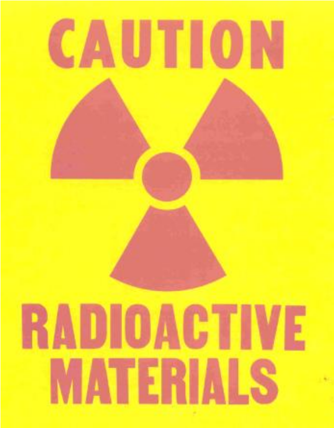
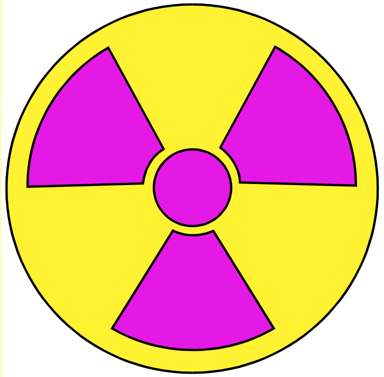
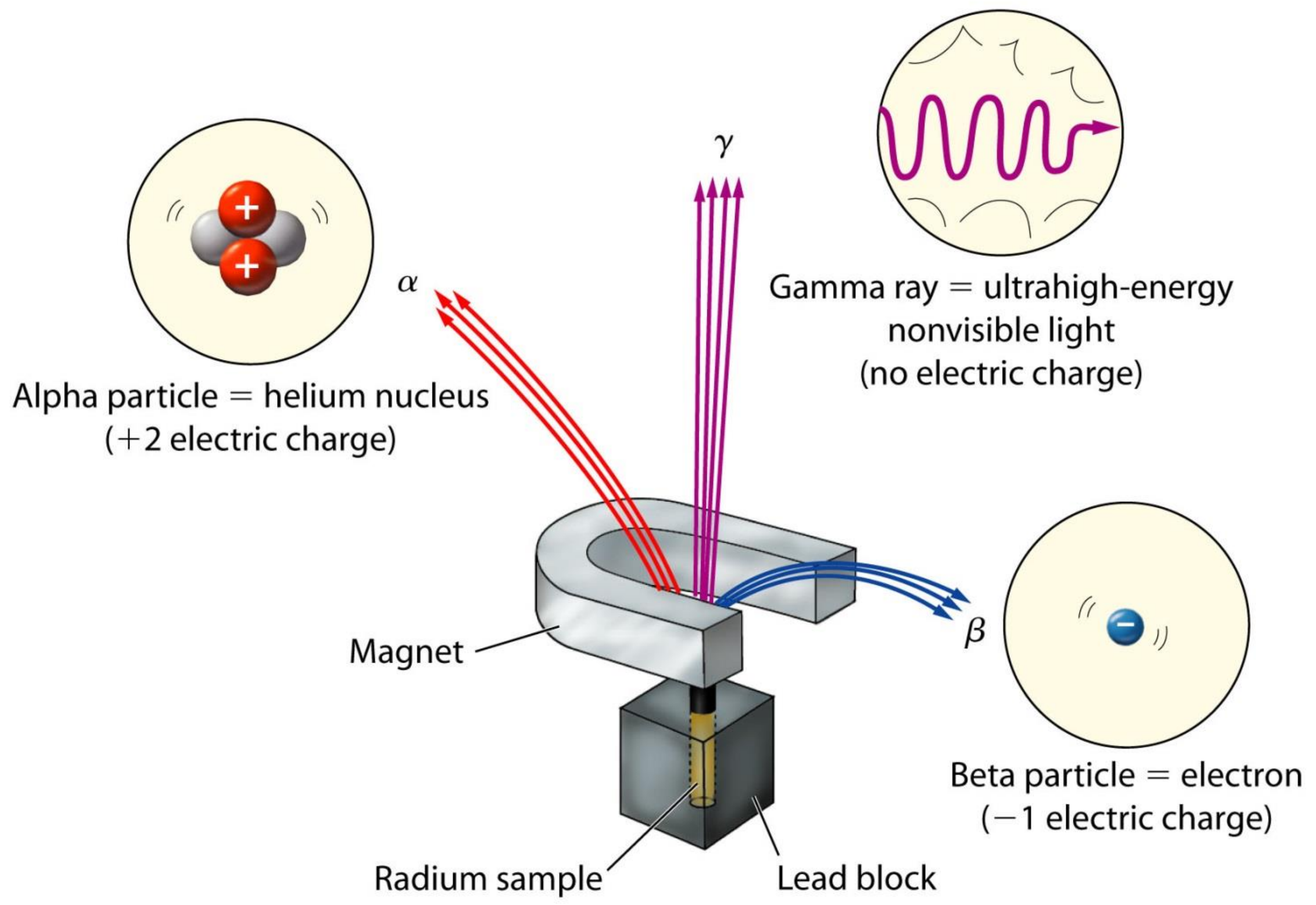
RADIATION PROTECTION





Rajvir Singh;
Scientific Officer 'H'
BSCS, BARC ;7738910465
rajvir@barc.gov.in

Radiation

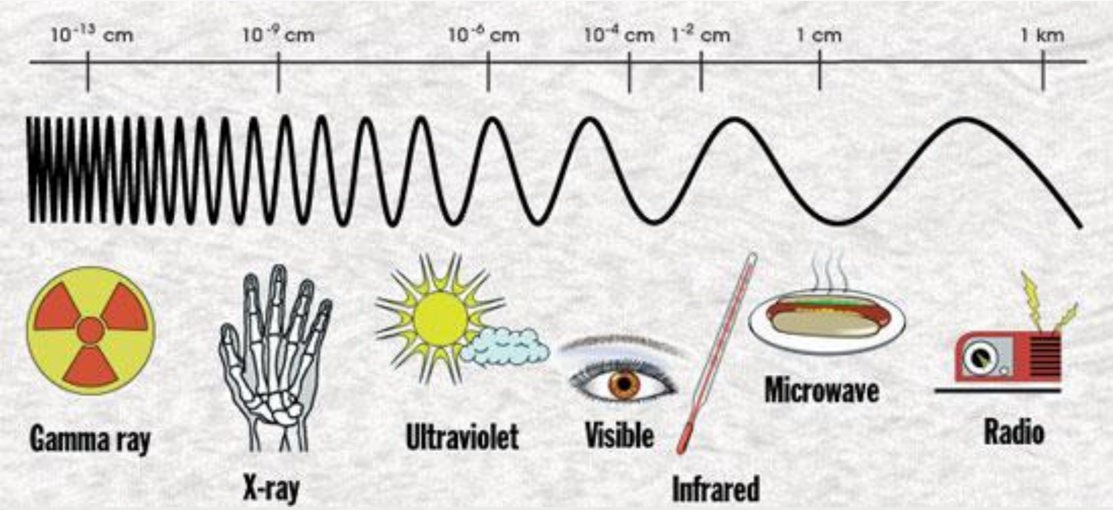


γ
α
β
Gamma ray = ultrahigh-energy nonvisible light (no electric charge)
Alpha particle = helium nucleus (+2 electric charge)
Magnet
Beta particle = electron (−1 electric charge)
Radium sample
Lead block

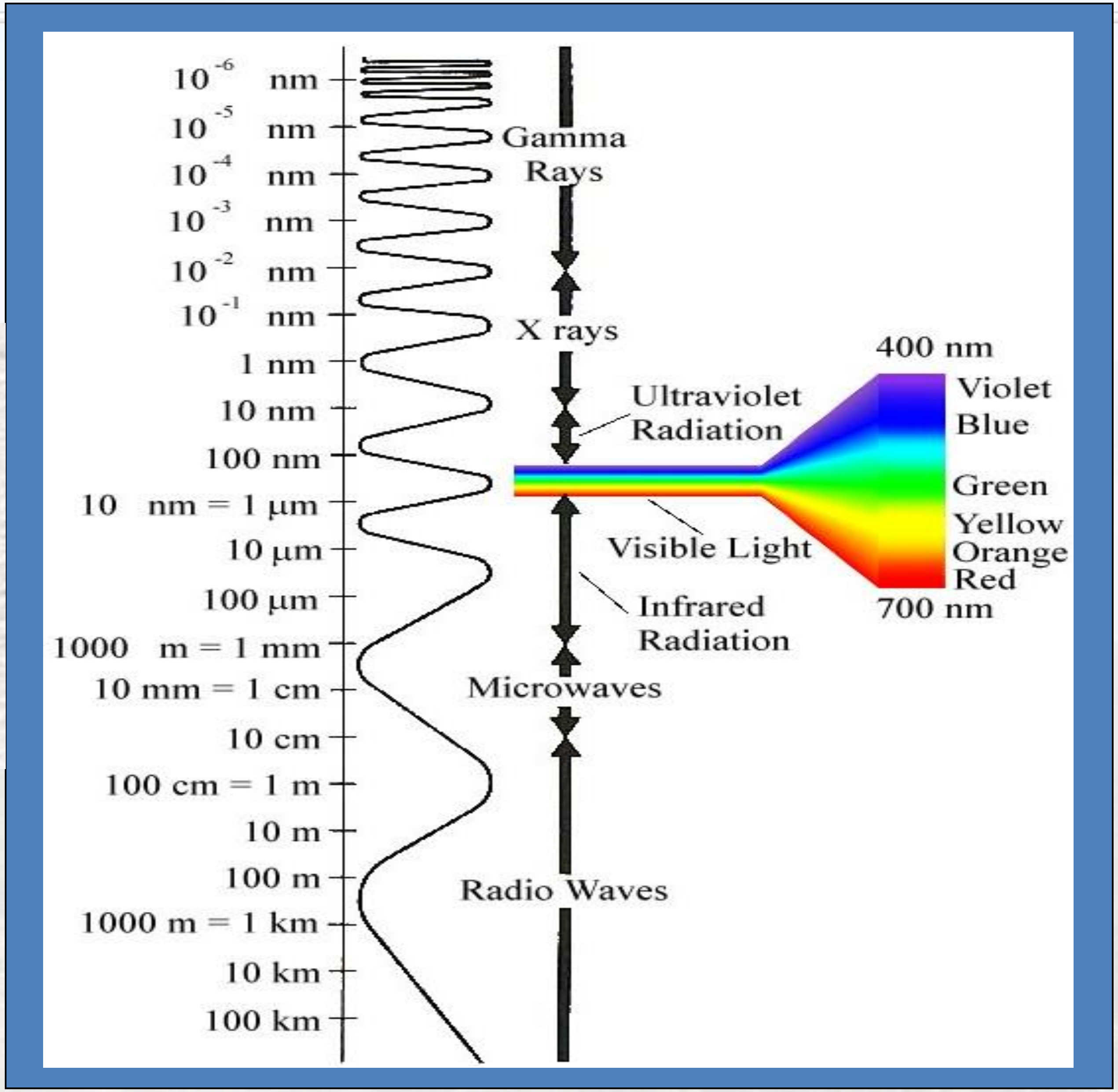
Radiation

➢Ionizing

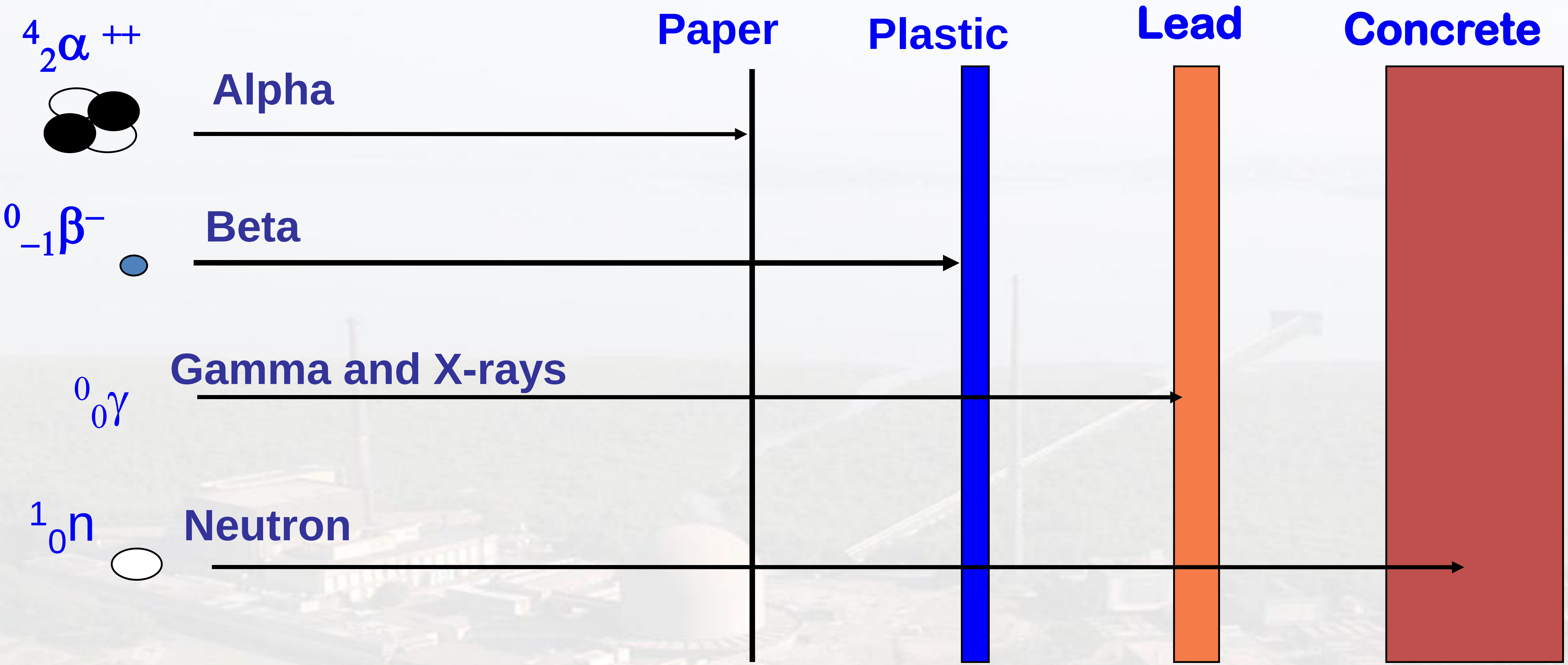
alpha particles, beta particles, neutrons, gamma rays, and x-rays.



