# Planning and Organization of Radiology Department

**Radiology** is the branch of science which concerned with the use of radiation for viewing internal structures and functions to diagnose the diseases

**Radiology** is a medical specialty using medical imaging technologies to diagnose and treat patients

**Medical Radiology** and **Imaging Technology** is the health profession concerned with the direct administration of radiations, primarily x-rays, in disease diagnosis and injury assessment and treatment

**Scope** of a modern radiology is not only limited to **imaging studies** but also has a **therapeutic role** in the form of minimal invasive interventional radiology setup

# HISTORY OF RADIOLOGY

- Wilhelm Roentgen discovered X-rays in 1895.
- First X-ray was of his wife's hand which was on a piece of glass.
- X-rays were used for entertainment: checked for foot sizes, used at circuses, bone portraits, home models were even sold for parties.
- In the beginning, there were a lot of safety issues due to the unknown hazards of radiation exposure.

# Growth of Radiology

- Several accidental coincidences lead to the discovery of X-rays by Wilhelm Conrad Roentgen in the year 1895.
- Since then a long-long way has been covered in this field.
- No medical science has seen such raid change as Radiology, especially in the past few decades.
- At the same time, No medical science has met the challenge as Radiology to move forward in an era of rapid change in medical technology.

# Few responsibilities of technologist are;

- Patient care: dealing with patients in various states of health
- Position patient correctly so desired anatomy is visualized
- Radiation protection: time, distance, shielding
- Live X-ray exams: Fluoroscopy (X-ray video)
- Responsible for cleaning and stocking all X-ray exam rooms
- Obtaining and documenting patient history

# Planning and Organization

- With rapid change in investigation technology, there is a continuous changing demand in the field of radio diagnosis and imaging service.

- Resulting in an advanced, and detailed systematic planning and organizing

- Having a foresight into future developments and requirements.

# Objective of the Radiology Department

a) To provide comprehensive high quality imaging service

b) Establishment and confirmation of clinical diagnosis

c) Providing high quality therapeutic radiology

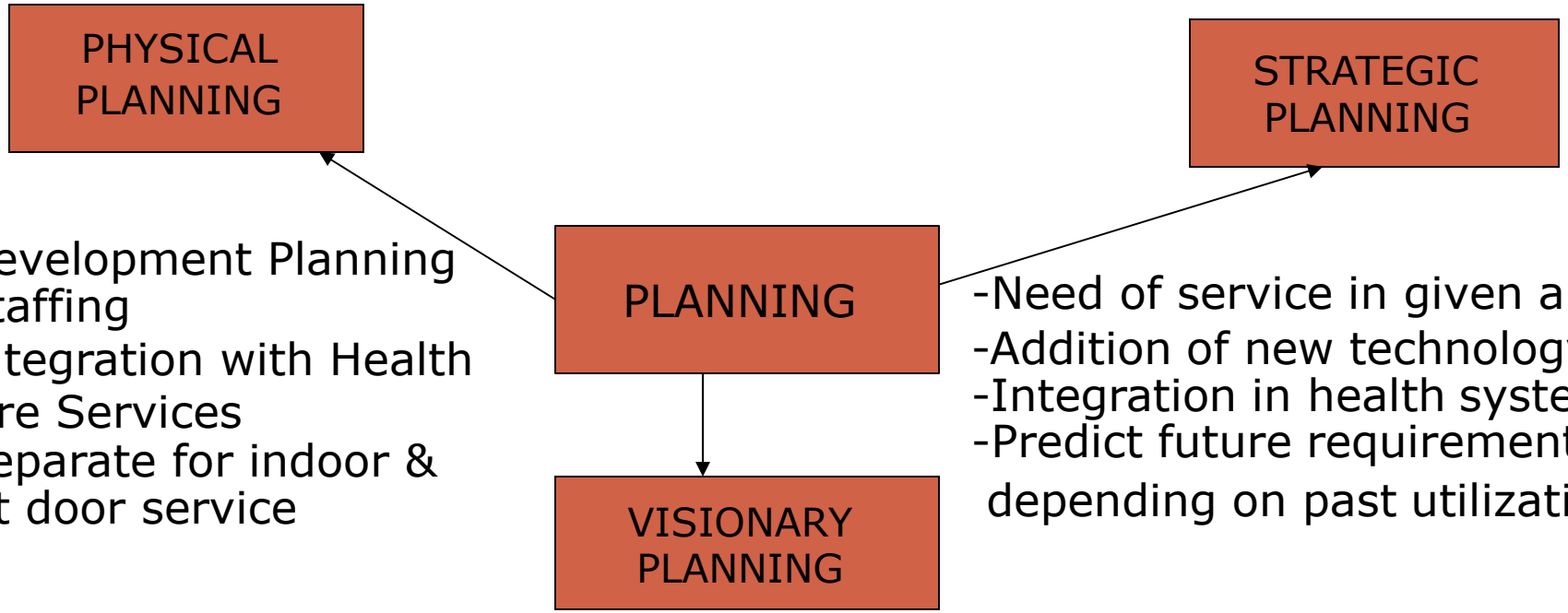
d) Commitment to training and research

# 2 types of radiology centres

- Radiology departments in a **hospital setting**
- **Dedicated** radiology centres, that works on referrals

- **Difference** – patient referral

# Planning Considerations

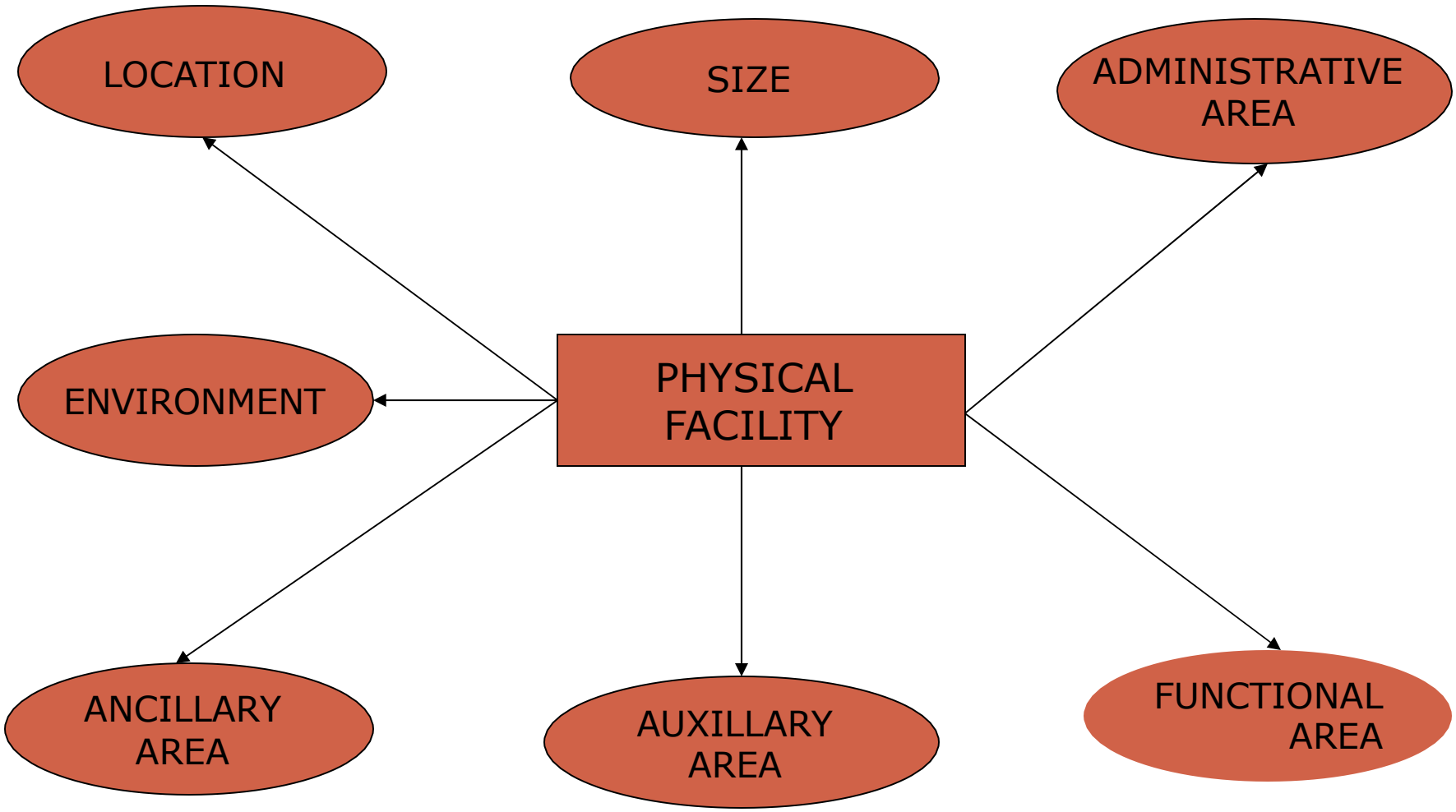



-Development Planning
-Staffing
-Integration with Health Care Services
-Separate for indoor & out door service

