



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

In the name of Allah, the most gracious, the most merciful

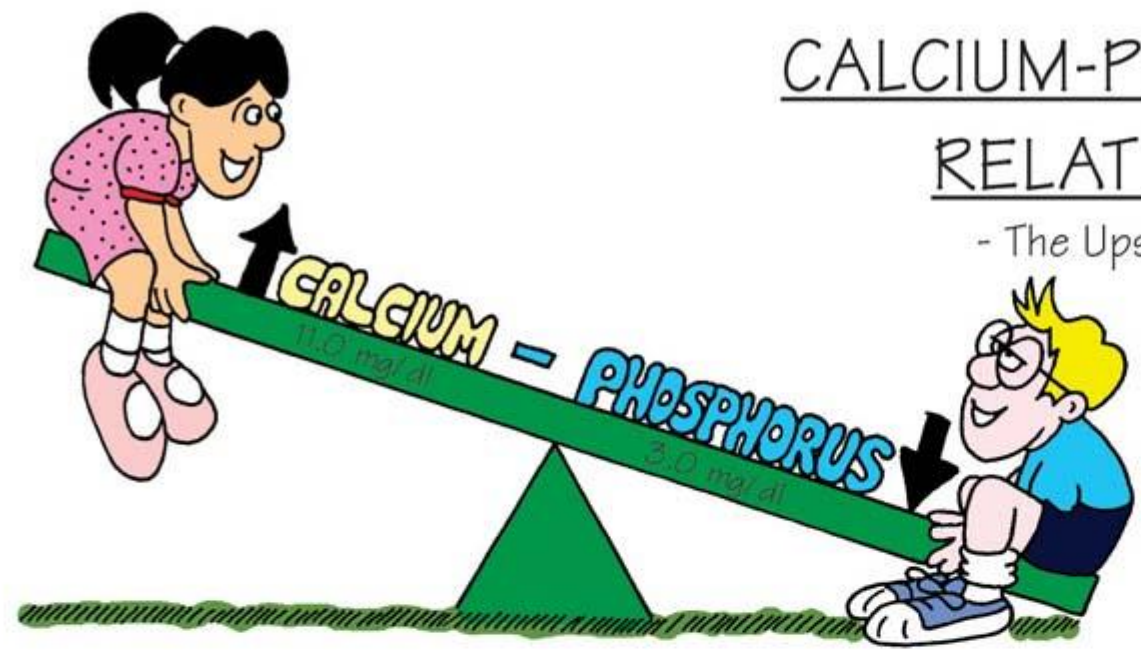


Hormonal Control Of Calcium & Phosphate Metabolism 2

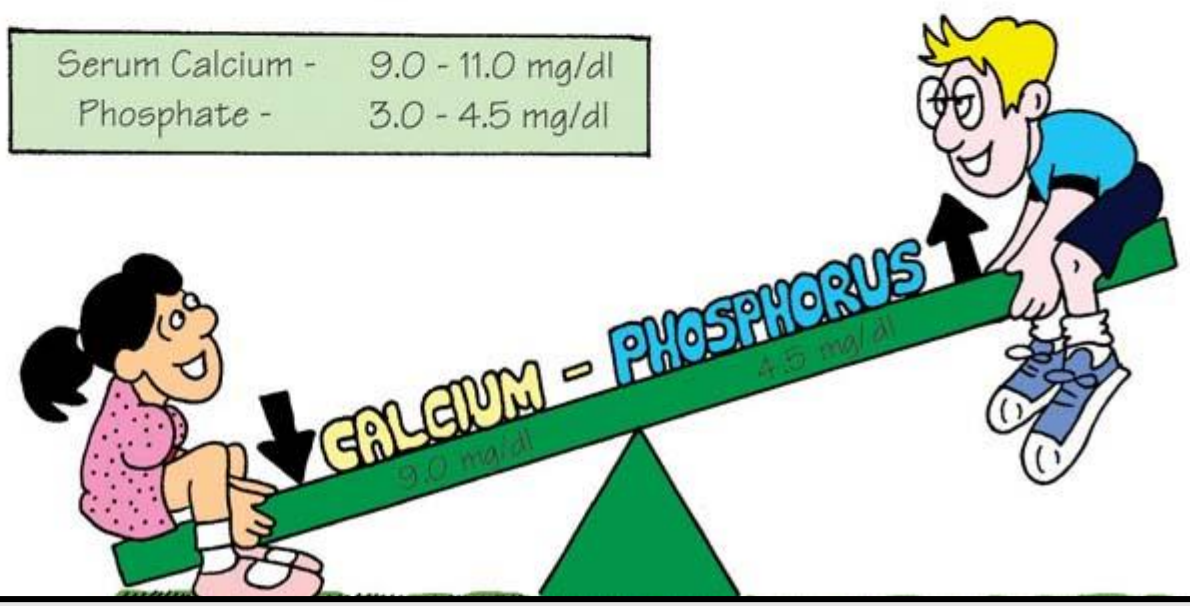
Dr Zubia Shah

CALCIUM-PHOSPHORUS RELATIONSHIP

- The Ups and Down -



Serum Calcium -	9.0 - 11.0 mg/dl
Phosphate -	3.0 - 4.5 mg/dl



Learning Objectives

- **Explain the physiological functions of calcitonin.**
- **Briefly explain the pathophysiology of parathyroid hormone, vitamin D and bone disease.**

