MED437
KING SAUD UNIVERSITY

PATHOLOGY
TEAM 437

Pathology

teamwork 437

Lecture one (1) : Fracture and Bone healing.

Color Index :-

- **VERY IMPORTANT**
- Extra explanation
- **Examples**
- **Diseases names: Underlined**
- **Definitions**

أعد المراجعة
غيداء آل مصمم
&
عبدالرحمن الحيسوني

نَستَهِينُ كل غالٍ كي نُحقِقَ الحُلم . . إن سئِمنا لا نُبالي بل نسِير للأمام . . إنّ قِمةَ الجِبالِ تستَحِقُ لا جَرم

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 THE POSSIBLE COMPLICATIONS OF HEALING PROCESS.
- UNDERSTANDS THE DIFFERENCE BETWEEN TRAUMA INDUCED AND PATHOLOGICAL FRACTURES.
- APPRECIATE THE IMPORTANCE OF ROAD TRAFFIC ACCIDENTS AS A MAJOR CAUSE OF DISABILITY IN SAUDI ARABIA

ANATOMY & HISTOLOGY OF THE BONE

D.Rekabi said: if you don't know the normal anatomy and histology of the bones " تفرقع واذهب إلئ غير رجعه " ☺ which means it's very very important to be familiar with it.

- **The bone is made of three parts:**

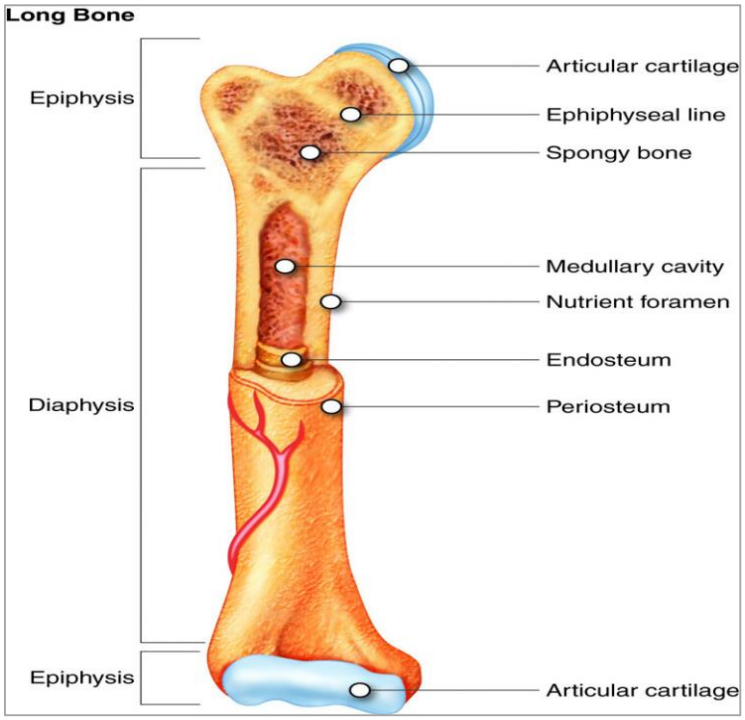
- **Epiphysis:** ends of bone, partially covered by articular cartilage and contains the epiphyseal line.
- **Diaphysis:** shaft of the bone.
- **Metaphysis:** above the epiphyseal line.
- ***Physis*:** growth plate.

DR. rekabi's note : there are some diseases that only effect one part of the bone. For example :osteomyelitis effects only the metaphysis. But it could spread later on.

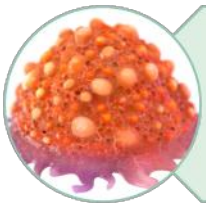
Epiphysis :(has centers for **ossification** and bone production, has epiphyseal line that is the growth plate of bone, it has the **osteoprogenitor** cells, it usually remains open until the **ossification is complete**, in children the epiphyseal line is open especially in long bone).

- **Cross section:**

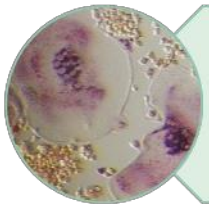
- **Periosteum:** located on the outward surface of the bone and its osteoprogenitor cells sits beneath.
- **Cortex:** composed of cortical bone or compact bone.
- **Medullary space:** composed of cancellous or spongy bone.



Bone cells :



Osteoblasts: (bone formation) arise from marrow mesenchymal cells; when active, are plump and present on bone surface; eventually are encased within the collagen they produce.



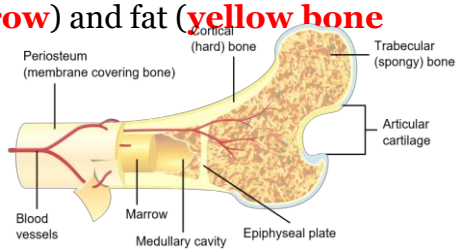
Osteoclasts: large multinucleated cells found attached to the bone surface at sites of active bone resorption.
Bone resorption: is resorption of bone tissue, that is the process by which osteoclasts break down the tissue in bones

We have two types of bone:

1. **compact /Cortical / lamellar** : Formed of **haversian** canals that contain (not active). The active ones are the osteoblast that form the **osteoid** (connective tissue in bone) and **osteoclasts** (mono or multi nuclear) are responsible for desorption and remodeling of bone

2. spongy / medullary / Trabecular: (woven bone is bone that has **trabeculae** / found in the **medulla**). The

* bone marrow *has progenitor stem cells* (**red bone marrow**) and fat (**yellow bone marrow).**
- Bone marrow biopsy is an **important diagnostic tool**.



