

RADIOLOGY

RR-8.0

Contents

Fundamentals of Radiology	1
Radionuclide Imaging and Radiotherapy	11
Respiratory Imaging : Part 1	20
Respiratory Imaging : Part 2	28
Cardiovascular and Neurological Imaging	41
Gastrointestinal and Genitourinary Tract Imaging	59
Women and Musculoskeletal Imaging	79

© Marrow | kumbhareshivani387@gmail.com | 103.183.91.92 | 2024-12-09



FUNDAMENTALS OF RADIOLOGY

----- Active space -----

Symbols :



Trefoil : Radiation Hazard



X-ray radiation hazard



Sealed radiation source

Electromagnetic Spectrum & Radiation Units

00:02:23

ELECTROMAGNETIC SPECTRUM

Radio waves : micro waves : Infrared : visible light : ultraviolet : X-rays : Gamma rays

(minimum)

Frequency and energy

(maximum)

Properties of Em Spectrum :

mass : Absent.

velocity : 3×10^8 m/s (Speed of light).

Types of waves : Crest and trough.

Properties of X-rays :

Frequency : High.

Energy : High.

Wavelength : 0.01 to 10 nm.

Energy content : 100 eV to 100 KeV.

RADIATION UNIT

	Conventional Unit	S.I Unit
Radiation exposure	Roentgen	Coulomb/kg (Charge/weight)
Radiation absorbed	Radiation absorbed dose (RAD)	Gray (Gy)
Absorbed dose equivalent	Radiation Equivalent in man (REM)	Sievert (Sv)
Radioactivity	Curie	Becquerel

Note : "Radioactivity" term coined by Henri Becquerel.

Effects of Radiation

00:10:12

Determining Factors :

- Duration } of exposure to radiation.
- Intensity } of exposure to radiation.
- Sensitivity of tissues to radiation.

----- Active space -----

Law of Radiobiology/Law of Bergonie and Tribondeau :

Radiosensitivity \propto Tissues with $\begin{cases} \text{Maximum undifferentiated cells.} \\ \text{Active mitosis.} \end{cases}$

most sensitive : **Bone marrow** > GIT > **CNS**/musculoskeletal system.

Acute Radiation Syndromes :

Stages :

Stage I : Prodromal (minutes to hours).

Stage II : Latent (Hours to days).

Stage III : manifest illness (Days to weeks).

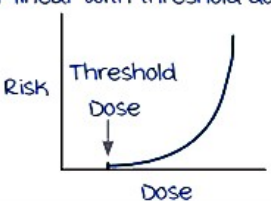
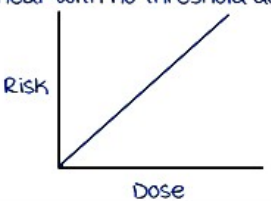
Stage IV : Recovery/death (Weeks to years).

Syndromes :

In order of appearance :

	Acute hematological syndrome	Acute GI tract syndrome	Acute CNS syndrome
Threshold dose	1 - 2 Gy (Least)	6 - 10 Gy	>20 Gy
manifestations	<ul style="list-style-type: none"> Pancytopenia Hemorrhage Infection } Death	Diarrhoea (1 st symptom)	-

Types of effects :

	Deterministic	Stochastic
Examples	<ul style="list-style-type: none"> Acute radiation syndromes Cataract Skin damage Sterility (Gonadal damage) 	<ul style="list-style-type: none"> Carcinogenesis Mutations/Chromosomal aberrations
Onset	Acute to subacute	Chronic/delayed
Threshold dose	Determined	Not determined
Severity	Dose dependent	Dose independent
Risk-Dose relationship	Non-linear with threshold dose 	Linear with no threshold dose 

