Food Constituents [continued]

6- Essential elements

Diet provides a number of inorganic elements that are needed for:

- Normal functioning of vital processes of the body.
- Formation and maintenance of bone and teeth.

Discussed elements are calcium, phosphorus, iron, iodine, fluorine, and trace elements {zinc, copper, selenium, magnesium, chromium, cobalt, molybdenum, and manganese. Iron, iodine and fluorine are also considered trace elements, but discussed with the first group of elements}.

A | Calcium

Ca. is the most abundant mineral in human body is about 1.4 gm\kg and 99% in bones and teeth, and 1% in soft tissues and body fluids. The normal plasma range for Ca is 2.15 – 2.55 mmol\l

Sources:

- Caseinogen, of milk and cheese: the richest source.
- Shellfish, canned fish [with bones], some green vegetables, molasses, and sesame: good sources.

Absorption of dietary calcium:

Vitamin D is needed for absorption in the intestine, absorbability is influenced by:

- Quality of diet: better absorbability with animal – protein diet.
- Calcium / phosphorus ratio in diet, and milk {optimal ratio, and so better absorption, in human than animal milk}
- Gastric acidity.

Absorption is interfered with by:

- Phytic acid of cereal seeds and bran.
- Oxalic acid and soluble oxalates of some vegetables and fruits.

Physiologic Role

- Calcium and phosphorus are the main elements of bone and teeth: they are needed for normal growth and development, and maintenance.
- Blood calcium is essential for normal clotting of blood.
- Calcium contributes to normal functioning of motor nerves, and prevention of nerve irritability.
- Calcium regulates pulse and contraction of heart.
Deficiency:
1. Deficiency disease and metabolic disorder of bone: Osteomalacia, rickets, and osteoporosis.
   • Rickets: affects young children. It is principally caused by vitamin D deficiency that affects absorption and metabolism of calcium, and rarely arises from inadequate calcium and phosphorus intake.
   • Osteomalacia: affects adults, especially multiparous mothers.
   • Osteoporosis: due to multiple causes related to bone density, and loss of bone substance, including deficiency of calcium, phosphorus, and vitamin D.
2. Tetany: due to severe calcium deficiency, _hypocalcaemia_ that causes increased irritability of motor nerves, usually in children and occasionally in adults.
3. Other hazards related to blood clotting, and regulation of pulse.

B] Phosphorus

The normal adult range of serum total phosphate level is 0.7–1.5 mmol/l.

Body phosphorus is found in:
- Skelton, mainly: 80%
- Body fluids and tissue cells: 20%

Sources:
- Calcium – rich foods. Specially milk and cheese: provide adequate phosphorus too.
- Protein – rich animal foods. specially egg yolk and meat of cattle, fish, and poultry: rich sources of phosphorus.

Bran of cereal grains contains phosphorus that is mostly, however, as phytic acid: not only unutilizable, but also interferes with absorption of calcium.

Physiological Role:
- Bone and teeth formation, by complex calcium phosphate.
- Phosphorus is a component of many enzymes of cell metabolism and functional activities.
- Formation of phospholipids.
- Phosphorus contributes to normal blood chemistry.

Deficiency: practically unknown, since phosphorus requirement is provided by animal and plant foods. No dietary allowance is specified.
C] Iron

There is approximately 4 gm of Fe in the body of an adult man.

Sources: animal and plant foods.

Animal foods: organ meat {liver, heart, kidney}, lean meat, shellfish and egg, while milk is poor in iron.

Plant foods: dried beans, nuts, green leafy vegetables, molasses.

Absorption: iron can be absorbed in the stomach and upper part of small intestine. Not all, but a certain percent only of dietary iron is absorbed: around 10%, normally.

Factors that control iron absorption:
1. Body need: the basic determining factor of iron absorption.
   a) Physiological: when more iron is needed for physiological processes, e.g. during pregnancy.
   b) Pathological: with haemorrhage, severe anaemia, haemopoietic disorders and other pathological conditions.

2. Contributing factors:
   • Quality of diet: absorbability of iron is more with high animal – protein diet, and low with predominantly plant diet.
   • Vitamin C: reducing effect of vitamin C facilitates absorption of iron, since it is absorbed in the ferrous state.
   • Gastric acidity: favours absorption.
   • Phytic acid, excess phosphates: impair iron absorption, due to formation of insoluble {unavailable} iron salts.

Iron Deficiency: causes "hypochromic microcytic anaemia", with diminished hemoglobin content of red cells, and oxygen – carrying capacity of blood.

D] Iodine

Sources:
• Chief source: vegetables and fruits grown on Iodine – rich soil.
• Other sources: sea foods, specially fish, and milk when pasture is rich in iodine.

Physiological Role: iodine is essential component of thyroid hormones that are needed for tissue metabolism and regulation of metabolic rate.

Deficiency:
• Goitre: simple or endemic, with enlarged thyroid.
- **Cretinism:** acquired, and occasionally congenital. Congenital cretinism is due to inadequate supply of the foetus with iodine. To maintain desirable tissue level of iodine the adults body's l minimum requirement is 50-75 microgram/ day

**E] Fluorine**

Fluorine is found in enamel of teeth, making it decay – resistant, and thus prevents dental caries {tooth decay}.

**Sources:**
- Water supply: potable water is the chief source. Content, however, varies in different areas, and optimal content is 1ppm {1 mg per litter}.
- Tea and seafood are relatively rich.

**Deficiency:** when potable water supply contains inadequate fluorine, especially of less than 0.1 ppm. Children suffer high incidence of dental caries.

**Excess Intake:** deep underground water of some areas may contain more than 1.5 ppm of fluorine, exposing consumers to "dental fluorosis". Fluorine content of river water is never so high.

