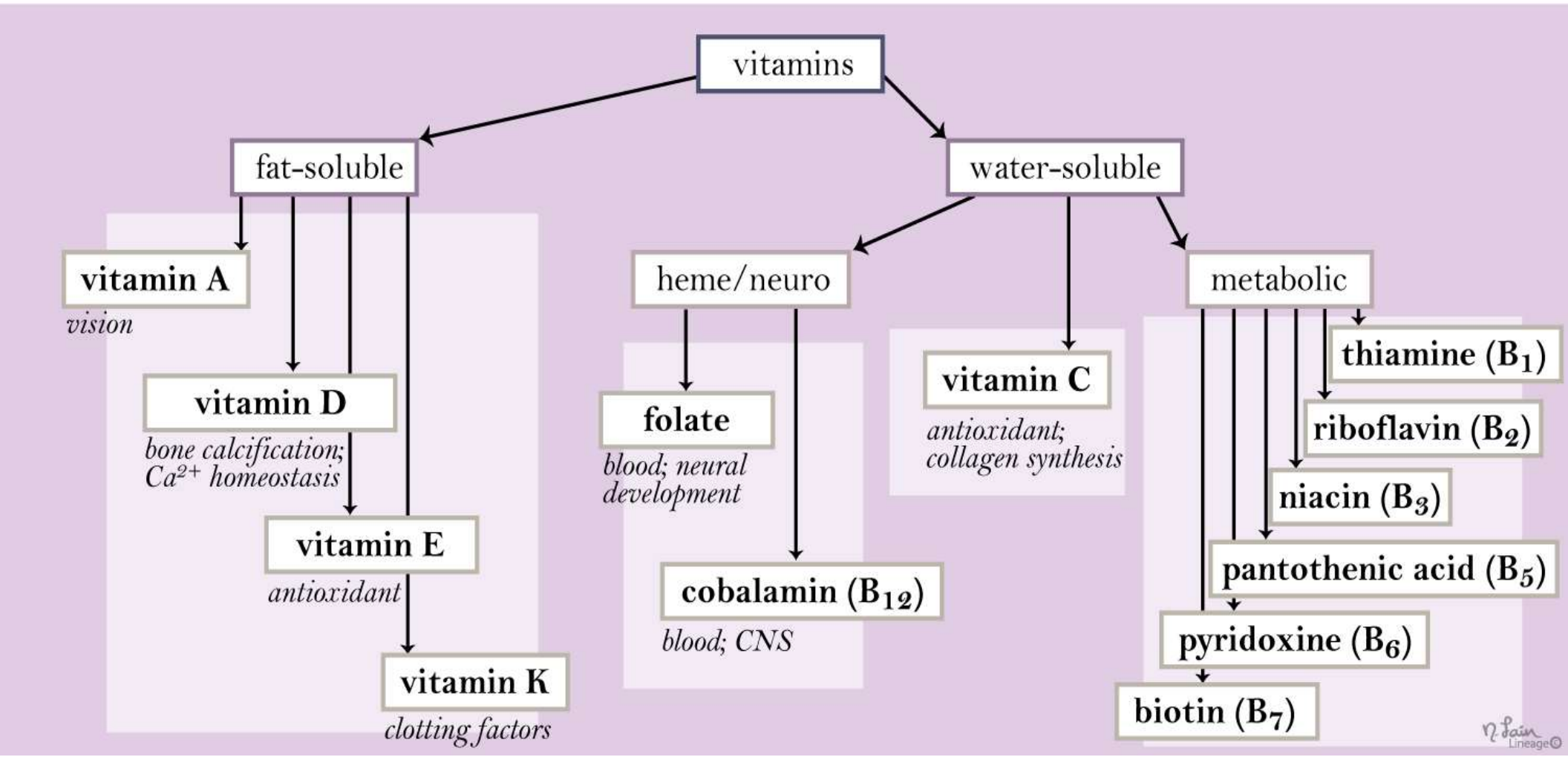
VITAMINES THE BASICS

D.HAMMOUDI, MD

Vitamin Algorithm



Vitamin Deficiency and Excess

- **Fat soluble vitamins**
  - **A, D, E, K**
  - readily stored in body fat
  - poorly absorbed in digestive disorders involving malabsorbtion of fat

