - Menisci
    - Ligaments
    - Tendons
    - Bursae
A diagrammatic parasagittal section through the extended right knee.
Anterior views of the right knee at full flexion after removal of the joint capsule, patella, and associated ligaments.
Classification of Joints

• Strength versus Mobility
  • A highly mobile joint is not very strong
    • Diarthrosis
  • A fairly immovable joint is strong
    • Synarthrosis
  • Limited mobility reduces the chance of injury
Articular Form and Function

• Types of Movement
  • Linear movements
  • Angular movements
  • Circumduction
  • Rotation
  • Special movements
Articular Form and Function

• Linear Movements
  • Two bones gliding past each other
    • Carpal/carpal
    • Tarsal/tarsal
    • Clavicle/sternum

• Angular Movements
  • Abduction/adduction
  • Flexion/extension
Gliding joint

Gliding joints, or *planar joints*, have flattened or slightly curved surfaces that slide across one another, but the amount of movement is very slight.

**Description:**
Monaxial

**Movement:**
Slight linear motion

**Examples:**
- Sternoclavicular and acromioclavicular joints
- Intercarpal and intertarsal joints
- Vertebrocostal joints
- Sacro-iliac joints
Abduction

Adduction

Abduction/adduction

Abduction

Adduction

Abduction

Adduction
Articular Form and Function

• Rotational Movements
  • Pronation/supination

• Circumduction Movements
  • Moving the joint in a circular manner
Figure 8.4 Rotational Movements

- **Head rotation**
  - Right rotation
  - Left rotation
- **Lateral (external) rotation**
  - Medial (internal) rotation

**Supination**

**Pronation**
Figure 8.3d Angular Movements

Circumduction
Articular Form and Function

• Special Movements
  • Inversion/eversion
  • Dorsiflexion/plantar flexion
  • Lateral flexion
  • Protraction/retraction
  • Opposition
  • Depression/elevation
Figure 8.5a Special Movements

Eversion/inversion
Figure 8.5b Special Movements

Dorsiflexion/Plantar flexion
Figure 8.5c Special Movements

Lateral flexion
Figure 8.5d Special Movements

Retraction

Protraction

Retraction/protracnon
Figure 8.5e Special Movements

Opposition
Figure 8.5f Special Movements

Depression/elevation

Depression

Elevation

Depression/elevation
Articular Form and Function

• Classification of Synovial Joints
  • **Gliding joint** (clavicle and manubrium)
  • **Pivot joint** (the joint at C₁ and C₂)
  • **Saddle joint** (carpometacarpal joint)
  • **Hinge joint** (elbow and knee joints)
  • **Ellipsoid joint** (metacarpophalangeal joint)
  • **Ball-and-socket joint** (shoulder and hip joints)
Gliding joint
Gliding joints, or planar joints, have flattened or slightly curved surfaces that slide across one another, but the amount of movement is very slight.

Description:
Monaxial

Movement:
Slight linear motion

Examples:
- Sternoclavicular and acromioclavicular joints
- Intercarpal and intertarsal joints
- Vertebrocostal joints
- Sacro-iliac joints
Pivot joint
Pivot joints permit rotation only.

Description: Monaxial Movement Rotation

Examples:
• Atlanto-axial joint
• Proximal radioulnar joint
Saddle joint

Saddle joints have complex articular faces. Each one resembles a saddle—concave on one axis and convex on the other.

Description:
Biaxial

Movement:
Angular motion

Example:
- First carpometacarpal joint
**Hinge joint**
Hinge joints permit angular motion in a single plane, like the opening and closing of a door.

**Description:**
Monaxial
Movement:
Angular motion

**Examples:**
- Elbow joint
- Knee joint
- Ankle joint
- Interphalangeal joint
**Ellipsoid joint**
In an ellipsoid joint, an oval articular face nestles within a depression on the opposing surface.

**Description:**
Biaxial
**Movement:**
Angular motion

**Examples:**
- Metacarpophalangeal joints 2–5
- Radiocarpal joint
- Metatarsophalangeal joints
Ball-and-socket joint
In a ball-and-socket joint, the round head of one bone rests within a cup-shaped depression in another.

Description:
Triaxial
Movement:
Angular motion, circumduction, and rotation.

Examples:
- Shoulder joint
- Hip joint
Temporomandibular Joint

- Known as the TMJ
  - Consists of the condylar process of the mandible and the mandibular fossa of the temporal bone
- Stylomandibular ligament
  - Connects the tips of the spinous processes together
- Lateral ligament
  - Connects zygomatic arch to the mandibular condyle
- Sphenomandibular ligament
  - Connects the sphenoidal spine to the medial side of the ramus
Figure 8.6a The Temporomandibular Joint

- Zygomatic arch
- Zygomatic bone
- Coronoid process
- External acoustic meatus
- Articular capsule
- Mastoid process
- Styloid process
- Lateral ligament
- Sphenomandibular ligament
- Stylomandibular ligament
- Ramus of mandible

