

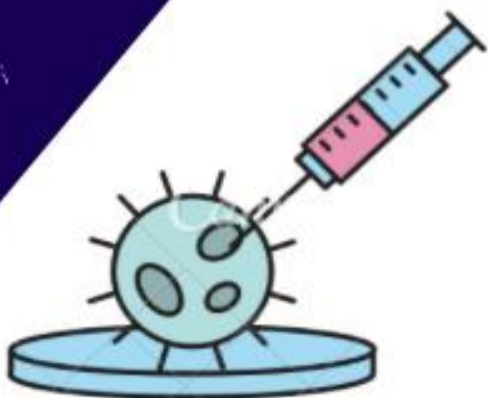


جامعة
الملك سعود
King Saud University



Fracture and Healing, Congenital & Development of bone disease

Editing File



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Index:
Important
NOTES
Extra Information

● Objectives:

- Know the different types of fractures
- Be aware of the mechanism and stages of fracture healing process
- Know the factors affecting healing process and possible complications of healing process
- Understands the difference between trauma induced and pathological fracture.
- Appreciate the importance of road traffic accidents as a major cause of disability in Saudi Arabia.

- Be aware of some important congenital and developmental bone diseases and their principal pathological features.
- Be familiar with the terminology used in some important developmental and congenital disorders
- Understand the etiology, pathogenesis and clinical features of osteoporosis

Recommendation & notes:

- Watch all the videos in this file, it's very helpful.
- Our resources: [alrikabi's lectures](#), [girls slides](#), Robbin's, [Team434](#), [Team438](#), [Team437](#) & [videos](#).
- Recommended to read Robbin's (ch21 - pages 797~805).

● [*Click for Rikabi's notes Congenital, developmental & metabolic bone disease*](#)

● [*Click for Rikabi's notes Fractures & Healing*](#)

Introduction to Bones

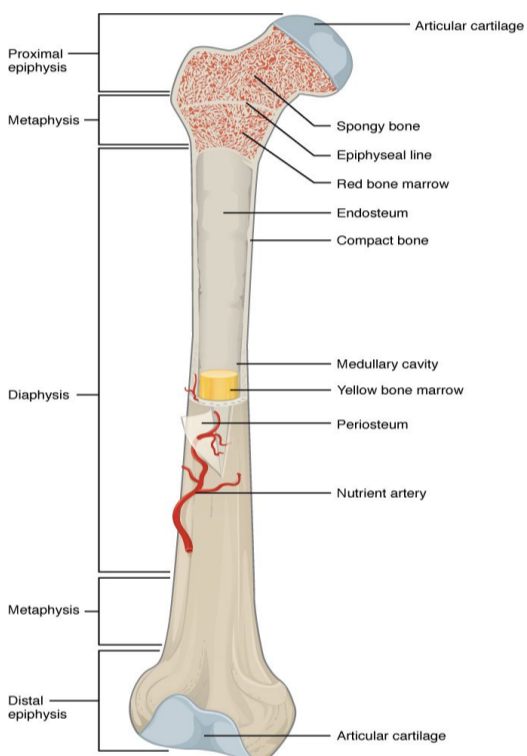
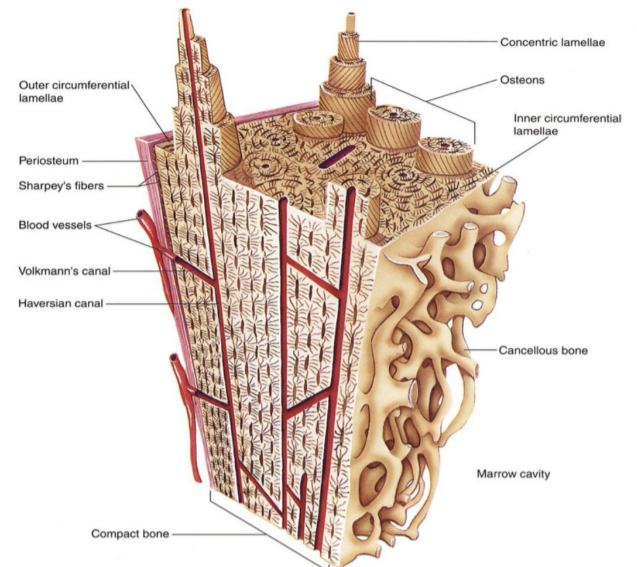


Introduction to Bone Biology

The skeletal system is composed of 206 bones. Each Bone is composed of an Organic Matrix (35%) and Inorganic Elements (65%).

Normal histology

Bone is composed of a specialized collagen-containing extracellular matrix (**osteoid**) synthesized by osteoblasts, which is mineralized by calcium-containing salts (hydroxyapatite)



Parts of a long bones

epiphysis (ends of bone, partially covered by articular cartilage)

physis (growth plate)

Metaphysis (junction of diaphysis and epiphysis)

diaphysis (shaft)

Cross section

Periosteum

Cortex (composed of cortical bone or compact bone)

Medullary space (composed of cancellous or spongy bone)



Normal anatomy

Lamellar bone

Osteoblast deposit the osteoid collagen in :

- 1- striated Parallel pattern.
- 2-layered bone surrounded by concentric collagen .
- 3- mechanically strong.
- 4- lesser tendency to fracture under stress.
- 5- takes more time to form

There are two main patterns of bone deposition:

Woven bone


Osteoblast deposit the osteoid collagen in :

- 1- Haphazard pattern
- 2- random arrangement of osteoid collagen fibers.
- 3- far less efficient and much weaker than lamella .
- 4- greater tendency to fracture under stress.
- 5- formed quickly

Osteoids


is the unmineralized, organic portion of the bone matrix that forms prior to the maturation of bone tissue. Osteoblasts begin the process of forming bone tissue by secreting the osteoid.

Osteoid : osteoblast got surrounded by calcium salts

Bone remodeling (or bone metabolism): 

is a lifelong process where previous formed bone tissue is removed from the skeleton, and new bone tissue is formed.

Bone cells: 

Osteoblasts:	Osteoclasts: (Regulation of <i>Osteoclast Activity</i> →) 
Arise from (marrow mesenchymal) osteogenic cell	Blood monocyte
when active, are plump and present on bone surface; eventually are encased within the collagen they produce.	large multinucleated cells found attached to the bone surface at sites of active resorption
Ossification (new bone formation): "Bone forming cell".	Bone resorption: is resorption of bone tissue, the process by which <i>osteoclasts</i> break down the tissue in bones.
Remodeling : bone are removed by osteoclasts and replaced by new bone matrix produced by osteoblasts	

Important factors that regulate Bone Remodeling:

1. **RANK (Receptor activator for nuclear factor-κB):**
(a member of the tumor necrosis factor (TNF)receptor family) is expressed on the cell membrane of *pre-osteoclasts* and *mature osteoclasts*.

2. **RANK Ligand (RANKL):**
is expressed by *osteoblasts* and marrow stromal cells.

3. **Osteoprotegerin (OPG).**

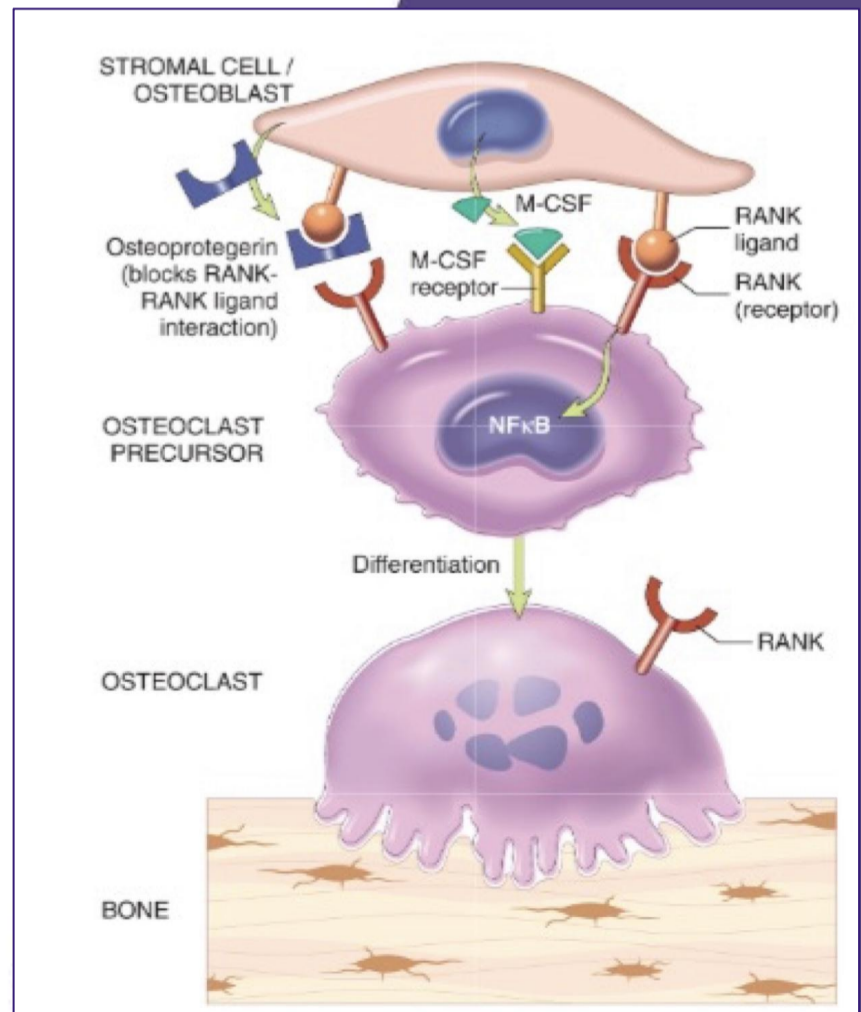
RANK ligand binds to RANK→ activation of the transcription factor NF-κB→ expression of genes → stimulate osteoclast formation, fusion, differentiation, function, and survival.