Characteristics

  - precursors for coenzymes
  - p**ancreatic enzymes required for absorption in the ileum**
    - malabsorption syndromes can cause fat-soluble vitamin deficiencies
      - e.g. steatorrhea, cystic fibrosis, and sprue
  - **stored in fat making toxicity possible (unlike water soluble vitamins)**
  - **Absorbed into the lymph and carried in blood with protein transporters = chylomicrons**
  - **Stored in liver and body fat and can become toxic if large amounts are consumed.**

- **Water soluble vitamins**
- include the B complex vitamins, B 1(thiamine), B 2 (riboflavin) , B 3 (niacin), B6 (pyridoxine), and BI2 (cobalamin); folic acid; and vitamin C (ascorbic acid).
- Not stored in the body and toxicity is rare.
- Alcohol can increase elimination, smoking, etc. cause decreased absorption.
- **Vitamin stores (fat stores longer than water)**
  - folate and thiamine may become depleted within weeks when eating a deficient diet

Water Soluble Vitamins

- B_1 (thiamine: TPP)
- B_2 (riboflavin: FAD and FMN)
- B_3 (niacin: NAD+)
- B_5 (pantothenic acid: CoA)
- B_6 (pyridoxine: PLP)
- B_{12} (cobalamin)
- C (ascorbic acid)
- biotin
- folate

•Characteristics

- **when consumed in excess are eliminated in the urine**
  - exceptions are B_{12} and folate (stored in liver)
- B-complex deficiencies often result in
  - **dermatitis,**
  - **glossitis,**
  - **diarrhea**

Fat vs. Water Soluble Vitamins

	Water Soluble	Fat Soluble
Absorption	Directly to blood	Lymph via CM
Transport	free	Require carrier
Storage	Circulate freely	In cells with fat
Excretion	In urine	Stored with fat
Toxicity	Less likely	More Likely
Requirements	Every 2-3 days	Every week

