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Y Drindod Dewi Sant
University of Wales
Trinity Saint David

‘TRANSFORMING EDUCATION, TRANSFORMING LIVES.....’

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Learning Outcomes

- Describe types of bony injury
- Discuss bone healing including timescales and timeframes that facilitate appropriate bone healing
- Discuss bones tolerance to loading



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Bony Anatomy

Constituents

- Organic (20-25%), Inorganic (65-70%), Water (10%)

Organic matrix

- 90% of the matrix is made of Type 1 collagen
- 8% is composed of proteoglycans and non collagenous proteins
- 2% is bone cells

Inorganic matrix

- Made of platelet-like crystals of hydroxyapatite (Ca,P)



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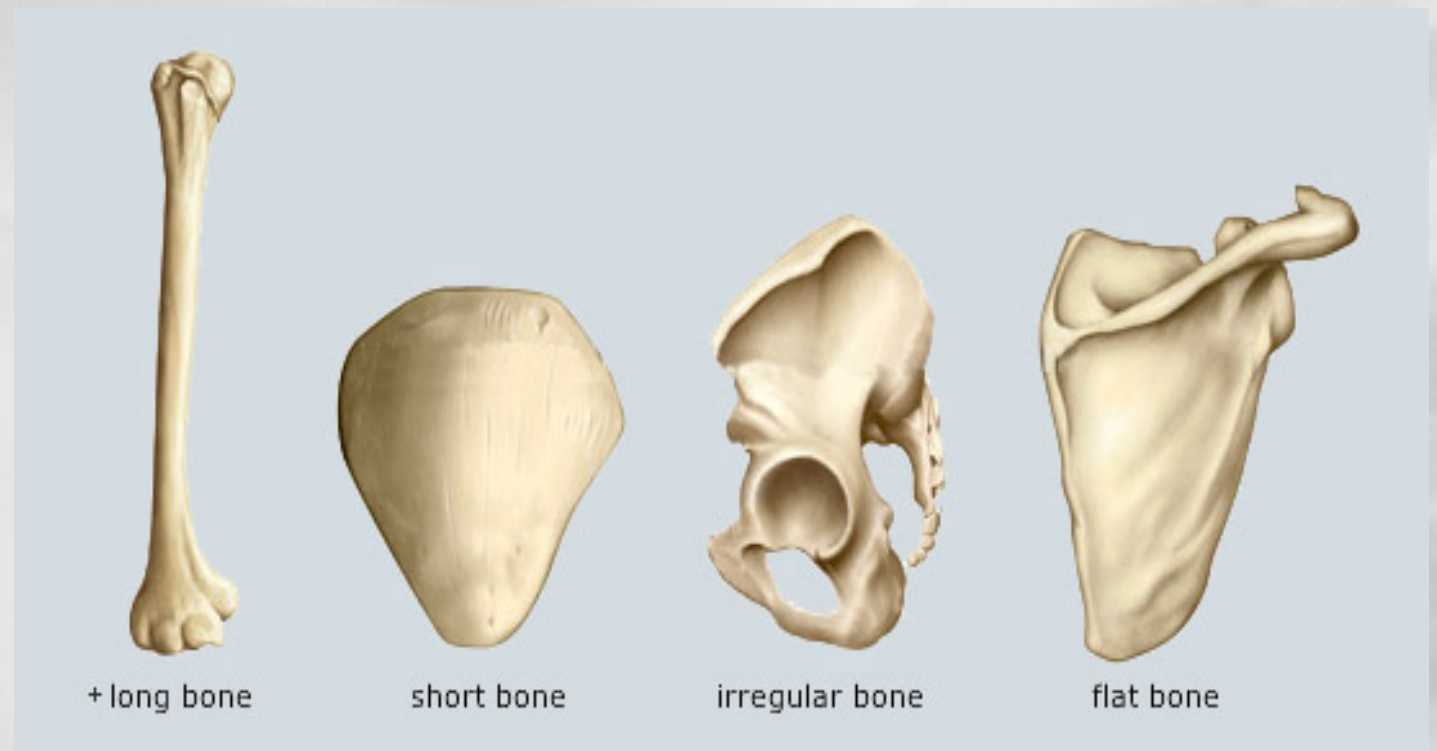
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Bony Anatomy