❖ **The actions of RANKL** can be **blocked** by **Osteoprotegerin (OPG)**, which is a receptor produced by a number of tissues including bone, hematopoietic marrow, and immune cells.

-What happens when OPG blocks RANK? *There will be less osteoclast activity.*

❖ **OPG** competitively **inhibits RANK ligand**. **OPG** production is regulated by signals similar to those that stimulate RANK ligand. (**hormones, cytokines, growth factors**) to influence the homeostasis of bone tissue and bone mass.

❖ **OPG, RANK, RANKL pathway:** 



Fracture and Healing



Click here for an educational assisting video

Classification of fractures

Fracture

Break in the continuity of bone (broken bone)



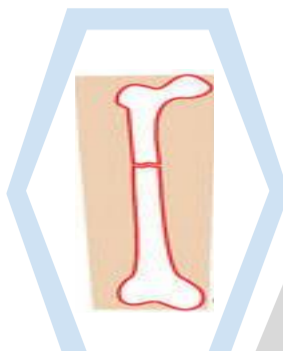
Clinical symptoms:

- Swelling
- Severe pain
- Loss of movement and function

*these symptoms do not necessarily indicate a fracture though.

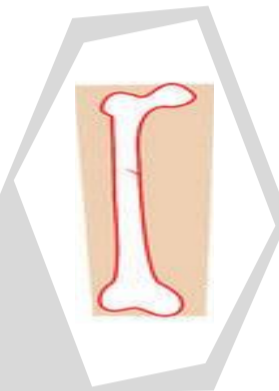
complete

- The bone is broken into two separate pieces



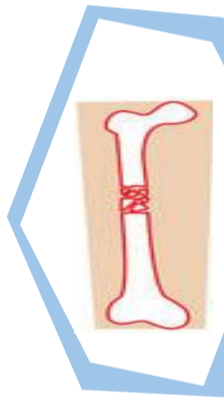
incomplete

- The bone is partly broken and still one piece



comminuted

- The bone is broken into more than two fragments
- Also called fragmented fracture



classification of fractures

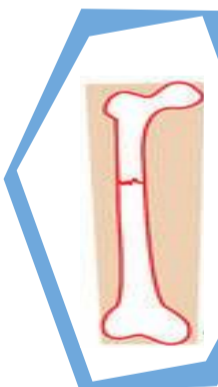
displaced

- The two ends of the bone are not lined up straight
- Could rupture the skin and then become a compound fracture



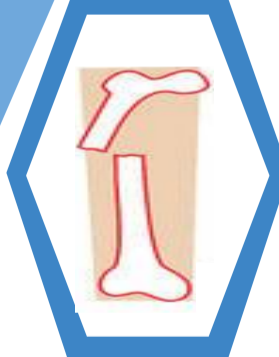
simple (closed)

- The overlying Tissue is intact
- **Doesn't** communicate with external environment



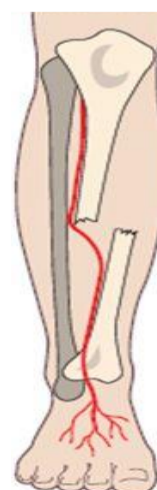
compound (open)

- Extends into the overlying skin
- Communicate with external environment
- **Prone to infection**
- "open to air"



Complicated fracture

Associated with damage to nerves, vessels or internal organs



there are many other types of fractures such as: avulsion fracture and compression fracture

pathological fracture

e.g. osteogenesis imperfecta; multiple fractures in infants

Incomplete fractures

01

Greenstick

Happens when a force applied to the long bones results in bending and breaking of the bone

Only occurs in **children** and youngs due to soft bones



02

hairline

AKA "Stress fracture"
Very small break Caused by repeated stress over time or minor injury
More common in athletes
It's usually linear



Greenstick fracture will heal very well because children have many osteoprogenitor cells

*Colles fracture

- Fracture of the distal end of radius
- The distal fracture fragment is displaced **dorsally**
- Usually occurs in patients more than 50 years
- The deformity like "dinner fork" shape

VS

Smith fracture

- Fracture of the distal end of radius
- The distal fracture fragment is displaced **ventrally**
- Also called "reverse Colles fracture"
- Less common than Colles fracture

Colles fracture occurs as a result of a fall on outstretched hand



Colles and smith fractures are types of fractures named by the first person who describe them

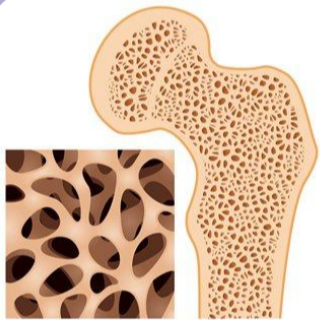


Causes of fractures

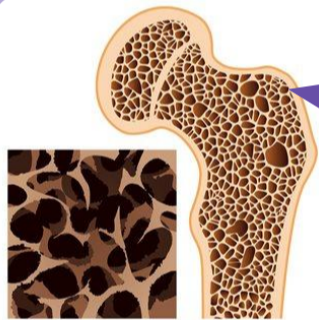


01 Traumatic fracture

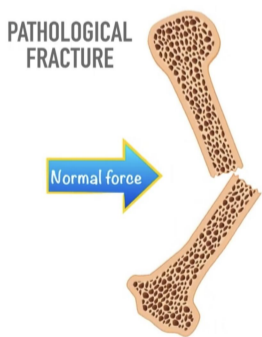
- Severe trauma e.g (MVA) (Motor Vehicle Accident)
- Trauma due to MVA is **major cause** of bone fracture



Healthy bone



Osteoporosis



02 Pathological fracture

- fracture occur with **minimal trauma** (because it's weak, any normal force will cause a fracture)
- caused by a disease affecting the structure of the bone

Examples:

- Osteoporosis; reduction in bone volume (هشاشة العظام)
- Osteosarcoma
- Osteomalacia (تلين العظام)
- Paget's disease of bone (chronic disease of the skeleton)
- Primary or Metastatic tumor
- Congenital bone disorders e.g osteogenesis imperfecta (abnormality in collagen I)

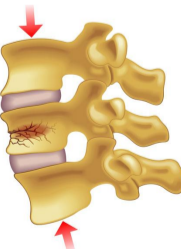
03 Stress fracture

- **Develops slowly** over time as a collection of microfractures.
- Associated with **increased physical activity**, especially with new repetitive mechanical loads on bone.
- Stress fractures are most common in the **weight-bearing bones** of the lower leg and foot .
- **Who is susceptible to stress fractures?** Track & field athletes and military recruits who carry heavy packs over long distance. **It's usually linear.**

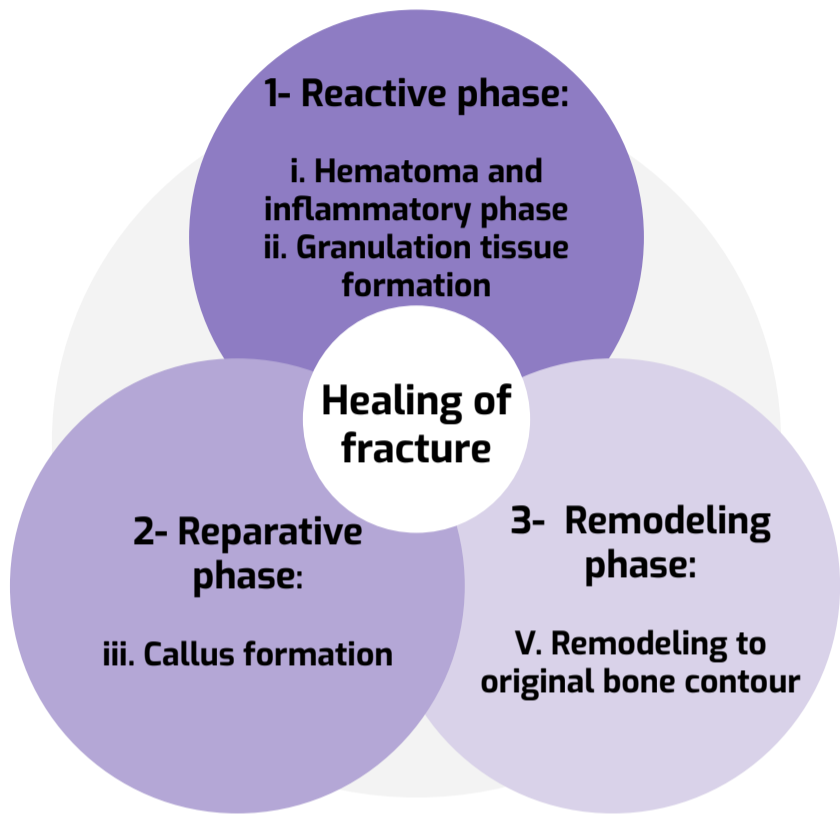
Avulsion fracture occurs when the tendon moved and pulls a piece of bone with it. this needs a severe trauma to happen (rare fracture)



Compression fracture usually occurs in vertebral column in patients with severe osteoporosis and more common in women



- How does a fracture heal?



