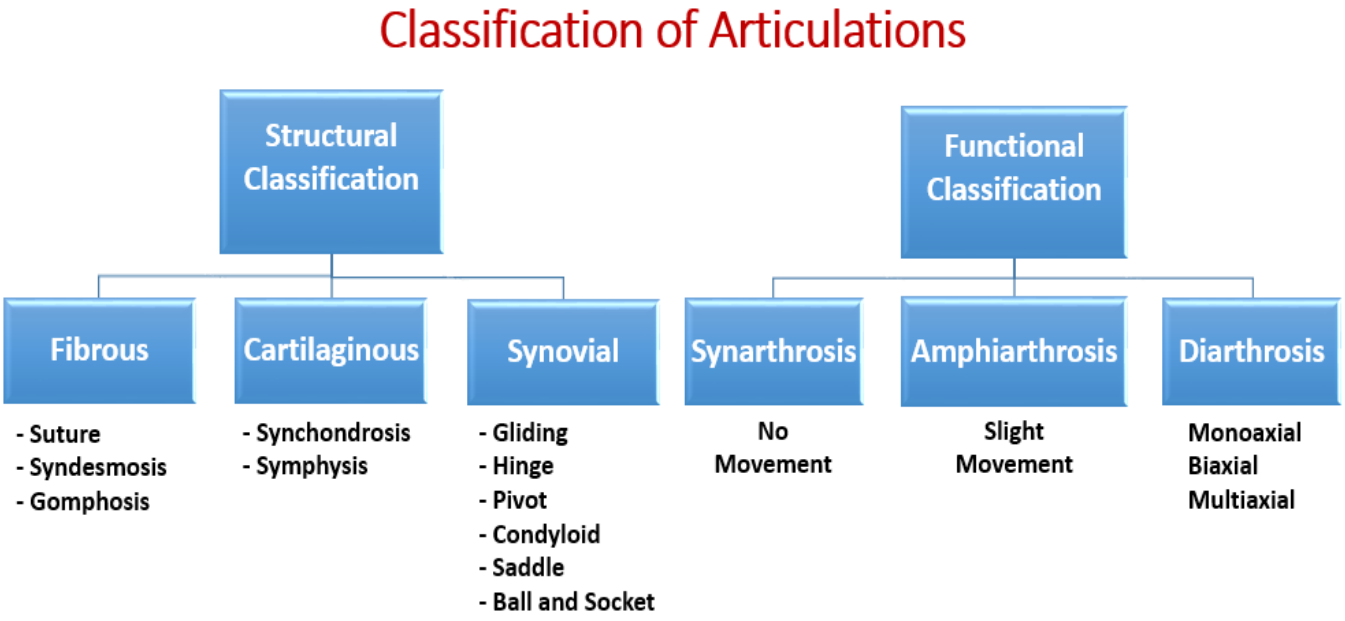
Anatomy Lecture Notes Section 2: Articulations

In anatomy an **articulation** (also called a **joint**) is a location where two or more bones meet and join. Often people think of joints in terms of moveable joints, but those are not the only articulations in the body. By definition, any place where two or more bones come together is an articulation, such that immoveable joints are also considered articulations.

Most of the articulations encountered in our anatomy course contain a single articulation, with each articulation containing the names of two bones, the sockets or the specific structures being connected.

The best strategy is to feel confident in the distinction between **structural** and **functional** classifications of articulations and nomenclatures used for each of these classifications. Simply put, structural nomenclatures focus on what material is bringing the bones together, and functional nomenclatures focus on what movement is allowed at that articulation. The flow chart below sketches out the three types of joints in the structural classification, and the three types of joints in the functional classification.

