

Vitamins

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Definition of Vitamin and Mineral

- Vitamins are *organic compounds* and minerals are *chemical elements* that are required as nutrients in small amounts by an organism.
- A vitamin is:
 - An organic compound *distinct* from fats, carbohydrates and proteins
 - *Natural component* of foods, present in minute amounts
 - Is *essential* for normal physiological function, usually in minute amounts
 - Cause a *specific deficiency syndrome* when absent or underutilized
 - Is *NOT synthesized by the host* in amounts adequate to meet normal physiological needs: human can make vitamins D₃ and B₃
- Vitamers are different forms of a particular vitamin, e.g. vitamins K₁ and K₂, vitamins D₂ and D₃, retinol and retinal (vitamin A), etc.

Origin of Vitamin

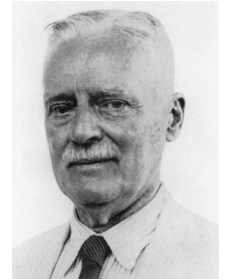
- Beriberi: a historic disease prevalent in Asian population due to major consumption of polished rice
- 1897, Christiaan Eijkman found antiberiberi factor in water or alcohol extracts of rice polishings
- 1901, Gerrit Grijns suggested beriberi-producing diets lack a certain substance that are important in central nervous system
- 1911, Casimir Funk isolates amine-containing concentrate from rice polishings that cured beriberi in an animal model and names it as “vitamine” for “vital amine”. This was later found to be thiamine, vitamin B1.
- 1912, Funk published the vitamin theory: antiberiberi, antirickets, antiscurvy, and antipellagra vitamins.
- 1920, Jack Drummond suggested to drop “e” from “vitamine” since not all of them are proven to be amines.



Beriberi (from Wikipedia)



Christiaan Eijkman



Gerrit Grijns



Casimir Funk



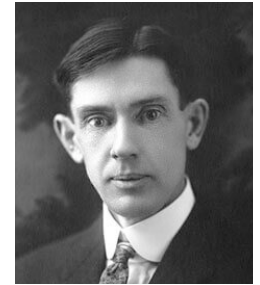
Jack Drummond

See: Rosenfeld, L. (1997). Vitamine—vitamin. The early years of discovery. *Clinical Chemistry*, 43(4), 680–685.

