AGA 2110
Anatomy & Physiology of farm animals

LECTURE 4 - CONNECTIVE TISSUE

Dr J Mufungwe
Department of Animal Science
UNZA

LEARNING OUTCOME

❑ Leaning outcomes

Students should know:

i. What connective tissue is
ii. Basic roles of connective tissue in the body
iii. Location of the types of connective tissue and their roles

CONNECTIVE TISSUE - INTRODUCTION

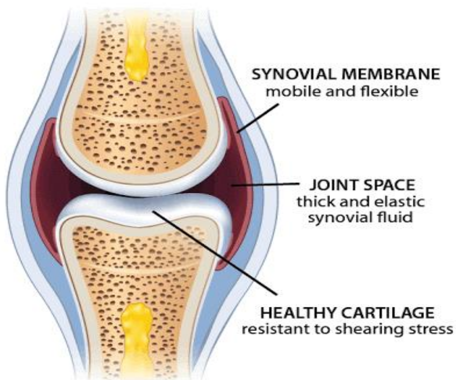
- Connective tissue is the most abundant & widely distributed of the primary tissues.
- Connective tissue is found everywhere in the body.
- Some organ systems, such as the skeletal & integumentary systems, are composed almost exclusively of connective tissue
- Blood, tendon, fat, cartilage & even bone are all examples of connective tissue,

EXAMPLES OF CONNECTIVE TISSUE

TYPE OF CONNECTIVE TISSUE	LOCATION	
LOOSE CONNECTIVE TISSUE (acts as packing material)	Around blood vessels,nerves, intestines	
FIBROUS	Tendons, ligaments.	
CARTILAGE	Joints, nose, sternum, trachea	
Bone	ALL over the body	
BLOOD (originates from bone & has fibers)	All over the body	

EXAPLES OF CONNECTIVE TISSUE

- - Cartilage, bone, fascia , fat, tendons ligament.



GENERAL ROLES OF CONNECTIVE TISSUE IN THE BODY

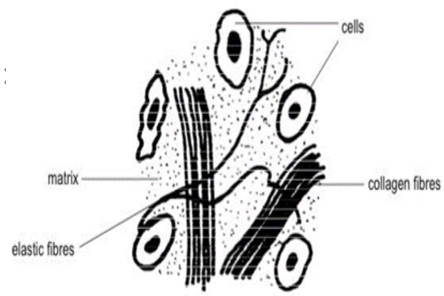
1. Connecting or separating different types of tissues and organs in the body
2. Hold organs in place
3. Cushion and protect organs eg fat
4. Act as a short absorber eg tendons, ligaments, fat
5. Give structure shape and strength eg bone
6. Reduce friction – cartilage
7. Provide support - bones support the muscle

❑ There are different types of connective tissue and different functions

COMPONENTS OF CONNECTIVE TISSUE

- It is diverse in structure & function
- Connective tissue has 3 main components:

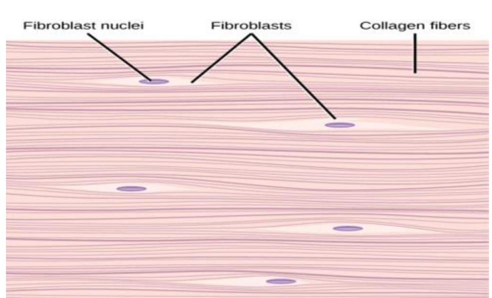
i. Cells – generally fibroblasts
ii. Fibres
iii. ground substance.

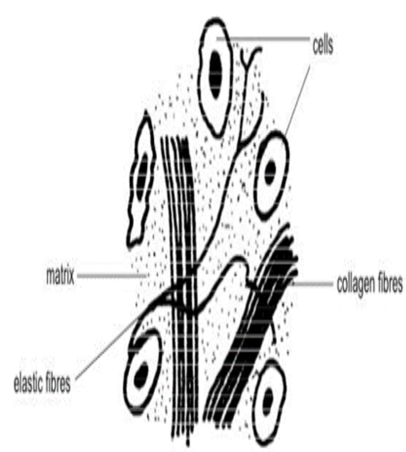


- Together the ground substance & fibres make up the extracellular matrix.

