Radiation in Occupational Health

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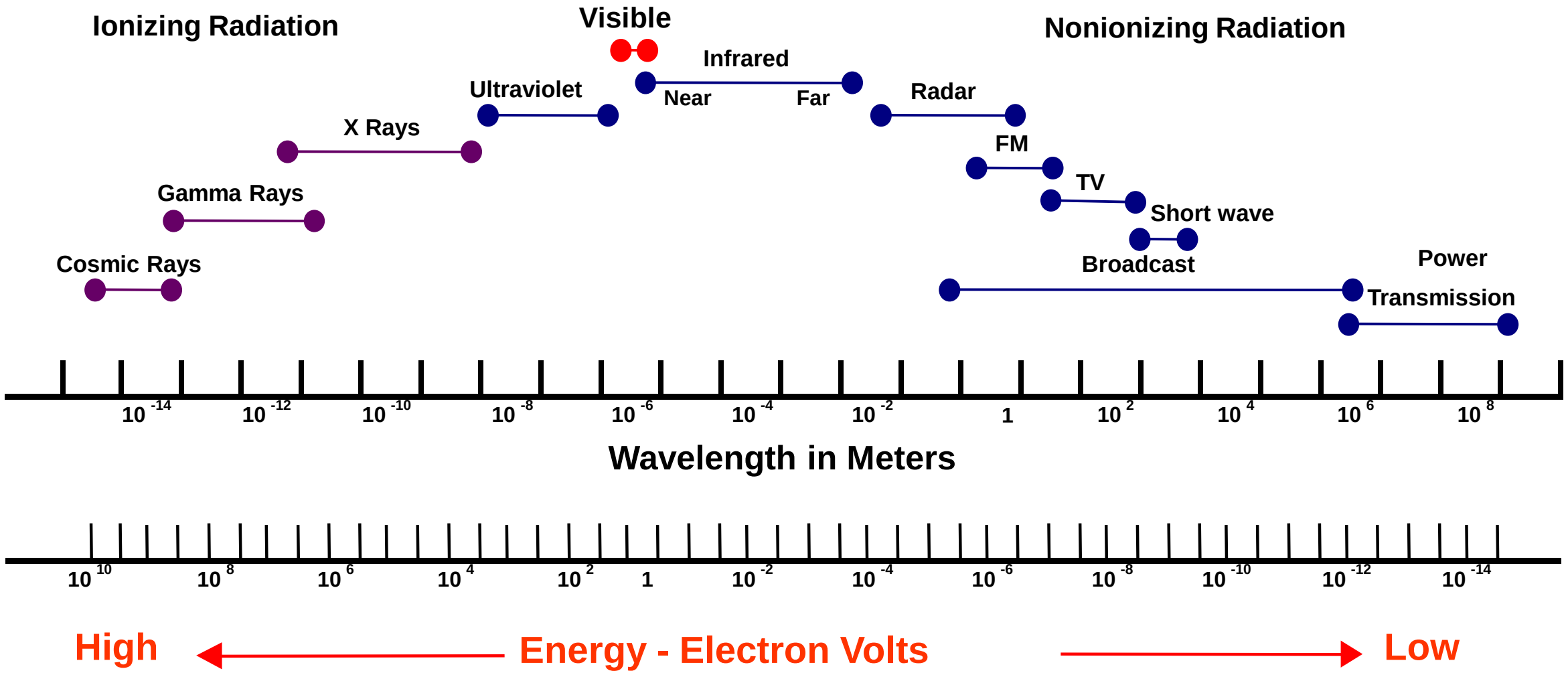
Radiation.... Historical Background