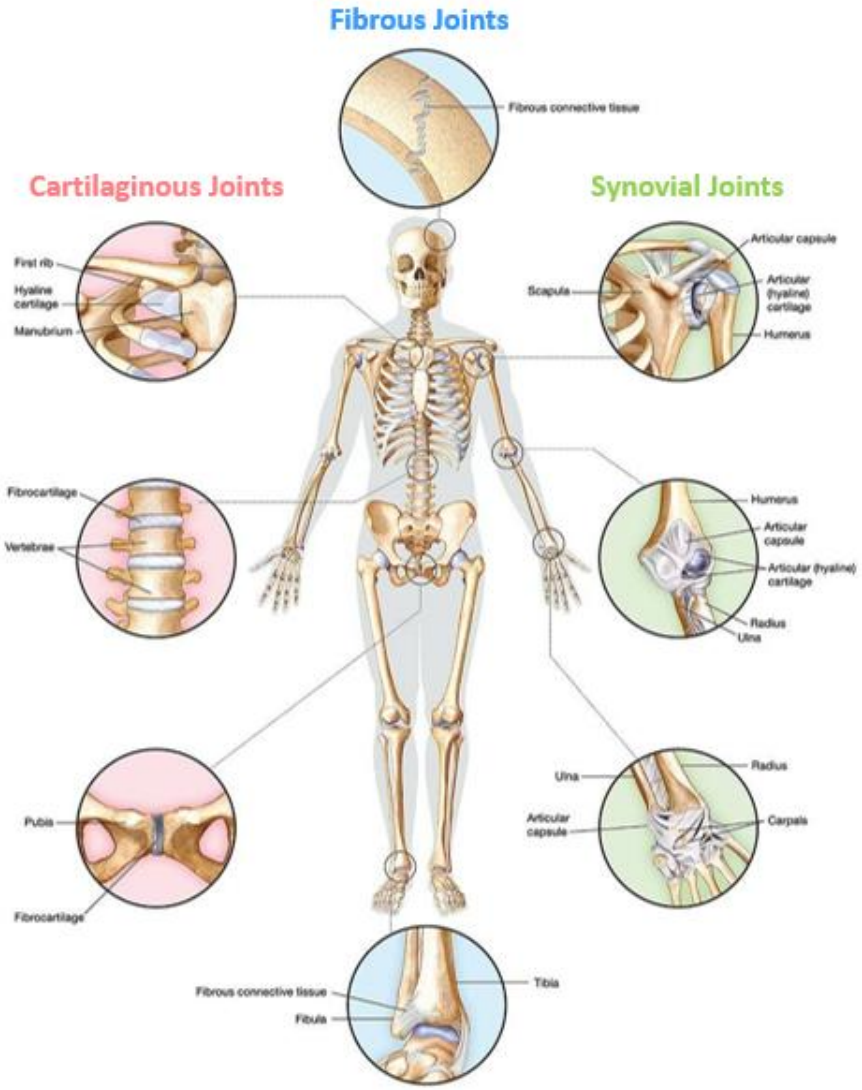


Initially, the names used for specific descriptive terms of joint classifications can appear convoluted or redundant or confusing. However, it is anatomy and therefore it tends to make perfect sense once you understand the meaning of the terms and the definition for the system of categorization. It is also common in anatomy to categorize the same thing in several different ways, if that makes sense. For example, in the flow chart above, as we get into more details it will be revealed that all the structural synovial joints we examine are various types of diarthrotic joints functionally. A more concrete example is that a symphysis joint is a joint held together by fibrocartilage, but it is also a type of amphiarthrotic joint because it allows for a slight degree of movement.

When discussing articulations, it goes hand in hand with the specific movement that occurs at a given joint, and this is referred to as the **action** at that joint. For example, the **humeroulnar joint** is the hinge

joint that is at the **elbow**, between the humerus and the ulna. The action at that hinge articulation is either flexion or extension (plus hyperextension). The actions at articulations can also be called 'directional movements'. The action at any joint is always described in reference to the **anatomical position**. For instance, flexion and extension are described as movements in a plane away from and then back to anatomical position respectively. Likewise, abduction and adduction are in the plane out (away from) of and then returning the body in the anatomical position. When examining various actions at articulations more thoroughly, it is often very useful to illustrate or demonstrate each of them on yourself. Not only does this clarify the meaning, but it puts it into a practical perspective. When you are reading a word question about an action at a joint, it is very helpful to be able to act it out right in front of yourself.

There are a few main objectives in this section. First is to introduce the classification schemes used for the joints of the body and give specific examples of each. Then, to describe the types of movement or actions that occur at various articulations of the bod. In this way we will be better able to understand the structural and functional components of joints of the skeleton and the movements that are permitted as a consequence.



Structural Joints of the Body

Shown above are illustrations of the type of classification of joints that is based on the structure (the materials) that connect the bones together.

Overview of the 2 types of Classifications for Articulations

Definition of an Articulation: Any place that two or more bones meet, not necessarily movable.

Structural types of Articulations

1. **Fibrous** – the bones brought together by fibers.
2. **Cartilaginous** – the bones brought together by cartilage.
3. **Synovial** – the bones brought together by an enclosed fluid filled cavity.

Functional types of Articulations (Note the root word -arthrosis = joint)

1. **Synarthrosis** – no movement possible at these joints.
2. **Amphiarthrosis** – slight movement possible at these joints.
3. **Diarthrosis** – highly moveable at these joints.

