NUCLEAR MEDICINE

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JÜLICH

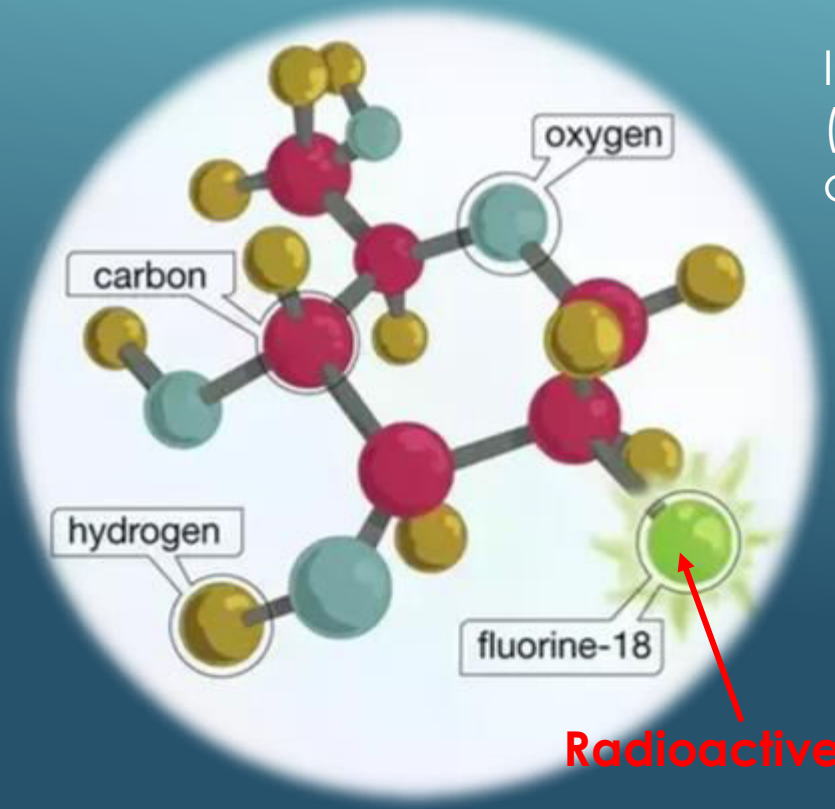
What is Nuclear Medicine ?

Nuclear medicine is a medical specialty involving the application of radioactive substances in the diagnosis and treatment of disease. Nuclear medicine imaging, in a sense, is "radiology did inside out" or "endoradiology" because it records radiation emitting from within the body rather than radiation that is generated by external sources like X-rays.

In addition, nuclear medicine scans differ from radiology, as the emphasis is not on imaging anatomy, but on the function. For such reason, it is called a physiological imaging modality. Single-photon emission computed tomography (SPECT) and positron emission tomography (PET) scans are the two most common imaging modalities in nuclear medicine.

https://en.wikipedia.org/wiki/Nuclear_medicine

Why is it called Nuclear Medicine?

