4.7.1 Medical uses of nuclear radiations

videos

Radioactive materials are widely used in medicine for the diagnosis and treatment of disease, and for the sterilisation of equipment. Different radioactive isotopes are used for these different jobs. The choice of isotope depends on the type (alpha, beta, gamma) of emission, the frequency of emissions (depends on the half-life), and the cost and availability of the isotope.

As a quick recap, the following table summarises the properties of the 3 radioactive emissions:

emission	*range in air*	*stopped by*	*ionising power*
alpha	< few cm	sheet of paper	high
beta	< 1m	thin sheet of aluminium	medium
gamma	unlimited	few cm of lead	low

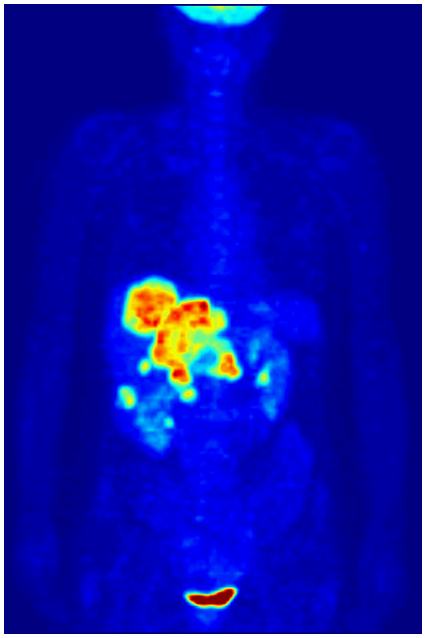
(1) Which radioactive emission would be least damaging to body cells? (Hint: The numbers of ions produced is proportional to the damage caused.)

(2) Which radioactive emission would not be able to pass into the body from outside?

(3) Which radioactive emission is likely to pass right through the body without causing damage?

Radioactive tracers

Radioactive tracers are radioactive substances which are introduced into the body to investigate the functioning of different organs. They are generally gamma emitters with a short half-life.



The gamma emissions are detected on the outside of the body using a gamma camera. This enables an image to be produced.

(4) Give two reasons why tracers are usually gamma emitters.

(5) Why does the radioactive isotope need to have a short half life?

One example of a tracer

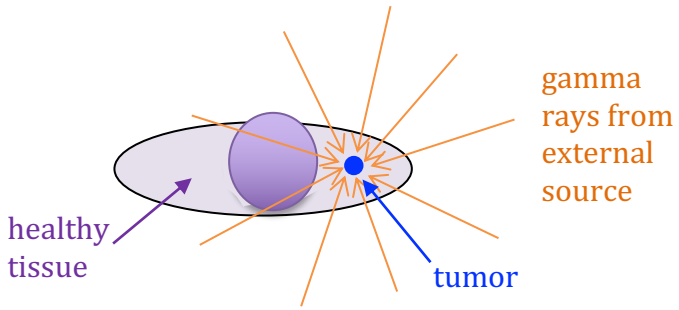
A radioactive isotope of iodine (iodine-131) can be used to investigate the functioning of the kidneys. A liquid containing a small quantity of iodine-131 is injected into the patient's bloodstream. A gamma camera records the gamma emissions from the radioactive iodine and can trace where it goes in the body. The kidneys remove iodine from the blood, and so the iodine accumulates in the kidneys. If the kidneys are functioning properly, the iodine should pass into the urine in the bladder.

(6) What would be observed if a kidney had a blockage so that it doesn't drain properly into the bladder?

Radiotherapy

Radioactive emissions can be used to kill cancer cells, in radiotherapy. The aim is to target the cancer cells in the body without damaging healthy cells. There are two ways of achieving this:

1) The radioactive isotope is placed close to the cancer cells in the body. This means that the cancer cells are exposed more to the radiation than healthy tissue which is further away.
2) An external source of gamma rays is directed at a cancer tumor from different directions. This can be achieved by rotating a gamma ray source around the patient. The targeting of gamma rays onto the tumor mean that healthy cells receive a much lower dose than cancerous cells.



(7) Why might a radioactive isotope that produces alpha particles be suitable for method 1), above?

(8) For method 2), there is a risk that some healthy tissue may be damaged. Why is the procedure still allowed?