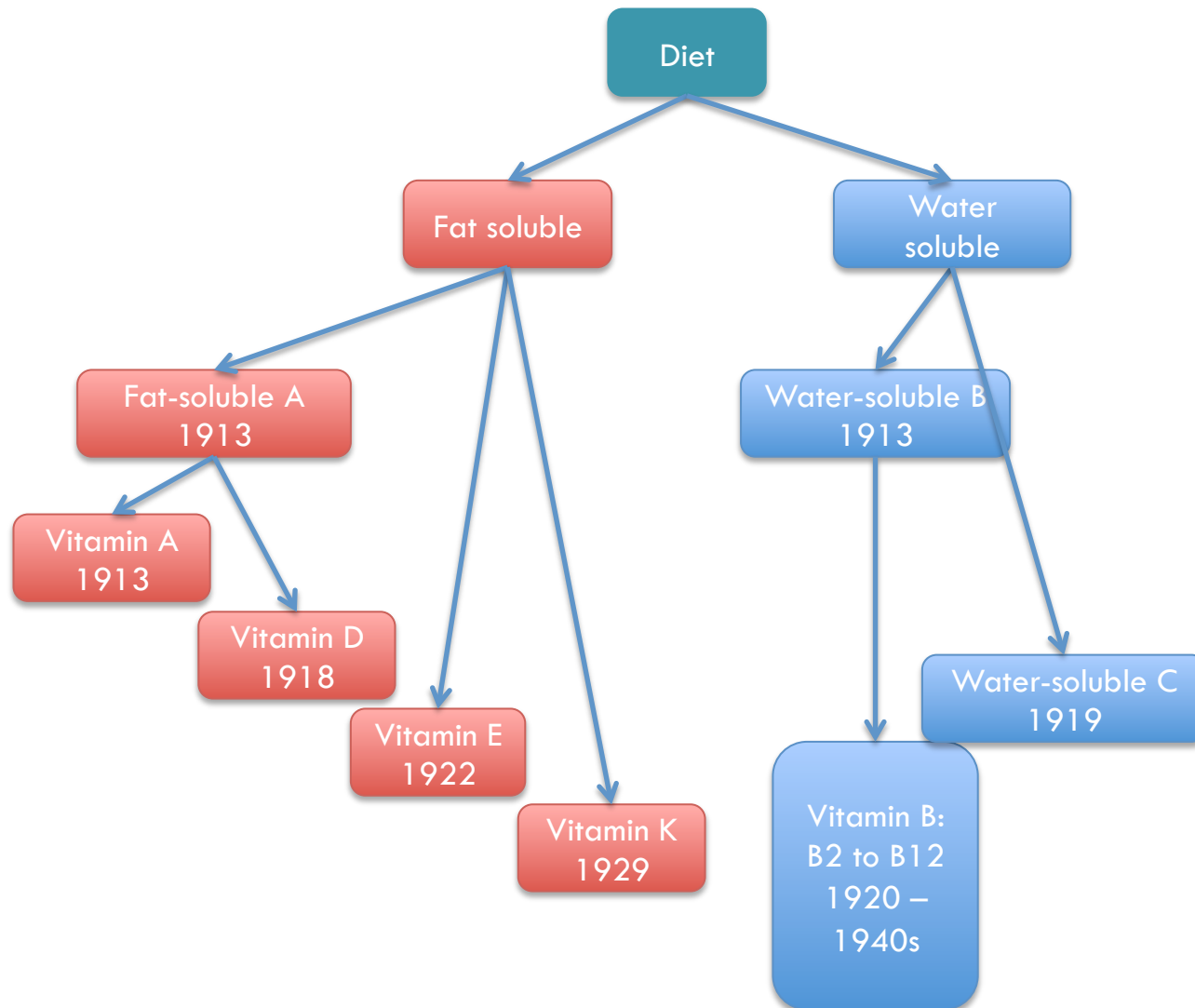
Pre-Vitamin History

- 1500 BC – Ancient Egyptians used liver - rich in vitamin A - applied to the eye to treat night blindness.
- 1536 – Jacques Cartier, exploring the St. Lawrence River, uses local native knowledge to save his men from scurvy by boiling the needles from cedar trees to make a vitamin C-rich tea.
- 1795 – British navy adds lemons to sailors' rations, 40 years after a Scottish naval surgeon, James Lind, had urged that citrus fruits be used to prevent scurvy.
- 1884 – Japanese navy eradicates beriberi by feeding sailors meat and fruit in addition to polished white rice, which lacked the thiamine-rich husks.
- 1911 – Casimir Funk names antiberiberi factor as vitamine.
- 1912 – Xavier Mertz – Antarctic explorer – dies of vitamin A poisoning from ingesting sled dog liver after supplies are lost in a crevasse.

