Nuclear Medicine

- Uses a device known as a Gamma Camera.
- Also known as a Scintillation or Anger Camera.
- Detects the release of gamma rays from Radionuclide.
- The radionuclide can be injected, inhaled or ingested by the patient.
- Unlike traditional radiology, the patient is the source.
Gamma Camera

- The Gamma camera uses a thick collimator with thousands of adjacent holes.
- The collimator attenuates about 99% of the energy striking the camera.
- Behind the collimator is the Scintillation crystal.
- The crystal uses the Compton effect. When a gamma ray strikes the crystal, it excites an electron. This causes a brief flash of light.
Photomultiplier Tube

● They are used to detect the flashes of light from the gamma rays striking the crystal.

● The photomultiplier tubes are about three inches in diameter.

● They are arranged in hexagonal clusters.

● A computer takes the signals generated by the PMT's and creates an image based on the location and strength of the signal on the array.
PET Scanner

- Positron Emission Tomography (PET).
- Is a multi-headed gamma camera that can be set up to detect simultaneous events on two different detectors.
- Provides images of blood flow and other biochemical functions.
- Drawback to PET systems, is they need a particle accelerator to produce the radionuclides.
SPECT

- Single Photon Emission Computed Tomography. (SPECT)
- Used in Cardiac stress testing.
- The detectors rotate around the patients body.
- Uses an "R" Trigger cardiac monitor to synchronize the camera.
Gamma Energy

- High gamma energy, will pass through the crystal without interacting with it.
- Low gamma energy, will be absorbed by the crystal without interaction.
- Gamma Counter- is used to measure the strength of the radionuclide.
Nuc Med Problems

- Spatial Resolution is used to calculate the point of origin of the photon.
- As distance from the source and camera increase, resolution decreases.
- Non-Uniformity, can be caused from a cracked or broken crystal.
- Artifact can be caused by structural defects in the collimator.
- This can cause a loss of resolution and linearity.
- [http://www.medphysics.wisc.edu/courses/mp573/NM%3FPET%20radlab/HalamaSlides.pdf](http://www.medphysics.wisc.edu/courses/mp573/NM%3FPET%20radlab/HalamaSlides.pdf)
Diagnostic Ultrasound

- 1 to 6 MHz is the frequency range used to image deeper structures, such as the liver and kidneys.
- It has lower axial and lateral resolution, but has deeper penetration.
- 7 to 18 MHz is the frequency range used for superficial structures. It has better axial and lateral resolution, but not as deep penetration.
Diagnostic Ultrasound Modes

● **A-Mode** is a single transducer that scans through the body. The echos are plotted on the screen as a function of depth.

● **B-Mode** is an array of transducers that scan as a plane through the body. The echos can be viewed as a 2D image on the screen.

● **M-Mode** is a rapid sequence of B-Mode scans that follow each other. This allows the measurement of motion.
Diagnostic Ultrasound Modes

- 3D Ultrasound - Is formed by coupling sets of adjacent 2D images.
- Bi-Planar Ultrasound - Has two 2D planes that are perpendicular to each other.
- Compression Ultrasound - Is used for vascular studies, such as Deep Vein Thrombosis.
- Doppler Mode - Uses the Doppler effect to see and measure blood flow.
Diagnostic Ultrasound Modes

- Continuous Doppler - Doppler information is sampled along a line through the body.
- Pulsed Wave Doppler - Is sampled from a small amount of volume and presented on a time line.
- Color Doppler - Velocity information is a color coded overlay on top of a B-Mode image.
- Duplex - Simultaneous presentation of 2D and Pulsed Wave Doppler information.
Diagnostic Ultrasound Probes

- Beamforming - is a complex set of control pulses from the generator. This allows the energy to be focused into an arc-shaped sound wave from the face of the transducer.
- Phased Arrays - Are used on transducers to change the direction and depth of focus of the sound wave.
- Omniplane Probe - is a probe that can rotate 180 degrees to obtain multiple images.
Diagnostic Ultrasound Limitations

- Ultrasound does not perform well when there is gas between the transducer and focus area.
- Ultrasound performance is reduced in large and obese patients.
- Ultrasound does not penetrate bone very well.
- http://en.wikipedia.org/wiki/Medical_ultrasonography
Film

- Base Density - is the density of unexposed film as set by the manufacturer.
- Fog - is a condition that occurs to film due to age, warm temperatures, chemical and radiation background exposure.
- Fog will cause a reduction in the film's contrast.
- Base & Fog should have a density of less than 0.25
Film

- Film Contrast - can be affected by several factors.
- These include the film type, processing conditions. Film density and fog levels.
- Film Speed - (Sensitivity) is the reaction time of the film to light and radiation.
- Fast Film requires a shorter exposure and reduces motion artifact. May give a grainy image.
- Slow Film shows finer detailed images. But requires a longer exposure time.
Film

- Film Latitude is the exposure range of film where acceptable densities are produced.
- Can either have a narrow latitude range or a wide one.
Intensifying Screens

- Used to convert x-rays into visible light.
- Placed inside the film cassette in front of the film. Helps reduce the dose to the patient.
- Fast screen has an increased brightness, shorter exposure time, but has lower resolution.
- Slow screen has increased resolution, but has decreased brightness and longer exposure time.
View Box and Room Lighting

- View box luminance is measured in NITs.
- Room Illumination is measured in lux.
Film Processors

- Developer - amplifies the latent image.
- Fixer - helps prevent the image from fading.
- Washer - removes the excess chemicals.
- Dryer allows the film to be handled and helps prevent scratches on the film.
Film Processor Problems

- Developer temperature too hot, will cause foggy images and cause high optical densities.
- Developer temperature too cold, will cause low optical densities.
- Developer temperature should be between 90 to 95 degrees F. Depending on the manufacturer.
- pH values of the developer and fixer should be checked daily.
Film Processor Artifacts

- Roller artifact - also called Pi lines. Will cause scratches in the same spot, on every film. This is caused by small nicks in the rollers.
- Guide Shoe artifacts - are evenly spaced lines running the same direction on the film. This is caused by the guide shoes in the developer being out of alignment.
- Improper dryer temp can cause the film to be damaged and scratched. If the film is wet coming out of the dryer, the temperature needs to go up.