Anatomy and Physiology of Equine Joints

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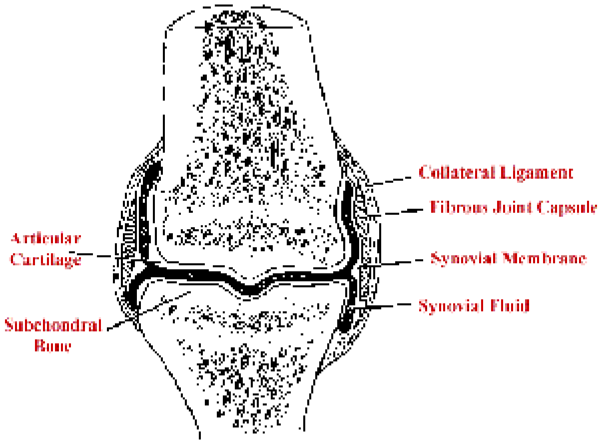
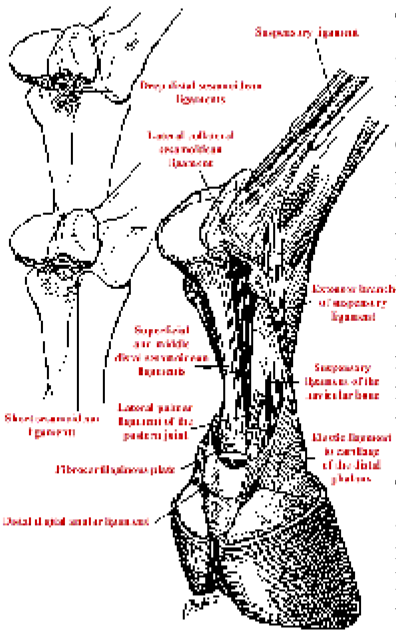
Joints allow the limbs to bend and the back to flex. There are three different kinds of joints described but the ones of principal interest to us are synovial joints. In addition, joints between adjacent facets of the vertebrae, as well as the junction of pelvis and vertebrae are synovial joints. A diagram of a typical synovial joint is illustrated in Figure 1.





The synovial joint consists of two bone ends covered by articular cartilage. The articular cartilage is smooth and resilient and enables frictionless movement of the joint. The joint stability is maintained by a fibrous joint capsule, which attaches to both bones and collateral ligaments, which are at the sides of most joints. Collateral ligaments are important in maintaining stability in joints such as the fetlock, carpus, elbow, hock and stifle. There are also intra-articular ligaments, the best example of which are the cruciate (cross) ligaments maintaining integrity of the femorotibial compartments of the stifle joint. In addition, there are other ligaments (outside the joint cavity) that also support the integrity of joints. The best examples are the distal sesamoidean ligaments and suspensory ligament that together with the sesamoid bones make up the suspensory apparatus and hold the fetlock in its correct position. Disruption of any of these structures leads to a failure of support of the fetlock joint (one of the common catastrophic injuries in the racehorse) (Figure 2).

The joint capsule itself is made up of the fibrous capsule (previously mentioned and providing structural integrity) and an inner lining layer called the synovial membrane. The synovial membrane secretes the synovial fluid, which provides lubrication within the joint itself. There are various disease processes that affect the nature of this synovial fluid because of inflammation and disease in the synovial membrane. The most common sign that the horse owner or trainer sees of any kind of arthritis (inflammation in the joint) is excessive fluid production. This is because of inflammation of the synovial membrane (synovitis). The fluid produced by inflamed synovial membrane generally has a lower viscosity (more watery). This is a sign of disturbance in production of hyaluronic acid, which is the key ingredient providing lubrication in the joint fluid.

The joint is a very well engineered structure. Frictionless motion is provided by the combination of a smooth articular cartilage surface as well as lubrication of both the articular cartilage and the synovial membrane together which make up the entire surface area of the inside of the joint. Shock absorption to the joint is provided by a combination of structures, including articular cartilage, subchondral bone (the bone beneath the cartilage), and the soft tissue structures (joint capsule and ligaments). Because of its resilient nature and ability to compress, articular cartilage in itself is a good shock absorber but its thickness and overall volume is far less than bone or soft tissues. Hence, the soft tissues and the bone are the primary shock absorbers in the joint and any disease that affects bone (fractures, etc) or soft tissue (fibrosis due to chronic inflammation) is going to interfere with this shock absorption. Resilience of the soft tissue is important for normal motion as well as shock absorption. It has been alluded to previously that friction comes from both articular cartilage and synovial membrane. Hyaluronic acid provides lubrication to the synovial membrane surface. Until recently it has been felt that it does not provide any lubrication to the articular cartilage but more recently with some new research, it has been shown that hyaluronic acid, in addition to another protein structure called lubricin, is involved in the lubrication of articular cartilage. This substance moving over the surface of the joints is called boundary lubrication. A second mechanism of lubrication of the cartilage is effected by fluid being squeezed out of the cartilage onto the surface when weightbearing occurs. When weightbearing ceases, the fluid is absorbed back into the cartilage, ready for a next cycle of weightbearing.