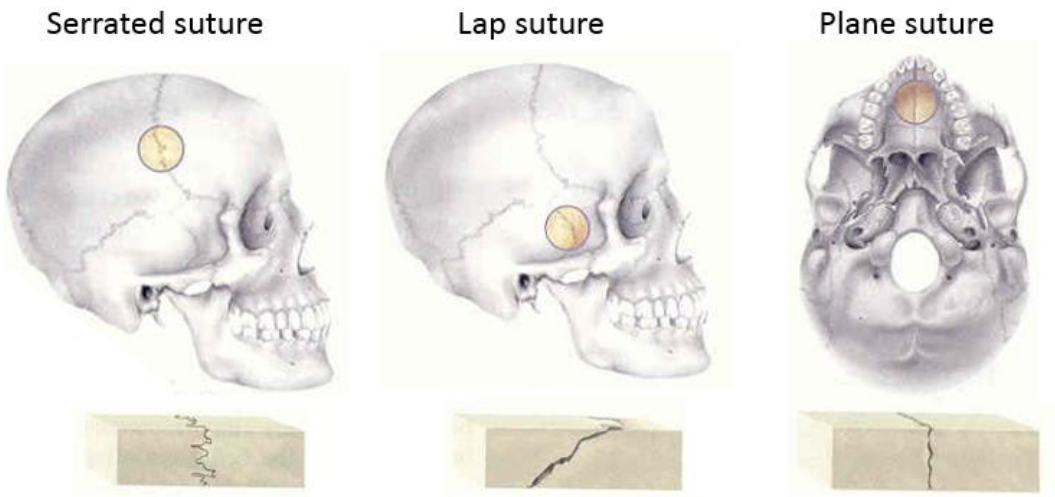
Presented below are the structural classifications with the functional types of articulations included in the description. Combining the two types of joint classification is the best way to describe joints.

Structural types of Articulations – with Functional Classification

1. Fibrous Joints - These are bones that are united by collagen fibers having various arrangements.

A. Sutures: These are **immovable joints** of the skull, they are joints that tightly knit two bones of the skull together. These include the following:

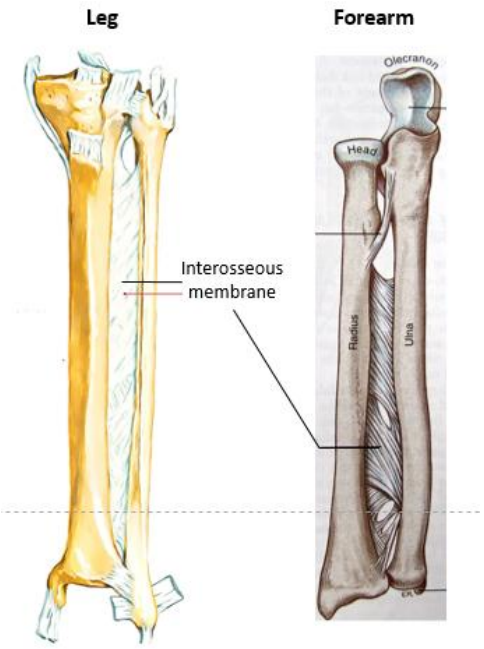
- Serrated or interdigitated or interlocking arrangement, such as in the sagittal or coronal sutures.
- Squamous or Lap arrangement, which has flat overlapping plates, as in the squamous suture.
- Plane arrangement, when there are 2 pieces butted together, as in the intermaxillary suture.



B. Synostosis: This is when an articulation is **ossified** or turned into bone. There are a few examples of bones that are two separate bones in development and they fused together to become one single bone. Specific examples are the 2 frontal bones that become one – the **metopic suture** discussed in the previous notes can sometimes be seen as a remnant of the fusion of the two frontal bones, but is usually absent in an adult skull. Likewise, the mandible is 2 separate bones in developmental stages and fuses together at the midline of the chin. People with a **chin cleft** had the 2 sides of the mandible fuse

together incompletely, leaving a little space, or a cleft. Finally, the epiphyseal lines are remnants of the epiphyseal plates, which are the growth plates for the length-wise growth of long bones in the body.

C. Syndesmosis: These are composed of a fibrous webbing that ties bones together. Recall that we have seen the term desmosomes before in epithelial tissue. The desmo = fibrous, and soma = body, thus together it means fibrous bodies. The **interosseous membrane** is the fibrous body that holds these types of articulation together. These joints allow for **slight movement**, and as you will see these joints are also categorized as a type of amphiarthrosis in terms of the degree of movement permitted.



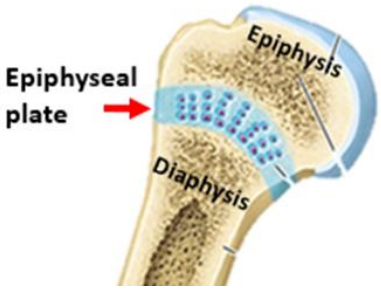
There are two locations where this articulation is found in the body: **1)** is between the length-wise articulation of the radius and ulna of the forearm; and **2)** is between the length-wise articulation of the tibia and fibula of the leg.