STRUCTURAL COMPONENTS OF CONNECTIVE TISSUE

- Cells suspended in ground matrix
- Most have fibres running through it
- Ground substance (matrix) ranges in texture from liquid, gel or calcified solid





CONNECTIVE TISSUE

- The chief functions performed by the various cells (fibroblasts) of the different types of connective tissue follow:

1) Production of intercellular substances ie the protein fibers
2) Binding & supporting
3) storing fat (adipocytes)
4) Insulation & protection
5) Production of various blood cells, which in turn have specific functions
6) Transporting substances within the body

CONNECTIVE TISSUE - VASCULARITY

- Connective tissues can have various levels of vascularity.

✓ Cartilage is avascular,

✓ Dense connective tissue is poorly vascularized.

✓ Others, such as bone, are richly supplied with blood vessels

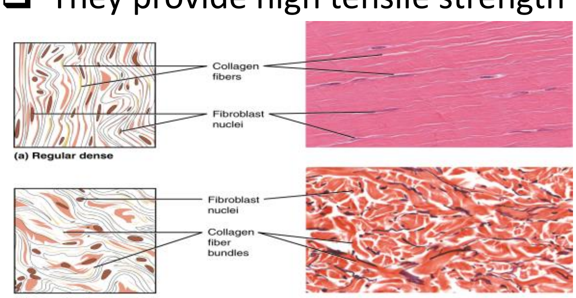
FIBERS FOUND IN CONNECTIVE TISSUE

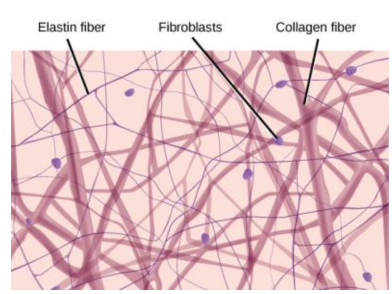
- ❑ Connective tissue fibers provide support.
- ❑ Three types of protein fibers are found in connective tissue

i. Collagen fibres
ii. Elastic fibres
iii. Reticular fibres

i. COLLAGEN FIBRES

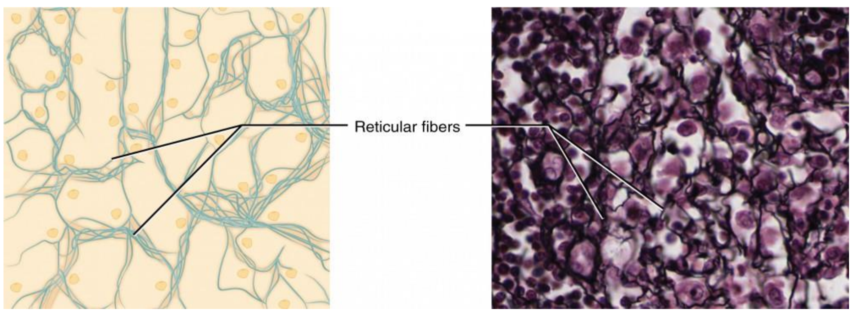
- ❑ The strongest & most abundant of all the connective tissue fibers.
- ❑ Composed of collagen protein & is secreted into the extracellular space
- ❑ They provide high tensile strength to the matrix.





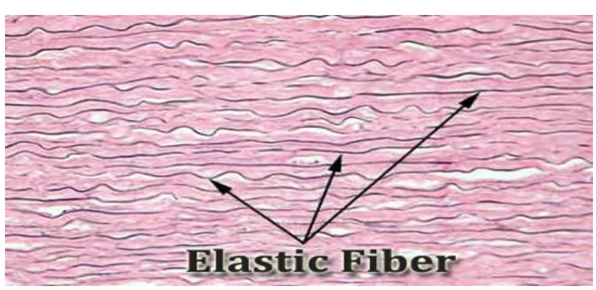
ii. RETICULAR FIBRES

- Reticular fibers are short, fine collagenous fibers
- can branch extensively to form a delicate network
- Inelastic



iii. ELASTIC FIBRES

- Elastic fibers are long, thin fibers that form branching network in the extracellular matrix.
- They help the connective tissue to stretch and recoil.



