Lecture 8

Articulations

Articulations

• Body movement occurs at joints (articulations) where 2 bones connect
• Weakest parts of the skeleton
• Articulation – site where two or more bones meet
• Functions of joints
  – Give the skeleton mobility
  – Hold the skeleton together

Joint Structure

• Determines direction and distance of movement (range of motion)
• Joint strength decreases as mobility increases

Classification of Joints: Structural

• Structural classification focuses on the material binding bones together and whether or not a joint cavity is present
• The three structural classifications are:
  – Fibrous
  – Cartilaginous
  – Synovial

Structural Classification

<table>
<thead>
<tr>
<th>Structural Category</th>
<th>Structural Type</th>
<th>Functional Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone fusion</td>
<td>Synostosis</td>
<td>Synarthrosis</td>
</tr>
<tr>
<td>Fibrous joint</td>
<td>Suture</td>
<td>Synarthrosis</td>
</tr>
<tr>
<td></td>
<td>Gomphosis</td>
<td>Synarthrosis</td>
</tr>
<tr>
<td></td>
<td>Syndesmosis</td>
<td>Amphiarthrosis</td>
</tr>
<tr>
<td>Cartilaginous joint</td>
<td>Synchondrosis</td>
<td>Synarthrosis</td>
</tr>
<tr>
<td></td>
<td>Symphysis</td>
<td>Amphiarthrosis</td>
</tr>
<tr>
<td>Synovial joint</td>
<td>Monoaxial</td>
<td>Diarthrosis</td>
</tr>
<tr>
<td></td>
<td>Biarticular</td>
<td>Diarthrosis</td>
</tr>
<tr>
<td></td>
<td>Triarticular</td>
<td>Diarthrosis</td>
</tr>
</tbody>
</table>

Overview

• Joint classifications: structural and functional
• Types of joints by functional classification
• Synovial joint detail
• Movements at synovial joints
• Classification of synovial joints by shape
• Examples of joints
• Injuries
• Arthritis
### Structural Classifications

- Bony (fused)
- Fibrous (collagen fibers)
- Cartilaginous (cartilage)
- Synovial (synovial fluid)

### Classification of Joints: Functional

- Functional classification is based on the amount of movement allowed by the joint
- The three functional classes of joints are:
  - Synarthroses – immovable
  - Amphiarthroses – slightly movable
  - Diarthroses – freely movable

### Functional Classification

<table>
<thead>
<tr>
<th>Functional Category</th>
<th>Structural Category and Type</th>
<th>Description</th>
<th>Example(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synarthroses (immovable)</td>
<td>Suture</td>
<td>Bones are interlocked</td>
<td>Between pairs of ribs, between ends of bones of facial bones</td>
</tr>
<tr>
<td>Synarthroses (immovable)</td>
<td>Gomphosis</td>
<td>Fibrous connection</td>
<td>Binds teeth to sockets</td>
</tr>
</tbody>
</table>

#### Synarthroses 1 of 2

- **Suture**
  - Bones are interlocked
  - Bound by dense fibrous connective tissue
  - Found only in skull

- **Gomphosis**
  - Fibrous connection (periodontal ligament)
  - Binds teeth to sockets

### Synarthrosis: Suture

![Synarthrosis: Suture](figure_8_1a)
Synarthroses 2 of 2

- **Synchondrosis**
  - A rigid cartilaginous bridge between 2 bones:
    - epiphyseal cartilage of long bones
    - between vertebrosternal ribs and sternum
- **Synostosis**
  - Fused bones, immovable:
    - metopic suture of skull
    - epiphyseal lines of long bones

Amphiarthroses

- Also called *slightly moveable joints*
- Can be fibrous or cartilaginous connections

**Functionally:**
- More moveable than synarthrosis
- Stronger than freely movable joint
- **Types:**
  - Syndesmosis
  - Symphysis

2 Types of Amphiarthroses

- **Syndesmosis:**
  - bones connected by *ligaments*
  - e.g. between tibia and fibula
- **Symphysis:**
  - bones separated by *fibrocartilage*
  - Examples?
Diarthroses

- Synovial joints
- Also called freely moveable joints
- At ends of long bones
- Found within articular capsules (continuous with periosteum) lined with synovial membrane and filled with fluid
- Include all limb joints and many others
- Subdivided by the type of motion each can undergo

Synovial Joints: General Structure

- Synovial joints all have the following
  - Articular cartilage
  - Joint (synovial) cavity
  - Articular capsule
  - Synovial fluid
  - Reinforcing ligaments

Synovial Joints: General Structure

- Articular cartilage: pads articulating surfaces within articular capsules to prevent bones from touching
- Synovial fluid lubricates the smooth surfaces, contains proteoglycans secreted by fibroblasts (from where?)
  Functions:
  1. Lubrication
  2. Shock absorption
  3. Nutrient distribution – from areolar tissue of synovial membrane to the articular cartilage and fibrocartilage pads

