



Biological Effects of Radiation



United States
Environmental Protection
Agency

15th Annual OSC Readiness Training Program

◆ www.oscreadiness.org ◆

What are the effects from radiation?





Radioactive Material can be Harmful !

- ◆ It need not be feared;
- ◆ But it **MUST** command your respect
- ◆ Even as small as 1 Nanocurie (1×10^{-9} Curie) if deposited in the right place can cause cancer.

Biological Effects

- ◆ We know more about biological effects with ionizing radiation than other environmental factors.
- ◆ Four large groups of people provided data:
 - Early Radiologist
 - Atomic bomb survivors
 - Large accidents (Chernobyl)
 - Radiation therapy patients



Chernobyl Reactor Accident



Chernobyl Radiation and Trauma Injuries

Acute Deaths: 31

Injuries and
Hospitalizations: 300

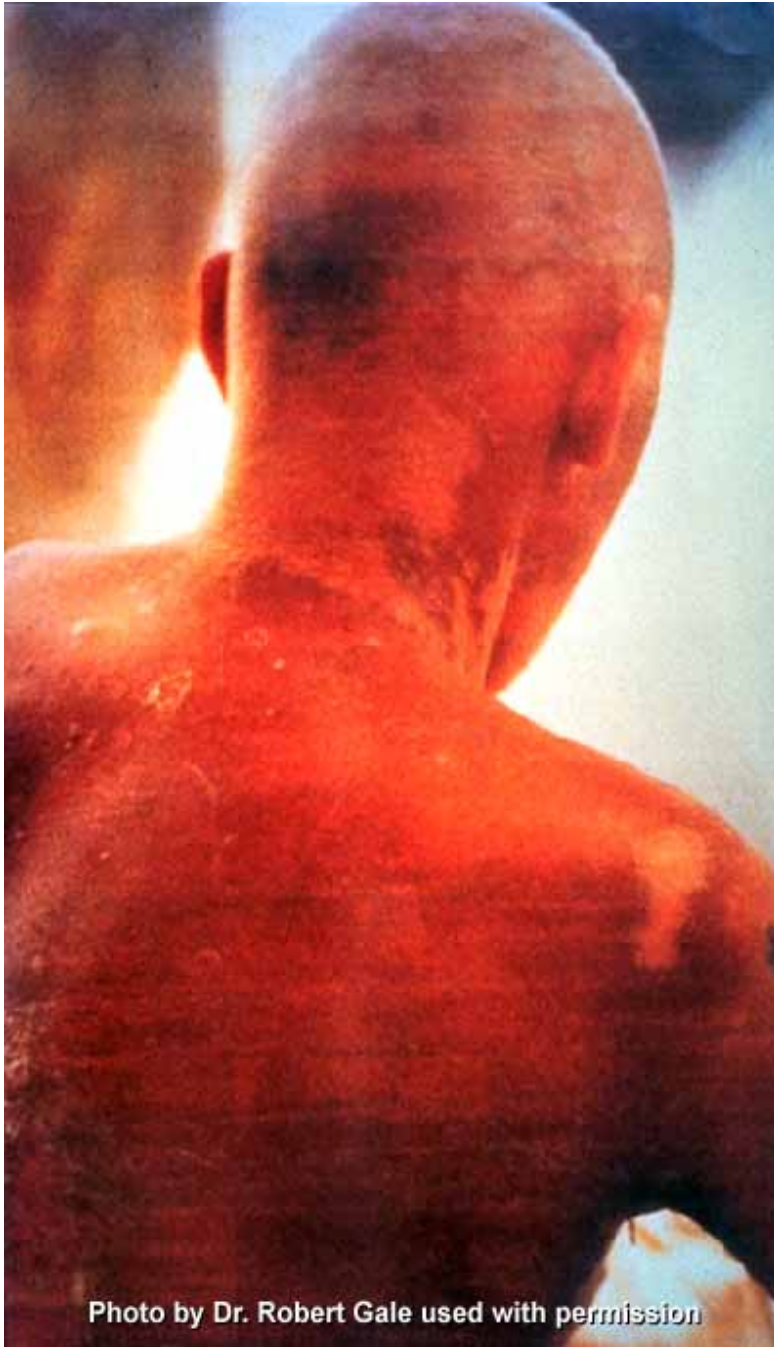
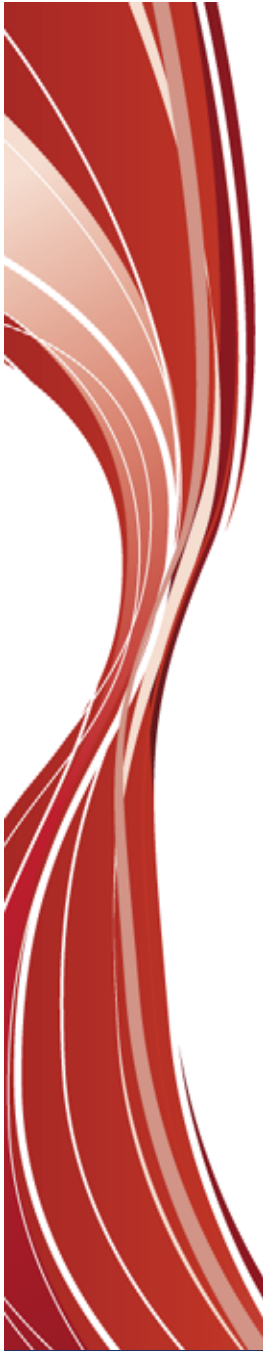


