

VITAMINS

- ▲ The word vitamin was originally derived from term "vital amine."
- ▲ They are micronutrients
- ▲ The body is unable to synthesize them and therefore it should be provided from outside

Classification:

- ▲ Fat soluble: vitamin A, D, E, K
- ▲ Water soluble: Vitamins of B group and Vitamin C.

VITAMIN-A



VITAMIN-A

▲ It was the 1st fat-soluble vitamin to be discovered.

Forms:

- ▲ **Pre - formed vitamin** – retinol (in animal foods)
- ▲ **Pro - vitamin** – beta carotene (plant foods)

converted to retinol in intestinal mucosa

Units

▲ Amount of Retinol a vit-A compound will yield is called as Retinol equivalent (RE).

▲ 1 IU of retinol = 0.3 mcg of retinol

▲ 1 mcg of retinol = 1 mcg of RE

▲ 1 mcg of B-Carotene = 0.167 mcg of RE

▲ 6 mcg of β -carotene = 1 mcg Retinol = 1 RE

Sources



Sources

ANIMAL FOODS: Liver, eggs, butter, cheese, whole milk, fish and meat.

Richest natural source: fish liver oil.

PLANT FOODS: Green leafy vegetables (cheapest source), most green and yellow fruits (papaya, mango, pumpkin), some roots (carrots)

FORTIFIED FOODS: Foods fortified with vitamin A (vanaspati, milk etc.)

Vitamin A: Functions

- Vision: indispensable for normal vision.
Production of retinal pigments needed for vision in dim light.
- Cellular Differentiation
- Retinoic acid acts as a hormone to affect gene expression and control cell development.
- Necessary for maintaining the integrity and normal functioning of glandular and epithelial tissue which lines intestinal, respiratory, urinary tracts, skin and eyes.

Functions contd.....

- Growth - Supports skeletal growth (Bone development and maintenance (bone remodeling).)

Other Functions:

- Vitamin A is necessary in several aspects of the immune system and is essential for the reproductive process.
- It is anti-infective

Other Functions contd...

- The possible “anticarcinogenic effects” of carotenoids may be linked with enhancement of the immune system.

- The antioxidant role of carotenoids is linked to a decreased cancer risk. May protect against some epithelial cancers viz. bronchial cancers

The RDAs of vitamin A (ICMR 1989)

Group	Retinol (mcg)
Lactation	950
Man	600
Woman	600
Pregnancy	800
Adolescents 13- 19 yrs	600
Children 7 to 12 yrs	600
Children 1 to 6 yrs	400
Infants	350

Beta Carotene values: 4 X retinol values

Vitamin A deficiency

Causes:

- 1) LOW INTAKE.
- 2) LOW ABSORPTION.
- 3) LOW FAT INTAKE
- 4) LOW PROTEIN INTAKE
- 5) INCREASED DEMAND

Vitamin A deficiency

Symptoms and signs:

- The signs of Vit A deficiency are predominantly ocular – termed as “**XEROPHTHALMIA**”

It includes:

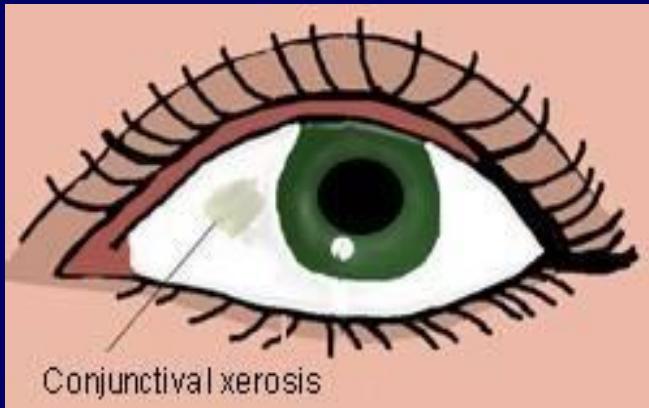
Nightblindness:

- First symptom.
- Inability to see in dim light
- It is due to impairment in dark adaptation.

Vitamin A deficiency signs contd....

