Connective tissue -2

Bone & cartilage

- skeletal tissue is specialized form of connective tissue divided into two types---
- Cartilage ,
- bone.

Cartilage

- **modified connective tissue**
- the cells (**chondrocytes**) are seperated by intercellular material **(matrix**) or ground substance.
- It can endure more stress than loose and dense C.T
- Its capability to regain original shape after deformation (Resilience) is **due to chondroitin sulfate** in the ground substance.
- It has **no blood vessels** or **lymphatics** (bd supply is confined to periphery) , nutrition of cells diffuse through matrix.
- It has **no nerves** thus pain insensitive.

peculiar features

- avascular and non nervous
- receive nutrition by diffusion from nearest capilleries
- If invaded by blood vessels ---mineralisation --- replaced by bone .

structure of cartilage

- **cells**—chondroblasts when active,chondrocyte when quiescent.
- **matrix-**-- composed of –organized fiber mesh work,
- amorphous ground substance with meshwork of **proteins** and **proteoglycan** filaments.
- each cartilage is covered on all sides by an outer membrane **called perichondrium**.
- perichondrium has—outer fibrous layer , inner smmoth layer of spindle shaped fibroblasts.deep to this layer are chondroblasts
- **articular cartilage** has **no perichondrium** so donot regenerate after injury.

Types of cartilage

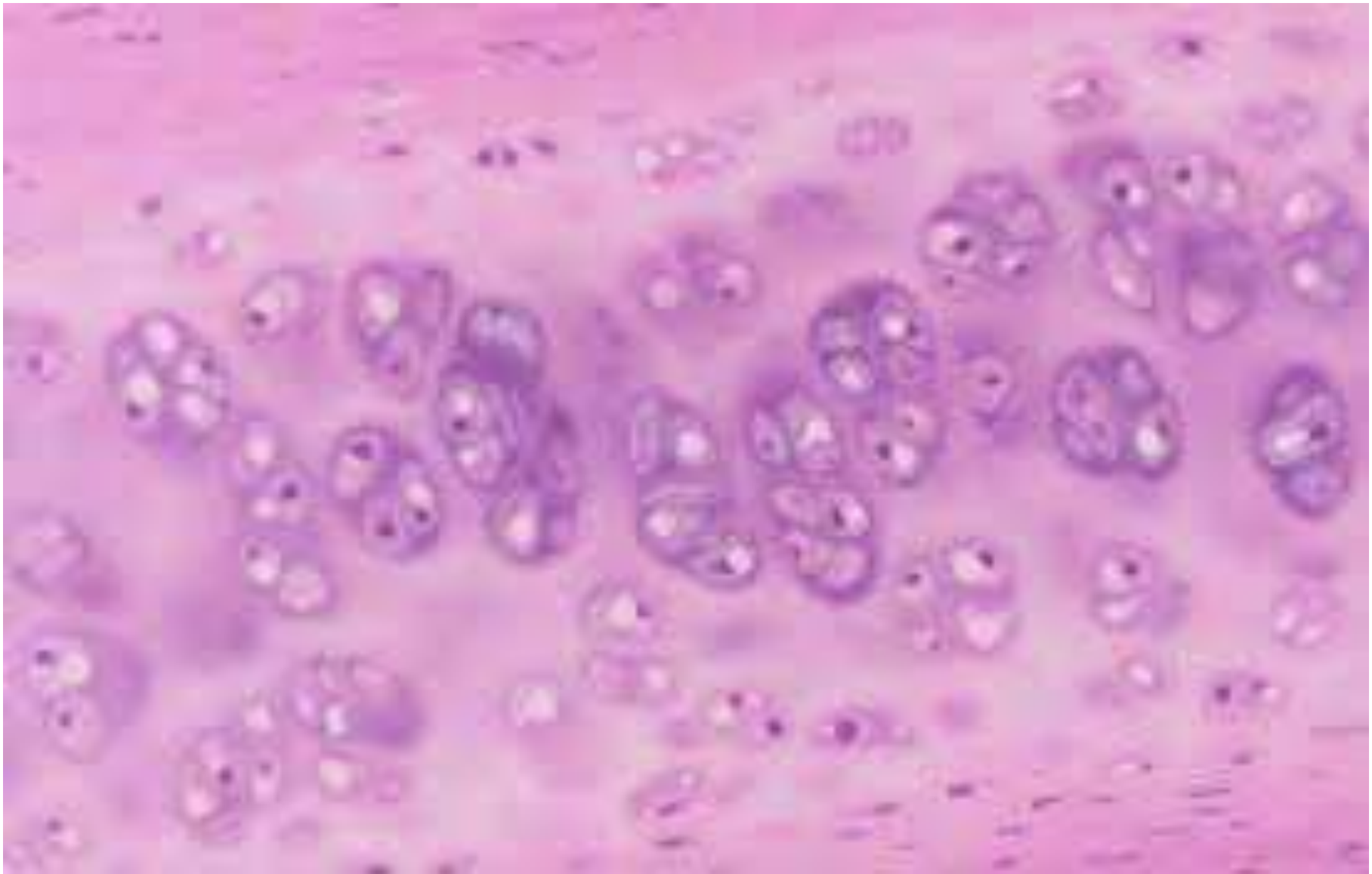
- hyaline
- White fibrocartilage
- elastic

