Anatomy

FOR 3RD YEAR MEDICAL PHYSICS STUDENTS

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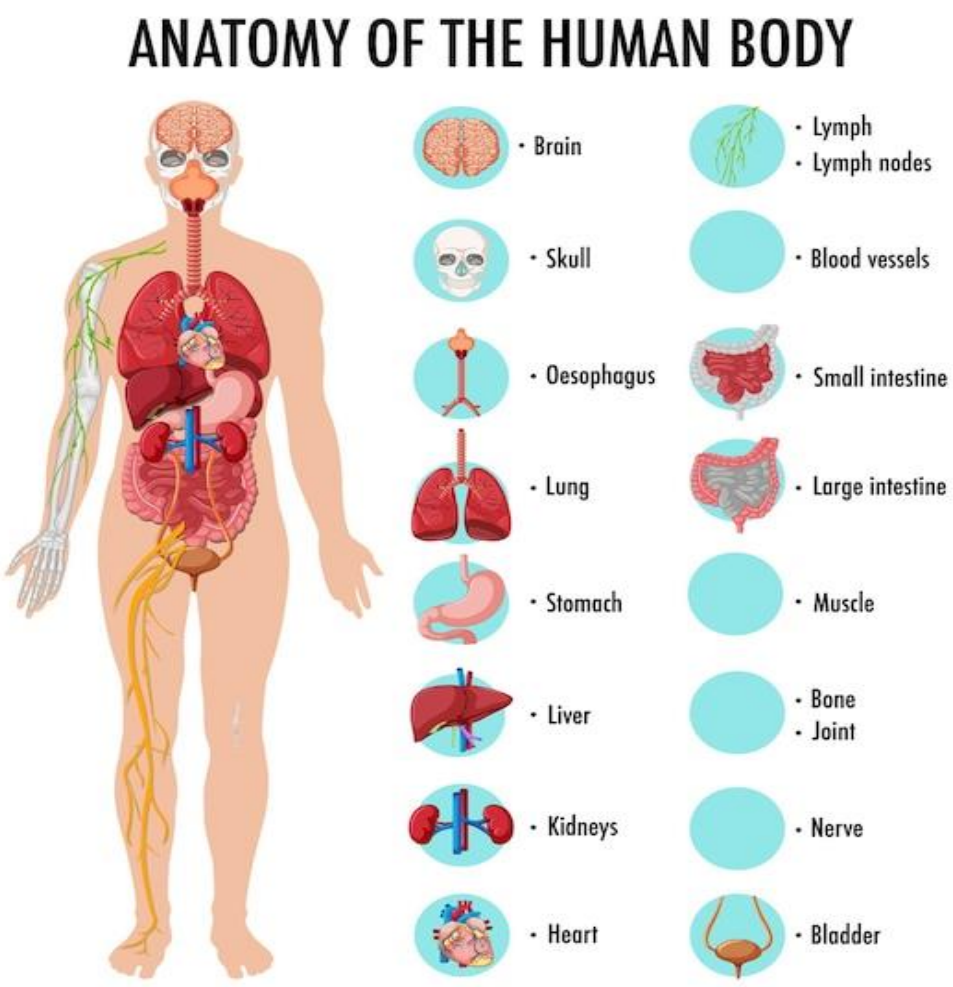


Skin

Skin, body's largest and the most extensive sensory organ, forms the outer and protective covering of the body. The skin covers the entire body; makes up about 7% of the body weight; varies in thickness in different parts of the body. It is usually subdivided into a superficial cellular part called the epidermis and the deep connective tissue part called the dermis.