Conjunctival xerosis:

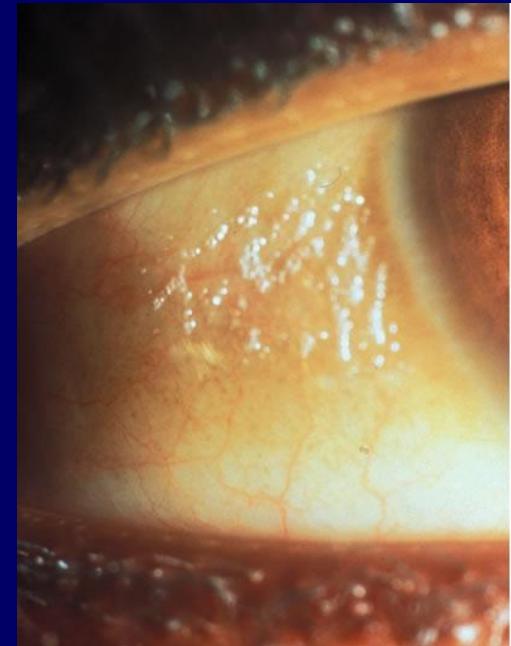
- First sign.
- The conjunctiva becomes dry and non-wettable (muddy and wrinkled).
- Described as “emerging like sand banks at receding tide.”



Vitamin A deficiency signs contd...

Bitot's spots:

- Triangular, pearly white or yellowish foamy spots on the bulbar conjunctiva on either side of the cornea.
- Frequently bilateral.
- In older individuals, they are inactive sequelae of earlier disease.



Vitamin A deficiency

Corneal xerosis:

- Cornea appears dull, dry and non wettable and eventually opaque.
- In more severe deficiency there may be corneal ulceration which may heal leaving a scar.



Vitamin A deficiency signs contd....

Keratomalacia:

- Liquefaction of cornea is a medical emergency.
- The cornea becomes soft and may burst open.
It leads to blindness.



WHO CLASSIFICATION OF XEROPHTHALMIA

PRIMARY SIGNS:-

X1A - Conjunctival xerosis.

X1B - Bitot's spot.

X2 - Corneal xerosis.

X3A - Corneal ulceration <1/3th

X3B - Corneal ulceration >1/3th

SECONDARY SIGNS:-

XN- Nightblindness.

XF - Fundal changes.

XS - Corneal sclerosis.



X3A: Keratomalacia of less than a third of the cornea.



X3B: Keratomalacia of greater than one-third of cornea.

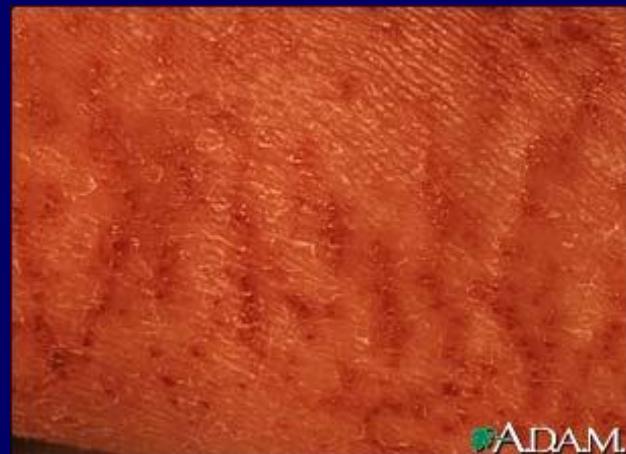


XS: Corneal scarring.

Vitamin A deficiency

Extraocular manifestations

- Anorexia
- Growth retardation
- Susceptibility to infections
- Enlargement of hair follicles
(follicular hyperkeratosis)
- Keratinization of epithelial
(mucous) cells
- Failure of normal cell
differentiation



Vitamin A deficiency contd...

Increased Demand: malabsorptive disorders, such as steatorrhea, pancreatic, liver or gall bladder disease, Alcoholism, chronic nephritis.

Decreased Absorption: Measles depress vitamin A status, which may already be low in children in developing countries, resulting in high mortality.

Vitamin A deficiency: Treatment

- Should be treated urgently
- Nearly all the early stages are reversible

Deficiency

Treatment

- 200,000 IU OR 110 mg Retinol Palmitate on 2 successive days
- All children with corneal ulcers should receive vitamin A irrespective of deficiency.
- All children with measles: 1 dose Vit A if not received in previous 1 month
- Severe malnutrition: 2 doses
- Prophylaxis –
 - 1970: 1-5 yr
 - 1992: 9 Month to 3 year
 - 2006: Upto 5 yr

Vitamin A deficiency: Prevention

Long term measures:

- Improvement of people's diet- for regular and adequate intake
- Reducing the frequency and severity of contributory factors.
- Nutrition education
- Public and community participation.

Short term measure:

- 6 months - 1 yr : 1 lakh IU
- 1- 6 yrs : 2 lakh IU of vitamin A orally every 6m
- Under the CSSM programme, total 9 doses: 9 m- 5 yrs

- Antenatal mothers to be given Vitamin A not exceeding 10,000 IU per day till symptoms disappear or levels come to normal

Vitamin A deficiency: Assessment

Prevalence criteria for determining the xerophthalmia problem.

