

4.6 Hazards of radiation

Radioactive materials produce radiation (alpha, beta, gamma) that is ionising. As the name suggests, when this radiation is absorbed by materials, some of the energy of the radiation goes into knocking electrons out of atoms (making ions). The more energy that the radiation carries, the more ions that are created. Alpha is by far the most ionising, followed by beta and then gamma.

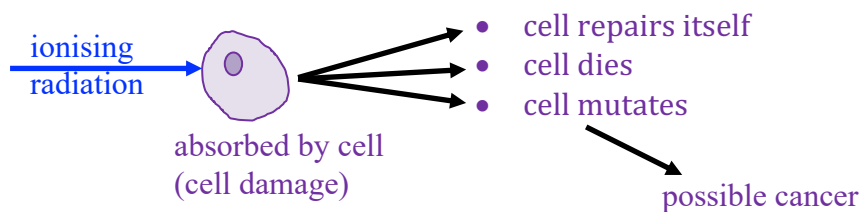


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(1) *What store of energy do moving particles (alpha, beta) have?*

(2) *An alpha particle consists of two protons and two neutrons. They are fast-moving. A beta particle is a fast-moving electron. Why do you think an alpha particle carries more energy? (Hint: Think of the formula for kinetic energy.)*

The danger of ionising radiation comes when it is absorbed by tissues in the body. What atoms in molecules in cells in the body become ionised by radiation, the chemistry of the cell is altered and the cell can be damaged. Three things can happen:




The cell can repair itself, it can die, or the DNA is damaged in a way which causes the cell to become cancerous.

When considering the hazards of radioactive materials, it is essential that you know the properties of alpha, beta and gamma. Here are some key properties:

- Alpha particles only travel a few centimeters in air and are stopped by a sheet of paper (or the skin).
- Beta particles travel about 1 metre in air and are stopped by a couple of millimetres of aluminium. They can easily penetrate the body.
- Gamma radiation (high energy electromagnetic radiation) can pass through the body easily and is stopped by a couple of centimetres of lead.

(3) *Why is a source of alpha radiation not dangerous if it is outside the body?*


(4) *When using a beta source, the source is held with tongs at arm's length. Why?*


(5)  *Radioactive sources are usually stored in lead lined boxes. Why?*


Irradiation and contamination


A radioactive material gives out radiation (alpha, beta, gamma). This radiation may be absorbed by an object. We say the object has been irradiated. The object does not become radioactive.

A radioactive material may rub off on an object. We say that the object has been contaminated.

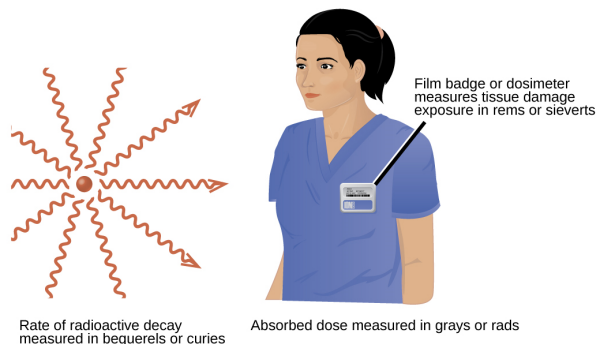
(6)  *Will a contaminated object be radioactive? Explain.*


(7)  *People who 'handle' radioactive materials wear disposable gloves. Why?*


(8)  *Some cancerous tumors can be killed by directing radiation at the tumor cells. Why is the person not radioactive after the treatment?*

(9)  *A source of alpha radiation can be extremely dangerous if it gets into the body (e.g. if it is swallowed or breathed in). What property of alpha radiation makes it so dangerous?*

Radioactive materials are used widely in medicine, industry and science. Workers in these industries must limit their exposure to radiation and avoid contamination. To reduce radiation exposure, workers limit their time of exposure and use shielding (e.g. lead apron). To avoid contamination, they often wear disposable clothing. Radiation exposure is monitored using a radiation badge. This usually contains a photographic film which blackens when exposed to ionising radiation.



(10)  *Why is the film contained in a light-proof container?*

(11)  *The government sets maximum exposure limits for workers. Why?*