

# Emergency in Pediatric Nutrition

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# Severe Acute Malnutrition

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# Severe acute malnutrition

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|          | 60-80% OF STANDARD<br>WT           | <60% OF STANDARD<br>WT |
|----------|------------------------------------|------------------------|
| No edema | Underweight, growth<br>retardation | Marasmus               |
| Edema    | Kwashiorkor                        | Marasmic kwashiorkor   |

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Refeeding  
syndrome

Vitamin A  
deficiency

Thiamin deficiency

# Definitions of malnutrition by WHO

| Nutritional status           | Severity | Criteria                                                |
|------------------------------|----------|---------------------------------------------------------|
| Underweight<br>(น้ำหนักน้อย) | Moderate | W/A Z score $< -2$ to $-3$ SD<br>(60 – $<75\%$ )        |
|                              | Severe   | W/A Z score $< -3$ ( $<60\%$ )                          |
| Wasting<br>(ผอม)             | Moderate | W/L or W/H Z score $< -2$ to $-3$ SD<br>(70 – $<80\%$ ) |
|                              | Severe   | W/L or W/H Z score $< -3$ ( $<70\%$ )                   |
| Stunting<br>(เตี้ย)          | Moderate | H/A Z score $< -2$ to $-3$ SD (85 – $<90\%$ )           |
|                              | Severe   | H/A Z score $< -3$ ( $<85\%$ )                          |

## WHO criteria

- Weight-for-length/height  $< -3SD$  or
- Mid-upper arm circumference  $< 115$  mm
- Edema of both feet  
(kwashiorkor with or without severe wasting)



*Child with  
marasmus*

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## Thai CPG criteria

- Severe wasting or marasmus  
(W/H  $< -3SD$  or  $< 70\%$ ) or
- Kwashiorkor: pitting edema, flaky paint dermatosis, hyperpigmented skin rash, brittle hair



*Child with severe acute  
malnutrition oedema*

# Pathophysiology



Depletion of fat, then glycogen



Reduction in activity to conserve energy expenditure

Slow growth

Decrease metabolic rate



Preserve brain and viscera



Increase TBW (ECF>ICF)

# Pathophysiology of SAM

|                       |                                                                                                                                                                                                                               |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Body composition      | Increase total body water<br>(loss lean mass)                                                                                                                                                                                 |
| Electrolyte imbalance | ↓ K, P, Mg<br>↑ Na                                                                                                                                                                                                            |
| GI and liver          | Villi atrophy, lactase deficiency, pancreatic insufficiency, decrease acid production from stomach, intestinal dysmotility<br>→ bacterial translocation, maldigestion, malabsorption, impaired gluconeogenesis → hypoglycemia |
| Anemia                | Iron deficiency                                                                                                                                                                                                               |
| Renal                 | Impaired concentrating ability<br>(↓ urea → ↓ hypertonicity in renal medulla)                                                                                                                                                 |

# Pathophysiology of SAM

|                            |                                                                    |
|----------------------------|--------------------------------------------------------------------|
| Endocrine                  | ↓ T3 (metabolism), ↓ insulin-like growth factor                    |
| Secondary immunodeficiency | Mucosal immunity, ↓ sIgA                                           |
| Cardiovascular             | ↓ cardiac output, stroke volume → hypotension<br>Sinus bradycardia |
| Respiratory system         | Diaphragm                                                          |
| Skin                       | Tyrosine deficiency → ↓ melanin<br>Pallor, poor skin turgor, hair  |
| CNS                        | Impaired cognitive function, mood                                  |

# Cause

Under 5 years

< 1yr  
(rapid growth)

Caregiver

Unable to eat

Chronic  
infection

Maldigestion/  
malabsorption

Poverty

Poor  
hygiene

Feeding

Anorexia

Infection

Diarrhea

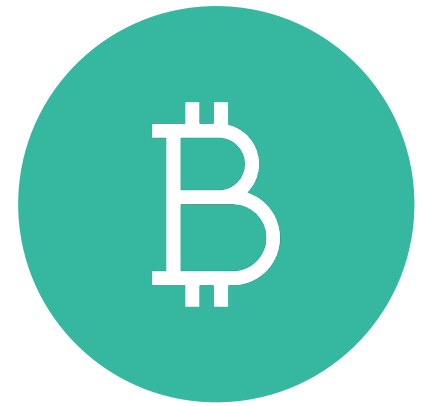
# How to manage patient with SAM



PHYSICAL EXAMINATION



INVESTIGATION



IPD VS. OPD



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# Time frame for the management

