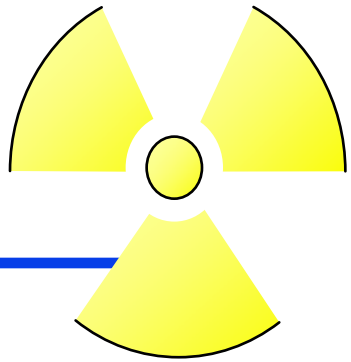
Radiation Safety – Health Physics

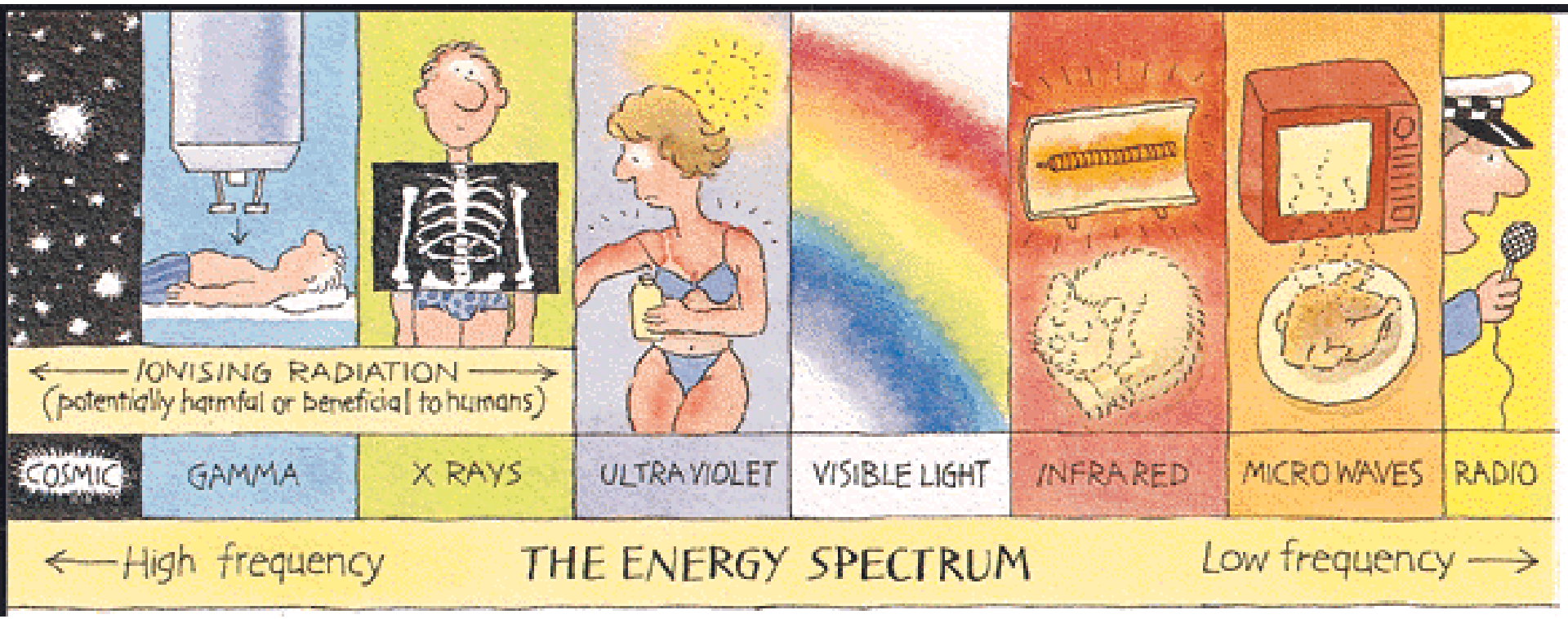
Neutron Spectroscopy Summer School

Training Outline



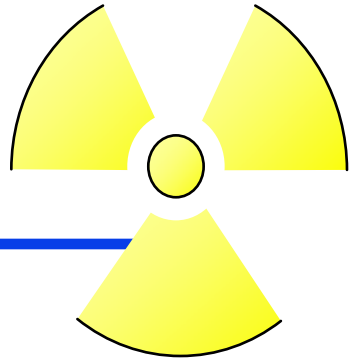
- Radiation, Ionization, & Radioactivity
- Radiation Protection & Safety
- Radiation Dose
- Questions ??

