# BASIC CONCEPTS IN DIAGNOSTIC IMAGING

**AHMAD AMER Al-BOUKAI**
*Associate Professor & Consultant Radiologist*
Radiology & Medical Imaging Department
King Khalid University Hospital
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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.

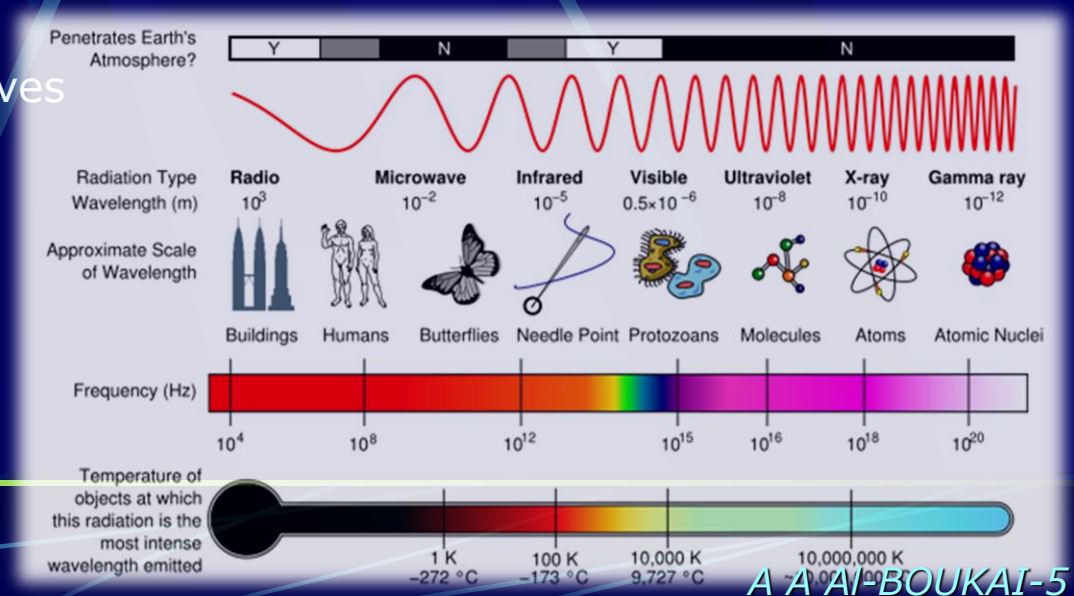
# WHAT ARE THE DIAGNOSTIC MODALITIES UTILIZED IN RADIOLOGY?

- PLAIN X-RAY
- COMPUTED TOMOGRAPHY (CT)
- MAGNETIC RESONANCE IMAGING (MRI)
- ULTRASOUND (US)
- NUCLEAR MEDICINE (NM)
- ANGIOGRAPHY (ANG)

# WHAT IS X-RAY?

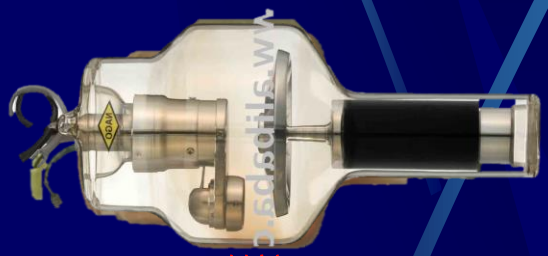
- ✓ It is a form of electromagnetic energy that travel at the speed of light
- ✓ Discovered and named by Dr. W. C. Röentgen at University of Würzburg, 1895
- ✓ Electromagnetic energy wave spectrum

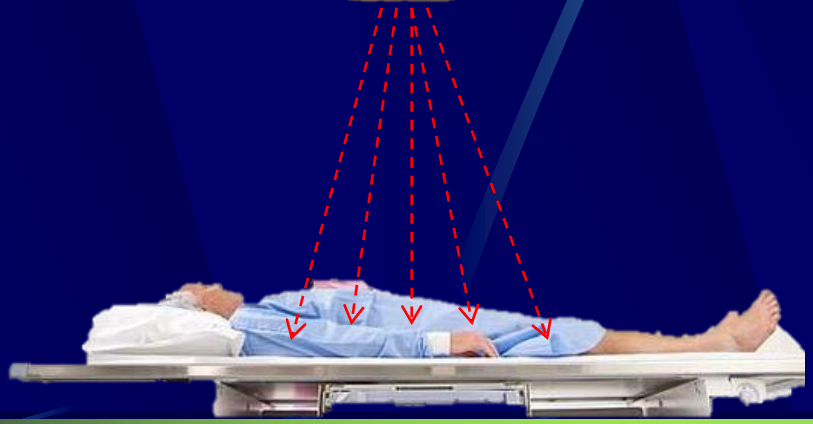
- Gamma Rays
- X-rays
- Visible light
- Infrared light
- Microwaves
- Radar
- Radio waves