-Need of service in given area
-Addition of new technology
-Integration in health system
-Predict future requirement depending on past utilization

-Planned infrastructure
-Anticipate pattern of change
-Get most out of available space
-Plan imaging environment
-Incorporate information system and networking capability

# Planning of Physical Facilities



## Location

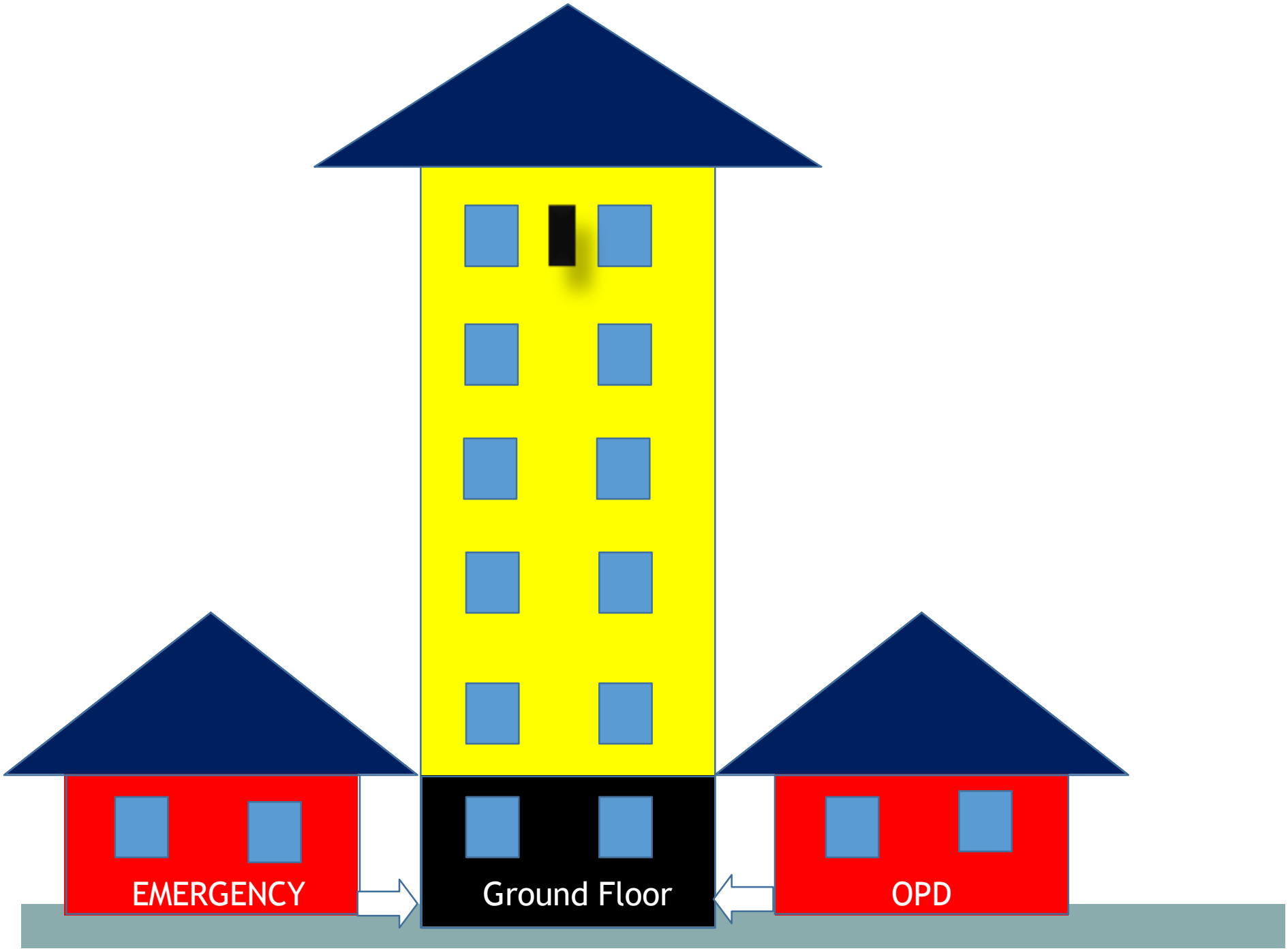
-Preferably in ground floor
-Away from main traffic
-Easy access to OPD, emergency and indoor

## Size

-Depends on the hospital size
-Types of services provided
-No. of machines to be installed

## Administrative Area

-Patient waiting area, reception
-Registration Counter
-Office of HOD
-Office of technologist
-Office of other technical staff & Nursing
-Store for supplies
-Circulation space for movement of patients, staff, trolley and stretcher

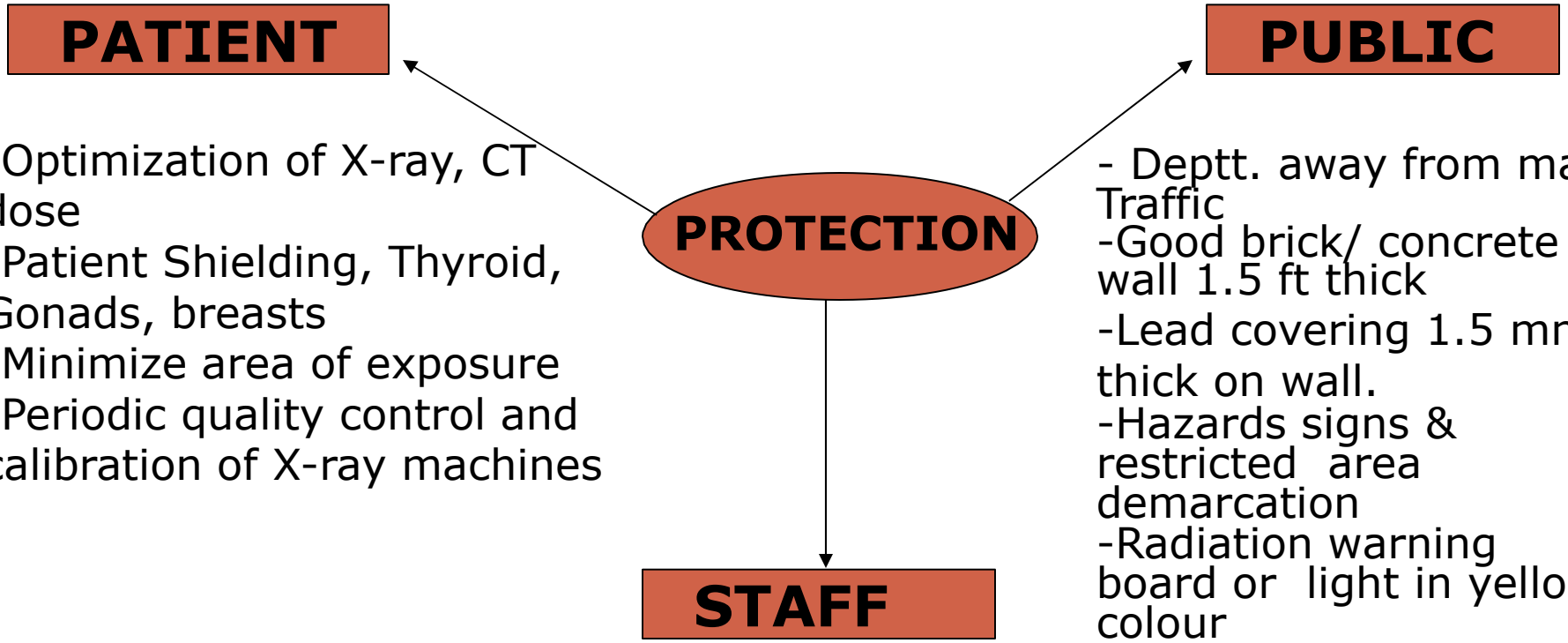

EMERGENCY
Ground Floor
OPD

# Safety Consideration

For Radiation Protection ALARA concept is used (As Low As Reasonably Achievable )

-Plan Radio protection prior to construction.
-Promote awareness among doctors and staff.
-Awareness among patient and public,
-Demarcation of restricted areas to prevent radiation hazards like:-
i)Acute and Chronic Skin
ii)Somatic and Genetic
iii)Deterministic (Not depending on dose)
iv)Stochastic (Depending on dose of exposure)

# Plan Radiation Protection




-Optimization of X-ray, CT dose
-Patient Shielding, Thyroid, Gonads, breasts
-Minimize area of exposure
-Periodic quality control and calibration of X-ray machines

- Deptt. away from main Traffic
-Good brick/ concrete wall 1.5 ft thick
-Lead covering 1.5 mm thick on wall.
-Hazards signs & restricted area demarcation
-Radiation warning board or light in yellow colour

-Distance between control panel and unit (minimum 3 mts.)
-Radio protection aprons, lead gloves and mask.
-Use of radiation monitoring devices TLD badges(Thermoluminescent Dosimeter) / films

# Protective Measures For Radiation Emmision

Radiation is an energy emitted in the form of a beam of ‘X- rays which are risk involved to life, health or property when exposures is high.

