Radiology
Technical consideration

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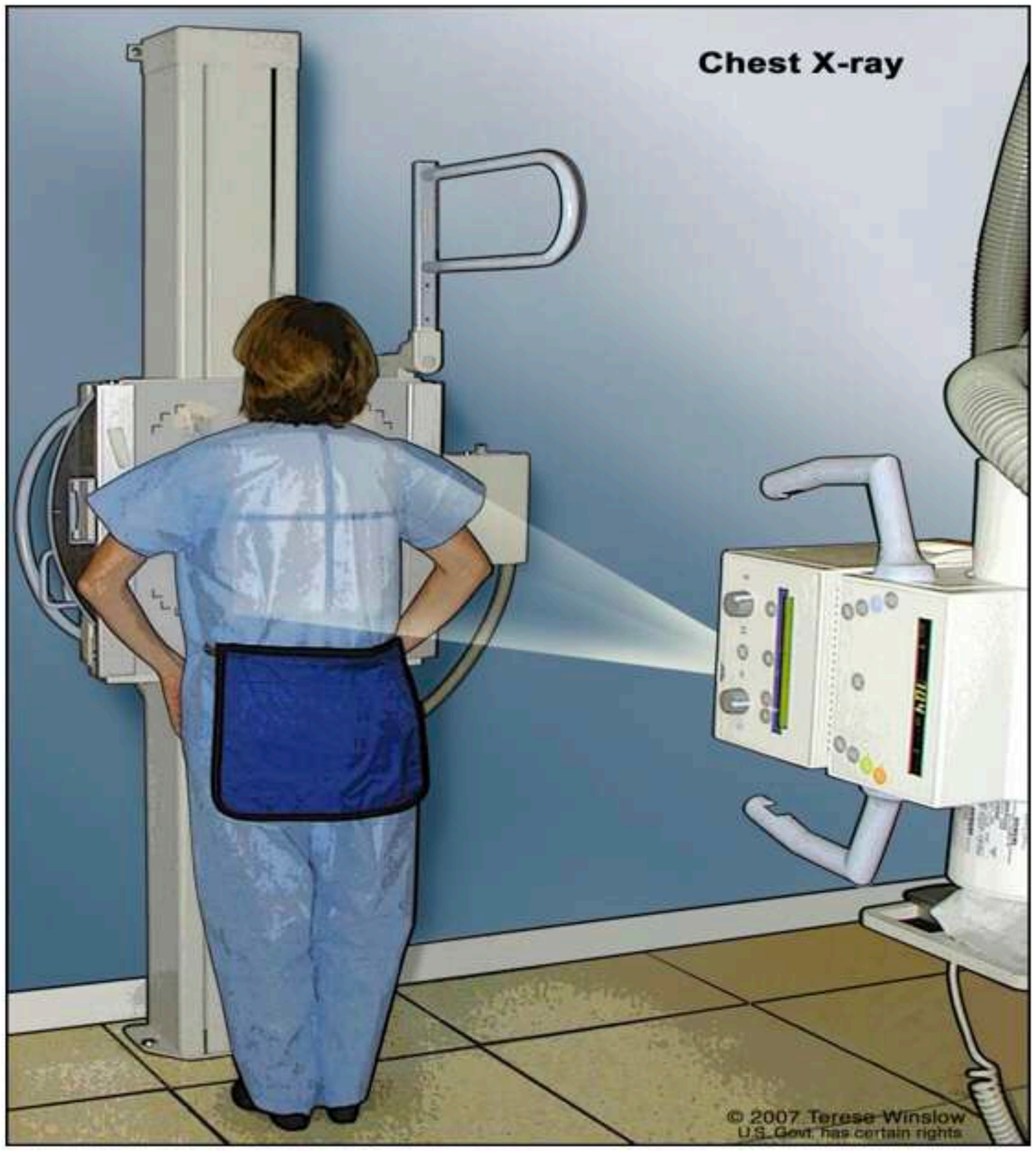
Film Radiography

Image Generation

X-rays are a form of radiant energy that is similar in many ways to visible light. X-rays differ from visible light in that they have a very short wavelength and are able to penetrate many substances that are opaque to light.

Regular x-rays (plain x-rays) account for about 80% of imaging examinations. X-ray examinations, or plain x-rays, are made by an x-ray beam passing through the patient. The x-rays are absorbed in different amounts by the various tissues or materials in the body. Most of the beam is absorbed or scattered.


Chest X-ray
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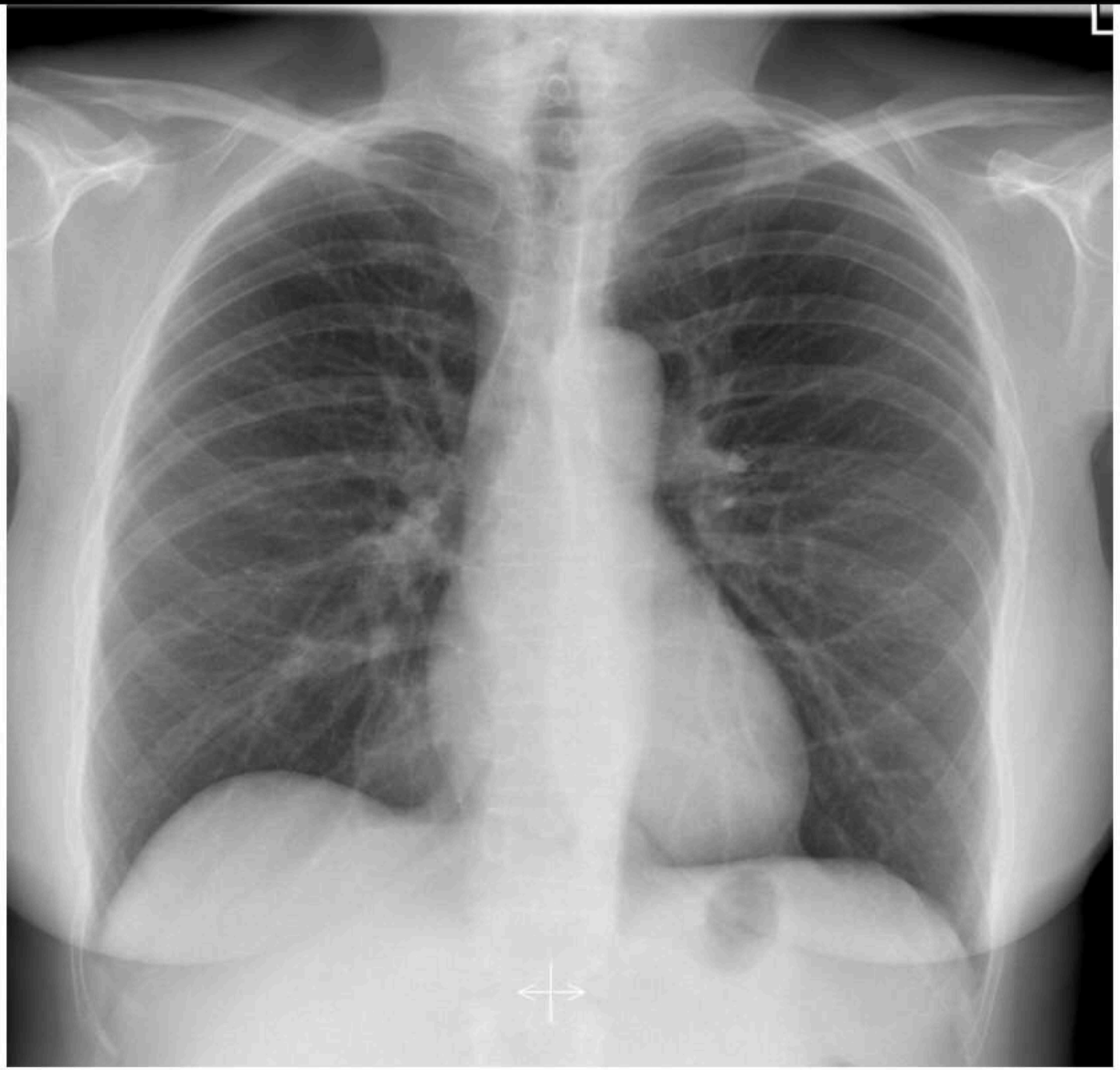
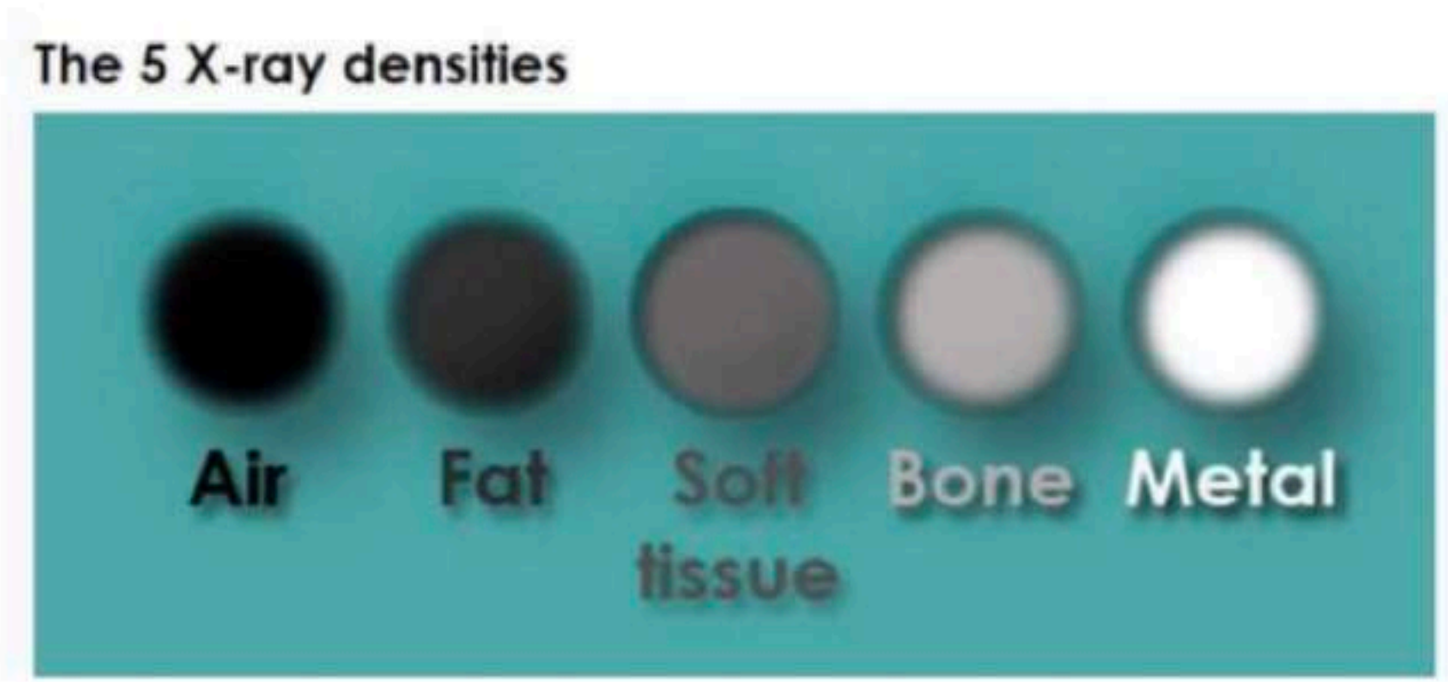
Basic radiographic densities

Principles of Interpretation

Conventional radiographs demonstrate five basic radiographic densities: air, fat, soft tissue, water, bone, and metal (or x-ray contrast agents). Air attenuates very little of the x-ray beam, allowing nearly the full force of the beam to blacken the image. Bone, metal, and radiographic contrast agents attenuate a large proportion of the x-ray beam, allowing very little radiation through to blacken the image. Thus, bone, metallic objects, and structures opacified by x-ray contrast agents appear white on radiographs. Fat and soft tissues attenuate intermediate amounts of the x-ray beam, resulting in proportional degrees of image blackening (shades of gray).



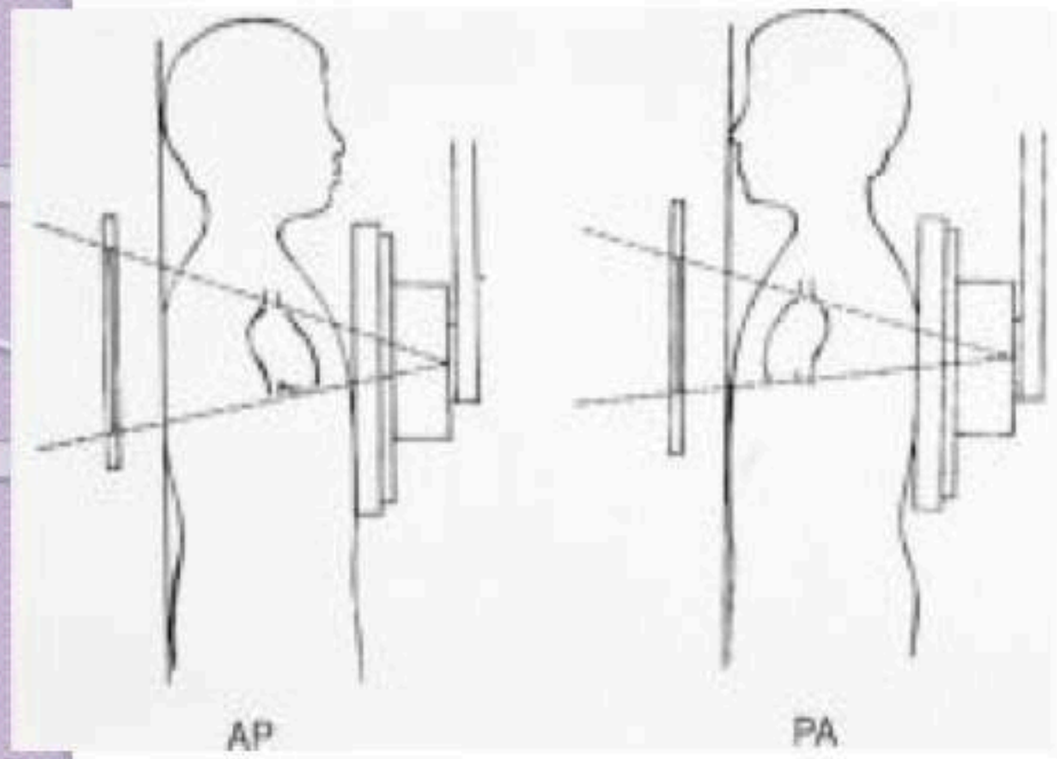
Difference densities according to differential attenuations