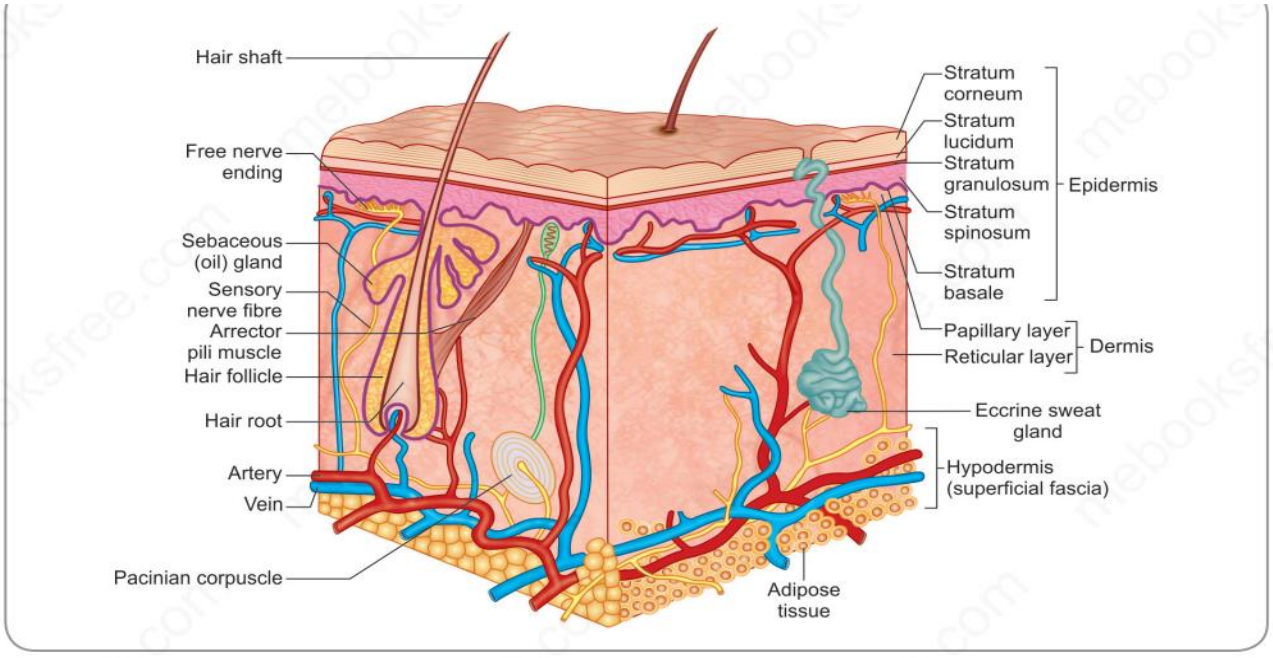


Fig. 2.1: Structure of skin

Epidermis

The epidermis is extremely thick on the palmar aspects of the hands and the plantar aspects of the feet, in order to withstand the constant wear and tear that occurs in these Dermis The dermis which is composed of connective tissue has blood vessels, lymphatics and nerves. It is of varying thickness in different parts of the body; in general, it is thinner on the anterior than on the posterior surface; it is thinner in women than in men. The dermis is connected to the underlying deep fascia or to the bones by the superficial fascia. Because the latter is immediately underneath the skin, it is also called the subcutaneous tissue. The dermis has densely packed collagen, elastic and reticular fibers. These fibers are responsible for the tone of the skin and provide strength, toughness, resilience and recoil. Though the fibers run in various

directions, in a specific location, they run parallel to each other. The pattern of the fibers determines the wrinkle lines of the body.

Dermis

The inner layer of the two main layers of the skin. The dermis has connective tissue, blood vessels, oil and sweat glands, nerves, hair follicles, and other structures. It is made up of a thin upper layer called the papillary dermis, and a thick lower layer called the reticular dermis. The role of the dermis is to support and protect the skin and deeper layers, assist in thermoregulation, and aid in sensation.

Specialized Structures of Skin

The skin also contains specialized structures and gives rise to its appendages. Together with its specialized structures, the appendages and the subcutaneous tissue immediately underneath, it forms the integumentary system The specialized structures occur within the dermis and are the hair follicles, the sebaceous glands and the sweat glands.

Histology of Skin

The epidermis has several layers called strata and four types of cells namely, the keratinocytes, melanocytes, Merkel cells and Langerhans cells. Wherever skin is thick, the epidermal strata are five; in thin skin they are four. From deep to superficial, these are stratum basale, stratum spinosum, stratum granulosum, stratum lucidum and stratum corneum.

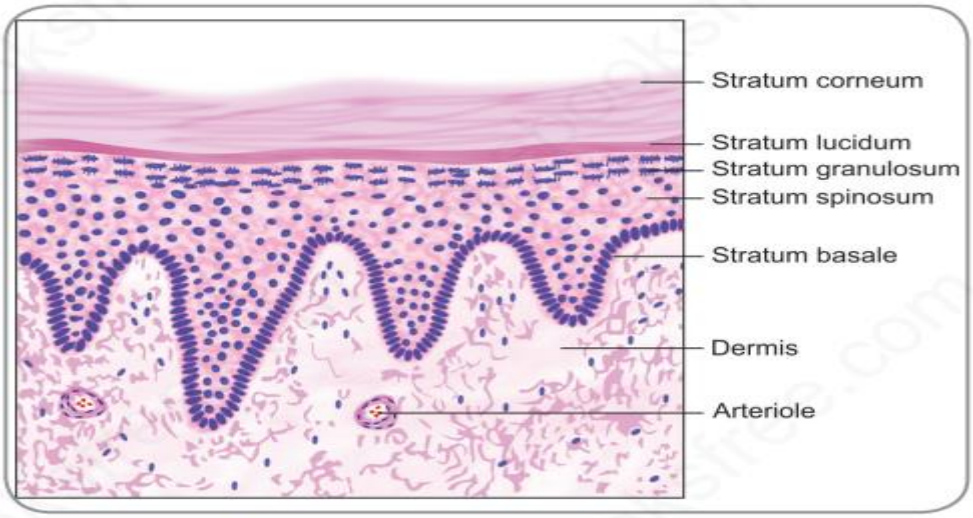


Fig. 2.3: Section showing the layers of epidermis

Skin color is predominantly due to a pigment called melanin. The carotene and hemoglobin are two other pigments which contribute to the complexion. Melanin is synthesized in the melanocytes of the epidermis and is then moved to the keratinocytes (which also are in the epidermis).