Calcitonin

secreted by thyroid gland → ↓ plasma calcium concentration - effects opposite to those of PTH

Synthesis and secretion occur in parafollicular cells, or C cells - in the interstitial fluid between the follicles of thyroid gland

Thyroid gland



Calcitonin

Inhibits Ca^{2+} reabsorption
in the kidney (excreted
in the urine)



Lowers Ca^{2+}
levels in blood



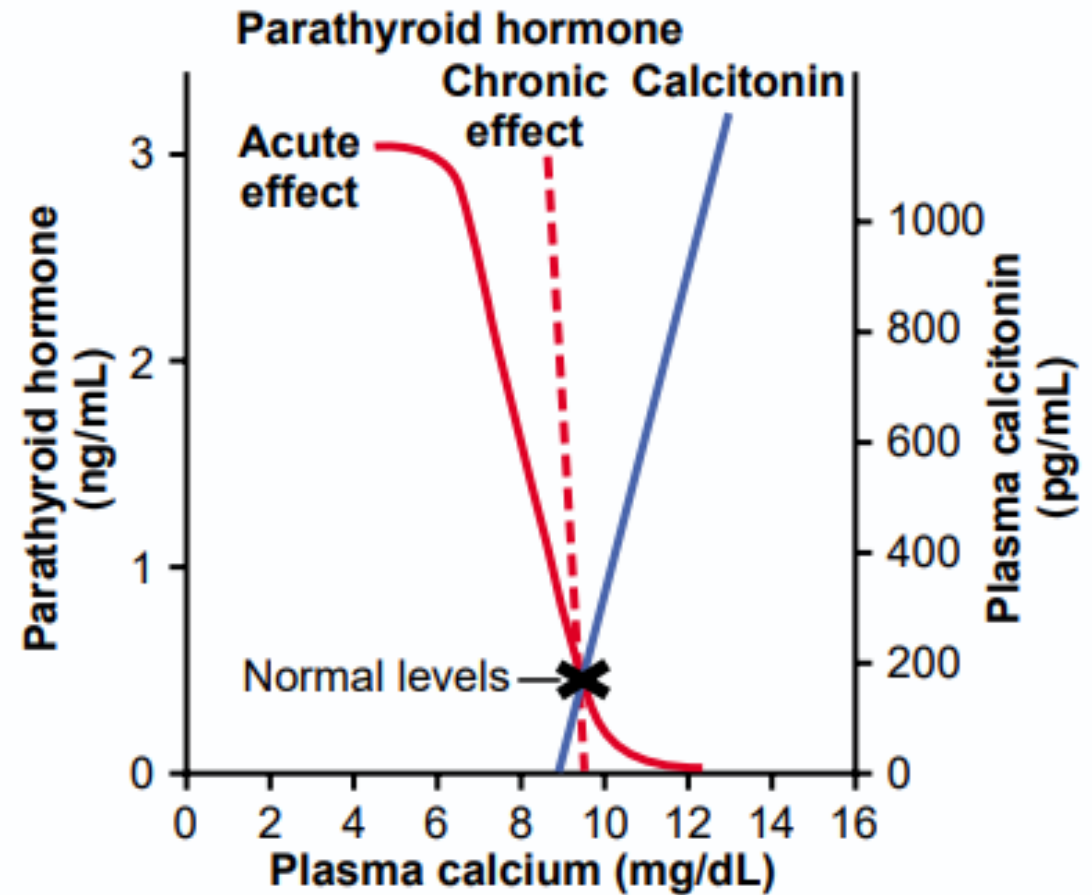
Inhibits Ca^{2+}
absorption by
the intestines



Promotes
deposition
of Ca^{2+}
into
bones (inhibits
osteoclasts and
stimulates osteoblasts)



Increased Plasma Calcium Concentration Stimulates Calcitonin Secretion



Calcitonin Decreases Plasma Calcium Concentration

Immediate effect is to decrease the absorptive activities of the osteoclasts and possibly the osteolytic effect of the Osteocytic membrane throughout the bone so more deposition of calcium in bones

More prolonged effect is to ↓ the formation of new osteoclasts → ↓ osteoblasts → ↓ osteoclastic and osteoblastic activity

