CHEMISTRY: SOAPS AND DETERGENTS

About soaps

- Soaps are anionic surfactants used for washing and cleaning. Surfactants are wetting agents that lower the surface tension of a liquid
- Soaps consist of sodium or potassium salts of fatty acids.
- They are obtained by reacting common oils or fats with a strong alkaline solution
- The earliest recorded evidence for use of soap is from Babylon c. 2800 BC

Mode of action

- Soap molecules have both a hydrophilic end and a hydrophobic end
- The hydrophilic end dissolves in water, while the hydrophobic end dissolves dirt and oil molecules
- As a result, although water and oil don’t mix, soaps allow oil to dissolve in water, allowing them to be rinsed away
- Thus, soaps allow water to remove normally insoluble matter by emulsification

Detergents

- Detergents are surfactants other than soap
- Detergents are commonly used as industrial soaps, due to their heavy duty grease removal capabilities
- Soaps differs from detergents in that in the case of former, excess of fat is used to consume the alkali and the glycerine is not removed, leaving a naturally moisturising soap
- In general detergents are substances that have cleaning properties. By definition, even water is a detergent

BIOLOGY: NUTRITION

Overview

- Nutrition is the supply to cells and organisms, of the materials necessary to support life
- Many common health problems can be prevented by a healthy diet
- A poor diet can have injurious impact on health, leading to problems such as scurvy, beriberi and kwashiorkor
- A healthy diet can also significantly prevent and mitigate systemic diseases like cardiovascular disease, diabetes and osteoporosis
- Eating a wide variety of fresh, unprocessed food has proven favourable compared to monotonous diets of processed food
- Consumption of whole plant foods slows digestion, allows better absorption and a more favourable balance of nutrients

Nutrients

- There are six major classes of nutrients: carbohydrates, fats, minerals, proteins, vitamins and water
- These can be classified into
Macronutrients: nutrients needed in large quantities. These include carbohydrates, fats, proteins and water. Fibre is another macronutrient whose functions have not been fully understood.

Micronutrients: nutrients needed in smaller quantities. These include minerals and vitamins. Antioxidants and phytochemicals are micronutrients as well, but their functions are not well understood.

• Most foods contain a mixture of nutrients
• Some nutrients may be stored internally (eg. Fat soluble Vitamins) while others are required more or less continuously

Carbohydrates

• Carbohydrates are sugars, and are classified as monosaccharides, disaccharides or polysaccharides depending on the number of monomer (sugar) units they contain
• Carbohydrates constitute a large part of foods such as rice, noodles, bread and other grain based products
• In general, simple saccharides are easier to digest and absorb than polysaccharides
• Since they are absorbed more quickly, simple carbohydrates lead to elevated levels of blood glucose

Fibre

• Dietary fibre is a carbohydrate (polysaccharide) that is incompletely absorbed in humans and some animals
• Like all carbohydrates, when metabolised it produces energy
• However, it does not contribute much energy due to limitations on its absorbability and digestion
• Dietary fibre consists mainly of cellulose, a polysaccharide that is indigestible in humans
• Whole grains, fruits and vegetables are good sources of fibre
• Fibre provides bulk to intestinal contents and stimulates peristalsis – the rhythmic muscular contractions of the intestines that moves digesta along the digestive tract
• For these reasons, fibre is important for digestive health. It helps alleviate constipation and diarrhoea and is said to reduce colon cancer

Fats

• Fat consists of fatty acids bonded to glycerol. Fatty acids are carboxylic acids that contain long chains of carbon and hydrogen atoms
• They are typically found as triglycerides
• Fats are classified as
  o Saturated fats: have all the carbon atoms in the fatty acid chains bonded to hydrogen atoms
  o Unsaturated fats: have some carbon atoms double bonded to themselves, thereby have fewer hydrogen atoms
• Studies have shown that unsaturated fats are preferable to saturated fats in terms of health effects
• Saturated fats are usually solids at room temperature (eg butter) while unsaturated fats are liquids at room temperature (eg olive oil)
• Trans fats are a type of unsaturated fat with trans-isomer bonds. These are rare in nature and usually created by an industrial process called hydrogenation. Trans fats are harmful to health (coronary heart disease) and their use is to be avoided
Proteins

- Proteins are the basis of many animal body structures and form enzymes that control chemical reactions in the body
- Proteins are composed of amino acids, which contain nitrogen atoms
- The body requires amino acids to produce new proteins and replace damaged proteins
- **Since the body cannot store protein, amino acids must be present in the daily diet**
- Diet with adequate proteins is especially important during early development and maturation, pregnancy, lactation or injury
- A complete protein source is one that contains all essential amino acids
- Sources of protein include meat, tofu, soy, eggs, grains, legumes and dairy products
- A few amino acids can be converted into glucose for energy (called *gluconeogenesis*). This process mainly happens only during starvation