1- Reactive phase

01

Bleeding from the fractured bone and surrounding tissue causes the fractured area to swell due to inflammation.

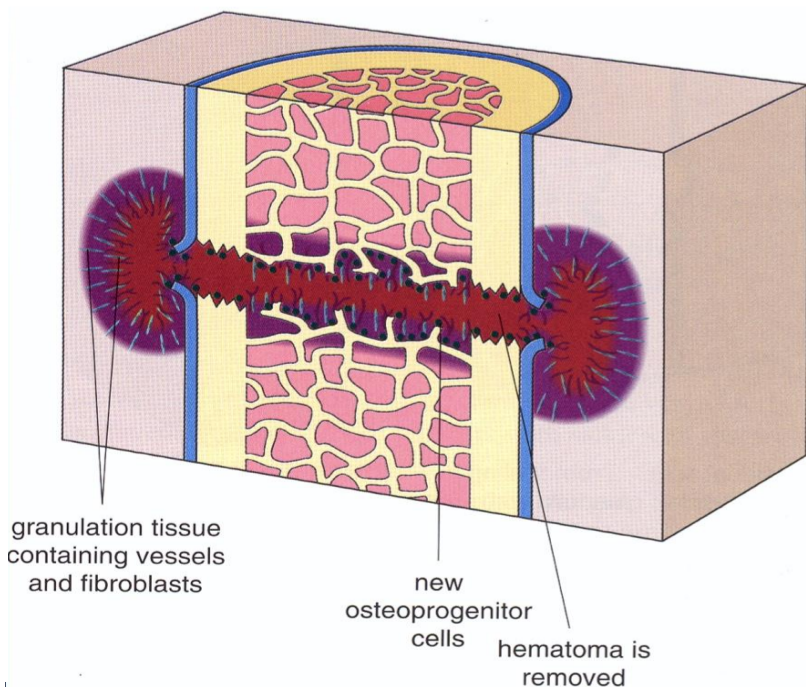
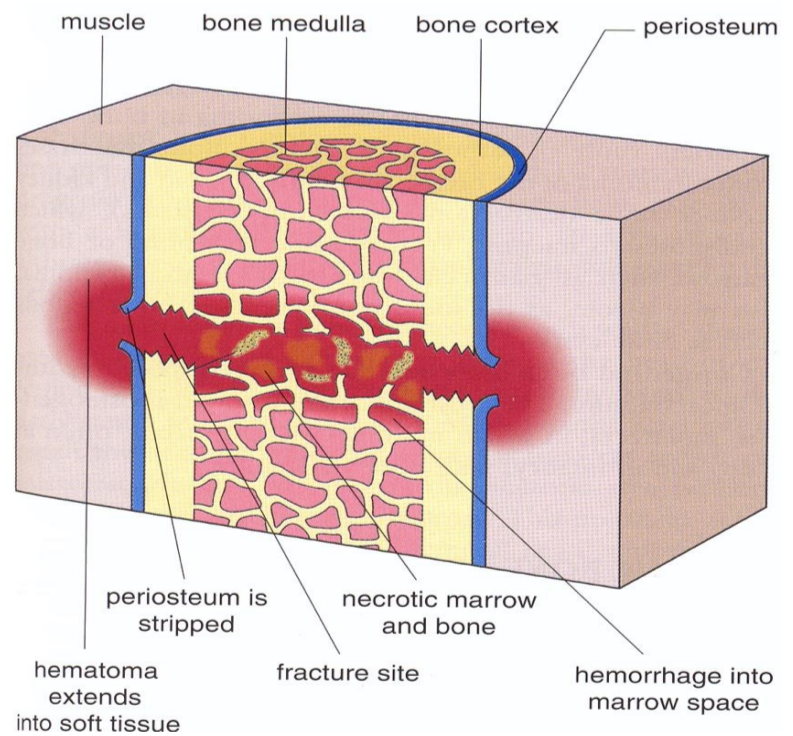
02

Inflammation is induced by chemical mediator produced from macrophages and other inflammatory cells with granulation tissue formation.

Tearing of blood vessels in the medullary cavity, cortex and periosteum lead to **hematoma** at the site of fracture.

The periosteum is stripped from the surface.

01



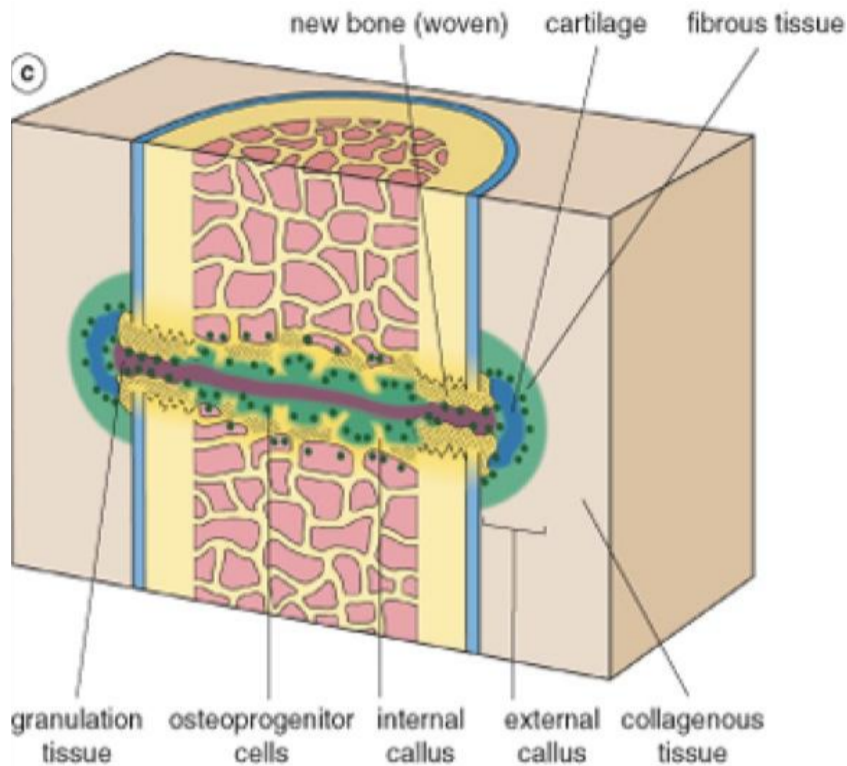
Organization of the hematoma is associated with

- Margination of **neutrophils** and **macrophages** into the fracture hematoma.
- They phagocytose the hematoma and necrotic debris

02

- How does a fracture heal?

2- Reparative phase



I - Soft callus

Degranulated platelets and marauding inflammatory cells → release a host of cytokines (e.g. platelet derived growth factor (PDGF), fibroblast growth factor (FGF), TNF beta 1) → activate bone progenitor cells.

Within a week: involved tissue is primed for new matrix synthesis

soft tissue callus: can hold the ends of the fractured bone in apposition but is noncalcified and cannot support weight bearing.

