

# Common Thyroid & calcium Disorders in Children

**Dr. Reem Al Khalifah**

**Consultant**

**Assistant professor**

**Pediatric Endocrinology**

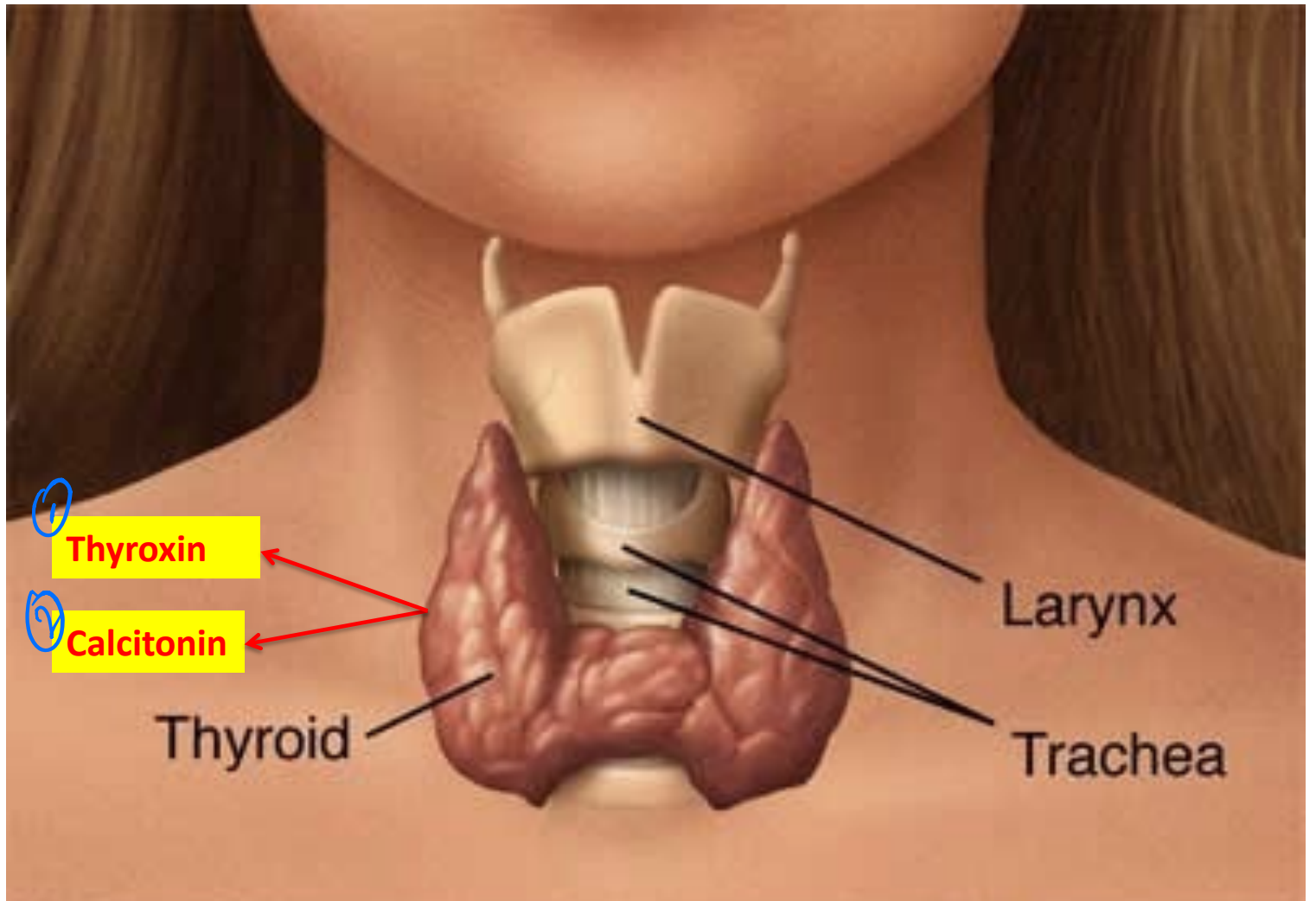
**King Saud University**



- \* → Important
- Blue → Notes

# Objectives

- Thyroid Anatomy and physiology
- Hypothyroidism
- Hyperthyroidism
- Rickets



# Hypothalamus

TRH

4 mechanisms to inhibit pituitary from secreting TSH :

- ① Dopamine
- ② Somatostatin
- ③ Glucocorticoids

(-)

(-)

(-)

TSH

④

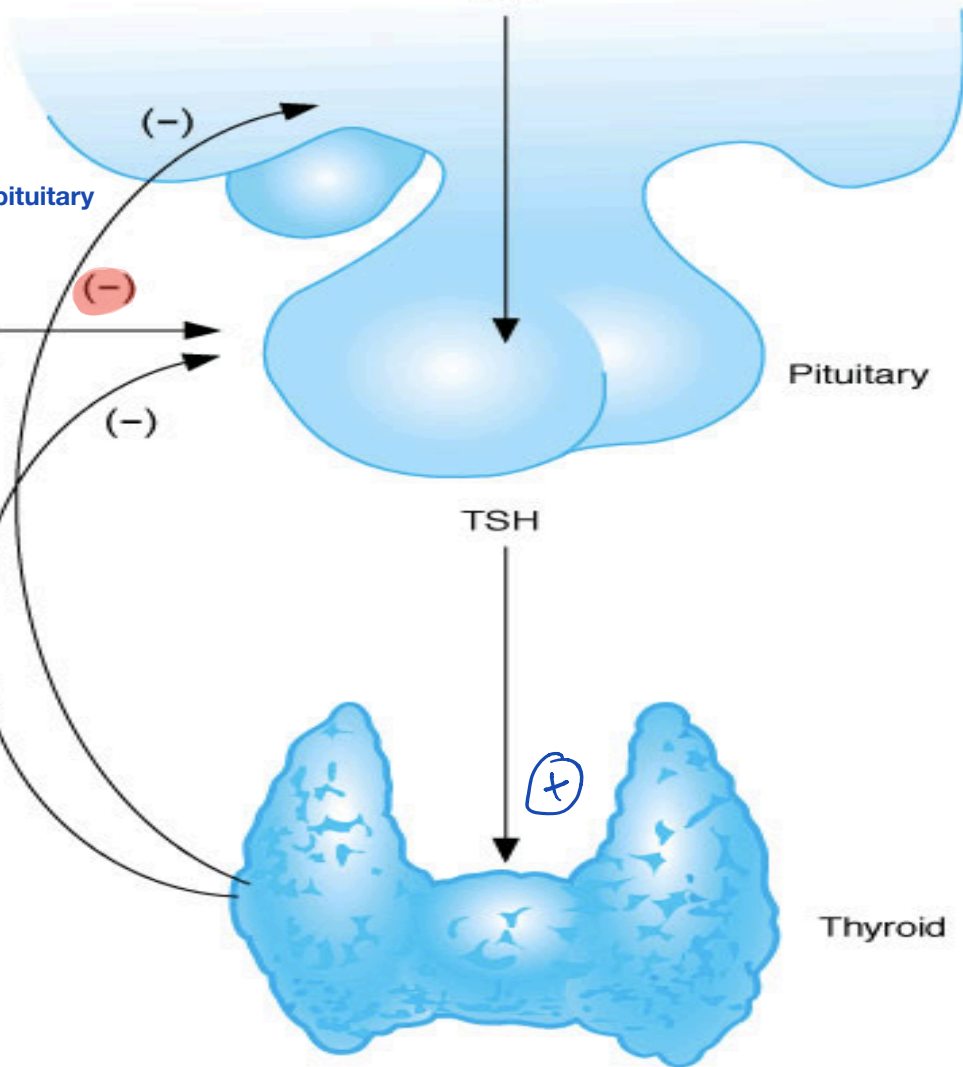
T<sub>4</sub>

T<sub>3</sub>

(+)

Pituitary

Thyroid







Each lab has its own normal values,  
so be aware for the future

# Thyroid Function: blood tests

TSH	0.4 – 5.0 mU/L
Free T4 (thyroxine)	9.1 – 23.8 pmol/l
Free T3 (triiodothyronine)	2.23-5.3 pmol/l

  
The most active & potent

	<u>T4</u>	<u>T3</u>
<b>Potency</b>	1	10
<b>Protein Bound</b>	10-20	1
<b>Half-Life</b>	5-7d	< 24h
<b>Secreted by thyroid</b>	100 ug/d	6 ug/d

- Peripheral Tissues will convert T4 to T3

Why pharmacodynamic and kinetics are important ?

To know the half life of each , So you know when exactly you should measure them.

