SPORTS PHYSICAL THERAPY

PATHOPHYSIOLOGY OF SKELETAL INJURIES

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PATHOPHYSIOLOGY OF SKELETAL INJURIES

This chapter provides an overview of the skeleton and its component parts. Special attention is paid to the process of bone formation or ossification and its unique implications for healing following skeletal injuries.

PATHOPHYSIOLOGY OF SKELETAL INJURIES

INTRODUCTION

Skeletal injuries are common in sport, especially in contact sports, such as football and rugby, and in individual sports such as skiing and gymnastics.

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- The skeleton can be divided into two subgroups:

1. Axial skeleton – bones of the skull, vertebral column, ribs and sternum
2. Appendicular skeleton – bones of the upper and lower limbs.

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Bone is a living, well organized, vascular form of connective tissue. It is largely composed of an organic protein, collagen, and an inorganic mineral, hydroxyapatite, which combine to provide a mechanical and supportive role in the body (Smith et al. 1983).

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- Wolff's law:

"states that bone responds to the stresses that are imposed upon it by rearranging its initial architecture in the best way to with- stand stress (Porter 2008)

PATHOPHYSIOLOGY OF SKELETAL INJURIES

- Wolff's law and the effect it has on bone healing
  - When mechanical stresses are put on bone, the bone has the ability to adapt by changing size, shape and structure.
  - *When optimal stress is placed on bone there is a greater bone deposition than bone resorption*.
  - This results in an increased bone density and a hypertrophy of periosteal bone.

