

**Department of Histology and Embryology, P.J. Šafárik University, Medical Faculty, Košice**

**Cartilage** : Syllabus for foreign students

Author: RNDr. Marianna Danková, PhD.

Revised by: prof. MUDr. Eva Mechírová, CSc.

## **CARTILAGE**

### **Characteristic :**

- supporting connective tissue
- tolerates mechanical stress without permanent distortion (firm consistency of extracellular matrix)
- resilient
- without blood vessels (avascular)

**Function :**

- supports soft tissues
- shock absorbing and sliding area for joints (smooth surface),
- essential for the development and growth of long bones

### **Composition :**

**A: CELLS :** 1. chondrocytes - synthesize and secrete extracellular matrix  
- located in matrix cavities – **lacunae**

**EM** : organelles typical of protein secretory cells (rER, GA)

2. chondroblasts – synthesize and secrete extracellular matrix

3. chondroclasts – belong to mononuclear phagocyte system  
involved in destruction of the cartilage

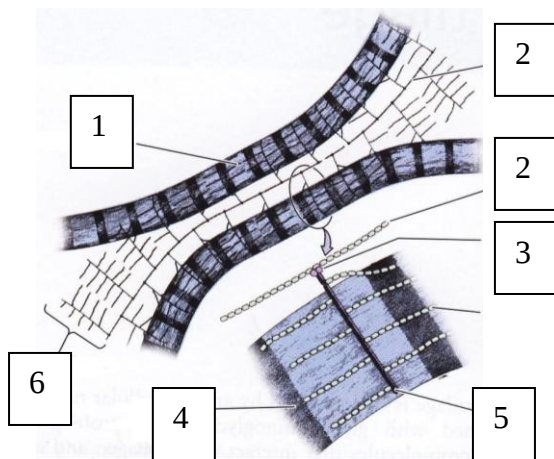
### **B: EXTRACELLULAR MATRIX :**

#### **a) amorphous ground substance**

1. glycosaminoglycans – hyaluronic acid, chondroitinsulfate, keratansulfate
2. proteoglycans – form proteoglycan aggregates that interact with collagen and bind the water
3. structural glycoproteins - chondronectin

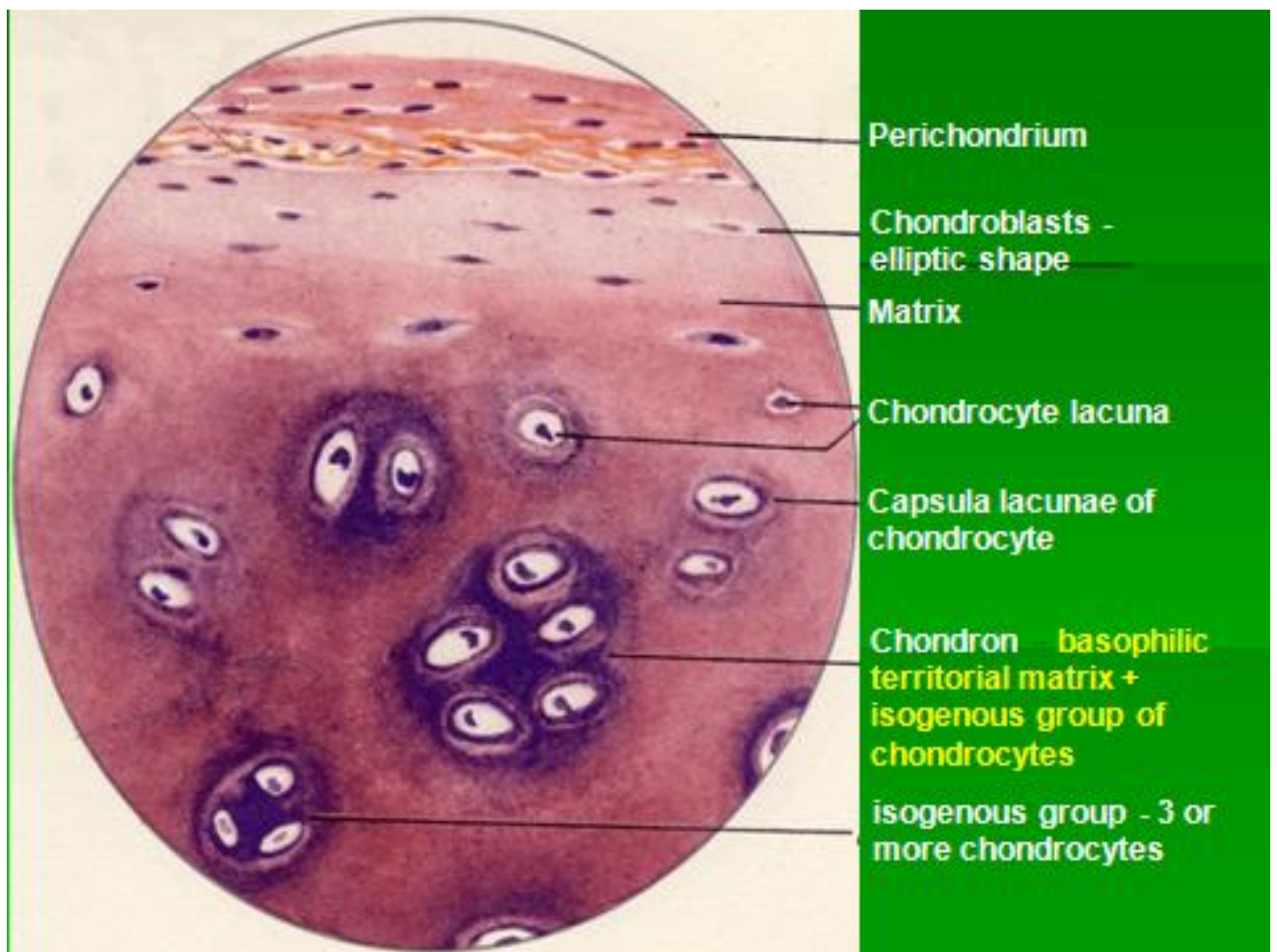
#### **b) fibrils** – 1. collagen II – fibres are not formed, fibrils with diameter 20nm

