GENERAL ANATOMY

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Group-B [7 MARKS]

Metaphysis :

↳ Definition:

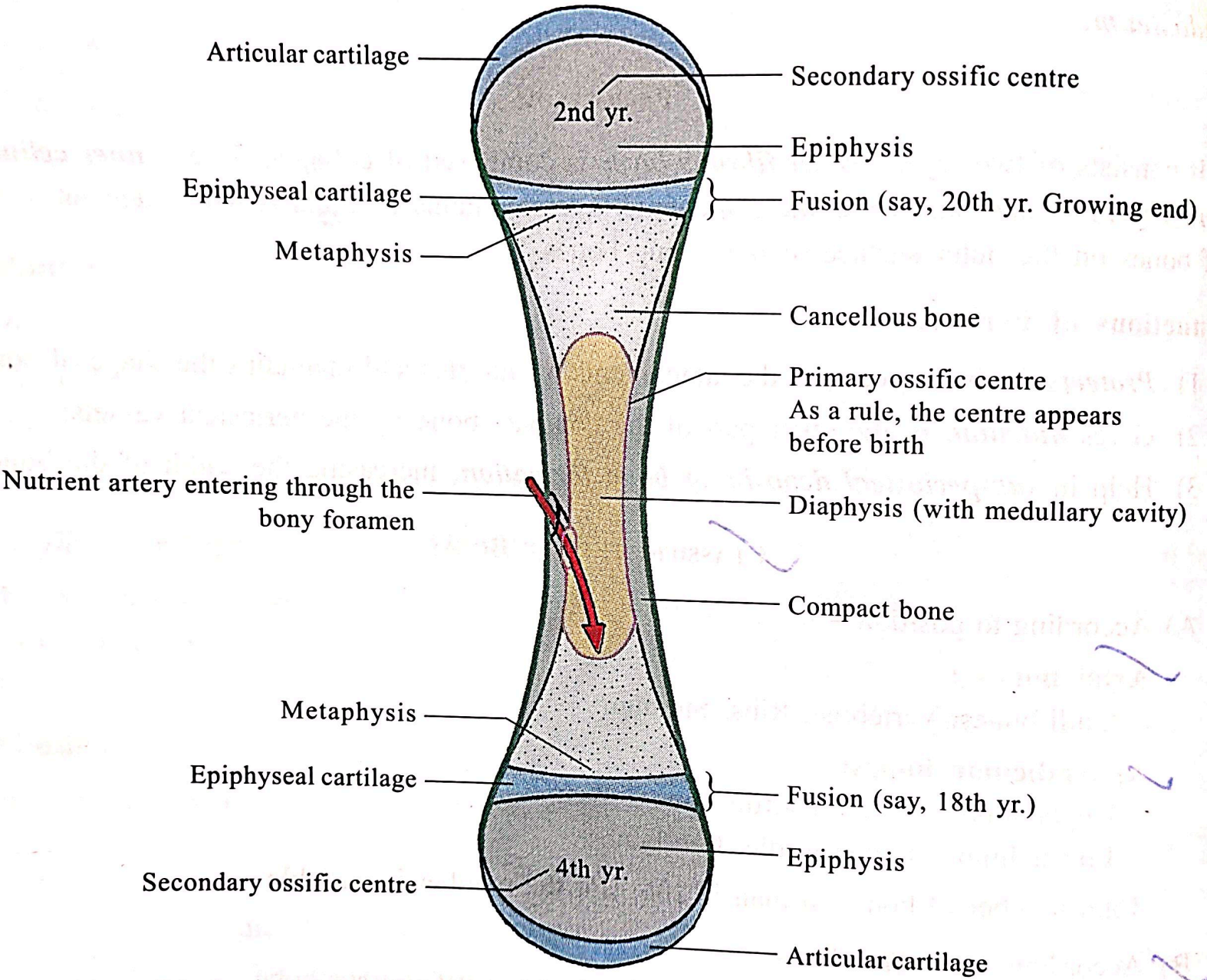
The end of diaphysis facing towards the epiphyseal cartilage is known as the Metaphysis. A bone grows in length at the expense of metaphysis. It mainly consists of cancellous bone.

↳ Importance of Metaphysis : i) It is the most actively growing area of long bone.

ii) Metaphysis has profuse blood supply from nutrient, periosteal and juxta-epiphyseal arteries. Here nutrient arteries form hair-pin like capillary loops. Micro-organisms circulating in the blood may settle in these loops. Hence, infection of a long bone affects primarily the metaphysis.

iii) Muscles, ligaments and joint-capsules are attached close to metaphysis. As a result, this area is likely to be managed by the shearing strain of the muscles. The juxta-epiphyseal strain predisposes to infection.

iv) Sometimes a part of the metaphysis may lie within the capsule of the joint. In such circumtances, the diseases of metaphysis may affect the joint or vice versa.