Updates on the management of severe acute malnutrition in infants and children. WHO 2013

|                           | Stabilization                                                                                |          | Rehabilitation                                                                                 |
|---------------------------|----------------------------------------------------------------------------------------------|----------|------------------------------------------------------------------------------------------------|
|                           | Days 1–2                                                                                     | Days 3–7 | Weeks 2–6                                                                                      |
| 1. Hypoglycaemia          |           |          |                                                                                                |
| 2. Hypothermia            |           |          |                                                                                                |
| 3. Dehydration            |           |          |                                                                                                |
| 4. Electrolytes           |           |          |                                                                                                |
| 5. Infection              |           |          |                                                                                                |
| 6. Micronutrients         | no iron  |          | with iron  |
| 7. Initiate feeding       |         |          |                                                                                                |
| 8. Catch-up feeding       |         |          |                                                                                                |
| 9. Sensory stimulation    |         |          |                                                                                                |
| 10. Prepare for follow-up |         |          |                                                                                                |

# Investigation

|                             | Result                      |
|-----------------------------|-----------------------------|
| Blood sugar                 | Hypoglycemia, hyperglycemia |
| Electrolyte                 | Na, K, metabolic acidosis   |
| P, Ca, Mg                   | Low serum level             |
| CBC with PBS                | Anemia, leukocytosis, DIC   |
| BUN, Cr                     | Renal function              |
| UA, stool exam, hemoculture | Dehydration, infection      |
| Stool fat                   | Fat malabsorption           |

# Admission criteria; complicated SAM

## Severe acute malnutrition with

- Age < 1yr + length for age < -1SD
- Age > 1yr + length for age < -1SD with complication
  - edema, high-grade fever, hypothermia, severe dehydration, lower respiratory tract infection, diarrhea
- Unable to eat/drink, loss follow up

# Treatment

Acute phase  
(1<sup>st</sup> week)

- Dehydration & Electrolyte imbalance
- Infection
- Stabilization

\* Refeeding  
syndrome \*

- Thiamin deficiency
- Vitamin A deficiency

Recovery phase  
(2<sup>nd</sup> week)

- Positive energy balance

# Acute phase

## 1. Hypothermia/ fever

## 2. Hypoglycemia (BS < 55mg/dL)

- Asymptomatic, stable vital signs, oral feeding
  - 10% glucose or 10% sucrose 50 ml oral → BS 30 min
  - Start BM/IF/medical formula q 30 min x 2hr then feed q 2hr
  - If BS < 55 mg/dL → give oral 1 dose → IV glucose
- Symptomatic, unstable vital signs, unable to eat/drink
  - 10% dextrose 2-4 ml/kg/dose (200-400 mg/kg/dose) iv slowly push in 5 min
  - Then iv dextrose; glucose infusion rate ~ age
  - BS q 15-30 min

### 3. Dehydration

#### Shock/severe dehydration

- Isotonic crystalloid (RLS, 0.9% NaCl) 10 ml/kg/dose in 10–15 min with v/s q 10–15 min until stable
- Maximum of 40 ml/kg → colloid + septic workup + antibiotics
- Fluid = 100ml/kg (deficit) + 100 ml/kg (maintenance) - loading dose iv drip in 24 hr (5%Dextrose + 0.45% NaCl)

**Acute  
phase**

# Acute phase

## 3. Dehydration

### Stable vital signs

- Mild dehydration:

ORS 50ml/kg in first 4 hrs then 100 ml/kg in 20 hrs

- Moderate dehydration:

ORS 100ml/kg in first 4 hrs then 100 ml/kg in 20 hrs

# Acute phase

## 4. Hypokalemia

- Intracellular shifting + low total body potassium
- Very low K + symptomatic; arrhythmia, weakness, EKG  
K 0.3–0.5 mEq/kg/dose, max 20 mEq/dose iv drip in 1–2 hr  
Urine output > 0.5 ml/hr  
Maximum peripheral IV K concentration 40 mEq/L
- Low K + asymptomatic  
KCl or KHCO<sub>3</sub> 2–4 mmol/kg/day qid (max 1 mmol/kg, 20 mmol)
- Hypophosphatemia → K<sub>2</sub>PO<sub>4</sub>

## Acute phase

### 5. Hypophosphatemia

- Serum phosphate  $< 3$  mg/dL (0.98 mmol/L)
- Oral phosphate supplement 0.3–0.6 mmol/kg/day  $\rightarrow$  diarrhea
- IV phosphate 0.5–0.8 mmol/kg/day iv drip in 24 hrs
- Serum phosphate  $< 1.5$  mg/dL (0.48 mmol/L)  
 $\rightarrow$  P 0.24–0.32 mmol/kg iv drip in 6–12 hrs
- Max 15 mmol/dose, 1.5 mmol/kg/day

**Acute  
phase**

## 6. Infection

- History & physical examination → septic workup
- Antibiotics → source of infection
- Empirical antibiotics; 3<sup>rd</sup> generation cephalosporin IV
- Ceftriaxone 75 mg/kg iv q 24 hr

# Nutritional management

## Energy

"Actual body weight" Holliday–Segar rule

First 10 kg  $\rightarrow$  100 kcal/kg/day

10–20 kg  $\rightarrow$  50 kcal/kg/day

>20 kg  $\rightarrow$  20 kcal/kg/day

BW 17 kg =  $(10 \times 100) + (7 \times 50) = 1350$

# Nutritional management

## Formula

- Continue breastfeeding
- Formula 20–30 kcal/oz, osmolarity <300 mOsm/L
- Carbohydrate maldigestion/malabsorption → Lactose free formula
- Fat malabsorption → MCT-oil containing formula

