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Vitamins, Minerals and Nutritional Supplements

Pharmacology

Fat-soluble vitamins, water-soluble vitamins, minerals, electrolyte preparations, nutritional supplements and deficiency treatment.

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CHAPTER 20 / PHARMACOLOGY 20. Vitamins, Minerals and Nutritional Supplements

1. Introduction

Vitamins are organic micronutrients required for normal metabolism; minerals are inorganic elements with structural, regulatory and enzymatic roles. Supplements replenish deficiencies or meet special requirements. They are not substitutes for balanced nutrition or treatment of an underlying illness. Dietary requirements differ from therapeutic replacement doses and vary by age, sex, pregnancy and national reference standards.

2. Fat-soluble vitamins

Vitamin	Functions / sources	Deficiency	Excess / precautions
A (retinol, carotenoids)	Vision, epithelial and immune function; dairy, eggs, orange/green vegetables	Night blindness, xerophthalmia	Excess preformed A: liver injury, fetal risk, intracranial pressure.
D (cholecalciferol/ ergocalciferol)	Calcium/phosphate regulation; sunlight exposure, fortified foods, fish	Rickets, osteomalacia	Hypercalcaemia, renal injury with excess.
E (tocopherols)	Antioxidant membrane protection; nuts, seeds, vegetable oils	Rare neuropathy or haemolysis in susceptible situations	High supplemental doses may increase bleeding.
K	Activation of clotting and bone proteins; leafy vegetables	Bleeding tendency	Important interaction with warfarin; avoid abrupt changes in intake.

Vitamin A and D may accumulate. High-dose preparations should be given only for authorized indications. Different vitamin D forms are not dose-interchangeable: calcitriol is active hormone and requires special monitoring.

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3. Water-soluble vitamins

Vitamin	Main function / source	Deficiency and key caution
B1 thiamine	Carbohydrate metabolism; whole grains, legumes	Beriberi, Wernicke encephalopathy; urgent replacement in suspected high-risk cases.
B2 riboflavin	FAD/FMN coenzymes; dairy, eggs	Angular cheilitis, glossitis.

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B3 niacin	NAD/NADP; meat, whole grains	Pellagra (dermatitis, diarrhoea, dementia); high therapeutic doses may cause flushing and hepatic effects.
B5 pantothenate	Coenzyme A; widespread in foods	Deficiency uncommon.
B6 pyridoxine	Amino acid metabolism, neurotransmitters	Neuropathy, dermatitis, selected anaemia; excessive long-term doses can cause neuropathy.
B7 biotin	Carboxylase cofactor; varied foods	Rare dermatitis/neurological symptoms; supplements may interfere with lab tests.
B9 folate	DNA synthesis; greens, legumes, fortified foods	Megaloblastic anaemia, fetal neural tube defect risk; assess B12 status.
B12 cobalamin	DNA synthesis and myelin; animal foods, fortified foods	Megaloblastic anaemia and neurological impairment.
C ascorbic acid	Collagen synthesis, iron absorption; fruits, vegetables	Scurvy, impaired wound healing; excess may cause GI symptoms or kidney stone risk.

Water-soluble does not mean harmless at unlimited doses. Treatment of a deficiency requires assessment of dietary intake, absorption, medication effects and underlying disease.

4. Mineral preparations

Mineral	Sources and physiological role	Deficiency / treatment considerations
Calcium	Dairy, fortified foods, ragi; bones, muscle and signalling	Hypocalcaemia; calcium salts for indicated replacement; constipation and interaction risks.
Iron	Meat, legumes, leafy vegetables; haemoglobin	Iron-deficiency anaemia; oral/IV therapy according to cause and tolerance.
Iodine	Iodized salt, seafood; thyroid hormones	Goitre and developmental effects; excess also affects thyroid function.
Zinc	Meat, legumes, nuts; enzymes and immune function	Growth and wound-healing problems; excessive zinc may cause copper deficiency.
Magnesium	Nuts, greens, legumes; enzyme and neuromuscular function	Hypomagnesaemia, arrhythmias; renal clearance and infusion safety matter.
Phosphorus	Protein-rich foods; ATP, bones	Hypophosphataemia with refeeding or other disorders; replacement requires monitoring.
Selenium / copper	Varied foods; enzyme systems	Deficiency uncommon in many populations; excess can be toxic.