II - Hard callus (peak healing step)

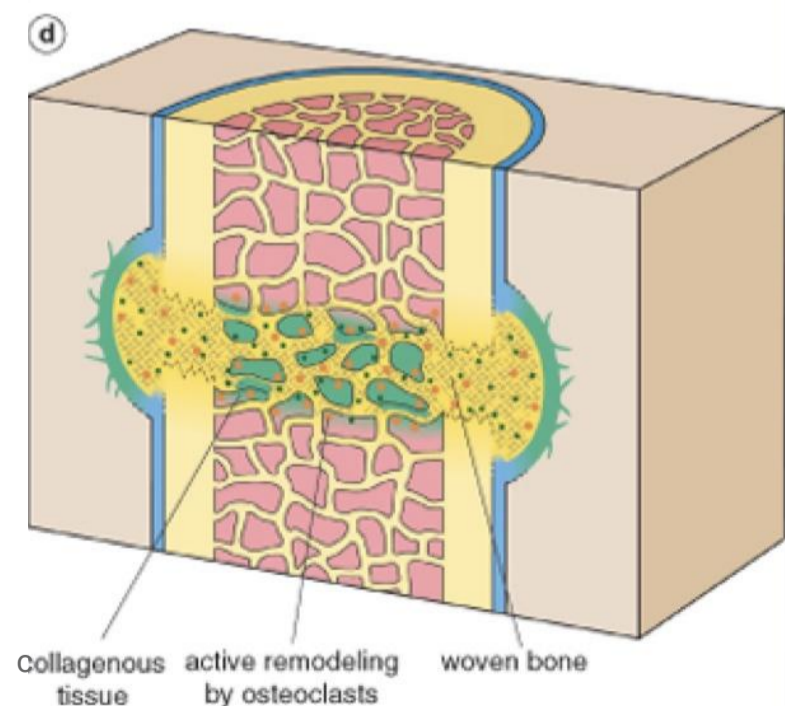
Bone **progenitors** in the periosteum and medullary cavity deposit new foci of woven bone (WHY? Because it is quick to make).

Activated mesenchymal cells at the fracture site → **cartilage-synthesizing chondroblasts.**

In uncomplicated fractures, this early repair process peaks within **2 to 3 weeks.**

Newly formed cartilage acts as a nidus for endochondral ossification, recapitulating the process of bone formation in epiphyseal growth plates. This connects the cortices and trabeculae in the juxtaposed bones. With ossification, the fractured ends are bridged by a **bony callus.**

Osteoprogenitor cell undergo metaplasia → transform to chondrocytes (Mimicking of endochondral ossification) → transform into osteoblast → osteoid → hard callus)

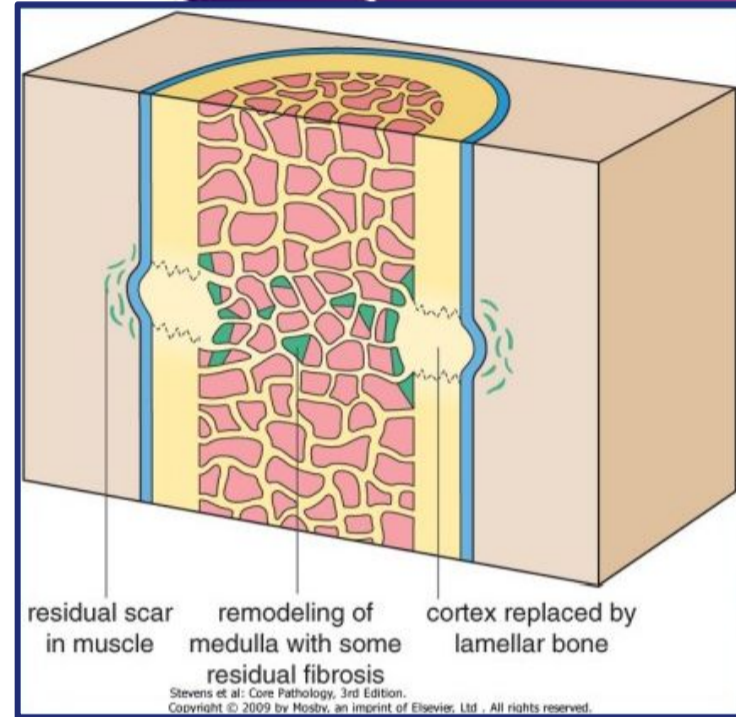


3- Bone remodelling

- Beginning about **8 to 12 weeks** after the injury, the fracture remodels itself, correcting any deformities that may remain as a result of the injury, this final stage of fracture healing can **last up to several years**.
- Although excess fibrous tissue, cartilage and bone are produced in the early callus.
- subsequent weight bearing leads to remodeling of the callus


rate of healing and ability to remodel a fractured bone depends on:

- Age
- Health
- The kind of fracture
- The bone involved



Factors disrupting the healing process

- 01 Displaced and comminuted factors
- 02 Infection
- 03 Inadequate minerals and vitamins
- 04 Inadequate immobilization
- 05 Vascular insufficiency;
This is particularly important on certain area such as the **Scaphoid** in the wrist and the **Neck of the femur**, both which can be associated with **Avascular necrosis** of fracture fragments.

 Avascular necrosis is the death of bone tissue due to lack of blood supply.
(Thx for 437)

Complications of bone fractures

1 **Delayed union;**
A fracture **takes long time to heal** more than expected

2 **Nonunion (pseudarthrosis)**
A fracture that **fails to heal** in reasonable amount of time
pseudarthrosis is a false joint which resembles a fibrous joint (Thx 43)

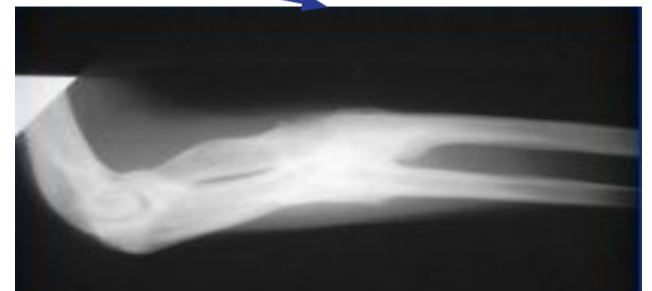
3 **Malunion**
A fracture that **does not heal in a normal alignment**

4 **Neurovascular injury**
cause **Avascular necrosis**

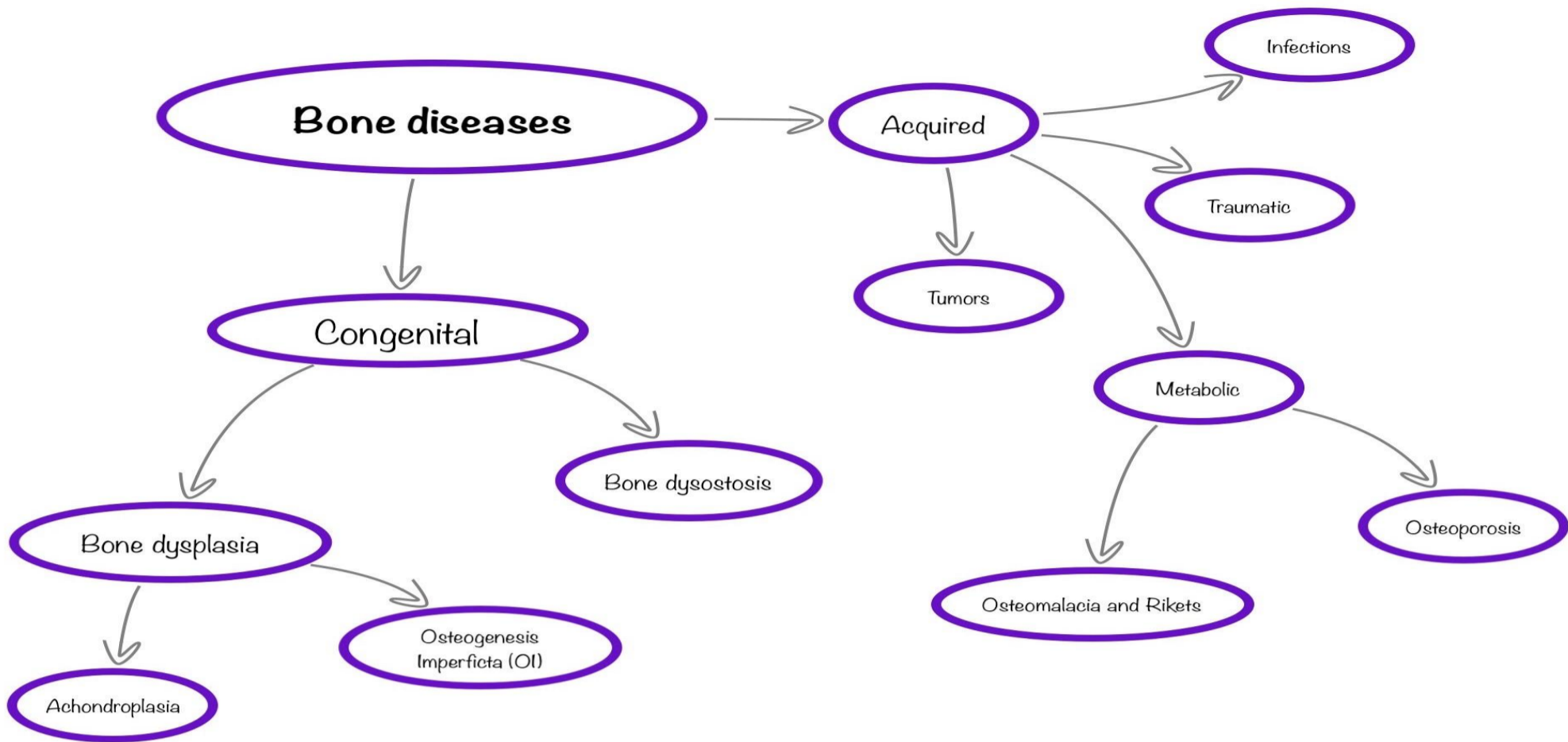
5 **Infection**
Open fracture can become infected

6 **post-traumatic arthritis**
fractures that extend into the joint (intra articular fractures)

7 **growth abnormalities**
A fracture in the open **physis**(growth plate) in a child can cause many problem



Development of bone disease



Bone Dysplasia

- Caused by genetic disorder.
- it's not premalignant.