Electromagnetic Radiation



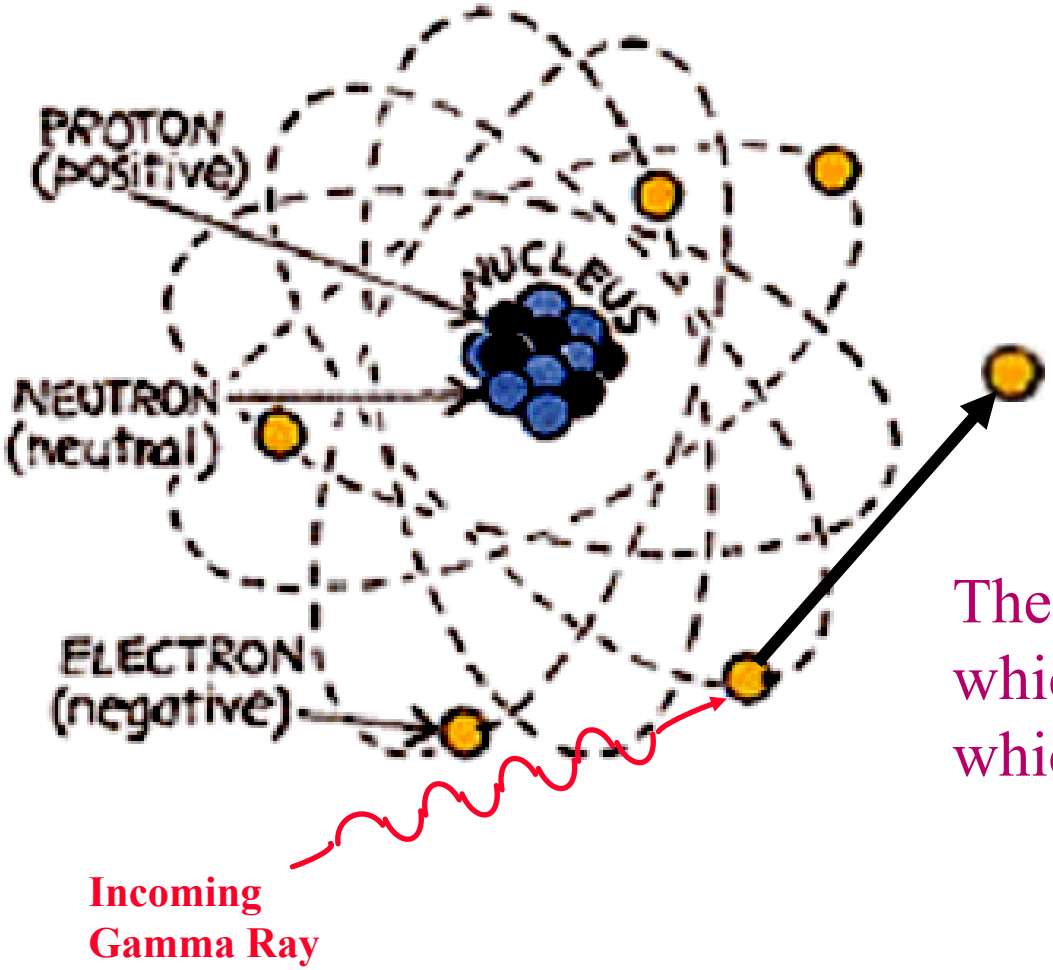
THE ELECTROMAGNETIC SPECTRUM

Definitions



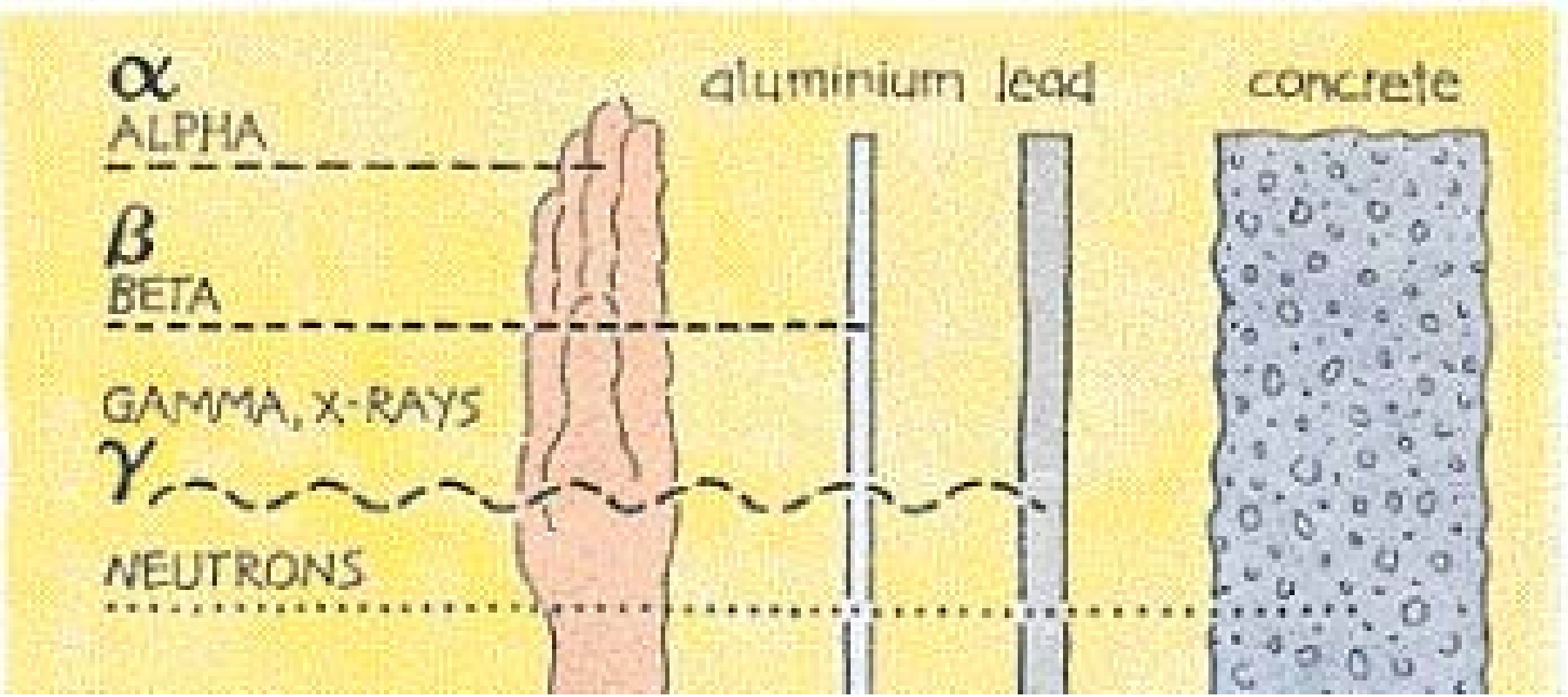
- **Radiation**: Energy (electromagnetic waves or particulates)
- **Ionization:** The removal of electrons from an atom
- **Ionizing Radiation:** Particles or rays with sufficient energy to remove electrons from atoms

Ionization



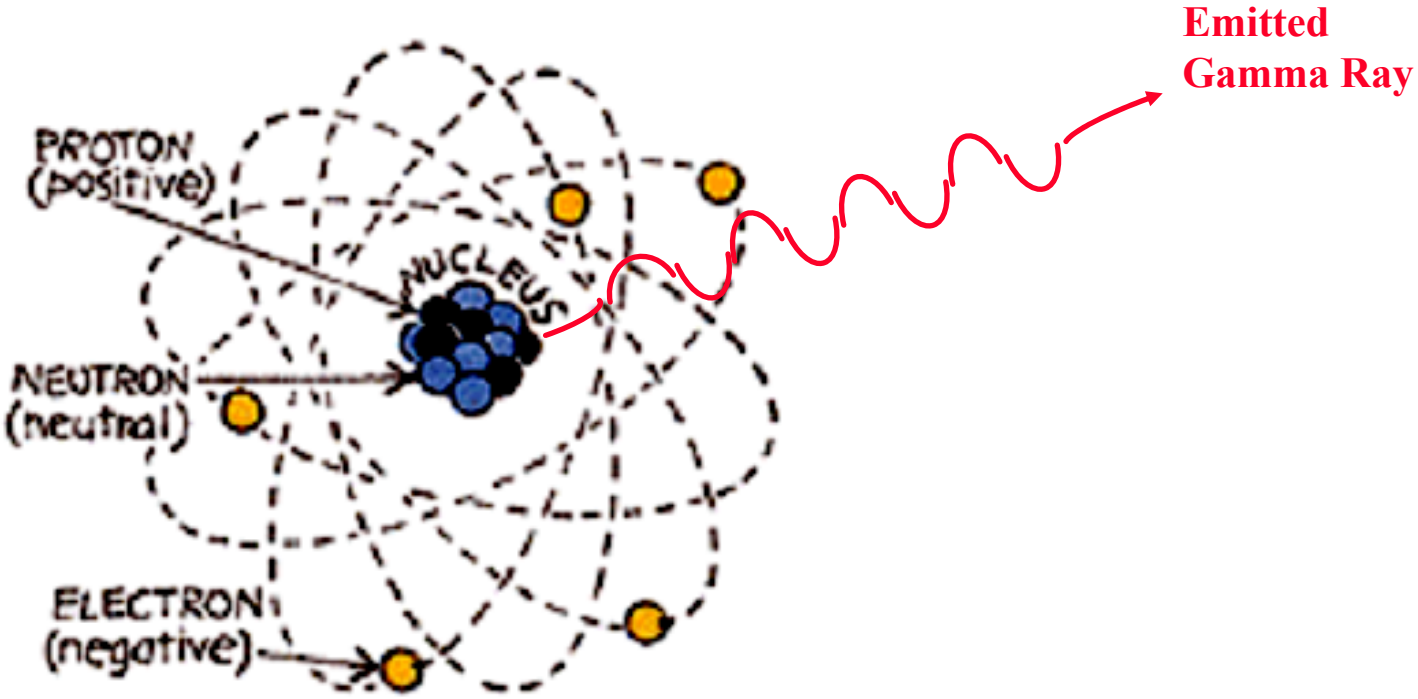
The ionized atom causes changes which **MAY** damage cells, which **MAY** cause health effects

