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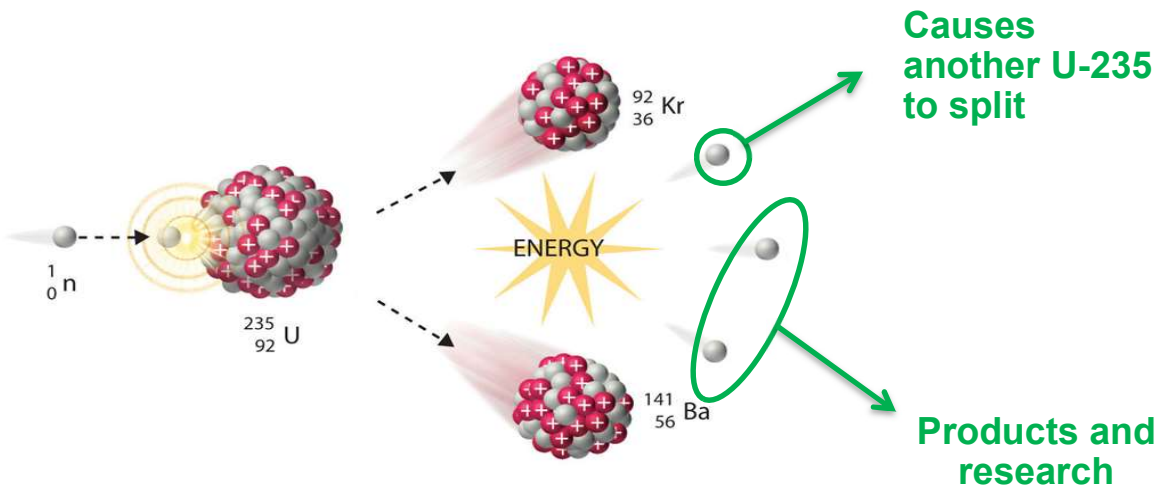
235
92 U

Uranium-235

Uranium-235 makes up only 0.72% of the uranium found in nature. It is the only fissile uranium isotope that can sustain a fission chain reaction. ANSTO's OPAL reactor uses low-enriched uranium fuel.

In nature, uranium-235 has a long half-life (700 million years) and decays by alpha emission.

Fission of uranium-235



Note: U-235 fission occurs in many different ways. Kr and Ba are just one example of a pair of fission fragments.

Fission (one example equation)

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + 3^{1}_{0}n + \gamma + heat$$

Decay

$$^{235}_{92}U \rightarrow ^{231}_{90}Th + ^{4}_{2}He^{2+} + \gamma$$

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99
Mo
42

Molybdenum-99

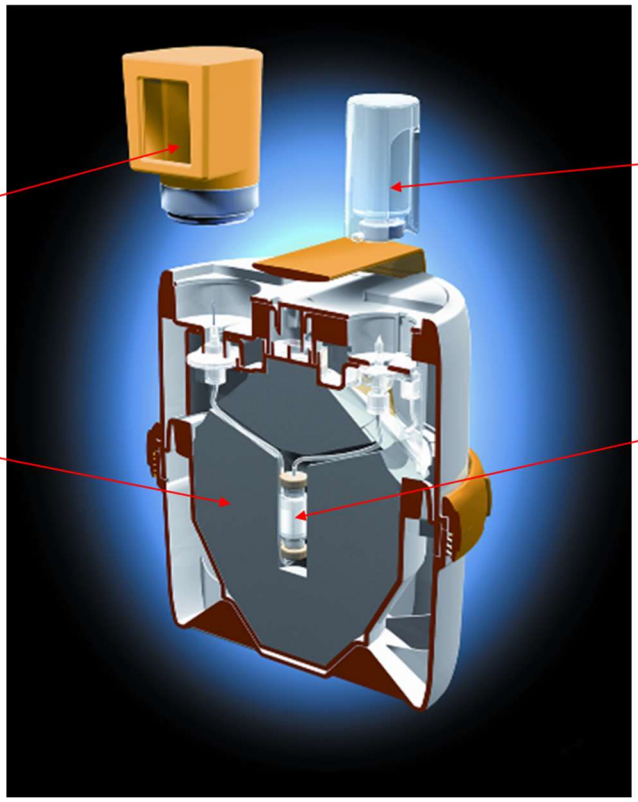
Molybdenum-99 is the 'parent' radioisotope used to make technetium-99m. It has a half-life of 66 hours and is transported in Gentech® generators to approximately 250 hospitals and medical centres across Australia.

Production

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{99}_{42}Mo + ^{134}_{50}Sn + 3^{1}_{0}n + \gamma + heat$$

Decay

$$^{99}_{42}Mo \rightarrow ^{99m}_{43}Tc + ^{0}_{-1}e + \gamma$$



Inside a Gentech® Generator

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$^{99m}_{43}Tc$

Technetium-99m

Technetium-99m is the decay product of molybdenum-99. It is a radioisotopic tag used in the diagnosis of cancers, heart disease and muscular and skeletal conditions.

