Secondary Education

3rd year: Sections LH - SE

Physics

Chapter 6: Applications & Dangers of Radioactivity

تم الاعتماد على الكتاب المدرسي الوطني الصادر عن المركز التربوي للبحوث والانماء

إعداد مصطفى سكرية

Chapter 6: Applications & Dangers of Radioactivity

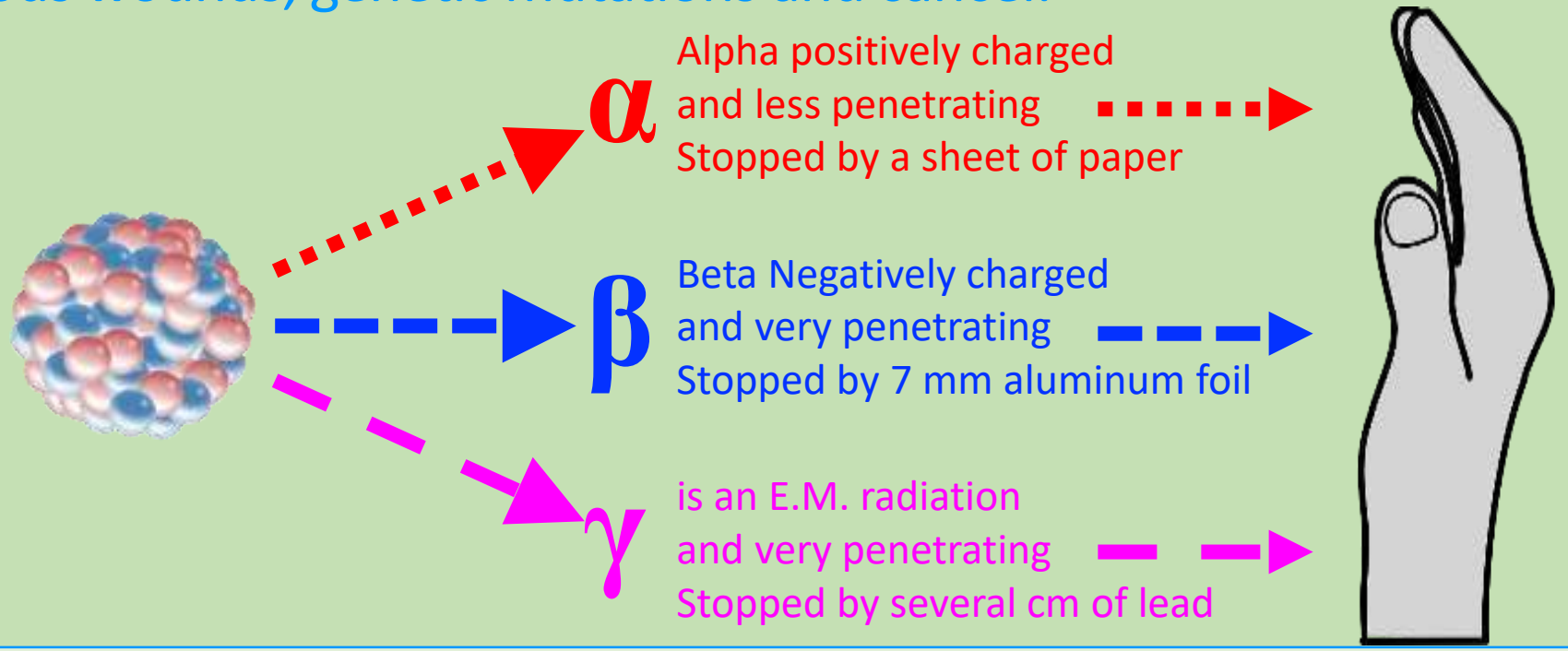
Objectives:

- Define the unit of measurement of radioactive rays.
- Name the types of biologic and genetic effects of radioactive rays .
- Give examples of the uses of radioactivity in medicine.
- Outline the method of disposal of nuclear wastes
- Name some detectors of radioactive radiation.
- Describe methods of protection from radioactive rays.

Chapter 6: Applications & Dangers of Radioactivity

Introduction

The radioactive rays (α, β, γ and neutron) are dangerous to the health of humans and the environment. If absorbed in high doses by tissues and living cells, these radiations provoke ionization that can destroy cells and lead to death. In weak doses, these radiations produce burns, serious wounds, genetic mutations and cancer.