Dr. rekabi's notes :

- The pathologic feature in bone necrosis **ARE THE SAME** regardless **the cause**.
- The dead bone will have an **EMPTY LACUNAE**, which spersed with areas of fat necrosis and insoluble calcium soaps.

Further information :

- The **cortex** is usually not affected. **WHY** ? Because it has a lot of blood supply.
- The overlying articular **cartilage** is also not effected. **WHY**? Because the synovial fluid can provide a nutritive support.
- After that the **osteoclast** will resorb any necrotic bony trabeculae.
- The remaining of any dead bone fragment can act as scaffolding for **new bone formation**. A process called : ***creeping substitution*** .

- Bone is mineralized osteoid; either **lamellar** bone or **woven** bone.

Lamellar bone	• Layered bone with concentric parallel lamellae. • Normal type of bone found in adult skeleton. • Stronger than woven bone.
Woven bone	• Osteoblasts deposit Osteoid collagen in random order. • Weaker and less efficient than Lamellar. • Rapidly produced • Greater tendency to fracture under stress

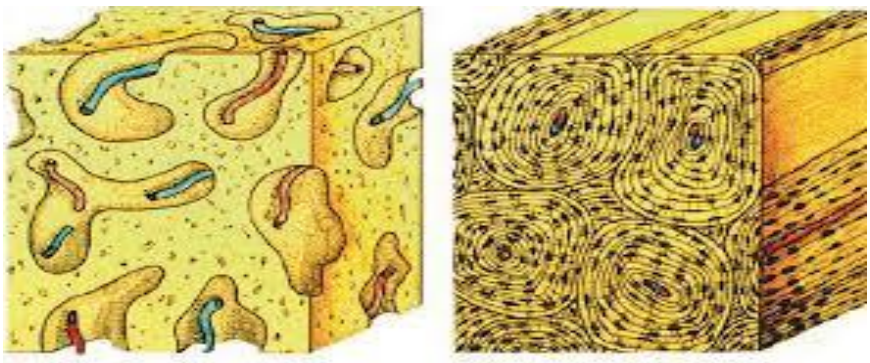
What is woven bone ? Woven bone, (also known as fibrous bone) which is characterized by a haphazard organization of collagen fibers and is mechanically weak. Lamellar **bone**, which has a regular parallel alignment of collagen into sheets ("lamellae") and is mechanically strong

When is woven bone formed ? After a fracture, **woven bone** forms initially and is gradually replaced by lamellar **bone** during a process known as "bony substitution." Compared to **woven bone**, lamellar **bone formation** takes place more slowly.

Dr.rekabi's note : woven bone is much weaker and haphazard pattern, and you can see it under theses conditions :

1) In children
2) Rapid healing
3) Fracture
4) Malignancy
5) and some pathological conditions

Why ? Because the bone under these conditions needs to form very fast so it will form in a haphazard pattern



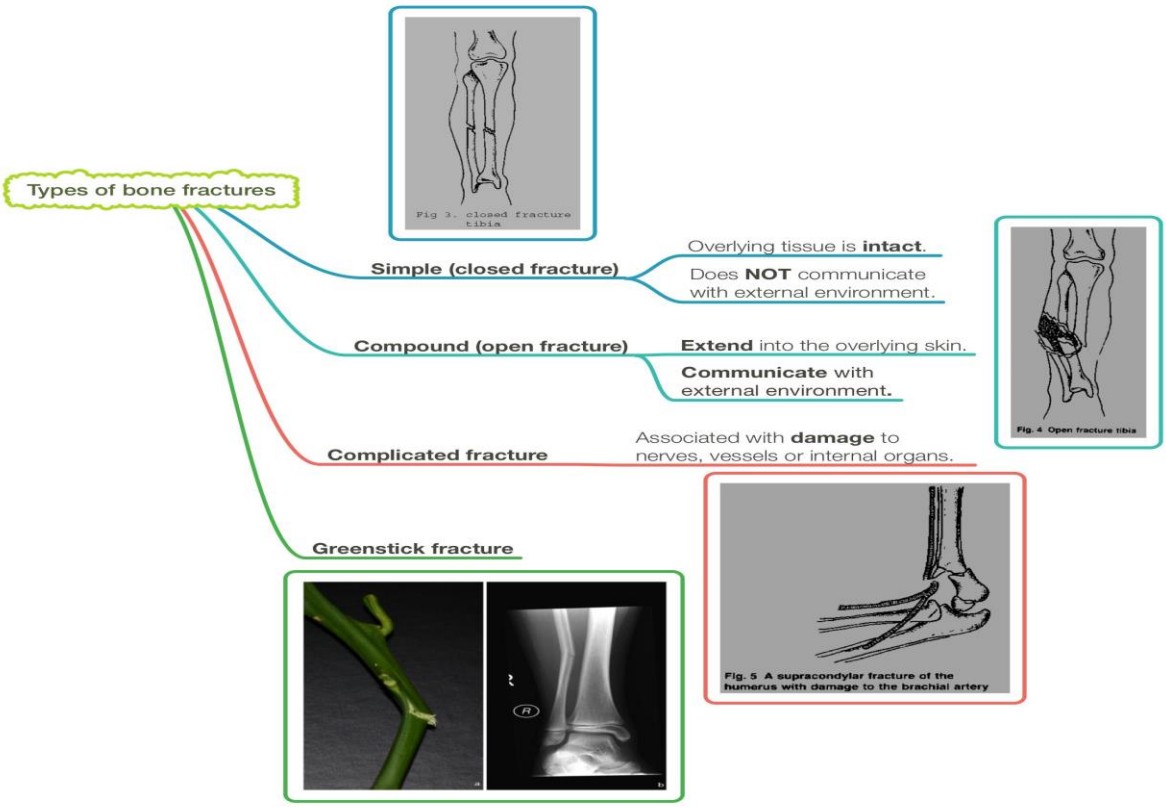
OVERVIEW OF FRACTURE :