Radiation danger in X-Ray room is sweltered/ scattered radiation.

Radiation decreases in proportion to square of distance. Distance is important protection in X-Ray room.

Metal cones and adjustable shutters are used to prevent sweltered radiation.

# X-ray Rooms :

- Must be large enough for the equipment
- Should have at least one patient change cubicle accessible from outside the room
- Must locate the operator's console where the primary beam will NEVER be directed towards it, but where the patient can be easily observed
- Must be able to accommodate large beds/trolleys, and any anaesthetic equipment likely to be used
- Must locate holes in floors for cables away from radiation beams, or be shielded
- Must have radiation warning signs on all doors
- Should have radiation warning lights outside for fluoroscopy, angiography and CT

# 1. Dark Room

Used to process photographic film (black/white), to make prints & to carry out associated tasks

**Said to be the lifeline of a radiology department**

i. Minimal floor area of 100 sq ft
ii. Ceiling 11 ft high
iii. Cassette loading area
iv. Cassette unloading area
v. Developing and film processing area
vi. Water tap
vii. Safe light (0 watt, 3ft distance, color-red/amber/green), Ventillation, exhaust fan
viii. Double door/self closing doors.
ix. Pass boxes (light & x-ray proof)
x. Walls lined with 1.6 mm lead equivalent.
xi. Walls and roof painted black
xii. Floor-chemical/stain resistant.
xiii. Equipments (benches, racks, hangers, tanks, immersion heaters)

**2. Drying room**
**3. Record room**
**4. Patient preparation room**
**5. Reporting room**

**(Can be modified as per dry film processing unit or digital imaging**

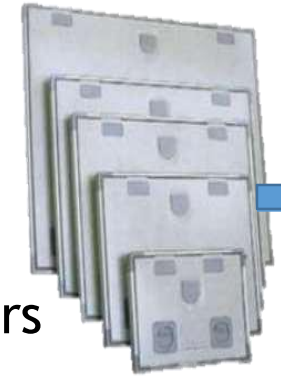
# DARK ROOM

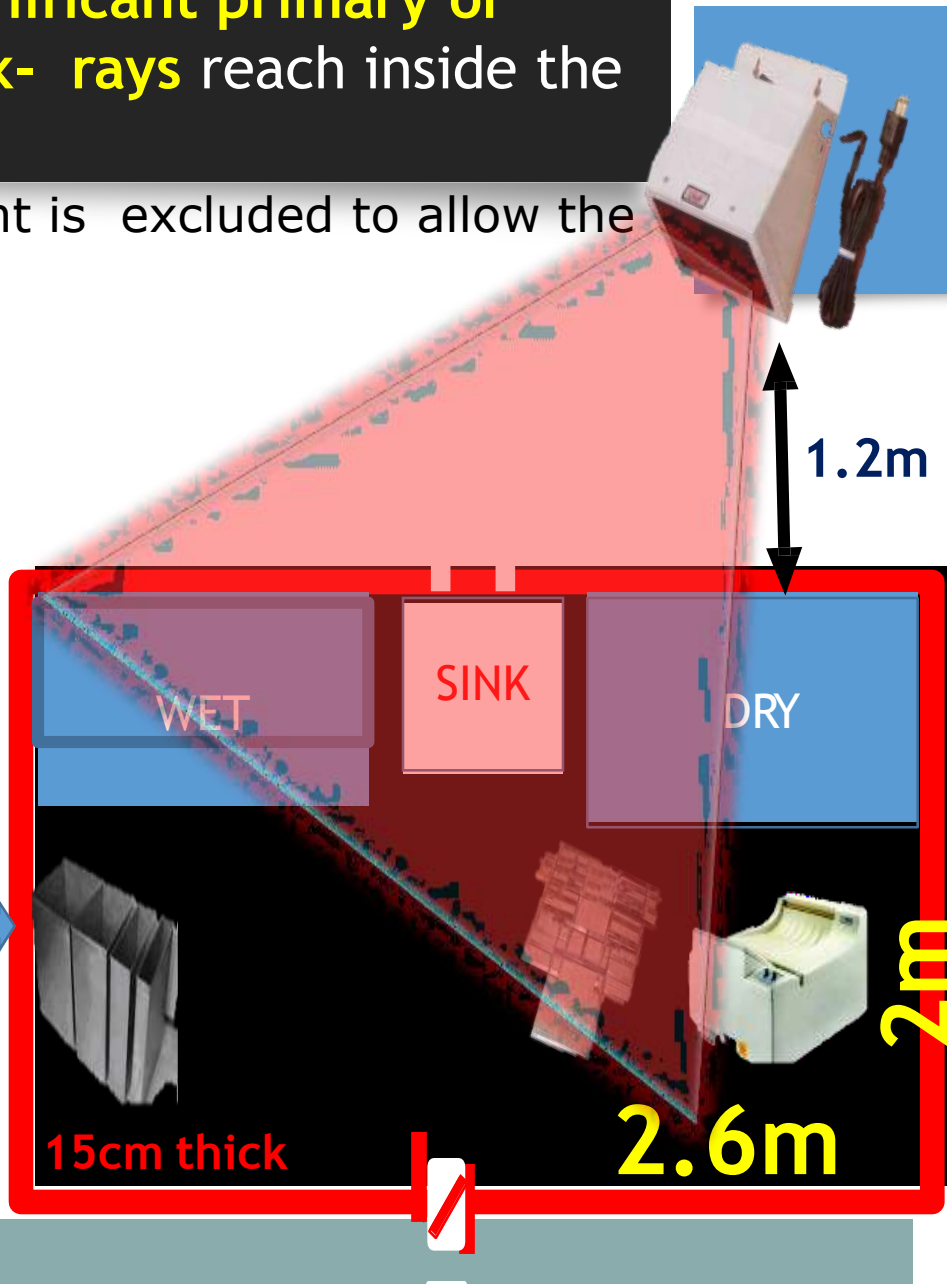
The dark room shall be located such that **no significant primary or secondary x- rays** reach inside the dark room.

- Made completely dark and normal light is excluded to allow the processing of X-ray films
- **Door systems –**
  - single/double door,
  - maze type,
  - revolving type

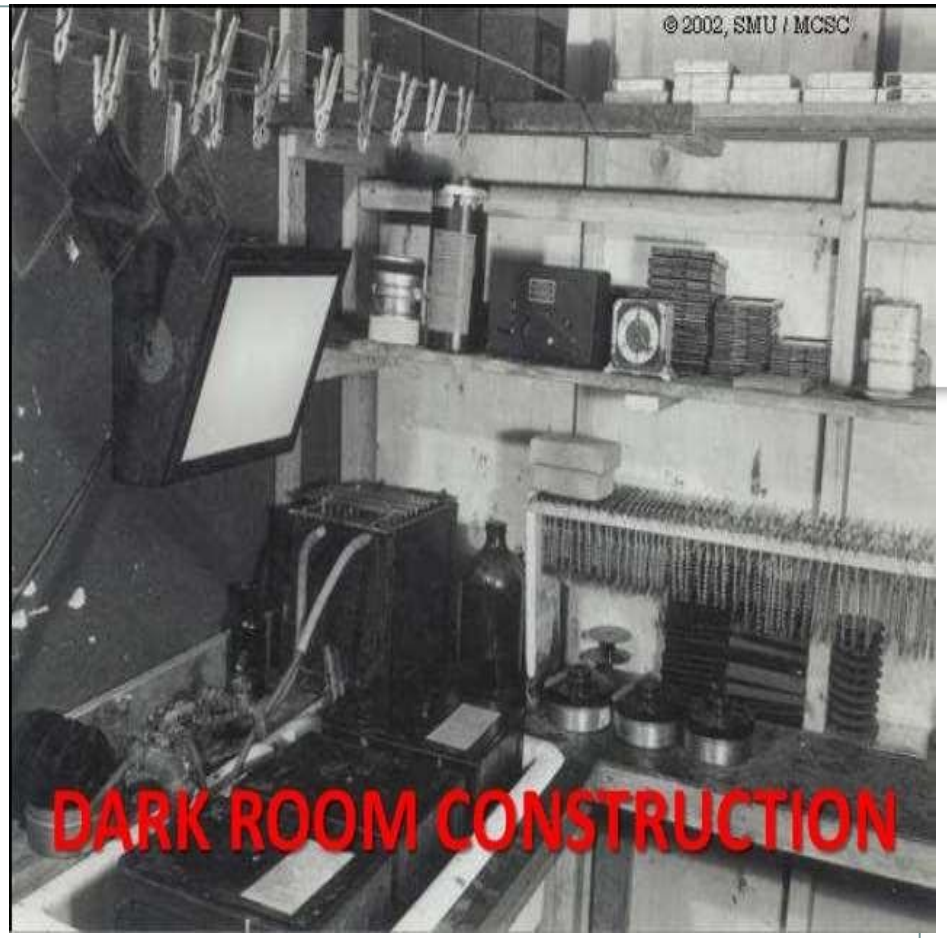
## Equipments used -

- Processing tanks,
- cassettes,
- safelight,
- hangers and
- automatic processors





