Nuclear Medicine

RADIOPHARMACEUTICAL CHEMISTRY

An alpha particle consists of two protons and two neutrons

- Common alpha-particle emitters
  - Radon-222 gas in the environment
  - Uranium-234 and -238) in the environment
  - Polonium-210 in tobacco

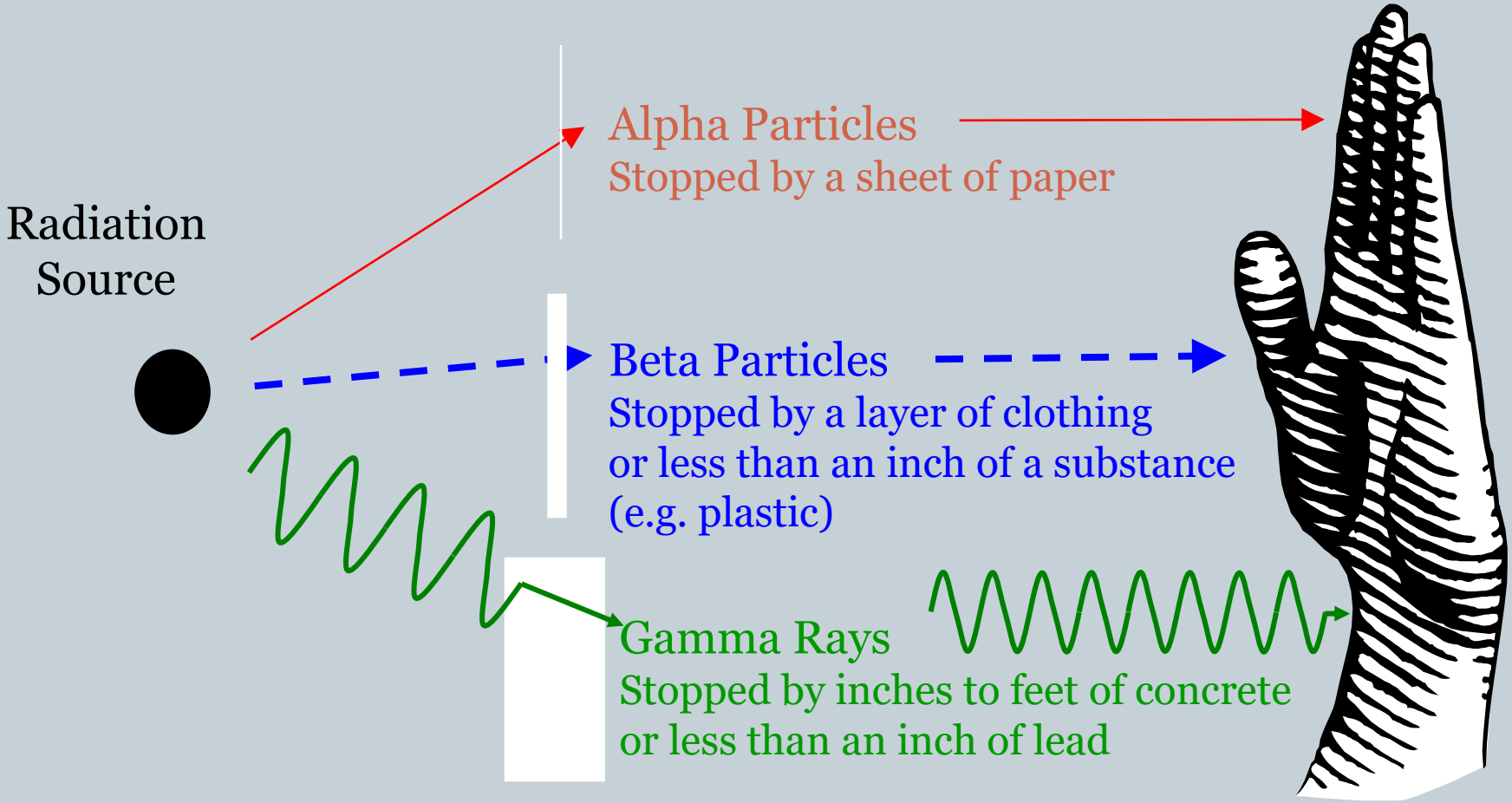
Radiation Types - Beta

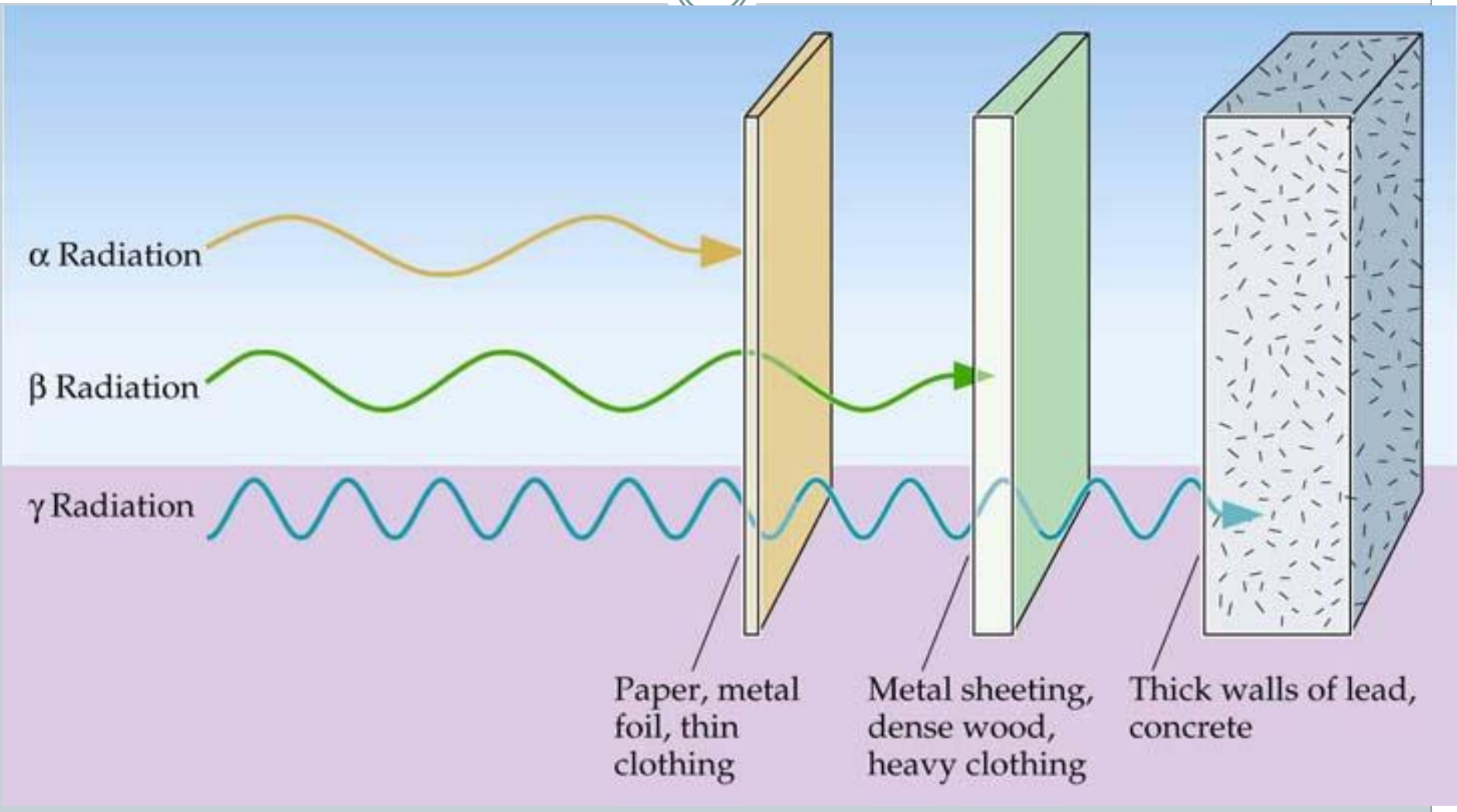
- A beta particle is a charged electron
  - Has the size and weight of an electron
  - Can be positively or negatively charged
- Penetration in materials
  - At low energies, a beta particle is not very penetrating – stopped by the outer layer of skin or a piece of paper
  - At higher energies, a beta particle may penetrate to the live layer of skin
- Common beta-particle emitters
  - Tritium (hydrogen-3) in the environment