Hyaline cartilage

- most of cartilages of body are hyaline
- ground glass appearance ,consists mostly of **chondroitin sulfate** and few **collagen** fibers.

site---articular cartilage,

- costal and tracheobronchial and laryngeal cartilages**.(except-epiglottis, corniculate,cuneiform and apex of arytenoid** cartilages.)
- **except articular cartilage** all hyaline cartilages are covered by fibrous membrane called perichondrium.



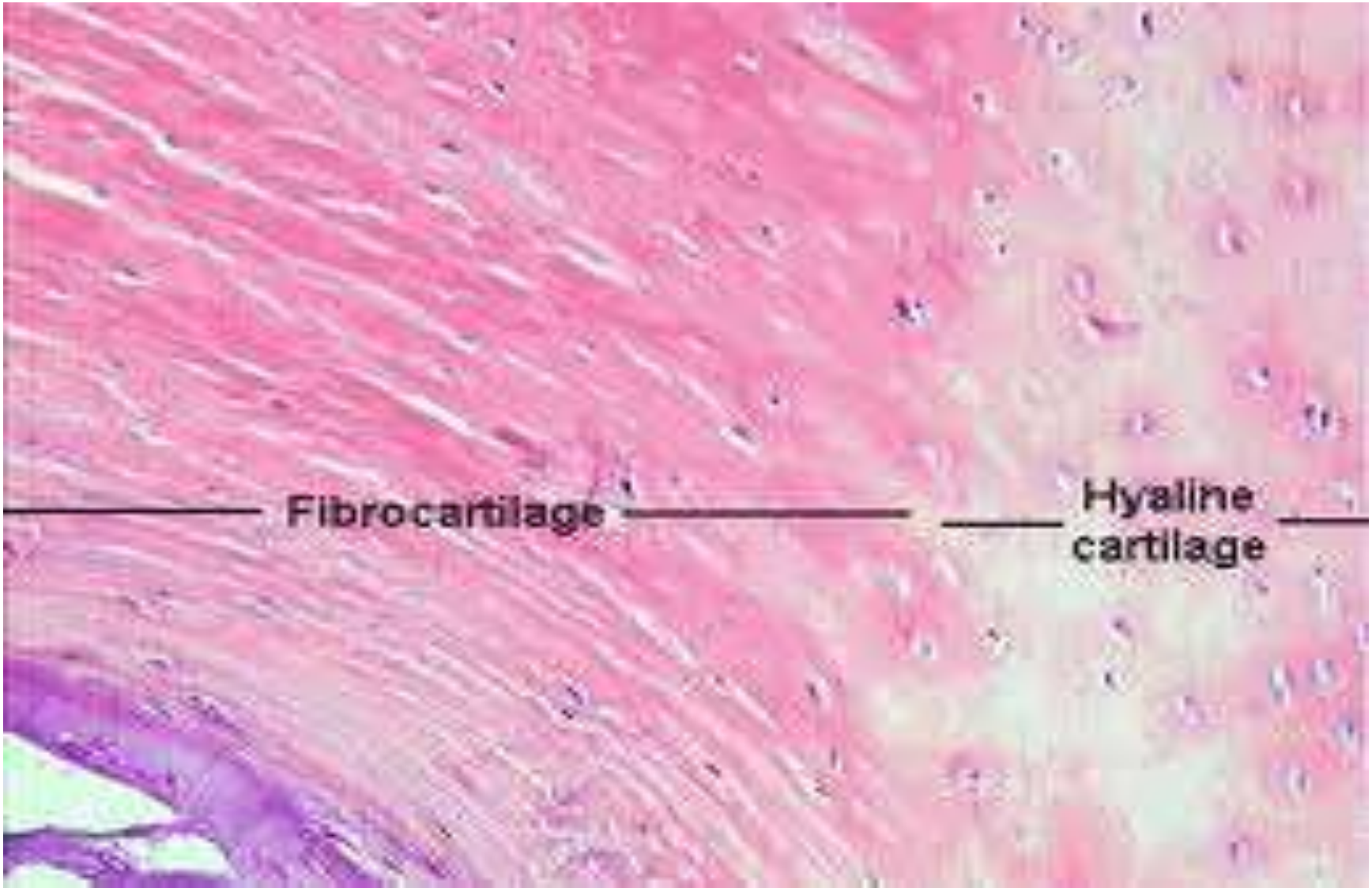
Elastic cartilage

- matrix is traversed by yellow elastic fibers which branch and anastamose in all directions
- sites—
- pinnae of ear, epiglottis
- corniculate cartilage
- cuneiform cartilage
- apex of arytenoid cartilages.


ELASTIC CARTILAGE
ELASTIC FIBERS

Fibrous cartilage

- collagen fibers of matrix predominate arranged in bundles
- ovoid cartilage cells are arranged in rows between the bundles
- site– intervertebral disc
- articular disc of temporomandibular joint
- meniscii of knee joint.


Fibrocartilage
Hyaline cartilage

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1) perichondrium is absent in the following cartilage –
- A) hyaline
- b) articular
- c) elastic
- d) cellular

2) example of elastic cartilage—
- A) epiglottis
- B) trachea
- C) intervertebral disc
- d) thyroid cartilage

3) hyaline cartilage has –

- A) bundles of collagen fibers
- b) cell nests
- C) large no of chondroblasts
- d) bundle of elastic fibers.

4) in calcification of cartilage matrix hardens because of deposition of –

