Vitamins, Minerals, and Nutritional Support

RATIONALE / OBJECTIVES

The activity of essential biochemicals and minerals is influenced by changes in body fluids and dietary intake. The student will describe the difference between energy producing substance and minerals and list an example of each, describe the role of vitamins in tissue function, list the water-soluble vitamins and describe at least three diseases resulting from vitamin deficiency, list the fat-soluble vitamins and two ways deficiency can occur, explain the main function of the main electrolytes, identify nutritional sources of vitamins and minerals, and methods of supplementation.

TEKS: 121.25 1A, 1C, 1D, 5 A, 5B, 5C, 5D, 5E, 5G  TAKS ELA 1, 3, 4, 5, 6 Science 2

KEY POINTS

Vitamins and Minerals RDA Chart

I. Essential Nutrients
   A. Vitamins and minerals are generally not regarded as drugs although they are required for maintaining normal function and are essential for life.
   B. When they are not obtained through a balanced diet, supplementation may be required.
   C. Doses in excess of RDA’s suggested amounts should only be taken when an inadequacy is diagnosed by a physician.
   D. Mounting evidence suggests that supplementing in adults may be beneficial
      1. prevention of cancer (vitamin E - prostate)
      2. minimizing toxicity of chemotherapy (vitamins A, E, C)
      3. bone demineralization (in the elderly, vitamin D)
      4. pregnancy
   E. RDAs (Recommended Dietary Allowance) and U.S. - Recommended Daily Allowance (U.S. - RDA); U.S. - RDA and RDA are NOT interchangeable!
      1. U.S. - RDA, previously called Minimum Daily Requirement, used by FDA to monitor quality claims in processing food for human consumption; nutrition advertising in product labels must meet legal requirements as established by U.S. – RDA
      2. RDA, published by National Research Council - National Academy of Sciences, Food and Nutrition Board
         a. not a requirement, but rather suggestion for daily intake of substances not synthesized by the body
         b. recommendations based on healthy individuals consuming 2000-calorie daily diet balanced from the 4 food groups
c. standard referenced healthy males considered to weigh 70 kg (150 - 160 lbs), women 60 kg (130 - 148 lbs), between 25 and 50 years
d. elderly individuals differ significantly in muscle mass and dietary requirements, yet no dietary allowance recommendations have been established for this age group as of yet