History of Discovery



Elmer McCollum
Univ. of Wisconsin



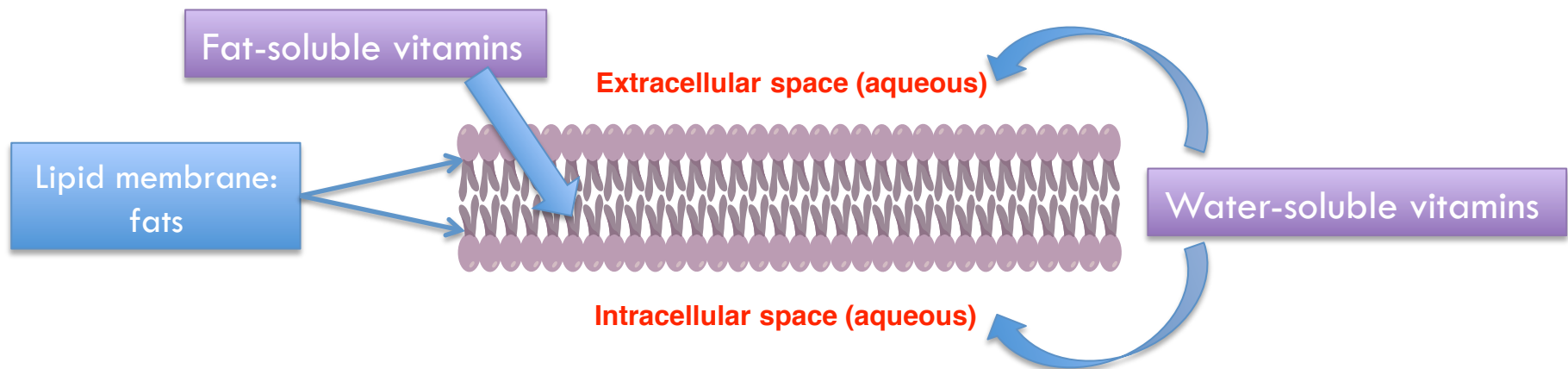
- In 1913, Elmer McCollum demonstrated two growth factors from diet: fat-soluble A and water-soluble B
- Fat-soluble A was found to cure both ocular disorders and rickets, which led to the discovery of two factors: vitamins A and D
- 1919, the antiscorbutic (anti-scurvy) factor found in lemon was named as water-soluble C and later vitamin C
- 1922, an anti-sterility factor was found, named vitamin E
- 1929, an antihemorrhagic factor was found, named vitamin K
- 1920 – 1940s, multiple identities of water-soluble B were discovered: vitamins B2, B3, B5, B6, B7, B9, and B12

History of Discovery – cont'd

Year discovered	Vitamin	Source
1912	Vitamin B ₁ (thiamin)	Rice bran
1912	Vitamin C (ascorbate)	Lemons
1913	Vitamin A	Milk/egg yolk
1918	Vitamin D	Cod liver oil
1920	Vitamin B ₂ (riboflavin)	Eggs
1922	Vitamin E	Wheat germ, Seed oils
1926	Vitamin B ₁₂ (cobalamin)	Liver
1929	Vitamin K	Alfalfa
1931	Vitamin B ₅ (pantothenic acid)	Liver
1931	Vitamin B ₇ (biotin)	Liver
1934	Vitamin B ₆ (pyridoxine, etc.)	Rice bran
1936	Vitamin B ₃ (niacin)	Liver
1941	Vitamin B ₉ (folate)	Liver

Classification of Vitamins Based on Solubility

- Fat-soluble vitamins: A, D, E, K
- Water-soluble vitamins: B's and C
 - B1, thiamine; B2, riboflavin; B3, niacin; B5, pantothenic acid; B6, pyridoxine, pyridoxal, or pyridoxamine; B7, biotin; B9, folate; B12, cobalamin



Storage and Excretion

- **Fat-soluble vitamins: ADEK**
 - Well retained in the body and tend to be stored in fatty tissues: adipose, muscles, liver
 - Therefore, it takes time to reach a deficiency state
 - More likely to cause toxicity on over-dosage because of the slow clearance
- **Water-soluble vitamins: BC**
 - Excreted rapidly and not well retained
 - Need regular replacement
 - Only vitamin B12 and B9 retained and stored at significant level in the body