T3 u measure it after

T4 after 6 weeks

# Effects of thyroid hormones

- Linear growth & pubertal development
- Normal brain development & function
- Calcium mobilization from bone
- Increase in basal metabolic rate
- Inotropic & chronotropic effects on heart
- Stimulates gut motility
- Increase in serum glucose, decrease in serum cholesterol
- Play role in thermal regulation



In  
pediatrics

First 3 years of life, why?  
Because in this time myelin sheath is still developing (myelination) and it is controlled by thyroid hormone



# HYPOTHYROIDISM

# Causes of hypothyroidism

## Primary

- Congenital
- Autoimmune (Hashimoto)
- Iodine deficiency
- Subacute thyroiditis
- Drugs (amiodarone)
- Irradiation
- Thyroid surgery

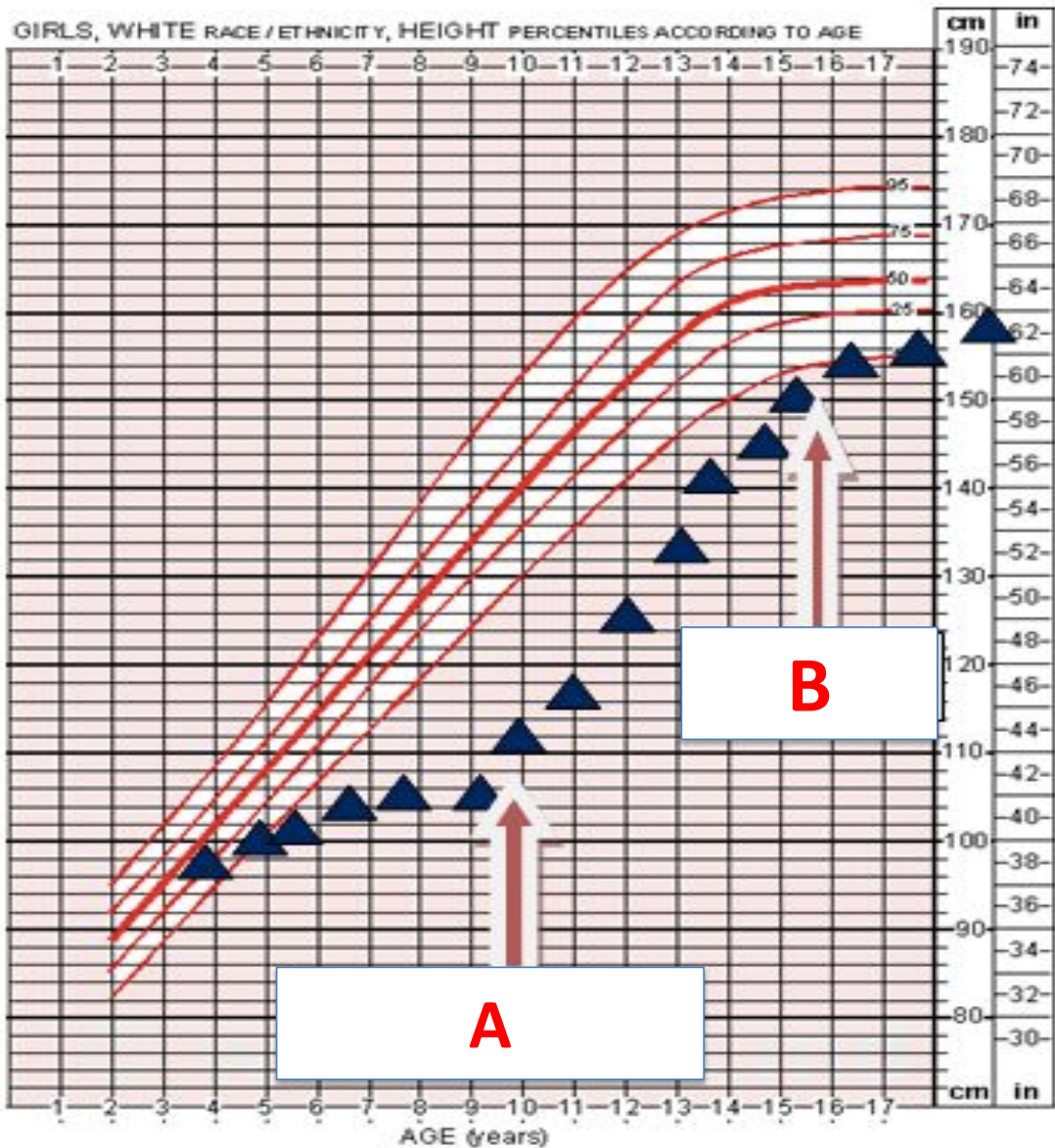
## Secondary

- TSH deficiency
  - TRH deficiency
- Any Problem in the hypothalamus or pituitary like (infection, adenoma,..)

# Clinical features

- Poor growth ..... **Stop growing**
  - Delayed bone age
  - Poor school performance
  - Delayed puberty
  - Weight gain
  - Fatigue
  - Constipation
  - Goiter
  - Dry skin
  - Cold Intolerance
  - Sinus Bradycardia
  - Delayed reflexes
- Umbilical hernias
  - Proximal myopathy
- 
- Short stature is the major issue in pediatrics

GIRLS, WHITE RACE / ETHNICITY, HEIGHT PERCENTILES ACCORDING TO AGE



- Before point A : hypothyroidism.
- At A: he was diagnosed with endocraniopathy
- Before Point B: after taking thyroxine.
- At B he reached the final growth spurt.

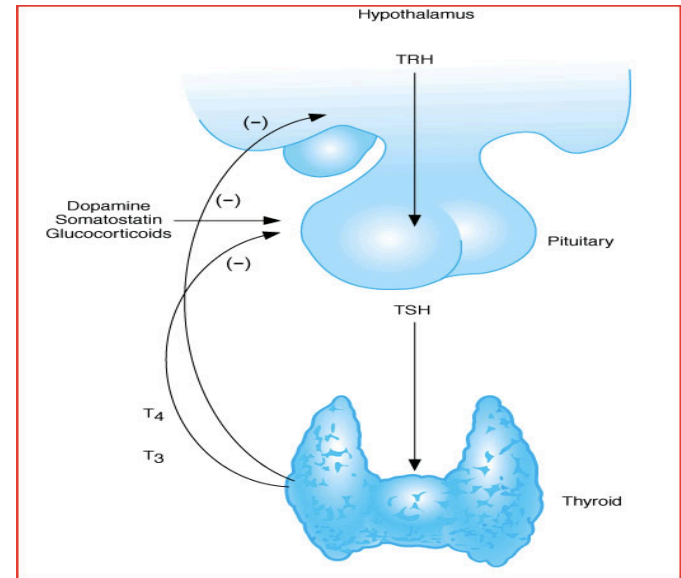
A

B



# Primary Hypothyroidism

- Decreased thyroid hormone levels
  - ↓↓T4
  - Possibly ↓ T3
  - ↑TSH

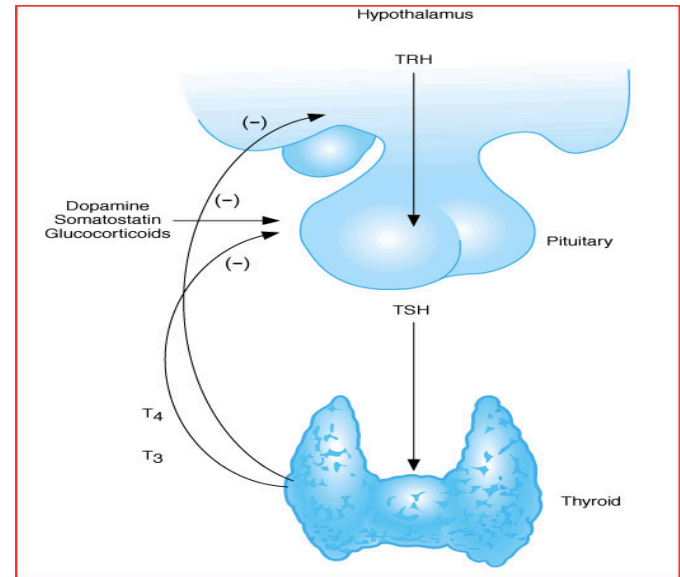


# Secondary Hypothyroidism

- Decreased thyroid hormone levels

- ↓↓ T4
- ↓ T3
- ↓ TSH

- Level of TSH is the way to differentiate between primary vs secondary



# Hashimoto's thyroiditis

- Most common cause of hypothyroidism
- Autoimmune lymphocytic thyroiditis
- Antithyroid antibodies:
  - Thyroglobulin Ab
  - Microsomal Ab
  - TSH-R Ab (block)
- Females > Males
- Runs in Families!

• Typically in adults



# Congenital Hypothyroidism

- It's an autosomal recessive disease
- In KSA it affects 1/1500, due to consanguinity

- 1 in 3000-4000 neonate
- The most common cause of treatable and preventable mental retardation..... The earlier dx the better IQ
- Congenital Anomalies increased by 10%(cardiac)
- In more than 90% of the cases it is permanent

# Impact on IQ when diagnosis is delayed

Age of Diagnosis	% with IQ > 85	
3 months		78%
6 months		19%
> 7 months	Mental retardation	0%

- Every day counts!

