☢ Alpha Emitter

Alpha emitters are radionuclides that emit alpha particles (2 protons + 2 neutrons). They have:

- **High linear energy transfer (LET)**
- **Very short range** in tissue (~50–100 µm)
- Ability to cause **double-strand DNA breaks**
- Minimal damage to surrounding healthy tissue

Key Alpha Emitters Used in TAT

1. Actinium-225 (^^225^^Ac)

- Half-life: ~10 days
- Emits 4 alpha particles via decay chain
- Commonly used in: prostate cancer (e.g., ^225^Ac-PSMA-617), glioblastoma
- Generator-produced from ^229^Th

2. Astatine-211 (^^211^^At)

- Half-life: ~7.2 hours
- Can be directly labeled to biomolecules
- Less toxic daughters (clean decay)
- Produced via cyclotron

3. Bismuth-213 (^^213^^Bi)

- Half-life: ~46 minutes
- Obtained from ^225^Ac/^225^Ra generators
- Used in: glioblastoma (^213^Bi-DOTA-substance P), leukemia
- Very potent for local intracavitary applications

4. Thorium-227 (^^227^^Th)

- Half-life: ~18.7 days
- Long-lived; suitable for antibodies with slow kinetics
- Under investigation for solid tumors
- Decays to ^223^Ra (also alpha emitter)

5. Lead-212 (^^212^^Pb)

- Half-life: ~10.6 hours
- Beta emitter itself, but decays to ^212^Bi (alpha emitter)
- Considered an “in vivo generator” of alpha particles
- Used in neuroendocrine and ovarian cancers

Selection Criteria for Clinical Use

- **Half-life** must match biological half-life of the carrier
- **Decay chain** should avoid long-lived toxic daughters
- **Chemical compatibility** with targeting ligand
- **Availability** and ease of production (reactor, generator, or cyclotron)

Summary

Alpha emitters offer unique advantages for targeted therapies in oncology, especially when localized and potent cell killing is needed. Ongoing clinical trials continue to explore their role in treating glioblastoma, prostate cancer, and hematological malignancies.