## Route: oral first!

- Enteral feeding → oral feeding < 50% at day 3 or < 80% at day 7

# Nutritional management

Start 20–25% of total energy requirement (Holliday–Segar)

Gradually increase feeding volume → 100% at day 7

Monitor electrolytes (Na, K), P, Mg at least daily

Vitamin supplement

- Vitamin A
- Vitamin B1 25–100 mg/day oral/IV before start feeding then 7–10 days
- Multivitamin (vitamin A 2,000–5,000 IU/day)
- Fe start at 2<sup>nd</sup> week or recovery phase
- Elemental zinc 1mg/kg/day (max 50 mg/day)

## 7. Initial re-feeding

### Treatment

Frequent (q 2–3h) oral small feeds

Low osmolality and low lactose

NG feeding if the child is eating  $\leq 80\%$  at 2 consecutive feeds

Calories at 100 kcal/kg/day

Protein at 1–1.5 g/kg/day

Liquid at 130 ml/kg/day or 100 ml/kg/day if edema

## 7. Initial re-feeding

### Monitoring

Amounts of feed offered and left over

Vomiting

Stool frequency and consistency

Daily body weight

# 8. Catch-up growth feeding

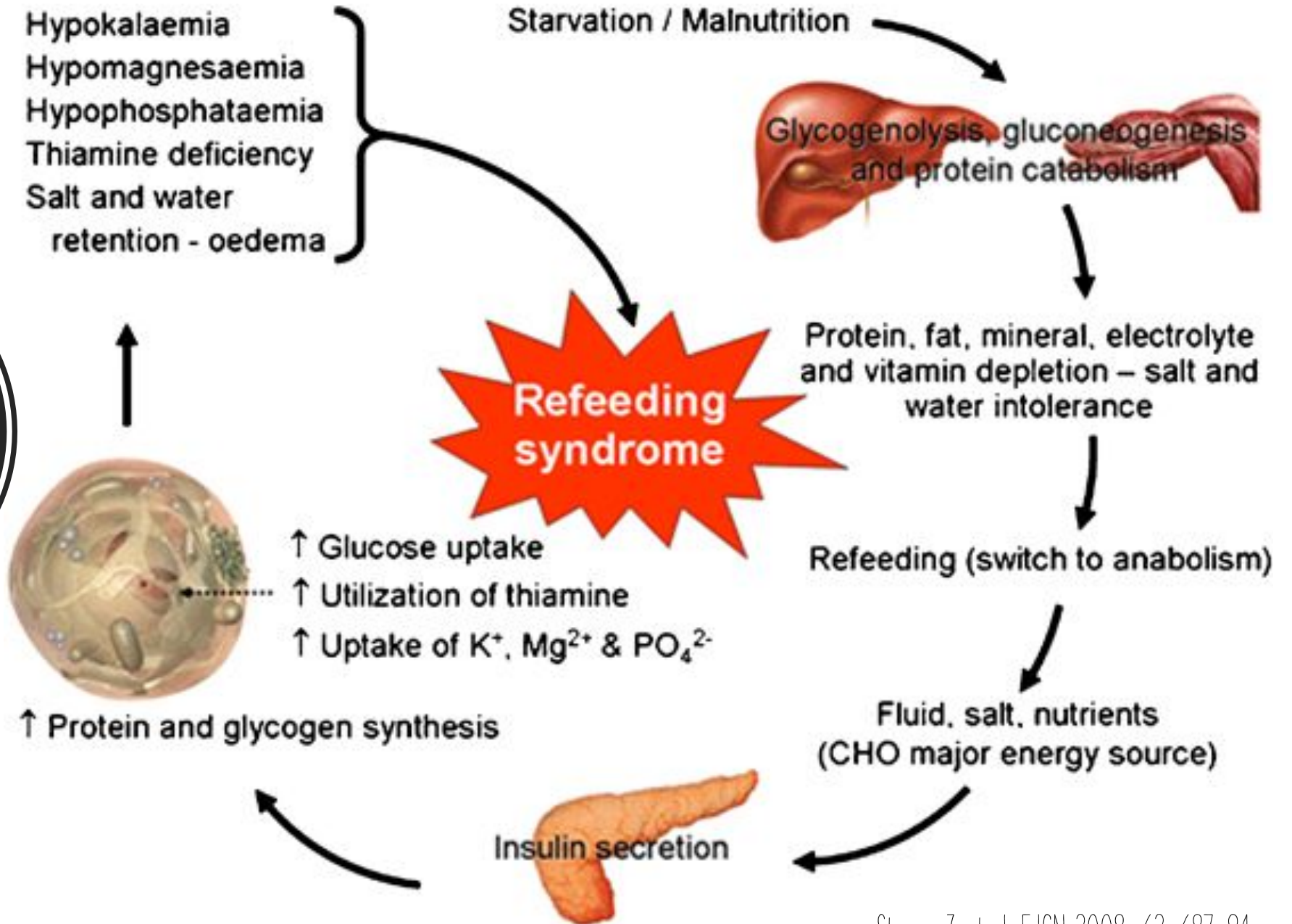
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Most cases can be managed as outpatients

