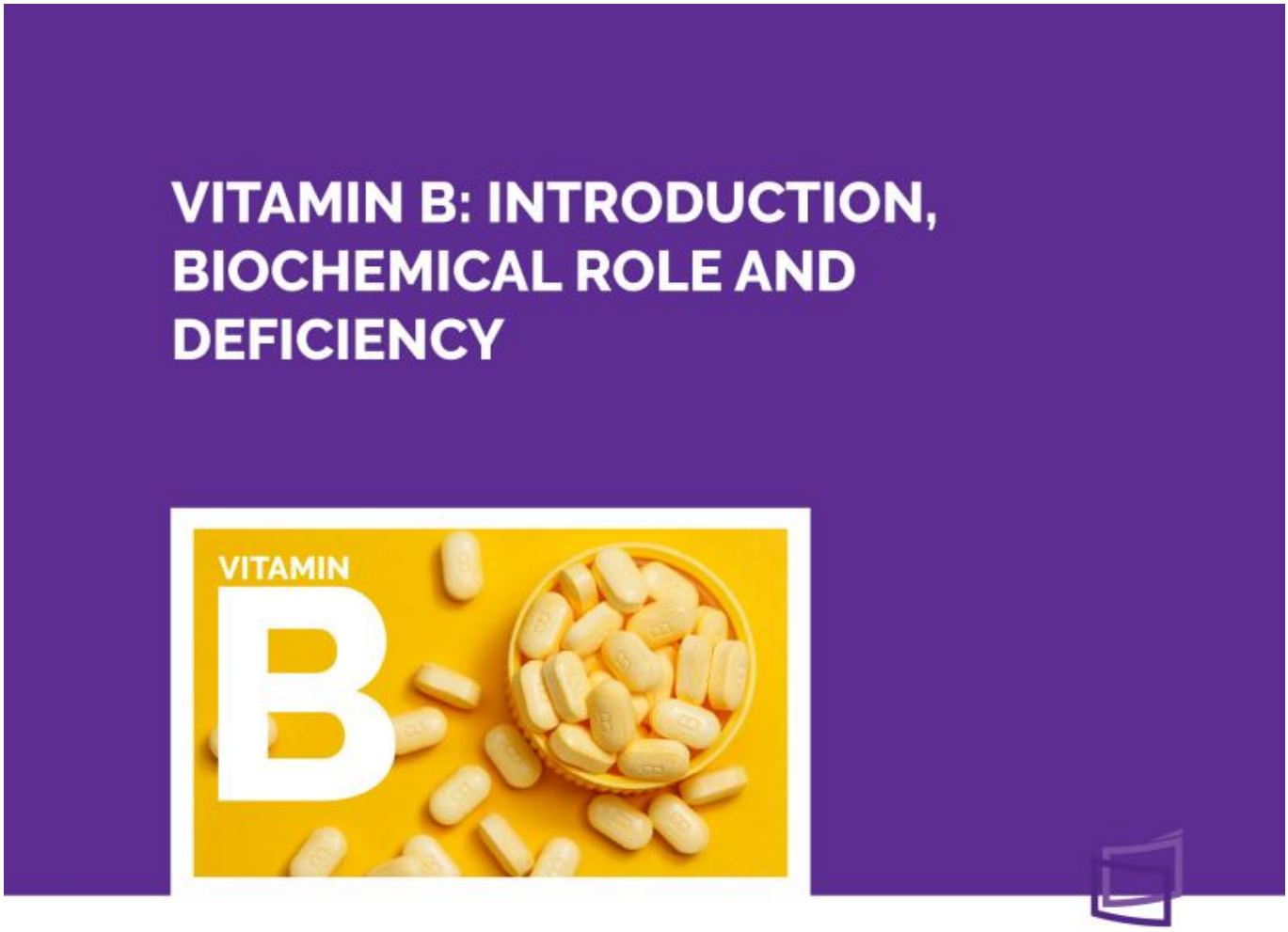
VITAMIN B: INTRODUCTION, BIOCHEMICAL ROLE AND DEFICIENCY

Education

Presentations

Vitamins are organic compounds essential for normal physiological functions. However, some of them are not synthesized endogenously by the body and therefore have to be sequestered in small quantities from the diet. Humans require 13 vitamins: namely A, D, E, K, C and the eight B vitamins: thiamine (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), vitamin B6, folate (B9) and vitamin B12.