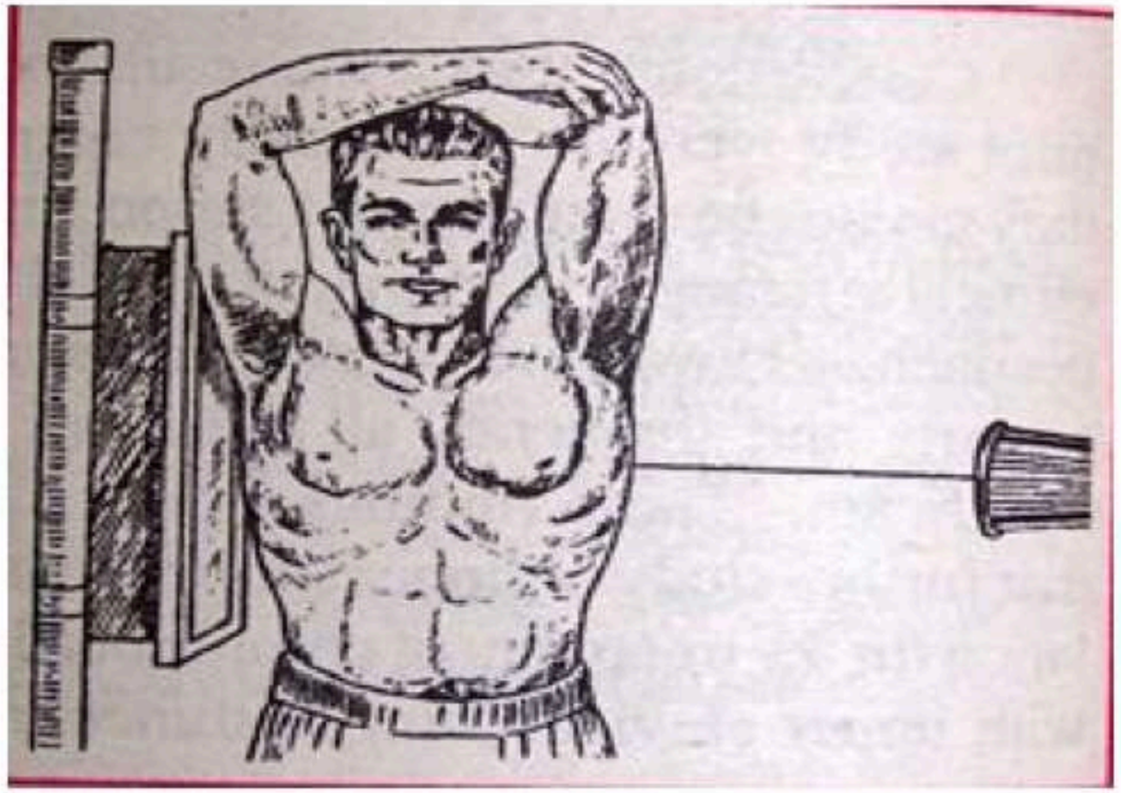


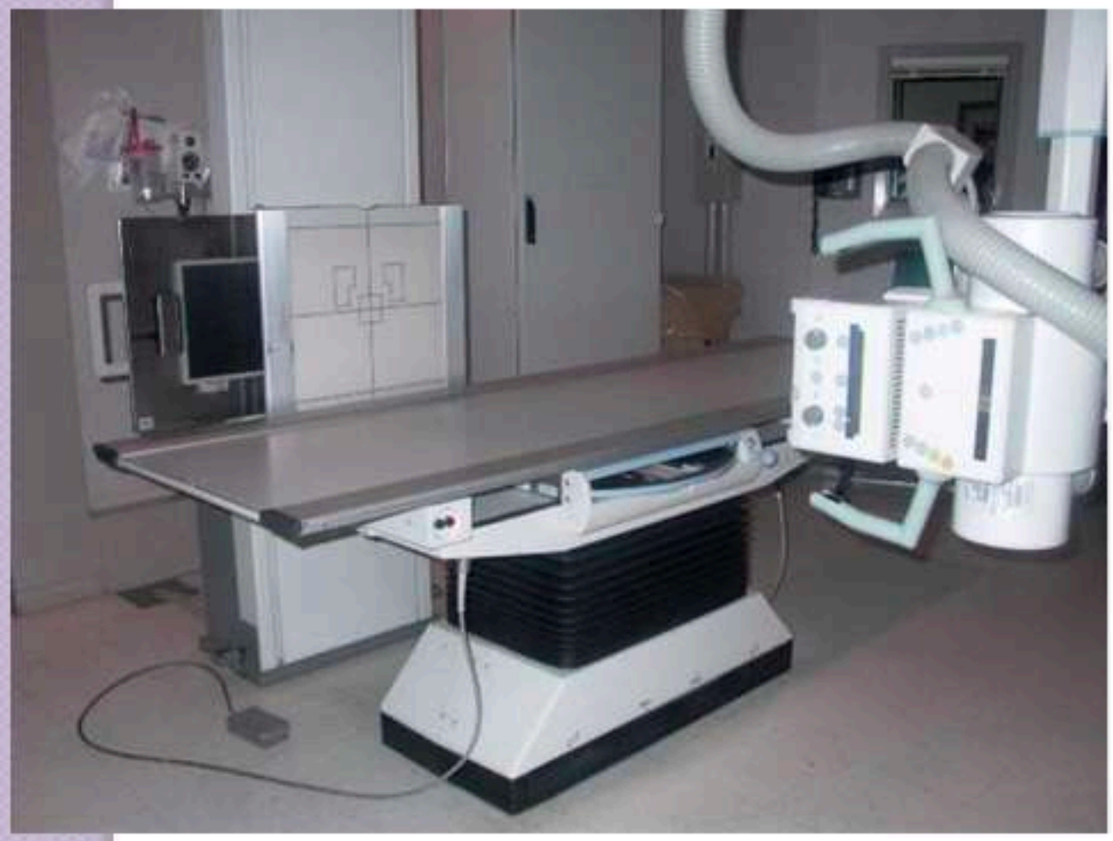
Radiographic Views

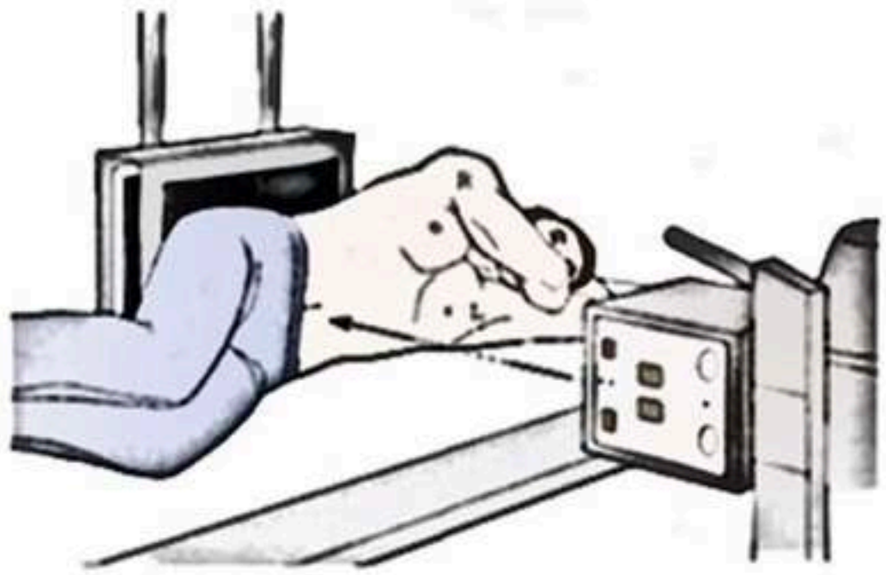
Chest and abdominal films are referred to as upright or supine, depending on the position of the patient. In addition, chest x-rays are usually described as posteroanterior (PA) or anteroposterior (AP) or lateral

These terms indicate the direction in which the x-ray beam traversed the patient on its way to the detector. PA means that the x-ray beam entered the *p*osterior aspect of the patient and exited *a*nteriorly. AP means that the beam direction through the patient was *a*nterior to *p*osterior. A left lateral decubitus view is one taken with the patient's left side down.


AP
PA

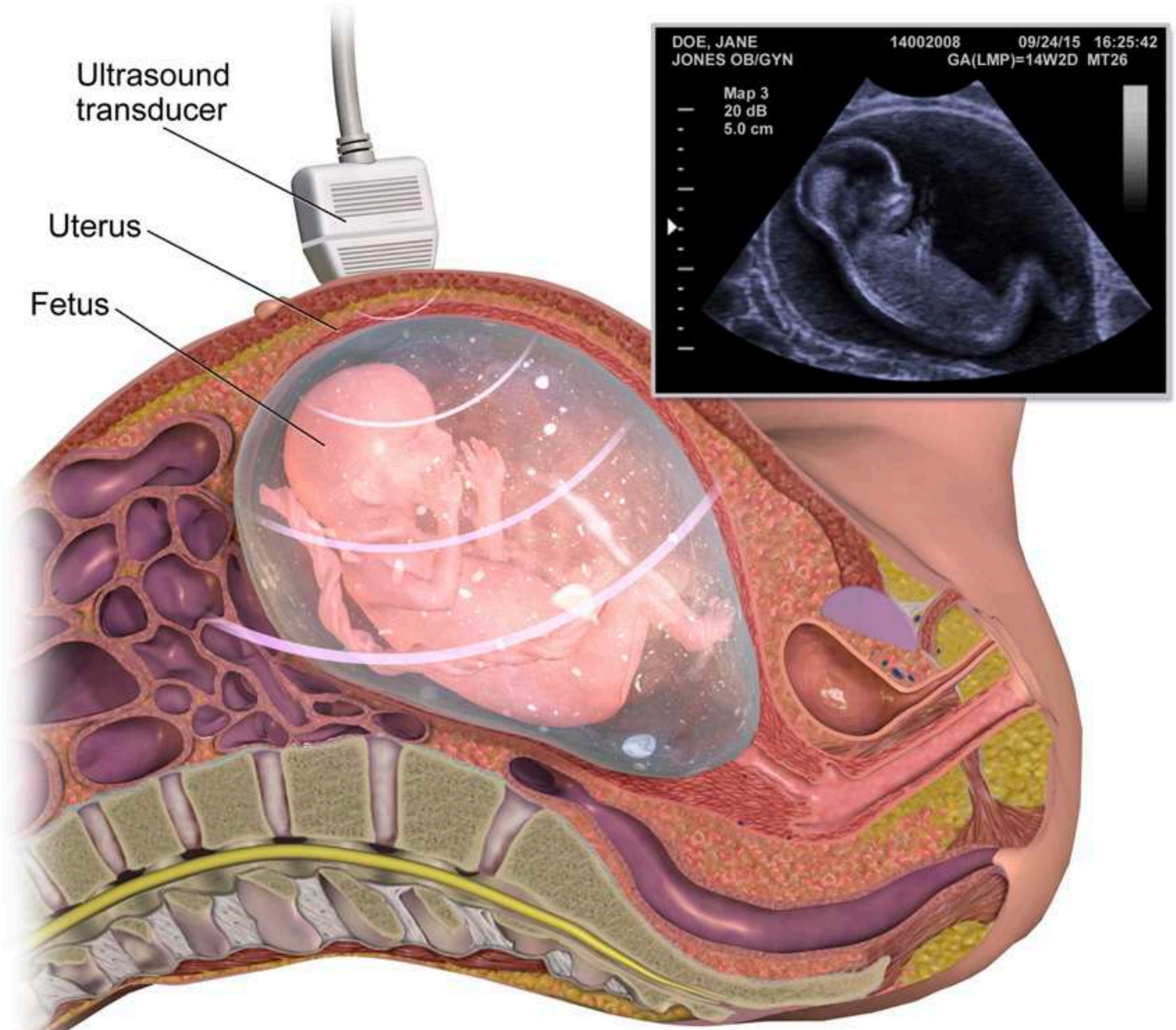






Ultrasound

- Ultrasonography is made up of longitudinal waves of frequency greater than 20,000 Hz
- Pulsed ultrasonographic imaging sends an ultrasonic pulse into the body and measures the time of echo return, which is related to the distance to the reflecting surface.
- Transducer is the main sonographic machine part which made from a material which can change the electrical waves to longitudinal sonographic waves (the range which is used from 3 mega HZ which is used in general abdominal US to 10-12 MHZ) in superficial organs like ophthalmic examination)
- The reflection of the tissue interfaces are received again by transducer and according to the amount of echoes received the tissue brightness will be different from tissue to a tissue



Fetal Ultrasound

Advantages of US

- No ionizing radiation
- SAFE (USED FOR FETAL EXAMINATION)
- Real time examination (biopsy)
- Available, cheep, accessible .
- Good soft tissue contrast in comparism to x ray
- Doppler examination for assessments of vessels and blood flow without contrast

Disadvantages

- Examiner dependant
- Low spatial resolution
- Gas shadow my obscure lesions
- Not useful in boney lesions

Abdominal ultrasound showing the gallbladder

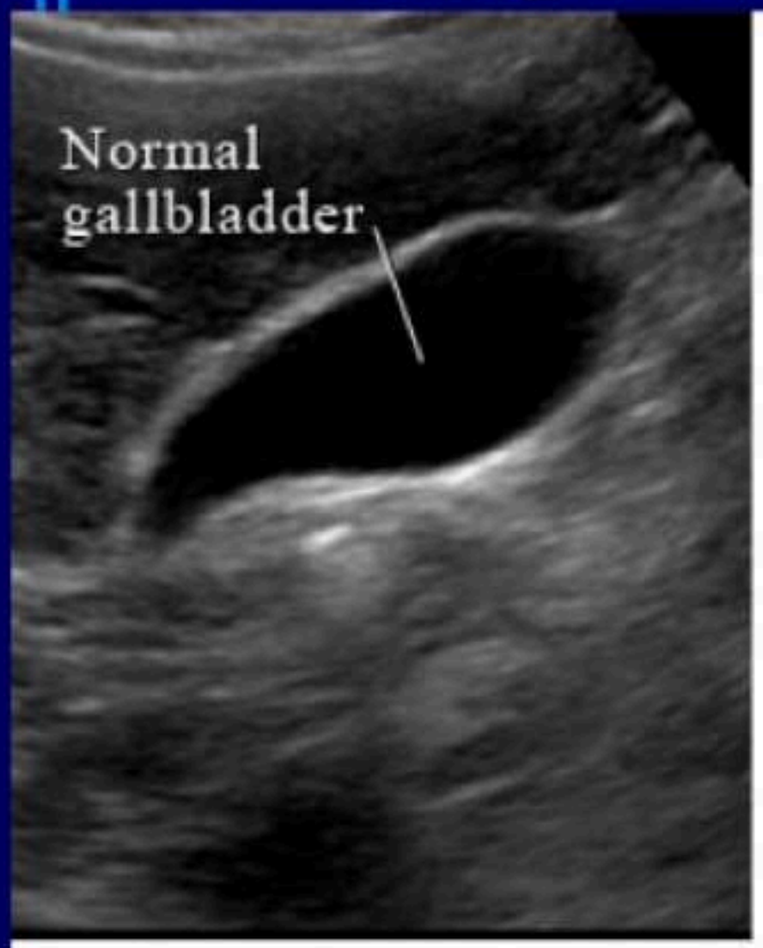
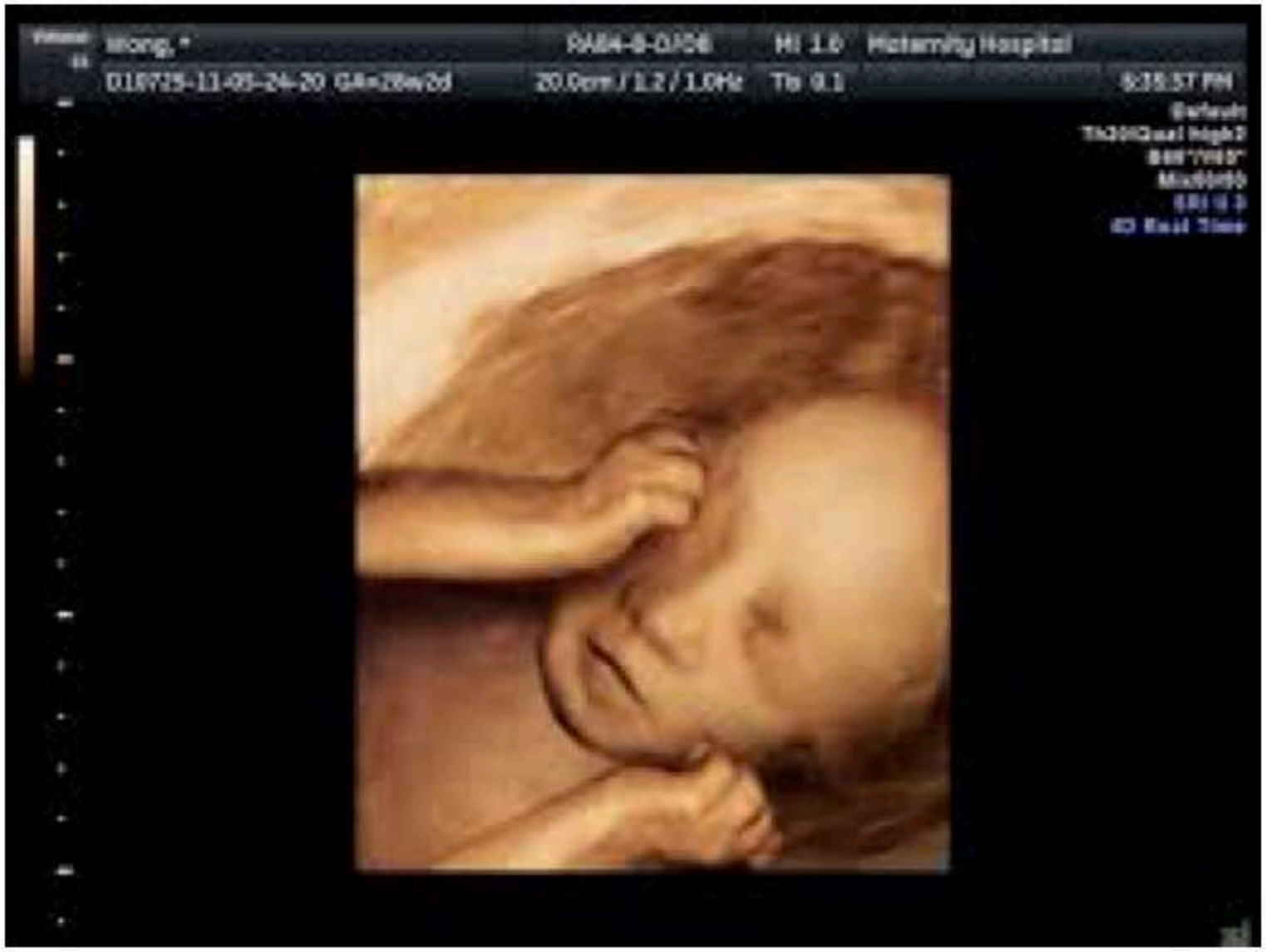