2. collagen I – form fibers, in fibrocartilage
3. elastic fibers – in elastic cartilage



- 1- collagen fibrils (collagen type II)
- 2 – hyaluronic acid
- 3 – link protein
- 4 – chondroitinsulfate - glycosaminoglycan
- 5 – core protein
- 6 - proteoglycan

- - the cartilage matrix immediately surrounding each chondrocyte is rich in glycosaminoglycans and poor in collagen – **territorial** or **capsular matrix** (intense basophilia, metachromasia)
- - matrix located between the capsules – **interrteritorial matrix**



## PERICHONDRIUM

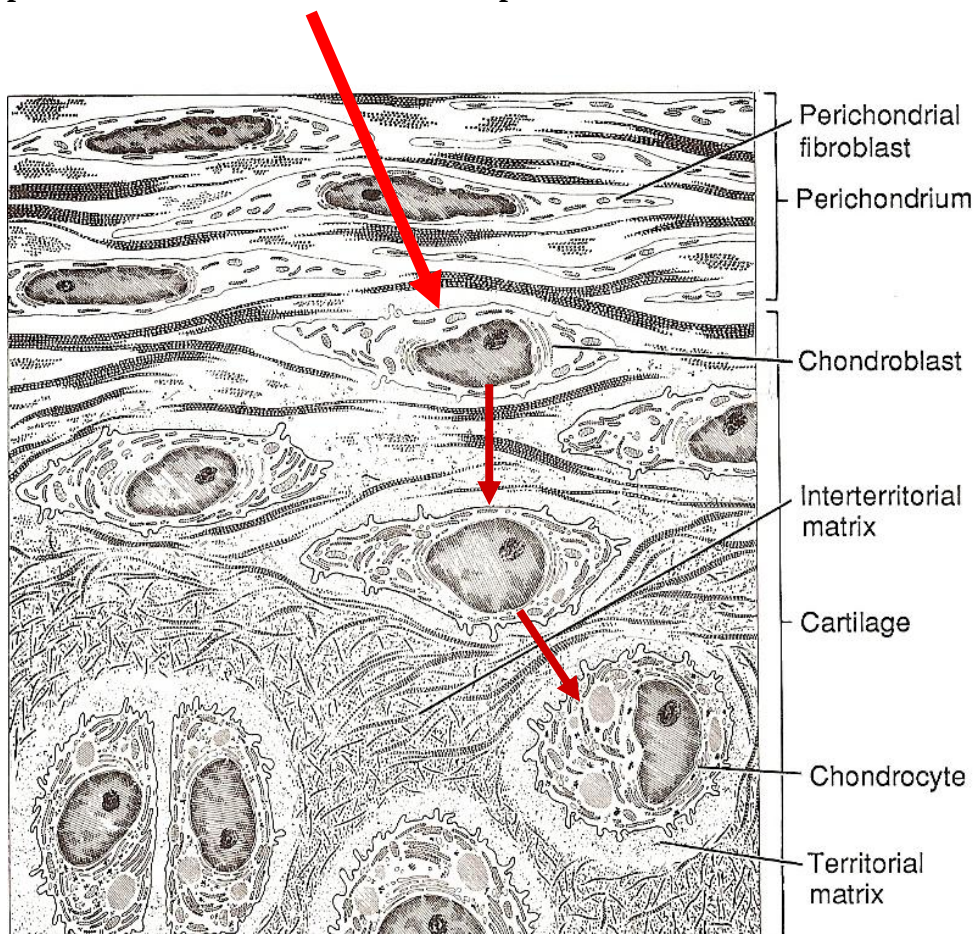
- capsulelike sheath of dense connective tissue that surrounds cartilage
  - harbors the vascular supply for avascular cartilage
  - connects cartilage with the surrounding tissues
  - articular cartilage – covers the surfaces of the bones of movable joints- is devoid of perichondrium and the nutrition is assigned by the diffusion of oxygen and nutrients from the synovial fluid
- 
- composed of two layers :
  - **1. fibrous – stratum fibrosum** - external part, contains fibres collagen I, small amount of cells - fibroblasts
  - **2. cellular – stratum chondrogenicum** abundant cells – fibroblasts and chondroblasts

