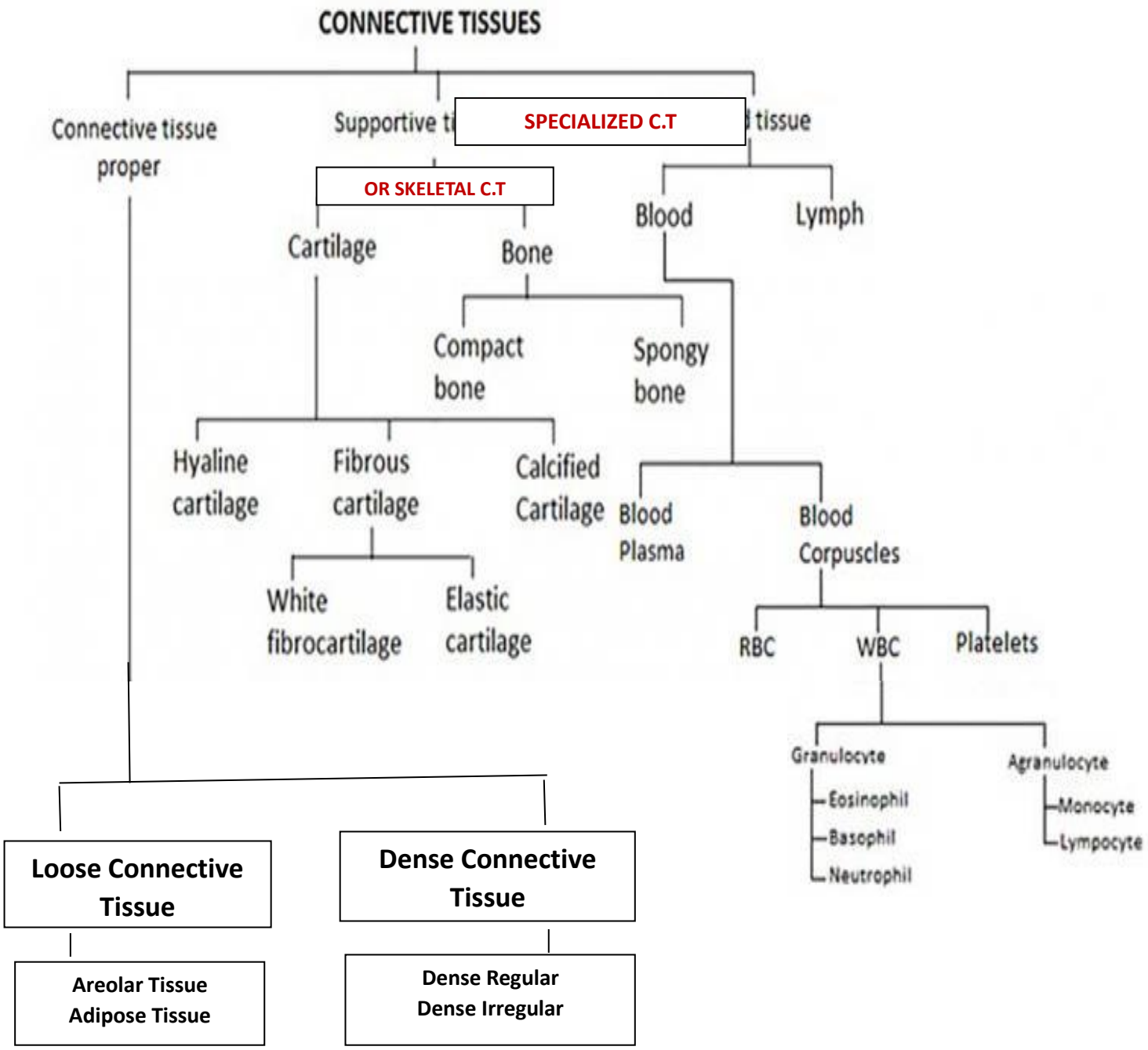
CONNECTIVE TISSUE

(BONE)

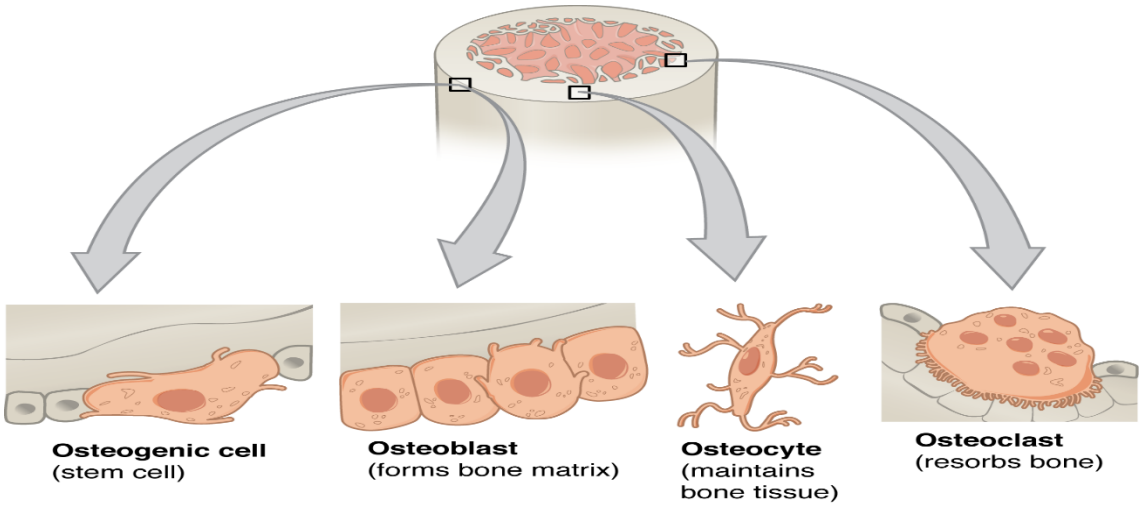


CLASSIFICATION OF CONNECTIVE TISSUE

(According to the nature of the cellular components and intercellular substances)