➢Non Ionizing: microwaves, ultraviolet light, lasers, radio waves, infrared light, and radar.



Penetration of Radiation



Approximate HVL in mm:

Energy	Lead	Iron	Concrete	Water
0.5 Mev	4.2	11.1	30	78
1.0 Mev	9.0	15.6	45	102
1.5 Mev	12.0	17.4	51	120
2.0 Mev	13.5	21.0	57	144

Absorption of Beta Radiation: Emax=1 MeV

Type of Material	Thickness (mm)	% Absorption
Surgeon's gloves		30
Cotton gloves		30
Neoprene gloves		50
Double neoprene gloves		70
Light coveralls		20
Plastic hood (PVC)	0.20	30
Safety glasses (lens)	3.56	90
Air	914.4	80
Plywood	6.35	100
Asbestos	3.17	90
Paper	3.17	90

Radiation Sources around us

Natural sources

Cosmic rays

Earth's surface

Home we live in

Food and drink we take

milli Sievert is a unit of radiation dose

Medical sources

CT scan

X-rays

Manmade sources

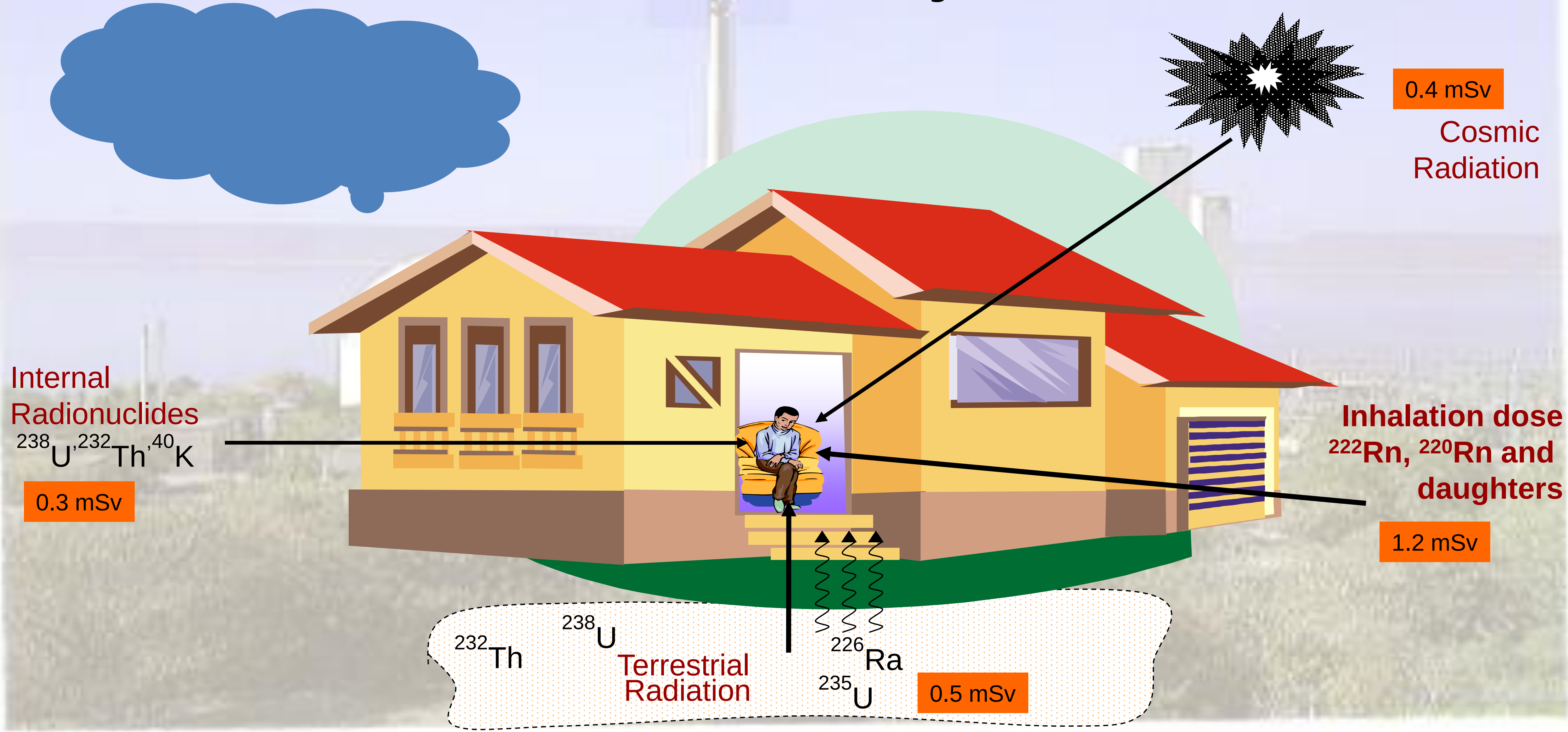
Nuclear power

Mining

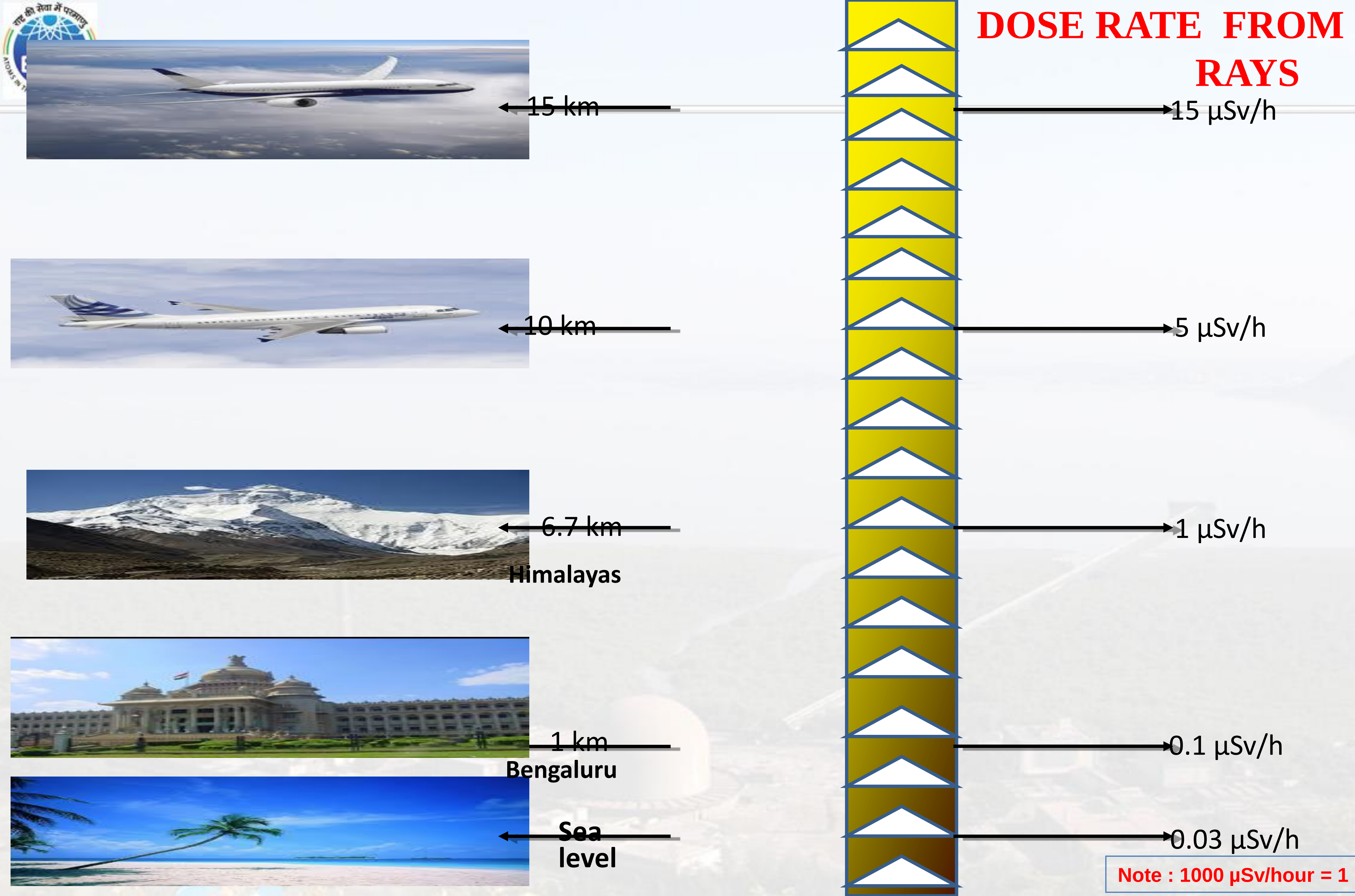
Waste

NATURAL BACKGROUND RADIATION DOSE

Contribution of various radionuclides and pathways to the annual dose to members of public from natural sources of ionizing radiation