Criteria	Prevalence in population at risk (6m – 6yrs)
Nightblindness	>1%
Bitot's spot	>0.5%
Corneal ulcer	>0.05%
Keratomalacia	>0.01%
Serum retinol(<10 mcg/dl)	>5%

Vitamin A toxicity

A chronic intake of vitamin A 10 times more than the RDA can result in **Hypervitaminosis A**.

Symptoms:

- Nausea,
- Vomiting,
- Anorexia,
- Sleep disorders,
- Skin desquamation,
- Enlarged liver
- Papillary edema.
- Possible teratogenic effects??
- Transplacental transfer in 1st trimester



VITAMIN D

VITAMIN D

The nutritionally important forms are:

- **Calciferol (Vitamin D2)** – derived by irradiation of the plant sterol
- **Cholecalciferol (Vitamin D3)** – Naturally occurring (preformed) vitamin D found in animal fats and fish liver oils.
- Also derived from exposure to UV rays which convert the cholesterol in the skin to Vitamin D.

Functions of vitamin D and its metabolites

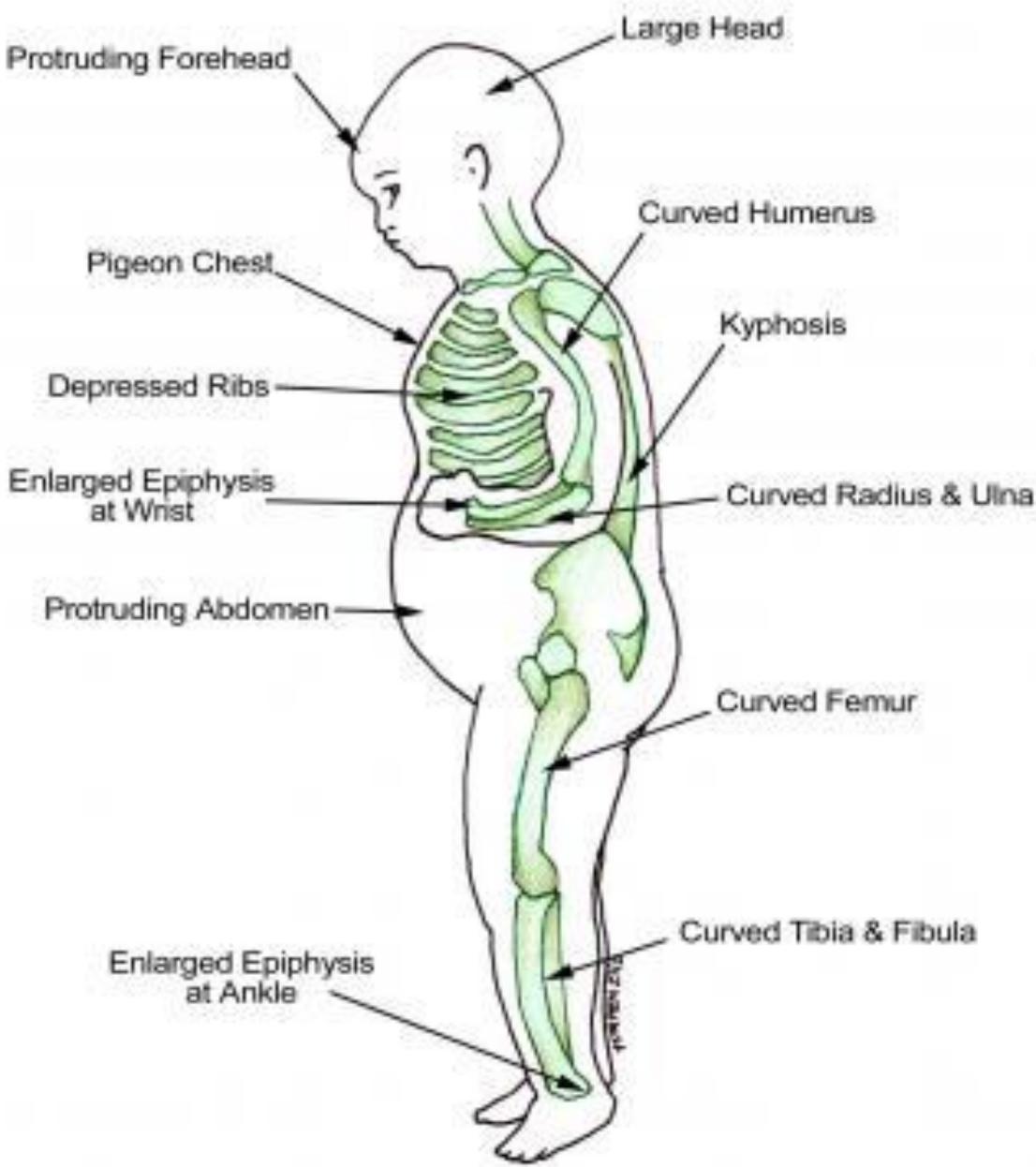
- **Intestine:** Promotes intestinal absorption of calcium and phosphorus
- **Bone:** Stimulates normal mineralization, Enhances bone reabsorption, Affects collagen maturation
- **Kidney:** Increases tubular reabsorption of phosphate
- **Other:** Permits normal growth.