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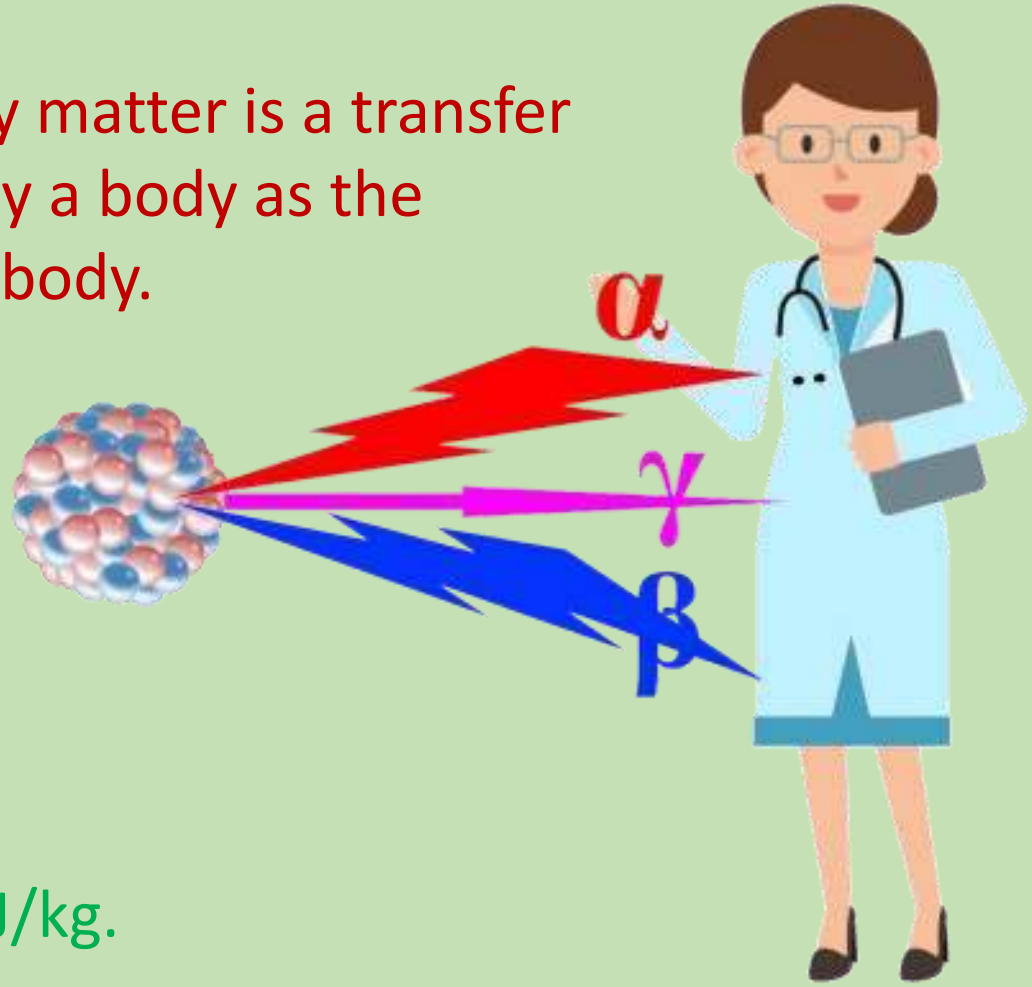
The absorbed dose

The absorption of rays or radioactive radiation by matter is a transfer of energy. We define **the absorbed dose (A.D.)** by a body as the energy transferred to the unit mass (1 kg) of the body.



$$\mathbf{A.D} = \frac{\mathbf{Energy\ received}}{\mathbf{Mass}}$$

In SI units, the absorbed dose is expressed in gray (symbol: Gy). 1 Gy = 1 J/kg.

In practice we use the rad. 1 rad = 10^{-2} Gy = 10^{-2} J/kg.

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The biologic and genetic effects of radiation

The absorption of radiation by living matter provokes some biologic and genetic effects. These effects depend on the absorbed dose and also on the nature of the radiation.

For every type of ray a coefficient called Relative Biologic Efficiency (R.B.E.) is defined.

Ray	β^-, β^+, γ	Neutron	α
R.B.E.	1	5 to 10	20

From the R.B.E. we can determine the physiological equivalent of the received dose, whose SI unit is the Sievert (Sv):

Physiological equivalent of dose (Sv) = Absorbed dose (Gy) $\times$ R.B.E.

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The biologic and genetic effects of radiation

Physiological equivalent of dose (Sv) = Absorbed dose (Gy) × R.B.E.

The same physiological equivalent of dose and for the same tissue or organ, the effects are identical whatever is the received ray.

Note that the molecules of DNA affected by small doses can be genetically damaged.

E.D (Sv)	Effects
> 10	Death
5	50 % mortality, Cancers, diarrhea, vomit, Blood disease.
2	10 % mortality, Cancers, diarrhea, vomit, Blood disease.
1.25	Digestive problems, Sterility, increased risk of cancers
0.05	Modification of blood formula