Functions

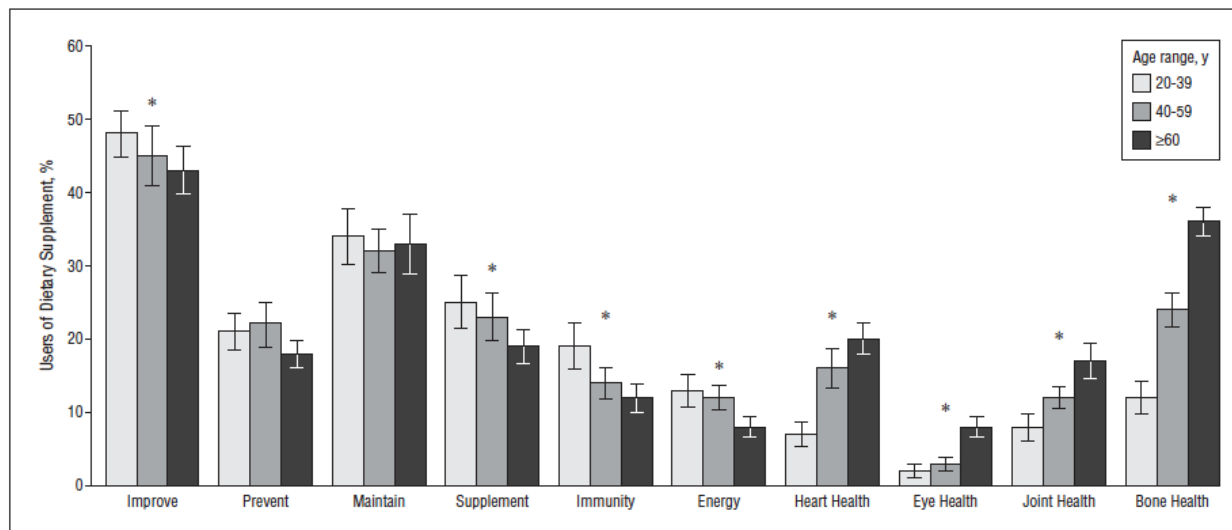
- Per definition, vitamins are essential to many life processes
 - Energy production by oxidation of biological molecules
 - Making biological molecules
 - Maintenance, growth, development, and/or production
 - Some vitamins participate in protection processes as antioxidants directly or indirectly: E, C, A, B2

Who Takes Vitamin/Mineral Supplements and Why?

Table 3. Prevalence of Use of Specific Types of Dietary Supplements and the Most Frequently Reported Motivation for Use of Each Product Type in Adults (≥20 Years) in the United States, 2007-2010^a

Type of Supplement	Users, No.	Overall (n = 11 956)	Men (n = 5911)	Women (n = 6045)	Most Common Reported Motivation	Users Reporting Motivation, %
Multivitamin-mineral	3404	31.9 (0.8)	28.5 (1.1)	35.2 (0.9) ^b	To improve overall health	48 (1)
Calcium	1342	11.6 (0.6)	4.4 (0.4)	18.5 (0.9) ^b	For bone health	74 (2)
ω-3/fish oil	1032	9.8 (0.6)	9.3 (0.6)	10.3 (0.8)	For heart health, lower cholesterol	48 (2)
Botanical supplements	841	7.5 (0.5)	6.6 (0.5)	8.4 (0.6) ^b	To improve overall health	27 (2)
Vitamin C	764	7.1 (0.5)	6.6 (0.5)	7.6 (0.6)	To boost immune system, prevent colds	45 (3)
Multivitamin	632	5.7 (0.4)	4.7 (0.3)	6.6 (0.5)	To improve overall health	31 (2)
Vitamin D	542	4.9 (0.4)	3.0 (0.3)	6.8 (0.6)	For bone health	38 (2)
Vitamin E	439	3.7 (0.2)	3.1 (0.3)	4.3 (0.4)	To improve overall health	40 (3)
Joint supplements	430	4.0 (0.3)	4.0 (0.4)	4.1 (0.3)	For healthy joints, prevent arthritis	76 (3)
Vitamin B ₁₂	408	3.3 (0.2)	2.5 (0.2)	4.0 (0.3)	To improve overall health	31 (3)
Iron	245	1.8 (0.1)	0.9 (0.2)	2.7 (0.2)	For anemia, low iron	67 (4)
Folic acid	194	1.5 (0.2)	1.0 (0.1)	2.0 (0.2)	Other reason	15 (4)
Protein/sports	155	1.6 (0.2)	1.9 (0.2)	1.3 (0.3)	To improve overall health	25 (4)
Fiber	109	1.1 (0.1)	0.8 (0.1)	1.3 (0.2)	For bowel/colon health	77 (5)
Potassium	119	0.9 (0.1)	0.7 (0.1)	1.2 (0.2)	For muscle related issues	24 (5)
Magnesium	125	1.1 (0.1)	0.9 (0.1)	1.4 (0.2)	To improve overall health	18 (4)
Vitamin B ₆	106	0.9 (0.1)	0.7 (0.1)	1.1 (0.2)	To improve overall health	24 (5)
Vitamin A	103	0.8 (0.1)	0.8 (0.1)	0.8 (0.1)	For eye health	44 (6)
Niacin	70	0.7 (0.1)	0.9 (0.2)	0.4 (0.1) ^b	For heart health, lower cholesterol	77.1 (6)

