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**QUESTION 1**

WHAT ARE RADIOACTIVE TRACERS?

* A radioactive tracer is a chemical compound in which one or more atoms have been replaced by a radionuclide so by virtue of its radioactive decay it can be used to explore the mechanism of chemical reactions by tracing the path that the radioisotope follows from reactants to products. Radiolabeling or radio-tracing is thus the radioactive form of isotopic labeling.

**Examples of Radioactive tracers**

* 1. Tritium: [Tritium](https://en.wikipedia.org/wiki/Tritium) and [C](https://en.wikipedia.org/wiki/Carbon-14)-labeled glucose are commonly used in [glucose clamps](https://en.wikipedia.org/wiki/Glucose_clamp_technique) to measure rates of [glucose uptake](https://en.wikipedia.org/wiki/Glucose_uptake), [fatty acid synthesis](https://en.wikipedia.org/wiki/Fatty_acid_synthesis), and other metabolic processes.
  2. Oxygen
  3. Nitrogen
  4. Fluorine
  5. sulfur

**Important of Radioactive tracers**

1. Radioactive tracer can be used to track the distribution of a substance within a natural system such as a [cell](https://en.wikipedia.org/wiki/Cell_(biology)) or [tissue](https://en.wikipedia.org/wiki/Tissue_(biology)), or as a [flow tracer](https://en.wikipedia.org/wiki/Flow_tracer) to track [fluid flow](https://en.wikipedia.org/wiki/Fluid_dynamics).
2. Radioactive tracers are also used to determine the location of fractures created by [hydraulic fracturing](https://en.wikipedia.org/wiki/Hydraulic_fracturing) in natural gas production.
3. Radioactive tracers form the basis of a variety of imaging systems, such as, [PET scans](https://en.wikipedia.org/wiki/PET_scan), [SPECT scans](https://en.wikipedia.org/wiki/SPECT_scan) and [technetium scans](https://en.wikipedia.org/wiki/Technetium-99m).

* CT Scan

A major use of radioactive tracers involves computed X-ray tomography or CT scans. These scans constitute approximately 75 percent of medical procedures with tracers. The radioactive tracer produces gamma rays or single photons that a gamma camera detects. Emissions come from different angles and a computer uses them to produce an image. The treating physician orders a CT scan that targets a specific area of the body, like the neck or chest, or a specific organ, like the thyroid.

* PET

Positron emission tomography, or PET, represents the latest technology to use radioactive tracers. It provides a more precise image and is used frequently in oncology with Flourine-18 as the tracer. PET is also used in cardiac and brain imaging with carbon-11 and nitrogen-13 radioactive tracers. Another innovation involves the combination of PET and CT into two images known as PETCT.

A radioactive tracer is a chemical compound having at least one radioactive element. Frequently used in medicine to follow the progress of substances in living tissues, it gives health care providers a precise way to “see” into the circulatory system and other organs. A technician prepares the compound, injects it into the patient and tracks it in the body with sensitive electronic detectors. In most cases, the material remains radioactive for only a few hours.

**Advantages of radioactive tracers**

## It is Non-Invasive

Using a radioactive tracer, a physician can examine the state of a patient’s organs without performing surgery or getting a biopsy. The tracer collects in the tissues and emits gamma rays radiation. Detectors produce detailed images of the affected organs by measuring the radiation. Combining these images with those from computed tomography (CT) scans results in a detailed picture with specific areas highlighted by the tracer.

## It is Specific

A chemist can design and synthesize radioactive compounds specifically suited for particular organs, tissues and biological processes. These compounds are radioactive versions of normal biological substances or substances known to collect in certain tissues. Chemically and biologically, the tracer acts the same as a non-radioactive compound, though it gives off detectable radiation.

## It is Safe

A radioactive tracer is used to detect and image tissues, not affect them with radiation, so it uses only small amounts of radioactive material. As no other processes in the human body produce gamma radiation, the energy produced by the tracer stands out clearly, even in small quantities. Chemists select radioactive materials that decay in a matter of hours or days, reverting to a normal state and posing no long-term problems.