Synovial membrane

- Has incomplete epithelium
- Areolar tissue underneath has rich blood supply
- Creates synovial fluid and proteoglycans (from fibroblasts) to make it viscous
- No blood supply enters the joint itself

Synovial Joints: Friction-Reducing Structures
Synovial Joints: Stability

- **Stabilizing Factors** - prevent injury by limiting range of motion:
  - Articular surfaces – shape determines what movements are possible
  - Ligaments – unite bones and prevent excessive or undesirable motion
  - Muscle tendons across joints acting as stabilizing factors, are kept tight at all times by muscle tone

Accessory structures Part 1

- **Cartilages**: Cushion the joint
  - Articular hyaline cartilage
  - Fibrocartilage meniscus (articular disc)
- **Bursa**: Cushion areas where ligaments, muscles, skin, tendons, or bones rub together
  - Flattened, fibrous sacs lined with synovial membranes and containing synovial fluid
  - Tendon sheath: elongated bursa that wraps completely around a tendon

Accessory structures Part 2

- **Fat Pads**: Protect articular cartilages
  - Superficial (overlying) to the joint capsule
- **Accessory Ligaments**: Support, strengthen joints
- **Tendons**: Attach to muscles around joint to help support it

Synovial Joints: Movement

- The two muscle attachments across a joint are:
  - Origin – attachment to the immovable bone
  - Insertion – attachment to the movable bone
- Described as movement along transverse (horizontal), frontal, or sagittal planes

Basic types of dynamic motion

- Linear motion (gliding)
- Angular motion
- Rotation

Linear Motion

- One flat bone surface glides or slips over another similar surface
- Examples – intercarpal and intertarsal joints, and between the flat articular processes of the vertebrae

Pencil maintains vertical orientation, but changes position
Angular Motion

• Pencil maintains position, but changes orientation
  – Tip stays fixed; pencil does not rotate
• Many examples

Angular Motion

• Flexion — bending movement that decreases the angle of the joint
• Extension — reverse of flexion; joint angle is increased
• Dorsiflexion and plantar flexion — up and down movement of the foot
• Abduction — movement away from the midline
• Adduction — movement toward the midline
• Circumduction — movement describes a cone in space

Angular Motion: Circumduction

• Angular motion in a circle
  – Again, tip does not rotate

Synovial Joints: Range of Motion

• Nonaxial — slipping movements only
• Monaxial/Uniaxial — movement in one plane
• Biaxial — movement in two planes
• Triaxial — movement in or around all three planes

Types of Movements at Synovial Joints

• Terms describe:
  – plane or direction of motion
  – relationship between structures
• In the anatomical position, all joints except one are at full extension

Rotation

• NOT angular
• Pencil maintains position and orientation, but spins
• Example — shaking your head
**Flexion/Extension**

- Angular motion in the Anterior–posterior plane
- Flexion reduces angle between elements
- Extension increases angle between elements

**Hyperextension**

- Angular motion
- Extension past anatomical position

**Angular Movement – F/E**

**Dorsiflexion and Plantar Flexion**

- **Dorsiflexion:**
  - flexion at ankle (lifting toes)
  - is "true flexion"
- **Plantar flexion:**
  - extension at ankle (pointing toes)

**Angular Movement - Hyperextension**

**Hyperextension**

- Angular motion
- Extension past anatomical position
Abduction and Adduction

- Both are Angular motion in the Frontal plane
- Abduction moves away from longitudinal axis
- Adduction moves toward longitudinal axis

Angular Movements - Ab/Ad/Circum

Circumduction

- Angular motion in a circle without rotation

Rotation

- The turning of a bone around its own long axis
- Left or right rotation
- Medial rotation (inward rotation):
  - rotates toward axis
- Lateral rotation (outward rotation):
  - rotates away from axis
- Examples
  - Between first two vertebrae
  - Hip and shoulder joints

Special Movements

- Supination and pronation
- Inversion and eversion
- Protraction and retraction
- Elevation and depression
- Opposition

Special Movements

(a) Supination (S) and pronation (P)
Special Movements

**Figure 8.6b**

(b) Inversion and eversion

Special Movements

**Figure 8.6c**

(c) Protraction and retraction

Special Movements

**Figure 8.6d**

(d) Elevation and depression

Special Movements

**Figure 8.6e**

(e) Opposition

Lateral Flexion

- Bends vertebral column from side to side

**Figure 9.12**

MOVIE

- Angular motions
Classification of Synovial Joints by Shape

- Gliding/Plane
- Hinge
- Pivot
- Ellipsoidal
- Saddle
- Ball-and-socket

Gliding Joints
- Flattened or slightly curved faces
- Limited motion (only examples of nonaxial)
- Also called linear motion
- 2 surfaces slide past each other:
  - between carpal or tarsal bones