Weak effect of Calcitonin on Plasma Calcium in Adult Humans

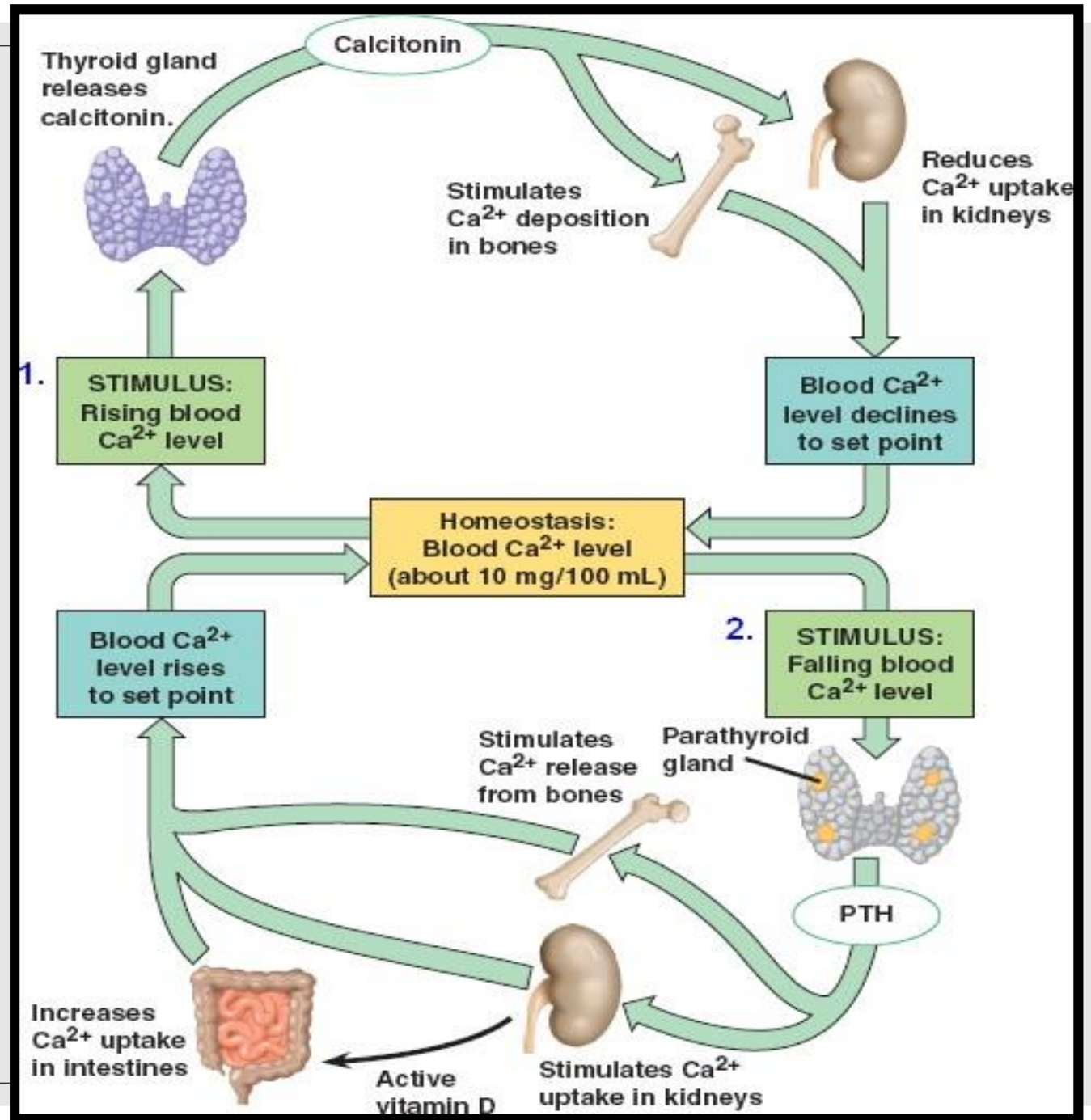
Decrease in plasma Ca^{++} by calcitonin \rightarrow powerful PTH secretion that overrides its effect

Daily rates of absorption & deposition of calcium are small, so calcitonin has little effect

In Children, effect is \uparrow as bone remodeling is rapid, 5grams or more per day (5-10 times that in ECF)
Paget's disease – greater osteoclastic activity \rightarrow potent effect of Calcitonin

Feedback Loop

- Negative feedback in calcium homeostasis. A rise in blood Ca^{2+} causes release of calcitonin from the thyroid gland, promoting Ca^{2+} deposition in bone and reducing reabsorption in kidneys.
- A drop in blood Ca^{2+} causes the parathyroid gland to produce parathyroid hormone (PTH), stimulating the release of Ca^{2+} from bone.
- PTH also promotes re-absorption of Ca^{2+} in kidneys and uptake of Ca^{2+} in intestines.




