

# BASIC CONCEPTS IN DIAGNOSTIC IMAGING

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# OBJECTIVES & GOALS

Introduce the various Medical Imaging Modalities

Understand the basics of image generation

Relate imaging to gross anatomy

Appreciate constraints and limitations

Develop imaging vocabulary in the interpretation





# WHAT IS RADIOLOGY?

- ✓ Medical specialty that supervises, perform and interprets imaging studies.
- ✓ Reports findings to referring physicians to help in the patients management.



# WHAT ARE THE DIAGNOSTIC MODALITIES UTILIZED IN RADIOLOGY?

PLAIN X-RAY

COMPUTED TOMOGRAPHY (CT)

MAGNETIC RESONANCE IMAGING (MRI)

ULTRASOUND (US)

NUCLEAR MEDICINE (NM)

ANGIOGRAPHY (ANG)



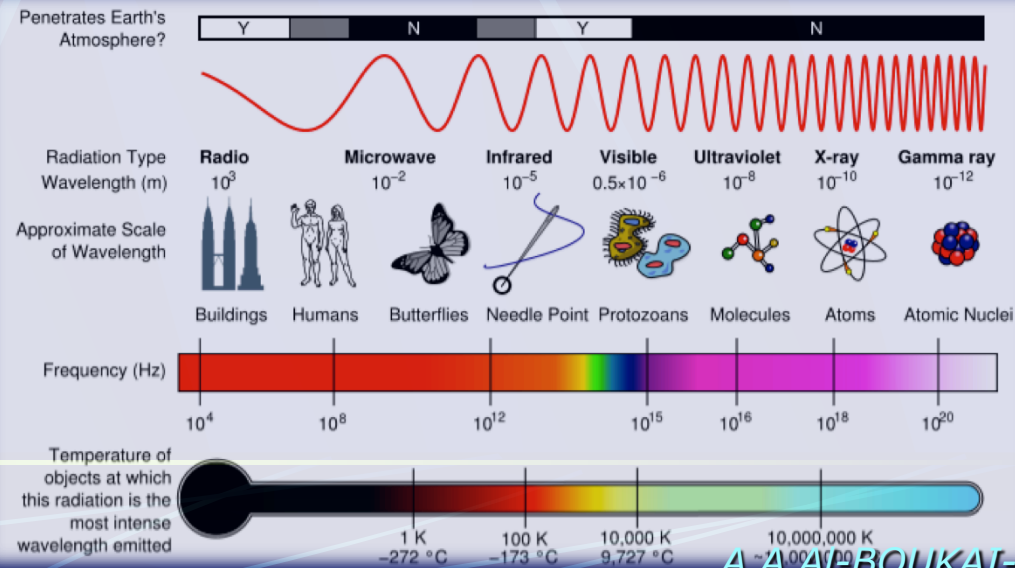




# WHAT IS X-RAY?

- ✓ It is a form of electromagnetic energy that travel at the speed of light
- ✓ Discovered and named by Dr. W. C. Röntgen at University of Würzburg, 1895
- ✓ Electromagnetic energy wave spectrum

- Gamma Rays
- X-rays
- Visible light
- Infrared light
- Microwaves
- Radar
- Radio waves

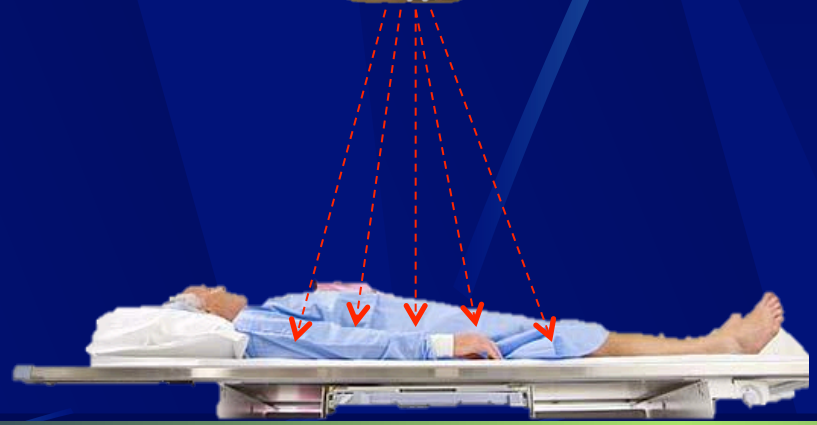
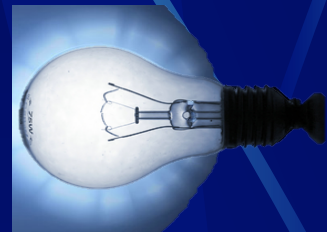
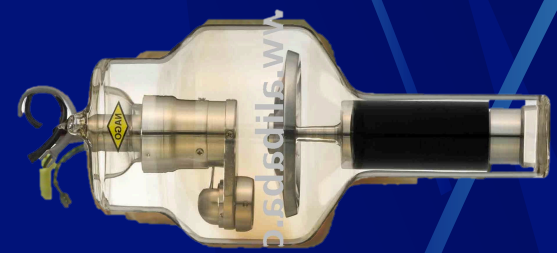




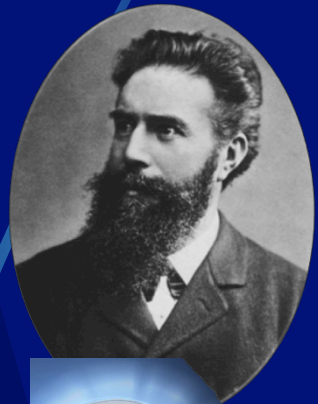
# WHAT IS X-RAY?