CONNECTIVE TISSUE - INTRODUCTION

- ❑ Is made up of cells, ground substance & fibers
- ❑ Different types of connective tissue exist
- ❑ Types of connective tissue vary according to;
- ✓Types of fibers present
- ✓ number & type of cells
- ✓Texture of the ground substance

NAMING OF CONNECTIVE TISSUE CELLS

- ❑ Connective tissue cells are named according to their functions

- ❑ Based on their functions, connective cells can end in the 'Suffix'
- ✓ blast – produce matrix
- ✓ cyte – maintain the matrix, mature cells
- ✓ clast - destroy matrix
- ❑ Examples; fibroblast, fibrocytes, fibroclasts
  osteoblast, osteocytes, osteoclasts
  chondroblast, chondrocytes, chondroclasts
- ❑ Other cells are found in connective tissue eg mast cells, macrophages.

EXTRACELLULAR MATRIX

- Composition of extracellular matrix distinguishes one type of connective tissue to another
- The components are

i. Protein fibers

ii. Organic ground substance – can be composed of either minerals (eg bone) or fluid (eg plasma in blood)

CATEGORIES OF CONNECTIVE TISSUE

In general, connective tissue is divided into two broad categories:

A. Connective tissue proper

B. Specialised connective tissue

CONNECTIVE TISSUE PROPER

Has 2 subclasses;

i. Loose connective tissue

ii. Dense connective tissue

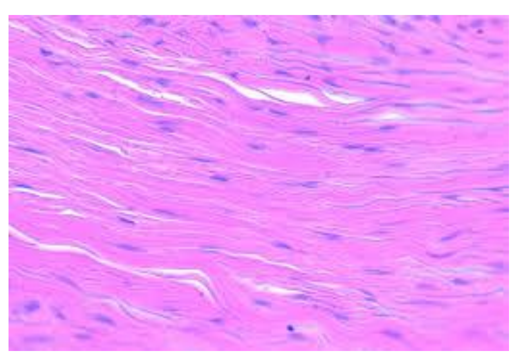
LOOSE CONNECTIVE TISSUE – protein fibers are loosely organised leaving large spaces between them

DENSE CONNECTIVE TISSUE – protein fibers are densely populated , provide tensile strength, elasticity, and protection.

LOOSE & DENSE CONNECTIVE TISSUE

LOOSE CONNECTIVE TISSUE

DENSE CONNECTIVE TISSUE



LOOSE CONNECTIVE TISSUE

- Contains a variety of different cell types.
- Loose connective tissue is widely distributed in the body, where it makes up the subcutaneous tissue or superficial fascia.
- It penetrates between organs to fill space & bind structures together.
- Because of its loose nature, it allows for movement of muscles relative to one another.
- Fibroblasts produce protein fibers
- Examples of loose connective tissue are; areolar, adipose & reticular tissue

LOOSE CONNECTIVE TISSUE

i. Areolar connective tissue –

- Is the most common type of connective tissue & is found everywhere in the body.
- It acts generally as packing material to support & cushion organs and other delicate structures of the body.
- It surrounds every organ
- Forms the subcutaneous layer that connects skin to muscle
- Envelops blood vessels, nerves, and lymph nodes
- is present in all mucous membranes as the lamina propria and submucosa.

LOOSE CONNECTIVE TISSUE

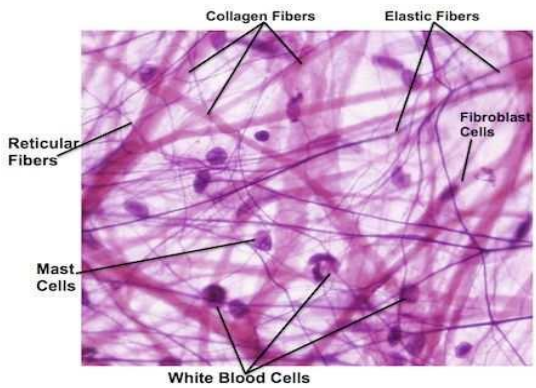
i. Areolar connective tissue –

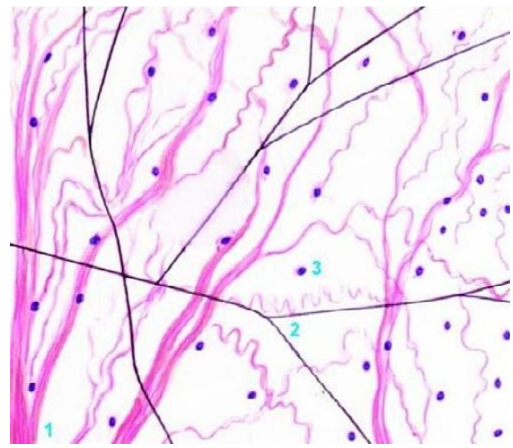
- It is supportive to body structures but is flexible and soft to enable organs the freedom to move within their Position
- Thus areolar tissue is moderately elastic but tears easily compared with the other types of connective tissue