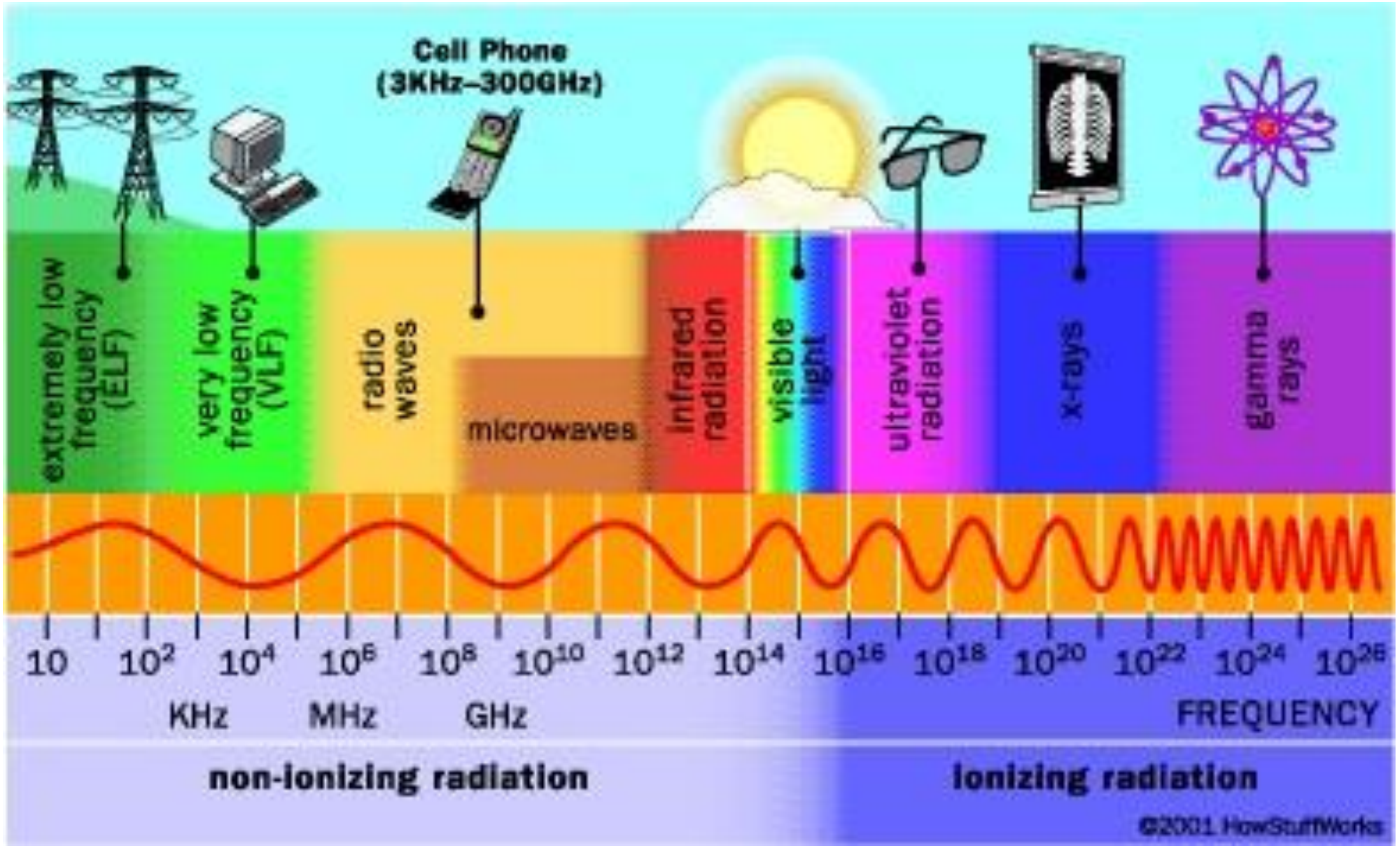
- 1895 - Roentgen discovered X-rays and in 1901 he received the first Nobel Prize for physics. Within one year, benefits of x-rays, such as visualization of fractures, and bad effects, such as x-ray dermatitis, were recognized.
- 1903 - Marie Curie and Pierre Curie, along with Henri Becquerel were awarded the Nobel Prize in physics for their contributions to understanding radioactivity, including the properties of uranium. A year later the application of radiation to cure cancer was reported. Marie died with aplastic anemia, and her daughter died with leukemia).
- Internationally developed radiation protection recommendations were formalized starting in the late 1920s
- 1942 - Enrico Fermi and others started the first sustained nuclear chain reaction in a laboratory beneath the University of Chicago football stadium.
- 1945 – Nuclear bombs dropped on Japan.