Examples

- 1- Achondroplasia
- 2- Osteogenesis imperfecta
- 3- osteopetrosis

Bone Dysostosis

- Aplasia (congenital absence of a digit).
- Extra bones.
- Abnormal fusion of bones (premature closure of cranial sutures).
- Usually it's not inherited.
- Dysostosis Affect single or few bones, and it's caused by defect in formation of mesenchymal cells.

Bone disease

Congenital diseases
Can be localized or entire skeleton

Acquired diseases
Imbalance between osteoblastic and osteoclastic activity

- Causes:**
- 1- Metabolic
 - 2- Infections
 - 3- Traumatic
 - 4- Tumors

Metabolic Examples:
- OSTEOPOROSIS
- Osteomalacia and Rickets (This disorder may be acquired through various causes or inherited)

Overview

is the most common skeletal dysplasia and a major cause of dwarfism.

Achondroplasia

The process of getting this disease

- It's transmitted as an **autosomal dominant** trait (from paternal allele) or spontaneous mutation.
- It's caused by defect in cartilage synthesis or growth due to mutation in gene located on the short arm (p arm) of chromosome number 4, location p16.3 called Fibroblast Growth Factor Receptor 3 (FGFR3).

The pathogenesis (mutation)

Characterized by:

Failure of cartilage cell proliferation of the epiphyseal plate of long bones, resulting in failure of longitudinal bone growth and subsequent **short limbs**.

- **FGFR3** is a receptor with tyrosine kinase activity that transmit Intracellular signals and inhibit the proliferation and function of growth plate chondrocyte (it controls the growth of epiphyseal plate).
- Consequently, the growth of epiphyseal plates is suppressed (the epiphyseal plate will close prematurely).

Clinical features

The Normal parts (not effected)

- 1- **Shortened proximal extremities**
- 2- Enlarged head with bulging forehead.
- 3- Conspicuous depression of the root of nose (shifted inside)

- 1- Membranous ossification is not affected, so that the skull, facial bones, and axial skeleton develop normally.
- 2- a trunk of relatively normal length (but some rare cases the trunk will be affected)
- 3- General health, intelligence, or reproductive status are not affected, and life expectancy is normal.



Overview

(brittle bone disease)
group of genetic disorders characterized by brittle bones.

Osteogenesis imperfecta

There are 4 main Types

with different manifestations classified according to severity of symptoms and mode of inheritance. (Type 1 is an autosomal dominant trait. In contrast, type 2 is autosomal recessive trait)

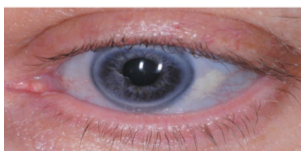
The pathogenesis

Defect in the synthesis of **type I collagen** leading to too little bone resulting in extreme skeletal fragility with susceptibility to fractures.
(Caused by mutation in the gene that encode the alpha1 and alpha2 chains of type I collagen)

some of them are fatal.
(Type 2 is uniformly fatal in utero, while type 1 has a normal life span)

Clinical features of Type 1:

1-Bluish sclera in both eyes due to defect in collagen (type 1) which will lead to thinning of sclera and making the choroid veins appear.
(reflecting the "blue pigment" of the choroid layer))



3-Pathological fractures because the bone is brittle



2-Dental imperfections (small, misshapen, yellowish) due to deficiency of dentin
Dentin is a major component in tooth.



4-Hear loss (deafness) due to abnormalities in the bones of middle ear (ossicles)

Metabolic bone diseases

Compromises four fairly common conditions in which there is an **imbalance** between osteoblastic (bone forming) and osteoclastic (bone destroying) activity:

Osteoporosis

Osteomalacia

Paget's disease of bone

Hyperparathyroidism

1. Osteoporosis



Helpful video

- ❖ Osteoporosis is an acquired condition characterized by **reduced bone mass** (the bone will become very fragile), but the ossification and calcification are normal, leading to bone fragility and susceptibility to fractures.
- ❖ Most fractures related to osteoporosis occur in the neck of femur.

It may be

- **Localized** e.g. disuse osteoporosis of a limb.
- involve the **entire skeleton**, as a **metabolic bone disease**.

Categories of Generalized Osteoporosis

Primary (No certain cause)	Secondary (Other disorders causing osteoporosis)
Idiopathic	Endocrine Disorders <ul style="list-style-type: none"> • Addison disease (hypocortisolism) • DM type 1 • hypo or hyperthyroidism • acromegaly (disorder that results from excess growth hormone (GH))
Post menopausal probably a consequence of declining levels of estrogen . In the decade after menopause, yearly reductions in bone mass may reach up to 2% of cortical bone and 9% of cancellous bone. Women may lose as much as 35% of their cortical bone and 50% of their cancellous bone by 30 to 40 years after menopause.	Gastrointestinal disorders <ul style="list-style-type: none"> • Malnutrition • Malabsorption • Hepatic insufficiency • Vitamin C, D deficiencies
Senile (advanced age)	Neoplasia <ul style="list-style-type: none"> • Multiple myeloma • Carcinomatosis (A condition in which cancer is spread widely throughout the body)
Environmental factors may play a role in osteoporosis in the elderly: <ul style="list-style-type: none"> • decreased physical activity • nutritional protein 	Drugs <ul style="list-style-type: none"> • Anticoagulants • Chemotherapy • Corticost
The most common forms of osteoporosis are the senile and postmenopausal types.	Others <ul style="list-style-type: none"> • Smoking * Immobilization • Anemia * Pulmonary disease

Morphology of Osteoporosis

The hallmark of osteoporosis is a **loss of bone**.

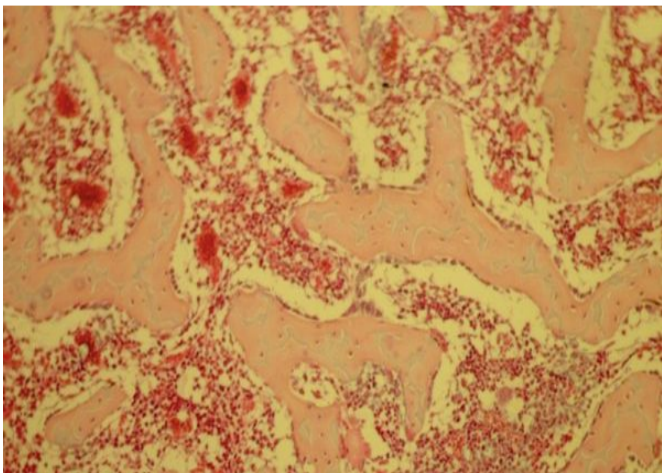
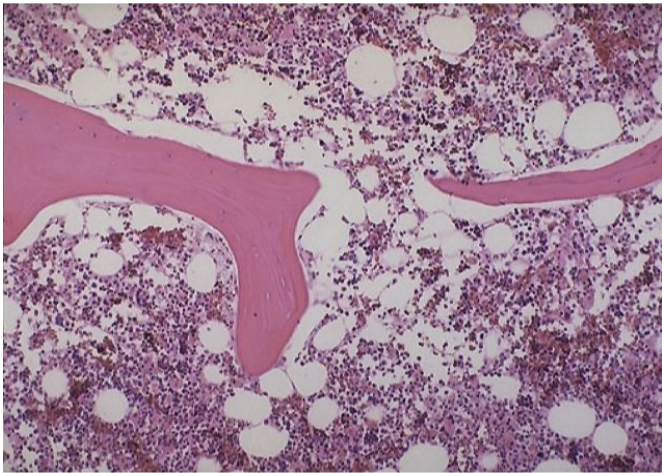
The cortices (plural of cortex) are thinned, with dilated haversian canals, and the trabeculae are reduced in thickness and lose their interconnections.

The mineral content of the bone (calcium, phosphorus) tissue is normal. Parathyroid hormone is normal, **sometimes will be slightly low**.

Osteoporosis affect all bones, but they love to affect the **VERTEBRAL COLUMN**.