AREOLAR LOOSE CONNECTIVE TISSUE

AREOLAR CONNECTIVE TISSUE

✓Loosely arranged connective tissue





FASCIA

- Fascia is located between the skin and the
- underlying muscle or bone. It is comprised of two
- layers. The top layer, superficial fascia, is
- attached to the skin while the bottom layer, deep
- fascia, covers the muscle or bone

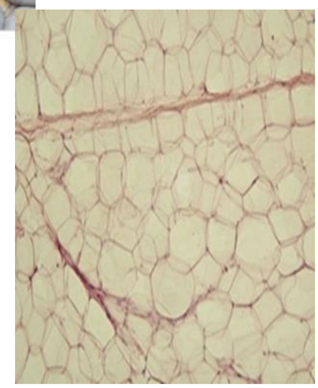
ii. ADIPOSE CONNECTIVE TISSUE (FAT)

- ❑ It is areolar tissue in which adipocytes or fat cells predominate
- ❑ It is found;
- ✓ beneath the skin
- ✓ in spaces between muscles
- ✓ behind the eyeballs
- ✓ on the surface of the heart
- ✓ surrounding the joints, in bone marrow &
- ✓ in the omentum of the abdomen.
- ❑ Fat is highly vascularized

ii. ADIPOSE TISSUE

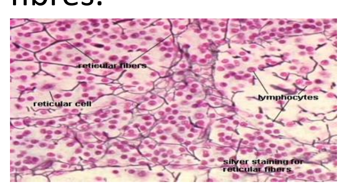
- ❑ It is areolar tissue in which adipocytes or fat cells predominate
- ❑ Found beneath the skin, spaces between muscles, surface of the heart, bone marrow, omentum of the abdomen.
- ❑ Its cells expand & wither depending on the amount of lipid that is being stored within them
- ❑ Adipose tissues is highly vascularised
- ❑ Roles of adipose tissue
- ✓ it is an energy store for the animals
- ✓ thermal insulator under the skin ie prevents heat loss
- ✓ Acts as a mechanical shock absorber around organs eg kidneys

FAT



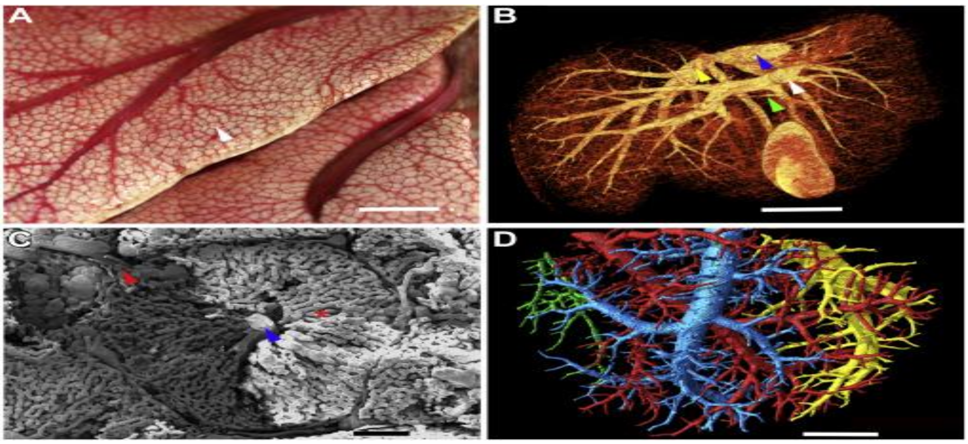
iii. RETICULAR CONNECTIVE TISSUE

- is composed of fine network of irregularly arranged thin reticular fibres
- Resembles areolar connective tissue in that it contains loosely arranged fibres & many fibroblasts suspended in a supportive ground substance.
- Unlike areolar connective tissue, however, reticular connective tissue contains only one type of fibre: reticular fibres.