- X-RAY

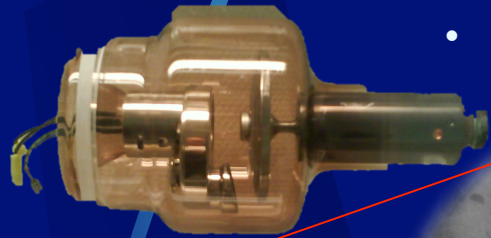
- VISIBLE LIGHT



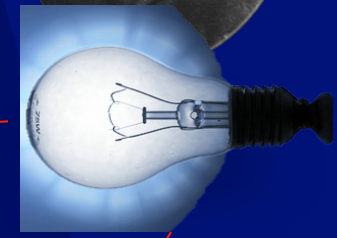
# WHAT IS X-RAY?



• X-RAY



• VISIBLE LIGHT





# WHAT IS X-RAY?

- ✓ X-rays are emitted and detected in cassette which generate either a hard copy film or a digital image
- ✓ X-ray beam interaction with body tissue can:
  - ✦ Pass all the way through the body → render the film dark (black)
  - ✦ Be deflected or scattered
  - ✦ Be absorbed
 } → render the film light (white)
- ✓ Air = low atomic # = x-rays get through = image is dark
- ✓ Metal = high atomic # = x-rays blocked = image is light (white)



# PLAIN X-RAY

## Pros

- Widely available
- Inexpensive
- Doesn't require advanced technologist knowledge
- Can be performed quickly
- Portable

## Cons

- Ionizing Radiation
- Relatively insensitive
- Requires patient cooperation





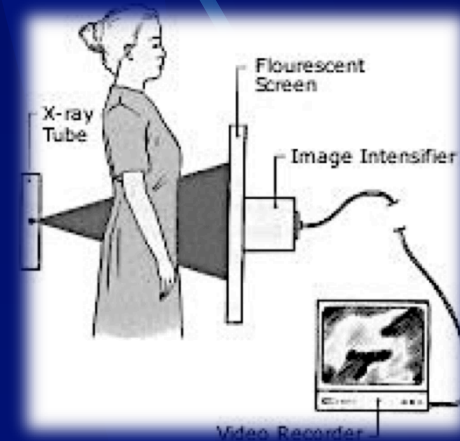
# FLUOROSCOPY

- ✓ Utilizes X-Rays
- ✓ Real-time imaging (Dynamic)
- ✓ Utilizes image intensifier
- ✓ Involves use of contrast agents



# FLUOROSCOPY

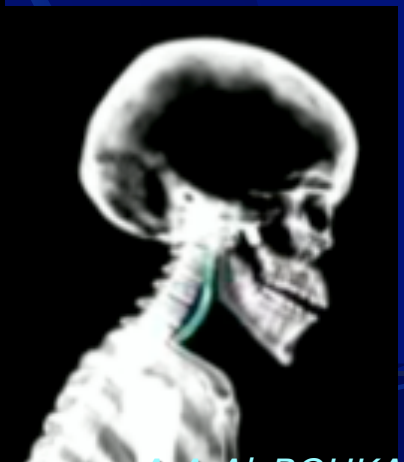
*A modality utilized in evaluation of Gastrointestinal Tract:*  
**Dynamic Contrast Studies**





# FLUOROSCOPY

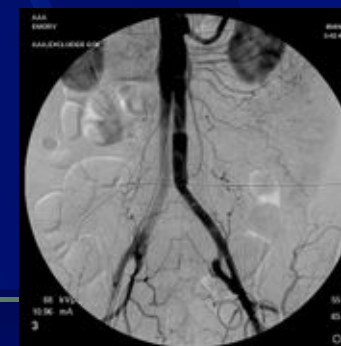
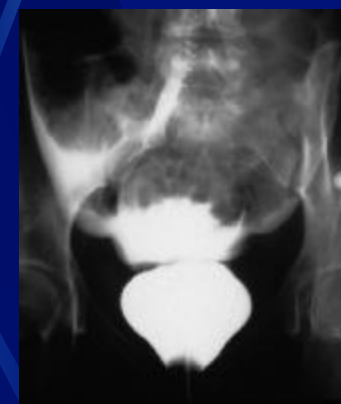
## Dynamic Contrast Studies