Lateral view of the right temporomandibular joint
Figure 8.6b The Temporomandibular Joint

Sectional view of the same joint

Articular surface of mandibular fossa
Articular disc
Condylar process
Neck of mandible
Articular capsule
Coronoid process
Zygomatic bone

Sectional view of the same joint

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Intervertebral Articulations

- Adjacent vertebrae articulate at their superior and inferior articular processes.
- Adjacent vertebral bodies are separated by intervertebral discs.
Intervertebral Articulations

- Intervertebral Ligaments
  - **Anterior longitudinal ligament**
    - Connects all the anterior surfaces of the vertebral bodies
  - **Interspinous ligament**
    - Connects the spinous processes of adjacent vertebrae
  - **Supraspinous ligament**
    - Connects the tips of the spinous processes together

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Intervertebral Articulations

• Intervertebral Ligaments (continued)
  • **Posterior longitudinal ligament**
    • Connects all the posterior surfaces of the vertebral bodies
  • **Ligamentum flavum**
    • Connects the laminae of adjacent vertebrae within the vertebbral arch
Intervertebral Articulations

• The Intervertebral Discs
  • Pads of cartilage between the vertebral bodies of adjacent vertebrae
Figure 8.7b Intervertebral Articulations

Intervertebral Ligaments
- Ligamentum flavum
- Posterior longitudinal ligament
- Interspinous ligament
- Supraspinous ligament
- Anterior longitudinal ligament

Intervertebral Disc
- End plate
- Anulus fibrosus
- Nucleus pulposus

Superior articular facet
Intervertebral foramen

Spinal cord
Spinal nerve

Lateral and sectional view
Intervertebral Articulations

- Vertebral Movements
  - Anterior flexion
    - Bending forward
  - Extension
    - Bending backward
  - Lateral flexion
    - Bending to the side
  - Rotation
    - Twisting
The Shoulder Complex

• Consists of:
  • Clavicle
  • Scapula
  • Humerus
The Shoulder Complex

- **Sternoclavicular Joint**
  - **Sternoclavicular ligament**
    - Connects clavicle to the manubrium
    - Anterior and posterior ligaments
  - **Interclavicular ligament**
    - Interconnects the clavicles
  - **Costoclavicular ligament**
    - Extends from the clavicle to the first rib
Figure 8.8 The Sternoclavicular Joint

- 1st rib
- Anterior sternoclavicular ligament
- Clavicle
- Subclavius muscle
- Costoclavicular ligament
- Costal cartilages
- 2nd rib
- Interclavicular ligament
- Sternal end of clavicle
- Articular disc
- Manubrium of sternum

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The Shoulder Complex

• The Shoulder Joint (or Glenohumeral Joint)
  • Ball-and-socket joint
    • Glenohumeral ligament
      • Connects humerus to the glenoid cavity
    • Coracohumeral ligament
      • Connects head of humerus to the coracoid process
    • Coracoclavicular ligament
      • Connects the clavicle to the coracoid process
The Shoulder Complex

• The Shoulder Joint
  • Coracoacromial ligament
    • Makes a connection between the coracoid process and the acromion
  • Acromioclavicular ligament
    • Connects the clavicle to the acromion
The Shoulder Complex

- The Shoulder Joint (Bursae)
  - **Subdeltoid bursa**
    - Forms a cushion between the deltoid muscle and the greater trochanter when the arm is abducted
  - **Subacromial and subcoracoid bursae**
    - Form a cushion between the acromion/coracoid process and the joint capsule
Anterior view of the right shoulder joint
ANIMATION Articulations: Humerus Abduction/Adduction
ANIMATION Articulations: Humerus Circumduction
The Elbow and Radioulnar Joints

• Elbow Joint (Hinge Joint)
  • **Radial collateral ligament**
    • Connects the lateral epicondyle of the humerus to the radius
  • **Ulnar collateral ligament**
    • Connects the medial epicondyle of the humerus to the ulna
  • **Annular ligament**
    • Connects the head of the radius to the ulna
ANIMATION Articulations: Elbow Flexion/Extension
ANIMATION Articulations: Elbow Pronation/Supination

Systemic
Skeletal System
Anatomical Movement
Elbow Pronation/Supination
Figure 8.10a The Elbow Joint

Humerus

Radial collateral ligament

Radial tuberosity

Antebrachial interosseous membrane

Radius

Ulna

Capitulum

Annular ligament (covering head and neck of radius)

Lateral view.
Medial view. The radius is shown pronated; note the position of the biceps brachii tendon, which inserts on the radial tuberosity.
The Joints of the Wrist and Hand

• The Joints of the Wrist
  • **Palmar radiocarpal ligament**
    • Connects radius to anterior scaphoid and lunate
  • **Dorsal radiocarpal ligament**
    • Connects radius to posterior scaphoid and lunate
  • **Ulnar collateral ligament**
    • Connects styloid process of the ulna to the triquetrum
  • **Radial collateral ligament**
    • Connects the styloid process of the radius to the scaphoid
Figure 8.12b The Joints of the Wrist and Hand