RETICULAR FIBERS

Reticular fibres in porcine liver



DENSE FIBROUS CONNECTIVE TISSUE

DENSE FIBROUS CONNECTIVE TISSUE

- Characterized by its densely packed arrangement of collagen fibers.
- Little room for ground substance & cells
- Fibroblasts are found intermingled with the fibres
- Fibroblasts manufacture fibres & ground substance
- The 3 major types of dense fibrous connective tissue are

i. dense regular
ii. dense irregular
iii. elastic

DENSE CONNECTIVE TISSUE

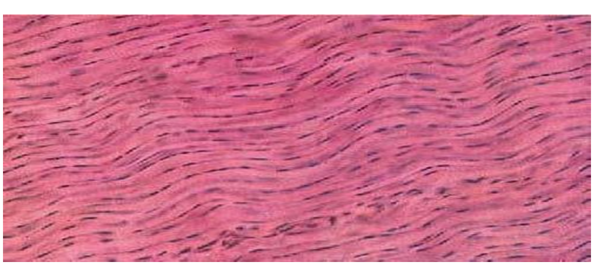
- ❑ contain essentially the same fibre as loose connective tissues.
- ❑ There are two types;

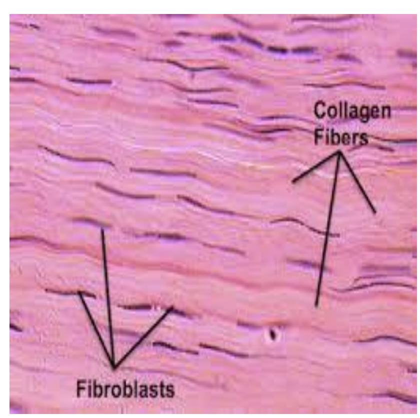
i. dense regular
ii. dense irregular
iii. Elastic tissue

- ❑ Regularity relates to the arrangement of the fibre elements
- In dense regular connective tissue, the fibers (especially collagenous fibers) are arranged in parallel bundles forming tendons.
- In dense irregular connective tissue, the collagenous fibers run in different directions

DENSE REGULAR CONNECTIVE TISSUE

- ✓ Thick collagen fibers lie in one direction
- ✓ Fiber appear thick rope-like
- ✓ Fibroblasts appear in rows parallel to the collagen fibers





DENSE FIBROUS CONNECTIVE TISSUE

DENSE REGULAR CONNECTIVE TISSUE

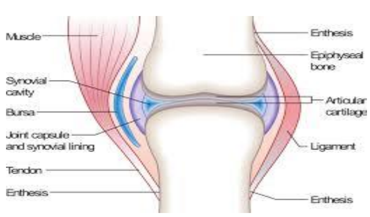
❑ **Location (where they can provide strength)**

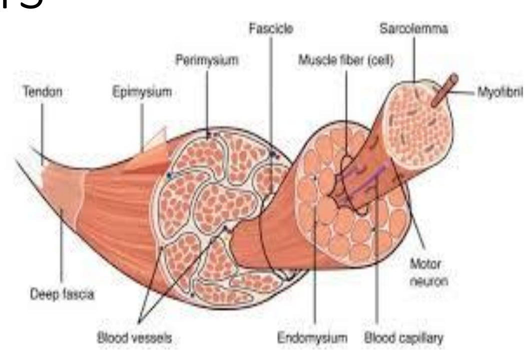
✓ Tendons that attach muscles to bone

✓ Ligaments that bone to bone

✓ Fascia sheets that cover muscles

TENDONS AND LIGAMENTS





DENSE FIBROUS CONNECTIVE TISSUE

B. **DENSE IRREGULAR CONNECTIVE TISSSUE**

- Composed of primarily collagen fibres that are arranged in thicker bundles than those found in dense regular connective tissue.
- Fibers are interwoven randomly to form a single sheet that can withstand forces from many different directions
- Location