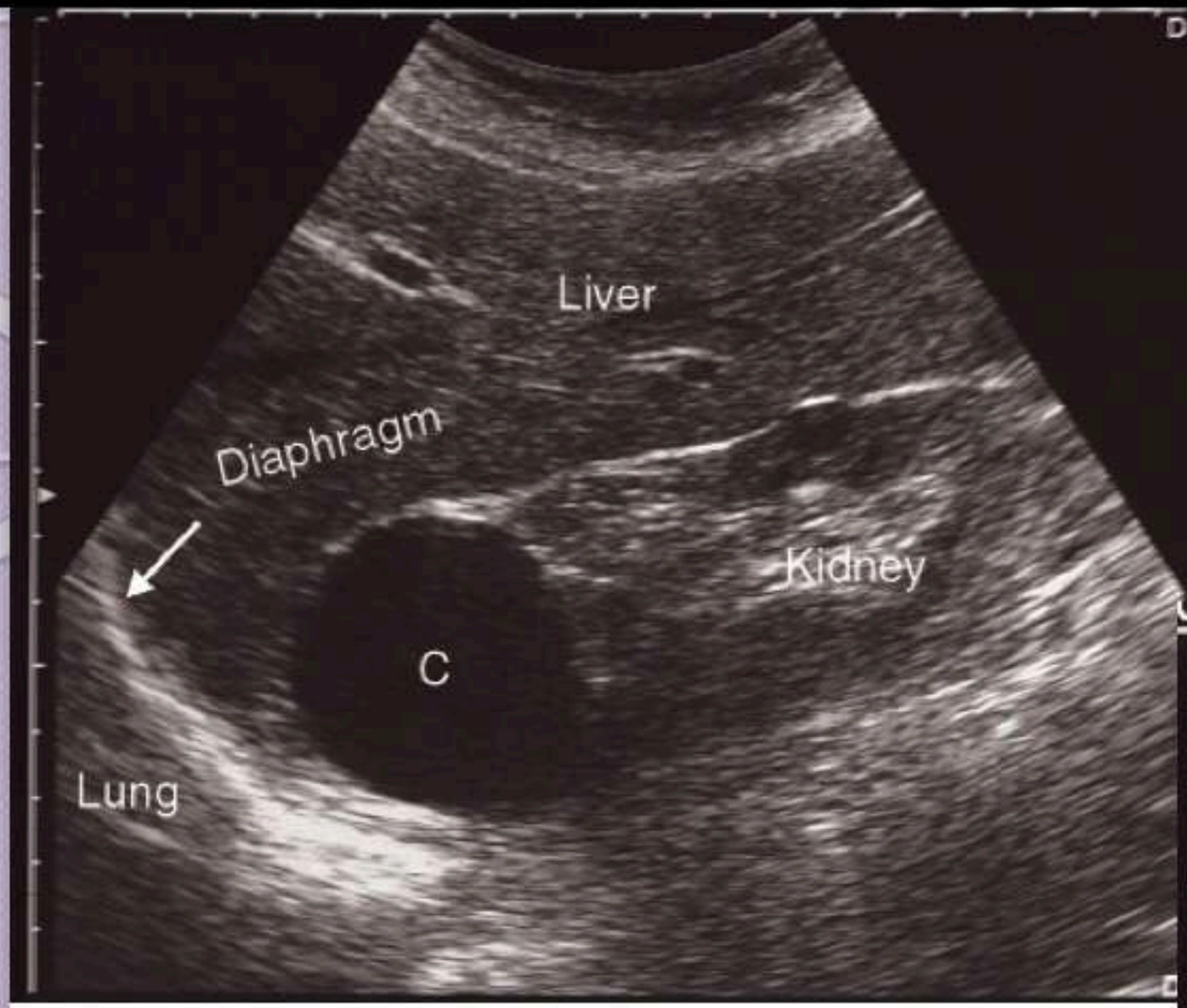
Figure 1

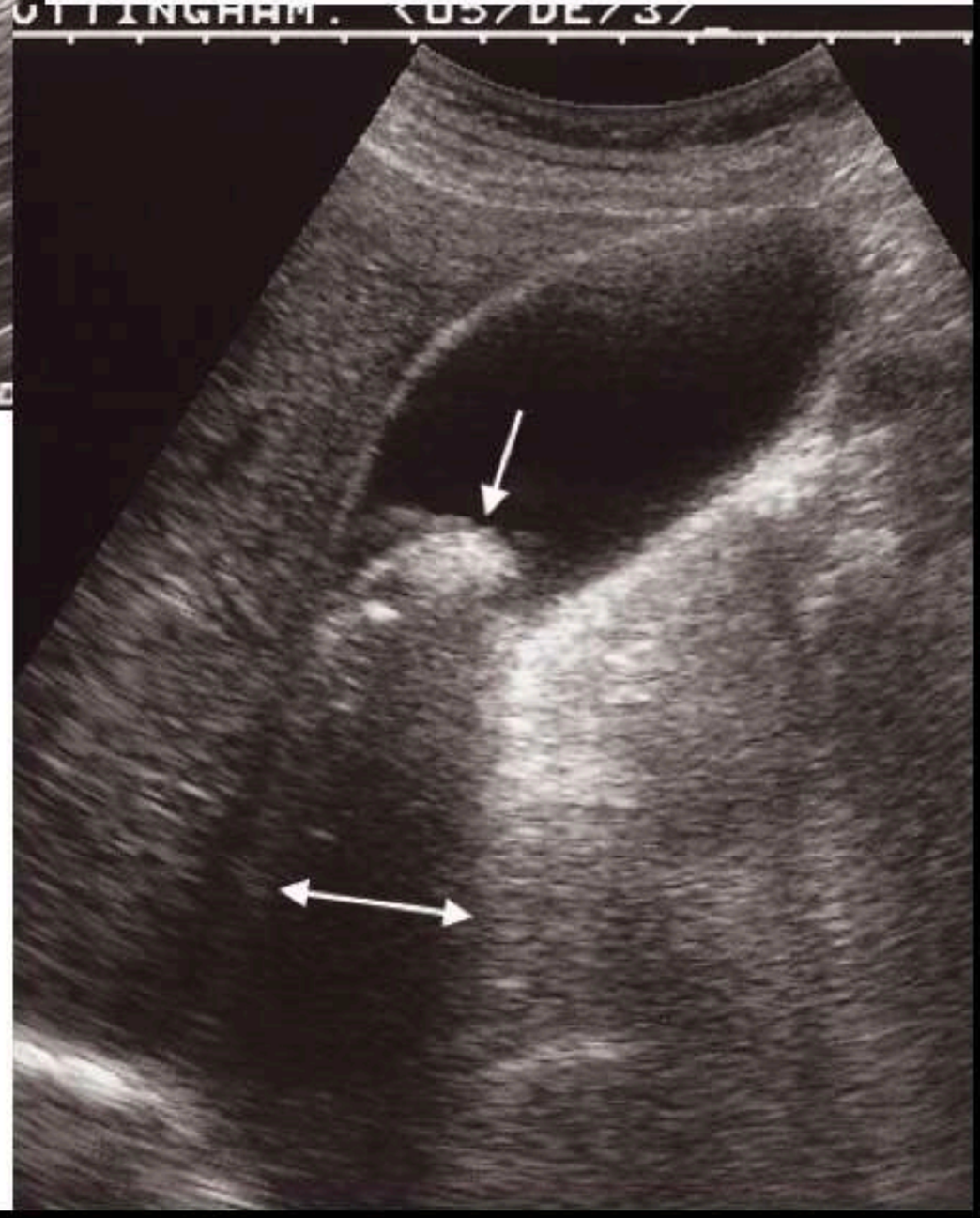
Figure 2

- Figure 1 shows a normal gallbladder on ultrasou
  gallstone in the gallbladder.

4 d ultrasound




Liver
Diaphragm
Kidney
C
Lung

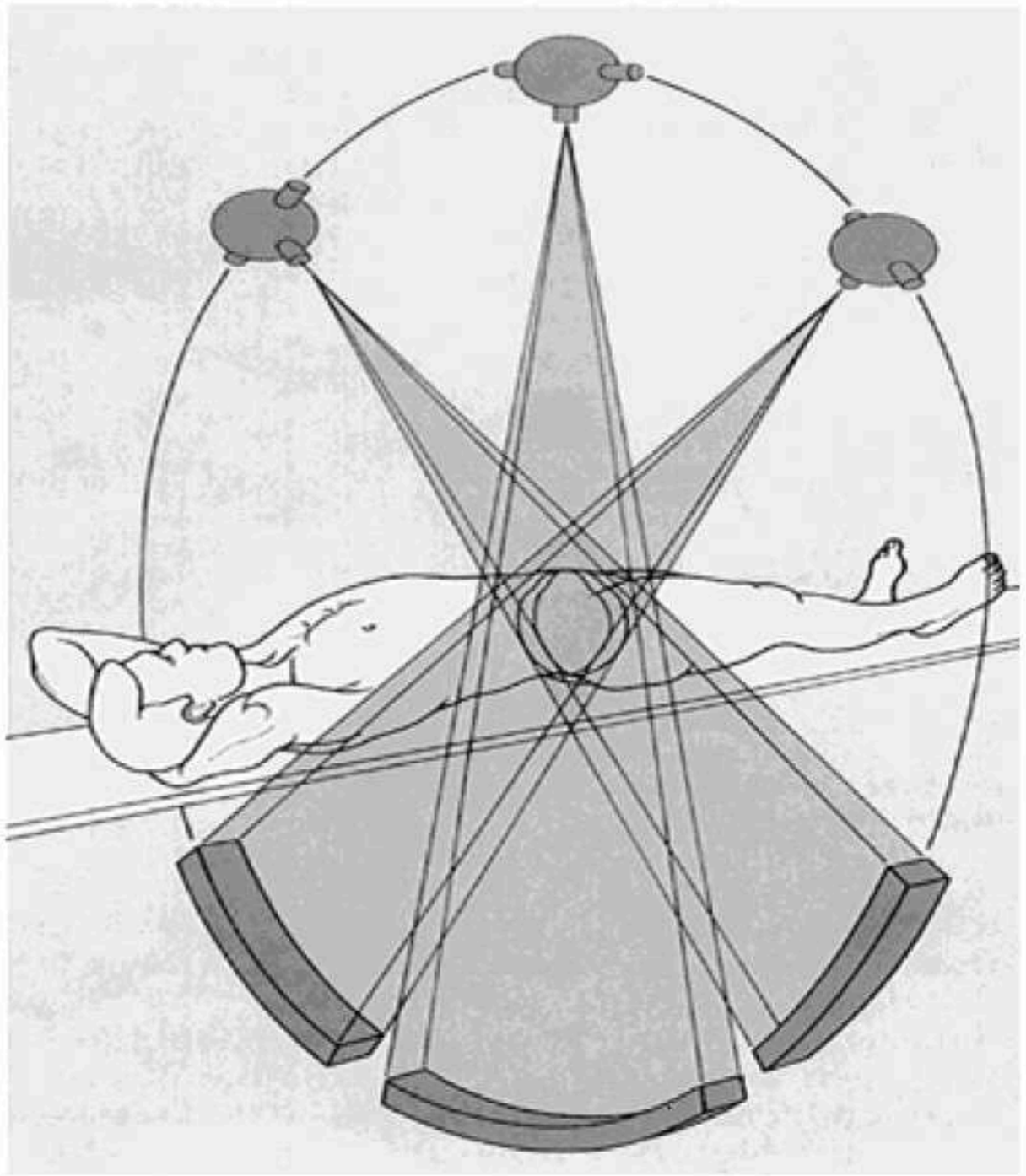


Computed Tomography

CT uses a computer to reconstruct mathematically a cross-sectional image of the body from measurements of x-ray transmission through thin slices of patient tissue. CT displays each imaged slice separately, without the superimposition of blurred structures that is seen with conventional tomography. The x-ray beam is attenuated by absorption and scatter as it passes through the patient. Sensitive detectors on the opposite side of the patient measure x-ray transmission through the slice. These measurements are systematically repeated many times from different directions