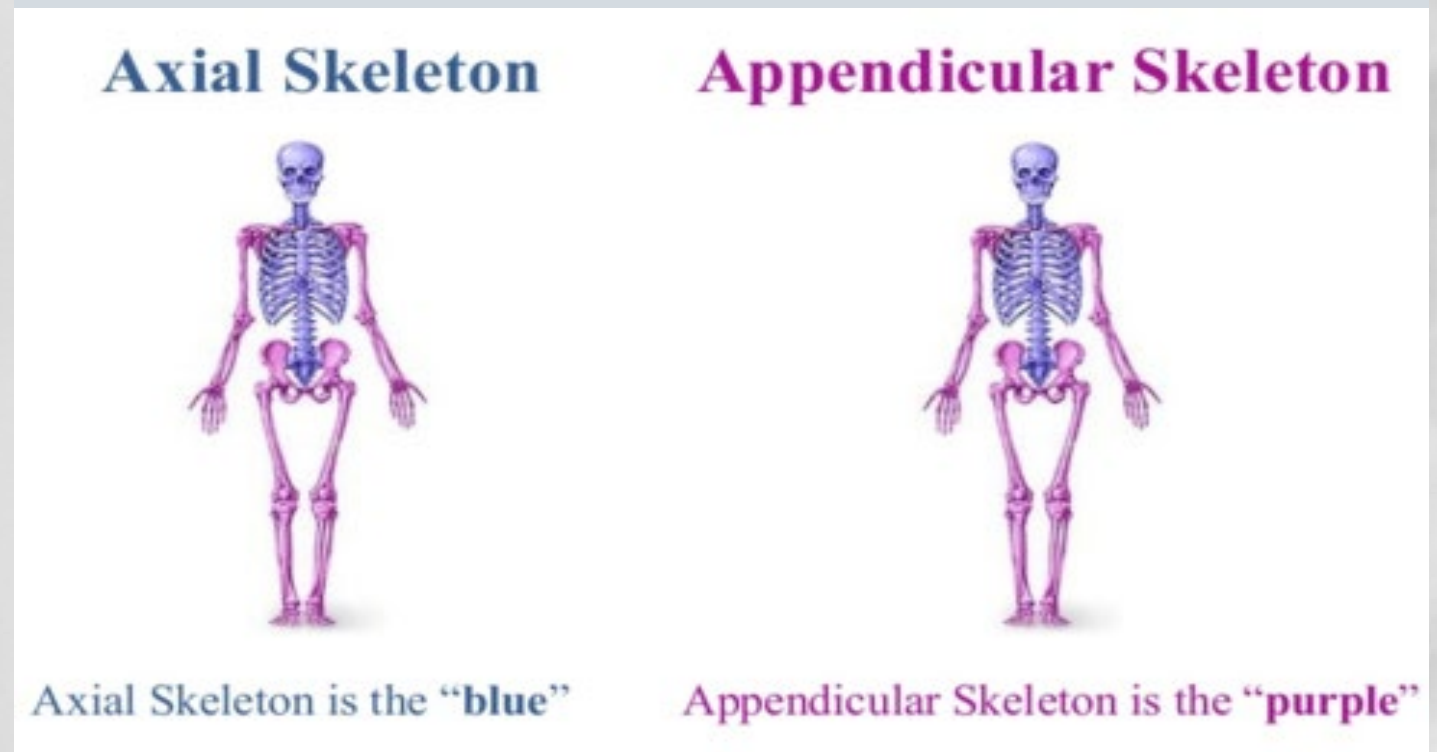
Types of Bones

- Long Bones
- Irregular
- Short
- Flat



Skeleton

- Appendicular
- Axial



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Bony Anatomy



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Bony Anatomy

Structure of Long Bones

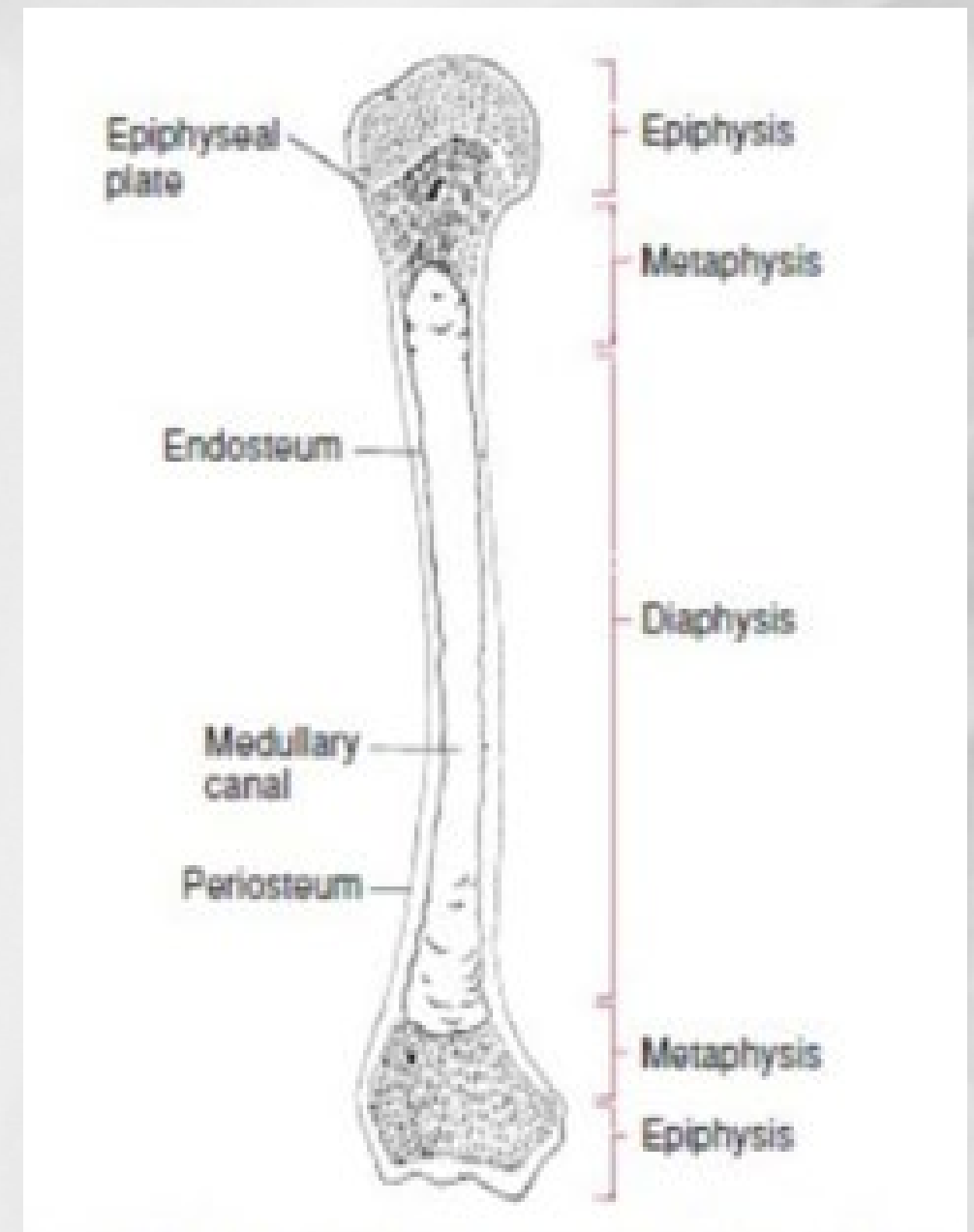
Types of tissue/ Terminology:

Woven – Immature form of bone, birth, growth, # healing

Lamellar – replaces woven

Cortical – hard (calcium 80-90%), structure/ protection

Trabecular – spongy, allows blood, tissues and bone marrow through



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Bony Injury

Potential Forces

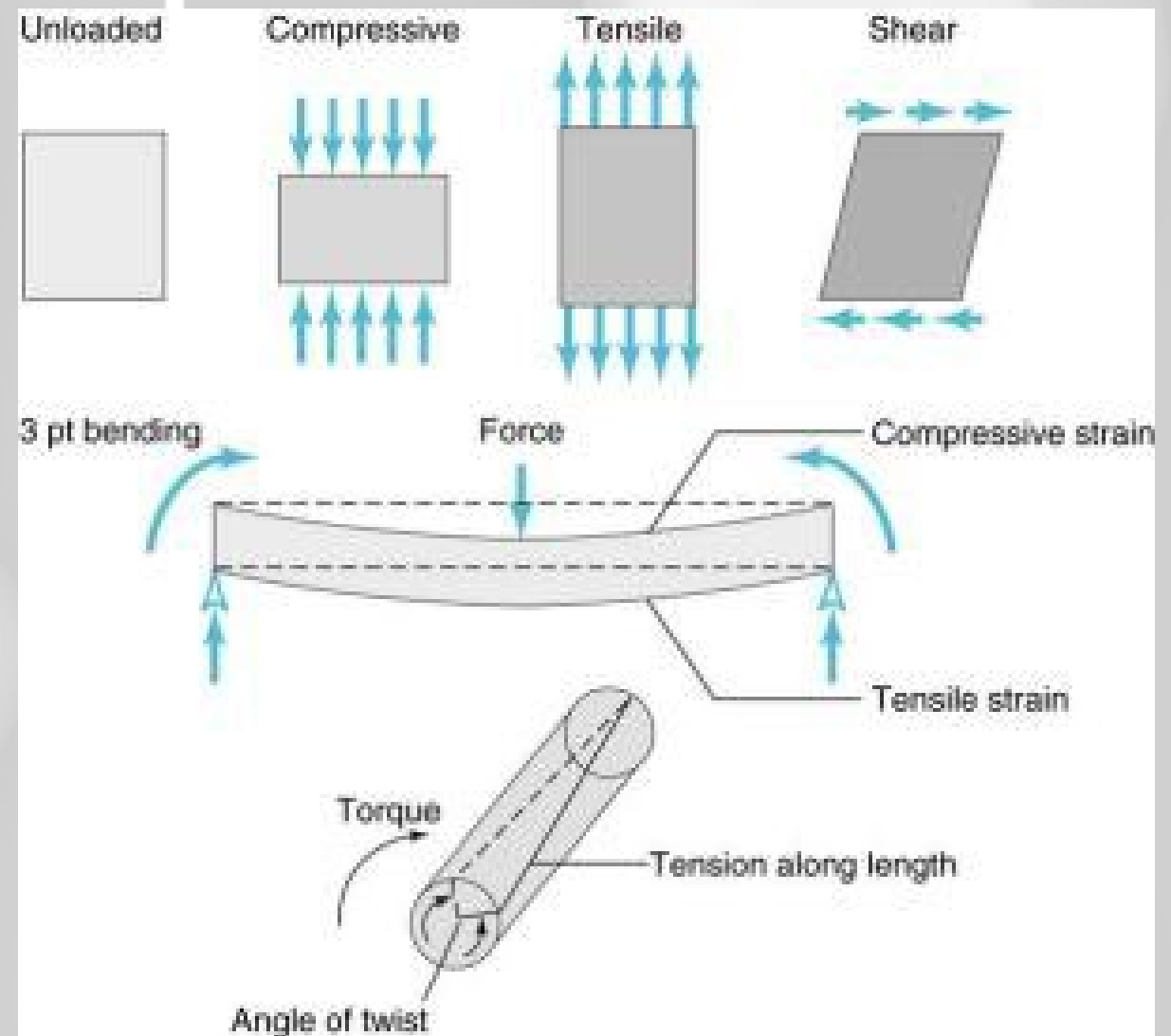
Tensile

Compression

Transverse

Torsion

Anisotropic



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Bony Injury

Bony Loading

Strain magnitude proportional with bone formation

Strain rate proportional to adaptive response

Irregular strain distribution leads to increased osteogenesis, whereas repetitive strains leads to reduced osteogenesis.

Strain cycles – a minimum number required to elicit a positive bone response.



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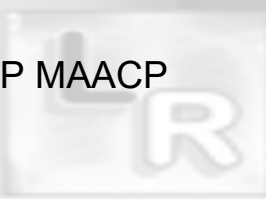
