Chapter 7

VITAMINS

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What are vitamins?

• Nutrients that our body does not make on its own. Thus we must obtain them from the foods we eat, or via vitamin supplements.

■ They are essential for providing good health and are necessary for many life functions.
Supplements, what are they?

• Defn: synthetic or natural substances which can be purchased as pills, tablets, capsules, wafers, powders, or liquids.
Top 10 ?’s asked about Vitamin Supplements
Should I get my vitamins from food or supplements?

- A diet high in fiber and low in fat is the best way to meet daily nutritional needs.
- If you closely follow the “food pyramid” then you should meet the RDA (Recommended Dietary Allowances) for vitamins and nutrients.
- Supplements are best when accompanied by a well balanced diet.
- Supplements should not replace a healthy diet.
- Food provides calories and energy that are required for daily activities, vitamin supplements do not provide energy or calories.
Do I need a multivitamin supplement?

• It does not hurt to get a little to take a multivitamin daily to ensure proper nutrition.

• Most college students are not eating a well balanced diet and could use the added nutrition of a multivitamin.

• When choosing a supplement, select one that meets 100-300% of the RDA.
What do Multivitamins contain?

• A multivitamin should contain fat-soluble vitamins A, D, E; water-soluble vitamins B1, B2, B6, B12, niacin, pantothenic acid, biotin, folic acid, and Vitamin C.

• They will also usually have minerals such as zinc, magnesium, copper, and calcium in them.
What does RDA mean?

• Recommended Dietary Allowances
• These are suggested levels of essential nutrients considered adequate to meet nutritional needs of healthy individuals.
What are antioxidants?

• Defn: Substances that fight off free-radicals in our bodies.

• Free radicals are compounds within our bodies that may lead to chronic disease and/or are involved in cell tissue damage.

• Examples of vitamins that contain antioxidants are... C, E, and Beta Carotene.
What is the difference between fat-soluble and water-soluble vitamins?

• Fat-soluble are stored in the liver and fatty tissues. These are not readily excreted from the body.

• Water-soluble vitamins travel in the blood and are stored in limited amounts. These are readily excreted from the body through urine.
What factors should I consider before taking a vitamin supplement?

- Do you eat foods high in vitamins and minerals?
- Are you dieting?
- Do you follow the Food Guide Pyramid?
- Do you smoke and/or drink regularly?
- Are you pregnant?
- Are you over 50 years old?
- Are you taking prescription drugs?
Can I take too many vitamins?

• For the most part vitamin supplements are safe to take.
• Follow the recommended dosages on the label of the bottle.
• Fat-soluble vitamins are more likely to be toxic to your health if taken in excess, because they are stored in the body, whereas water-soluble are excreted.
Should I take my vitamins with food?

• It is advised to take your vitamins with a snack or meal to avoid stomach irritation.

• The presence of carbohydrates and proteins stimulate digestive enzymes that will allow for better absorption of nutrients for the supplements. (Iron should be taken on an empty stomach)
Stress & Nutrition of Your Body

• Stress can cause your body to excrete nutrients rather than using them to perform vital functions.

• Stress can also cause the production of free radicals which play a role in the development of cancer, heart disease, and aging.
Supplements that aid in suppressing stress

• Increasing serotonin levels in the brain wards off stress related symptoms like depression, irritability, and frustration.

• The mineral magnesium can help to regulate serotonin levels.

• Antioxidant supplements can also break up free radicals that cause harm to your body.
The B Vitamins
B-1, B-2, B-3, B-6, B-12
B-1 Thiamin (Vitamin F)

- Important in:
  - Producing energy from carbohydrates
  - proper nerve function
  - stabilizing the appetite
  - promoting growth and good muscle tone
  - ATP production
Sources of B-1

• Pork
• Fish
• Liver
• Legumes
• Nuts
• Whole grain or enriched breads and cereals
Recommendations

- Men 14+
  - 1.2 mg/day
- Women 14-18
  - 1.0 mg/day
- Women 19+
  - 1.1 mg/day

- 1 broiled pork chop,
- 1.25 cups corn flakes
  - OR
- 1 baked potato (w/ skin)
- 0.5 cup of lentils
- 1 cup raisin bran
Warnings

• B-1 is nontoxic even at high dosages
B-1 Deficiency

• Loss of appetite
• Weakness & Feeling tired
• Insomnia
• Loss of weight
• Depression
• Heart & Gastrointestinal problems
Who’s at Risk?

- Homeless & Malnourished
- Alcoholics
- People with malabsorption conditions
B-2 Riboflavin

• Important in:
  – energy production
  – carbohydrate, fat, and protein metabolism
  – formation of antibodies and red blood cells
  – cell respiration
  – maintenance of good vision, skin, nails, and hair
  – alleviating eye fatigue
Sources of B-2

• Large amounts in
  – dairy
  – eggs
  – meats

• Small amounts in
  – leafy green vegetables
  – enriched grains
Recommendations

- Men 14-70
  - 1.3 mg/day
- Women 14-70
  - 1.0 mg/day
- 71+
  - Larger doses

- 1 cup raisin bran
- 1 cup milk
- 1 egg
  OR
- 1 small extra lean hamburger
- 1 cup plain yogurt
- 0.5 cup fresh cooked spinach
- 1 cup cottage cheese
Warnings

• B-2 is nontoxic at supplemental and dietary levels.

• Light can destroy riboflavin, so purchase milk in opaque containers.
B-2 Deficiency

- Itching and burning eyes
- Cracks and sores in mouth and lips
- Bloodshot eyes
- Dermatitis
- Oily skin
- Digestive disturbances
Who’s at Risk?

