Chapter 9: Articulations

- The body is adapted to movement, which occurs only at joints where 2 bones connect (articulations). Joints have different structures that determine the direction and distance they can move. Joints always compromise strength to increase mobility.

I. The Classification of Joints, p. 259

Objectives
1. The major categories of joints, and the structure and function of each category.
2. The basic structure of a synovial joint, the common accessory structures and their functions.

♣ The distance and direction a joint can move is called range of motion. Joints can move a little (amphiarthrosis), a lot (diarthrosis) or not at all (synarthrosis).

Table 9-1
Functional classification

♣ Joints can be divided into functional groups:
  - Synarthroses, or immovable joints, are bound together by fibrous or cartilaginous connections, which may fuse over time.
  - Amphiarthroses, or slightly moveable joints, may have fibrous or cartilaginous connections.
  - Diarthroses, or synovial joints, are freely moveable, and are subdivided by type of motion.

Table 9-2
Structural Classification

♣ Joints can also be classified by structure:
  - bony
  - fibrous
  - cartilaginous
  - synovial

Synarthroses (Immovable Joints), p. 260

♣ Synarthroses are very strong. At a synarthrosis, the edges of the bones may touch or interlock. The 4 types of synarthrotic joints are:
  1. suture:
     - bones are interlocked and bound by dense fibrous connective tissue
     - found only in the skull
  2. gomphosis:
     - a fibrous connection (periodontal ligament)
- binds teeth to sockets

3. **synchondrosis**:
   - a rigid cartilaginous bridge between 2 bones
   - e.g. the epiphyseal cartilage of long bones
   - e.g. the connection between vertebrosternal ribs and the sternum

4. **synostosis**:
   - fused bones, immovable
   - e.g. the metopic suture of the skull
   - e.g. epiphyseal lines of long bones

**Amphiarthroses (Slightly Moveable Joints), p. 260**

♣ An amphiarthrosis is more moveable than a synarthrosis, and stronger than a freely movable joint.

♣ The 2 major types of amphiarthrotic joints are:
  1. **syndesmosis**: bones connected by ligaments
  2. **symphysis**: bones separated by fibrocartilage

**Diarthroses (Moveable Joints), p. 260**

♣ Diarthroses (synovial joints) are found at the ends of long bones, within articular capsules lined with synovial membrane.

♣ The articulating surfaces of the bones within the articular capsules are padded with articular cartilages, which prevent the bones from touching. The smooth surfaces are lubricated by synovial fluid to reduce friction.

♣ Synovial fluid (which contains slippery proteoglycans secreted by fibroblasts) has 3 main functions:
  1. lubrication
  2. nutrient distribution
  3. shock absorption

♣ Synovial joints have several kinds of accessory structures:
  1. **Cartilages and fat pads** cushion the joint.
     - a fibrocartilage **meniscus** or **articular disc** lies between bones and may subdivide a synovial cavity.
     - **fat pads** superficial to the joint capsule protect articular cartilages
  2. Various kinds of **accessory ligaments** support and strengthen joints.
     - an injury which tears collagen fibers in a ligament is a **sprain**
  3. **Tendons** attached to muscles around a joint help support the joint.
  4. **Bursae** are pockets of synovial fluid that cushion areas where tendons or ligaments rub.

♣ Several factors stabilize joints and prevent injury by limiting range of motion:
1. collagen fibers of the joint capsule and associated ligaments
2. the shapes of articulating surfaces and menisci
3. other bones, muscles, or fat pads around the joint
4. tendons of opposing (articulating) bones may help control or limit movement

An injury to a joint in which articulating surfaces are forced out of position is called a dislocation (luxation). A partial dislocation is a subluxation. Luxation can damage articular cartilage, tear ligaments, or distort the joint capsule.

II. Form and Function of Synovial Joints, p. 263

Objectives
1. What are the dynamic movements of the skeleton?
2. What are the types of synovial joints, and the relationship of their structures to motion?

Describing Dynamic Motion, p. 263

Figure 9-2

Refer to Figure 9-2 to describe linear motion, angular motion, and rotation:
1. In linear motion, the pencil maintains its vertical orientation, but changes its position.
2. In angular motion, the pencil maintains its position, but changes its orientation. (A circular angular motion is called circumduction.)
3. When the pencil maintains both its position and orientation, but spins on its axis, this motion is called rotation.

Terms to describe the number of planes or axes in which a joint can move are:
1. monaxial (1 axis)
2. biaxial (2 axes)
3. triaxial (3 axes)

Types of Movements at Synovial Joints, p. 264

In a clinical setting, accurate terms must be used to describe movement, including the plane or direction of motion, and the change in relationship between the elements or structures involved.

