RADIATION PROTECTION FOR THE ENVIRONMENTAL HEALTH SPECIALIST

Facts

Radiation:
- The shedding of extra energy from a radioisotope or radionuclide
- Energy emitted in the form of waves or particles
  - Waves=Gamma or X-Rays
  - Particles=Alpha, Beta, Neutrons

Energy Spectrum:
- High energy
  - Short wavelength
  - High frequency
- Low energy
  - Long wavelength
  - Low frequency

Ionizing:
- Higher energy EM waves or particles (can pull electron from orbit)
- Alpha
  - Occurs from unstable nuclei w/too many protons & neutrons
  - Positively charged
  - Straight-line paths w/high energy along path & *burst* of ionization at end
- Beta (a.k.a., negatrons and positrons)
  - Occurs from unstable nuclei w/too many neutrons
  - Decay by emission of negative beta particles (negatron)
  - Electron ejected from a radioactive nucleus that is neutron-rich
  - Negatrons are negatively charged
  - More penetrating than alphas, but dependent upon energy
  - Best shielding: low Z-number materials (plastic, cardboard, Plexiglas, wood)
  - Do NOT use high Z-number materials w/high-energy beta emitters or it will result in *bremsstrahlung* breaking radiation (a.k.a, x-rays)
- Gamma
  - Packets of pure energy (*electromagnetic radiation*)
  - Higher in energy and more penetrating than alpha or beta
  - Photons (excess energy) emitted from unstable nuclei
  - Only difference between x-rays and gamma rays are their origin
    - Gamma rays originate from *within* the nucleus
    - X-rays originate from *outside* the nucleus
  - No mass
  - No electric charge
  - Low specific ionization (SI) and low linear energy transfer (LET)
- Neutron
  - Indirectly ionizing radiation
  - No charge

    - Can be more penetrating than gamma (depending on medium)
    - Activation can occur
    - Best shielding: hydrogen products (e.g., water, paraffin, wax, concrete)
- Damage due to ionizing radiation
    - At cell or subcellular level
    - Interaction is within cell itself or DNA of the cell
    - Subcellular components could be affected
    - **Damage is repairable**
    - Apoptosis (cell death) can occur, which is a natural event

Non-Ionizing:
- Lower energy EM waves or particles (can excite electron, but not pull from orbit)
- Examples: visible light, RF, ultrasound

Sources of Natural Background Radiation:
- Cosmic
    - Origin in space
        - Protons
        - Alpha particles
        - Assorted atomic nuclei
- Cosmogenic
    - Produced by action of cosmic radiation in atmospheric gas atoms
    - Major contributors are Hydrogen and Beryllium
- Terrestrial
    - Results from presence of primordial radionuclides and their decay products
    - Radium, Radon, Thorium, Actinium

- Irradiation (exposure) is the process of exposing an individual to radiation.

Contamination:
- The spread of radioactive materials to places where it should not be
- Two types
    - External
        - On skin surfaces or clothing
        - Almost all can be removed by removing clothing
    - Internal
        - Ingestion, inhalation, absorption (open cuts/wounds)

Safety:
- Time (less time near means less exposure)
- Distance (inverse square law…increase distance between you and source)
- Appropriate shielding
    - Do NOT use Pb with high-energy beta due to x-ray production
    - Do NOT use thin Pb with high-energy gamma due to scattering
    - Good shielding for high-energy particles are *low Z-number* materials

        - Wood, Plexiglas, cardboard, particleboard
    - Good shielding for photon radiation (x-rays, gamma rays) are sufficiently thick *high Z-number* materials
        - Lead (Pb), tungsten (W), depleted uranium (U)

ALARA:
- Concept that all radiation exposure should be kept as low as reasonably achievable
- Social and economic conditions taken into account

- Geiger Counter (GM) used to detect radiation.

Cell Types & Radiosensitivity:
- Little or no mitosis=low radiosensitivity
    - CNS
    - Sense organs
    - Adrenal module
- Low mitotic rate=moderate radiosensitivity
    - Liver
    - Thyroid
    - Vascular endothelium
    - Connective tissue
- Frequent mitotic rate=high radiosensitivity
    - Epidermis
    - Intestinal epithelium
    - Bone marrow
    - Gonads
    - Stem cells

- Contaminated items should be stored for *at least* 10 ½-lives before release from storage.