Advanced Osteoporosis signs: Kyphosis(dowager's hump), vertebral collapse./ Creases appear often (patient can get shorter due to frequent fractures).

Edge of the lower ribs can rub against the iliac crest, Once enough bone is lost, susceptibility to fractures increases.



Normal



Osteoporotic bone

postmenopausal osteoporosis

senile osteoporosis

Prominent bone loss

Trabecular bone loss often is severe

Cortical bone loss is prominent

Classical pathological fracture

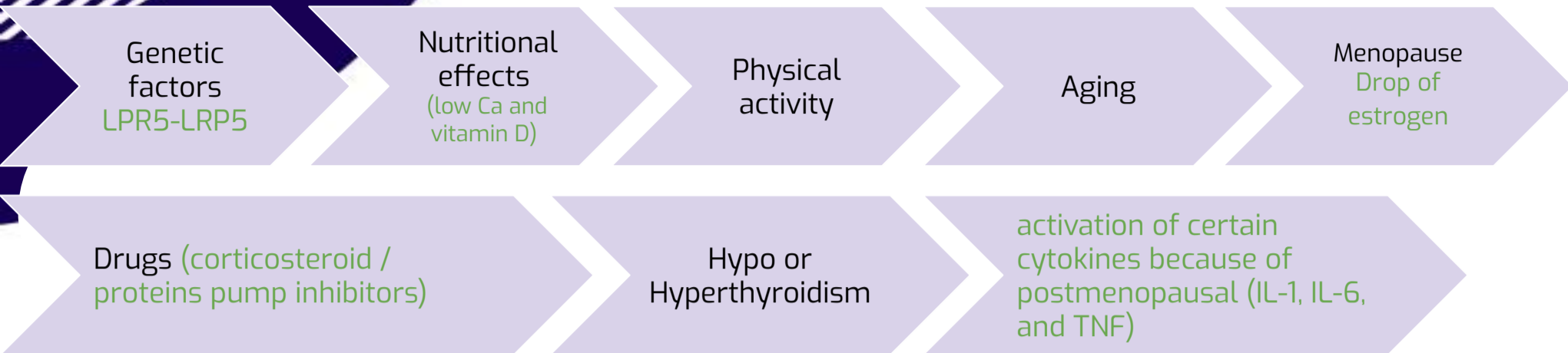
Compression fractures (because of the **low bone volume**) and collapse of vertebral bodies.

Predisposing to fractures in other weight-bearing bones, such as the **femoral neck** (very common)

	postmenopausal osteoporosis	senile osteoporosis
Prominent bone loss	Trabecular bone loss often is severe	Cortical bone loss is prominent
Classical pathological fracture	Compression fractures (because of the low bone volume) and collapse of vertebral bodies.	Predisposing to fractures in other weight-bearing bones, such as the femoral neck (very common)

Osteoporosis pathophysiology

Occur when the balance between bone formation and resorption tilts in favor of resorption



❖ In senile

Bone mass peaks during young adulthood; the greater the peak bone mass, the greater the delay in onset of osteoporosis. In both men and women, beginning in the third or fourth decade of life, bone resorption begins to outpace bone formation.

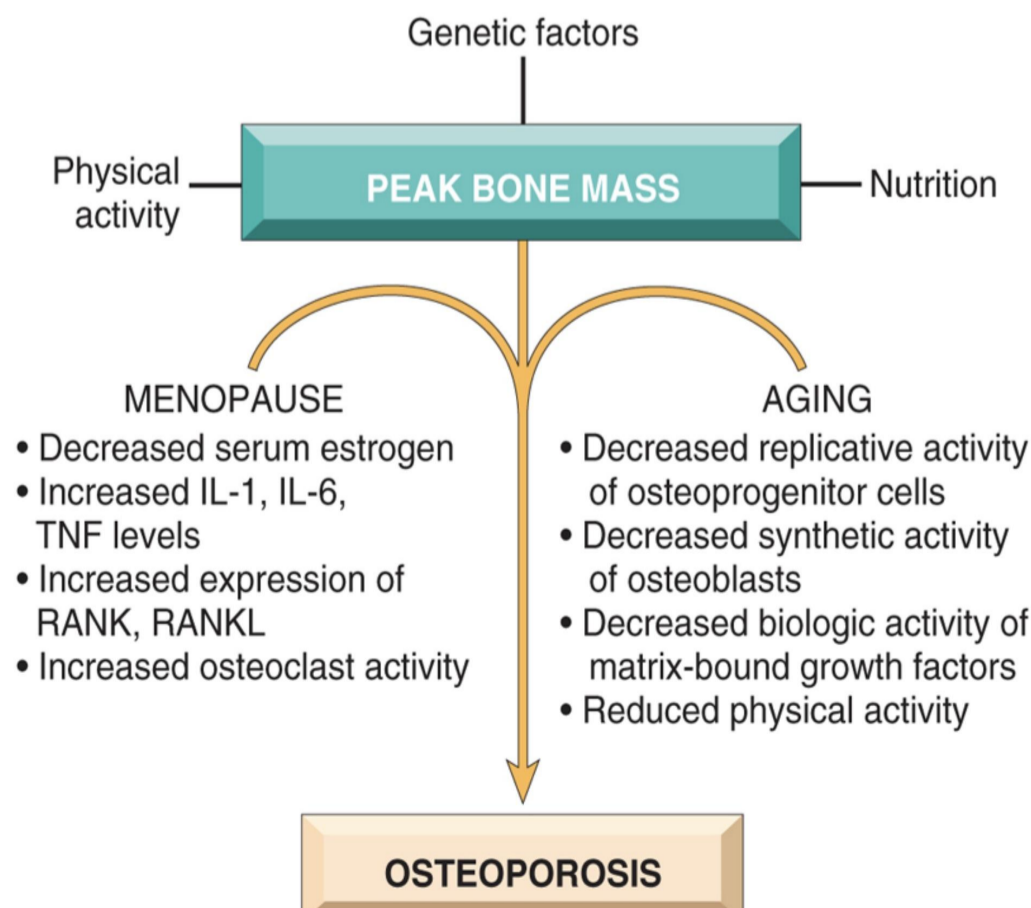
Osteoblast decrease as you grow, so the secretion of the osteo integrins will be reduced.

*Bone peak mass : is the maximum amount of bone a person has during their life.

❖ **The postmenopausal drop** in estrogen leads to increased cytokine production (especially IL-1, IL-6, and TNF), presumably from cells in the bone. These suppress OPG production.

go back to RANK & RANKL.

- Decreased estrogen
- Decreased osteoblasts which secrete osteo integrin which inhabits the osteoclasts action
- Action of osteoclast increases due to lack of osteo integrin
- Increased bone lysis



Osteoporosis

4- clinical features

- Difficult to diagnose
- Remain asymptomatic ----> fracture
- Fractures (Vertebrae, Femoral neck)
- Patients with osteoporosis have normal serum levels of calcium, phosphate, and alkaline phosphatase

5- diagnosis

Bones density by radiographic measures :

- **Plain X ray:** cannot detect osteoporosis until 30% to 40% of bone mass has already disappeared.
- **Dual-emission X-ray absorptiometry (DXA scan):** is used primarily to evaluate bone density, to diagnose and follow up pt. with osteoporosis.



6- prognosis

- Osteoporosis is **rarely** lethal
- Patients have an increased mortality rate due to the complications of fracture. e.g. hip fractures can lead to decreased mobility and an additional risk of numerous complications: deep vein thrombosis, pulmonary embolism and pneumonia

7- Prevention Strategies

- The best long-term approach to osteoporosis is prevention.
- children and young adults, particularly women, with a **good diet** (with enough calcium and vitamin D) and get plenty of **exercise**, will build up and maintain bone mass.
- This will provide a good reserve against bone loss later in life.
 - Exercise places stress on bones that builds up bone mass

Metabolic bone disease

2. Osteomalacia and Rickets,

In osteomalacia and Rickets, osteoblastic production of bone collagen is normal but mineralization is inadequate. It is a manifestations of vitamin D deficiency

Osteomalacia and Rickets: they are the same but osteomalacia occurs in adult and rickets occur in children, They are characterized by malabsorption.

Rickets refers to the disorder in children, in which it interferes with the deposition of bone in the growth plates.

Rickets is caused by: MALNUTRITION

Rickets symptoms:

- the skull will be deformed
- the frontal bones will not be able to close
- Pseudo fractures (looser's zone)

Osteomalacia is the adult counterpart, in which bone formed during remodeling is under mineralized, resulting in predisposition to fractures.