II. Fat-soluble Vitamins
A. Vitamin A: chemical class: Retinol
   Provitamin A (beta-carotene) most important member of biologically active compounds known as vitamin A
   1. Source: A₁ (retinol) found in fish liver oils, animal liver, yellow vegetables, palm oil, parsley, spinach, dandelion leaves
      a. synthetic retinol provides more consistent blood levels than dietary sources
      b. vitamin A activity expressed as retinol equivalents (RE): one RE = 1 mcg of retinol or 6 mcg of beta-carotene
   2. Function in body
      a. required for production of visual purple (rhodopsin) - important for adequate visual dark adaptation
      b. dietary beta-carotene converted to retinol in intestines
      c. retinol combines with opsin (a protein) to form rhodopsin
      d. rhodopsin enables specialized retinal cells, the rods, to adapt to very low intensity light
      e. beta-carotene deficiency will result in "night blindness"
      f. vitamin A also involved in synthesis of RNA (ribonucleic acid), cholesterol, and proteins instrumental in maintaining integrity of epithelial cells
      g. vitamin A deficiency results in retarded cell growth and produces hyperkeratosis, dry brittle nails, increased hair loss, urinary stones, increased infection, drying of cornea, and night blindness
   3. Clinical indication
      a. administered orally as replacement therapy in deficiency conditions resulting from biliary disease, pancreatic disease, hepatic disease, partial gastrectomy, and cystic fibrosis
      b. parenteral vitamin A also available for conditions such as anorexia, malabsorption syndrome, and vomiting, making oral administration impossible
      c. used topically for skin abrasions, minor burns, sunburn, diaper rash, and noninfected skin irritation resulting from indwelling drains, such as colostomy or ileostomy
      d. vitamin A acid (13-retinoic acid or trans-retinoic acid) used in treating acne vulgaris
   4. Treatment of deficiency
      a. RDA for vitamin A 1000 mcg (RE) for men
      b. 800 mcg (RE) for women
      c. 800 - 1300 mcg (RE) for pregnant and nursing women
d. treatment of adult deficiency ranges from 100,000 - 500,000 IU per day up to 2 weeks
e. treatment required to continue past 2 weeks may range from 10,000 - 20,000 IU daily for 2 months
f. oral preparations available OTC individually or in multivitamin products
g. oral and injectable also available by prescription
5. Treatment of acne
   a. retinoic acids available as oral formulation
   b. taken b.i.d. for up to 20 weeks
   c. topical gels applied q d
   d. topical creams or liquid preparations will adhere to hand requiring thorough handwashing after application to avoid accidental exposure of sensitive tissues, such as the eyes
6. Overdose: healthy individuals should have adequate stores of vitamin A within the liver; excessive supplementation may cause hypervitaminosis
   a. toxicity will vary with age, general condition of individual, and dose ingested
   b. acute toxicity may show in symptoms such as headache, irritability, and vertigo associated with increase in cranial pressure
   c. symptoms of chronic toxicity may include lethargy, desquamation (shedding of epithelial lining), dry, cracked skin, arthralgia and cirrhotic-like liver syndrome
   d. once accurately diagnosed, supplement should be discontinued
   e. if necessary, supportive treatment with prednisone may be required
   f. liver function enzymes ought to be monitored until clinical profile improves
   g. overdose characteristics of hypervitaminosis A can result from overuse of oral formulation or accidental oral ingestion of topical formulation
   h. symptoms include headache, vomiting, facial flushing, vertigo and abdominal pain
7. Contraindication
   a. hypersensitivity to vitamin A
   b. malabsorption syndrome (PO)
   c. Accutane (oral retinoic acid) contraindicated in pregnant women or in women anticipating to become pregnant!
8. Interactions
   a. decreased absorption of vitamin A
   b. increased levels of vitamin A
9. Teaching points for patients
   a. if dose missed do not double next dose but omit missed dose
   b. ophthalmic exams may be indicated throughout therapy
c. do not use mineral oil while on therapy
d. notify physician of nausea, cracked lips, increased hair loss, or headache
e. do not take more than prescribed amount

B. Vitamin D: term for a group of compounds with similar activity
   1. Source: provitamins are can be found in fish liver oils, egg yolks, fortified commercial dairy products such as whole milk, butter, bread, and cereals
      a. after absorption of two provitamins active forms of vitamin D produced by
         i. metabolic conversion in the liver
         ii. action of ultraviolet (UV) irradiation of skin
      b. in liver and kidney further conversion of vitamin D into more active forms
         i. vitamin D₃
         ii. 25-hydroxidihydrotachysterol
         iii. calcitrol
      c. vitamin D activity expressed as international units (IU) of vitamin D₃
   2. Function in the body: essential for metabolism of bone and cartilage
      a. regulates serum calcium levels in conjunction with parathormone and calcitonin by modulating bone formation
      b. clacitrol, most active form of vitamin D, responsible for intestinal calcium and phosphorus absorption
      c. deficiency produces weakened skeletal structure (rickets) in children, osteomalacia in adults, sustained muscle contraction (tetany), and impaired nerve conduction
   3. Clinical indication
      a. various forms administered orally and parenterally in treatment of conditions resulting from or associated with low serum calcium: metabolic bone disease, postoperative tetany, hypoparathyroidism, and renal dialysis
      b. increasingly recognized various ways elderly may develop deficiencies
      c. applied topically as cream containing vitamins A, E, and D for temporary relief of minor burns, chafed or dry skin, sunburn, abrasions, noninfected skin irritations including diaper rash; may be applied to irritated areas resulting from ostomy connections
   4. Treatment of deficiency
      a. RDA is 200 IU for men and women
      b. treatment of adult deficiency ranges from 12,000 - 500,000 IU of vitamin D activity daily
      c. therapy continued with calcium supplementation until improvement noted in serum calcium, phosphorus, and BUN (blood urea nitrogen)
      d. ergocalciferol (D₂) and cholecalciferol (D₃) used in treatment and prophylaxis of deficiency
e. other forms used in management of serum calcium disorders, 
etany, hypophosphatemia, and hypoparathyroidism