Note : Diaphysio-epiphyseal fusion at the upper end takes place two years later than that of lower end-hence, called the growing end.

Fig. 6-3 - A typical young and growing long bone.

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Synovial joint : ↳ Structural characteristics of synovial joint:

i) The articular cartilage: The articular cartilage of most joint is hyaline in structure, except in those bones which are ossified in membrane where it is composed of fibro-cartilage.

Hyaline articular cartilage is avascular, non-nervous and elastic. On the convex articular surface (male) the cartilage is thickest in the centre and thinnest at the periphery. On the concave surface (female), however, it is thinnest at the centre and thickest at the periphery. The articular cartilage, once damaged, cannot be replaced by hyaline tissue. Replacement is done by fibrous tissue, hence articular cartilage is indispensable.

ii) Synovial fluid: It is a viscous and gliary fluid, which fills up the joint cavity. The synovial fluid is a dialysate of blood plasma into which hyaluronic acid is added from the synovial membrane. The hyaluronic acid is a high polymer of mucopolysaccharide and is secreted by the synovial cells and probably by the mast cells of synovial membrane. The viscosity of the fluid depends on the concentration of hyaluronic acid. More acid makes the fluid more viscous.

iii) Synovial membrane: It is a highly vascular, and cellular connective tissue membrane, which lines the inner aspects of the fibrous capsule and the bones lying within the capsule, but ceases at the periphery of articular cartilage, articular disc or meniscus.

iv) The articulating bones are connected by a number of ligaments which are additional to fibrous capsule.

v) Sometimes, the joint cavity is divided completely or incompletely by articular disc or meniscus, which is composed of fibro-cartilage.

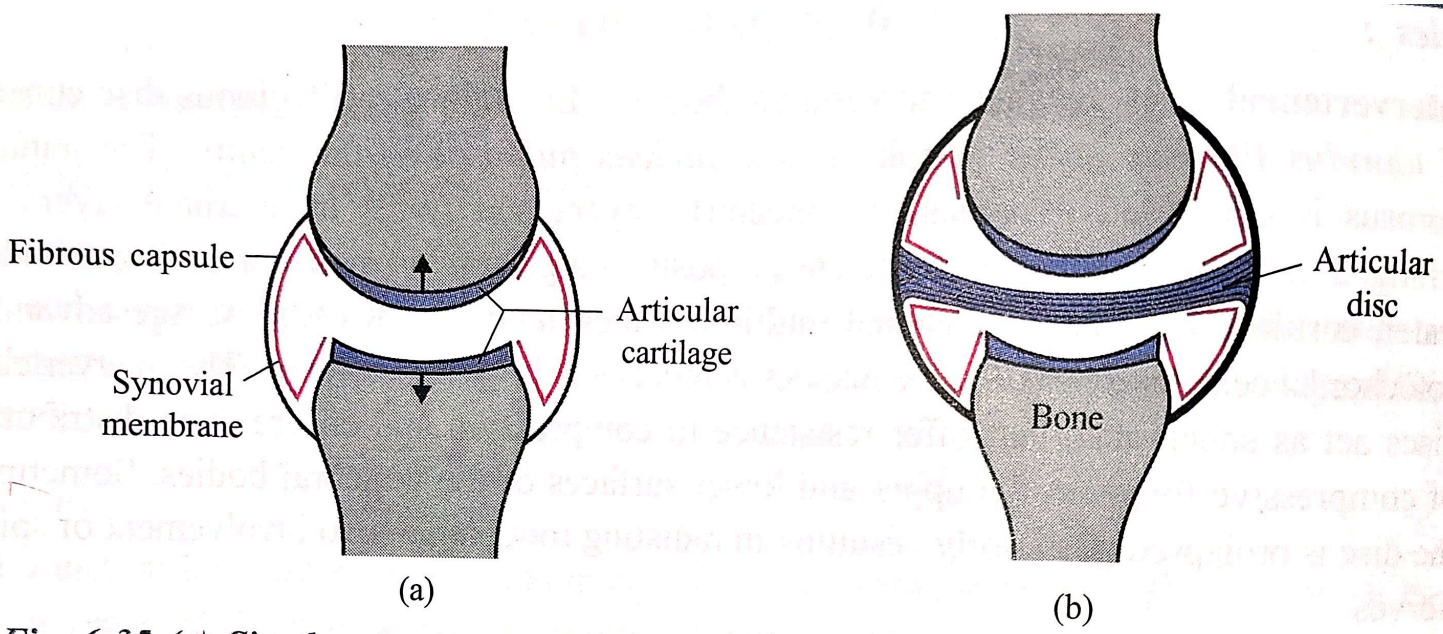

Fig. 6-35 (a) Simple synovial joint ; (b) Synovial joint (completely divided by Articular disc).