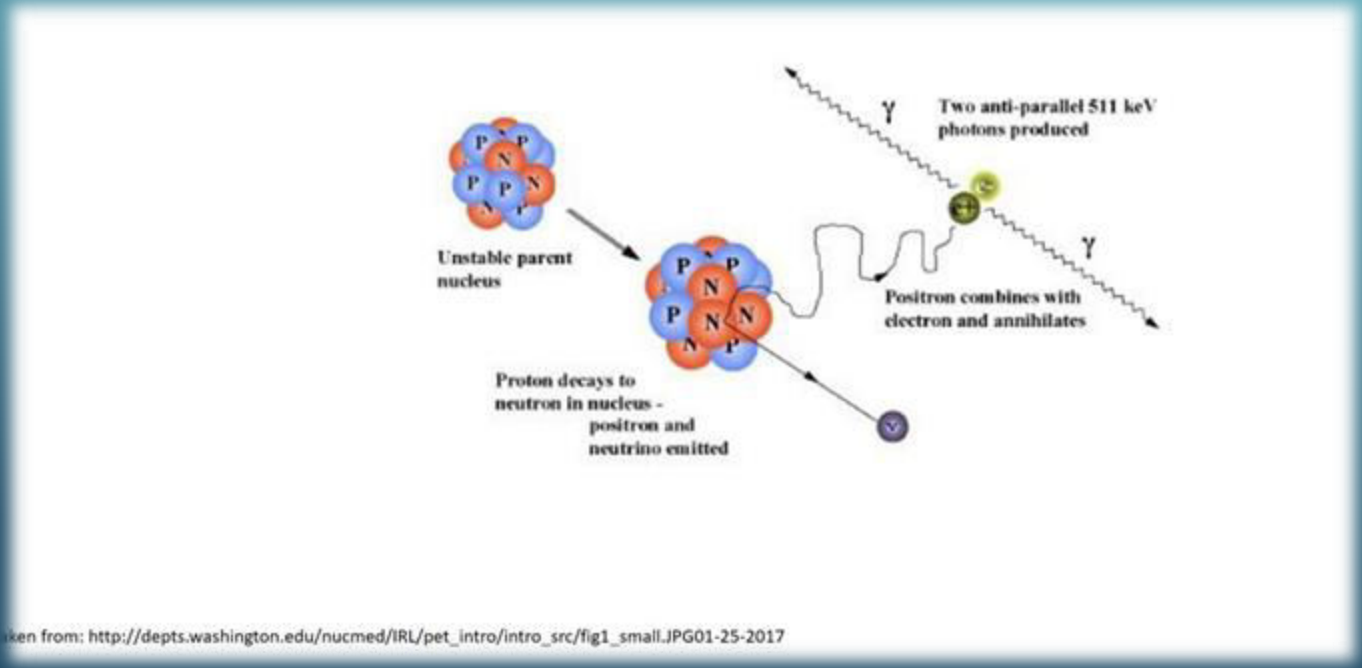


In all cases, in a nuclear medicine study, scientists are administering (usually injecting) a tiny quantity of a drug that has a radioactive atom attached so we can trace its a path through the body

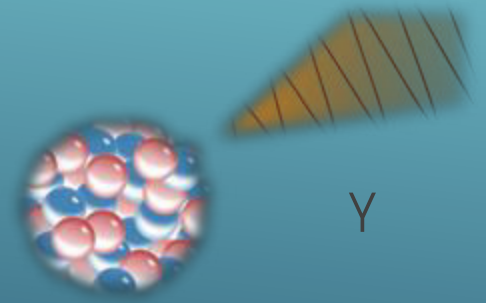
Scientists use special scanners to detect the gamma rays emitted from the nucleus of the radioactive atom

They typically inject about one-millionth of a single grain of radioactive molecule

Radiation Decay



ken from: http://depts.washington.edu/nucmed/IRL/pet_intro/intro_src/fig1_small.JPG01-25-2017

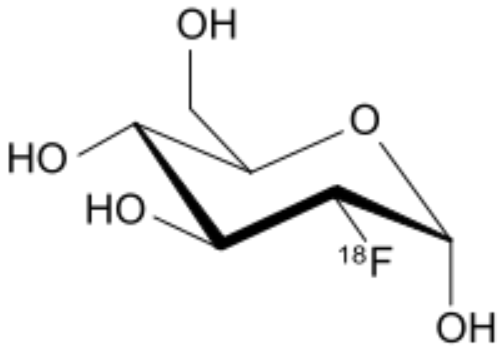


Gamma-ray is high-energy electromagnetic radiation, it can go through the body

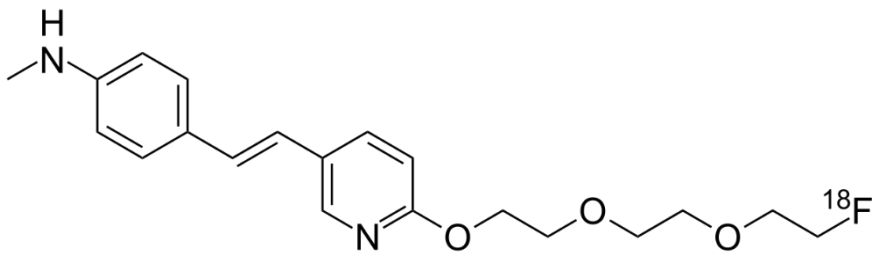
This property is what we use for imaging. Scanners are designed to detect these gamma rays

