

Cartilage and Bone

Connective tissue is one of the four basic tissue types. It fills spaces between organs and tissues, and provides them with structural and metabolic support. Connective tissue comprises three components, namely cells, fibers and amorphous ground substance.

| | | |
|----------------------------------|-------------------------|-----------------------------------|
| General connective tissue | Soft connective tissue | Mesenchyme |
| | | Gelatinous connective tissue |
| | | Loose connective tissue |
| | | Adipose tissue |
| | | Reticular connective tissue |
| | Dense connective tissue | Irregular dense connective tissue |
| | | Regular connective tissue |
| Special connective tissue | Cartilage | |
| | Bone | |
| | Blood | |
| | Haematopoietic tissue | |

You should be able to:

1. Describe the basement membrane and its components.
2. Explain the general structure and functions of connective tissues and its components.
3. Identify and distinguish between the types of connective tissue.
4. Explain the components (cells, fibers and ground substance) of connective tissue.
5. Identify the main fibers (collagen, elastic, reticular) and cells of connective tissues and properties and functions of each.
6. Explain the distribution of collagen types (Types I, II, III and IV) in the connective tissue types.
7. Distinguish the relative differences in the amount of connective tissue components in various connective tissues types.
8. Identify the three types of proper connective tissue, namely loose connective tissue, irregular dense connective tissue and regular dense connective tissue.

Connective tissue comprises a number of components. Study each example of connective tissue according to the following scheme:

1. Types of cells present
2. Extracellular fibers
3. Types present
4. Arrangement e.g. parallel, irregular, loose, dense, etc.
5. Appearance of the amorphous ground substance e.g. colourless

Also take note of the following:

1. The staining reaction of the amorphous ground substance, cells and fibers.
2. The relative ratio of the three components to one another.

3. The relative ratio of the different cells to one another.
4. The relative ratio of the different types of fibers.
5. The distribution of the cells in relation to the fibers.

The musculoskeletal system consists of the bones, cartilage, muscles, joints, tendons and ligaments in the human body. The musculoskeletal system support the body, allow for motion and protect internal organs. It can be viewed as two separate systems what function together. Cartilage and bone are specialised forms of connective tissue.

You should be able to:

1. Identify and describe cartilage and bone.
2. Identify and describe matrix of and cells present in cartilage and bone.
3. Describe the properties of cartilage and bone.
4. Describe the formation of cartilage and bone.
5. Define the cellular and non-cellular elements of cartilage and bone.
6. Identify the different types of cartilage.
7. Describe how the structure of cartilage relate to its properties.
8. Identify the different types of bone.
9. List the steps and describe the process of endochondral and intramembranous ossification.
10. Identify the zones present during endochondral bone formation.
11. Describe the process of bone remodelling.
12. Identify and describe periosteum and endosteum.

| Cartilage | | |
|-------------------|--------|-------|
| Name | Number | Stain |
| Elastic cartilage | 9 | R/F |
| Fibrous cartilage | 10 | H/E |
| Hyaline cartilage | 73 | H/E |

| Bone | | |
|--|--------|-------|
| Name | Number | Stain |
| Bone development | 11 | H/E |
| Compact bone (cross section) | 12 | H/E |
| Compact bone (ground cross section) | 13 | None |
| Compact bone (ground longitudinal section) | 14 | None |

This is a section through the pinna of the ear to demonstrate elastic cartilage.

1. View the slide at low magnification. You should see two surfaces, connected by an arch on one side. A darker stained area of elastic cartilage is present in the centre of the slide.

- Name the three types of cartilage.
- Name at least one place where each type of cartilage occurs.
- List the specific function of the cartilage in the area where it occurs.

2. View the slide at higher magnifications.

- What is the English meaning of the word lacuna?
- Name two cells associated with cartilage.
- What structure is noticeably absent from all types of cartilage, as well as tendons?