GROSS ORGANIZATION OF BONE OR OSSEOUS TISSUE)

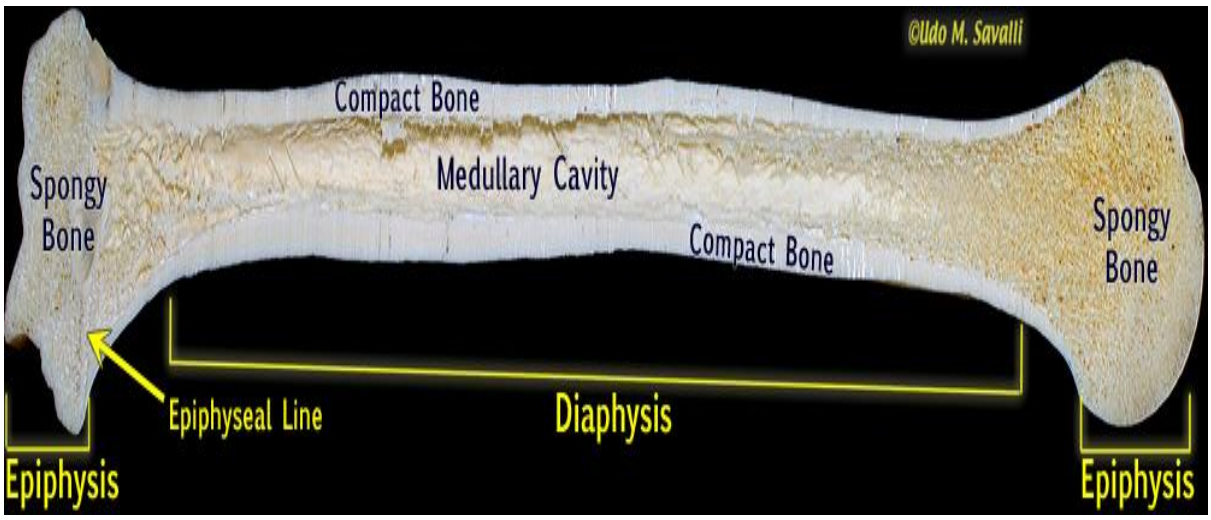
1) **Cells:** In actively growing bones, four types of bone cells are distinguishable—osteogenic cells, osteocytes, osteoblast and osteoclast.

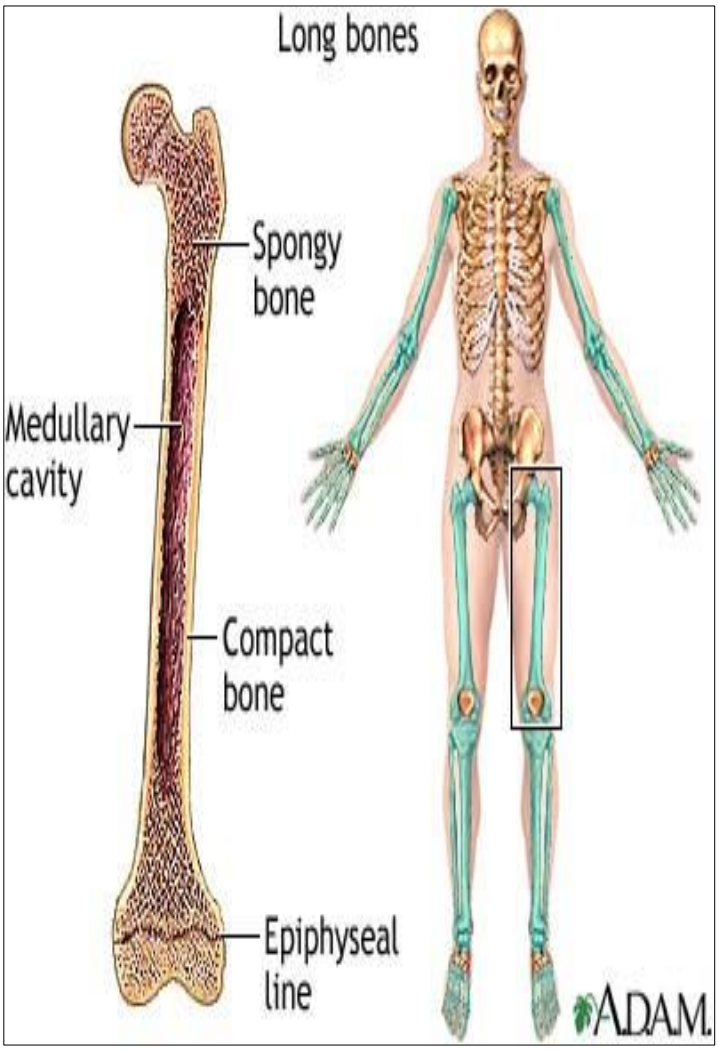


Bone Cells (Table 6.3)		
Cell type	**Function**	**Location**
Osteogenic cells	Develop into osteoblasts	Endosteum, cellular layer of the periosteum
Osteoblasts	Bone formation	Endosteum, cellular layer of the periosteum, growing portions of bone
Osteocytes	Maintain mineral concentration of matrix	Entrapped in matrix
Osteoclasts	Bone resorption	Endosteum, cellular layer of the periosteum, at sites of old, injured, or unneeded bone