# Congenital Hypothyroidism: Causes

- Agenesis Gland not formed at all
- Dysgenesis Not completely formed
- Dyshormonogenesis Problem in hormones or transporter
- Ectopic gland
- Iodine deficiency From the mother
- Maternal anti-thyroid medication

## Clinical Features of Congenital Hypothyroidism

Finding	%
<b>Lethargy</b> <small>Most common</small>	<b>96%</b>
<b>Constipation</b>	<b>92%</b>
<b>Feeding problems</b>	<b>83%</b>
Respiratory problems	76%
Dry skin	76%
Thick tongue	67%
Hoarse cry	67%
Umbilical hernia	67%
Prolonged jaundice	12%
Goiter	8% ↘

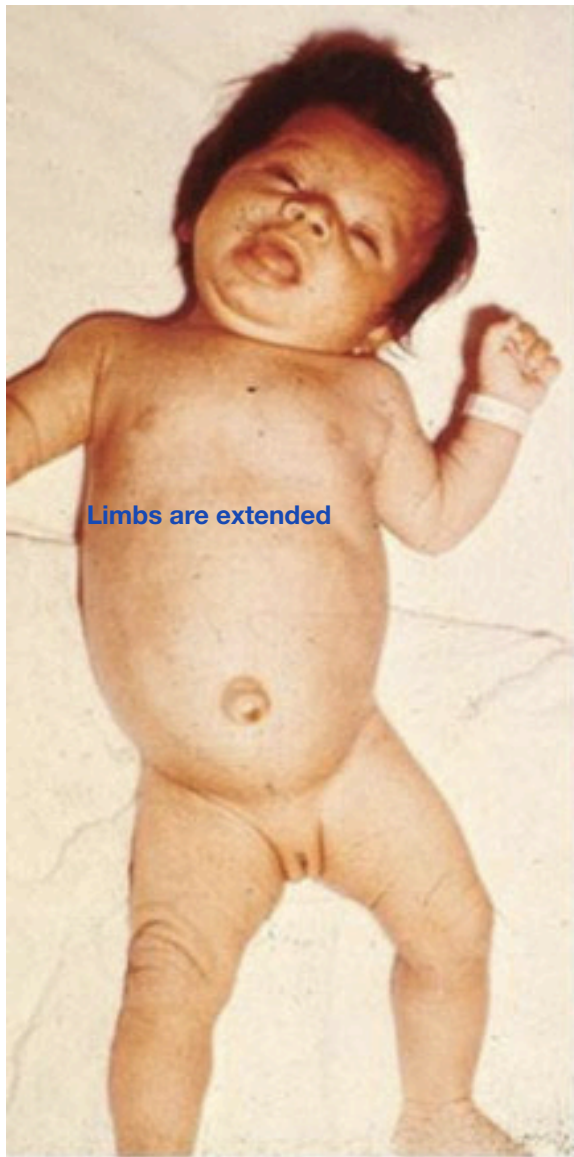
Ectopic thyroid gland on the tongue base, Not functioning





Macroglossia

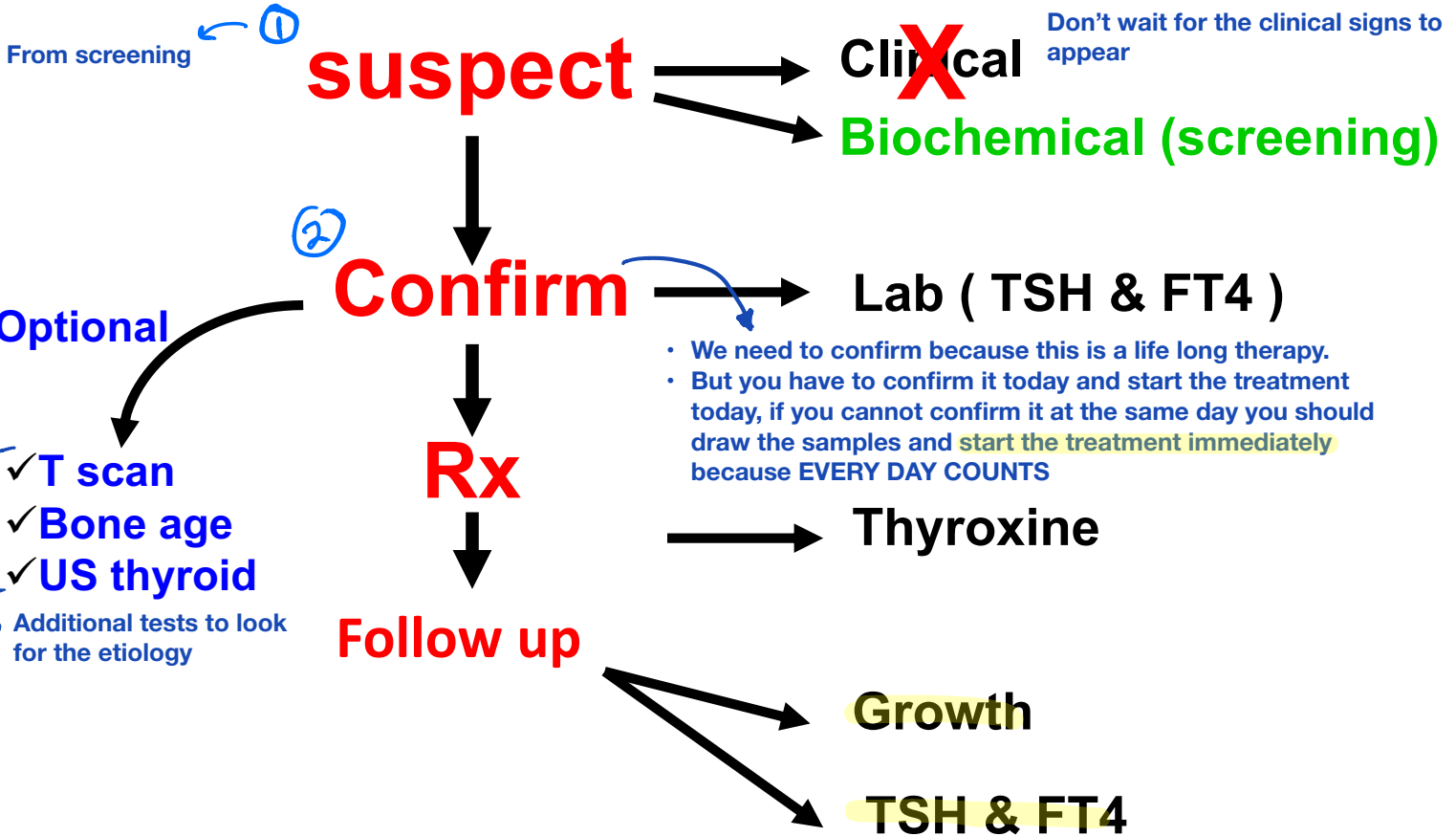




Big tongue  
cretinism



# Congenital Hypothyroidism



# Management

**High TSH & Low T4**

**Levothyroxine (T4)**

## Dose

10 -15 ug/kg/day  
12 -17 ug/kg/day  
37.5 – 50 ug/day

Higher dose in  
Severe cases

**T4 < 5ug/dl**

## Form

**Tablets**  
**25-50-75 ug**  
**Crush it, add to**  
**5-10 cc water**  
**Or milk**

## Goals

**Normal T4**  
**In 2 wks**  
**(upper 1/2 of N)**


**Normal TSH**  
**In one month**  
**(lower 1/2 of N)**

- Syrup isn't good, use tablets (same as for adults)
- Taking it 30min before the meal , same hour every day.

# Newborn Screening Criteria

- Aim is to identify affected infants before development of clinical signs
  - Preventing mental retardation and Preserving the IQ
- High incidence 1/3,000 to 1/4,000
- Mental retardation if not treated
  - It's very cost effective
- Levothyroxine \$3.00

# Screening Technique

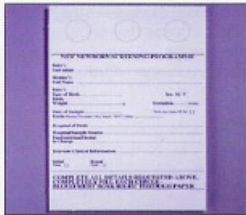
- Specimen is a blood spot on a filter paper
  - Obtained by heel prick
- Or
  - cord blood
- TSH or TSH+FT4 or FT4
  - Ideally 
- What are the cases in which you will not catch the diagnosis if you only test the TSH? SECONDARY hypothyroidism ( they will be flagged as normal)

# Neonatal Screening

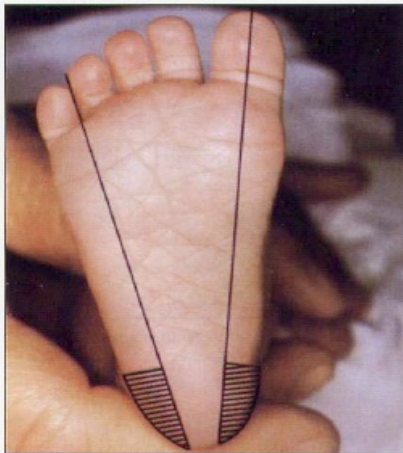
## Blood Specimen Collection and Handling Procedure




- 1** Equipment: sterile lancet with tip approximately 2.0 mm, sterile alcohol prep, sterile gauze pads, soft cloth, blood collection form, gloves.