Classification of synovial joint :

↳ Synovial joints are classified as follows,—

A) According to the number of articulating bones—

i) Simple : Only two bones enter into articulation.

eg. Interphalangeal joints of the fingers and toes.

ii) Compound : More than two articular bones are involved sharing a common articular capsule.

eg. Ankle and radiocarpal joints.

iii) Complex : Joint is divided into two compartments by a articular disc or meniscus.

eg. knee joint, sternoclavicular joint.

B) According to axis of movements and shape of articular surfaces - the joints may be uniaxial, biaxial, polyaxial and plane.

i) Uniaxial : It has one degree freedom of movement and is subdivided into three types,—

a) Hinge or Ginglymus joint ; eg. Interphalangeal joints of the finger and toes, elbow and ankle joints.

b) Pivot or Trochoid joint ; eg. Atlanto-axial joint, Radio-ulnar joint.

c) condylar joint ; eg. knee joint and temporo-mandibular joint.

ii) Biaxial : These joints have two degree freedom of movements, and present two varieties,—

a) Ellipsoid joint ; eg. Radio-carpal, metacarpo-phalangeal, metatarso-phalangeal and atlanto-occipital joints.

b) Saddle joint ; eg. Carpo-metacarpal joint of thumb. and sterno-clavicular joint.

iii) Polyaxial : They posses three degree freedom of movement and morphologically are known as ball and socket or spheroidal joints.

eg. typical - Shoulder and hip joints ; Talo-calcaneo-navicular jt (Restricted)

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iv) Plane: The articular surfaces are flat and produce gliding movements in various directions.

eg. Inter-carpal and inter-tarsal joints, articulations between articular processes of the vertebrae (facet joints).

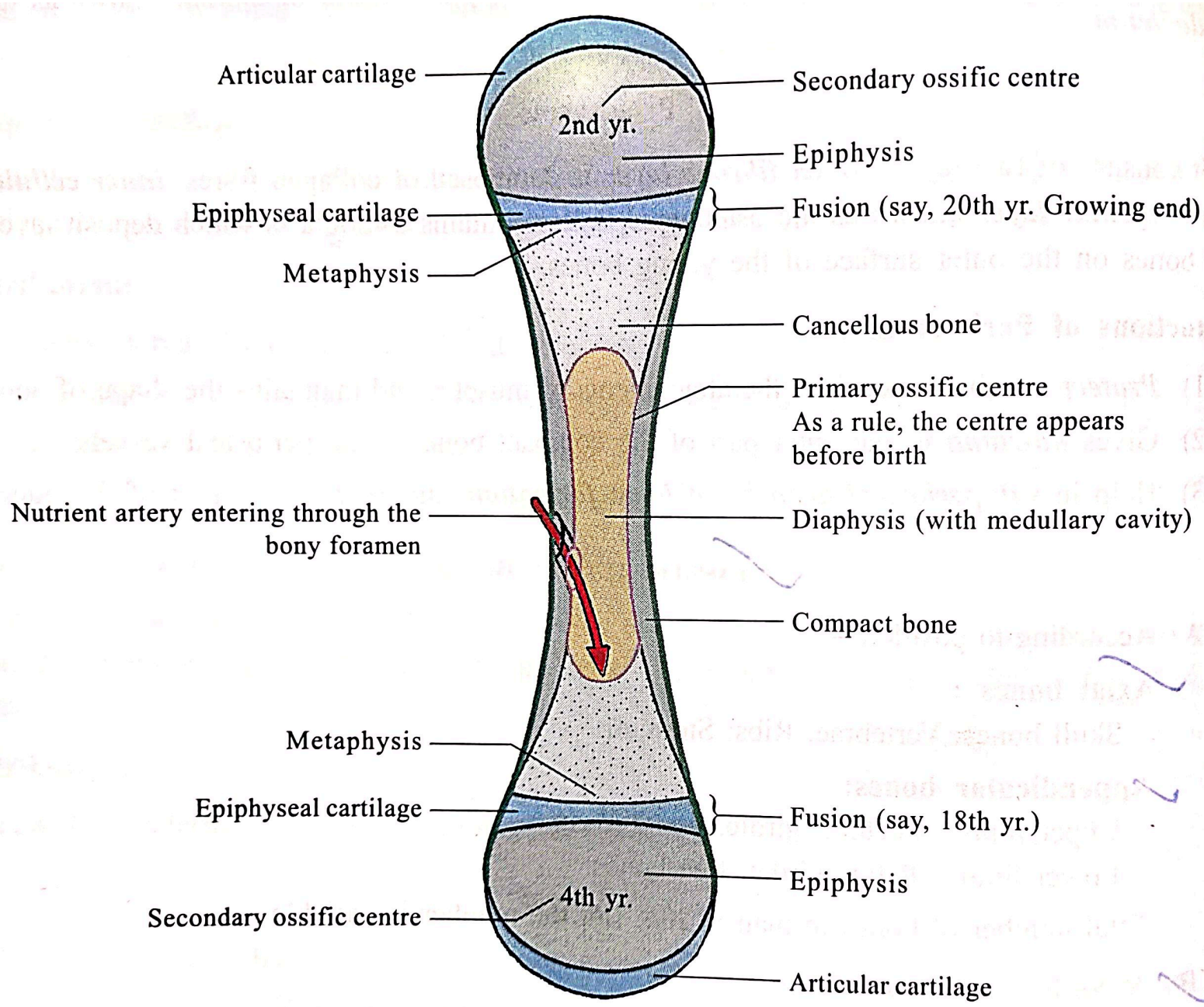
SHORT NOTES. GROUP-C [3 MARKS]