Summary of Control of Calcium Ions

The First line of Defense

- Buffer function of **exchangeable calcium in bones**
- **Mitochondria** of many tissues especially liver and intestine contain a significant amount of calcium

The Second line of Defense

- **Hormonal control** of calcium ion concentration
- Within 3-5 min of \uparrow in Ca^{++} , the PTH \downarrow and brings calcium levels back to normal; calcitonin \uparrow and causes bone deposition of calcium

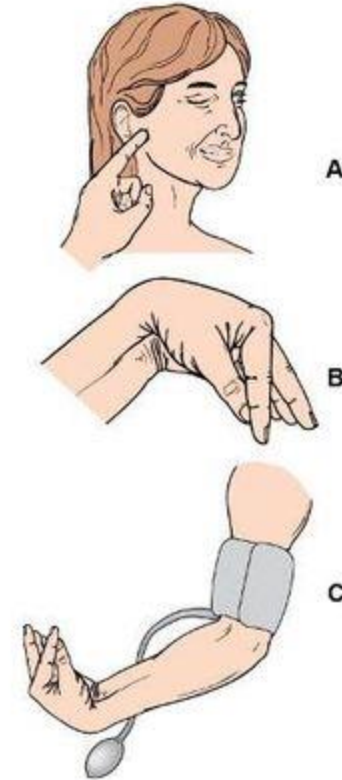


Pathophysiology of Parathyroid Hormone, Vit D & Bone Disease

Hypocalcemia

■ Manifestations

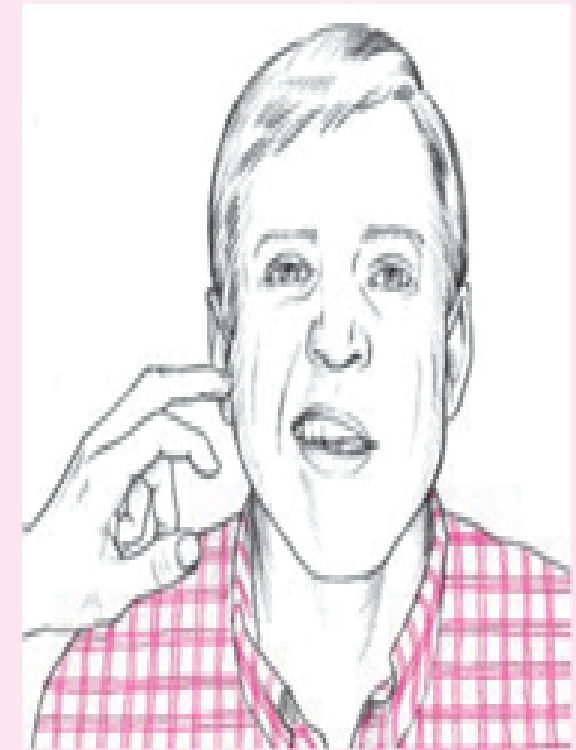
- Weakness/Tetany
- Positive Trousseau's or Chvostek's sign
- Laryngeal stridor
- Dysphagia
- Tingling around the mouth or in the extremities



Chvostek Sign (Weiss Sign)

Eliciting Chvostek's sign

Begin by telling the patient to relax his facial muscles. Then stand directly in front of him, and tap the facial nerve either just anterior to the earlobe and below the zygomatic arch or between the zygomatic arch and the corner of his mouth. A positive response varies from twitching of the lip at the corner of the mouth to spasm of all facial muscles, depending on the severity of hypocalcemia.





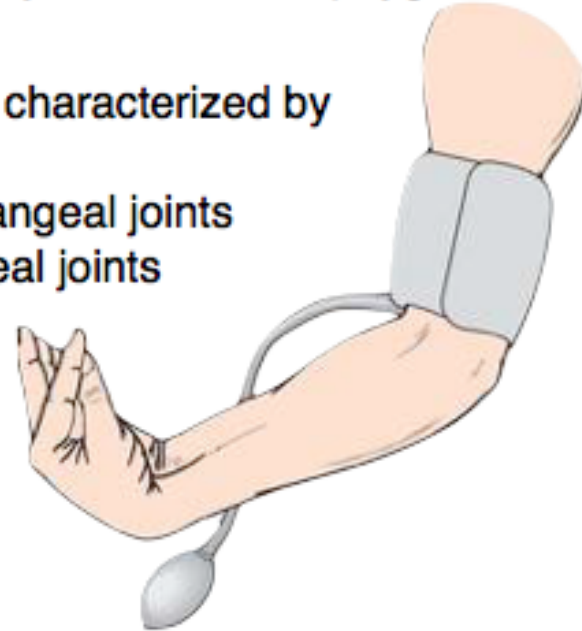
Hypocalcemia

Trousseau's Sign

Induction of carpopedal spasm by inflation of a sphygmomanometer above SBP for 3 minutes

Response: Carpopedal spasm characterized by

- Adduction of the thumb
- Flexion of the metacarpophalangeal joints
- Extension of the interphalangeal joints
- Flexion of the wrist