Radiopharmaceuticals

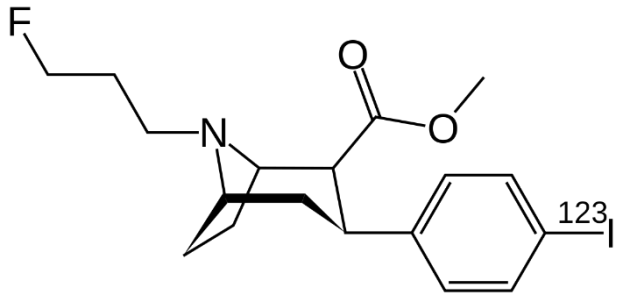
In nuclear medicine procedures, in all cases, a radioactive atom is attached to a "molecule of interest" so that we can track those molecules once they enter the body. There radioactively labeled molecules are called **radiopharmaceuticals**. They are virtually always injected into the blood stream



Fluorodeoxyglucose(^{18}F)
(cancer imaging , brain metabolism, cardiac metabolism)



Florbetapir (^{18}F)
(Amyloid imaging for Alzheimer`s disease)



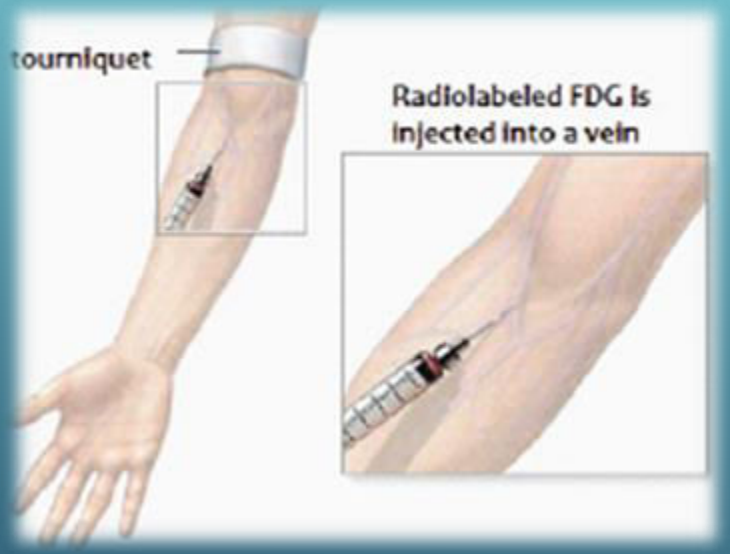
Ioflupane (^{123}I)
Parkinson`s disease

https://www-pub.iaea.org/publications/PDF/trs465_web.pdf

Nuclear medicine imaging equipment

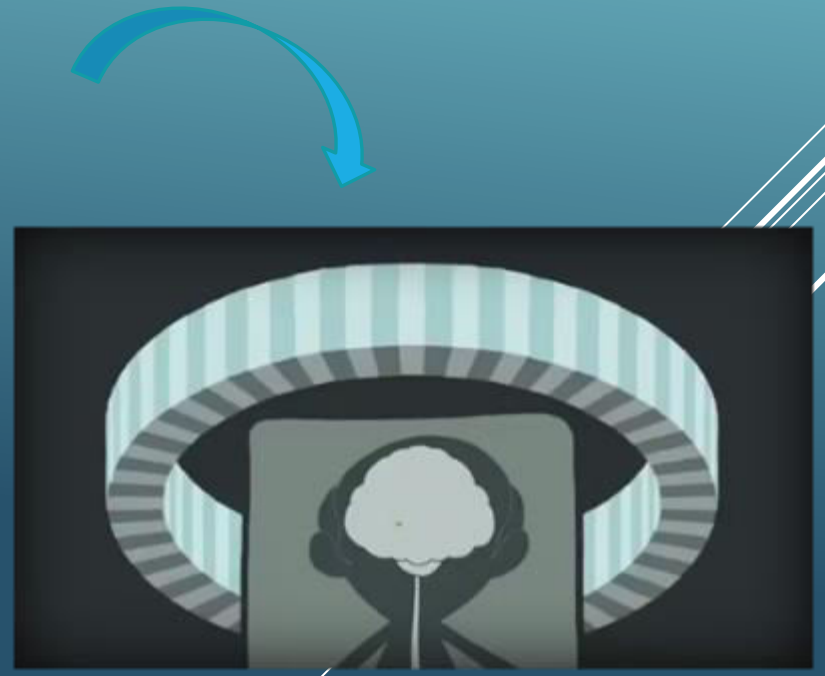
- Positron Emission Tomography (PET)
- Single Photon Emission Computed Tomography (SPECT)