  - Carbon (14) in the environment
  - Phosphorus (32) used in research and medicine

Radiation Types - Photon

- A photon is an x or gamma ray
  - Has no weight
  - Has no charge
- Penetration in materials
  - At low energies, a photon can be stopped by a very thin (almost flexible) layer of lead or several centimeters of tissue
- At higher energies, inches of lead might be necessary to stop a photon and they can pass right through a human
- Common photon emitters
  - Cesium (137)
  - Technetium (99m) used in medicine
  - Iodine (131) used in medicine

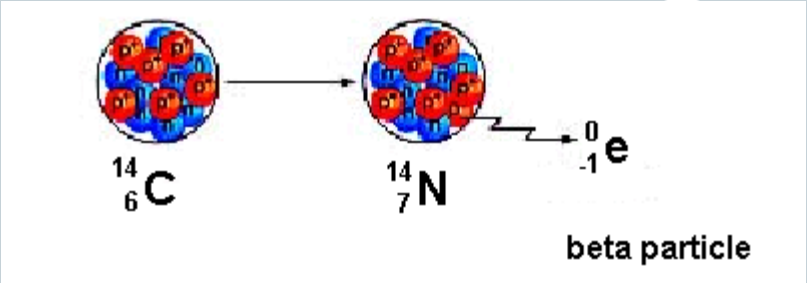
Types of Ionizing Radiation




α Radiation
β Radiation
γ Radiation
Paper, metal foil, thin clothing
Metal sheeting, dense wood, heavy clothing
Thick walls of lead, concrete

