**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.