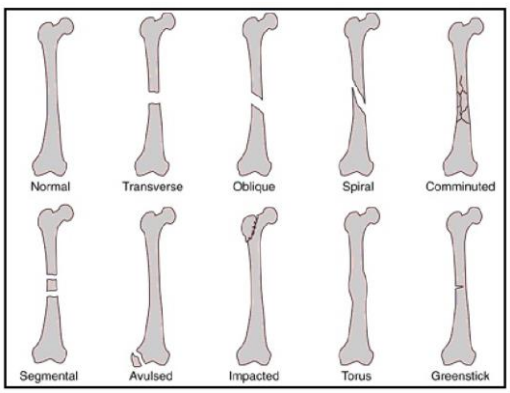
- **Fracture**: a disruption of the continuity of a bone caused by an external element, event, trauma or a disease.

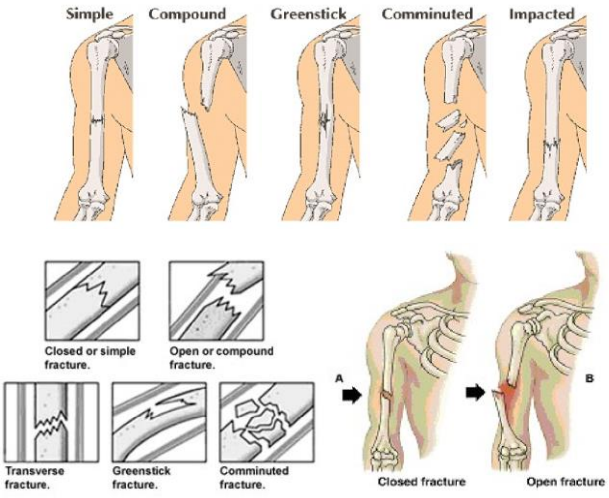
  -The majority are caused by Road Traffic Accidents (the number 1 cause of death in Saudi Arabia is **RTA** - readers are advised to drive safely ☺)

- **Types of fractures** : Fracture are <u>generally</u> classified into two major types:

  closed fractures (Simple) OR **open fractures (compound).**

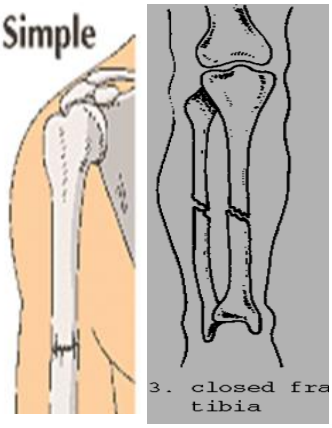




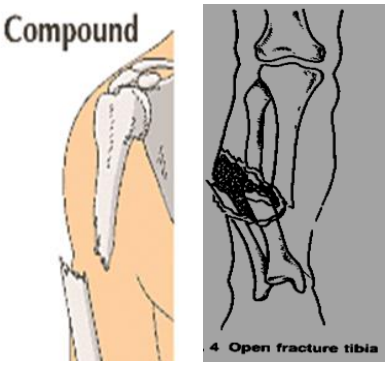


FRACTURE AND ITS DIFFERENT TYPES

- **Closed simple fracture:**
  - Linear.
  - if it happens to a child it may not need a cast and it will heal on its own but if it happens to an old person it needs a cast.
  - **Some characteristics of closed simple fracture:**
    1. it has no bleeding or open wound
    2. it has swelling, hemorrhage, loss of function, pain when moving, and hematoma formation.
    3. It needs an x-ray.



- **Displaced/compound fracture:**
  - Both part of bone are not opposed, they are displaced.
  - sometime we call it compound (open) when there is displacement and rupture of the skin.
  - **These kind of fractures are prone to infection.**
  - Open fractures are characterized by swelling and blood oozing out.



- **Green stick fracture:**
  - Is an incomplete fracture of long bones
  - usually seen in children; the bone is still intact.

- **Splintered or comminuted fracture:**
  - the bone is broken into many smaller fragments at the site of fracture.
  - It is also called a fragmented fracture.
  - It is a closed fracture.

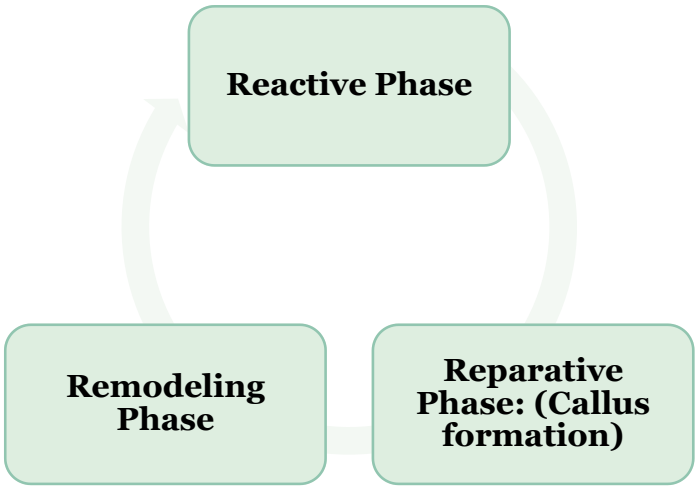
Sometimes fracture cause deformities like **colles fracture.**

▪**Colle's fracture:** a very famous fracture which occurs in the distal radius that heals badly causing a fork like shape of the arm (الشوكة شكل) it is common in people with osteoporosis. Colle's fractures can be treated with closed reduction.