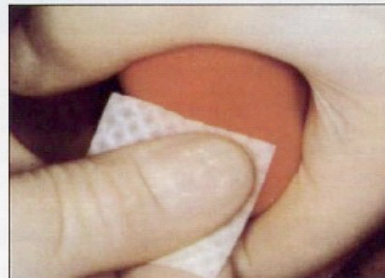
- 2** Complete ALL information. Do not contaminate filter paper circles by allowing the circles to come in contact with spillage or by touching before or after blood collection. Keep "SUBMITTER COPY" if applicable.



- 3** Hatched area (  ) indicates safe areas for puncture site.



- 4** Warm site with soft cloth, moistened with warm water up to 41°C, for three to five minutes.

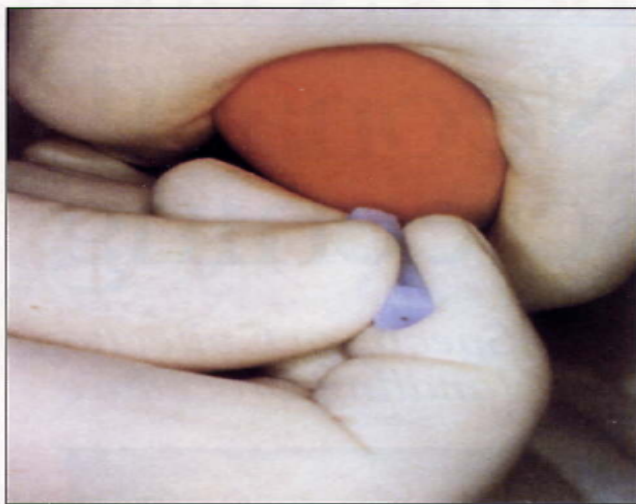


- 5** Cleanse site with alcohol prep. Wipe DRY with sterile gauze pad.

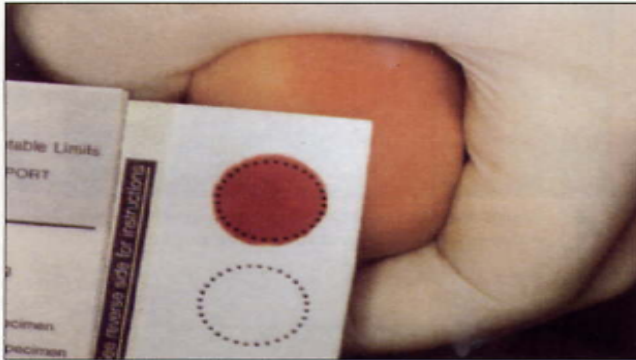








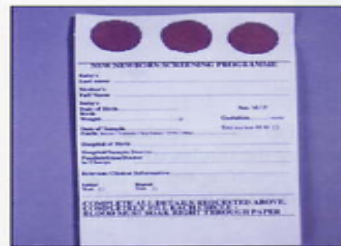
- 6** Puncture heel. Wipe away first blood drop with sterile gauze pad. Allow another **LARGE** blood drop to form.



- 7** Lightly touch filter paper to **LARGE** blood drop. Allow blood to soak through and completely fill circle with **SINGLE** application to **LARGE** blood drop. (To enhance blood flow, **VERY GENTLE** intermittent pressure may be applied to area surrounding puncture site). Apply blood to one side of filter paper only.



- 8** Fill remaining circles in the same manner as step 7, with successive blood drops. If blood flow is diminished, repeat steps 5 through 7. Care of skin puncture site should be consistent with your institution's procedures.



- 9** Dry blood spots on a dry, clean, flat non-absorbent surface for a minimum of four hours.



- 10** Mail completed form to testing laboratory within 24 hours of collection.

# Good Specimen

FILL FIVE CIRCLES WITH BLOOD



BE SURE IT SOAKS THROUGH

# IQ Outcome

Pre-screening

• 76

Post-screening

• 104

الحمد لله!



**> screening**



**< screening**





- They are severely short
- Delayed puberty



A man and **3 females** (age range, 17-20 y) with myxedematous cretinism from the Republic of the Congo in Africa, a region with **severe iodine deficiency**.

# Treatment of Hypothyroidism

- Replacement thyroid hormone medication:  
**Thyroxine**

# Your turn

- 2 days old baby has a TSH= 150, FT4= 5 on newborn screening. what is your next best step:
  - A. Repeat TSH, FT4, follow up in 1 week
  - B. Do US thyroid after 1 week
  - C. Start levothyroxin 50mcg
  - D. repeat TSH, FT4 and start treatment





# HYPERTHYROIDISM

# Causes of hyperthyroidism

- Graves Disease
  - The most common
  - As same in adults
- Overtreatment with thyroxine
- Thyroid adenoma (rare)
- Transient neonatal thyrotoxicosis

# Hyperthyroidism

- Increased thyroid hormone levels
  - ↑ T4 +/- High T3
  - ↓ TSH (suppressed)

# Graves' Disease

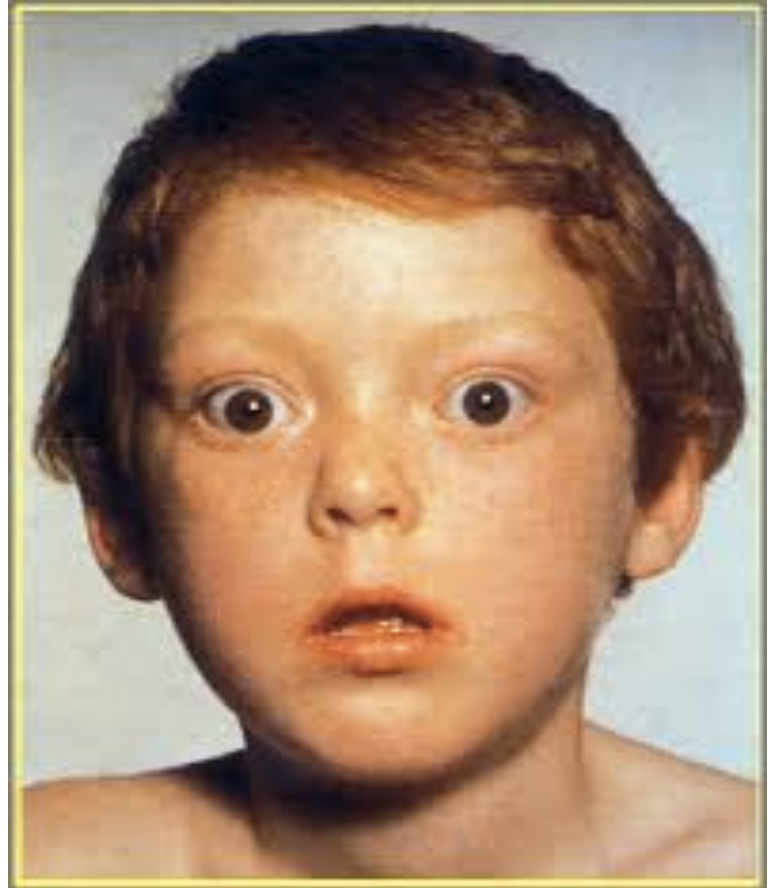
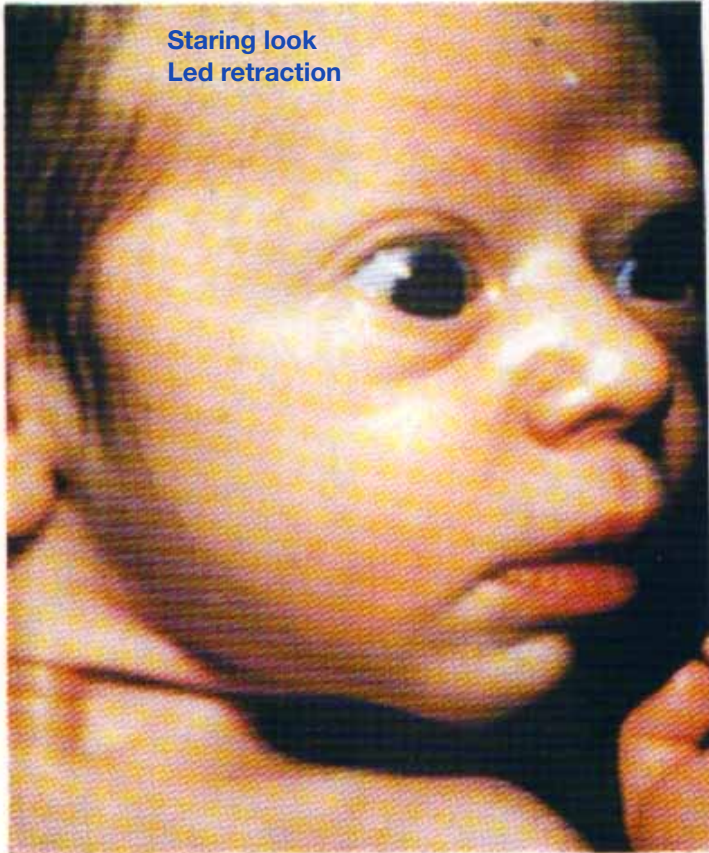
- Most common cause of hyperthyroidism
- Autoimmune process
- TSH-R stimulating antibody Will go to the thyroid gland and attached them self to TSH receptors
- 40-70% relapse after 2 years of treatment