Skin has several important functions. These are as follows:

‰Giving protection from environment, from ultraviolet radiation, from injuries and from harmful substances,

‰Acting as a container for the internal structures and organs of the body,

‰Regulating body temperature (or thermoregulation) through evaporation of sweat and through its blood vessels

‰Preventing dehydration,

‰Providing sensations through the superficial nerves and their endings,

‰Synthesizing and storing vitamin D

Muscles

The human body contains a very large number of muscles; they form the major bulk of limbs and some other parts of the body and contribute to the various movements which the individual can make. Thus the muscles are also part of the locomotor apparatus. Study of muscles is called myology.

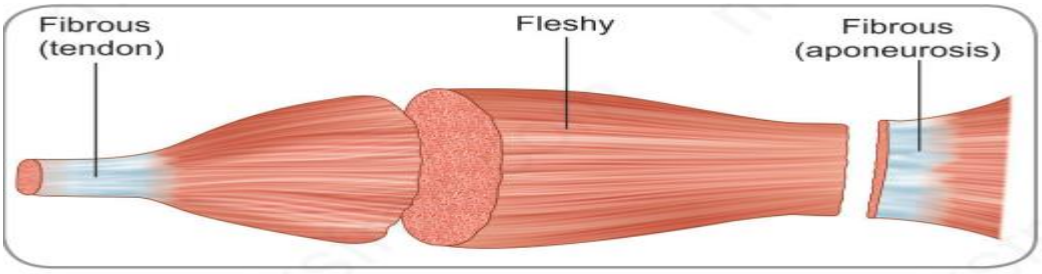


Fig. 3.1: The belly and the tendinous cross-sections-comparison

Contractility (to be able to shorten and lengthen itself by contractions) is the important property that underlines all muscles.

Muscles are of three types, namely, (1) striated, (2) non striated and (3) cardiac muscles. The striated muscles are so called because of the presence of lines or striations when this tissue is seen under the microscope. No lines are present in the tissue of other muscles and hence, such muscles are called non striated muscles. Cardiac muscle is found in the heart.

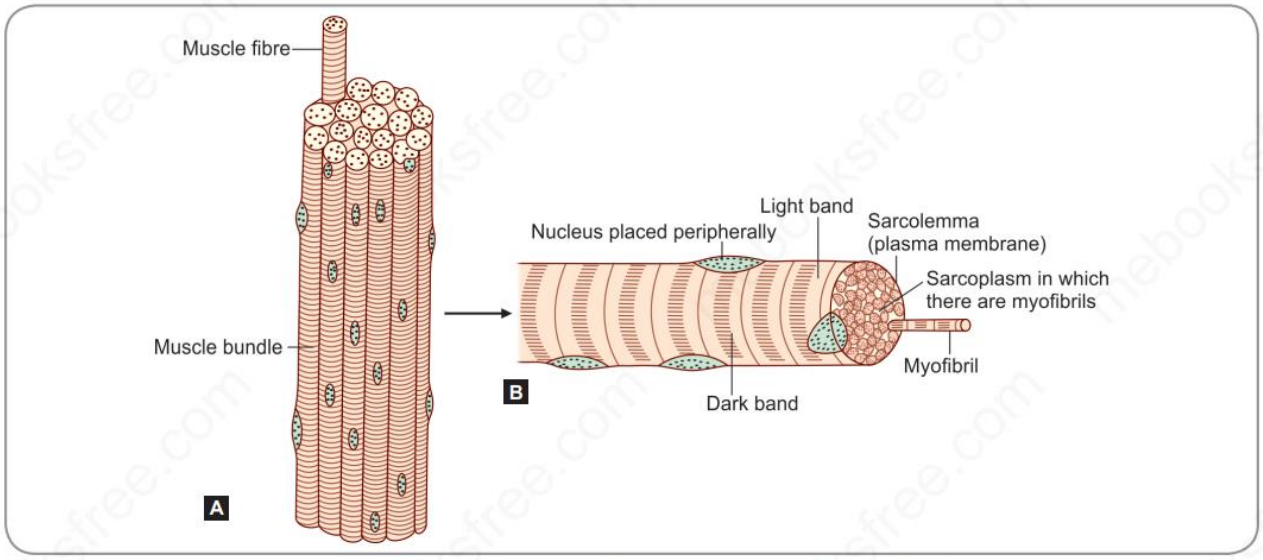
‰Striped muscles: Due to the presence of striations or stripes;

‰Skeletal muscles: Due to their attachments to bones

‰ Somatic muscles: Due to their presence in the body wall, limbs and structures developmentally related to the body wall; attached to the bone. Tendons and aponeuroses have lower metabolism and hence, are less richly supplied with blood vessels than the belly portion. (Fig. 3.1)

‰ Voluntary muscles: Due to the fact that they can be made to move at will. They form the major bulk of the human body amounting to about 40 to 50 percent of the total body mass. They are responsible for various body movements and thus give energy. For this reason, they have been called the engines or motors of the body. The ends of the muscle are usually thinner and non-contractile; this is the portion by which the muscle is attached to the bone (sometimes to cartilage or ligament). When the non-contractile portion is cord-like, it is called a tendon when it is flattened, it is an aponeurosis (Fig. 3.1). The tendon and aponeurosis consist of dense connective tissue and have a shiny, yellowish-white color in sharp contrast to the reddish-brown color of the belly. Though both ends of the muscle may have tendons, when the tendon is very short, the muscle appears to be directly.