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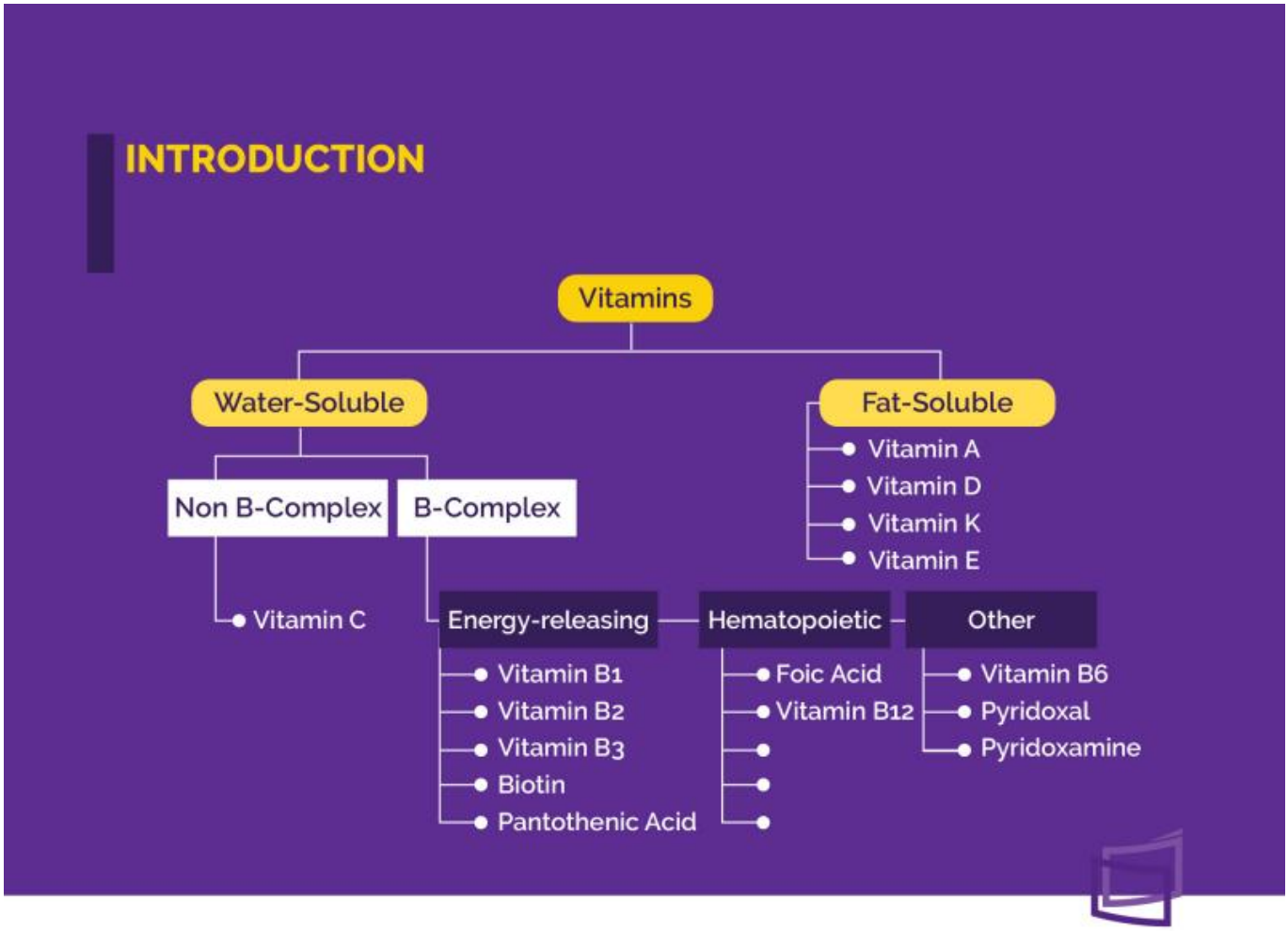
INTRODUCTION
Vitamins
Water-Soluble
Fat-Soluble
Non B-Complex
B-Complex
Vitamin A
Vitamin D
Vitamin K
Vitamin E
Vitamin C
Energy-releasing
Hematopoietic
Other
Vitamin B1
Vitamin B2
Vitamin B3
Biotin
Pantothenic Acid
Foic Acid
Vitamin B12
Vitamin B6
Pyridoxal
Pyridoxamine