# Clinical manifestations

- Heat intolerance
- Hyperactivity, irritability
- Weight loss
- normal to increased appetite
- diarrhea
- Tremor, Palpitations
- sweating
- Lid retraction & Lid Lag (thyroid stare)
- Proptosis
- menstrual irregularity
- Goitre

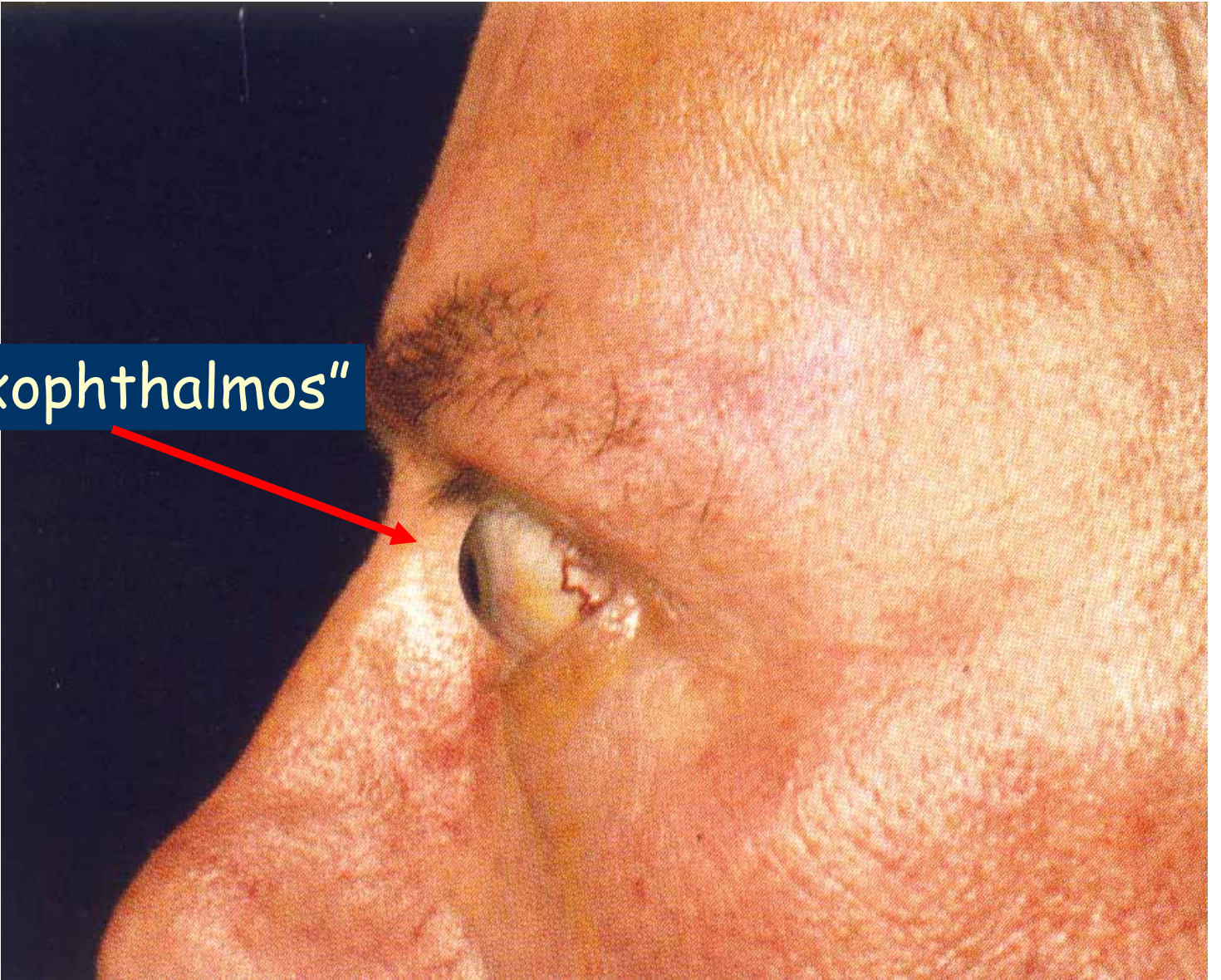
**Baby graves:**

Passing of antibody from mother to baby, Dx immediately after birth or before by US.





"Exophthalmos"



Led retraction



Grave's  
ophthalmopathy

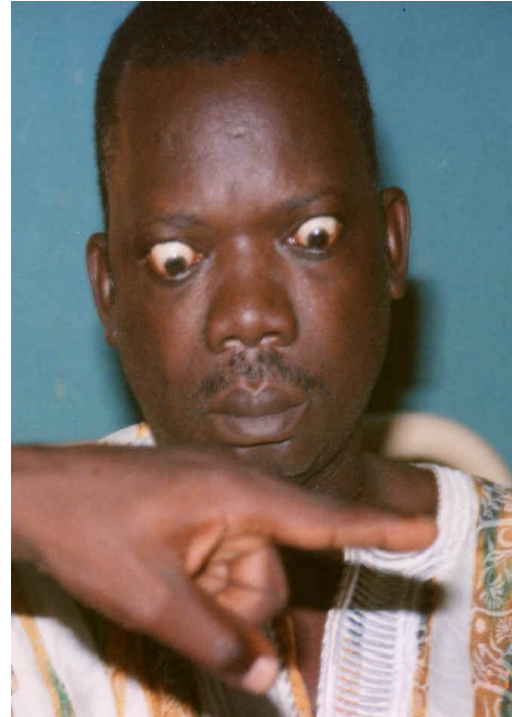


# Hyperthyroid Eye Disease

Echomosis



Led lag



# Investigations

- TSH, free T3&T4
- Thyroid antibodies (TSH receptors antibodies)
- Radionucleotide thyroid scan (increase uptake)

