Lecture Three / Radiopharmaceuticals

1.1 Radiopharmaceuticals

It is are radioisotopes bound to biological molecules able to target specific organs, tissues or cells within the human body. These radioactive drugs can be used for the diagnosis and, increasingly, for the therapy of diseases.

Radiopharmaceuticals are unique medicinal formulations containing radioisotopes which are used in major clinical areas for diagnosis and/or therapy.

- **Radioisotope is the radiation source (radioactive atom)**

- **Pharmaceutical is the vector molecule that targets the organ**

- **Radioisotope + pharmaceutical = radiopharmaceutical (radiotracer)**

1.2 Specific conditions of a radiopharmaceutical

- Be available.
- Has suitable energy for detection (minimum 60 and maximum 500 kV).
- Have a suitable physical half-life (short enough to reduce the patient's absorbed dose and long enough to complete the test)

- It has a suitable biological half-life (it should not stay in the body for a long time).
- Ability to focus on the desired organ selectively.

1.3 Application of radiopharmaceuticals in Diagnostic

The organs in the human body are able to absorb chemicals. For example, the thyroid takes up iodine and the brain consumes glucose. These observations are the basis to the development of a range of radiopharmaceuticals which include attaching **radioisotopes** to biomolecules. When a radiotracer enters the body, it is incorporated into its biological pathways, metabolised, and then excreted. These radiopharmaceuticals can be used to investigate the flow of blood in the brain, amongst other organs such as the liver, lungs, heart, kidneys and including investigations into bone growth.However, the amount of radiopharmaceutical given to a patient can range from a small dose of 5 microcuries to 35 millicuries. To put this into context, the radiation received from these dosages is about the same amount of radiation received from an X-ray study of that particular organ.

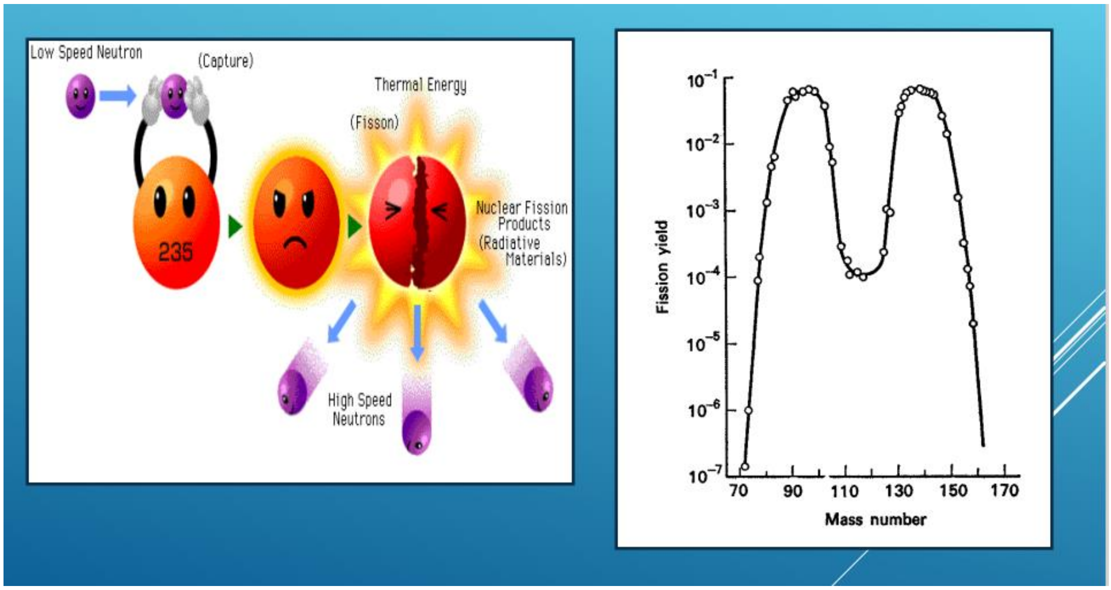
Radiopharmaceuticals used in the diagnosis of the disease state

Disease State	Radiotracer
Brain diseases and tumours	2-deoxy-2-[^{18}F]fluoro-glucose, indium-111 pentetreotide, iofetamine (^{123}I), sodium pertechnetate (^{99m}Tc), technetium-99m exametazime, technetium-99m gluceptate, technetium-99m pentetate
Cancer and tumours	2-deoxy-2-[^{18}F}fluoro-glucose,

	gallium-67 citrate, indium-111 pentetreotide, methionine (^{11}C), radioiodinated iobenguane, sodium fluoride (^{18}F), technetium-99m arcitumomab, technetium-99m nofetumomab merpentan
Colorectal disease	technetium-99m arcitumomab

1.4 Application of radiopharmaceuticals in treatment

- Due to their ionizing properties, ionizing rays are very effective in destroying healthy or unhealthy cells in the body
- Iodine 131 for the treatment of hyperthyroidism and thyroid
  - Phosphorus 32 for the treatment of erythrocytes (polycythemia)
  - Gold 198 for the treatment of ovarian cancer
  - Yttrium 90 for the treatment of liver cancers



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1.4 Production of radiopharmaceuticals

- More than 20 elements are found in uranium-236 fission products.
- The distribution of fission fragments is seen in the previous curve. Fission of uranium-236 usually results in a fission fraction in the mass range of 85 to 105 and other fragments with a mass number in the range of 130 to 150.
- If the half-life of one of the fission fragments is long enough, it can be removed from the fission product and used as a medical radionuclide.
- Like the conversion of vanadium 99 to zirconium 99 and with the decomposition of beta to neobium 99 and the decomposition of beta to molybdenum 99