UNIT 4: NUCLEAR IMAGING

4.5 Single Photon Emission Computed Tomography (SPECT) and Positron Emission Tomography (PET)

Single Photon Emission Computed Tomography (SPECT) and **Positron Emission Tomography (PET)** are both non-invasive imaging techniques used primarily in nuclear medicine for diagnostic purposes. While both techniques involve the use of radiotracers to detect gamma radiation from inside the body, they differ in the types of tracers used and the principles of operation.

SPECT (Single Photon Emission Computed Tomography):

1. **Principle of Operation:**

   • SPECT detects gamma rays emitted from a radiopharmaceutical that has been injected into the body.

   • The radiopharmaceutical used in SPECT emits single photons, which are captured by a gamma camera.

   • The gamma camera rotates around the patient to capture multiple 2D images from different angles, which are then reconstructed into a 3D image.

2. **Radiopharmaceutical:**

   • The radiopharmaceutical used in SPECT typically contains a radionuclide like Technetium-99m (Tc-99m) or Iodine-123.

   • These substances emit single photons that can be detected by the gamma camera.

3. **Applications:**

   • SPECT is commonly used in cardiology, neurology, and oncology. It can assess brain activity, heart function, and tumor detection.

4. **Resolution:**

   • SPECT typically has lower spatial resolution compared to PET but provides functional information about organ function and blood flow.

PET (Positron Emission Tomography):

1. **Principle of Operation:**

   • PET involves the detection of annihilation photons produced when a positron (released from a radioactive substance) encounters an electron in the body.

   • The positron and electron annihilate each other, releasing two photons that travel in opposite directions. These photons are detected by a ring of detectors surrounding the patient.

- The data is used to create a detailed image of metabolic activity in the body.

2. **Radiopharmaceutical:**

- The radiopharmaceutical in PET typically contains a positron-emitting isotope such as Fluorine-18 (18F), often used in the commonly known FDG (fluorodeoxyglucose) scan.

- FDG is a glucose analog that accumulates in areas of high metabolic activity, making it useful for detecting cancer and brain activity.

3. **Applications:**

- PET is used to evaluate metabolic processes, including cancer detection, brain function, and heart disease.

- It is particularly valuable in oncology for detecting and monitoring tumors, as malignant cells tend to have a higher metabolic rate than normal cells.

4. **Resolution:**

- PET offers higher spatial resolution and more precise functional imaging than SPECT, allowing for more accurate detection of abnormalities.

Key Differences:

- **Radiotracers**: SPECT uses single-photon-emitting isotopes, while PET uses positron-emitting isotopes.
- **Image Resolution**: PET generally provides higher resolution images than SPECT.
- **Cost and Complexity**: PET is more expensive and technologically complex compared to SPECT, which is more widely available.
- **Clinical Use**: PET is preferred for detecting metabolic activity and cancer, while SPECT is used for a variety of functions, including cardiac imaging.