Causes of fracture

Traumatic Fracture: Severe trauma	**Stress Fracture:**	**Pathological Fractures**
• **What is it ?** Trauma due to motor vehicle accidents is of major cause of bone fracture.	**What is it?** it is nondisplaced , linear and simple. Develops slowly over time as a collection of **microfractures .** **When?** -following a very long march and fatigue exercises. associated with increased physical activity -especially with new repetitive mechanical loads on bone. **Where ?** stress fractures are most common in the weight-bearing bones of the lower leg and foot and ankle. **Example** ?Track and field athletes and military recruits who carry heavy packs over long distances are particularly susceptible.	**What is it ?** fractures that occurs because there is a disease in the bone, **that means a minor trauma can causes a fracture.** **Example ?** The underlying bone is abnormal: - Osteoporosis - Osteomalacia - Paget's disease of bone - Primary or metastatic tumor - Congenital bone disorders (e.g. Osteogenesis imperfecta) - Cyst in bone

Healing of fractures



Reactive Phase: **Hematoma** and inflammatory response, and granulation tissue formation.

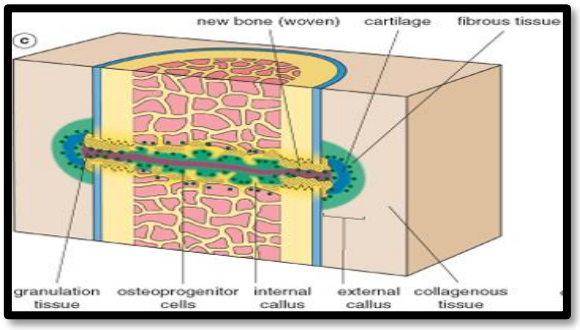
1) Bleeding from the fractured bone and surrounding tissue causes the **fractured area to swell**

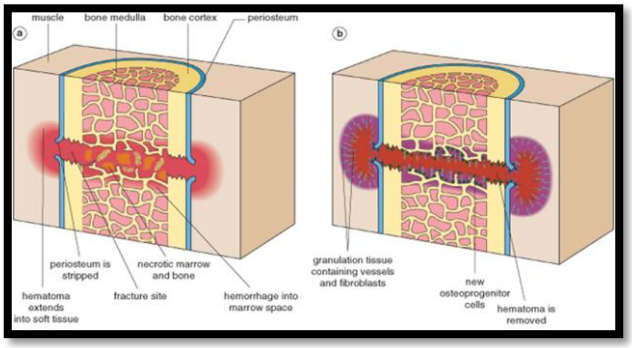
2) This stage begins day one of bone fracture and lasts about 2 to 3 hours.

3) Degranulated **platelets** and migrating **inflammatory cells** release PDGF, TGF-β, FGF, IL1, IL2, IL6, AND TNF -> activate **osteoprogenitor cells** in the periosteum, medullary cavity, and surrounding soft tissues.

4)stimulate osteoclastic and osteoblastic activity can extend to soft tissue.

5) inflammation induced by **chemical mediator** produced from **macrophages** and other inflammatory cells with **granulation tissue formation**





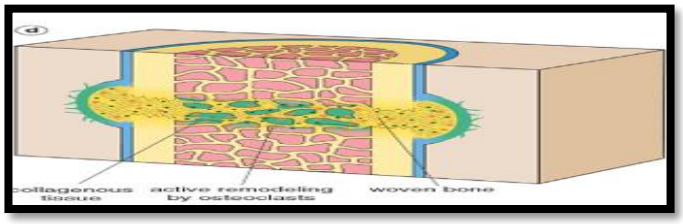
2-Reparative Phase: (Callus formation)

A - Soft callus:

By the end of the first week the hematoma is organizing, the adjacent tissue is being modulated for future matrix production, **and the fractured ends of the bones are being remodeled**. This **fusiform** and predominantly **uncalcified** tissue—called **soft-tissue callus or procallus.**

B - Hard callus:

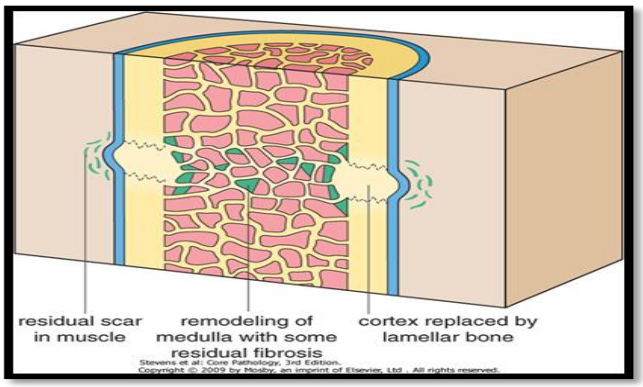
Bone **progenitors** in the **periosteum and medullary cavity** deposit new foci of woven bone, and **activated mesenchymal cells at the fracture** site differentiate into cartilage-synthesizing chondroblasts. The newly formed cartilage acts as a nidus for endochondral **ossification**. With ossification, the fractured ends are bridged by a bony callus**.**
Osteoblasts produce woven bone, resulting in a bony callus that stabilizes the fracture site.