- Unlike osteoporosis, calcium will be reduced in Osteomalacia.
- Osteomalacia is caused by malabsorption of Ca^{++} Diarrhea
- Biopsy stained the calcium and bone black
- Connective tissue isn't calcified and it appears pink
- Tests : calcium low / phosphorus low
- Renal osteodystrophy makes the patient lose calcium with urine

Rickets

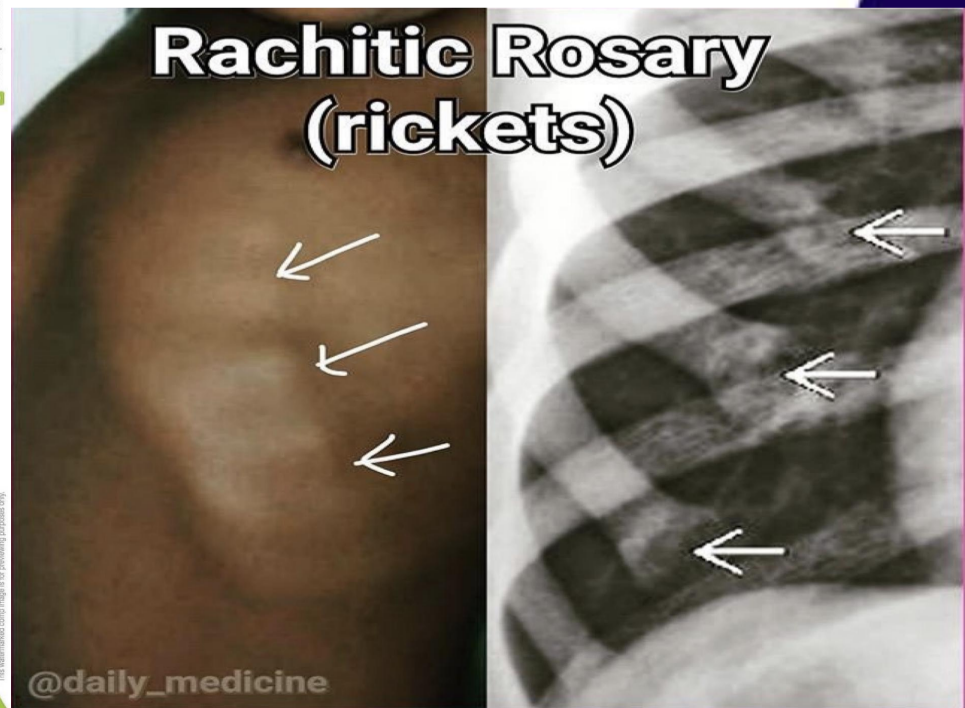
Normal

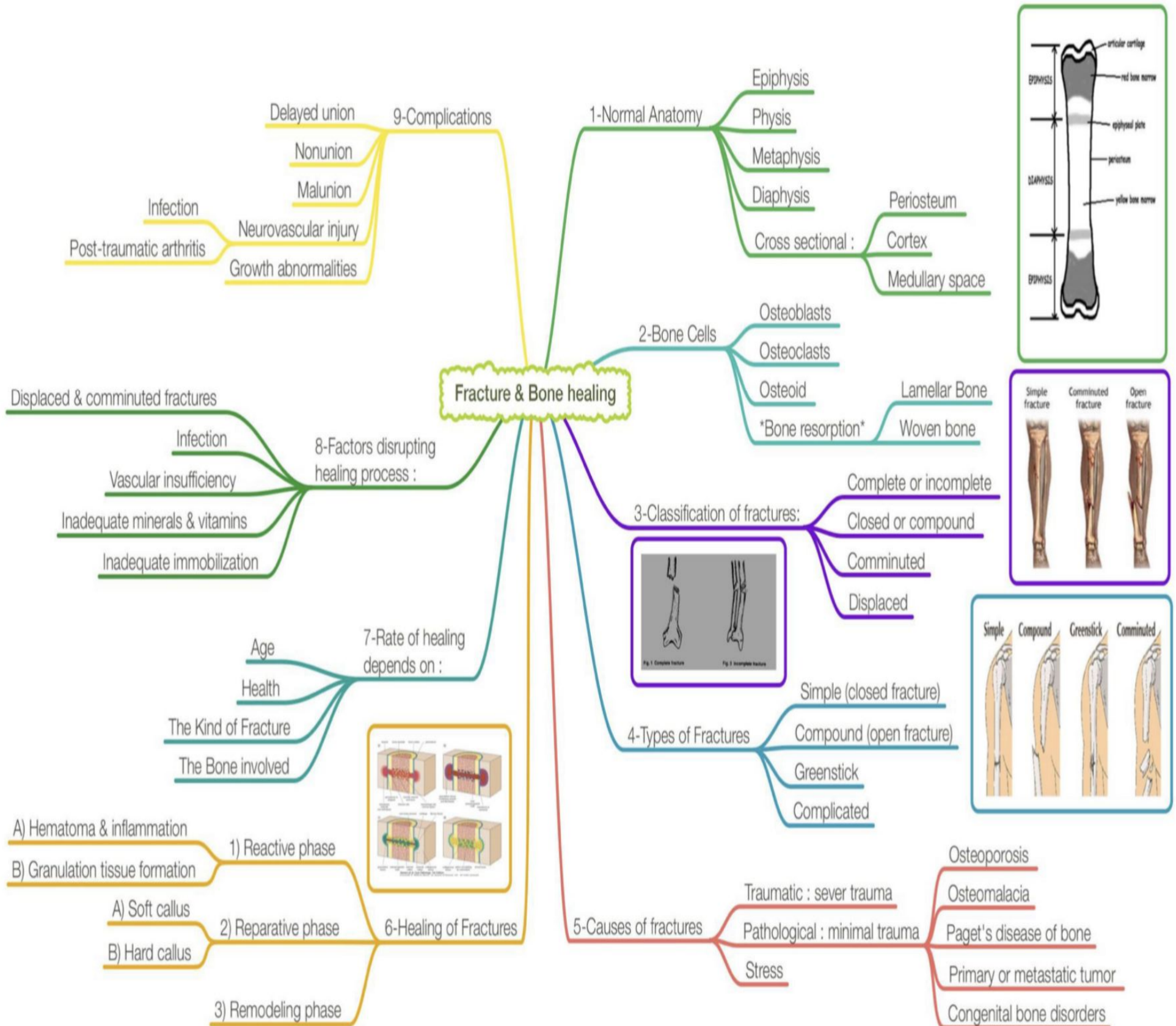
Leg bowing

Rickets



Rachitic Rosary (rickets)





	Etiology	Pathogenesis	Clinical features	
Osteogenesis Imperfecta	<p>Congenital</p> <p>Type1: autosomal dominant.</p> <p>Type2: autosomal recessive.</p>	<ul style="list-style-type: none"> Defect in the synthesis of type I collagen. 	<ol style="list-style-type: none"> Abnormal bone Blue sclera Teeth deformities Hearing loss 	
Achondroplasia	<p>Congenital</p> <ul style="list-style-type: none"> Autosomal dominant trait but many cases arise from spontaneous mutation. Mutation on gene that is located on the short arm of chromosome 4, fragment 16.3 which is called (FGFR3). 	<ul style="list-style-type: none"> Failure of cartilage cell proliferation at the epiphysial plates of the long bones. 	<ol style="list-style-type: none"> Short proximal extremities. Enlarged head with bulging forehead. Depression of the root of the nose. bowing of the legs and neck. <p>General health, intelligence, or reproductive status are not affected, and life expectancy is normal.</p>	
Osteoporosis	<p>Acquired</p> <ul style="list-style-type: none"> characterized by reduced bone mass. It may be localized or may involve the entire skeleton 	<ul style="list-style-type: none"> Occur when the balance between bone <u>formation</u> and <u>resorption</u> tilts in favor of resorption. the greater the peak bone mass, the greater the delay in onset of osteoporosis. 	Diagnosis	Prognosis
			<ul style="list-style-type: none"> Plain X ray DXA scan Biopsy 	<ul style="list-style-type: none"> Osteoporosis is rarely lethal. Patients have an increased mortality rate due to the complications of fracture.
Osteomalacia And Rickets	<p>Acquired</p> <ul style="list-style-type: none"> Inadequate mineralization. vitamin D deficiency. Calcium levels are low. 	<ul style="list-style-type: none"> Rickets disorder in children, interferes with the deposition of bone in the growth plates. Osteomalacia is the adult, the bone formed during remodeling is undermineralized. 		

Helpful figures

figures were taken from Robbins and team 434

MAP 10.6 Metabolic Bone Disease

OSTEOPOROSIS

What is osteoporosis?

This is a bone disorder that is characterised by loss of trabecular bone and increased fracture risk. It is more common in postmenopausal women due to ↓ oestrogen levels and ↑ bone resorption.

Causes

There is no single cause of osteoporosis but there are risk factors that predispose patients to this condition. These include:

- Loss of protective oestrogen in postmenopausal women.
- Prolonged steroid use.
- Increasing age.
- Excessive alcohol intake.
- Smoking.
- Positive family history.
- Diet deficient in calcium.
- Endocrine disorders such as diabetes mellitus and hyperthyroidism.