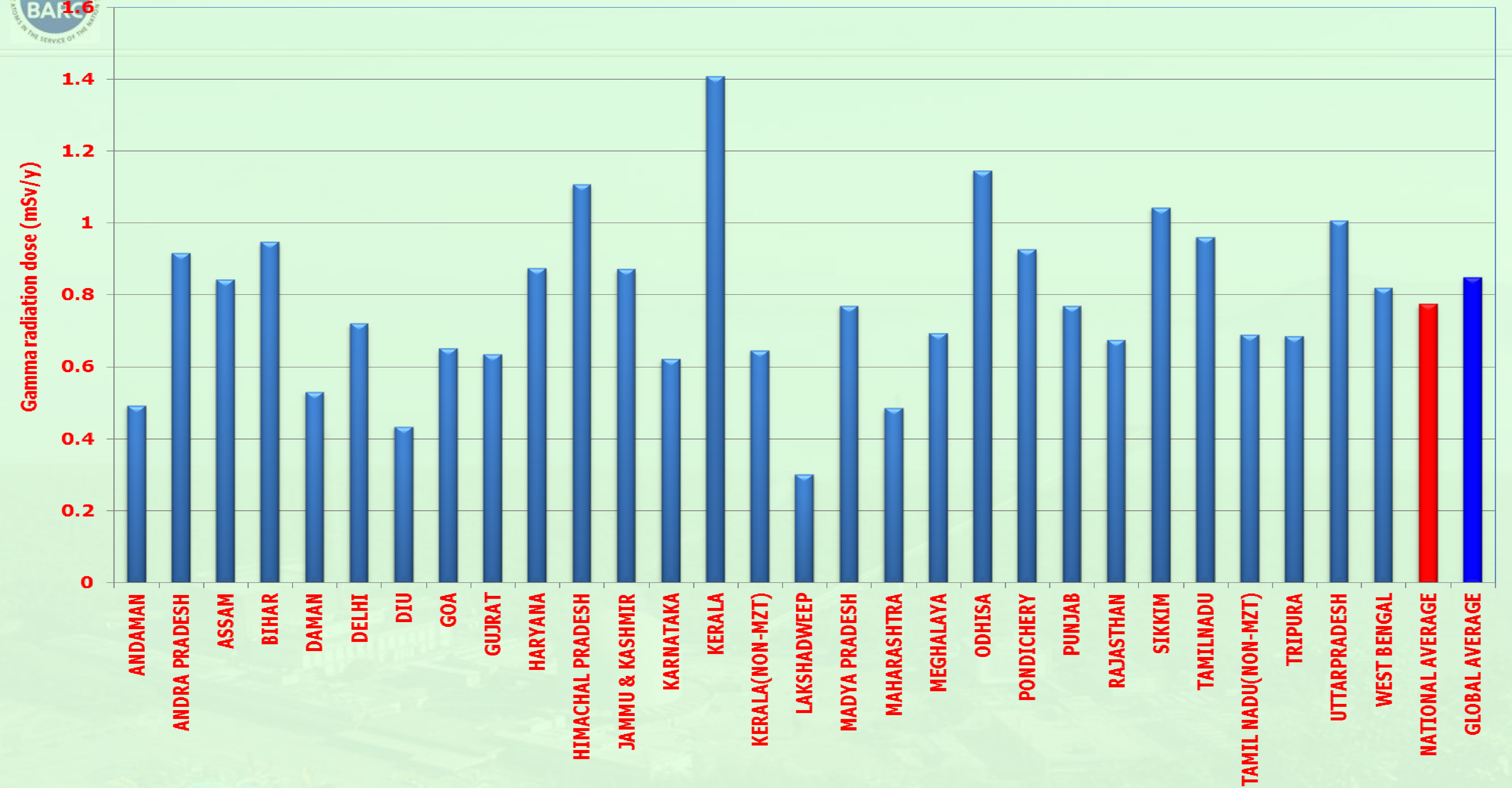
DOSE RATE FROM COSMIC RAYS



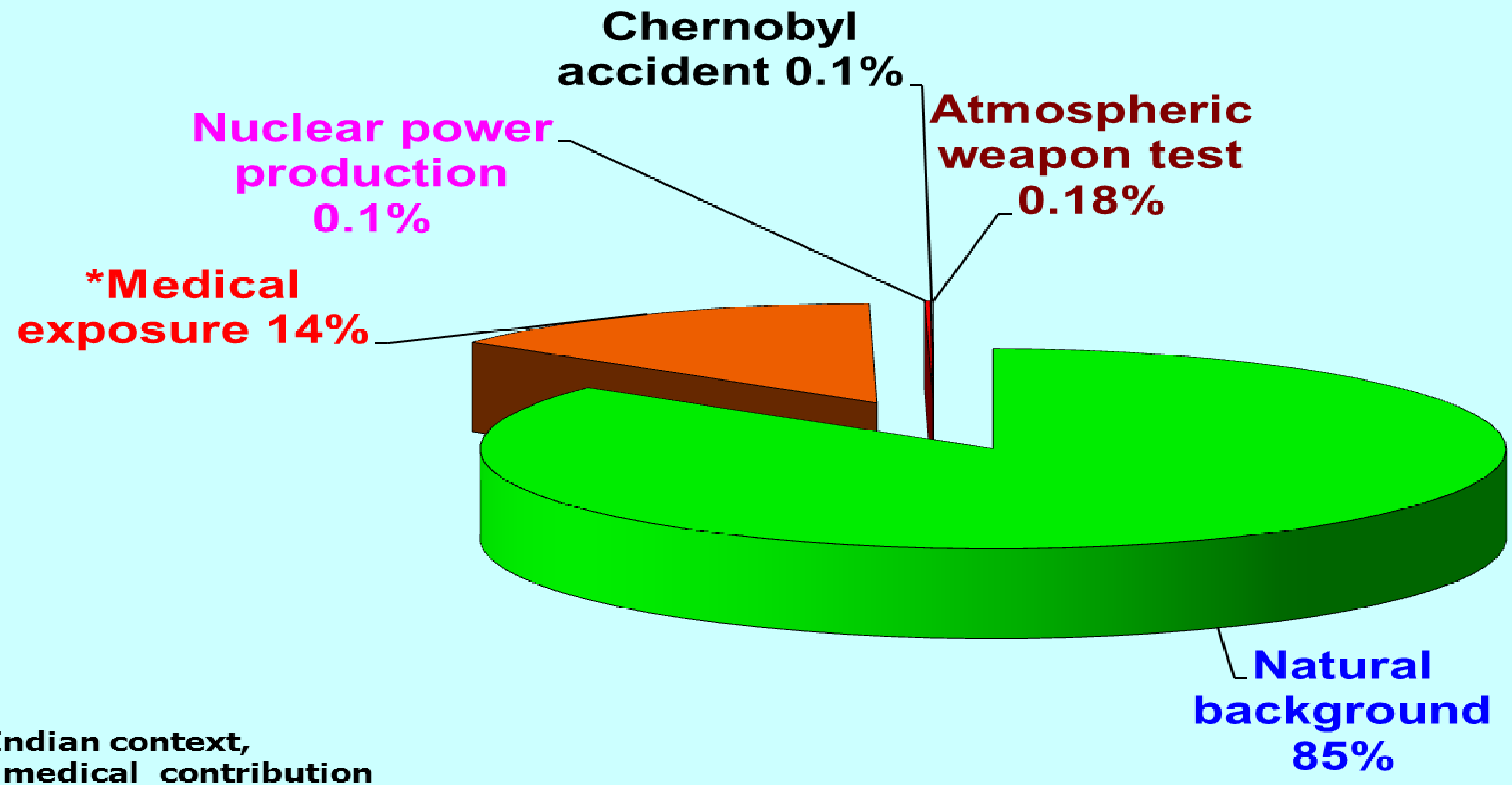
Note : 1000 µSv/hour = 1 mSv/hour

External gamma radiation dose (mSv/y) around different cities in India

Statewise external gamma dose (mSv/y) in India



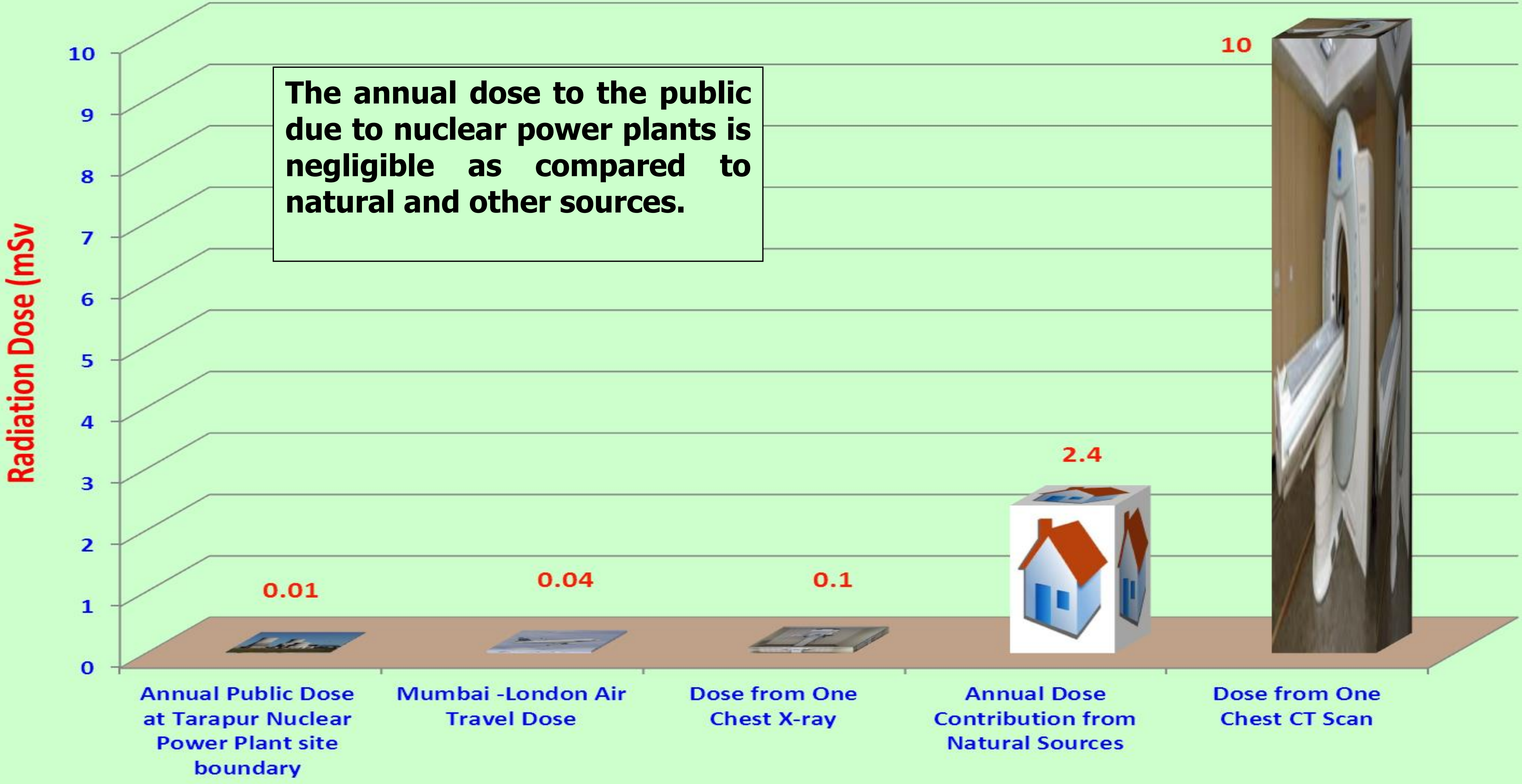
COMPOSITION OF TOTAL RADIATION DOSE TO THE POPULATION



* In Indian context, the medical contribution is about 2%

UNSCEAR, 2000

COMPARISON OF RADIATION DOSE



Radiation and Other Hazards

- Can not be smelled, seen or felt;
- Lesser experience;
- Medical symptoms (D, W or Y);
- Many misconceptions; but
- Small RM, can be easily detected.

Aggravation of Radiation Impact

- Distorted knowledge of the radiation risk;
- Inadequate information policy for public;
- Prevention & Consequences minimization is poorly developed;
- Knowledge of FRs, Decision Makers is not good enough;
- Public awareness of radiation risks is not good.

Radiation Emergency

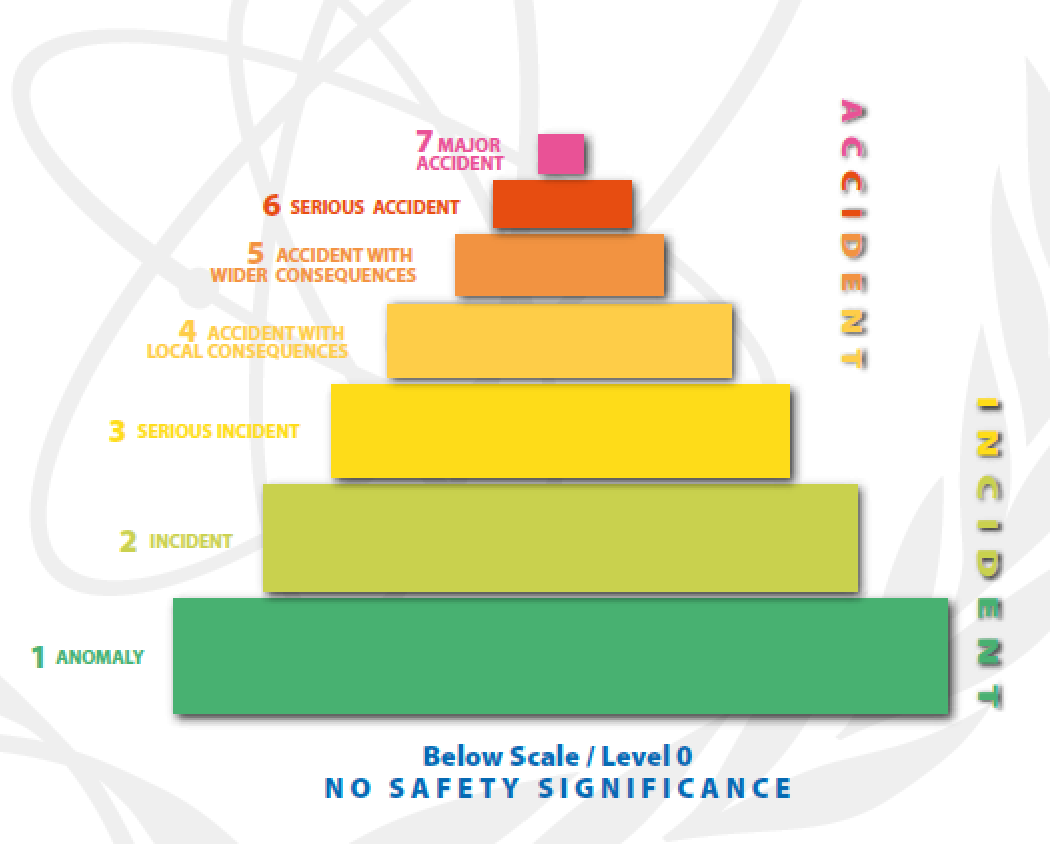
- Nuclear (Power Plant Accident, Criticality Accident)

  (more severe but less probable)

- Radiological (RDD, IED, Transport Accident etc)

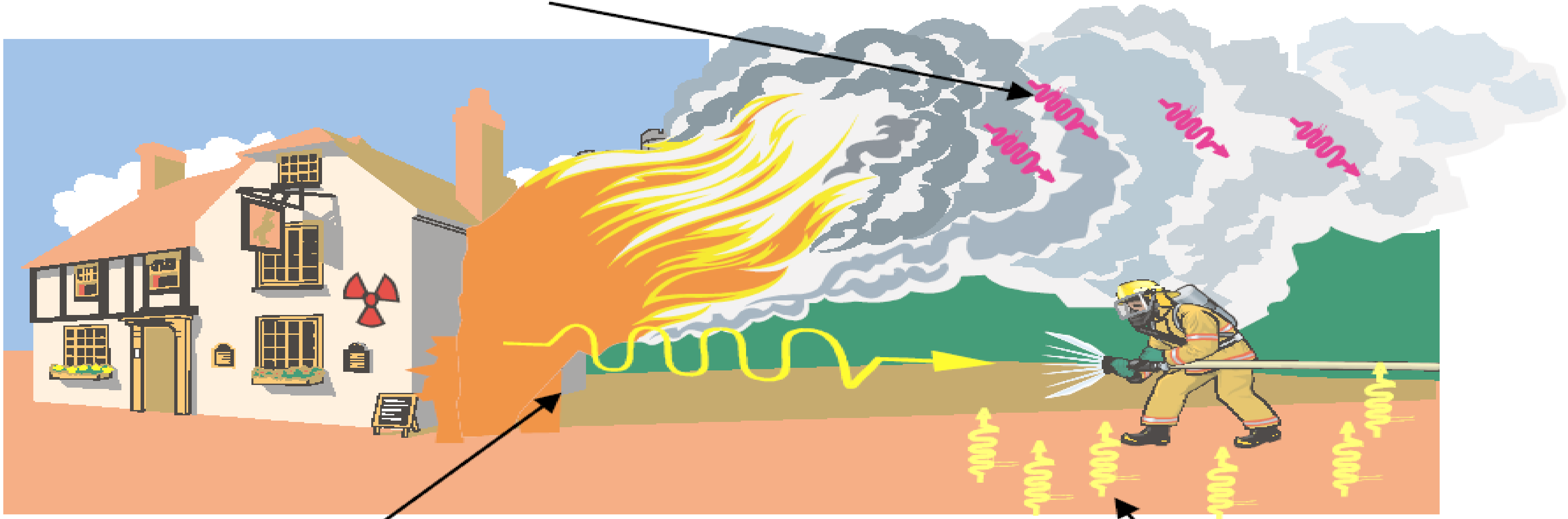
  (less severe but more probable)

- INES (CMG)



SOURCES OF EXPOSURE TO RESPONDER

Radioactive particulates (external & internal)