3. Remodeling Phase: (remodeling of the original bone contour)

1) Beginning about **8 to 1 2 weeks after the injury**, the fracture site 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.
2) Although **excess fibrous tissue, cartilage, and bone** are produced in the early callus, subsequent weight bearing leads to remodeling of the callus.

*بإختصار هو ان الاوستيوكلاست تشيل اي زواد من تكوين العظم وتنحته.



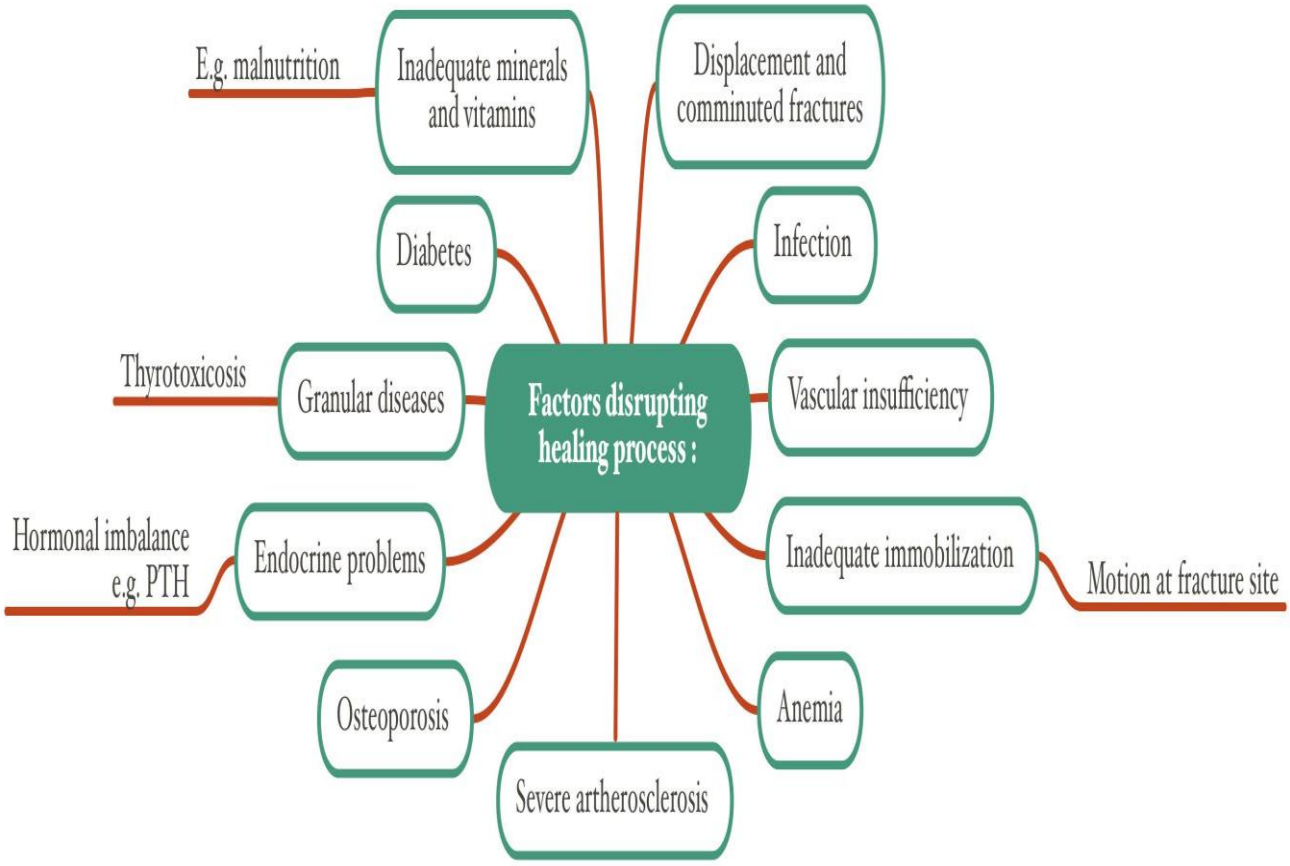
To make it stick to your head .. The steps of bone healing are :-

ReaRepRem ريارييريم

Factors disrupting healing process

- The rate of **healing and the ability to remodel** a fractured bone vary tremendously for each person and depend on**:**

Age	Health
The type of Fracture	The bone involved



FACTORS DISRUPTING HEALING PROCESS

1) Infection:

A risk in **comminuted and open fractures** is a serious obstacle to fracture healing. The infection must be eradicated before successful bone reunion and remodeling can occur.

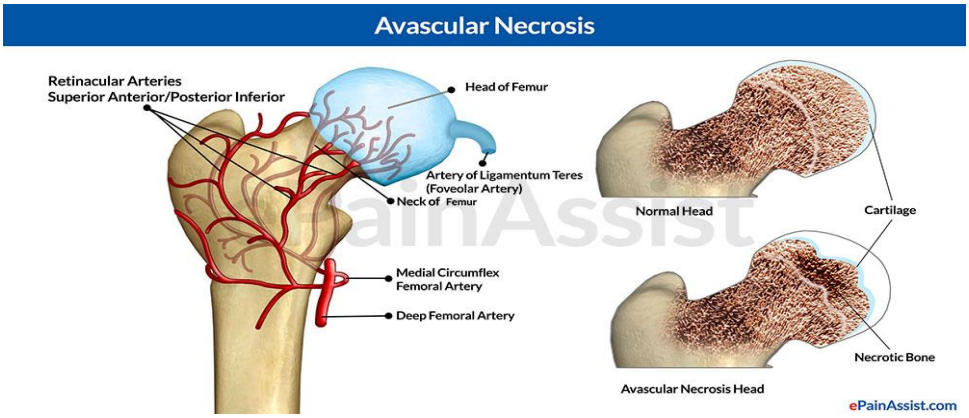
2) Vascular insufficiency:

This is particularly important in certain areas such as the:
1-**caphoid bone** in the wrist more often in : tuberosity
2-neck/head of the femur more often in : sub trochanteric

both of which can be associated with **avascular necrosis** of fracture fragments.