Tissue	Histology	Function	Location
Skeletal	Long cylindrical fiber, striated, many peripherally located nuclei	Voluntary movement, produces heat, protects organs	Attached to bones and around entrance points to body (e.g., mouth, anus)
Cardiac	Short, branched, striated, single central nucleus	Contracts to pump blood	Heart
Smooth	Short, spindle-shaped, no evident striation, single nucleus in each fiber	Involuntary movement, moves food, involuntary control of respiration, moves secretions, regulates flow of blood in arteries by contraction	Walls of major organs and passageways



Figs 3.2A and B: Structure of skeletal muscles **A.** Muscle bundle **B.** Muscle fibre

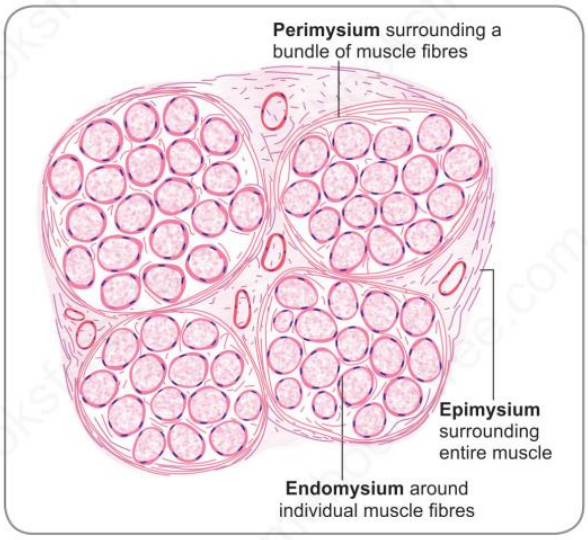


Fig. 3.3: Connective tissue present in relation to skeletal muscle

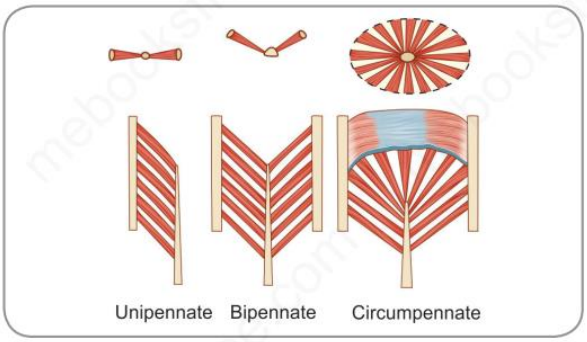
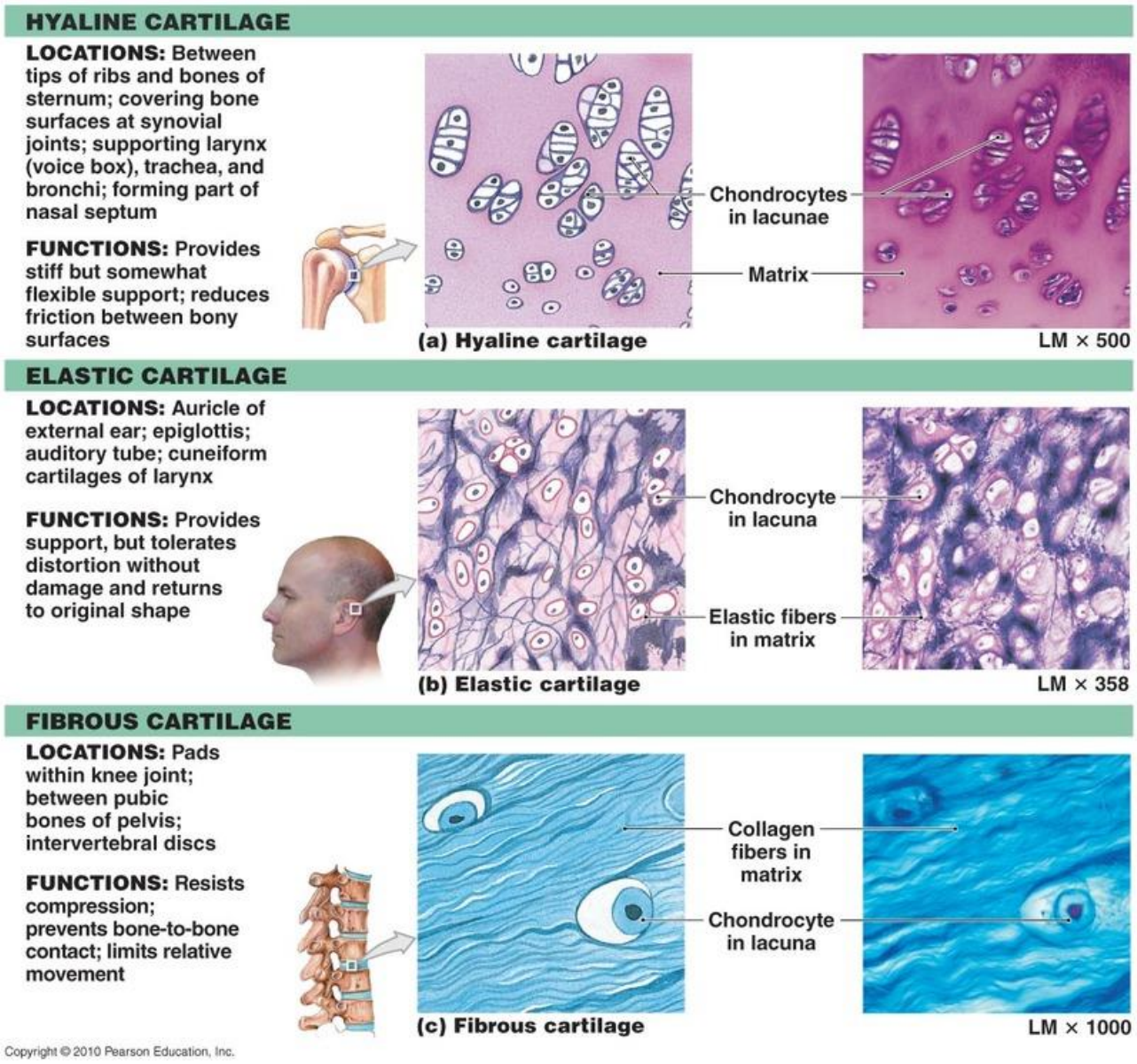


