VITAMINS

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Vitamins

Definition: Organic components required in trace amounts (µg to mg/day) in the diet for health, growth, and reproduction.

Causes of vitamin deficiency: Inadequate intake, impaired absorption, insufficient utilization, increased requirements and/or increased rate of excretion.

Food groups that forms the best source of Vitamin

Laboratory assessment of vitamin status:

1- Measurement of the vitamin or its cofactor in whole blood, plasma, RBCs, WBCs or tissue biopsy.

2- Measurement of the vitamin or one of its major metabolites in urine.

3- Measurement of blood or urine concentration of a metabolite that accumulates when a vitamin-dependent metabolic pathway is blocked because of vitamin deficiency.

4- Load (saturation) test: similar to (3) but the pathway is stressed.

5- Assay of the activity of an enzyme that depends on the vitamin as a cofactor. e.g., the activity of red cell AST or ALT reflects B6 status.

6- Enzyme cofactor saturation test: In vitro assay of the activity of an enzyme before and after addition of the cofactor form of the vitamin. Normally, when the vitamin (cofactor) concentration is sufficient in serum, there is little increase in enzyme activity.

7- Finally, therapeutic trial may be the only definitive diagnostic tool.

Classification of vitamins:

- **Fat-soluble vitamins:** A, D, E, and K
  - Absorption, transport, and storage follow the same lines of lipids & decrease in malabsorption.
  - Deficiency manifestations are delayed.
  - Not excreted in urine ➔ hypervitaminosis may occur.
- **Water-soluble vitamins:** B complex vitamins and C.
  - Excreted in urine ➔ rarely accumulate to toxic concentrations.

Vitamin A

Precursors: Carotenes, converted to vitamin A in the walls of the small intestine and in the liver.

Methods of estimation:

1- Neeld-Pearson colorimetric method

2- Fluorometry: greenish fluorescence by UV.

3- HPLC: The best method.

4- Vitamin A absorption test.

PROTEIN

1-3 years	16 g/day
4-6 years	24 g/day
7-10 years	28 g/day
Average adult	50-62 g/day

Tofu + rice

Beans/Legumes + wholegrains (eg: Beans on Toast!)

Cereals + Soya milk

Tahini + Legume (eg Humus)

Beansprouts + Wholegrains

NB. Protein needs are automatically met by a balanced, varied diet. There is even protein in potatoes...

FATS

Essential fatty acids: omega 3 and Omega 6 (alpha-linolenic (3) and linoleic (6)) important to ensure good regular supplying of Omegas ★

*Flaxseed Oil

*Hempseeds (oil)

*Green Leafy Vegetables

Tofu

Nuts and nut oils (eg: almonds, walnuts, hazels)

Avocados

Olive Oil

-olive oil best for cooking (all oils should be fresh, unprocessed and stored in a dark, cool place)

A

FOUND IN HEALTHY DIET

BUT INCREASED COOKED

Carrots

Spinach

Green Leafy Vegetables

Watercress

Tomatoes

Yellow and Red Peppers

Mangoes

Dried Apricots

B group

FOUND IN HEALTHY, HEALTHY DIET

Green Leafy Vegetables

Wheatgerm

Brewer's Yeast

Wholegrains

Beansprouts

Bananas

Avocados

Nuts

Mushrooms

Currants

Legumes

Yeast Extract

B1 Thiamin

B2 Riboflavin

B3 Niacin

B6 Pyridoxin

Folic acid

Pantothenic Acid

Biotin

B12 (see next column)

B12 *

SOURCE - BEST OBTAINED ON DIET RAW

1-3 years	0.7 mcg/day
4-10 years	1-1.4 mcg/day
an Adult	2.00 mcg/day

★

Many fortified Products: (check labels)

eg: Cereals

Soya milks

Soya "meats"

eg: mince, sausages, burgers

Margarine

Yeast extract

Nutritional Yeast

* Important to ensure good dietary supply from enriched foods or supplement.