Direct from radioactive source (external)

Contaminated surfaces (external & internal)

MAJOR PROTECTIVE ACTIONS

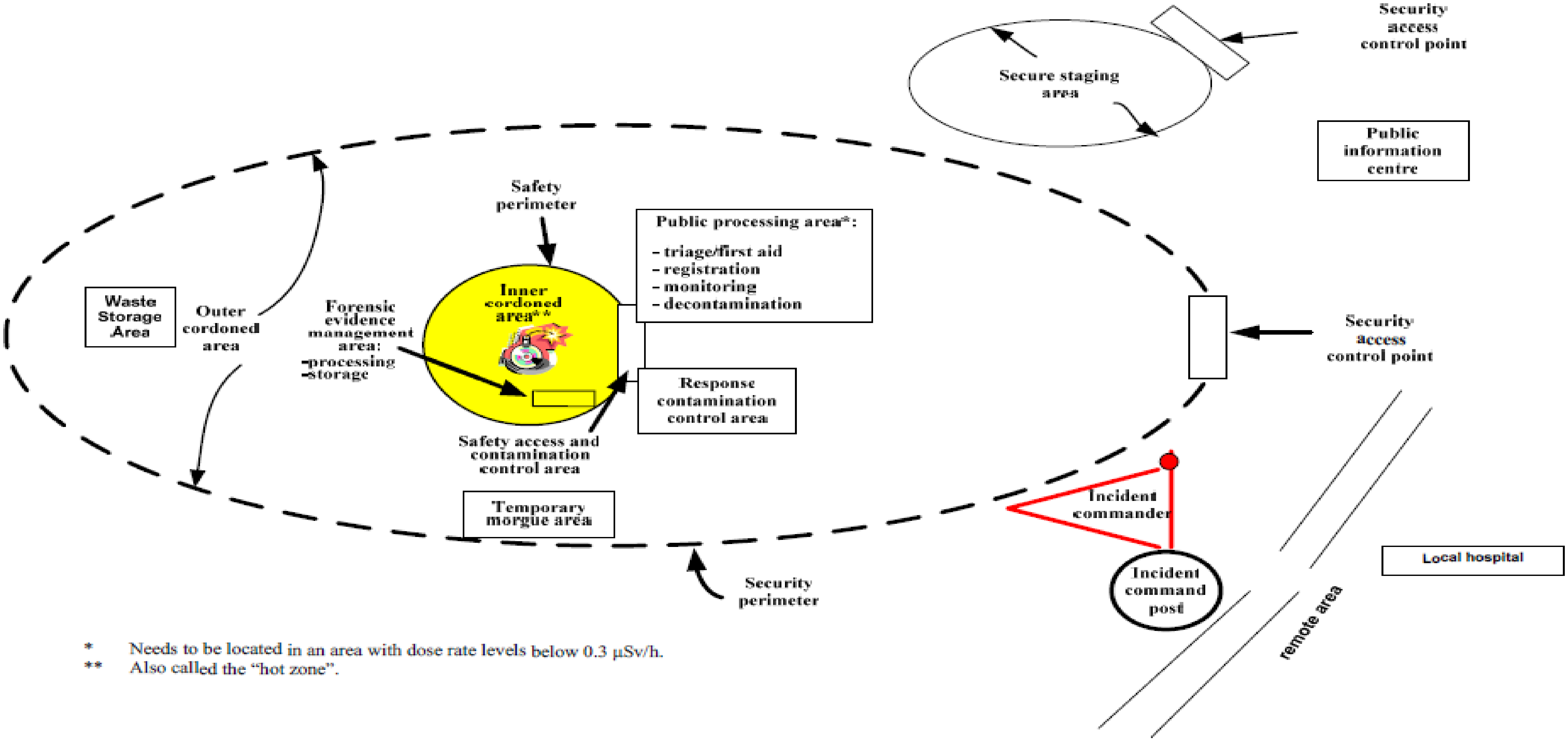
- Removal of non-essential personnel;
- Monitoring and decontamination;
- Performance of life saving actions without delay;
- Usage of respiratory protection,
- Avoidance of inadvertent ingestion.

- Public in twice the radius: not to eat; avoid smoking; get monitored; avoid inadvertent ingestion.

Protection of Responders

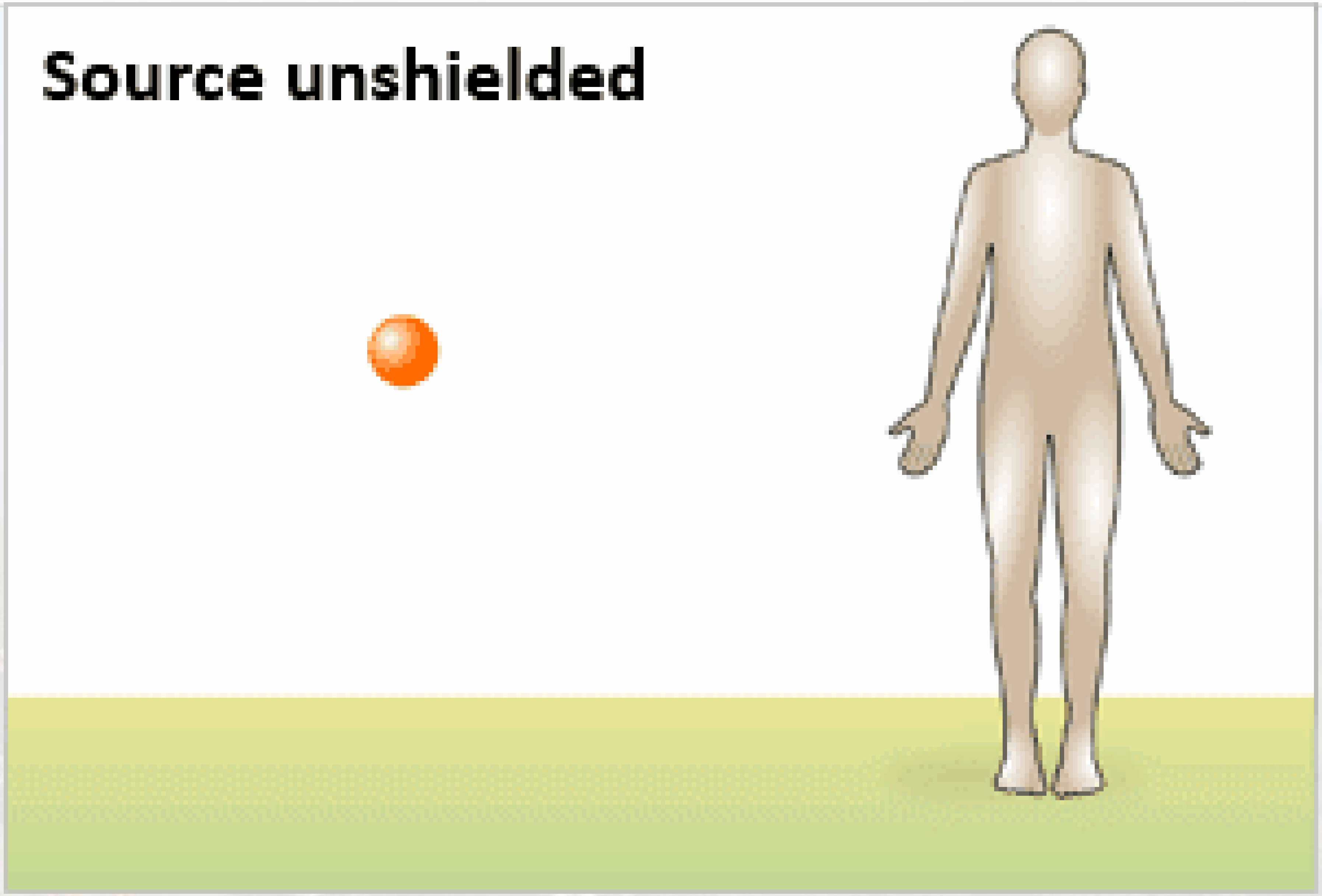
- Personal Dosimeter
- Portable dose-rate meter with alpha, beta and gamma capability
- Personal Protective Equipment (PPE)
- Full body-covering suit, or SCBA
- Water supply, hose, etc.

Water is number one option to decontaminate wounds, personnel, clothing, buildings, etc.

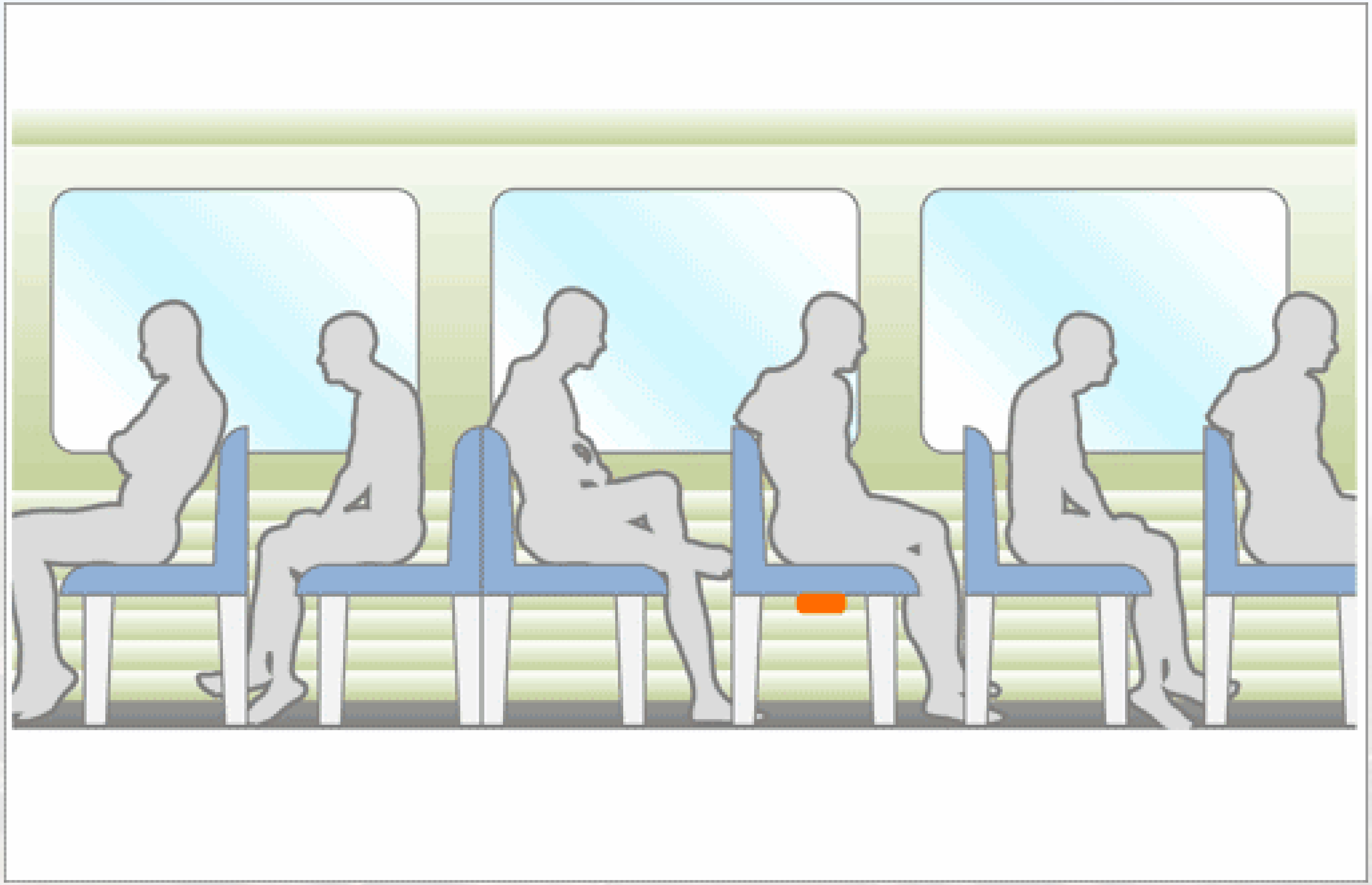


Generic layout of the response facilities and locations within areas established for a radiological emergency.

