Radiological Preparedness & Emergency Response

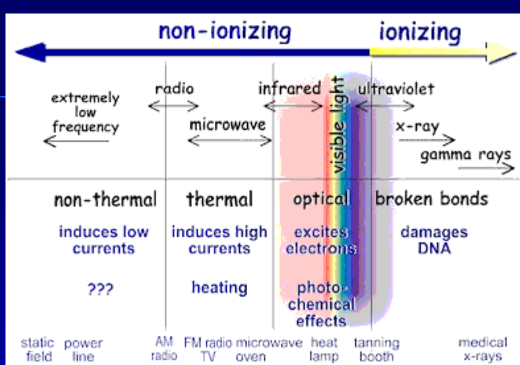
Session II

Basic Radiation Physics

Objectives

- Discuss the difference between ionizing and non-ionizing radiation.
- Describe radioactive decay.
- Discuss the different types of ionizing radiation.

Radiation in Pop Culture



Radiological Preparedness & Emergency Response

Different Types of Radiation

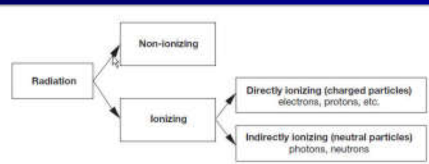
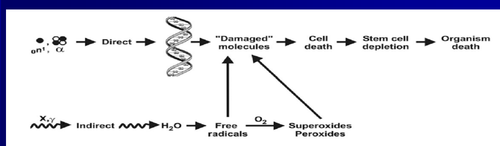


FIG. 1.1. Classification of radiation.

Radiological Preparedness & Emergency Response

Ionizing Radiation

- Damages DNA.
- Produces free radicals by damaging water molecules.



Radiation Damage

- Deterministic
  - Threshold dose
  - Local radiation injury
  - Acute radiation syndrome
- Stochastic
  - Random
  - Oncogenesis
  - Teratogenesis

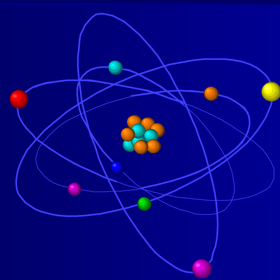
Cell Sensitivity

High

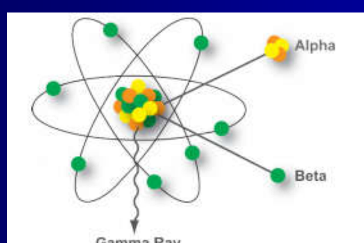
Low

- Embryos!!!
- Blood-forming organs (numbers).
- Cancer cells / tumors.
- GI tract.
- Skin (including hair follicles).
- Muscles.
- Central nervous system.

What is an Atom Composed Off?



Why do Certain Atoms Emit Radiation and are Radioactive?



Example of an Alpha Particle Emitter: Polonium-210

- Alpha particles
  - Positively charged, easily stopped by a thin paper, do not present an external hazard.
  - Inhaled/ingested, can result in significant organ damage.

http://www.blackcatsystems.com/science/radprod.html

$$^{210}_{84}Po \rightarrow ^{206}_{82}Pb + ^{4}_{2}\alpha$$

parent — daughter — ejected

Radiological Preparedness & Emergency Response

Example of a Beta Particle Emitter: Carbon-14

- Beta particles
  - Negatively charged. electrons, can travel several centimeters through air. Stopped by clothes.
  - If internalized can cause problems.
  - "beta burn".

$$^{14}_{6}C \rightarrow ^{14}_{7}N + ^{0}_{-1}e^{-} \text{ (ejected)}$$

Example of a Gamma Ray Emitter: Cesium-137

- Gamma rays
  - Electromagnetic waves.
  - Gamma rays are the same as x-rays -- the difference is their source from within the atom: nuclear for gamma, extranuclear for X-rays.
  - Are a significant hazard (depending on duration of exposure, distance from the source, and type of shielding).

