Renal Bone Disaese

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Epidemiology

Definition

NIH definition:

- **Osteoporosis** is a systemic skeletal disorder characterized by compromised bone strength to an increased risk of fracture.

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- Bone quality
- Bone quantity

Epidemiology

- A systematic review and meta-analysis
  - N: 103,334,579
  - Age:15–105 years

Journal of Orthopaedic Surgery and Research volume 16, Article number: 609 (2021)

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- Prevalence of osteoporosis in women of the world: 23.1 (95% CI 19.8–26.9)
- Prevalence of osteoporosis among men of the world was found to be 11.7 (95% CI 9.6–14.1)

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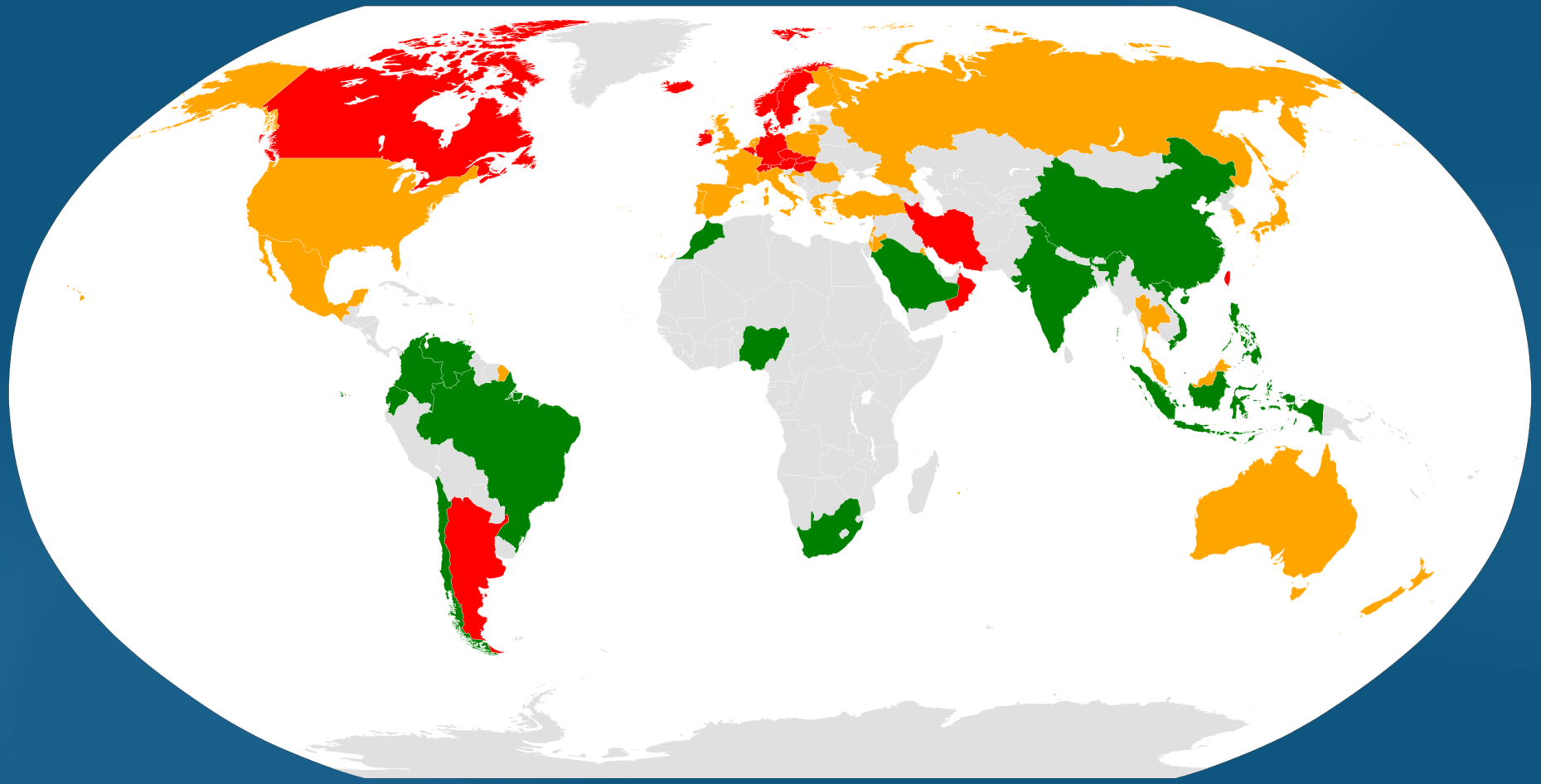

Age-standardised hip fracture rates in 2012.[199] Low (< 150 / 100 000) Medium (150–250 / 100 000) High (> 250 / 100 000)

Osteoporos Int 23, 2239–2256 (2012)

Definition

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- **Chronic Kidney Disease**, defned as a glomerular filtration rate (GFR) <60 ml/min per 1.73 m2 for >3 months.

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- **Chronic Kidney Disease**, defned as a glomerular filtration rate (GFR) <60 ml/min per 1.73 m2 for >3 months.
  - Affects up to 15% of adults
  - Almost half of elderly individuals

Epidemiology

- The prevalence of osteoporosis was 31.8% among CKD G3–5 patients in the Kashmir valley

Saudi J. Kidney Dis. Transplant. 2017;28:538–544

- According to the Third National Health and Nutrition Examination Survey (NHANES III), 24% of women and 11% of men with osteoporosis have advanced CKD (defined here as an estimated glomerular filtration rate [eGFR] < 35 mL/min/1.73 m2).

J Bone Miner Res. 2014;29(11):2520-2526.

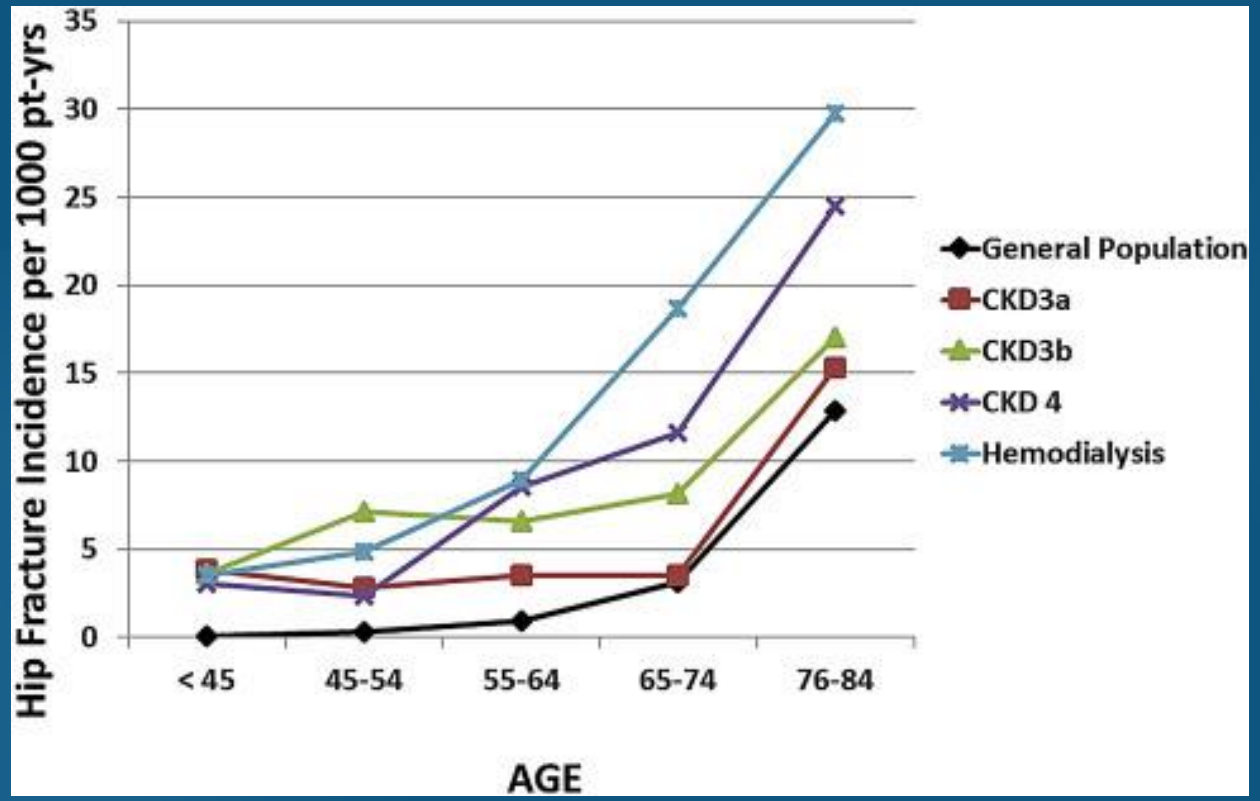
Epidemiology

Risks of Hip and Nonvertebral Fractures in Patients With CKD G3a–G5D: A Systematic Review and Meta-analysis

Am J Kidney Dis. 2020 Oct;76(4):521-532.

- Studies reported data from 250,440,035 participants
- 5,798,566 with CKD G3a-G5D
- **Conclusions:**
  - Risks for hip and non-vertebral fractures are increased in CKD G3a-G5D.
  - The relative risk of hip fracture is greater in the younger than the older population and increases progressively with loss of GFR.

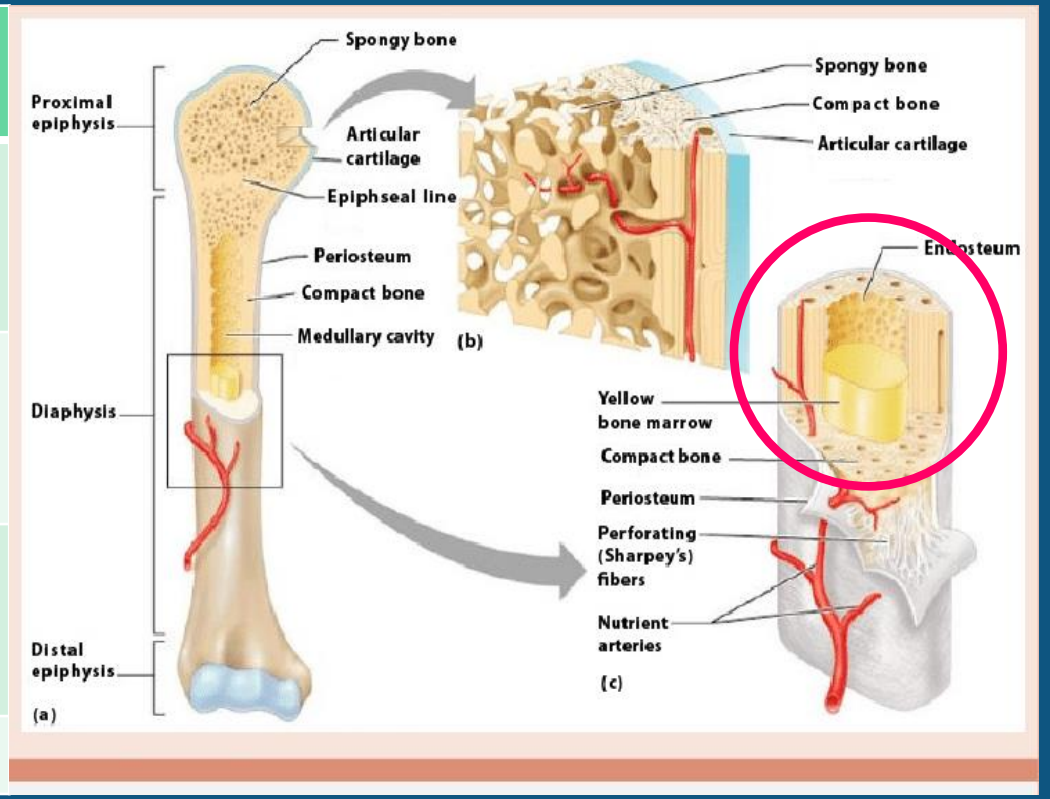
Epidemiology



Osteoporosis

Type of bone

	Cortical or compact bone	Trabecular or cancellous bone
Location	Outer shell of bones and the shafts of long bones	Ends of long bones, within vertebrae, and in the pelvis
Structure	Dense, solid, and organized into osteons (Haversian systems)	Porous, spongy, and composed of a network of interconnected rods
Function	Provides strength, support, and protection.	Provides shock absorption, and is metabolically active
Remodeling	Slower remodeling rate	Higher turnover rate