Remember: Conversions: Vitamins are required for

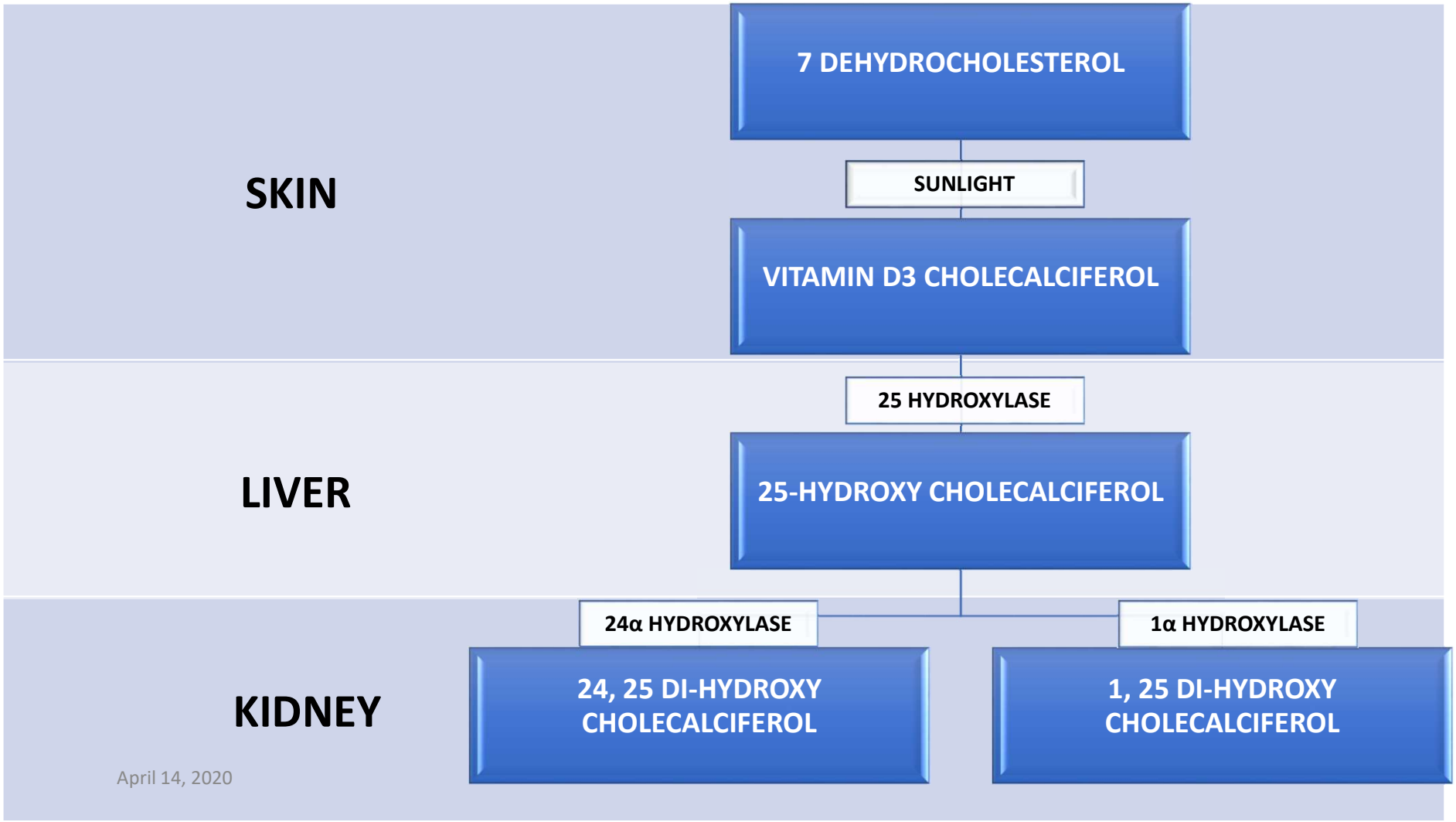
- The conversion of homocysteine to methionine requires **vitamin B12**
- Conversion of methylmalonyl CoA to succinyl CoA requires **vitamin B12**
- Degradation of cystathionine requires **vitamin B6**
- Hydroxylation of proline requires **vitamin C**
- **Vitamin A is necessary** for formation of retinal pigments (deficiency can cause night blindness) and for **appropriate differentiation** of epithelial tissues (including hair follicles, mucous membranes, skin, bone, and adrenal cortex)
- **Vitamin C is necessary for** collagen synthesis
- **Vitamin D is important** in calcium absorption and metabolism
- **Vitamin E is important in** the stabilization of cell membranes
- **Vitamin K is necessary for** normal blood coagulation

Fat-soluble vitamins (vitamins A, D, E, and K

- **Deficiency may result from**
  - malnutrition
  - intestinal malabsorption syndromes,
  - pancreatic exocrine insufficiency,
  - biliary obstruction,
  - all of which are associated with poor absorption of fats.
- **Excess intake** (i.e., hypervitaminosis) with resultant toxicity may occur, especially with **vitamins A and D.**

- Vitamin A retinol, B-carotenes
- Vitamin D cholecalciferol
- Vitamin K phylloquinones, menaquinones
- Vitamin E tocopherols

VITAMIN-D


SKIN
7 DEHYDROCHOLESTEROL
SUNLIGHT
VITAMIN D3 CHOLECALCIFEROL
LIVER
25 HYDROXYLASE
25-HYDROXY CHOLECALCIFEROL
KIDNEY
24α HYDROXYLASE
1α HYDROXYLASE
24, 25 DI-HYDROXY CHOLECALCIFEROL
1, 25 DI-HYDROXY CHOLECALCIFEROL

WATER SOLUBLE VITAMINS

- Because these vitamins are not stored in the body, regular intake is essential, except for vitamin BI2