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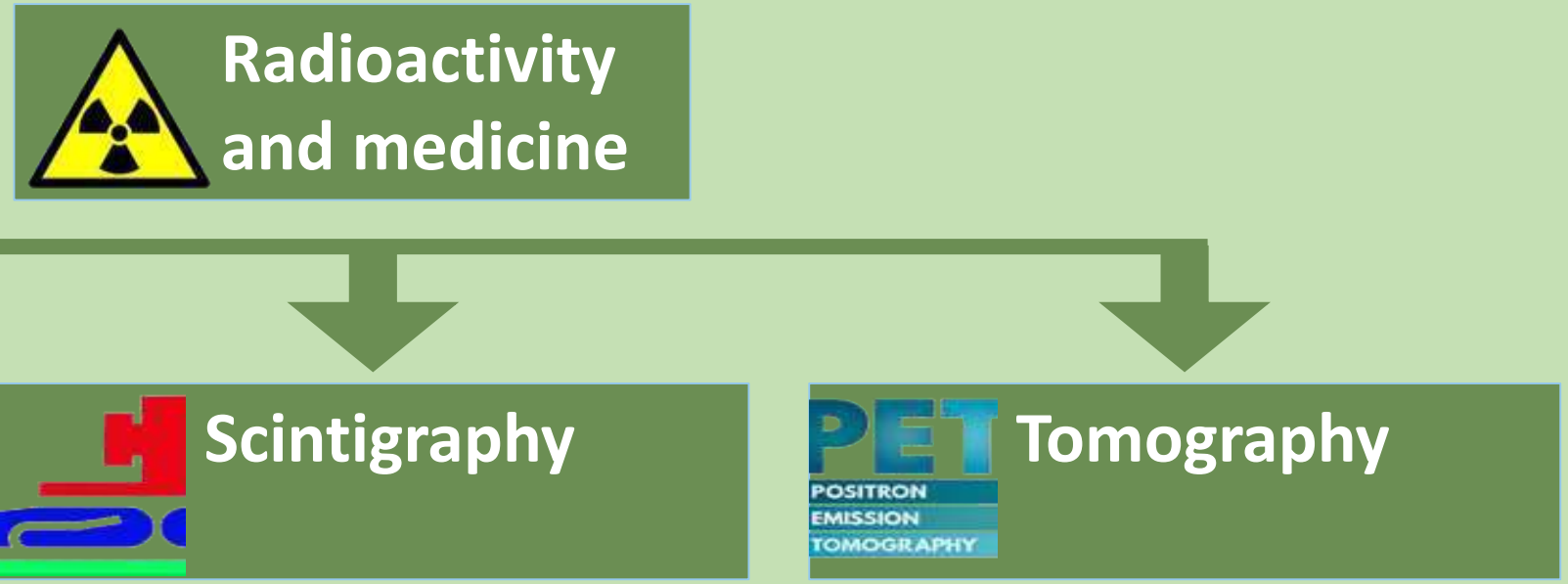
Radioactivity and medicine

Although radioactive rays are harmful for humans, they can be beneficial in some conditions and in several domains.



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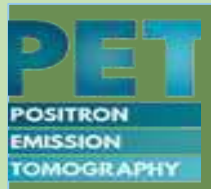
Radioactivity and medicine

Radiotherapy

Radiotherapy is the destruction of cancerous cells by irradiating the tumor by a radioactive rays γ.

Scintigraphy



Tomography

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Radioactivity and medicine

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Tomography

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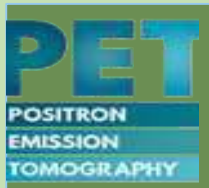

Tomography

To study brain functioning by implanting a radioactive source of β^+ in molecules circulating in the brain positron + electron $\rightarrow 2\gamma$

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Nuclear wastes

The fuel used in nuclear power stations to produce electric energy remains extremely radioactive, even at the end of its cycle of use because it will always contain some radioactive elements. The unused fuel and products of fission are collectively named nuclear wastes.

Wikipedia.org

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Nuclear wastes

Radioactive wastes are classified into two groups according to their radioactive period:

- Wastes of short radioactive period (T < 30 years): these wastes become harmless after 300 years. They are shut in metallic barrels and concrete containers that are put in cement structures under a big insulated heap of clay.
- Wastes of long radioactive period: these wastes need thousands of years to become harmless. They are buried underground, at a depth of several hundreds meters. This storage must be made in areas of steady geological formations, away from water circulation and must last for thousands of years.

Chapitre 6 : Applications et Dangers de la Radioactivité

Protection against radioactive radiation

Protection against large doses of radioactive radiation is crucial because they are extremely dangerous.

- In the case of a leak:
  - People should be evacuated to a building having lead walls that stop the radiations.
  - Filtering masks are used to protect the respiratory tract.
- The personnel in nuclear power plants must wear protective clothing that stop the radiation.

Euronews.com Forest fire burning around the Chernobyl nuclear power plant, Ukraine, April 4, 2020

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Application

1) Nuclear energy is used in medicine in two fields: diagnosis and therapy.
   Give an example of this use in each field.
   Diagnosis: Scintigraphy or tomography
   Therapy: radiotherapy
2) The nuclear wastes are dangerous. Why?
   Because they contain radioactive substance that can pollute the surrounding area by dangerous radiations and then may lead to death of people.
3) How can the danger of the nuclear wastes be reduced?
   Their danger can be reduced by Packing them in some containers underground.
4) Every day, nuclear wastes are formed in Lebanon. From where do they come?
   In Lebanon, radioactive wastes come from the hospitals and Radiology nuclear centers.
5) Give two side effects of treatment by radiotherapy.
   Fatigue ; lack appetite ; vomiting

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