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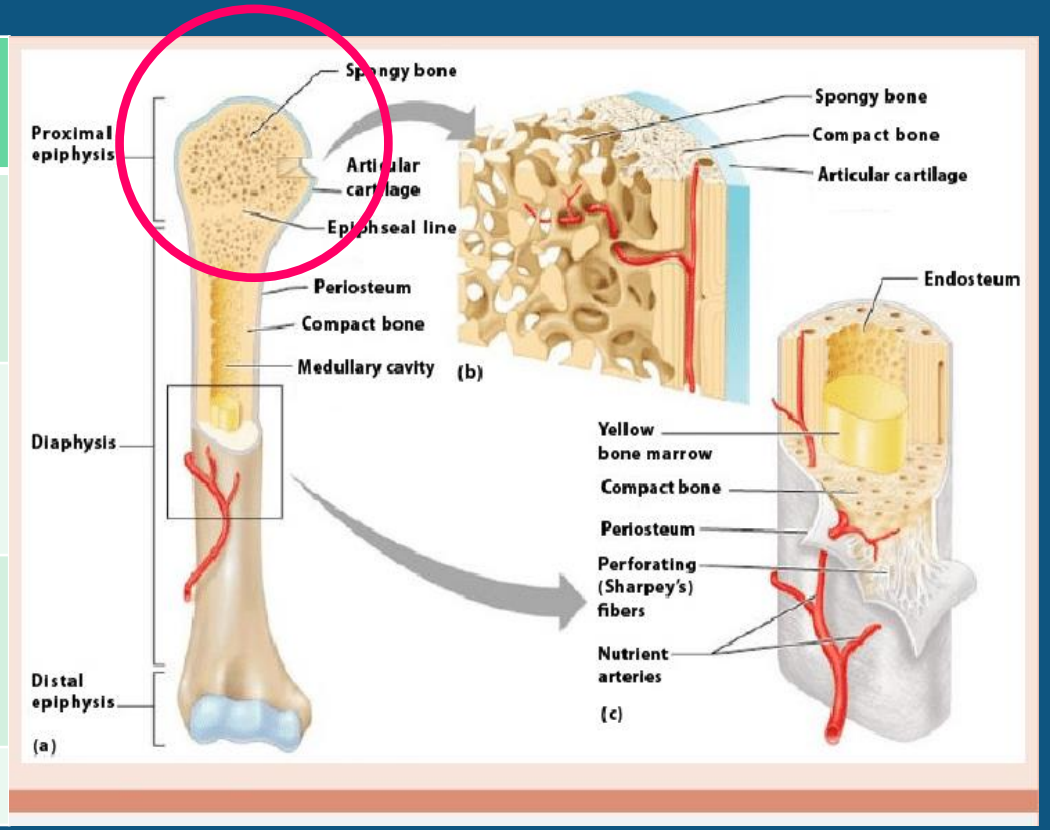
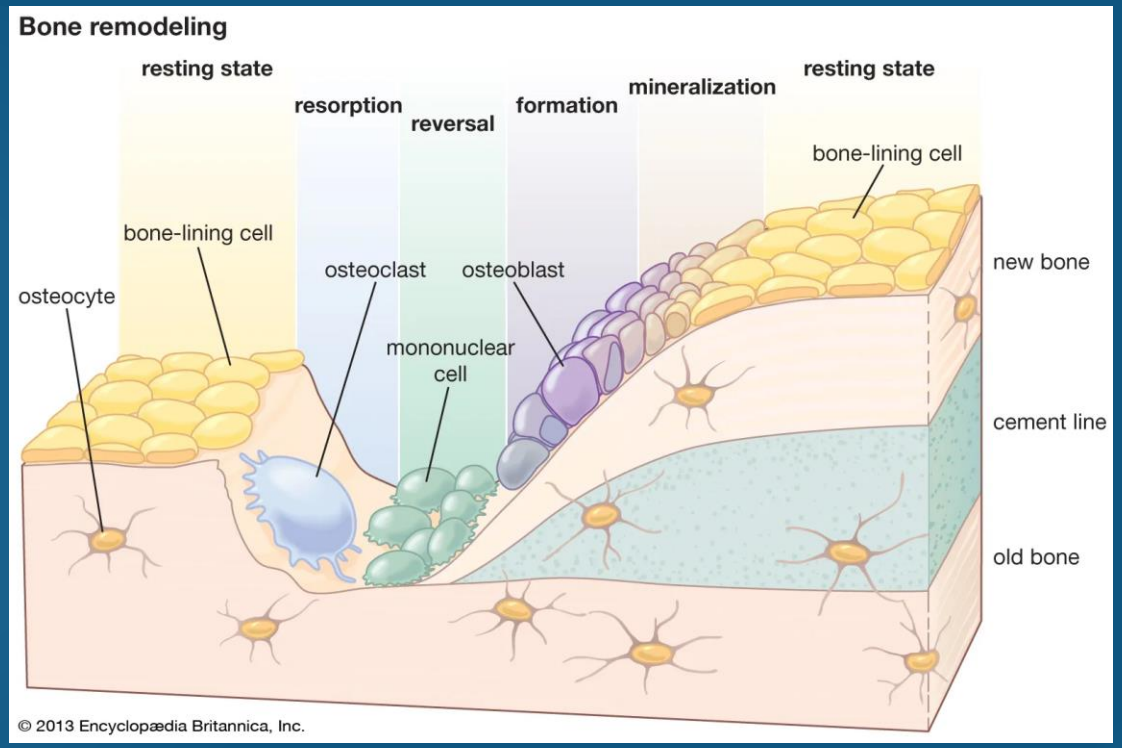
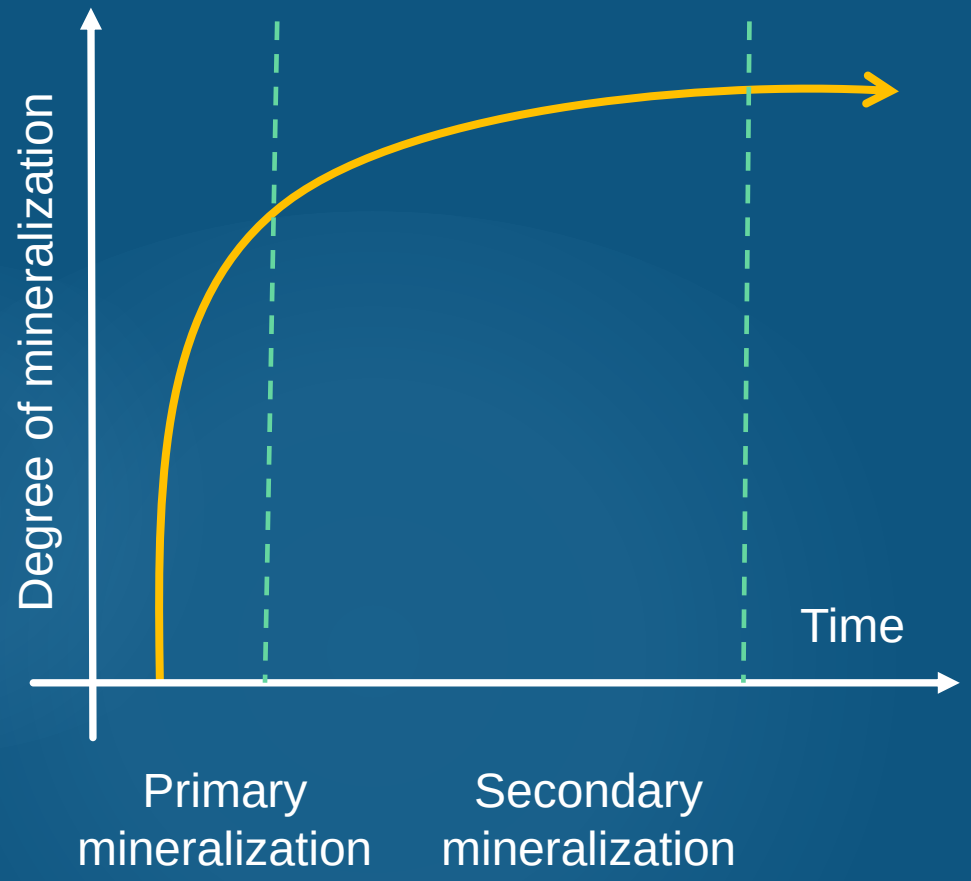


