Type of Imaging Modalities In Radiology

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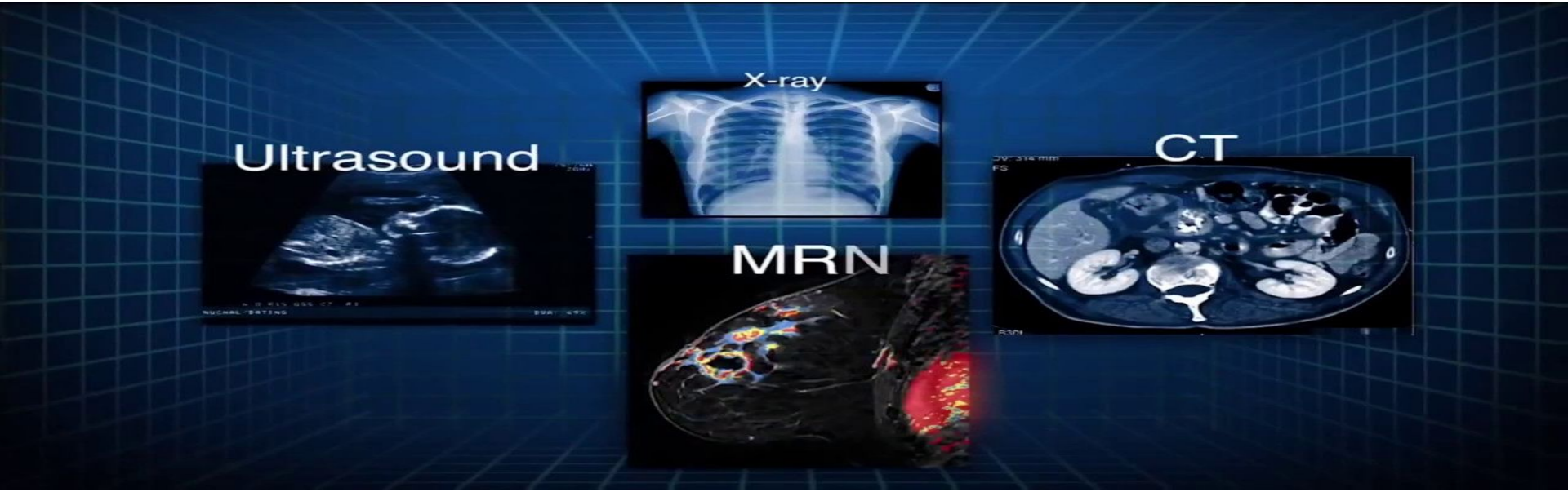
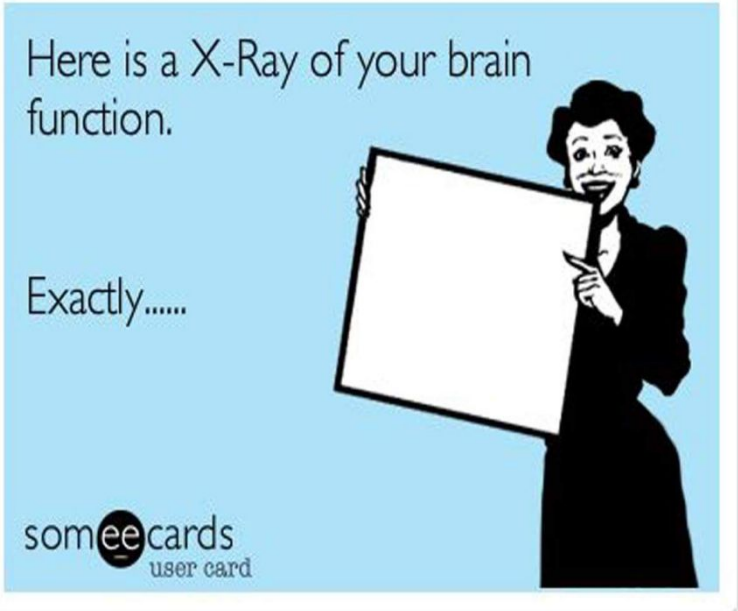
- **Medical imaging** is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention, as well as visual representation of the function of some organs or tissues.
- Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease.



- As a discipline it is part of biological imaging and incorporates radiology which uses the imaging technologies of:
  - X-ray,
  - CT,
  - ultrasound,
  - MRI,
- and nuclear medicine functional imaging techniques as positron emission tomography (PET) and Single-photon emission computed tomography (SPECT).