Sign that a child has reached rehabilitation phase are:

- Return of appetite
- No episodes of hypoglycemia (metabolically stable)
- Reduced or disappearance of all edema

# Refeeding syndrome



| Hypophosphatemia                                                                                                    | Hypokalemia                                                                                      | Hypomagnesemia                                                                                                                                         | Thiamin deficiency                                                                 |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Weakness (diaphragm)<br>RS failure<br>Hemolysis<br>CVS failure<br>Encephalopathy<br>Confusion, stupor<br>Convulsion | Nausea vomiting<br>Constipation<br>Muscle weakness<br>RS failure<br>Cardiomyopathy<br>Arrhythmia | Nystagmus, convulsion<br>Fatigue<br>Muscle spasms/cramp<br>Anorexia/nausea/vomiting<br>Diarrhea<br>Arrhythmia<br>Refractory hypokalemia & hypocalcemia | Lactic acidosis<br>Muscle weakness<br>Heart failure<br>Confusion<br>Encephalopathy |

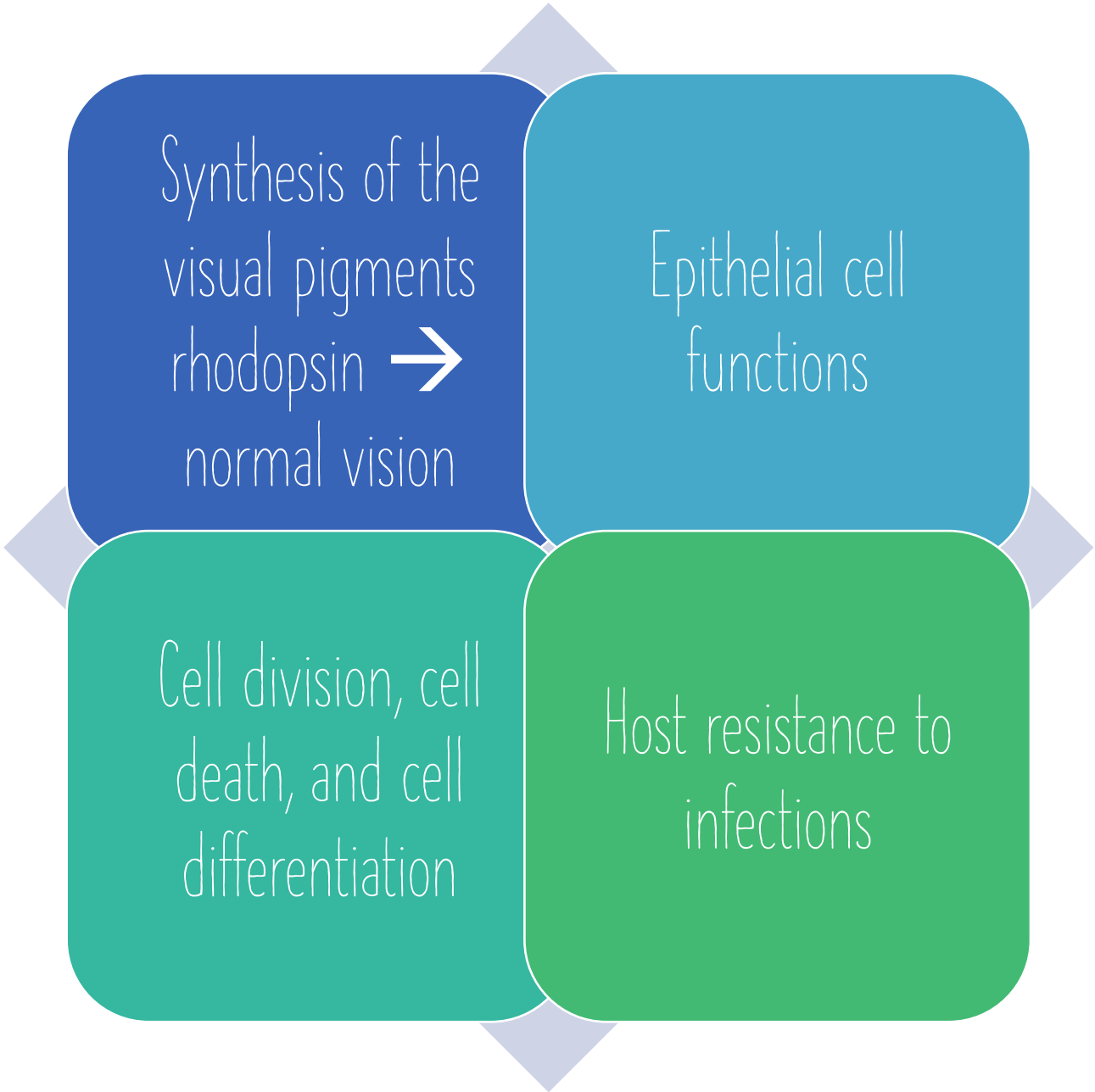
# Refeeding Syndrome

- Severe malnutrition (kwashiorkor or marasmus)
- Rapid weight loss
- Prolonged fasting
- Hunger striker (high stress unfed > 7 days)
- Pre-existing electrolyte imbalance
- Chronic infection
- Malabsorption (IBD, short bowel syndrome)
- Morbid obesity with weight loss