# FLUOROSCOPY

## Main Uses of Fluoroscopy

- Gastrointestinal Imaging
- Genitourinary Imaging
- Angiography
- Other:
  - Intraoperative
  - Foreign body removal
  - Musculoskeletal



# FLUOROSCOPY

## Pros

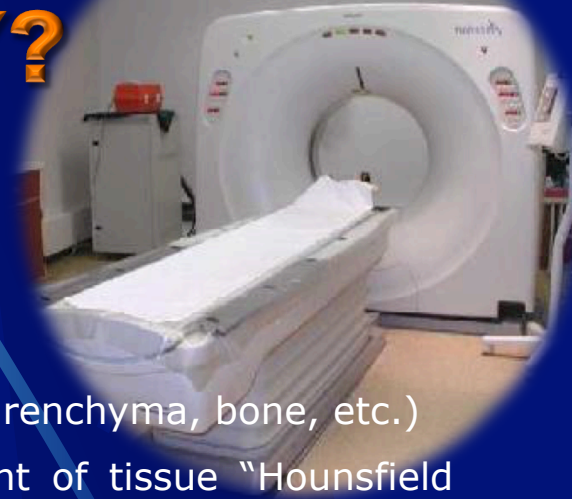
- Widely Available
- Inexpensive
- Functional and Anatomic
- No sedation required

## Cons

- Requires ingestion/injection of contrast medium
- Patient cooperation
- Time consuming



# WHAT IS COMPUTED TOMOGRAPHY?



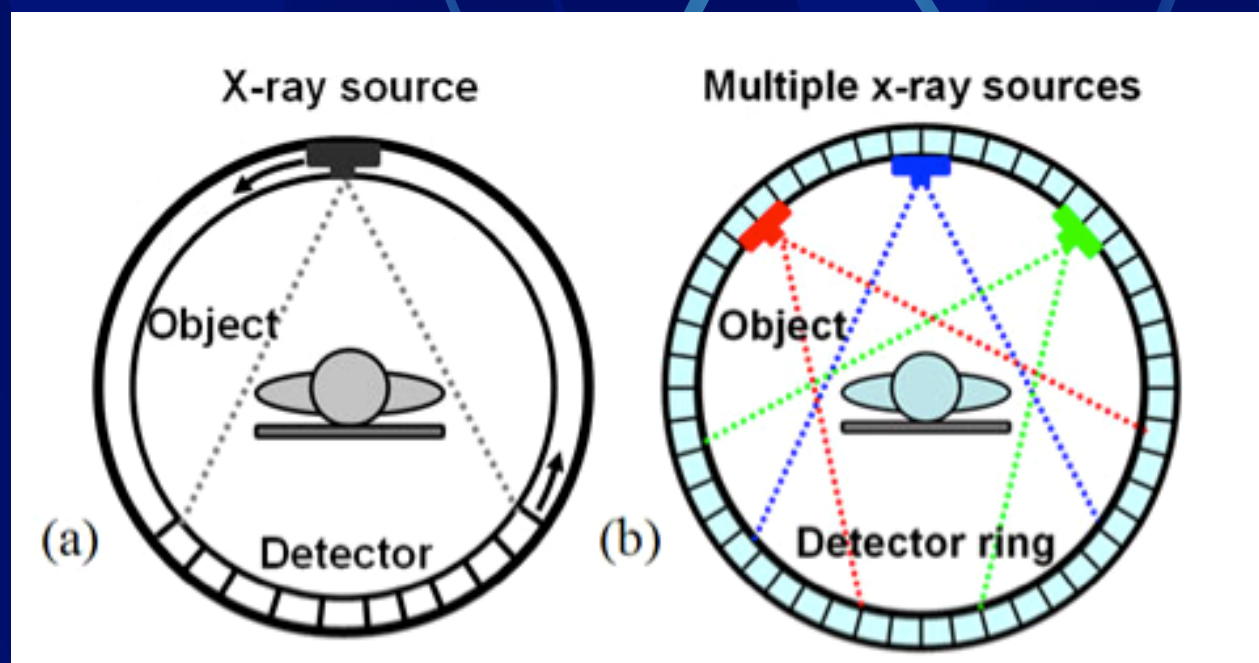
- ✓ Cross Sectional imaging modality
- ✓ Mobile X-ray tube that rotates around a patient.
- ✓ Data displayed in multiple window settings (lungs parenchyma, bone, etc.)
- ✓ Density measurements analyze chemical component of tissue "Hounsfield Unit (HU)" :

Image key = shades (Densities)

Fat	= -150	Soft tissue	= 20-80
Air	= -1000	Blood	= 45-75
Water	= 0	Bone/calcium	= >100- >1000