5. Overdose: hypervitaminosis may occur from administration in excess 
of daily needs
   a. acute toxicity may produce: weakness, headache, nausea, vomiting, 
      constipation, muscle or bone pain, and metallic taste
   b. later changes in renal and liver function may be observed: 
      elevated BUN, elevated AST (aminotransferase), elevated ALT 
      (alanine aminotransferase), albuminuria, elevated levels of calcium 
      and phosphate in blood and urine
   c. bone demineralization in adults possible, persisting even after 
      discontinuation of supplementation
   d. death following cardiac or renal failure has occurred

6. Drug interactions: especially in patients on hemodialysis
   a. antacids containing magnesium may contribute to 
      hypermagnesemia in combination with vitamin D
   b. vitamin D in combination with digitalis products or verapamil has 
      been observed to lead to atrial fibrillation due to hypercalcemia

C. Vitamin E: also known as alpha-tocopherol

1. Source:
   a. available synthetically
   b. can be found naturally in vegetable oils, eggs, cereals, milk, meat 
      and leafy vegetables
   c. absorption depends on availability of bile salts
   d. absorption related to ingestion of polyunsaturated fatty acids 
      (linoleic acid)
   e. most of alpha-tocopherol stored in fatty tissue, liver and muscle after 
      absorption from intestines

2. Function in the body: exact mechanism not fully known
   a. does act as antioxidant, preventing formation or accumulation of 
      toxic metabolites
   b. acts as cofactor in metabolic reactions
   c. essential to maintenance of RBC (red blood cell) membranes

3. Clinical indication:
   a. topically for temporary relief of minor burns, chapped or chafed 
      skin, diaper rash
   b. used in treatment of cancer
   c. antioxidant role attributed to reduce incidence of certain cancers
   d. act as protective agent in oxygen therapy in premature infants
   e. various oral formulations available for treatment of deficiency

4. Treatment of deficiency: deficiency and resulting anemia rare because 
   adequate amounts available in foods
   a. RDA for men 12 IU
   b. RDA for women 15 IU

5. Overdose:
   a. appropriate treatment discontinuation of supplementation until 
      cessation of symptoms
   b. symptoms include fatigue, headache, nausea, weakness, and diarrhea

6. Drug interactions: may increase likelihood of bleeding if administered 
   concomitantly with anticoagulant therapy due to suppression of platelet
aggregation

D. Vitamin K: K\textsubscript{1}, also known as phytonadione
1. Source: primary source of vitamin K in humans is bacterial synthesis in intestines; can also be found in green vegetables, cabbage, cauliflower, fish liver, eggs, milk, and meat
2. Function in body:
   a. required for synthesis of blood clotting factors II, VII, IX, and X in liver
   b. interference with synthesis or metabolism may result in bleeding and hemorrhage
3. Clinical indication: variety of conditions may require vitamin K replacement
   a. bleeding resulting from suppressed coagulation due to malformation of vitamin K-dependent clotting factors
   b. conditions which impair or eliminate bacterial vitamin K synthesis, e.g. antibiotic therapy
   c. conditions that interfere with vitamin K metabolism
   d. also indicated in prophylaxis and management of hemorrhagic disease in newborns when mother received oral anticoagulants, anticonvulsants, or antibiotics during pregnancy (these may have interfered with vitamin K dependent clotting mechanisms)
   e. vitamin K will NOT reverse bleeding associated with heparin overdose!
4. Treatment of deficiency: deficiency and resulting coagulation disorders usually do not require dietary limitation
   a. RDA for men is 80 mcg
   b. RDA for women is 65 mcg
   c. replacement may be achieved through oral and parenteral administration
   d. individualized doses range from 2.5 - 25 mg until coagulation returns to normal, or desired therapeutic level in case of anticoagulation therapy
   e. length of treatment generally based on PT (protime) evaluation
5. Overdose: Not likely to occur with oral preparations; adverse reactions may be experienced with parenteral administration and show following symptoms: flushing, vertigo, brief hypotension, pain and swelling at injection site with repeated injections; severe allergic reactions, including death, have occurred after intravenous injection!