Radiation Exposure

00:21:32

----- Active space -----

	Types	Scans	Exposure values (mSv)
Danger	CT/PET/radionuclide studies (Highest exposure)	PET Scan	25
		CT Abdomen	10
		CT Thorax	8
		Bone Scan	-
		CT Head/Brain	3.5
Warning	Diagnostic procedures (multiple exposure)	Barium Enema	7
		Intravenous Urogram	-
		Barium meal follow through	-
		Barium meal	-
		Barium Swallow	-
		micturating Cystourethrography (MCU)	1.2
Safe	Spot radiographs (Exposure once/ twice)	Lumbar Spine	1.0
		Abdomen X-ray	-
		Hip X-ray	-
		Skull X-ray	-
		Chest X-ray	0.02
		Limb/Joint X-ray	0.01 (least)

Guidelines :

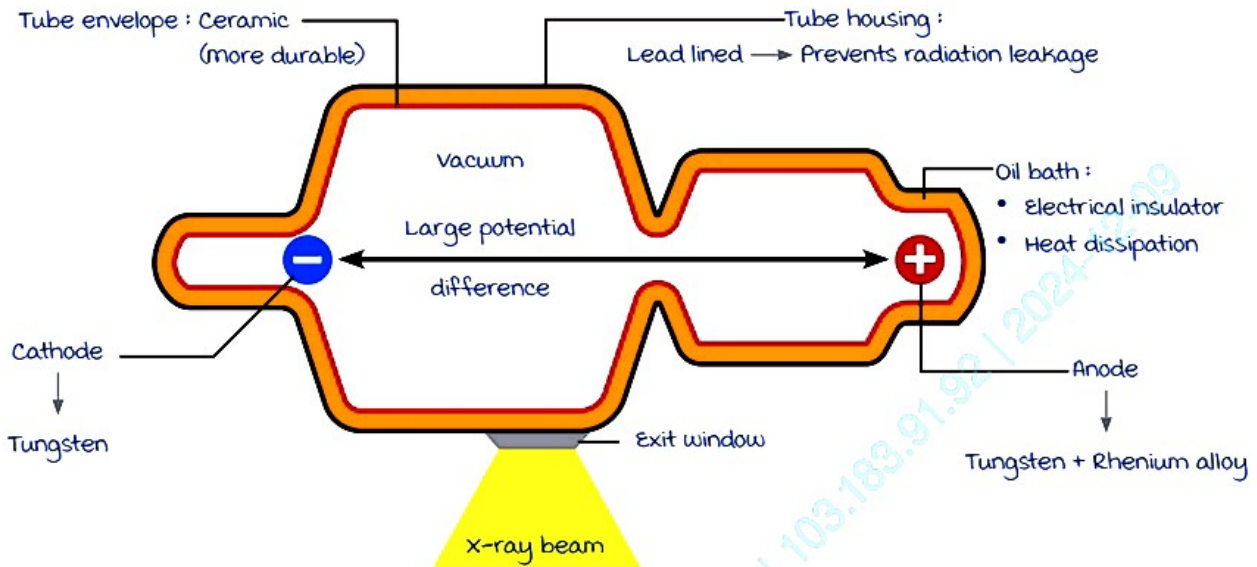
International guidelines : By International Commission on Radiological Protection (ICRP) & International Commission on Radiation units (ICRU).

		Public exposure	Occupational exposure
effective dose		1 mSv/year	<ul style="list-style-type: none"> 20 mSv/year or 50 mSv in any 1 yr. OR < 100 mSv in 5 years.
Annual equivalent dose	Lens of eye	15 mSv	150 mSv
	Skin	50 mSv	500 mSv
Pregnant females		<1 mSv	

Indian guidelines : By Atomic Energy Regulatory Board (AERB). 

Same as international, except occupational exposure → effective dose of 30 mSv in any 1 year provided <100 mSv in 5 years.