# WHAT IS X-RAY?

- X-RAY
- VISIBLE LIGHT





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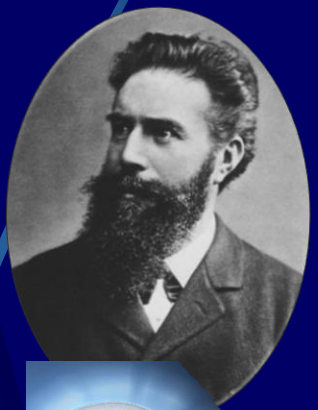
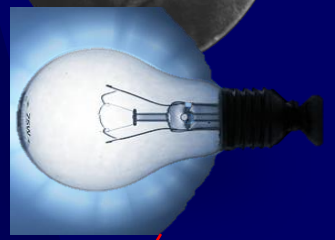


- X-RAY

- 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 shadow)
  - ✧ Be deflected or scattered
  - ✧ Be absorbed

  } → render the film light (white shadow)

- ✓ Air = low atomic # = x-rays get through = image is dark (black)
- ✓ 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

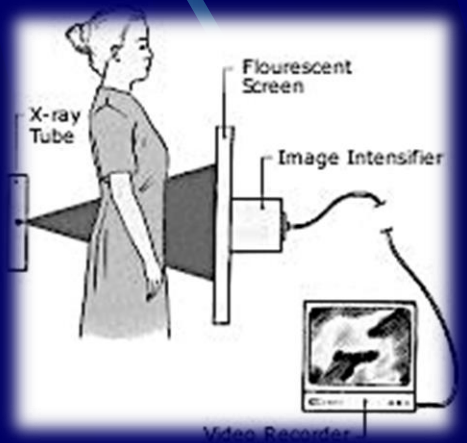
# FLUOROSCOPY

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

# FLUOROSCOPY

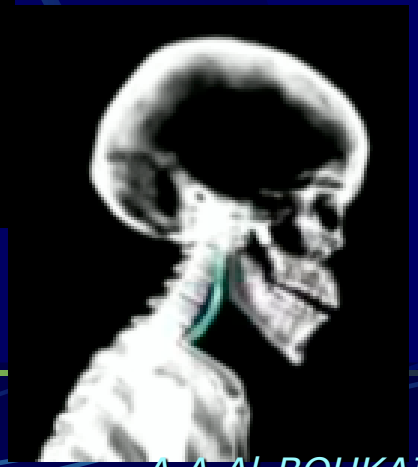
*A modality utilized in evaluation of Gastrointestinal Tract:*

