

# ☢ Alpha Particle

An **alpha particle** ( $\alpha$ ) is a type of ionizing radiation consisting of **two protons and two neutrons** — the same as a **helium-4 nucleus** ( ${}^4\text{He}^{2+}$ ).

## ▢ Physical Characteristics

- **Massive** compared to other radiation (about 7,000–8,000 times heavier than an electron)
- **Charge:** +2
- **Energy:** High energy (typically 5–8 MeV)
- **Range in tissue:** Very short (~50–100 micrometers)

## ⚡ Biological Effects

- Causes **dense ionization** along its short path
- Induces **double-strand DNA breaks**
- Highly effective at killing cells with **a few particles per cell**
- Due to short range, must be **delivered directly to or near cancer cells**

## ▢ Penetration and Shielding

- Cannot penetrate skin
- Stopped by **a sheet of paper**, skin, or a few centimeters of air
- Dangerous **only if inhaled, ingested, or injected**

## ▢ Medical Relevance

- Used in **Targeted Alpha Therapy (TAT)**
- Paired with tumor-targeting molecules for **highly selective cancer treatment**
- Examples of alpha-emitting isotopes:  ${}^{213}\text{Bi}$ ,  ${}^{225}\text{Ac}$ ,  ${}^{211}\text{At}$

## ▢ Summary

Alpha particles deliver **high-energy, localized damage** to cells, making them powerful tools in cancer therapy when precisely targeted. Their **short path and high cytotoxicity** are key advantages in modern radionuclide therapies.

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