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<td>Pivot Joint</td>
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<td></td>
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<td>Ellipsoidal Joint</td>
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Hinge Joints
- Cylindrical projections of one bone fits into a trough-shaped surface on another
- Angular motion in a single plane (monaxial)
- Flexion/extension only
- Elbow, knee

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Pivot Joints
- Rounded end of one bone protrudes into a “sleeve,” or ring, composed of bone (and possibly ligaments) of another
- Rotation only (monaxial)
- Shaking your head

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Ellipsoidal Joints
- Oval articular face within a depression
- Motion in 2 planes (baxial)
- Some wrist joints (e.g. radiocarpal)
Saddle Joints

• 2 concave faces, straddled (biaxial)
• Thumb (carpometacarpal)

Ball-and-Socket Joints

• A spherical or hemispherical articular face head of one bone articulates with a cuplike socket of another (triaxial)
• Shoulder, hip

MOVIE

• Types of synovial joint motion

Specific joint examples

Vertebrae, shoulder, elbow, hip, knee

IMPORTANT

• You DO NOT need to know the names of specific ligaments in the examples that follow. Only learn the general concepts about these joints (and the terms listed in blue).
• You DO need to know what type of joint is found at any site in the body

Intervertebral Articulations
Intervertebral Articulations

- C2 to L5 spinal vertebrae articulate in two places:
  - at inferior and superior articular processes
  - between adjacent vertebral bodies
    - symphyseal joints (symphysis = fibrocartilage pad)
- The atlas and axis have a pivot joint (monaxial synovial)

Intervertebral Discs

- Intervertebral discs:
  - pads of fibrocartilage that separate vertebral bodies
- Slipped (bulging) disc:
  - bulge in outer anulus fibrosus of disc
  - invades vertebral canal, may press on nerves or cord
- Herniated disc:
  - Inner, gelatinous nucleus pulposus breaks through anulus fibrosus
  - presses on spinal cord or nerves

Damage to Intervertebral Discs

Movements of the Vertebral Column

- Flexion/Extension
  - bends anteriorly and posteriorly
  - Caused by small gliding movements of adjacent vertebrae
- Lateral flexion:
  - bends laterally
- Rotation

Temporomandibular Joint (TMJ)

- Mandibular condyle articulate with the temporal bone
- Two types of movement
  - Hinge – depression and elevation of mandible
  - Side to side – (lateral excursion) grinding of teeth

Temporomandibular Joint

Figure 9–8

Figure 8.13a, b
Activity
• Get in small groups
• Compare and contrast the shoulder, hip, and knee joints on the basis of:
  – Range of motion
  – Stability/Protection
  – Injury frequency

The Shoulder Joint
• Also called the glenohumeral joint:
• Ball-and-socket triaxial diarthrosis in which stability is sacrificed to obtain greater freedom of movement
• Head of humerus articulates with the glenoid fossa of the scapula
• Allows more motion than any other joint
• Is the least stable
• Supported by skeletal muscles, tendons, ligaments

Shoulder Stability
• Weak stability is maintained by:
  – Thin, loose joint capsule
  – Four ligaments – coracohumeral, and three glenohumeral
  – Tendon of the long head of biceps, which travels through the intertubercular groove and secures the humerus to the glenoid cavity
  – Rotator cuff (four tendons) that encircles the shoulder joint and blends with the articular capsule

Socket of the Shoulder Joint
• Glenoid labrum:
  – deepens socket of glenoid cavity
  – fibrocartilage lining
  – extends past the bone
Processes of the Shoulder Joint

- **Acromion** (clavicle) and **coracoid process** (scapula):
  - project laterally, superior to the humerus
  - help stabilize the joint
- **Shoulder Separation**
  - Partial or complete dislocation of **Acromioclavicular joint**

Shoulder Muscles (FYI)

- Also called **rotator cuff**:
  - **supraspinatus**
  - **infraspinatus**
  - **subscapularis**
  - **teres minor**

The Hip Joint

- **Ball-and-socket triaxial diarthrosis**
- Head of the femur articulates with the acetabulum
- Socket of acetabulum is extended (made larger) by fibrocartilage **acetabular labrum**
- Good range of motion, but limited by the deep socket and strong ligaments
- Stronger than shoulder, but more limited range of motion

Hip (Coxal) Joint

- **Acetabular labrum**
- **Iliofemoral ligament**
- **Pubofemoral ligament**
- **Ischiofemoral ligament**
- **Ligamentum teres**

Hip Stability

- **Acetabular labrum**
- **Iliofemoral ligament**
- **Pubofemoral ligament**
- **Ischiofemoral ligament**
- **Ligamentum teres**
The Knee Joint