- A) calcium salts
- B) carbohydrates
- C) proteins
- D) chondroblasts

Bone

- highly vascular , living constantly changing , mineralized connective tissue.
- remarkable for its hardness, resilience,regenerative capacity and characterstic growth mechanism.
- has cells (osteocytes) embedded in matrix
- matrix composed of organic materials mainly—collagen fibers, inorganic salts rich in calcium and phosphate.
- fibrous tissue—toughness, and resilience
- salts ----------hardness and rigidity and make them opaque to x rays.
- has blood vessels, lymph vessels and nerves.

- **Functions** of bone—
- protection for vital organs
- supporting framework of body
- serve as levers for muscles
- contain marrow i.e factory for blood cells
- storehouse of calcium and phosphate essential for many functions i.e muscle contraction


Long Bone
Articular cartilage
Epiphysis
Ephiphyseal line
Spongy bone
Medullary cavity
Diaphysis
Nutrient foramen
Endosteum
Periosteum
Articular cartilage
Epiphysis
file from the Wikimedia Commons

Parts of a long bone—

- epiphysis
- epiphyseal cartilage
- Diaphysis, metaphysis
- **Metaphysis-**---portion of diaphysis adjacent to epiphyseal cartilage.
- consist of vascular tissue where growth activities are manifested.

importance of metaphysis---

- Growth activities,
- most vascular part (bd vessels supplying the bone anastamose in this area)
- most of muscles are inserted in this area
- area is liable for injury ..