# How to prevent

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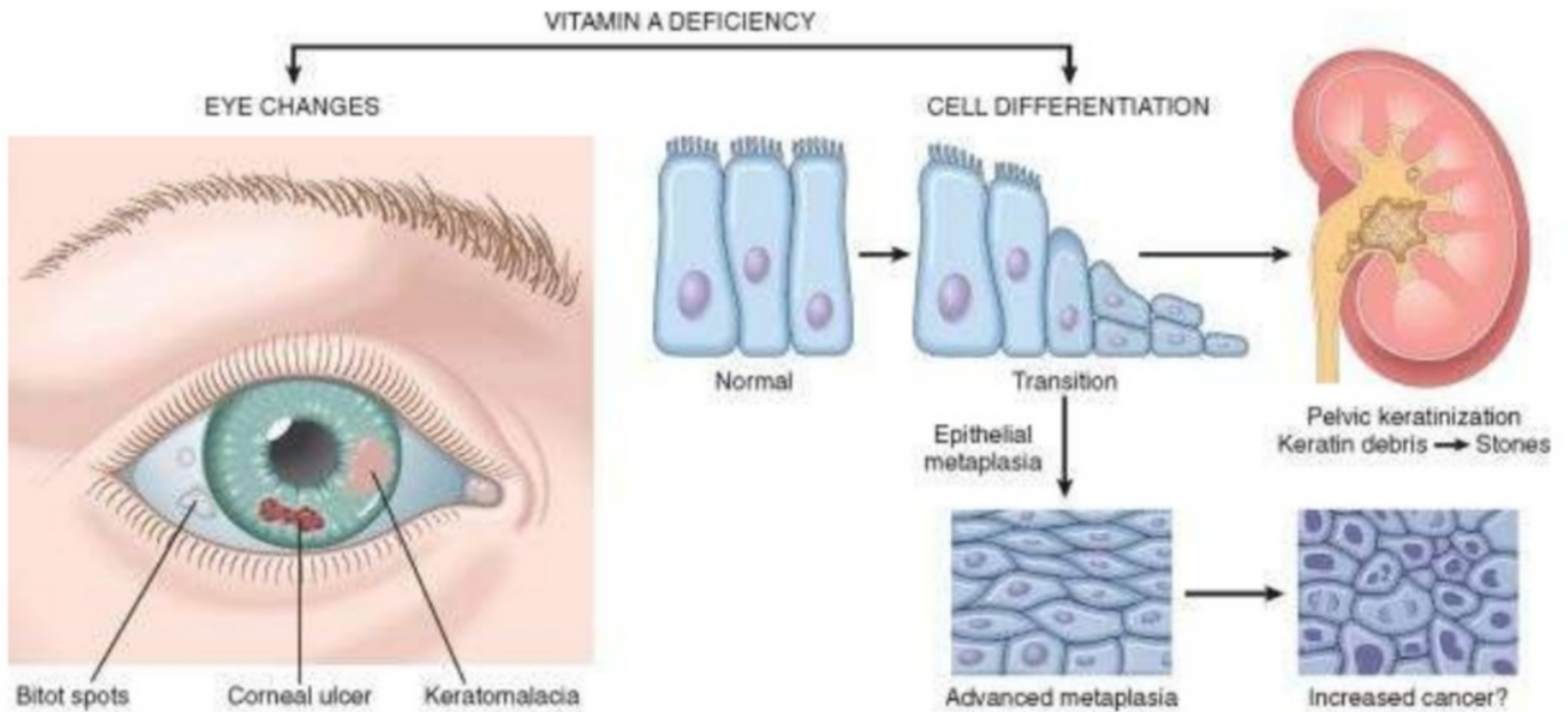
Synthesis of the  
visual pigments  
rhodopsin →  
normal vision