- Floor area not less than 2.6x2m
- Room made completely lightproof
- Should not be damp(unwanted moisture) or subjected to extreme of temperature
- Water and electrical outlets provided
- Sufficient space to accommodate a **dry bench (3x2),** a **wet bench** and **a sink.**
- Should be near the x-ray examination area
- **Walls** of solid concrete **(15cm thick)**
- **Lead box** inside to store boxes of unexposed films



## Processing Tanks

- Developer,
- **rinsing,**
- fixer and
- washing
- Made of **stainless steel** to avoid erosion
- 1 to 10 gallon

## Cassettes

- Used to hold the X- ray film and **intensifying screens**
- Excludes all **light** from entering the cassette

## Safelight

- Lamp used which doesn't affect the X-ray film processing
- Gives sufficient light to facilitate work
- Must be atleast **1.2m above the work area**

# Hangers

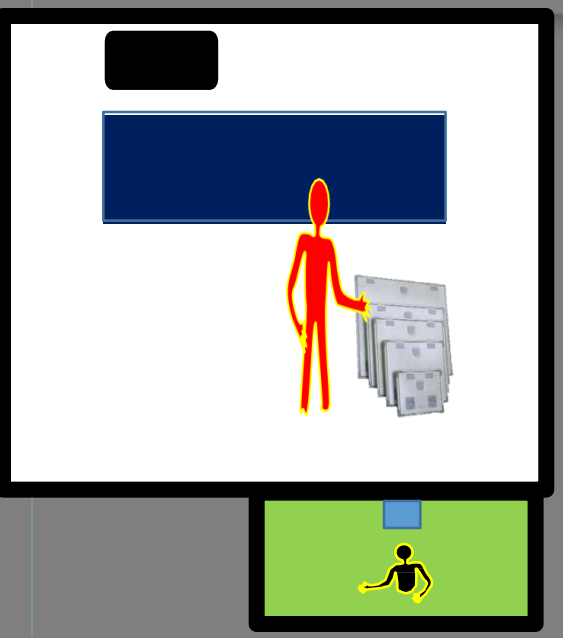
- Instrument or device for holding radiographic film during processing procedure
- Made of stainless steel
- Clip, channel and spring types

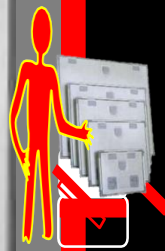
# Automatic processor

- Fast efficient method for processing film
  Developer,
  fixer,
  washing,
  Dryer
- Contains rollers instead of rinsing

# PASS BOX

- **Cassette Transfer Cabinet** – allows cassettes to be transferred to and from the darkroom without the worry of light or radiation entering.



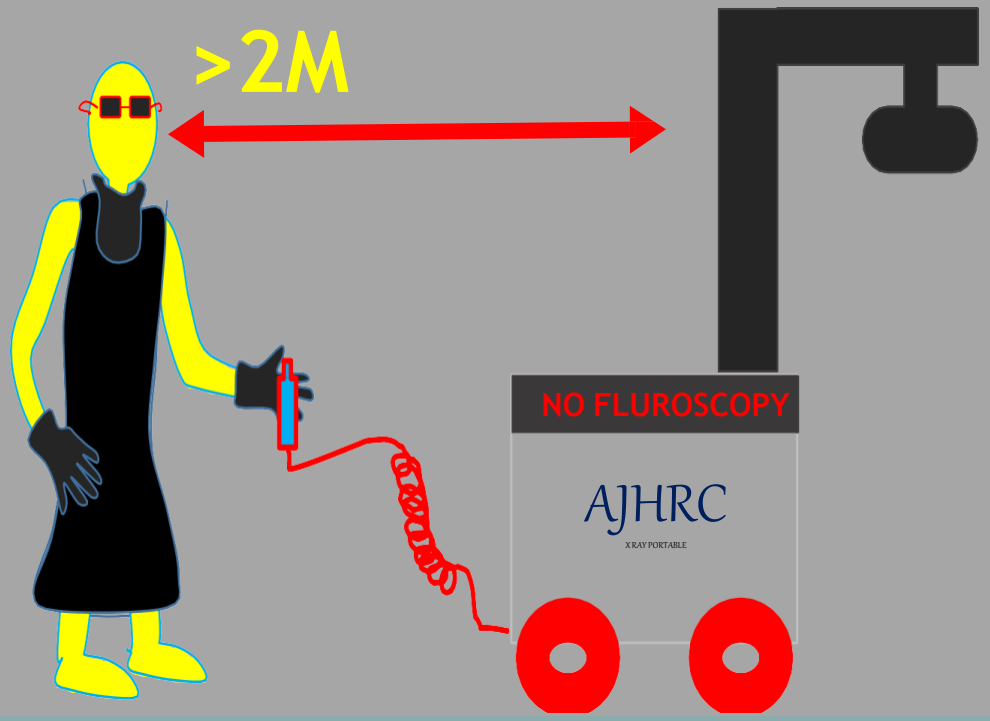





**Extra heavy duty constructions**
with
1. double light and radiation traps,
2. welded doors (2)

## Mobile Equipment

- Movement of mobile x-ray equipment shall be **restricted** within the **institution** for which it is registered.
- The distance between operator and x-ray equipment shall not be less than **2 m** during exposure.
- Operator shall always use radiation protection devices such as protective apron while operating the x-ray equipment.
- **Fluoroscopy shall not be carried out** with mobile equipment.



## ❑ Safety Personnel

- Every X-ray department shall have a **Radiological Safety Officer (RSO)** having qualifications as prescribed and approved by the competent authority from time to time.

- The RSO has responsibility of ensuring compliance with appropriate **radiation safety/regulatory requirements** applicable to his/her X-ray installation

## Radiologist

- All installations having x-ray unit with fluoroscopy facility, and all establishments performing special procedures, shall have the services of a qualified radiologist or related medical practitioner, with adequate knowledge of **radiation protection** for **interpretation** and **reporting.**

## X-ray Technologist

- All x-ray installations shall have a radiologist/related medical practitioner or a qualified x- ray technologist, with adequate knowledge of **radiation protection**, to operate the x-ray unit.

## Service Engineer

- All **manufacturers, suppliers** and **service agencies** of diagnostic x-ray equipment shall have qualified service engineers for
  - **installation,**
  - **servicing and**
  - **maintenance of the equipment.**

# X-RAY ROOM CONSTRUCTION

1. Shielding of wall of X-Ray room with lead equivalent of 1 mm.
2. Concrete Wall: 8-12 cm thick
3. Brick Wall: 12 to 15 cm thick
4. Two important areas must be looked into
e) Wall behind chest stand
f) Wall of dark room
5. Lead glass window between operator and X-ray tube
6. Distance between X-ray table and control table should be as far as possible between 10 ft to 15ft.

# PRINCIPLE OF MACHINE INSTALLATION

-X- Ray tube should never point towards the control unit.

-It should not point towards dark room.

-It should not point towards, door, window or towards corridor wall.

-Lead lying up to 4 ½ of wall of patient waiting space.