- People with cataracts
- People with Sickle Cell Anemia
- Alcoholics
B-3 Niacinamide & Niacin

• Important in:
  – energy production
  – maintenance of skin and tongue
  – improves circulation
  – maintenance of nervous system
  – health of the digestive track
B-3 Niacinamide & Niacin

• Two Types
  – Niacinamide (Nicotinamide)
    • does not regulate cholesterol
  – Niacin (Nicotinic Acid)
    • highly toxic in large doses
    • Inosital Hexaniacinate is a supplement that gives the cholesterol regulation without high toxicity
Recommendations

• Men 14+
  16 mg/day
• Women 14+
  14 mg/day

• 1 cup rice
• 4 oz. broiled salmon
• 1 tbsp peanut butter
• 1 bagel
• OR
• 1 small extra lean hamburger
• 0.5 cup grape nuts cereal
Warnings

• In doses of only 50-100 mg nicotinic acid can cause dilation of blood vessels and potentially painful tingling (“niacin flush”), diarrhea, nausea, vomiting, and long term liver damage.

• Nicotinamide is almost always safe to take, although a few cases of liver damage have been reported in doses of over 1000 mg/day.
B-3 Deficiency

• Pellegra
  – disease caused by B-3 deficiency
  – rare in Western societies
• gastrointestinal disturbance, loss of appetite
• headache, insomnia, mental depression
• fatigue, aches, and pains
• nervousness, irritability
Who’s at Risk?

• Most people get plenty of B-3 from their diet because it is added to white flour.
B-6 Pyridoxine

- Important in:
  - Production of red blood cells
  - Conversion of tryptophan to niacin (B-3)
  - Immunity
  - Nervous system functions
  - Reducing muscle spasms, cramps, and numbness
  - Maintaining proper balance of sodium and phosphorous in the body
Recommendations

- Men 14-50
  1.3 mg/day
- Men 50+
  1.7 mg/day
- Women 14-18
  1.2 mg/day
- Women 19-50
  1.3 mg/day
- Women 50+
  1.5 mg/day
- 1 chicken breast
- 0.5 cup cooked spinach
- 1 cup brown rice
  OR
- 1 baked potato with skin
- 1 banana
- 4 oz. lean sirloin
Warnings

• High doses of B-6 may be recommended to treat PMS, carpal tunnel syndrome, and sleep disorders, but continued use of high doses may result in permanent nerve damage.

• Pregnant women should always consult their doctor before taking this supplement and all others.
B-6 Deficiency

• nervousness, insomnia
• loss of muscle control, muscle weakness
• arm and leg cramps
• water retention
• skin lesions
Who’s at Risk?

• very rare
• alcoholics
• patients with kidney failure
• women using oral contraceptives
B-12 Cobalamin

• Important in:
  – proper nerve function
  – production of red blood cells
  – metabolizing fats and proteins
  – prevention of anemia
  – DNA reproduction
  – energy production?
Recommendations

• Men and Women
  14+
  2-3 mcg/day

• 1 chicken breast
• 1 hard boiled egg
• 1 cup plain low fat yogurt
  OR
• 1 cup milk
• 1 cup raisin bran
Warnings

• Vegetarians need to look for fortified sources (soy milk, supplements).
• Elderly often have trouble absorbing.
B-12 Deficiency

- anemia
- nerve damage
- hypersensitive skin
Who’s at Risk?

• pernicious anemia
  – B-12 injections often taken regularly
• HIV
• Chronic Fatigue Syndrome
Vitamin A
What is Vitamin A?

• Fat-soluble
• Retinol
  – One of the most active, usable forms
• Found in animal and plant sources
What does it do?

• Vision
  – Generates pigments for the retina
  – Maintains surface lining of eyes

• Bone growth

• Reproduction

• Cell division and differentiation

• Healthy Skin

• Regulate Immune System
Where does it come from?

- Animal Sources
  - Eggs
  - Meat
  - Cheese
  - Milk
  - Liver
  - Kidney
  - Cod
  - Halibut fish oil
Plant Sources

- Carrots
- Sweet Potatoes
- Cantaloupe
- Pink Grapefruit
- Apricots
- Broccoli
- Spinach
- Pumpkin
What do these plants have in common??

- Most are orange or yellow in color
- Beta-Carotene is precursor of Vitamin A
- Masked in some green plants
How much is enough?

- Children
  2000 – 3500 I.U.

- Men
  5000 I.U.

- Women
  4000 I.U.
Signs of Deficiency

- Night blindness
- Decreased resistance to infections
- Extremely dry skin, hair or nails
Who Is At Risk For Deficiency?

• Young children
• Children with inadequate health care
• Adults in countries with high incidences of vitamin A deficiency or measles
• Adults or children with diseases of the pancreas, liver, intestines, or inadequate fat digestion/absorption
Too Much Can Be Toxic!!