Fig. 3.4: Skeletal muscle-shape and architecture

Cartilages and Bones

Cartilage is a connective tissue; like all other types of connective tissue, cartilage also has cells and extra cellular matrix. The cells are called chondrocytes. The extracellular matrix has a jelly-like ground substance and collagen fibers. The glycosaminoglycan molecules (long sugar molecules) in the ground substance have negative charges in them.



Histologically, cartilage is classified into three types, namely the hyaline cartilage, the white fibrocartilage and the elastic cartilage. Each type is distinguished by the type of fiber that dominates the matrix. The most characteristic property of cartilage is its resilience. This is the ability to get back to its original shape after being compressed. This ability makes pieces of cartilage act as buffers in areas where friction and compression occur. Resilience of cartilage is due to the fact that it holds lot of water in its matrix Cartilage is also capable of rapid growth. It is in abundance in the embryo. Cartilage tissue secretes certain chemicals which prevent blood vessels from growing into it.

Bone (or osseous tissue) is a tissue of great strength and resilience. It is the hardest tissue of the body. It consists of cells, fibers and a matrix. The matrix is extracellular

(outside the cells) and is calcified (has deposition of calcium salts). This calcification gives hardness and strength to the bone tissue. The presence of fibers gives some amount of elasticity.

Functions of Bones

Bones have several important functions that it is almost impossible to imagine the human body without bones. Bones, along with the joints, (Fig. 4.1) cartilage and some connective tissue, form a bony skeleton that accords a framework to the human form. The muscles, connective tissue and skin clothe this framework, ultimately leading to the familiar human appearance. Blood vessels and nerves go to different parts of the body in close proximity to the bones.