III. Water Soluble Vitamins: these include all the B vitamins and vitamin C.
A. B Vitamins: family of B-Vitamins is divided into:
   - B\textsubscript{1} - thiamine
   - B\textsubscript{2} - riboflavin
   - B\textsubscript{3} - niacin, nicotinic acid
   - B\textsubscript{5} - calcium pantothenate
   - B\textsubscript{6} - pyridoxine
   - B\textsubscript{9} - folic acid
   - B\textsubscript{12} - cyanocobalamin

1. Source: available in yeast, whole grains, soybeans, liver, milk, egg yolks, leafy green vegetables, and fruit
2. Function in Body: integral to cell reproduction and maturation
   a. thiamine combines with ATP (adenosine triphosphate) to form coenzyme critical for carbohydrate metabolism; requirements increase with increased carbohydrate intake
   b. riboflavin combines with proteins to form coenzymes in respiratory system
   c. niacin forms two coenzymes in oxidation-reduction reactions
   d. pyridoxine forms coenzyme in carbohydrate, fat, and protein metabolism; requirements increase with increased dietary protein
   e. pantothenate precursor of coenzyme A associated with synthesis of fatty acids and steroid hormones
   f. cyanocobalamin and folic acid essential for cell growth, reproduction, and hematopoiesis

3. Clinical Indication:
   a. thiamine for treatment of B\textsubscript{1} deficiency (beriberi); symptoms include weakness, paresthesia, hypotension, sensory and motor dysfunction, psychosis, ataxia, confusion (Wernicke's encephalopathy), and cardiovascular damage
   b. riboflavin, pantothenate, pyridoxine for treatment of B\textsubscript{2} deficiency; symptoms of riboflavin deficiency include vascularization of cornea, itching and burning of the eyes, photophobia, glossitis, seborrheic dermatitis
   c. lack of pantothenate include fatigue, headache, sleep disturbance, muscle cramps, and impaired coordination
   d. niacin as treatment and prevention of pellagra; characterized by the three "D's": diarrhea, dermatitis, dementia; also pharmacologically proven to reduce hyperlipedemia

4. Treatment of Deficiency: replacement achieved through oral and parenteral administration (10 -20 mg thiamine i.m.) until resolution of symptoms; then oral supplementation for several months; in severe cases symptoms may not fully improve.
   Riboflavin deficiency easily corrected with daily oral doses of 25 mg.
   Niacin available in parenteral form, but usually preferred to correct deficiencies with oral doses of 100 - 500 mg /d.

5. Overdose: not likely to occur. Some adverse reactions may occur with individual vitamin preparations:
   a. in large doses - thiamine: sensation of warmth, sweating, urticaria, tightness in throat, and gastrointestinal bleeding (hemorrhage)
   b. niacin may cause gastrointestinal distress, diarrhea, generalized flushing (vasodilation not confirmed to be therapeutically useful), decreased glucose tolerance, and elevated uric acid and liver function tests

6. Cautions: severe hypersensitivity reactions, including death, to parenteral administration have been documented! Imperative to perform intradermal sensitivity test prior to intravenous administration.
   Riboflavin may cause orange discoloration of urine - patients should be alerted to this possibility, though occurrence is clinically inconsequential.

B. Vitamin C (Ascorbic Acid): RDA for adults 60 mg/d
   1. Source: easily obtainable in citrus fruit, green vegetables, tomatoes, potatoes, strawberries, and green peppers.
2. Function in the Body: involved in formation of catecholamines, steroids, and conversion reactions such as folic acid to folinic acid.

3. Clinical Indication: recommended for wide range of conditions, such as common cold to cancer; only clinically recognized use is in prevention and treatment of vitamin C deficiency or scurvy.

4. Treatment of Deficiency: Scurvy, characterized by degenerative changes in bone and soft tissue; other symptoms of deficiency include bleeding gums, loose teeth, poor bone development; easily corrected by dietary adjustment and oral supplementation ranging from 70 - 500 mg/d.