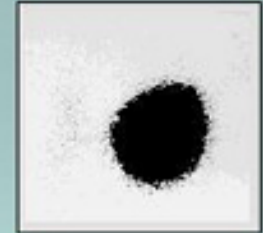
# Thyroid Scan in Thyrotoxicosis

Homogeneous bilateral increase uptake



**Graves' Disease**

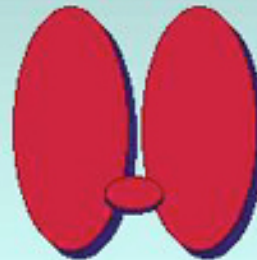
Unilateral increase uptake



**Follicular Adenoma**



**Multinodular Goiter**



**Subacute Thyroiditis**

# Treatment

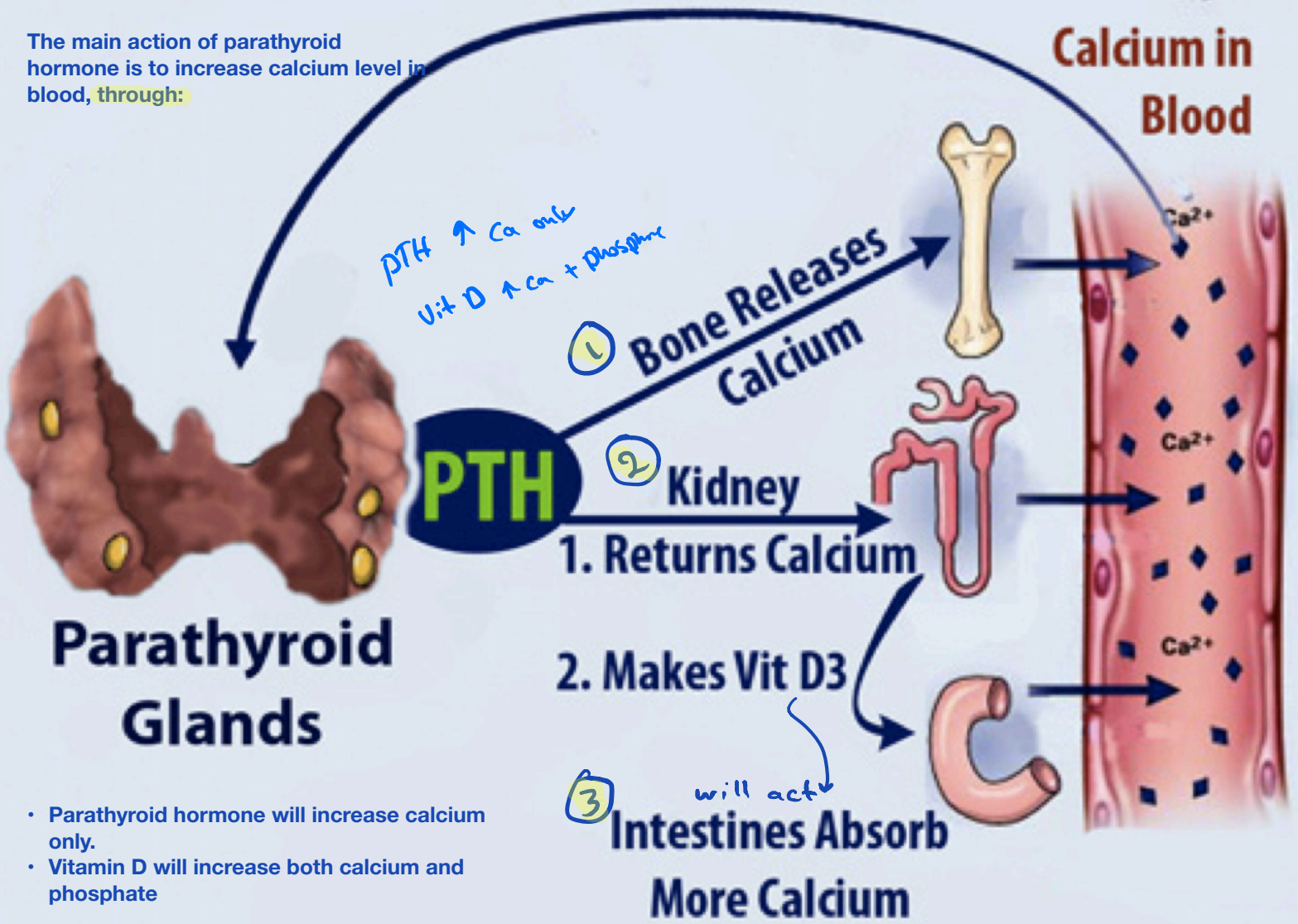
- *Beta*-blockers To control palpitations
- Carbimazole To inhibit thyroid hormone synthesis
- PTU (propylthiouracil)
- Radioactive iodine (in adults)
- surgery

Carbimazole is an antithyroid agent that decreases the uptake and concentration of inorganic iodine by thyroid, it also reduces the formation of di-iodotyrosine and thyroxine.



**RICKETS** الكُساح

The main action of parathyroid hormone is to increase calcium level in blood, through:



- Parathyroid hormone will increase calcium only.
- Vitamin D will increase both calcium and phosphate

# SUN

## UVB

7-dehydrocholesterol

Pre-D<sub>3</sub>

D<sub>3</sub>

SKIN

## CIRCULATION

D<sub>3</sub>

DBP

LIVER

D<sub>3</sub>

25(OH)D

D<sub>3</sub>

## VITAMIN D FROM DIET

## FROM DIET

(absorbed through intestines)

Actions of vitamin D:

①

Intestine

↑ Ca

↑ Po4

Activation happens here in the kidney

1α25(OH)D

## KIDNEY

②

Bone

↑ mineralization

③

Immune cells

# Calcitonin

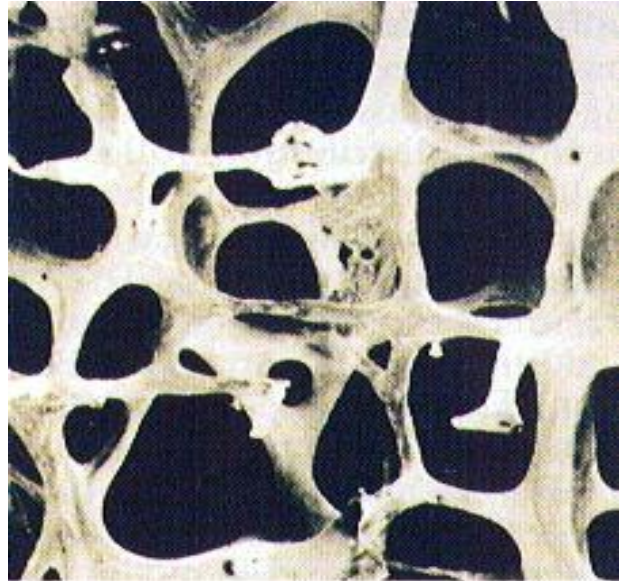
- It is a calcium lowering hormone
- Secreted by Thyroid C cells

Anti - PTH



# Rickets

- Reduced **mineralization** of bone matrix due to calcium deficiency.



# Rickets

## Vitamin D Deficiency

Nutritional · Most common

Intestinal malabsorption

anticonvulsants

Rickets of prematurity

Hepatobiliary

## Renal

Renal osteodystrophy:CRF

Familial hypophosphataemic rickets

Renal tubular acidosis

Fanconi syndrome

Vitamin D dependent type 1 rickets

Vitamin D dependent type 2 rickets

# Rickets Effect at growth end plate

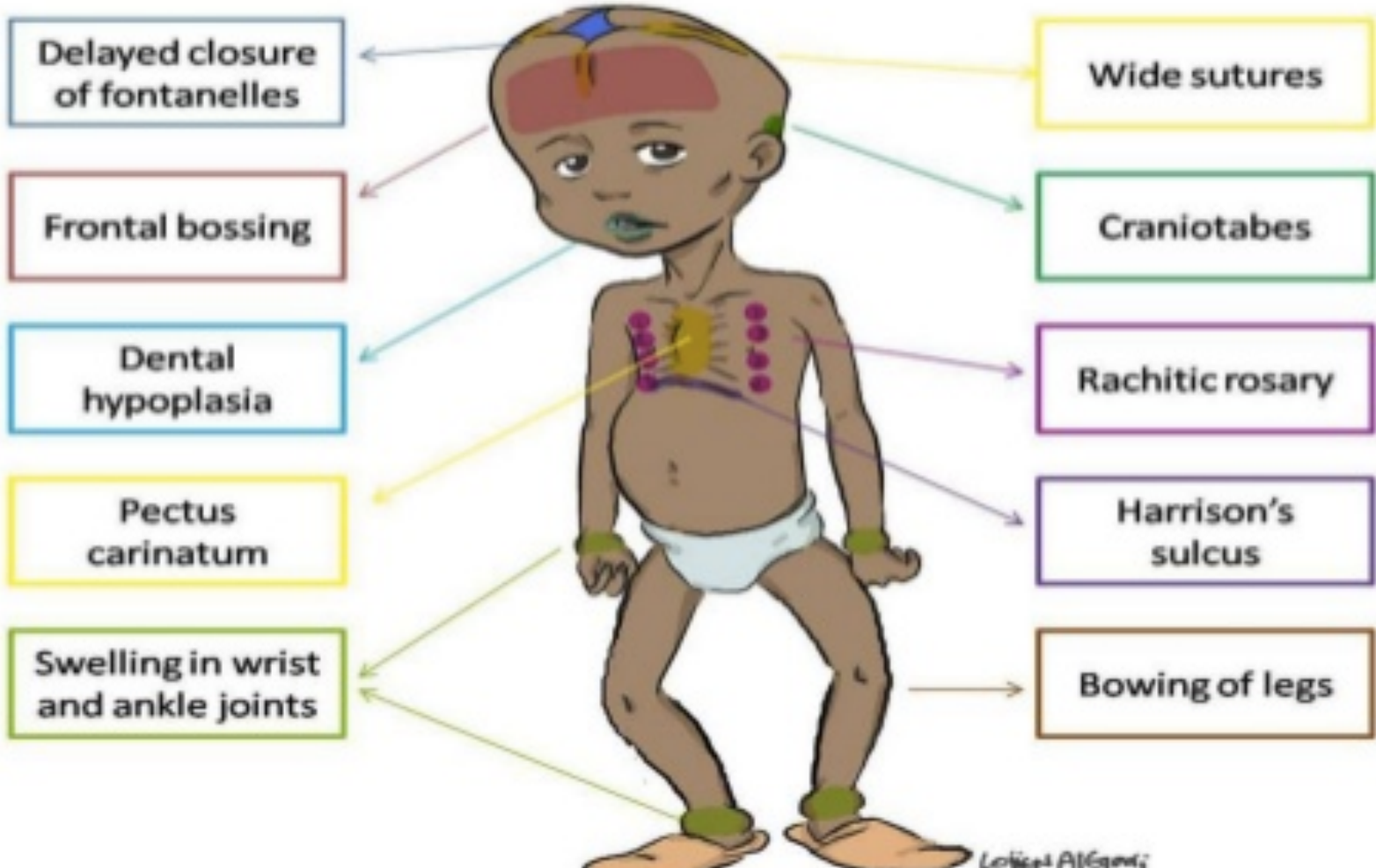
Inadequate growth plate mineralization.