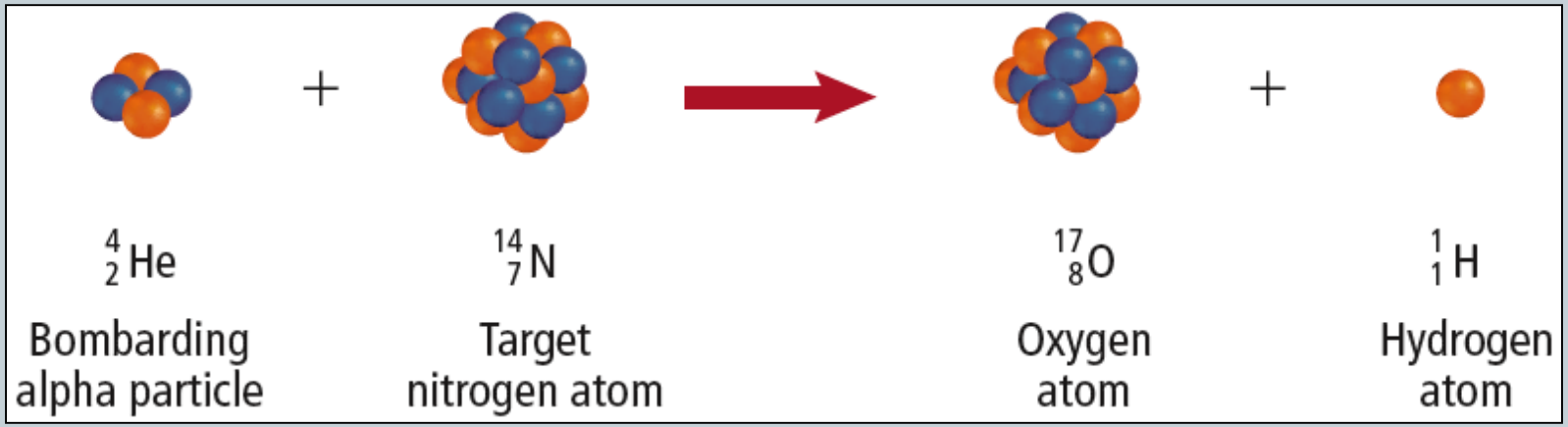
Products of Natural Radioactivity

Particle*	Symbol	Charge	Mass Number	Identity
Alpha	$^{4}_{2}\alpha$	2+	4	Helium nucleus
Beta	$^{0}_{-1}\beta$	1-	0	Electron
Gamma	$^{0}_{0}\gamma$	0	0	Proton of light



$$^{1}_{0}n \rightarrow {}^{1}_{1}p + {}^{0}_{-1}e$$

Induced Nuclear Reactions



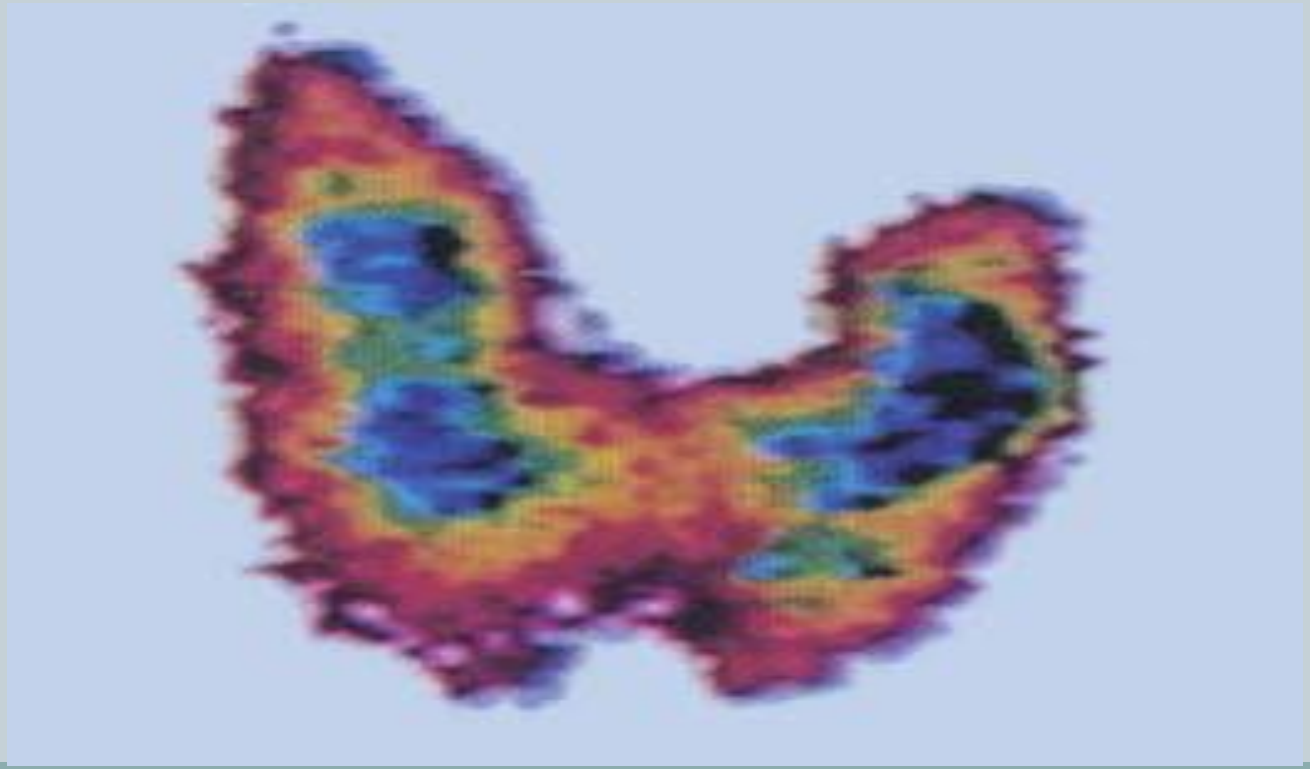
Clinical Uses Therapeutically

ROUTE OF ADMINISTRATIONS:
TELE THERAPY
IMPLANTATION BY WIRE OR CAPSULE

DIAGNOSTICALLY
ROUTE OF ADMINISTRATIONS:

ORALLY
PARENTERAL(IV)
INHALE

An image of a thyroid gland obtained through the use of radioactive iodine.