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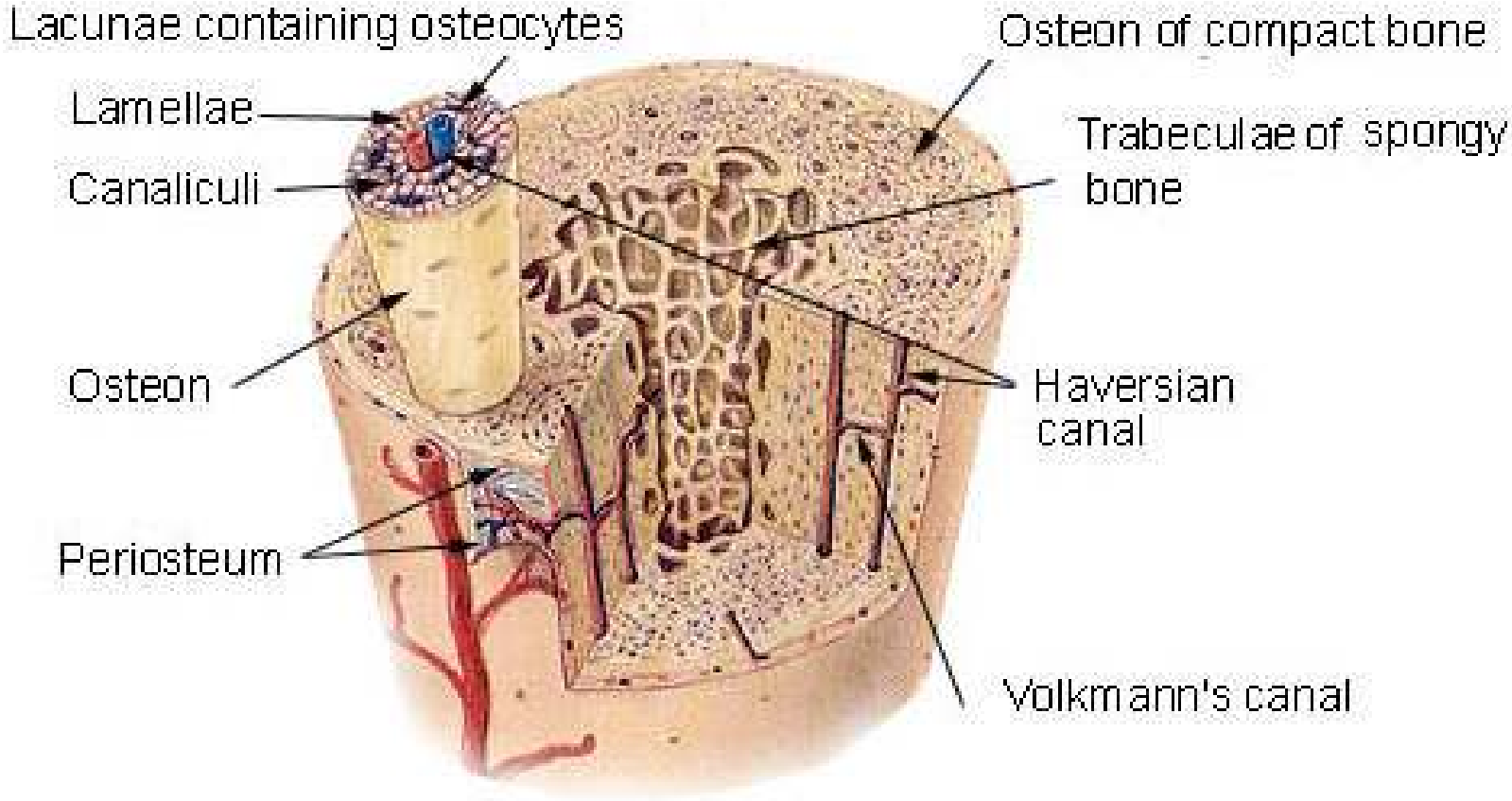
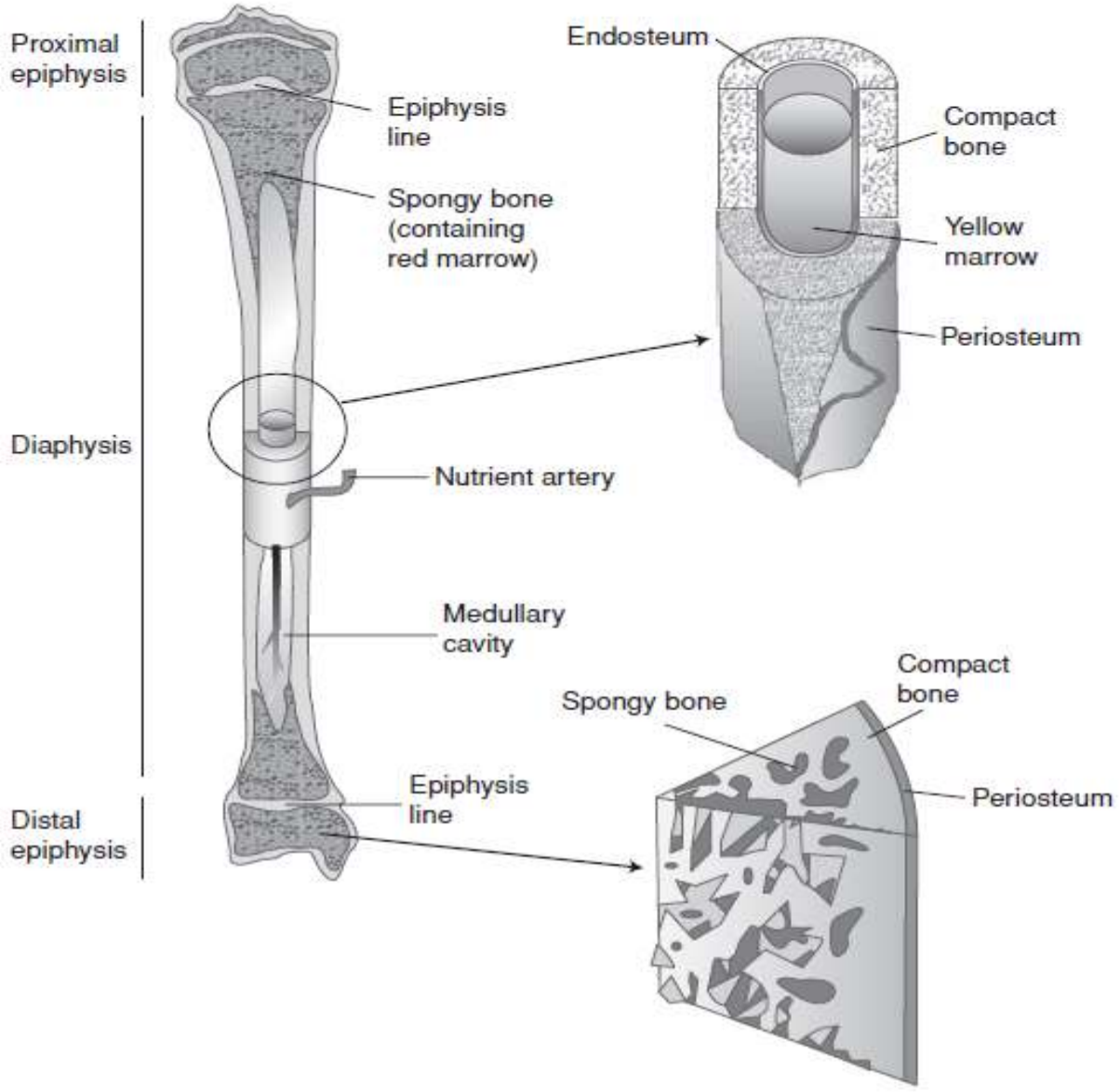
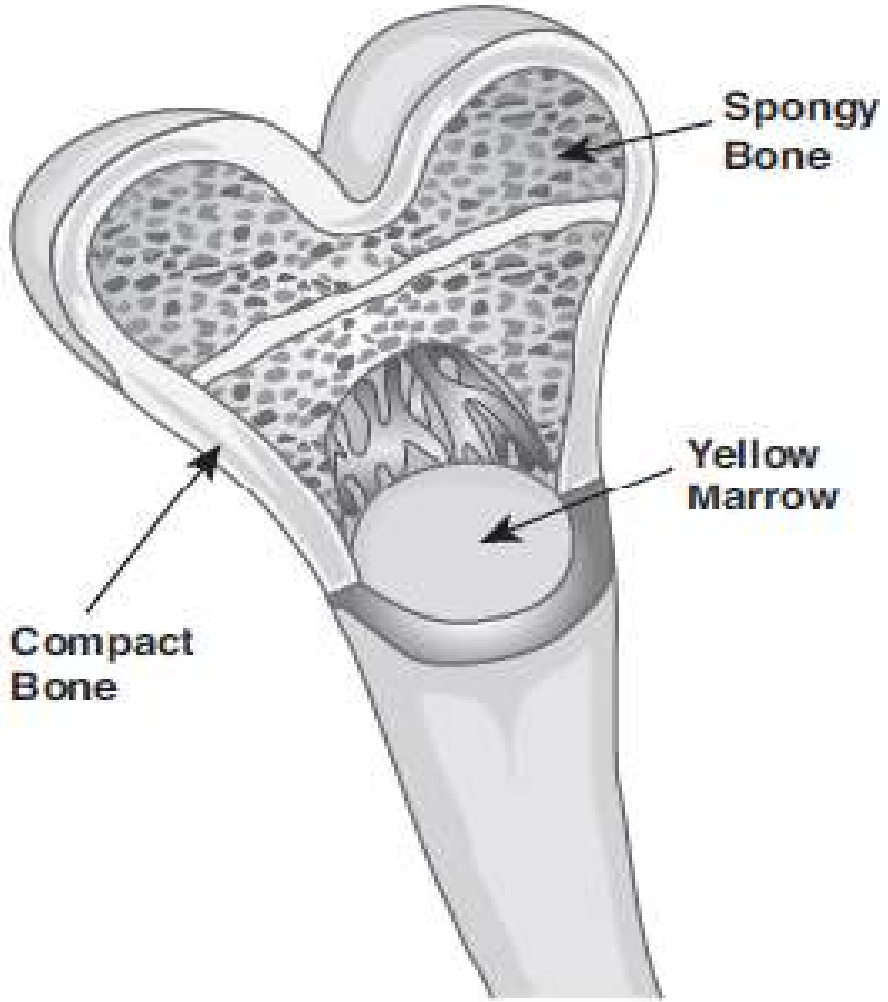
- Functions of Bones

