Micronutrients

Water-soluble Vitamins: Coenzymes

Inactive enzyme + Vitamin coenzyme → Active enzyme

Thiamin (B₁)

- thiamin pyrophosphate (TPP)
  - Energy metabolism

Thiamin deficiency, toxicity

Adequate intake

Deficiency

Scurvy

Beriberi

Wernicke-Korsakoff syndrome

Excess

None reported

Adequate intake

Thiamin

Success

None reported

Deficiency

Scurvy

Beriberi

Wernicke-Korsakoff syndrome
Riboflavin (B<sub>2</sub>)

- electron carriers
  - FAD
  - FMN

Riboflavin deficiency, toxicity

- Excess
  - None recognized

- Deficiency
  - Uncommon
  - Araboflavinosis
  - glossitis

Niacin (B<sub>3</sub>)

- Names
  - Nicotinic acid = niacin
  - Nicotinamide = niacinamide

- Coenzymes
  - NAD<sup>+</sup>
  - NADP<sup>+</sup>

- Functions
  - Energy metabolism
  - Fatty acid synthesis
Micronutrients

Food sources of niacin

Niacin deficiency, toxicity

Vitamin B₆: Pyridoxine

- **Coenzyme**: pyridoxal phosphate (PLP)
- **Other forms**
  - Pyridoxal
  - Pyridoxamine
- **Functions**
  - Protein, carb metabolism
  - RBCs
  - Neurotransmitter synthesis
  - Homocysteine metabolism
Micronutrients

Food sources of B₆

Vitamin B₆ deficiency, toxicity

Vitamin B₉: Folic Acid

- Coenzymes
  - Tetrahydrofolate
  - Dihydrofolate
- Functions
  - DNA synthesis
  - Homocysteine metabolism
Micronutrients

Folic Acid deficiency, toxicity

Adequate intake
None reported
Masks Vit. B12 deficiency

Folate
Excess
Cells don't divide normally
Deficiency
Megaloblastic anemia
Neural tube defects

Cells divide normally
Deficiency

Megaloblastic blood cells

Neural Tube Defects

Healthy spine
Spinal cord
Spinal fluid
Vertebra

Spina bifida
Skin on back
Spinal cord
Spinal fluid
Vertebra

Vitamin B₁₂: Cyanocobalamin

• “cobalamin”
• Folate activation
• Myelin sheath maintenance
• Homocysteine metabolism
Micronutrients

**B<sub>12</sub> deficiency, toxicity**

- **Excess**: None recognized
- **Deficiency**: Pernicious anemia (Megaloblastic anemia), Nerve degeneration

**Vitamin B<sub>5</sub>: Pantothenic acid**

- **Coenzyme A (CoA)**
  - energy extraction
  - fatty acid synthesis

*pantothen means "from everywhere"*

**Pantothenic acid deficiency, toxicity**

- **Excess**: None reported
- **Deficiency (RARE!)**: Weakness, Fatigue, Impaired muscle function
Micronutrients

Vitamin B<sub>7</sub>: Biotin

- **Functions**
  - amino acid metabolism
  - fatty acid metabolism
  - DNA synthesis

Vitamin B<sub>7</sub> deficiency, toxicity

- Excess
- Unknown
- Adequate intake
- Deficiency (rare)
  - Dematitis
  - Hair loss

Vitamin C: Ascorbic Acid

- **Functions**
  - antioxidant
  - collagen synthesis
  - synthesis of dopamine, noradrenaline and adrenaline
Micronutrients

Vitamin C deficiency, toxicity

- Excess: Diarrhea, GI symptoms
- Adequate intake
- Deficiency: Scurvy

Vitamin C deficit

Choline

- Functions
  - Precursor: acetylcholine
  - Precursor: phospholipids
  - Precursor: betaine

Choline deficiency, toxicity

- Excess: Fishy body odor, hypotension, sweating, salivation, vomiting
- Adequate intake
- Deficiency: No natural deficiency, liver damage?