D. Gomphosis: This is a joint between bone and teeth wherein collagen fibers hold teeth in place within the alveolus (tooth socket) of the maxillary and mandible bones. The fibers are called **periodontal ligaments** (peri = around, and dontal = teeth). These are **immovable**, synarthrotic, joints.

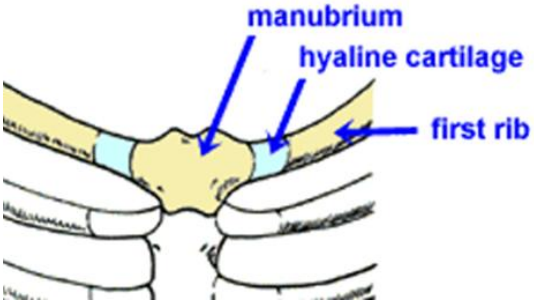
2. Cartilage Joints

These joints occur where bones are entirely joined by cartilage, either **hyaline cartilage** or **fibrocartilage**.

A. Synchondrosis: These are joints that have **hyaline cartilage** joining two bones together. There are two important examples. **1)** The epiphyseal (growth) plates, which join the bony portion of the epiphysis of a long bone together with the bony portion of the diaphysis. The hyaline cartilage resides at the metaphysis during the growth phase.



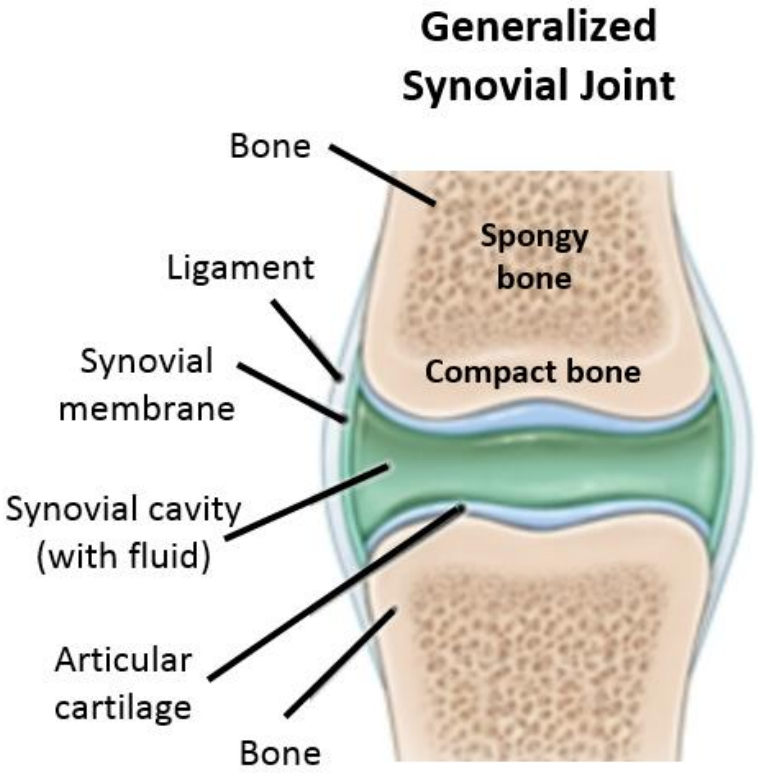
2) The 1st sternocostal joint, where rib #1 attaches to the sternum. In this instance the bone of the manubrium of the sternum is joined directly to the bone of the first rib with hyaline cartilage. In terms of functionality, this synchondrosis joint forms an **immovable joint**, which is the functional category of synarthrosis (no movement permitted).



All of the other **sternocostal joints**, which can also be called sternochondral joints or costosternal articulations, are actually synovial plane joints between the costal cartilages of the true ribs with the body of the sternum.

B. Symphysis: These are articulations that are connected by **fibrocartilage**. The intervertebral discs that join the bodies of adjacent vertebrae are examples of these joints, as it the pubic symphysis which joins the two pubic bones of the os coxa together. These are **slightly movable** amphiarthrotic joints.

3. Synovial Joints: These are joints that have a capsule enclosing a cavity that is lined with a fluid secreting synovial membrane. These articulations allow the **highest degree of movement** compared to the other structural joints. They have **hyaline (articular) cartilage** on the ends of the bone (epiphysis) to provide a surface that allows movement across it with very low friction, as these surfaces are bathed with slippery, viscous and protective **synovial fluid**.



Articular Capsule

The articular (joint) capsule is the structure in all synovial joints that encases an area in between the two articulating portions of the bone, leaving a small space in the middle. The articular capsule has an outer '**fibrous layer**', which is made out of (dense irregular connective tissue, and Inner '**cellular layer**', which is made of a synovial membrane (see image above).