- Hypervitaminosis A leads to toxic symptoms:
  - Dry, itchy skin
  - Headaches and fatigue
  - Hair loss
  - Liver damage
  - Blurred vision
  - Loss of appetite
  - Skin coloration
Other Side Effects

• Severe birth defects
  – Women of child-bearing age should not consume more than 8000 IU per day
  – Retin-A (acne cream) or Accutane can cause birth defects
  – Retinol is most dangerous form because the body will not convert as much beta-carotene to vitamin A unless needed but it can still be harmful
• Skin can take on a yellow/orange glow
• Most cases of vitamin A overdose occur from supplements but can occur from diet
• RDA is considering establishing an Upper Limit
Foods High In Vitamin A

Retinol

– Liver (3 oz)
  30,325 IU  (610% DV)

– Fortified milk (1 c)
  1,355 IU  (10% DV)
... Foods High In Vitamin A

Beta-Carotene

- Carrot (1 raw) 20,250 IU (410% DV)
- Carrot juice (1/2 c) 12,915 IU (260% DV)
- Mango (1 raw) 8,050 IU (160% DV)
- Sweet Potatoes (1/2 c) 7,430 IU (150% DV)
- Spinach, boiled (1/2 c) 7,370 IU (150% DV)
- Cantaloupe (1 c) 5,160 IU (100% DV)
- Vegetable Soup (1 c) 3,005 IU (60% DV)
Polar Bear Liver

One ounce of polar bear liver contains enough vitamin A (retinol) to kill a person!
Vitamin A, Beta-Carotene, and Cancer

- Surveys suggest that diets rich in vitamin A and beta-carotene can lower the risk for cancer (especially lung cancer)
- However, one study was stopped because subjects with increased beta-carotene had a 46% higher risk of dying from lung cancer
- Another study showed that smokers were more likely to develop lung cancer if they took beta-carotene supplements
- Beta-carotene supplements are not advisable except in rare situations
Vitamin E
Vitamin E

What is it?

• Fat soluble
• Antioxidant
  – Reduce the energy of the free radical
  – Stop the free radical from forming in the first place
  – Interrupt an oxidizing chain reaction to minimize the damage of free radicals
Vitamin E

What does it do?

• Protects cell membranes and other fat-soluble parts of the body (LDL cholesterol) from oxidation
  – May reduce the risk of heart disease
  – May also discourage development of some types of cancer
• Promotes normal growth and development
• Promotes normal red blood cell formation
• Acts as anti-blood clotting agent
• Plays some role in the body’s ability to process glucose
• Also been known to aid the process of wound healing
Vitamin E

Heart disease:
• Two studies published in the *New England Journal of Medicine* by Harvard researchers
• Of 127,000 health professionals, those who took large doses of Vitamin E had a 40% lower risk of heart disease
Vitamin E

What’s the difference?

• Alpha Tocopherol
• Tocopherol
• Tocopheryl (Acetate, Succinate)
Vitamin E

What’s the difference?

- “d” = natural
- “dl” = synthetic
Vitamin E

Where does it come from?

- wheat germ oil
- vegetable oils
- nuts and seeds
- whole grains
- egg yolk
- leafy green vegetables
Specific Food Sources

- vegetable oils
  - Corn, cottonseed, and peanut oil
- nuts and seeds
  - Almonds, hazelnuts, sunflower seeds, walnuts, and margarine
- whole grains
  - whole-wheat flour, wheat germ
- Vegetables and fruits
  - Spinach, lettuce, onions, blackberries, apples, and pears
### Vitamin E

**Recommended Daily Allowances (RDA):**

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Children</th>
<th>Adult Males (18+)</th>
<th>Adult Females (18+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12 months</td>
<td>6-7 mg</td>
<td>3-4 mg</td>
<td>8 mg</td>
</tr>
<tr>
<td>1-3 years (boys)</td>
<td></td>
<td>6-7 mg</td>
<td>8 mg</td>
</tr>
<tr>
<td>1-3 years (girls)</td>
<td></td>
<td>3-4 mg</td>
<td>10 mg</td>
</tr>
<tr>
<td>4-8 years</td>
<td>8 mg</td>
<td>3-4 mg</td>
<td>10 mg</td>
</tr>
<tr>
<td>9-18 years (boys)</td>
<td>11 mg</td>
<td>8 mg</td>
<td>11 mg</td>
</tr>
<tr>
<td>9-18 years (girls)</td>
<td>12 mg</td>
<td>8 mg</td>
<td>12 mg</td>
</tr>
<tr>
<td>19+</td>
<td>15-21 IU</td>
<td>24 IU</td>
<td>24 IU</td>
</tr>
</tbody>
</table>

**Pregnant and Lactating Women:**

- Pregnant: 12 mg
- Lactating: 11 mg
Vitamin E

Other effects:

• Taking more than RDA of vitamin E improves the immune system in the elderly
  – Jean Mayer (USDA Human Nutrition Research Center) & Simin Meydani, D.V.M., Ph.D. (Nutritional Immunology Laboratory)
  – The Journal of the American Medical Association
Vitamin E

Who is likely to be deficient?

- Severe vitamin E deficiencies are rare
- Lack of vitality
- Lethargy
- Apathy
- Inability to concentrate
- Muscle weakness
Vitamin E

Can you take too much?

- No harmful effects at 50 times RDA (1200 – 1500 IU)
- At 2,400 IU per day, may cause bleeding due to its clot-preventing ability
- May reduce body’s supply of vitamin A
- May alter immune system
- Vitamin E toxicity is rare
Vitamin E

*Natural foods or supplements?*

- Natural form more bioavailable
- Easier to obtain the amount needed from supplements
Vitamin E

*Who should take supplements?*

- People over the age of 55
- Smokers
- People who abuse alcohol
- Anyone with inadequate caloric or nutritional dietary intake or increased nutritional requirements
Vitamin E

**Miscellaneous:**

- Freezing may destroy Vitamin E
- Extreme heat causes Vitamin E to break down
- Avoid deep-fat frying foods that are natural sources of Vitamin E
- Reduces potential toxicity of Vitamin A - Excessive doses causes Vitamin A depletion
Vitamin C
Vitamin C

- Ascorbic acid (Toxic to viruses, bacteria, and some malignant tumor cells)
- Antioxidant
- Water-soluble
What are C’s functions in the body?