Positron Emission Tomography

- What is PET ?
- By which principle it work ?
- How can be performed ?
- Benefits and risks ?
- Common isotopes used?
- Main differences between PET and CT scan ?

PET scan is a functional imaging technique that is used to observe metabolic processes in the body.

Positron emission tomography (PET):

uses small amounts of radioactive materials called radiotracers(the biological active molecule chosen Fludeoxyglucose(FDG) an analogue of glucose)

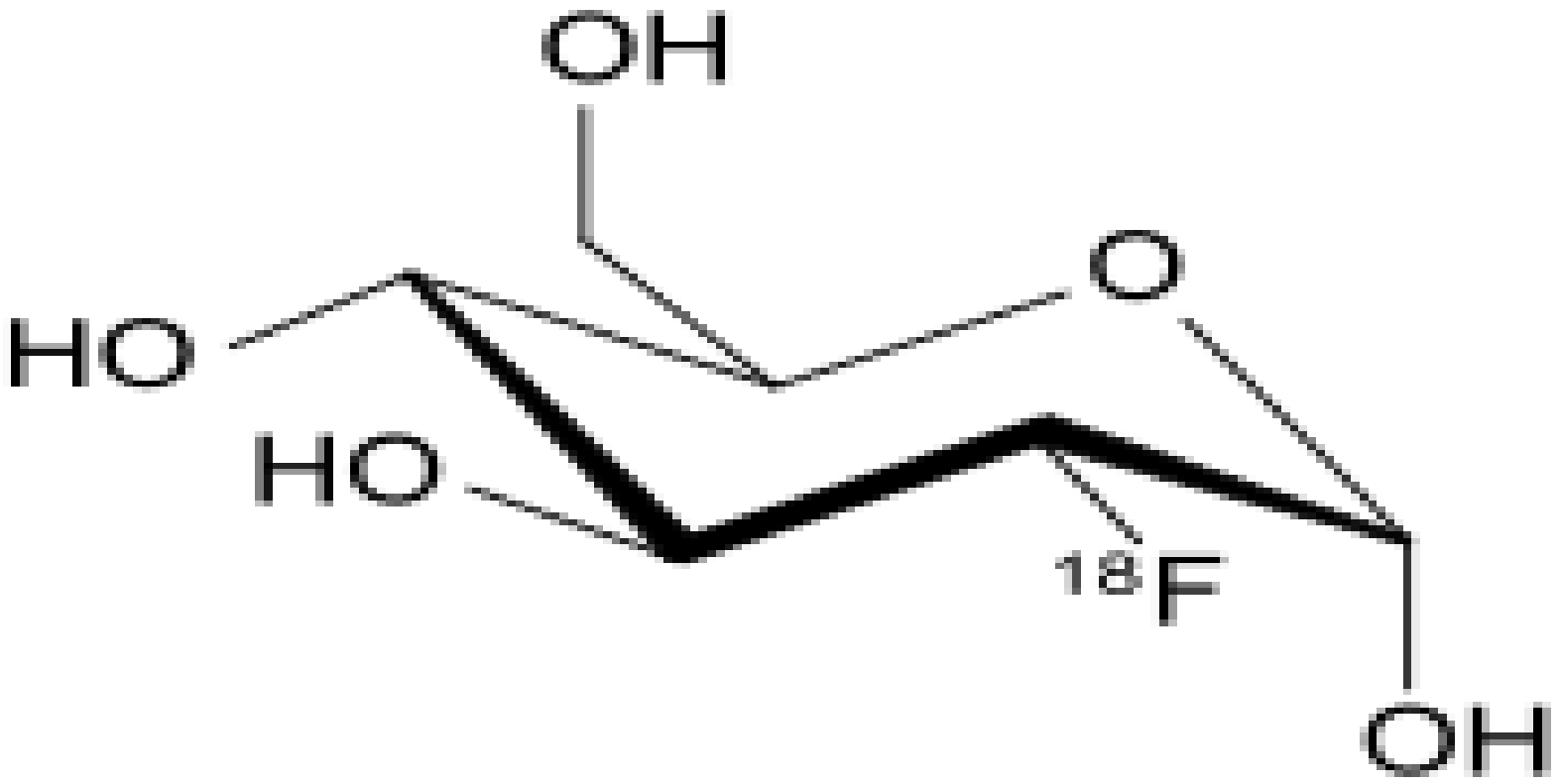
a special camera and a computer to help evaluate your organ and tissue functions.

By identifying body changes at the cellular level ,recently use of PET to detect the cancer tumours, may also used in cardiology and neurology.