The growth plate increases in thickness.

The columns of cartilage cells are disorganized.

# 10 important clinical features in Rickets

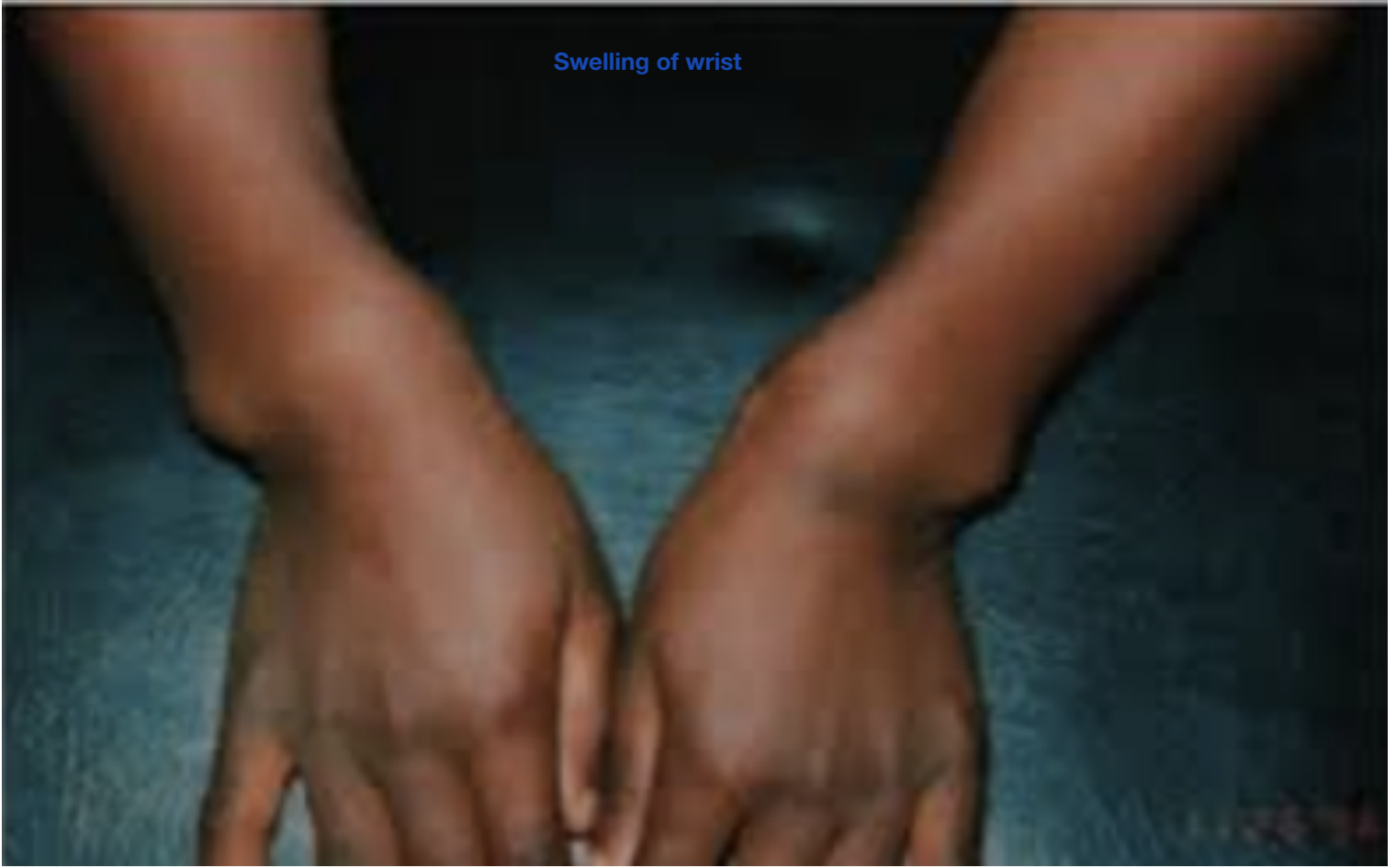
- The posterior fontanelle usually closes by age 2-3 months.
- The anterior fontanelle usually closes between 9 months and 18 months. (Doctor said around 15 months)



- Rachitic rosary



Swelling of wrist





**Bowing**

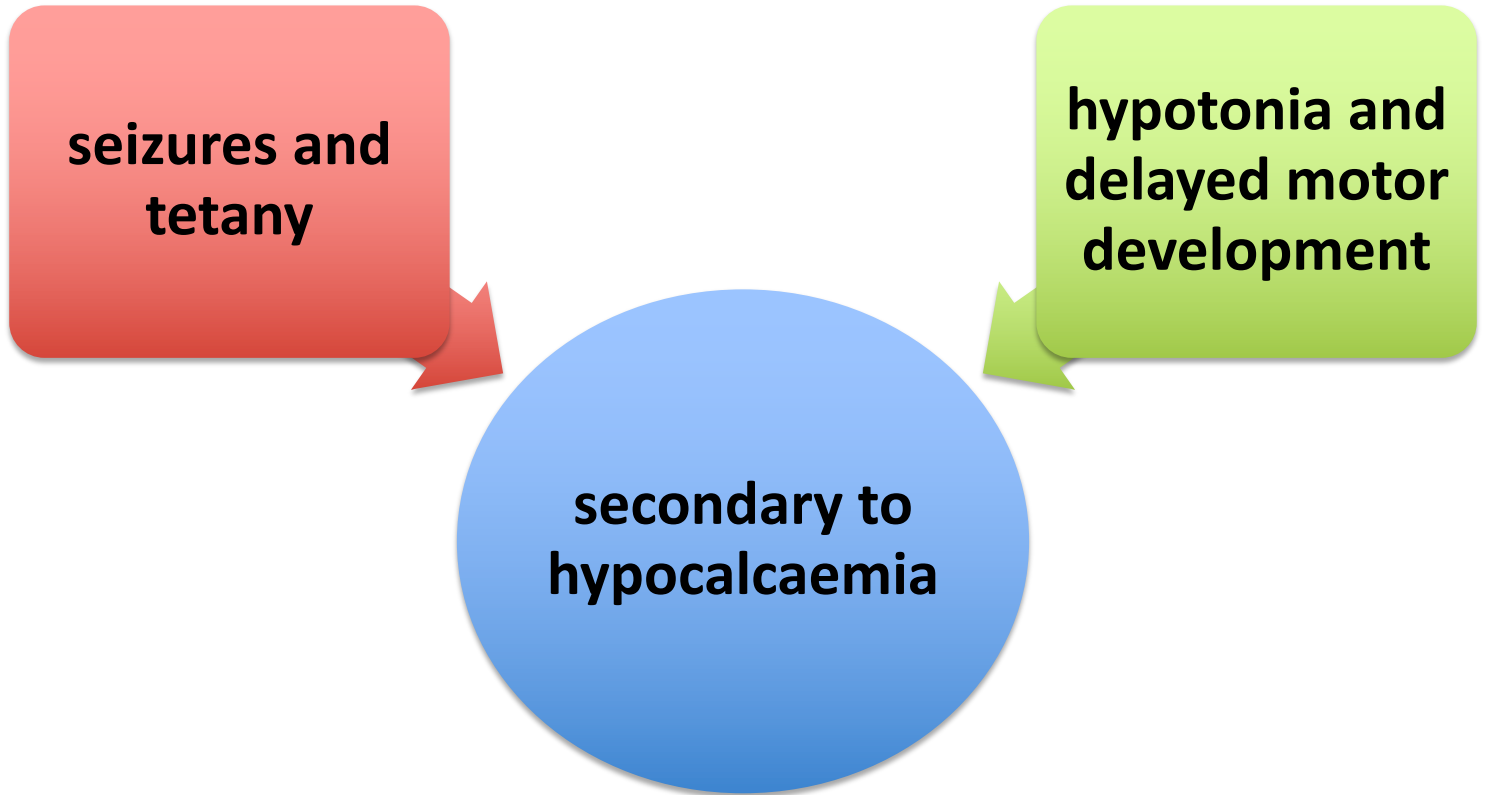


Bowing





# Extra – skeletal manifestations



How can differentiate  
between low calcium level  
due to low parathyroid  
hormone Vs low vitamin D?  
By phosphate (see the table)