Vitamin D: Sources

- **Sunlight:** Synthesized by the body by the action of UV rays on 7-dehydrocholesterol stored in the skin.
- **Foods:** Liver, egg yolk, butter, cheese, milk and other fortified foods.
- Fish liver oil is the richest source.

Deficiency of vitamin D

- **Rickets:** failure of osteoid to calcify in young children (6m–2 yrs).
 - Characteristics: growth failure, bone deformity, muscular hypotonia, tetany, convulsions due to hypocalcemia.
 - Elevated serum alkaline phosphate.
 - Bony deformities: curved legs, deformed pelvis, pigeon chest, harrison's sulcus, rickety rosary, kyphoscoliosis. Milestones of bony development are delayed.
- **Osteomalacia:**
 - More in females during pregnancy and lactation



Vitamin D Deficiency: Prevention

Measures:

- Educating the parents to expose their children regularly to sunshine
- Periodic dosing with Vitamin D in those who remain indoors
- Vitamin fortification of the foods

Vitamin D: Hypervitaminosis

Signs:

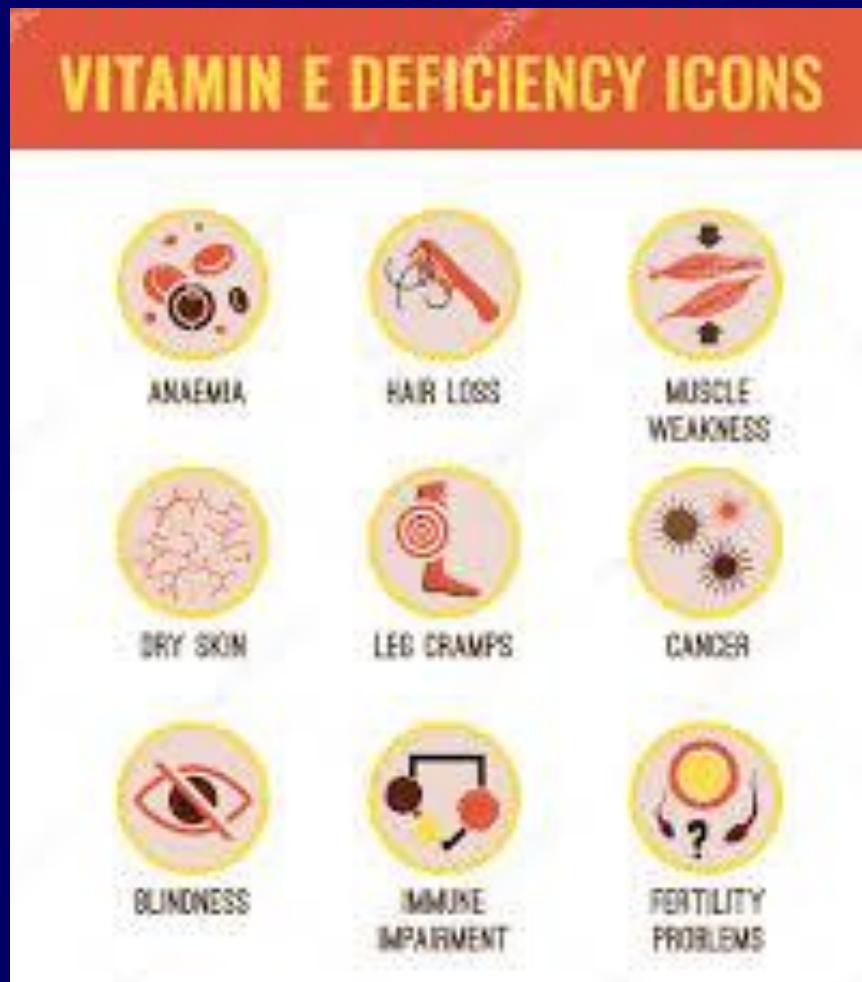
- Anorexia,
- Vomiting,
- Thirst,
- Drowsiness,
- Coma,
- Cardiac arrhythmias
- Renal failure

RDA:

- Adults: 2.5mcg (100 IU)
- Infants and children: 5 mcg (200 IU)
- Pregnancy and lactation: 10 mcg (400 IU)

Vitamin E

Sources: Vegetable oils, cotton seed, sunflower seed, egg yolk, butter, foods rich in PUFA.