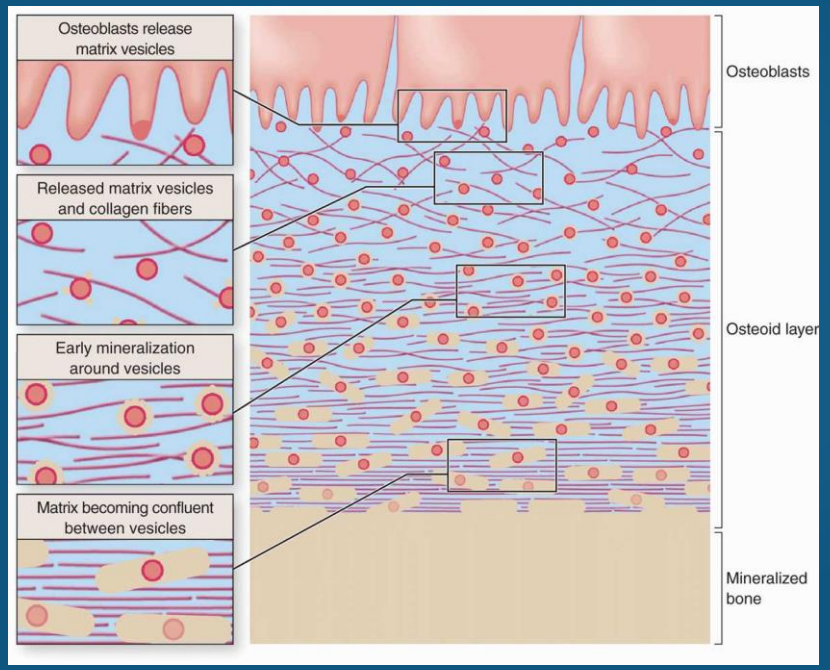
Bone remodeling

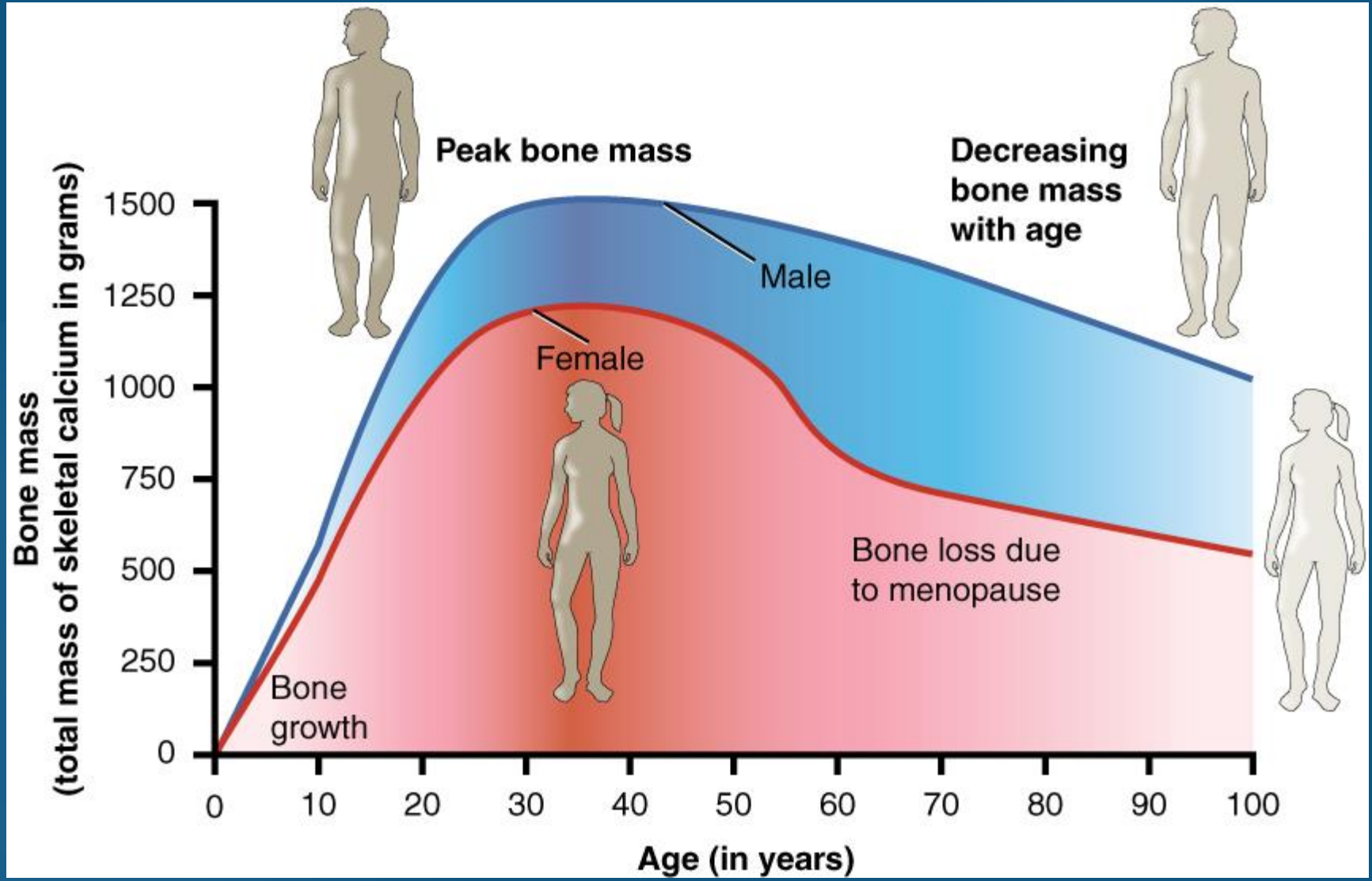
- Bone remodeling is a continuous process where old bone is resorbed and replaced with new bone.
- This process is crucial for maintaining bone strength, repairing microdamage, and regulating calcium levels in the body



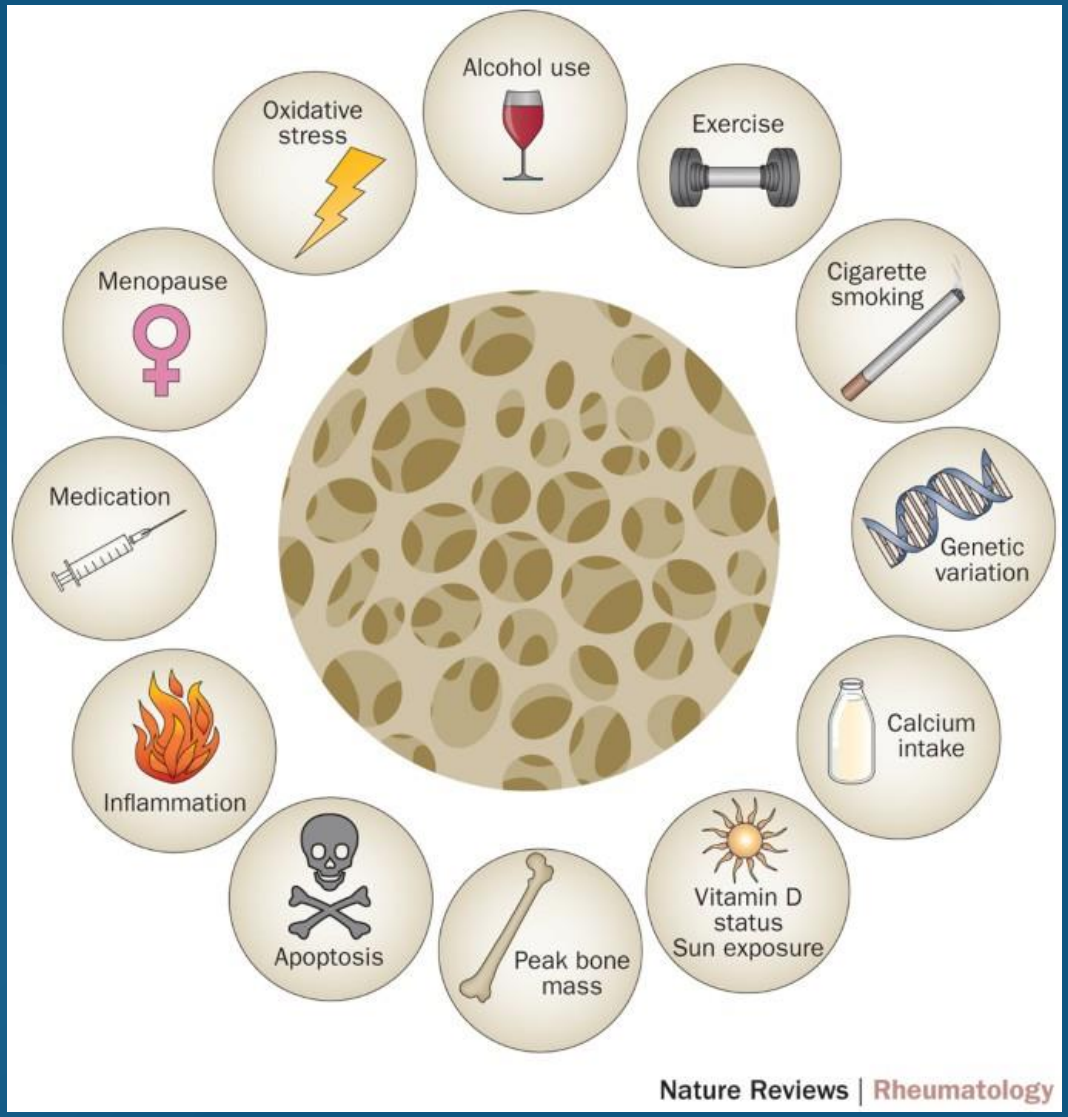
Primary vs secondary mineralization



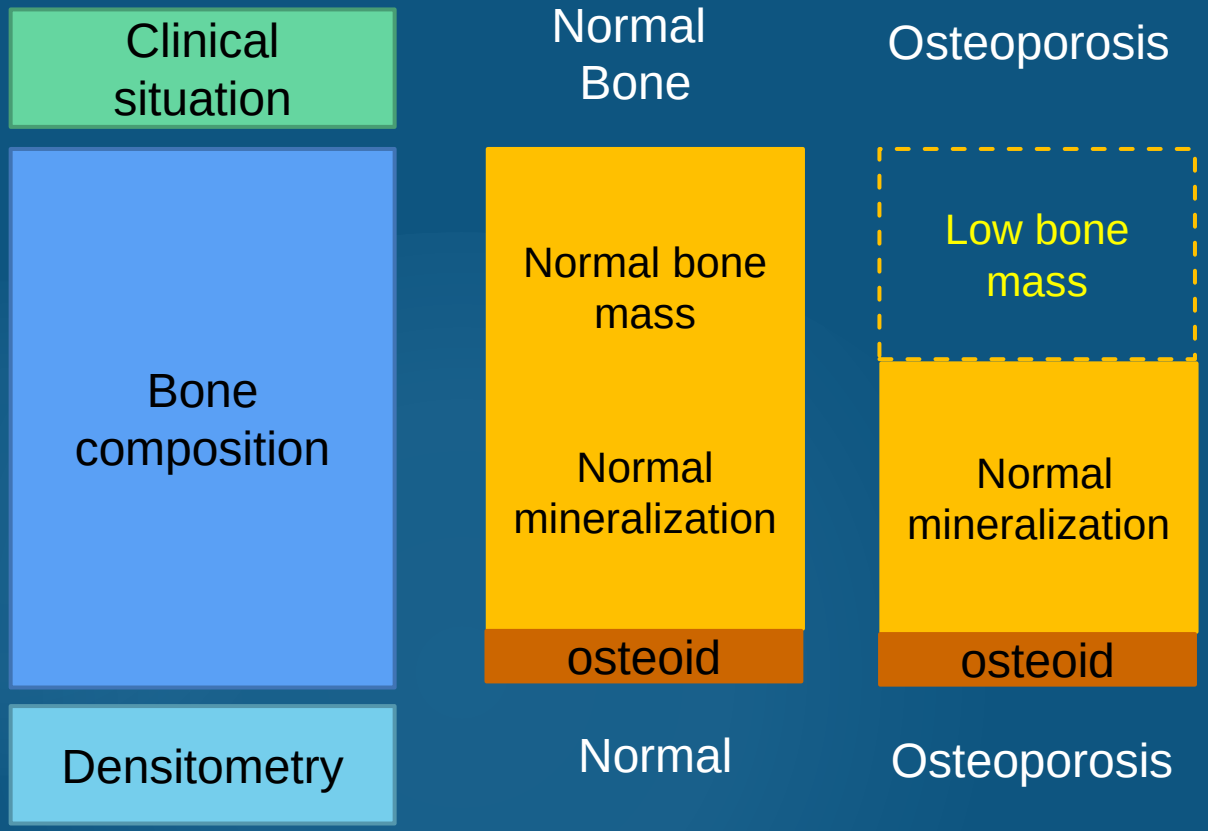



Peak bone mass
Decreasing bone mass with age
Male
Female
Bone loss due to menopause
Bone growth
Bone mass (total mass of skeletal calcium in grams)
1500
1250
1000
750
500
250
0
0
10
20
30
40
50
60
70
80
90
100
Age (in years)