- Vitamin BI2 is stored in the liver in quantities sufficiently large so that deprivation for months or years is necessary for **deficiency to develop = storage usually a year.**

Vitamin	Enzyme	Deficiency State
Thiamine (B1)	• Pyruvate dehydrogenase • α ***Ketoglutarate dehydrogenase*** • Transketolase	• **Wernicke Korsakoff Syndrome** • **Wet Beriberi** • **Dry Beriberi**
Biotin	• Pyruvate carboxylase • Acetyl CoA carboxylase • Propionyl CoA carboxylase	• **Consumption of eggs containing avidin** • **Alopecia, Muscle pains**
Pyridoxine	• Aminotransferases	• **Isoniazid therapy** • **Sideroblastic anemia** • **Chielosis/stomatitis** • **Convulsions**
Riboflavin	• Dehydrogenases	• **Corneal neovascularization** • **Chielosis/stomatitis** • **Magenta tongue**
Niacin	• Dehydrogenases	• **Pellagra** • **Diarrhea, Dementia, Dermatitis, Death**
Pantothenic	• Fatty acid Synthase • Fatty acyl CoA synthase	• **Rare** • **Burning foot syndrome**

- Toxicity from excessive intake is rare, because excess vitamin is excreted in the urine.

Folic Acid	• Thymidylate synthase	• **Alcholics and pregnancy** • **Homocystenemia** • **Macrocytic anemia** • **Neural tube defects**
Vitamin B_{12} **Extrinsic factor of castle**	• Homocysteine methyltransferase • Methyl malonyl CoA mutase	• **Pernicious anemia** • **Megaloblastic anemia** • **Neuropathy** • **SACD** • **Methyl malonic aciduria**
Vitamin C **post translation modifier**	• Propyl and Lysyl hydroxylase • Dopamine hydroxylase	• **Diet deficient in citrus** • **Scurvy**

	Metabolic Functions	Clinical Manifestations of Deficiency
Vitamin B_1 (thiamine)	Coenzyme thiamine pyrophosphate plays a key role in carbohydrate and amino acid intermediary metabolism	Wet beriberi; dry beriberi; Wernicke-Korsakoff syndrome
Vitamin B_2 (riboflavin)	Component of FAD and FMN and is essential in a variety of oxidation-reduction processes	Cheilosis; corneal vascularization; glossitis; dermatitis
Vitamin B_3 (niacin, nicotinic acid)	Component of NAD and NADP, essential to glycolysis, the citric acid cycle, and to a variety of oxidations (can be synthesized from tryptophan); deficiency requires diet lacking both niacin and tryptophan	Pellagra
Vitamin B_6 (pyridoxine)	Required for transamination, porphyrin synthesis, synthesis of niacin from tryptophan	Cheilosis; glossitis; anemia; convulsions in infants; neurologic dysfunction
Vitamin B_{12} (cobalamin)	1-Carbon transfers required for folate synthesis and activation of FH_4; $N^{5,10}$-methylene FH_4 is required for conversion of dUMP to dTMP in DNA synthesis	Megaloblastic anemia; neurologic dysfunction

Folic acid	1-Carbon transfers in a number of metabolic reactions; $N^{5,10}$-methylene FH_4 required for DNA synthesis	Megaloblastic anemia; neurologic dysfunction is not a feature (as it is in vitamin B_{12} deficiency)
Vitamin C (ascorbic acid)	Required for hydroxylation of proline and lysine, which are essential for collagen synthesis; hydroxylation of dopamine in synthesis of norepinephrine; enhances maintenance of reduced state of other metabolically active agents, such as iron and FH_4	Scurvy, defective formation of mesenchymal tissue and osteoid matrix; defective wound healing; hemorrhagic phenomena

FAD = flavin adenine dinucleotide; FMN = flavin mononucleotide; NAD = nicotinamide adenine dinucleotide; NADP = nicotinamide adenine dinucleotide phosphate; FH_4 = tetrahydrofolate; $N^{5,10}$-methylene FH_4 = activated tetrahydrofolate