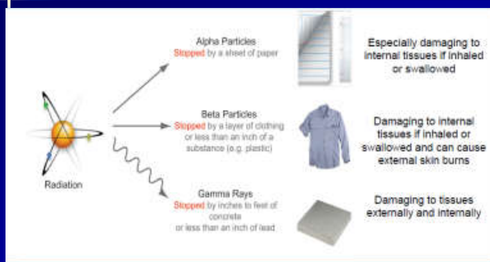
Radiological Preparedness & Emergency Response

Example of a Neutron Emitter: Uranium-235

- Neutrons
  - Neutron irradiation can turn previously nonradioactive materials radioactive.
  - Uncharged. Causes whole body irradiation like Gamma rays.
  - Emitted from fission reactions.

Radiological Preparedness & Emergency Response

Differences



EMORY UNIVERSITY SCHOOL OF MEDICINE

CDC Video

EMORY UNIVERSITY SCHOOL OF MEDICINE

Radiation Measurement Units

S.I.	Formula	USA
1 Becquerel (Bq)=	$1/3.6 \times 10^{10}$ x	Curie (Ci)
1 Gray (Gy) =	100 x	RAD
1 Sievert (Sv) =	100 x	REM

EMORY UNIVERSITY SCHOOL OF MEDICINE

Difference Between RAD and REM - Gray and Sievert

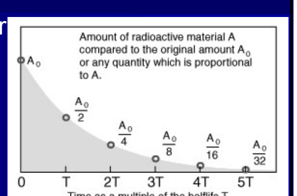
- RAD and Gray express the amount of energy deposited per gram of tissue or material.
- REM and Seivert express the health effect from the radiation deposited in a specific organ by a specific type of radiation.
- For gamma rays 1 RAD = 1 REM.

What is a Radiation Source Activity?

- Activity reflects how radioactive a source is.
- How many disintergrations or decays are occurring every second.
- As time passes, a radioactive source is no longer radioactive.
- The amount of time needed depends on the source radiological half life.

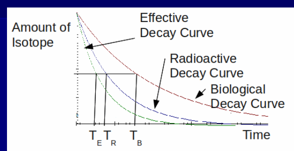
Physical Half Life

- Time required for activity to be reduced by ½
- Specific to each radionuclide
  - I-131 = 8 day
  - Cs-134 = 2 yr
  - Cs-137 = 30 yr



Biological and Effective Half-Life

- Biological: time required for body to eliminate ½ of a particular element

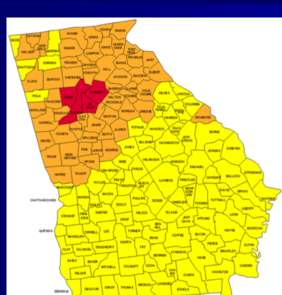


- **Effective: combined effect of radioactive decay and physical elimination**
- **Effective half-life is ALWAYS less than physical or biological half-life**

Where is Radiation Found?

- Natural sources
  - Radon
  - Cosmic rays
- Man-made sources

Radon Map Georgia



Background Radiation

People on Earth Are Exposed to Radiation Every Day of Their Life

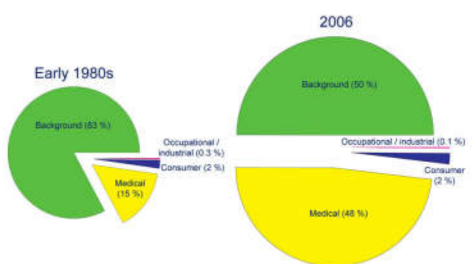
In 2006, the average person in the United States received an annual radiation dose of 6.2 milliSieverts

Source of Radiation	Percent Contribution to Total
Radon & thoron (Background)	37
Space (Background)	5
Internal body (Background)	5
Terrestrial (Background)	5
Medical procedures	48
Consumer products	2
Industrial releases	< 1
Occupational	< 1

Source: National Council on Radiation Protection and Measurements Report No. 160 (2009)

28

NCRP Report No. 160, *Ionizing Radiation Exposure of the Population of the United States*



	Early 1980s	2006
Collective effective dose (person-Sv)	835,000	1,870,000
Effective dose per individual in the U.S. population (mSv)	3.6	6.2

ALARA

- "As Low As Reasonably Achievable"
- Work activities in radiation areas must be carefully planned to minimize radiation doses to workers
- Dose to general public kept low
- Control of releases of radioactive materials to the environment

Summary Points

- Ionizing radiation damages cells and DNA.
- Ionizing radiation includes alpha particles, beta particles, gamma rays and neutrons.
- People are exposed to background radiation at all times.

Any Questions?