## Dynamic Contrast Studies



# FLUOROSCOPY

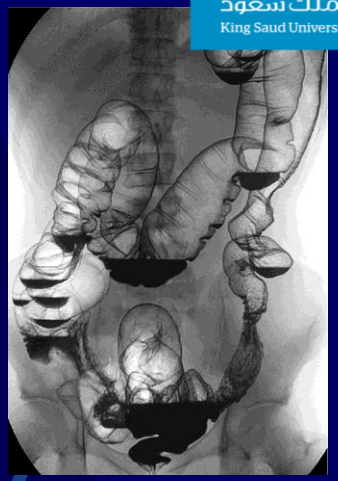
## Dynamic Contrast Studies



# FLUOROSCOPY

## Main Uses of Fluoroscopy

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



# FLUOROSCOPY

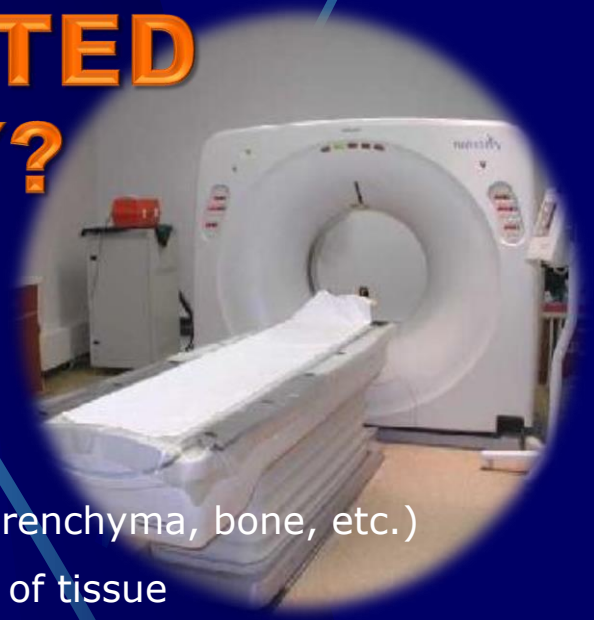
## Pros

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

## Cons

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

# WHAT IS COMPUTED TOMOGRAPHY?



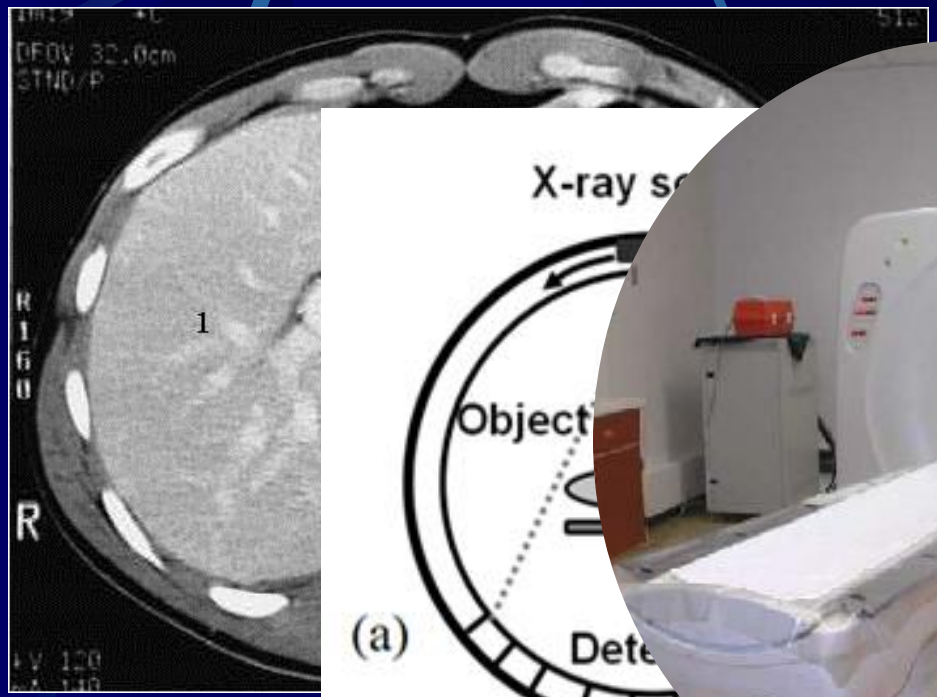
- ✓ Cross Sectional imaging modality
- ✓ Mobile X-ray tube that rotates around a patient.
- ✓ Data displayed in multiple window settings (lungs parenchyma, bone, etc.)
- ✓ Density measurements analyze chemical component of tissue

"Hounsfield Unit (HU)" :

*Image key* = shades (Densities)