CONVENTIONAL RADIOGRAPHY

■ Images produced through the use of ionizing radiation are called ***conventional radiographs*** or, more often, **plain films.**

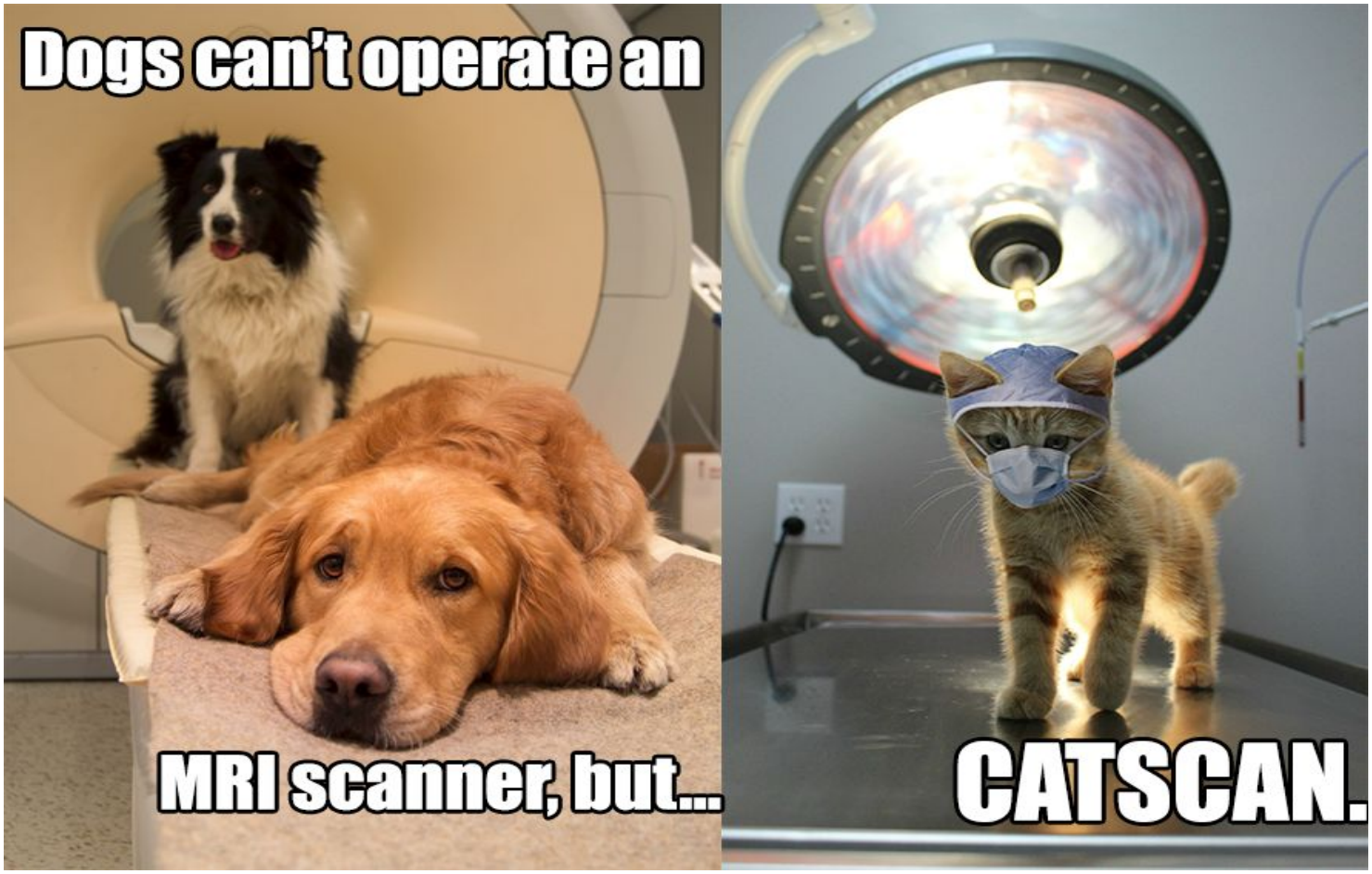
■ The major advantage of conventional radiographs is that the images are relatively **inexpensive** to produce, can be obtained almost **anywhere** by using portable or mobile machines, and are still **the most widely obtained imaging studies.**

■ They require a **source** to produce the x-rays (the "x-ray machine"), a method to **record** the image (a film, cassette, or photosensitive plate), and a way to **process** the recorded image (using either chemicals or a digital reader).

Common uses and disadvantages

- Common uses for conventional radiography include the ubiquitous chest x-ray, plain films of the abdomen, and virtually every initial image of the skeletal system to evaluate for fractures or arthritis.
- The major disadvantages of conventional radiography are the **limited range of densities** it can demonstrate and that it **uses ionizing radiation.**