Photo by Dr. Robert Gale used with permission



An acute exposure may only be to a part of the body.

Analytical x-ray machines may deliver doses of several million mrem in a few seconds!

Accidents have resulted in the loss of fingers.

Strong beta emitters (P-32) can provide large doses to the hands.



Injury from X-ray Source



6 - 21 Weeks after exposure. Small ulcerated present.



18 - 21 months after exposure. Tissue necrosis.



After skin grafting

1945 criticality Accident @ Los ALomos



General Public Perceptions

◆ Common Views

- Mysterious
- Cannot detect by our five senses
- Sinister
- Unknown Danger
- Deadly
- Causes Cancer

Media Perceptions

- ◆ **Media avoids complex risk assessments with only two words:**
 - Deadly Radiation
 - Lethal radioactivity
 - Ticking Time bomb
 - Toxic substances
 - Hazardous wastes



General Scientific Perceptions

- ◆ Scientists' Views
 - Part of natural world
 - Easily measurable
 - Risks are well known
 - Major benefit in medicine
 - Cures Cancer

Risks Associated With Occupational Exposure

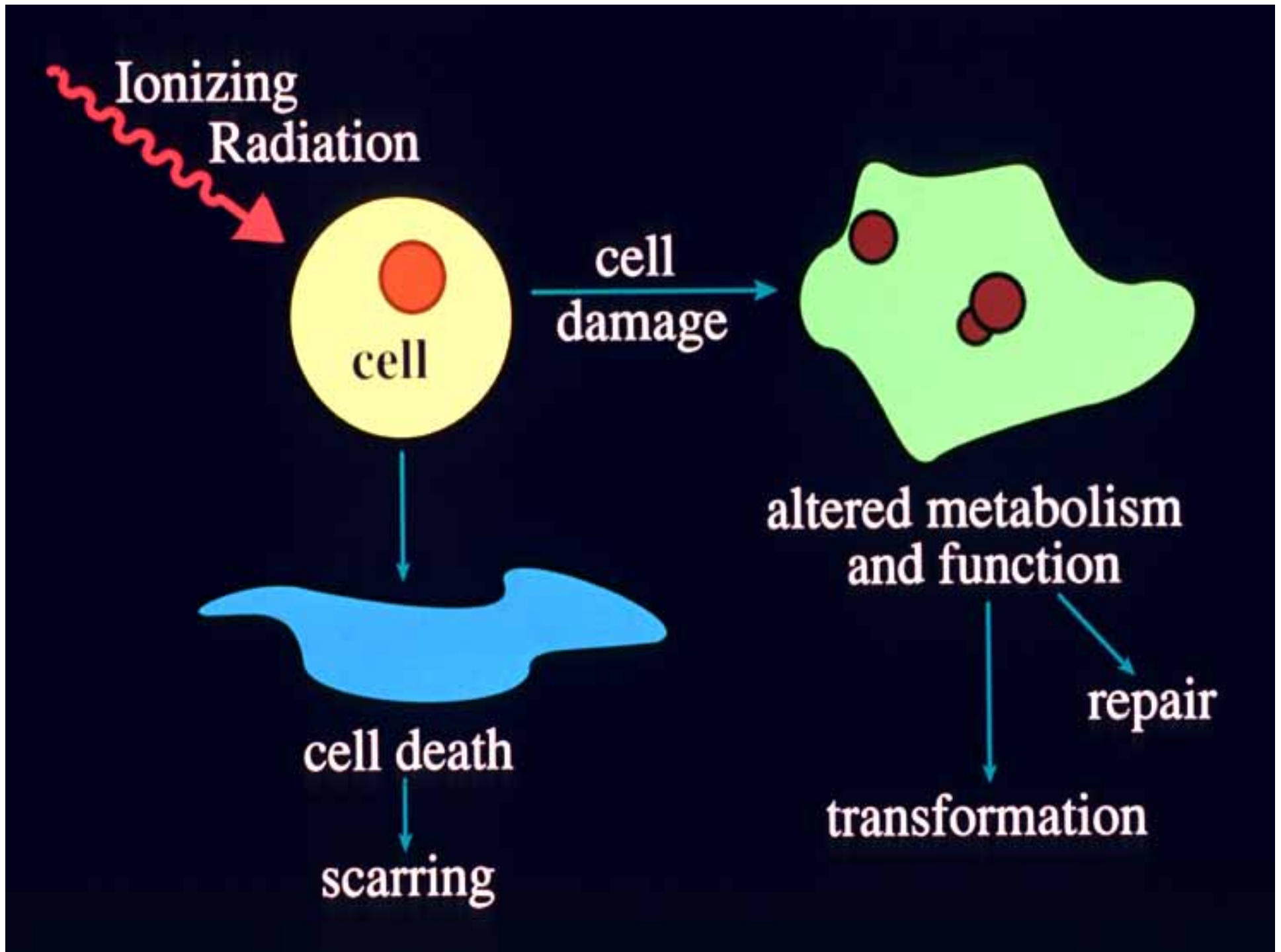
- ◆ Is There a Safe Level of Exposure to Ionizing Radiation ?