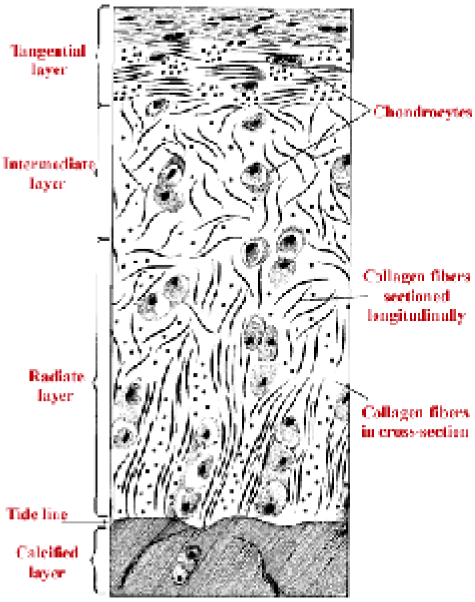


Figure 4. Diagram of adult articular cartilate showing four layers and arrangement of chondrocytes and collagenous fibers. Click to enlarge.

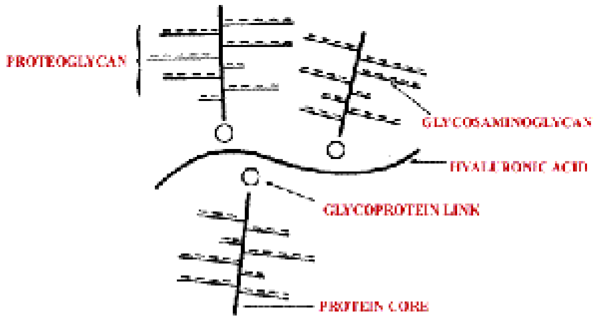
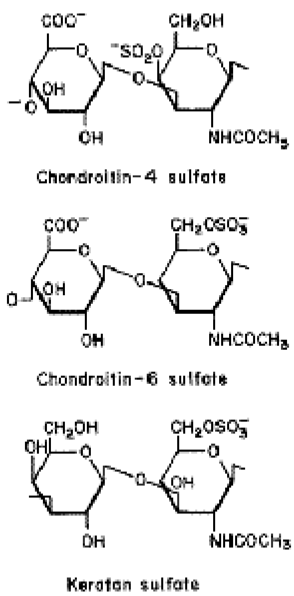


Figure 5. Diagram of a portion of a proteoglycan aggregate in articular cartilage. Click to enlarge.

Figure 6. Diagrams of structures of chondroitin-4-sulfate, chondroitin-6-sulfate, and keratan sulfate. Click to enlarge.



Microscopic and Biochemical Makeup of Articular Cartilage

A basic understanding of how the articular cartilage is made is important to understand the use of various drugs. On a normal microscopic section, the articular cartilage appears as a glasslike structure containing cells. The glasslike material outside the cells is called matrix. The matrix is made up of a framework of collagen and within the framework are contained molecules called proteoglycans, as well as water (Fig 4). Both the collagen and proteoglycans are very important for normal function of articular cartilage. The following is a diagram of a proteoglycan molecule (Fig 5). It consists of a backbone of protein with side chains of glycosaminoglycans (Fig 6). The glycosaminoglycans are chains of sugars that have negative charges but repel each other. Because of this, the molecule is somewhat like a bristlebrush. Because of the repulsion of the side chains as well as attraction of water to the molecule because of the negative charges, the proteoglycans provide the stiffness to the cartilage and resist compression. They are trapped within the collagen framework that contains them and the collagen framework is equally important for this compressive function. Loss of proteoglycans or breakdown of collagen means that the articular cartilage cannot function normally.