5. Special Consideration: no overdose potential with vitamin C; doses up to 10 g/d have been used prophylactically for colds and as adjunct therapy in cancer treatment to promote wound healing; though debatable as to effect of this regime, evidence has been provided that even large doses of vitamin C do not cause adverse effects of any significance; in worst case scenario vitamin C can produce diarrhea and promote formation of renal calculi in patients prone to such, due to acidification of urine; patients prone to renal calculi ought to avoid megadoses (> 2g/d).

Vitamin C may cause false-negative amine-dependent fecal occult blood test; therefore should not be taken 48 - 72 hours prior to test.

IV. Body Water:

A. General:
   1. most abundant component of the body; 60 -70 % total body weight
   2. though body able to do without food, vitamins, and minerals for acute periods of time, lack of water incompatible with life
   3. many essential substances exist within body in form of solution dissolved in water
   4. distributed between two main compartments:
      a. intracellular fluid compartment (intracellular fluid - ICF)
      b. extracellular fluid compartment (extracellular, fluid - ECF; plasma and interstitial fluid)
   5. fluid in those compartments normally maintained at relatively constant amounts
   6. dehydration results from loss of water
   7. water retention cause edema
   8. substances dissolved in fluid compartments directly affected by fluid volume shifts or changes

B. Fluid Balance:
   1. normal daily fluid intake by average adult 3000 ml; approx. 3 quarts; includes fluids from drinking, in food, and water produced as by-product of metabolic activities
   2. normal daily output should be same amount as intake; includes water lost in urine, feces, perspiration, and respiration
   3. additional fluids may be lost in case of illness: hemorrhage, diarrhea, vomiting, fever
   4. large amounts lost must be replaced to avoid undesirable effects on body
   5. usually adequate fluid intake accomplished by drinking and adjusting amount as needed
in medical emergencies fluid loss may be great enough to require other means of rapid and/or high volume replacement of lost fluids; usual means is intravenous fluid replacement

intravenous fluid therapy involves infusion of large amounts of fluids into a vein to increase blood volume and provide nourishment, including vital vitamins, minerals, and carbohydrates as indicated

V. Minerals:

A. Sodium (Na⁺):
1. main cation (positive charge) of extracellular fluid
2. major role in maintenance of normal fluid balance
3. average diet sufficient to supply adequate amounts to meet body's requirements
4. kidneys help maintain normal Na levels in plasma and other body fluids
5. vomiting and diarrhea can cause significant loss of extracellular fluid volume through Na loss
6. sodium depletion also caused through excessive diuresis
7. consequently fluid shift from intracellular compartment to attempt fluid balance and blood volume
8. failure to replace lost Na and H₂O cause decrease of blood volume and blood pressure, eventually leading to circulatory collapse
9. replacement of Na, usually as NaCl (sodium chloride) via I.V. administration in various concentrations

B. Potassium (K⁺):
1. main cation of intracellular fluid
2. important in maintaining cell structure and function
3. vital in regulation of muscle function, especially heart muscle
4. depletion causes lack of muscle tone, weakness, paralysis
5. excess levels may cause cardiac arrhythmias, especially heart block
6. normal concentration 4.1 - 5.6 meq/L (milliequivalent per liter)
7. administered as KCl (potassium chloride) intravenously (slow rate!, never push!!!) or orally in various concentrations

C. Calcium (Ca²⁺):
1. cation, usually associated with bone formation
2. also vital role in muscle contraction and blood coagulation
3. normal serum concentration 4.5 - 5.7 meq/L
4. deficiency in blood results in hyperexcitability of nerve and muscle fibers (tetany)
5. excess causes muscle weakness; may lead to cardiac and respiratory failure
6. when administered I.V. usually administered in form of calcium gluconate or calcium chloride