◆ Epiphyseal Cartilage: ↳ Definition: The plate of hyaline cartilage which intervenes between the epiphysis and diaphysis of a growing bone, is called Epiphyseal cartilage.

↳ Charecteristics:

i) As long as bone grows in length, epiphyseal cartilage persists. When the full length is reached (usually after puberty) the epiphyseal cartilage is replaced by bone.

ii) Ossification begins earlier in females than in males and fusion between the epiphysis and diaphysis is completed earlier in females by as much as 2 or 3 years.



Note : Diaphysio-epiphyseal fusion at the upper end takes place two years later than that of lower end-hence, called the growing end.

Fig. 6-3 - A typical young and growing long bone.

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Plasma cells: The cells are numerous in the mucous and submucous coats of the gut and in the greater omentum. Each cell is rounded in shape without any processes and presents granular cytoplasm which is stained with basic dyes. The basophilia is due to intense ribosome granules which are attached to endoplasmic reticulum; the latter are arranged concentrically around the nucleus. The nucleus is eccentric in position and typically presents clumps of chromatins in radiating manner, resembling 'cart-wheel' in appearance.

↳ Functions: a) The plasma cells liberate humoral antibodies to counter act the action of antigens and help in the defence mechanism of the body.

b) The plasma cells are not present at birth, but appear in the postnatal life.

c) These cells are derived from bursa equivalent or bone marrow lymphocytes (B-lymphocytes), particularly when the latter are exposed to antigens. Plasma cells form a small population in bone marrow. Myeloma is malignant proliferation of a particular clone of plasma cells in bone marrow.

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Light-microscopic structure of lymph node:

Each node consists of capsule and gland substance:—

i) Capsule: The fibrous capsule invests the entire node and is separated from the gland substance by a sub-capsular space which receives the terminations of numerous afferent lymph vessels. A number of tuberculae extend into the gland substance from the capsule. The subcapsular space is traversed by coarse reticular fibres to which the reticular cells are attached.

ii) The Gland substance: The gland substance consists of outer cortex and inner medulla. The cortex presents the following:—

ⓐ Numerous tuberculae extend inwards from the capsule and convey the blood vessels. Each tubercula is accompanied by para-tubercular spaces which consist of coarse reticular fibres and are continuous with subcapsular space.

ⓑ The areas between the para tubercular spaces are occupied by fine reticular fibres, the interstices of which are filled with the cells of the primary lymph follicles. Each follicle consists of a germinal centre in the middle containing lymphoblasts and free lymphocytes and plasma cells at the periphery.

In the medulla, the tuberculae divide into numerous septa. The spaces between the septa are occupied by irregular cords of lymphocytes known as medullary cords. Finally the cords reach the hilum of the lymph node from which efferent lymph arises.

The structural framework of a lymph node consists of capsule, tuberculae and reticular fibres. The interstices of reticular fibres are filled with fixed reticular cells and free lymphocytes and plasma cells.

↳ Peculiarities of lymph nodes: ⓐ Presence of fibrous capsule; ⓑ filter lymph ; ⓒ Presence of afferent and efferent lymph vessels.