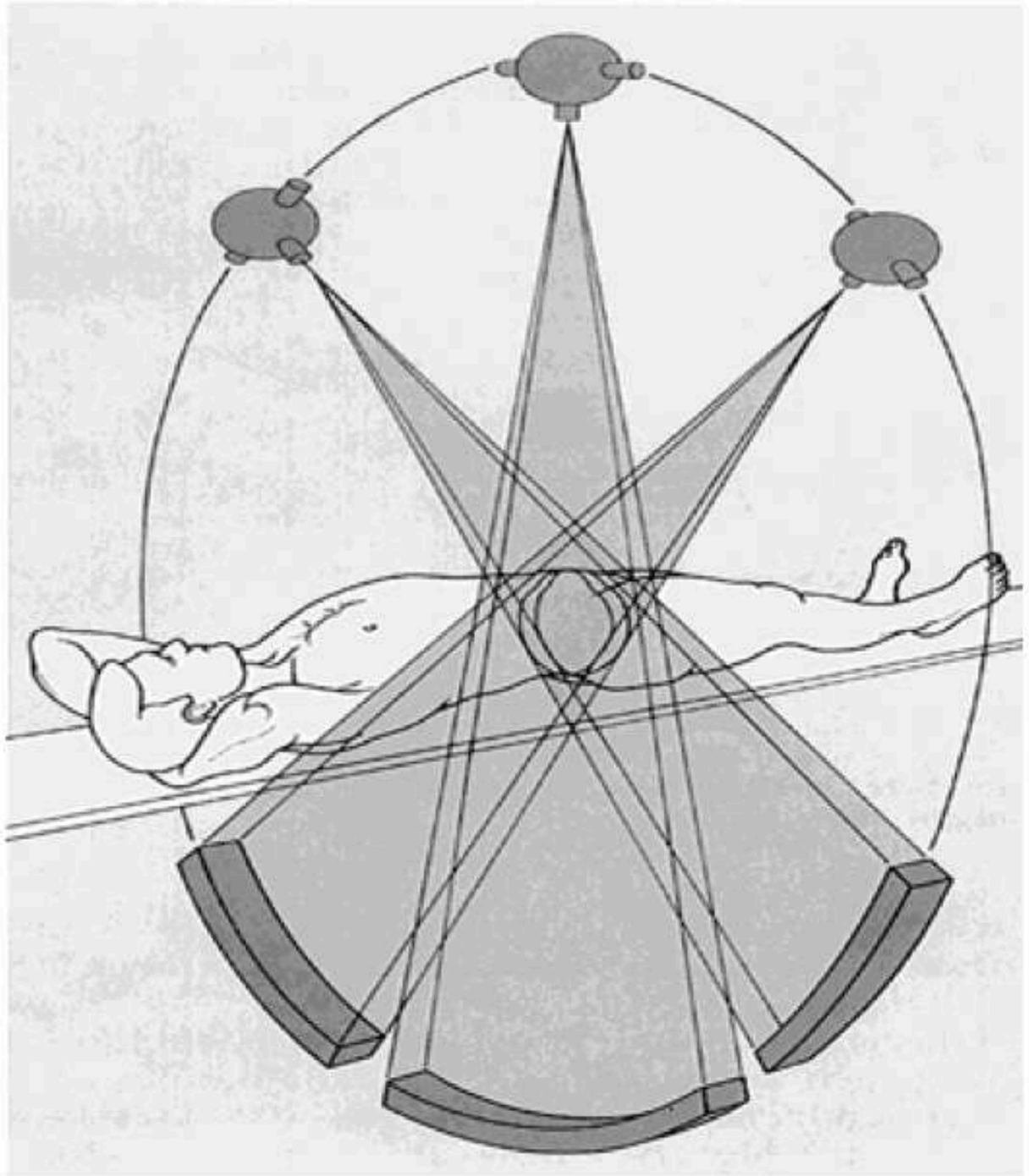
Computerized Axial Tomography (CAT)

In this process a small beam of x-ray is passed through a plane of the body while the x-ray tube moves in an arc or a circle around the body



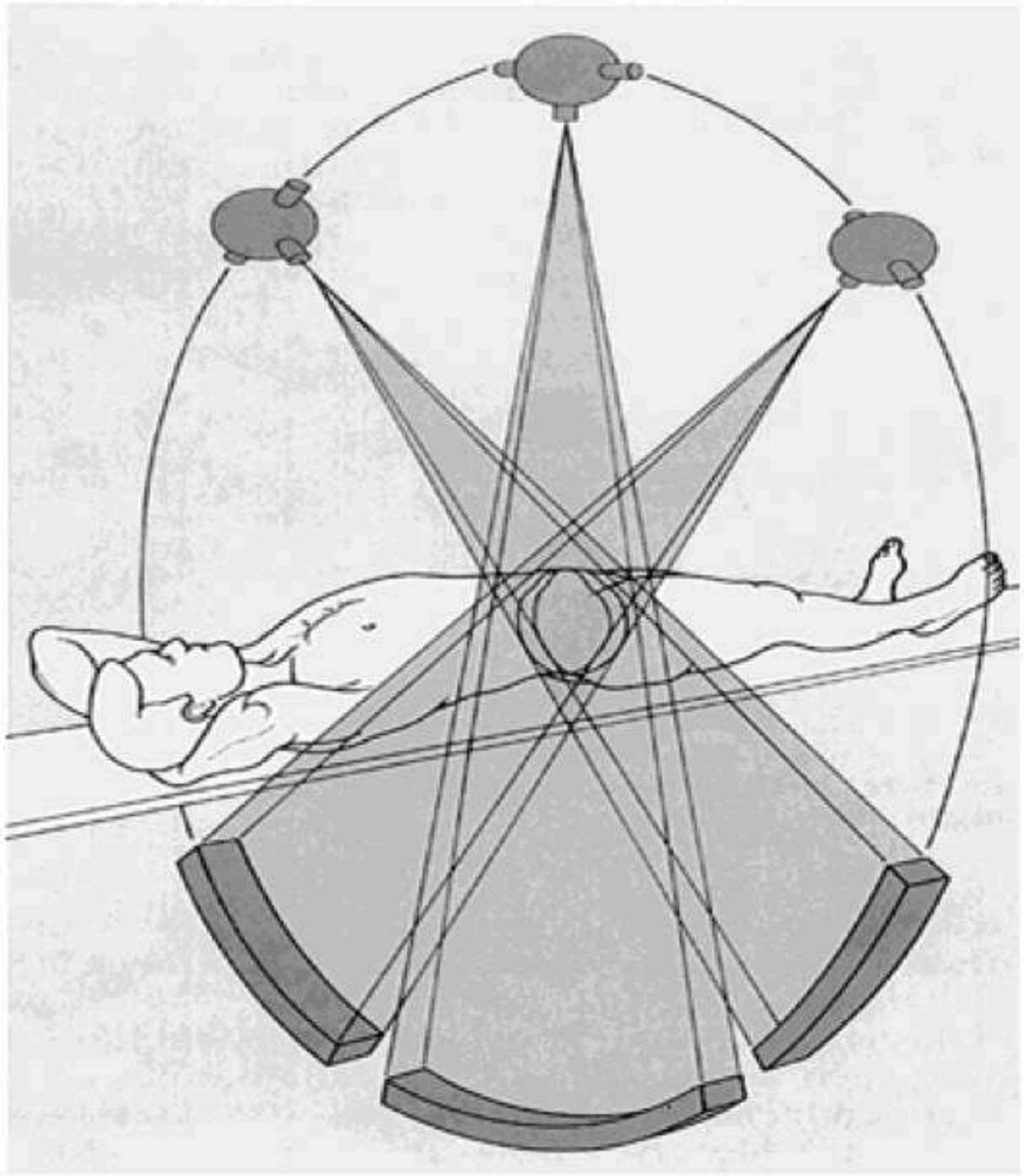
Computerized Axial Tomography (CAT)

The amount of radiation absorbed by different elements of the chosen plane varies according to X ray absorptions by different tissues



Computerized Axial Tomography (CAT)

A computer stores a large amount of data from a selected region of the body, making it possible to determine the spatial relationship of the radiation-absorbing structures within it



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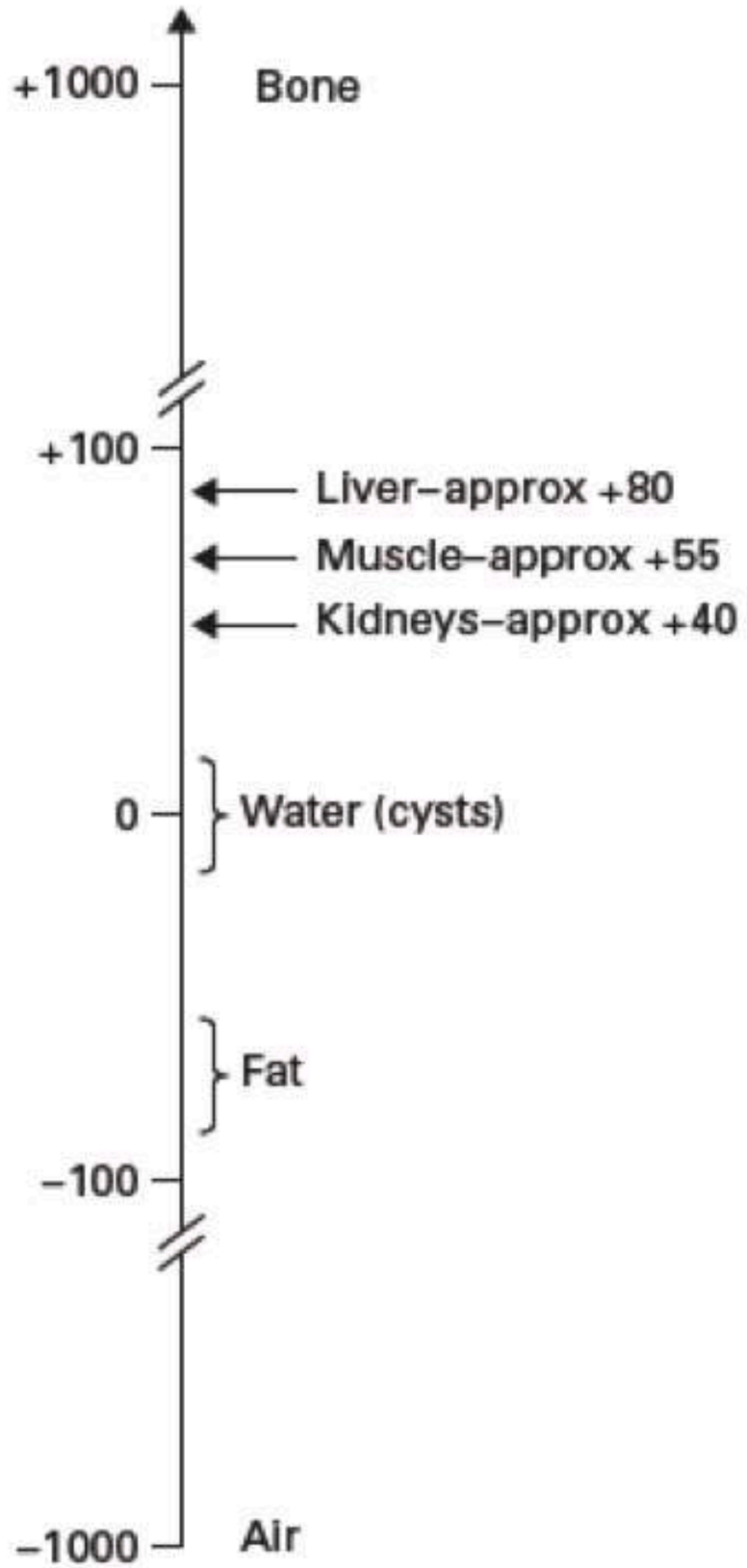


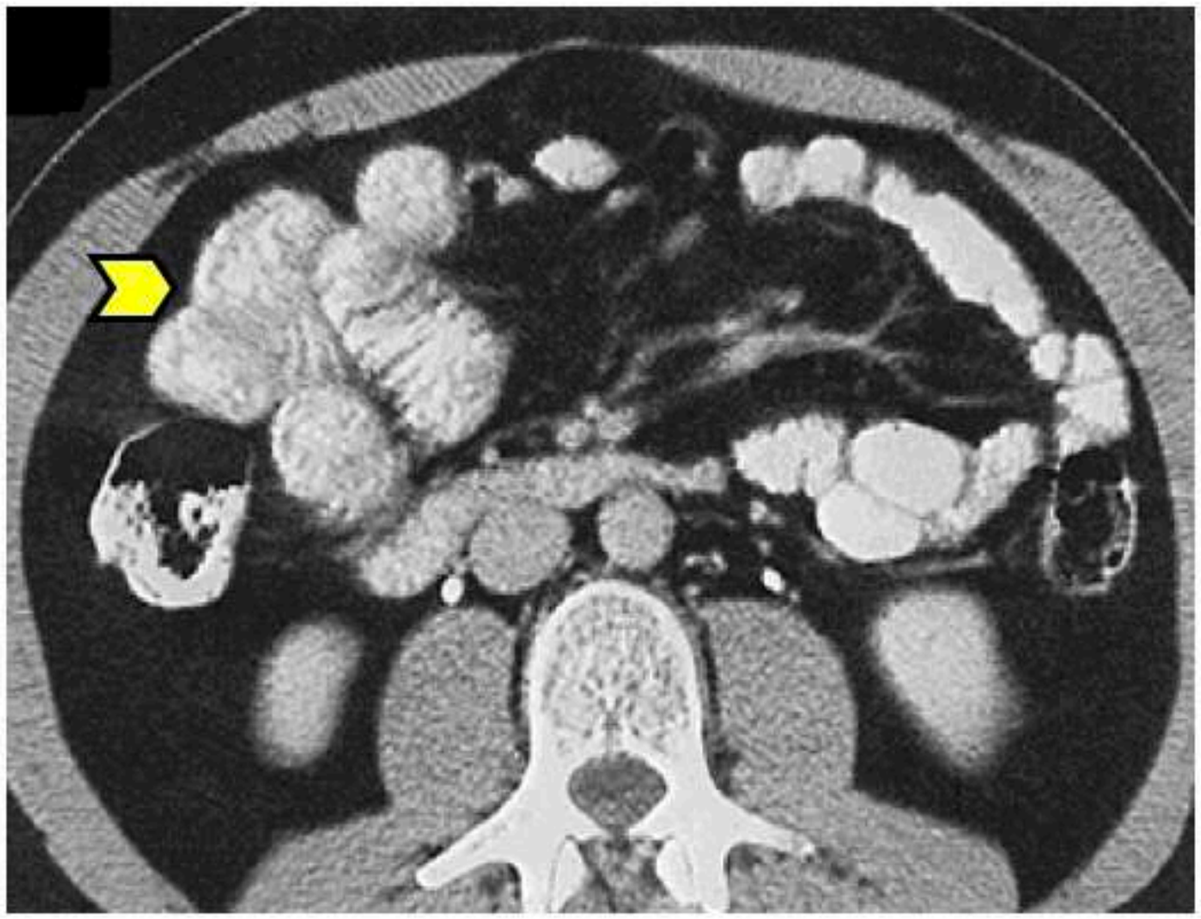
Fig. 1.2 Scale depicting the CT density (Hounsfield units) of various normal tissues in the body.