Ligaments of Synovial Joints

Most ligaments are made of **dense regular connective tissue**, and elastic ligaments are made of elastic connective tissue. They can be located within the joint capsule, these are termed **intracapsular ligaments**. The anterior cruciate and posterior cruciate ligaments of the knee are good examples of this. Other ligaments can be located outside of the joint capsule, these are termed **extracapsular ligaments**. The lateral and medial collateral ligaments of the knee are good examples of these.

There is always a trade-off between flexibility at a joint and the stability of a joint, as determined by:

- The 'fit' of articulating surfaces of the bones with each other.
- Tightness of ligaments associated with the joint.
- The strength of muscles and tendons that cross the joint.
- The location of the articulation in the body and how much it is used.

The Types of Movement at Articulations

Body movements in anatomy are basically described as the **actions** that are possible at a particular **articulation** (joint). Additionally, the category of movement is in reference to the **anatomical position**. Therefore, whenever we are trying to determine body movement, it is essential to focus on the precise joint or joints involved in the movement, and always use the anatomical position as a frame of reference to name the action.

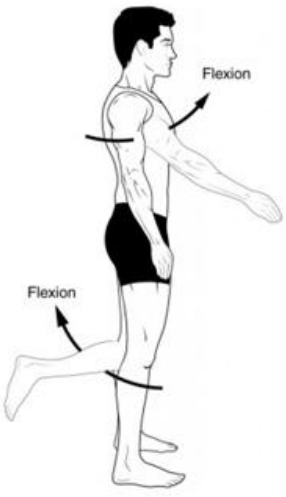
As customary, the names used in anatomy have a lot of meaning. The body action of "abduction" literally means to take away, as in abduct! It is also extremely useful to understand that these body actions are most often paired and therefore many actions have paired **opposing actions**. If there is a movement of a body part in one direction, then there will need to be an action in the opposite direction in order to return the body part to the anatomical position. The opposite of abduction is "adduction", which means moving toward midline or *adding* back to the body! Another important example is flexion which is opposed by extension. If there is lateral rotation, then there will also be medial rotation. As you become more familiar with the body action terms listed and defined below, the natural opposing actions will become more clear.

A. Gliding – this involves a sliding action at the articulation. For example, the most common places these movements are found are at the **intercarpal joints** of the wrist and the **intertarsal joints** of the foot.

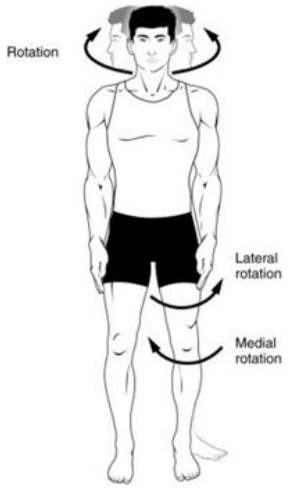
B. Angular Movement

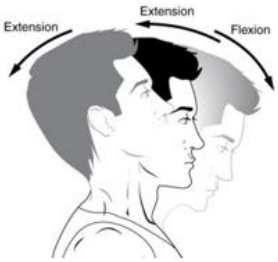
1. **Abduction** - movement of body part away from anatomical position in the frontal plane, abduction means to take away.
2. **Adduction** - movement in the frontal plane restoring anatomical position, "adding to" the body.
3. **Flexion** - movement out of anatomical position in the sagittal plane, bending your knee.
4. **Extension** - movement restoring anatomical position in the sagittal plane.

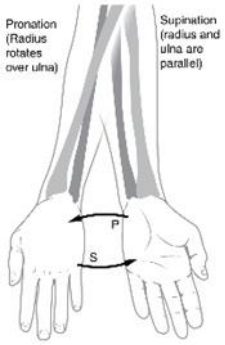
See the examples below of what these actions at articulations look like in body movements.



5. Hyperextension - moving body part back, past anatomical position.
6. Rotation - turning around its own long axis, e.g., turning your head to the side.
7. Circumduction - pivoting around the origin of a limb, able to make circles in the air with the movements at the articulation, a combination of adduction, abduction, flexion and extension.