Life & Radiation

- **All life is dependent on small doses of electromagnetic radiation: For example, photosynthesis and vision use the sun radiation.**

Electromagnetic Spectrum




Cell Phone
(3KHz–300GHz)
extremely low frequency (ELF)
very low frequency (VLF)
radio waves
microwaves
infrared radiation
visible light
ultraviolet radiation
x-rays
gamma rays
10
10²
10⁴
10⁶
10⁸
10¹⁰
10¹²
10¹⁴
10¹⁶
10¹⁸
10²⁰
10²²
10²⁴
10²⁶
KHz
MHz
GHz
FREQUENCY
non-ionizing radiation
ionizing radiation
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Radiation

Nonionizing

Ultraviolet, visible light, infrared, microwaves, radio & TV, power transmission

Ionizing

Radiation capable for producing ions when interacting with matter:

x-rays, alpha, beta, gamma, cosmic rays

Ultraviolet - Sources

- Sun light (Most harmful UV is absorbed by the atmosphere)
- Fluorescent lamps
- Electric arc welding
  Can damage the eye (cornea)
- Germicidal lamps

Can cause: Eye damage from sun light
Skin cancer

Ultraviolet - Effects

- High ultraviolet – kills bacterial and other infectious agents
- High dose causes - sun burn – increased risk of skin cancer
- Pigmentation that results in suntan
- Sunblock lotions contain chemicals that absorb UV radiation (UVA, UVB)
- UV reacts in the skin to produce Vitamin D that prevents rickets

Visible Light

- Energy between 400 and 750 nm
- High energy – bright light produces a number of adaptive responses
- Standards are set for the intensity of light in the work place (measured in candles or lumens)

Infrared Radiation

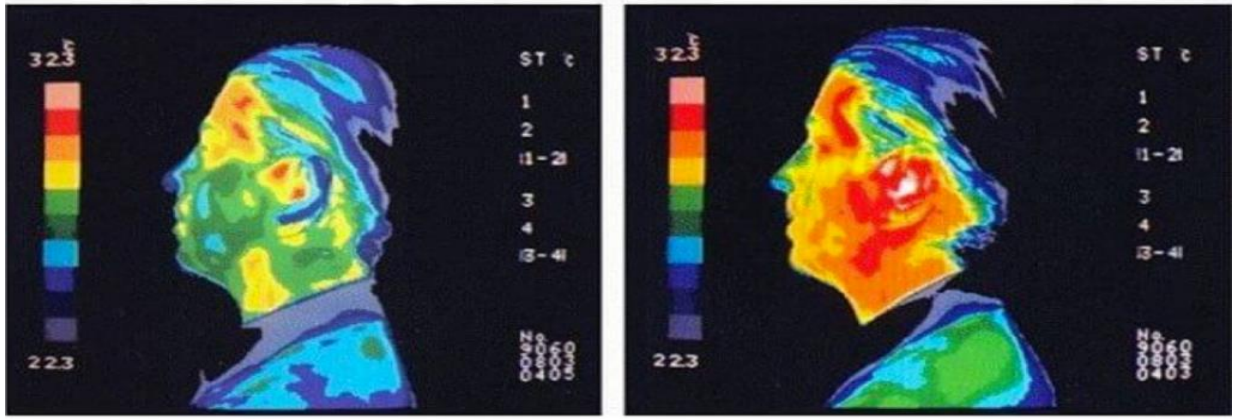
- Energy between 750 nm to 0.3 cm
- The energy of heat – Heat is the transfer of energy
- Can damage – cornea, iris, retina and lens of the eye (glass workers – “glass blower’s cataract”)