Computerized Axial Tomography (CAT)

Important diagnostic information about tissues in the scanned regions of interest is thereby made

Contrast enhancement may be used

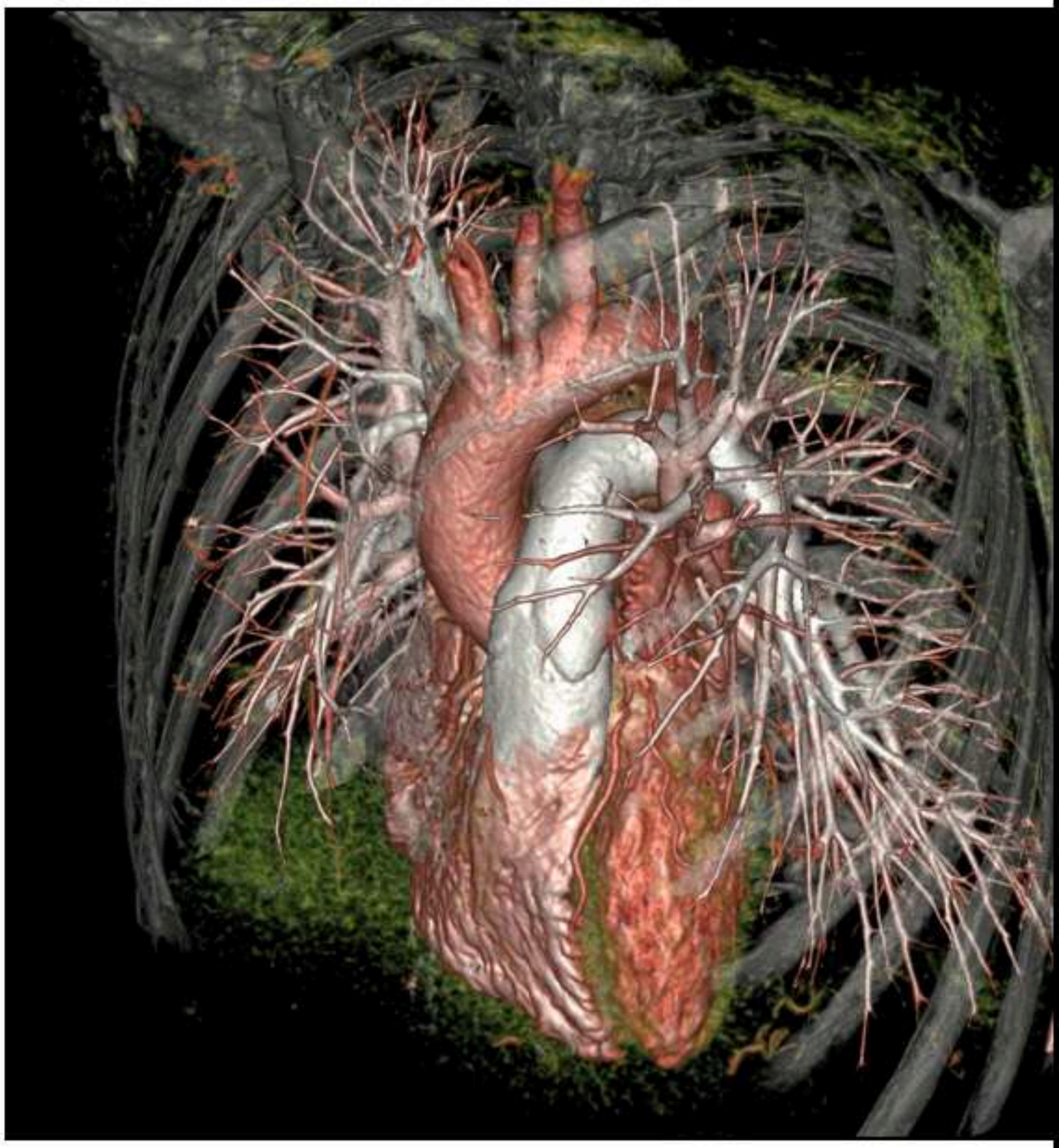
Contrast enhancement of the bowel after oral administration of barium



ADVANCES OF CT

- Faster CT machines, due to multidetector capabilities, have made imaging of the heart and circulatory system very practical in a number of clinical settings. The faster capability has allowed the imaging of the heart with minimal involuntary motion, which creates motion blur on the image.

- 3D RECONSTRUCTION
- Multiplanar reconstruction the simplest method of reconstruction. A volume is built by stacking the axial slices



Advantages of CT scan

- CT is very good for imaging bony structures and calcifications.
- Good soft tissue and spatial resolution .
- Short examination time (suitable for pediatric and some emergencies)
- Suitable for Coronary and cardiac examination (advance multi detector CT scan)

Disadvantages

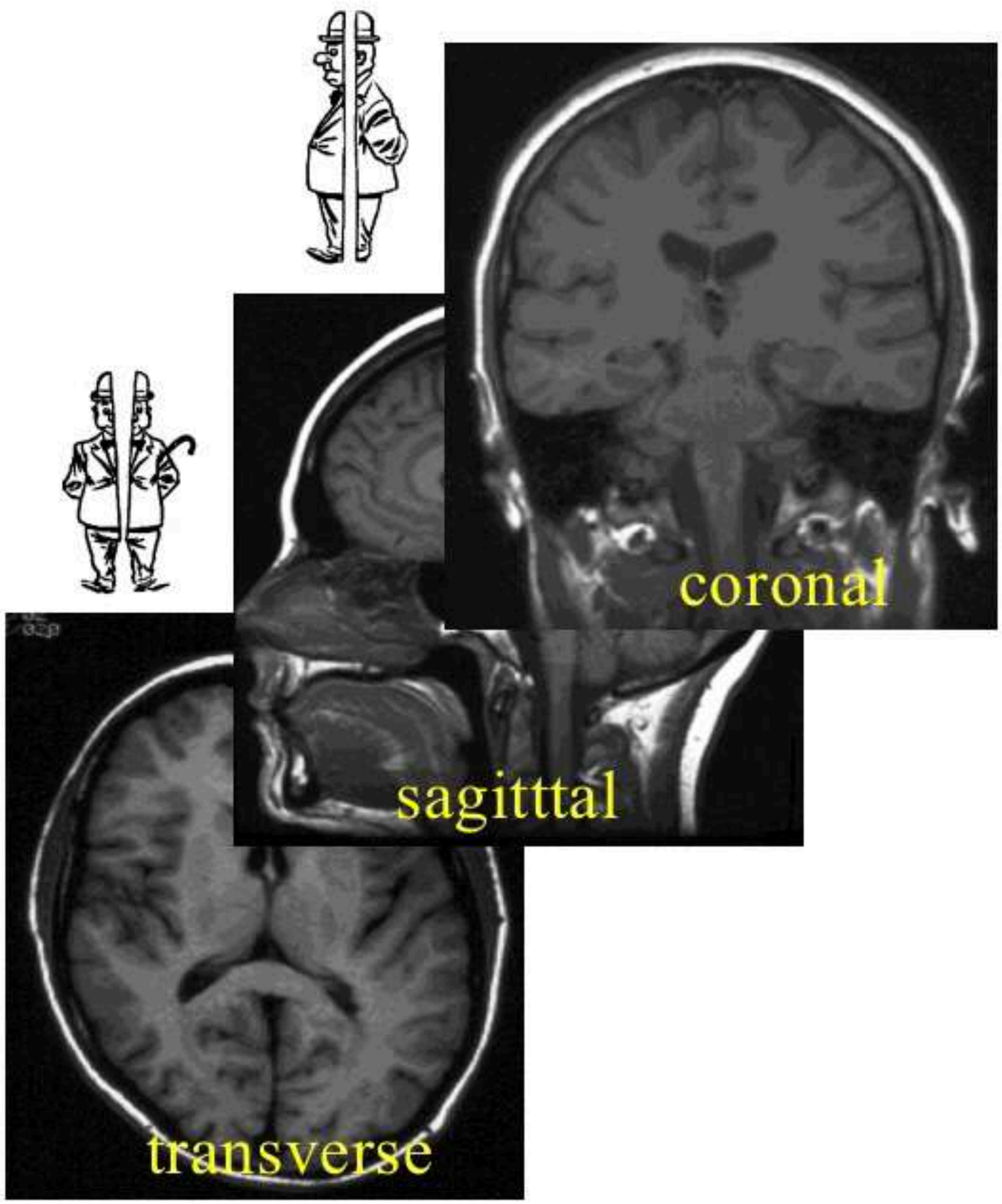
- Radiation single CT scan may give radiation equivalent to more than 400 chest X ray
- Contrast : CT scan may need injection of contrast material which may cause some adverse reactions or allergy in some patients or it may be contraindicated in some patients
- CT scan have poor soft tissue contrast in comparison to MRI

Shaded surface 3D CT reconstruction. The images can be viewed in any desired projection and give a better appreciation of the pelvis. Two fractures are demonstrated in the left innominate bone (arrows), which were hard to diagnose on the plain film

Magnetic Resonance Imaging (MRI)

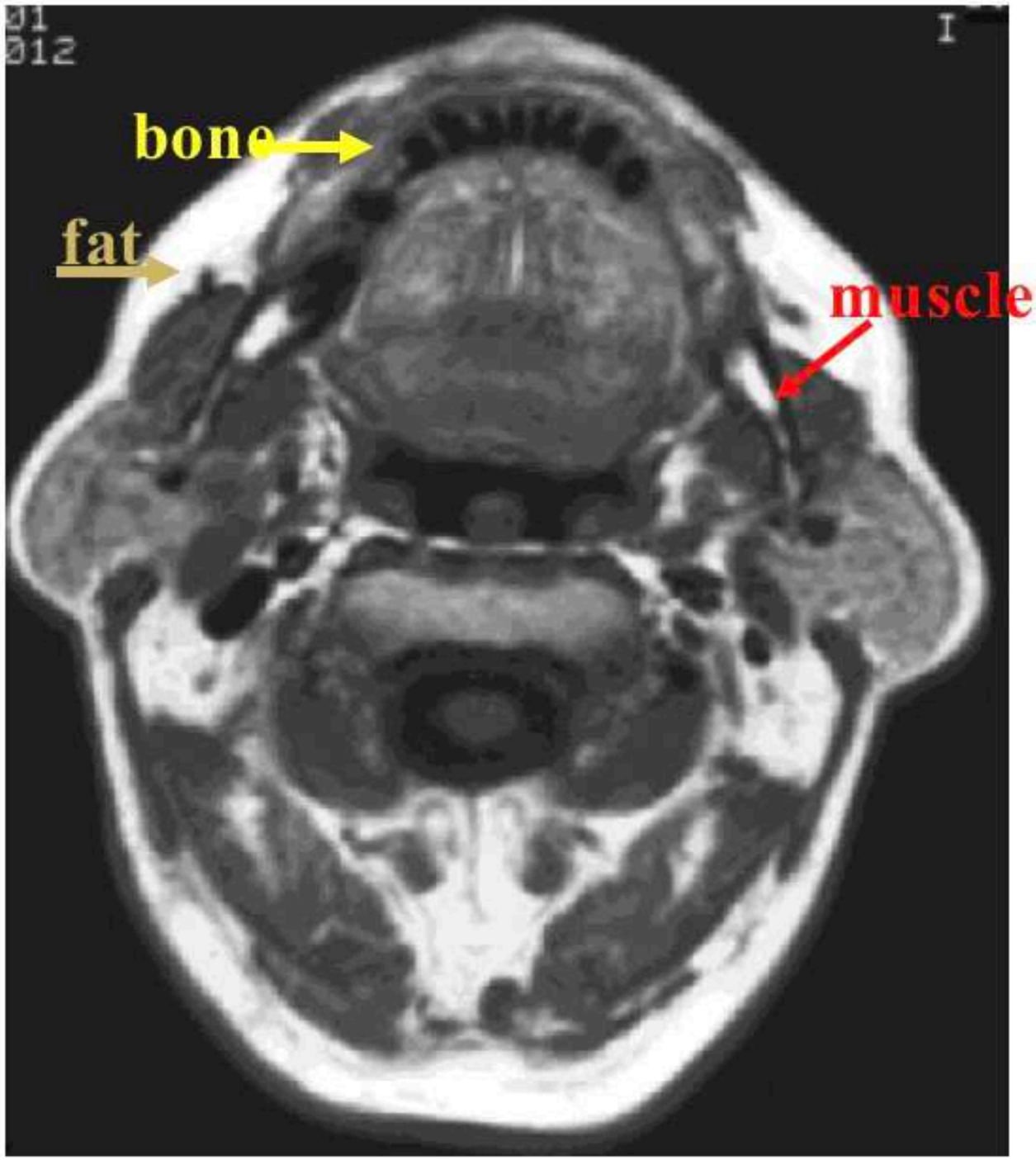
Uses non-ionizing radiation and has no demonstrated adverse biological effects.

Magnetic resonance images can be obtained in any tissue plane

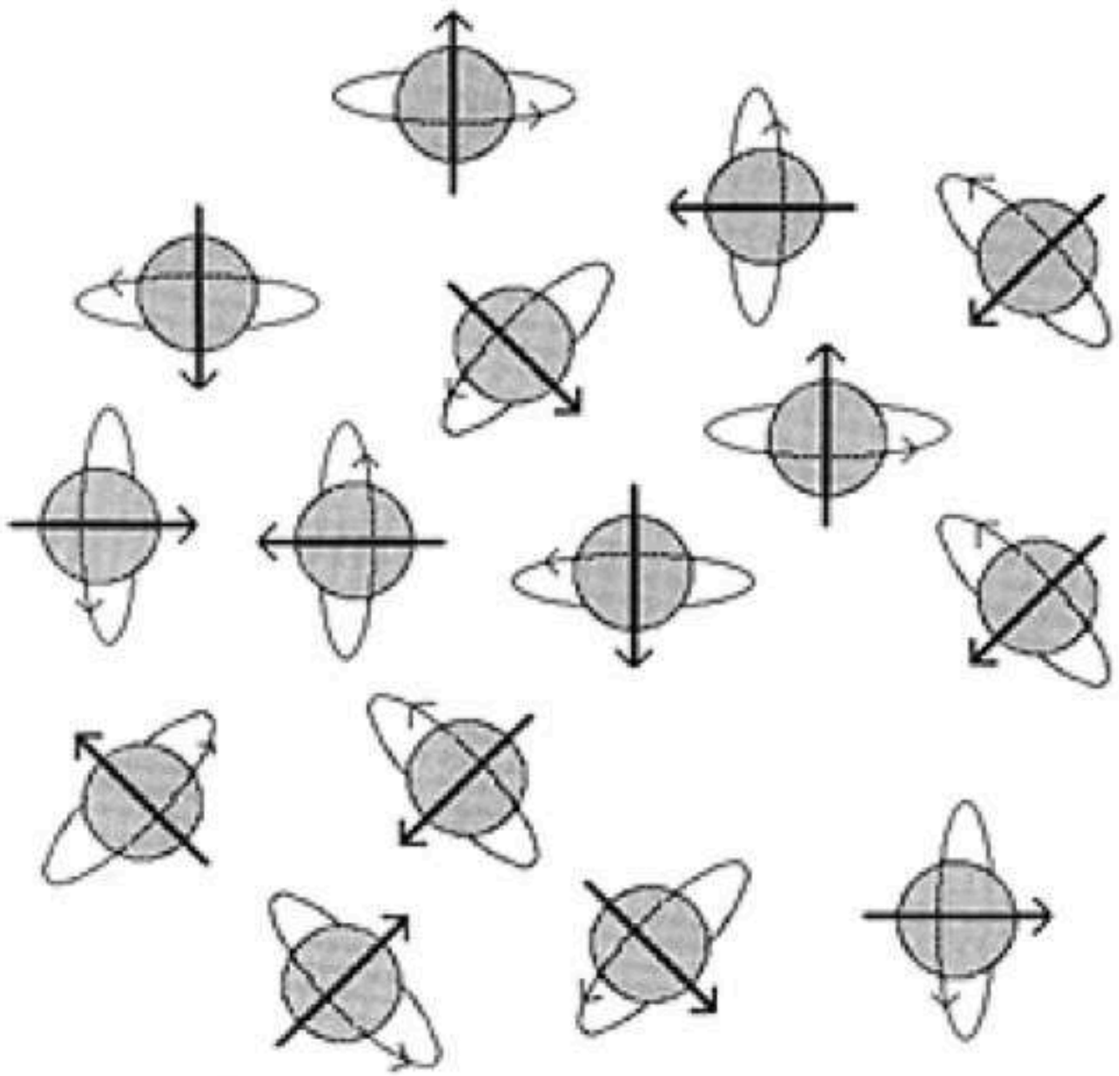


Magnetic Resonance Imaging (MRI)

The appearance of an MR image is a function of the chemical composition of the various types of tissue