How do we make the images in PET?



First inject the radioactive tracer

When in the body it decays and we get the two back-to back photons



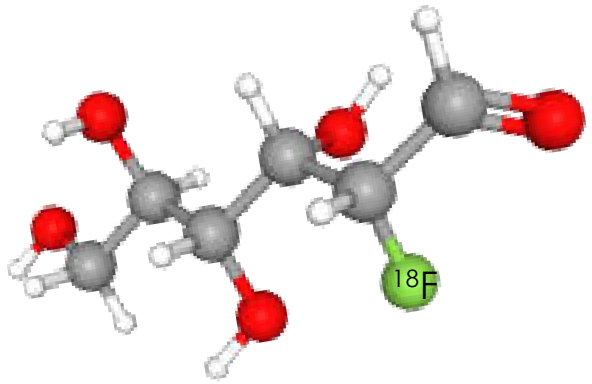
Then we detect literally millions of these events over about 10-20 minute and from this we can calculate the distribution of the radioactive tracer in the body and create the image

https://www.youtube.com/watch?v=yrTy03O0gWw
https://www.youtube.com/watch?v=GHLBcCv4rqk

What is Nuclear medicine used for?

Cancer Detection:[f-18]FDG

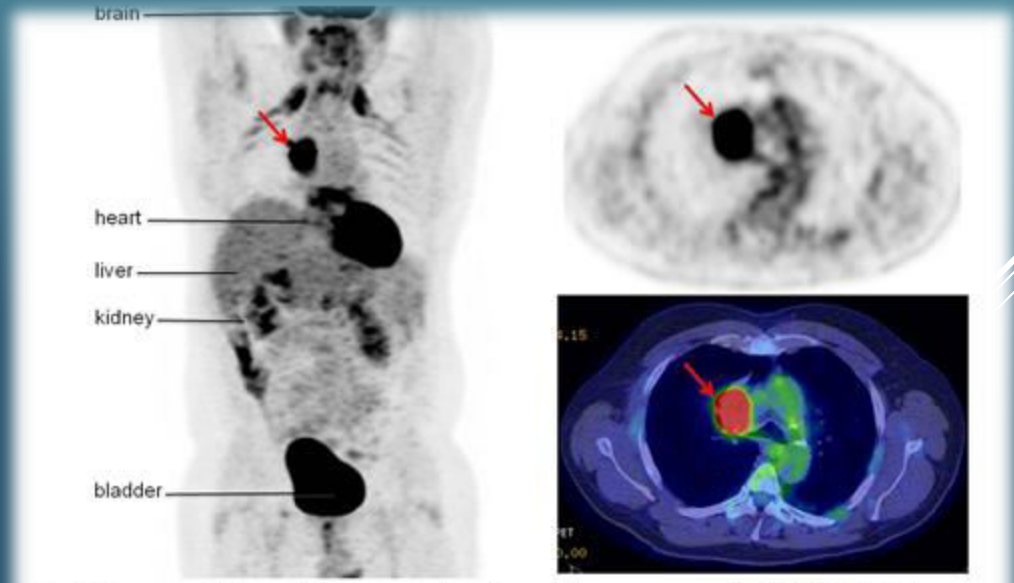
[F-18] Fluorodeoxyglucose



Localization mechanism: metabolic trapping of FDG in cells metabolizing glucose. Cancer cell metabolize glucose at a very high rate