PET principle

- PET use x-ray in order to present a 3D picture
- short line radioactive tracer isotope injected into the living subject usually in blood circulation ,the tracer is chemically incorporated into a biological active molecule
- There is a waiting period while the active molecule become concentrated in tissues of inert
- Radioisotope undergo a PE decay it will emit a positron

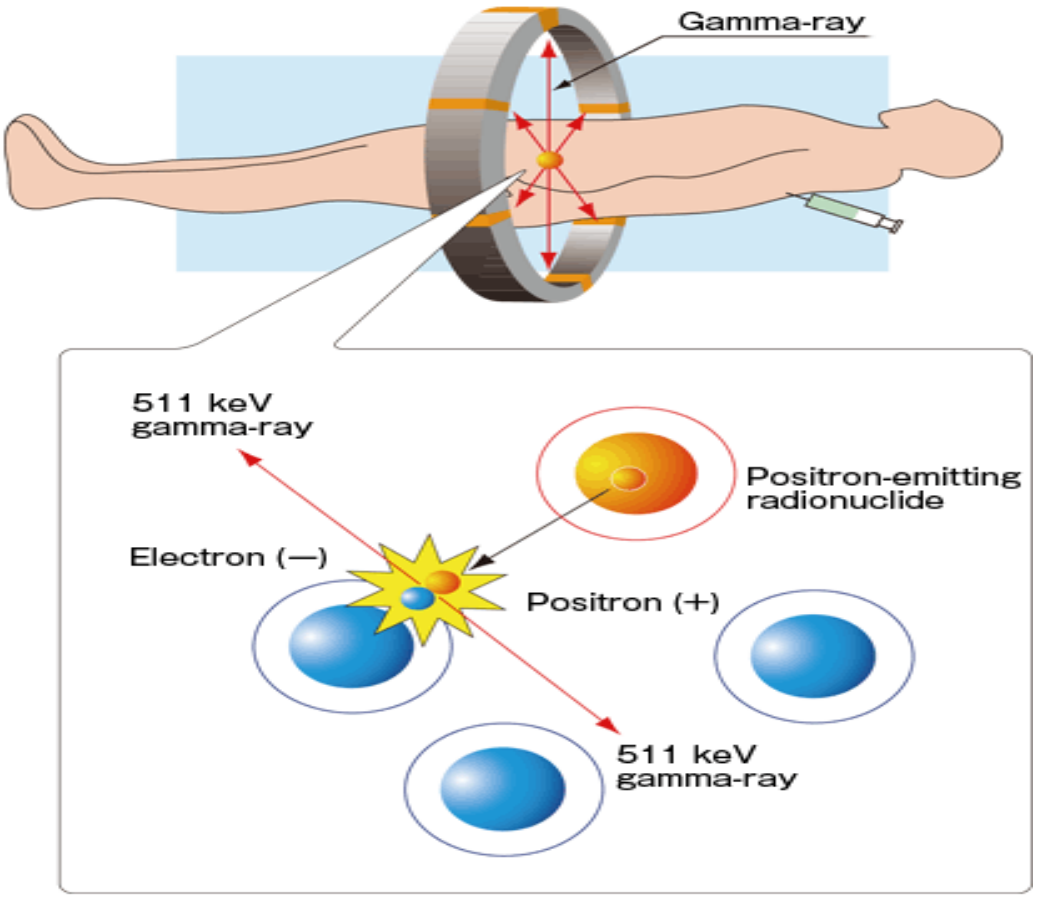
Fludeoxyglucose(FDG) an analogue of glucose



PET principle

- Travelling few(milli meter)the positron encounter an electron
- The encounter annihilates them both produce a pair of (gamma) photon moving in opposite directions
- These are detected when they reach scintillators in the scanning device create a burst of light
- The technicians can the create an image of the parts of brain for example which are overactive

Principle of work



How can we performed it ?

- If you're pregnant or believe you could be pregnant, tell your doctor. The test may be unsafe for your baby. You should also tell your doctor about any medical conditions you have. If you have diabetes, you'll get special instructions for test preparation because fasting beforehand could affect your blood sugar levels.

How can we performed it ?

- Before the scan, you'll get tracers through a vein in your arm, through a solution you drink, or in a gas you inhale. Your body needs time to absorb the tracers, so you'll wait about an hour before the scan begins.
- Next, you'll undergo the scan. This involves lying on a narrow table attached to a PET machine, which looks like a giant letter "O." The table glides slowly into the machine so that the scan can be conducted.

How can we performed it ?

- You'll need to lie still during the scan
- You may be asked to hold your breath for short periods.
- You'll hear buzzing and clicking noises during the test.

When all the necessary images have been recorded, you will slide out of the machine. The test is then complete.

A picture clarify the process of diagnosis of pathological conditions or any other abnormalities and complications ,