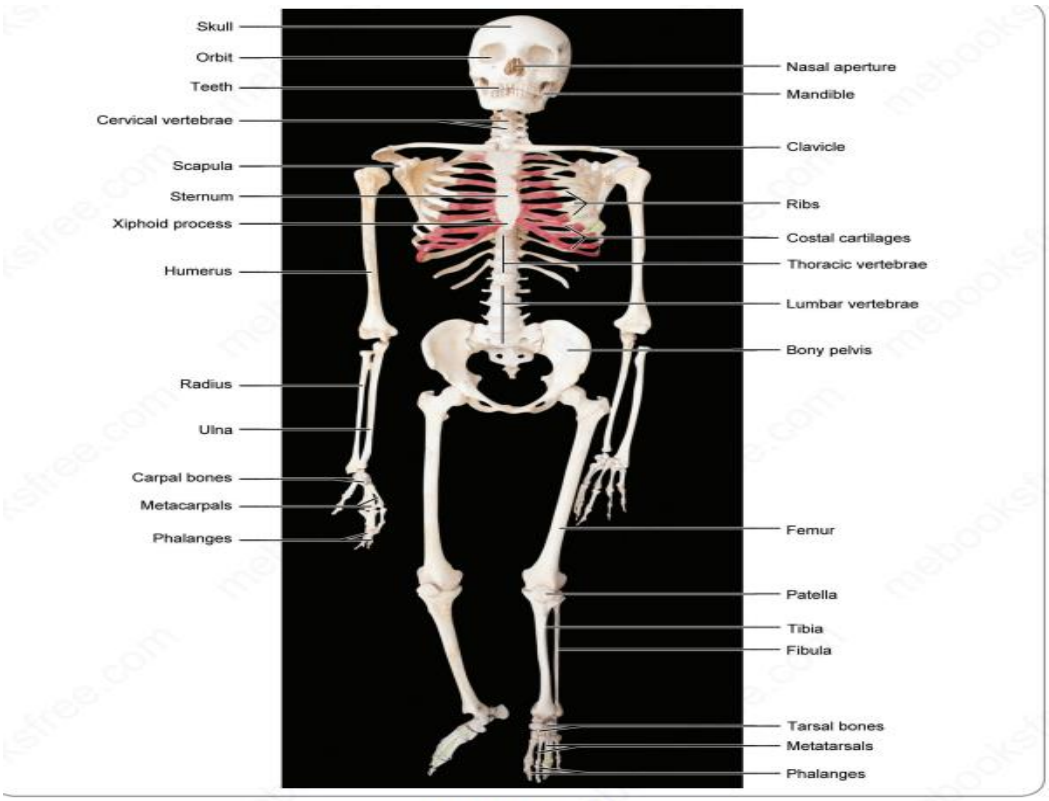


Fig. 4.1: Human skeleton

Various functions of bones and the bony skeleton can be listed as follows:

‰Framework: Skeleton gives shape and form to the human body.

‰Protection: Internal structures and organs are given protection by the various parts of the skeleton; cranium protects brain; thoracic cage protects the lungs and the heart.

‰ Leverage for muscle action: Skeletal muscles are attached to the bones and the bones act as levers for the muscles to contract.

‰Storage: Bones are reservoirs of calcium salts.

‰ Blood formation: Within their cavities, bones have the blood forming bone marrow.

Classification of Bones (Fig. 4.3)

Depending on the physical structure and appearance of the bone, two types of it are described, namely, the compact bone and the cancellous bone.

Bones are classified according to their general shapes and each category has its own predominant characteristics

1- Long bones 2-Short bones 3-Flat bones 4- Irregular bones

Special Types of Bones

These are bones which either have a specialized cause for appearance or have a specialized modification of architecture. Two examples in the human body are the sesamoid bones and the pneumatic bones.

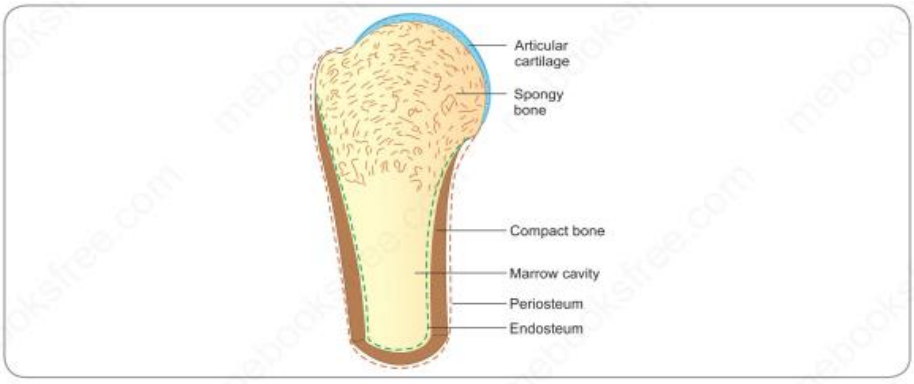


Fig. 4.2: Some features of bone structure as seen in a longitudinal section through one end of a long bone