Structure of X-ray Tube :



X-rays are produced when **electron beam** strikes **anode**.

mechanisms of X-Ray Production :

	Continuous spectrum	Characteristic spectrum
mechanism	Acceleration/deceleration of e^-	Shifting of e^- from outer to inner shell
Frequency of use	70-80% (m/c)	20-30%
Additional points	AKA Bremsstrahlung/white/braking radiation.	used in mammography.

X-ray Interactions :

Occurs inside patient's body.

	Compton effect (m/c)	Photoelectric effect
AKA	mid energy phenomenon	Low energy phenomenon
Interaction b/w	x-ray photon & outer shell e^-	x-ray photon & inner shell e^-
Outcome :	\uparrow Deviation of x-ray	No deviation
• Scatter radiation	more (\uparrow Distortion)	Absent
• Image resolution	Low	Better
• Desired level	\downarrow effect	\uparrow effect

Factors Determining Exposure of X-ray Image :

----- Active space -----

Adjustments done on X-ray console based on image requirement.

	Tube potential (TP)	Tube current (TC)
unit	Kilovoltage Peak (kVp)	milli-Ampere second (mAs)
Determines	<ul style="list-style-type: none"> \propto Penetration $\propto \frac{1}{\text{Image contrast}}$ 	\propto Image contrast

Thermoluminescent Dosimeter (TLD) Badge :

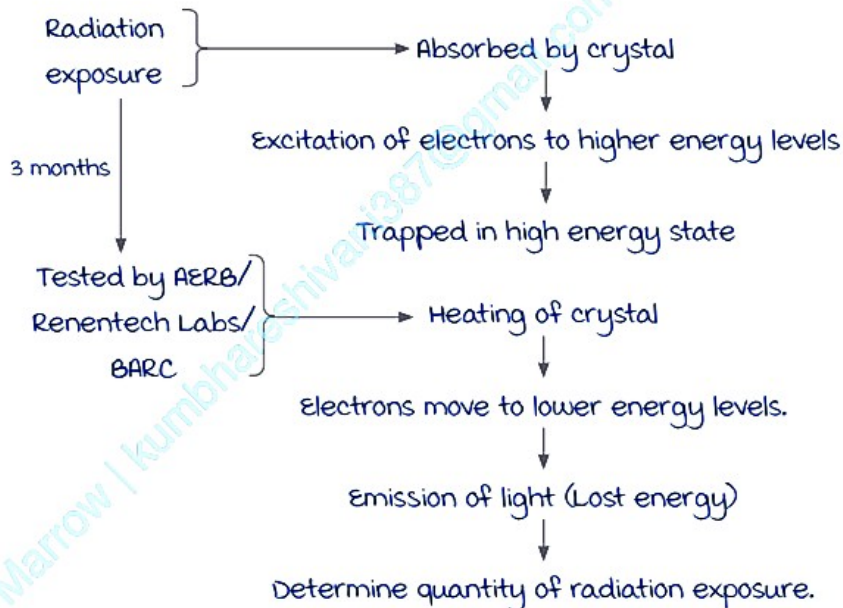
use : monitors occupational radiation exposure.

Range : 0.01 mGy - 10Gy.

Composition : Phosphor crystals

- Lithium Fluoride (LiF).
- Lithium Borate.
- Beryllium Oxide (BeO).

mechanism of action :



TLD badge

Computed Tomography (CT)

00:47:49

CT Room :

Equipment : CT equipment room + CT console.

CT equipment room :

- Lined by **lead** → Prevent leakage of radiation.
- Thickness :
 - Lead : 1/16th inch (OR)
 - Concrete : 4-6 inches.

----- Active space -----

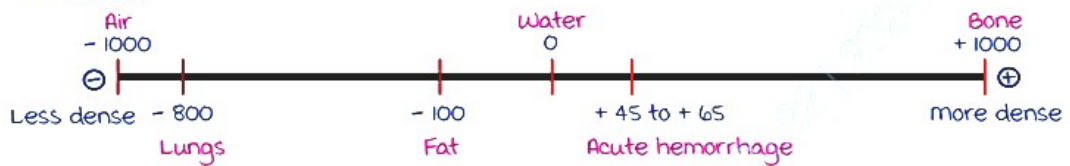
Hounsfield unit/CT value scale :

- Numerical value of tissues on CT scan.