1. Linear Motion (gliding):
   - 2 surfaces slide past each other
   - e.g. between carpal or tarsal bones

2. Angular Motions

Figure 9-3a

flexion:
- in the anterior-posterior plane
- reduces the angle between elements
extension:
- in the anterior-posterior plane
- increases the angle between elements
hyperextension:
- extension past anatomical position

Figure 9-3b,c
abduction:
- in the frontal plane
- moves away from the longitudinal axis of the body
adduction:
- in the frontal plane
- moves toward the longitudinal axis of the body

Figure 9-3d
circumduction:
- a circular motion without rotation

• 3. Rotational Motions

Figure 9-4
rotation: the direction of a rotation from anatomical position, relative to the longitudinal axis of the body.
- left or right rotation
- medial rotation (inward rotation): rotates toward the axis
- lateral rotation (outward rotation): rotates away from the axis
- pronation: rotates the forearm, radius over ulna
- supination: the forearm in anatomical position

• 4. Special movements of specific articulations:

Figure 9-5a
inversion: twists the sole of the foot medially
eversion: twists the sole of the foot laterally

Figure 9-5b
dorsiflexion: flexion at the ankle (lifting toes)
plantar flexion: extension at the ankle (pointing toes)

Figure 9-5c
opposition: movement of the thumb toward fingers or palm (grasping)

Figure 9-5d
protraction: moves a body part anteriorly, in the horizontal plane (pushing
forward)
retraction: the opposite of protraction, moving anteriorly (pulling back)

**Figure 9-5e**
elevation: moves in a superior direction (up)
depression: moves in an inferior direction (down)

**Figure 9-5f**
lateral flexion: bends the vertebral column from side to side.

_A Structural Classification of Synovial Joints, p. 267_

- Synovial joints may be classified by the shapes of their articular surfaces, as follows:

**Figure 9-6a**
1. gliding joints:
   - flattened or slightly curved faces
   - limited motion (nonaxial)

**Figure 9-6b**
2. hinge joints:
   - angular motion in a single plane (monaxial)

**Figure 9-6c**
3. pivot joints:
   - rotation only (monaxial)

**Figure 9-6d**
4. ellipsoidal joints:
   - an oval articular face within a depression
   - motion in 2 planes (biaxial)

**Figure 9-6e**
5. saddle joints:
   - two concave faces, straddled (biaxial)

**Figure 9-6f**
6. ball-and-socket joints:
   - a round articular face in a depression (triaxial)

**Key**
_A joint can’t be both highly mobile and very strong. The greater the mobility, the weaker the joint, because mobile joints rely on muscular and ligamentous support rather than solid bone-to-bone connections._
III. Representative Articulations, p. 269

Objectives
1. Describe the articulations between the vertebrae of the vertebral column.
2. Describe the structure and function of the shoulder, elbow, hip and knee joints.
3. Explain the relationship between joint strength and mobility, using specific examples.

Intervertebral Articulations, p. 269

Figure 9-7
• From the second cervical vertebra to the last lumbar vertebra, the spinal vertebrae articulate at their inferior and superior articular processes (gliding joints), and between adjacent vertebral bodies (symphyseal joints).

• Within the symphyseal joints, pads of fibrocartilage (intervertebral discs) separate the vertebral bodies. The tough outer layer (anulus fibrosus) attaches the disc to adjacent vertebrae. The elastic, gelatinous core (nucleus pulposus) absorbs shocks. As the vertebral column moves, the nucleus pulposus shifts, allowing the intervertebral disc to conform to the motion.

• Intervertebral ligaments bind vertebrae together and stabilize the vertebral column:
  1. anterior longitudinal ligament (connects anterior bodies)
  2. posterior longitudinal ligament (connects posterior bodies)
  3. ligamentum flavum (connects laminae)
  4. interspinous ligament (connects spinous processes)
  5. supraspinous ligament (connects tips of spinous processes, C7 to sacrum)
  6. ligamentum nuchae (contiguous with supraspinous ligament, C7 to skull)

Figure 9-8
• Damage to discs includes:
  - A slipped disc, which is a disc with a bulge in the anulus fibrosus that invades the vertebral canal.
  - In a herniated disc, the nucleus pulposus breaks through the anulus fibrosus and presses on the spinal cord or nerves.

• The vertebral column can move in 4 ways:
  1. flexion (bending anteriorly)
  2. extension (bending posteriorly)
  3. lateral flexion (bending laterally)
  4. rotation

Table 9-3 summarizes the articulations and movements of the axial skeleton.
The Shoulder Joint, p. 272

Figure 9-9

- The shoulder joint (glenohumeral joint) allows more motion than any other joint. Therefore, it is also the least stable.

- The shoulder joint is a ball-and-socket diarthrosis between the head of the humerus and the glenoid cavity of the scapula. The socket of the glenoid cavity is deepened by a lining of fibrocartilage (the glenoid labrum) that extends past the bone.

- The acromion of the clavicle and the coracoid process of the scapula project laterally, superior to the humerus, and help stabilize the joint, but position is maintained mainly by skeletal muscles, tendons and ligaments (glenohumeral, coracohumeral, coracoacromial, coracoclavicular, and acromioclavicular ligaments).

- A common injury is partial or complete dislocation of the shoulder joint (shoulder separation).

- The main support for the shoulder joint is a muscle group called the rotator cuff (supraspinatus, infraspinatus, subscapularis and teres minor muscles).