- A complicated hinge joint
- Largest and most complex joint of the body
- Allows flexion, extension, and limited rotation
- Three joints in one surrounded by a single joint cavity
  - Femoropatellar joint
  - Lateral and medial tibiofemoral joints (at medial and lateral condyles)
- Transfers weight from femur to tibia

Menisci of the Knee

- Medial and lateral menisci:
  - fibrocartilage pads
  - one at each femur–tibia articulation
  - cushion and stabilize joint
  - give lateral support
- Standing with legs straight "locks" knees by jamming lateral meniscus between tibia and femur which may interrupt venous return from lower leg

FYI: 7 Ligaments of the Knee Joint

- Patellar ligament (anterior)
- 2 popliteal ligaments (posterior)
- Anterior and posterior cruciate ligaments (inside joint capsule)
- Tibial collateral ligament (medial)
- Fibular collateral ligament (lateral)

Knee Ligaments and Tendons – Anterior surface

- Tendon of the quadriceps femoris muscle
- Patellar ligament
- Lateral and medial patellar retinacula
- Fibular and tibial collateral ligaments
Knee – Interior Supporting Structures

- All inside the joint capsule:
  - Anterior cruciate ligament
  - Posterior cruciate ligament
  - Medial meniscus (semilunar cartilage)
  - Lateral meniscus

Synovial Joints: Knee – Interior Supporting Structures

Knee – Posterior Superficial View

- Adductor magnus tendon
- Articular capsule
- Oblique popliteal ligament
- Arcuate popliteal ligament
- Semimembranosus tendon

The Elbow Joint

- A stable hinge joint that allows flexion/extension only
- Articulations between humerus - radius, humerus – ulna
- Biceps brachii muscle:
  - attached to radial tuberosity
  - controls elbow motion

Articulations of the Elbow

- Humeroular joint:
  - larger articulation
  - trochlea of humerus and trochlear notch of ulna
  - limited movement
- Humeroradial joint:
  - smaller articulation
  - capitulum of humerus and head of radius

Synovial Joints: Elbow

- Annular ligament
- Ulnar collateral ligament
- Radial collateral ligament
Injuries: Sprains and Strains

**Sprain**: ligaments with torn collagen fibers
- Partially torn ligaments slowly repair themselves
- Completely torn ligaments require prompt surgical repair

**Strain**: Muscles with torn fibers, also called “pulling a muscle”

Injuries: dislocations

- **Dislocation (luxation)**:
  - Articulating surfaces forced out of position
  - Damages articular cartilage, ligaments (sprains), joint capsule
- **Subluxation**:
  - A partial dislocation

Cartilage Injuries

- The snap and pop of overstressed cartilage
- Common aerobics injury
- Repaired with arthroscopic surgery (questionable effectiveness)

Inflammatory and Degenerative Conditions

- **Bursitis**
  - An inflammation of a bursa, usually caused by a blow or friction
  - Symptoms are pain and swelling
  - Treated with anti-inflammatory drugs; excessive fluid may be aspirated
- **Tendonitis**
  - Inflammation of tendon sheaths (which are enlarged bursa) typically caused by overuse
  - Symptoms and treatment are similar to bursitis
### Arthritis

- All forms of rheumatism that damage articular cartilages of synovial joints
- More than 100 different types of inflammatory or degenerative diseases that damage the joints
- Most widespread crippling disease in the U.S.
- Symptoms – pain, stiffness, and swelling of a joint

### Osteoarthritis

- Caused by wear and tear of joint surfaces, or genetic factors affecting collagen formation
- Affects women more than men
- 85% of all Americans develop OA
- Generally in people over age 60
- The exposed bone ends thicken, enlarge, form bone spurs, and restrict movement
- Joints most affected are the cervical and lumbar spine, fingers, knuckles, knees, and hips
- Treatments include glucosamine sulfate and CSPG to decreases pain and inflammation

### Rheumatoid Arthritis

- Chronic, inflammatory, autoimmune disease of unknown cause
- Involves the immune system
- Usually arises between the ages of 40 to 50, but may occur at any age
- Signs and symptoms include joint tenderness, anemia, osteoporosis, muscle atrophy, and cardiovascular problems
  - The course of RA is marked with exacerbations and remissions
- Treatments include Enbrel, Remicade, Humira, methotrexate

### Developmental Aspects of Joints

- By embryonic week 8, synovial joints resemble adult joints
- Few problems occur until late middle age
- Advancing years take their toll on joints:
  - Ligaments and tendons shorten and weaken
  - Intervertebral discs become more likely to herniate
  - Most people in their 70s have some degree of OA

### Summary

- Joint classifications: structural and functional
- Types of joints by functional classification
- Synovial joint detail
- Movements at synovial joints
- Classification of synovial joints by shape
- Examples of joints
- Injuries
- Arthritis