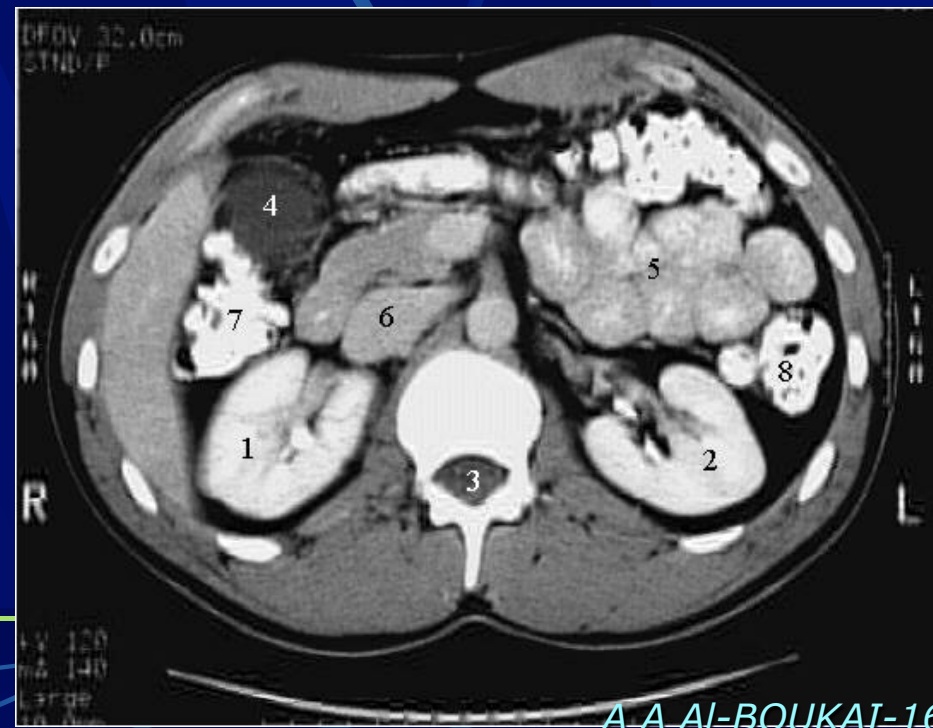
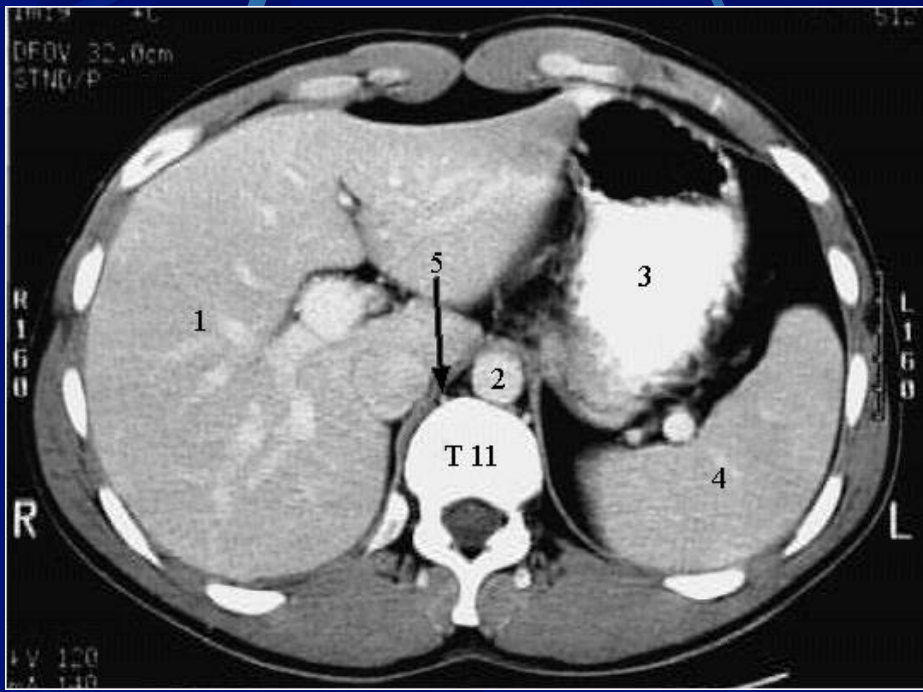


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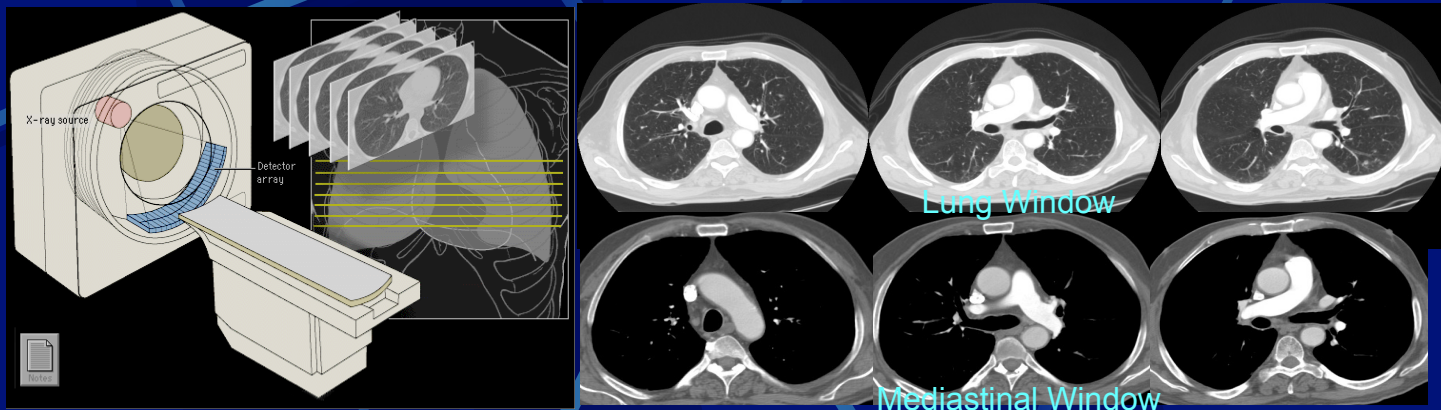