- Protects you body from free radicals
- Helps form connective tissue that hold your bones, muscles, and tissues together (collagen)
- Aids in the healing of wounds
- Aids the body in absorbing iron from plant sources
- Helps to keep your gums healthy
- Helps your body to fight infections
- Aids in the prevention of heart disease
- Helps prevent some forms of cancer
Harmful effects in larger doses:
(over 1000mg/ dose)

- Diarrhea
- gastrointestinal discomfort
- rebound Scurvy
- Avoid chewable tablets (may cause damage to teeth)
• Since Vitamin C is water-soluble excess amounts that the body does not need will be excreted, but larger doses can cause some problems. . .
Vitamin C daily recommendations

- LINK
Recommended Dietary Intake

- Men: 60mg/day
- Women: 60mg/day
- Pregnant women: 95mg/day
- Children: 45mg/day

- Take divided doses of the vitamin twice daily to get the best results, and less excretion.
- Smoking, oral contraceptives, steroids, excessive alcohol consumption, and analgesics increase the need for this vitamin.
Sources of Vitamin C

- Guava, Broccoli, Cantaloupe, Red Bell Pepper, Orange Juice, Strawberries, Tomato Juice, Raw Tomato, Sweet Potato, Tangerine, Spinach, Leafy Greens, Berries, Citrus Fruits
- LINK (list of fruits & veggies that are good sources of C)
- www.heartinfo.org/nutrition/vitc42898.htm
Deficiency of C causes:

- Weight loss
- Fatigue and joint pain
- Scurvy (bruising easily, bleeding gums, and tendency for bones to fracture)
- Reduced resistance to colds and infections
- Slow healing of wounds and fractured bones
Fact or Fiction: Vitamin C causes Kidney Stone formation

• *Department of Nutrition, Harvard School of Public Health*

• Study done on 45,251 men that had no previous cases of kidney stones. Some subjects took up to 30 times the RDA values, and showed no increased risk of kidney stone formation.
To learn about more cool facts about Vitamin C, log on to:

- LINK
- www.cforyourself.com
Food or Supplement?

- The **Mayo Clinic** states that “your body needs macronutrients (proteins, carbohydrates, and fat) for energy and micronutrients (vitamins and minerals) for many functions. Whole foods are an excellent choice.” They also stated that “an orange provides not only vitamin C but also carotene, calcium, and free sugars for energy. A vitamin C supplement is lacking these.”

- The **American Heart Association** “recommends that healthy individuals obtain adequate nutrient intakes from food eaten in variety and moderation, rather than from supplements.”
Congressional Mandate for the ODS:

- To explore the role of dietary supplements to improve health care
- To promote scientific study of dietary supplements in maintaining health and preventing chronic disease.
- To conduct and coordinate research on dietary supplements at the National Institute of Health.
- To collect & compile databases of federally funded research & scientific papers on dietary supplements.
- To coordinate funding for research on dietary supplements.
- To provide advice to other HHS agencies related to dietary supplements.
ODS Scientific Goals:

• 1: Evaluate the role of dietary supplements in the prevention of disease and reduction of risk factors associated with disease.
• 2: Evaluate the role of dietary supplements in physical and mental health and in performance.
• 3: Explore the biochemical and cellular effects of dietary supplements on biological systems and their physiological impact across the life cycle
• 4: Improve scientific methodology as related to the study of dietary supplements.
• 5: Inform and educate scientists, health care providers, and the public about the benefits and risks of dietary supplements.
Definition and Classification

• Non-caloric organic nutrients
• Needed in very small amounts
• Facilitators – help body processes proceed; digestion, absorption, metabolism, growth etc.
• Some appear in food as precursors or provitamins
Definition and Classification

- 2 classes, Table 7.1
  - Fat soluble:
    - Water soluble:
Definition and Classification

• Fat soluble vitamins
  – Found in the fats and oils of food.
  – Absorbed into the lymph and carried in blood with protein transporters = chylomicrons.
  – *Stored in liver and body fat and can become toxic if large amounts are consumed.
Definition and Classification

• Water soluble vitamins
  – Found in vegetables, fruit and grains, meat.
  – Absorbed directly into the blood stream
  – Not stored in the body and toxicity is rare. Alcohol can increase elimination, smoking, etc. cause decreased absorption.
Fat Soluble Vitamins

• Vitamin A (precursor – beta carotene)
  – 3 forms: retinol (stored in liver), retinal, retinoic acid
  – Roles in body:
    • Regulation of gene expression
    • Part of the visual pigment rhodopsin, maintains clarity of cornea (yes eating carrots is good for your eyesight)
    • Required for cell growth and division - epithelial cells, bones and teeth
    • Promotes development of immune cells, especially “Natural Killer Cells”
    • Antioxidant
Fat Soluble Vitamins

• Vitamin A
  – Deficiencies cause:
    • Night blindness, xerophthalmia (keratin deposits in cornea), macular degeneration.
    • Skin and mucous membrane dryness and infection, keratin deposits.
    • Anemia
    • Developmental defects – bones, teeth, immune system, vision
Fat Soluble Vitamins

• Vitamin A
  – Toxicities (RetinA/Accutaine, single large doses of supplements, eating excessive amounts of liver) cause:
    • Fragile RBCs, hemorrhage
    • Bone pain, fractures
    • Abdominal pain and diarrhea
    • Blurred vision
    • Dry skin, hair loss
    • Liver enlargement
Fat Soluble Vitamins