Ionizing Radiation

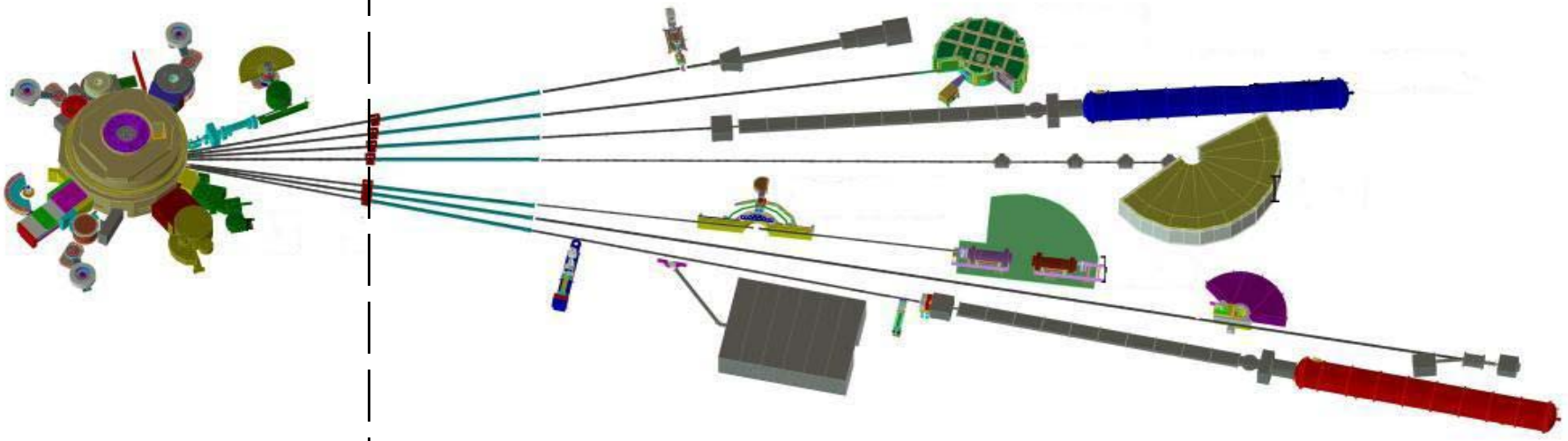


Atoms & Radioactivity

Most atoms are stable, but some may emit excess energy (radiation) and are called radioactive.



Radiation Sources



Confinement | *Guide Hall*

Radiation Exposure

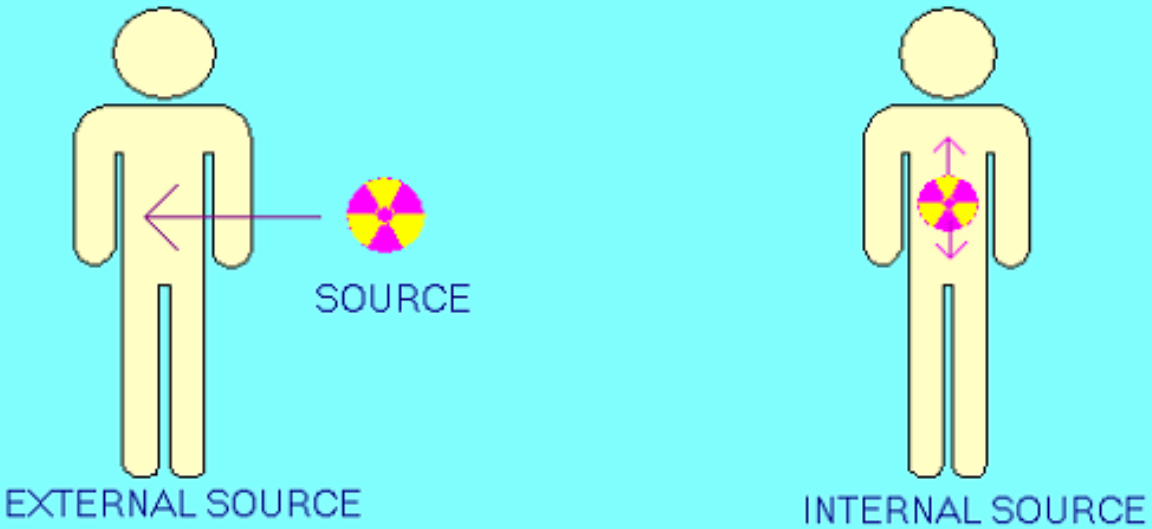
SOURCE GEOMETRY

There are two ways that you can be exposed to a radiation source:

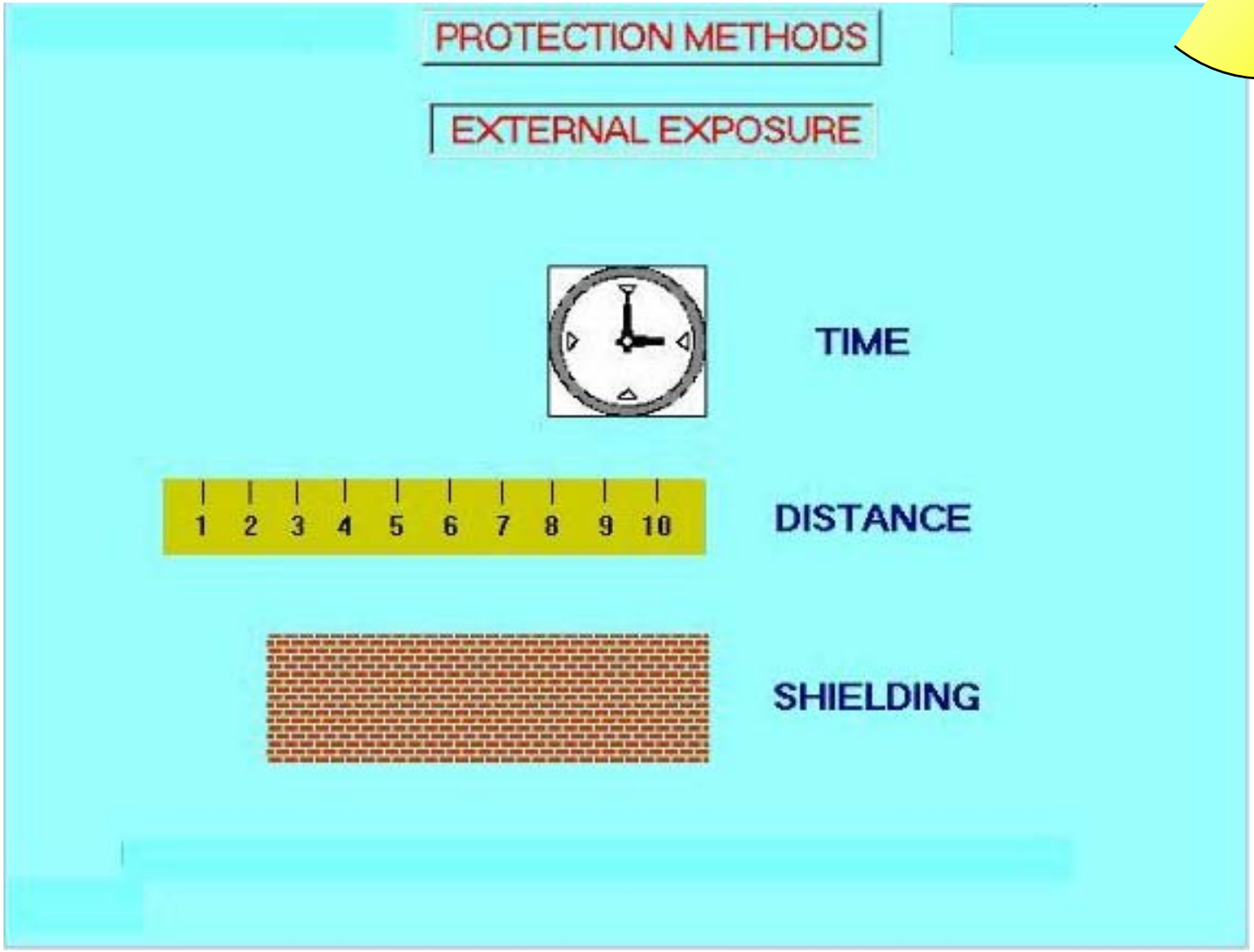
1. If the source is outside the body, you will receive an external exposure.

2. If the source gets into the body, you will receive an internal exposure.

Both kinds of exposure are of equal concern, despite subjective feelings to the contrary by many workers.