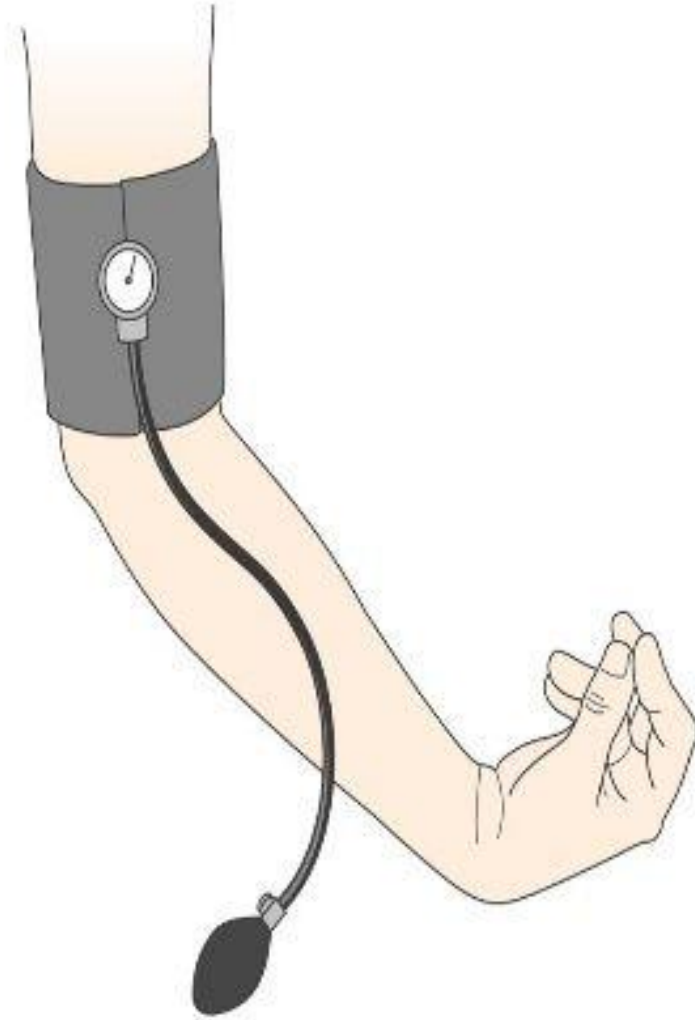
Chvostek's sign

Contraction of the ipsilateral facial muscles elicited by tapping the facial nerve just anterior to the ear

Response: Twitching of the lip to spasm of all facial muscles



A. Positive Chvostek's Sign



B. Positive Trousseau's Sign

Pathophysiology of Parathyroid Hormone, Vitamin D and Bone Disease

- **Hypoparathyroidism**
- **Hyperparathyroidism**
- **Rickets & Osteomalacia or Adult Rickets**
 - **Osteoporosis**

Hypoparathyroidism

Hypoparathyroidism

When parathyroid glands do not secrete sufficient PTH → bone resorption decreases & osteoclasts become inactive, but bones are strong

Effects of Parathyroidectomy

During thyroid surgery → serious consequences as PTH is essential for life

Parathyroidectomy → low plasma Ca^{++} →

neuromuscular hyperexcitability followed by full-blown hypercalcaemic tetany

Plasma phosphate levels usually rise as the plasma calcium level falls

Hyperparathyroidism

Hyperparathyroidism

Primary

- Tumors → osteoclastic activity Bones show decalcification → multiple fractures & ↑ alkaline phosphatase
- ↑ Ca^{++} → 12-15mg/dl → depression of CNS & PNS, muscle weakness, constipation, peptic ulcer, lack of appetite and depressed relaxation of heart during diastole
- PT poisoning, metastatic calcification & Kidney stones