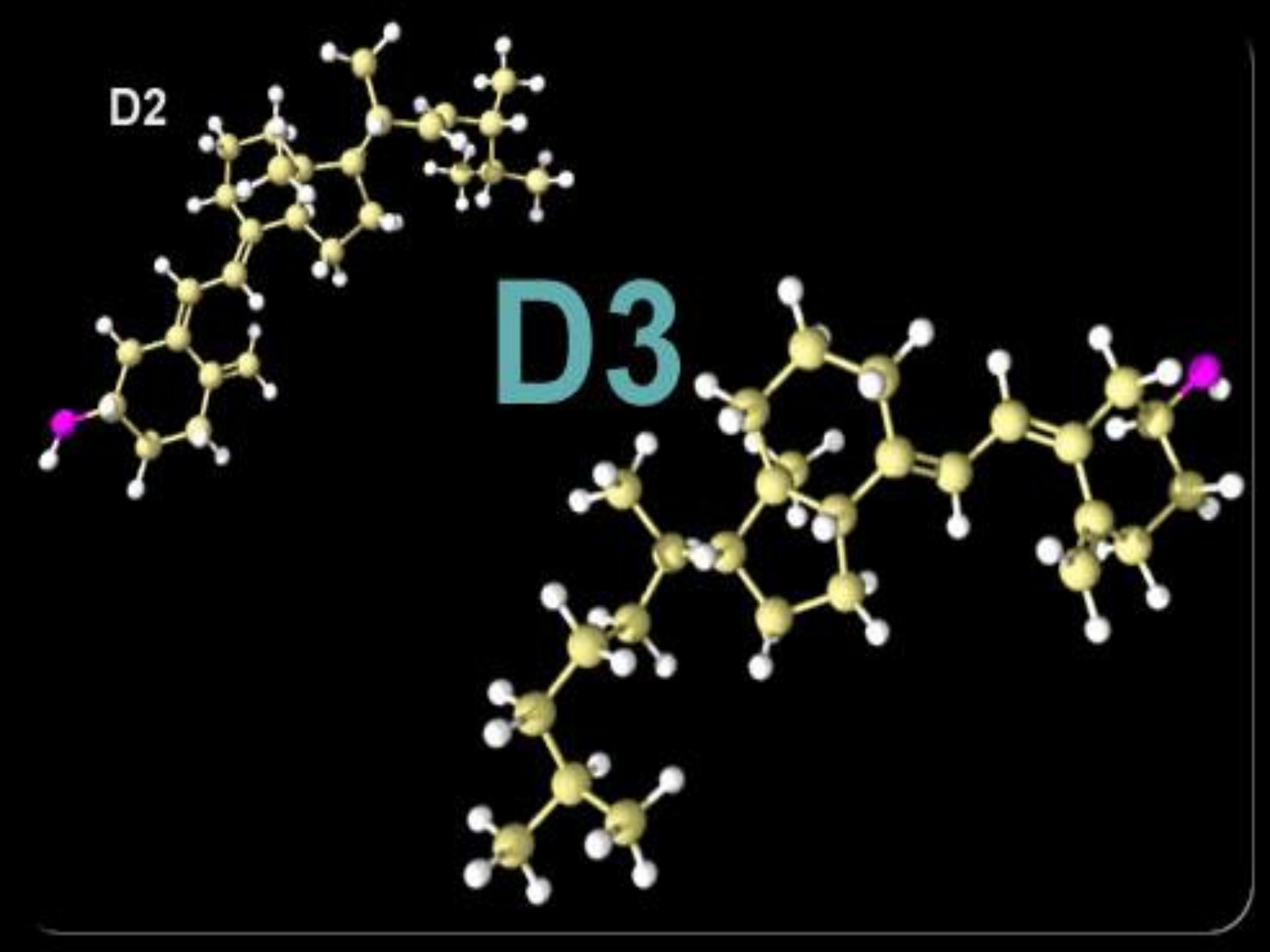
Vitamin D

Types: ergocalciferol (D2), Choleacalciferol (D3)

Chemistry and metabolism: mention activation

Functions:

- Increased intestinal absorption of Ca and P.
- Increased bone metabolization of Ca and P.
- Increased renal tubular reabsorption of Ca.
- Increased serum P, total and ionized Ca.
- Increased urine Ca (due to increased filtered load of Ca).

