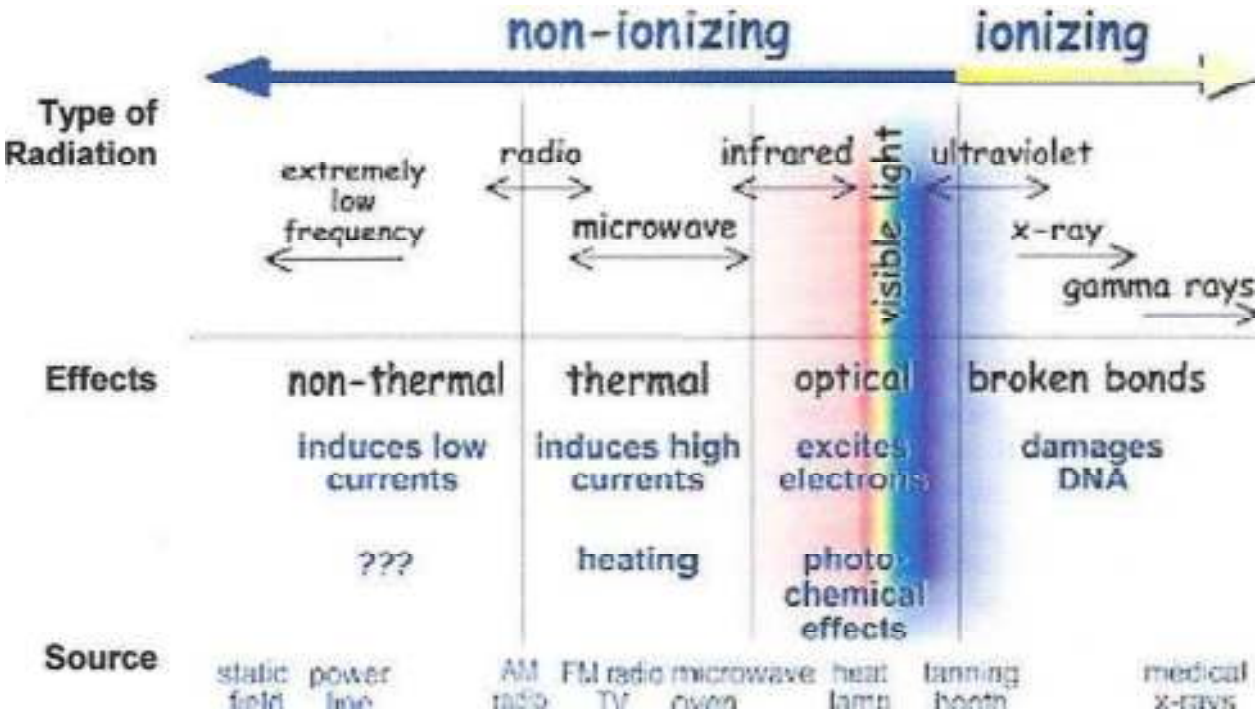
Ionizing and Non-Ionizing Radiation Study Guide

Radiation- Energy emitted from a body or source that is transmitted through an intervening medium or space and absorbed by another body. Transmission is in the form of waves but wave/particle duality under quantum physics.

Radiation is classified as being either **non-ionizing** or **ionizing**. Non-ionizing radiation is longer wavelength/lower frequency lower energy. While ionizing radiation is short wavelength/high frequency higher energy.

Ionizing Radiation has sufficient energy to produce ions in matter at the molecular level. If that matter is a human significant damage can result including damage to DNA and denaturation of proteins. This is not to say that **non-ionizing radiation** can't cause injury to humans but the injury is generally limited to thermal damage i.e. burns.



There is a great deal of information on the above chart. One of the most interesting things is that the visible spectrum is essentially the divide between ionizing and non-ionizing radiation. This makes sense clinically when we think of UV radiation causing skin cancer.

Types of Non-Ionizing Radiation and Their Clinical Effects-

Referring again to the chart above we can see that Non-Ionizing radiation comes in the forms of:

1. ELF (extremely low frequency)
2. Radio Frequencies
3. Microwave Frequencies
4. Lasers
5. Infrared
6. Visible Spectrum
7. Ultraviolet

This list is in order of lowest to highest frequency.

1. ELF

Power plant or line workers

Inconclusive evidence of leukemia link

2. 3. Radiofrequency and Microwave Frequency Exposures-

Occupational Exposures-

Radar and communications equipment, industrial and commercial ovens

Other Exposures

Cell Phones

Clinical Effects-

There is a great deal of controversy regarding potential cancer risks, particularly with cell phone use. We know that exposure to radio and microwave frequency sources can cause burns and clinically this is what you are most likely to see.