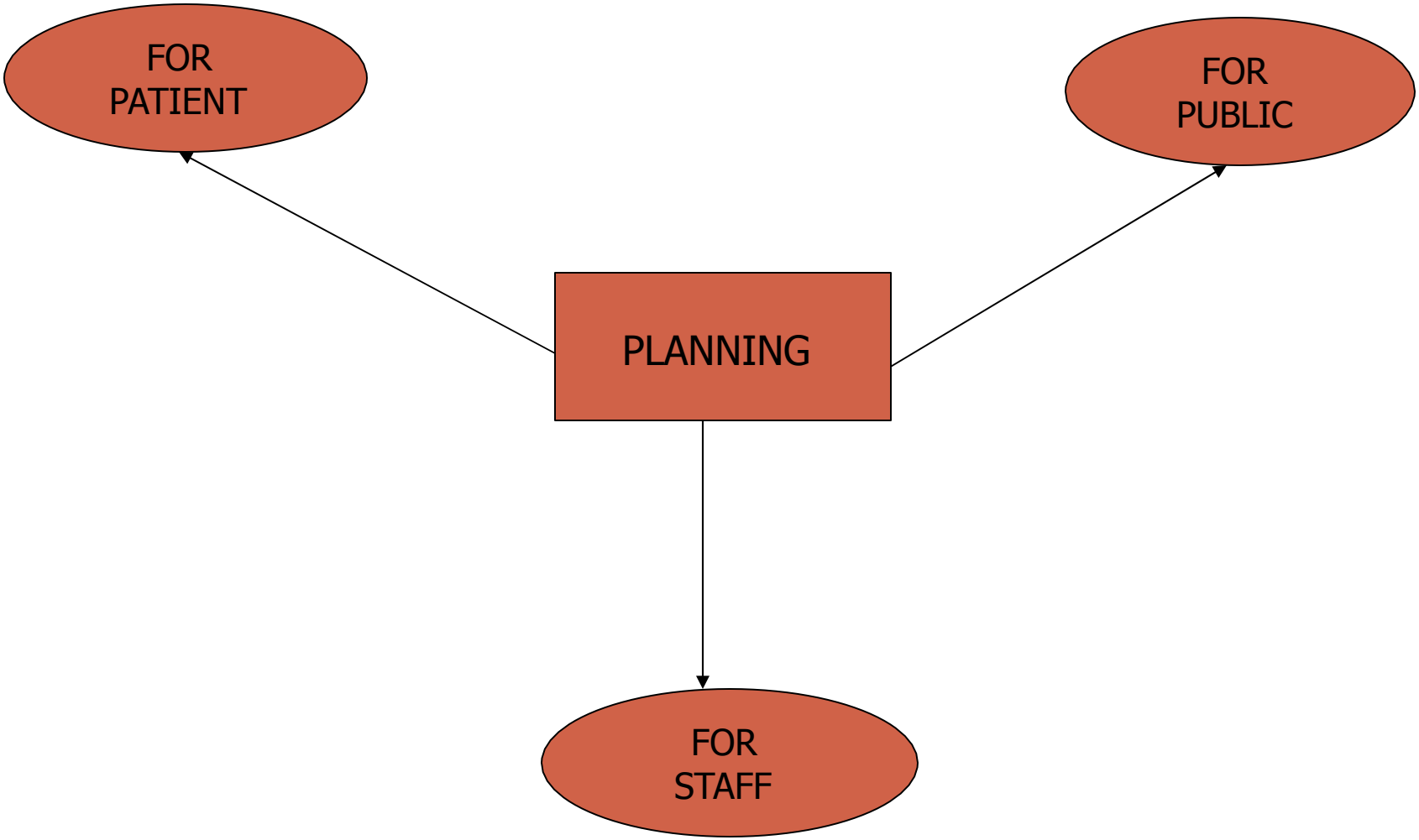
# MRI AND C.T. ROOM

-Patient must not have any metals on body even dental fixtures, pace makers.

-No metal fixtures in the MRI Room. Non magnetic tables and trolley.

-Away from public passage, screen between control room and machine.

# NUCLEAR IMAGING AREA



# HOT AREA

-This area include receiving, diluting, holding, counting and issuing of radio isotopes.

-Floor and work surface should be non- porus

-All work to be done in glove box or under hood box

-Radio active level needs to be monitored

-Inter locking lead brick

-Lead gloves to be used while handling

-Separate toilet for radio active used patients

## DIAGNOSTIC AREA

-All walls and doors to be painted with good quality washable paints.
-A portable contamination monitor with aural alarms to be used.
-Minimum furniture to be kept
-Adequate number of lead containers
-Ventilation fume hoods to be provided
-Drainage pipe should be directly connected to sewerage

## SUPPORTING AREA

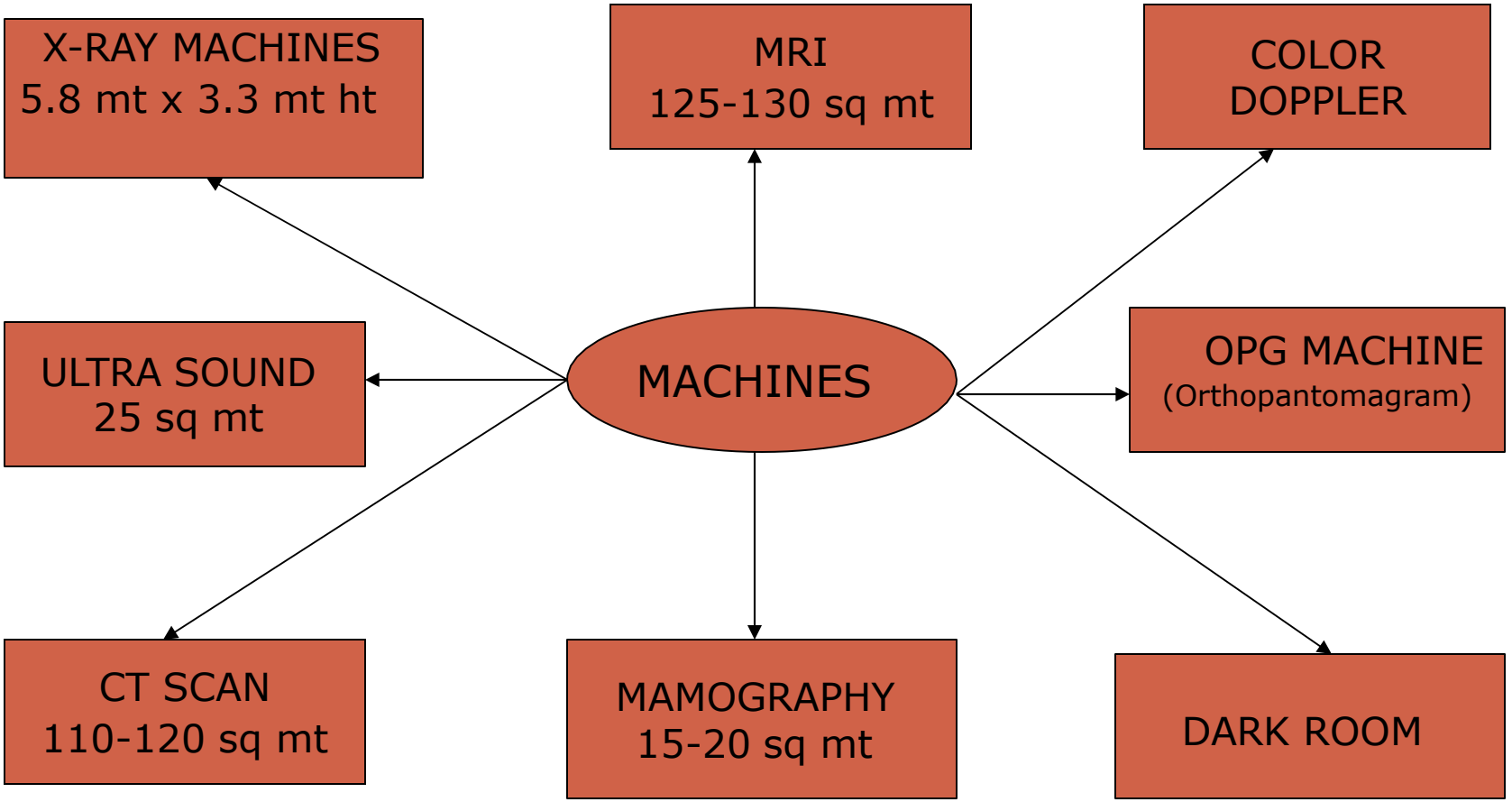
-Waiting area away from circulatory corridor
-Toilets separate for radio active and non radio active patients.