D. Hydrogen (H⁺):
1. major source from dissociation of H₂O
2. reaction regulates acidity or alkalinity of body fluids
3. normal pH of blood about 7.4
4. when pH < 7.4 → acidosis
5. pH > 7.4 → alkalosis
6. several buffer systems to maintain normal body pH
7. failure to maintain pH causes acid-base disturbances
8. different types of acidosis and alkalosis:
   a. Metabolic Acidosis:
      - caused by excessive loss of bases, e.g. HCO$_3^-$ (bicarbonate), e.g. through diarrhea, starvation, vomiting, diabetic coma
      - treatment by administration of NaHCO$_3$ (sodium bicarbonate) in addition to fluids and other electrolytes as indicated
   b. Respiratory Acidosis:
      - associated with increased levels of CO$_2$ (carbon dioxide) in blood
      - caused by interference with respiratory gas exchange
      - CO$_2$ combines with H$_2$CO$_3$ (carbonic acid)
      - carbonic acid can dissociate into hydrogen ions $\rightarrow$ pH of blood will be lowered causing acidosis
      - treatment requires increase of oxygen, e.g. temporary hyperoxygenation to balance off high CO$_2$ levels
   c. Metabolic Alkalosis:
      - usually associated with excessive loss of K$^+$ or Cl$^-$
      - most often caused by severe vomiting (Cl$^-$) or diarrhea (K$^+$)
      - treatment requires replacement of electrolytes in addition to treating cause
   d. Respiratory Alkalosis:
      - produced by respiratory hyperventilation
      - causes may be mechanical respirator or salicylate poisoning
      - CO$_2$ levels of blood are lowered
      - treatment requires lowering of O$_2$ levels

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**ACTIVITIES**

I. Research and report on a disease or disorder caused by vitamin and mineral deficiency or excess such as scurvy, rickets, goiter, palagra, osteomalitia, osteoporosis, etc. See Disease Report Guidelines.

**MATERIALS NEEDED**

Library
Computer with Internet access
Key: Unit Quiz Vitamins and Minerals

**ASSESSMENT**

Unit Quiz Vitamins and Minerals
Disease Report Rubric

**ACCOMODATIONS**

For reinforcement, the student will design a poster depicting conditions caused by vitamin and mineral deficiency or excess.

For enrichment, the student will research and report on vitamins and minerals that antagonize a selected pharmaceutical agent, such as Cumadin and Vitamin K.
Disease Report Guidelines

The report on a disease has two parts: a written portion and an oral presentation portion.

Written Report

1. The written report must be typed, double spaced, 12 font, 4 text pages.
2. A bibliography page and a cover page must be included.
3. The cover page should be in the following format:
   
   Disease Report Title  
   Student Name  
   Date  
   Instructor's Name  
   Class and Period

4. The report must include the following:
   
   o Introduction  
   o Body Systems Involved  
   o Diagnosis: lab tests, physical exam, x-rays, etc.  
   o Treatment: medications, radiation, surgery, physical therapy, etc.  
   o Complications of the Disease: chronic/acute, side effects of treatments, physical limitations, etc.  
   o Prognosis: cure, improvements, fatal, expected length of course of disease  
   o Reason for Choosing This Disease  
   o Conclusion

5. Spelling and grammar count!

Oral Presentation of Disease Report

1. Oral presentation must be a minimum of 10 minutes in length
2. A minimum of three different types of visual aids must be used in the presentation.
Unit Quiz: Vitamins, Minerals, and Nutritional Supplements

1. Match the following letters to their appropriate number (not all choices apply):

   1. _____ vitamin A      a. Na⁺
   2. _____ vitamin B₁      b. ascorbic acid
   3. _____ vitamin B₂      c. phytonadione
   4. _____ vitamin B₃      d. niacin
   5. _____ vitamin B₅      e. NaCl
   6. _____ vitamin B₆      f. retinol
   7. _____ vitamin B₉      g. thiamine
   8. _____ vitamin B₁₂     h. riboflavin
   9. _____ vitamin C      i. KCl
  10. _____ vitamin D      j. K⁺
  11. _____ vitamin E      k. calcium pantothenate
  12. _____ vitamin K      l. H⁺⁺
  13. _____ calcium      m. H⁺
  14. _____ hydrogen      n. pyridoxine
  15. _____ potassium      o. Ca⁺⁺
  16. _____ sodium      p. folic acid
                        q. cyanocobalamine
                        r. cholecalciferol
                        s. phytonadione
                        t. alpha-tocopherol
                        u. NaHCO₃
                        v. acidosis

