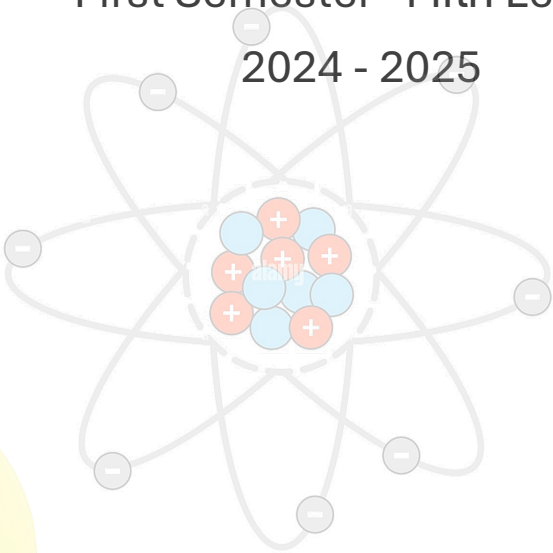
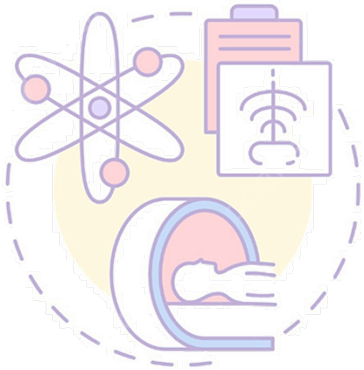
Radiation Protection

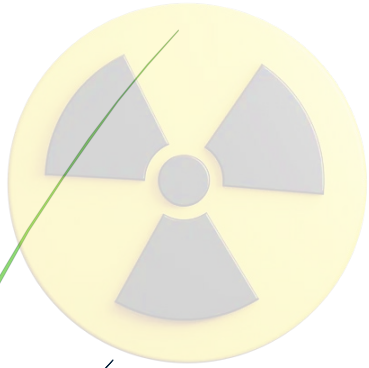
The Second Stage

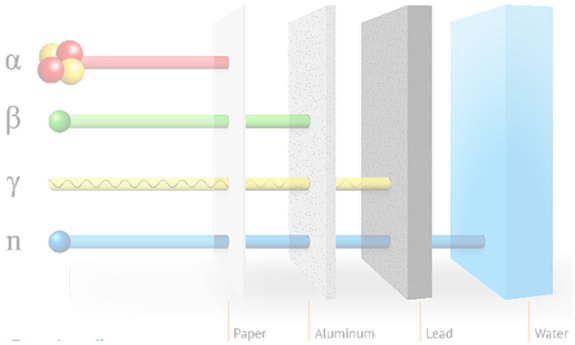
First Semester –Fifth Lecture

2024 - 2025









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Radiation Measurement Units

OUTLINES:

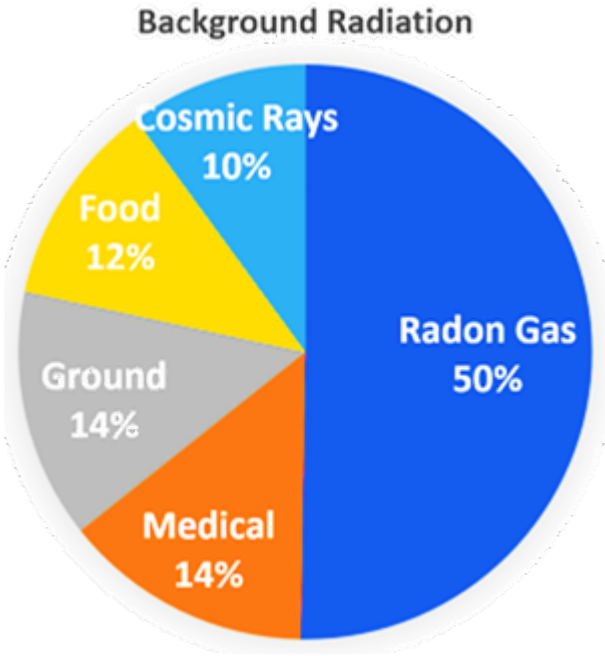
- ✓ System of Physics Units.
- ✓ Radiation Units.
- ✓ Exposure Units.
- ✓ Absorbed Dose.
- ✓ Equivalent Dose.
- ✓ Effective Dose.