Vitamin K

Occurs in 2 major **forms**:

Vit K₁ (Fresh green vegetables and fruits)

Vit K₂ (Synthesized by the intestinal bacteria)

Functions: Stimulate the production and release of certain coagulation factors

RDA: 0.03 mg/kg for adults

Deficiency: Decrease in prothrombin content of blood and blood clotting time is prolonged.

THIAMINE (Vitamin B₁)

- It is essential for the utilization of carbohydrates.
- Thiamine pyrophosphate (TPP), the coenzyme of cocarboxylase plays a part in activating transketolase, an enzyme involved in the direct oxidative pathway for glucose.
- **Deficiency** – accumulation of pyruvic and lactic acids in tissues and body fluids.

THIAMINE

Sources:

- Whole grain cereals, wheat, gram, yeast, pulses, oilseeds and nuts.

Thiamine losses:

- Milling (polished rice)(75% loss of thiamine, 60% of riboflavin and niacin and 15% protein), washing, cooking, prolonged storage of fruits and vegetables, cooking with baking soda

RDA:

- 0.5 mg per 1000 kcals of energy intake.

Prevention of thiamine losses

PARBOILING: Central Food Technological Research Institute recommends “**hot soaking process**”

Soak the paddy in hot water (65-70°C) for 3-4 hr



Drain the water



Steam the soaked paddy in the same container for 5-10 min.



Drying followed by homebounding or milling

Benefits of Parboiling

During steaming- a greater part of vitamins and minerals present in the outer aleurone layer are driven into the inner endosperm.

During drying process- the germ gets attached more firmly to the grain.

The heat used in drying hardens the rice grain.

The grain becomes more resistant to insect invasion and therefore more suitable for storage.

Disadvantage: development of a peculiar smell

Deficiency of thiamine

The two principal deficiency diseases are:

➤ Beriberi:

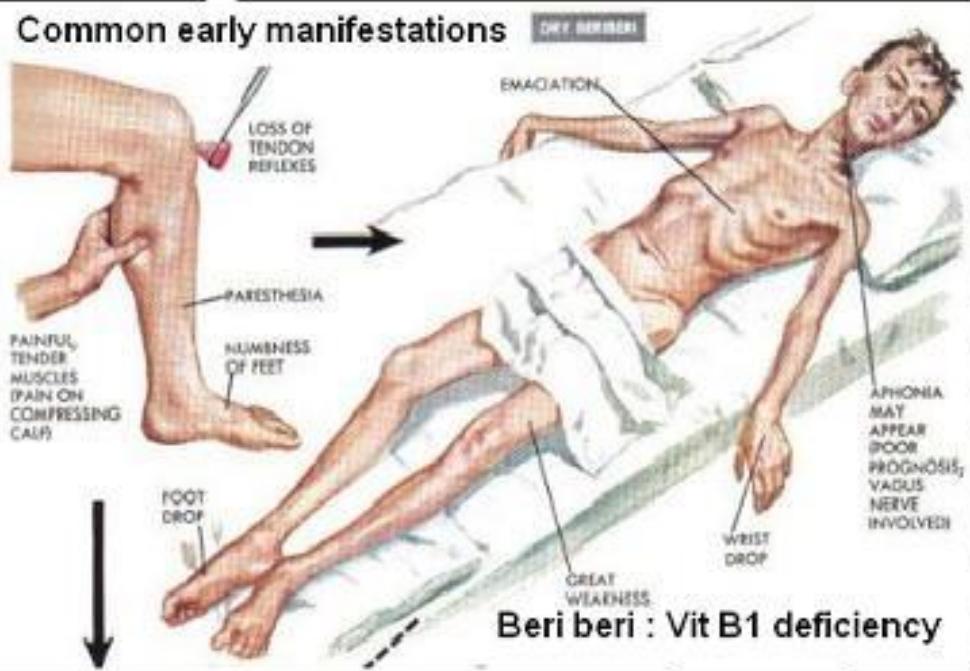
It may occur in three main forms:

- Dry form: Peripheral neuritis,
- Wet form: Cardiac beriberi
- Infantile beriberi: in infants b/w 2-4m of life. The affected baby is usually breast-fed by a thiamine-deficient mother who commonly shows signs of peripheral neuropathy.