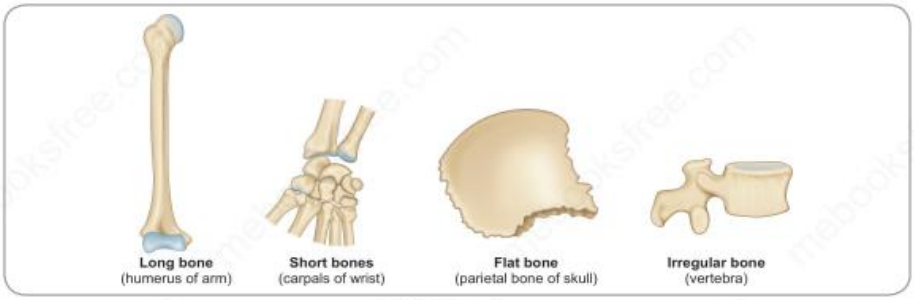


Fig. 4.3: Types of bones

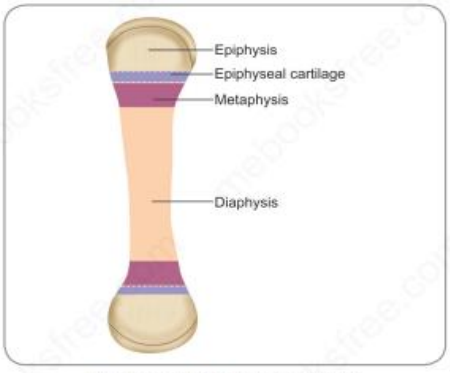
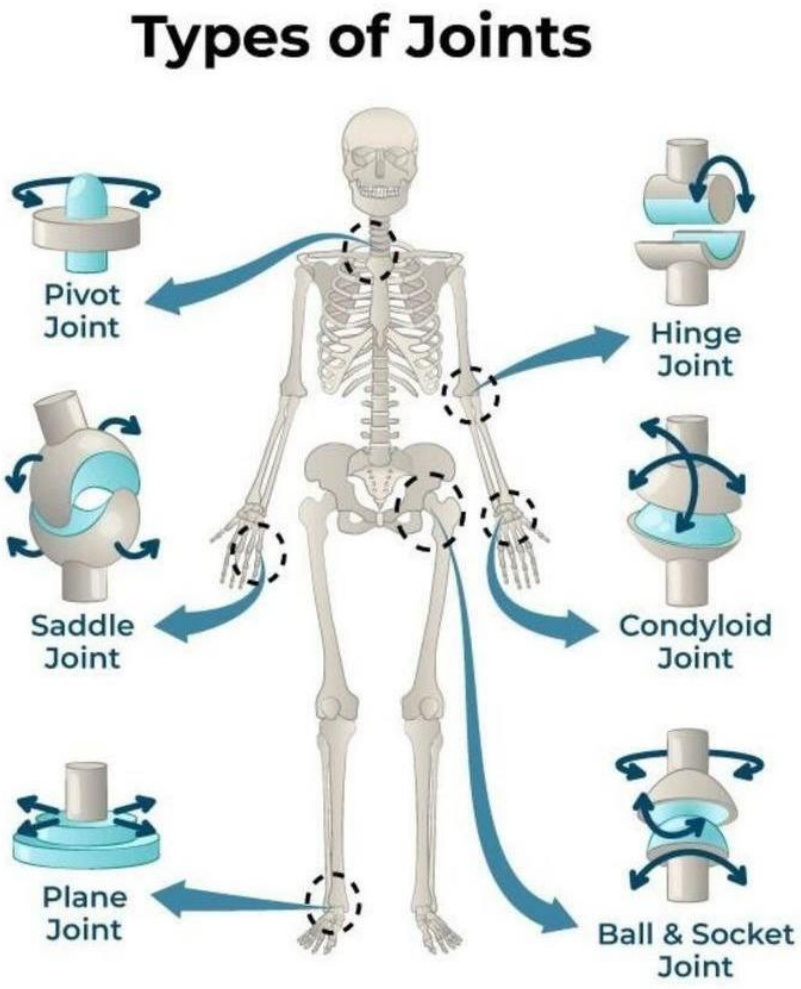


Fig. 4.4: Parts and features of a long bone

Joints

A joint is a junction between two or more bones or cartilages. Some joints are merely bonds of union between different bones and do not allow movement. Joints of the skull belong to this category. Some joints allow slight movement, while some others (like the shoulder joint) allow great freedom of movement.



CLASSIFICATION OF JOINTS

Classification by Movements

Joints essentially are anatomical entities which allow movements to occur. Hence, they can be classified according to the range of mobility

‰ Immobile joint A joint where there is no movement; examples are the sutures of the skull.

‰ Partially mobile joint A joint where there is limited movement; examples are the intervertebral discs

‰Freely mobile joint A joint where there is a wide range of movement examples are the shoulder, hip and knee joints.

Classification by Number of Bones

Joints are, by definition, junctions of two or more bones. They can, therefore, be classified according to the number of articulating bones.

‰Simple joint: A joint where two bones articulate.

‰ Compound joint: A joint where more than two bones articulate within a single capsule; examples are the wrist and elbow.

‰ Complex joint: A joint where the joint cavity is completely or partially divided; examples are the temporomandibular and the knee joints.

Classification by the Intervening Continuity

Joints can also be classified by the continuity of tissue intervening between the bones.

