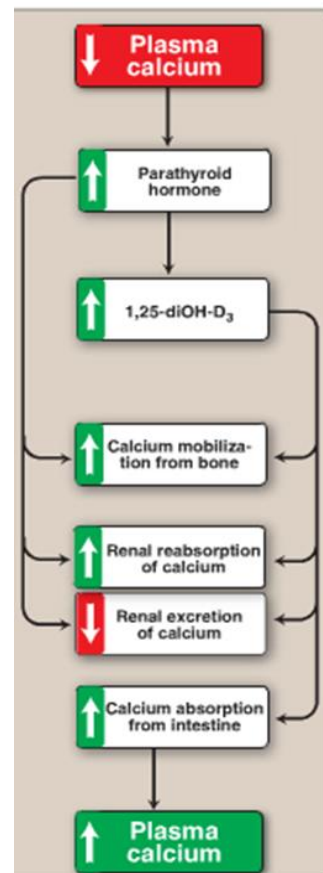




- Vitamin D (fat-soluble vitamin):

- **There are two main types of vitamin D:**
 - ✓ D2 (ergocalciferol): which is found in plants.
 - ✓ D3 (cholecalciferol): which is found in animal sources such as salmon fish (most commonly), egg and cheese.
- **What is the precursor of vitamin D?**
 - ✓ It is cholesterol. Simply, 7-dehydrocholesterol (an intermediate in cholesterol synthesis) will be converted to cholecalciferol in dermis and epidermis of the skin when exposed to sunlight and this explains why it is recommended that people expose themselves to sunlight to avoid vitamin D deficiency.
- **Metabolism of vitamin D (keep in your mind that vitamin D2 and D3 must be converted to their active forms in the liver and kidneys thus expressing their biologic functions):**
 - ✓ Cholecalciferol → liver (25-hydroxylase) → 25-hydroxy cholecalciferol → kidneys (1 hydroxylase) → 1,25 hydroxy cholecalciferol (the active form of vitamin D).
- **Functions of vitamin D:**
 - ✓ In intestines: absorption of calcium and phosphate.
 - ✓ In kidneys: reabsorption of calcium and phosphate.
 - ✓ In bones: stimulating mineralization of bones.
- **Regulation of the enzyme (1-hydroxylase) in kidneys (see the image):**
 - ✓ It is stimulated directly via low plasma phosphate and indirectly via low plasma calcium (which triggers the release of parathyroid hormone from parathyroid glands).
- **Vitamin D deficiency:**
 - ✓ It results from reduced nutritional intake or reduced exposure to sunlight.
 - ✓ It results in:
 - ❖ *Rickets (in children)*: defective mineralization of growing bone.
 - ❖ *Osteomalacia (in adults)*: impaired mineralization of bone matrix.



- Vitamin B12 (cobalamin):

- **How to diagnose B12 deficiency:**
 - ✓ When there is ↑homocysteine → this indicates **B12 or folic acid** deficiency (because it is not being converted to methionine).
 - ✓ When there is ↑L-methylmalonyl CoA → this indicates **B12** deficiency only (because it is not being converted to succinyl CoA).
Notice that when B12 is deficient, unusual fatty acids accumulate and become incorporated into cell membranes, including those of the nervous system (neurologic manifestations of vitamin B12 deficiency). In addition, megaloblastic anemia will occur (Characterized by large RBCs and hypersegmented neutrophils on peripheral blood smears).
- **Vitamin B12 to be transported in intestine has to bind to intrinsic factor (which is produced by parietal cell of the stomach.** Notice that these cells are also responsible for producing the acid of the stomach). Vitamin B12-intrinsic factor complex will be absorbed in the terminal ileum. If there is an autoimmune disease



- destroying parietal cells of the stomach → no production of intrinsic factor → pernicious anemia.
- **Significant amounts of vitamin B12 are stored in the body and it could take years before manifestations of deficiency appear (in contrast to folic acid).**
- **Folic acid:**
- **Folate deficiency occurs due to:**
 - ✓ Decreased intake (e.g. green leafy vegetables).
 - ✓ Increased demand (e.g. in pregnancy and lactation).
 - ✓ Poor absorption (e.g. pathology of small intestine, alcoholism and methotrexate).

Notice that folate deficiency will also result in megaloblastic anemia (resembling B12 deficiency) due to inability of RBCs to synthesize DNA when these two vitamins are lacking. In addition, folate deficiency in a pregnant woman results in neural tube defects of the baby thus pre-conception supplementation must be provided to avoid such a complication (0.4 mg/day).
- **Niacin (nicotinamide):**
- **The biologically active co-enzyme forms of niacin are:**
 - ✓ NAD⁺
 - ✓ NADP⁺

They function in oxidation-reduction reactions.
 - **Sources of niacin:** unrefined and enriched grain and cereals, milk and liver.
 - **Deficiency of niacin:**
 - ✓ Occurring in people with corn-based diet (why?) → because corn is deficient in niacin.
 - ✓ Deficiency will result in “Pellagra” that is characterized by the four D’s:
 - ❖ Dermatitis.
 - ❖ Diarrhea.
 - ❖ Dementia.
 - ❖ And if untreated, Death!
 - **Clinical use of niacin:**
 - ✓ It is used in those patients with hyperlipidemia because it decreases both plasma triglycerol and cholesterol and increases HDL level (good cholesterol) in the same time.
- **Riboflavin (vitamin B2):**
- **The biologically active co-enzyme forms of riboflavin are;**
 - ✓ FMN: reversibly accepting two hydrogen atoms to form FMNH₂
 - ✓ FAD: reversibly accepting two hydrogen atoms to form FADH₂
 - **Vitamin B2 deficiency results in:**
 - ✓ Dermatitis.
 - ✓ Cheilosis (fissuring at the corners of the mouth).
 - ✓ Glossitis (tongue appears smooth and purplish).