Reducing External Exposure



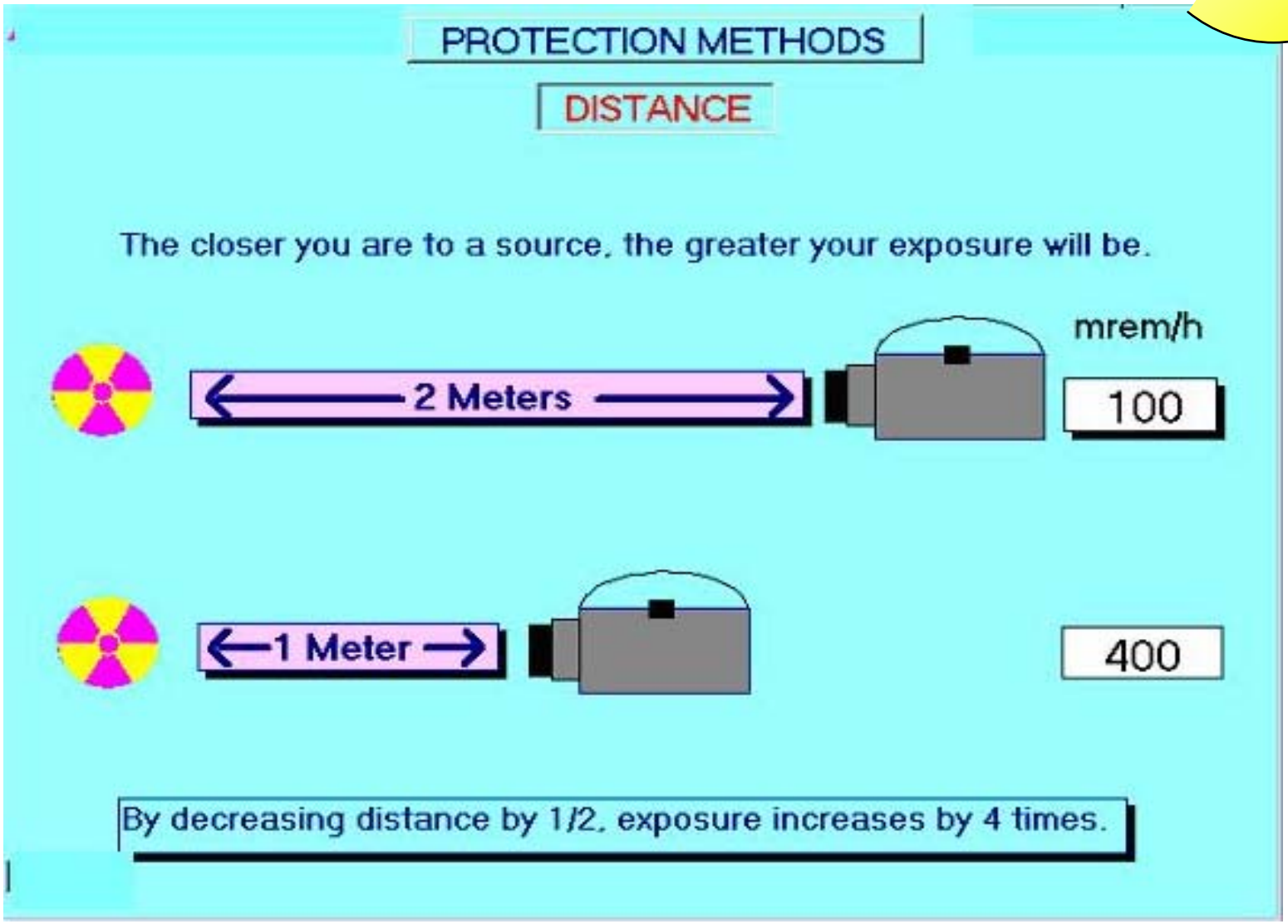
Time

PROTECTION METHODS

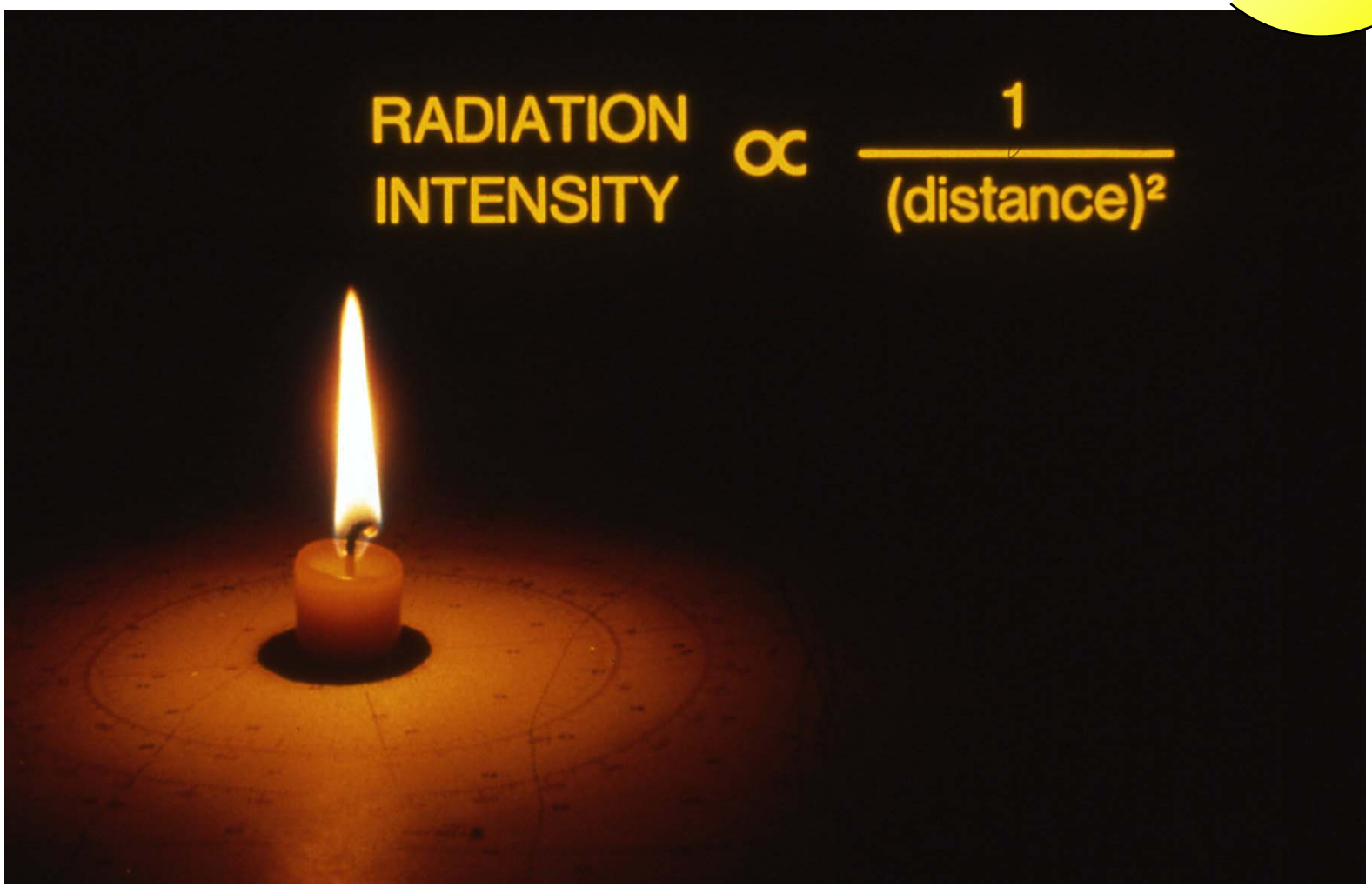
TIME

Always remember that the longer the exposure, the greater the dose, which leads to a greater amount of damage. Thus, your **first protective measure** should be to **minimize the time** of exposure.