- It is estimated that ~50% of adult population in the US takes some type of dietary supplement, typically to “improve/maintain overall health”.
- 75% of products are used without care-provider recommendation
- US Supplement industry is \$37 billion



Multivitamins

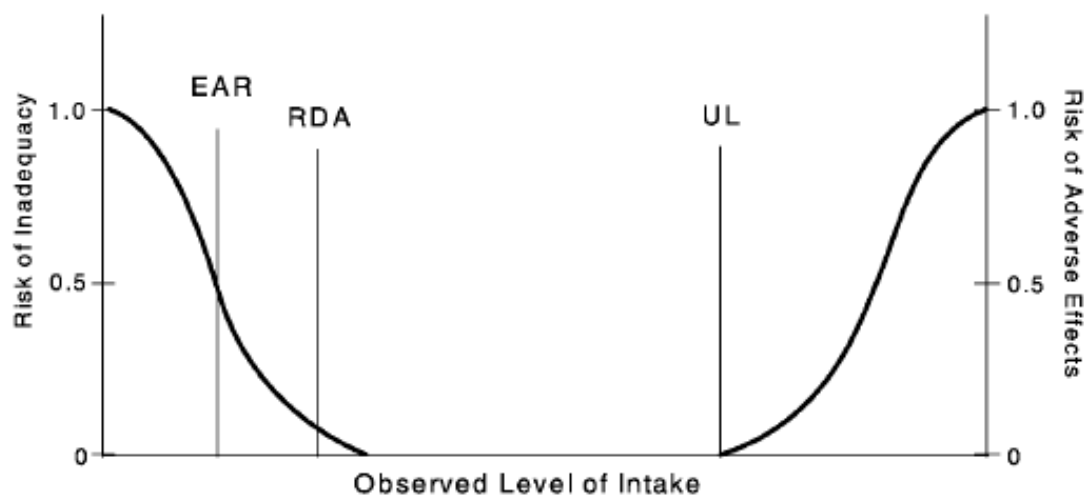
- It is estimated that ~30% of the adult US population take multivitamins daily.
- A clinical trial of male physicians taking multivitamins concluded there was a very modest, but (statistically) significant, reduction in total cancers with daily multivitamin use (*NEJM*, 308:1871 (2012)).
- Do we need to supplement diets with vitamins/multivitamins? Under certain circumstances.

When are Vitamin Supplements Worthwhile?

- Inadequate intake – alcoholics, poor, elderly, dieters, poor diet
- Increased needs – pregnancy, lactation, infants, smokers, injury, trauma, recovery from surgery, infection, certain genetic disorders of metabolism
- Poor absorption – elderly, gastrointestinal disorders, specific GI surgeries, e.g. gallbladder removal, gastric bypass, cystic fibrosis, severe diarrhea, drug-induced vitamin deficiencies – e.g. long term antibiotic use, cholestyramine, mineral oil

Dietary Reference Intakes (DRI)

- DRI Reports produced by the Food & Nutrition Board of the Institute of Medicine, National Academies of Science. <https://www.nal.usda.gov/fnic/dietary-reference-intakes>
- Estimated average requirements (EAR): the average daily nutrient intake level estimated to meet the requirements of half of the healthy individuals in a group.
- Recommended Dietary Allowance (RDA): the average daily dietary intake level; sufficient to meet the nutrient requirements of nearly all (97-98%) healthy individuals in a group. Calculated from the EAR.
- Tolerable Upper Limit (UL): maximum adult daily intake unlikely to cause harm.



$$RDA = 1.2(EAR)$$

Daily Values (DVs)

- Set by FDA
- Two groups: Daily Reference Values (DRVs) for energy-producing nutrients, e/g. fats, carbohydrates, protein etc. and Reference Daily Intakes (RDIs) for vitamins and minerals.
- A DV is often, but not always, similar to one's RDA for that nutrient.
- DV is primarily used for labeling purposes. % DV on label is based on 2,000 calories/day diet for adults and children over 4 yrs.