1. *Support:* Bones provide a framework for the attachment of muscles and other tissues.
2. *Protection:* Bones such as the skull and rib cage protect internal organs from injury.
3. *Movement:* Bones enable body movements by acting as levers and points of attachment for muscles.
4. *Mineral storage:* Bones serve as a reservoir for calcium and phosphorus, essential minerals for various cellular activities throughout the body.
5. *Blood cell production:* The production of blood cells, or hematopoiesis, occurs in the red marrow found within the cavities of certain bones.

Compact Bone & Spongy (Cancellous Bone)




Proximal epiphysis
Diaphysis
Distal epiphysis
Epiphysis line
Spongy bone (containing red marrow)
Nutrient artery
Medullary cavity
Epiphysis line
Endosteum
Compact bone
Yellow marrow
Periosteum
Spongy bone
Compact bone
Periosteum


Spongy
Bone
Yellow
Marrow
Compact
Bone

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Categories of bones

1. Long bones:
2. Short bones:
3. Flat bones:
4. Irregular bones:
5. Sesamoid bones:
6. Sutural bones:

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BONE FORMATION AND GROWTH

1.Osteoblasts (bone forming cells) mononuclear, cells of mesenchymal origin.

2.Osteoclasts (bone eating cells).

3.Osteocytes (cells of the matrix) found in mature adult bone.

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BONE METABOLISM

Bone metabolism is under constant regulation by a host of hormonal and local factors. Three of the calcitropic hormones that most effect bone metabolism are parathyroid hormone, vitamin D and calcitonin.

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BONE METABOLISM

- Vitamin D regulates calcium absorption and excretion, especially when calcium intake is low.
- When calcium levels in the blood drop, parathyroid hormone (PTH) is released. PTH causes calcium to be released from the bones; this then raises the low calcium levels in the blood.
- Calcitonin reduce blood calcium (Ca^{2+}), opposing the effects of parathyroid hormone (PTH).