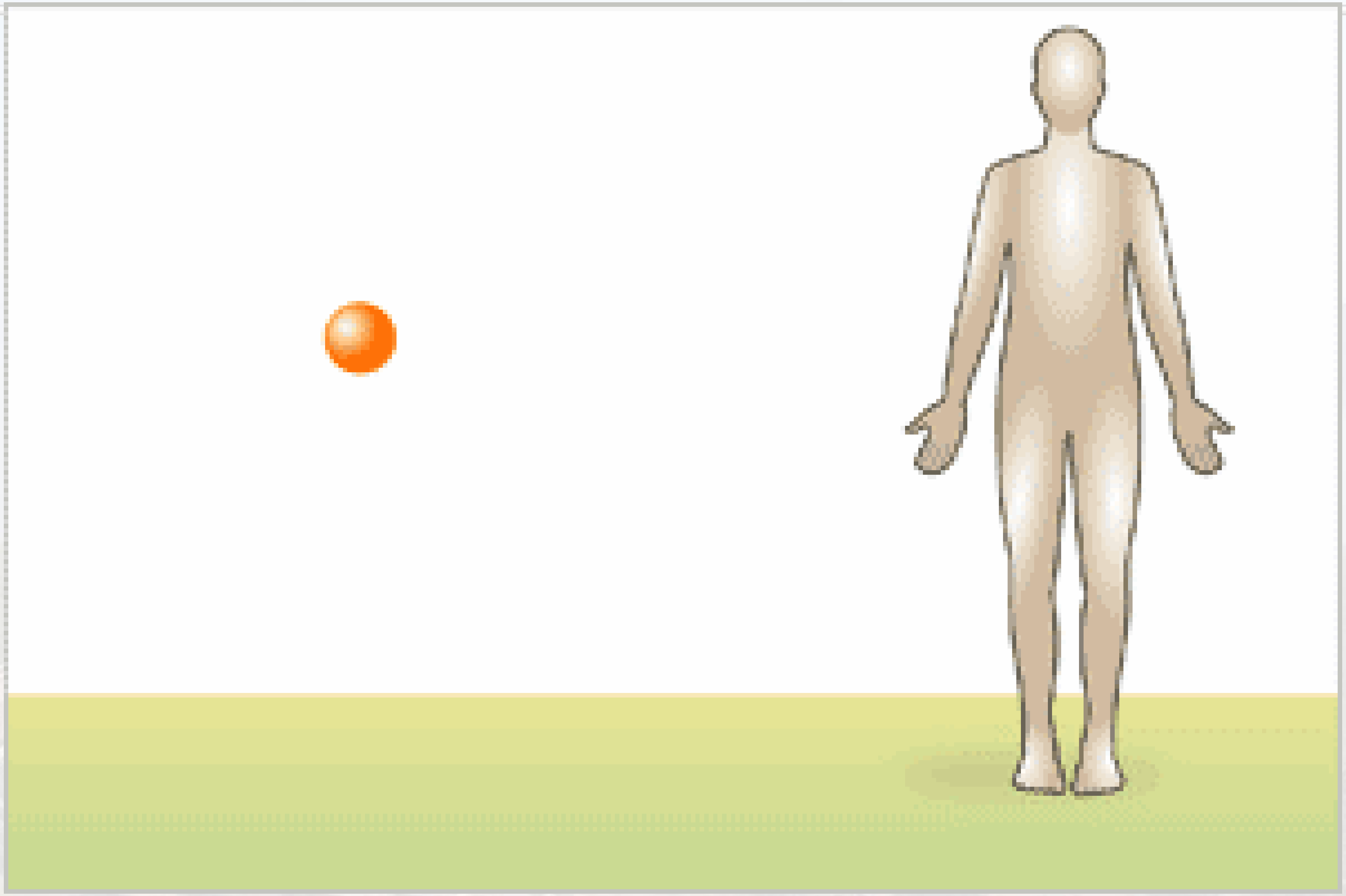
External Exposure



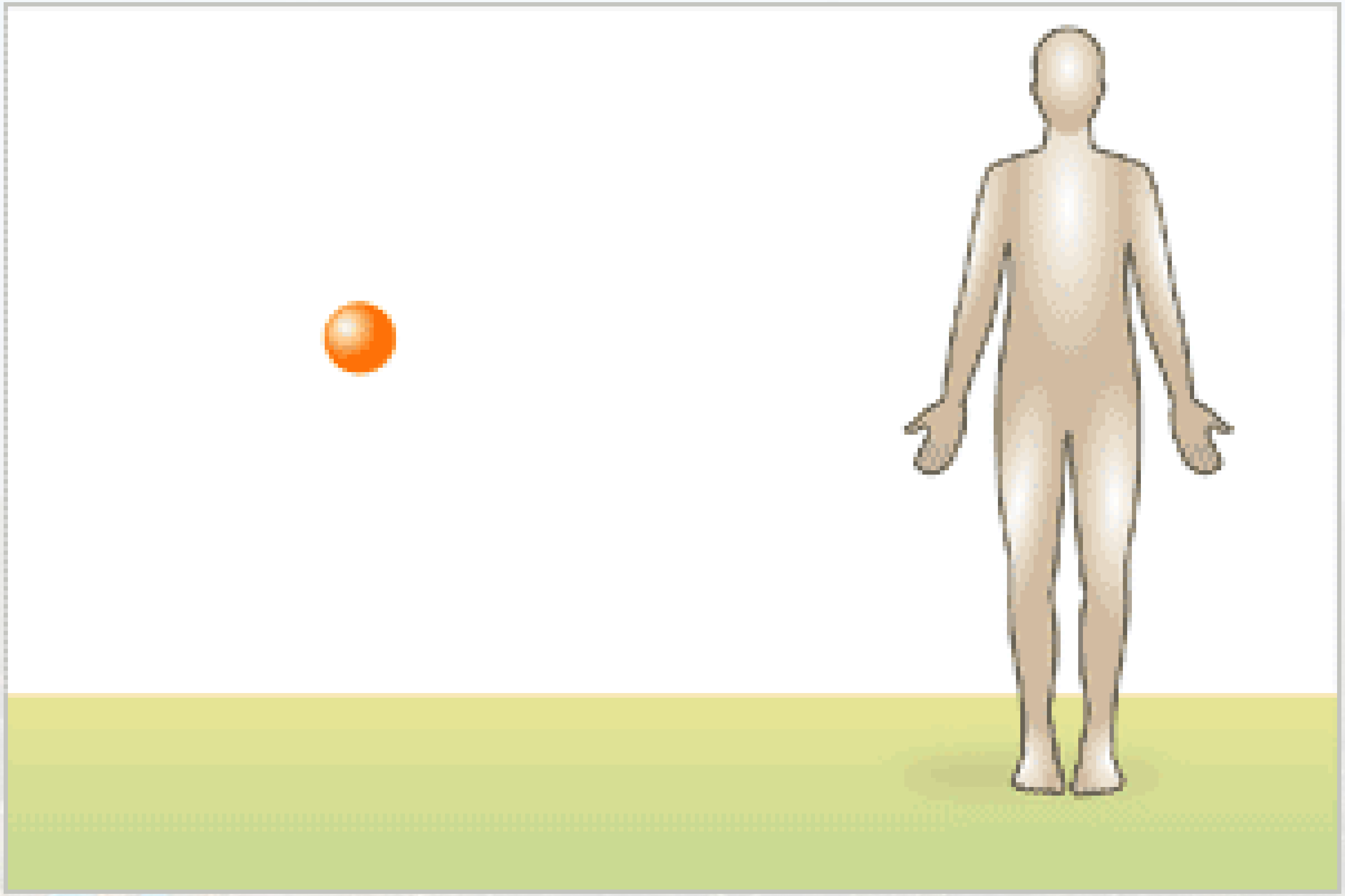
External Exposure



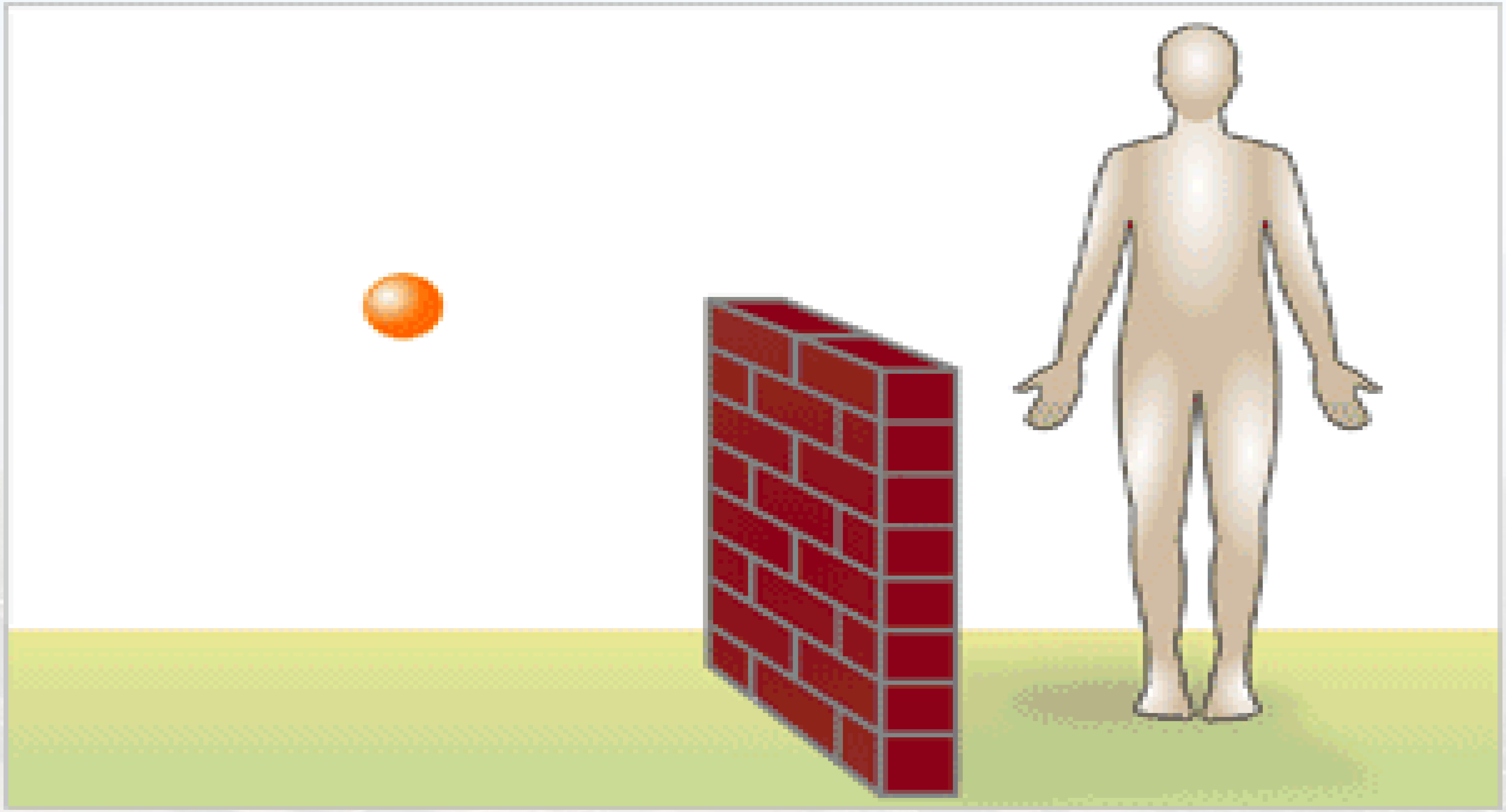
External Contamination



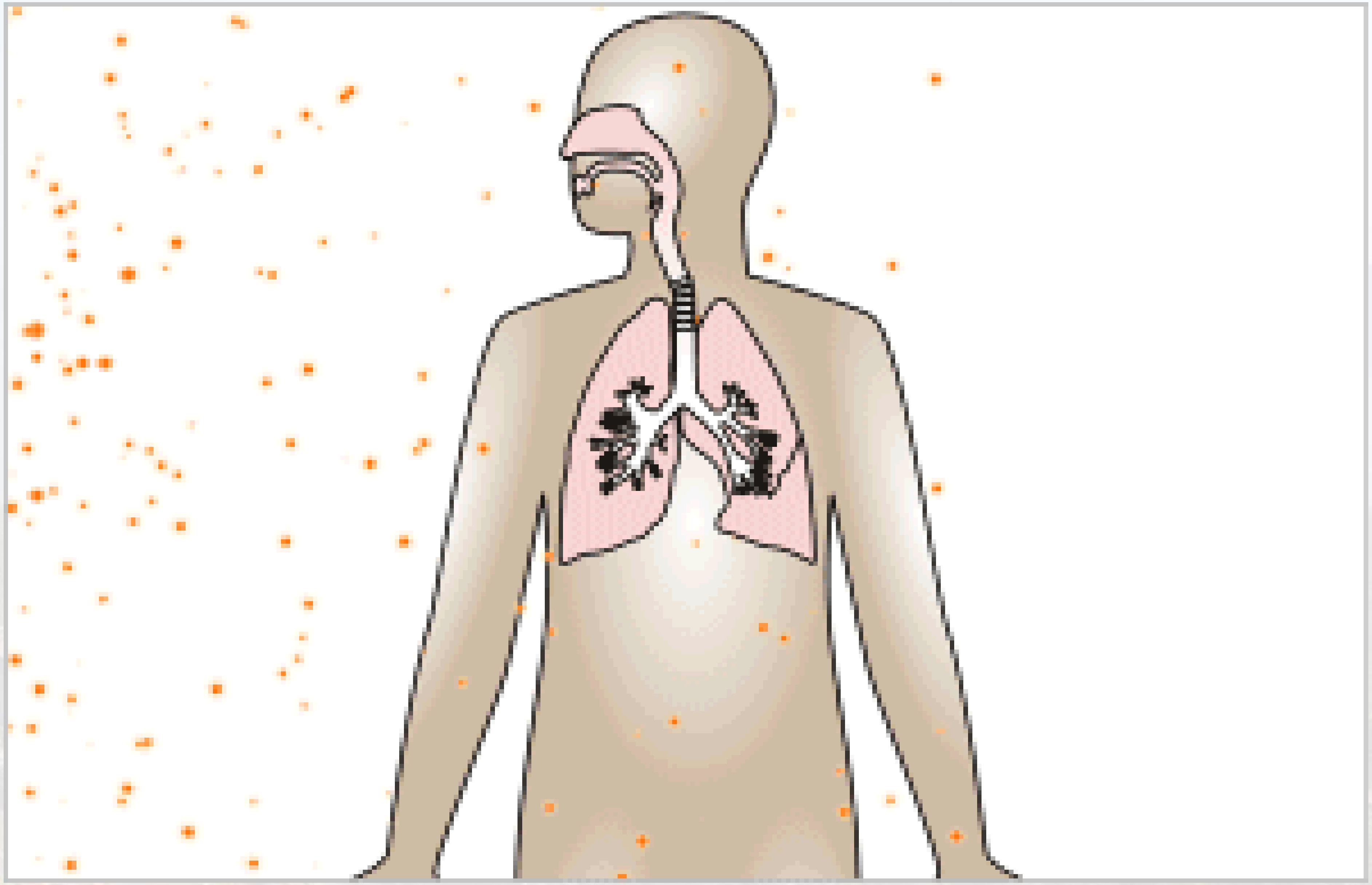
Full Body Contamination



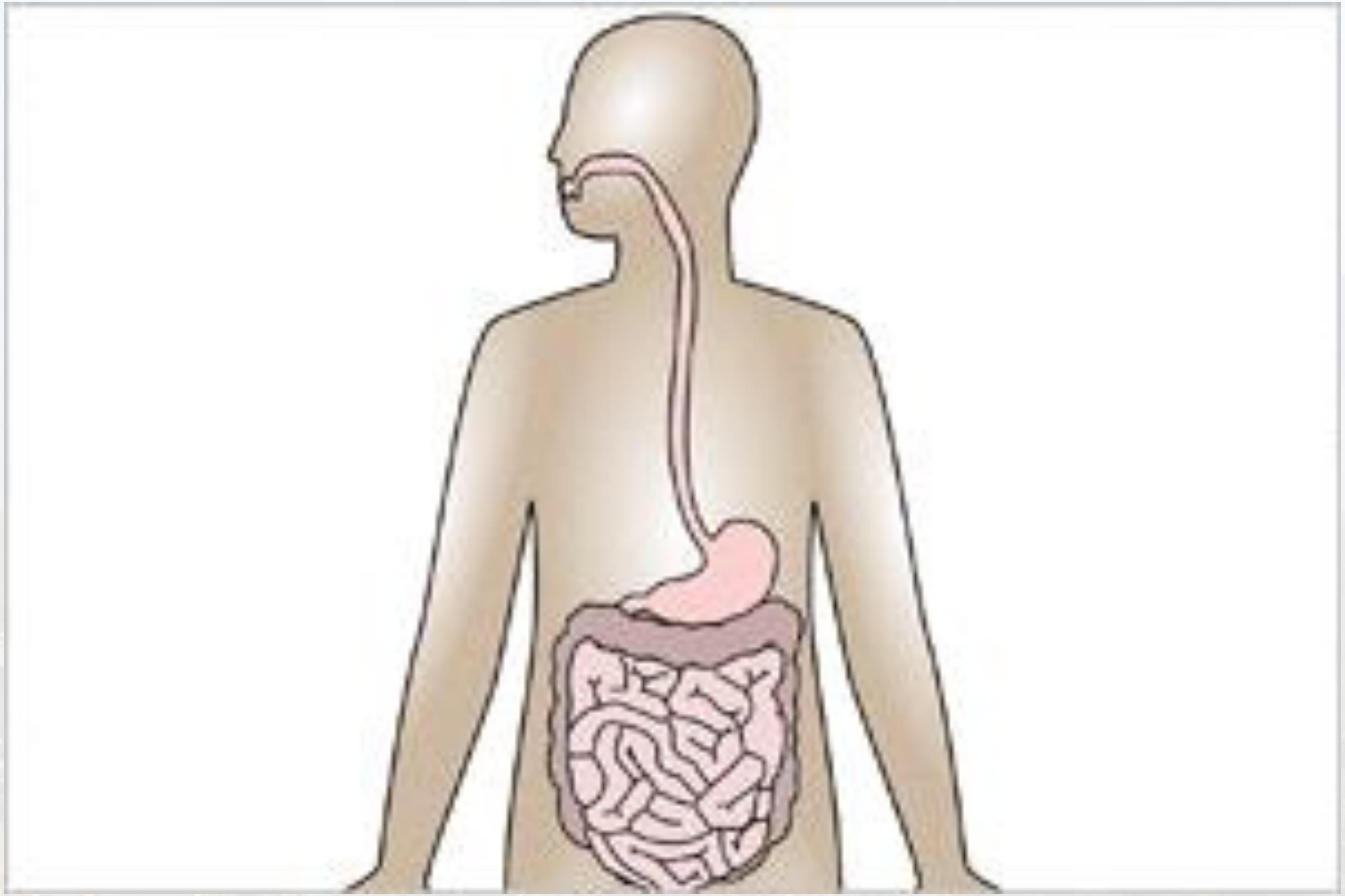
Partial Body Contamination



Internal Contamination : Respiratory

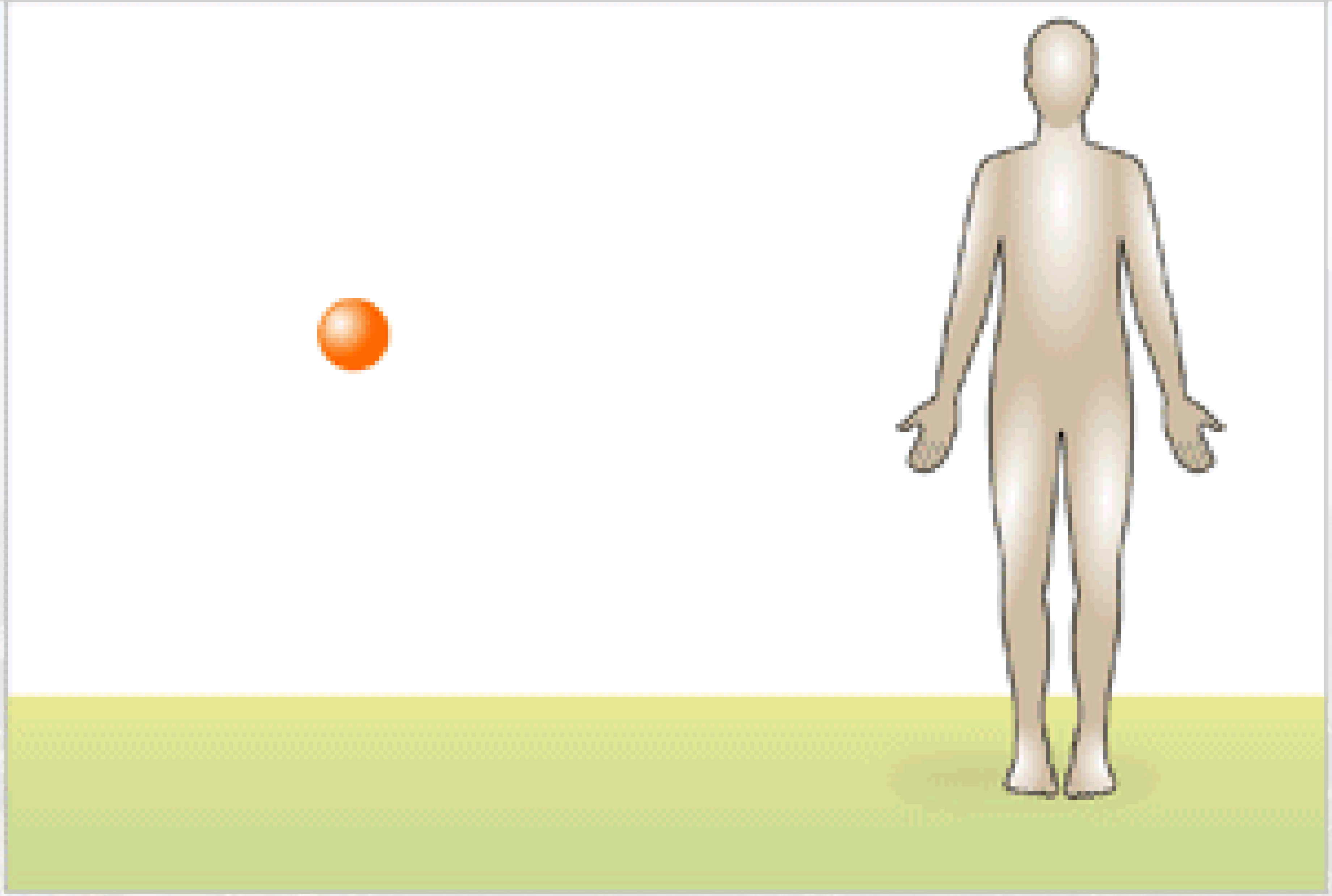


Internal Contamination : Digestive

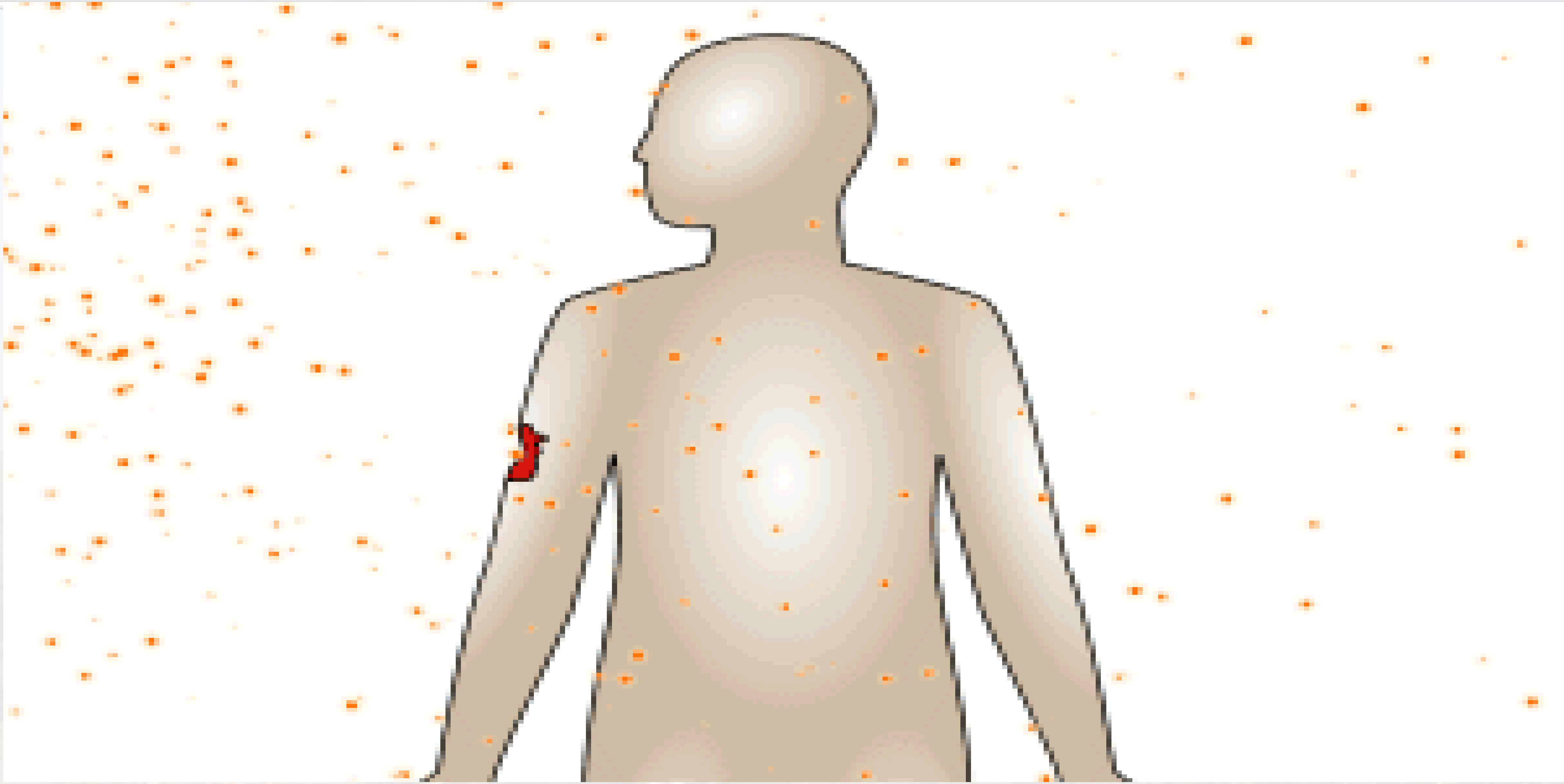


Internal Exposure: Inhalation, Ingestion

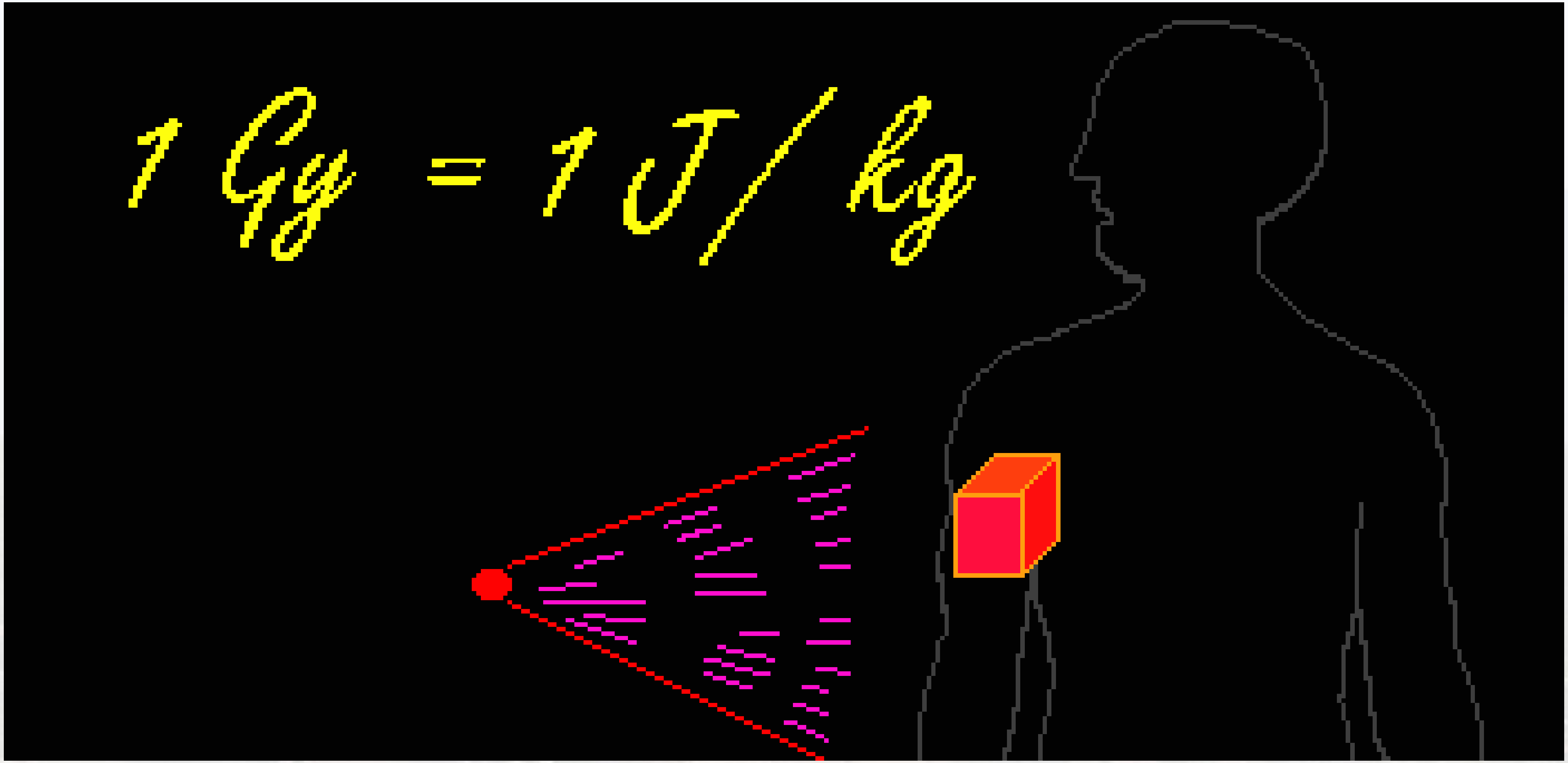
Wound Contamination Shrapnel



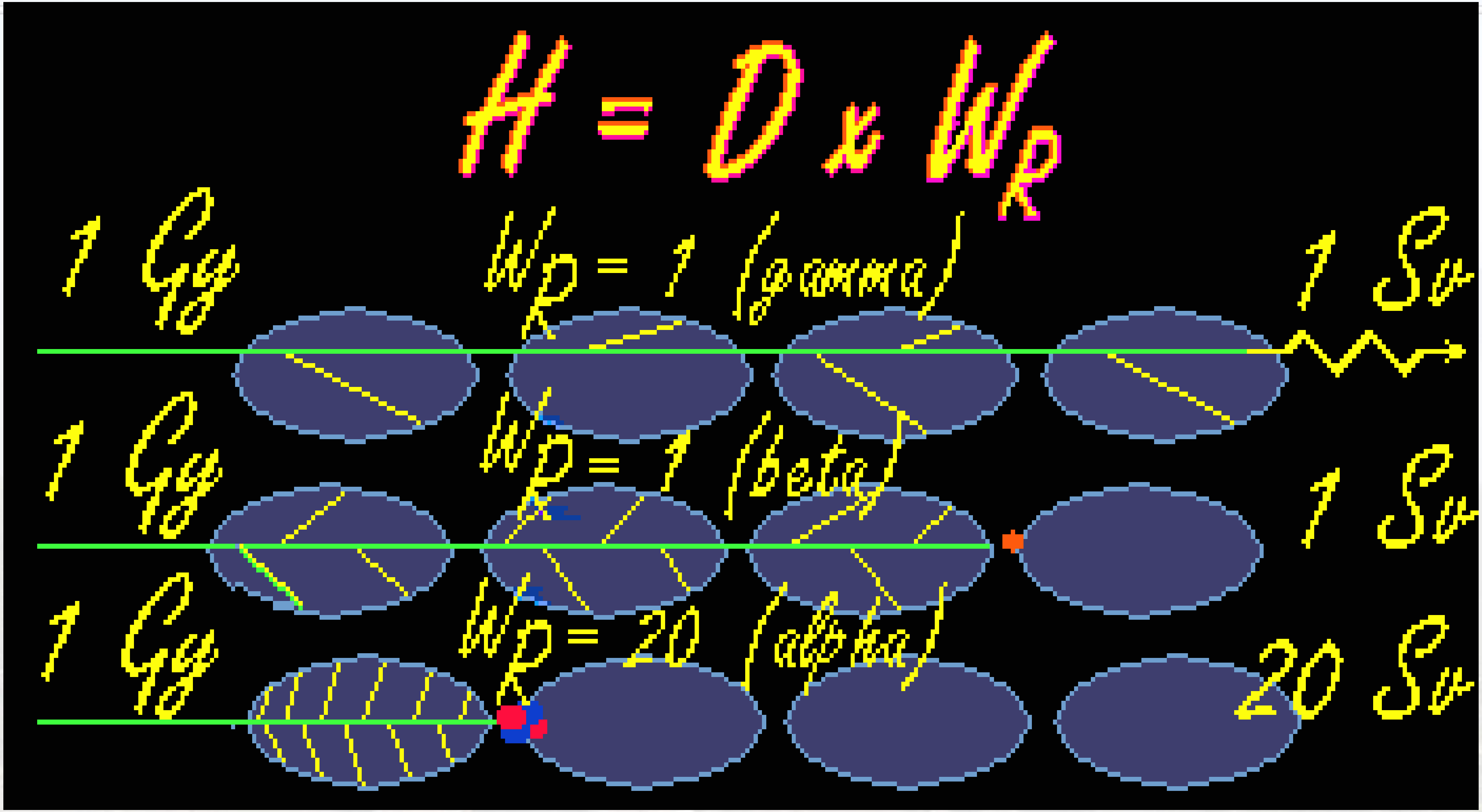
Open Wound Contamination



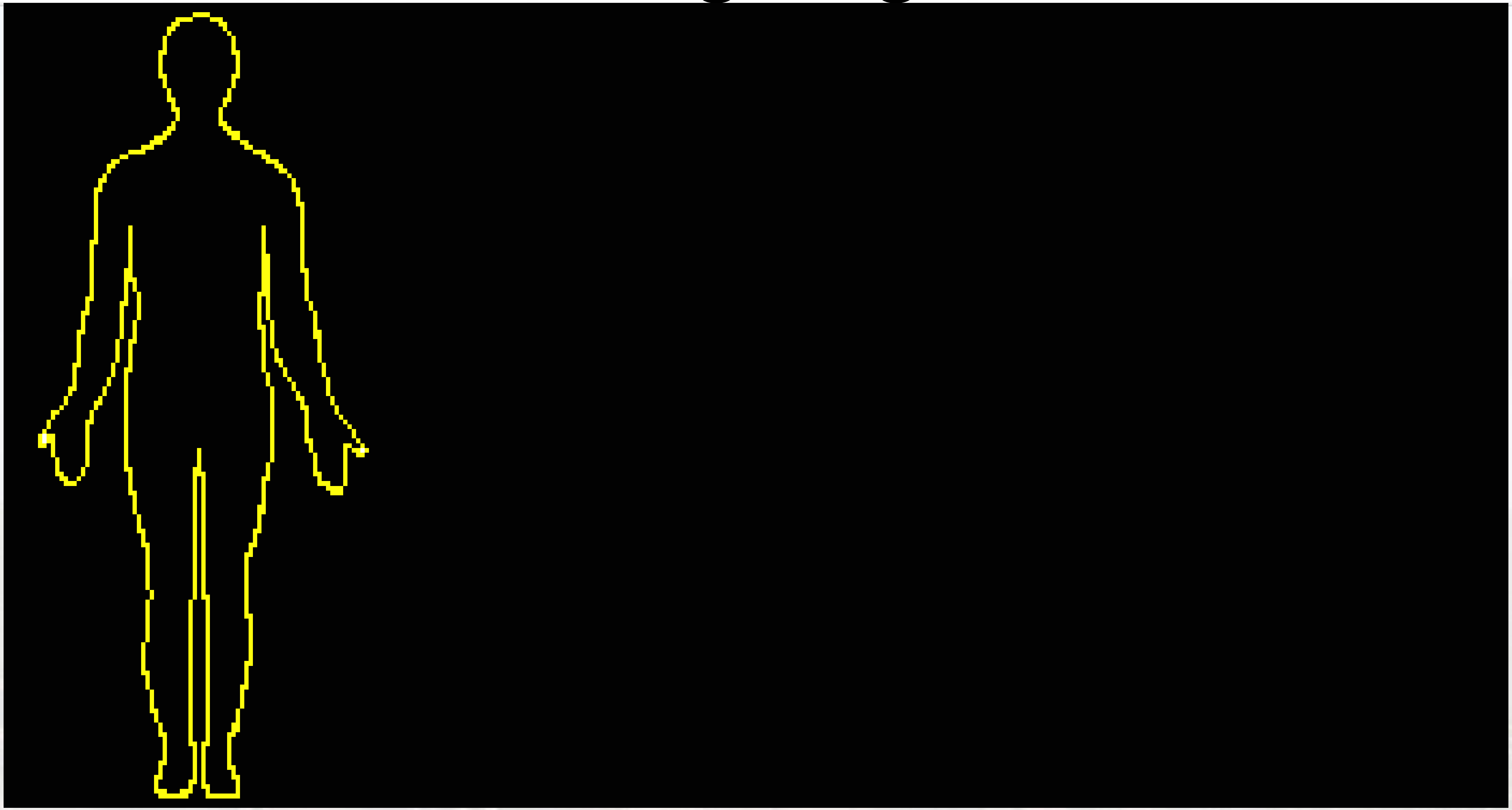
Absorbed Dose



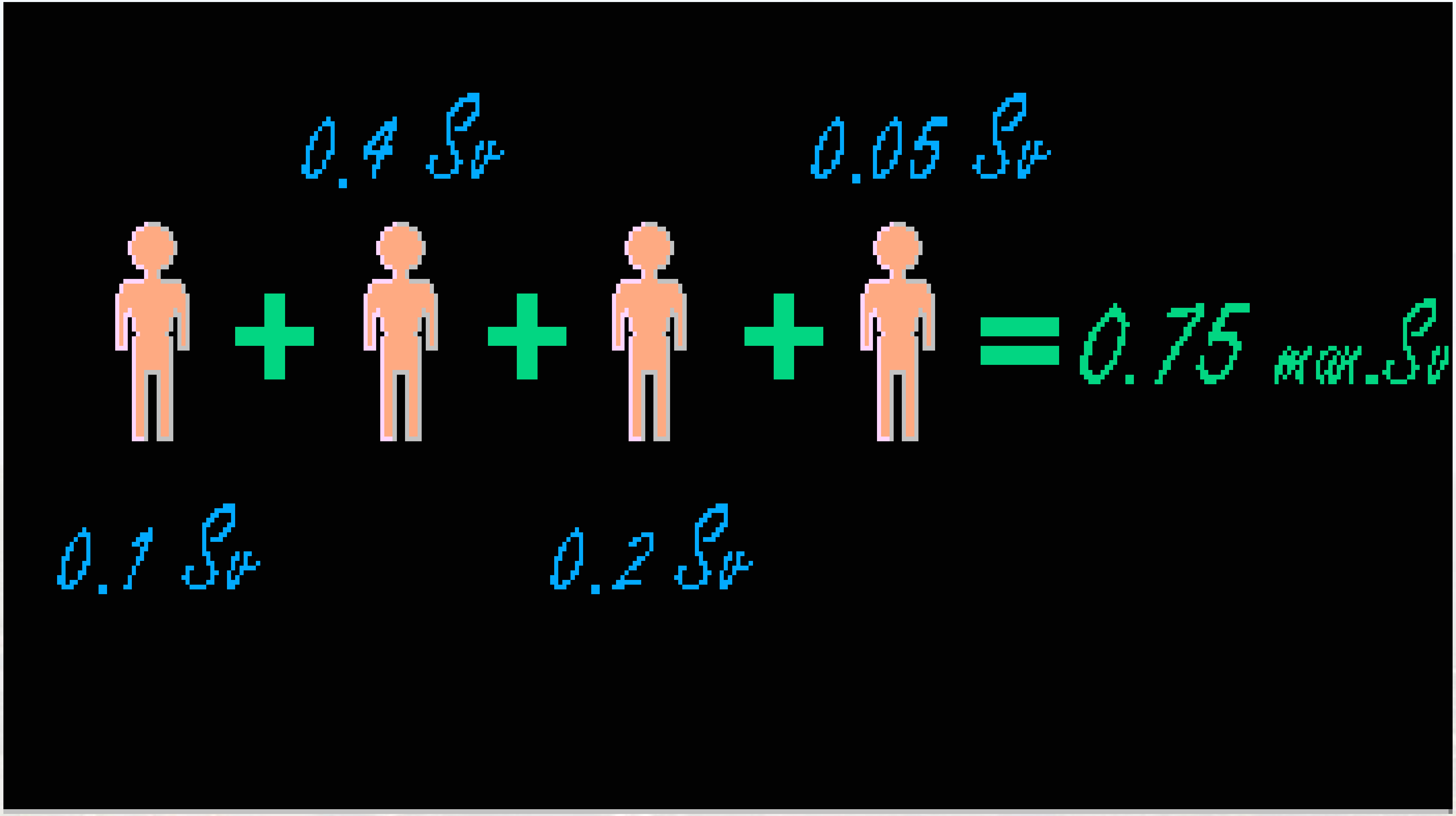
Radiation Weighting Factors



Tissue Weighting Factors



Collective Dose



Radiation Protection

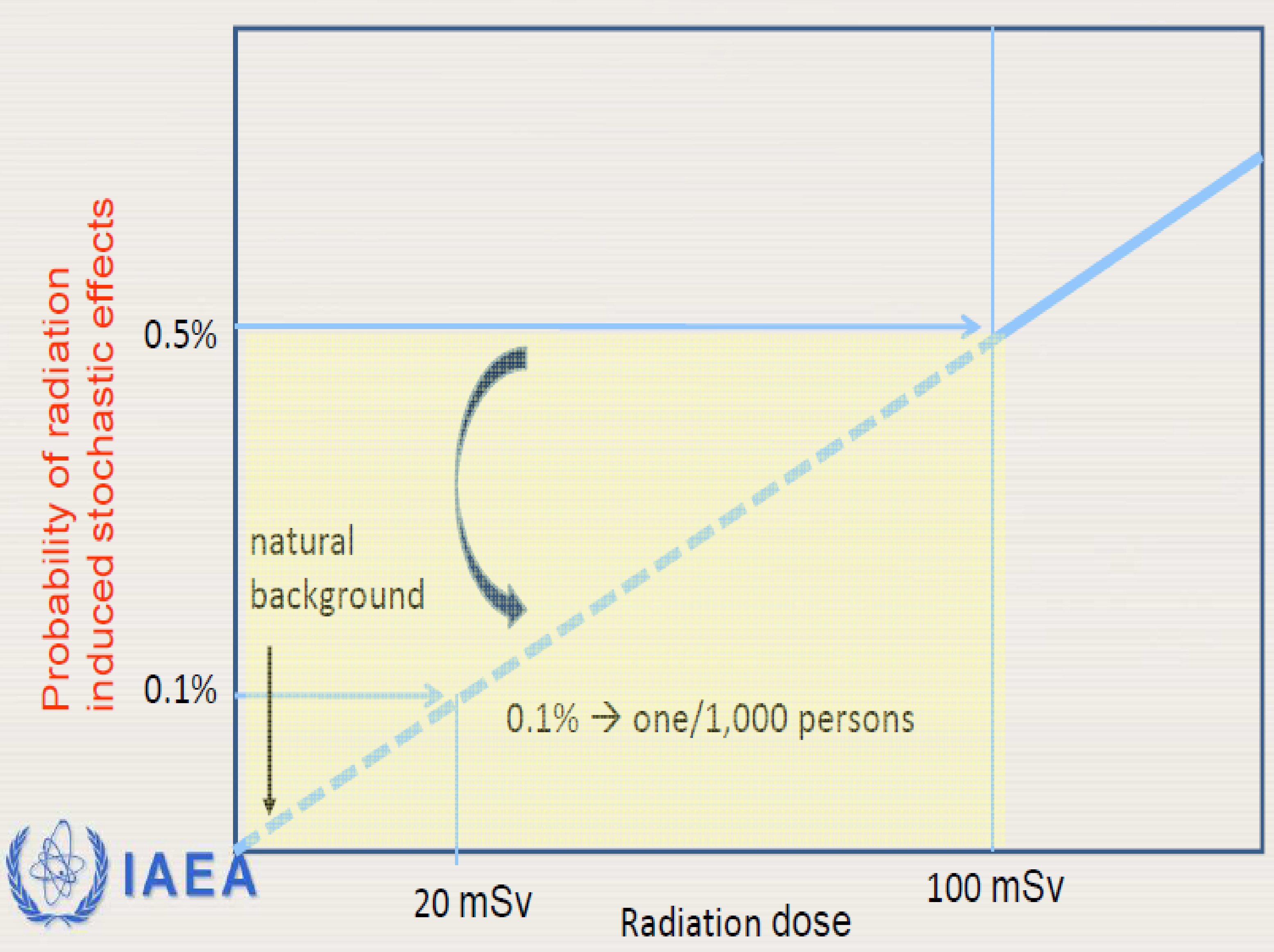
- Radiation risks to workers, public and environment have to be assessed and controlled.

- No threshold level of radiation dose below which there are no associated radiation risks.

Risk <100 mSv: No immediate effects

Yes, stochastic effects may occur with a small probability, and in proportion to the increase in dose over the background dose

(ICRP Publ.103)



TWO MAIN GOALS IN RP

1. to protect against deterministic effects

2. to restrict occurrence of stochastic effects

Basic Safety Standards

three exposure situations

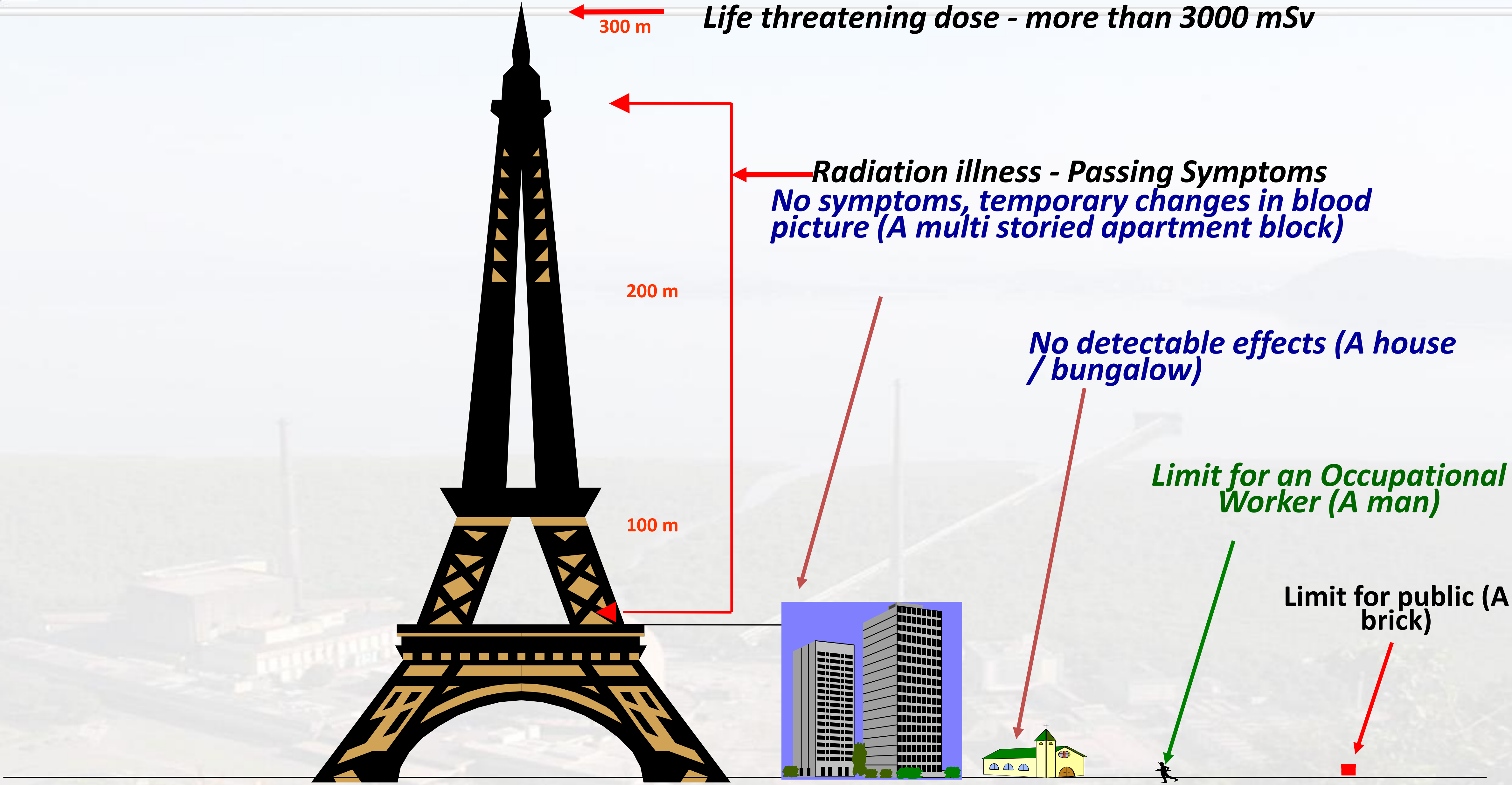
- planned (20 mSv/Y, 100 mSv in 5 Y)
- emergency (task specific, < 500 mSv)
- existing (1-20 mSv/Y)

Reference Level
20-100 mSv

three categories of exposure

- occupational (100 mSv/5y;30 mSv/y), (Eye:150m/y), (Skin: 500 mSv/y), (1 mSv for preg Lady), Apprentices: 6 mSv/y; Skin 150 mSv/y
- public (1 mSv/y) (Eye:15 mSv/y, Skin: 50 mSv)
- medical (No Limits)

A Perspective on radiation doses – in comparison to other industries, the limits are fixed at extremely low levels