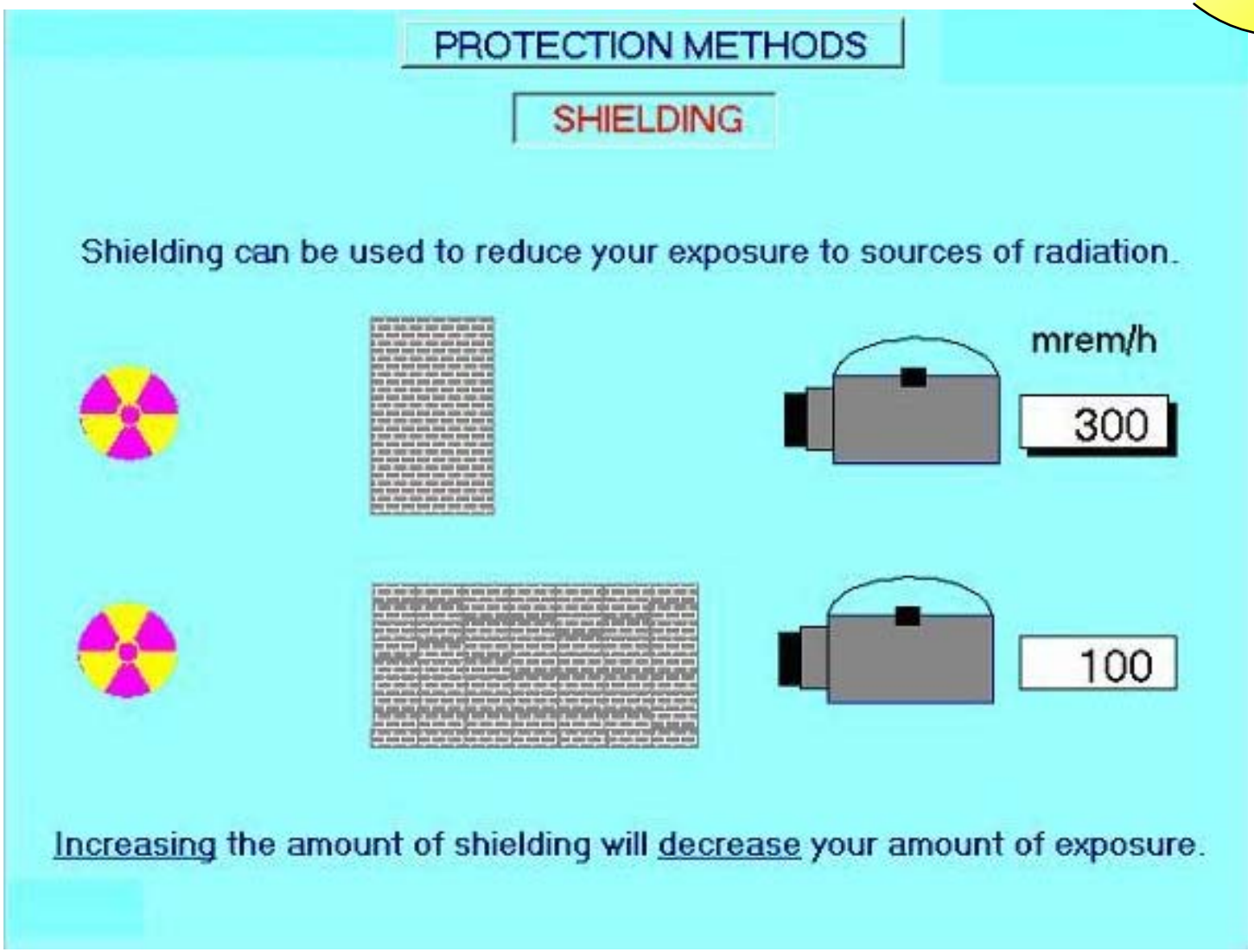
Distance


PROTECTION METHODS
DISTANCE
The closer you are to a source, the greater your exposure will be.
mrem/h
2 Meters
100
1 Meter
400
By decreasing distance by 1/2, exposure increases by 4 times.