Performance of PET scan

Benefits

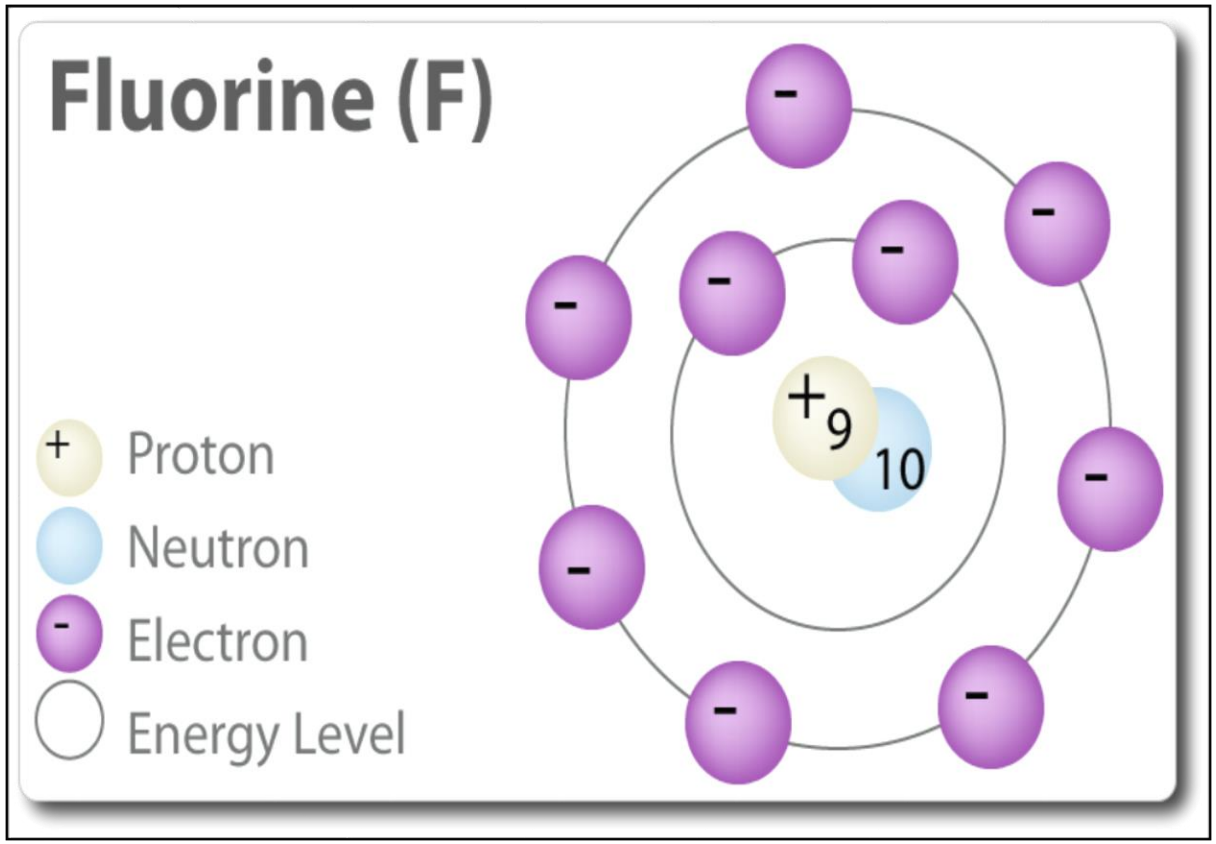
- medicine examinations provide unique information—including details on both function and anatomic structure of the body .
- nuclear medicine scans yield the most useful information needed to make a diagnosis or to determine appropriate treatment .
- Nuclear medicine is less expensive and may yield more information than surgery by identifying changes in the body at the cellular level .

Risks

A radioactive drug (tracer) will be put into body. The amount of radiation was exposed, and the risk of negative effects

1. Cause a major allergic reaction.
2. Expose unborn baby to radiation if pregnant
3. Expose your child to radiation if breast-feeding

Isotope:- each of two or more forms of the same element that contain equal numbers of protons but different numbers of neutrons in their nuclei, and hence differ in relative atomic mass but not in chemical properties



Fluorine isotope
(most common use isotope)

Common isotops used in PET scan

Isotope	Half-life	Maximum energy (Mev)	Range in water (mm)
^{18}F	109.7 min	0.635	2.39
^{11}C	20.4 min	0.96	4.11
^{13}N	9.96 min	1.19	5.39
^{15}O	2.07 min	1.72	8.2