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Clinical Point

Osteoporosis

Condition characterised by low bone mass and microarchitectural deterioration leading to skeletal fragility and increased risk of fractures.

RISK FACTORS

- Family Hx, Postmenopausal, Late onset menstrual periods, sedentary life, inadequate Ca/ Vit D, smoking, alcohol, caffeine, somatotype,
- Caucasian, Asian



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Bony Injury

Types of Bony Fracture

Simple/Open/Closed
Communitied/Greenstick/Avulsion
Transverse/Spiral/Oblique

ABC

Alignment
Bones
Cartilage



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Bony Injury



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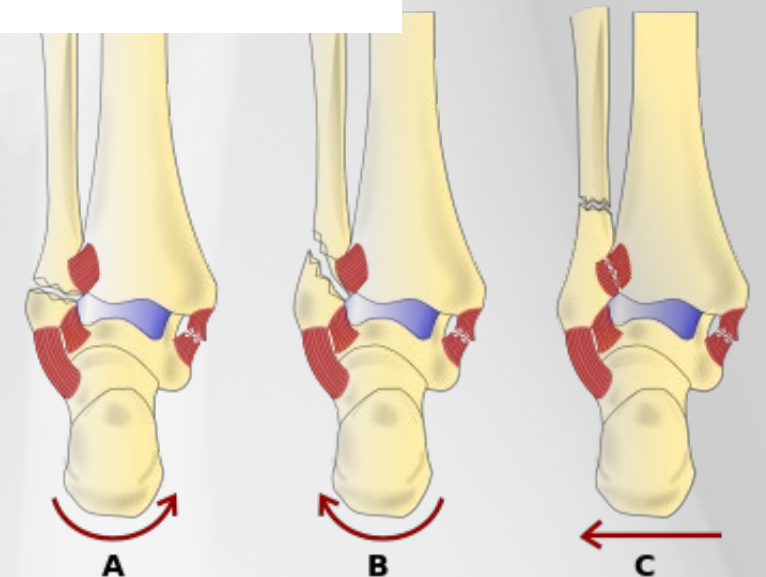
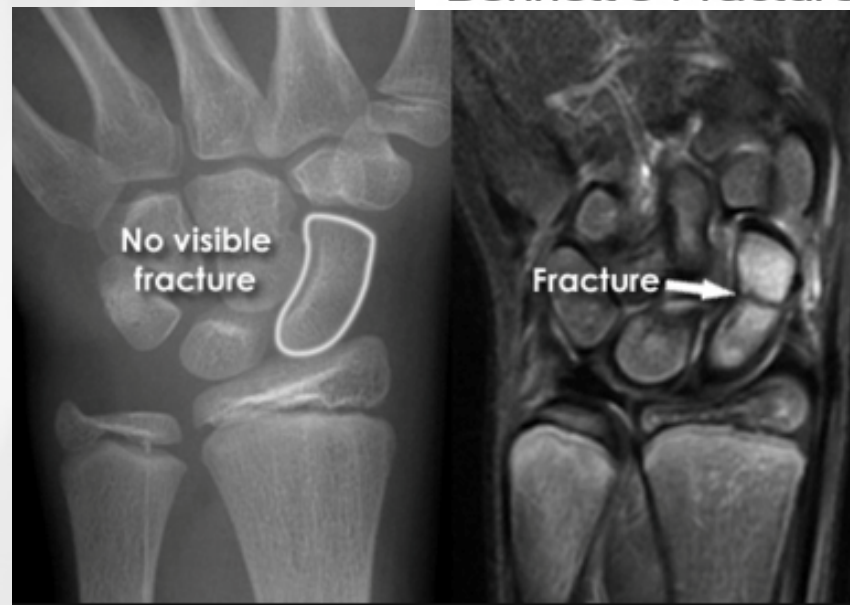
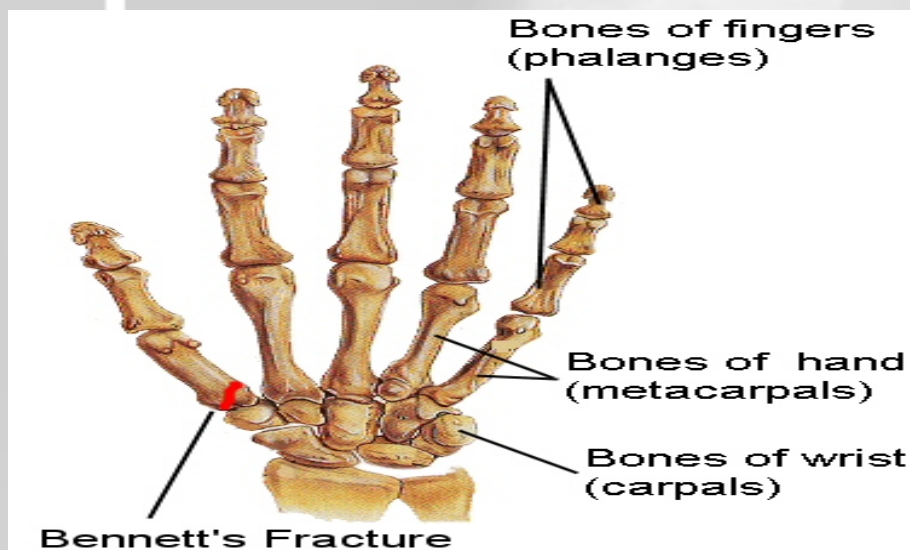
Common Sporting Fractures

