

Uses of nuclear radiation

4.4.3.3 · Atomic structure · revision notes

How nuclear radiation is used in medicine to explore internal organs (tracers) and to control or destroy unwanted tissue (radiotherapy), and how to weigh up benefits against risks using data. Expect 'describe' and 'explain' questions and 6-mark 'evaluate' questions. GCSE Physics only, not in Combined Science.

Key facts

- Tracer: gamma emitter with a short half-life, detected outside the body by a gamma camera
- Radiotherapy: ionising radiation kills cancer cells
- Internal source: placed in or next to the tumour
- Gamma for tracers: passes out of the body and is weakly ionising
- External beams from several directions: large dose to tumour, smaller dose to healthy tissue
- Use radiation when the benefit is greater than the risk

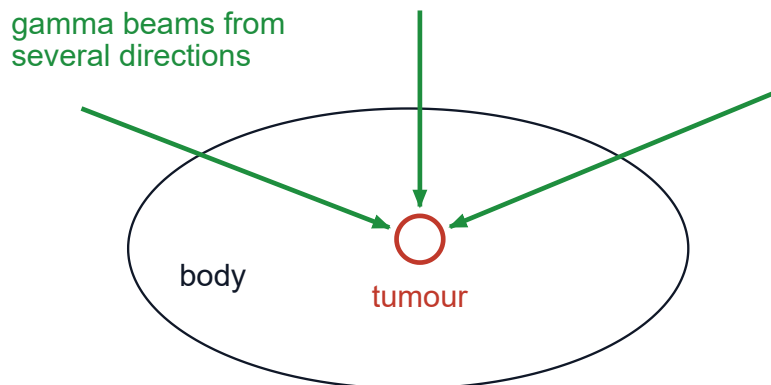
Notes

Exploring internal organs: tracers

- A **radioactive tracer** is swallowed or injected. It travels through the body to the organ being investigated.
- A detector outside the body (a **gamma camera**) builds up an image, showing how well the organ is working or where there is a problem.
- The tracer should emit **gamma** rays: they pass out of the body to the detector, and they are weakly ionising, so they do little damage.
- It should have a **short half-life** (a few hours), so the activity in the body soon falls. Technetium-99m (half-life about 6 hours) is widely used.
- The thyroid gland absorbs iodine, so a radioactive isotope of iodine can be used to examine it.

Controlling or destroying unwanted tissue

- Ionising radiation damages and kills cells, so it can be used to destroy cancer cells. This is **radiotherapy**.
- External: beams of gamma rays are aimed at the tumour from several directions (the source moves around the patient). The tumour gets a large dose; healthy tissue gets a smaller one.



each part of the healthy tissue gets only a small dose

The beams overlap only at the tumour, so it gets a large dose.

- Internal: a small radioactive source is placed in or next to the tumour, so most of the radiation is absorbed by the tumour cells.
- Radioactive iodine can be swallowed to destroy unwanted thyroid tissue, because the thyroid absorbs iodine.

Weighing up the risks

- Any exposure to ionising radiation carries some risk: healthy cells can be damaged, and the risk of cancer rises slightly.
- Radiation is used when the benefit, such as diagnosing or treating a serious illness, is greater than the risk.
- Perceived risk is how dangerous people think something is. It can differ from the real risk shown by data, so compare doses, e.g. with the yearly dose from background radiation.

Don't lose marks

- ✗ Saying a tracer should emit alpha. Alpha would not leave the body and is strongly ionising, so it would damage cells.
- ✗ Saying a tracer should have a long half-life 'so it lasts longer'. The patient would stay radioactive for too long.
- ✗ In 'evaluate' questions, giving only benefits or only risks, or giving no conclusion.
- ✗ Saying external radiotherapy makes the patient radioactive. The patient is irradiated, not contaminated.

More tips

Memory tricks

- Tracer checklist: **G**amma + **S**hort half-life ('GS: Get Scanned').
- Radiotherapy: aim from many angles, all meeting at the tumour.
- Evaluate = benefits + risks + data + a justified conclusion.

Exam technique

- In a 6-mark evaluation, use the numbers given, e.g. compare the dose with the yearly background dose.
- Use the words 'ionising', 'damages cells' and 'half-life' in medical-use answers.
- When asked why something is suitable, give each property **AND** the reason it helps.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 4

Name two medical uses of nuclear radiation

Exploring internal organs with tracers; destroying unwanted tissue such as tumours.

Grade 5

Describe how a medical tracer is used

A gamma emitter is swallowed or injected and detected outside the body by a gamma camera.

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