Further information by Dr.rekabi (important)

- What is **Avascular necrosis**? It is the death of bone tissue due to a lack of blood supply.
- **How** ? if the tuberosity for example is fractured The fracture can cause a compromise to the circulation (cutting of the artery). Pain and reduction of movement will occur as a result. يعني هذي الاماكن بالأساس يوصلها دم قليل .. فتيخيلو يصير فيه كسر ؟ ممكن الكسر يسبب انسداد وبالتالي بيصير نيكروسس
- **Avascular necrosis could occur in the femur without trauma**! the reason would be a disease (Legg-Calve-Perthes disease) patient has a limp and hip pain. Usually in **children** or **young men**. Etiology unknown.



3) Inadequate immobilization:

-Permits constant at the fracture site -> the normal constituents so of **callus** don't form -> instead the healing site will be composed of **fibrous tissue and cartilage.**

-It will result in **delayed union and nonunion**

-The callus will then undergo **cystic degeneration** -> creating **pseudoarthrosis**

أي عندما يتم تحريك العظم اثناء الكسر، ما راح يتكون الكالس الطبيعي بينما بيتكون بداله فايبروس تيشو، بديهياً إذا ما راح يلتأم الكسر بشكل طبيعي وبيتأخر ال healing prosess وممكن حتى ما يتكون ! كل هذا بس عشان حركنا الكسر انتهبوا ☺ طيب وبعدين ايش بيصير ؟ قلنا بيصير بدال العظم فايبروس..بكذا بيحوي ان مكان العظم joint

So What is **pseudoarthrosis**? It's a **false joint** which resembles **a fibrous joint.**

-How can we treat pseudoarthrosis? The normal healing can be achieved only when the fibrous tissues are removed by intervention (such as surgery).

-Damage to the nerves, blood vessels, and skeletal muscle also interfere with callus formation, which leads to pseudoarthrosis.

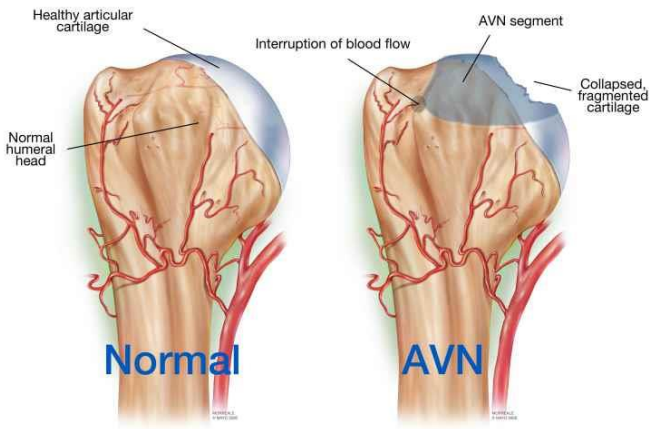
Dr.rekabi's note:

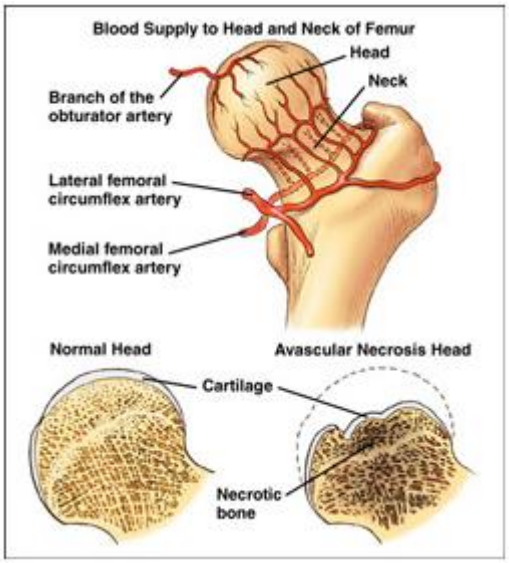
مكان الpseudoarthrosis يطلع اسود بينما العظام ابيض ليش ؟ لأن الصبغه البيضاء تصبغ الكالسيوم، والكالسيوم موجود فقط بالعظم الطبيعي، بهذه الحاله راح الكالسيوم ، إذاً ما راح ينصبغ وبتبين منطقه غامقه.