Epiphysis

- end of long bone that develop from secondary centre of ossification.
- present only in long bones
- becomes continues with rest of bone when epiphyseal cartilage undergo ossification
- four types—
- A) pressure epiphysis
- b) traction
- c) atavistic
- d) aberrent

- A) pressure –
- Transmits body weight, protect epiphyseal cartilage
- e.g.—head of femur
- head of humerus
- condyles of humerus and tibia

B**) traction** ---

produced by pull of muscles

- e.g.—trochanters of femur
- tubercles of humerus

C**) atavistic**—

- Phylogenetically independent bones but with the progress of evolution it has retrogressed and its rements are found to remain fused with adjacent bonese.g **coracoid process of scapula** ,

Posterior tubercle of talus or os trigonum

- Aberrant ---
- i.e not always present,
- normally metacarpal bones have only one epiphysis at the distal end, except first metacarpal which has its epiphysis at the proximal end. Sometimes 1st MC may have an additional epiphysis at distal end called abberent epiphysis.

Classification of bones

Acc. To development/ossification—

- intramembranous ossification—bone directly from mesenchyme e.g **bones of skull, vault, face and clavicle**
- enchondral ossification—mesenchyme—cartilage—bone e.g **all long bones of body**
- membranocartilagenous e.g **temporal bone, occipital bone**

Acc. To position / region---

- axial skeleton—skull,face hyoid, vertebrae. Ribs sternum
- appendicular ---limb bones

Acc. To shape

- long bones—limb bones
- short bones-hand bones
- flat bones—skull, scapula
- irregular bones—vertebrae,girdle bones
- pneumatic bones—skull bones,
- sesamoid bones--

Pneumatic bones

- possess hollow space within their body,
- Present in close proximity to nasal cavities.& directly or indirectly communicate with it.

function---

- make bone lighter,
- helps in resonance of viberation of sound
- act as air conditioning chamber by adding humidity and temperature to the air suitable for purpose of the body
- inflammation of nasal cavity from sinus es .

Sesamoid bones

- small ovoid modules of bones and are named because of resembelence to the seeds.
- they develop in tendon & are **subjected to friction** during movement of joints.
- they act as pulleys for muscle contraction.

E.g—

- patella---in quadriceps femoris,
- pisciform—in flexor carpi ulnaris
- flabella----in lateral head of gastronemius
- two bones beneath head of 1st MT in flexor hallucis brevis
- on cuboid bone—in peroneus longus tendon.

Accessory bones

- accessory /**supranumerary bones** are not regularly present.
- may appear with an **extra center of ossification** and fail to unite with main bone mass.
- can be mistaken for fractures on x ray.
- Common in skull
- **E.g** ---sutural or wormian bones, interparietal bones.

heterotopic bones

- bones are sometimes **formed in soft tissues** where they are not normally present---**e.g** scars
- Horse riders often develop heterotopic bones in their thighs (**Rider's bones**) develop because of haemorragic bloody areas that undergo calcification and eventual ossification.

Ossification of bone

- The process of bone formation is called as ossification. Ossification involves differentiation of osteoblasts which secrete organic intercellular substance and deposition of calcium salts and crystals.