**F] Trace Elements**

Some elements are essential for human nutrition, through needed in minute amounts {traces}:
- Iron, Iodine and fluorine, discussed before.
- Zinc, copper, selenium, magnesium, chromium, molybdenum and manganese, discussed here.
- Cobalt, needed for vitamin B$_{12}$ in ruminant animals, but not for man.

1- **Zinc:**

Required zinc is provided by foods of balanced diet, especially muscle meats of farm animals and fish, and seafood. Zinc is coenzymes of zinc – containing enzymes of protein and carbohydrate metabolism. They are essential for synthesis of DNA and RNA.

**Deficiency:**
Balanced diet with adequate animal – protein foods provides zinc requirement. Deficiency may arise with:
- Plant, or largely plant, diet.
- Using low-extraction flour, where phytate interferes with absorption of zinc.
- Morbidity associated with increased protein loss. Deficiency causes growth retardation, failure to thrive, delayed sexual maturation (with hypogonadism, especially in males).

**Relatively more dietary zinc is needed for:**
- Children below 10 years.
- Pregnant and lactating mothers.
Zinc intake can be assessed by zinc content of hair and nails.

2- Copper:
**An adult has 80 mg of Cu in their body**

**Sources:**
Liver, kidney, shellfish, dried beans, nuts and raisins are good sources, while milk is poor in copper. Average diet, however, provides copper requirement, and so dietary deficiency is uncommon, if any.

**Functions:**
- Plays a role in oxidation-reduction enzyme systems.
- **Haemopoietic role:**
  - Better absorption of iron.
  - Synthesis of hemoglobin and cytochrome.

**Deficiency:** not reported in adults. Deficiency in infants (rare) shows impaired growth, mental retardation, brittle hair, anaemia (must be managed by iron and copper), and contributes to manifestation of PEM.

3- Selenium:

**Sources:**
Seafoods, meat (muscles), organ meat, and whole grains.

**Functions:** the most important is that selenium is a component of some oxidation-preventing enzymes (oxidation would otherwise damage membranes of the body).

**Deficiency:** effect of selenium deficiency in man is not known yet.

4- Magnesium:

**Sources:**
Magnesium is widely available in most foods, specially meat, organ meat, seafoods, green vegetables (in chlorophyll), dairy products, nuts and cereals.

{Hard water contains magnesium}.

**Functions:**
**Extracellular magnesium:** needed in neuromuscular transmission.
Intracellular magnesium:
- A component of matrix of bone.
- Essential cofactor of many enzyme systems, e.g. phosphorylation and synthesis of nucleic acid.

Deficiency:
Arises from some pathological conditions:
- Acute diarrheal disease and PEM.
- Chronic renal failure.
- Chronic malabsorption syndrome.
- Chronic alcoholism.

Manifestations: vary with the extent of deficiency that may be mild (usually asymptomatic), moderate or severe. Cases may show irritability, emotional disturbance, muscle disorders and other hazards.

5- Chromium;
Sources:
A balanced diet provides required chromium.
- Spices and yeast: the highest content.
- Eggs, meat and dairy products: good sources.
- Plant foods: low or poor content.

Function: studies in animals showed that chromium is needed for normal glucose metabolism (may be a cofactor for insulin).
Deficiency: arises from inadequate dietary intake and low absorbability form to meet body need and excretion in urine, causing:
- Glucose intolerance.
- Impaired release of free fatty acids, and sequelae.

6- Cobalt;
Cobalt is a component of vitamin B12 (cobalamin). Since sources of B12 are animal foods, and so biosynthesis in man, cobalt is needed for ruminant animals, and no man where dietary cobalt is excreted in urine.

8- Manganese:
Sources: dietary content varies, for example:
Cereals, whole unrefined grains, dried fruits, nuts and tea[very rich], liver, peanuts and white bread [rich], vegetables and fruits [moderate].

Function: managanese activates many enzymes.
Deficiency: reported in animals not in man.

Water:
Water forms about 70% of body weight. It is necessary for life, being a constituent of all body cells, that is needed for body functioning.

**Daily requirement:**
Not fixed, but varies with climate, physical activity and other factors. An adult in temperate climate needs about 2.5 liters of water a day, obtained from potable water, and water, content of ingested fluids and foods. A healthy individual takes water need on satisfying feeling of thirst. More water intake is needed with increased physical activity, hot environment, [more sweating], and conditions associated with excessive fluid loss.

**7- Fibers**
Fiber is material from planet cell walls that is resistant to digestion by enzymes of the human small intestine, and is often classified according to its solubility in water. Water soluble fibers tend to be efficiently broken by bacteria in the colon. Water insoluble fibers pass through the body mostly unchanged. Dietary fiber is a complex mixture of both.

**Sources:**
Fruits [banana], vegetables [potato], breads and cereals, nuts and seeds.

**Recommended daily intake:**
- **Infant:** 6-20 weeks: 9.1 gm of fiber/L of formula
- **Children:** age + 5 gm / day [beginning at age 2- age 18].
- **Adults:** 20-35 gm / day.

**The mechanical and metabolic effect of soluble and insoluble fibers**

<table>
<thead>
<tr>
<th>Effect</th>
<th>Soluble</th>
<th>Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay gastric emptying</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Increase fecal bulk and increase frequency of bowel movement</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Regulate colonic transit time</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Slows glucose absorption from small intestine</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Reduces postprandial blood glucose levels</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Lowers serum total cholesterol and LDL cholesterol</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Conditions that can be improved by increasing fiber intake:**
- Diseases of colon.
Diabetes mellitus: it improve glycemic control and increase sensitivity insulin ------decrease the dose of medication

Hyperlipidemia -------- it decreases serum lipid levels LDL.

Obesity: fullness.