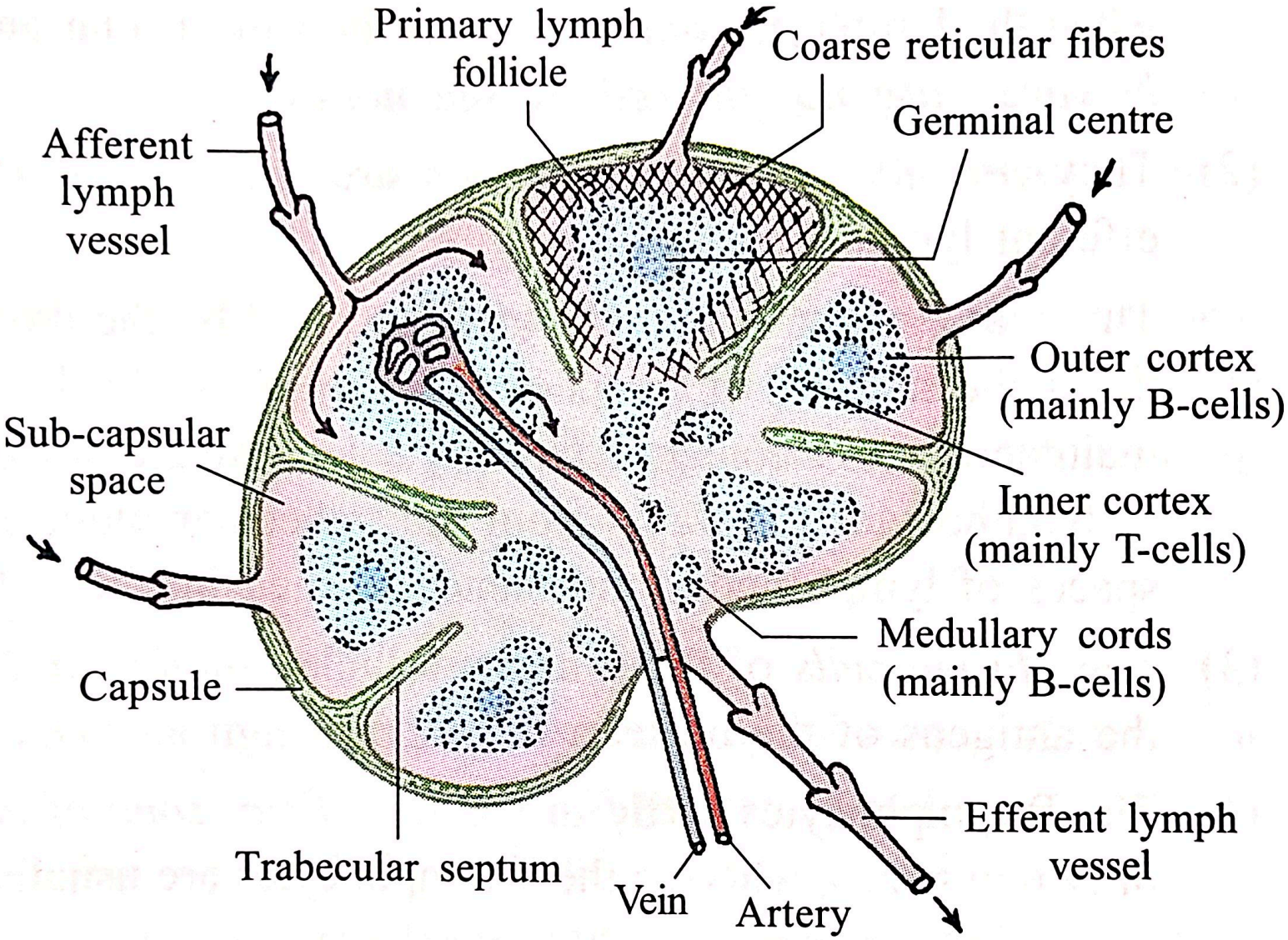

Fig. 10-7 Structure of a lymph node.

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Turner's Syndrome:

↳ Chromosome abnormal: In case of Turner's syndrome, classical karyotype is 45, XO with complete deletion of one X chromosome. Sometimes, XX/XO mosaicism is observed; 46, XX qi with iso-splitting of one X-chromosome is recorded in a few Turner's syndrome patients. Barr body is negative.

↳ Clinical features: The important clinical features of Turner's syndrome are as follows, —

i) The affected individual is female in phenotype, short is stature with webbing of neck, bilateral cubitus valgus, 'sheild' chest and low set ears.

ii) The gonads are represented by streaks of fibrous tissue; the gonadal dysgenesis is associated with primary amenorrhea. Some patients manifests lymphoedema and co-arctation of aorta.

↳ Causes: The primary cause of this syndrome is the non-disjunction in gametogenesis. In 75% of Turner's patient the X-chromosome is maternal in origin. A Turner female may be affected by haemophilia, if her mother is a carrier of haemophilic gene and transmits that gene to her Turner daughter through the X-chromosome.

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Klinefelter's Syndrome:

↳ Chromosomal abnormality: In most cases of klinefelter's syndrome, karyotype shows 47, XXY. On rare occasions, as many as four X chromosomes with a single Y chromosome are observed. XXYY chromosome constitution are on record in a few klinefelter's patients. Barr body is present in phenotypic male.

↳ Clinical features : The important clinical features of klinefelter's syndrome are, —

i) The subject is male presenting small testes, dysgenesis of seminiferous tubules with azoospermia, occasional gynaecomastia and mental retardation. Increased number of X chromosomes makes the individual more mentally retarded.

ii) The subject shows some behavioural defects.

↳ Causes : Such chromosomal abnormalities are due to non-disjunction in gametogenesis. The two X chromosomes are of maternal origin in about 75% of klinefelter's patients. When the sex chromosome number is four or more, the non-disjunctional events have occured during meiosis I and meiosis II.