# ELECTRICAL SUPPLY

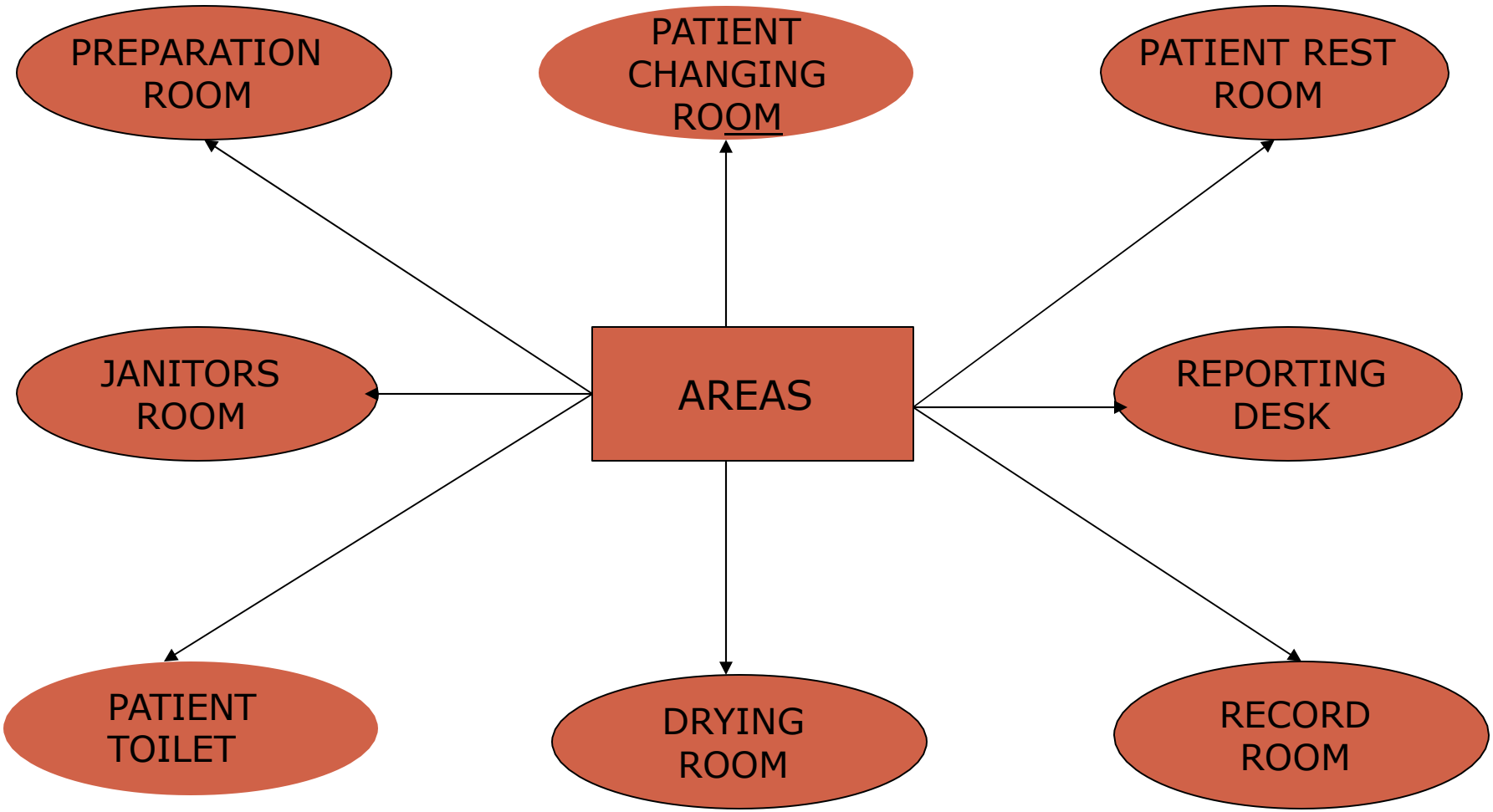
- **3Phase electric supply**
- **Separate connections from main**
- **Generators/backup facilities-CPU  WATER SUPPLY-continuous with heating equipments**

# FUNCTIONAL AREA

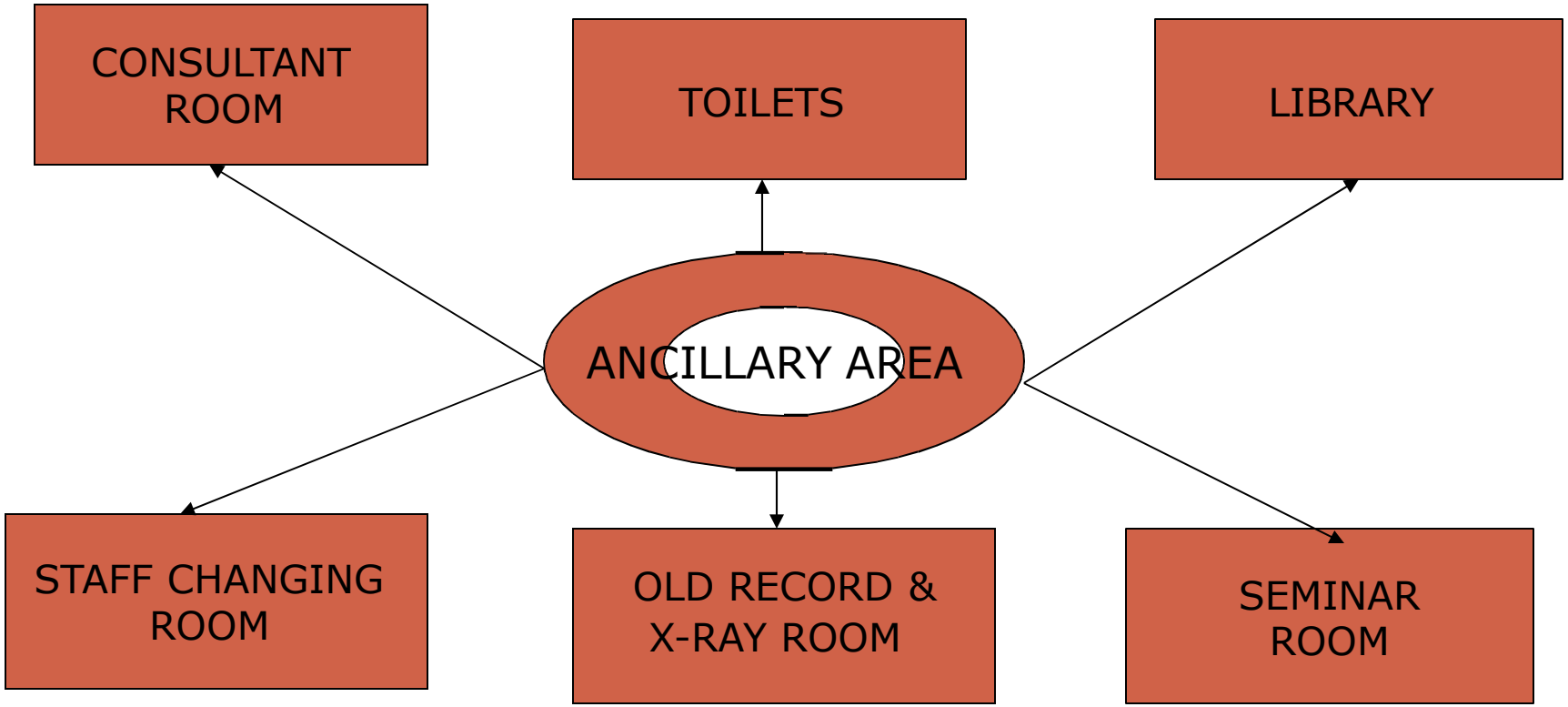
The functional area have installation of all machines like



# AUXILLARY AREA



# ANCILLARY AREA




## ENVIRONMENT

-There should be public address system
-Back up electricity supply
-Proper ventilation and air change
-Air conditioning of machine rooms

# ORGANIZATION AND STAFFING

**Manpower planning** depends on

-Work load
-Type of Service
-Timing of Service

There should be a standard operating procedure for all category of staff for smooth organizational functioning.