Microwaves & Radio Waves

- Energy between 0.1 cm to 1 kilometer
- Varity of industrial and home uses for heating and information transfer (radio, TV, mobile phones)
- Produced by molecular vibration in solid bodies or crystals
- Health effects – heating, cataracts

Thermal Effects

Heat Generated on the face by 15 minute of cell phone use due to their electromagnetic radiation



BEFORE USING A MOBILE PHONE

USING MOBILE PHONE FOR 15 MINUTES

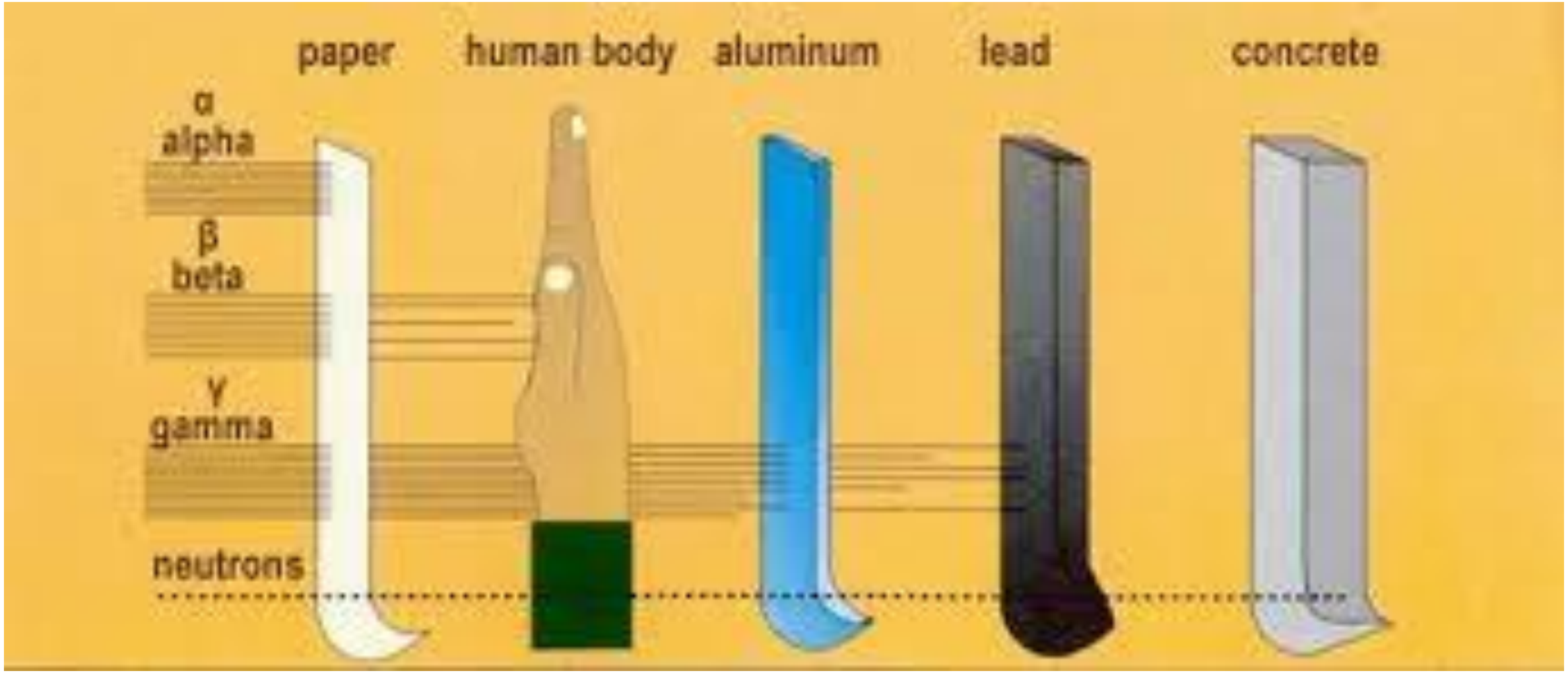
Electrical Power

- Standard in homes and businesses
- Highest level of exposure from electric-power generation and distribution system (high voltage power lines)
- Medical system – Magnetic imaging
- Acute health effects – shock
- Long-term health effects appear to be few but some data do suggest adverse effects