INTRODUCTION

The B-Vitamins are water-soluble, so get excreted from the body and must frequently be replenished. One can get B vitamins from the number of proteins rich dietary sources such as fish, poultry, meat, eggs, and dairy products. Leafy green vegetables, beans, and peas also have B vitamins.

B-Vitamins itself not provide any fuel for energy. Our body consumes energy-yielding nutrients such as carbohydrates, fat, and protein as a fuel. The B-vitamin complex helps the body to use that fuel. Other B-group vitamins play vital roles such as assisting the cells to multiply by making new DNA.

INTRODUCTION

Table 1 shows the list of B vitamins and their role, sources, and RDA.

Vitamin	Generally Known as	Good Dietary Sources	RDA[1] (mg)	Principal Bioactive Coenzymes (and Principal Coenzyme Role)	Symptoms of Deficiency	Specific Risk Factors for Deficiency
B_1	Thiamin (e)	Cereals (esp. whole grain), brown rice, green vegetables, potatoes, pasta, liver, pork, eggs	1.2/1.1	Thiamine pyrophosphate (Generation of leaving group potential)	Mild deficiency: general fatigue/weakness gastro-intestinal symptoms. Deficiency: "Beri-beri"— Peripheral nerve damage and cardiovascular dysfunction leading to: pain, impaired sensory perception; swelling, weakness and pain in the limbs; shortness of breath, irregular heart rate, heart failure	Alcohol abuse, obesity

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B_2	Riboflavin	Dairy products, leafy vegetables, legumes, liver, kidneys, yeast, mushrooms	1.3/1.1	Flavoproteins: flavin adenine dinucleotide (FAD) or flavin mononucleotide (FMN) (redox reactions)	Weakness, oral pain/ tenderness, burning/ itching of the eyes, dermatitis, anaemia	inherited riboflavin malabsorption/ utilisation (10%–15% prevalence)
B_3	Niacin	Meat, fish, whole grain cereal, legumes, mushrooms, nuts	16/14	Nicotinamide adenine dinucleotide (NAD) and its phosphate (NADP) (redox reactions)	Pellagra: dermatitis/ photo dermatitis, alopecia, muscle weakness, twitching/ burning in the extremities, altered gait, diarrhoea	Alcohol abuse

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B_5	Pantothenic acid	Meat, whole grain cereals, broccoli	5	Co-enzyme A (CoA) (acyl activation and transfer)	Numbness/burning sensations in extremities, dermatitis, diarrhoea	
B_6	Vitamin B6 (referring to: pyridoxal, pyridoxamine, pyridoxine)	Meat, fish, legumes, nuts, bananas, potatoes	1.3/1.3 (1.7/1.5 >50 year)	pyridoxal-5'-phosphate (PLP) and pyridoxamine-5'-phosphate (PMP) (Generation of leaving group potential)	Anaemia	Alcohol abuse, age-related malabsorption, contraceptive medications
B_7	Biotin	Eggs, liver, pork, leafy vegetables	30 (µg)	biotin (carboxylation reactions)	Seborrheic eczematous rash, tingling/burning of the extremities	Type II diabetes, poor gluco-regulation

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Vitamin	Generally Known as	Good Dietary Sources	RDA[1] (mg)	Principal Bioactive Coenzymes (and Principal Coenzyme Role)	Symptoms of Deficiency	Specific Risk Factors for Deficiency
B_9	Folic acid/ folate	Leafy vegetables, legumes, citrus fruits	400 (µg)	tetrahydrofolates inc. methyltetrahydrofolate (One carbon transfer)	megaloblastic anaemia, peripheral neuropathy, spinal cord lesions, metabolic abnormalities	Common genetic polymorphisms (inc. MTHFR C667T) Low Riboflavin and B12
B_{12}	Vitamin B12 (referring to: the cobalamins)	Meat, fish and other animal products	2.4 (µg)	Methylcobalamin, adenosylcobalamin (vicinal rearrangements)		age-related malabsorption, vegetarians, vegans Genetic polymorphisms