# WHAT IS COMPUTED TOMOGRAPHY?





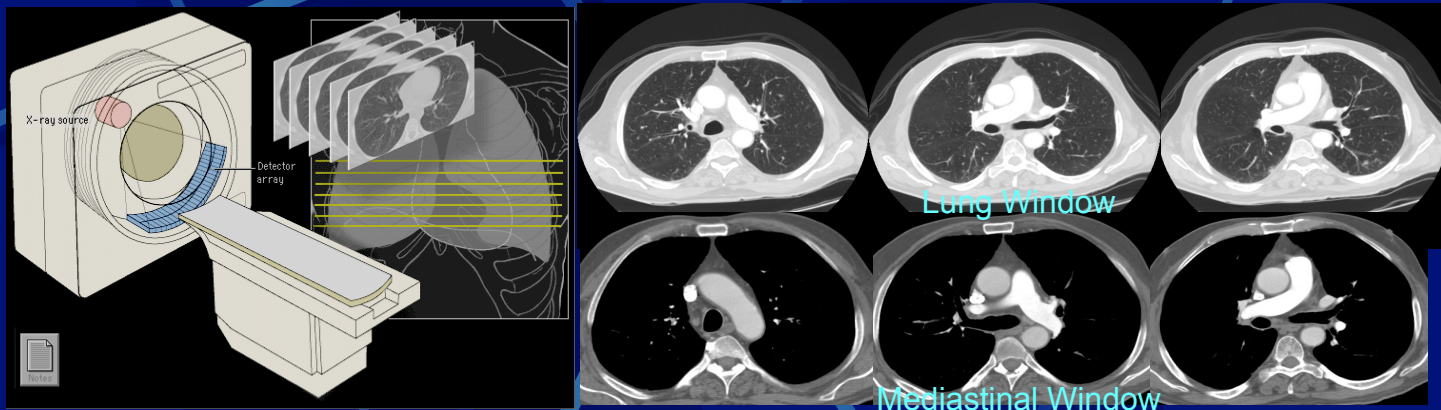
# COMPUTED TOMOGRAPHY?



- Relies on x-rays transmitted through the body.
- Differs from conventional radiography in that a more sensitive x-ray detection system is used.
- Images consist of sections (slices) through the body, and the data are manipulated by a computer.
- Has very small differences in x-ray absorption values compared with conventional radiography; the range of densities recorded is increased approximately 10-fold.



# COMPUTED TOMOGRAPHY?



- So gradations of density within soft tissues can be recognized, e.g. brain substance from cerebrospinal fluid, or tumor from surrounding normal tissues.
- There is major risk behind CT scan, 1 Brain CT scan radiation = 200 x-ray radiation , pelvic CT radiation = 400 x-ray radiation which means don't request a CT scan unless it is needed and we can't use it for a pregnant women unless it is necessary
- **Wide window** to visualize more structure within certain organ such as bronchi, vessels and alveoli in the lung (Lung window).
- **Narrow window** to visualize certain structures within certain region such as major vessels and heart in mediastinum (Mediastinal window).



# COMPUTED TOMOGRAPHY APPLICATIONS

- **NEURO-IMAGING**

- Acute head trauma, acute intracranial hemorrhage
- Low sensitivity for early ischemic stroke, intracranial metastatic disease, white matter degenerative disease

- **HEAD AND NECK IMAGING**

- Soft tissue of neck, paranasal sinuses, temporal bone imaging, orbital wall imaging



# COMPUTED TOMOGRAPHY APPLICATIONS

- **BODY IMAGING**
  - Chest, Abdomen, Pelvis (with enteric and IV contrast)
  - Pulmonary nodules, Renal Calculi (without contrast)
  - Acute appendicitis (with enteric and IV contrast)
- **SPECIALIZED PROTOCOLS:**
  - Liver masses, pancreatic tissue, renal masses, adrenal masses