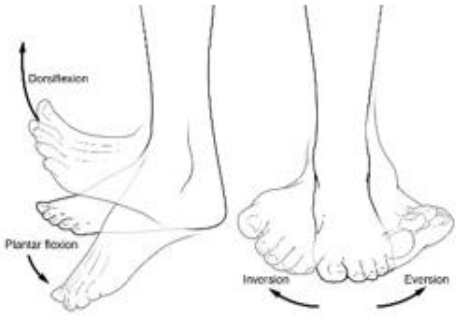


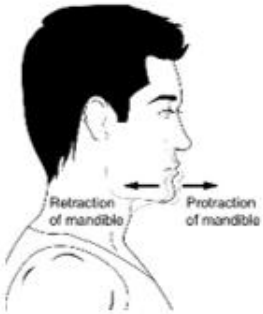


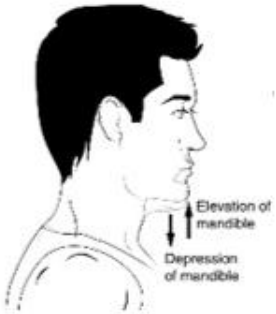


C. Special Movements

1. Eversion - pointing the sole of the foot outward, laterally.
2. Inversion - pointing the sole of the foot inward, medially. Most common way to sprain an ankle.
3. Dorsiflexion - pointing the foot (toes) upward.
4. Plantar flexion - pointing the toes downward, extending the ankle, standing on 'tippy toes'.
5. Lateral flexion - bending the spine to the left or right side (not twisting it though).
6. Protraction - movement anteriorly in the horizontal plane – e.g., jutting out your jaw.
7. Retraction - the reverse of protraction, bringing back to anatomical position.
8. Opposition - movement of thumb toward the fingers. To grasp objects. Reposition is opposite.
9. Elevation - movement superiorly, e.g., shrugging shoulders.
10. Depression - restoring joint and body position after elevation.







Synovial Joints - A quick examples and descriptions of them:

A. Gliding (planar) – permit gliding motion only. Monoaxial
B. Hinge – movement in one plane only, flexion and extension is an example. Monoaxial.
C. Pivot – spinning of one bone along its length, rotation. The atlas spinning on the axis.
D. Ellipsoidal (condyloid) – radiocarpal joints at the wrist. Promote greater movement. Biaxial.
E. Saddle joint – permits multiple degrees of motion, for example at base of thumb. Biaxial.
F. Ball and Socket joints – the greatest range of motions are permitted here. Triaxial

Specific Joints in the Body

A. Temporomandibular joint – This is a hinge joint with some lateral movement possible form the pterygoid muscle which insert onto the medial (internal) surface of the mandible.

B. Intervertebral joints – These are fibrocartilaginous joints that are called symphyses joints and are amphiarthrotic in that they allow slight movement between each vertebral pair. These articulations are strongly stabilized by several vertebral ligaments.

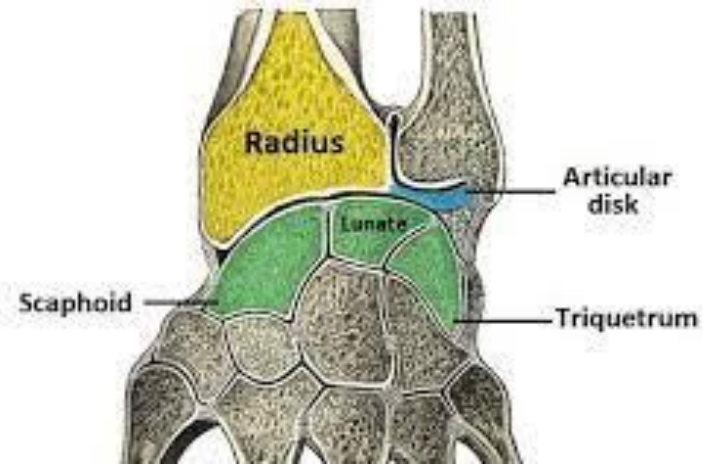
1. Anterior longitudinal ligament.
2. Posterior longitudinal ligament.
3. Ligamentum flavum – connects lamina to lamina of vertebrae.
4. Interspinous ligament - between spinous processes of vertebrae.
5. Supraspinous ligament - connects spinous processes tip to tip.

C. Sternoclavicular joint – this is a stable joint, offers limited movement, although combined with the other articulations at the shoulder add to the flexibility of that region of the body.