Types of ossification

1. Membranous ossification
2. Cartilagenous ossification

Membranous ossification

- Mesenchymal cell condensation at the site of bone formation.
- Mesenchymal cells differentiate into osteoblasts.
- Osteoblasts secrete organic intercellular substance (matrix). Collagen fibers get embedded in this matrix. This matrix with collagen fibers is called as osteoid.
- Calcium salt deposition starts in osteoid under the influence of alkaline phosphatase secreted by osteoblasts. This is now called a lamellus. A new osteoid is formed by osteoblasts over this lamellus. Few osteoblasts get entrapped between two lamellae and become osteocytes. This process lead to the formation of a number of lamellae one over the other and form trabeculae. There is a marrow space between the trabeculae.
- Examples are the bones of the skull.

Cartilagenous ossification

- Bone formation occurs at the expense of dead cartilage. Most bones ossify in cartilage. At the site of bone formation mesenchymal cells get collected. These cells become chondroblasts and form hyaline cartilage. Mesenchymal cells at the surface form perichondrium. This framework increases in length by interestitial growth and following zones are apparent:

1. Zone of proliferation – epiphyseal plate
2. Zone of maturation of cartilage cells – metaphysis
3. Zone of hypertrophy of cells – diaphysis
4. Zone of calcification of matrix – diaphysis
- Death of cartilage cells

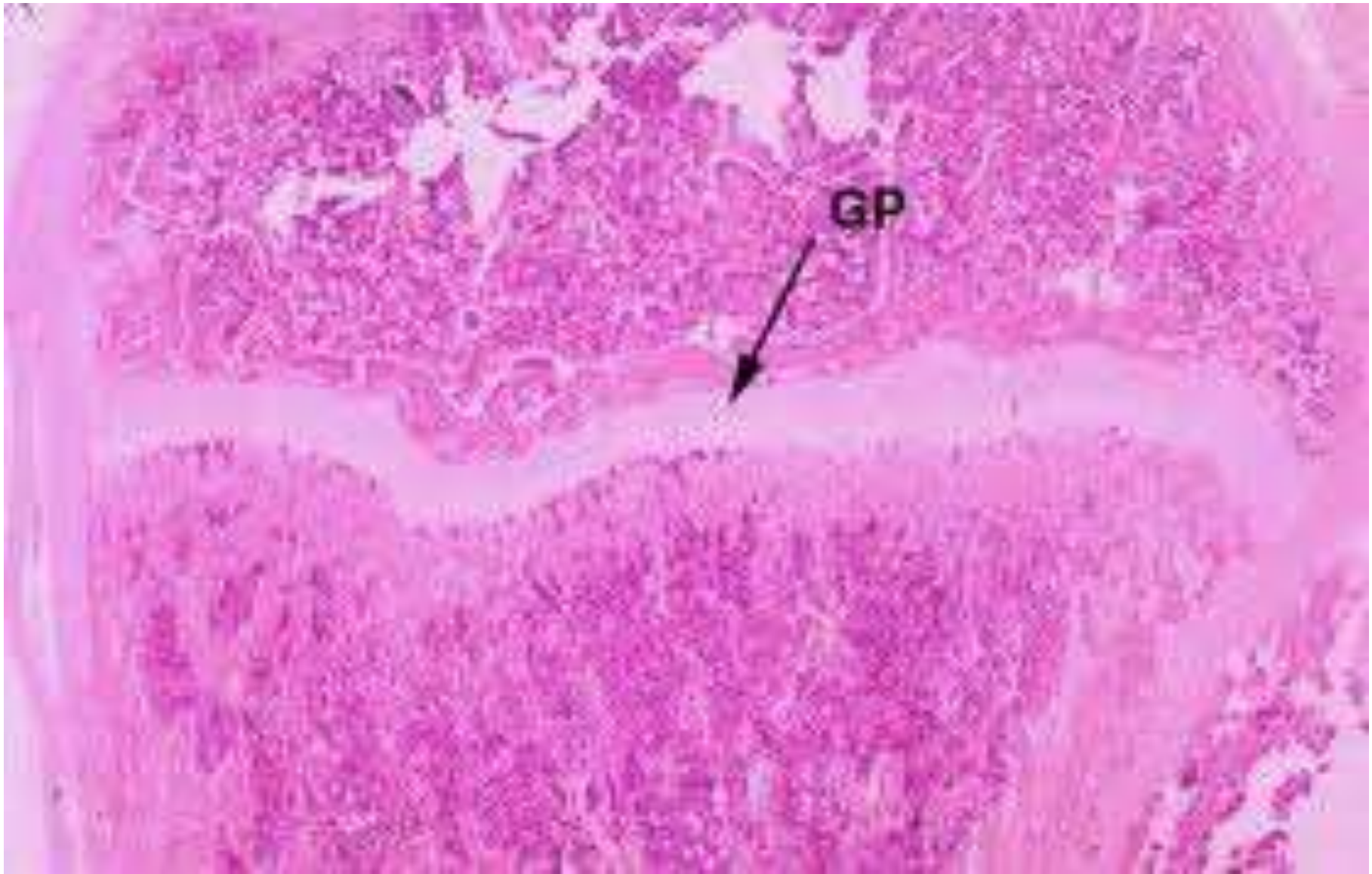
5. Periosteal collar formation
- Periosteal bud formation
- Deposition of bone