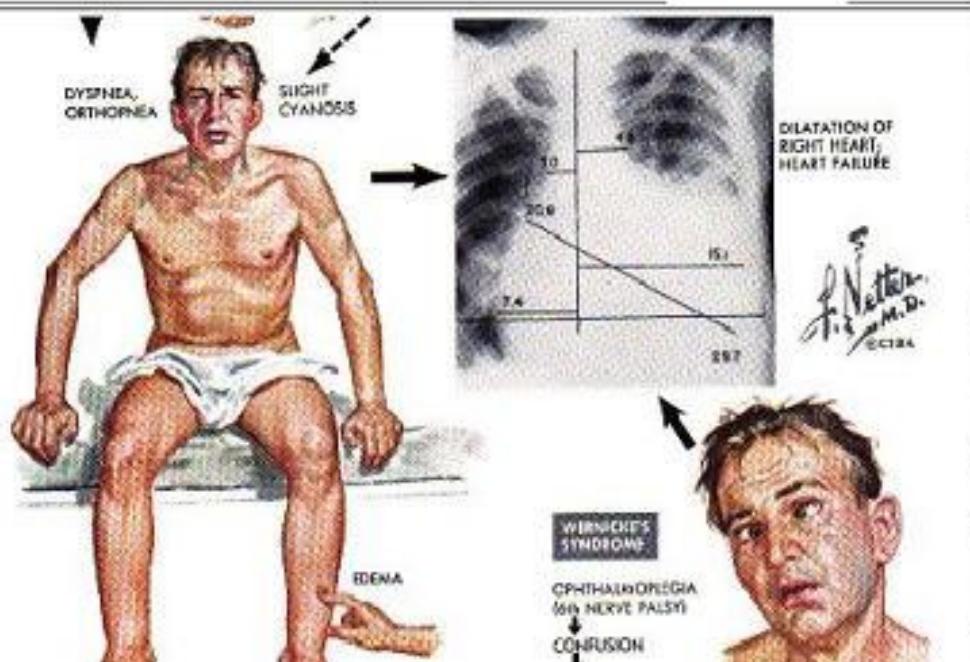
➤ Wernicke's encephalopathy

- seen in alcoholics: characterized by ophthalmoplegia, polyneuritis, ataxia and mental deterioration

Common early manifestations



Beri beri : Vit B1 deficiency



WHAT ARE THE SYMPTOMS OF BERIBERI?

The symptoms of beriberi vary depending on the type (wet or dry). The following are symptoms of wet beriberi:

- shortness of breath during physical activity
- waking up short of breath
- rapid heart rate
- swollen lower legs

The symptoms of **dry** beriberi include:

- decreased muscle function, particularly in the lower legs
- tingling or loss of feeling in the feet and hands
- pain
- mental confusion
- difficulty speaking
- vomiting
- involuntary eye movement
- paralysis

RIBOFLAVIN (Vitamin B₂)

Functions:

Cellular oxidation, acts as a cofactor in a number of enzymes involved with energy metabolism.

Sources:

- Milk, eggs, liver, kidney and GLV
- Germination increases the riboflavin content.

Deficiency

- Angular stomatitis

RDA

- 0.6mg/1000 kcal of energy intake.

NIACIN

Functions:

- For metabolism of carbohydrates, fat and protein
- Also essential for normal functioning of the skin, intestinal and nervous systems.

Sources:

- Liver, kidney, meat, poultry, fish, legumes and groundnut
- Milk is a poor source

NIACIN (Vitamin B₃)

Deficiency

- Pellagra (3 D's- Diarrhea, dermatitis and dementia)
- In addition – Glossitis and stomatitis
- Dermatitis is bilaterally symmetrical on body surfaces exposed to sunlight

RDA

- 6.6mg/1000 kcal of energy intake.

PYRIDOXINE (Vitamin B₆)

Functions:

- Important role in the metabolism of amino acids, fats and carbohydrate.

Sources:

- Milk, liver, meat, egg yolk, fish, whole grain cereals, legumes and vegetables.

PYRIDOXINE (Vitamin B₆)

Deficiency:

- Riboflavin deficiency impairs its optimal utilization.
- Associated with peripheral neuritis.
- INH acts as an antagonist. Supplement with 10mg/d pyridoxine.