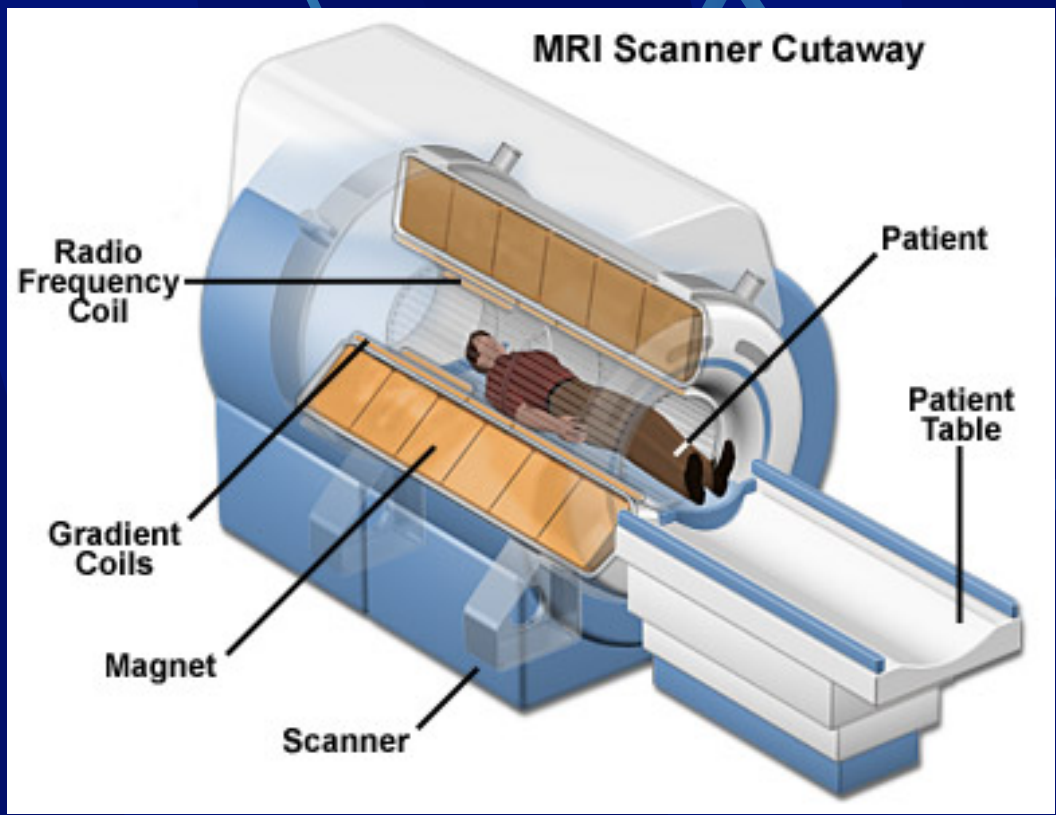
# COMPUTED TOMOGRAPHY APPLICATIONS

- **ACUTE ABDOMEN**
  - decrease rate of false laparotomy procedures
- **TRAUMA SPINE IMAGING** (cervical, thoracic, lumbar)
- **OTHER OSSEOUS STRUCTURES** (pelvis, extremities)
- **VASCULAR IMAGING**
  - CT angiography--- i.e. coronary arteries





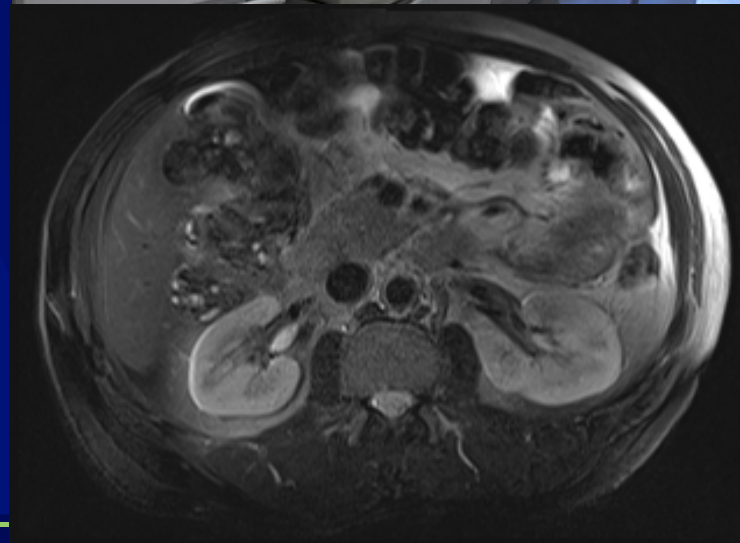
# MAGNATIC RESONANCE IMAGING



# MAGNETIC RESONANCE IMAGING

- Simply, hydrogen atoms (protons) in water molecules and lipids >> magnetism affects all protons causes them to line up in one direction >> magnets can be switched on and off to change the direction of the magnetic field >> whenever the water molecule spin around they give a light radio wave >> MRI machine can detect it >> show it as images
- So gradations of density within soft tissues can be recognized, e.g. brain substance from cerebrospinal fluid, or tumor from surrounding normal tissues.