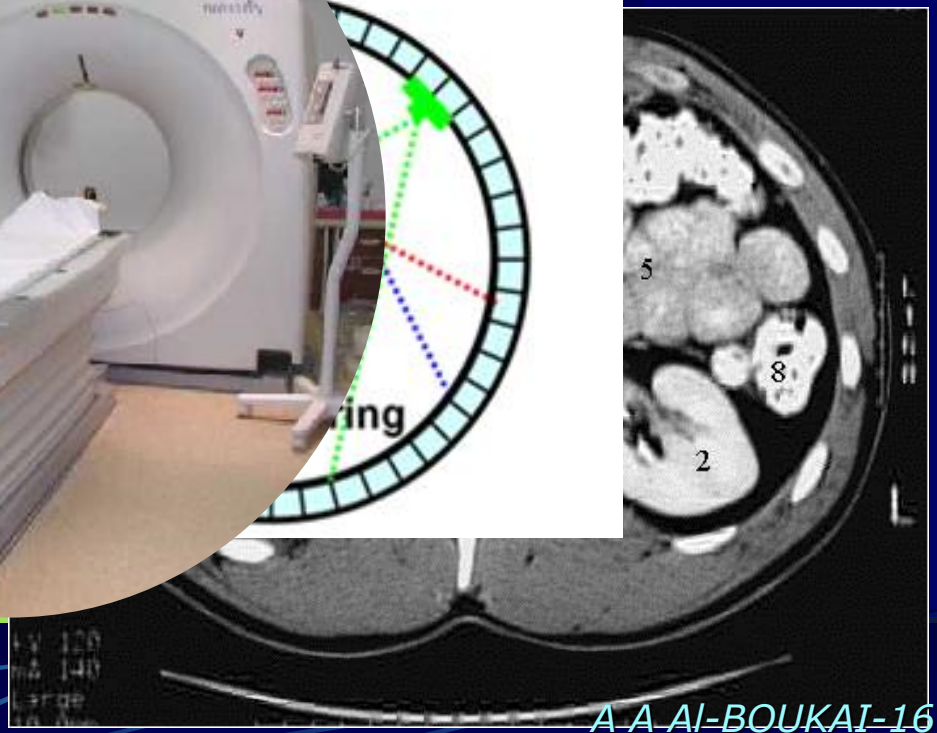
| | | | |
|---|---|---|---|
| Fat | = -150 | Soft tissue | = 20-80 |
| Air | = -1000 | Blood | = 45-75 |
| Water | = 0 | Bone/calcium | = >100- >1000 |

# WHAT IS COMPUTED TOMOGRAPHY?







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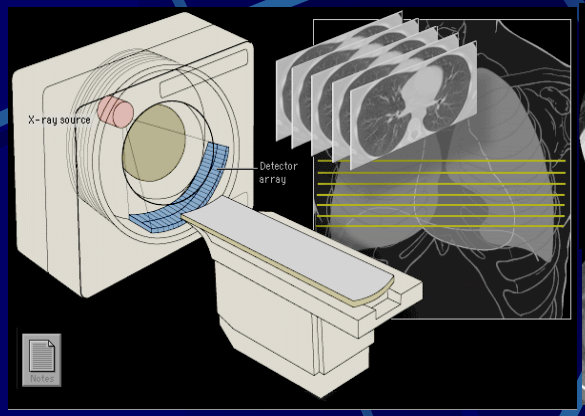
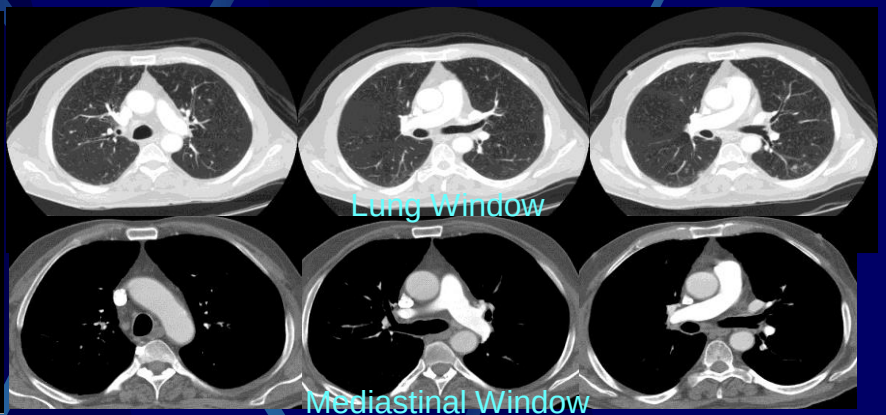
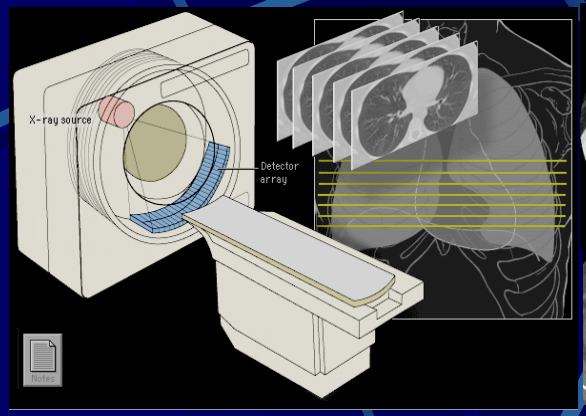
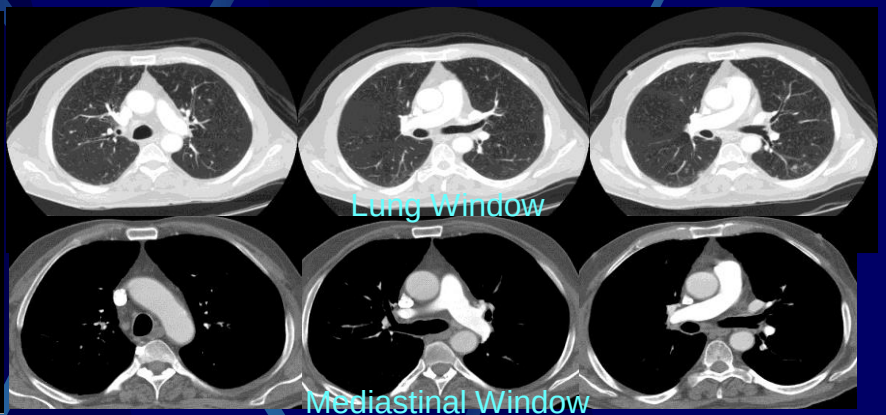