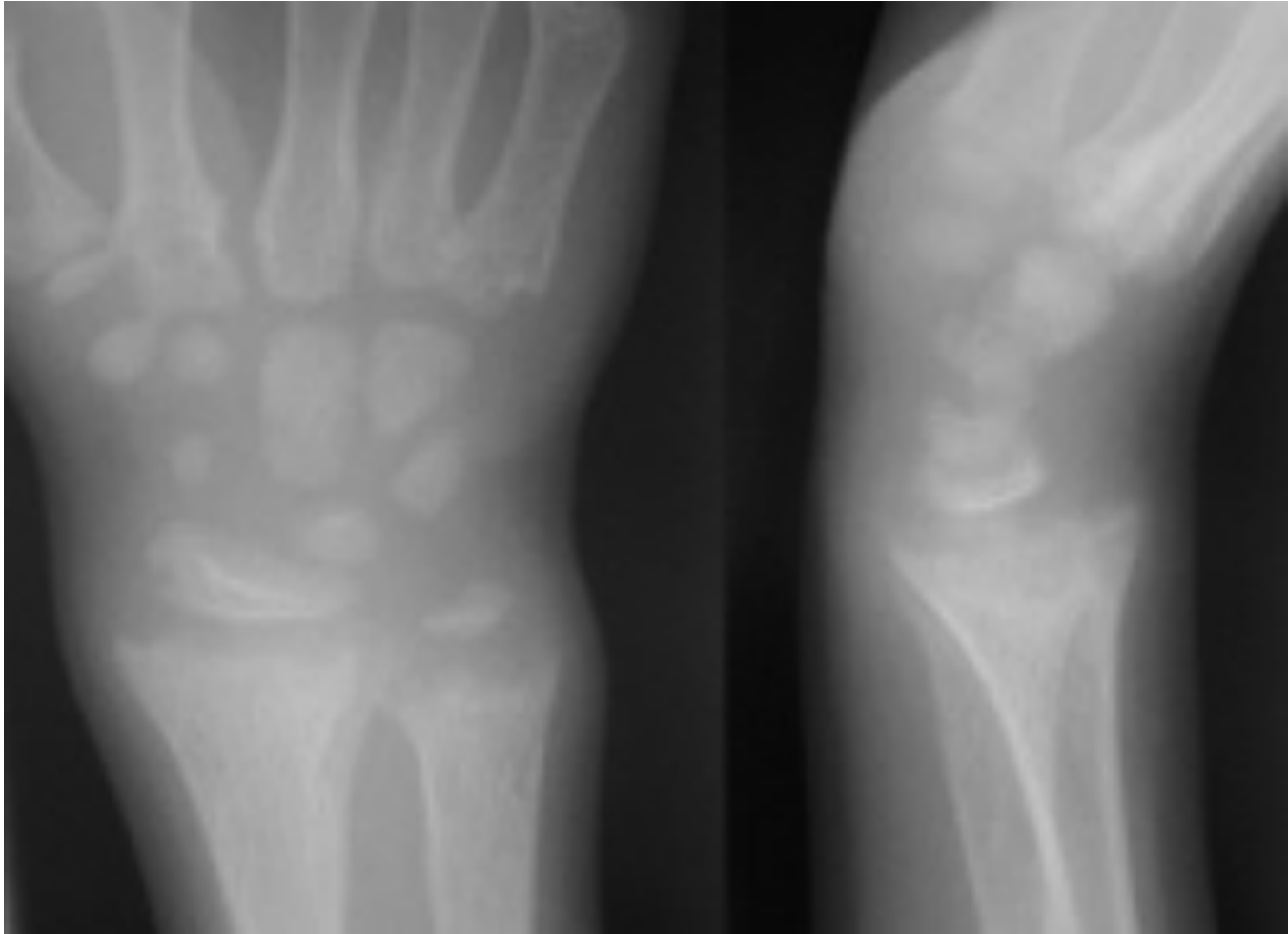
# Investigations

- ↓ or normal serum Ca
- ↓ Phosphorus
- ↑ alkaline phosphatase
- ↓ Vit D level
- ↑ Parathyroid hormone

	Vitamin D def	Low PTH
Calcium	↓	↓
Phosphorus	↓	↑
Vit D level	↓	N
PTH	↑	↓



Wide growth plate  
Cupping & frying  
Osteopenia



# Vitamin D Resistant Rickets

Causes:

1

Defective final conversion of Vit. D in to active form

- Because the enzyme not functioning
- Decrease in level of (1,25-dihydroxycholecalciferol)

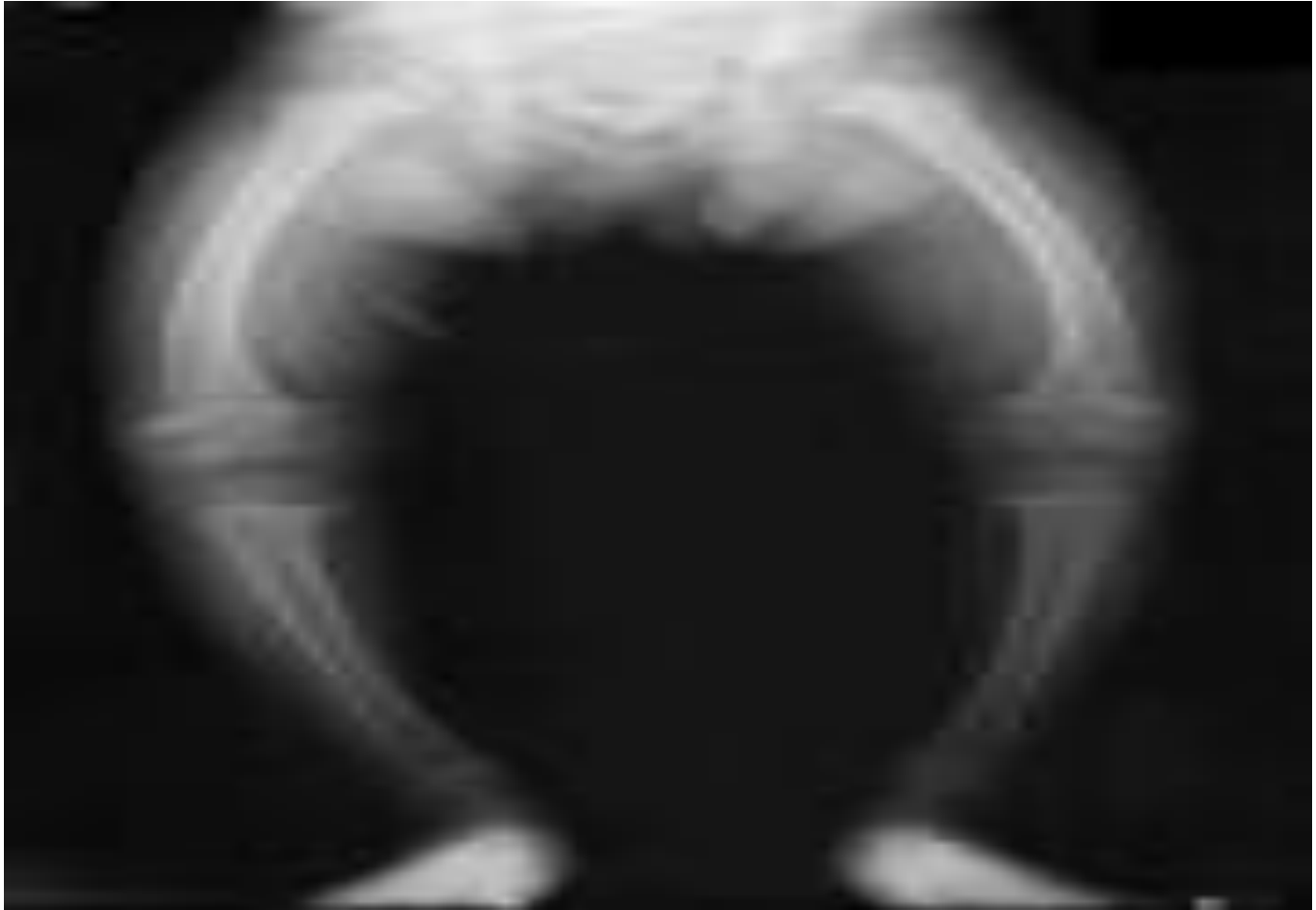
2

End organ insensitivity

- Receptors not responding
- Increase level of (1,25-dihydroxycholecalciferol)

Both are very rare

## Bowing



Vitamin D Resistant Rickets

# Treatment of Rickets

- Vitamin D supplement
- Type and dose depends on underline cause of Rickets

Children: give vit D

Older than 2 years old : 50000 weekly

Less than 2 years old : 1000- 2000 daily

+ give calcium to prevent hungry bone syndrome

Full term 1 year old girl who presented with afebrile tonic clonic convulsions. she has no chronic illnesses or medication. On examination he has no apparent dysmorphic features and his vital signs were normal.

Labs are most likely to show:

- A** ↓ Ca, ↓ Phosphorus, ↑ ALP
- B** ↓ Parathyroid hormone
- C** ↓ Ca, ↑ Phosphorus, ↑ ALP
- d** ↓ Ca, ↑ Phosphorus, ↓ ALP



• It's due to vitamin D deficiency



