Define the terms *parallel* and *perpendicular* and provide a visual example of each.
Planes & Axes

- **Planes of Action** =
  - Three fixed lines of reference along which the body is divided.
  - Each plane is at right angles (or perpendicular) to the other two planes
    - The Sagittal Plane
    - The Frontal Plane
    - The Transverse Plane

Lippert, p27
**The Sagittal Plane**
- Passes through the body from front to back
- Divides the body into right and left parts
- Motions occurring in this plane are ________________ and ________________

Lippert, p27
Planes & Axes continued

- The Frontal Plane
  - Passes through the body from side to side
  - Divides the body into front and back parts
  - Motions occurring in this plane are ___________________ and ___________________
Planes & Axes continued

- The Transverse Plane
  - Passes through the body horizontally
  - Divides the body into top and bottom parts
  - The motion that occurs in this plane is_____________________

Lippert, p27
Planes & Axes continued
• Whenever a plane passes through the midline of a part, it is referred to as a **cardinal plane**, because it divides the body into equal parts.

Lippert, p27
## Terminology

**PLANES**
- Sagittal
- Frontal
- Transverse / Horizontal

**AXES OF MOTION**
- Medial-lateral
- Anterior-posterior
- Superior-inferior
Joint movement occurs around an axis that is always perpendicular to its plane.

Joint movement occurs in the _______________ plane and around the ________________ axis.

Joint movement occurs in the _______________ plane and around the ________________ axis.

Joint movement occurs in the _______________ plane and around the ________________ axis.
Degrees of Freedom

- Joints can also be described by the degrees of freedom, or number of planes, in which they can move.
  - Uniaxial joint = moves in only 1 plane and around 1 axis. Therefore, it has 1 degree of freedom.
  - Biaxial joint = moves in 2 planes and around 2 axes. Therefore, it has 2 degrees of freedom.
  - Triaxial joint = moves in all 3 planes and around all three axes. Therefore, it has 3 degrees of freedom.
  - **What is the maximum # of degrees of freedom that an individual joint can have?**

Lippert, p28
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Flexion
  - The bending movement of 1 bone on another, bringing the two segments together
  - Usually occurs between the anterior surfaces of bones (except the knee)

Lippert, p8
Osteokinematics (the movement of bones)

- **Fundamental Motions that occur at Synovial Joints**
  - **Extension**
    - The straightening movement of one bone away from another
    - This motion usually returns the body part to anatomical position after it has been flexed
    - Joint surfaces tend to move away from each other
    - **Hyperextension** is the continuation of extension beyond the anatomical position

Lippert, p8
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Abduction & Adduction
  - Abduction is movement away from the midline of the body
  - Adduction is movement toward the midline
  - The shoulder and hip can abduct and adduct
  - Exception = the reference point for the fingers is the middle finger and the reference point for the toes is the second toe

Lippert, p8-9
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Horizontal Abduction and Horizontal Adduction
  - Motions of the shoulder which cannot occur from anatomical position
  - The shoulder must first flex or abduct 90 degrees so that the arm is at shoulder level (and perpendicular to the ground)
  - From this position, shoulder movement backward is horizontal abduction and movement forward is horizontal adduction

Lippert, p9
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Radial and Ulnar deviation
  - Radial deviation is a term used to refer to wrist abduction. When the hand moves laterally, or toward the thumb side, it is radial deviation.
  - Ulnar deviation is a term used to refer to wrist adduction. When the hand moves medially from the anatomical position toward the little finger, it is ulnar deviation.

Lippert, p9
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Lateral bending or side-bending
  - When the trunk moves sideways, lateral bending or side-bending is used. (Truck OR neck)
  - Right lateral bending (or right side-bending) is when the right shoulder moves toward the right hip.
  - Left lateral bending (or left side-bending) is when the left shoulder moves toward the left hip

Lippert, p9
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Rotation of the Spine (cervical or trunk)
  - Right rotation is when the face moves toward the right side.
  - Left rotation is when the face moves toward the left side.
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Circumduction
  - A circular motion; a combination of flexion, abduction, extension and adduction

Lippert, p9
Osteokinematics (the movement of bones)

- **Fundamental Motions that occur at Synovial Joints**
  - **Internal and External Rotation**
    - Rotation is movement of a bone around its longitudinal axis
    - Internal rotation (aka medial rotation) occurs when the anterior surface rolls inward toward the midline
    - External rotation (aka lateral rotation) occurs when the anterior surface rolls outward, away from midline

Lippert, p9
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Pronation and Supination
  - Rotation of the forearm is referred to as pronation and supination
  - In anatomical position, the forearm is in supination (the palm of the hand faces anteriorly)
  - In pronation, the palm of the hand faces posteriorly (in the anatomic position)
  - When the elbow is flexed, the “palm up” position is supination and the “palm down” position is pronation.