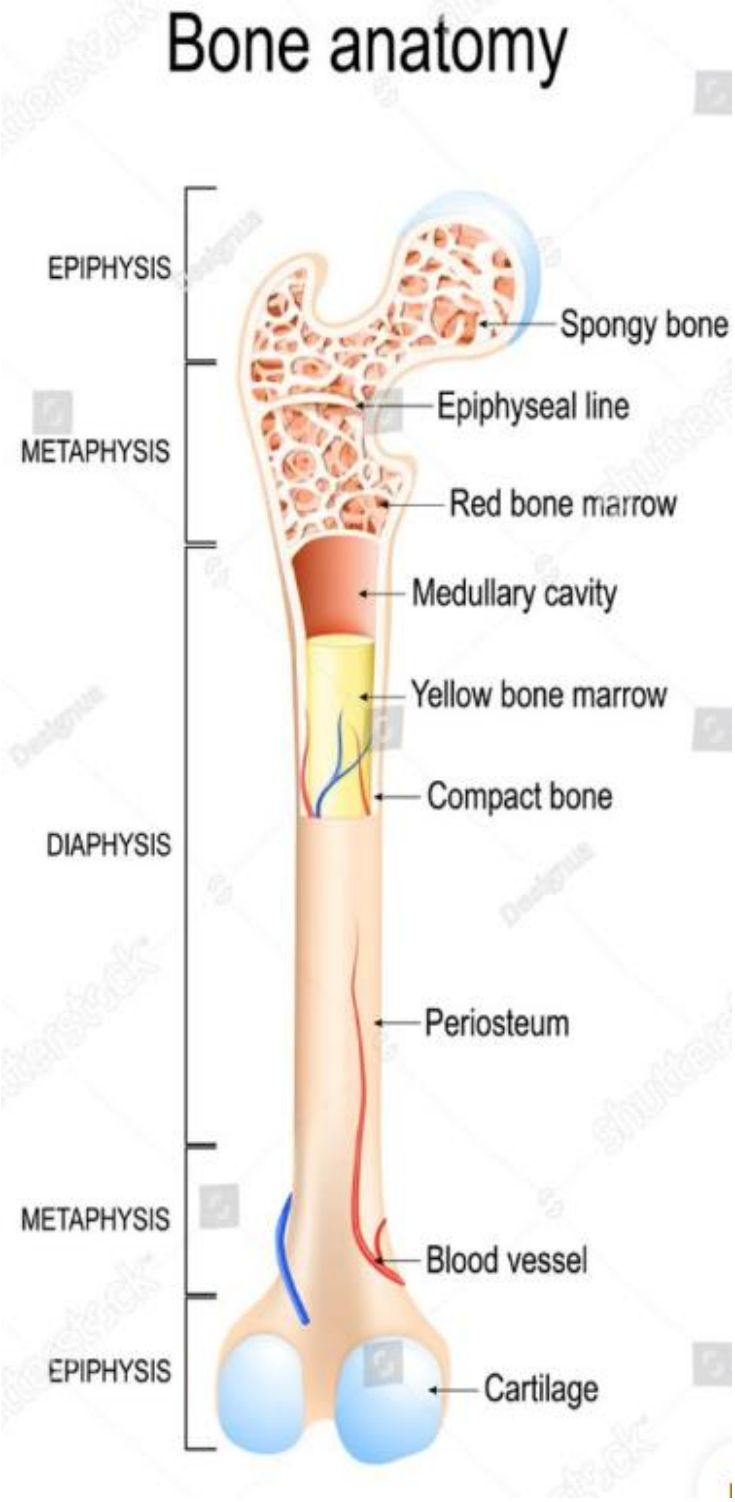
2) **Interstitial substance or Bone Matrix—**It is composed of two major components – organic matrix and an inorganic salt
   - 70 % of matrix contains inorganic salts, which is responsible for bone rigidity and 30% contains organic materials like proteins etc.
   - Matrix is made up of sugar and proteins. The proteins present in Bone is called as Ossein.

3) Fibres: The matrix contains fibres. The organic fractions consist of collagenous fibres embedded in an amorphous ground substance. In adult mammals, about 95% of the organic matrix is collagen.





Longitudinal sections of long bones



Gross Anatomy of Bones

A long bone has two main regions: the **diaphysis** (Tip ends) and the **epiphysis** (centre part)

The wider section at each end of the bone is called the **epiphysis** (plural = epiphyses), which is **filled internally with spongy bone**, another type of osseous tissue.

Red bone marrow fills the spaces between the spongy bone in some long bones.

Each epiphysis meets the diaphysis at the **metaphysis.**

During growth, the metaphysis contains the **epiphyseal plate,** the site of long bone elongation. Epiphyseal plate is made up of **Cartilage.**

When the bone stops growing in early adulthood (approximately 18–21 years), the epiphyseal plate becomes an **epiphyseal line**

The diaphysis is the hollow, tubular shaft or body that runs between the proximal and distal ends of the bone.