Sectional view through the wrist showing the radiocarpal, intercarpal, and carpometacarpal joints.
Figure 8.12c The Joints of the Wrist and Hand

Stabilizing ligaments on the anterior (palmar) surface of the wrist
The Joints of the Wrist and Hand

• The Joints of the Hand
  • **Carpometacarpal joint**
    • Connects the metacarpals to the distal carpals
  • **Intercarpal joint**
    • Connects one carpal bone to another
  • **Metacarpophalangeal joint**
    • Connects metacarpals to the proximal phalanges
  • **Interphalangeal joint**
    • Joint between the proximal, middle, and distal phalanges
Sectional view of the bones that form the wrist and hand
Representative Articulations
ANIMATION Articulations: Wrist Flexion/Extension
ANIMATION Articulations: Wrist Circumduction
ANIMATION Articulations: Hand Opposition
The Hip Joint

• Hip Joint (Ball-and-Socket Joint)
  • Iliofemoral ligament
  • Pubofemoral ligament
  • Ischiofemoral ligament
    • The above ligaments connect the femur to the acetabular rim
• Transverse acetabular ligament
  • Connects the femur to the inferior acetabular rim
• Ligament of the femoral head
  • Connects the fovea capitis to the transverse acetabular ligament
Anterior view of the right hip joint. This joint is extremely strong and stable, in part because of the massive capsule.
Posterior view of the right hip joint showing additional ligaments that add strength to the capsule.
Figure 8.14a Articular Structure of the Hip Joint

View showing the position and orientation of the ligament of the femoral head
The Knee Joint

• Supporting Ligaments
  • Tibial collateral ligament
    • Formerly called the medial collateral
  • Fibular collateral ligament
    • Formerly called the lateral collateral
  • Patellar ligament
  • Patellar retinaculum
  • Popliteal ligaments
  • Anterior cruciate ligament (ACL)
  • Posterior cruciate ligament (PCL)
The Knee Joint

• Supporting Ligaments
  • **Tibial collateral ligament**
    • Connects the medial epicondyle of the femur to the tibia
  • **Fibular collateral ligament**
    • Connects the lateral epicondyle of the femur to the fibula
  • **Patellar ligament**
    • Connects the tibial tuberosity to the patella
    • This is an extension of the rectus femoris tendon
The Knee Joint

- Supporting Ligaments
  - **Patellar retinaculum**
    - Connects the medial and lateral edge of the patella to the tibia
The Knee Joint

• Knee Joint

  • **Popliteal ligament**
    • Connects the femur to the head of the tibia and the head of the fibula

  • **Anterior cruciate ligament (ACL)**
    • Connects the tibia to the lateral edge of the intercondylar fossa of the femur

  • **Posterior cruciate ligament (PCL)**
    • Connects the tibia to the medial edge of the intercondylar fossa of the femur
Anterior views of the right knee at full flexion after removal of the joint capsule, patella, and associated ligaments.
Figure 8.16b The Knee Joint, Part II

Ligaments that Stabilize the Knee Joint

- Anterior cruciate ligament
- Tibial collateral ligament
- Posterior cruciate ligament

Posterior view of the right knee at full extension after removal of the joint capsule
The Joints of the Ankle and Foot

• The Ankle Joint (Talocrural Joint)
  • Tibiotalar joint
    • Joint between the tibia and the talus
  • Fibulotalar joint
    • Joint between the lateral malleolus and the lateral edge of the talus
The Joints of the Ankle and Foot

- **Ligaments of the Ankle**
  - **Deltoid ligament**
    - Connects the tibia to the navicular, calcaneus, and the talus on the medial side
  - **Lateral ligaments**
    - **Calcaneofibular**: connects the fibula to the calcaneus
    - **Anterior talofibular**: connects the fibula to the anterior edge of the talus
    - **Posterior talofibular**: connects the fibula to the posterior edge of the talus
Lateral view of the right foot showing ligaments that stabilize the ankle joint.
Medial view of the right ankle showing the medial ligaments.
The Joints of the Ankle and Foot

- The Joints of the Foot
  - **Intertarsal joint**
    - Joint between one tarsal and another tarsal
  - **Tarsometatarsal joint**
    - Connects the tarsal bones to the metatarsal bones
  - **Metatarsophalangeal joint**
    - Connects the metatarsals to the digits
ANIMATION Articulations: Foot Dorsiflexion/Plantar Flexion
ANIMATION Articulations: Foot Inversion/Eversion
a Superior view of bones and joints of the right foot.
Aging and Articulations

• As we age, joints are subjected to wear and tear
  • Rheumatism
    • Pain and stiffness affecting the skeletal system, muscular system, or both
  • Arthritis
    • Includes all rheumatic diseases that affect synovial joints
    • Involves damage to the articular cartilages
Bones and Muscles

- Musculoskeletal System
  - The skeleton and muscles are structurally and functionally interdependent