- ➢ Background Radiation.
- ➢ Peak Skin Dose.
- ➢ ALARA principles.
- ➢ Exposure doses for occupational, patients and public.
- ➢ Dose limits:
  - ♦ Maximum permissible occupational dose.
  - ♦ Occupational and non-occupational exposure – limit dose.
  - ♦ Maximum permissible public dose.
  - ♦ Maximum permissible Patient dose.
  - ♦ Whole body, tissues and organs dose limits.

What is Background Radiation?

Background radiation is a measure of the level of ionizing radiation present in the environment at a particular location which is not due to deliberate introduction of radiation sources (لا يرجع إلى الإدخال المتعمد لمصادر الإشعاع).

Background radiation originates from a variety of sources, **both natural and artificial.** These include both cosmic radiation and environmental radioactivity from naturally occurring radioactive materials (such as radon and radium), as well as man-made medical X-rays, fallout from nuclear weapons testing and nuclear accidents.



Radon gas is the most background radiation present as the figure describes it. Radon is a chemical element; it has symbol ***Rn*** and atomic number 86. It is a radioactive noble gas and is colorless and odorless. Of the three naturally occurring radon isotopes, only ^{222}***Rn*** has a sufficiently long half-life (3.825 days) for it to be released from the soil and rock where it is generated.

❖ **Peak Skin Dose.**

The maximum absorbed dose to the most heavily exposed localized region of skin (defined as; the localized region of skin that lies within the primary x-ray beam for the longest period of time or multiple exposures during a fluoroscopically guided procedure). The notation used by the International Commission on Radiation Units and Measurements for this quantity is ***D-skin, local*** (ICRU, 2005). The notation used by the National Council on Radiation Protection and Measurements is ***D-skin, max*** (NCRP, 2010).

Peak skin dose is measured in units of ***Gy*** (NCRP, 2010).

The Peak skin dose is the most important quantity to determine because it is estimating the risk of deterministic effects and injury, so it is The highest dose for a single area of the skin.

Deterministic effects describe a cause-and-effect relationship between ionizing radiation and certain side effects. They are also known as non-stochastic effects to contrast them with chance-like stochastic effects (e.g. cancer induction).

These effects depend on the dose, dose rate, dose fractionation, irradiated volume, and type of radiation.

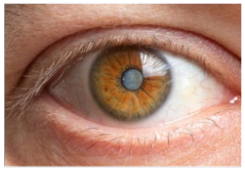
Deterministic effects have a *threshold* below which the effect does not occur. The *threshold* may be very low and may vary from person to person. However, once the threshold has been exceeded, the severity of an effect increases with the dose.

Examples of Deterministic Effects (doses are given as absorbed doses and expressed in grays (Gy)):

- skin erythema: 2-5 Gy
- irreversible skin damage: 20-40 Gy
- hair loss: 2-5 Gy
- sterility: 2-3 Gy
- cataracts: 0.5 Gy
- lethality (whole-body): 3-5 Gy
- fetal abnormality: 0.1- 0.5 Gy

Skin erythema

Normal Eye



Cataract Eye

RADIATION DOSES Millisieverts (mSv)

10,000	Acute radiation poisoning – death within weeks
6,000	Typical dose received by Chernobyl nuclear plant workers who died within one month of accident
3,000	Survival rate approximately 50 percent
2,200	Reading found near tanks used to store radioactive water at Fukushima plant, Sep 3, 2013
1,000	Causes radiation sickness and nausea, but not death. Likely to cause fatal cancer many years later in about 5 of every 100 persons exposed
700	Vomiting, hair loss within 2-3 weeks
500	Allowable short-term dose for emergency workers taking life-saving actions
400 per hour	Peak radiation level recorded inside Fukushima plant four days after accident
350 per lifetime	Exposure level used as criterion for relocating residents after Chernobyl accident
250	Allowable short-term dose for workers controlling 2011 Fukushima accident
100	Lowest level linked to increased cancer risk
20 per year	Average limit for nuclear industry workers
10	Full-body CT scan
2.4 per year	Person's typical exposure to background radiation
0.01	Dental x-ray

❖ ALARA principles

What is the ALARA Principle?

ALARA is an acronym used in radiation safety for "**As Low As Reasonably Achievable**." The ALARA radiation safety principle is based on the minimization of radiation doses and limiting the release of radioactive materials into the environment by employing all "reasonable methods." ALARA is not only a sound radiation safety principle, but it is a regulatory requirement for all "radiation protection programs." The ALARA concept is an integral part of all activities that involve the use of radiation or radioactive materials and can help prevent unnecessary exposure as well as overexposure. The three major principles to assist with maintaining doses "As Low As Reasonably Achievable" are ***time, distance and shielding***.