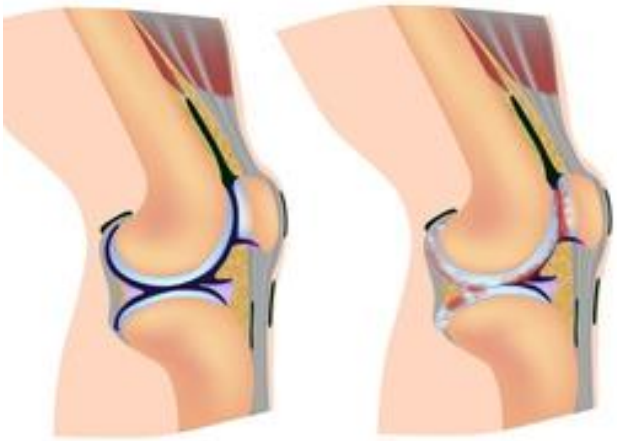
Complications

هنا المضاعافات اللي ممكن تحدث بينما السلايد اللي قبل تعطل التئام العظام، لا تلخبطون ☺

- **Complications**
  - **Delayed union** — A fracture that **takes longer** to heal than expected
  - **Nonunion** — A fracture that **fails to heal** in a reasonable amount of time.
  - **Malunion** — A fracture that **does not heal in normal alignment**
  - **Neurovascular injury**
    - **Infection** — Open fracture can be infected
    - **Post-traumatic arthritis** — Fracture that extend into the joints
  - **Growth abnormalities** — A fracture in the open physis or **growth plate in child**, can cause problems.

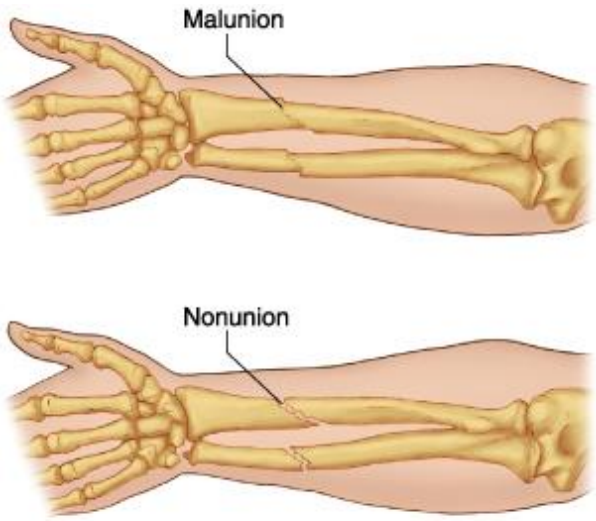






Healthy Joint

Post-traumatic Arthritis



Malunion

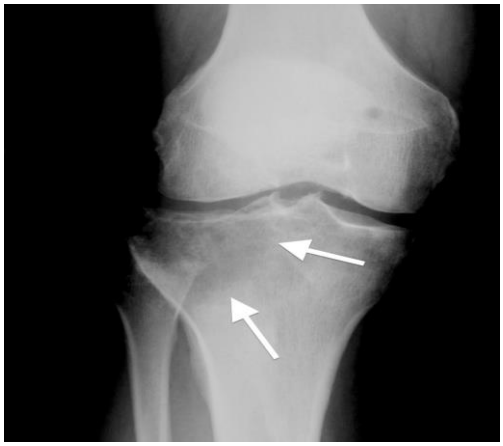
Nonunion

CLINCAL CASES :

Pathological Fracture

A person come to the emergency and can't move his leg , after doing an x-ray they find lytic bone lesion and fracture of the femur (abnormal bone). we should treat the fracture and take a biopsy of the bone. The biopsy shows a metastatic tumor from lung cancer.

- Most common tumor of bone is metastatic.

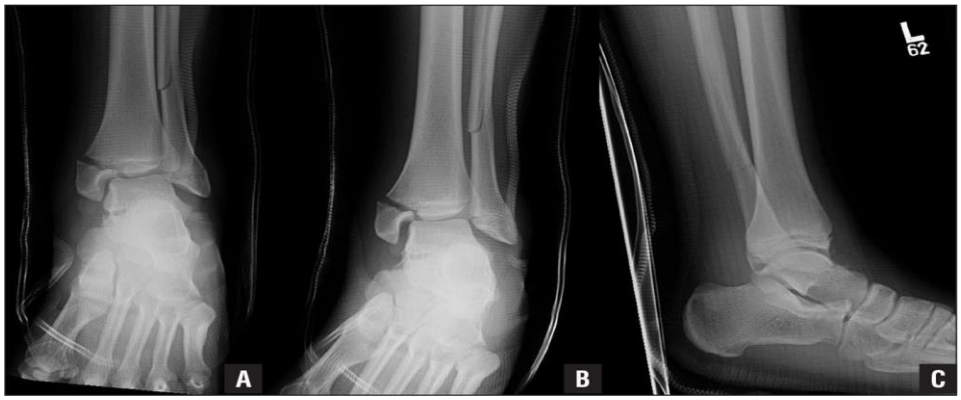


Closed Fracture

A women with a fractured ankle : we could see extreme swelling / hemorrhagic area and hematoma formation ورم دموي which is an accumulation of blood within the soft tissue and loss of function (can't move).

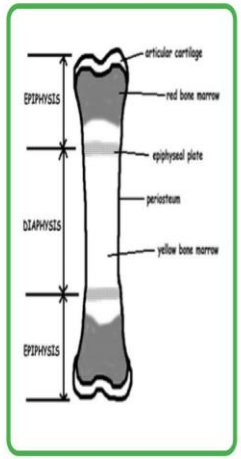
-Diagnosis: This is a closed fracture because there is no bleeding or open wound.

- Further examination: So we do x-ray to determine which bone is fractured.