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5. Electrolyte preparations and oral rehydration

Sodium and chloride replacement may use prescribed crystalloid solutions. Potassium supplements treat documented deficits or specified needs; concentrate is a high-alert product and must never be administered by direct IV push. Calcium gluconate or chloride and magnesium sulfate are used in selected monitored indications; formulations are not automatically interchangeable. Phosphate replacement may affect calcium and renal function. Oral rehydration salts are prepared in the exact water volume indicated on the packet; over-concentrated or incorrectly diluted ORS may be harmful.

6. Nutritional supplements and therapeutic nutrition

Oral nutritional supplements may provide energy and protein to individuals unable to meet needs through usual intake. Enteral formula is prescribed according to gastrointestinal function, nutritional needs and clinical conditions. Parenteral nutrition is a specialized IV treatment requiring assessment, strict asepsis and metabolic monitoring. Refeeding syndrome can occur in undernourished individuals after nutrition restarts; phosphate, potassium, magnesium and thiamine require attention. Follow a multidisciplinary nutrition plan rather than rapidly increasing intake without assessment.

7. Nursing responsibilities and patient education

Assess dietary history, weight trend, deficiency symptoms and relevant laboratory results. Verify elemental mineral content and vitamin form, prescribed dose, route and duration. Check duplicate supplements, herbal products, interactions and renal/hepatic status. Counsel on balanced food sources, safe storage, correct administration and avoiding megadoses. Record supplements during medication reconciliation, including biotin before relevant laboratory tests.

8. Examination questions

Long answer questions

1. 1. Classify vitamins and discuss deficiency and toxicity of fat- and water-soluble vitamins.
2. 2. Describe common mineral and electrolyte preparations with nursing safety measures.

Short answer questions

- Vitamin A toxicity; thiamine; B12; folic acid; iron preparations; ORS; refeeding syndrome.

Very short answer questions

- Deficiency of vitamin C causes? - Scurvy.
- Vitamin K is required for synthesis of functional forms of which proteins? - Selected clotting factors.
- Can concentrated KCl be given IV push? - No.

9. Quick revision

A, D, E and K are fat-soluble. B-group and C are water-soluble but can still cause toxicity at excessive doses. Replacement should match the deficiency and clinical setting. Verify electrolyte concentration and route carefully.

Conclusion

Nutritional pharmacotherapy supports metabolism and recovery when the appropriate nutrient, formulation and treatment plan are selected and monitored safely.

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Practice questions

Choose one best answer. The answer key and explanations follow the questions.

1. Night blindness and xerophthalmia are associated with deficiency of which vitamin?

A. Vitamin D
B. Vitamin E
C. Vitamin K
D. Vitamin A

2. Which adverse effect can result from excessive vitamin D supplementation?

A. Hypercalcaemia and renal injury
B. Hypocalcaemia and tetany
C. Hypophosphataemia with rickets
D. Hypomagnesaemia with muscle weakness

3. Dermatitis, diarrhoea and dementia in pellagra are associated with deficiency of which vitamin?

A. Ascorbic acid (C)
B. Niacin (B3)
C. Thiamine (B1)
D. Riboflavin (B2)

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Answer key and explanations

1. D - Vitamin A

Vitamin A supports vision and epithelial function; deficiency causes night blindness and xerophthalmia.

2. A - Hypercalcaemia and renal injury

Excess vitamin D can cause hypercalcaemia and renal injury.

3. B - Niacin (B3)

Niacin deficiency causes pellagra, classically including dermatitis, diarrhoea and dementia.

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