Factors affecting bone growth

1. Vitamin A – controls and coordinates the activity of osteoblasts and osteoclasts.
2. Vitamin C – helps in formation of intercellular matrix.
3. Vitamin D- is required for the absorption of calcium and phosphorus from the intestine.
4. Hormones – Hypersecretion of growth hormone leads to gigantism or acromegaly.
   - Parathormone increases resorption of calcium from bones.
   - Calcitonin secreted by parafollicular C cells of the thyroid helps in deposition of calcium in bones
   - Sex hormones lead to early fusion of epiphysis.
5. Mechanical factors – tensile forces help in bone formation while compressive forces lead to bone resoprtion.

Growth of long bone

- Epiphyseal plate of cartilage—
- it seperates epiphysis from metaphysis.
- proliferation of cells in this plate are responsible for lengthwise growth of a long bone
- structure of epiphyseal cartilage is as follows – **zone of resting stage**
- **--zone of proliferating young cartilage cells**, arranged in rows of longitudinal columns
- **zone of mature cartilage**
- **zone of calcified cartilage** (bone formation)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- during growth period a long bone increases in thickness and in length.
- Bone grows in **thickness** by multiplication of cells in periosteum.
- bone grows in **length** by multiplication of cells in epiphyseal cartilage
- growth in length of long bone proceeds more in one direction,called **growing end**.
- shape of bone is maintained by removal of unwanted bone is called **remodeling** .

Applied

- in **rickets** the cartilage cells of epiphyseal plate do not die and plate becomes thick and irregular . Due to weight –bearing rachitic children may be bow-legged.
- **osteoporosis**-during old age both organic and inorganic components of bone decrease, producing osteoporosis,a reduction in quantity of bone.thus bone becomes brittle,lose elasticity and fracture easily.

- Hyposecretion of alfa cells of pituatory—**Dwarfism**,
- hypersecretion of alfa cells of pituatory—**gigantism**
- **Osteitis** fibrosa—calcium is removed from bones by stimulating osteoclastic resorption ,due to hypersecretion of parathyroid gland.
- fracture means break in continuity of bone.,for healing—the two broken ends are brought close together approx. to their normal position called **reduction of a fracture**.
- greenstick fractures more common in children than in adults, incomplete breaks by bending of bones

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- 1) vertebrae are classified as—
- A) short bone
- b) irregular bone
- c) flat bone
- d) sesamoid bone
- 2) following bone develops in a tendon—
- A) pisciform
- b)scaphoid
- C)cuboid
- d)triquetral

- 3) coracoid process of scapula is an example of—
- A)pressure
- B)traction
- C)atavistic
- D)aberrant
- 4)following cells do the functins of resorption of bone—
- A)osteoblast
- B)osteoclast
- C)osteocyte
- D) osteogenic

- syphilis is common in---
- A) long bone
- B) short long bone
- C) irregular bone
- D) pneumatic bone.