Osteoporosis



Osteoporosis



Chronic renal failure

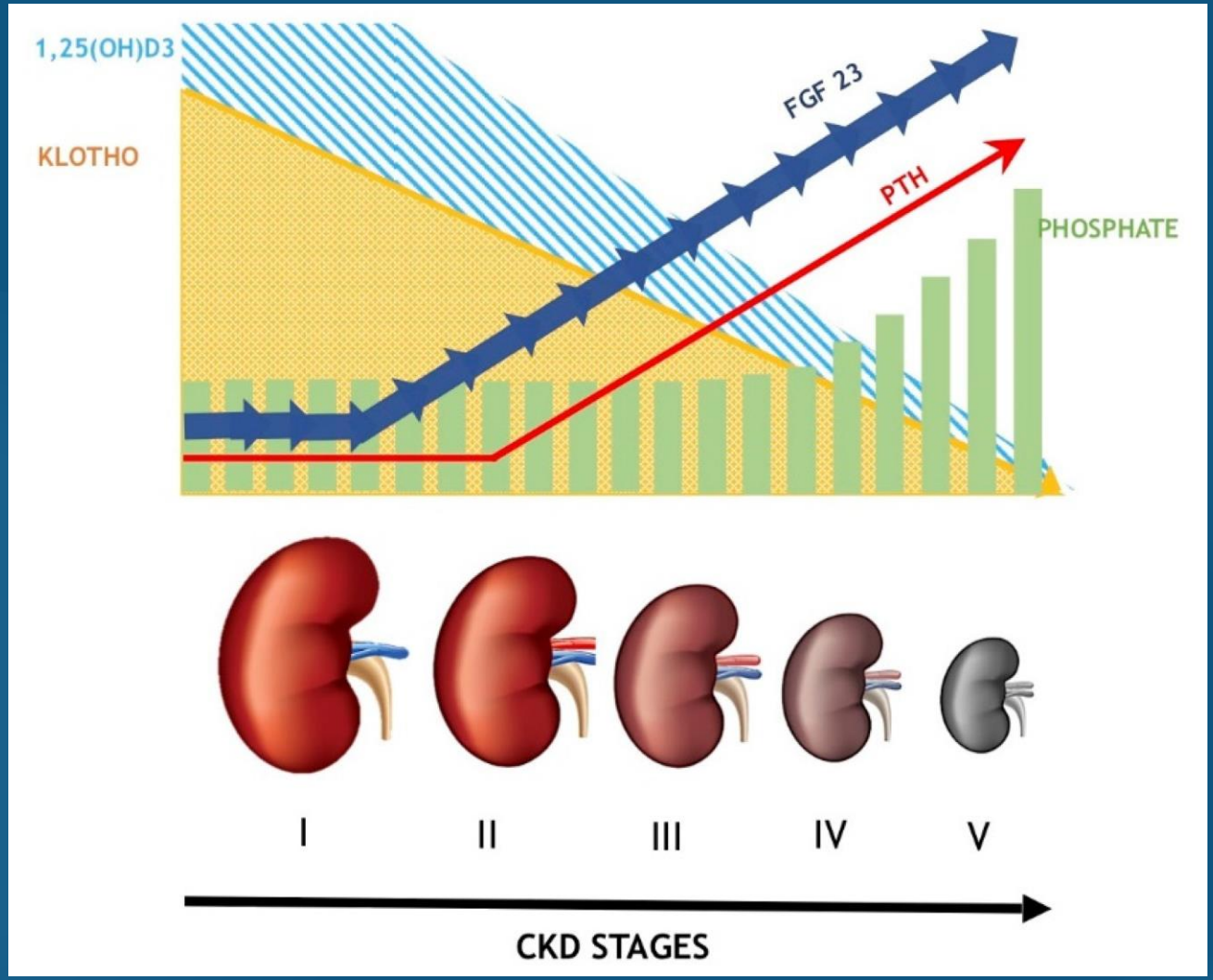
Lifestyle	Medications

• Sedentary lifestyle
• Caucasian woman of northern European descent
• Smokers
• Low body weight
• Low protein intake
• Heavy drinkers
• Positive family history
	• Phenytoin (Dilantin) therapy
	  • reduces vitamin D metabolism
	• Cytotoxic/antineoplastic drugs
	• Selective serotonin reuptake inhibitors (SSRIs)
	  • e.g. fluoxetine, sertraline, paroxetine
	• Antiretroviral therapy
	• Cyclosporine
	• Furosemide

Genetic Polymorphisms	Diseases
• Calcitonin receptor • Estrogen receptor-1 • Type I collagen alpha-1 chain (COL1A1) • osteogenesis imperfecta in adults • Vitamin D receptor • LRP5 (low-density lipoprotein receptor-related protein)	• Malabsorption syndromes • Liver disease • Hyperthyroidism • Type I diabetes mellitus • Cancer • Chronic renal failure • COPD • Rheumatoid arthritis • Sarcoidosis

Chronic renal failure

Chronic renal failure



CKD–MBD

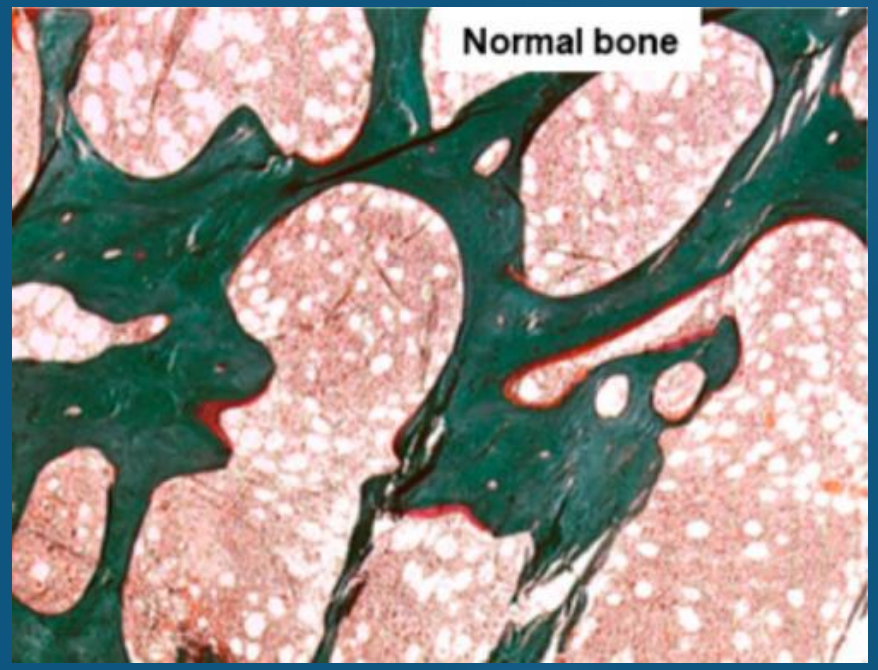
Chronic kidney disease–mineral bone disorders (CKD–MBD) is defined as a systemic disorder of mineral and bone metabolism due to CKD manifested by either one or a combination of the following:

- Abnormalities of calcium, phosphorus, PTH, or vitamin D metabolism
- Abnormalities in bone turn-over, mineralization, volume, linear growth, or strength
- Vascular or other soft tissue calcification

TMV Classification

TMV classification developed by the 2006 National Kidney Foundation working group on renal osteodystrophy

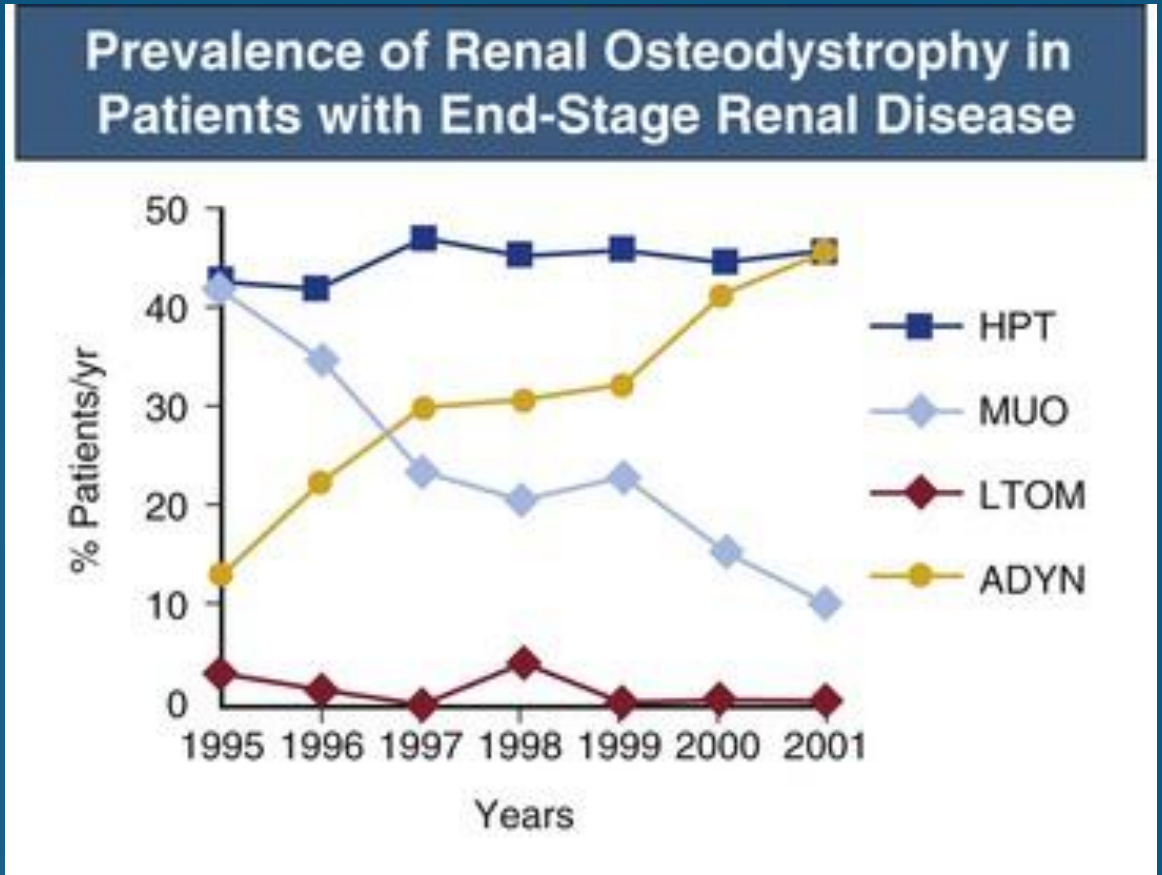
- T= Turnover
- M= Mineralization
- V= Volume



Renal osteodystrophy

1) Osteitis fibrosa cystica
2) Osteomalacia
3) Adynamic bone disease
4) Mixed uremic osteodystrophy