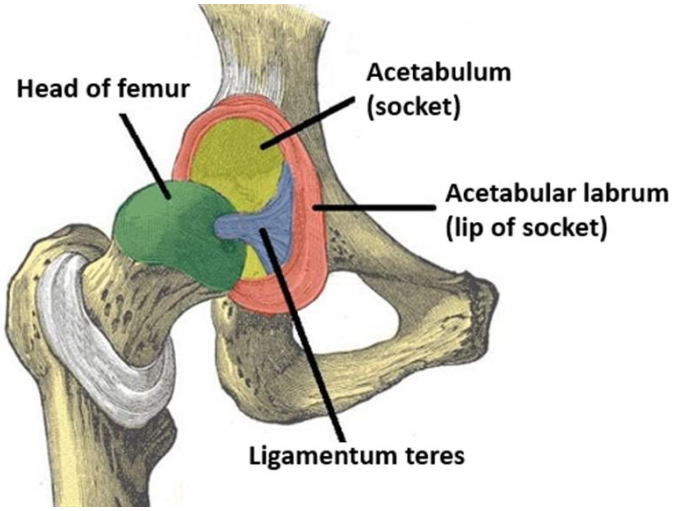
D. Shoulder joint – the **glenohumeral** joint provides maximum mobility and flexibility, this articulation has very little stability and as a consequence it is the most movable joint in the entire body. There is a very poor fit between head of humerus and glenoid fossa, held mostly by muscles and ligaments. This ball and socket joint has a very shallow socket, unlike the hip joint with its deep acetabulum. The anatomy of this joint is precisely why it is the most commonly displaced joint in the human body. There is always a tradeoff between mobility and stability at articulations.

E. Elbow joint – the **humeroulnar** joint is a hinge joint that has articulating surfaces that have exceedingly good fit with each other, think of the wrench-like ulnar notch in close association with the trochlea (medial condyle) of the humerus. This tight articular fit makes for a highly stable joint.

F. Wrist joint – the **radius** and three proximal carpals, the **scaphoid**, the **lunate** and the **triquetrum** articulate here. They have an additive movement around the curvatures of the first three carpal bones of the proximal row and the distal end of the radius, proving an ellipsoid or condyloid synovial joint between each, enabling the wrist to have the actions of flexion, extension, lateral and medial flexion, and circumduction.



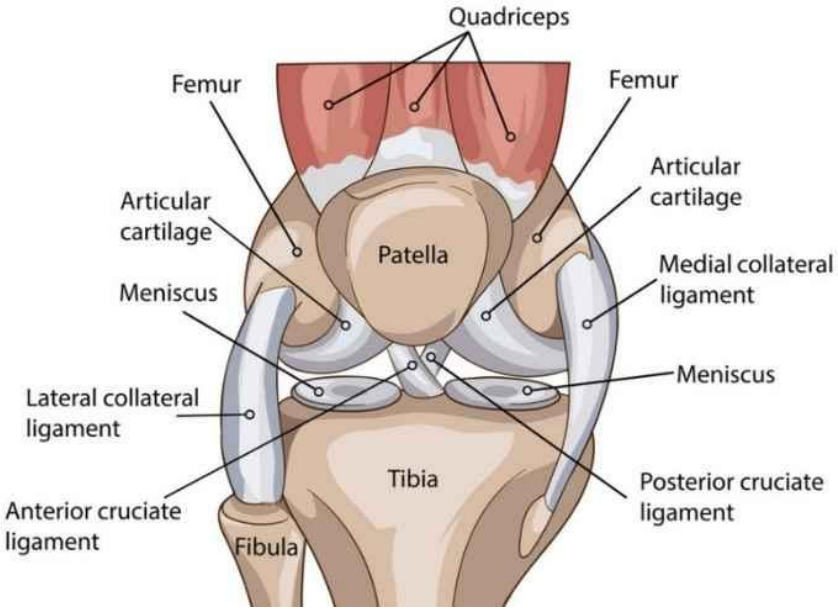
G. Hip joint – This can be called the **acetabulofemoral** or **coxofemoral** joint. At this joint there is an excellent fit between the head of femur into the deep acetabulum. It is one of two 'ball-and-socket' joints (along with the shoulder joint) with the large femoral head acting as the ball and the deep acetabulum ('vinegar cup') acting as the socket. It is the depth of this socket which gives the hip joint much greater stability than the shoulder joint, which in contrast has a very shallow socket. Also in contrast to the hip joint, the shoulder joint does not have large powerful muscles crossing over that articulation to provide additional stabilization.



The **ligamentum teres**, or round ligament, is a cord-like tether connecting the fovea capitis of the femoral head to the acetabulum. It acts to secure the femoral head in place within the socket (acetabulum) of the os coxa. The large and significantly heavy muscles that travels across the hip joint also adds to its stability.

H. Knee joint – Interestingly, at this joint there is a very poor fit of the articulating bones. For this reason, several factors and structures are involved in this joint which act to stabilize it.

1. Strong capsule ligaments – with lateral and medial collateral ligaments on either side.
2. Menisci - fibrocartilage pads to enhance fit between condyles and head of tibia.
3. Intercondylar eminence - provides some lateral stabilization, attachment for ligaments.
4. Cruciate ligaments provide a tightening with extension of the joint, and this limits anterior and posterior motions past the normal anatomical degree. Injuries occur to these ligaments when the knee joint experience hyperextension or lateral and medial deviation.
5. Popliteal ligaments - reinforce back of the knee.