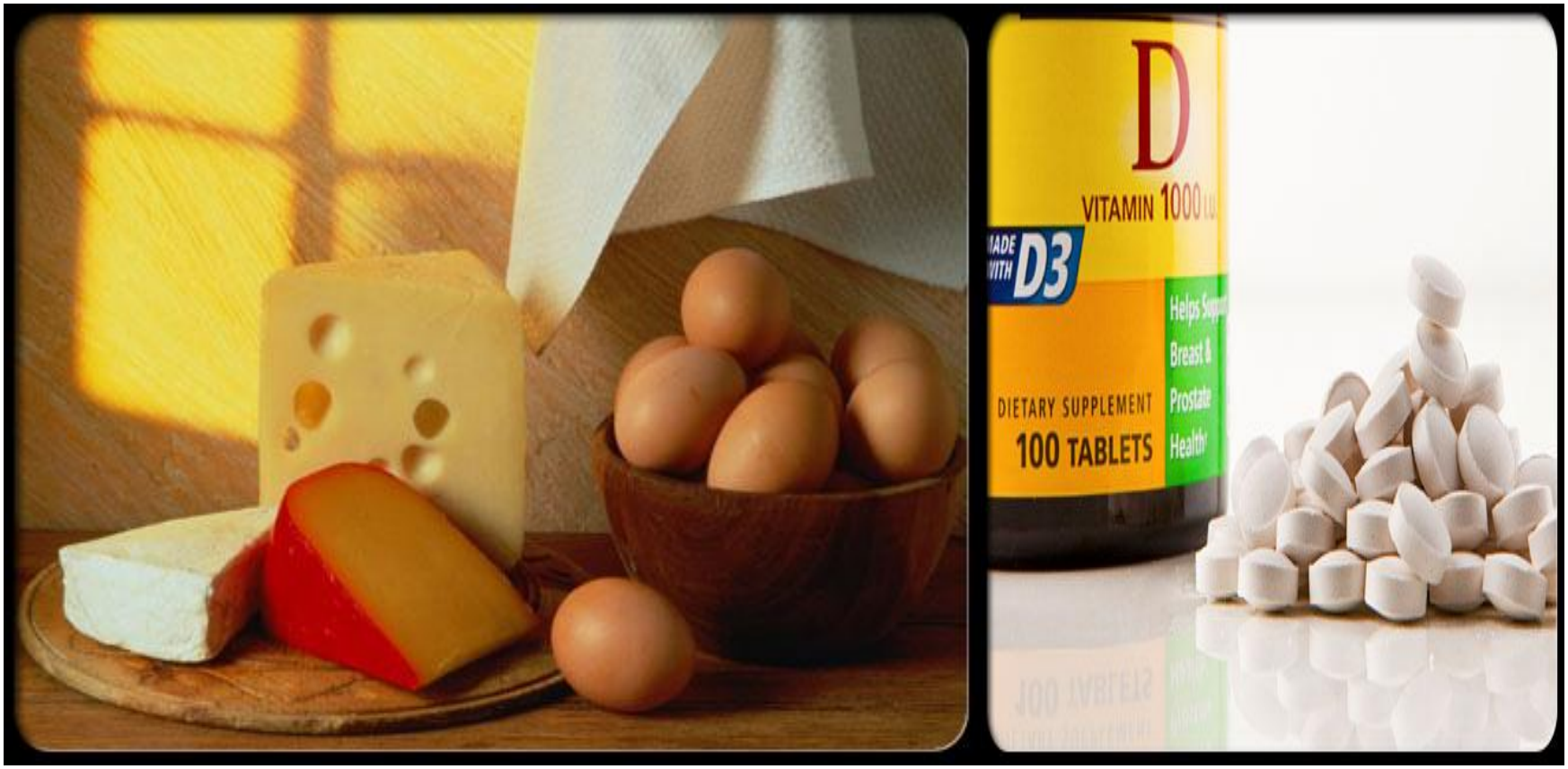

D2
D3

Methods of estimation of Vitamin D:

1- HLPC: with UV detection.

2- Competitive protein binding (CPB).

RIA.




Vitamin
D

Vitamin E

Methods of estimation:

- Colourimetry.
- GLC and HPLC: Best methods.
- Indirect: Assessment of the degree of red-cell hemolysis after treatment of them with hydrogen peroxide. Hemolysis is more in cases of vitamin E deficiency.

Vitamin E protects brain after stroke

Blocking the function of a brain enzyme with a specific kind of vitamin E can prevent nerve cells from dying after a stroke, says an Indian American scientist.