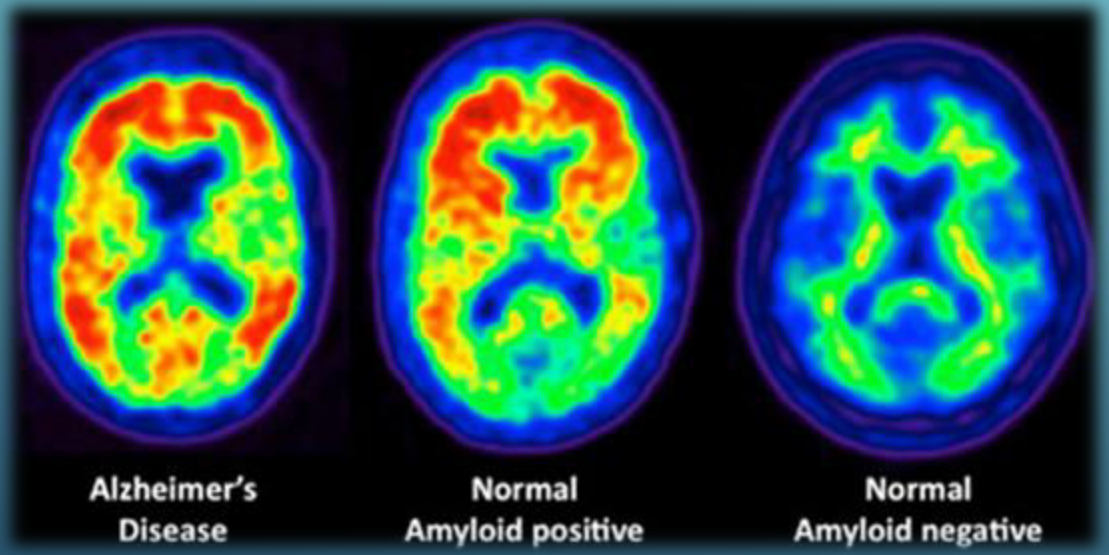
Imaging Modality PET

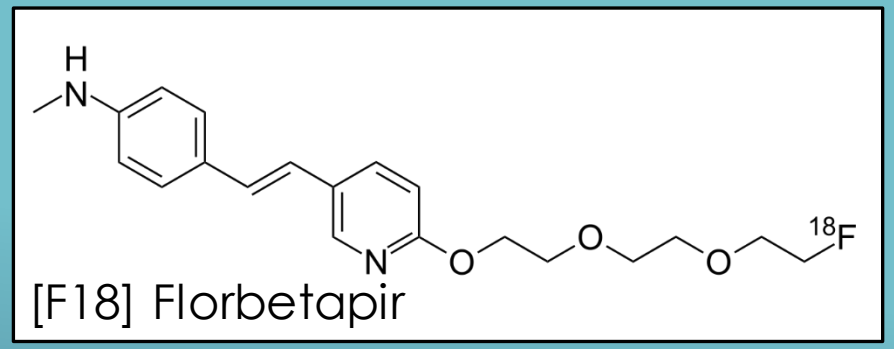
Commonly used in: Lung Cancer, Breast Cancer, Colorectal Cancer, Head and neck Cancer



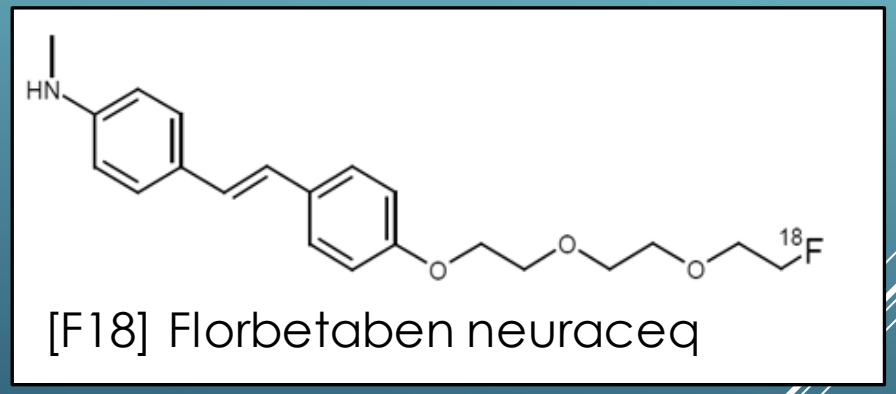
This 55-year-old smoking man developed a new cough. PET/CT shows a large, active cancer (arrow) compressing the bronchus leading to the right lung.