(*Source: IAEA (1997) Publication on Radiation, Health and Society - 97-05055 IAEA/PI/A56E)*

Intervention

- ❖ Justification
- ❖ Optimization
- ❖ Limitation
- ➢ Intervention Levels
- • EAL
- • GIL
- • OIL

SAFETY PERIMETER FOR RADIOLOGICAL EMERGENCY

Situation	Radius (m)
Initial determination – open area	
Unshielded or damaged potentially DS	30
Major spill from a potentially DS	100
Fire, explosion or fumes involving a potentially DS	300
Suspected bomb (RDD), exploded/ unexploded	400
Nuclear Weapon in Fire	1000
Initial determination - inside a building	
Damage, loss of shielding or spill involving a potentially DS	Affected and adjacent areas
Fire or other event involving a potentially DS	Entire building and appropriate outside distance as indicated above
Expansion based on radiological monitoring	
100 µSv/h; 1000 Bq/cm2, 100 Bq/cm2 (Alpha)	Wherever these are measured

RESTRICTION OF EXPOSURE

- **Protection by either one or a combination of:**

  A. Engineering controls (Activity, physical form, barrier, design etc., time, shielding and distance).

  B. Administrative methods (effectiveness relies on the co-operation and awareness).

  C. Personal protective equipment (PPE) (as a last line of defence).

Personal Protective Equipment (PPE)

- **Need for PPE: to provide protection from chemical, radiological, physical, electrical, mechanical, or other hazards.**
- **No single combination of protective equipment and clothing is capable of protecting against all hazards.**
- **Thus PPE should be used in conjunction with other protective methods, including exposure control procedures and equipment.**
- **PPE Selection: based on the conditions at the scene.**

SELECTION OF PPE

- **Essential information before selecting PPE:**

(A) Nature of the exposure.

1. **Information about conditions at workplace.**
2. **Radionuclide(s) present.**