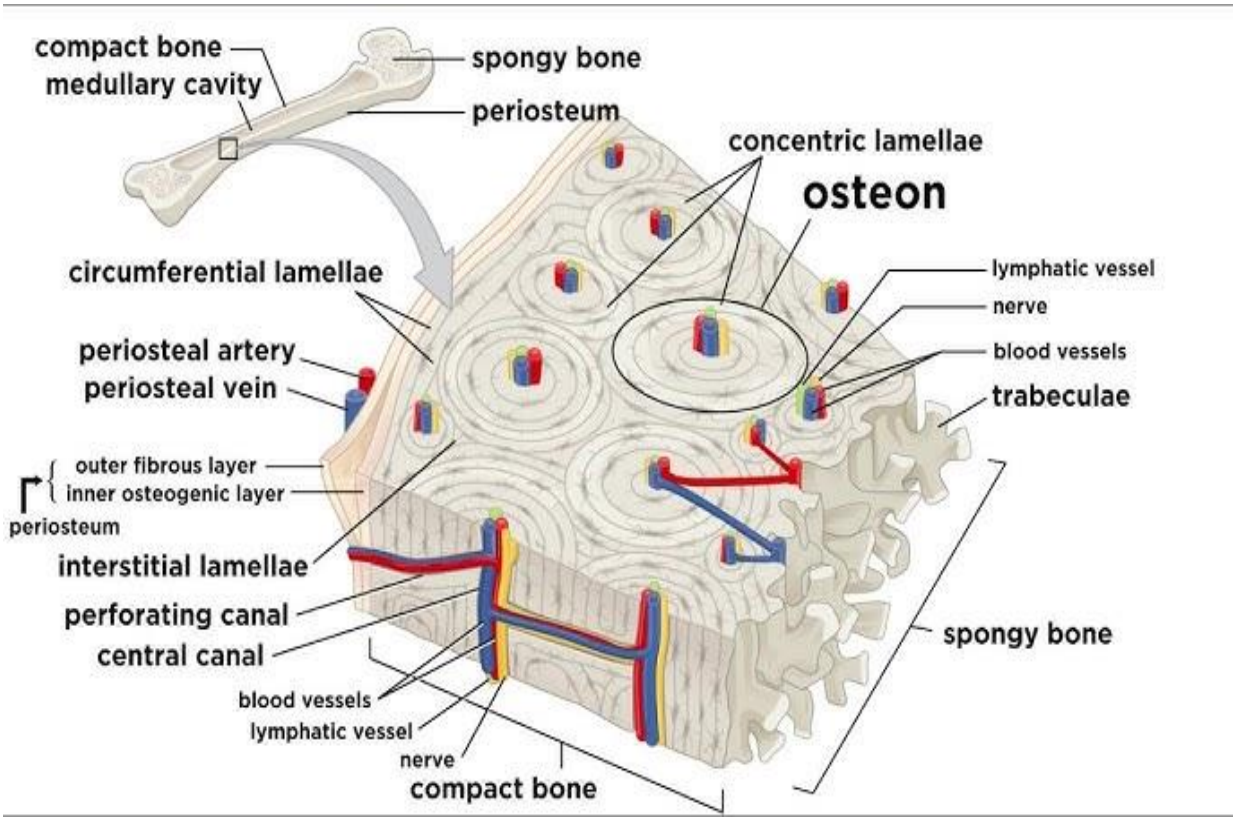
Inside the diaphysis is the **medullary cavity**, which is filled with **yellow bone marrow in an** adult.

The outer walls of the diaphysis **(cortex, cortical bone)** are composed of **dense and hard compact bone**, a form of osseous tissue.

TWO FORMS/ TYPES OF BONE

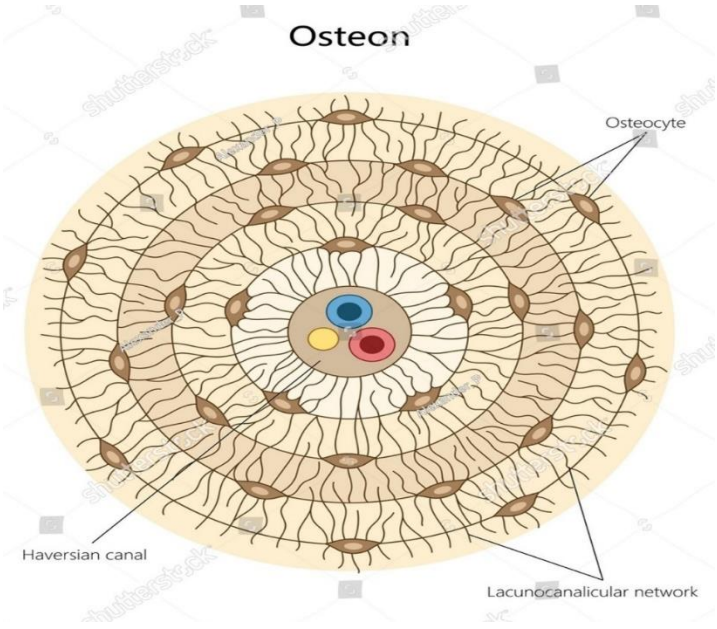
1) COMPACT BONE
2) SPONGY OR CANCELLOUS BONE

Compact Bone



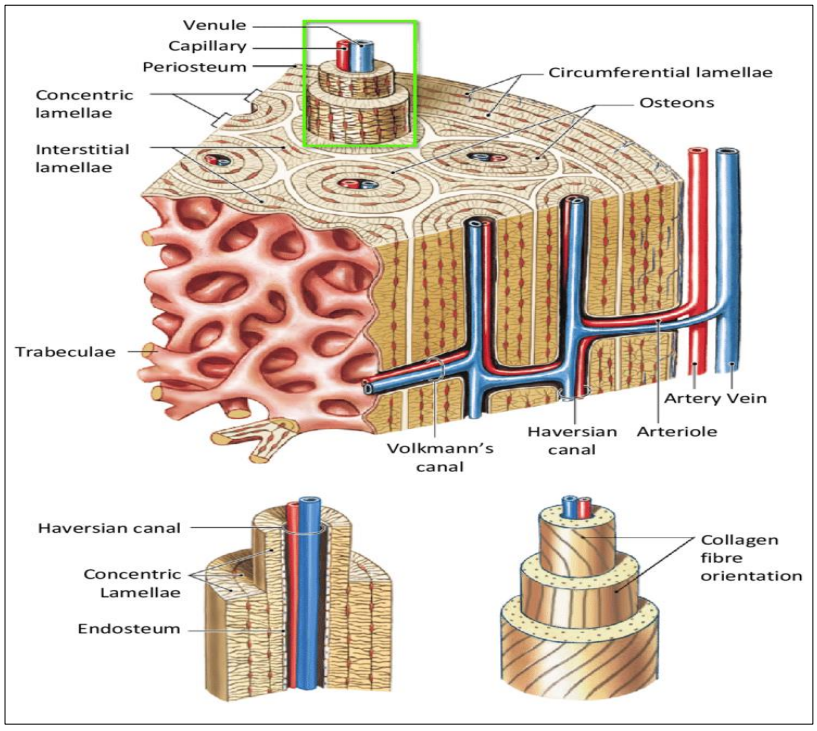
- The solid continuous mass next to medullary cavity is the COMPACT BONE. This kind of osseous tissue is very hard having lamellated with Haversian system
- Compact Bone is covered by an Outer tough membrane called Periosteum. Periosteum is composed of outer fibrous tissue and inner layer of elastic tissue which contains osteoblast and osteoclast cells)
- Attache dto the periosteum is Blood vessels, nerve and muscles.
- The central hollow part of the compact bone is called MARROW CAVITY Or MEDULLARY CAVITY which is enclosed by a thin fibrous membrane called ENDOSTEUM (present on the inner region of the hard bone/ compact bone)
- MEDULLARY CAVITY of long Bone is filled up with YELLOW BONE MARROW which is composed of Adipose tissue.
- COMPACT BONE is largely composed of mineralized ground substances called bone matrix. The mineralized salts deposits are in concentric layers called LAMELLAE (3-7 µm thick). Within the lamellae are lenticular cavities called LACUNAE on bone matrix. Each is filled with Osteocytes.
- From each lacunae, slender branching tubular passages radiates from all the directions. These passages are called CANALICULI which penetrates the interstilial substance of the lamellae, linking with canaliculi of neighbouring lacunae.
- This interconnecting canaliculus helps in exchange of metabolites between bone cells nearest perivascular spaces.