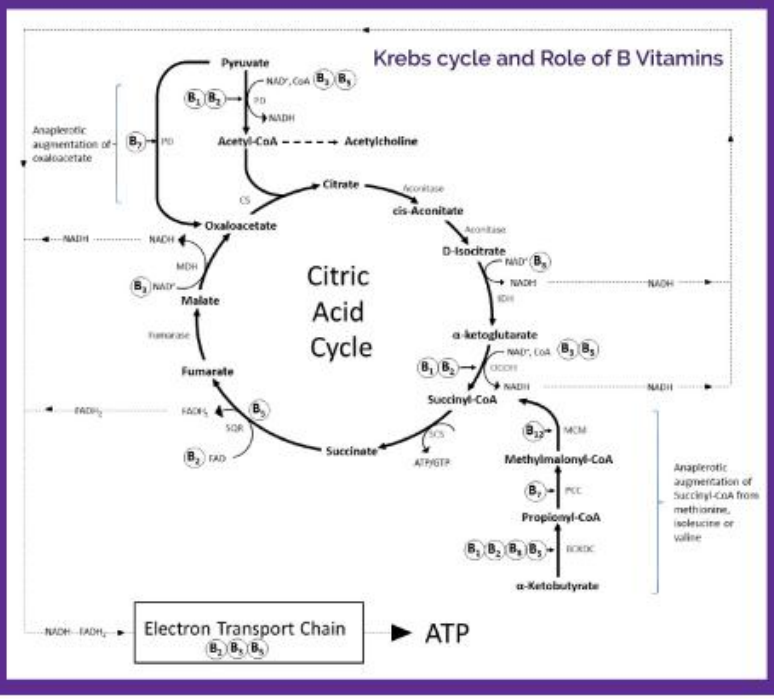
BIOCHEMICAL ROLE OF B VITAMINS:

B vitamins act as coenzymes in a substantial proportion of the enzymatic processes that underpin every aspect of cellular physiological functioning. As a coenzyme, the biologically active form of the vitamin binds within a protein "apoenzyme" creating a "holoenzyme," thereby increasing the resultant enzyme's competence in terms of the diversity of reactions that it can catalyse. In this role, the B vitamins play key interacting roles in the majority of cellular functions. As an example of their ubiquity, the primary bioactive form of vitamin B6, pyridoxal 5′-phosphate, is an essential cofactor in the functioning of over 140 separate ubiquitous enzymes required for the synthesis, degradation, and interconversion of amino acids, whereas the active coenzyme form of pantothenic acid, coenzyme A (CoA), is an obligatory co-factor for approximately 4% of all mammalian enzymes.

KREBS CYCLE AND VITAMIN B

- Krebs cycle, series of chemical reactions that generate energy, in the form of ATP, in the mitochondria of eukaryotes.
- Carbohydrates, fats and proteins are first converted to acetyl-CoA, via pyruvate
- Then undergo eight enzymatic reactions that result in the production of NADH and FADH2, which transfer the energy generated by the citric acid cycle to the electron transport chain.
- This in turn leads to the synthesis of ATP, the energy currency of cells.
- The B vitamins acts as co-factors/enzymes such as FAD (B_2), NAD (B_3) and as a component of CoA (B_5), or Co-enzyme Q10 (B_5).