CT or CAT scan



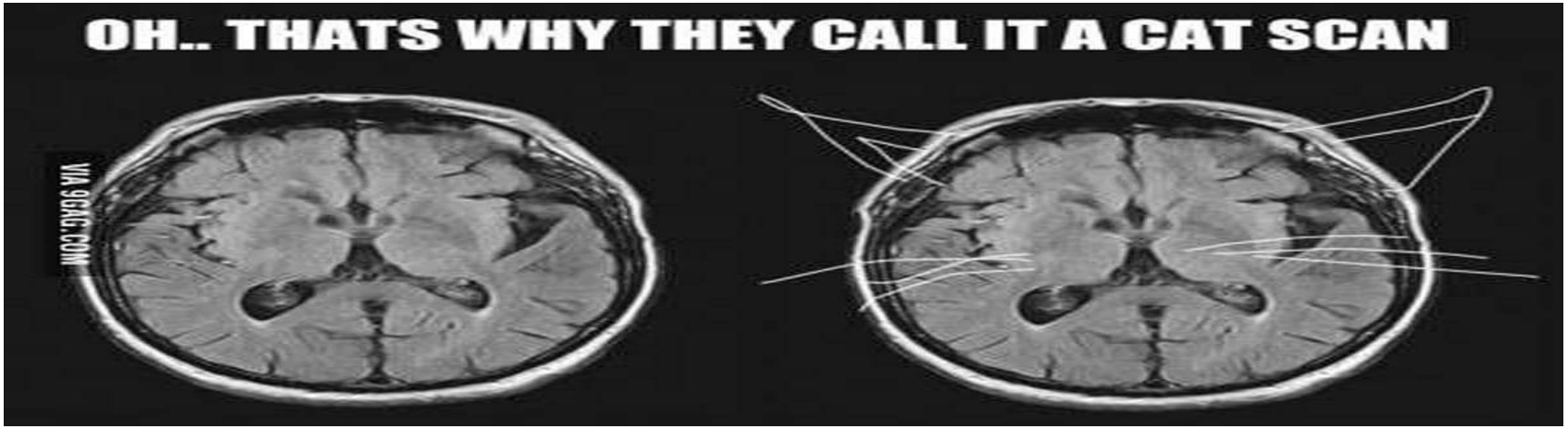
COMPUTED TOMOGRAPHY

■ CT (or “CAT”) scanners, first introduced in the 1970s, brought a quantum leap to medical imaging.

■ Using a gantry with a rotating x-ray beam and multiple detectors in various arrays (which themselves rotate continuously around the patient), along with sophisticated computer algorithms to process the data, a large number of two-dimensional, slicelike images (each of which is millimeters in size) can be formatted in multiple imaging planes.