Difference between PET and CT scan

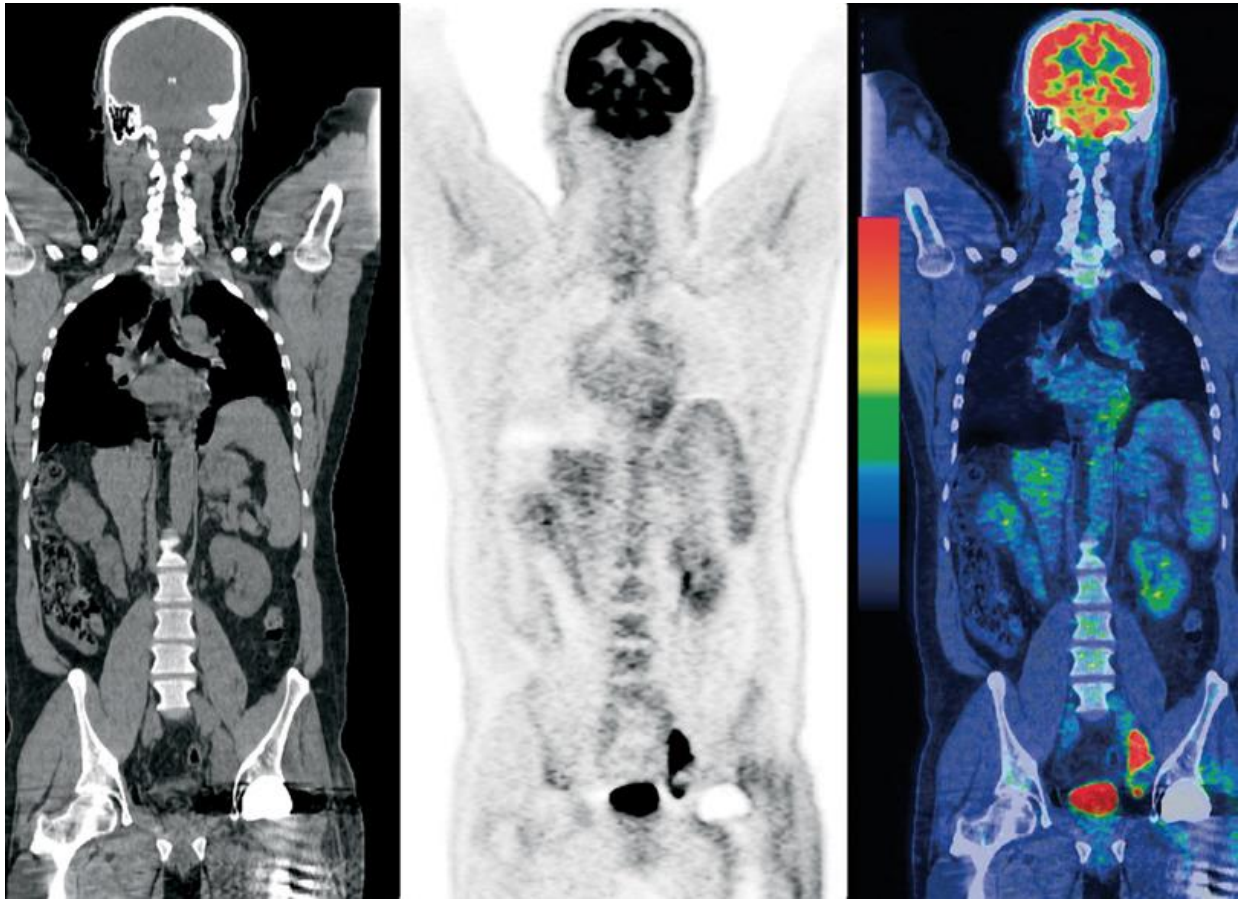
PET	CT scan
1) Higher cost than CT	1) Cost less than PET and MRI
2) Take 2-4 hours to complete scan	2) Completed within 5 min ,so its less sensitive to patient
3) Radiation exposure from moderate to high	3) The effective radiation dose from CT ranges from 2 to 10 (mSv)
4) Use radioactive tracer	4) Use x-ray for imaging
5) Can image biological process of the body	5) CT can outline bone inside the body very accurately

