Nutrition for the Musculoskeletal Practice

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Three Types of Cartilage

1. Hyaline cartilage
2. Elastic cartilage
3. Fibrocartilage

Hyaline Cartilage

Hyaline cartilage is found in most articular cartilages of joints throughout the body.¹

Found lining articular surface of:

- Nasal septum²
- Tracheal rings²
- Larynx²
- Costal cartilages²
- Covering articular surfaces of bones in synovial joints.¹
  - Articular cartilage

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Articular Cartilage Structure

- Glycosaminoglycans
- Collagen
- Chondrocytes
- Water

Articular Cartilage
Articular Cartilage

Composed of basically two elements:

1. Cellular component
   - Chondrocytes which produce and maintain the intercellular matrix

2. Intercellular matrix
   - Water (~60% to 80% of matrix)
   - Protein polysaccharides called glycosaminoglycans (GAG) molecules (~5% to 10% of matrix)
     - Examples of GAG molecules are keratin sulfate, chondroitin sulfate and hyaluronic acid
     - Groups of GAG molecules are called proteoglycan aggregates
   - Collagen (~10% to 30% of matrix)
# Glycosaminoglycans

<table>
<thead>
<tr>
<th>Name</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyaluronic acid</td>
<td>E.g., synovial fluid, articular cartilage, skin, vitreous humor, ECM of loose connective tissue, intervertebral disc</td>
</tr>
<tr>
<td>Chondroitin sulfate</td>
<td>E.g., cartilage, intervertebral disc, bone, heart valves, skin, and cornea</td>
</tr>
<tr>
<td>Heparan sulfate</td>
<td>E.g., basement membranes, lung, liver, and aorta</td>
</tr>
<tr>
<td>Dermatan sulfate</td>
<td>E.g., skin, blood vessels, heart valves tendon, and lungs</td>
</tr>
<tr>
<td>Keratin sulfate</td>
<td>E.g., cornea, bone, cartilage aggregated with chondroitin sulfates, and intervertebral disc</td>
</tr>
</tbody>
</table>

• Biochemical and cellular changes in cartilage result in depletion of the GAG molecules and a subsequent drop in water content. The cartilage becomes thinner and is less able to provide the cushioning necessary during loading.

• Think of the analogy of a kitchen sponge; as it soaks up water it becomes soft and resilient. When it dries out, its physical characteristics change completely as it becomes less compliant.

• By supporting healthy GAG synthesis, water is drawn back into the cartilage matrix.
Articular Cartilage: Blood Supply

Articular cartilage has no intrinsic blood supply.¹

Chondrocytes must use diffusion to obtain nutrients needed for structure and function. Sources include:

- Blood vessels within the synovial membrane
- Synovial fluid
- Blood vessels in the adjacent subchondral bone²,³

Minerals and Articular Cartilage

- Minerals are important constituents of the enzyme systems that control GAG and collagen synthesis in the cartilage matrix.

- E.g.,
  - Manganese is a trace mineral which has a role in collagen synthesis and the synthesis of glycosaminoglycans.¹
  - Zinc is a component of the enzyme that controls the production of collagen in the cartilage matrix.²
  - Copper dependent enzymes are also involved in the linking of collagen and elastin.³


Intervertebral Disc (IVD)

Each IVD is reinforced peripherally by two ligaments

1. Anterior longitudinal ligament
2. Posterior longitudinal ligament

Consists of three main parts

1. Outer anulus fibrosus
2. Inner gelatinous nucleus pulposus
3. Cartilaginous end plates (i.e., vertebral end-plate)
   - Consists of hyaline and fibrocartilage.

The anulus fibrosus, nucleus pulposus, and vertebral endplates all consist of water, cells (i.e., chondrocytes, proteoglycans), and collagen.

Vertebral End-Plate

Composed of:
• Chondrocytes
• Collagen
• Glycosaminoglycans
  • Proteoglycan aggregates

Intervertebral Disc (IVD)

Blood supply

• In adult discs, blood vessels are normally restricted to the outmost layers of the anulus.¹

• The nucleus pulposus and inner anulus of the disc are supplied by capillaries that arise in the vertebral bodies, penetrate the subchondral bone, and terminate at the vertebral end-plate.¹

• The vertebral endplate is porous and this porosity allows fluid and other metabolites to enter and leave the anulus fibrosus and nucleus pulposus by osmotic action.²


Tendon and Ligaments

Tendon and ligament major constituents\textsuperscript{1,2}

- Water\textsuperscript{1}
- Collagen\textsuperscript{1}
- Fibroblasts: Responsible for the production and maintenance of tendon collagen and non-collagenous constituents\textsuperscript{1}
- Fibrocartilage: Occurs in the tendon … both where the tendon inserts into bone … and where it wraps under the bone. \textsuperscript{1}
- Proteoglycans: Make up less than 1% of the dry weight of tensile tendons.\textsuperscript{1}

Meniscus

- Menisci
  - Fibrocartilage which consists of:
    - Chondrocytes
    - Proteoglycans
    - Collagen
    - Water\(^1,2\)
  - Blood supply
    - Limited to the outer one-third of each menisci\(^3\)

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