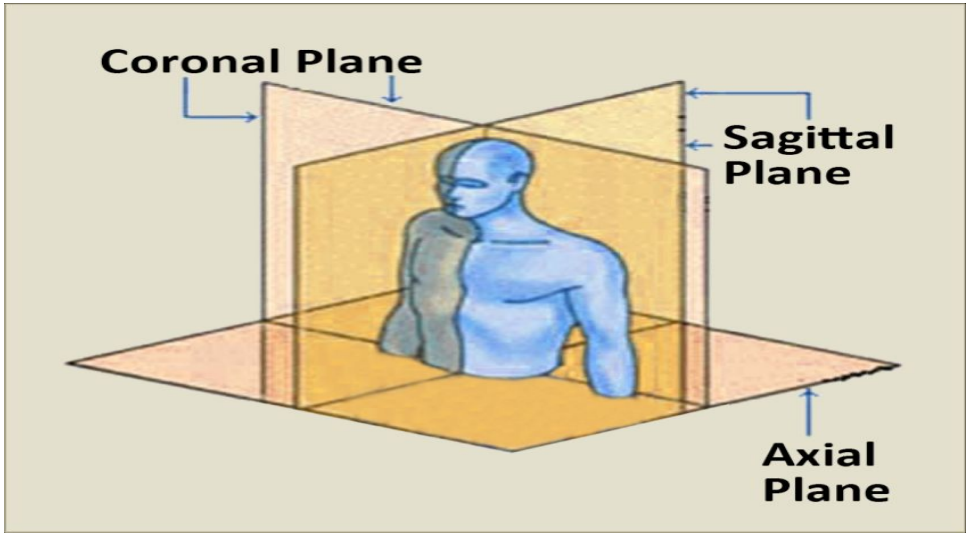
CT or CAT

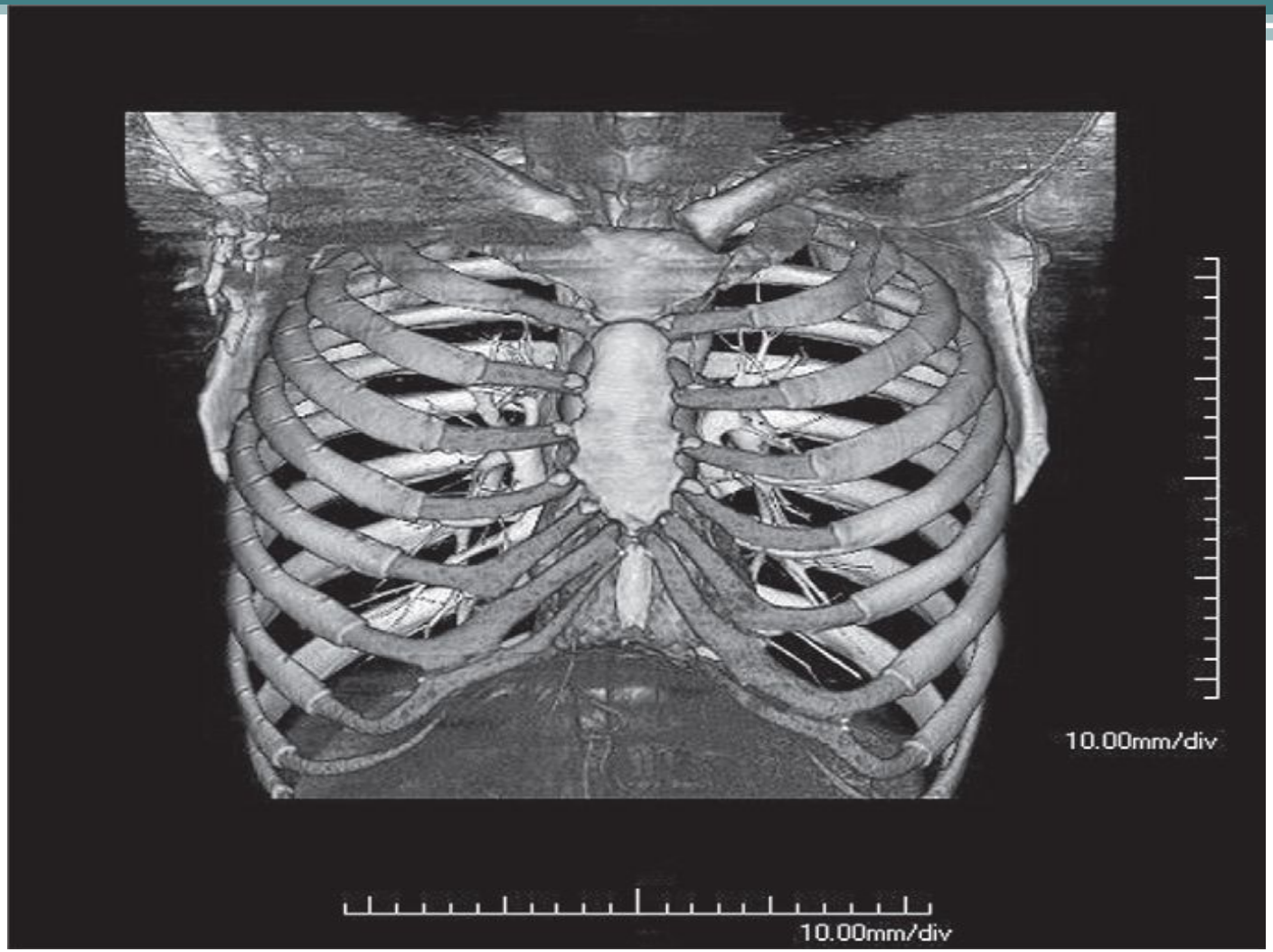
- **A CT scanner** is connected to a **computer** that processes the data though various **algorithms** to produce **images** of diagnostic quality.
- A CT image is composed of a matrix of thousands of tiny squares called ***pixels,*** each of which is computer-assigned a **CT number** from –1000 to +1000 measured in **Hounsfield units (HUs),** named after Sir Godfrey Hounsfield, the man credited with developing the first CT scanner (for which he won the Nobel Prize in Medicine in 1979 with Allan Cormack).



- Traditionally, CT images were viewed mostly in the axial plane. Now, because of volumetric acquisition of data, CT scans can be shown in any plane: axial, sagittal, or coronal.
- Volumetric data consist of a series of thin sections that can be **reassembled** for a three-dimensional reconstruction.
- Surface and volume rendering in three dimensions can produce CT images of amazing, realistic quality (Next slide).
- ■ One of the major benefits of CT scanning over conventional radiography is its ability to **expand the gray scale,** which enables differentiation of many more densities available on conventional radiographs.