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Down's Syndrome:

↳ Chromosomal abnormality: In case of Down's Syndrome, the chromosomal abnormality is Trisomy 21; Translocation D/G, Trisomy 21; Translocation 22/21; Trisomy 21; Translocation 21/21.

↳ Clinical features: The important clinical features of Down's syndrome are as follows,—

i) The affected individuals show round face with epicanthic folds (hence also known as Mongolism).

ii) Mental retardation, hypotonia, a single line in the palm (simian line) across the base of four fingers and a long potruding tongue.

iii) They are susceptible to infection and often have congenital heart disease. Children with Down's syndrome are easy to manage and they love music. They usually die young.

iv) They can show unusual salivation.

↳ Causes: i) Majority of Mongal babies have 47 chromosomes with trisomy 21, but about 3% have normal 46 chromosomes with translocation.

ii) Trisomy 21 baby is usually born to an aged mother; increased maternal age predisposes to non-disjunction carrying two 21 chromosomes, instead of one, in gametogenesis.

iii) The banding pattern techniques have revealed that about one-third of cases is of paternal in origin, suggesting also paternal age effect.

iv) When mother carries translocation between two 21 chromosomes, she will have repeated translocated Mongol babies.

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Osteoclasts: ↳ Definition: These cells, that help in resorption of the bones, found in naked contact with bones, erode them and occupy in Howship's lacunae; The cells are provided with brush borders for absorption and the latter are directed towards the bones.

↳ Morphology: i) Each osteoclast is a large cell with multiple nuclei (12-20), posseses eosinophilic cytoplasm and is devoid of any processes. The cytoplasm contains Golgi apparatus and numerous lysosomes which are filled with acid phosphates and other hydrolytic enzymes.

ii) The brush borders are produced by numerous microfilli which about on the bone surface.

iii) Electron micrograph shows that each osteoclast in Howship's lacuna posseses from within outwards ruffled border with microvilli projecting into the lacuna, clear zone which surrounds the ruffled border and seals off bone-cell interface at the periphery by the attachments of actin filaments, contains cytoplasmic vesicles and basal zone containing nuclei, mitochondria and golgi - apparatus.

↳ Functions: i) The osteoclasts remove both the mineral and organic components of the bony matrix. It appears that the primary function of the osteoclasts is on the mineral, since these cells are not found in uncalcified bone.

ii) The osteoclasts secrete collagenase and other enzymes and pump protons to provide a local acid environment in the subcellular sealed pocket between the ruffled border and bone-cell interface. This promotes localized digestion of collagen and dissolves the calcium salt crystals.