Where are the most common fractures in general population?

Bennetts

Scaphoid

Weber



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Bony Injury

Other Bony Injuries

Contusions

Sub-periosteal – blood under periosteum, high force
Inter-osseous – high compressive force, b/v affected
Subchondral – cartilage and bone disrupted, bleed.

Stress Fractures

Accumulation of microdamage that is not adequately repaired by remodeling process.



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Bony Injury

Wolff's Law – Remodelling

Balance between osteoblasts and osteoclasts

- Osteoporosis occurs when osteoclast activity Predominates

- Piezoelectric effect – generation of electrical charge through mechanical stimulus (squeeze).

- Potential to be altered by electrotherapy?



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Bony Injury



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Bony Injury

Bony Stress Reaction

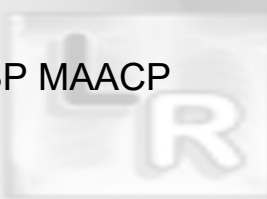
Symptoms often occur before radiological change

Grade 0	1	2	3	4
Normal remodelling	Mild stress reaction	Moderate reaction	Severe reaction	Stress Fracture
Detectable by bone scan	Positive bone scan, not detectable on X Ray No structural compromise	Positive bone scan Minimal changes on X Ray No structural compromise	Positive bone scan, positive X Ray Structural changes evident	Positive bone scan Positive X-Ray Structural failure
Asymptomatic	Local pain during activity No pain at rest	Local pain during activity Tender to palpation at rest	Significant pain Does not stop with cessation of exercise Palpable mass	Extreme pain with weight bearing, compression, percussion, vibration



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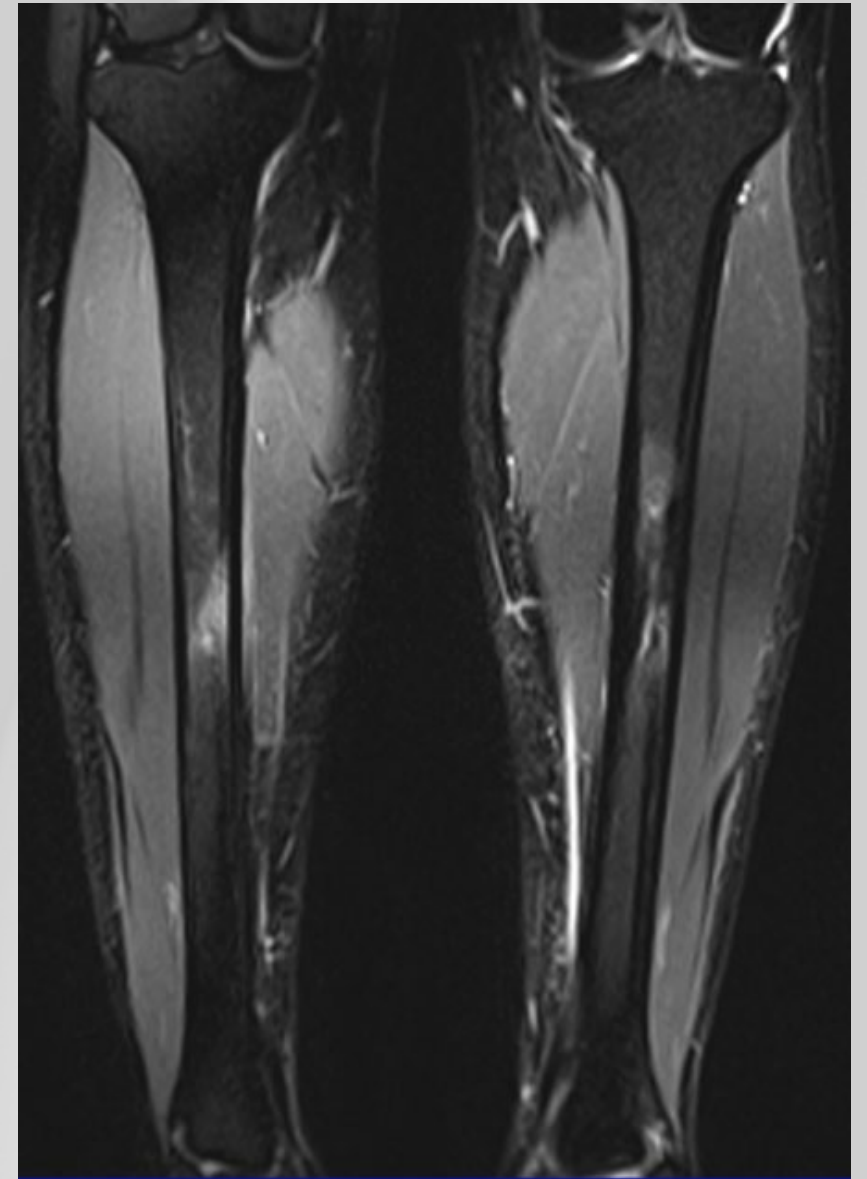
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Bony Stress Reaction