Tc-99m is a pure gamma emitter, and is detected with a SPECT scan. It has a half-life of 6 hours.

Decay

$$^{99m}_{43}Tc \rightarrow {}^{99}_{43}Tc + \gamma$$

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131
I
53

Iodine-131

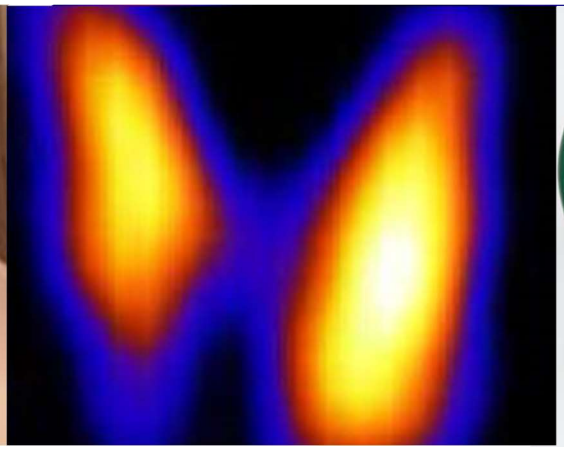
Iodine-131 is a reactor-produced negative beta emitter used in the treatment of thyroid cancer. The thyroid absorbs iodine and the I-131 emits high energy beta particles to attack nearby cancer cells. It has a half-life of 8.02 days.

Production

$$^{130}_{52}Te + ^{1}_{0}n \rightarrow ^{131}_{52}Te \rightarrow ^{131}_{53}I + ^{0}_{-1}e$$

Decay

$$^{131}_{53}I \rightarrow ^{131}_{54}Xe + ^{0}_{-1}e + \gamma$$



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$^{60}_{27}Co$

Cobalt-60

Cobalt-60 is a negative beta emitter and gamma emitter, produced in a nuclear reactor by neutron irradiation of Cobalt-59.

Gamma irradiation from Co-60 is used to sterilise bones and soft structural tissues for transplants, as well as medical equipment.

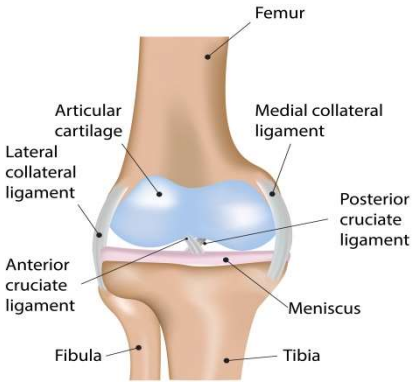
Queensland fruit fly pupae are also sterilised by Co-60 to control outbreaks. Co-60 has a half-life of 5.27 years.

Production

$$^{59}_{27}Co + {}^{1}_{0}n \rightarrow {}^{60}_{27}Co + \gamma$$

Decay

$$^{60}_{27}Co \rightarrow {}^{0}_{-1}e + {}^{60}_{28}Ni + \gamma\gamma$$



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$^{14}_{6}C$

Carbon-14

Carbon-14 is a negative beta emitter and a naturally-occurring radioisotope. One in a trillion atoms of carbon is carbon-14.

ANSTO scientists can determine the age of organic remains by measuring the ratio of radioactive carbon to non-radioactive carbon isotopes. This technique allows the dating of various objects, from coral to Egyptian mummies to First Nations cultural objects.

Carbon-14 has a half-life of 5,730 years.

Decay $^{14}_{6}C \rightarrow {}^{14}_{7}N + {}^{0}_{-1}e$

Traditional owner, Ian Waina, contemplating a painting of a kangaroo that we now know must be more than 12,700 years old based on radiocarbon dating of wasp nests overlying it. Credit: Peter Veth, Balanggarra Aboriginal Corporation

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$^{36}_{17}Cl$

Chlorine-36

Chlorine-36 is a negative beta emitter that is used to measure the age of water up to 2 million years old.

The amount of chlorine-36 increases over time when cosmic rays hit argon in the Earth's atmosphere.

Chlorine-36 has a half-life of 301,000 years.

Decay

$$^{36}_{17}Cl \rightarrow {}^{36}_{18}Ar + {}^{0}_{-1}e$$

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$^{10}_{4}Be$

Beryllium-10

Beryllium-10 is a negative beta emitter that is used to measure the age of rocks up to 15 million years old. The concentration of beryllium-10 builds up over time, as cosmic rays hit the surface of rocks. So, the greater the concentration of beryllium-10, the older the rock.

Beryllium-10 has a half-life of 1,390,000 years.

Decay

$$^{10}_{4}\mathrm{Be} \rightarrow {}^{10}_{5}\mathrm{B} + {}^{0}_{-1}\mathrm{e}$$