• Vitamin A
  – DRI: 700(women)-900(men) micrograms/day, UL 3000 micrograms
  – Sources, see snapshot 7.1
**VITAMIN A AND BETA-CAROTENE**

**DRI RECOMMENDED INTAKES:**
Men: 900 µg/day
Women: 700 µg/day

**TOLERABLE UPPER INTAKE LEVEL:**
Adults: 3,000 µg vitamin A/day

**CHIEF FUNCTIONS:** Vision; maintenance of cornea, epithelial cells, mucous membranes, skin; bone and tooth growth; regulation of gene expression; reproduction; immunity

**DEFICIENCY:** Night blindness, corneal drying (xerosis), and blindness (xerophthalmia); impaired bone growth and easily decayed teeth; keratin lumps on the skin; impaired immunity

**TOXICITY:**
*Vitamin A:* Increased activity of bone-dismantling cells causing reduced bone density and pain; liver abnormalities; birth defects
*Beta-carotene:* Harmless yellowing of skin

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**GOOD SOURCES**

<table>
<thead>
<tr>
<th>Food</th>
<th>Serving</th>
<th>Vitamin A Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FORTIFIED MILK</strong></td>
<td>1 c</td>
<td>150 µg</td>
</tr>
<tr>
<td><strong>BEEF LIVER</strong></td>
<td>3 oz</td>
<td>6,582 µg</td>
</tr>
<tr>
<td><strong>CARROTS</strong></td>
<td>¼ c</td>
<td>671 µg</td>
</tr>
<tr>
<td><strong>BOK CHOY</strong></td>
<td>¾ c</td>
<td>180 µg</td>
</tr>
<tr>
<td><strong>SWEET POTATO</strong></td>
<td>¼ c</td>
<td>961 µg</td>
</tr>
<tr>
<td><strong>APRICOTS</strong></td>
<td>3 apricots</td>
<td>100 µg</td>
</tr>
<tr>
<td><strong>SPINACH</strong></td>
<td>½ c</td>
<td>472 µg</td>
</tr>
</tbody>
</table>

*These foods provide 10 percent or more of the vitamin A Daily Value in a serving. For a 2,000-calorie diet, the DV is 900 µg/day.

*Vitamin A recommendations are expressed in retinol activity equivalents (RAE).

This food contains preformed vitamin A.
Fat Soluble Vitamins

• Vitamin D – precursor is cholesterol, converted by UV from sunlight exposure, therefore is a “non-essential” vitamin.
  – Roles:
    • Increases calcium absorption in bone, intestines, kidney. Promotes bone growth and maintenance.
    • Stimulates maturation of cells – heart, brain, immune system, etc.
Fat Soluble Vitamins

• Vitamin D
  – Deficiencies: *rickets* (children), *osteomalacia* (adults). What are some of the causes of deficiencies?
  – Toxicities (5X DRI)
    • Loss of calcium from bone and deposition in soft tissues.
    • Loss of appetite, nausea and vomiting, psychological depression.
Bowed legs
– Characteristic of rickets
Beaded ribs
–
Characteristic of rickets
Fat Soluble Vitamins

• Vitamin D
  – DRI – 5 micrograms/day for ages 19-50, 10 for ages 51-70, 15 for ages >70.
  – Sources, see snapshot 7.2
**VITAMIN D**

**DRI RECOMMENDED INTAKES:**
- Adults: 5 µg/day (19–50 yr)
  - 10 µg/day (51–70 yr)
  - 15 µg/day (>70 yr)

**TOLERABLE UPPER INTAKE LEVEL:**
- Adults: 50 µg/day

**CHIEF FUNCTIONS:** Mineralization of bones and teeth (raises blood calcium and phosphorus by increasing absorption from digestive tract, withdrawing calcium from bones, stimulating retention by kidneys)

**DEFICIENCY:** Abnormal bone growth resulting in rickets in children, osteomalacia in adults; malformed teeth, muscle spasms

**TOXICITY:**
- Elevated blood calcium; calcification of soft tissues (blood vessels, kidneys, heart, lungs, tissues of joints), excessive thirst, headache, nausea, weakness

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**GOOD SOURCES**

- **FORTIFIED MILK**
  - 1 c = 2.5 µg

- **SALMON**
  - 3 oz = 4.3 µg

- **SHRIMP**
  - 3 oz = 3.0 µg

- **SUNLIGHT**
  - Promotes vitamin D synthesis in the skin.\(^a\)

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*These foods provide 10 percent or more of the vitamin D Daily Value in a serving. For a 2,000-calorie diet, the DV is 10 µg/day.

\(^a\)Avoid prolonged exposure to sun.

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Fat Soluble Vitamins

• Vitamin E – tocopherol, *alpha-, beta -, gamma-, and delta-
  – Roles:
    • Antioxidant (protects polyunsaturated fats)
    • Prevention of damage to lungs, RBCs, WBCs (immunity), heart
    • Necessary for normal nerve development
Fat Soluble Vitamins

• Vitamin E
  – Deficiencies (decreased absorption of fats- liver disease, low fat diets)
    • Premature babies – fragile RBCs (hemolysis)
    • Loss of muscle coordination, vision, immune functions
  – Toxicities (more than 1000 milligrams/day)
    • Increases the effects of anticoagulants (Coumadin, Warfarin)
Fat Soluble Vitamins

• Vitamin E
  – DRI 15 milligrams/day (alpha-tocopherol)
  – Sources, see snapshot 7.3
**VITAMIN E**

**DRI RECOMMENDED INTAKE:**
Adults: 15 mg/day

**TOLERABLE UPPER INTAKE LEVEL:**
Adults: 1,000 mg/day

**CHIEF FUNCTIONS:** Antioxidant (protects cell membranes, regulates oxidation reactions, protects polyunsaturated fatty acids)

**DEFICIENCY:** Red blood cell breakage, nerve damage

**TOXICITY:** Augments the effects of anti-clotting medication

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*These foods provide 10 percent or more of the vitamin E Daily Value in a serving. For a 2,000-calorie diet, the DV is 30 IU or 20 mg/day.