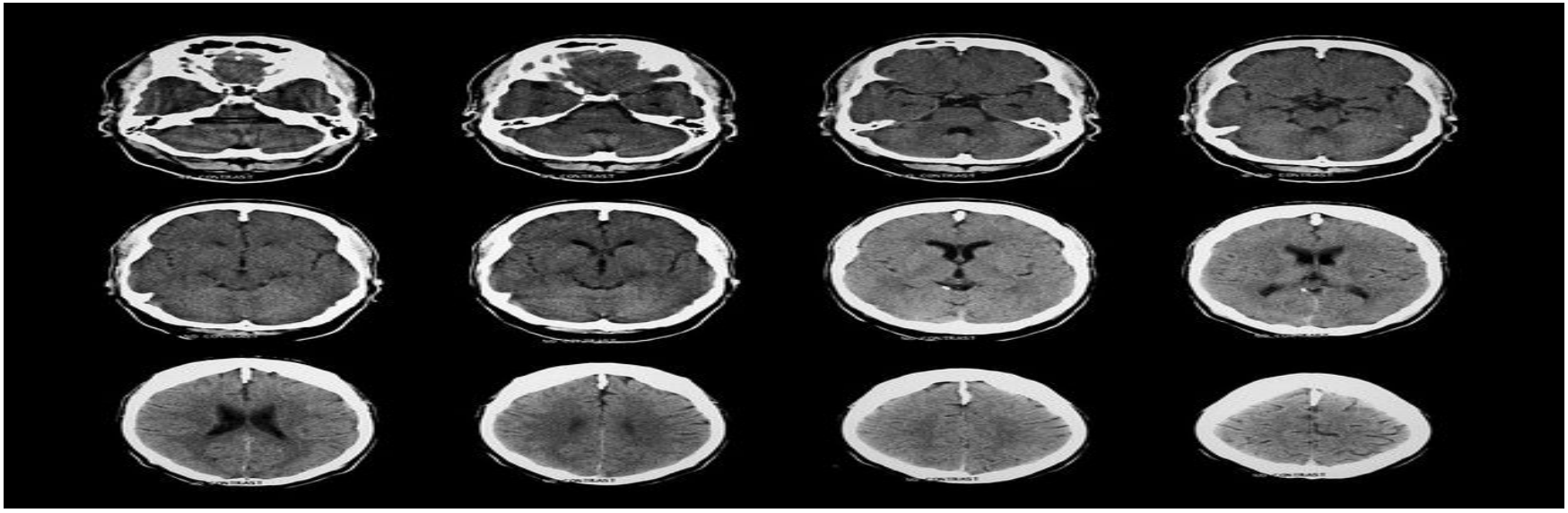
X-ray Vs CT scan





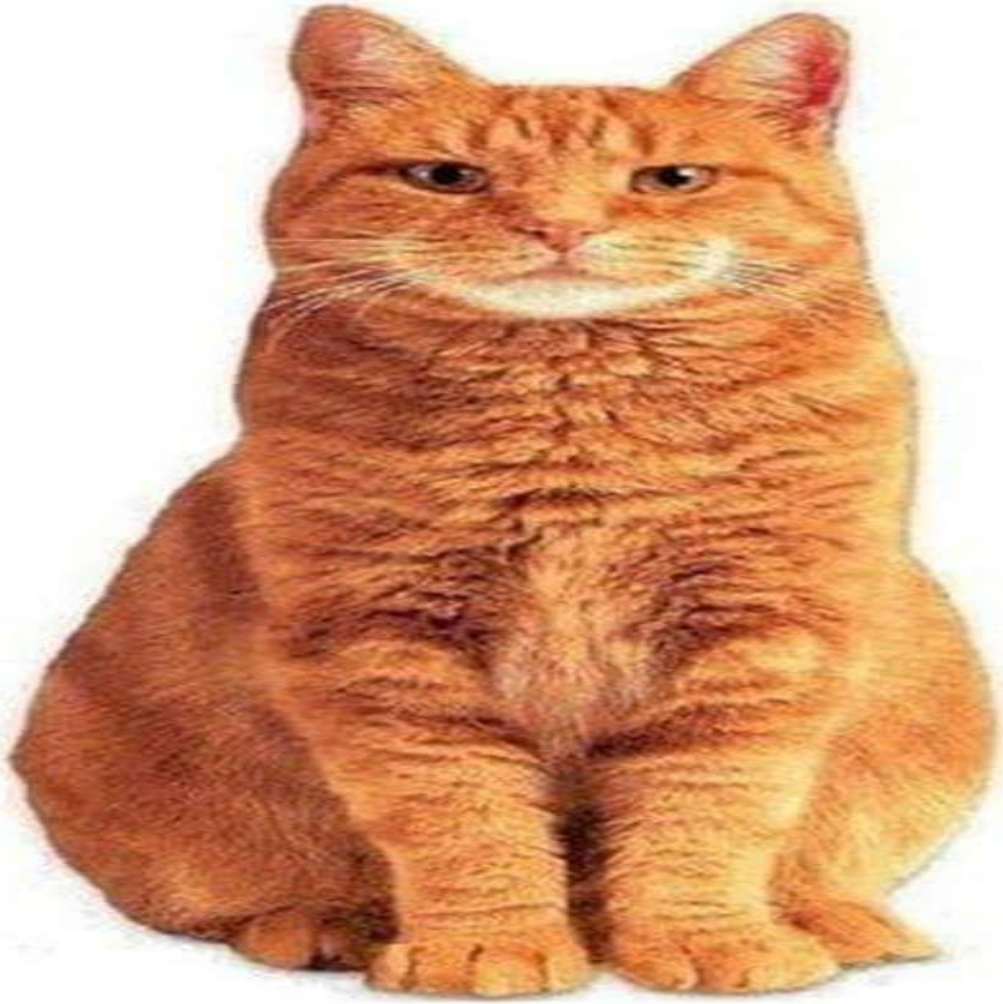
Three-dimensional computed tomography rendering of normal rib cage.

- **CT scans are the cornerstone of cross-sectional imaging** and are widely available, although not as yet truly portable.
- Production of CT images requires an expensive scanner, a space dedicated to its installation, and sophisticated computer processing power. Like conventional x-ray machines, CT scanners utilize ionizing radiation (x-rays) to produce their images.



PLEASE STARE INTO MY EYES FOR ONE MINUTE.

THEN SCROLL DOWN.



THANK YOU. YOUR CAT SCAN IS NOW COMPLETED.

ULTRASONOGRAPHY

- ■ Ultrasound probes utilize acoustic energy above the audible frequency of humans to produce images, instead of using x-rays as both conventional radiography and CT scans do.
- ■ An ultrasound **probe** or **transducer** both produces the ultrasonic signal and records it. The signal is processed for its characteristics by an onboard computer. Images are displayed either as static images or in the form of a movie (or “cine”).