RDA:

- Adults- 2 mg/day,
- Pregnancy and lactation- 2.5 mg/day.

VITAMIN B₁₂

Functions:

- It cooperates with folate in the synthesis of DNA.
- Useful in synthesis of fatty acids in myelin

Sources:

- Liver, kidney, meat, fish, eggs, milk and cheese.
- Not found in foods of vegetable origin.
- Also synthesized by colonic bacteria.
- Stored in liver (2 mg)- acute deficiency is rare.

RDA

- Infants and children – 0.2 mcg
- Normal adults – 1mcg
- Pregnancy and lactation – 1.5 mcg

Vitamin B₁₂ deficiency

- Megaloblastic anaemia (pernicious anaemia),
- Demyelinating neurological lesions in the spinal cord and
- Infertility (in animal species).

Folate

Function:

- Synthesis of nucleic acid.
- Normal development of blood cells in the marrow.
- Folic acid supplementation during pregnancy increases the birth weight of infants and decrease the incidence of LBW babies

Sources:

- GLV, Liver, meat, dairy products, eggs, milk, fruits, cereals
- Overcooking destroys much of folic acid.

Folate

Deficiency

- Megaloblastic anaemia, glossitis, cheilosis, GI disturbances viz. diarrhea, distension and flatulence, infertility

RDA:

- Requirements are greatest in conditions where there is rapid cell multiplication.
- Children and healthy adults: 100mcg
- Lactation: 150 mcg
- Pregnancy: 400mcg

VITAMIN C

- It is the most heat sensitive vitamin.
- Man, monkey and guinea pig are perhaps the only species known to require vitamin C in their diet

Functions:

- In tissue oxidation.
- Formation of collagen, which accounts for 25% of total body protein. Collagen provides a supporting matrix for the blood vessels, connective tissues, bones and cartilage.
- Facilitates absorption of iron from vegetable foods.

VITAMIN C

Sources:

- fresh fruits, GLV, germinating pulses. Amla is one of the richest source both in fresh and dry form.

RDA: 60mg

Deficiency leads to **Scurvy** characterized by:

- Swollen and bleeding gums,
- Subcutaneous bruising or bleeding into the skin or joints,
- Delayed wound healing,
- Anaemia and weakness.

MINERALS

MINERALS

More than 50 chemical elements are found in the human body, which are required for growth, repair and regulation of vital body functions

Can be divided into three groups:

- **Major Minerals:** Ca, P, Na, K and Mg
- **Trace Elements:** Requirement is less than few mg/day - Fe, I, F, Zn, Cu, Co, Cr, Mn, Mo, Se, Ni, Sn, Si, Vanadium.
- **Trace contaminants with no known function:** Pb, Hg, Ba, Boron, Al

CALCIUM

An average adult body contains about 1200 g of Ca
98% of which is found in the bones.

Functions:

- Formation of bones and teeth,
- Coagulation of blood,
- Contraction of muscles,
- Cardiac action,
- Milk production,
- Relay of electrical and chemical messages.

CALCIUM

Sources:

Milk and milk products, eggs and fish

Cheapest dietary sources: GLV, cereals and millets

Absorption:

Enhanced by Vit. D and decreased by phytates, oxalates and fatty acids.

Deficiency:

No clear cut disease due to Ca deficiency has been observed even with low intake until the Vit D intake is adequate

RDA:

400-500 mg

IRON

The adult human body contains 3-4g of iron – 60 - 70% of which is present in the blood as circulating iron.

Functions:

- Formation of Hb, myoglobin, cytochromes, catalase and certain enzymes
- Oxygen transport and cell respiration
- Brain development and function
- Regulation of body temperature
- Muscle activity
- Catecholamine metabolism

IRON

Sources: Two forms-

- Haem iron (liver, meat, poultry and fish)
- Non-haem iron (vegetable origin - cereals, GLV, legumes, nuts, oilseeds, jaggery, dried fruits)

Absorption:

- Enhanced by haem iron rich foods, ascorbic acid and cooking in iron vessels
- Decreased by phytates, oxalates, carbonates, phosphates, dietary fibre, milk, eggs, tea
- Iron absorption from habitual Indian diets is less than 5%

IRON

Iron losses:

- 1mg/d in an adult and 2mg/d in menstruating women

Deficiency: 3 stages:

- Decreased storage of iron without any detectable abnormalities
- Latent iron deficiency- iron stores are exhausted: detected by serum ferritin level
- Overt iron deficiency- decrease in concentration of circulating Hb – anaemia, .