## STAFFING

The category of staff required for Radiology Services are

**DOCTORS**

-Head of Radiology
-Sr. Consultant
-Jr. Consultant
-Sr. Resident
-Jr. Resident

**TECHNICAL STAFF**

-Tech. Supervisor/Technologist
-Imaging/Radiology Technologist
-Sr. Technician/Technician
-Jr. Radiographer
-Dark Room Assistant, -Dark Room Attendant

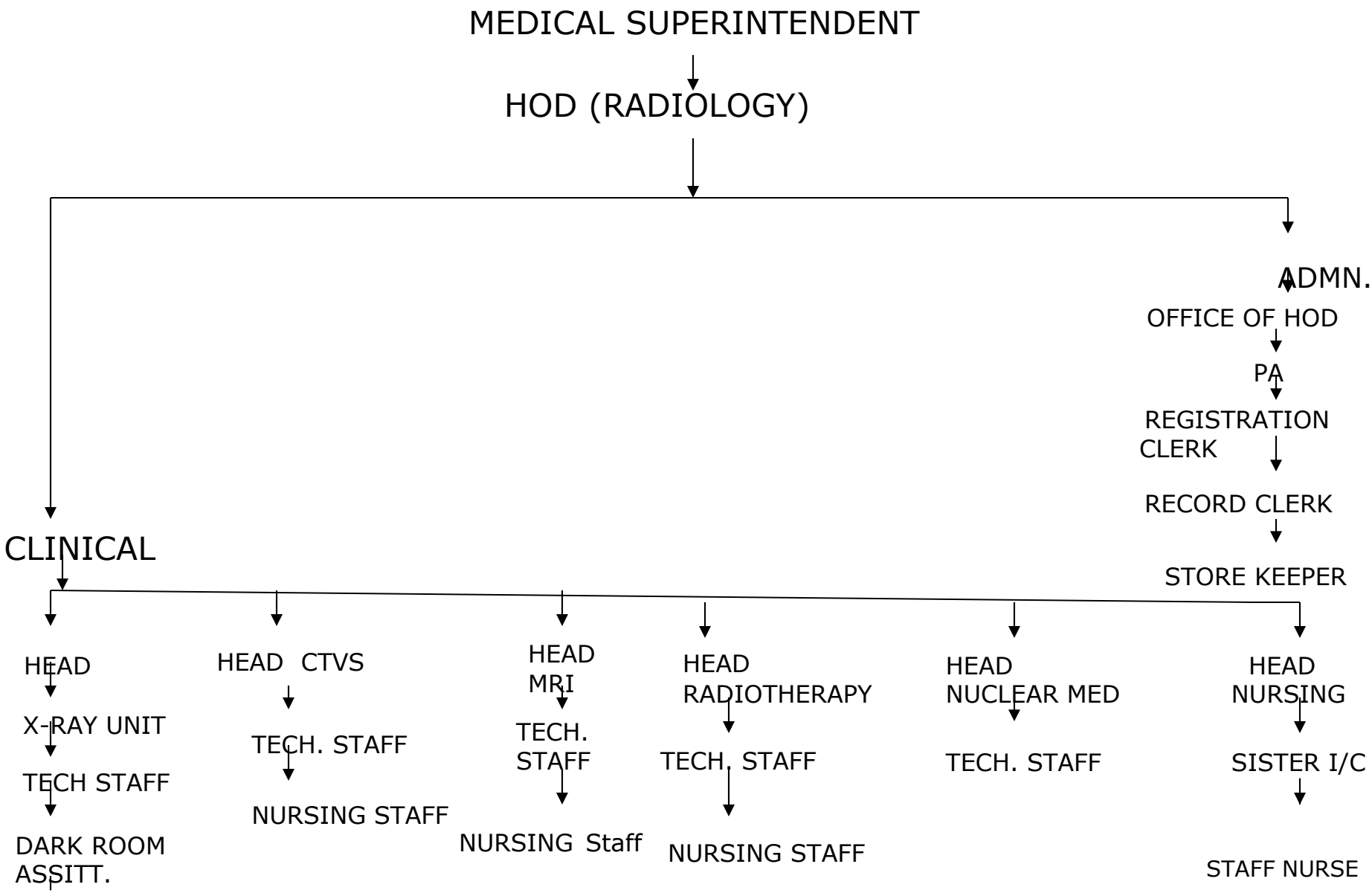
**NURSING**

-Sister In charge
-Staff Nurse

**OTHERS**

-Receptionist
-Clerks
-Store keeper
-Helper
-Nursing Attendant
-SafaiKaramchari

# ORGANOGRAM


MEDICAL SUPERINTENDENT
HOD (RADIOLOGY)
ADMN.
OFFICE OF HOD
PA
REGISTRATION CLERK
RECORD CLERK
STORE KEEPER
CLINICAL
HEAD
X-RAY UNIT
TECH STAFF
DARK ROOM ASSITT.
HEAD CTVS
TECH. STAFF
NURSING STAFF
HEAD MRI
TECH. STAFF
NURSING Staff
HEAD RADIOTHERAPY
TECH. STAFF
NURSING STAFF
HEAD NUCLEAR MED
TECH. STAFF
HEAD NURSING
SISTER I/C
STAFF NURSE

# EQUIPMENTS

Procurement → Installation → Maintenance

## PROCUREMENT

- All the equipments in the radiology department are technically very advance, sophisticated, sensitive and expensive but critical to patient care.

-Hence a detail specification be made prior to purchase and installation.

## INSTALLATION

-Before installation the structure of the building and environmental aspect to be looked into.

-The images are obtained either by transmission of rays or emission of dose of radio isotopes through the organ to be viewed, which reflects gamma rays picked by camera.

The various equipments in use are-

1. X- ray Machines
2. Ultrasound Machine
3. Doppler Machine
4. Computer assisted Tomography (CAT Scan)
5. Magnetic Resonance Imaging (MRI)
6. Position Emission Tomography (PET)
7. Mammography
8. Nuclear Imaging System

## ACCESSORIES

-Cassettes
-X-ray, CT, MRI films
-Dyes, Apron, Gloves
-Hangers, Clips etc

FLUROSCOPY

ULTRA SOUND

MAMO GRAPHY

CT_ SCAN

MRI

BONE DENSITO METER

# EQUIPMENTS MAINTENANCE

-Daily Maintenance - Tech. staff
-Preventive Maintenance - Supplier
-Comprehensive Maintenance
-Warranty and Guarantee
-Breakdown Maintenance
-Emergency Maintenance

Maintenance helps in:-

-Reduction in down time
-Safety of equipment and man
-Credible cost effective service
-Increase equipment life

# MANAGERIAL ISSUES (CONCEPT)

Application of managerial tools to ensure effective and efficient running or functioning of the department.

The concept of management is

| | | |
|---|---|---|
| P – | Planning | -Infrastructure, manpower, equipments |
| O – | Organizing | -Organ hierarchy, manpower, job responsibility |
| L - | Leading | -Standard Operating Procedure |
| I - | Integrating | - With other health care services |
| C - | Controlling | - Maintenance, staff discipline |
| E - | Evaluation | - Level of staff and patient satisfaction and change in policy required. |