3. Identify

1. Lacunae.
2. Chondrocytes.
3. Matrix.
4. Perichondrium.

- Which cartilage cells are present in the lacunae?
- Which cells are associated with the perichondrium?
- What structure is the equivalent of the perichondrium in bone?

4. Make an annotated drawing of a portion of the cartilage and perichondrium in fine detail.

- What is the shape of the lacunae?
- How does the lacunae appear in comparison with those found in hyaline and fibrous cartilage?
- Describe the matrix of elastic cartilage in one short sentence.

This is a cross and longitudinal section of tendon just prior to its attachment to bone.

1. View the available slides.
2. Identify, at appropriate magnification:
 1. Chondrocytes
 2. Collagen fibers
 3. Matrix
3. Make a detailed annotated drawing of a portion of fibrocartilage.

- What is characteristic of the shape and arrangement of the chondrocytes?
- How does the amorphous ground substance appear?
- How are the collagen fibers arranged?
- How does this tissue differ from dense regular connective tissue?

This specimen is a longitudinal section through the head of a rabbit's femur.

1. View the slide at low magnification and orientate the various regions of the developing bone. You should see the head of the femur, attached muscle, and red pulp on the inside bordering the marrow space.

- Make an annotated line drawing of a cross-section of a complete femur, indicating the various structures found on a femur.
- Name the two types of bone growth.
- Make a list of bones for each type of bone growth.

2. Identify the following:
 1. The orientation of the head of the femur.
 2. The epiphysial plate.
 3. The shaft of the femur.

- Which two processes takes place in the head of a femur?
- What process takes place along the shaft of the femur?

3. View the region of the epiphyseal plate at high magnification.

- List the zones seen in endochondral ossification.
- Describe the events taking place in each zone of endochondral ossification.
- What is the function of osteoblasts?
- Make a line diagram of an osteoblast.
- What is the function of osteoclasts?
- Make a line diagram of an osteoclast.

4. Identify the following:
 1. The different zones of endochondral bone development.
 2. Osteoblasts and osteoclasts.
 3. Bone marrow.

- What is characteristic of each of the zones?

5. Make an annotated drawing of each of the different zones of bone development.

- What is characteristic of osteoblasts?
- What is characteristic of osteoclasts?
- In which zones are osteoblasts and osteoclasts found?
- Does your specimen have a secondary ossification centrum?

This is a cross section through decalcified bone. There are two ways to study bone histology. Dry bone is cut and polished before mounting on a slide. Bone decalcification is the removal of the mineral component using an acid, leaving the bone soft and easy to cut. In dry ground bone, the organic material is removed. In contrast, in decalcified slides the relationship between the living components of bone is retained.

Compare the view as seen on this slide, decalcified bone stained with haematoxylin and eosin, with that seen on slide 13 and 14, ground sections of unstained macerated bone.

1. View the slide at low magnification. You should see the outer edge of the bone, as well as the inner bone marrow cavity. Depending on the preparation, some muscle tissue could be attached to the outside.

- What are the three main cells associated with bone?
- What is the origin of each of the three main cells associated with bone?
- Where are the stem cells for bone growth located?

2. Identify the following:
 1. Compact decalcified bone.
 2. Marrow cavity.
 3. Blood vessels.
 4. Attached muscle fibres.

- Which tissue comprises the attachment between bone and muscle?

3. View higher magnifications of the slide. Structural detail should be visible. At highest magnification, the cells associated with bone should be visible.

- All cells, tissues and structures in the body needs _____ which is supplied by _____.
- What is present inside Haversian canals?
- What is the function of Haversian canals?
- What is the function of Volkmann's canals?
- What is present inside Volkmann's canals?

4. Identify the following:
 1. Haversian and Volkmann's canals
 2. Lacunae
 3. Bone matrix
 4. Periosteum
 5. Fat cells of the bone marrow

- How are lacunae arranged?
- What is found inside lacunae?