2. Complete the following table by placing the substances listed below in their correct column (not all choices apply):

<table>
<thead>
<tr>
<th>water-soluble vitamins</th>
<th>fat-soluble vitamins</th>
<th>minerals (electrolytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

vitamin A - vitamin B - vitamin C - vitamin D - vitamin E - vitamin K - ascorbic acid
calcium - hydrogen - sodium - potassium - riboflavin - protein - carbohydrates
3. Define the following concepts; use complete sentences:

a. water-soluble vitamins

b. fat-soluble vitamins

4. Differentiate in short paragraph RDA and U.S. - RDA
ANSWER KEY TO UNIT QUIZ:
VITAMINS, MINERALS, AND NUTRITIONAL SUPPLEMENTS

1. Matching:
   1 f
   2 g
   3 h
   4 d
   5 k
   6 n
   7 p
   8 q
   9 b
   10 r
   11 t
   12 s
   13 o
   14 m
   15 j
   16 a

2. (any order within the column)

<table>
<thead>
<tr>
<th>water-soluble vitamins</th>
<th>fat-soluble vitamins</th>
<th>minerals (electrolytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>vitamin C</td>
<td>vitamin A</td>
<td>potassium</td>
</tr>
<tr>
<td>vitamin B</td>
<td>vitamin D</td>
<td>sodium</td>
</tr>
<tr>
<td>ascorbic acid</td>
<td>vitamin E</td>
<td>hydrogen</td>
</tr>
<tr>
<td>riboflavin</td>
<td>vitamin K</td>
<td>calcium</td>
</tr>
</tbody>
</table>

3. **a. water-soluble**: vitamins B and C; not stored in fatty tissue, readily used up after absorption, easily excreted through urine; unlikely to cause severe side effects due to toxicity or overdose; chronic inadequate intake because of poor diet can lead to substantial deficiencies

   **fat-soluble**: vitamins A, D, E, K; well stored in liver and fatty tissue; affected by conditions that limit fat absorption; due to ability to be stored can cause overdose with sometimes severe symptoms

4. **RDA** Recommended Dietary Allowance; suggestion for daily intake of elements not produced in body; derived from healthy individuals consuming 2000cal/d balanced from four basic food groups

**U.S. - RDA** United States Recommended Daily Allowance; used by FDA to monitor claims for quality of food processing intended for human consumption; nutrition advertising presented in product labels must meet legal requirements of U.S.- RDA
# VITAMINS and MINERALS: RECOMMENDED DAILY ALLOWANCES
and CONDITIONS RELATED to DEFICIENCIES

<table>
<thead>
<tr>
<th>Vitamin/Mineral</th>
<th>RDA [70 kg males/(60 kg females) 20 - 50 years]</th>
<th>Conditions Related to Deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>1000 (800) mcg</td>
<td>night blindness, dry skin, decreased epithelial cell growth</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>60 (60) mg</td>
<td>bleeding gums, loosening teeth, increased bruising</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>200 (200) IU</td>
<td>bone loss, serum calcium</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>12 (15) IU</td>
<td>possible anemia</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>80 (65) mcg</td>
<td>decreased coagulation, increased risk of hemorrhage</td>
</tr>
<tr>
<td>Vitamin B₁ (thiamine)</td>
<td>1.5 (1.1) mg</td>
<td>anorexia, constipation, peripheral neuritis</td>
</tr>
<tr>
<td>Vitamin B₂ (riboflavin)</td>
<td>1.7 (1.3) mg</td>
<td>glossitis, ocular itching, vascularization</td>
</tr>
<tr>
<td>Vitamin B₃ (pyridoxine)</td>
<td>2 (1.6) mg</td>
<td>anemia, convulsions</td>
</tr>
<tr>
<td>Folate (folic acid)</td>
<td>200 (180) mcg</td>
<td>macrocytic anemia, neuropathy</td>
</tr>
<tr>
<td>Vitamin B₁₂ (cyanocobalamin)</td>
<td>2 (2) mcg</td>
<td>macrocytic anemia, poor muscle coordination</td>
</tr>
<tr>
<td>calcium</td>
<td>800 (800) mg</td>
<td>bone loss</td>
</tr>
<tr>
<td>iron</td>
<td>10 (15) mg</td>
<td>microcytic anemia</td>
</tr>
</tbody>
</table>

Hitner - Nagle: Basic Pharmacology, 4th edition, Glencoe