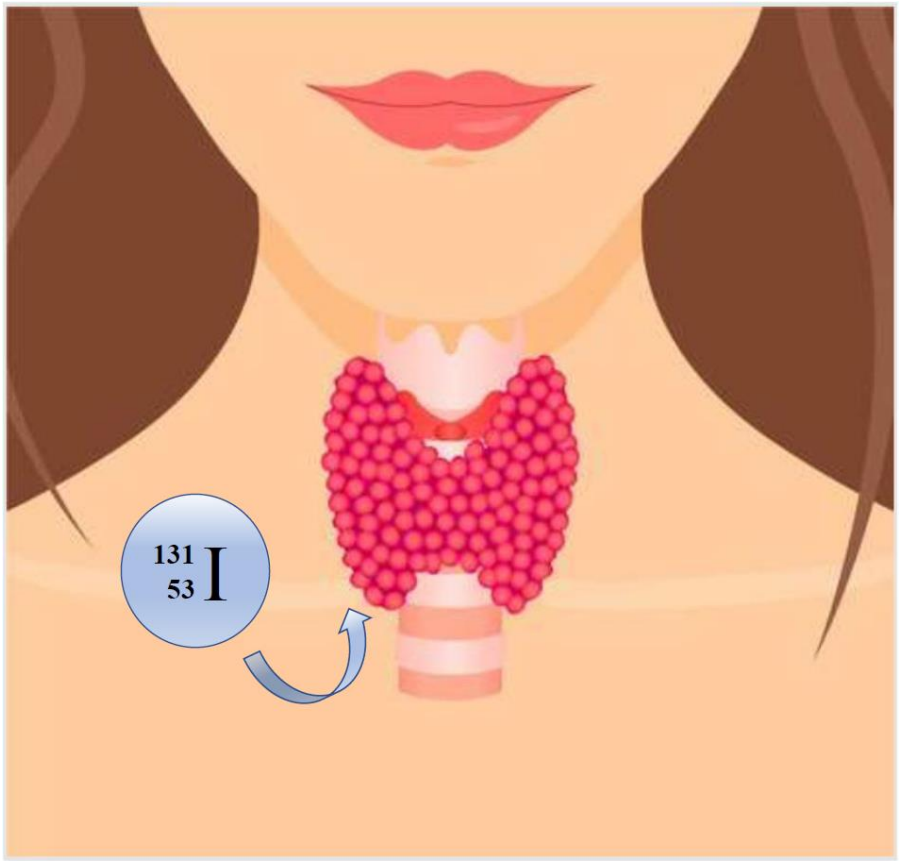
Radioisotope Therapy

Your family was deeply distressed when the diagnosis came in and you were told that your sister has thyroid cancer. The news wasn't all bad though. The cancer was caught early, and with current therapies, the survival rate is very high. The doctor told you that he recommended radioiodine (^{131}I or iodine-131) therapy.

You recall watching a documentary about the Chernobyl nuclear disaster which devastated northern Ukraine in 1986. The explosion which resulted from a nuclear reactor meltdown threw dangerous radioisotopes into the air, resulting in the deaths of dozens of people, as well as lasting health effects on thousands of residents in the surrounding area. One of the primary isotopes released by that event was iodine-131, which is now known to increase the risk of getting thyroid cancer. This is because the thyroid gland absorbs iodine from the blood, and the iodine-131 (which is radioactive) causes mutations in the cells of the thyroid, potentially making them cancerous.[1]



This whole situation now has you confused. If ^{131}I causes thyroid cancer, then why would you use the very same thing to cure it? You talk to the doctor about your concerns, but she tells you not to worry about it. According to her, "at high dosage the ^{131}I kills the cell instead of mutating the DNA and it has a short half-life, so after a short time, no radioactive material is left in the body." You don't completely understand what she told you, so you set out to do more research about how radioactive iodine therapy works, how it affects the body, and what the doctor meant by "half-life." Not only do you want to understand these things for yourself, but you also want to be able to explain it to the rest of your family, to help put their minds at ease.

Questions you ask yourself:

What is a radioisotope? How is iodine-131 different from normal iodine?

How is the iodine-131 that's administered to the body depleted? What does it turn into that makes it harmless to the body?

What is meant by the half-life of a radioactive material? What is the half-life of iodine-131?

While you were researching about half-lives, you read that radioactive decay is a type of exponential decay, which has a decay constant (***k***) that is related to the half-life. What is the equation that relates ***k*** to half-life, and what is the value of ***k*** for iodine-131?

How can a radioactive material like ^{131}I cure diseases like thyroid cancer when the documentary you watched clearly indicates that the same radioactive material can also cause cancer?

Why do you think that the doctor didn't recommend using iodine-129 or iodine-132 as the isotope of choice for the treatment?

The doctor gave your sister a sodium iodide ($Na^{131}I$) pill which is labelled as "iodine-131: 7145 MBq (at the time of ingestion)." Find out what this means and how many radioactive iodide-131 ions your sister ingested through the pill. Determine the quantity in grams of ^{131}I as well.

You and your family are obviously disturbed about radioactive material being in your sister's blood, so plot a graph of the quantity of radioactive iodine-131 left in the body over time (in increments of days) until 21 days after administration.

With the knowledge that you have now obtained on the subject of radioiodine therapy, how will you explain the situation to your family to put their minds at ease?

Reference:

1. https://www.radioactivity.eu.com/site/pages/Chernobyl_Iodine_131.htm