Symptoms often occur
before radiological
change

What factors cause Bony Stress?

Biomechanics/ Growth
Inflammatory/ Genetic



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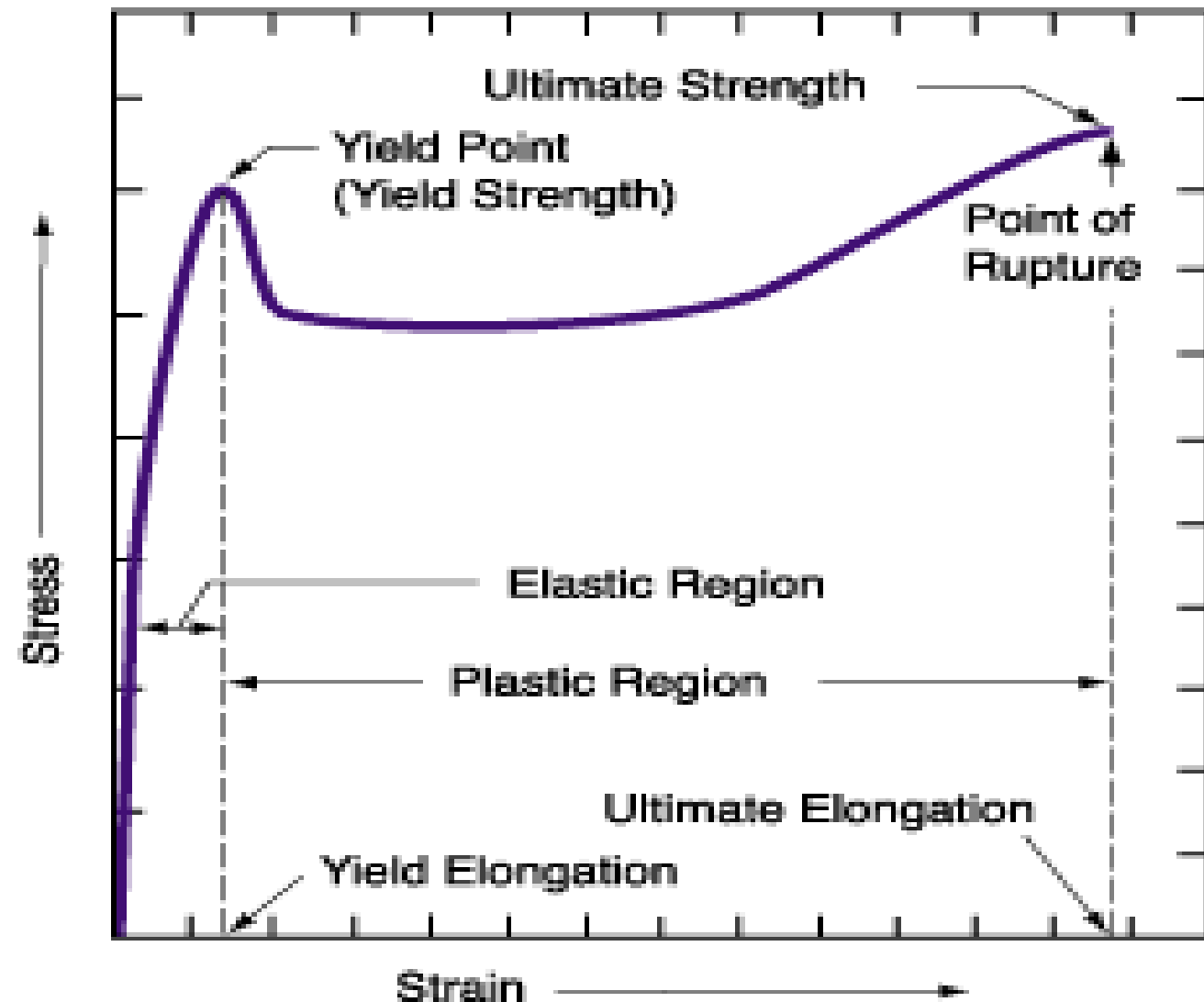
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Bony Injury