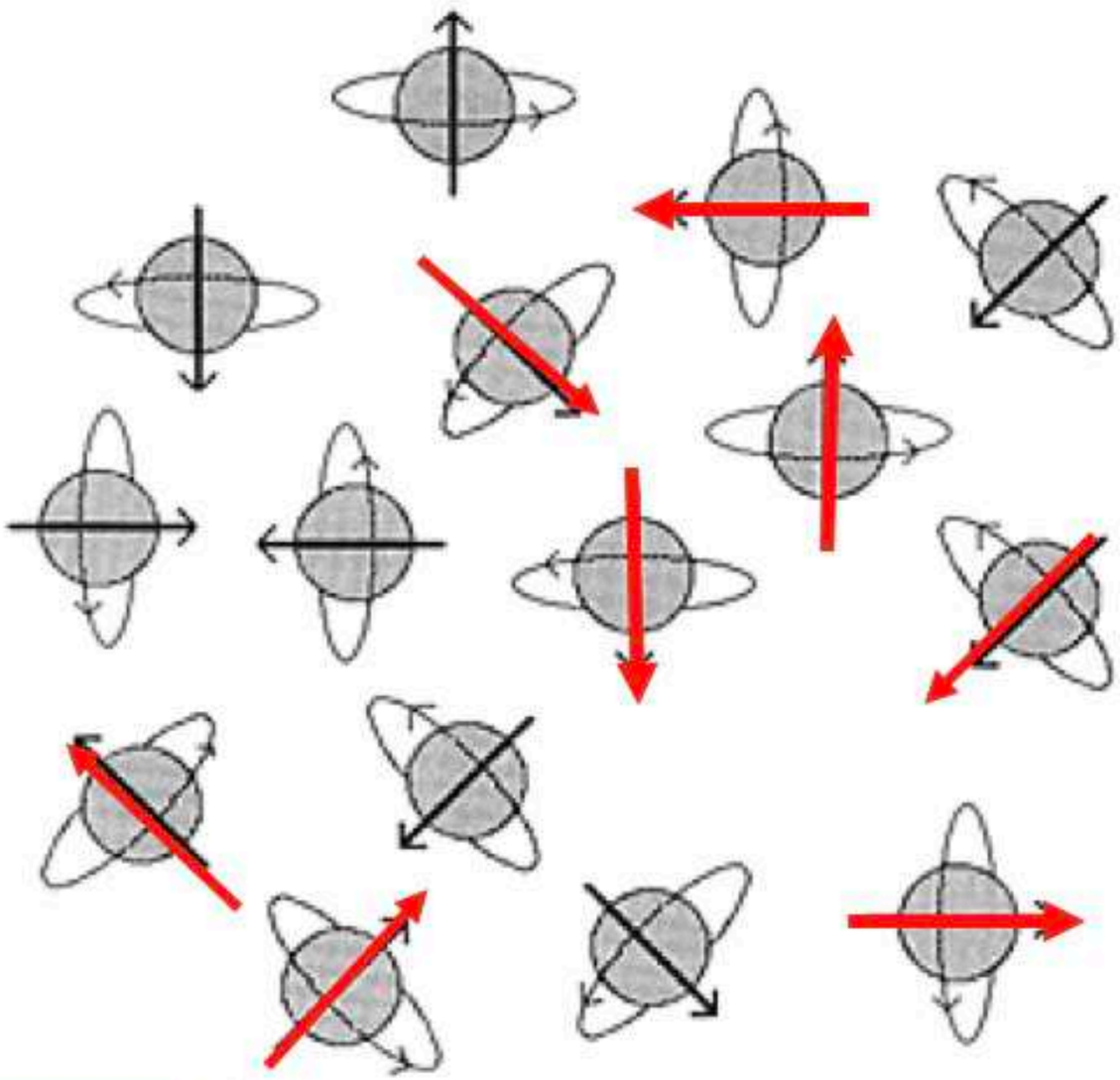
Magnetic Resonance Imaging (MRI)



At the atomic level, water and adipose are composed of hydrogen, oxygen, carbon, and phosphorus atoms. The ***hydrogen atom*** contains a proton and an orbiting electron.

A spinning charged particle (the proton) produces a local magnetic field

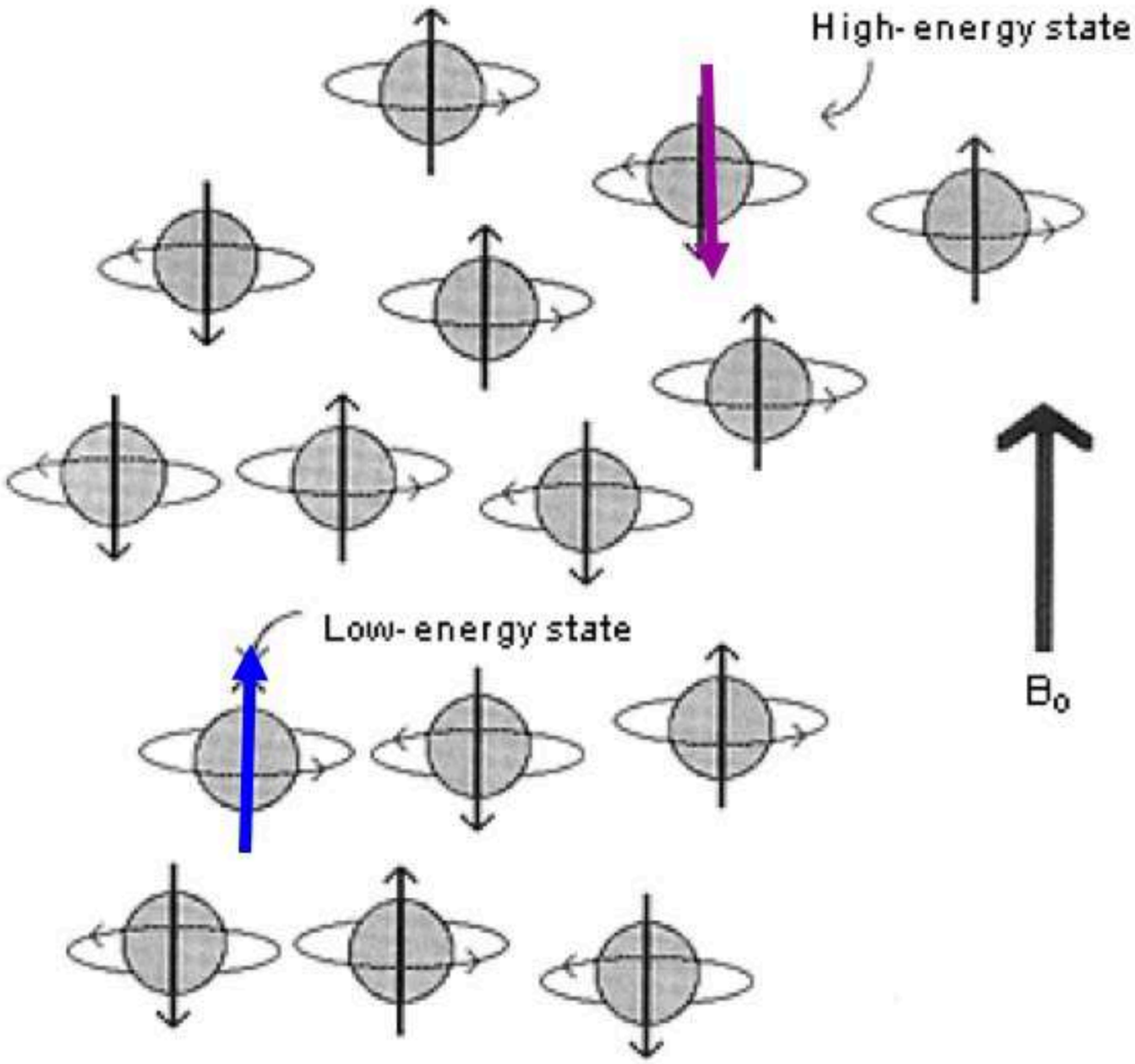
Magnetic Resonance Imaging (MRI)



In the absence of any external forces, the magnetic moments of protons in tissue are oriented randomly

Magnetic Resonance Imaging (MRI)

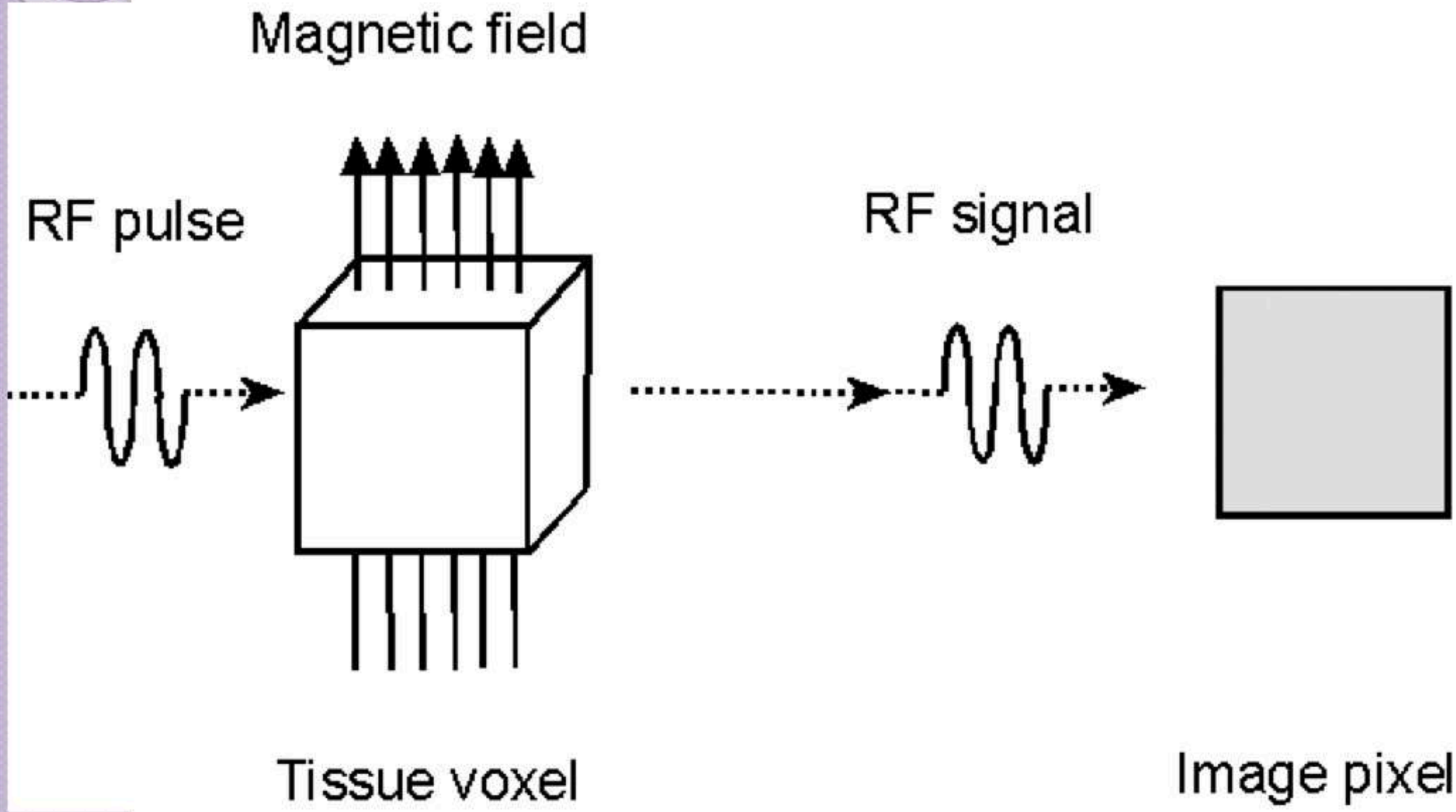
If the protons are placed in a strong magnetic field, their magnetic dipoles align ***with*** and ***against*** the strong magnet



Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging (MRI) combines a strong magnetic field and radiofrequency (RF) energy to study the distribution and behaviour of hydrogen protons in fat and water

RF energy is used to generate a second magnetic field, perpendicular to the static magnetic field of the machine.



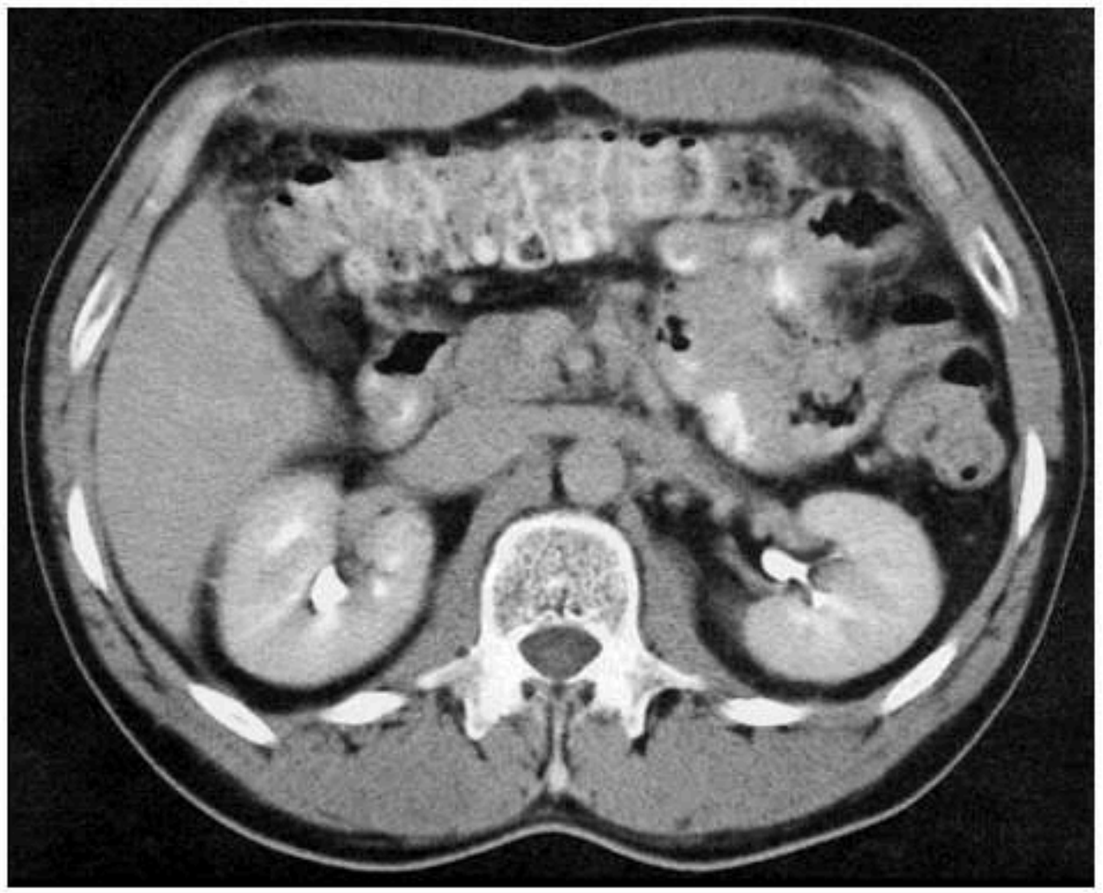
Box 1.1 Appearance of water and fat on different magnetic resonance (MR) sequences

Sequence	Water signal intensity	Fat signal intensity
T1-weighted	Low	High
T2-weighted	High	High
T1 with fat saturation	Low	Low
T2 with fat saturation	High	Low

