**V. Cartilaginous Tissue**

Cartilaginous tissue is a **specialized connective tissue** with a **hard consistency**, capable of **resisting compression**. It provides **structural support**, with cells embedded in a **gel-like extracellular matrix (ECM)**.

This tissue **lacks blood vessels, lymphatic vessels, and nerves**. Instead, it is surrounded by a **vascularized connective tissue** called the **perichondrium**. The cartilage is **entirely nourished by diffusion** of nutrients from adjacent tissues through the **aqueous phase** of the **ground substance**. Despite its rigidity, the **cartilage matrix contains about 75% water**, contributing to its flexibility and resilience.

**V.1. Components of Cartilaginous Tissue**

**V.1.1. Cells of Cartilaginous Tissue**

There are two main types of cartilage cells: **chondroblasts** and **chondrocytes**.

**A. Chondroblasts**

Chondroblasts are **young, highly active cells** with an **ovoid shape** and a **central spherical nucleus**. Their cytoplasm contains **well-developed organelles**, along with **lipid and glycogen inclusions**.

Chondroblasts **secrete the extracellular matrix and fibers around them**. Once trapped in their own secretions, they become **chondrocytes**.

**B. Chondrocytes**

Chondrocytes are **large, rounded cells** located within **small cavities called lacunae (or chondroplasts)**. In a living state, they adapt to the **shape of their lacunae**.

Active chondrocytes have a **well-preserved nucleus**, along with a **visible Golgi apparatus, mitochondria, and endoplasmic reticulum cisterns**. They are responsible for **synthesizing and maintaining the surrounding matrix** and can **resorb the adjacent ground substance** to expand their lacunae.



**V.1.2. Extracellular Matrix (ECM)**

The **high water content** of the ECM (**75% of its weight**) allows **cartilage to be flexible and deformable**. The ECM consists of **collagen fibers** embedded in an **amorphous ground substance**, rich in **proteoglycans**.

The primary proteoglycan in cartilage is **aggrecan**, which gives cartilage its **compressibility and elasticity**. The **main glycosaminoglycans (GAGs)** present are:

* **Chondroitin sulfate** and **keratan sulfate**, which contribute to the **water content** and **elasticity** of cartilage.
* These proteoglycans are attached to **hyaluronic acid**, further enhancing the structural integrity of cartilage.

Additionally, the ECM contains:

* **Proteolytic enzymes**, responsible for **breaking down** and **renewing** the cartilage matrix.
* **Growth factors and cytokines**, produced by **chondrocytes** or **other cells** (e.g., monocytes/macrophages), which regulate cartilage maintenance and repair.

**V.2. Types of Cartilage**

Cartilage classification is based on the **abundance and type of fibers** in the ECM. Depending on the **amount of collagen or elastic fibers**, cartilage is categorized into **three histological types**.

**V.2.1. Hyaline Cartilage**

Hyaline cartilage is **the most common** type in the body but **the least resistant**. It is found in:

* **Ribs (costal cartilage)**, connecting them to the sternum.
* **Nose**, forming the tip and wings.
* **Larynx, trachea, and bronchi**, providing structural support.
* **Ends of growing long bones** and **joint surfaces**.
* **Fetal skeleton**, where it serves as a **temporary model** before being replaced by bone.

In **fresh cartilage and histological sections**, the **ECM appears amorphous and homogeneous** because the **collagen fibers are not visible**—they have the **same refractive index** as the ground substance.

In hyaline cartilage:

* **Type II collagen** is the dominant fiber, forming **thin microfibrils** arranged in a **loose network**.
* The **perichondrium** covers hyaline cartilage **except** in **joints and epiphyseal plates** (growth regions of long bones).
* **Perichondrial cells** can still **generate new cartilage** through **appositional growth**.

**V.2.2. Elastic Cartilage**

Elastic cartilage is characterized by the **presence of numerous branched elastic fibers**. These fibers form a **dense filamentous network** within the **extracellular matrix (ECM)**, surrounding the **chondrocytes**.

Elastic cartilage is **more flexible** than hyaline cartilage, allowing certain structures to **maintain their shape** while still being **flexible**. It is found in:

* **External ear canal**
* **Auditory (Eustachian) tubes**
* **Epiglottis** (a flap that prevents food from entering the trachea)

This type of cartilage provides both **structural support** and **elasticity**, enabling these organs to **return to their original shape** after being deformed.

**V.2.3. Fibrocartilage (Fibrous Cartilage)**

Fibrocartilage is an **intermediate** between **dense connective tissue** and **cartilaginous tissue**.

**Histological characteristics:**

* **Chondrocytes** are arranged **in parallel rows**—either **isolated**, in **pairs**, or in **small linear groups**.
* The **ECM** contains **thick bundles of Type I collagen fibers**, making it **highly resistant to mechanical stress**.
* Unlike hyaline and elastic cartilage, **fibrocartilage has no perichondrium**.

**Fibrocartilage is the strongest** of the three cartilage types and is found in:

* **Intervertebral discs** (between vertebrae)
* **Menisci of the knees**
* **Labrum (cartilaginous rings) of the hip and shoulder joints**

This type of cartilage provides **great tensile strength**, making it **essential** for areas exposed to **high pressure and mechanical stress**.