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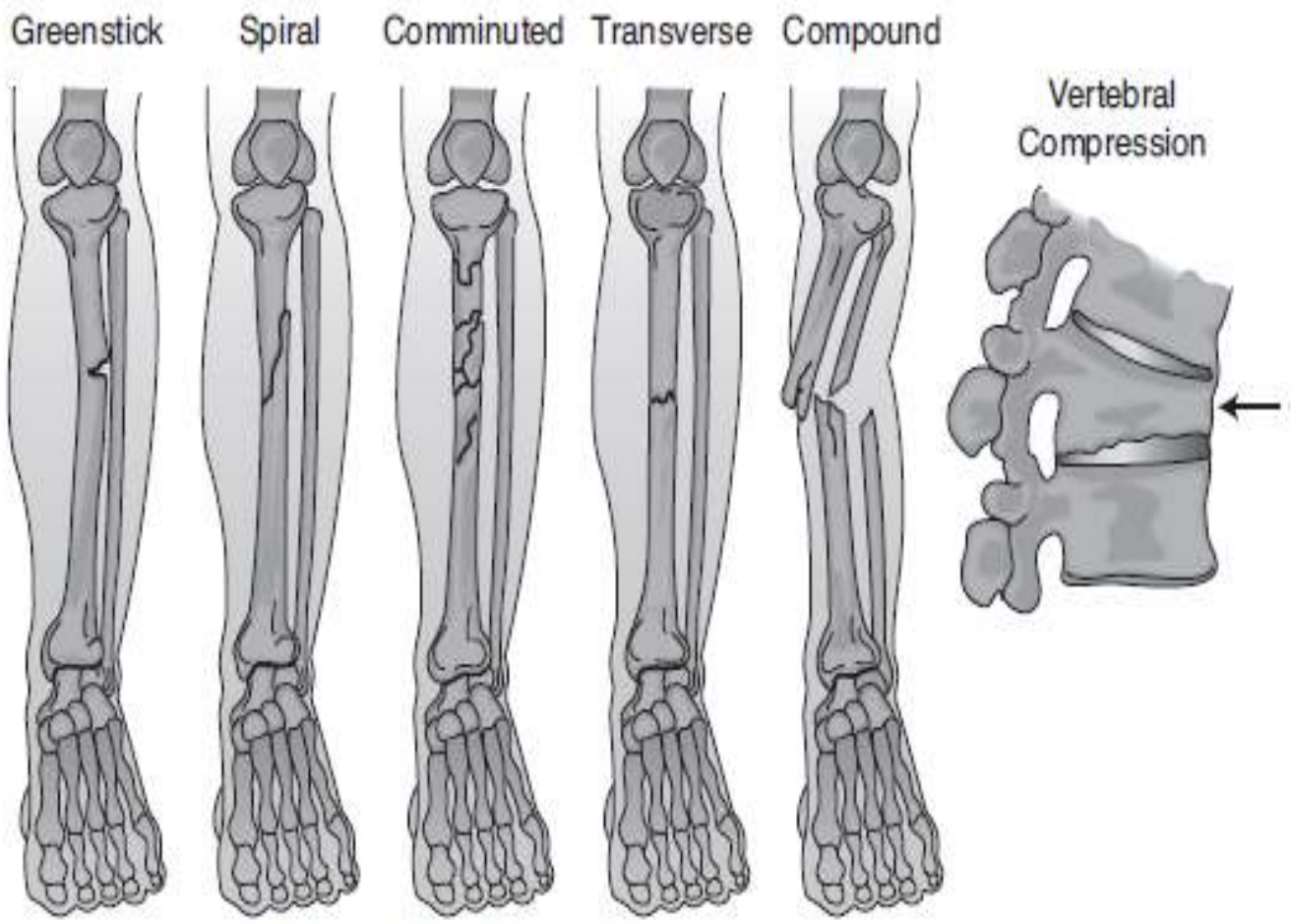
CARTILAGE

- Hyaline cartilage (articular) – covers joint surfaces
- Fibrocartilage – knee meniscus, vertebral discs
- Elastic cartilage – outer ear



Typical Bone Fractures

Diagram illustrating common fractures.