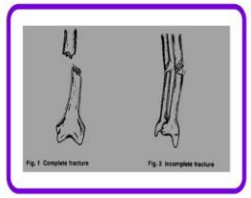
Fracture & Bone healing

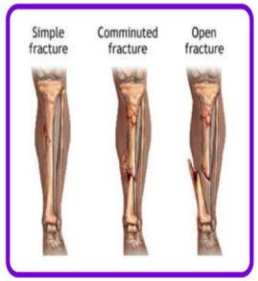
1-Normal Anatomy
- Epiphysis
- Physis
- Metaphysis
- Diaphysis
- Cross sectional :
  - Periosteum
  - Cortex
  - Medullary space



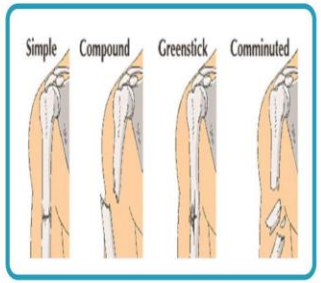
2-Bone Cells
- Osteoblasts
- Osteoclasts
- Osteoid
- *Bone resorption*
  - Lamellar Bone
  - Woven bone

3-Classification of fractures:
- Complete or incomplete
- Closed or compound
- Comminuted
- Displaced



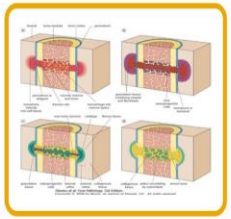


4-Types of Fractures
- Simple (closed fracture)
- Compound (open fracture)
- Greenstick
- Complicated



5-Causes of fractures
- Traumatic : sever trauma
- Pathological : minimal trauma
  - Osteoporosis
  - Osteomalacia
  - Paget's disease of bone
  - Primary or metastatic tumor
  - Congenital bone disorders
- Stress

6-Healing of Fractures
- 1) Reactive phase
  - A) Hematoma & inflammation
  - B) Granulation tissue formation
- 2) Reparative phase
  - A) Soft callus
  - B) Hard callus
- 3) Remodeling phase



7-Rate of healing depends on :
- Age
- Health
- The Kind of Fracture
- The Bone involved

8-Factors disrupting healing process :
- Displaced & comminuted fractures
- Infection
- Vascular insufficiency
- Inadequate minerals & vitamins
- Inadequate immobilization

9-Complications
- Delayed union
- Nonunion
- Malunion
- Neurovascular injury
  - Infection
  - Post-traumatic arthritis
  - Growth abnormalities

MCQS

1) Where is osteoid collagen deposited in a mechanically strong, parallel stratified pattern?

A) Woven Bone

B) Spongy Bone

C) Trabecular Bone

D) Cortical Bone

2) The fracture has contact with the external environment (the fracture extends into the overlaying skin)?

A) Compound Fracture

B) Closed (Simple) Fracture

3) What is this fracture (in the following picture)?

A) Displaced Fracture

B) Complicated Fracture

C) Greenstick Fracture

D) Closed Fracture (Simple)

4) What is the type of fracture associated with damage to nerves, vessels, or internal organs?

A) Displaced Fracture

B) Complicated Fracture

C) Greenstick Fracture

D) Closed Fracture (Simple)

5) Which of the following is reason for a pathological fracture?

A) Osteoporosis

B) Severe Trauma

C) Stress Fractures

D) Due To Motor Vehicle Accidents

1-d
2-a
3-c
4-b
5-a

SAQ

- 1) A women tripped over in the tub and could not move her foot which had become swollen and painful, she will need to go the hospital and get an emergency x-ray of her ankle. What is the most likely reason and why ?

- 2) The swelling in a fracture is caused by?

- 3) What is a Colle's fracture?

- 4) What do inflammatory cells release to activate osteoprogenitors?

- 5) Name three factors that disrupt the healing process?

ANSWERS

- 1) A fracture because she has the three signs of a fracture which are: the inability to move, pain, and swelling.
- 2) The swelling is because of the formation of a hematoma (the bone is a vital organ that has blood vessels, and bone marrow is very active) after there is a fracture there is a rupture in the blood vessels and you will get a hematoma.
- 3) It is a fracture of the distal end of the radius and it is the most common fracture of the forearm, it results from a fall onto outstretched hand and the fracture has a dinner fork appearance.
- 4) They release PDGF, TGF-β, FGF and IL-1 ,IL-6 ,1L-2 ,and TNF.
- 5) 1- Infection, 2- Vascular insufficiency (avascular necrosis), 3- Disturbance in the parathyroid gland.

A helpful video:
https://www.youtube.com/watch?v=MNkI6Of2PRs

MEMBERS :

Males:

-leader : فيصل الطحان

عبدالجبار اليماني

محمد باحاذق

أحمد الراشد

عبدالله بالعبيد

عبدالله السرجاني

أحمد الحربي

أنس السيف

فايز الدرسوني

داود إسماعيل

فهد الفايز

محمد بن معيوف

فهد النحابي

سعد الفوزان

سيف المشاري

تميم الوهيبي

رشيد البلاع

عبدالله المعيزر

محمد الأصقه

محمد الصويغ

عبدالعزيز المهنا

نواف السبيعي

خالد العقيلي

Females:

-leader : بثينة آل ماجد

-روان الحربي

-وفاء العتيبي

-الجوهرة الشنيفي

-رزان الزهراني

-رهف الشمري

-روان مشعل

-منيرة المسعد

-لميس السويلم

-نوف العتيبي

-رزان الزهراني

-هديل عورتاني

-فاطمة بالشرف

-ابتسام المطيري

-رناد الفرم

-غرام جليدان

-بلقيس الراجحي

-نورة القاضي

-آلاء الصويغ

-ريم القحطاني

Gently contact us if you have any questions/comments and suggestions:

* EMAIL: pathology437@gmail.com
* TWITTER : @pathology437

GOOD LUCK!☺

Resources:-

1- Females slides
2- Robbins reference book

Pathology

teamwork 437