Which Form of Radiation is the Most Dangerous and the Most Beneficial?

Radioactivity Revealed
Ivanhoe Girls' Grammar School
Madeleine Breebaart
Junior

Introduction

Radiation. Such a controversial topic. It can be harmful, but so useful, and there are so many types of it. But is it worth the risk? The different types all have positives and negatives, but which one is the highest scoring in both categories? Is it Alpha, that's toxic if it's ingested, but can be blocked by paper, Beta, which is the source of electricity, that can be good or bad, or Gamma, which can cure cancer, but too much and it causes cancer.

Explanation of Scientific and Technical Principles

Radiation is energy traveling from a source via electromagnetic waves or particles. Alpha radiation is positively charged, high-energy particles with two protons and neutrons (*figure 1a)*. It is used in cancer treatment, destroying cancer cells and sparing healthy cells with its limited penetration range. It's also used in smoke detectors, pacemakers, thermal generators etc. Alpha particles can't penetrate more than paper (*figure 2*) but if ingested, it can be extremely dangerous. Alpha particles are highly ionizing, i.e. it knocks electrons off atoms. It's the heaviest and slowest radiation type, so inside your body it moves less and damages locally.

Beta particles are the product of beta decay (*figure 1b).* They are electrons or positrons and are lightly ionizing. They are used to treat shallow disease like skin cancer, using techniques like brachytherapy, where the radiation is brought close to the target. Beta particle mid-range is also useful for medical imaging, self-luminous substances and carbon dating. Beta particles can penetrate more than alpha particles but cannot surpass materials like aluminium (*figure 2).* If beta particles penetrate skin, they can cause radiation burns that look like severe sunburns, cataracts if they strike the lens of the eye, and if ingested, can cause damage to internal organs. If internal organs receive exposure to beta particles, it can increase the chance of cancer, as they damage DNA (*figure 3)*.

Gamma rays are not particles but energy and can have the shortest wavelengths in the universe (*figure 1c).* They are used in sterilization, radiotherapy and medical imaging. Gamma rays are stopped by high density or atomic number substances like lead (*figure 2).* High energy gamma rays can be dangerous and can damage tissue, DNA (*figure 3)*, the immune system and lead to genetic defects.

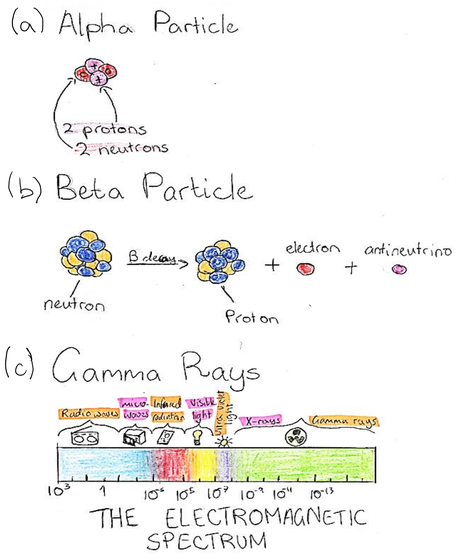


Figure 1 a) alpha particle composition, b) beta particle production process, c) electromagnetic spectrum

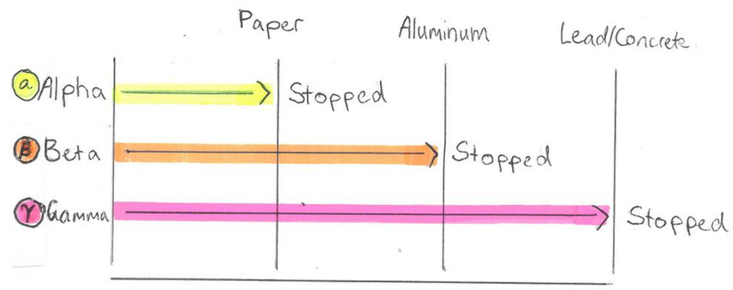


Figure 2 stopping power for alpha, beta and gamma radiation

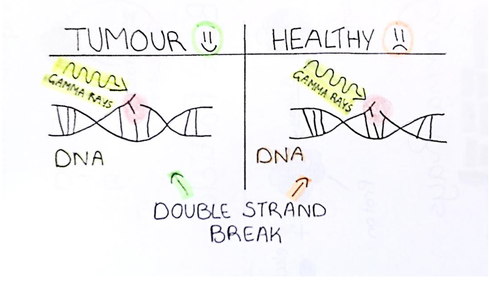


Figure 3 double strand break from gamma rays, examples of good and bad impact

Significance and Impact

Radiation, though we can't see it, is everywhere in the real world. It is found in the sun and stars (cosmic radiation), in nature (natural background radiation) and even naturally found in our bodies (internal radiation).

Radiation is used to cure and diagnose many diseases through radiotherapy (irradiating cancer cells), nuclear medicine (treating diseases with radioactive substances), radiology (diagnostic imaging) and brachytherapy (bringing radiation close to a tumour).

It's important to understand radiation because it can be so dangerous. It can kill you in an instant or over a long period of time, and can make you very sick, all while being invisible. One of the most dangerous types of radiation are Gamma rays.

Gamma rays are pure energy and can have a positive and negative impact. It can penetrate skin, breaking skin cells and chemicals bonds (*figure 3)*, and while it can cure cancer, it can also cause it. It also has a significant impact on the world beyond science, such as radioactive dating, detecting fraud and forensic investigations to solve crime.

Acknowledgements and References

International Atomic Energy Agency. (2025, October 21). What is radiation?
1. *IAEA*. https://www.iaea.org/newscenter/news/what-is-radiation#:~:text=Radiation%20is%20energy%20that%20can%20be%20described,and%20science**%20Nuclear%20techniques%20and%20materials%20production

2. Alpha particles. (n.d.). In *https://www.arpansa.gov.au/understanding-radiation/what-is-radiation/ionising-radiation/alpha-particles*.

3. Radiation sources and doses | US EPA. (2026, February 19). US EPA. https://www.epa.gov/radiation/radiation-sources-and-doses

4. Bennett, D. (2022, August 30). *10 uses of alpha radiation*. In https://www.sciencing.com/10-uses-alpha-radiation-8691923/

Acknowledgement:
I would love to thank my mother Dr Leah McDermott for helping me by checking some scientific facts and the accuracy of my diagrams.