Lippert, p9-10
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Pronation and Supination

Lippert, p9-10
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Plantarflexion and Dorsiflexion
  - Dorsiflexion is flexion at the ankle (bringing the toes up toward the anterior tibia)
  - Plantarflexion is extension at the ankle (pointing the foot down, moving the toes away from the anterior tibia)

Lippert, p8
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Inversion and Eversion
  - Inversion and eversion are terms specific to the ankle joint
  - Inversion is adduction of the calcaneus (moving the sole of the foot inward at the ankle)
  - Eversion is abduction of the calcaneus (moving the sole of the foot outward at the ankle)

Lippert, p10
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Protraction and Retraction
  - Protraction and retraction are linear movements along a plane parallel to the ground.
  - Protraction is a moving away from midline and retraction is a motion toward midline.
  - Examples:
    - Shoulder girdle:
    - Jaw:

Lippert, p10
Osteokinematics (the movement of bones)

- Fundamental Motions that occur at Synovial Joints
- Protraction and Retraction
Osteokinematics (the movement of bones)

• “Neutral” position: refers to midway between
  o Shoulder internal rotation and external rotation
  o Forearm pronation and supination
  o Wrist flexion and extension
  o Wrist ulnar and radial deviation
  o Hip internal and external rotation
  o Ankle dorsiflexion and plantarflexion
  o Spine: rotation and sidebending
**Movement**

- **Movement can be done:**
  - Actively
  - Passively
  - Active Assisted
Osteokinematics and Arthrokinematics

- **Osteokinematics**
  - Movements of the shaft of bones that we can see
  - Flexion, extension, abduction, adduction, etc
  - Under voluntary control
  - Aka physiological motion, osteokinematic motion

- **Arthrokinematics**
  - Movements taking place within the joint at the joint surfaces, that we cannot see
  - Not under voluntary control
  - Aka accessory motion, arthrokinematic motion

Lippert, p31 & 33
Arthrokinematics

- Types of Arthrokinematic Motion
  - Roll
  - Glide (aka slide)
  - Spin

  - Most joint movement involves a combination of all three of these motions.

Lippert, p33
Types of Arthrokinematic Motion continued

- **Roll**: the rolling of one joint surface on another
  - New points on each surface come into contact throughout the motion
  - Example: a ball rolling across the ground

http://www.youtube.com/watch?v=3CcQvREqgPM

Lippert, p33
Arthrokinematics

- Types of Arthrokinematic Motion continued
- **Glide (aka slide):** linear movement of a joint surface parallel to the plane of the adjacent joint surface
  - In other words, one point on one joint surface (remains the same) contacts new points on the other joint surface
  - Example: An ice-skater’s blade (one point) sliding across the ice surface (many points)

http://www.youtube.com/watch?v=1kKlGrIFuXY&feature=related

Lippert, p33
• Types of Arthrokinematic Motion continued

• **Spin**: the rotation of the movable joint surface on the fixed adjacent surface
  - Essentially, the same point on each surface remains in contact with each other
  - Example: a top spinning on the table (if it were to remain upright and in one place)
    - [http://www.youtube.com/watch?v=MkbZcbswoOY](http://www.youtube.com/watch?v=MkbZcbswoOY)

Lippert, p33
**Arthrokinematics**

- **The Convex-Concave Rule**
  - Knowing that a joint surface is concave or convex is important because shape determines motion.
  - A concave joint surface will move on a fixed convex surface in the same direction the body segment is moving.
    - Therefore, the concave joint surface moves in the same direction as the body segment’s motion.
  - A convex joint surface will move on a fixed concave surface in the opposite direction as the moving body segment.
    - Therefore, the convex joint surface moves in the opposite direction as the body segment’s motion.

Lippert, p34-35
Arthrokinematics

- The Convex-Concave Rule
Joint Congruency

- How well joint surfaces match or fit.
- Close-packed/Closed-pack Position =
  - Joint surfaces have maximum contact with each other
  - Ligaments and capsules holding the joint together are taut
- Open-packed/Loose-packed Position (aka resting position) =
  - Position of maximum in-congruency
  - Parts of the capsule and supporting ligaments are lax
Through which plane is this body cut?
Through which plane is this body cut?