*Image key* = shades (Intensities)



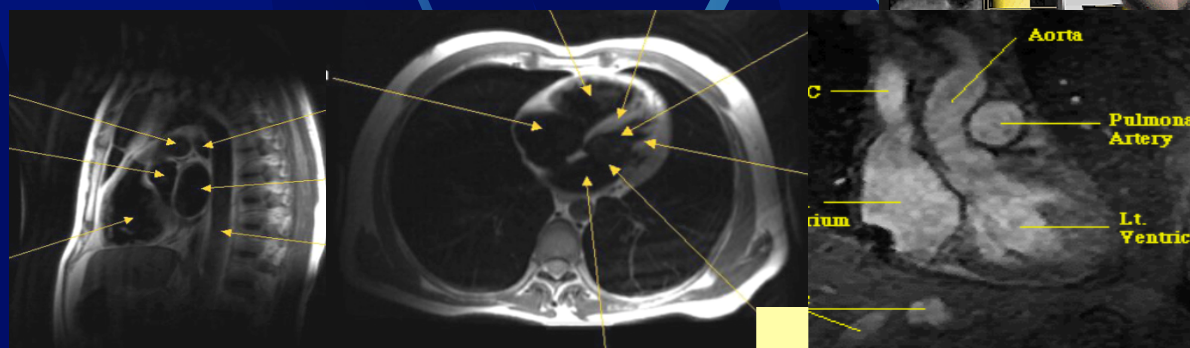


# MAGNETIC RESONANCE IMAGING

Sagittal

Axial

Coronal



## ADVANTAGES

- ✓ Best for soft tissue imaging
- ✓ No ionization
- ✓ Can be done for pregnant women
- ✓ Images can be obtained in any plane
- ✓ Useful for soft tissue pathology (Tumor, infection)

## DISADVANTAGES

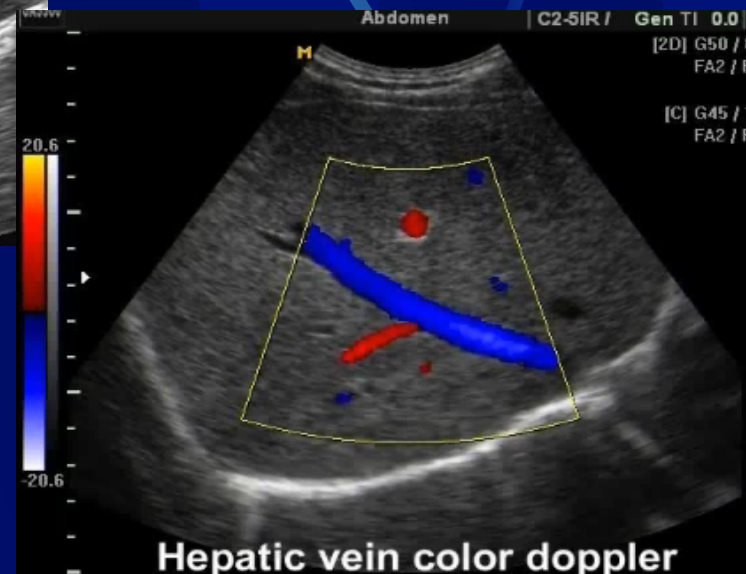
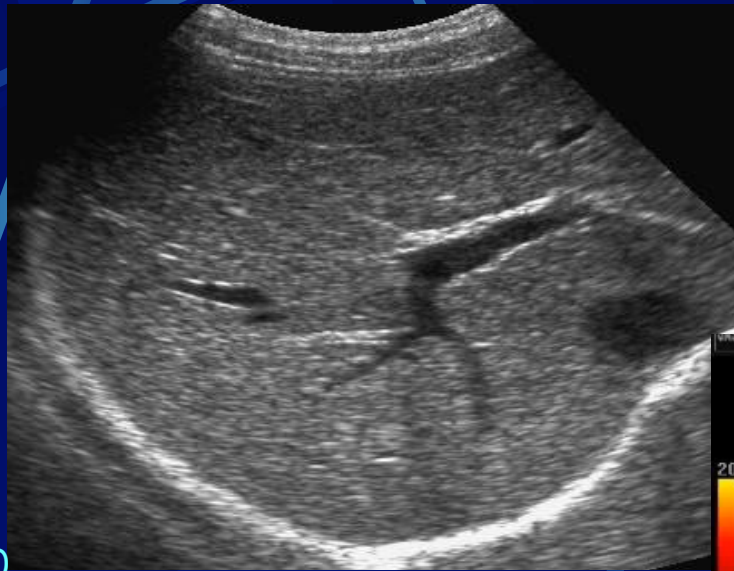
- ✓ Expensive
- ✓ Time consuming
- ✓ Phobia (narrow place)
- ✓ No metals allowed
- ✓ Motion