Difference

CT scan

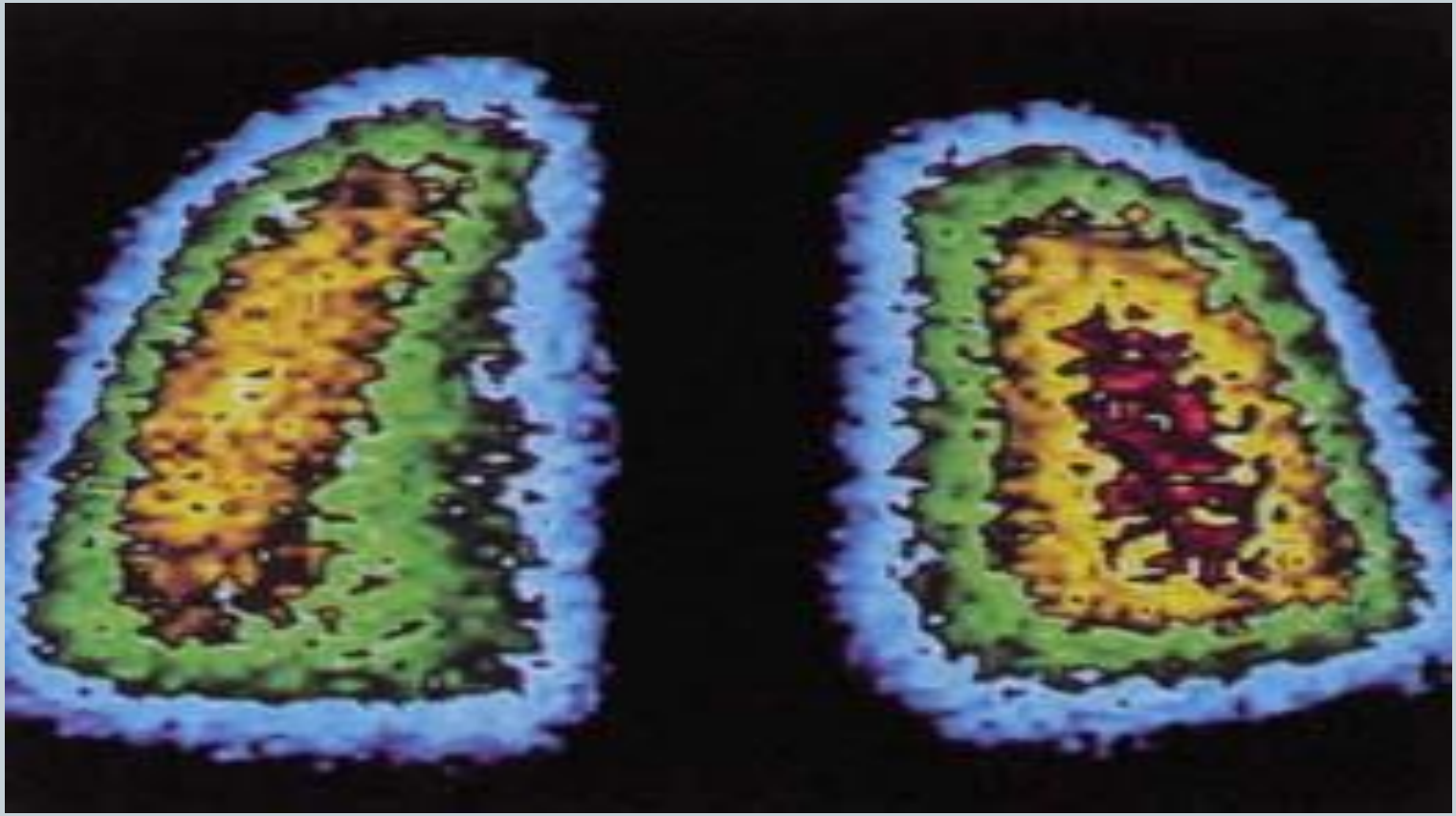
PET scan

Image taken by PET to the left side ,the middle one taken by CT scan ,while the last one is both PET\CT scan combined image



PET\CT scan image

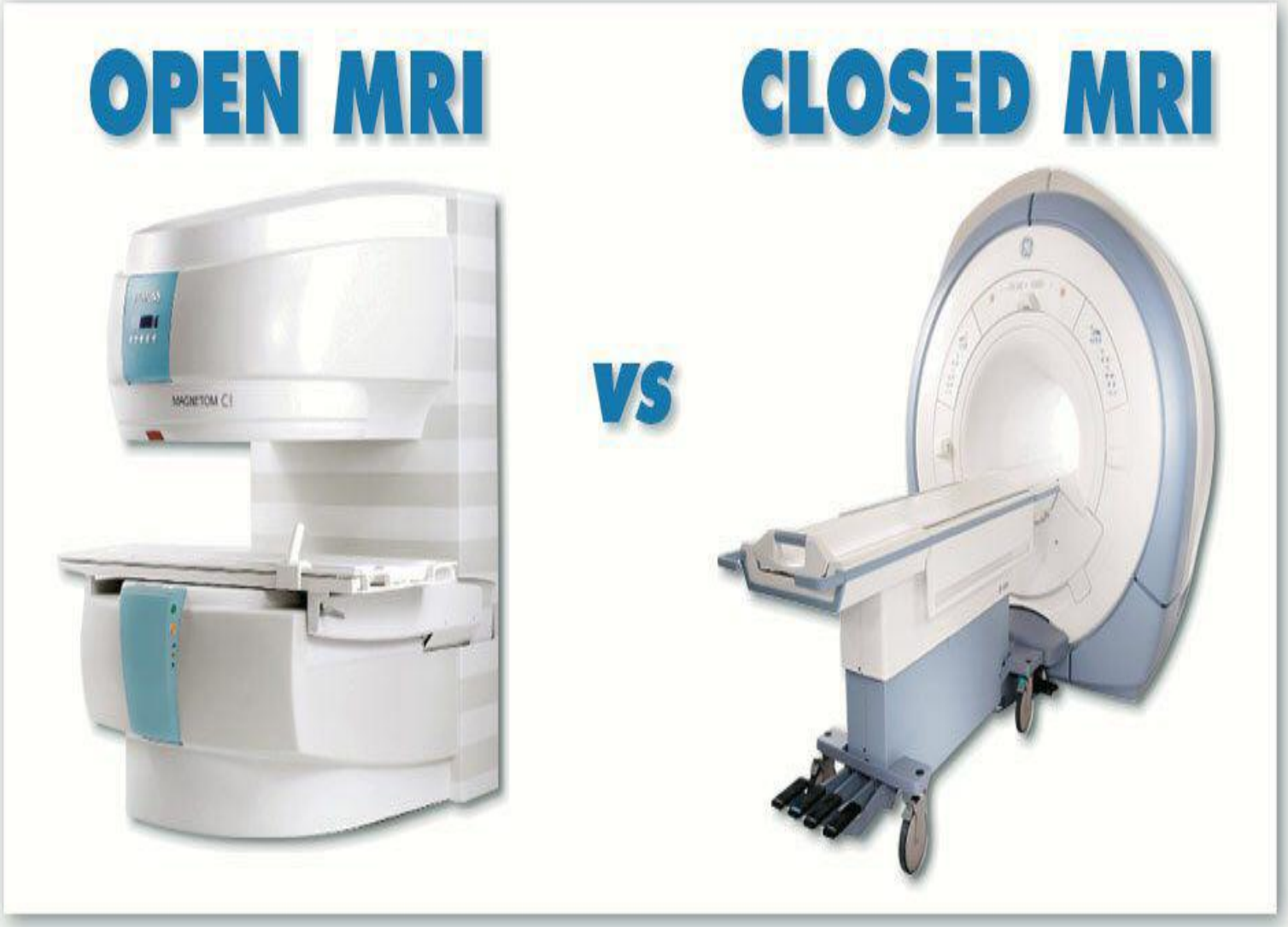
Images of human lungs obtained from a γ-ray scan



MRI

Magnetic Resonance Image :

Use Magnetic Field


OPEN MRI
CLOSED MRI
VS
MAGNETOM C!


FONAR

THE END

THANK YOU