Dose vs. Effect

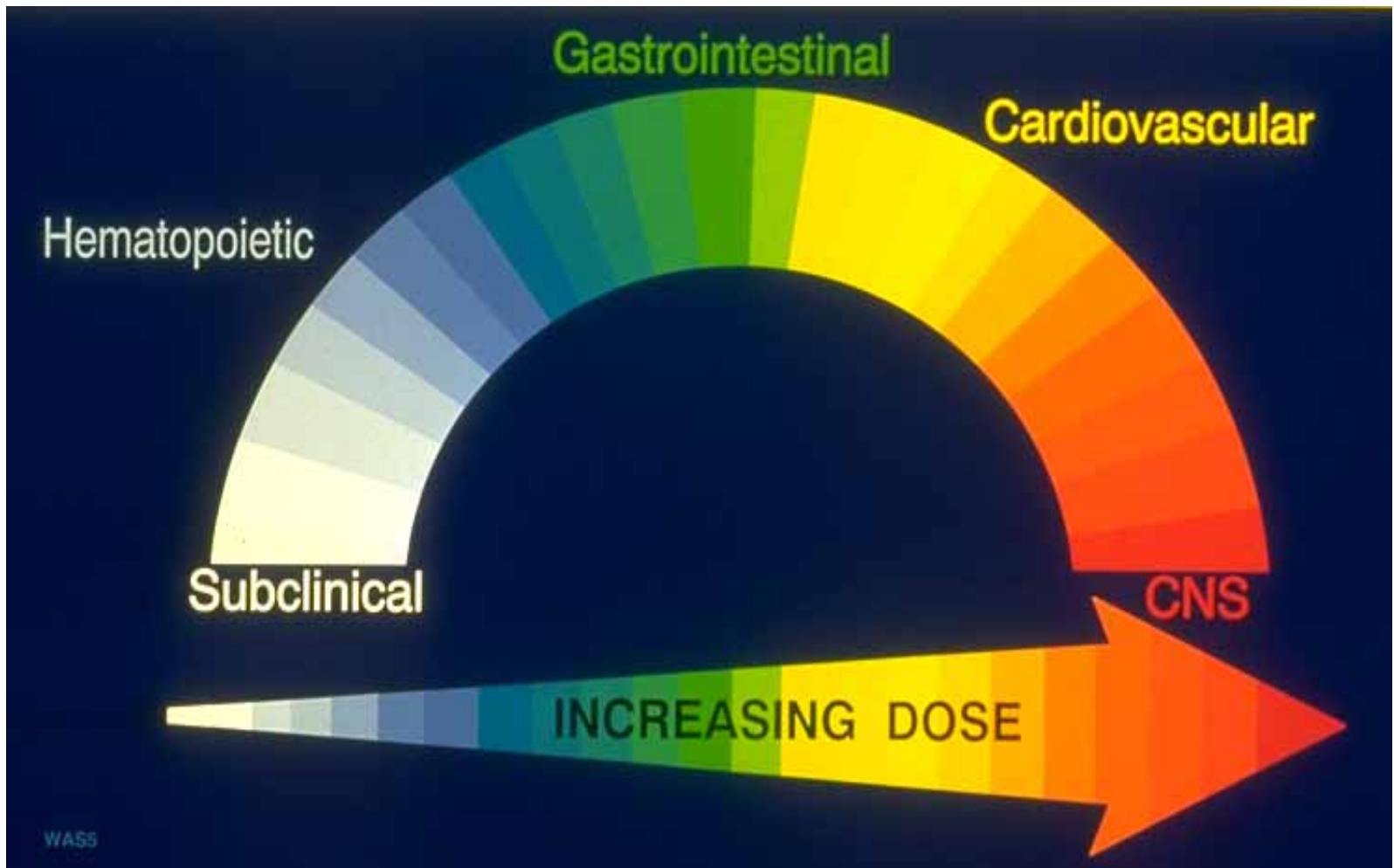
◆ $LD_{50} = 450$ RADs to Whole Body
(Gamma Radiation)