Renal osteodystrophy



Osteitis fibrosa cystica

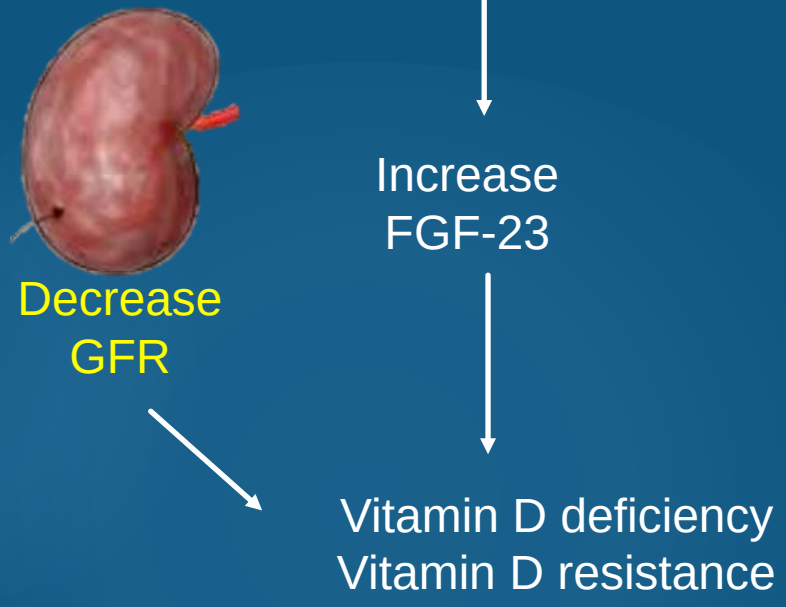
Osteitis fibrosa cystica

Hyperphosphatemia

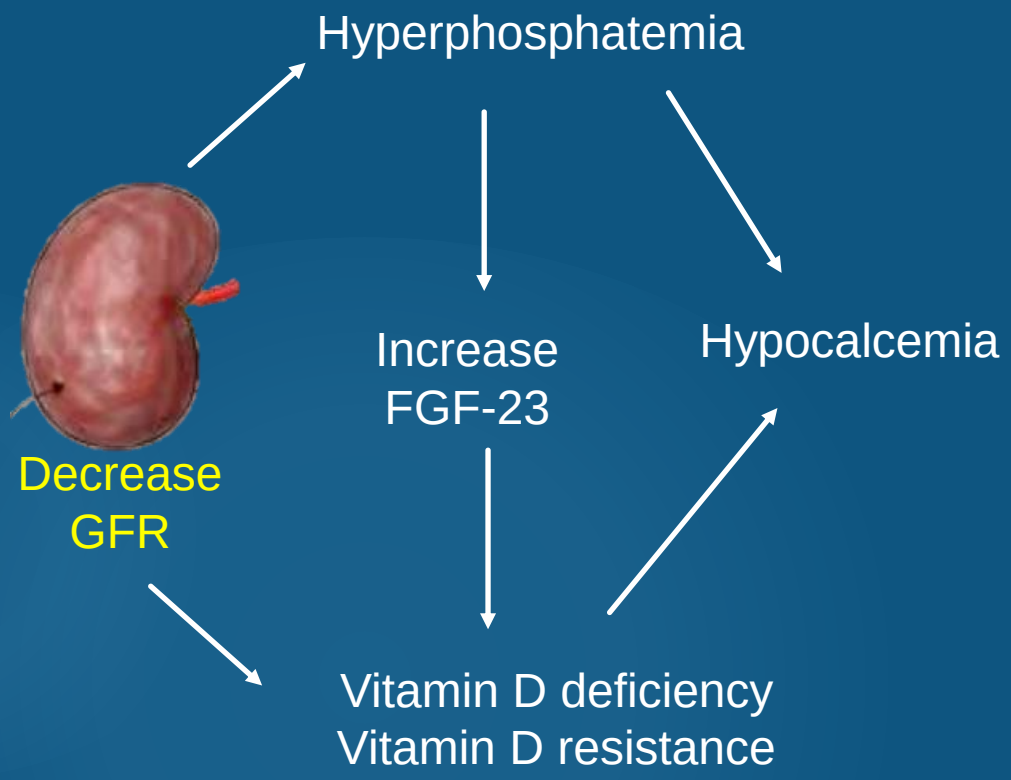
Decrease GFR

Vitamin D deficiency
Vitamin D resistance

Osteitis fibrosa cystica



Osteitis fibrosa cystica



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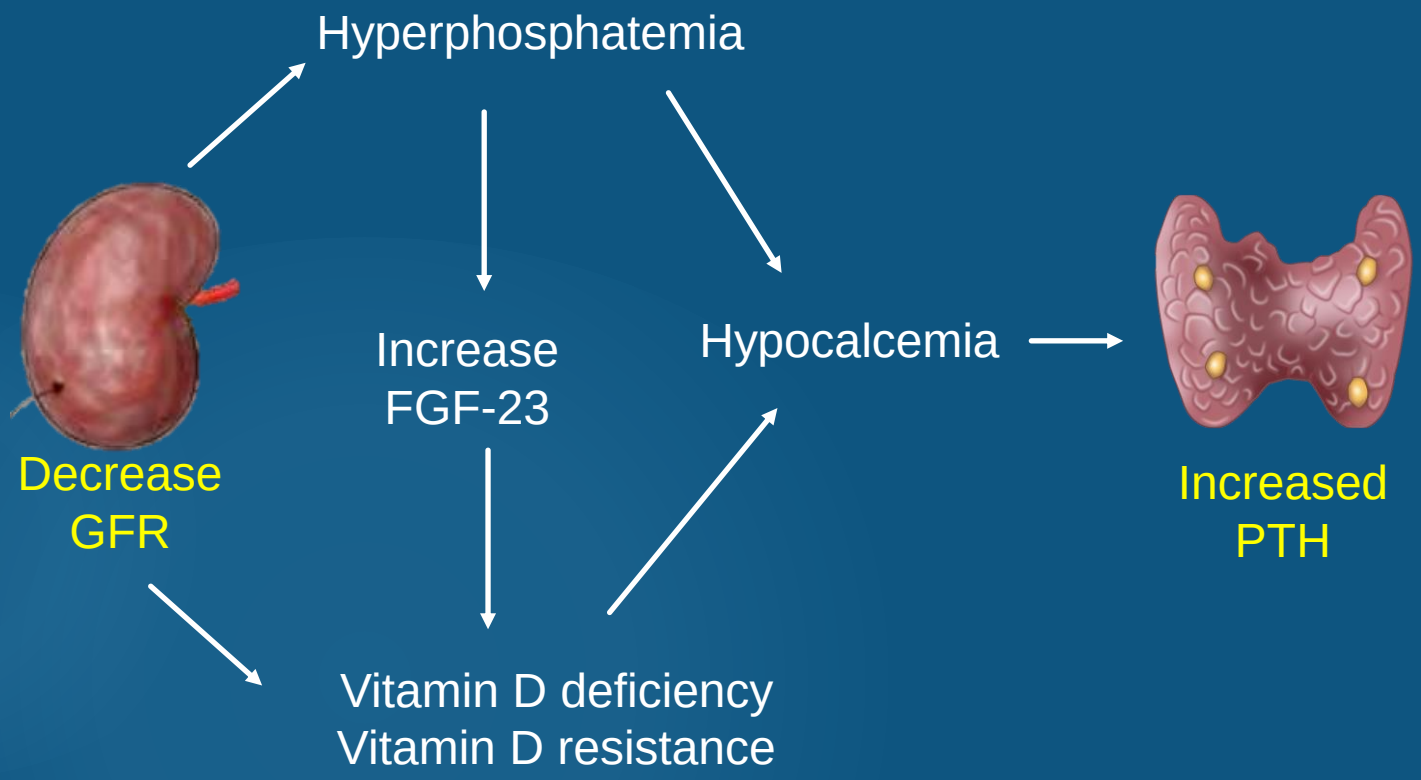
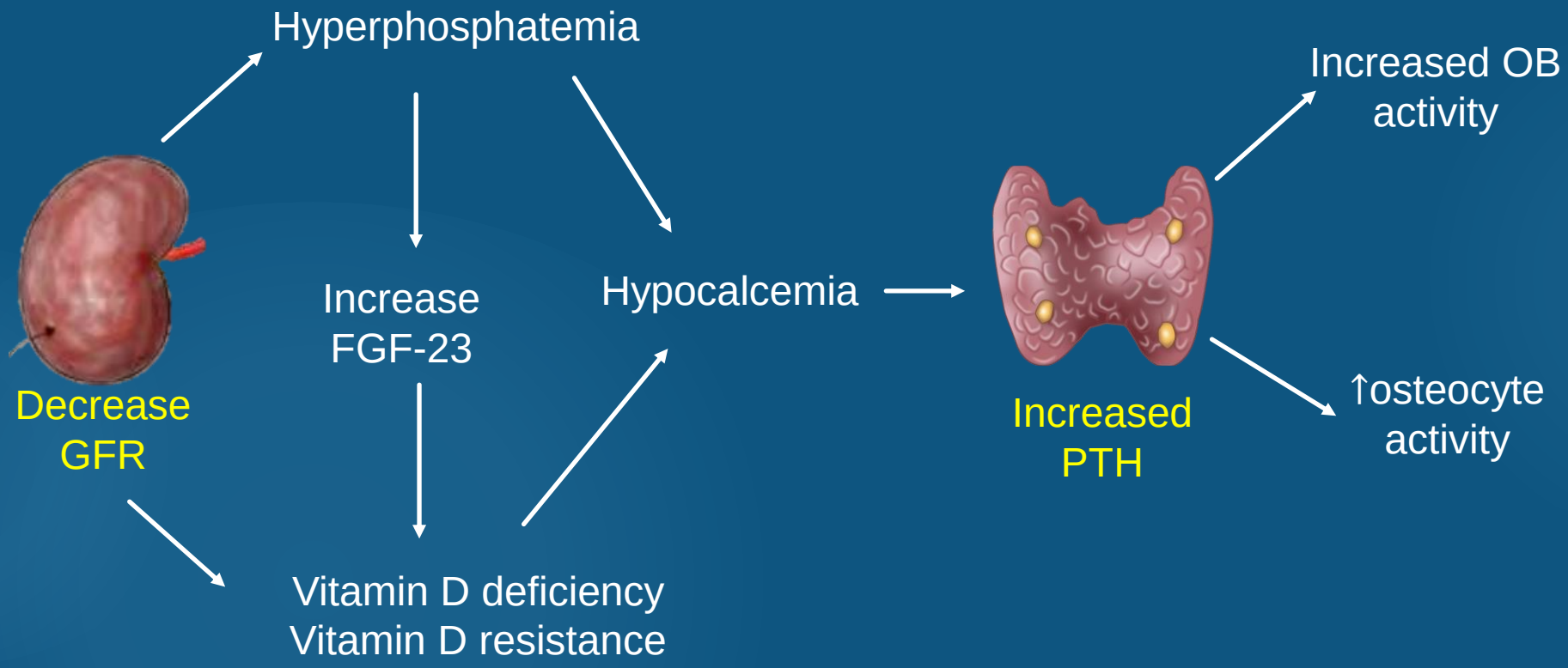