In mouse brain cells, scientists found tocotrienol, a natural form of vitamin E, that stopped the enzyme from releasing fatty acids that eventually kill neurons (brain cells).

They intend to pursue tests of its potential to both prevent and treat strokes in humans.

Vitamin K

Functions:

- Necessary for hepaitic synthesis of plasma clotting factors II, VII, IX, and X, proteins S and C. In case of vitamin K absence or antagonism, these proteins remain non-functional, called proteins induced in vitamin K absence or (PIVKA).
- Synthesis of bone Gla protein (osteocalcein).

Methods of estimation:

- Sectrophometry.
- HPLC.
- RIA.
- Indirect = Prothrombin time.

Vitamin C (Ascorbic Acid)

- **Chemistry and Sources:** acts as a reducing agent in several important hydroxylation reactions.
- The best sources are: citrus, berries, melons, tomatoes, green pepper, raw cabbage, and green leafy vegetables.

- It Loses activity with heat

Functions:

Cofactor for protocollagen hydroxylase.
Involved in tyrosine metabolism. Synthesis of epinepharine steroids, folic acid metabolism and leukocyte functions.
Iron absorption.

Absorption, Transport, and Metabolism:

Absorption of Vitamin C occurs readily from the stomach. The half life of vitamin C in human is about 16 days.

Deficiency: SCURVY.
Inability to form adequate intercellular substance in connective tissue ➔ swollen, tender and bleeding bruised loci at joints.
Infantile scurvy also known as *Barlow' diseases*.
Radiological changes of osteoporosis or die suddenly from heart failure.
Toxicity: Large doses are considered non toxic except for GIT symptoms.

- **Methods of estimation:**
- Sectrophometry.
- Fluorometry.
- HPLC.

Vitamin B1 (Thiamine)

- **Sources:** unrefined cereal grains, liver, heart, and kidney.
- **Functions:** Coenzyme for:
- Oxidative carboxylation of α-ketoacids; an important step in glycolysis.
- Trans-ketolation that occurs in hexose monophosphate (HMP) shunt.

Deficiency (causes and symptoms): BERIBERI
Adults: confusion, anorexia, muscle weakness, ataxia, peripheral paralysis, ophthalmoplegia, edema (wet beriberi), muscle wasting (dry beriberi), tachycardia, and enlarged heart.
Infants: symptoms appear suddenly and severely, often involving cardiac failure and cyanosis.

Methods of estimation:

- Thiochrome test.
- Blood pyruvate.
- Pyruvate tolerance test.
- RBCs transketolase.

Vitamin B2 (Riboflavin)

- **Sources:** Liver, kidney, and heart rich sources, many vegetables also are good sources.
- **Functions:** Component of coenzymes flavin mononucleotide (FMN) and flavin adenine dinucleotide (FAD). These are coenzymes for oxido-reductases needed for energy production.

Deficiency:

Avitaminosis B2: sore throat, hyperemia and edema of the pharyngeal and oral mucous membranes, angular stomatitis, glossitis (magenta tongue), and oral normochromic anemia associated with pure RBC aplasia of the bone marrow.

Severe riboflavin deficiency can affect the conversion of vitamin B6 to its coenzyme and even the conversion of tryptophan to niacin.

Methods of estimation:

- Fluorometric or HPLC.
- Glutathione reductase activity.

Vitamin B6

- **Chemistry and sources:** Pyridoxine (Pyridoxal), pyridoxamine, and pyridoxal are the 3 natural forms of vitamin B6.
- **Functions:**
- Pyridoxal Phosphate (PLP) is the active form of the vitamin that acts as a cofactor for:
- Transaminases (AST and ALT), decarboxylases and amino levulinate synthase.
- Many steps in carbohydrate, lipid, and protein metabolism.

Deficiency:

++ xanthurenic acid in urine.

- Transaminases activity in serum and RBCs

EEG abnormalities appear within 3 weeks.

Epileptiform convulsions are a common finding in young subjects.

Skin changes include dermatitis.

Lymphopenia and anaemia.

Methods of estimation:

- Fluorometric or HPLC.
- Fluorometric measurement of PLP.
- Activity of AST and ALT.
- Xanthurenic acid excretion.