- **BODY OR LAMELLAE of COMPACT BONE shows 3 common patten: ----**
  1) Haversian Or Osteon System
  2) 2) Interstilial Lamellae And
  3) 3) Circumferential Or Periosteal Lamellae.



1) HAVERSIAN SYSTEM:

- The hard wall of the body or lamellae contains a minute longitudinal tunnel called Haversian Canal.
- Each canal is provided with – blood vessels, lymph vessels and nerves. It is surrounded by 4-20 concentric layers of Matrix (Concentric layers are called LAMELLAE, which varies in size)
- Between the layers of Lamellae, no. of lacunae presents which contains osteocytes. From lacunae minute channels come out called Canaliculi.
- One Lacunae communicates with other lacunae and also with Harversian canal through canaliculi.



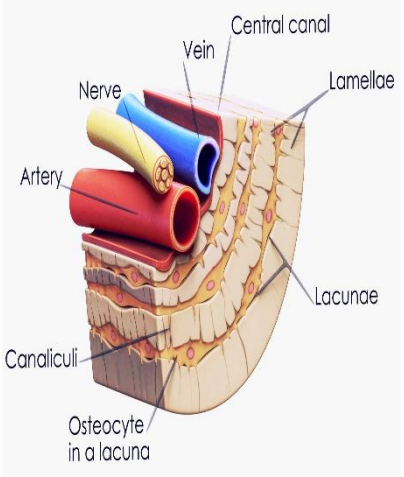
- **Therefore, Concentric lamellae, Harversian canal, lacunae , bone cells and canaliculi forms 1 Haversian System**

2) INTERSTILIAL LAMELLAE:

- The spaces between the Haversian systems are not lamellated (ie., not in concentric layers) in regular appearance. Haversian system and interstilial system are sharply demarcated or separated by a line called cement line.

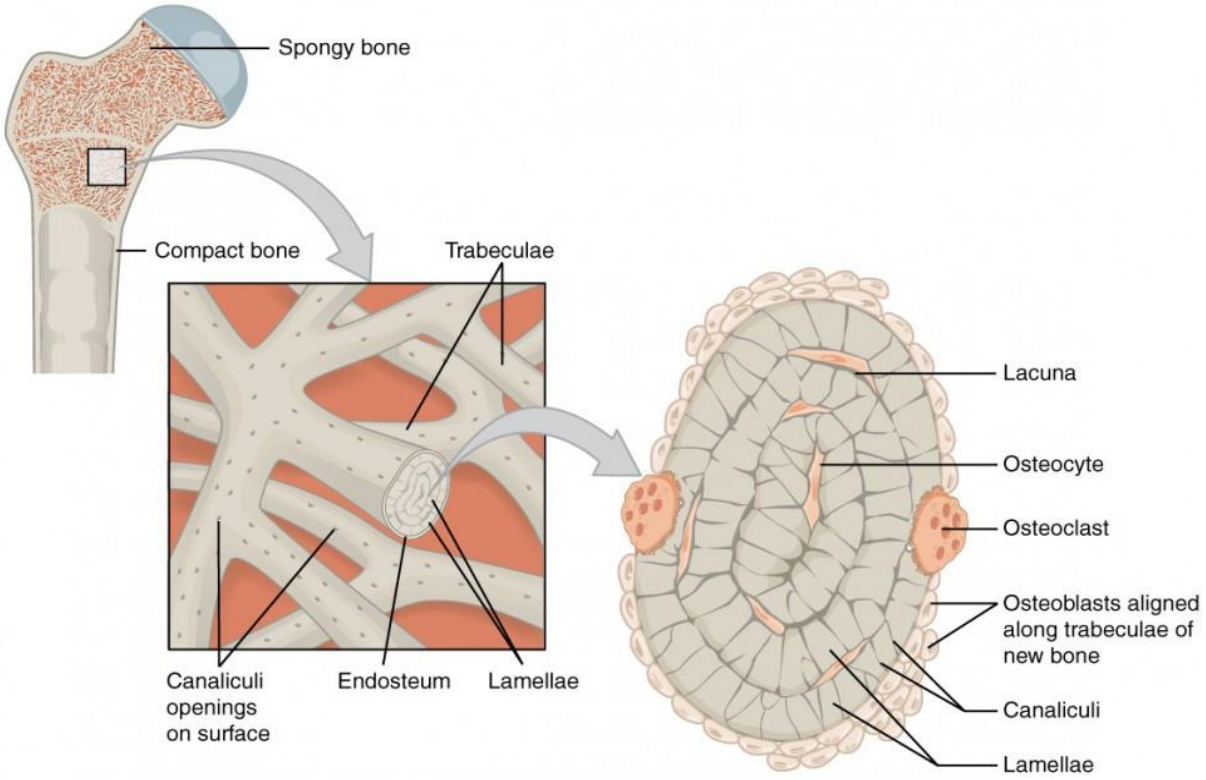
3) CIRCUMFERENTIAL LAMELLAE:

- These lamellae are arranged parallel to the outer and inner surfaces of the compact bone wall so, Compact bone consists of branching concentric tubular lamellae (ie., Haversian Lamellae) with intervals or spaces filled in by interstilial lamellae which is covered externally and internally by more parallel circumferential lamellae.
- Harversian canals present in compact bone are connected with one another and also connected with MEDULLARY CAVITY by channels called VOLKMANN'S CANALS, can be distinguished from Harversian canal as they are not enclosed by concentrically arranged lamellae also blood channels or vessels are often larger



Body or shaft of long bone such as humerus, femur are compact in natur

SPONGY OR CANCELLOUS BONE



In this type of Bone, Calcification is less than Compact bone so it is softer.

- Deposition of Calcium forms the lamellae but irregularly arranged forming lattice network of matrix spikes called trabeculae.
- Trabeculae are thin and usually not penetrated by blood vessels, which are covered by Endosteum.
- No Harversian System is present in spongy bone. Only pieces of lamellar bone present.
- Minute pieces between lamellae are called lacunae from which branching or canaliculi are developed.
- Inside lacunae, osteocytes present
- Since no blood vessels penetrated in trabeculae, bone cells are nourished by diffusion from surface via minute Canaliculi
- The space present in spongy bone contains or filled by RED BONE MARROW, protected by trabeculae and RED BONE MARROW contains mostly blood forming tissue and small number of Adipose Tissues.
- Blood forming tissue helps in haematopoiesis.

SPONGY BONE is found in inner parts of flat bones and round ends of long bones.

Distinguish between Cartilage and bone

Characters	Cartilage	Bone
(i) Type	Cartilage is an elastic supporting tissue.	Bone is a kind of rigid supporting tissue.
(ii) Conversion	Cartilage is converted to bone.	Bone is not converted to cartilage.
(iii) Ground substance or Matrix	Matrix is entirely organic.	Matrix is both organic and inorganic types.
(iv) Fibres	White and yellow fibres are noticed.	Only white collagenous fibres are present.
(v) Cytoplasmic processes	Cells are without any cytoplasmic processes.	Cells are with cytoplasmic processes.
(vi) Lacuna	A group of cells are found in a lacuna.	Single cell is present in the lacuna.
(vii) Lamella	In cartilage lamella is absent.	Lamella is present in bone.
(viii) Haversian system	Absent.	Present.
(ix) Marrow	Absent.	Present.
(x) Volkmann's canal	Absent.	Present.
(xi) Blood vessels	Absent.	Present.
(xii) Covering	Perichondrium is found except white fibrocartilage.	Both periosteum and endosteum are noticed.

Distinguish between Red bone marrow and Yellow bone marrow

Subject	Red bone marrow	Yellow bone marrow
(i) Position	Red bone marrow is found in spongy bone.	Yellow bone marrow is noticed in marrow cavity of long bones.
(ii) Composition	It contains a certain amount of adipose tissue.	It also contains more adipose tissue than that of Red bone marrow.
(iii) Function	It is provided with mostly blood forming tissue.	It has no blood forming function.

Distinguish between Osteocyte and Chondrocyte

Subject	Osteocyte	Chondrocyte
(i) Type	Bone cell	Cartilage cell
(ii) Position	Osteocyte is housed within the lacuna of bone ground substance.	Chondrocyte is located within the capsule of cartilage matrix.
(iii) Cytoplasmic process	The cytoplasmmic processes enter into canaliculi.	No cytoplasmic processes are noticed and rather they are large and rounded.
	Osteocytes are solitary.	Generally they remain in groups of 2-4 in a capsule.
(iv) Example	They remain in fully developed bone.	They are present in articular cartilage and epiphyseal cartilage.