**GOOD SOURCES**

- **MAYONNAISE** (safflower oil)
  - 1 tbs = 3.0 mg

- **SAFFLOWER OIL** (cooked)
  - 1 tbs = 4.7 mg

- **CANOLA OIL**
  - 1 tbs = 2.4 mg

- **WHEAT GERM**
  - 1 oz = 6.0 mg

- **SUNFLOWER SEEDS** (shelled)
  - 2 tbs = 9.0 mg
Fat Soluble Vitamins

- **Vitamin K** – produced by bacteria in large intestine
  - Roles
    - Promotes synthesis of blood clotting proteins (**Interferes with Coumadin**)
    - Bone formation
  - Deficiencies are rare but seen in infants, after prolonged antibiotic therapy, and in patients with decreased bile production.
  - Toxicities (>1000 mg/day): rupture of RBCs and jaundice
Fat Soluble Vitamins

• Vitamin K
  – DRI: 90(women) – 120(men) micrograms/day
  – Sources, see snapshot 7.4
**VITAMIN K**

**DRI RECOMMENDED INTAKES:**
- Men: 120 µg/day
- Women: 90 µg/day

**CHIEF FUNCTIONS:** Synthesis of blood-clotting proteins and bone proteins

**DEFICIENCY:** Hemorrhage; abnormal bone formation

**TOXICITY:** Opposes the effects of anti-clotting medication

*These foods provide 10 percent or more of the vitamin K Daily Value in a serving. For a 2,000-calorie diet, the DV is 60 µg/day.

Water Soluble Vitamins

• 8 B vitamins – Tender Romance Never Fails with 6 to 12 Beautiful Pearls (Thiamin, Riboflavin, Niacin, Folate, B₆, B₁₂, Biotin, and Pantothenic acid)
  – Aid in metabolism of and energy release from carbohydrates, lipids, amino acids.
  – Mode of action – coenzymes or parts of coenzymes that are necessary for the proper activity of enzymes, fig 7.9
Without the coenzyme, compounds A and B don’t respond to the enzyme.

With the coenzyme in place, compounds A and B are attracted to the active site on the enzyme, and they react.

The reaction is completed with the formation of a new product. In this case, the product is AB.

The product AB is released.

Fig. 7-9a, p. 233
Muscles and other tissues metabolize protein.

Brain and other tissues metabolize carbohydrates.

Liver and other tissues metabolize fat.

Bone tissues make new blood cells.

Digestive tract lining replaces its cells.
Water Soluble Vitamins

• Thiamin and Riboflavin
  – Roles – energy metabolism in cells, part of nerve cell membranes.
  – Deficiencies
    • Beri beri, edema &/or muscle weakness
    • Alcohol abuse – Wernicke-Korsakoff syndrome
  – DRI thiamin:1.1(women) – 1.2(men) mg/day; riboflavin 1.1(women) – 1.3(men) mg/day
  – Sources: All food groups except fats and oils
THIAMIN

DRI RECOMMENDED INTAKES:
Men: 1.2 mg/day
Women: 1.1 mg/day

CHIEF FUNCTIONS: Part of coenzyme active in energy metabolism

DEFICIENCY: aBeriberi with possible edema or muscle wasting; enlarged heart, heart failure, muscular weakness, pain, apathy, poor short-term memory, confusion, irritability, difficulty walking, paralysis, anorexia, weight loss

TOXICITY: None reported

*aThese foods provide 10 percent or more of the thiamin Daily Value in a serving. For a 2,000-calorie diet, the DV is 1.5 mg/day.
*aSevere thiamin deficiency is often related to heavy alcohol consumption.

GOOD SOURCES:

- WHOLE WHEAT BAGEL
  ½ bagel = 0.19 mg

- ENRICHED CEREAL (ready-to-eat)
  ½ c = 0.38 mg

- PORK CHOP
  3 oz = 0.56 mg

- SUNFLOWER SEEDS
  2 tbs = 0.41 mg

- GREEN PEAS (cooked)
  ¼ = 0.23 mg

- BAKED POTATO
  1 whole potato = 0.22 mg

- WAFFLE
  1 waffle = 0.25 mg

- BLACK BEANS (cooked)
  ½ c = 0.21 mg
**RIBOFLAVIN**

**DRI RECOMMENDED INTAKES:**
- Men: 1.3 mg/day
- Women: 1.1 mg/day

**CHIEF FUNCTIONS:** Part of coenzymes active in energy metabolism; supports vision and skin health

**DEFICIENCY:** Cracks and redness at corners of mouth; painful, smooth, purplish red tongue; sore throat; inflamed eyes and eyelids, sensitivity to light; skin rashes

**TOXICITY:** None reported

*These foods provide 10 percent or more of the riboflavin Daily Value in a serving. For a 2,000-calorie diet, the DV is 1.7 mg/day.