Comparisons

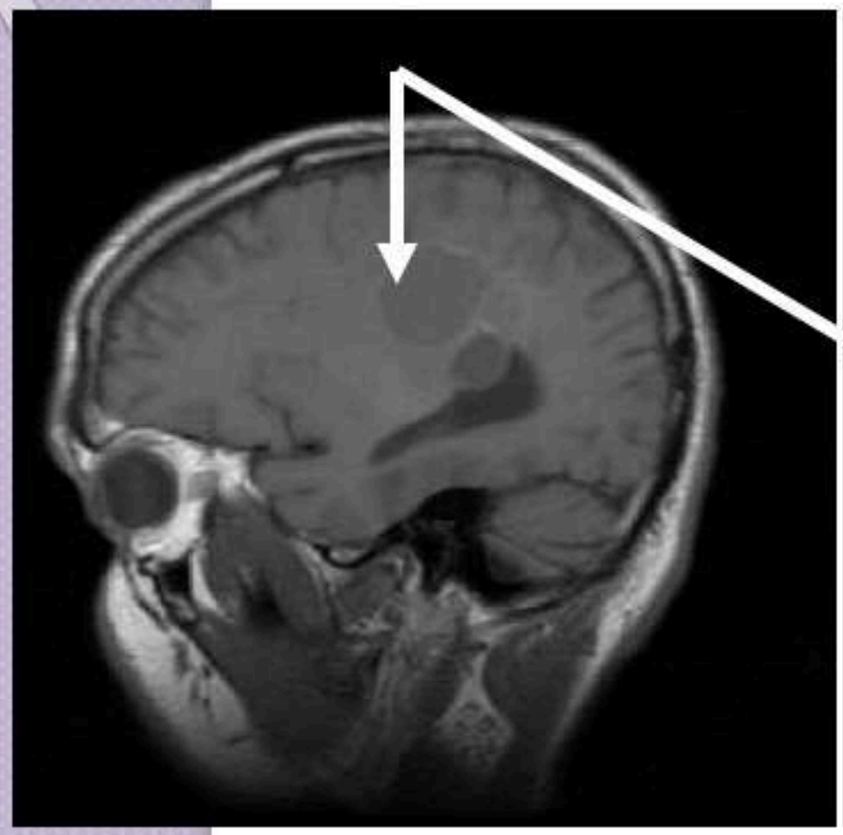
MRI image

CT image

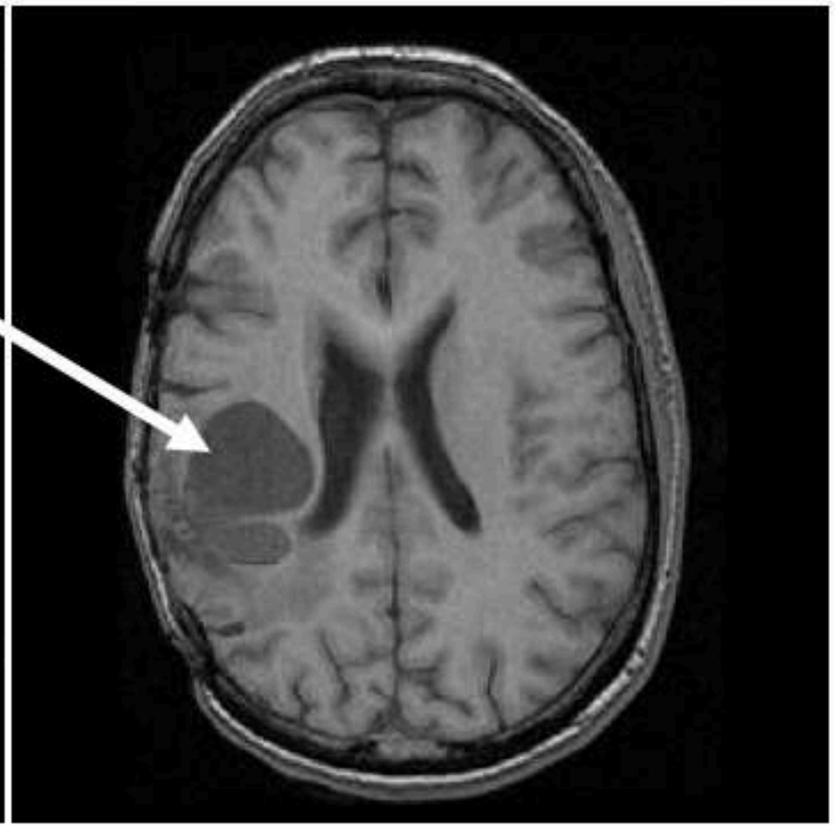


Compare bone and soft tissue density

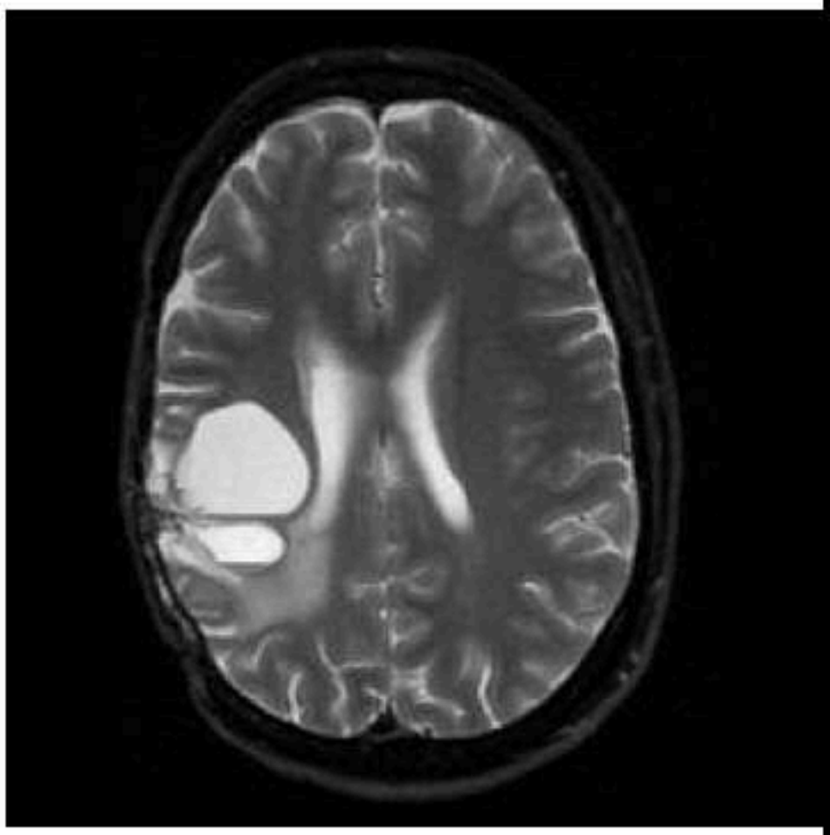
Brain Tumor Imaging



T_1-weighted Sagittal



T_1-weighted Axial



T_2-weighted Axial

Advantage of MRI

- Non ionizing radiation
- Multiplanar images (cross section , saggital and coronal views)
- The ability of imaging vessels without contrast (MR angiography)
- Have a good soft tissue contrast

Contraindication of MRI

- Patient with pacemaker
- Patient with bullet injury or ferromagnetic F.B ,or surgical clip (because of heat and missile effect)
- Pregnancy especially first trimester
- Claustrophobia reported that between 1 % and 10 % of patients experience some degree of claustrophobia which in the extreme cases results in their refusal to proceed with the scan

DISADVANTAGES OF MRI

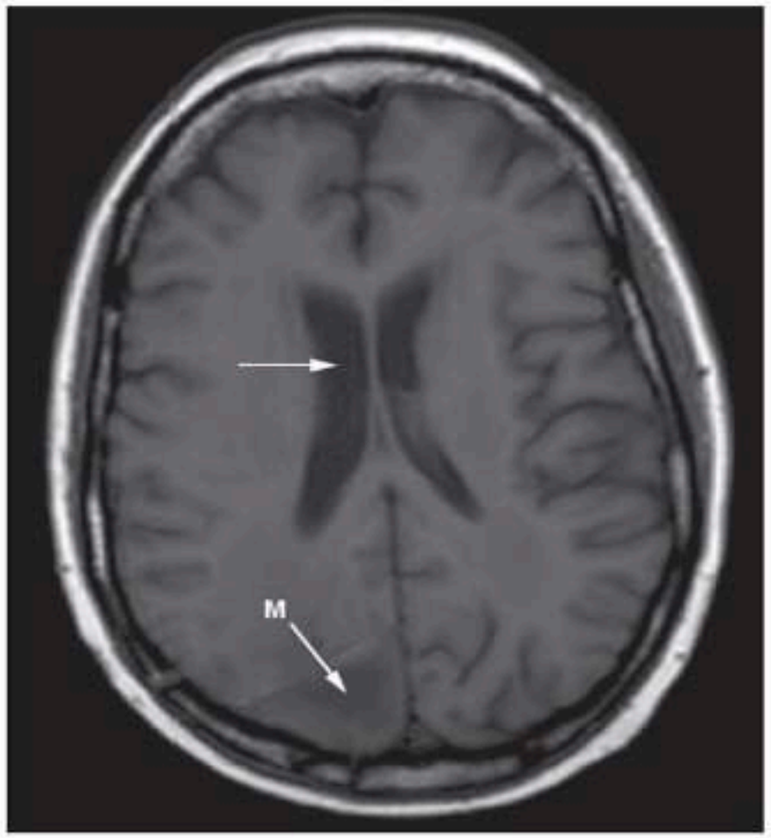
- Expensive
- Long scan times
- Audible noise (65-115dB)
- Isolation of patient (claustrophobia, monitoring of ill patients)
- Exclusion of patients with pacemakers and certain implants

THE CHANGING MAGNETIC FIELDS CAN DO DAMAGE TO:

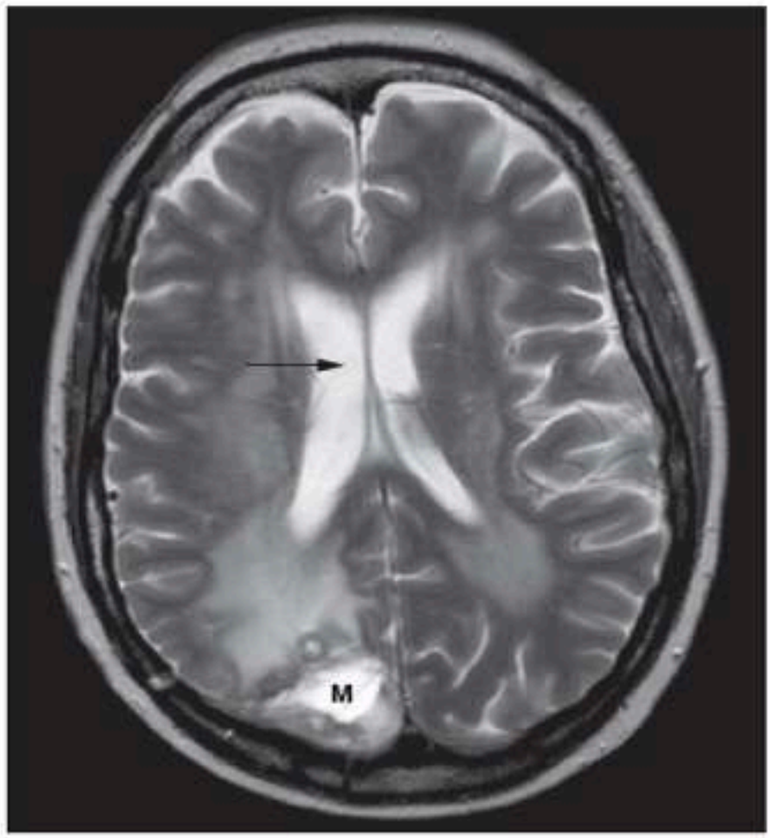
- Monitoring equipment
- Infusion pumps
- Credit cards
- Cellular telephones
- Any electronic device

THE FOLLOWING ARE (USUALLY*) OKAY:

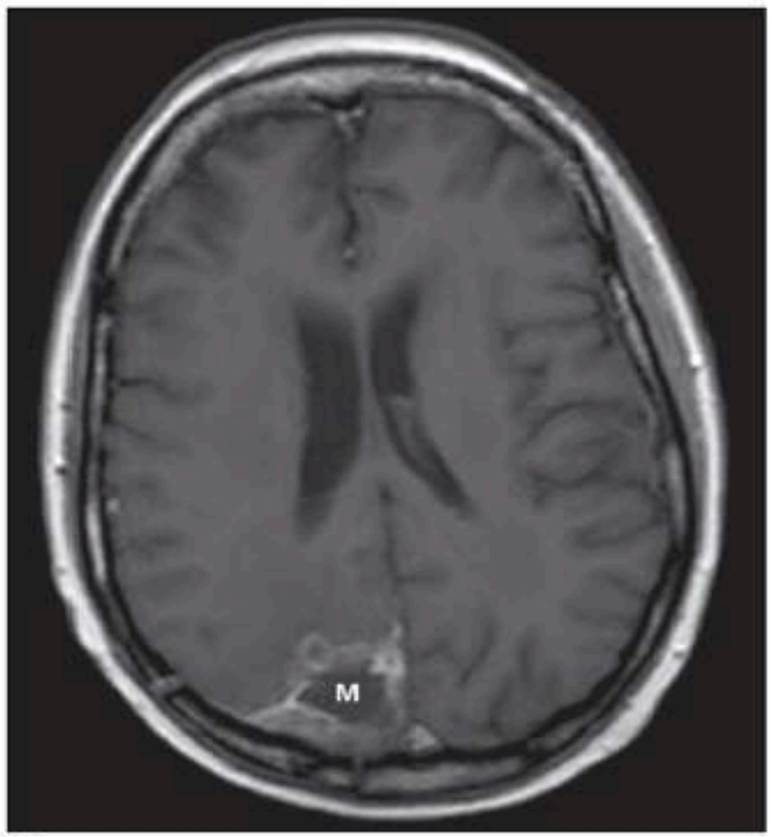
- Gold
- Silver
- Digital watches
- Eyeglass frames
- Snaps/zippers fastened to clothing
- Dental work
- IUCD



(a)



(b)



(c)

Fig. 1.11 MRI of the brain. (a) Axial T1-weighted image. (b) Axial T2-weighted image. (c) Axial T1-weighted image following gadolinium. Note that the cerebrospinal fluid within the lateral ventricles is of low signal intensity on T1 and high signal intensity on T2-weighted images (arrows). Note also that the intensity of the white and grey matter of the brain differs on the two images. There is a metastasis from a breast carcinoma (M) in the right occipital pole, showing oedema around the mass on the T2-weighted image and enhancement on the post contrast image.

Ionizing Radiation

- Although many patients benefit from radiation's ability to destroy cancer cells or capture real-time images of the human body, radiation can harm healthy cells wherever it enters the body. It is well documented that ionizing radiation can cause damage ranging from uncontrollable cell replication to cell death
- X-ray and gamma waves have the highest energy, and thus can pass through the human body. When these waves of energy enter a cell, their wavelengths may collide with the electrons of the cells' atoms, possibly resulting in damage to the cell.
- When an x-ray's wavelength of energy collides with an atom's electron, the electron may be bumped out of its orbit leaving the atom with an unbalanced charge and in an unsteady state. In this state, the atom is called a radical. Like H2O2 , This process is called ionization.