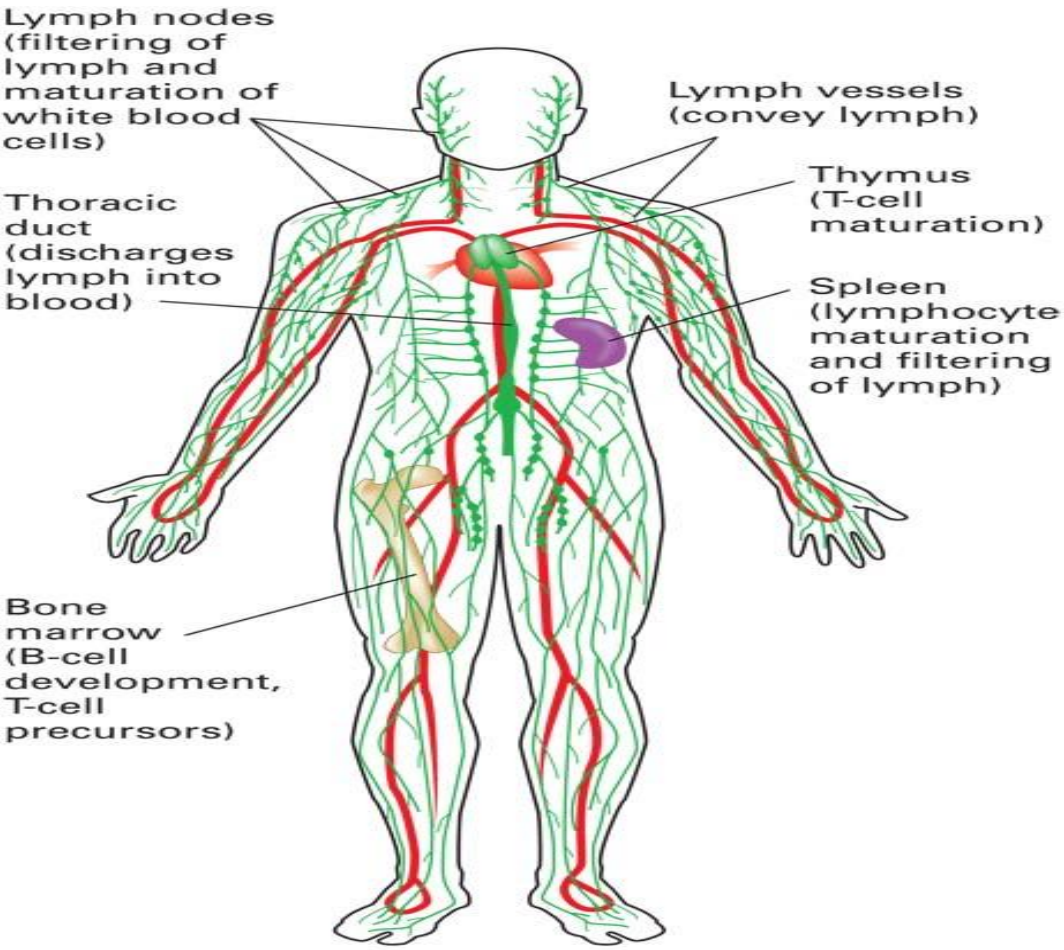
Distinguish between compact bone and spongy bone

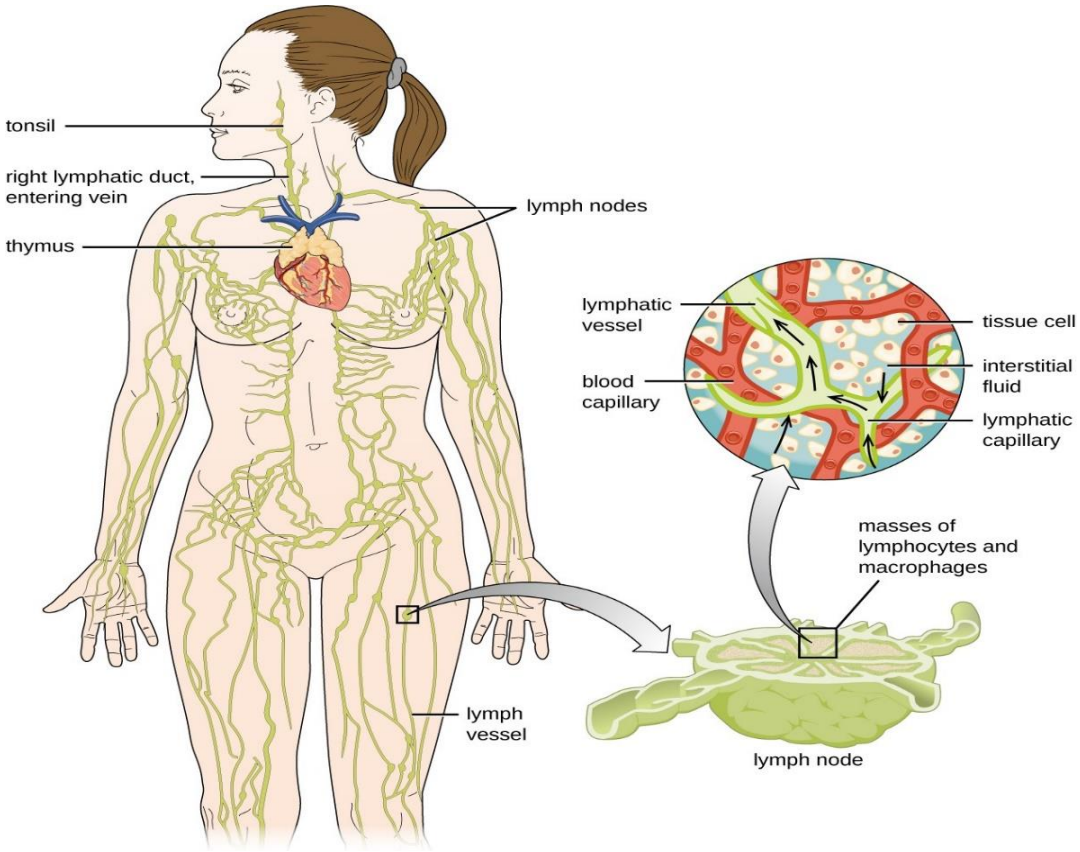
Subject	Compact bone	Spongy bone
(i) Kind of bone	(i) This kind of bone is very hard having lamellated with Haversian system.	(i) This type of bone is lamelllated without any Haversian system.
(ii) Nature of calcification	(ii) Here calcification is dense.	(ii) In spongy bone the calcification is less than the compact bone and so it is softer.
(iii) Presence of partition	(iii) Compact bone is devoid of minute partitions.	(iii) Spongy bone is provided with many minute partitions.
(iv) Occurrance	(iv) Shaft or body of the long bones such as humerus and femur, etc., are compact in nature.	(iv) Distributed to the inner parts of the flat bones, round ends of the long bones, the body of the vertebrae, etc.