## Growth

- newly formed chondrocytes synthesize collagen fibrils and ground substance

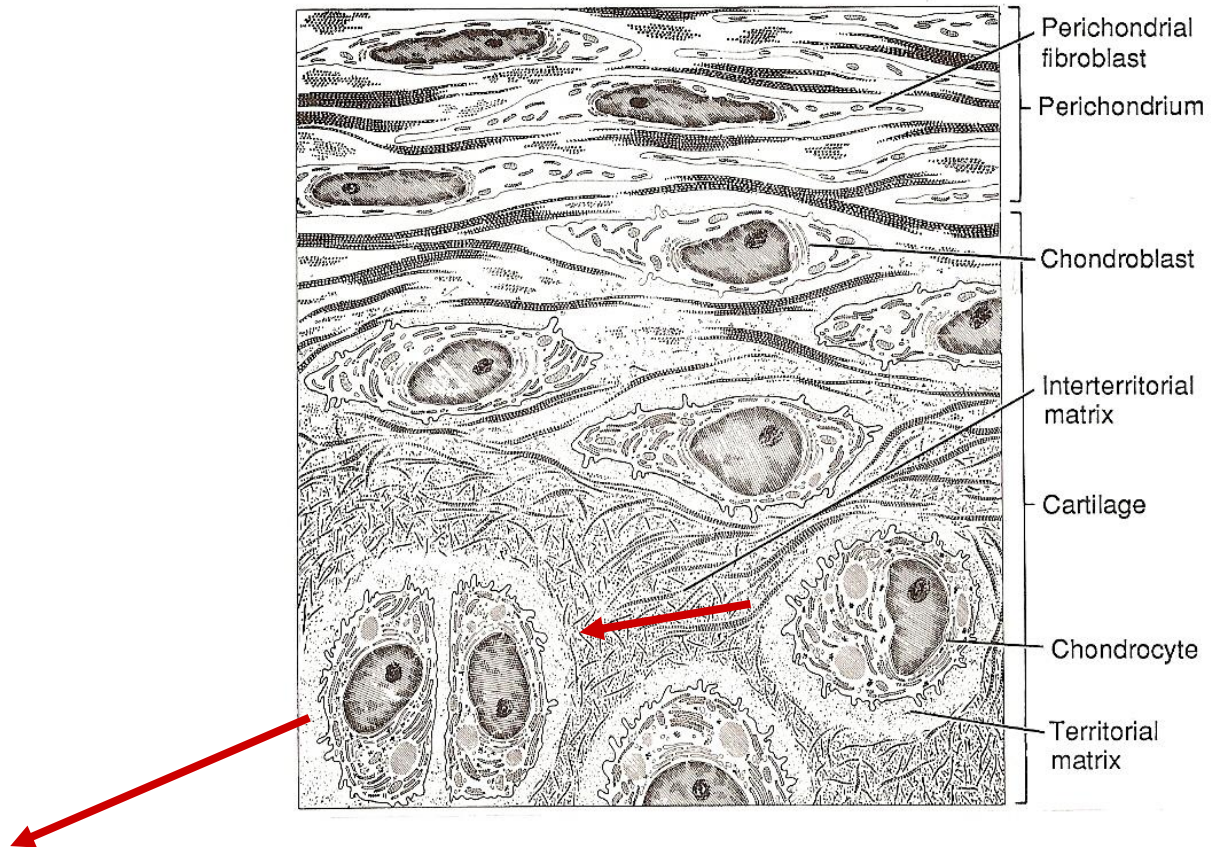
**1. Appositional growth** – resulting from the differentiation of perichondrial cells chondroblasts of the perichondrium proliferate and become chondrocytes; once they have surrounded themselves with extracellular matrix, they are incorporated into the existing cartilage