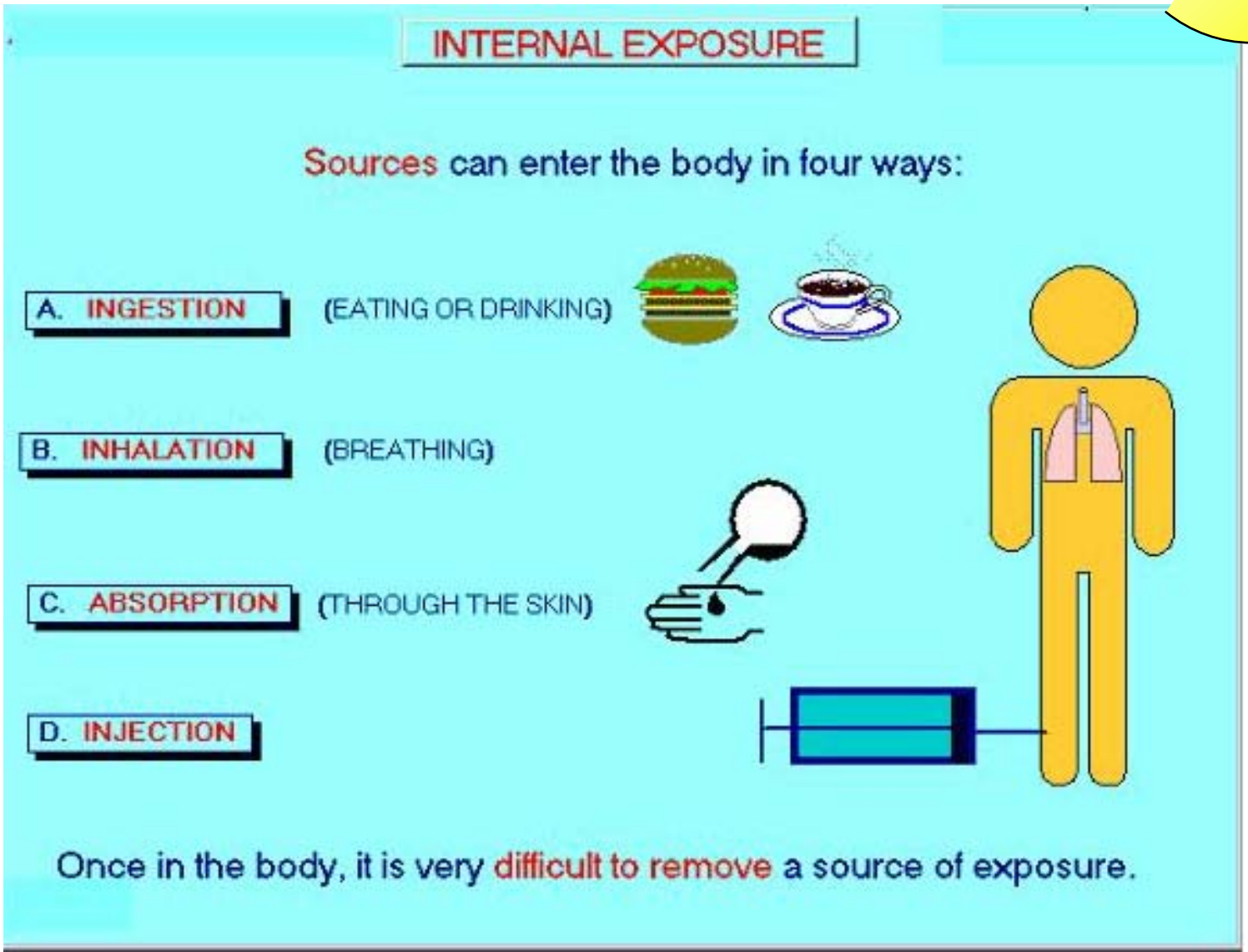
Distance – Inverse Square Law



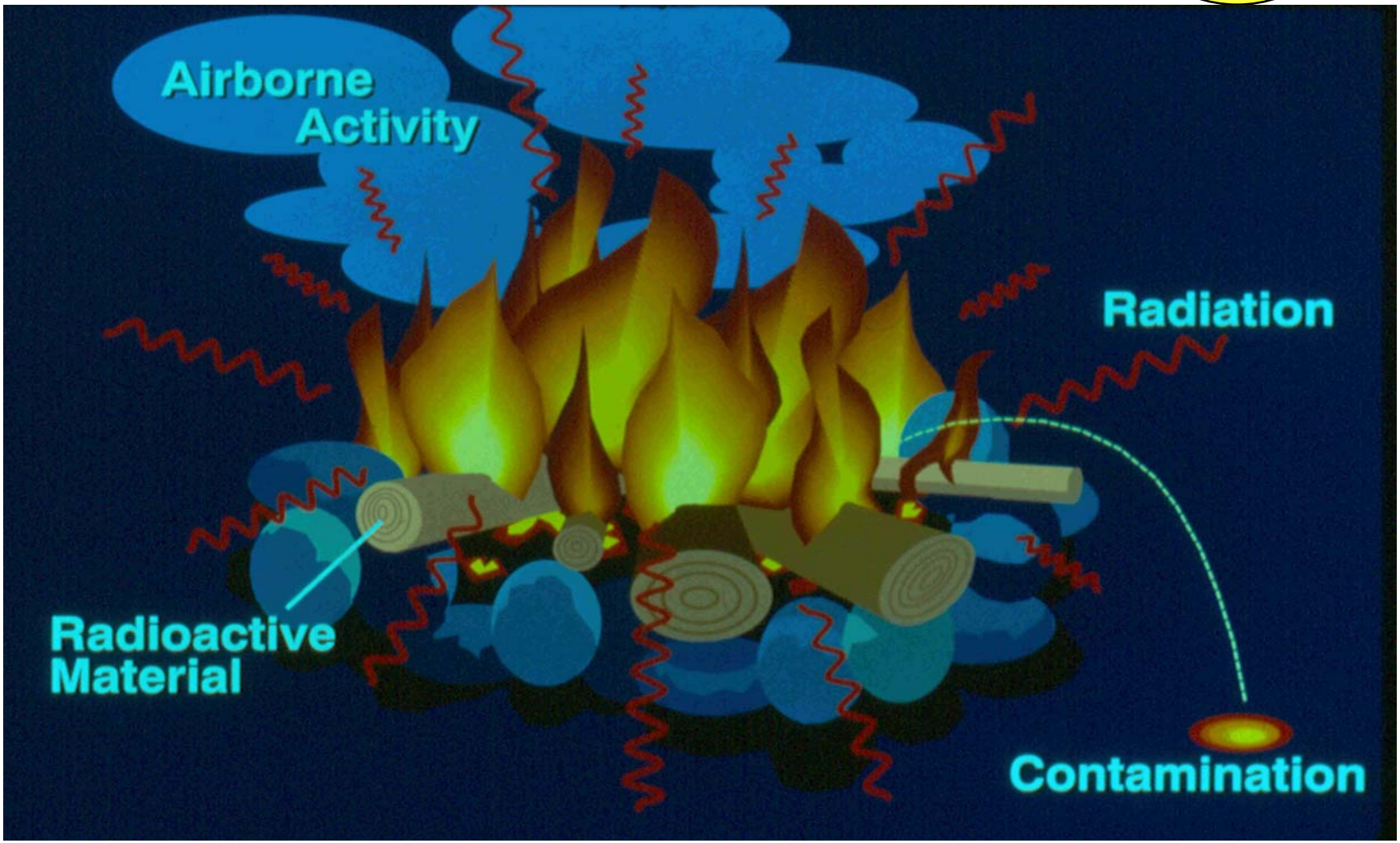
Shielding


PROTECTION METHODS
SHIELDING
Shielding can be used to reduce your exposure to sources of radiation.
mrem/h
300
100
Increasing the amount of shielding will decrease your amount of exposure.

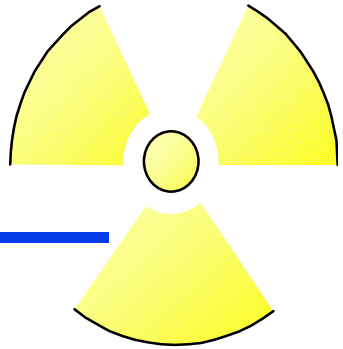
Internal Exposure



Campfire Analogy



Radiation Dose Units



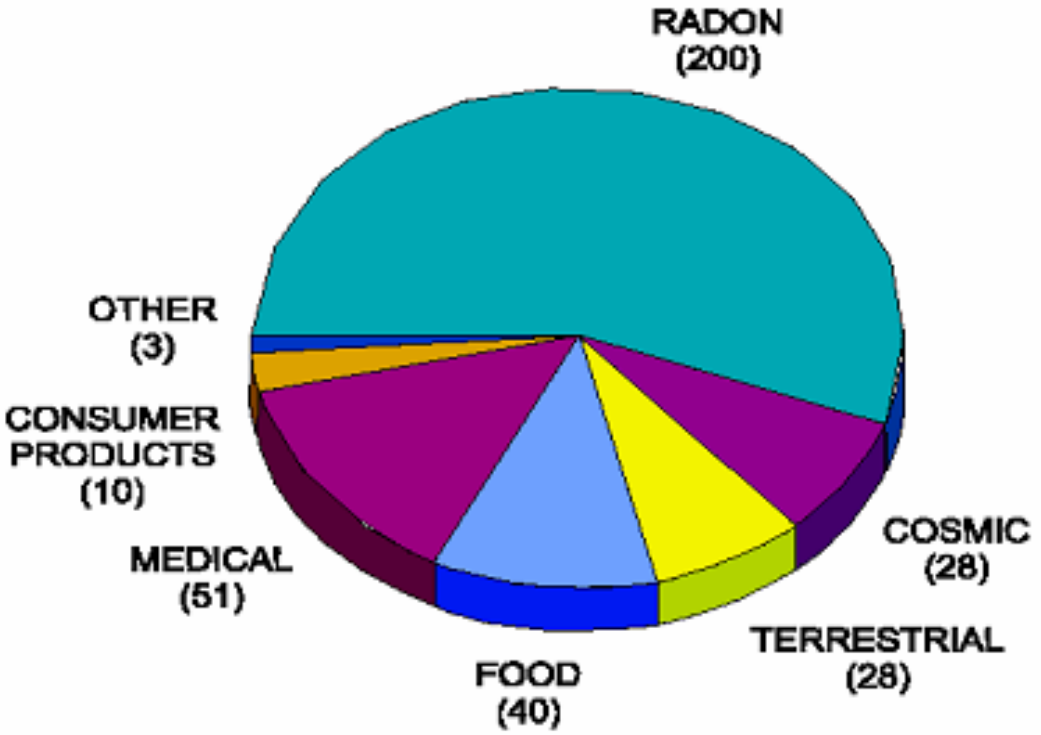
Dose Units are known as the rad and rem

rad = the amount of energy absorbed in tissue

rem = relates the amount of ionization in air (R) or the amount of absorbed energy (rad) to the degree of biological damage

Radiation Type	Quality Factor (QF)
X-ray	1
Gamma rays	1
Beta particles	1
Neutrons	3-10
Alpha particles	20

Average Background Dose



US Average	~ 360 mrem/yr
Denver, CO	~ 700 mrem/yr
Brazil (beaches)	~ 5,000 mrem/yr