Brain imaging- Alzheimer's Disease





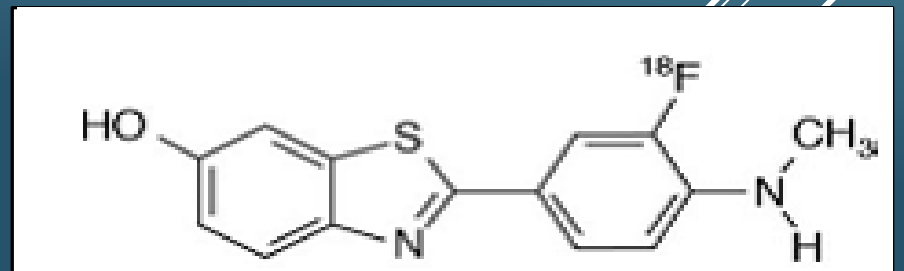
[F18] Florbetapir



[F18] Florbetaben neuraceq

Localization mechanism: binding to Amyloid proteins characteristically found on brain tissue in Alzheimer`s Disease

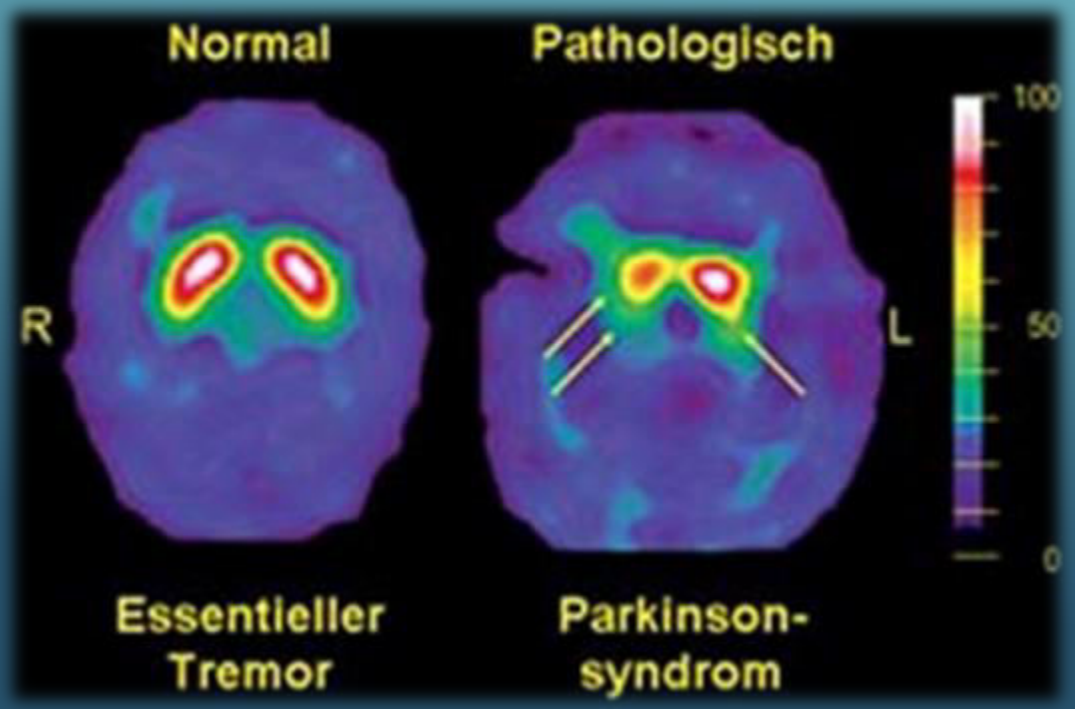
Imaging modality: **PET**



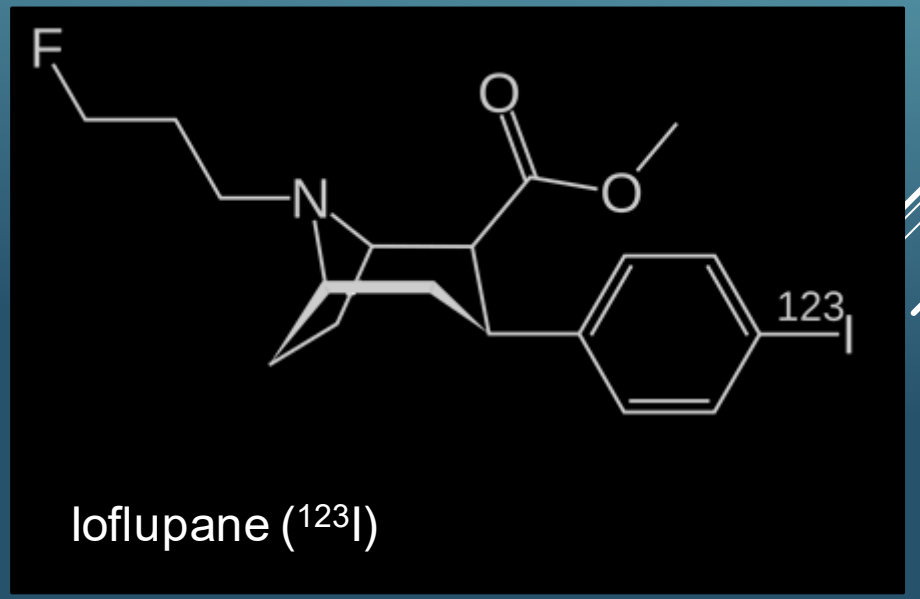
Flutametamol Vizamyl

https://speciality.medicaldialogues.in/more-amyloid-in-the-brain-more-cognitive-decline-jama-neurology