## proliferation of chondroblasts from perichondrium



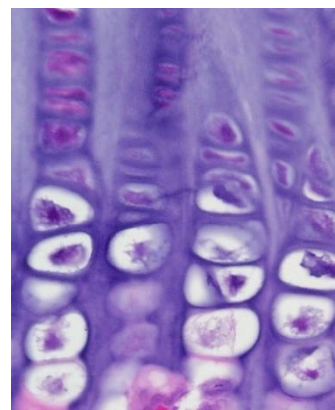
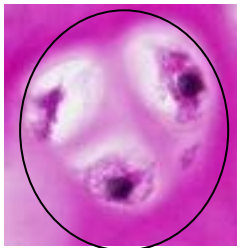
## **2. Interstitial growth** – mitotic division of preexisting chondrocytes

1. during early phases of cartilage formation
2. within the epiphyseal plates in long bones (increasing the length)
3. within articular cartilage



1. Oval isogenous groups

2. Columns of isogenous groups during ossification



## **Regeneration**

by appositional growth from perichondrium;  
the chondroblasts from perichondrium invade the damaged area and generate new cartilage  
in extensively damaged areas the cartilage is replaced by dense connective tissue

## Types of cartilage:

1. Hyaline cartilage
2. Elastic cartilage
3. Fibrocartilage

### 1. HYALINE CARTILAGE

**Incidence :** articular surfaces, wall of large respiratory passages – larynx, trachea, bronchi, epiphyseal plate, ventral ends of ribs, embryonic temporary skeleton

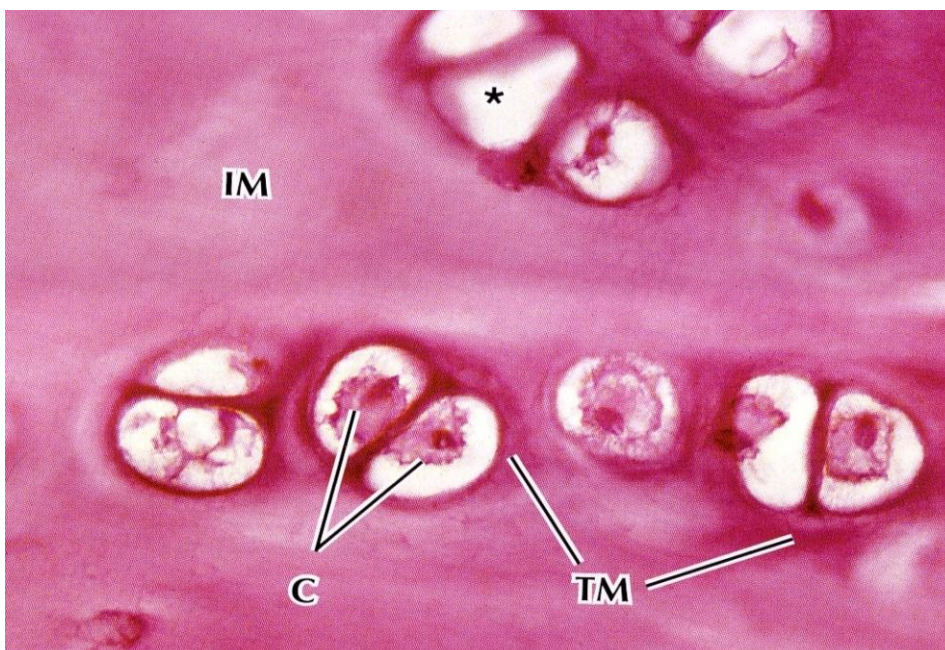
**Appearance :** bluish-white, translucent