**GOOD SOURCES**

- **MILK**
  - 1 c = 0.45 mg

- **YOGURT (plain)**
  - 1 c = 0.60 mg

- **BEEF LIVER (cooked)**
  - 3 oz = 2.9 mg

- **COTTAGE CHEESE**
  - 1 c = 0.38 mg

- **ENRICHED CEREAL**
  - Ready-to-eat;
  - ½ c = 0.43 mg

- **SPINACH (cooked)**
  - ½ c = 0.21 mg

- **ORK CHOP (lean only)**
  - 3 oz = 0.23 mg

- **MUSHROOMS (cooked)**
  - ½ c = 0.23 mg
Water Soluble Vitamins

• Niacin – can be produced from the amino acid tryptophan.
  – Roles: energy metabolism
  – Deficiencies: Pellagra – dermatitis, diarrhea, dementia, death
  – Toxicities (2 - 3X DRI): *prevents blood clotting, causes liver damage, enhances action of Coumadin
Water Soluble Vitamins

• Niacin
  – DRI 14(women) -16(men) mg/day
  – Sources, snapshot 7.8
    • Meats
    • Some vegetables and grains
NIACIN

DRI RECOMMENDED INTAKES:
Men: 16 mg/day
Women: 14 mg/day

TOLERABLE UPPER INTAKE LEVEL:
Adults: 35 mg/day

CHIEF FUNCTIONS: Part of coenzymes needed in energy metabolism

DEFICIENCY: Pellagra, characterized by flaky skin rash (dermatitis) where exposed to sunlight; mental depression, apathy, fatigue, loss of memory, headache; diarrhea, abdominal pain, vomiting; swollen, smooth, bright red or black tongue

TOXICITY: Painful flush, hives, and rash ("niacin flush"); excessive sweating; blurred vision; liver damage, impaired glucose tolerance

GOOD SOURCES:

CHICKEN BREAST
3 oz = 8.9 mg

PORK CHOP
3 oz = 3.9 mg

BAKED POTATO
1 whole potato = 3.3 mg

TUNA (in water)
3 oz = 11.3 mg

ENRICHED CEREAL
(ready-to-eat)
¾ c = 5.0 mg

MUSHROOMS (cooked)
¾ c = 3.5 mg

*Niacin DRI Recommended Intakes are expressed in niacin equivalents (NE); the Tolerable Upper Intake Level refers to preformed niacin.

*These foods provide 10 percent or more of the niacin Daily Value in a serving. For a 2000-calorie diet, the DV is 20 mg/day. The DV values are for preformed niacin, not niacin equivalents.

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Snapshot 7-8, p. 238
Water Soluble Vitamins

• Folate
  – Role: required for synthesis of DNA - ***pregnancy
  – Deficiencies (drug interactions, smoking)
    • Anemia
    • Decreased immunity
    • Decreased digestive and cardiovascular function
    • Colon and cervical cancers
    • *Neural tube defects, ?other birth defects
Water Soluble Vitamins

• Folate
  – Toxicities (>1000 mg/day): rare, interferes with anticancer drugs.
  – DRI 400 milligrams/day
  – Sources, snapshot 7.8
DRI RECOMMENDED INTAKE:
Adults: 400 µg/day

TOLERABLE UPPER INTAKE LEVEL:
Adults: 1,000 µg/day

CHIEF FUNCTIONS: Part of a coenzyme needed for new cell synthesis

DEFICIENCY: Anemia, smooth, red tongue; depression, mental confusion, weakness, fatigue, irritability, headache; a low intake increases the risk of neural tube birth defects

TOXICITY: Masks vitamin B₁₂-deficiency symptoms

These foods provide 10 percent or more of the Daily Value in a serving. For a 2,000-calorie diet, the DV is 400 µg/day.

Folate recommendations are expressed in dietary folate equivalents (DFE). Note that for natural folate sources, 1 µg = 1 DFE; for enrichment sources, 1 µg = 1.7 DFE.

Some highly enriched cereals may provide 400 or more micrograms in a serving.
Water Soluble Vitamins

• Vitamin B$_{12}$ (requires **intrinsic factor** for absorption)
  – Roles: works with folate, part of insulating sheath around nerves.
  – Deficiencies:
    • Pernicious anemia
    • Paralysis
    • Nerve damage in fetus
Water Soluble Vitamins

- Vitamin $B_{12}$
  - DRI 2.3 micrograms/day
  - Sources, see snapshot 7.9
    - Meat and dairy
    - Implications for vegans??
VITAMIN B_{12}

**DRI RECOMMENDED INTAKE:**
Adults: 2.4 μg/day

**CHIEF FUNCTIONS:** Part of coenzymes needed in new cell synthesis; helps to maintain nerve cells

**DEFICIENCY:** Pernicious anemia;\(^a\) anemia (large-cell type);\(^b\) smooth tongue; tingling or numbness; fatigue, memory loss, disorientation, degeneration of nerves progressing to paralysis

**TOXICITY:** None reported

\(^a\) These foods provide 10 percent or more of the vitamin B_{12} Daily Value in a serving. For a 2,000-calorie diet, the DV is 6 μg/day.

\(^b\) The term *pernicious anemia* refers to the vitamin B_{12} deficiency caused by a lack of stomach intrinsic factor, but not to anemia from inadequate dietary intake.