Osteitis fibrosa cystica



Osteitis fibrosa cystica

Decrease GFR

Hyperphosphatemia

Increase FGF-23

Hypocalcemia

Vitamin D deficiency
Vitamin D resistance

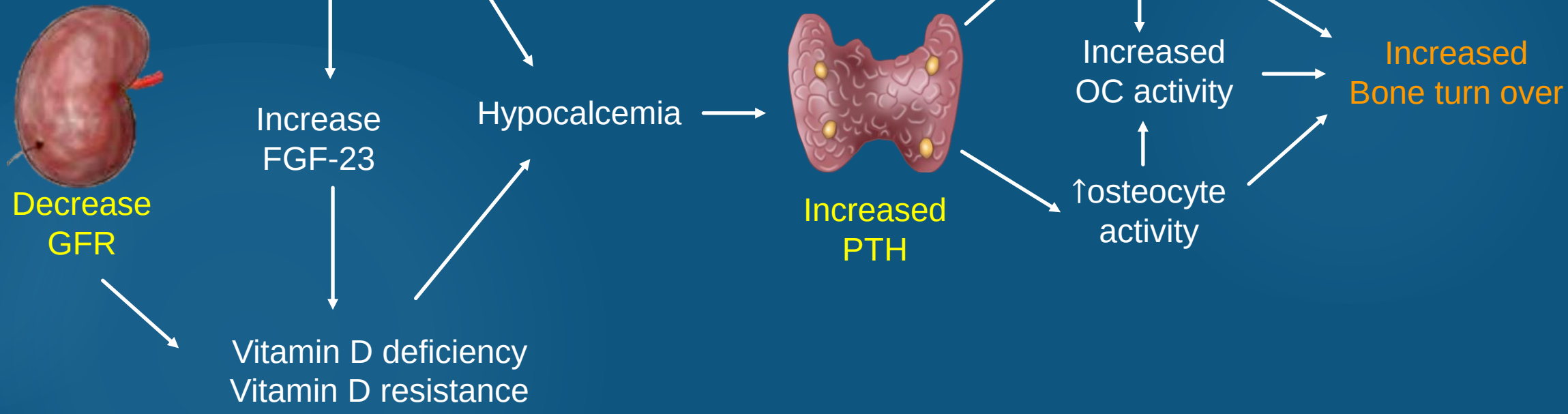
Increased PTH

Increased OB activity

Increased OC activity

↑osteocyte activity

Osteitis fibrosa cystica



Osteitis fibrosa cystica

Decrease GFR

Hyperphosphatemia

Increase FGF-23

Hypocalcemia

Vitamin D deficiency
Vitamin D resistance

Increased PTH

Increased OB activity

Increased Osteoid

Increased OC activity

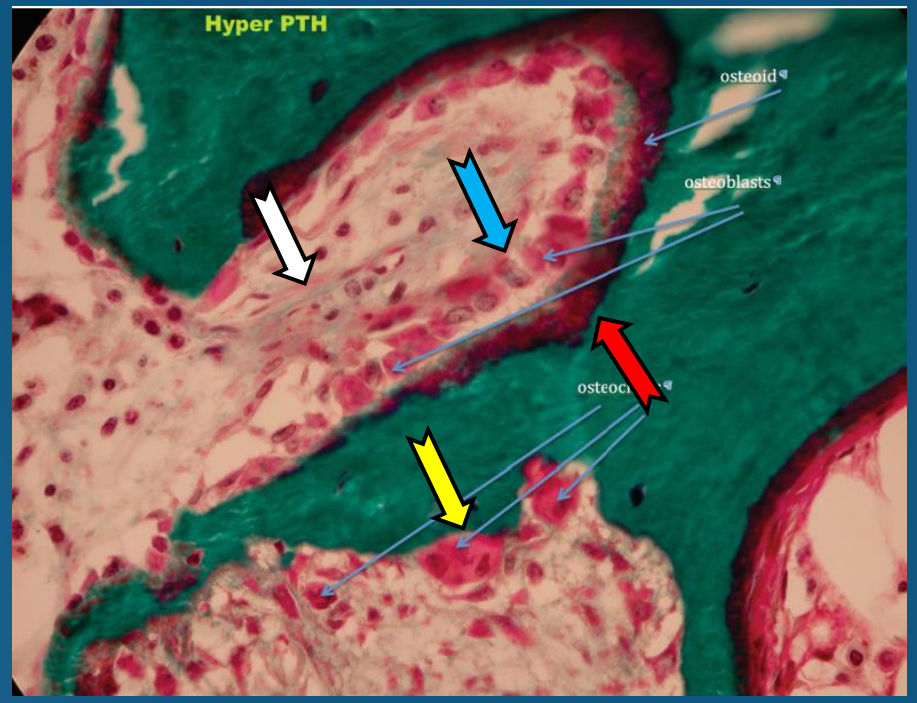
Increased Bone turn over

↑osteocyte activity

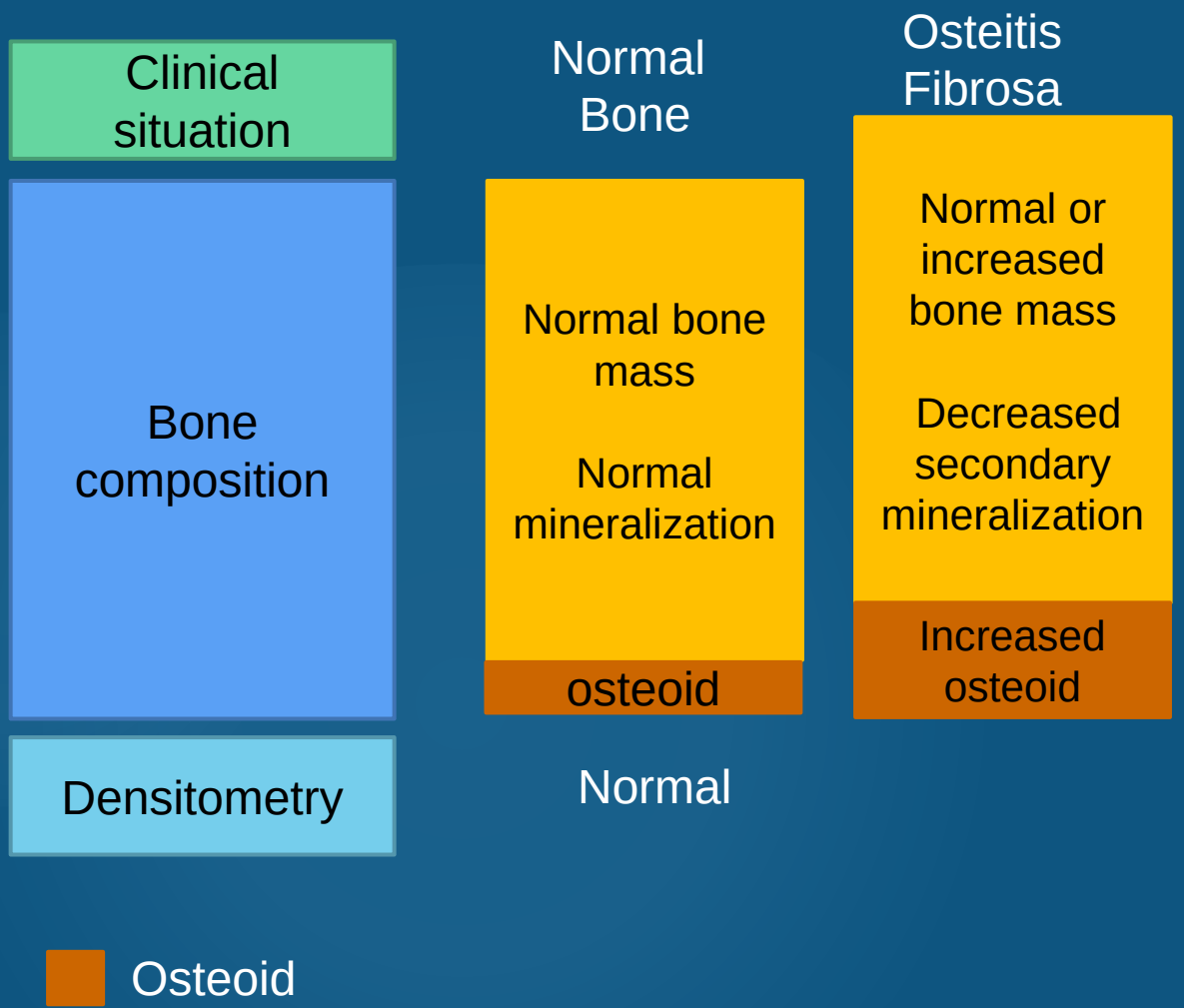
Increased fibroblast activity

Fibrosis

Osteitis fibrosa cystica



Osteitis fibrosa cystica



Adynamic bone disease

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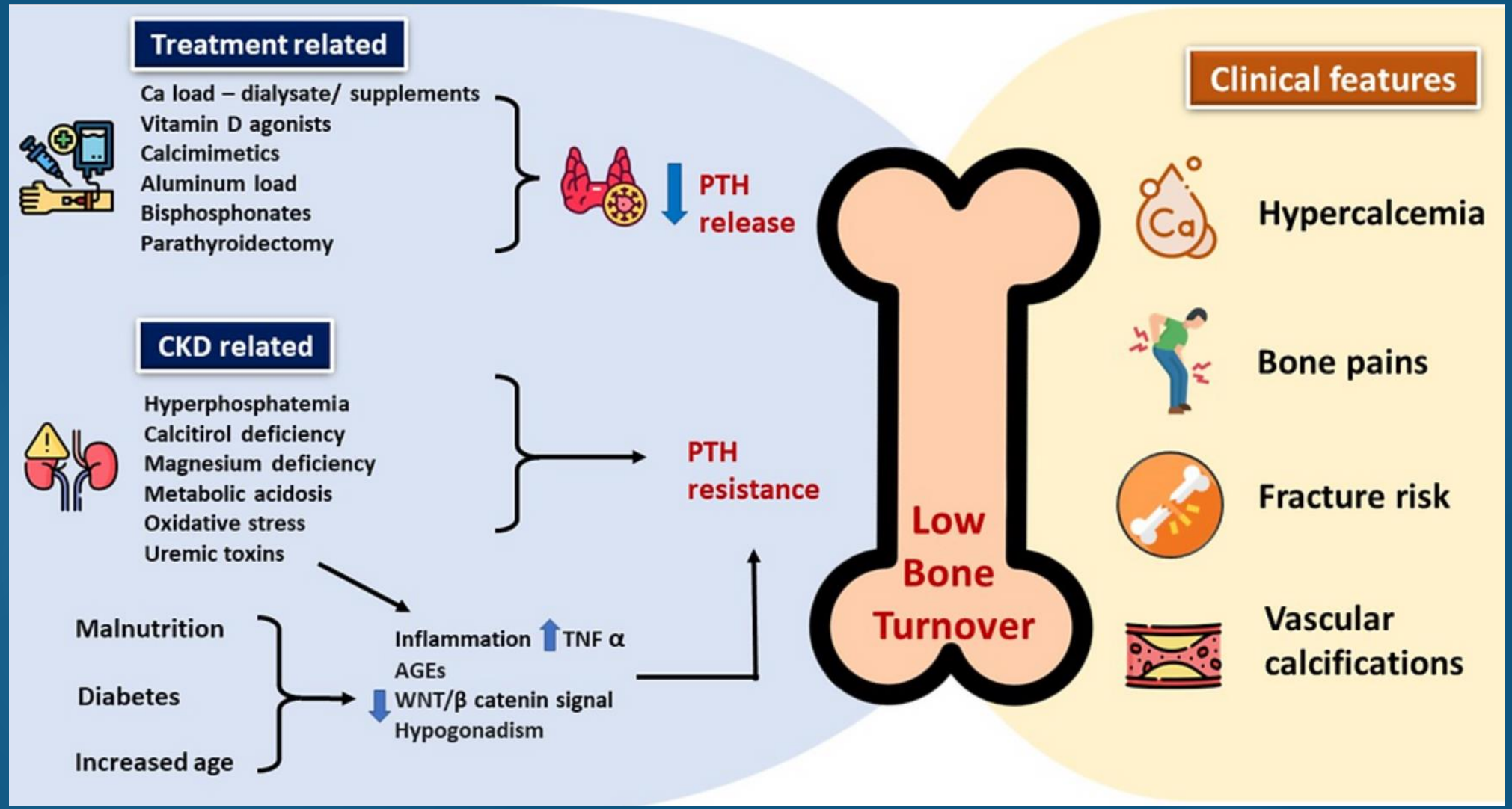

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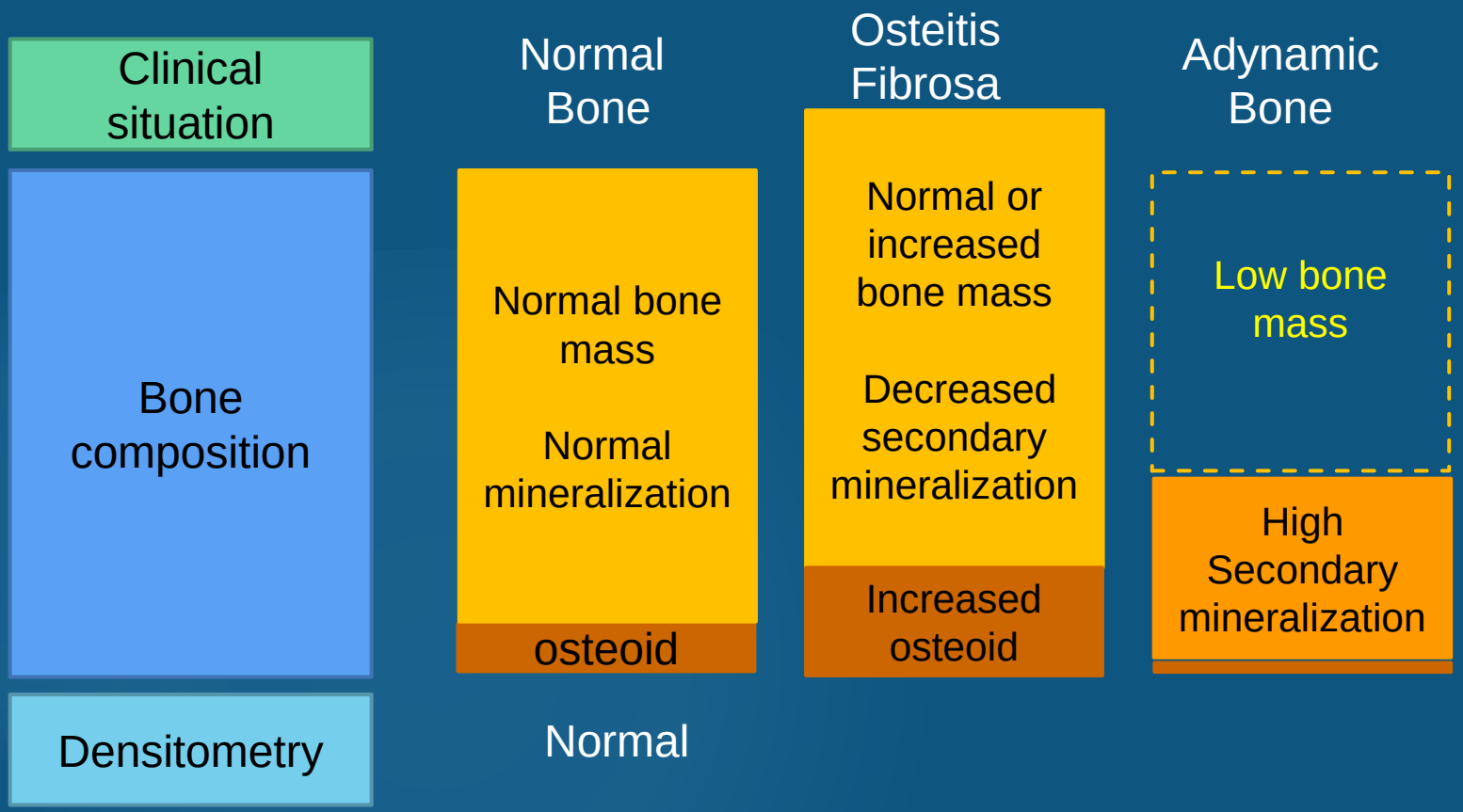