Function of bones:

1) Provides structural framework to body
2) Support and protect softer tissues
3) Provides surface for the attachment of muscles
4) Serves as storage site for calcium and phosphate
5) Helps in production of blood cells
6) Limb bones serve weight bearing functions

VASCULAR OR FLUID TISSUE—blood and lymph





1) BLOOD

COMPOSITION OF BLOOD

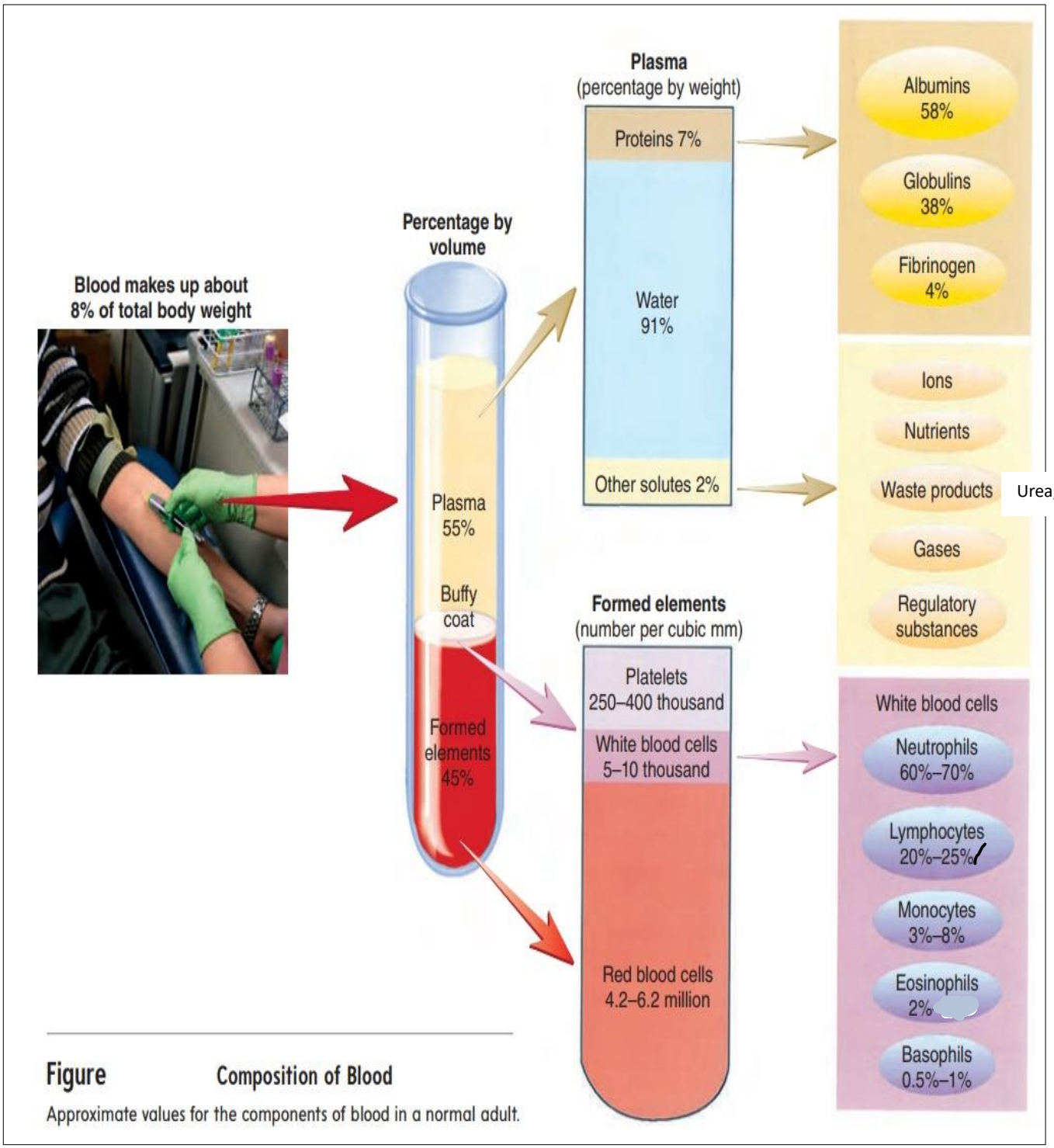


Figure Composition of Blood

Approximate values for the components of blood in a normal adult.

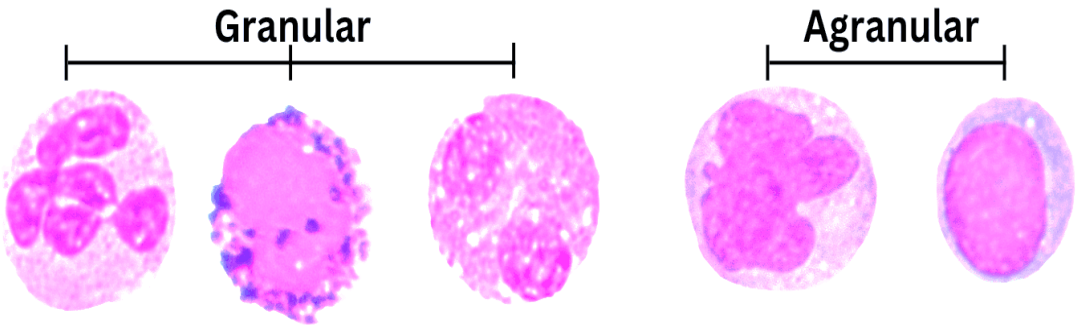
TYPES OF WHITE BLOOD CELLS

Leukocytes

(White Blood Cells)

Leukocytes or white blood cells are part of the immune system.

They account for ~1% of blood volume and occur in lymphatic tissue.



neutrophil
- multilobed nucleus
- kill bacteria and fungi

basophil
- bi- or tri-lobed nucleus
- inflammatory response

eosinophil
- bi-lobed nucleus
- kill parasites; allergic response

monocyte
- kidney-shaped nucleus
- remove dead cells

lymphocyte
- eccentric nucleus
- kill viruses; make antibodies