Benefits

- ■ Ultrasound scanners are relatively **inexpensive** compared with CT and MRI scanners. They are **widely available** and can be made **portable** to the point of being handheld.
- ■ Because ultrasonography utilizes no ionizing radiation, it is particularly useful in obtaining images of children and women of **childbearing age** and **during pregnancy.**
- ■ **Ultrasonography is widely used in medical imaging.** It is usually **the study of first choice** in imaging the female pelvis and in pediatric patients, in differentiating cystic versus solid lesions in patients of all ages, in noninvasive vascular imaging, in imaging of the fetus and placenta during pregnancy, and in real-time, image-guided fluid aspiration and biopsy.

- ■ Other common uses are evaluation of cystic versus solid breast masses, thyroid nodules, and tendons and in assessment of the brain, hips, and spine in newborns. Ultrasonography is used in settings ranging from intraoperative scanning in the surgical suite to the medical tent in the battlefield.
- ■ Ultrasonography is generally considered to be **a very safe imaging modality** that has no known major side effects when used at medically diagnostic levels.

MAGNETIC RESONANCE IMAGING

- ■ MRI utilizes the potential energy stored in the body's **hydrogen atoms.** The atoms are manipulated by very strong magnetic fields and radiofrequency pulses to produce enough localizing and tissue-specific energy to allow highly sophisticated computer programs to generate two- and three dimensional images.
- ■ However, they utilize **no ionizing radiation** and produce much higher contrast between different types of soft tissues than is possible with CT.

"Your cat scan looks fine, your pet scan looks fine, your MRI looks fine, but your insurance reimbursement doesn't look fine."

- ■ MRI is widely used in neurologic imaging and is particularly sensitive in imaging soft tissues such as the muscles, tendons, and ligaments.

- ■Contraindications of MRI:
- Cardiac pacemaker or metal valve.
- Brain aneurysm and aortic clips
- Endoprosthesis
- Metal objects:

Within the eye;
Near the spinal cord;
Cochlear implants;
Insulin pumps;
Neurostimulators.
Claustrophobia

"Conventional medicine says take aspirin. In the absence of tort reform, defensive medicine says MRI and Cat Scan."

FLUOROSCOPY

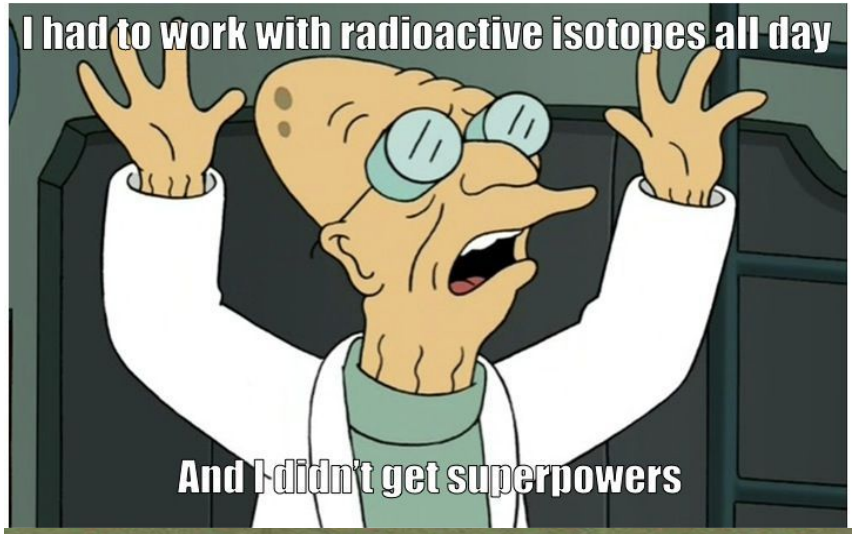
- Fluoroscopy is a modality in which ionizing radiation (x-rays) is used in performing **real-time visualization** of the body in a way that allows for evaluation of the motion of body parts, real-time positioning changes of bones and joints, and the location and path of externally administered barium or iodine contrast agents through the gastrointestinal and genitourinary tracts and blood vessels. Images can be viewed as they are acquired on video screens and captured as either a series of static images or moving (video) images.