Epithelial cell  
functions

Cell division, cell  
death, and cell  
differentiation

Host resistance to  
infections

**Vitamin A:**  
**retinol**



# Night blindness

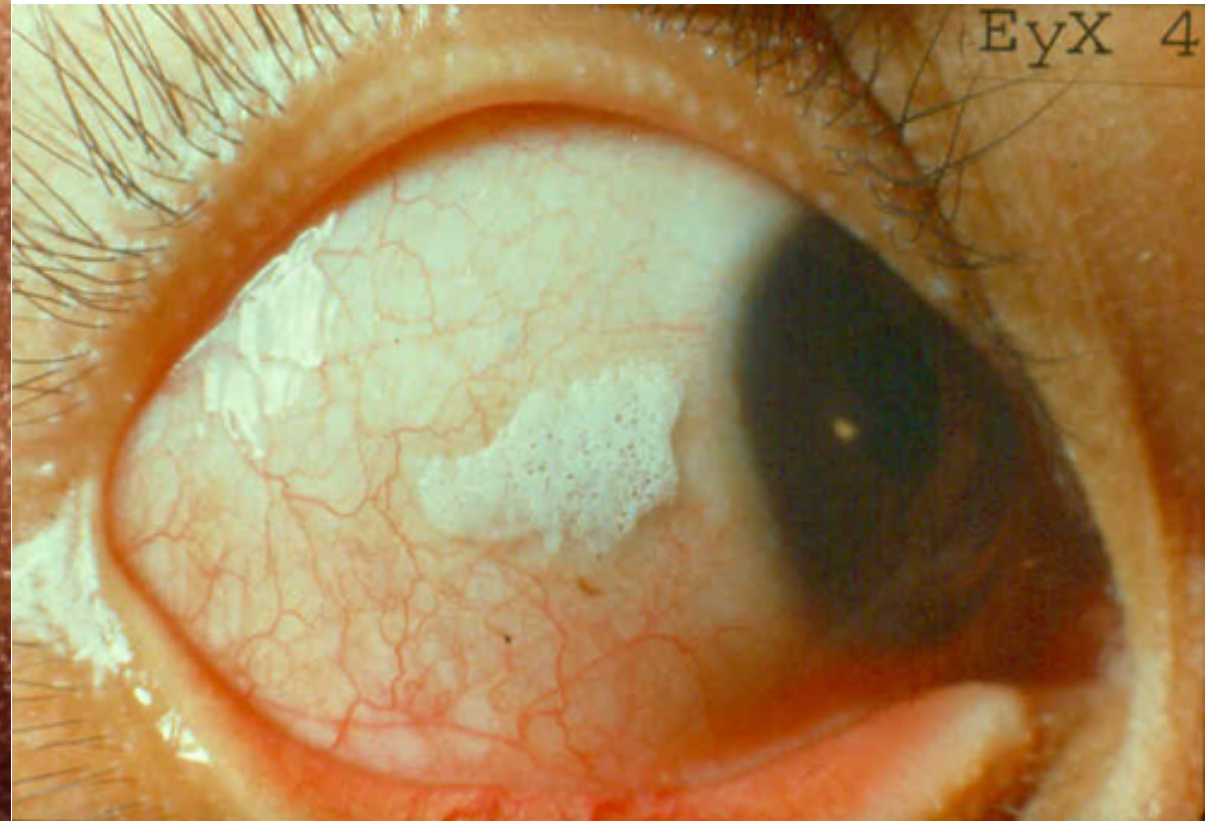


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# Bitot spots



Oomen HAPC. Vitamin A deficiency, xerophthalmia and blindness. Nutr Rev. 1974.



<http://medchrome.com/better-you/general-health-issues/vitamin-sources-metabolism-deficiency/>



Follicular hyperkeratosis



Xerophthalmia



Advanced xerophthalmia with dull cornea

# Vitamin A treatment regimens

Schedule:

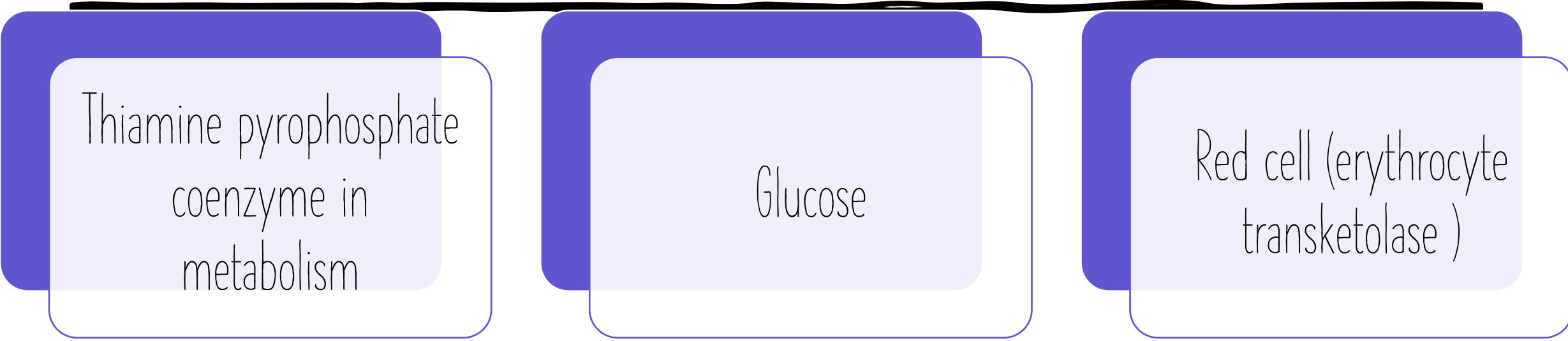
1. Severe PEM

(Kwashiorkor or Wt/Ht < -3 SD), day 1

2. Measles, day 1 and 2

3. Xerophthalmia, day 1, 2 and 14

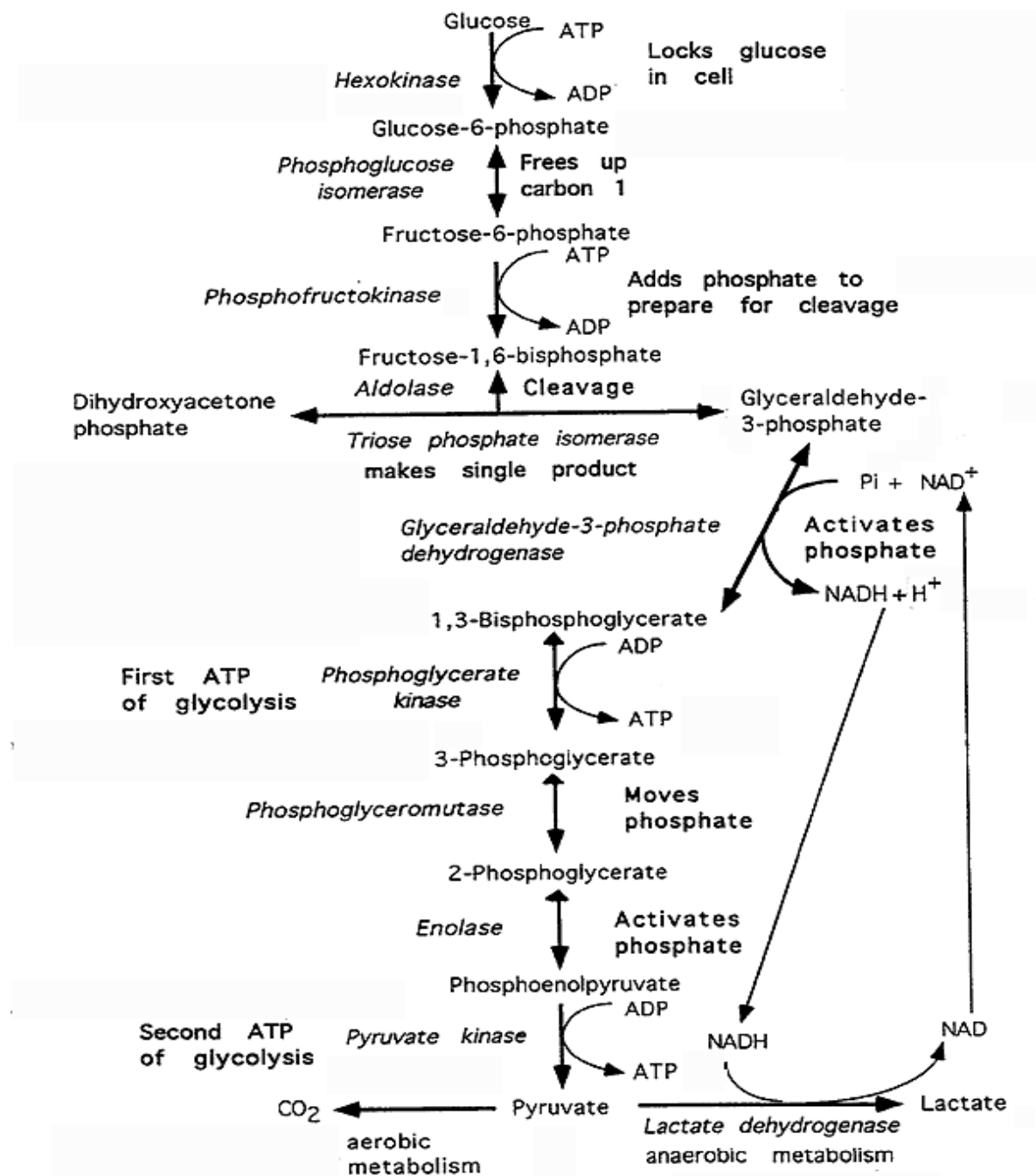
| Age                                                                                                  | Vitamin dosage (IU)                                                                     |
|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Infant : 0 - 5 mo                                                                                    | 50,000                                                                                  |
| Infant : 6 - 11 mo                                                                                   | 100,000                                                                                 |
| Children : male $\geq$ 12 mo<br>female 12 mo - 12 yr, $\geq$ 50 yr                                   | 200,000                                                                                 |
| Female 13 - 49 yr:<br>- Xerophthalmia<br>(night blindness, Bitot's spot)<br>- Active corneal lesions | - 10,000 everyday or 25,000 every wk for at least 3 mo<br>- 200,000 on days 1, 2 and 14 |