Parkinson`s Disease



Localization Mechanism: [I-123]Ioflupane is taken up and stored in vesicles of presynaptic brain cells



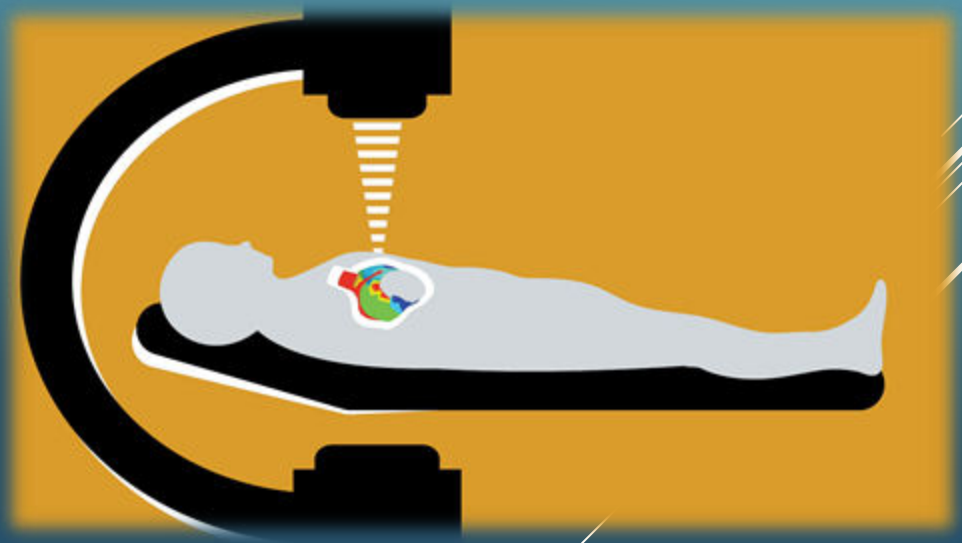
Ioflupane (^{123}I)

Imaging Modality: SPECT

https://poseidonia.healthcare/parkinsons-disease

Therapeutic Application

Very large doses of radiation can kill cells, damage the DNA, and finally cause death. However, we can use the toxic effects of radiation to treat cancer if we use them specifically and carefully.