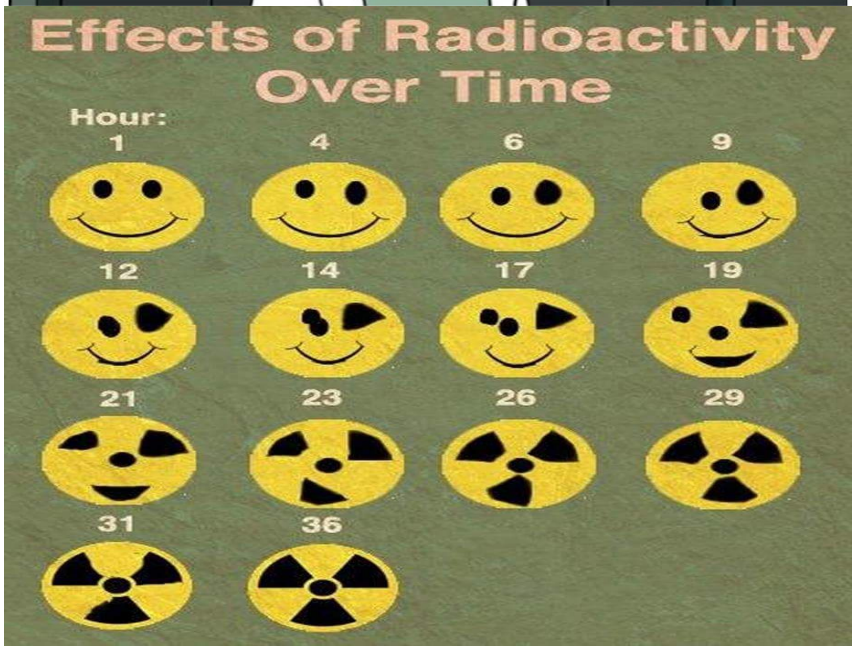
■ In **interventional radiology,** iodinated contrast is selectively injected into blood vessels or other ducts that can be imaged fluoroscopically to demonstrate normal anatomy, pathology, or the position of catheters or other devices

■ Radiation doses in fluoroscopy can be **substantially higher** than those used in conventional radiography because so many images are acquired for every minute of fluoroscopy time. Therefore the dose is reduced by using the **shortest possible fluoroscopy time** to obtain diagnostic images.

NUCLEAR MEDICINE

- A **radioactive isotope (radioisotope)** is an unstable form of an element that emits radiation from its nucleus as it decays. Eventually, the end product is a stable, nonradioactive isotope of another element.
- Radioisotopes can be produced **artificially** (most frequently by neutron enrichment in a nuclear reactor or in a cyclotron) or may occur **naturally.** Naturally occurring radioisotopes include **uranium** and **thorium.** The **vast majority of radioisotopes** used in medicine are produced **artificially.**