Health Physics Labels/Signs

>5 mrem/hr
(whole body dose)

>100 mrem/hr
(whole body dose)

~100,000 mrem/hr
(localized dose)

Radiation Dosimetry

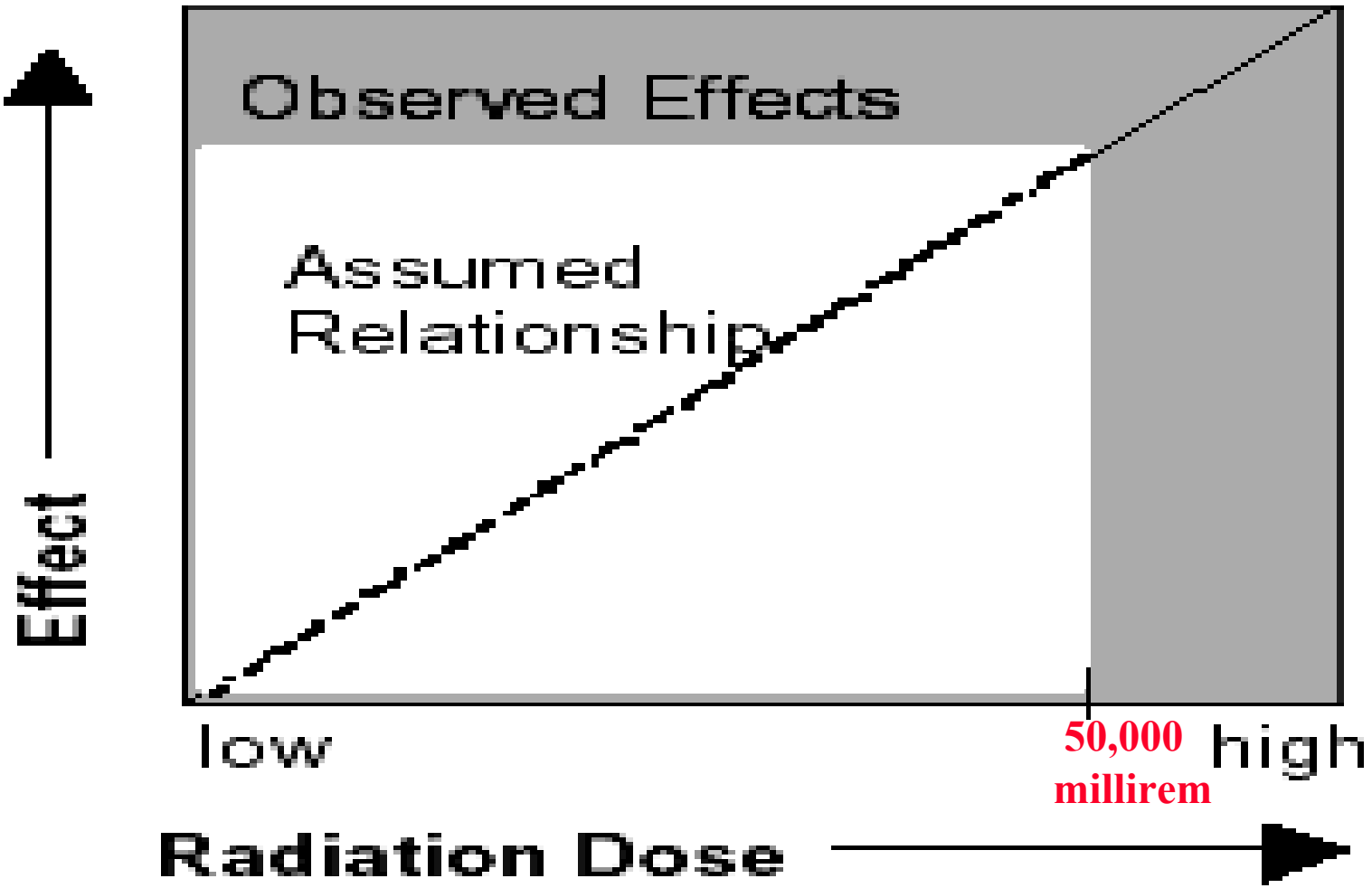
Pocket Dosimeter

Real-Time Dose Readout

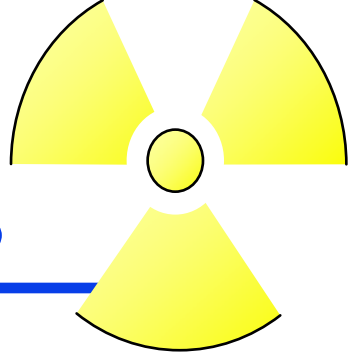
General Public Dose
Limit = 100 mrem/yr

Occupational Dose
Limit = 5,000 mrem/yr

Radiation Dose and Risk



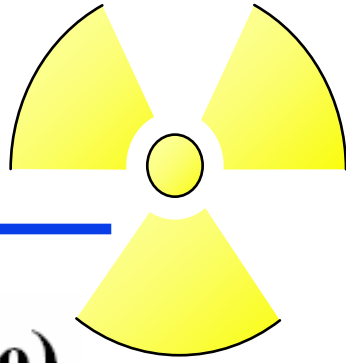
Radiation Risk Comparisons



Activity*	Cause of Death
Smoking 1 cigarette	Cancer, Heart Disease
Travel 50 miles by car	Fatal Accident
Drinking 30 cans of diet soda	Cancer (saccharin)
Eating 100 grilled steaks	Cancer (benzopyrene)
Chest X-ray (10 mrem)	Cancer

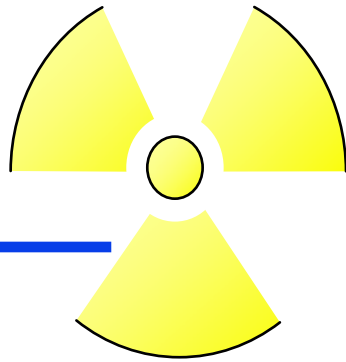
***Performing this activity increases your chance of dying by one in a million (1×10^{-6})**

Loss of Life Expectancy



Cause	Life Lost (time)
Smoking 20 cigarettes a day	6 years
Overweight (by 15%)	2 years
Alcohol consumption (U.S. average)	1 year
Agricultural accidents	320 days
Construction accidents	227 days
Auto accidents	207 days
Home accidents	74 days
Occupational radiation dose (1 rem/y)	51 days

Ionizing Radiation - Overview



Can not see it, feel it, or smell it

- we must rely on training and equipment to protect ourselves

Relatively simple to detect and measure

- unlike chemical and biological hazards
- we can quickly assess and take action

Biological effects have been intensely studied for 50 years