**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.