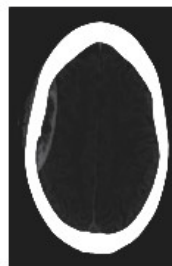
$$HU_x = 1000 \times \frac{\mu_x - \mu_{\text{water}}}{\mu_{\text{water}}}$$

HU_x : Hounsfield unit of tissue
 μ : Linear attenuation co-efficient

- It is determined by **electron density**.
- Values :



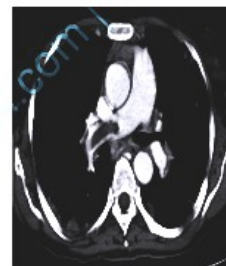
Windowing : Adjusting image contrast using range of Hounsfield units appreciable to human eye.



Brain window
(0 to 100 HU)



Bone window
(900 to 1000 HU)



mediastinal window
(0 to 100 HU)



Lung window
(-900 to -700 HU)

CT Polytrauma/whole body CT/Pan-scan :

Standard protocol :

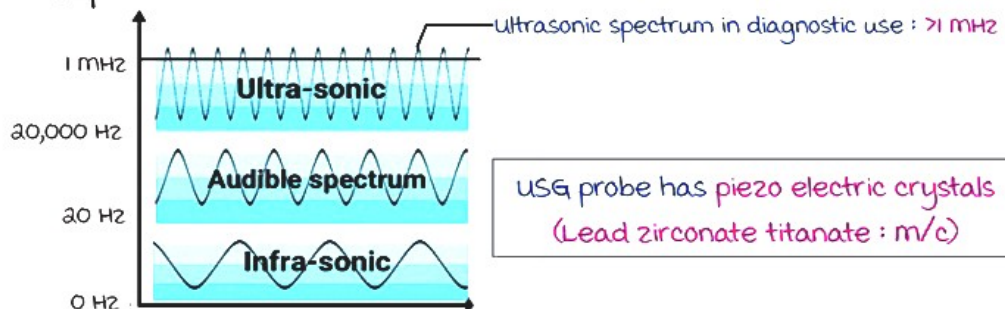
- Non contrast CT of the **head + cervical spine**.
- Contrast enhanced CT of the **chest + abdomen + pelvis**.

Note : **Limb CT is not included**.

Ultrasonography

00:57:45

Sound Spectrum :



USG Basic Principle :

Reverse piezoelectric effect :

Electric current passing through the crystal produces vibrations in the tissues.

Piezoelectric effect :

vibrations reflected by tissues are converted back into electric impulses.

----- Active space -----

Magnetic Resonance Imaging (MRI)

01:02:40

Principle :

Based on gyromagnetic property of **hydrogen** nucleus → magnetic field.

Contraindications :

Absolute C/I : Interference/effect of magnetic field → Fatal consequences.

1. **metallic foreign body in eye.**
2. Cardiac pacemaker.
3. Cochlear implants.
4. Ferromagnetic hemostatic CNS aneurysm clips.

Relative C/I :

1. Claustrophobia : Sedate the pt. → Then do MRI
2. Insulin pumps.
3. Nerve stimulators.
4. Prosthetic heart valves.
5. 1st trimester of pregnancy.

Faraday's Cage :

Shielding : Prevents action/interference of MRI magnet on outside devices & vice-versa.

Wooden panels wrapped with copper wires



Faraday's cage

Contrast Media :

01:08:54

Imaging modality	Contrast media
x-ray/CT	Barium, Iodine
USG	Stabilized microbubbles (Expired by lungs → Safe in renal failure)
MRI	Gadolinium