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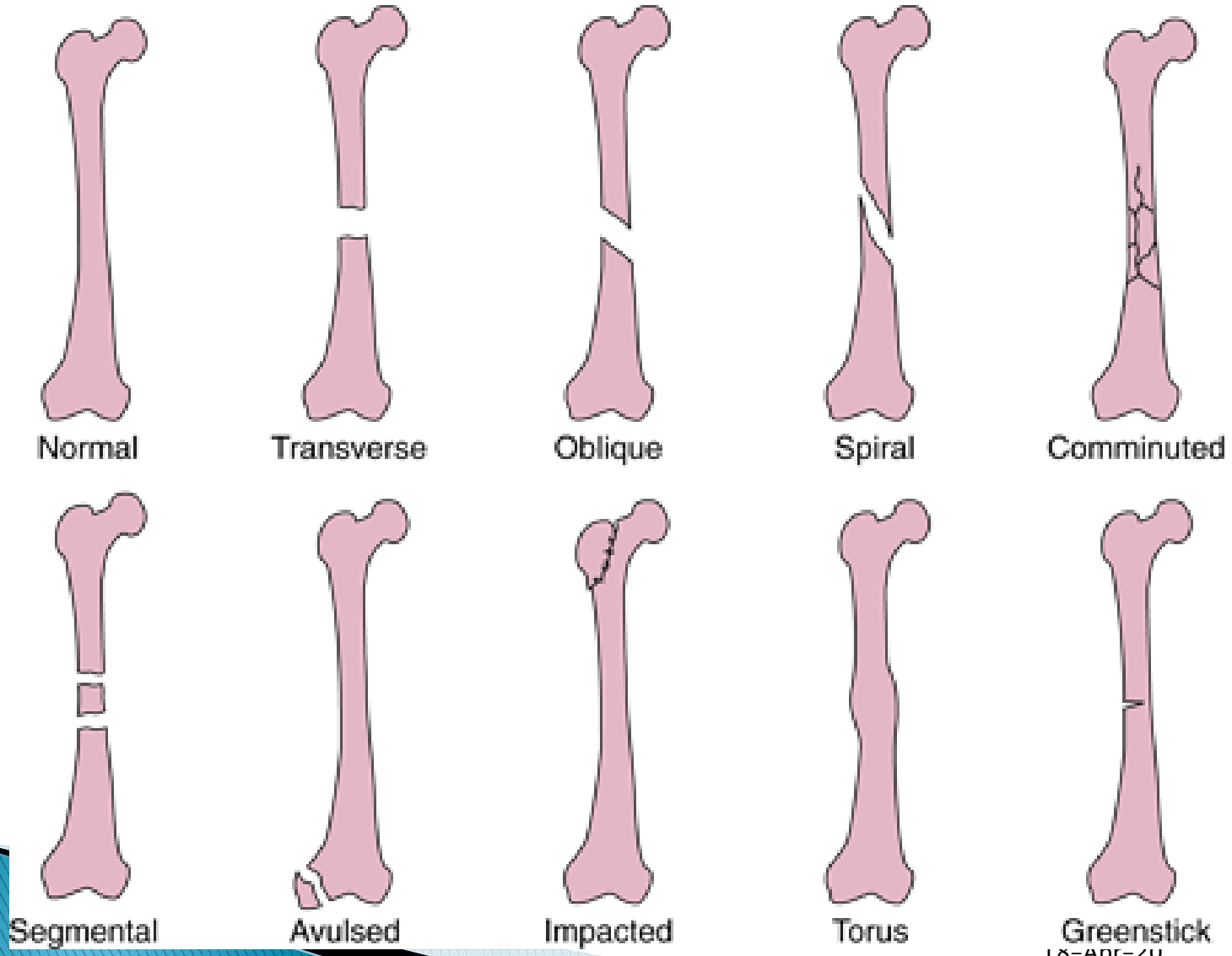
TYPES OF FRACTURE



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Stress fractures ???

Stress fractures occur mostly on legs and feet from repetitive stress on those areas from sports like sprints, hurdles, gymnastics etc., which requires constant running and jumping.

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Stress fractures

1. Insufficiency fracture
2. fatigue fracture

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Several mechanisms of Stress fractures