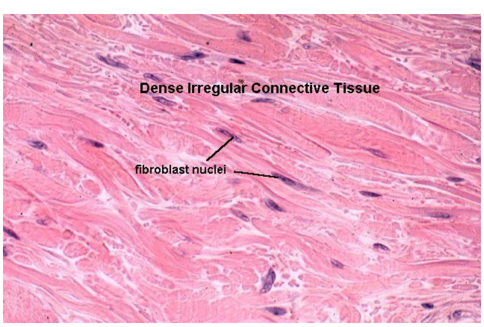
✓dermis of the skin

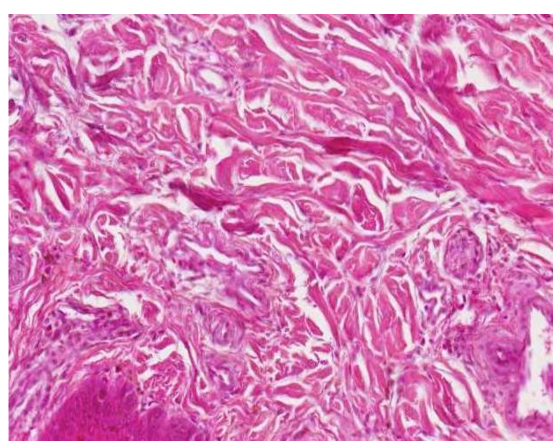
✓ fibrous coverings of organs such as kidneys, testis, liver & spleen

✓ forms the tough capsule of the joints

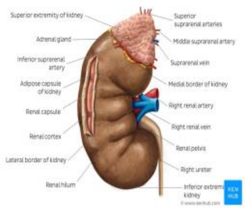
DENSE IRREGULAR CONNECTIVE TISSSUE

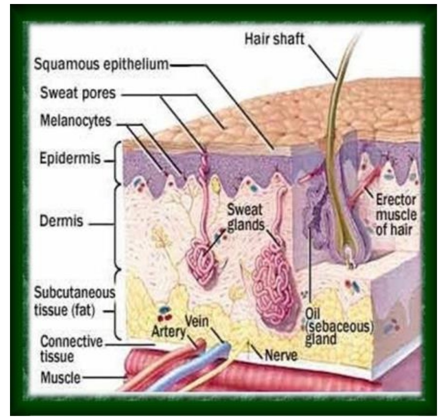
- Fibers not parallel but irregular

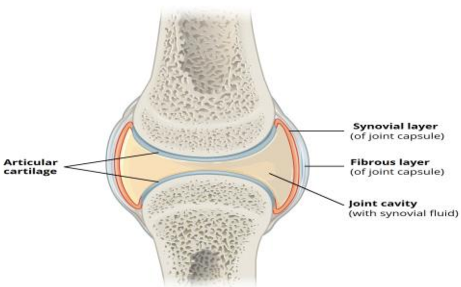




DENSE IRREGULAR CONNECTIVE TISSUE







DENSE FIBROUS CONNECTIVE TISSUE

ELASTIC CONNECTIVE TISSUE

❑ Found in relatively few regions of the body

❑ Occur in regions of the body that require stretching eg in the walls of;

✓Arteries

✓ stomach

✓ large airways (bronchi)

✓ bladder

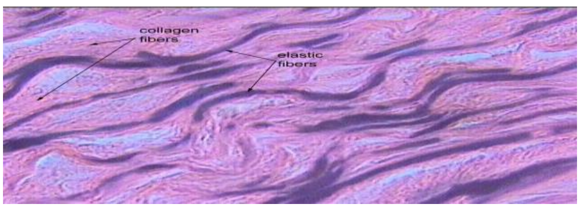
✓regions of the heart

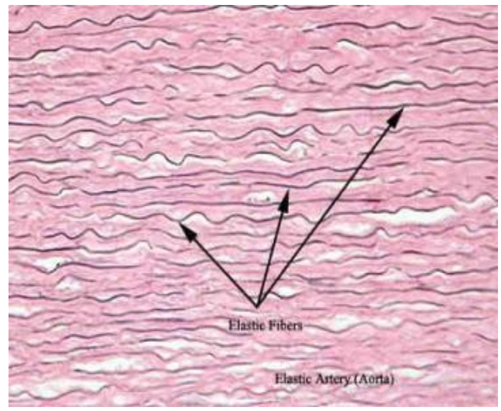
✓ between the vertebrae

❑Composed of elastic fibers

ELASTIC FIBERS

- Wave like rubber band structure relates to their flexibility
- Has sheets of collagen fiber & elastic fibers





SPECIALISED CONNECTIVE TISSUE

- ❑ 3 types of specialised connective tissue

1. Cartilage
2. Bone
3. Blood

CARTILAGE

- ❑ Found in joints – prevent friction
- ❑ Also found in ear, nose, vocal cords, trachea, larynx
- ❑ Does not contain nerves – can tolerate compression