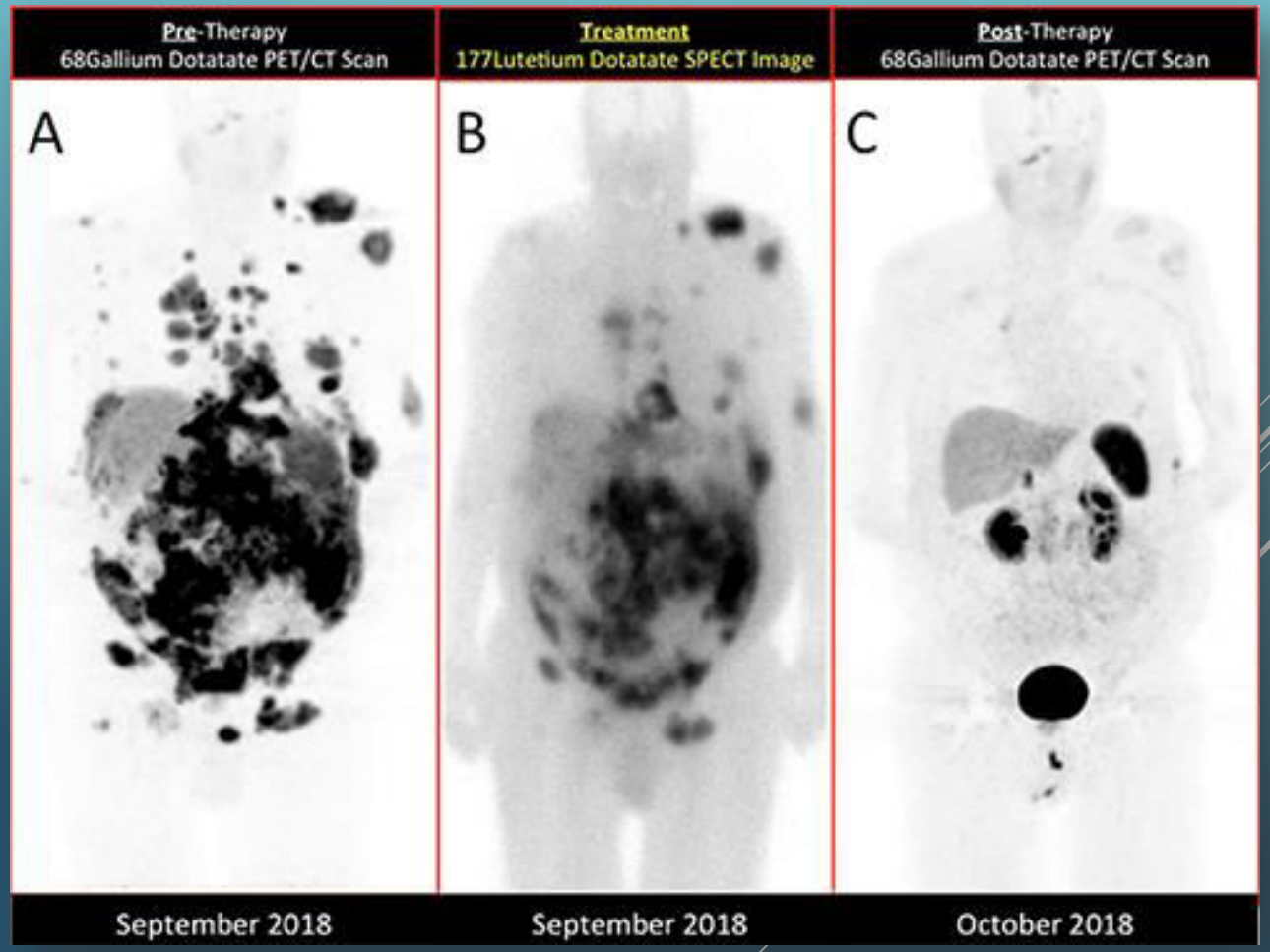


radiation therapy uses ionizing radiation like x-rays or gamma rays to kill cancer cells, thereby stopping their cells from continuing to grow and divide

https://jloog.com/pic/get
https://www.cancer.gov/about-cancer/treatment/types/radiation-therapy

Targeted alpha therapy

LU177 Lutathera



https://medicalxpress.com/news/2016-12-alpha-therapy-results-metastatic-prostate.html
https://ronnyallan.net/2017/05/08/waiting-on-lu-177-prrt

Thank you for your attention