1. Weight bearing
2. Muscle actions
3. Muscle fatigue
4. Running

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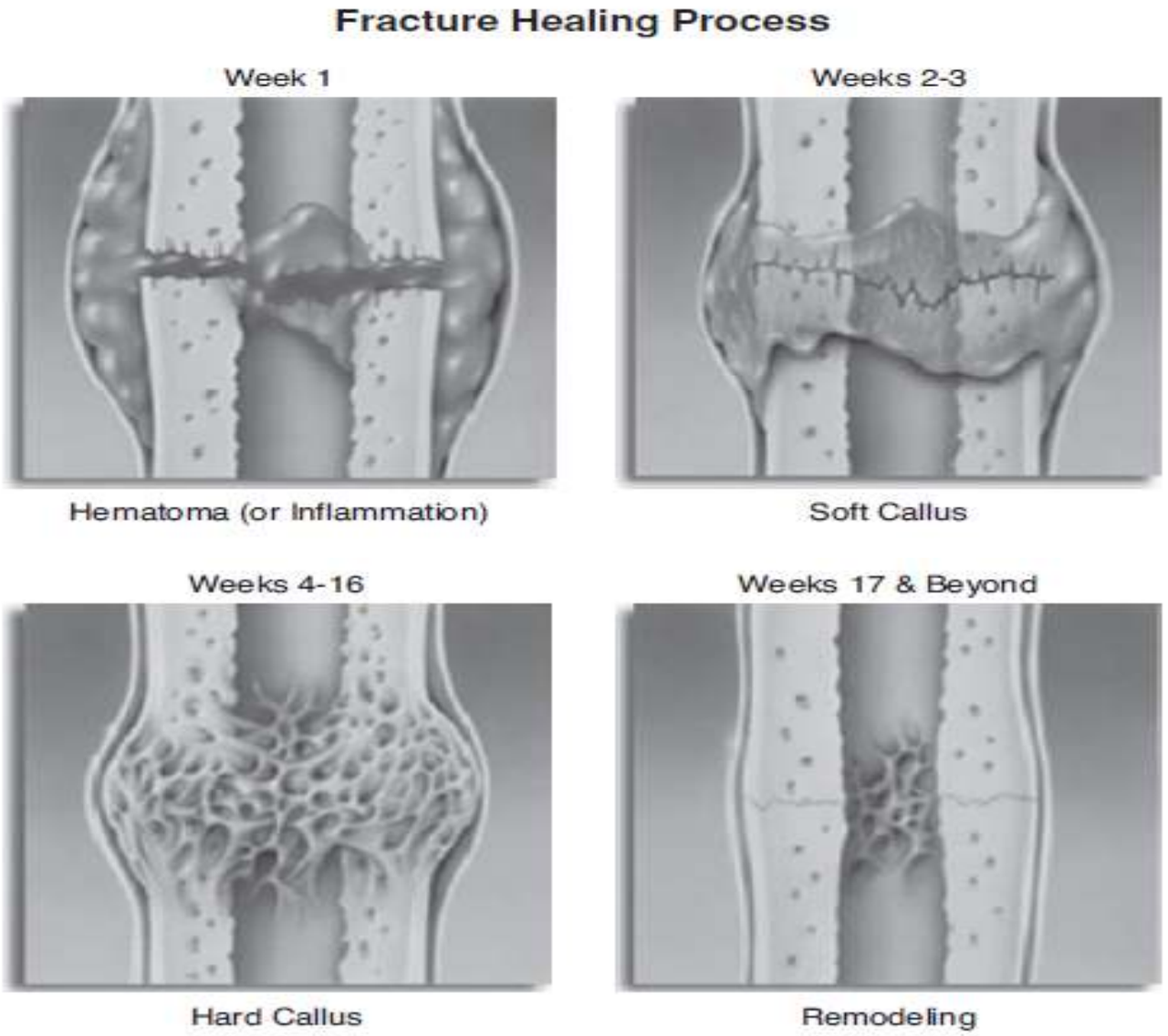
CLINICAL FEATURES OF A FRACTURE

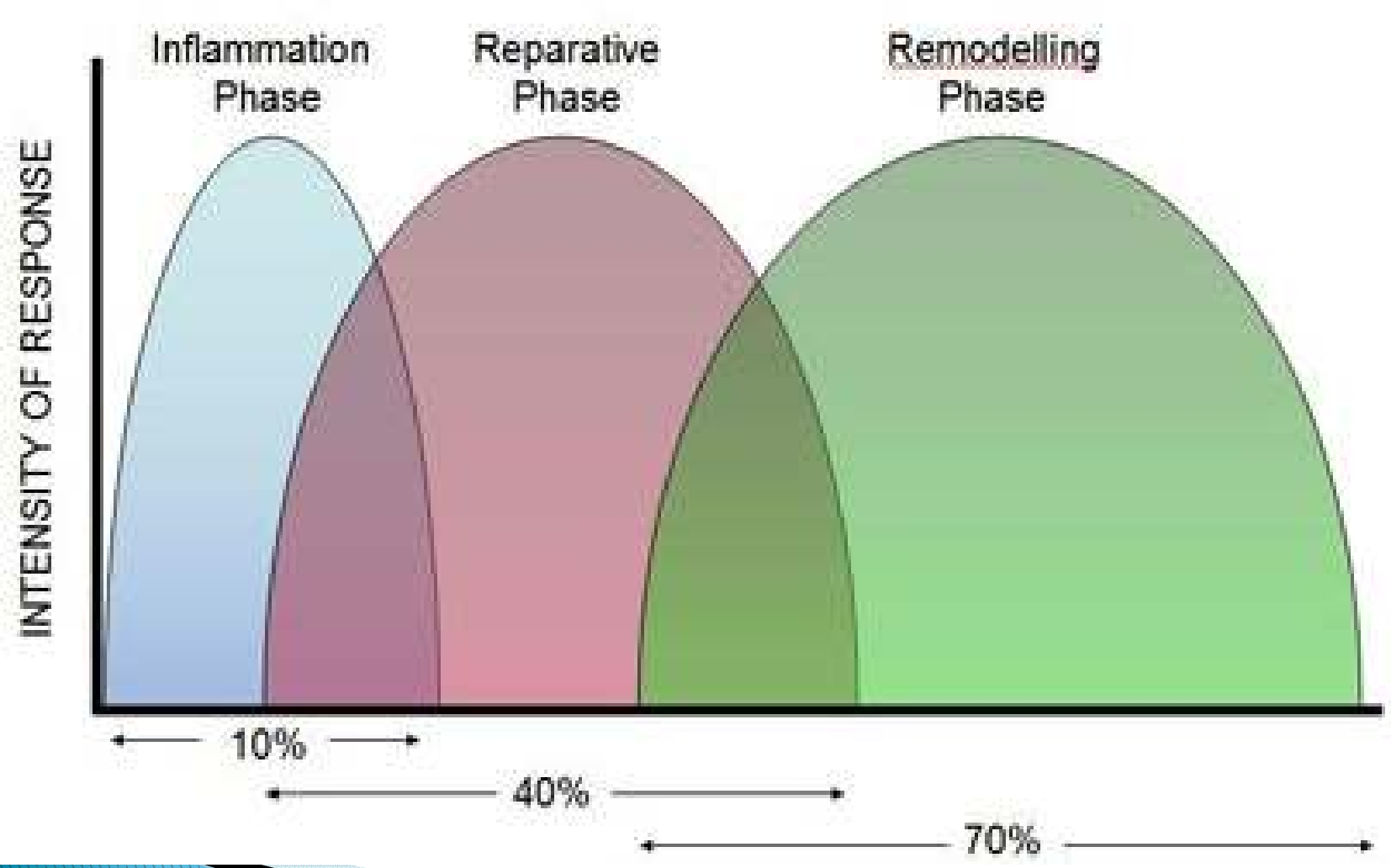
1. PAIN
2. DEFORMITY
3. OEDEMA
4. MUSCLE SPASM
5. SHOCK
6. ABNORMAL MOVEMENTS
7. LOSS OF FUNCTION
8. LIMITATION OF JOINT MOVEMENT.