CARTILAGE

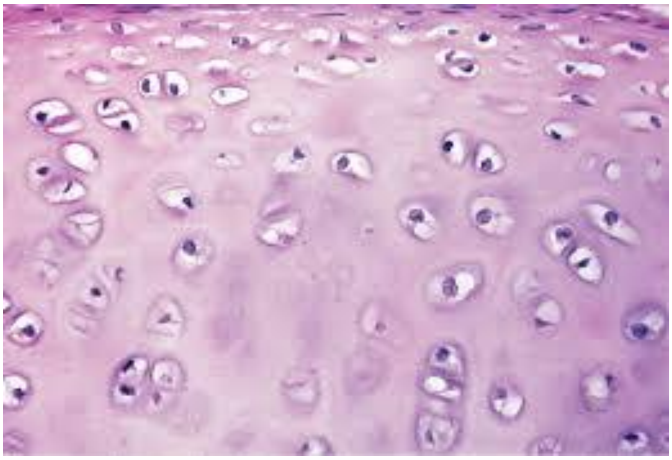
- ❑ Like other forms of connective tissue, it is composed of cells & a matrix
- ❑ Cartilage cells are called chondrocytes which live in hollowed-out pockets in the matric called **lacunae**
- ❑ Cartilage is avascular, it receives nutrition from the surrounding membrane called perichondrium which is rich in blood vessels
- ❑ Chondrocytes produce a large amount of collagenous extracellular matrix, abundant ground substance that is rich in proteoglycan and elastin fibers
- ❑ 3 types of cartilage exist which differ from each other based on type of fibre found in the matrix;

a) Hyaline cartilage
b) Elastic
c) Fibrocartilage

CARTILAGE

- Three types of cartilage found in the body:
- Hyaline cartilage is found on the ends of bones and acts as cushioning in joints.
- Elastic cartilage makes up body parts such as the ears.
- Fibrocartilage provides cushioning between the inter vertebral discs.

CARTILAGE – MICROSCOPIC VIEW

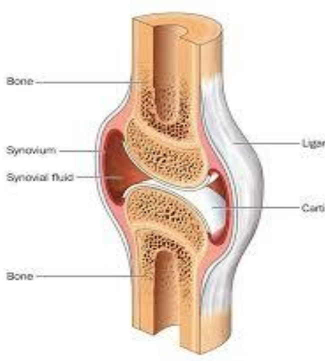


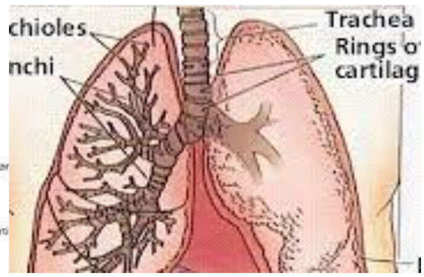
A. HYALINE CARTILAGE

- ❑ The most common form of cartilage found in the body
- ❑ Hyaline cartilage has fewer cells than elastic cartilage; there is more intercellular space
- ❑ It is composed of closely packed collagen fibers making it tough but is more flexible than bone
- ❑ Most rigid type of cartilage & is enclosed in a perichondrium
- ❑ It is found in the following places;

✓ Nose
✓articular cartilage at the ends of long bones in the joints
✓ connects ribs to the sternum
✓ forms supportive rings in the trachea
✓Growth plates of long bone in growing animals

HYALINE CARTILAGE





B. ELASTIC CARTILAGE

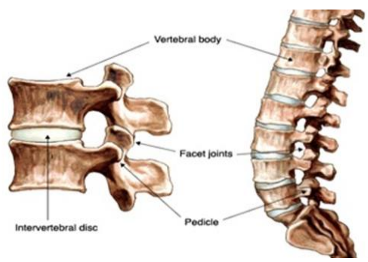
- ❑ In elastic cartilage cells are closer together creating less intercellular space
- ❑ Contains elastic fibers which form dense branching bundles
- ❑ Fibres give elastic cartilage flexibility hence can withstand repeated bending
- ❑ Found in the following places