## Metabolic Tracking

In addition to imaging a single organ with a tracer, a doctor can follow the tracer’s progress as the body metabolizes it. Organs break down and combine chemical compounds with others through a long chain of biological processes. If the right atoms of the compound are radioactive, a doctor can see if the tracer stops in certain parts of the body or if it passes on to other tissues and organs.

Radioactive tracers utilize the positive qualities of radioactivity, the ability to emit a signal, while minimizing the negative effects. Isotopes use elements with a short half-life to reduce the dangers of radioactive exposure to the patient. A half-life represents the amount of time it takes for one-half of a substance's radioactivity to decay. For example, a material with a half-life of six hours will lose half of its radioactivity in six hours and then another one-half at the 12-hour mark, leaving one-fourth of its strength. The shorter the half-life the less radioactive exposure.

**QUESTION 2**

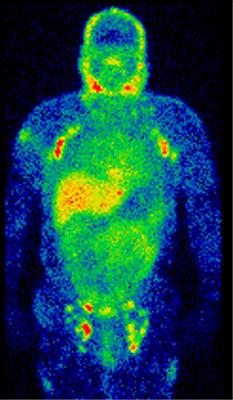
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Radioactive tracers plays an important role in nuclear medicine.

What is nuclear medicine?

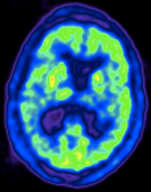
It is a medical specialty that uses radioactive tracers (radiopharmaceuticals) to assess bodily functions and to diagnose and treat disease. Diagnostic nuclear medicine relies heavily on imaging techniques. It relies on specially designed cameras which allows doctors to track the path of these radioactive tracers. Single [Photon](javascript:;) Emission [Computed Tomography](javascript:;) (SPECT) and Positron Emission Tomography (PET) scans are the two most common imaging modalities in nuclear medicine.

## What is Single Photon Emission Computed Tomography (SPECT)?



SPECT imaging instruments provide three-dimensional (tomographic) images of the distribution of radioactive tracer molecules that have been introduced into the patient’s body. The 3D images are computer generated from a large number of projection images of the body recorded at different angles. SPECT imagers have gamma camera detectors that can detect the [gamma ray](javascript:;) emissions from the tracers that have been injected into the patient. Gamma rays are a form of light that moves at a different wavelength than visible light. The cameras are mounted on a rotating gantry that allows the detectors to be moved in a tight circle around a patient who is lying motionless on a pallet.

## What is Positron Emission Tomography (PET)?

PET scans also use radiopharmaceuticals to create three-dimensional images. The main difference between SPECT and PET scans is the type of radiotracers used. While SPECT scans measure gamma rays, the decay of the radiotracers used with PET scans produce small particles called positrons. A positron is a particle with roughly the same mass as an electron but oppositely charged. These react with electrons in the body and when these two particles combine they annihilate each other. This annihilation produces a small amount of energy in the form of two [photon](javascript:;)s that shoot off in opposite directions. The detectors in the PET scanner measure these photons and use this information to create images of internal organs.

## What are nuclear medicine scans used for?

1. SPECT scans are primarily used to diagnose and track the progression of heart disease, such as blocked coronary arteries. There are also radiotracers to detect disorders in bone, gall bladder disease and intestinal bleeding.

2. SPECT agents have recently become available for aiding in the diagnosis of Parkinson's disease in the brain, and distinguishing this malady from other anatomically-related movement disorders and dementias.

* The major purpose of PET scans is to detect cancer and monitor its progression, response to treatment, and to detect metastases. Glucose utilization depends on the intensity of cellular and tissue activity so it is greatly increased in rapidly dividing cancer cells..

N/B: A combination instrument that produces both PET and CT scans of the same body regions in one examination (PET/CT scanner) has become the primary imaging tool for the staging of most cancers worldwide.