Osteomalacia

Osteomalacia

Osteomalacia is characterized by:

- Reduced mineralization
- Increased unmineralized osteoid
- Prolonged mineralization lag time

Osteomalacia

Osteomalacia

Low bone turnover

Aluminum deposition

Osteomalacia

Low bone turnover

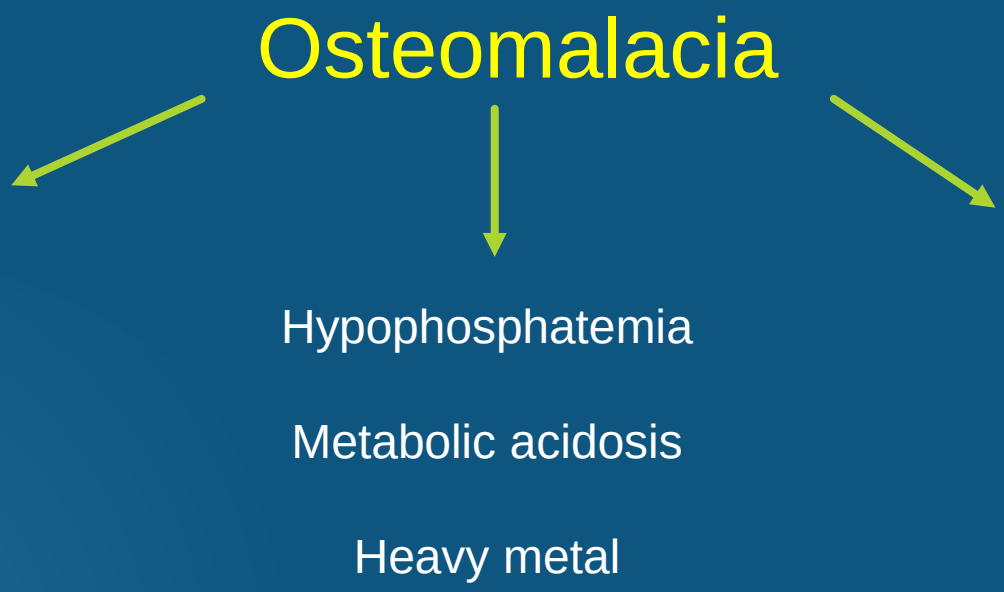
Aluminum deposition

High bone turnover

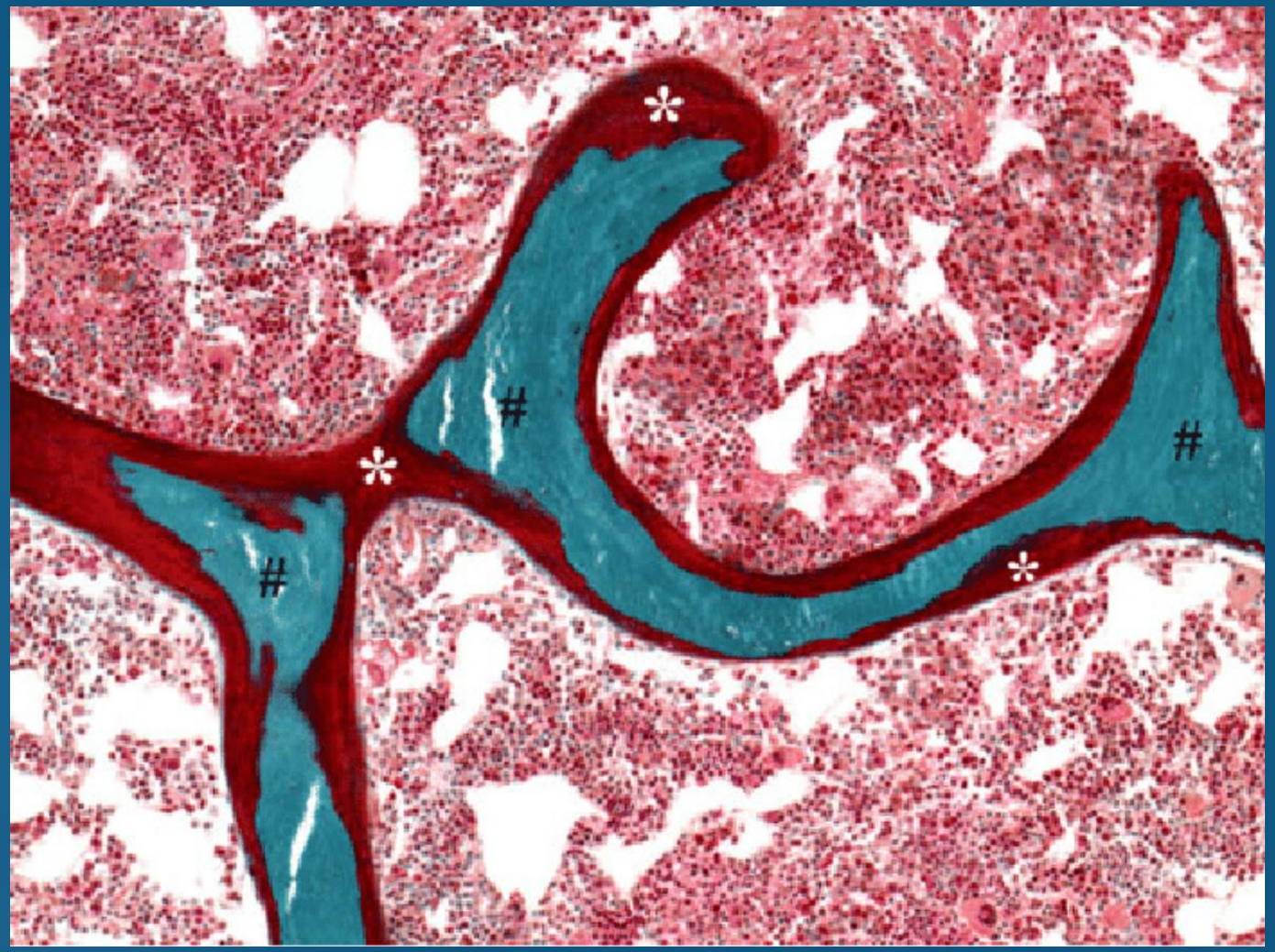
Vitamin D deficiency

Hypocalcemia

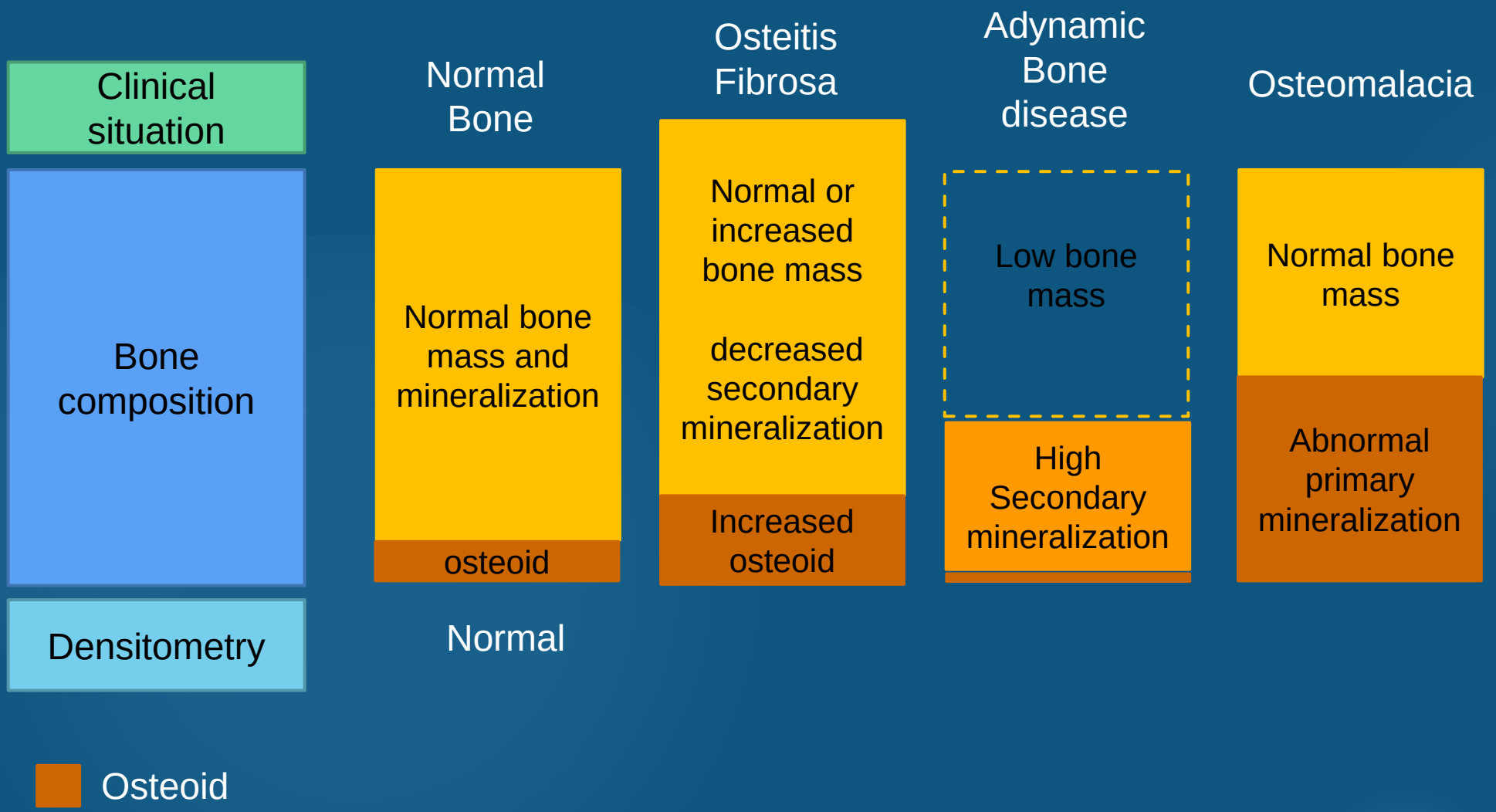
Osteomalacia



Osteomalacia



Osteomalacia



Osteoid

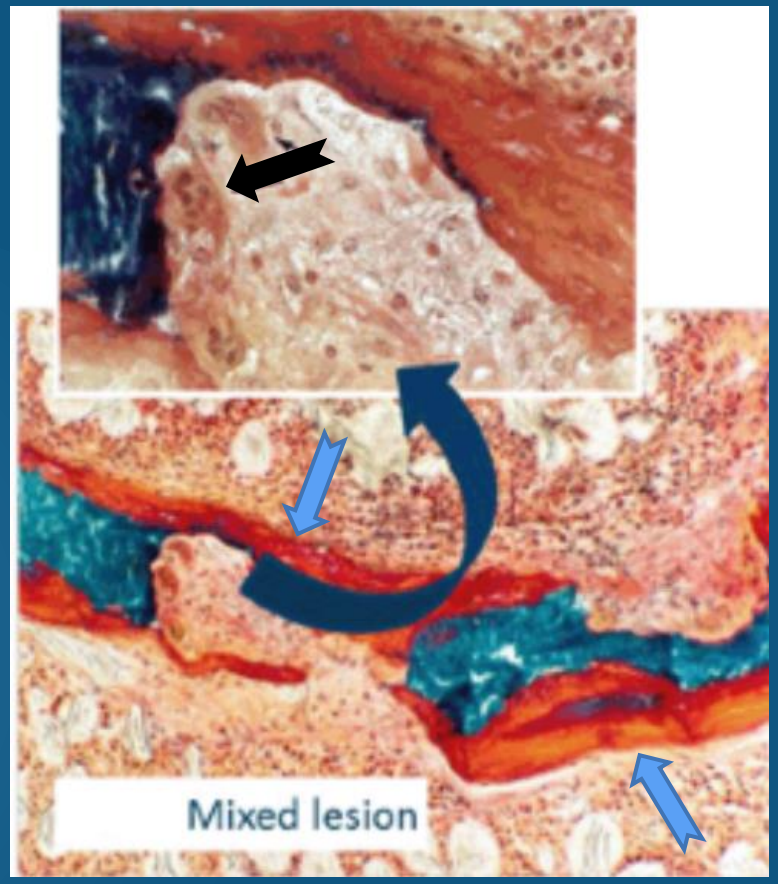
