

TOPIC IX: SKELETAL SYSTEM

Learning Outcomes: Upon completion of Topic IX (9), you should be able to

- a) Describe the main functions of the skeletal system.
- b) Compare and contrast intramembranous and endochondral ossification in bone formation.
- c) Compare and contrast endochondral and appositional growth.
- d) Describe the factors affecting bone remodeling and growth (e.g. mechanical stress, nutrition, hormones).
- e) Describe the factors that contribute to the development of osteoporosis.
- f) Briefly describe the process of bone repair after a fracture.

A) Skeletal System Overview:

Functions:

- 1) support
- 2) protection of vital organs
- 3) attaches muscles + allows movement
- 4) red marrow produces rbc, wbc
- 5) stores Ca^{++}

B) Bone Ossification:

- before week 8, skeleton of embryo constructed of fibrous membranes + hyaline cartilage
- bone formation begins at ~8th week → 20 years
- types:
 - 1) Intramembranous ossification
 - flat bones e.g. some skull bones, mandible, clavicle
 - develop from fibrous CT membrane
 - process:
 - osteoblasts produce spongy bone along CT fibres
 - periosteum forms and then osteoblasts under it lay down compact bone
 - fontanel = unossified membranes in the skull that remain at birth
 - 2) Endochondral ossification (most bones)
 - hyaline cartilage used as a “model” (similar shape) for bone construction – then ossifies to form spongy bone
 - periosteum forms and the osteoblasts beneath lay down compact bone
 - articular cartilage + epiphyseal plates = cartilage that has not ossified

C) Bone Growth (postnatal):

1) Growth in length

- = endochondral growth - at epiphyseal plates
- process:
 - cartilage grows → matrix near diaphysis becomes bone
 - growth in length stops when epiphyseal plate ossifies into epiphyseal line (closure)

2. Growth in diameter

- = appositional growth
- process:
 - osteoblasts beneath periosteum secrete bone matrix (external bone surface)
 - osteoclasts resorb bone on the endosteal surface ∴ size of cavity keeps pace with growing bone

3) Factors Affecting Bone Growth/Remodelling

a) Mechanical Stress

- typically due to muscle action
- examples:
 - i) moderate exercise → ↑ osteoblast activity in areas of stress (more building than breakdown)
 - ii) injury that restricts movement → ↓ osteoblast activity + no change in osteoclast activity → ↓ bone mass
 - iii) weights or electric currents - may speed healing by ↑ osteoblast activity

b) Nutrition

- Ca^{++} , PO_4^- - required for production of bone matrix
- vitamin C - required for collagen production
- vitamin D - ↑ absorption of Ca^{++} from intestine
 - if lacking vitamin D → rickets (soft bones) in children

c) Hormones

- growth hormone, thyroid hormone → stim. bone growth
- estrogen (E) + testosterone
 - ↑ osteoblast activity
 - E (both sexes) - ossification of epiphyseal plate (to line)
- calcitonin
 - inhibits osteoclast activity
 - ↑ Ca^{++} movement from blood ⇒ bone; promotes bone growth

- parathyroid hormone (PTH)

- \uparrow osteoclast activity + \downarrow osteoblast activity $\therefore \uparrow$ blood Ca^{++}

D) Osteoporosis:

- \downarrow in bone mass

- risk factors:

- 1) increasing age - ♀ + ♂ (\downarrow sex hormones)
- 2) post-menopause \downarrow E
- 3) inadequate diet (\downarrow vit D, Ca^{++})
- 4) illness, excess PTH
- 5) too little/excessive exercise (stress – cortisol)
- 6) drugs e.g. cortisone, alcohol - \downarrow osteoblast activity
- smoking \downarrow E

E) Bone Repair:

- process:

- 1) begins with formation of a blood clot
- 2) clot replaced by a callus - consists of fibrous network + fibrocartilage islets
- 3) callus ossifies \rightarrow intramembranous + endochondral ossification
- 4) takes 4 - 6 weeks \rightarrow cast required since movement can re-fracture new matrix