- Relies on x-rays transmitted through the body.
- Differs from conventional radiography in that a more sensitive x-ray detection system is used.
- Images consist of sections (slices) through the body, and the data are manipulated by a computer.
- Has very small differences in x-ray absorption values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

- BONE

to visualize cortex, medulla and trabeculae → Wide 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)

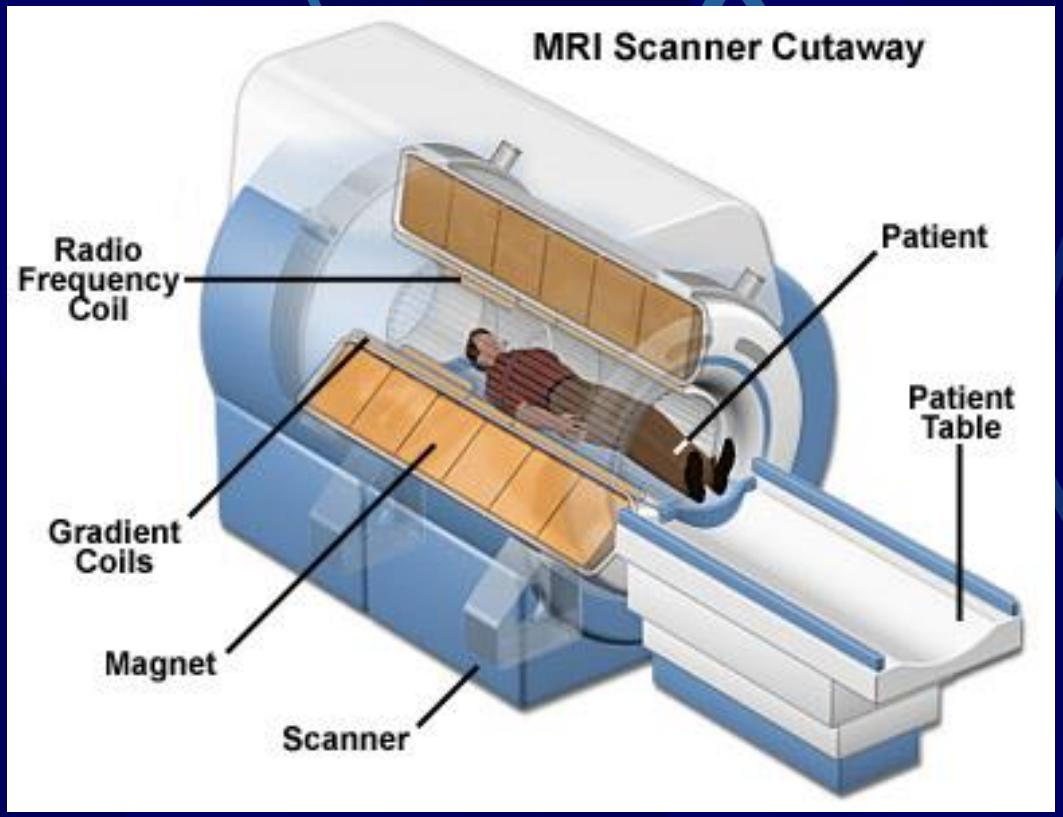
- SPECIALIZED PROTOCOLS:

  -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

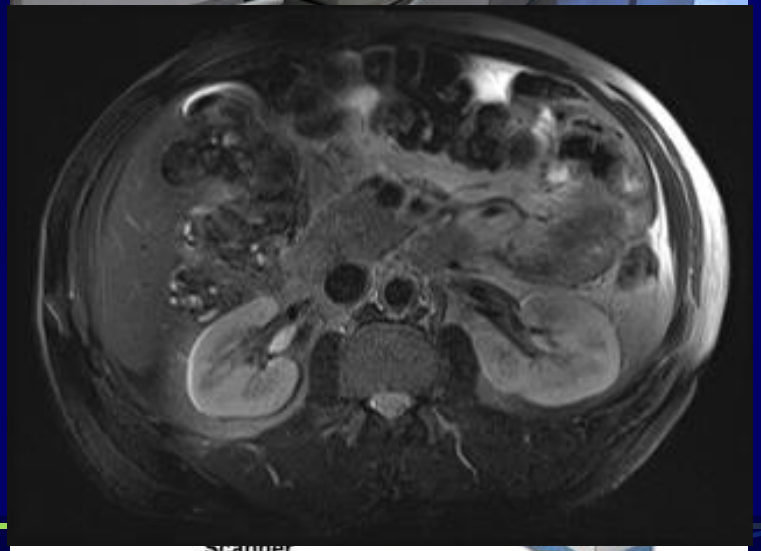
# MAGNATIC RESONANCE IMAGING



# MAGNATIC 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)

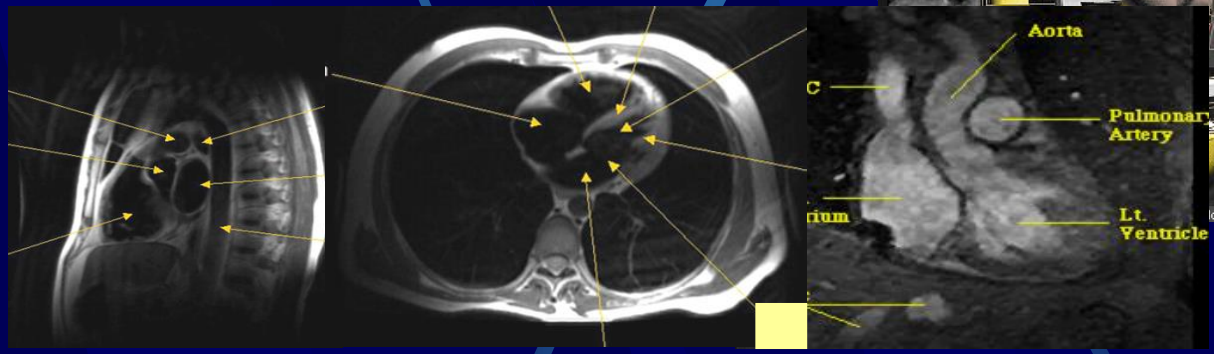


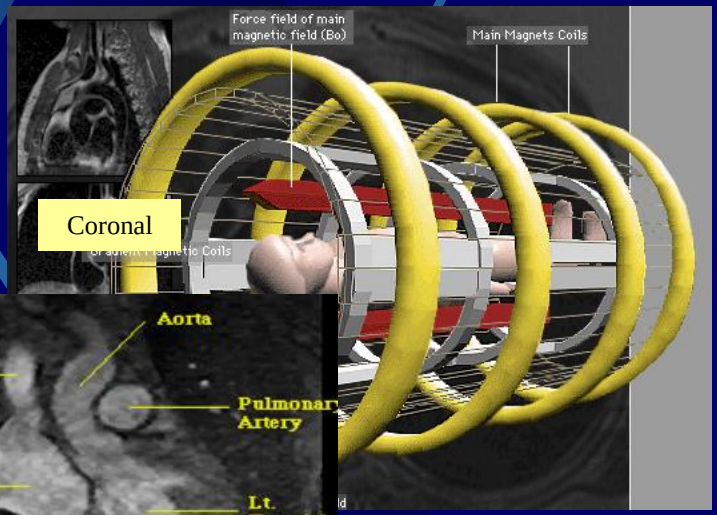
# MAGNATIC RESONANCE IMAGING

Sagittal

Axial