Onizing Rediation, Key Facts

- Ionizing radiation is a type of energy released by atoms in the form of electromagnetic waves or particles and capable for producing ions when interacting with matter (remove an electron from an atom).
- People are exposed to natural sources of ionizing radiation, such as in soil, water, and vegetation, as well as in human-made sources, such as x-rays and medical devices.
- Ionizing radiation has many beneficial applications, including uses in medicine, industry, agriculture and research.
- As the use of ionizing radiation increases, so does the potential for health hazards if not properly used or contained.

Ionizing Radiation



Gamma-rays

- Electromagnetic photons or radiation (identical to x-rays except for source)
- Emitted from nucleus of radioactive atoms – spontaneous emission
- Highly penetrating, extensive shielding required
- Serious radiation hazard

X-rays

- Overlap with gamma-rays
- Electromagnetic photons or radiation
- Produced from orbiting electrons or free electrons – usually machine produced
- Emitted with various energies & wavelengths
- Highly penetrating – extensive shielding required
- Radiation hazard
- Discovered in 1895 by Roentgen

Ionizing Radiation Health Effects

We evolved on earth with a certain level of naturally occurring ionizing radiation from cosmic rays, and radioactive materials in the earth.

We have in our bodies mechanisms to repair damage that may occur from the naturally occurring sources.

Health Effects…

Beyond certain thresholds, radiation can impair the functioning of tissues and/or organs and can produce acute effects such as skin redness, hair loss, radiation burns, or acute radiation syndrome. These effects are more severe at higher doses and higher dose rates (1 Sv=1000 mSv).

If the radiation dose is low and/or it is delivered over a long period of time (low dose rate), the risk is substantially lower because there is a greater likelihood of repairing the damage.

There is still a risk of long-term effects such as cancer, however, that may appear years or even decades later. Effects

Radiation Units

Exposure – X (joul/kg)

(Related to energy from source)

Absorbed Dose – Gray (Gy)

(amount of energy absorbed)

Equivalent Dose – Sievert (Sv)

(effective dose) (makes different sources of radiation equivalent for comparison)

Regulations … Standards

Occupational Exposure Guidelines

100 mSv over 5 years (average 20 mSv/year) with a maximum of 50 mSv in any one year

General public

Background about 3 mSv/year

Recommended exposure limits are set by the US National Council on Radiation Protection (NCRP) and world wide by International Council on Radiation Protection (ICRP).

Half-life

- Rate of decay of radioisotope
- How long it takes to lose half their strength

- Can range from very short to billions of years

- For Carbon is 5730 years, which makes it valuable for dating

Reducing Exposure

- **Time**
  Reduce the time spent near the source of radiation.

- **Distance**
  Increase the distance from the source of radiation.

- **Shielding**
  Place shielding material between you and the source of radiation.

Rules to Remember When Working With Radiation

Everyone must take radiation overexposure seriously. Hence, preventive measures and rules must be strictly followed to avoid critical health conditions.

- Acquire adequate training to better understand the nature of radiation hazards.
- Reduce handling time of radioactive materials and equipment.
- Be mindful of your distance from sources of radiation. Increase distance as much as possible.
- Use proper shielding for the type of radiation.
- Isolate or contain harmful radioactive materials properly.
- Armor yourself with appropriate protective clothing and dosimeters.
- Conduct contamination surveys in the work area.
- Do not eat, drink, smoke, or apply cosmetics in an area where unsealed radioactive substances are handled.
- Observe proper radioactive waste disposal.