CHEMISTRY, NUCLEAR CHEMISTRY FOR A&P
revised 25 August 2016
Marieb, pp 26-61, JFL 22-43, Martini pp31-56, Martini’s 7th, pp 27-57, 8th: 53-107, 9th: 27-61, 10th: 26-63

ATOMIC MODEL OF MATTER:
- Subatomic particles, atomic number, atomic weight
- Major elements in cells: CHNOPS
- Isotopes different forms of an element (with differing masses)

RADIOACTIVITY:

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Composition</th>
<th>Source</th>
<th>Penetration</th>
<th>Damage to Tissues</th>
</tr>
</thead>
<tbody>
<tr>
<td>alpha</td>
<td>$2N + 2P$</td>
<td>U, Pu, Ra, etc</td>
<td>low</td>
<td>great, esp. epithelium</td>
</tr>
<tr>
<td>beta</td>
<td>electron, positron</td>
<td>many: ex: $^3H$, $^{14}C$, $^{32}P$, $^{131}I$</td>
<td>moderate</td>
<td>moderate</td>
</tr>
<tr>
<td>gamma</td>
<td>electromagnetic ray</td>
<td>many</td>
<td>high</td>
<td>low</td>
</tr>
</tbody>
</table>

Ionizing radiation: radiation with enough energy to eject orbiting electrons (ionization)

CANCER AND RADIATION:
- CARCINOGENESIS:
  1) mutation of cell cycle regulatory genes
  2) repeated tissue trauma to stimulate mitosis

Radioactivity is a mutagen because it can mutate cell cycle regulatory genes

Tissue susceptibility is proportional to intrinsic mitotic rate:
- Epithelial tissue: high mitotic rate (most common form of cancer) form carcinomas (“crab tumor”)
- Connective tissue: moderate mitotic rate, can be stimulated to divide form sarcomas (“flesh tumor”)

CHEMICAL ACTIVITY:
- Orbital model, octet rule for chemical activity, valence shell, electronegativity

Bonds:
- Ionic: Complete transfer of $e^-$, makes cations vs anions
- Covalent: strongest of chemical bonds (vs polar covalent bonds)
- Hydrogen bonds: crucial in biology, water as universal solvent

KNOW: Oxidation-reduction: reducing agents give electrons, oxidizing remove. Oxidation = aging

WATER:
- Solvent in which life's processes take place (solvent + solute = solution)
- pH: acids vs bases, $pH = -\log_{10}[H^+]$
- Acid donates protons, base accepts protons
- Buffer maintains concentration of protons in solution

CHEMICAL REACTIONS:
- Anabolic ("up throw") uses ATP for energy
- Catabolic ("down throw") generates ATP

ORGANIC COMPOUNDS

Carbohydrates: $C_nH_{2n}O_n$ (p 43-45)
- Monosaccharides: glucose, fructose, galactose (only monosaccharides can be absorbed, metabolized)
- Disaccharides: maltose, lactose, sucrose (must be hydrolyzed before absorption)
- Polysaccharides (glycans): starch, glycogen, cellulose (the latter is indigestible, serves as fiber in diet)
- Mucopolysaccharides: in mucus, ground substance, synovial joint fluid (Proteoglycans)

Lipids:
- Fats (triglycerides), fatty acids (simple fat), phospholipids, steroids

Proteins: Protein linear sequence of amino acids, joined by peptide bonds
- Comprise enzymes, structural proteins
- Fibrous proteins: collagen, keratin, elastin, actin and myosin
- Globular proteins: hemoglobin, albumin
- Transport, buffer (albumin) defense, hormones
- Most secreted proteins are glycoproteins

Enzymes:
- Protein catalysts (LEARN)
- Catalysis: speeds up a reaction by reducing the energy required for activation
- Enzymes: protein catalysts, active site, substrate, shape critical.
- Alter shape of an enzyme, destroy activity (heat, cold, pH, high salt, etc)

Nucleic Acids:
- Genetic material: deoxyribonucleic acid, polymer of nucleotides A, T, G, C
- Ribonucleic acid, also a polymer, but with A, U, G, C, and ribose in backbone

CENTRAL DOGMA OF MODERN GENETICS:
- DNA: the “genetic material” chromosones in the nucleus, reproduced by replication
- Transcription: DNA directs the synthesis of RNA, in the nucleus. (p 85)
- Translation: Ribosomes use mRNA to direct protein synthesis (p 88-89)

PROTEIN: Product of “gene expression” = enzymes, structural proteins, antibodies, etc.