Diagnosis of anaemia: Cut off points

	g/dl (venous blood)
Adult males	13
Adult females, non- pregnant	12
Adult females, pregnant	11
Children, 6m – 6 yrs	11
Children, 6 – 14 yrs	12

Evaluation of iron status

- **Haemoglobin concentration:** relatively insensitive index of nutrient depletion
- **Serum iron concentration:**
More useful than Hb concⁿ.
Normal range: 0.8-1.8mg/l. Values <0.5mg/l indicate deficiency
- **Serum ferritin:**
Reflects the size of iron stores.
Most useful in population where prevalence of iron deficiency is not high.
Values <10mcg/l indicate absence of iron stores.
- **Serum transferrin saturation:** s/b >16%. N- 30%

Iron Requirements

CATEGORY	Mg/day	CATEGORY	Mg/day
Man	28	Boys 10-12 yrs	34
Woman	30	Girls 10-12 yrs	19
Pregnancy	38	Boys 13-15 yrs	41
Lactation	30	Girls 13-15 yrs	28
Children 1-3 yrs	12	Boys 16-18 yrs	50
Children 4-6 yrs	18	Girls 16-18 yrs	30
Children 7-9 yrs	26		

Interventions for anaemia

- **Severe (<10g/dl):** high doses of Iron or blood transfusion
- **If b/w 10- 12 g/dl:**
 1. Iron and folic acid supplementation
 2. Iron fortification
 3. Other strategies

Changing dietary habits, deworming, nutrition education

IFA supplementation

Age group	Elemental Fe (mg)	FA (mcg)	Frequency	Colour
6m-59 m	20	100	Biweekly	Syrup
5-9 yr	45	400	Weekly	Pink
10-19 yr	60	500	Weekly	Blue Sugar coated
Women non pregnant 20-49 yr	60	500	Weekly	Red Sugar coated
Pregnant, lactating	60	500	Daily from 4 th month till 180 days postpartum	Red sugar coated

Iodine

- It is an essential micronutrient.
- Required for the synthesis of the thyroid hormones.
- Blood level is 8-12 mcg/dl.
- **Sources:**
Sea foods and cod liver oil
- **Goitrogens:**
Chemical substances which interfere with iodine utilization by the thyroid gland e.g. brassic group of vegetables.
- **RDA:**
150 mcg/day

Spectrum of IDD in approximate order of increasing severity

Disorders	Level of severity
Goitre	Grade I
	Grade II
	Grade III
	Multinodular
Hypothyroidism	Varying combinations of clinical signs
Subnormal intelligence Delayed motor milestones Mental deficiency Hearing defects Speech defects	Variable severity

Spectrum of IDD in approximate order of increasing severity

Disorders	Level of severity
Strabismus	Unilateral
	Bilateral
Nystagmus	
Spasticity (extrapyramidal)	
Neuromuscular weakness	Muscle weakness in legs, arms, trunk Spastic diplegia Spastic quadriplegia
Endemic cretinism	Hypothyroid cretinism Neurological cretinism
Intrauterine death Spontaneous abortion (miscarriage)	

Epidemiological assessment of Iodine deficiency

- Indicators:
 - Prevalence of goitre
 - Prevalence of cretinism
 - Urinary iodine excretion
 - Measurement of thyroid function by determination of serum T4 and TSH
 - Prevalence of neonatal hypothyroidism: Sensitive indicator of environmental iodine deficiency

Goitre control

- WHO targets - <10% prevalence in endemic areas
- **4 essential components**

❖ **Fortification**

- Iodized salt: Not less than 30 ppm at production point and not less than 15 ppm at consumer level
- Injectable iodized oil (IM)
- Oral iodized oil

❖ **Iodine monitoring**

❖ **Manpower training**

❖ **Mass communication**

FLUORINE

- Essential for the normal mineralization of bones and formation of dental enamel
- **Sources:**
 - Drinking water: N- 0.5 mg/L to 3-12 mg/L
 - Foods: Sea fish, cheese and tea
- **Deficiency:**
 - Dental caries
- **Excess:**
 - Dental Fluorosis (>1.5 mg/l of intake)
 - Skeletal fluorosis (lifetime daily intake of >3-6 mg/l)
 - Genu valgum and osteoporosis in predominant sorghum eaters.
- **RDA:** 0.5 to 0.8 mg/l

INTERVENTIONS

- Changing the water source: Surface water
- Chemical treatment : Nalgonda Technique by National Environmental engineering research institute (NEERI).
- By lime and alum sequentially followed by flocculation, sedimentation and filtration
- Use of fluoride toothpastes in fluorosis endemic areas is not recommended.