Mixed uremic osteodystrophy

Mixed uremic osteodystrophy

- Mixed uremic osteodystrophy is a disorder combined feature of osteitis fibrosa cystica and osteomalacia.

- The disease characterized by high bone turnover and abnormal mineralization as seen with osteomalacia

Mixed uremic osteodystrophy



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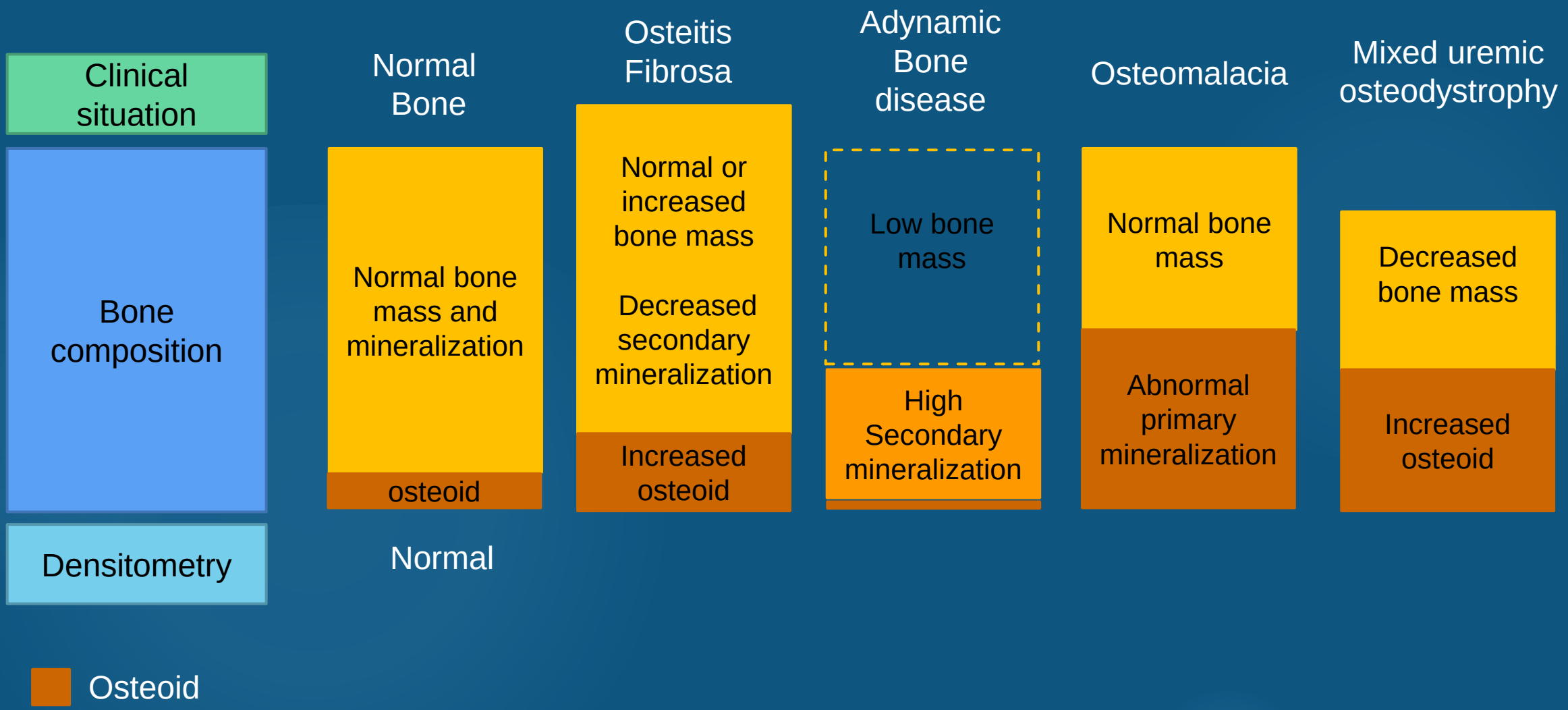
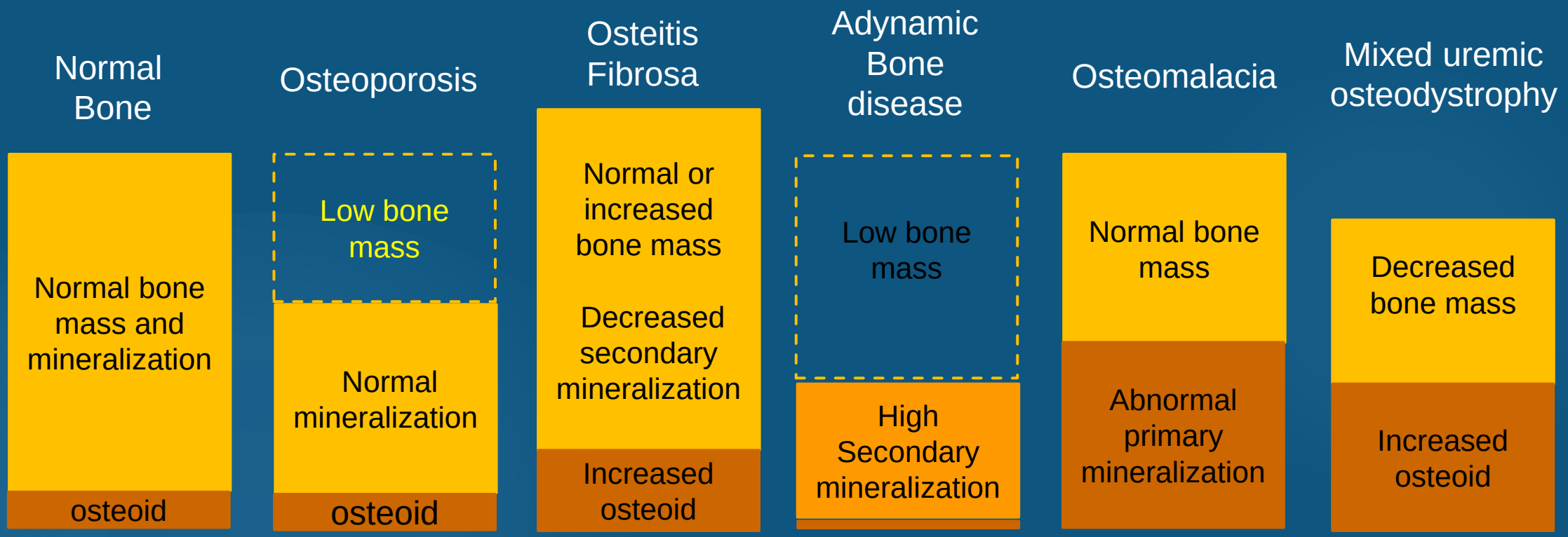
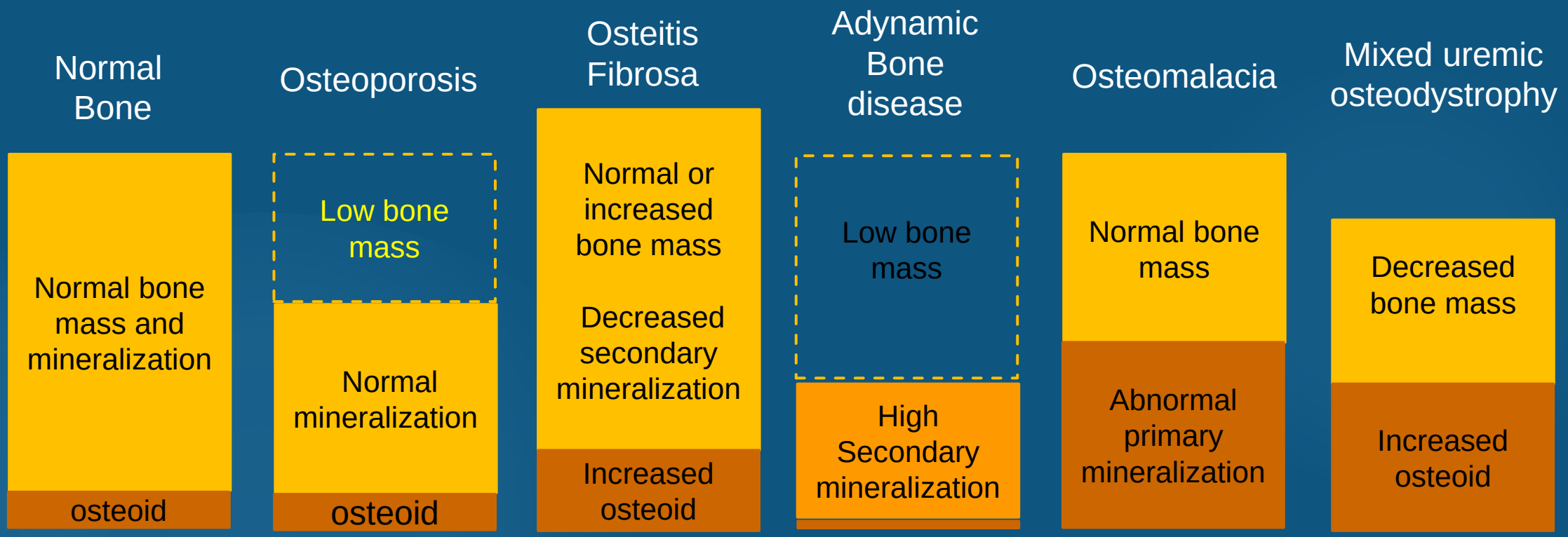




Osteoid

Densitometry



Osteoid

Densitometry