# ULTRASOUND



# ULTRASOUND



## ULTRASOUND

Echogenicity  
Shadowing  
Doppler for flow

## ADVANTAGES

No radiation  
Can be portable  
Relatively inexpensive

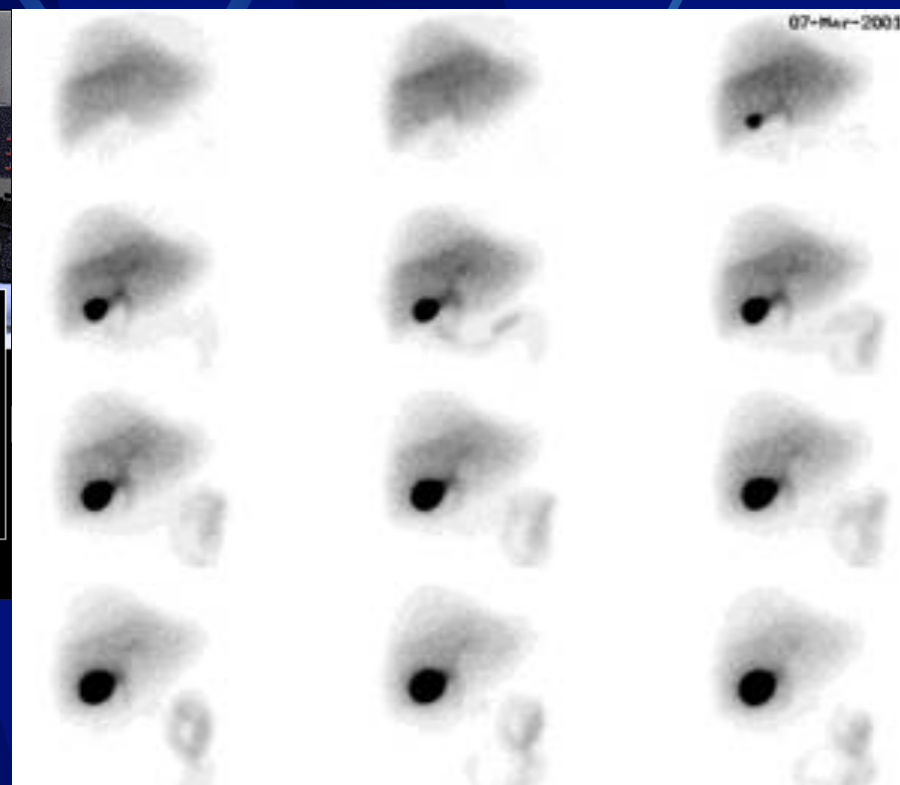
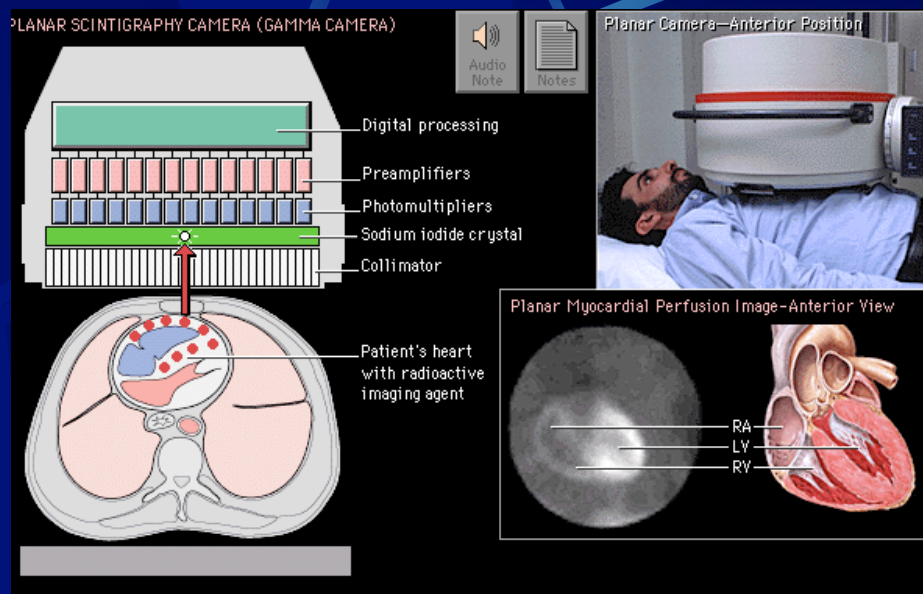




# NUCLEAR MEDICINE



# NUCLEAR MEDICINE



- ✓ Uses gamma rays to produce an image (Counts or Activity).
- ✓ Radioactive nuclide given IV, per os, per rectum etc.
- ✓ Rays emitted from the patient
- ✓ Physiologic imaging (Abnormal function, metabolic activity).
- ✓ Poor for anatomical information.
- ✓ Radioactivity stays with the patient until cleared or decayed



# CONTRAST MEDIA

## Natural contrast in the body

- Air
- Fat
- Bone

## Added contrast in the body

- Barium sulfate
- Iodine (Water Soluble)



# CONTRAST MEDIA

- Barium sulfate
- Iodine (Water Soluble)







THANKS