$LD_{50} = 400$ RADs to Whole Body
(30 Day Exposure)

(4 Gray = 400 RADs)



Acute Radiation Syndrome



Other Levels

- ◆ 100 RADs to Whole Body
 - Skin Redness
 - Hair Loss
 - Skin Cancer
 - Onset of radiation syndrome

Other Symptoms

- ◆ Nausea / Vomiting
- ◆ Malaise & Fatigue
- ◆ Increased Body Temperature
- ◆ Hemopoietic Syndrome – Blood
(100 RAD - Gamma)
- ◆ Gastrointestinal Syndrome (400 RADs
Gamma)
- ◆ Central Nervous System Syndrome
(1000 RADs - Gamma)

Some Everyday Risks

- ◆ Same Chance of Death (1 in 1,000,000)
 - 300 Mile Automobile Ride
 - Eat 40 Tablespoons of Peanut Butter
 - Living 2 Days in Boston
 - Drinking 0.5 Liter of Wine
 - Living with a Smoker for 2 Months
 - 2.5 mRem to Whole Body

Dose vs. Effect

- ◆ Hiroshima
- ◆ Nagasaki
- ◆ Czech Mine Workers
- ◆ Industrial Accidents
- ◆ Military Accidents
- ◆ Medical Accidents
- ◆ Chernobyl

High Dose Effects

- ◆ But What About Low Dose Effects ?

Does ZERO Dose EQUAL ZERO Risk ?



Acute Effects of Exposure

- ◆ Skin Redness (Sunburn-like)

Radiation Therapy Accident



Very Lucky Lady!