3. **Type of potential exposure(s).**
4. **Magnitude of possible doses.**
5. **Physical form of source(s).**
6. **Nature/concentration(s) of contamination.**
7. **Presence of other hazards.**

(B) Performance data for PPE. .

(C) Acceptable level of exposure.

Limitations of PPE

Decisions about PPE use must consider its limitations.

- **Safety Hazards**
- **Restricted movement**
- **Restricted vision**
- **Communicating difficulty**
- **Psychological stress**
- **Heat stress and risk of dehydration**

Highest levels of PPE generally cannot be worn continuously for more than 30 minutes.

PPE in Radiation Emergencies

- Choice of PPE depends on:
  - Response role and specific tasks;
  - Risk of contamination;
- PPE can protect against:
  - External contamination;
  - Internal contamination;
- Other physical hazards (e.g., debris, fire/heat, or chemicals);
- PPE cannot protect against Gammas and X-rays.

PPE for First Responder/ First Receiver

- **Combined hazards**
  Protect against anticipated hazards
- **Identified hazard (Radiation)**
  Contamination: PPE usually provides sufficient protection
  Exposure: PPE confers no protection
  Minimize time spent near a radiation source
  Maximize distance from a radiation source
  Increase physical shielding
  Person exposed to radiation but not contaminated pose no threat of exposure.

Conclusion

- PPE most useful for Airborne Contamination Scenarios.
- Effectively No Protection for External Exposures (Gamma, X).
- Little Protection against Beta Contamination.
- Full Protection against External Alpha Contamination.
- Very Good Protection for Internal Exposures and Skin Contamination.
- Usual precautions against infection (gloves, mask, etc.) will provide sufficient protection for contamination.

Thanks for Attention

Questions ?

Levels of PPE

- Level A when the highest level of respiratory, skin, eye and mucous membrane protection is needed.