The Point of No Return

Typical Stress-Strain Curve



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Bony Injury

Fracture Healing – Management Principles

Reduction

- Ensure correct bone alignment

Immobilisation

- Maintain the alignment until sufficient healing has occurred

Rehabilitation

- Return to full function



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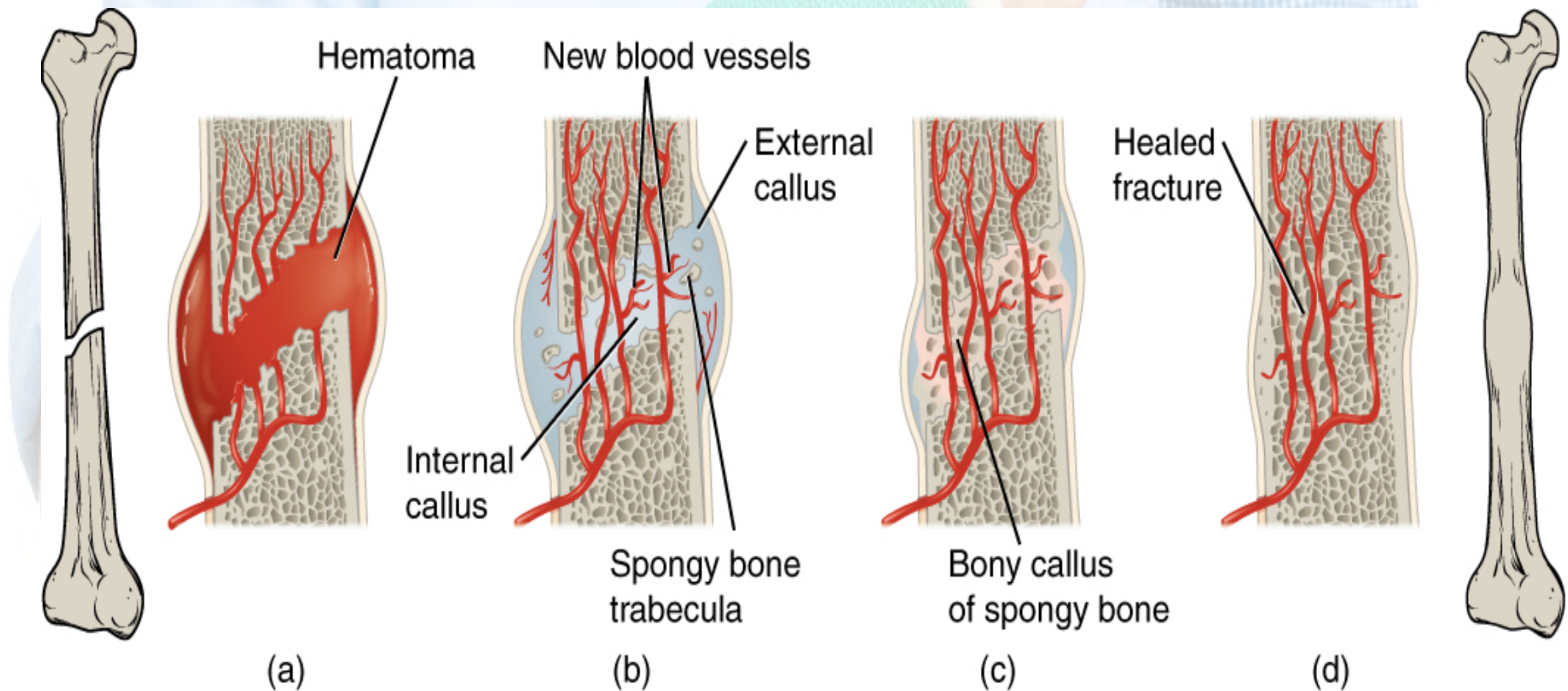
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Bony Injury

Fracture Healing



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Bony Injury

COFFEE BREAK TASK

Describe what these are? When they would be used? What areas of the body use these?