STAGE OF FRUCTURE HEALING



Fracture healing process.

STAGES OF FRACTURE HEALING



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Healing remodeling process during injury/rehabilitation

- About 20% of all bone tissue is replaced annually by the remodeling process. The total process takes about 4–8 months, and occurs continually throughout our lives.

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Effects on the bone healing process

Nutrition

Calcium plays an important role in helping attain peak bone mass during bone development and preventing fractures in later life. The daily recommended allowance of calcium intake is _____ (Thatcher et al. 2009).

800-1200 mg

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Effects on the bone healing process

Multiple factors can affect the bioactivity of calcium:

- High-fat or high fibre diets can interfere with or decrease the activity of calcium
- Large doses of ZINC supplementation or mega doses of vitamin A can lower calcium bioactivity
- High protein diets can decrease calcium reserves by increasing Urinary excretion of calcium

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Effects on the bone healing process

- Effect of NSAID's on fracture healing
- Prostaglandins mediate inflammation, influence the balance of bone formation and resorption; processes that are essential for new bone formation.
- NSAIDs inhibit cyclo-oxygenases, which are essential for prostaglandin production (Dumont et al. 2000).

PATHOPHYSIOLOGY OF SKELETAL INJURIES
Effects on the bone healing process

- Conditions that have a negative effect

1. Infection
2. Poor reduction (poor realignment of fracture)
3. Loss of local blood supply due to injury
4. Vascular injury
5. Failure to make callus (metabolic abnormalities)

PATHOPHYSIOLOGY OF SKELETAL INJURIES
Effects on the bone healing process

- Conditions that have a negative effect

6. Formation of scar and fat tissue instead of callus
7. Poor nutrition
8. Alcohol abuse
9. Smoking.

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Risk factors for osteoporosis

- The patient's sex
- Age
- Vertigo
- HIV
- Gastric
- Ethnicity
- Family history
- People with small frames
- Smoking
- Estrogen exposure
- Anorexia and/or bulimia
- Cardiovascular disease
- Some medications:
  - Corticosteroids
  - Selective serotonin reuptake inhibitors (SSRIs)
  - Blood thinning medications
  - Methotrexate
- Thyroid hormone
- Breast cancer

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Risk factors for osteoporosis cont;

- Long-term low calcium consumption
- Some medical conditions and surgical procedures –
  - Gastrectomy (stomach surgery)
  - Crohn's disease
  - Celiac disease
  - Vitamin D deficiency
  - Cushing's disease
- Long-term physical inactivity
- Too much caffeine consumption
- Alcoholism
- Depression

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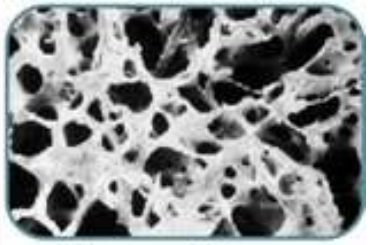
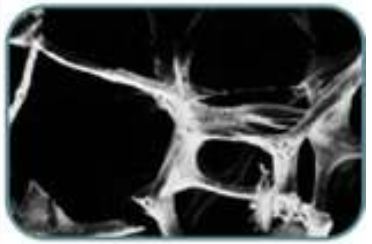
OSTEOPOROSIS DIAGNOSIS