# MANAGEMENT ISSUES

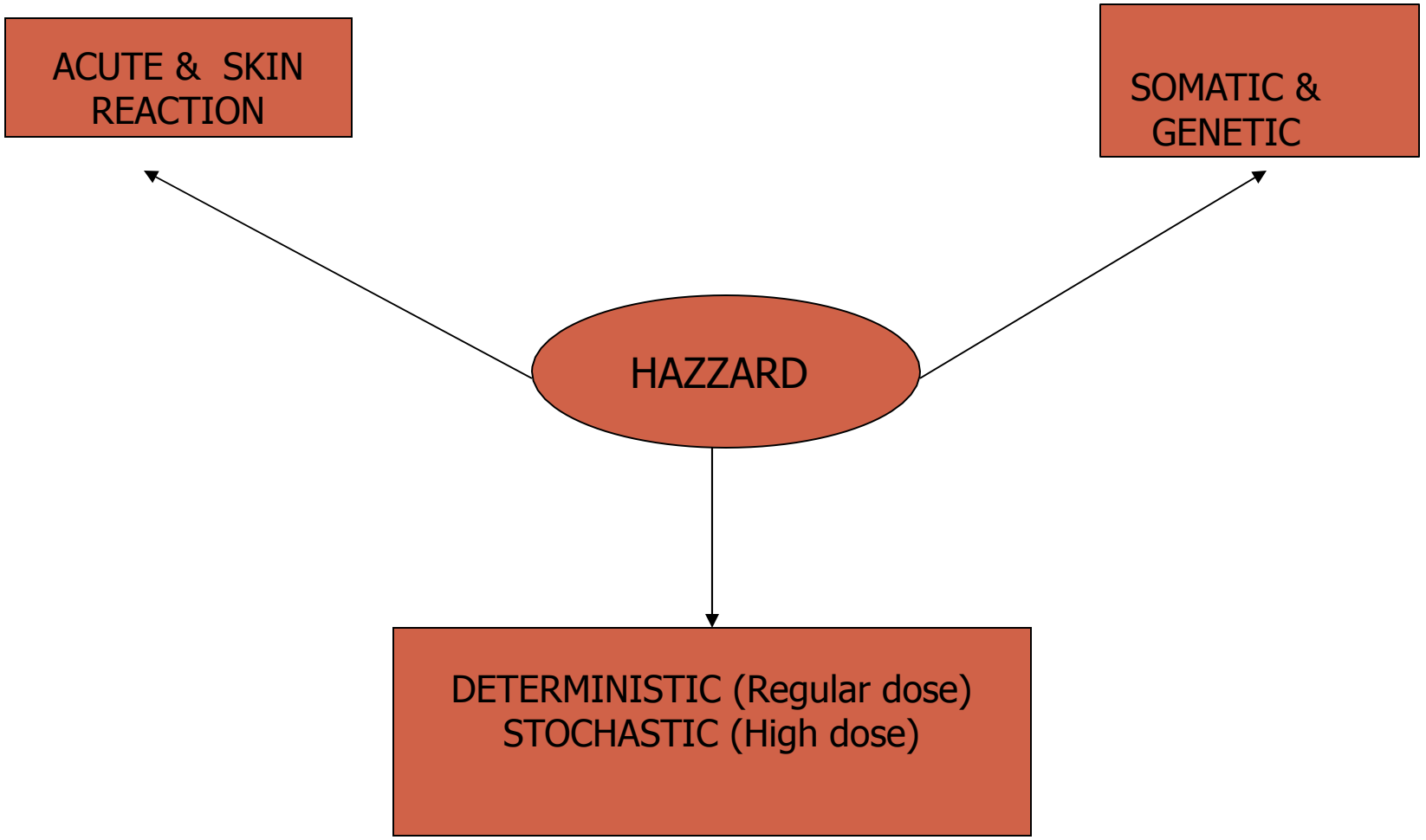

A. ISSUES AT INPUT
- Registration Timing
- Any restriction in number
- Prior appointment
- Reception and information

A. PROCESS
-Ensure trained manpower at machines
-Ensure functional status
-Correction of processing status
-Ensure part to be exposed
-Prevent mal practices
-Training of staff
-Follow safety protocol for patient and staff
-Developing solutions & cassettes

A. OUTPUT
- Quality of films
- Correct reporting, misinterpretation of report.
- Matching number in film and record
- Level of patient satisfaction

The ultimate aim of any service is to achieve its desired objective with full satisfaction of both consumer and provider.

# TYPES OF RADIATION HAZZARD



# RADIATION HAZARDS

1. **ACUTE EFFECT –**

Heavy dose in short period of time: Cerebral-convulsions, blurring, headache, Gastric-nausea, vomiting, abdominal pain

Blood- a plastic anemia, marrow depression

2. **CHRONIC EFFECT –**

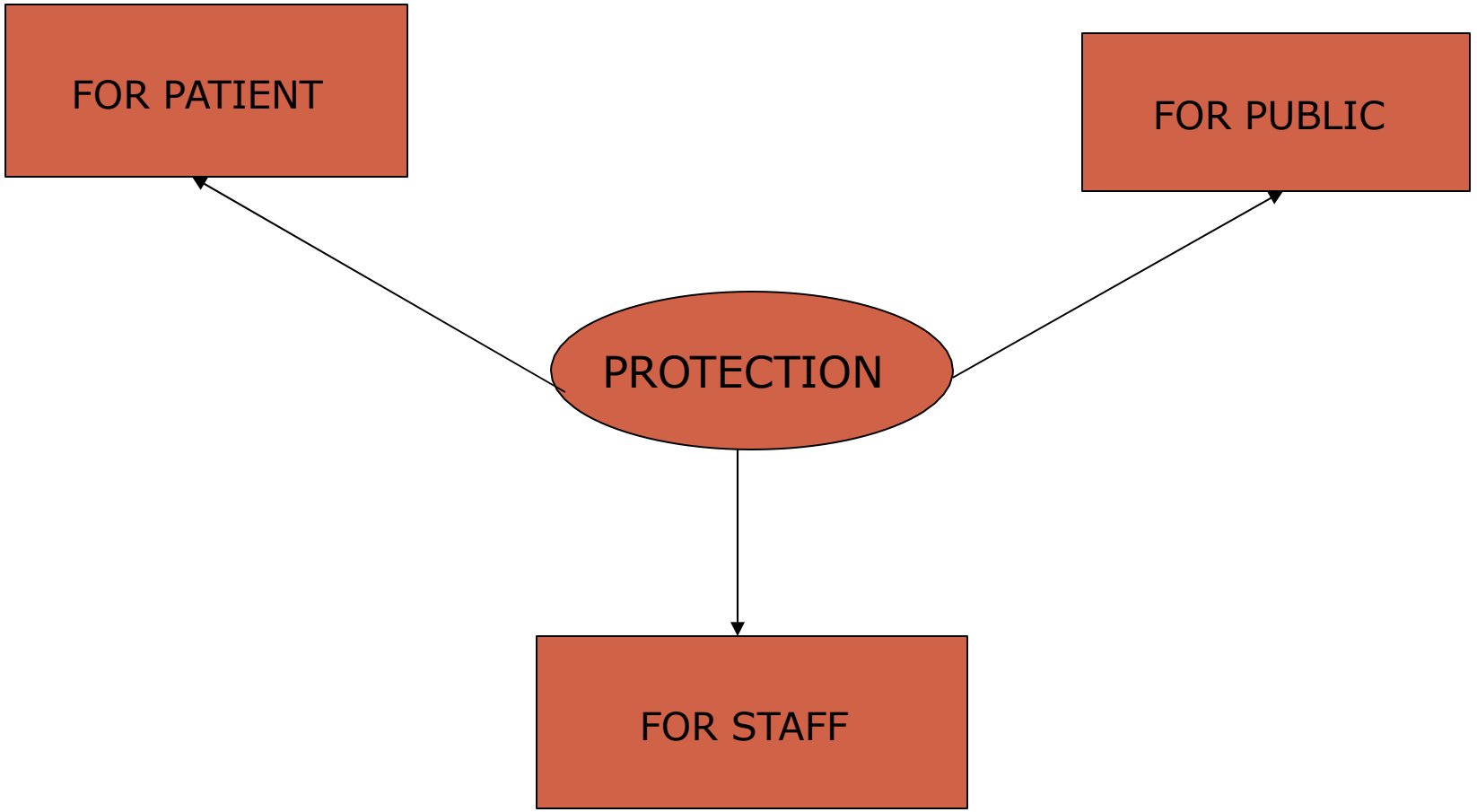
Due to continuous short exposure

Skin-loss of hair, burns, brittle nails, amputation fingers.

Blood-anemia, leukemia, leucopenia.

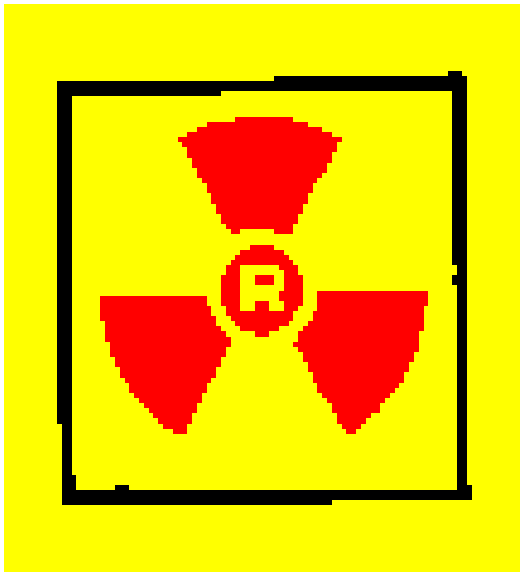
Eye-cataract, irido cyclitis. Others-Sterility, obesity, cancer.

# RADIO PROTECTION



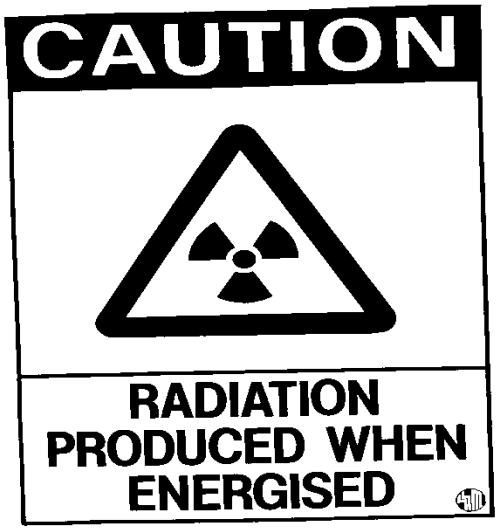
## FOR PATIENT:

- Optimization of X-Ray/ CT dose.
- Shielding of patient parts (thyroid, breast, gonads)
- Lead aprons, gloves and goggles to be used while handling and positioning
- Unnecessary exposure to be avoided
- Periodic quality control and calibration of machines



# FOR PUBLIC:

- Away from general traffic
- 4 ½ ft high  lead covering of 10 mm thick on  wall
- Warning board to be used (Restricted area)
- Yellow glow signs for radiation area

# FOR STAFF:

- Adequate distance (3 mt) between machine and control panel
- Lead apron lead equivalent of 0.5 mm thick
- Gloves and goggles while positioning the patient
- Film/ TLD badges to be used
- Monitoring of radiation exposure every month