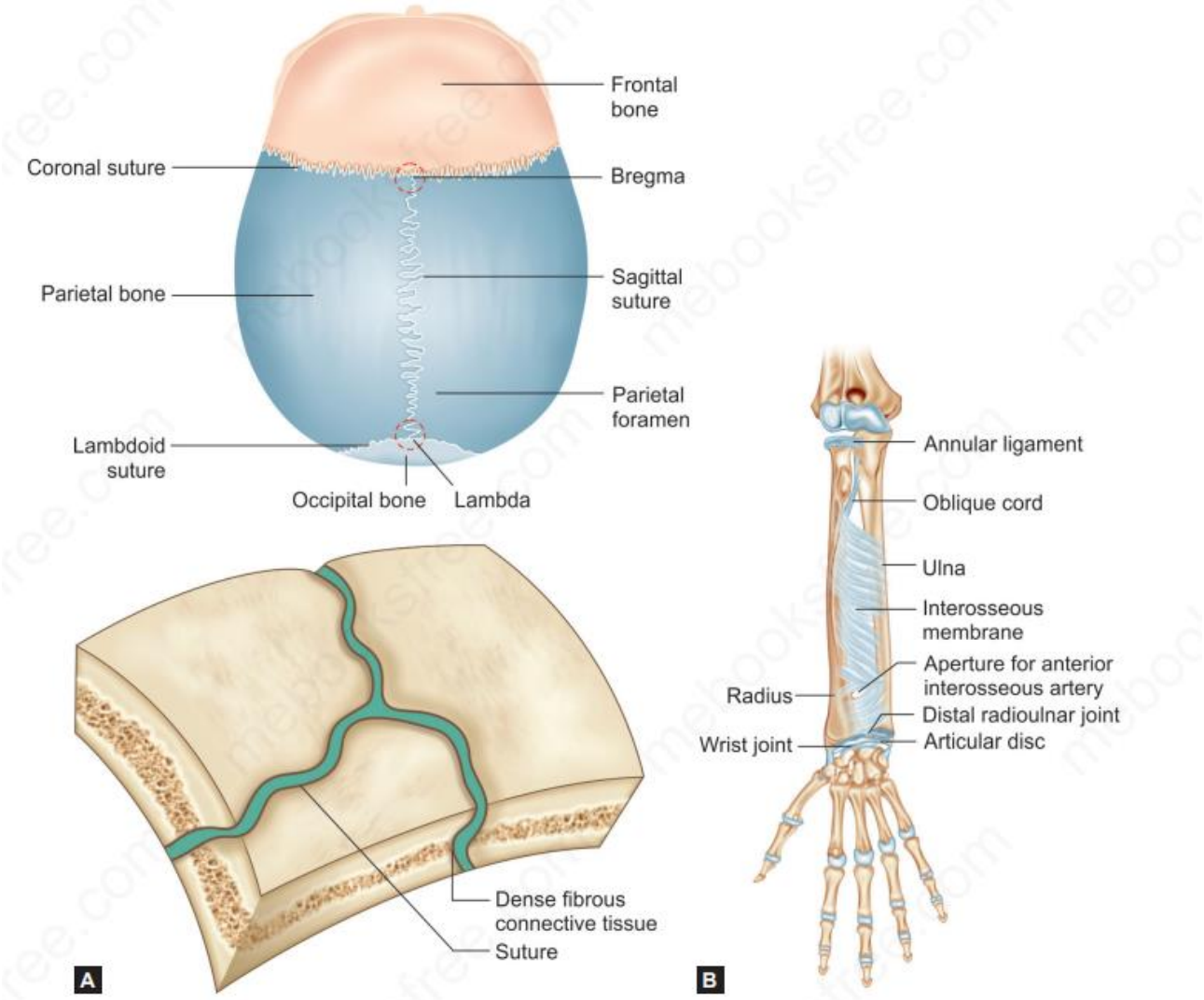
‰Contiguous joint ‰Interrupted joint ‰Transitional joint:

Classification by the Intervening Tissue

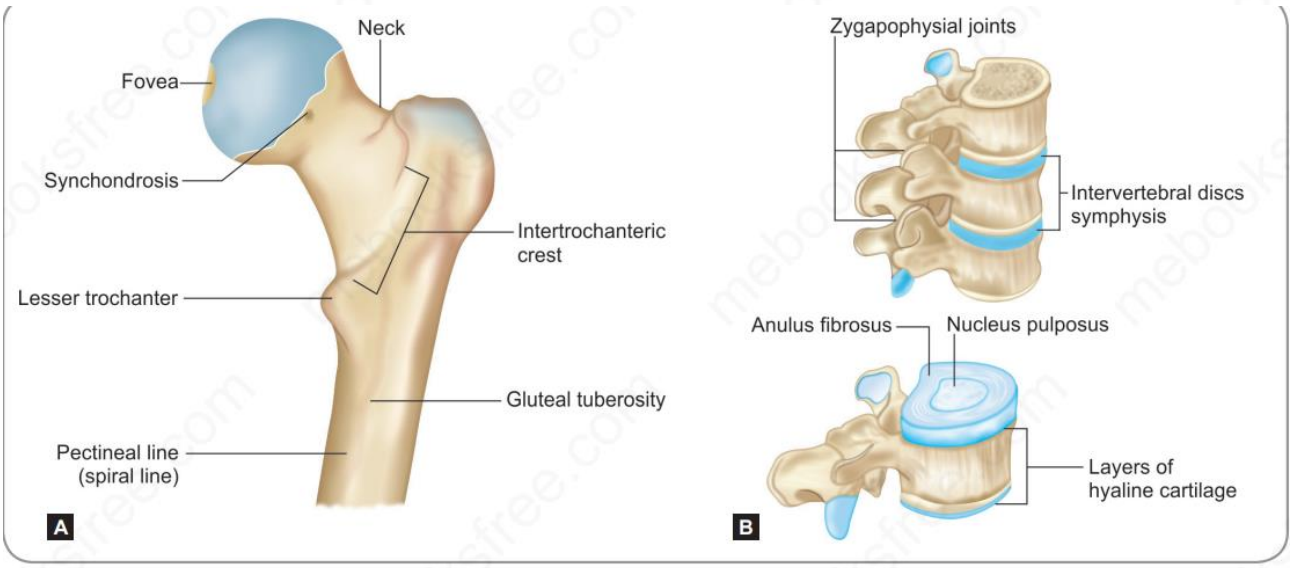
‰Fibrous joint: Where the intervening tissue between bones is fibrous (Fig. 5.1).

‰Cartilaginous joint: Where the intervening tissue is cartilaginous (Fig. 5.2).

‰ Synovial joint: Where a cavity exists between the bones and synovial membrane lines this cavity (Fig. 5.1)



Figs 5.1A and B: Types of fibrous joints **A.** Suture **B.** Syndesmosis



Figs 5.2A and B: Types of cartilaginous joints **A.** Synchondrosis (primary cartilaginous joint) **B.** Symphysis (secondary cartilaginous joint)