- Level B protection when the highest level of respiratory protection is needed, but a lesser level of skin and eye protection is needed.
- Level C: when the type of airborne substance is known, concentration measured, criteria for using air-purifying respirators met, and skin and eye exposure is unlikely.
- Level D: is primarily a work uniform and is used for nuisance contamination only. It requires only coveralls and safety shoes/boots.

IC actions in response to general RE

(1)	(2)
▪ Stand off, observe & assess.	▪Establish response areas/facilities.
▪ Determine ICA.	▪ Account all response personnel.
▪ Reposition response personnel, vehicles and equipment.	▪ Manage triage, registration, Monitoring, decontamination.
▪ Follow PP guidelines.	▪ Establish security perimeter at scene and other facilities.
▪ Take life saving actions.	▪ Limit contamination spread
▪ Establish ICP and staging area.	▪ Notify transport, medical, national EOC.
▪ Consider terrorism/bomb/second event.	▪ Consider need for full response
▪ Check & identify packages, people, papers and vehicles.	▪ Brief requested teams upon arrival.
▪ Mark ICA.	▪ Keep the public informed.
▪ Evacuate public from ICA.	▪ Treat scene as a crime scene.
▪ Request RA, get phone advice.	▪ Do not attempt recovery or decontamination of the scene.
▪ Request initial assessment.	

Concerns for Radiological Emergency

Indirect damages to health, environment, social life and economics could be high

- **Response capability to radiological terrorist attack is not good enough;**
- **Used IRS has significant, high or extremely high activity;**
- **IRS control and accountability, especially in fields other than nuclear industry , is not good enough;**
- **Easy to create RDD, easy to deliver and disperse it;**
- **Direct and especially legislative base on radiation safety, protection of public and environment is not good enough;**