Niacin (Nicotinic Acid)

- **Sources:**
- Yeast, lean meat, liver, milk, and green leafy vegetables are good sources. Plant foodstuff especially cereals such as corn and wheat, contains niacin bound in forms that are not available for nutritional purposes.
- **Functions:**
- Nicotinamide is a component of nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP) that act as coenzymes for several oxido-reductases.

Deficiency: PELLAGRA ➔ Dermatitis, Diarrhea, and Dementia. Other GIT manifestations include achlorhydria, glossitis and stomatitis. Pellagra is a 2nry manifestation of carcinoid syndrome and Hartnup disease.

Toxicity ➔ vascular dilatation (flushing) with burning sensation in the hand and face

Methods of measurement:

- Fluorometric or HPLC.
- Measurement of the activity of NAD and NADP-dependent enzymes.

Folic Acid

- **Sources:** green vegetables, potatoes, cereals, fruits, and organ meat.
- **Functions:** Folic acid is reduced intracellularly into di- then tetra-hydro folate (FH-2 then FH4). This is important for:
- Conversion of serine to glycine.
- Catabolism of histidine ➔ formiminoglutamic acid ➔ glutamic acid
- Synthesis of thymidine methionine and purine.

Metabolism:

Folate and vitamin B12 metabolisms are linked by the reaction that transfers a: methyl group N5-methyl-tetrahydrofolate to cabalamin.

In cabalamin deficiency, folate is trapped as N5-methyl-tetrahydrofolate and is not recycled as tetrahydrofolate (FH4) into the folate pool

Deficiency: Megaloblastic anemia, but no subacute combined degeneration of the spinal cord.

Methods of estimation: See vitamin B12

Vitamin B12

- **Sources:** It is associated closely with animal proteins, and the only significant dietary sources are meats, milk or milk products, and eggs. It is not found in vegetables.
- **Functions:**
- Synthesis of methionine.
- Methylmalonyl CoA ➔ succinyl CoA.

Metabolism:

Ingested B12 binds to intrinsic factor (IF), which is a glycoprotein secreted by gastric parietal cells. The complex binds to specific receptors in the terminal ileum and becomes internalized into the cells. The complex then dissociates; and free B12 passes into the portal blood to the liver where it almost totally gets stored. Unlike other B vitamins, B12 can be stored for as long as 5 years.

Deficiency: results in (SCD) subacute combined degeneration of the spinal cord with or without metabolistic anemia.

Methods of estimation of B12 and folate:

Microbiological assays: Reference Methods.

Competitive protein binding (CPB) radioassays.

Chemiluminescence or microparticle enzyme immunoassays.

Shilling test.

Methylmalonic acid (MMA) test.

Formiminoglumatic acid (FIGLU) in urine.

Methods of estimation of B12 and folate:

1- Microbiological assays: Reference Methods, but difficult and lengthy. Have largely been replaced by the other more convenient and more precise methods.