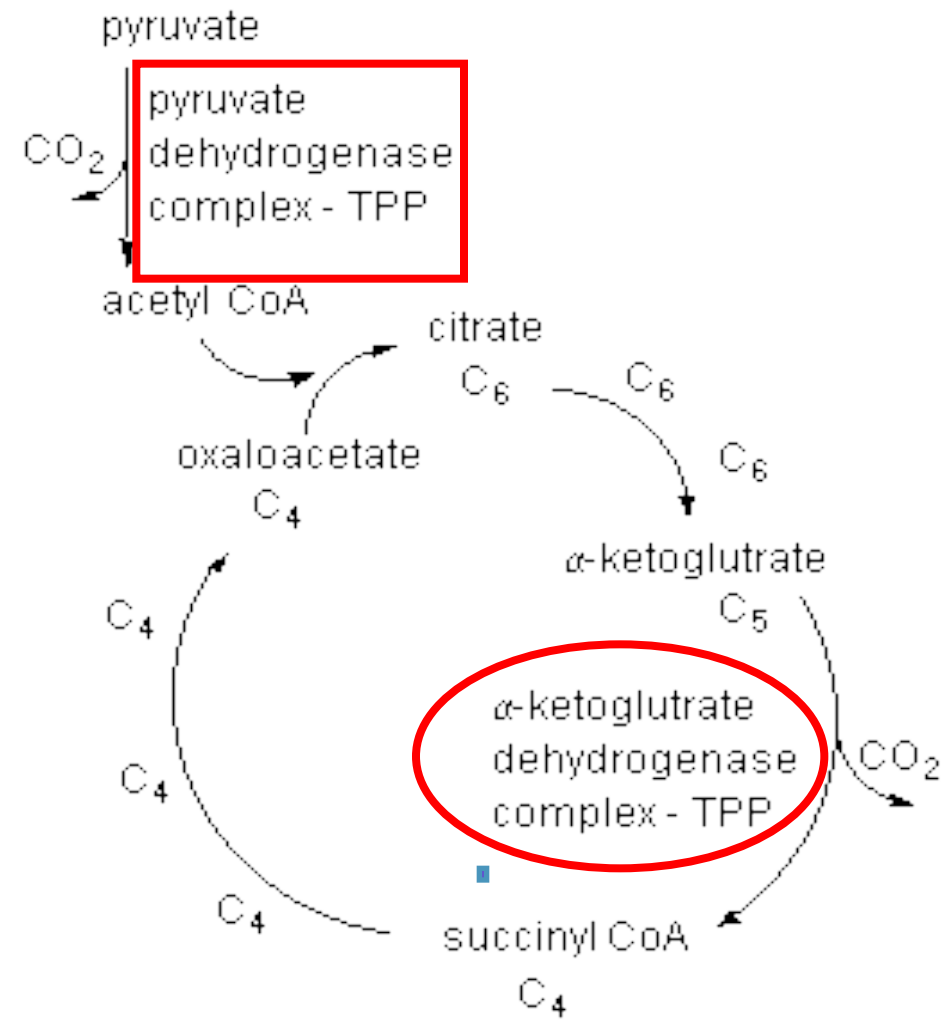


Thiamine pyrophosphate  
coenzyme in  
metabolism

Glucose

Red cell (erythrocyte  
transketolase )





# Cardiovascular (wet) beriberi

Mild cyanosis, dyspnea

Tachycardia, wide pulse pressure

Hepatomegaly, generalized edema

Lactic acidosis

Heart failure

EKG: increased Q-T interval, inverted T wave



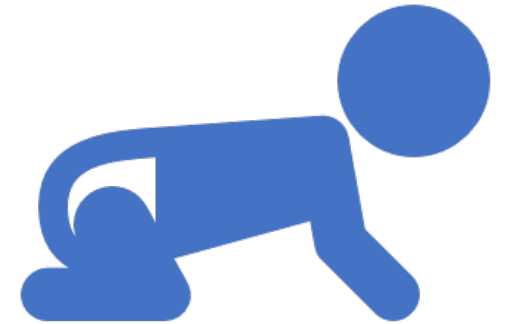
# Infantile beriberi

Breastfed infants (usually by age 3–4 wk) by thiamine-deficiency mother

Cardiac form: high output heart failure

Aphonia form

Cerebral form: pseudomeningitis



# Diagnosis

- Clinical setting
- Low erythrocyte transketolase activity (ETKA)
- High thiamine pyrophosphate effect (TPPE)
  - Normal 0–14%



# Treatment

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|                            |                                       |
|----------------------------|---------------------------------------|
| Life threatening condition | 50-100 mg of thiamine IV/IM 7-14 days |
|                            | Then 3-5 mg of thiamine/day x 6wks    |

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|                  |                                |
|------------------|--------------------------------|
| Stable condition | Children 10 mg/day x 7-14 days |
|                  | Adult 50 mg/day x 7-14 days    |
|                  | Then 3-5 mg/day x 6 wk         |
|                  | Multivitamin supplement        |

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# Sources of Thiamine