\(^c\) Large cell-type anemia is known as either *macrocytic* or *megaloblastic anemia.*

<table>
<thead>
<tr>
<th>Good Sources</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHICKEN LIVER</td>
<td>3 oz = 14.0 μg</td>
</tr>
<tr>
<td>SARDINES</td>
<td>3 oz = 7.5 μg</td>
</tr>
<tr>
<td>SIRLOIN STEAK</td>
<td>3 oz = 2.0 μg</td>
</tr>
<tr>
<td>TUNA (in water)</td>
<td>3 oz = 3.0 μg</td>
</tr>
<tr>
<td>COTTAGE CHEESE</td>
<td>1 c = 2.0 μg</td>
</tr>
<tr>
<td>SWISS CHEESE</td>
<td>1½ oz = 1.5 μg</td>
</tr>
<tr>
<td>PORK ROAST (lean)</td>
<td>3 oz = 1.0 μg</td>
</tr>
</tbody>
</table>

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Snapshot 7-10, p. 242
Water Soluble Vitamins

• Vitamin $B_6$
  – Roles:
    • Conversion of amino acids to other amino acids
      – Ex.: Tryptophan to niacin
    • Synthesis of hemoglobin and neurotransmitters
    • Release of glucose from glycogen
    • Immune function
    • Promotes steroid hormone activity
    • Development of nervous system
Water Soluble Vitamins

• Vitamin B6
  – Deficiencies
    • Anemia
    • Dermatitis
    • Muscle weakness
    • Behavioral problems
    • ?Heart disease
  – Toxicities (>100 mg/day) – muscle weakness, nerve damage
Water Soluble Vitamins

• Vitamin B6
  – DRI 1.3 milligrams/day
  – Sources, see snapshot 7.10
    • Meat and dairy
    • Vegetables and fruits
VITAMIN B₆

DRI RECOMMENDED INTAKE:
Adults (19–50 yr): 1.3 mg/day

TOLERABLE UPPER INTAKE LEVEL:
Adults: 100 mg/day

CHIEF FUNCTIONS: Part of a coenzyme needed in amino acid and fatty acid metabolism; helps to convert tryptophan to niacin and to serotonin; helps to make hemoglobin for red blood cells

DEFICIENCY: Anemia, depression, confusion, abnormal brain wave pattern, convulsions; greasy, scaly dermatitis

TOXICITY: Depression, fatigue, impaired memory, irritability, headaches, nerve damage causing numbness and muscle weakness progressing to an inability to walk and convulsions; skin lesions

GOOD SOURCES*

BEEF LIVER (cooked)
3 oz = 0.87 mg

BAKED POTATO
1 whole potato = 0.70 mg

BANANA
1 whole banana = 0.66 mg

CHICKEN BREAST
3 oz = 0.35 mg

SWEET POTATO (cooked)
½ c = 0.29 mg

SPINACH (cooked)
½ c = 0.22 mg

* These foods provide 10 percent or more of the vitamin B₆ Daily Value in a serving. For a 2,000-calorie diet, the DV is 2 mg/day.

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Snapshot 7-11, p. 243
Water Soluble Vitamins

• Biotin and Pantothenic acid
  – Roles:
    • Metabolism of carbohydrates, fats and proteins
    • Synthesis of lipids, neurotransmitters, steroid hormones, hemoglobin.

• “Non-B vitamins”: choline, carnitine, inositol, lipoic acid, etc. No beneficial effects proven!!
Water Soluble Vitamins

• Vitamin C, ascorbic acid – history of controversy
  – Roles:
    • Connective tissue development, collagen
    • Antioxidant
    • Promotes iron absorption, immunity?
    • Protects vitamin E
Water Soluble Vitamins

• Vitamin C
  – Deficiency – *Scurvy* (skin and mucous membrane damage), anemia.
  – Toxicity (> 2grams/day) – pro-oxidant, activates oxidizing agents.
  – DRI – 75(w) – (90(m) milligrams/day. Increased for smokers.
  – Sources, see snapshot 7.11
  – Notes: can interfere with diagnostic tests for diabetes, and blood clotting
  – ??Prevents colds
**VITAMIN C**

**DRI RECOMMENDED INTAKES:**
Men: 90 mg/day  
Women: 75 mg/day  
Smokers: +35 mg/day

**TOLERABLE UPPER INTAKE LEVEL:**  
Adults: 2,000 mg/day

**CHIEF FUNCTIONS:** Collagen synthesis (strengthens blood vessel walls, forms scar tissue, provides matrix for bone growth), antioxidant, restores vitamin E to active form, supports immune system, boosts iron absorption

**DEFICIENCY:** Scurvy, with pinpoint hemorrhages, fatigue, bleeding gums, bruises; bone fragility, joint pain; poor wound healing, frequent infections

**TOXICITY:** Nausea, abdominal cramps, diarrhea; rashes; interference with medical tests and drug therapies; in susceptible people, aggravation of gout or kidney stones.

*These foods provide 10 percent or more of the vitamin C Daily Value in a serving. For a 2,000-calorie diet, the DV is 60 mg/day.

**GOOD SOURCES:**
- **ORANGE JUICE**  
  \( \frac{1}{2} \text{ c} = 62 \text{ mg} 

- **GREEN PEPPERS (raw)**  
  \( \frac{1}{2} \text{ c} = 60 \text{ mg} 

- **BRUSSELS SPROUTS (cooked)**  
  \( \frac{1}{2} \text{ c} = 48 \text{ mg} 

- **BROCCOLI (cooked)**  
  \( \frac{1}{2} \text{ c} = 51 \text{ mg} 

- **GRAPEFRUIT**  
  \( \frac{1}{2} \text{ grapefruit} = 36 \text{ mg} 

- **STRAWBERRIES**  
  \( \frac{1}{2} \text{ c} = 43 \text{ mg} 

- **SWEET POTATO**  
  \( \frac{1}{2} \text{ c} = 20 \text{ mg} 

- **BOK CHOI (cooked)**  
  \( \frac{1}{2} \text{ c} = 22 \text{ mg} 

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Vitamin/Mineral Supplements

• Who needs them?
• Who does not need them?
• Oyo read - Controversy, pp257-263