Coronal



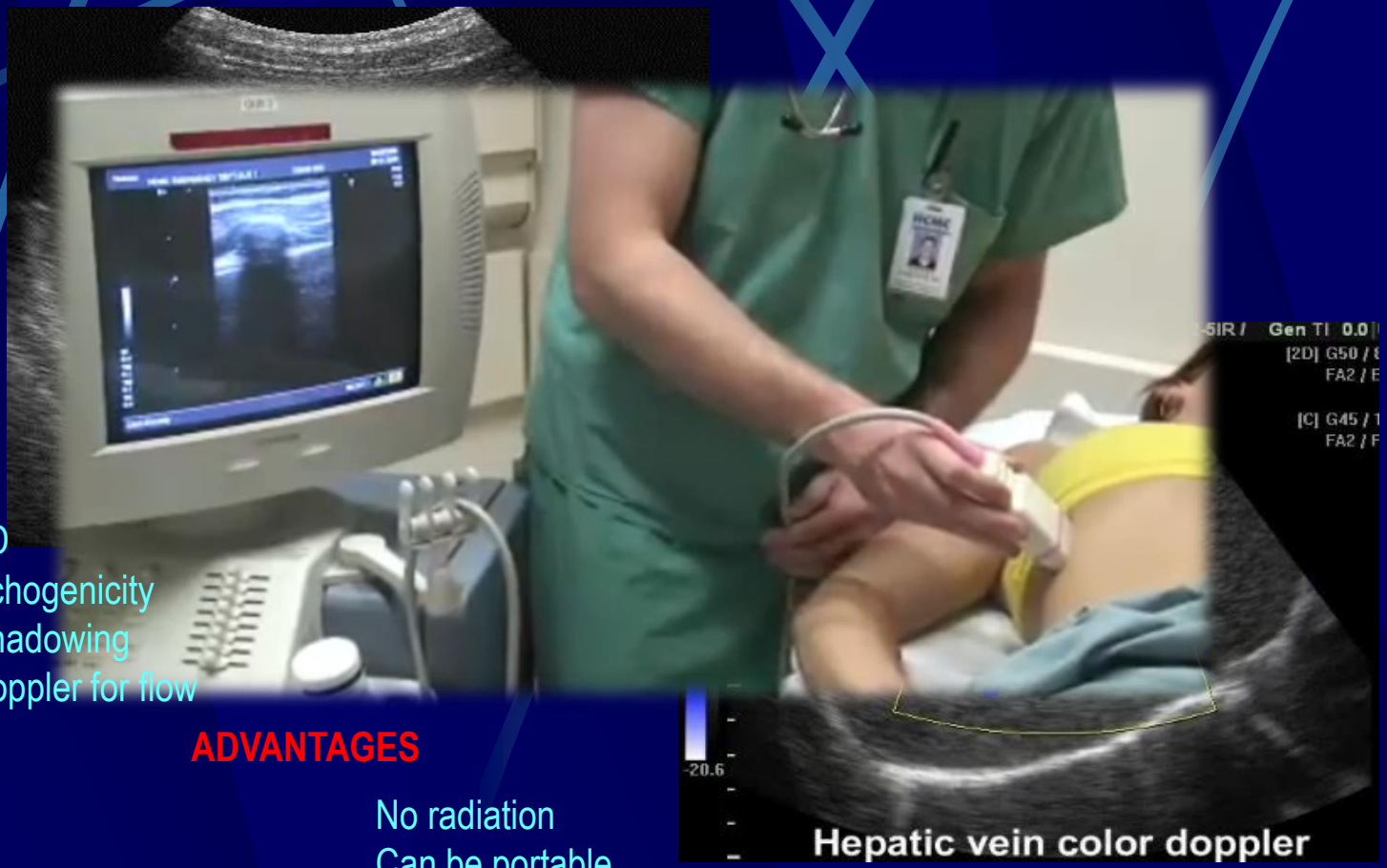

## ADVANTAGES

- ✓ 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

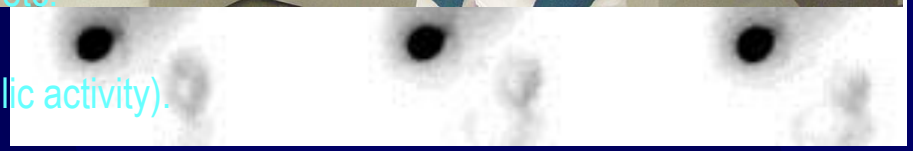
Echogenicity
Shadowing
Doppler for flow

**ADVANTAGES**

No radiation
Can be portable
Relatively inexpensive

# 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