Minerals

- Dietary minerals are the chemical components required by living organisms other than the four elements carbon, oxygen, nitrogen, hydrogen that are present in nearly all organic molecules
- Dietary minerals include some metals as well (sodium, potassium) which are usually found in ionic state
- Minerals are recommended to be supplied in the daily diet
- **Most famous dietary mineral is iodine (added to salt) which prevents goitre**
- Macrominerals (required more than 200 mg/day) include
  - Calcium: electrolyte, also needed for structural growth (teeth, bones)
  - Chlorine: electrolyte
  - Magnesium: required for processing ATP (energy)
  - Phosphorous: required component of bones, essential for energy processing
  - Potassium: electrolyte (heart and nerve health)
  - Sodium: common electrolyte, needed in large quantities. Most common source is common salt. Excess sodium depletes calcium and magnesium leading to high BP and osteoporosis
  - Sulphur: essential for certain amino acids and proteins
- In addition to the macrominerals, many other minerals are required in trace amounts. These include cobalt, copper, chromium, iodine, iron, manganese, molybdenum, nickel, selenium, vanadium, zinc

Vitamins

- A vitamin is an organic compound required as a nutrient in tiny amounts by an organism
- A compound is called a vitamin when it cannot be synthesised in sufficient amounts by an organism, and must be obtained from the diet
- Thus, the term “vitamin” is conditional both on the circumstance and the organism. For instance ascorbic acid is termed Vitamin C for some organisms but not for others, and Vitamins D and K are required in the human diet only under certain circumstances
- Vitamins must be supplied in the diet (except Vitamin D, which can be synthesised by the skin in the presence of UV radiation)
- Fresh fruits and vegetables are good sources of vitamins
- Vitamin deficiencies may result in diseases like goitre, scurvy, osteoporosis, impaired immune system etc
- Excess of some vitamins can also be dangerous: excess Vitamin A can cause jaundice, nausea, blurry vision, vomiting, muscle pain etc
Water

- About 70% of non-fat mass of the body is water
- To function properly, the body requires between one and seven litres of water every day
- It is recommended that daily water intake for an adult male be 3.7 l and for females be 2.7. However, these requirements vary with climate, activity level and other factors
- Too little water can lead to dehydration
- Too much water can lead to water intoxication, a potentially fatal disturbance to the brain. However, this is very rare in normal humans and usually only occurs during water drinking contests or intense bouts of exercises when electrolytes are not replenished

Malnutrition

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Deficiency</th>
<th>Excess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbohydrates</td>
<td>Low energy</td>
<td>Diabetes, obesity</td>
</tr>
<tr>
<td>Fats</td>
<td>None</td>
<td>Cardiovascular disease, obesity</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>none</td>
<td>Cardiovascular disease</td>
</tr>
<tr>
<td>Protein</td>
<td>Kwashiorkor (edema, anorexia, inadequate growth)</td>
<td>Rabbit starvation (diarrhoea, headache, low BP, low heart rate)</td>
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<tr>
<td></td>
<td></td>
<td>Discomfort/hunger that can only be satisfied by eating fats and carbohydrates</td>
</tr>
<tr>
<td>Sodium</td>
<td>Hyponatremia (electrolyte imbalance)</td>
<td>Hypernatremia, hypertension</td>
</tr>
<tr>
<td>Iron</td>
<td>Anaemia</td>
<td>Cirrhosis (chronic liver disease), heart disease</td>
</tr>
<tr>
<td>Iodine</td>
<td>Goitre, hypothyroidism</td>
<td>Iodine toxicity</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>Night blindness, xerophthalmia (dry eyes)</td>
<td>Hypervitaminosis A (birth defects, liver problems, osteoporosis)</td>
</tr>
<tr>
<td>Vitamin B1</td>
<td>Beri-beri</td>
<td></td>
</tr>
<tr>
<td>Vitamin B2</td>
<td>Cracking of skin</td>
<td></td>
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<tr>
<td>Vitamin B12</td>
<td>Pernicious anaemia</td>
<td></td>
</tr>
<tr>
<td>Niacin (Vitamin B3)</td>
<td>Pellagra (diarrhoea, dermatitis, dementia, death)</td>
<td>Dyspepsia (indigestion), cardiac arrhythmias</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Scurvy</td>
<td>Diarrhoea</td>
</tr>
<tr>
<td>Vitamin D</td>
<td>Rickets</td>
<td>Hypervitaminosis D (dehydration, vomiting, constipation)</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Nervous disorders</td>
<td>Hypervitaminosis E (anticoagulant)</td>
</tr>
<tr>
<td>Vitamin K</td>
<td>Haemorrhage</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>Osteoporosis</td>
<td>Fatigue, vomiting, depression, cardiac arrhythmias</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Hypertension</td>
<td>Weakness, nausea, vomiting</td>
</tr>
<tr>
<td>Potassium</td>
<td>Hypokalaemia, cardiac arrhythmias</td>
<td>Hyperkalaemia, palpitations</td>
</tr>
</tbody>
</table>

LAST WEEK: ENVIRONMENTAL CHEMISTRY, VACCINES

NEXT WEEK: TBD