Supplement Facts

Serving Size 1 Tablet

Each Tablet Contains	% DV
Vitamin A 2,500 IU (40% as Beta-Carotene)	50%
Vitamin C 60 mg	100%
Vitamin D 500 IU	125%
Vitamin E 50 IU	167%
Vitamin K 30 mcg	38%
Thiamin 1.5 mg	100%
Riboflavin 1.7 mg	100%
Niacin 20 mg	100%
Vitamin B ₆ 3 mg	150%
Folic Acid 400 mcg	100%
Vitamin B ₁₂ 25 mcg	417%
Biotin 30 mcg	10%
Pantothenic Acid 10 mg	100%
Calcium 220 mg	22%
Phosphorus 20 mg	2%
Iodine 150 mcg	100%
Magnesium 50 mg	13%
Zinc 11 mg	73%
Selenium 55 mcg	79%
Copper 0.5 mg	25%
Manganese 2.3 mg	115%
Chromium 45 mcg	38%
Molybdenum 45 mcg	60%
Chloride 72 mg	2%
Potassium 80 mg	2%
Boron 150 mcg	*
Nickel 5 mcg	*
Silicon 2 mg	*
Vanadium 10 mcg	*
Lutein 250 mcg	*
Lycopene 300 mcg	*

*Daily Value (DV) not established.

Ingredients: Calcium Carbonate, Potassium Chloride, Dibasic Calcium Phosphate, Magnesium Oxide, Ascorbic Acid (Vit. C), Microcrystalline Cellulose, dl-Alpha Tocopheryl Acetate (Vit. E), Pregelatinized Corn Starch, Modified Food Starch. **Contains < 2% of:** Acacia, Ascorbyl Palmitate, Beta-Carotene, BHT, Biotin, Boric Acid, Calcium Pantothenate, Calcium Stearate, Cholecalciferol (Vit. D₃), Chromium Picolinate, Citric Acid, Corn Starch, Crospovidone, Cupric Sulfate, Cyanocobalamin (Vit. B₁₂), FD&C Blue No. 2 Aluminum Lake, FD&C Red No. 40 Aluminum Lake, FD&C Yellow No. 6 Aluminum Lake, Folic Acid, Gelatin, Hydrogenated Palm Oil, Hypromellose, Lutein, Lycopene, Manganese Sulfate, Medium-Chain Triglycerides, Niacinamide, Nickelous Sulfate, Phytonadione (Vit. K), Polyethylene Glycol, Polyvinyl Alcohol, Potassium Iodide, Pyridoxine Hydrochloride (Vit. B₆), Riboflavin (Vit. B₂), Silicon Dioxide, Sodium Ascorbate, Sodium Benzoate, Sodium Borate, Sodium Citrate, Sodium Metavanadate, Sodium Molybdate, Sodium Selenate, Sorbic Acid, Sucrose, Talc, Thiamine Mononitrate (Vit. B₁), Titanium Dioxide, Tocopherols, Tribasic Calcium Phosphate, Vitamin A Acetate (Vit. A), Zinc Oxide. **May also contain < 2% of:** Maltodextrin, Sodium Aluminosilicate, Sunflower Oil.

SUGGESTED USE: Adults – Take one tablet daily with food. Not formulated for use in children. Do not exceed suggested use.

As with any supplement, if you are pregnant, nursing, or taking medication, consult your doctor before use.

IMPORTANT INFORMATION: Long-term intake of high levels of vitamin A (excluding that sourced from beta-carotene) may increase the risk of osteoporosis in adults. Do not take this product if taking other vitamin A supplements.

Keep out of reach of children.

Store at room temperature. Keep bottle tightly closed.

Bottle sealed with printed foil under cap. Do Not Use if foil is torn.

Marketed by: Pfizer, Madison, NJ 07940 USA

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Questions? Comments? Call 1-877-CENTRUM

For most recent product information, visit www.centrum.com

Designate both DRV and RDI

Standardization

- Units of biological activity (IU) superceded, where known, by potencies based on weight (mg, mg) of the most active vitamer.
- Institute of Medicine guidelines use weight.
- FDA labels use both.