Secondary

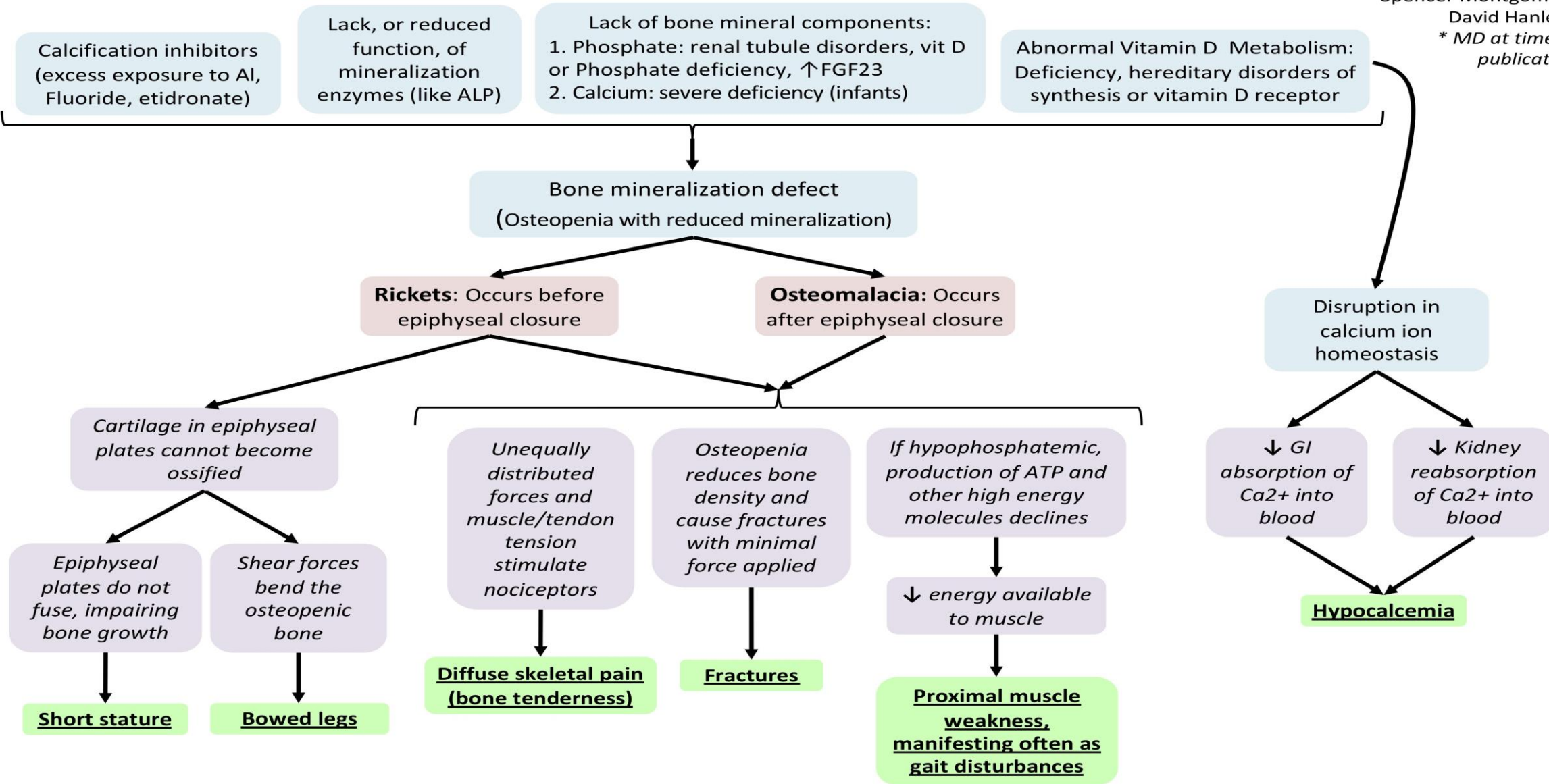
- ↑ level of PTH secondary to hypocalcemia
- Caused by Vit D deficiency or chronic renal disease

Hypercalcemia of Malignancy

- a common complication of cancer
 - About 20% have bone metastases → hypercalcemia by eroding bone
 - this erosion is produced by prostaglandins (PG E₂) from the tumour
- include breast, kidney, ovary, and skin cancers

Rickets and Osteomalacia: Pathogenesis and clinical findings

Author:
Payam Pournazari
Reviewers:
Yan Yu
Spencer Montgomery
David Hanley*
* MD at time of publication