4. LASER (Light Amplification by Stimulated Emission of Radiation)

Beams of coherent light with single wavelength and frequency

May be in the IR, Visible or UV spectrum

Eye is most sensitive to injury from LASER

Four classes by risk of injury:

1. No damage
2. Low chance for damage due to blink
3. A)Cause injury with direct exposure
   B)Cause injury even when reflected
4. Requires controls to prevent injury

5. Infrared

Penetrates superficial layers of the skin, causes thermal injury, potential for damage to the cornea, iris, lens of the eye

Welding, glassmaking, heating and dehydrating processes

6. Visible Spectrum

400 to 750nm wavelengths

ROYGBIV (Red, Orange, Yellow, Green, Blue, Indigo, Violet)

Possibility of retinal injury from 400-500 nm blue frequencies

8. Ultraviolet Radiation

200nm to 400 nm

Bridge between Non-Ionizing and Ionizing Radiation

Three regions

UV-A 315nm-400nm

UV-B 280nm-315nm

UV-C ‹280nm

A and B bands produce biologic effects on the skin and the eyes. Photokeratitis, conjunctivitis, sunburn, photosensitization reactions, skin cancers

Majority of exposures are to outdoor workers, other exposures include welders, people who work in drying and curing industries and laboratory, kitchen or medical industries exposed to germicidal ultraviolet

Types of Ionizing Radiation and Their Clinical Effects-

Ionizing radiation is emitted from radioactive atomic structures as high energy electromagnetic waves (gamma and x-rays) or as actual particles (alpha, beta, neutrons)

1. Gamma Rays
2. X-Rays
3. Alpha Particles
4. Beta Particles
5. Neutrons

Penetration of Radiation

Gamma Rays, Xrays and Neutrons Penetrate Body Easily, Need lead to shield for gamma and x-rays, massive shielding for Neutrons

Alpha and Beta Particles are essentially blocked by the skin with Beta Particles penetrating more deeply with the potential to cause burns. Alpha particles can be stopped by paper, Beta by plastic

Alpha Particles can cause significant damage if taken internally, see former Soviet Spy

Radiation Measurement

Roentgen (R)- Describes a radiation field in terms of the amount of ionizations produced in air, not in common use today

Rad- Conventional unit of absorbed dose of radiation per unit mass.

Gray (Gy) – 1 Gray=100 Rads

Rem- Absorption measure to whole body or specified organ, takes into account radiation quality, Rem=rads x quality factor, each type of ionizing radiation has a different quality factor

Sievert (Sv)- 1SV=100 Rem

Ionizing Radiation Exposure Limits

Occupational- National Council on Radiation Protection (NCRP) annual exposure 5 rem

Background Exposure for a US resident is 360mrem

Common Occupational Exposures-

- Medicine- Radionuclides, X-Ray
- Nuclear Power Industry

- Document Dating
- Food Preservation
- Airplane/Space Flight
- Transportation of Radioactive Material

Four Ionizing Radiation Exposure Categories-

1. Radioactive Contaminates on Intact Skin
2. Local Radiation Injuries
3. Whole Body Exposure
4. Internal Deposition

Acute Radiation Syndrome

Over 100 rad in a single exposure or within 24-48 hours, progressive predictable series of signs and symptoms developing over a period ranging between a few hours to several weeks

Clinical response and prognosis generally depends on damage sustained by hematopoietic system.

Lethal dose for 50% of healthy humans is 350 to 450 rad (3.5 to 4.5 Gy)

Prodromal Period- 1 to 6 hours after exposure

Anorexia, Nausea, Vomiting, Diarrhea

Initial Symptoms subside after a few hours to two days

Ominous signs include diarrhea, skin erythema, lymphocyte count less than 1000, short or no latent period

Latent Period- Variable in duration hours to 30 days

Manifest Illness

Fatigue, GI symptoms, desquamation, deep ulcerations, bone marrow depression, Stomatitis, hemorrhagic phenomena

Death or Recovery

CBC normalizes in six months to a few years, Clinical recovery within 6 months, persistent fatigue

Long Term Effects

- Chronic Radiodermatitis
- Cataracts
- Sterility
- Prenatal Effects
- Cancer
- Genetic Effects
- Shortened Life Span

Management of Radiation Exposures

1. Radioactive Contaminates on Intact Skin- Wash skin, do not break skin
2. Local Radiation Injuries- Estimate whole body exposure, wound care, nutritional support, analgesics, infection control, consultation
3. Whole Body Exposure
    - 100 rem or less-
        - Complete history for record
        - Advise regarding potential late effects (cancers)
        - Follow as outpatient, counseling
    - 100 rem to 200 rem
        - Complete exposure history radiation source and strength
        - Consider Lab testing CBC with diff
    - 200 rem to 300 rem
        - Hospitalize
    - 300 rem or more
        - Transfer to Tertiary Care Center
    - Supralethal exposure of more than 5000 rem
        - Supportive care at any hospital will do will die in a few days
4. Internal Deposition
    - Reduce Absorption- Binding Agents, Antacids
    - Expedite Elimination- Cathartics
    - Organ Saturation- Potassium Iodide
    - Displacement- Calcium, Iodide
    - Chelation