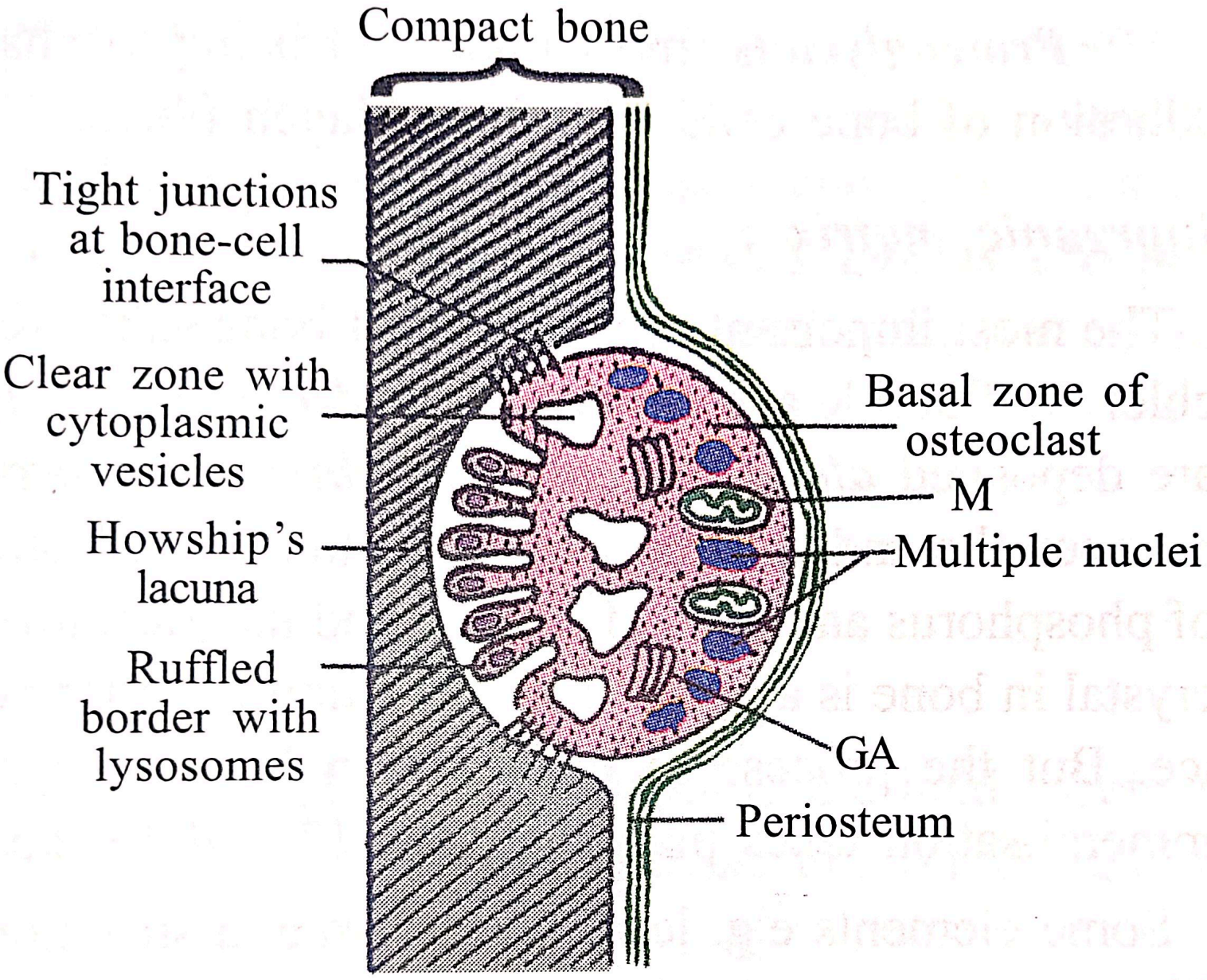

Fig. 6-16 Ultrastructure of osteoclast in Howship's lacuna

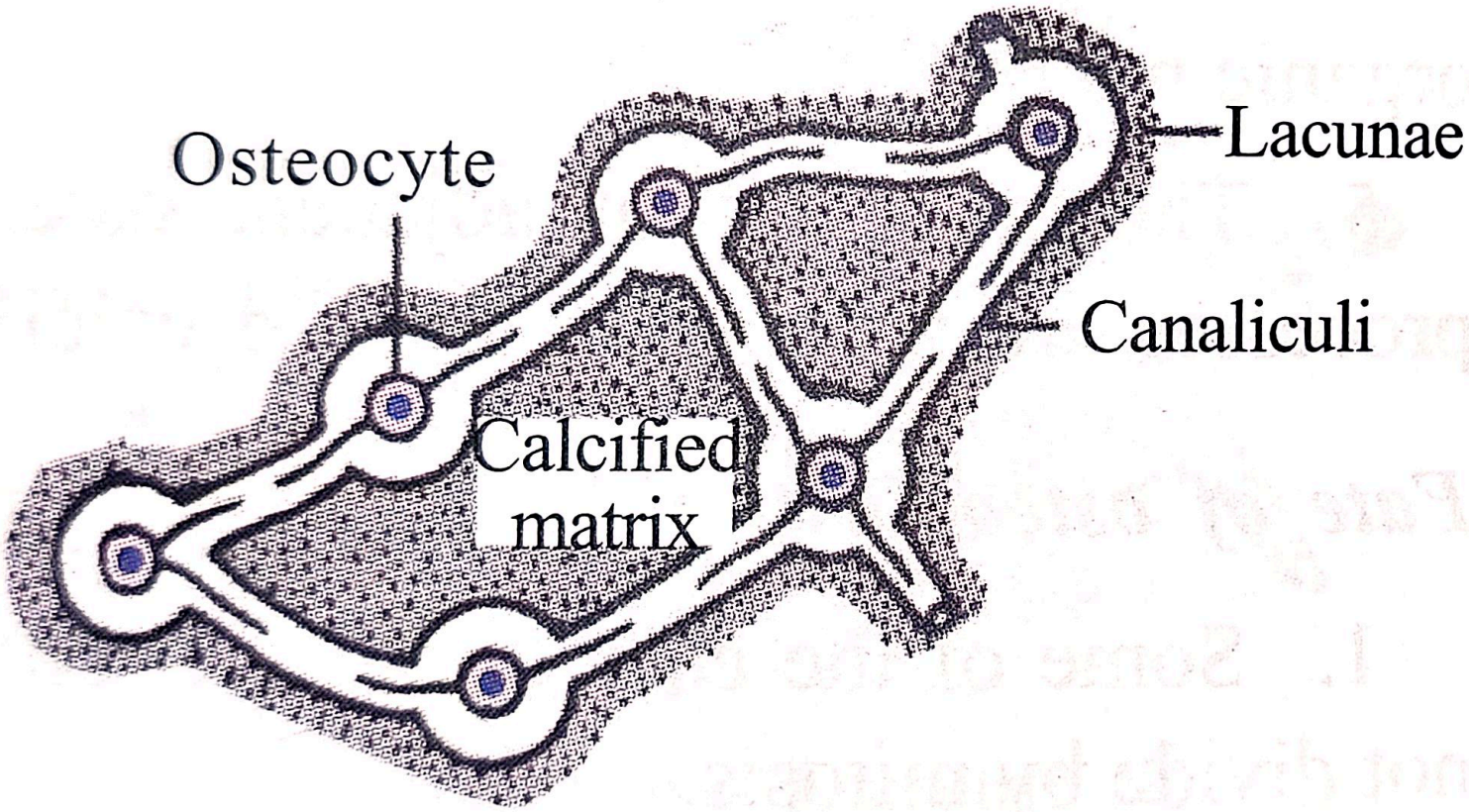

Fig. 6-15 - Osteoblasts and Osteocytes in calcification matrix

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Laws of ossification:

The laws of ossification are as follows,—

i) Primary centre of ossification is single and appears before birth. [exception- carpal bones]

ii) Secondary centres of ossification can be single or more and appear after birth. [exception- lower end of femur]

iii) The centres that appears fast fuses last. [exception- lower end fibula]

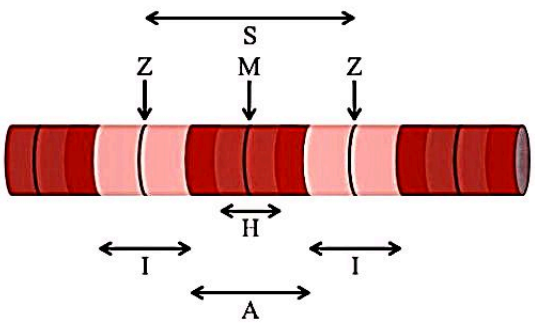
iv) The secondary centres fuse together to form a single epiphysis, which in turn, fuses with diaphysis. [exception- upper end of humerus]

v) The direction of the nutrient artery is opposite to the direction of the growing end of the bone.

Sarcomere definition

A sarcomere is the functional unit of striated muscle. This means it is the most basic unit that makes up our skeletal muscle. Skeletal muscle is the muscle type that initiates all of our voluntary movement. Herein lies the sarcomere's main purpose. Sarcomeres are able to initiate large, sweeping movement by contracting in unison. Their unique structure allows these tiny units to coordinate our muscles' contractions.
In fact, the contractile properties of muscle are a defining characteristic of animals. Animal movement is notably smooth and complex. Dexterous movement requires a change in muscle length as the muscle flexes. This calls for a molecular structure that can shorten along with the shortening muscle. Such requisites are found in the sarcomere.

Upon closer inspection, skeletal muscle tissue gives off a striped appearance, called striation. These "stripes" are given off by a pattern of alternating light and dark bands corresponding to different protein filaments. These stripes are formed by the interlocking fibers that comprise each sarcomere. Tubular fibers called myofibrils are the basic components that form muscle tissue. However, myofibrils themselves are essentially polymers, or repeating units, of sarcomere. Myofibrils are fibrous and long, and made of two types of protein filament that stack on top of each other. Myosin is a thick fiber with a globular head, and actin is a thinner filament that interacts with myosin when we flex.