Open reduction internal fixation -

Cannulated Screws –

I/M Nail –

External fixation –

K-wires –



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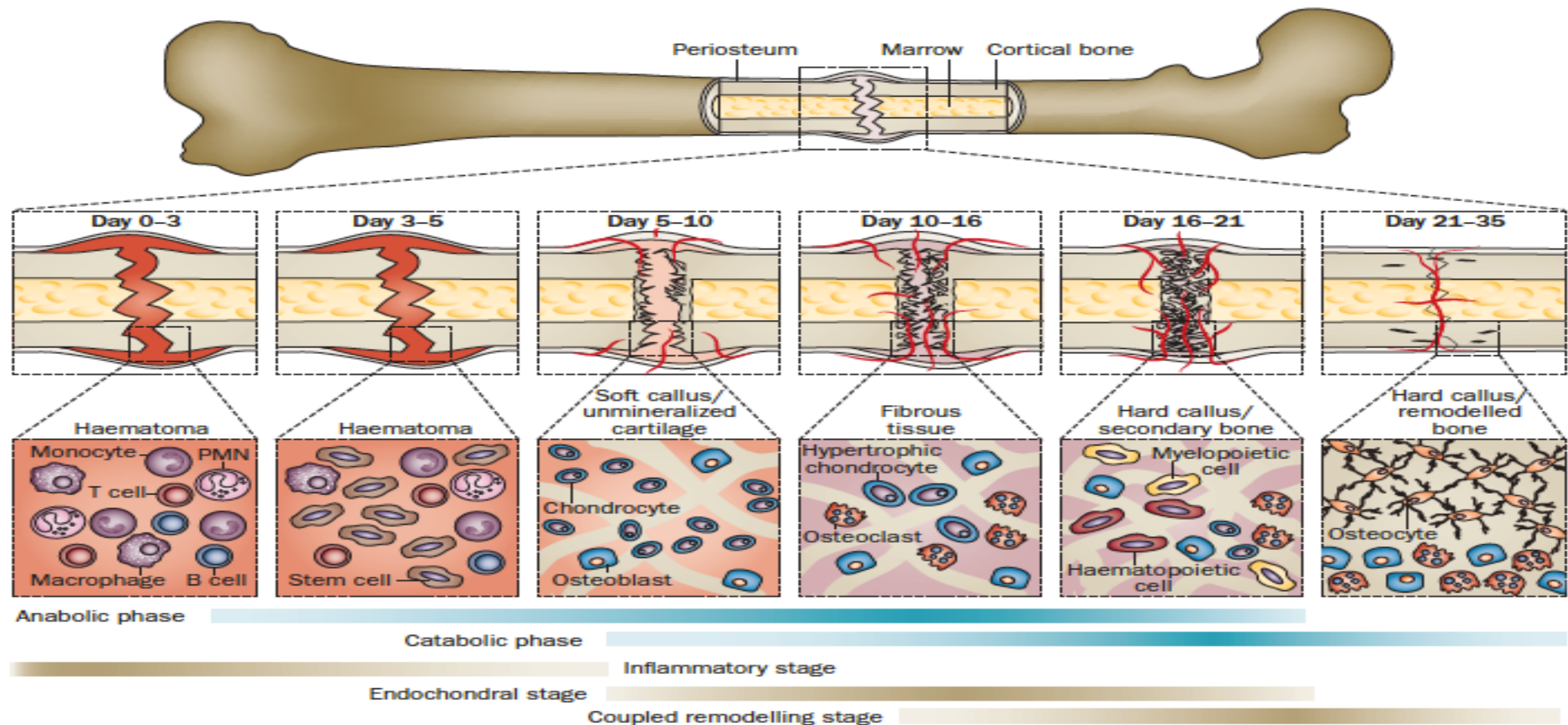
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Fracture Healing



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Bony Injury

Fracture Healing

Internal fixation

- Pins/Plates/Wires
- Prevent mvt #
- ↓ piezoelectric
- ↓ mechanotherapy
- Longer Healing Time
- < 1yr
- Risk ↓ / ↑ of further #
- Removal of ORIF?

Callus

- Less stability in # site
- Compressive Load needed (P & FWB)
- No increased risk ↓ / ↑ #
- No hardware issues
- No surgery required
- Hypomobility of other joints?



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Bony Injury

Fracture Healing

- Union – callus formation, but # line still visible on X-Ray : PWB
- Consolidation – bone fully repaired, no movement at # site. Trabeculae bone crosses # site. FWB

Fracture Site	Union time (wk)	Consolidation time
Proximal 1/3 rd humerus	3	6
Distal 1/3 rd radius/ulna	6	12
Proximal 1/3 rd femur	4-6	8-12
Distal 1/3 rd femur	6	12
Proximal 1/3 rd tibia	6-8	12-16
Distal 1/3 rd tibia	8-10	16-20



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Fracture Healing

Application

- Bone responds better to compression forces
- Awareness of Tensile/Shear/Torsion/Bending

Factors affecting healing

- Age
- Pathology (Diabetes/ PVD/ Hypothyroidism)
- Drugs (Steroids/NSAIDs/Alcohol/Antibiotics)
- Lifestyle (Smoking/Diet – vit B6/C/D Protein ca^{2+})



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Example

A 24 year old football player has just fractured my right tibial plateau.
What factors are going to affect her recovery?



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Conclusion

Contusions/ Stress reaction/ Fracture

Healing

- Reduction
- Immobilisation (important decision)
- Rehabilitation

Factors affecting and promoting healing

- Oxygen? Mechanical Load, Piezoelectric stimulus, Age, Diet, Drugs, Lifestyle.



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