✓Epiglottis AND larynx

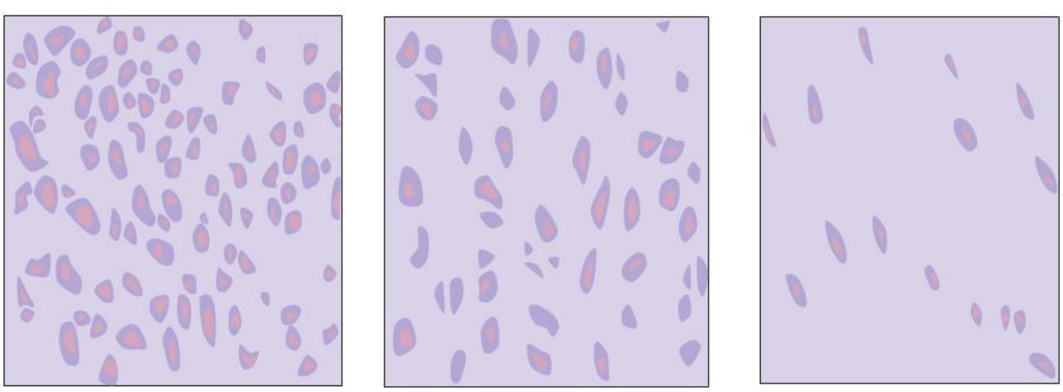
✓Pinnae (external ears) of animals

C. FIBROCARTILAGE

- Fibrous cartilage has the fewest cells so it has the most intercellular space.
- Contains thick bundles of collagen fibers & a few chondrocytes
- Designed to take compression hence is found in spaces between vertebrae of the s pine, between bones in pelvic girdle & in the knee joint



TYPES OF CARTILAGE

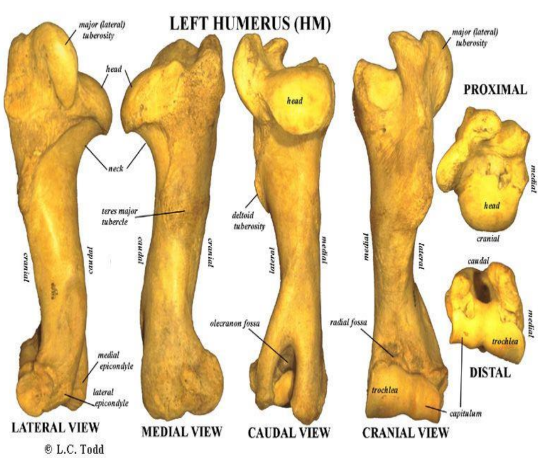


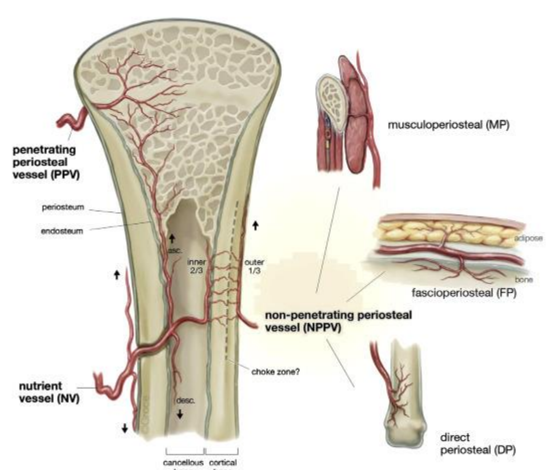
A. Elastic Cartilage　B. Hyaline Cartilage　C. Fibrous Cartilage

BONE

- Bone (osseous connective tissue) is the hardest & most rigid type of connective tissue.
- Its specialized matrix is a combination of organic collagen fibres & inorganic calcium salts, such as calcium phosphate & calcium carbonate.
- The calcium salts alone would render bone brittle, but when combined with collagen fibres, bone becomes more flexible and has greater strength
- Despite the rigidity of its matrix, bone, unlike cartilage is well vascularized

BONE





BLOOD

- ❑ This is the red fluid that passes through vessels & carries nutrient molecules & gases throughout the body.
- ❑ The liquid component of blood is called plasma and this constitutes the matrix.
- ❑ The fibrous component of the matrix is a variety of protein molecules suspended in solution and visible only when blood clots. Blood is rich with a variety of cell types, such as;

✓erythrocytes (red blood cells)

✓leukocytes (white blood cells)

✓ thrombocytes (platelets)

✓Proteins – fibrin, albumin

SUMMARY – CONNECTIVE TISSUE