S= Sarcomere

What Is Karyotyping?

Karyotyping is a laboratory procedure that allows your doctor to examine your set of chromosomes. “Karyotype” also refers to the actual collection of chromosomes being examined. Examining chromosomes through karyotyping allows your doctor to determine whether there are any abnormalities or structural problems within the chromosomes.

Chromosomes are in almost every cell of your body. They contain the genetic material inherited from your parents. They’re composed of DNA and determine the way every human develops

When a cell divides, it needs to pass on a complete set of genetic instructions to each new cell it forms. When a cell isn’t in the process of division, the chromosomes are arranged in a spread out, unorganized way. During division, the chromosomes in these new cells line up in pairs

A karyotype test examines these dividing cells. The pairs of chromosomes are arranged by their size and appearance. This helps your doctor easily determine if any chromosomes are missing or damage

USEFULLNESS :-

1. An unusual number of chromosomes, incorrectly arranged chromosomes , or malformed chromosomes can all be signs of a genetic condition. Genetic conditions vary greatly, but two examples are Down syndrome and Turner syndrome.
2. Karyotyping can be used to detect a variety of genetic disorders. For example, a woman who has premature ovarian failure may have a chromosomal defect that karyotyping can pinpoint. The test is also useful for identifying the Philadelphia chromosome. Having this chromosome can signal chronic myelogenous leukemia (CML).
3. Babies can be karyotype tested before they’re born to diagnose genetic abnormalities that indicate serious birth defects, such as Klinefelter syndrome. In Klinefelter syndrome, a boy is born with an extra X chromosome.