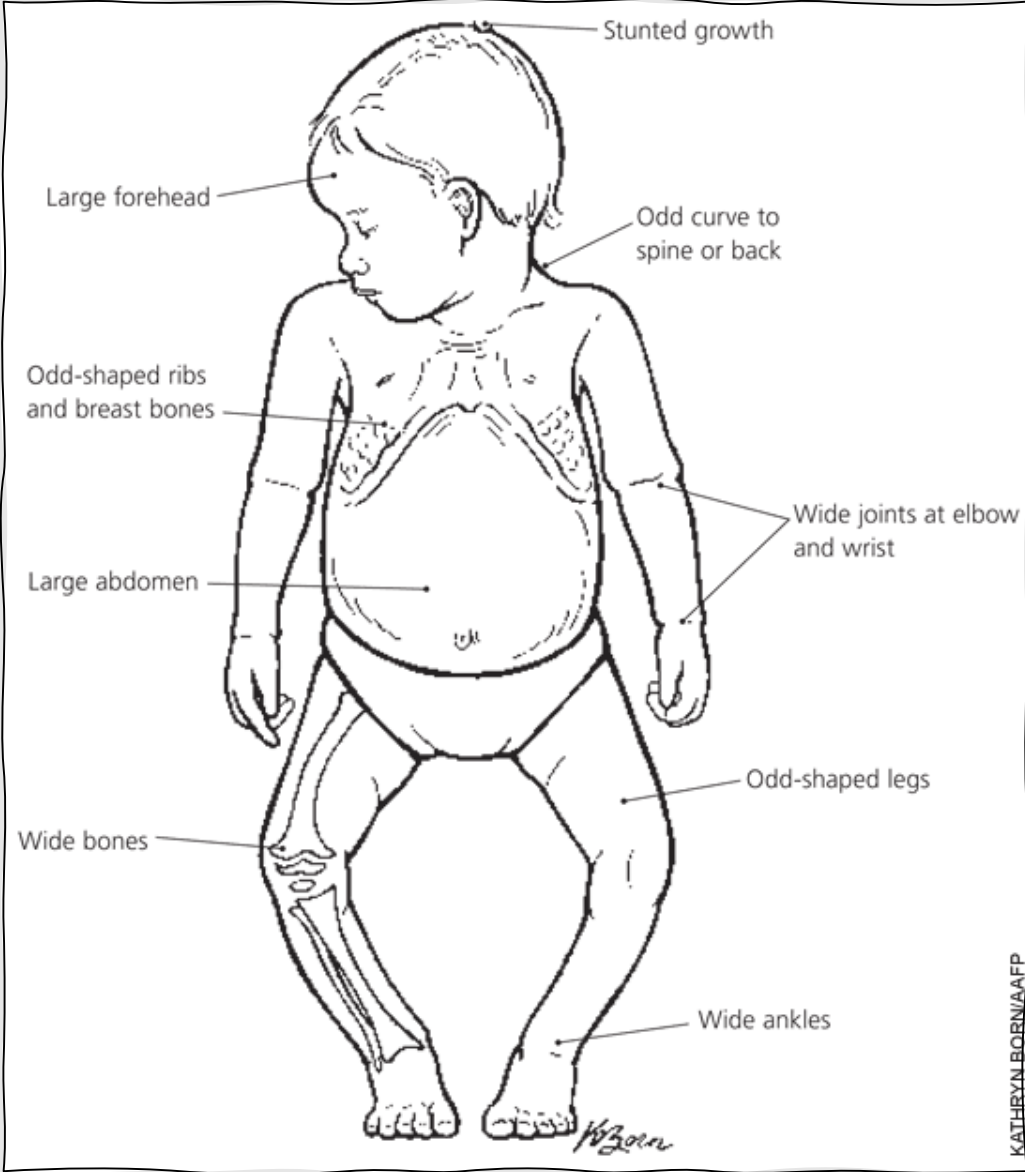
Rickets

- Vitamin D deficiency in children
- Usually due to inadequate exposure to sun
- ↓ Cholecalciferol → ↓ Calcium levels
- Bones are elastic and can bend under pressure
- Tetany sometimes develops
- Treatment – vitamin D and calcium, exposure to sun

↑ PTH secretion →
↑ osteoclastic
activity of the bones
Followed by
↑ osteoblastic
activity
↓ calcification of
bones



Rickets



KATHERYN BORN/AAFP

Normal anatomy



Rickets





Rickets

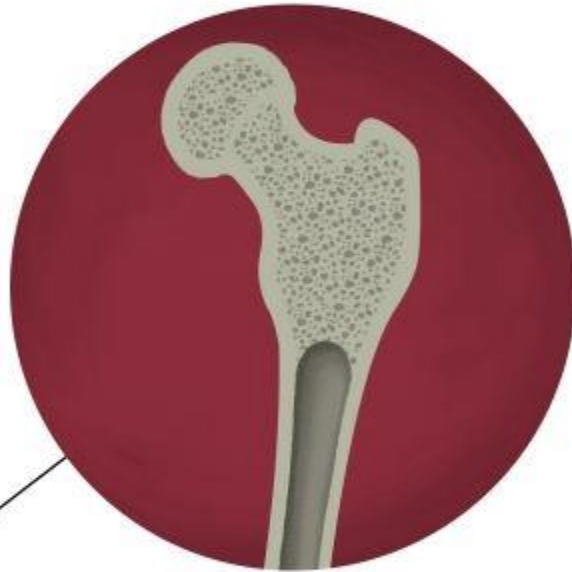
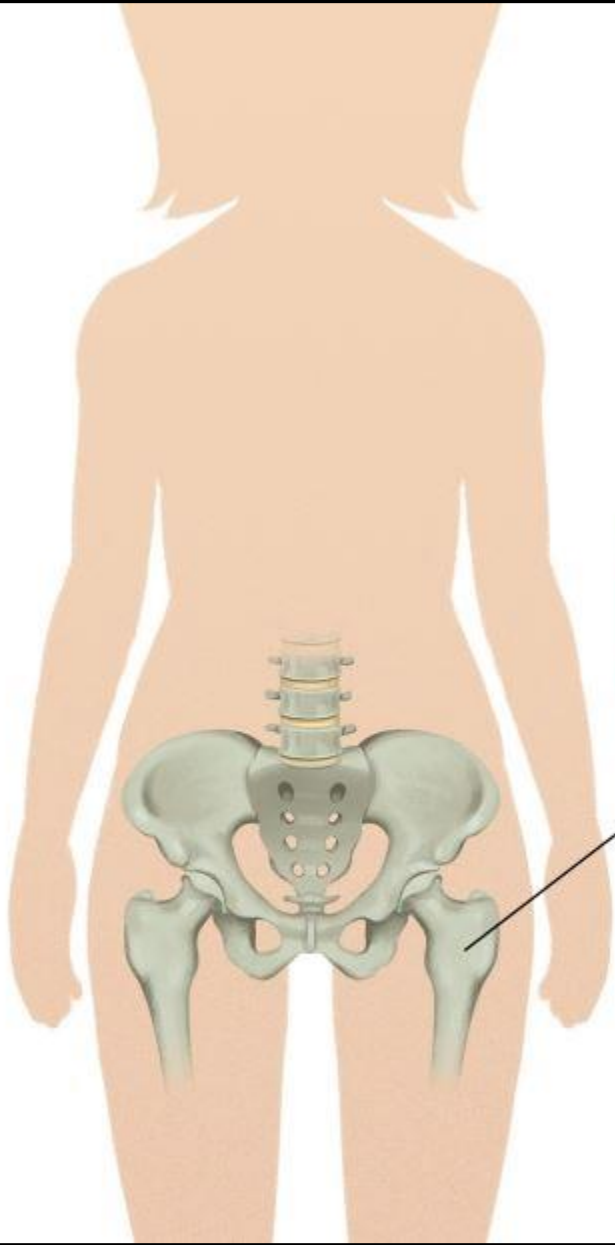


