3.1.1 Water Soluble Vitamins
Overview of Vitamins

- essential for good health
- organic molecules
- individual units
- regulate body processes
- micronutrients
- solubility – fat or water
Water Soluble Vitamins

• **B-complex;** $B_1$ (thiamin); $B_2$ (riboflavin); $B_3$ (niacin); $B_5$ (pantothenic acid); $B_6$ (pyridoxine); $B_7$ (biotin); $B_{12}$ (cobalamin); folate

• **Vitamin C** (ascorbic acid)
**General Characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamins in Food</td>
<td>Attached to a protein; may be destroyed during cooking or during storage.</td>
</tr>
<tr>
<td>Absorption</td>
<td>Mostly in small intestine; diffusion or active transport; altered bioavailability.</td>
</tr>
<tr>
<td>Circulation</td>
<td>In bloodstream, 1st stop is liver.</td>
</tr>
<tr>
<td>Excretion</td>
<td>For most B vitamins the kidneys filter out excess which is excreted in urine.</td>
</tr>
<tr>
<td>Toxicity</td>
<td>Minimal effect, although some exist.</td>
</tr>
<tr>
<td>Function</td>
<td>B vitamins are coenzymes in energy metabolism + other functions; Vitamin C acts as antioxidant</td>
</tr>
</tbody>
</table>
B vitamins and energy metabolism
Thiamin (B₁)

• Functions:
  * coenzyme in energy metabolism
  * nerve function

• Food Sources:
  whole grains, enriched grains, pork, legumes, tuna, some fruits

• Deficiency: beriberi

• Toxicity: No
Riboflavin (B₂)

- **Functions:**
  * coenzyme FADH₂ (electron carrier)
  * formation of other vitamins

- **Food Sources:**
  liver, fortified cereals, dairy products, mushrooms, spinach, tomatoes

- **Deficiency:** ariboflavinosis

- **Toxicity:** No
Niacin (B3)

- Functions:
  * coenzyme NADH (electron carrier)
  * protein synthesis
  * DNA maintenance and replication

- Food Sources:
  fish, fortified cereals, liver, beef, tomatoes, mushrooms, turkey

- Deficiency: Pellagra

- Toxicity: Yes
Pantothenic acid (B₅)

- Functions:
  * coenzyme A (CoA), energy production
  * heme synthesis
  * lipid synthesis

- Food Sources:
  fish, fortified cereals, liver, yogurt, broccoli, mushrooms, turkey

- Deficiency: burning feet syndrome

- Toxicity: No
Pyridoxine (B₆)

- **Functions:**
  * coenzyme in amino acid metabolism
  * heme synthesis
  * synthesis of neurotransmitters

- **Food Sources:**
  fish, garbanzo beans, fortified foods, liver, yogurt, meat, broccoli, banana

- **Deficiency:** small, pale red blood cells

- **Toxicity:** neurological problems
Biotin (B₇)

• Functions:
  * coenzyme in energy metabolism
  * synthesis of fatty acids

• Food Sources:
  peanuts, almonds, mushrooms, tomato, egg yolk, carrots, banana

• Deficiency: depression, skin irritation, loss of muscle control

• Toxicity: No
Folate (folic acid)

- Functions:
  * coenzyme; single carbon transfers
  * normal development; cell division and protein synthesis

- Food Sources:
  fortified foods, garbanzo beans and other legumes, spinach, orange

- Deficiency: Macrocytic anemia

- Toxicity: No
Defective Neural Tube Development

This portion of the neural tube will become the brain. During early fetal life, the neural tube closes.

This portion of the neural tube will become the spine.

A neural tube defect occurs when the neural tube does not close completely and neural tissue becomes exposed.

Vertebra
Spinal cord
Spinal fluid
Skin

Spina bifida baby

Fig. 10.12
Cobalamin (B$_{12}$)

- **Functions:**
  * coupled reactions with folate
  * homocysteine metabolism
  * energy metabolism

- **Food Sources:**
  fortified foods, fish, beef, dairy, shellfish

- **Deficiency:** Pernicious anemia

- **Toxicity:** No
Vitamin C (ascorbic acid)

History:

- 250 yrs ago sailors died from scurvy
- first ever nutrition intervention study – James Lind 1746
- adding citrus fruit to diet prevented scurvy
Vitamin C (ascorbic acid)

- Functions:
  * antioxidant
    - protects cells from free radicals
    - helps prevent oxidation of iron
  * cofactor
    - in collagen formation
    - in hormone production
    - in neurotransmitter production
  * Stress
    - adrenal glands release Vit C
Vitamin C (ascorbic acid)

- Food Sources:
  - fruits and vegetables esp. peppers, strawberries, orange, broccoli, potato, tomatoes, kiwi

- Deficiency: Scurvy

- Toxicity: some people experience gastrointestinal problems
Vitamin C (ascorbic acid)

RDA: 90 mg/day (males);
    75 mg/day (females)

UL:  2000 mg/day (2g/day)
See tables 10.1 & 10.4 for summary of water-soluble vitamins
Vitamin Supplements - No

- whole grain products, fruits & vegetables = good source of water soluble vitamins
- other foods also contribute vitamins
- a **well balanced diet** will provide the essential vitamins
Vitamin Supplements - Yes

- when absorption is poor e.g. Vit B$_{12}$ injections
- availability/ variety of food is limited
- during times of rapid growth & development (e.g. pregnancy)