KREBS CYCLE AND VITAMIN B



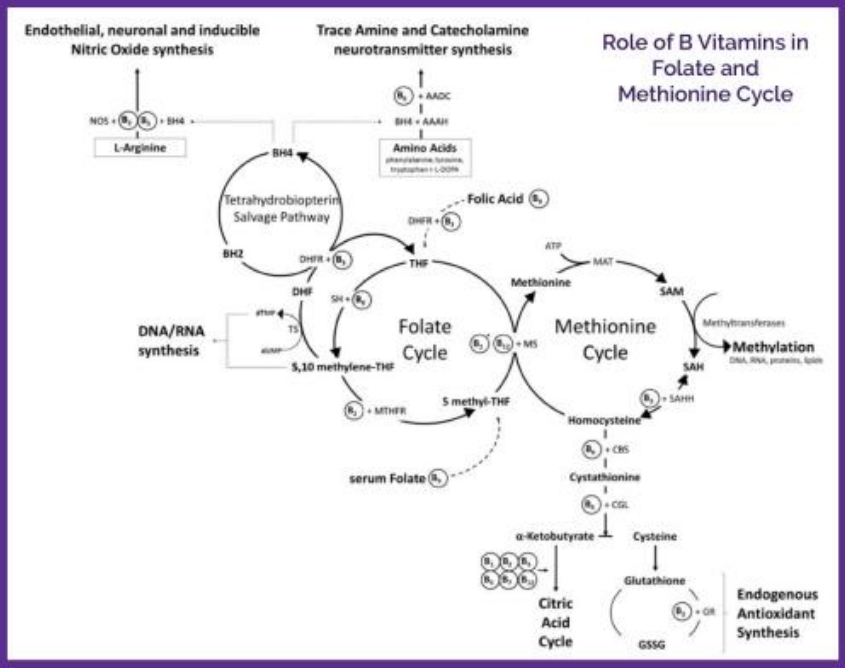
ROLE OF B VITAMINS IN FOLATE AND METHIONINE CYCLE

- Dietary folate enters the folate cycle and rotates through several enzymatic modifications, which generate the one-carbon units required for the synthesis of DNA/RNA and the methyl groups required to regenerate methionine from homocysteine.
- The "methionine cycle" provides the methyl groups required for all genomic and non-genomic methylation reactions in the form of S-adenosyl methionine (SAM).
- These two enzymatic cycles are essential to cellular function, including via interactions with other pathways.

ROLE OF B VITAMINS IN FOLATE AND METHIONINE CYCLE

- As an example of the latter, the re-salvaging from dihydrobiopterin of tetrahydrobiopterin, an essential cofactor in trace amine and catecholamine neurotransmitter synthesis and nitric oxide production, is rate limited by provision of the enzyme dihydrofolate reductase produced by the folate cycle. * FAD (vitamin B_2) is a cofactor for methionine synthase reductase in the recycling of the vitamin B12 cofactor for methionine synthase.

ROLE OF B VITAMINS IN FOLATE AND METHIONINE CYCLE



DEFICIENCY OF B VITAMINS:

Table 2 shows Deficiency of B Vitamins:

Vitamin B Type	Deficiency Condition
B_1 (Thiamine)	Mild deficiency: general fatigue/weakness gastro-intestinal symptoms. Deficiency: "Beriberi"— Peripheral nerve damage and cardiovascular dysfunction leading to: pain, impaired sensory perception; swelling, weakness and pain in the limbs; shortness of breath, irregular heart rate, heart failure
B_2 (Riboflavin)	Weakness, oral pain/tenderness, burning/itching of the eyes, dermatitis, anaemia
B_3 (Niacin)	Pellagra: dermatitis/photo dermatitis, alopecia, muscle weakness, twitching/burning in the extremities, altered gait, diarrhoea
B_5 (Pantothenic acid)	Numbness/burning sensations in extremities, dermatitis, diarrhoea
B_6 (Pyridoxine)	Anaemia
B_7 (Biotin)	Seborrheic eczematous rash, tingling/burning of the extremities
B_9 (Folic acid)	Megaloblastic anaemia, peripheral neuropathy, spinal cord lesions, metabolic abnormalities
B_{12} (Cobalamins)	Megaloblastic anaemia, peripheral neuropathy, spinal cord lesions, metabolic abnormalities

DEFICIENCY OF B VITAMINS:

Nutrition is a major factor affecting public health. An inappropriate, unhealthy diet involving either insufficient consumption of certain nutrients and trace elements may be a cause of various diseases: heart disease, cancer, diabetes mellitus, obesity, anaemia and other micronutrient deficiencies. **Every year, over 1 million people die in the European region (14 percent of all deaths) because of the lack of certain nutrients in the food.**

The situation in Russia is that certain regions are deficient in vitamins, minerals and trace elements. A number of steps need to be taken to change the situation, so that the diets of the population can be healthier: providing for the growth, normal development and vital activities, promoting better health and preventing disease.

Vitamin B, RDA