- The shoulder has several important bursae that reduce friction across the joint (the subacromial, subcoracoid, subdeltoid and subscapular bursae).

The Elbow Joint, p. 273

Figure 9-10

- The elbow is a stable hinge joint with articulations between the humerus, radius and ulna.

- The largest articulation is the humeroulnar joint (trochlea of humerus with the trochlear notch of ulna) which has a limited degree of movement. The smaller articulation (between the capitulum of the humerus and head of radius) is the humeroradial joint.

- Elbow motion is controlled by the biceps brachii muscle (attached to the radial tuberosity), and stabilized by several ligaments (the radial collateral, annular, and ulnar collateral ligaments).

The Hip Joint, p. 274

Figure 9-11

- The hip joint (coxal joint) is a strong ball-and-socket diarthrosis with a wide range of motion.
The head of the femur fits into the socket of the acetabulum, which is extended by a fibrocartilage rim (acetabular labrum).

The strong articular capsule is reinforced by several ligaments (including the iliofemoral, pubofemoral, ischiofemoral, and transverse acetabular ligaments, and the ligamentum teres) and supported by large muscles.

The hip joint is very stable. Stress on the angle of the neck tends to cause fractures rather than dislocations.

**The Knee Joint, p. 275**

**Figure 9-12**

The knee joint is a complicated hinge joint, transferring weight from the femur to the tibia. It has 2 femur-tibia articulations (at the medial and lateral condyles) and 1 between the patella and the patellar surface of the femur.

The 2 femur-tibia articulations are cushioned by fibrocartilage pads (the medial and lateral menisci), which stabilize the joint and give lateral support. Fat pads and bursae also protect the joint.

7 major ligaments support the knee joint:
- patellar ligament (anterior, contains the patella)
- 2 popliteal ligaments (posterior)
- anterior and posterior cruciate ligaments (inside the joint capsule)
- tibial collateral ligament (medial)
- fibular collateral ligament (lateral)

Standing with legs straight “locks” the knees by jamming the lateral meniscus between the tibia and femur.

*Table 9-4* summarizes the articulations of the appendicular skeleton.

**IV. Aging and Articulations, p. 278**

**Objective**

1. Describe the effect of aging on articulations, and discuss the most common clinical problems that develop as a result.

- **Rheumatism** is the general term for pain and stiffness of the skeletal and muscular systems.

- **Arthritis** specifically includes all forms of rheumatism that damage the articular cartilages of the synovial joints:
  - *osteoarthritis*, caused by wear and tear of joint surfaces or genetic factors affecting collagen formation, generally affects people over age 60.
- **rheumatoid arthritis** is an inflammatory condition which may be caused by infection, allergy or autoimmune disease, and involves the immune system.
- **gouty arthritis** occurs when crystals (uric acid or calcium salts) form within the synovial fluid due to metabolic disorders.

- Joint immobilization reduces flow of synovial fluid and can cause arthritis-like changes which may be treated by **continuous passive motion** (therapy).

- With age, bone mass decreases and bones become weaker. Osteoporosis increases the risk of hip fracture, hip dislocation and pelvic fracture.

**V. Integration with Other Systems, p. 278**

**Figure 9-13**

- Living bones are constantly building up (by osteoblasts) and breaking down (by osteoclasts). The balance between bone building and bone recycling depends on:
  1. age
  2. physical stress
  3. hormone levels
  4. rates of calcium and phosphorus uptake and excretion
  5. genetic and environmental factors.

- The skeletal system:
  - supports and protects all body systems
  - stores reserves of fat, calcium and phosphorus
  - and manufactures cells for the immune system.

**Clinical Patterns, p. 278**

- Other body systems affect the skeletal system. Changes in other systems can cause skeletal system disorders such as bone tumors, osteoporosis, arthritis, or **rickets** (demineralization causing softening of the bones).

**SUMMARY**

In chapter 9 we learned about:
- the classification of joints by motion and structure
- the 4 types of synarthroses
  - (suture, gomphosis, synchondrosis, and synostosis)
- the 2 types of amphiarthroses
  - (syndesmosis, symphysis)
- the structures and accessory structures of diarthroses
- the 3 forms of dynamic motion
  - (linear or gliding, angular, and rotation)
- the 3 planes of motion
  - (monaxial, biaxial, and triaxial)
- the movements of synovial joints
(gliding, flexion, extension, hyperextension, abduction, adduction, circumduction, rotation, pronation, supination, inversion, eversion, dorsiflexion, plantar flexion, opposition, protraction, retraction, depression, elevation, and lateral flexion)

- the 6 structural types of synovial joints
  (gliding, hinge, pivot, ellipsoidal, saddle, and ball-and-socket)
- the structures and movements of: intervertebral articulations
- the structures and movements of the shoulder joint
- the structures and movements of the elbow joint
- the structures and movements of the hip joint
- the structures and movements of the knee joint
- the effects of aging on joints
- the relationship of the skeletal system to other body systems