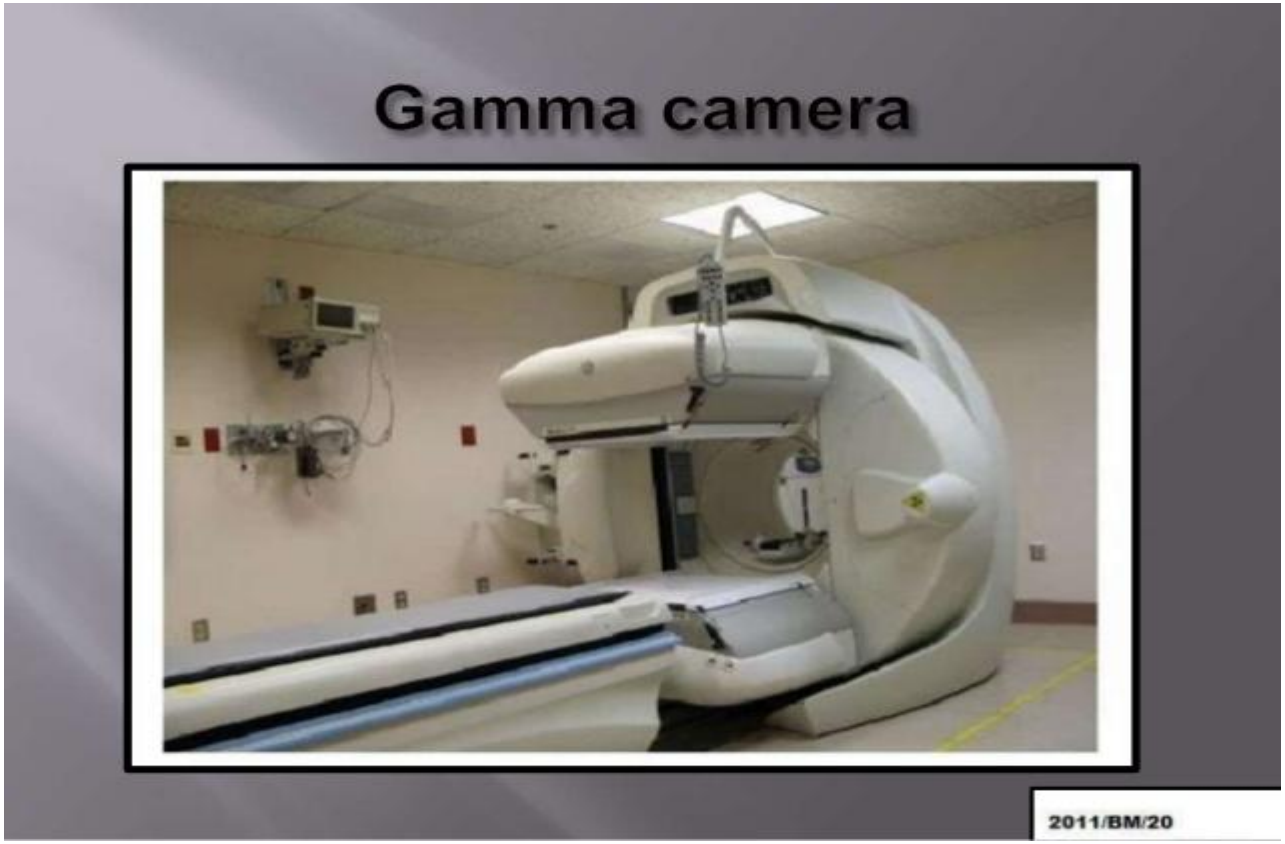




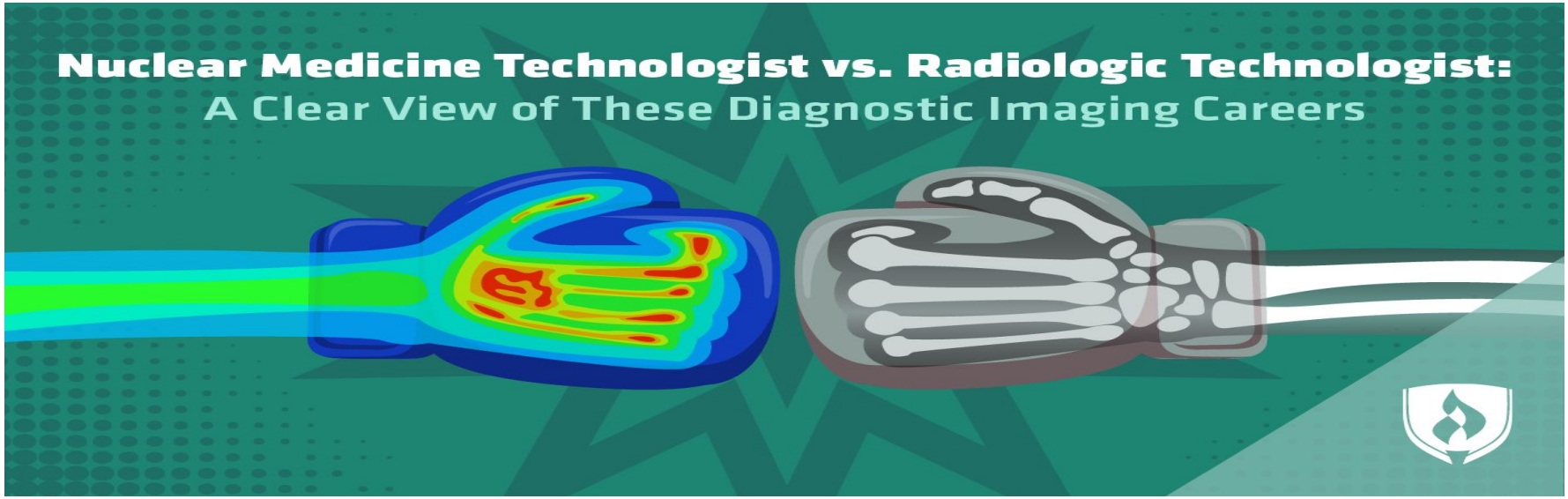
Radiopharmaceuticals are combinations of **radioisotopes** attached to a **pharmaceutical** that has binding properties that allow it to concentrate in certain body tissues, such as the lungs, thyroid, or bones. Radioisotopes used in clinical nuclear medicine are also referred to as ***radionuclides, radiotracers,*** or, sometimes, simply ***tracers.***

■ Various body organs have a specific affinity for, or absorption of, different biologically active chemicals. For example, the thyroid takes up **iodine;** the brain utilizes **glucose;** bones utilize **phosphates;** and **particles** of a **certain size** can be trapped in the lung capillaries.

- ■ After the radiopharmaceutical is carried to a tissue or organ in the body, usually via the bloodstream, its radioactive emissionsn allow it to be measured and imaged using a detection device called a ***gamma camera.***



■ **Positron emission tomography (PET)** is used to produce three-dimensional images that depict the body's biochemical and metabolic processes at a molecular level. It is performed using a **positron (positive electron)**-producing radioisotope attached to a targeting **pharmaceutical.**



■ PET scanning is most often used in the **diagnosis and treatment follow-up of cancer.** It is frequently used **to locate hidden metastases** from a known tumor or to **detect recurrence.** Oncologic PET scans make up about 90% of the clinical use of PET.

■ Unlike other modalities that use ionizing radiation, the patient can briefly be the **source** of radiation exposure to others (e.g., technologists) in nuclear medicine studies. To limit exposure to others, the principles of **decreasing the time** in close proximity to the patient, **increasing the distance** from the source, and **appropriate shielding** are used.

"I have the results of your PET scan and your CT scan. You are not claustrophobic."

- ■ Compared with CT and fluoroscopy, nuclear medicine studies, in general, produce less patient exposure.
- The types of scans that deliver the highest dose relative to other nuclear scans are cardiac studies and PET examinations.

"Cat scans are for felines. I will give your dog a pet scan."

Thank you for your attention !!!

This guy partially amputated his finger on a circular saw. "I stopped paying attention for one second!" he said.

Literature

- https://www.google.com
- https://www.wikipedia.org
- ^ Jump up to:[a] [b] *James A.P.; Dasarathy B.V. (2014). "Medical Image Fusion: A survey of state of the art". Information Fusion.* ***19****: 4–19. arXiv:1401.0166. doi:10.1016/j.inffus.2013.12.002.*