2**- <u>Competitive protein binding (CPB) radioassays</u>:**

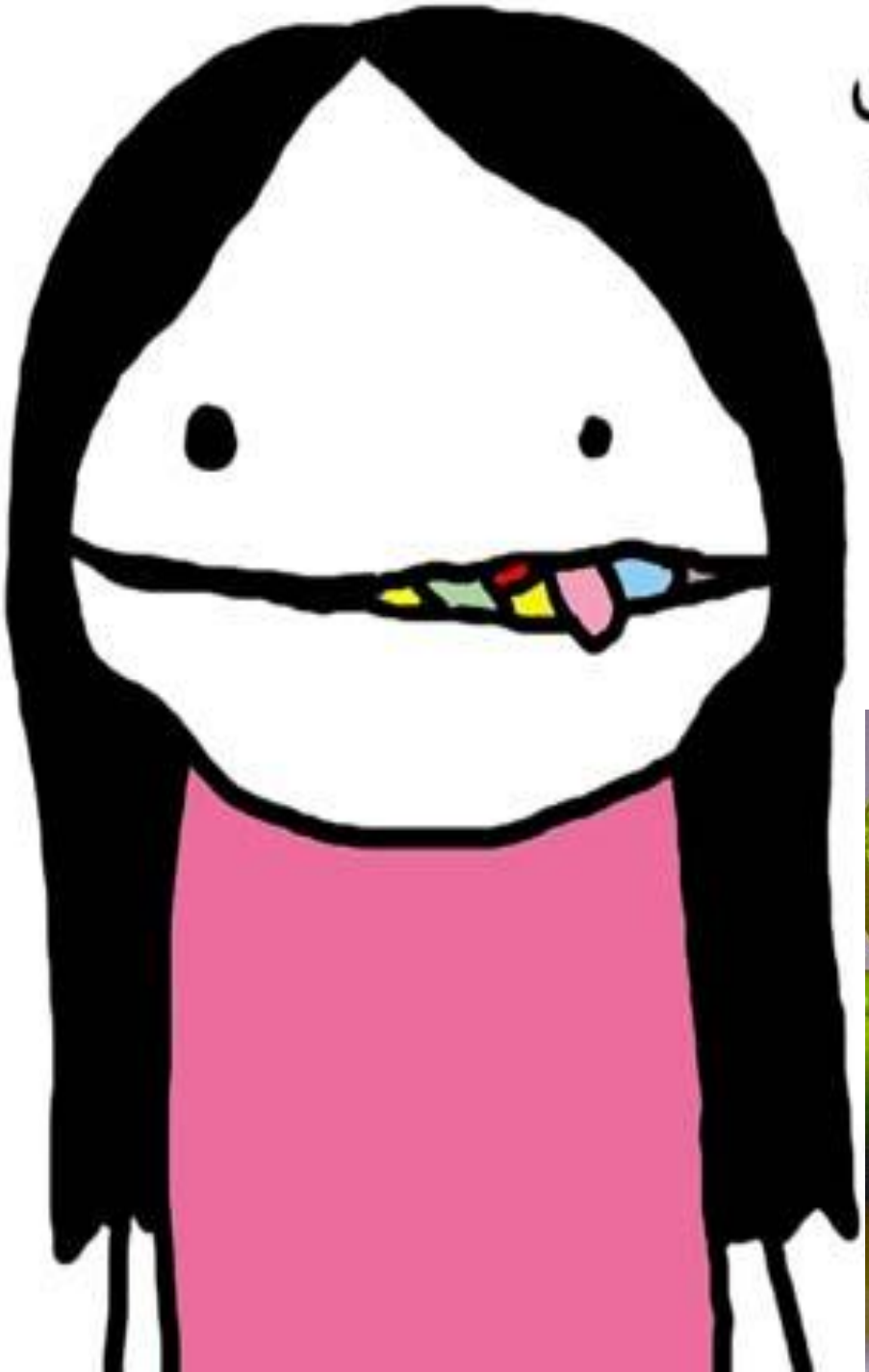
Competition is setup between serum B12 (or folate) and exogenously added Co-labeled B12 (or I-labeled folate) for a limited amount of IF (or lactoglobulin). After separation of free from bound labeled B12 (or folate), the activity of the labeled bound vitamin is measured and is inversely proportional to the concentration of the vitamin in serum. Measurement of B12 or folate can be done separately or simultaneously using a γ-counter that discriminates between the disintegrations of Co and I tracers in the specimen.

3- Recently, they can be measured by **chemiluminescence** or **microparticle enzyme immunoassays** (using the **IMx** system) in an automated fashion.

4- **Shilling test:** A large IM dose of B12 (non-labeled) is given to saturate its stores and binding proteins. A small oral dose of radioactive B12 is then given. The 24-h urine radioactivity is measured. Normally > 8% of the radioactive dose is recovered in urine. In pernicious anemia and malabsorption < 7% only is recovered. The test is repeated two days later but with simultaneous IF oral asministration. In case of pernicious anemia (IF deficiency) the condition will resemble normal i.e., > 8% of radioactivity will be recovered in urine; but will remain < 7% in case of malabsorption syndrome.

5- Methylmalonic acid (MMA) test: In case of B12 deficiency, the concentration of MMA excreted in urine will be high. The latter is measured by gas chromatography.

6- Formiminoglumatic acid (FIGLU) in urine: The concentration of urinary FIGLU in urine increases in case of folate deficiency. The test can be stressed by measuring FIGLU in urine after a loading dose of histidine (*histidine loading test*) causing greater increase in urine FIGLU excretion level.



You would never guess how many vitamins I can swallow at once.

THANK YOU