I. Ankle joints – there are 3 different joints at the anatomical ankle, they are: **1)** The talocrural joint (between the tibia, fibula and talus), this is essentially a wobbly a hinge joint between tibia and talus, responsible for dorsiflexion (heel strike, toes up) and plantarflexion (tippy toes down, heel up). **2)** The subtalar joint (between the talus and calcaneus), this articulations is what allows for the inversion and eversion movements of the foot. **3)** The inferior tibiofibular joint (between the distal ends of the tibia and fibula), which is a fibrous joint so it is not very movable and in fact provides much stability to the ankle. Importantly, the lateral and deltoid ligaments help to stabilize this joint.

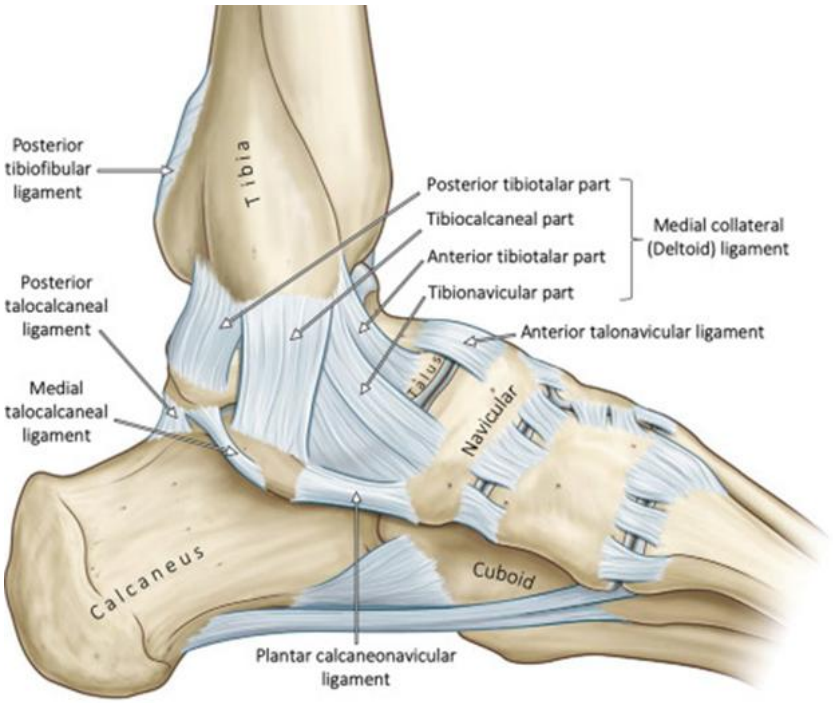
Flexion and extension, abduction and adduction, and even circumduction can be achieved here at the ankle joint. The 4 special movements that occur at the ankle are:

1. Eversion – when the sole of the foot is moving outward or laterally.
2. Inversion –when the sole of the foot is moving inward or medially.
3. Dorsiflexion - pointing the toes upward, or the heel strike.
4. Plantar flexion - pointing the toes downward, extending the ankle, standing on 'tippy toes'.

An important anatomical feature of any joint but particularly of the ankle joint, is the stabilizing presence of many **ligaments** at this articulation. As we can imagine, actions at the feet can be critical and stability is paramount.

The main stabilizing ligaments at the ankle is the **deltoid ligament** (which is actually a group of 4 ligaments). This is a large, strong ligament on the medial aspect of the ankle is composed of the **anterior tibiotalar**, **posterior tibiotalar**, **tibiocalcaneal**, and **tibionavicular** ligaments. They help to stabilize the ankle against excessive outward movement.

The other ligaments include the **medial talofibular**, **posterior talofibular**, and the **anterior talofibular** (most commonly injured ankle ligament),which connects the front of the talus to the fibula on the lateral side of the ankle. Lastly, there is it the **calcaneofibular** ligament laterally, which binds the calcaneus to the fibula, providing stability to the subtalar joint.



J. Foot joints – All of these joints of the foot work together to provide a variety of flexible movements at the foot, yet also maintain the necessary stability, this is especially achieved with the numerous ligaments of the foot (see image on the previous page). Below are brief descriptions of the movements allowed at these articulations of the foot.

The foot contains several joints that fall into 4 basic categories:
1. Intertarsal joints, which are between neighboring tarsal bones. Allows for gliding movements.
2. Tarsometatarsal joints (also called Lisfranc joints), which are between the tarsals and the metatarsals, allowing for a gliding action in between these bones.
3. Metatarsophalangeal joints are between the tarsals and the metatarsals allowing for circumduction.
4. Interphalangeal joints, these are hinge joints between the phalanges, which allow for flexion, extension and hyperextension of the toes.