5. Make an annotated drawing:
 1. A line diagram indicating the macroscopic features and locations of structures of bone.
 2. A section of bone in which Haversian systems and periosteum are indicated.

- What is the function of lacunae?

| Ground bone | None |
|--|------|
| Slide 13: Ground bone – This is a cross ground section of macerated bone. | |
| Slide 14: Ground bone – This is a longitudinal ground section of macerated bone. | |

1. View the slide at low magnification. You should see an area of white-yellow compact bone, and cancellous bone on one side.

- What structure line the outer and inner surface of compact bone?
- What structure is found directly beneath each of these structures?

2. Identify:
 1. The unstained white-yellow compact bone.
 2. The marrow cavity.

- What processes takes place inside the marrow cavity?
- What tissue is seen inside the marrow cavity?

3. View the slide at appropriate higher magnifications. At the highest magnification, lacunae and canaliculi will be visible.

- How is oxygen, carbon dioxide and nutrients distributed throughout the body?
- How does nutrients reach the inside of compact bone?
- How does waste products leave compact bone?

4. Identify:
 1. A Haversian system.
 2. Haversian and Volkmann's canals.
 3. Lacunae and lamellae.
 4. Canaliculi.
 5. Interstitial lamellar systems.
 6. Circumferential lamellar systems

- Name the four lamellar systems found in compact bone.
- Make a progressive diagram to illustrate how each lamellar system is formed.

5. Make an annotated line drawing of a section of bone in which all three types of lamellae and their components are indicated. Include a cross- as well as longitudinal section, indicating how the components identified above differ on each view.

- How are the lacunae and lamellae arranged in the three systems respectively?
- How are the lamellae and lacunae arranged with respect to one another?
- What course do the canaliculi take?
- Explain why the lacunae all lie parallel to one another in the longitudinal section.
- How does the course of the Haversian canal differ from the Volkmann's canal?

Slide 73: Trachea

1. H/E

This specimen is a section through the trachea. This specimen is used to study the following:

1. Pseudostratified ciliated columnar epithelium
2. Hyaline cartilage
3. The trachea and its associated structures

1. View the slide at very low magnification. You should be able to see the opening of the trachea, layers of the trachea and surrounding adventitia.

- Describe the anatomy of the trachea and its relationships in the thorax.
- Every surface in the body implies a _____.
- List the epithelium of the respiratory system, starting at the nasal cavity and follow all surfaces into the alveolus.
- Name the three types of cartilage found in the human body.

2. Identify the following:

1. The large ring-shaped trachea
2. C-shaped cartilage rings
3. Layers of the tracheal wall
4. Ducts and vessels in the tracheal wall

- Name the epithelium found in the trachea.
- List the component cells of the tracheal epithelium and the function of each cell.
- Where does new cartilage growth come from?

3. View the slide at a higher magnification. Identify the different layers seen macroscopically as well as the following:

1. Epithelium of the trachea
 1. The four types of cells found in the epithelium
2. Lamina propria
3. Submucosa
4. Cartilage
 1. Lacunae
 2. Chondrocytes
 3. Matrix
 4. Perichondrium
5. Muscle
6. Adventitia

- What are two prominent structures in the lamina propria?
- What prominent structures are found in the submucosa?
- What cartilage is found in the trachea?
- What type of contractile tissue are seen in the trachea?
- Where is the contractile tissue located in the trachea?

4. Make annotated line drawings of the following. Use appropriate relative sizes:

1. The trachea and its structures.
2. The epithelium of the trachea and its four constituent cells. Clearly indicate each of the four cell types.
3. A portion of the cartilage and perichondrium in fine detail.

- How does each one of the four cell types appear in this epithelium?
- Why is this epithelium described as pseudostratified?
- What are the functions of each of the four cell types?
What is characteristic of the shape, size and arrangement of the lacunae?
- What is the appearance of chondrocytes?
- What is the appearance of the matrix?
- What type of growth is found in hyaline cartilage?