#### **Composition :**

##### **1. chondrocytes**

- spherical in shape, at the periphery elliptic
- appear in groups - up to 8 cells originating by mitotic division of a single chondrocyte – **isogenous group**
- housed in matrix cavities- **lacunae** (in living tissue fill the lacunae, shrinking during preparation)

**2. extracellular matrix - (glassy )-** cells are surrounded by basophilic matrix – **territorial (capsular) matrix** (rich in acidic glycosaminoglycans) and **interterritorial matrix** – smooth, paler, less basophilic (**collagen II** - does not form fibres, fibrilles interact with proteoglycan aggregates, are not visible by LM because their refractive index is similar to that of ground substance and are masked by the glycosaminoglycans; hence the matrix appears homogeneous and smooth)



## **2. ELASTIC CARTILAGE**

**Incidence :** epiglottis, auricle of the ear , Eustachian tube, cuneiform and corniculate cartilages in larynx

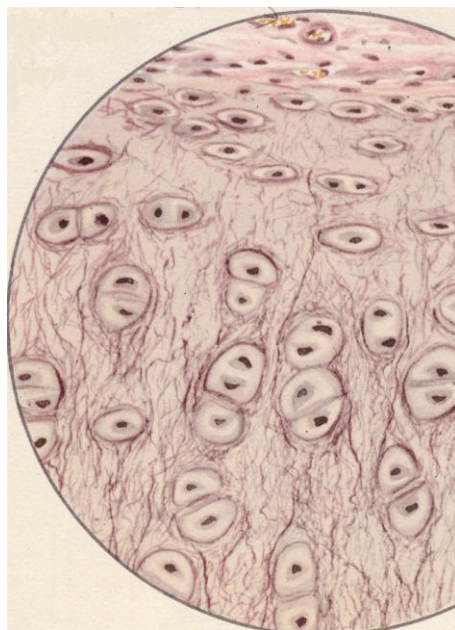
**Appearance :** yellowish color

### **Composition :**

**1. chondrocytes** – similar to hyaline cartilage, housed in lacuna singly or in pairs (coffee bean)

**2. extracellular matrix** – fibrils of collagen II and network of fine elastic fibers (are arranged in more or less regular fashion between the cells), less amount of ground amorphous substance

On the surface - perichondrium is identifiable

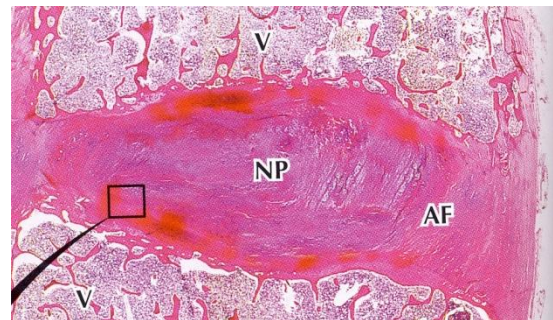
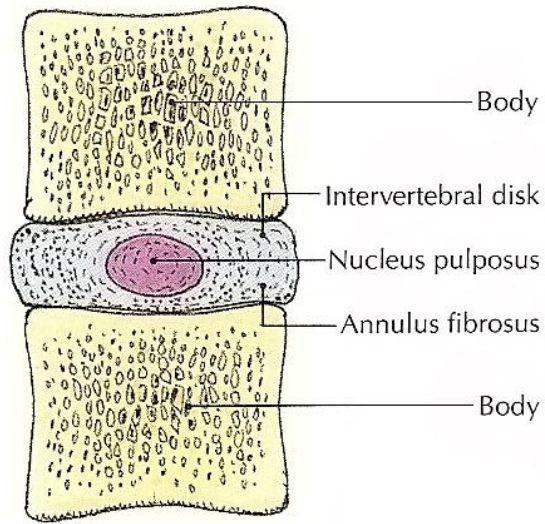


### 3. FIBROCARILAGE

**Incidence** : intervertebral discs, symphysis pubis

#### INTERVERTEBRAL DISC

- shock absorber
- situated between articular surfaces of neighbouring vertebrae
- have 2 components:
  1. Annulus fibrosus – fibrocartilage, concentric layers
  2. Nucleus pulposus – in the centre; ground substance + few cells, col. II.



**Appearance** : characteristics between dense connective tissue and cartilage

#### **Composition** :

1. **chondrocytes** – small, spindle-shaped, similar to fibroblasts  
arranged singly or in long rows
  2. **extracellular matrix** – great number of collagen I fibers – acidophilic,  
amorphous matrix less abundant
- Perichondrium is not identifiable.