Osteomalacia

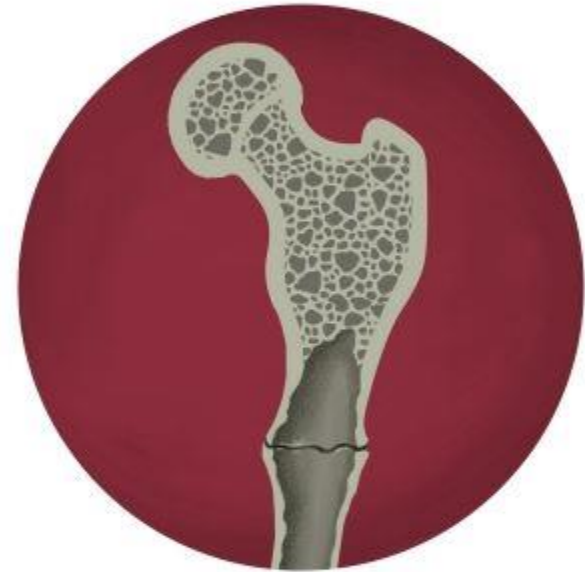
- **Adult Rickets**
- **Vitamin D deficiency**

**Not dietary deficiency
Steatorrhea is the usual
cause**

- Bones are weak
- Easy pathological fracture
- Treatment – calcium and vitamin D supplements



Healthy bone



Osteomalacia

Osteoporosis

↓ bone matrix
↓ osteoblastic activity
↓ Osteoid formation



Normal bone

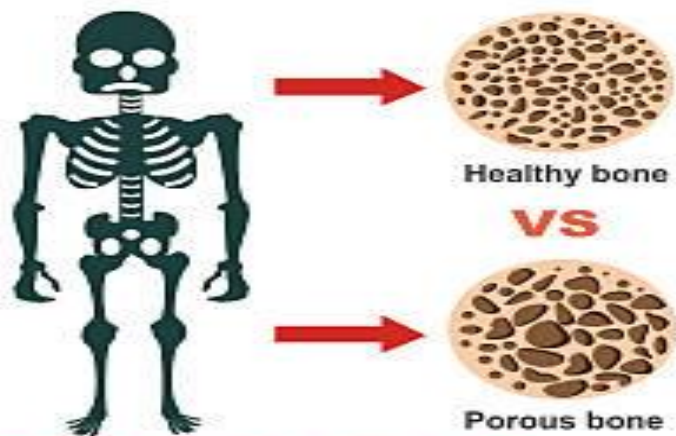


Osteoporotic bone

Comparison of normal and osteoporotic bone. Note the reduced density of osteoporotic trabecular bone compared to normal trabecular bone.

OSTEOPOROSIS

Normally healthy bones look like a honeycomb. If they've lost density, they're easily broken. They can be called "porous bones".



PREVENTION

You can prevent and strengthen your bones for the rest of your life by the following ways:

Workout can boost your bone health.



Take vitamins and supplements.



Eat high calcium and vitamin D foods.



Avoid smoking and drinking.



RISKS

Here are some factors for osteoporosis, and of course they are out of your control :



Gender

Women are likely to get osteoporosis more than men.



Age

The elderly aged over 45 are at high risk for the bone disease.



Race

Asian Americans are likely to develop osteoporosis.



Body Size

Having a small frame is considered to be at risk for porous bones.

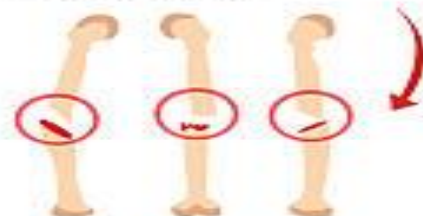
SYMPTOMS

It might have no symptoms in the early stage, but here are signs of the disease gradually having weakened your bones.



Loss of height over time

Because your spine has tiny fractures that're usually unnoticed and painless.



*Sample of broken bones



Back pain

Fractured bones in the low back can cause the severe pain, usually lasting for a week.

*Low back pain



Hunched Posture

Having longtime compression fracture in the spine can develop to the kyphosis.

200 Million Women worldwide are affected from osteoporosis.

Bone fracture

People with porous bones can get more easily injured than expected if they fall or bump.



Summary

Assignment

Make a flow chart showing the mechanism of action of parathyroid hormone and physiological role of Vitamin D and Calcitonin in Calcium metabolism.

Deadline: 9th September 2022



Any

Questions?

References

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Thank You