Ionization of an Atom

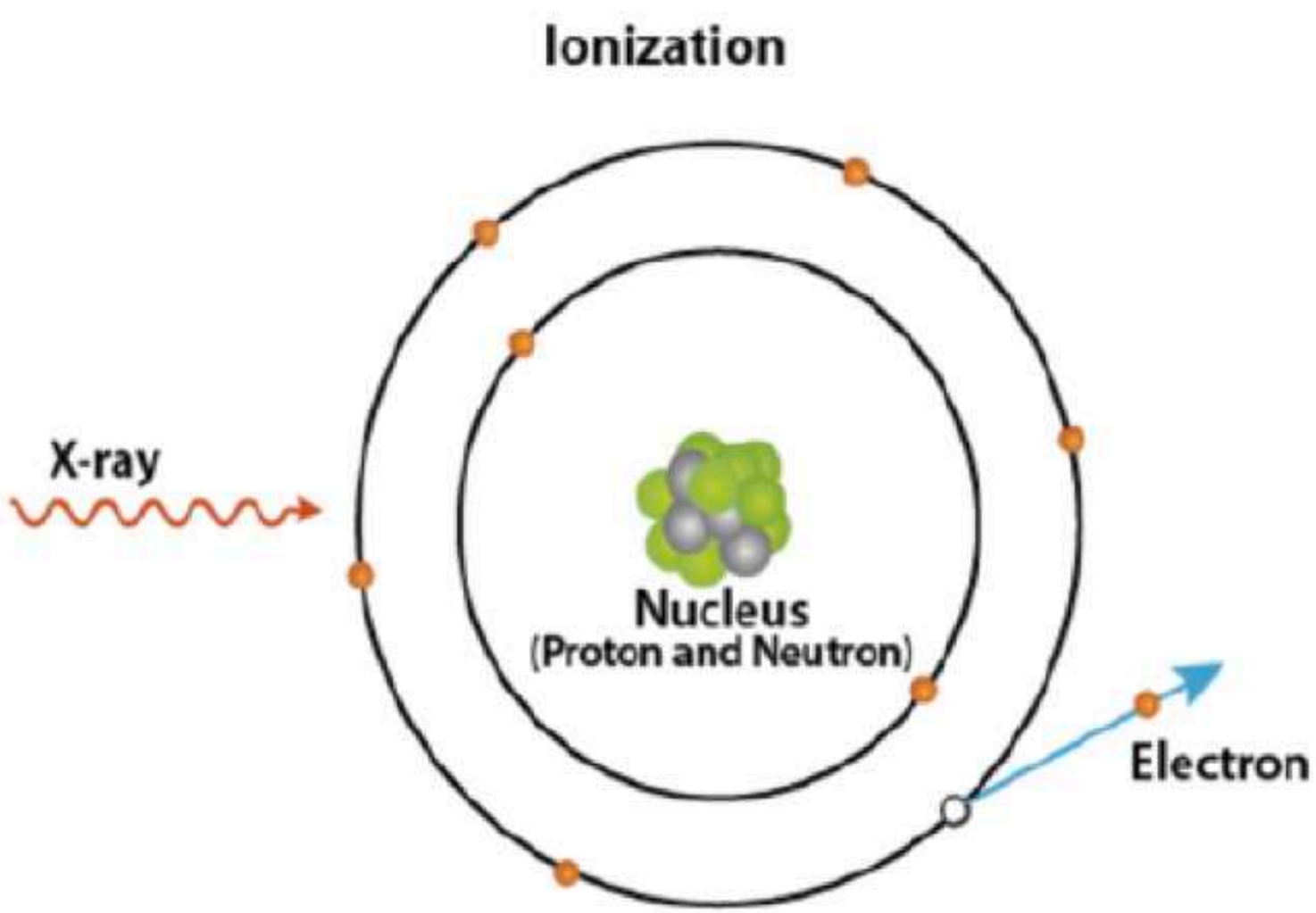


Figure 1. *Ionization of a cell. When struck by an x-ray beam, electrons may leave their atom's orbits, creating a radical.*

Radiation effect

- Unstable radicals seek a reaction to stabilize them, making them highly chemically reactive. The radicals react with and alter the chemical bonds within a cell, particularly interrupting bonds within DNA molecules and those between water molecules' hydrogen and oxygen atoms
- DNA damage
- DNA molecules are susceptible to both direct and indirect radiation damage. Direct damage occurs when the radiation energy directly breaks DNA bonds; indirect damage occurs when radiation-generated radicals break DNA bonds

DNA Damage

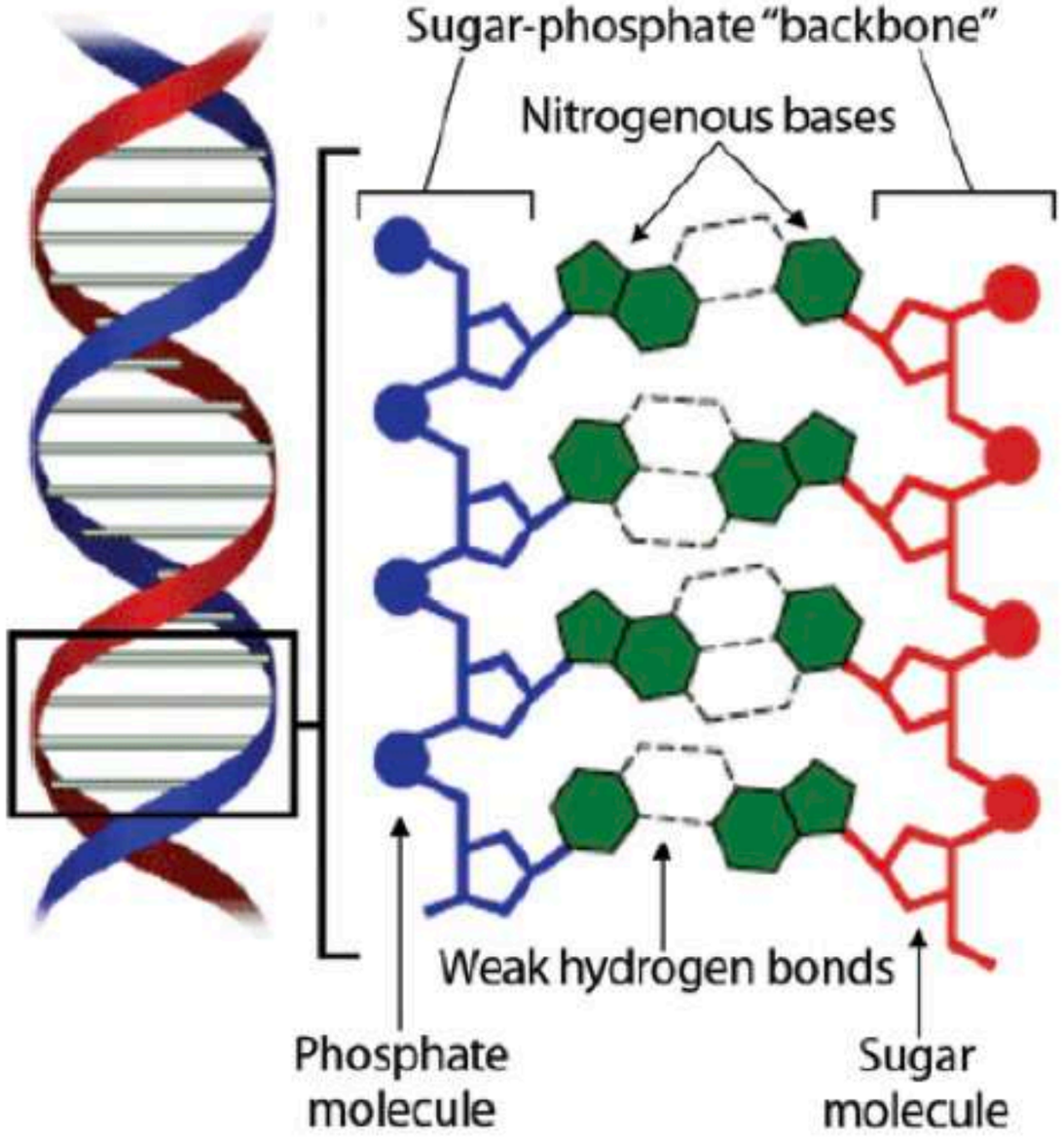


Figure 2. *A DNA double helix (left) and a detailed view of the components that comprise the DNA. Image courtesy of Understanding Evolution, University of California Museum of Paleontology.*

Infants and children

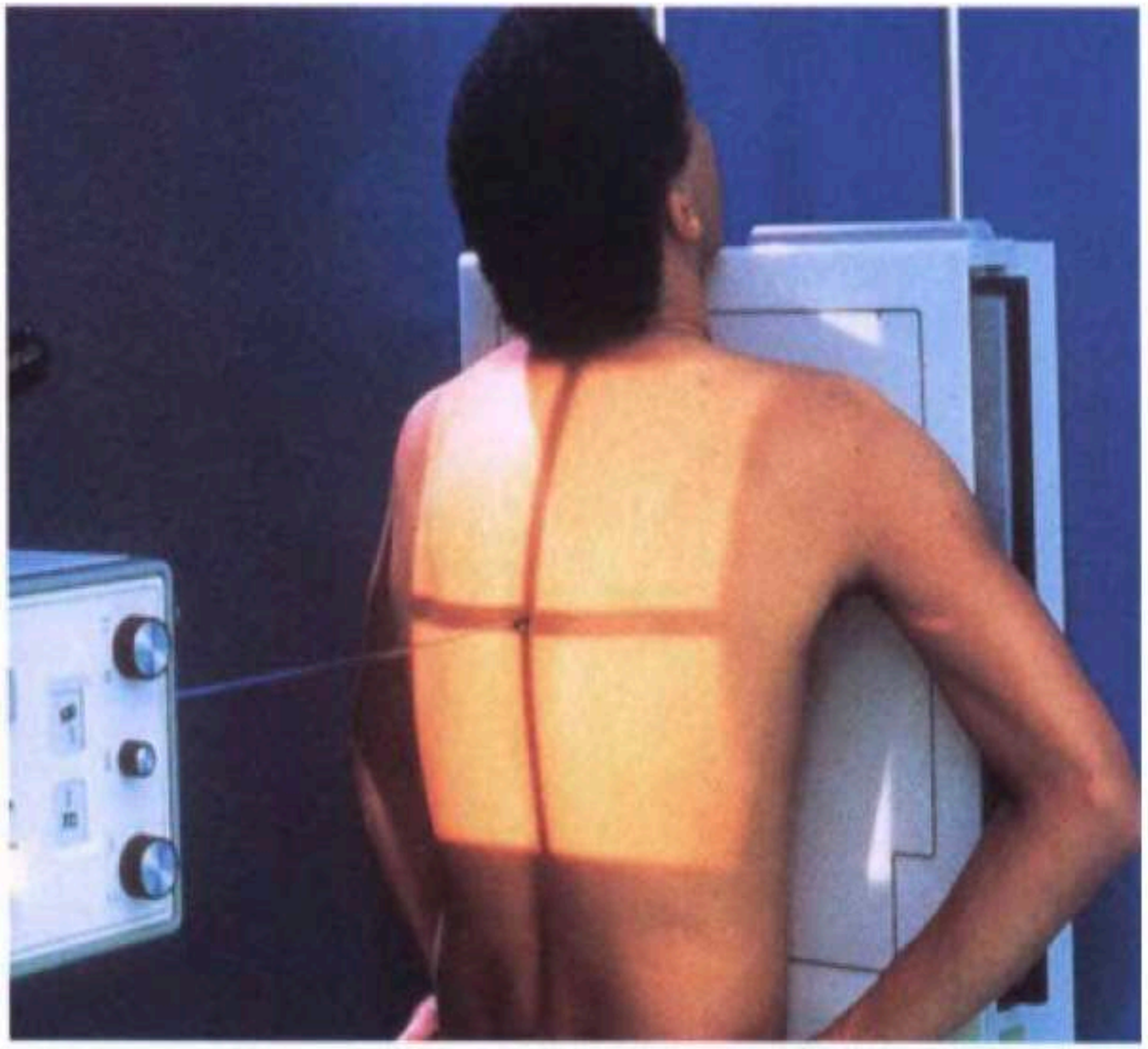
As children are more radiosensitive than adults and their longer life expectancy gives greater opportunity for the radiation detriment to be expressed, special care must be taken to ensure that any radiation doses to children are justified by the diagnostic information to be gained as a result of the procedure.

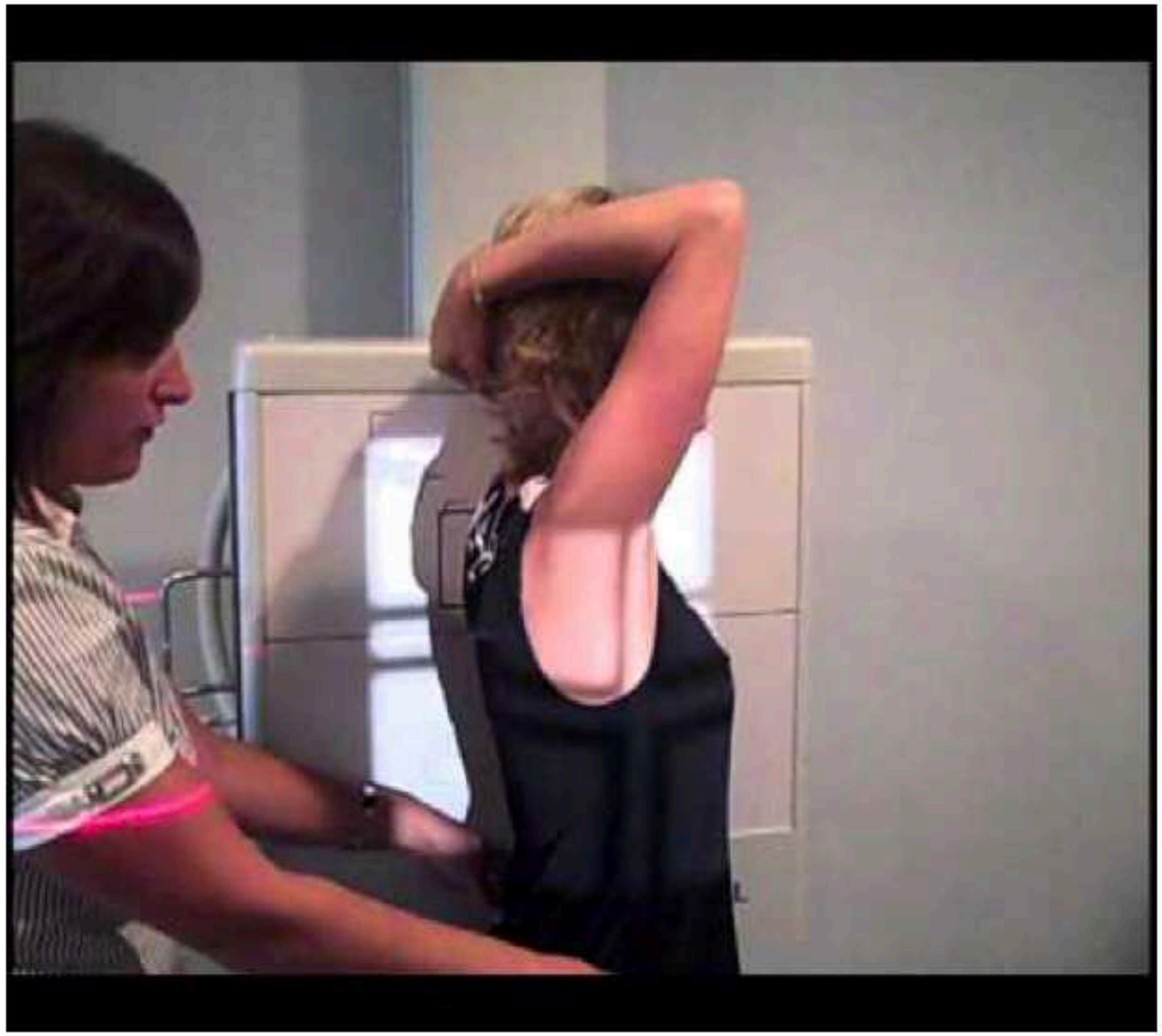
RADIATION PROTECTION OF STAFF AND PUBLIC

Almost anything that will help to reduce patient doses, use non ionizing examinations will also tend to reduce staff dose

Monitoring of radiology department and staff by dosimeter badges is very helpful in protection of radiologist and staff .

Quiz
name the radiographic Views below:






Thank you!