BMD Through DEXA Scan

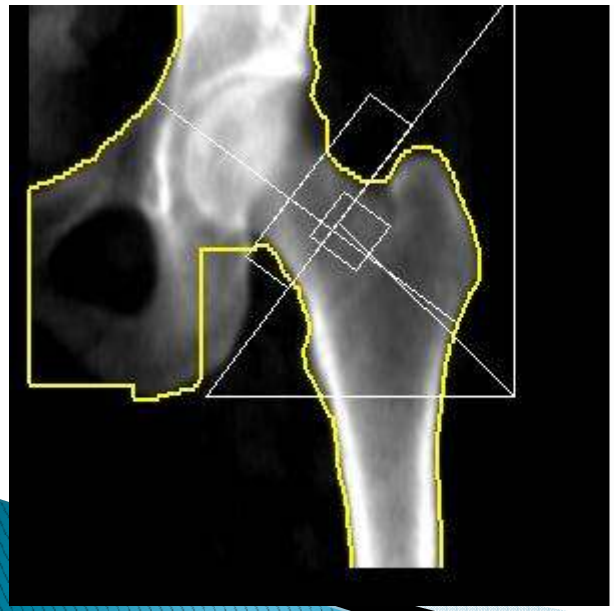
- **Normal**: A bone BMD is considered normal if the T-score is within 1 standard deviation of the normal young adult value. Thus a T-score between 0 and -1 is considered a normal result.
- **Low bone mass (medically termed osteopenia)**: A BMD defines osteopenia as a T-score between -1 and -2.5. This signifies an increased fracture risk but does not meet the criteria for osteoporosis.
- **Osteoporosis**: A BMD less than -2.5 standard deviations from the normal defines osteoporosis.

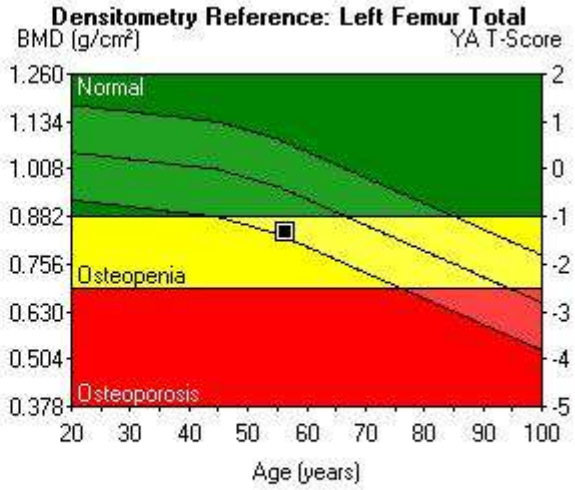


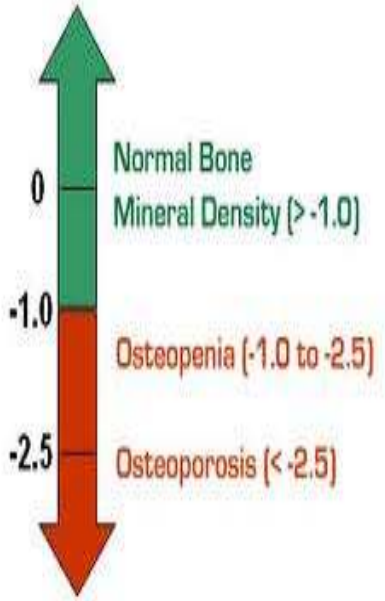
Normal Bone



Osteoporotic Bone







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- According to the WHO diagnostic criteria, women with bone density levels more than 2.5 standard deviations below the young adult reference mean are considered to have osteoporosis (Kanis et al. 1994).

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- One mode of athletic activity, gymnastic training, invokes high impact loading strains on bone, which many have powerful osteogenic effects (Taaffe et al. 1997).

PATHOPHYSIOLOGY OF SKELETAL INJURIES
The Female Athlete

- The female triad is defined as a serious syndrome (Micklesfiled et al. 2007) consisting of three interrelated components:

1. Disordered eating
2. Amenorrhea
3. Osteoporosis.

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The Female Athlete

- The athletes most at risk are those participating in sports in which success is determined by thinness and aesthetics (Micklesfiled et al. 2007).

PATHOPHYSIOLOGY OF SKELETAL INJURIES
The Female Athlete

- Extensive reports confirm that female athletes who present with menstrual dysfunction have a lower BMD than amenorrhoeic athletes (Marcus et al 1985).

Thank you