Signs and symptoms

This is often asymptomatic until the patient presents with pathological fracture. Patients may report loss in height, back pain and have a dowager's hump (hyperkyphosis) on physical examination.

Investigations

- Bloods: FBC, U&Es, LFTs, TFTs, glucose, serum calcium, serum phosphate, alkaline phosphatase levels and PTH.
- Dual-energy X-ray (DEXA) scan: a T-score >−2.5 is diagnostic.
- Radiology: X-ray, CT and MRI scan to assess fractures.

Treatment

- Conservative: patient education. Modify risk factors, e.g. smoking and alcohol cessation. Encourage weight-bearing exercise. Assess activities of daily living.
- Medical: selective oestrogen receptor modulators (SERMs), calcitonin and bisphosphonates.

OSTEOMALACIA

What is osteomalacia?

This is a metabolic bone disorder characterised by low mineral bone content and deficient vitamin D. This leads to soft bones; however, the amount of bone is normal. In children this condition is called rickets.

Causes

Remember **REVOLT**:

- **RE**sistance to vitamin D.
- **V**itamin D deficiency.
- **O**steodystrophy (renal).
- **L**iver disease.
- **T**umour-induced osteomalacia.

Signs and symptoms

- Bone pain.
- Myalgia.
- Pathological fracture.

Investigations

- Bloods: FBC, U&Es, LFTs, TFTs, glucose, serum calcium, serum phosphate, alkaline phosphatase, PTH and vitamin D levels.
- Radiology: X-ray to assess fractures.

Treatment

- Conservative: patient education. Dietary advice concerning calcium and vitamin D intake.
- Medical: vitamin D supplements, e.g. cholecalciferol and calcitriol.

Complications

- Increased risk of fracture.

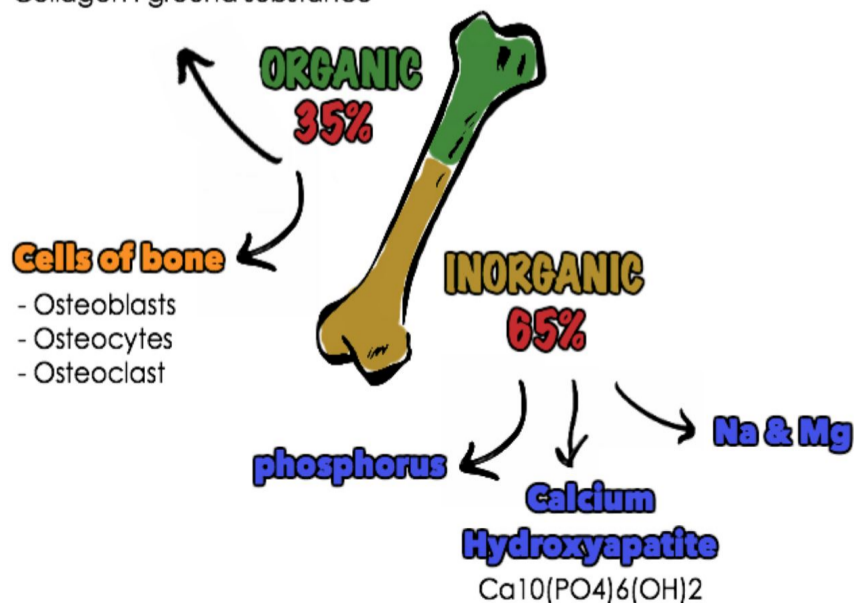
CONGENITAL DISORDERS OF BONE AND CARTILAGE

Abnormalities in a single bone or a localized group of bones are called **dysostoses** and arise from defects in the migration and condensation of mesenchyme. They manifest as absent, supernumerary, or abnormally fused bones. Global disorganizations of bone and/or cartilage are called **dysplasias**. Developmental abnormalities can be categorized by the associated genetic defect.

- FGFR3 mutations are responsible for achondroplasia and thanatophoric dysplasia, both of which manifest as dwarfism.
- Mutations in the genes for type I collagen underlie most types of osteogenesis imperfecta (brittle bone disease), characterized by defective bone formation and skeletal fragility.
- Mutations in *CA2* and *TCIRG1* result in osteopetrosis (in which bones are hard but brittle) and renal tubular acidosis.

Proteinaceous Osteoid

Collagen I ground substance



Quiz

1- unmineralized, organic portion of the bone matrix

- | | | | |
|--------------|----------------|------------|---------------------|
| a- Epiphysis | b- Osteoclasts | c- Osteoid | d- Epiphyseal plane |
|--------------|----------------|------------|---------------------|

2- Osteoblast deposit the osteoid collagen in Haphazard pattern and random arrangement :

- | | | | |
|------------------|---------------|-----------------|--------------------|
| a- Lamellar bone | b- Woven bone | c- Compact bone | d- trabecular bone |
|------------------|---------------|-----------------|--------------------|

3- A fracture in the open physis would result in which one of these complications?

- | | | | |
|-------------|------------|-------------------------|-----------------------------|
| a- nonunion | b-malunion | c- growth abnormalities | d- post traumatic arthritis |
|-------------|------------|-------------------------|-----------------------------|

4-: The first step of fracture healing is

- | | | | |
|--------------------------|-----------------------|---------------|--------------------------|
| a- hard callus formation | b- hematoma formation | c- remodeling | d- soft callus formation |
|--------------------------|-----------------------|---------------|--------------------------|

5- The swelling in a fracture is caused by

- | | | | |
|-----------------------|--------------------------|--------------------------|---------------|
| a- hematoma formation | b- soft callus formation | c- hard callus formation | d- remodeling |
|-----------------------|--------------------------|--------------------------|---------------|

6- Which one of these fractures is prone to infection

- | | | | |
|--------------|---------------|-----------|-------------|
| a- displaced | b- greenstick | C- colles | d- compound |
|--------------|---------------|-----------|-------------|

7- 16 years old boy fall on outstretched hand which fracture may happen

- | | | | |
|---------------|-----------|----------|-------------|
| a- comminuted | b- colles | C- smith | d- hairline |
|---------------|-----------|----------|-------------|

8- fracture has only one side damaged and only occurs in children

- | | | | |
|---------------|-----------|-------------|-------------|
| a- greenstick | b- simple | C- hairline | d- complete |
|---------------|-----------|-------------|-------------|

Quiz

1- A 5 years old boy born with a congenital disease was referred to Physician. On physical examination most of his decreased height is due to very short limbs. However, his trunk and head appear normally proportioned for his age and he has above average IQ. What is the most likely diagnosis?

- | | | | |
|--------------------|-------------------|----------------------------|-----------------|
| a- Alport syndrome | b- Achondroplasia | c- Osteogenesis imperfecta | d- Osteoporosis |
|--------------------|-------------------|----------------------------|-----------------|

2- 3 years old child was referred to a physician with multiple fractures. On physical examination, the child has blue sclera, diminished hearing, misshapen teeth. What is the most likely diagnosis?

- | | | | |
|------------|------------------|--------------------------|----------------------------|
| a- Rickets | b- Osteopetrosis | c- Shaken child syndrome | d- Osteogenesis imperfecta |
|------------|------------------|--------------------------|----------------------------|

3- Which of the following is associated with secondary osteoporosis

- | | | | |
|--------------------------|-----------|--------------|-------------------------|
| a- hepatic insufficiency | b- Senile | c- menopause | d- vitamin B deficiency |
|--------------------------|-----------|--------------|-------------------------|

4- Which of the following is a characteristic of senile osteoporosis

- | | | | |
|-------------------------|--------------------------|-----------------------|--------------------------|
| a- trabecular bone loss | b- compression fractures | c- cortical bone loss | d- hepatic insufficiency |
|-------------------------|--------------------------|-----------------------|--------------------------|

5- Which of the following is true In osteomalacia and Rickets

- | | | | |
|--|---|--|--|
| a-collagen production is low and mineralization is inadequate. | b- collagen production is normal but mineralization is inadequate | C-collagen production is normal and mineralization is high | d-collagen production is high and mineralization is inadequate |
|--|---|--|--|

6- The postmenopausal drop in estrogen leads to

- | | | | |
|-----------------|------------|-------------------------------|-----------------------|
| a- osteomalacia | b- rickets | C- reduce osteoclast activity | d- increase cytokines |
|-----------------|------------|-------------------------------|-----------------------|

- SAQ

- 1- what is the pathogenesis of Osteogenesis Imperfecta?
- 2- what is the classical pathological fracture in postmenopausal osteoporosis?
- 3- What are the causes of osteoporosis ?

SAQ ANSWERS:

1. Defect in the synthesis of type I collagen
2. COMPRESSION FRACTURE
3. Nutritional affect, menopause, Aging... etc

MCQ ANSWERS:

1. B
2. D
3. A
4. C
5. B
6. D

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