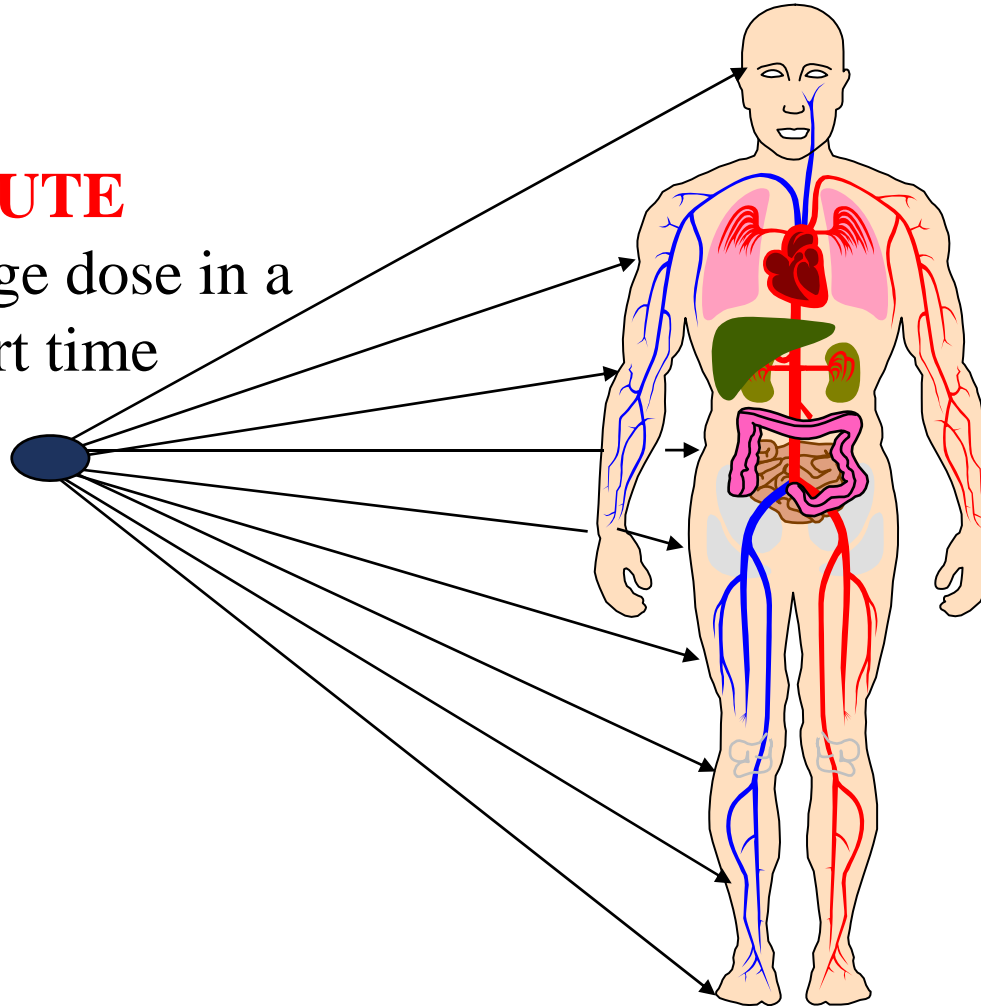
Health Effects

- ◆ Somatic
 - Tissue Damage
 - Skin Redness
 - Hair Loss
 - Sterility
 - Cancer

Biological effects depends on whether it is an ACUTE DOSE or a CHRONIC DOSE.

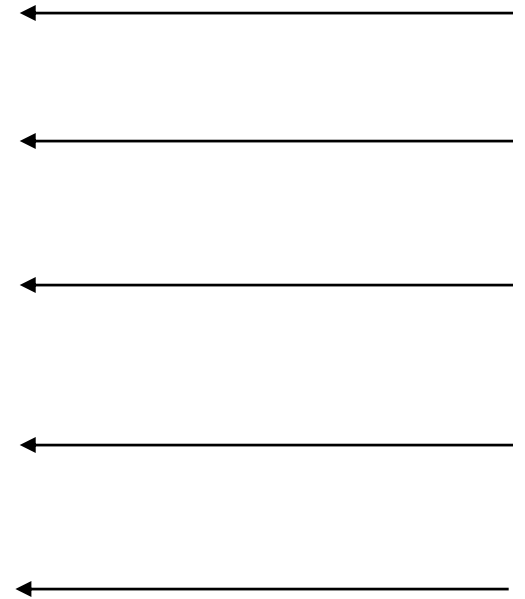
ACUTE

Large dose in a short time



CHRONIC

Small doses over a long time





Health Effects

- ◆ Genetic
 - Mutations
 - DNA Damage
 - Birth Defects



Risks Associated With Occupational Exposure

- ◆ Delayed Effects

 - Cancer


 - Bone Cancer

 - Lung Cancer

 - Leukemia

 - Cataracts

Annual Exposure Limits



◆ Whole Body	5,000 mRem
◆ Skin	30,000 mRem
◆ Eyes	15,000 mRem
◆ Hands, Feet, Arms Ankles (Extremities)	75,000 mRem

Women of Reproductive Age

◆ Lower Exposure Limits:

500 mRem per Year

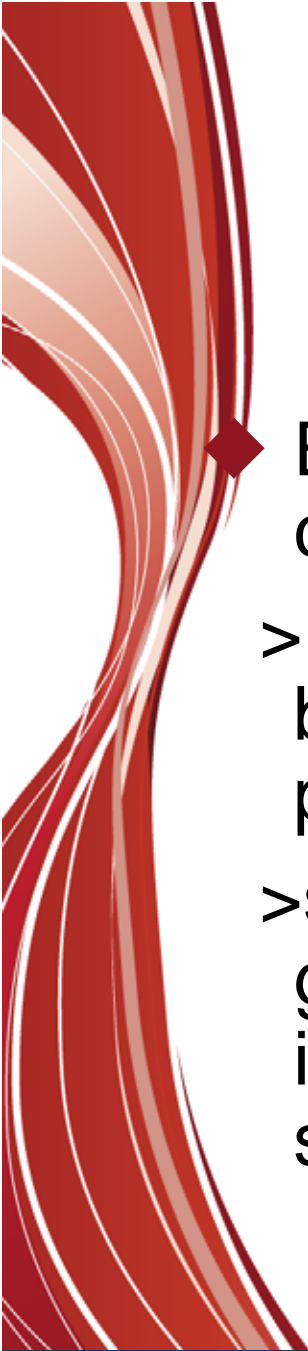
No More Than 40 mRem / Month !

First Trimester is most Sensitive Time

Modes of Exposure

- ◆ External
 - Irradiation
 - External Surface Contamination

Understanding Exposure

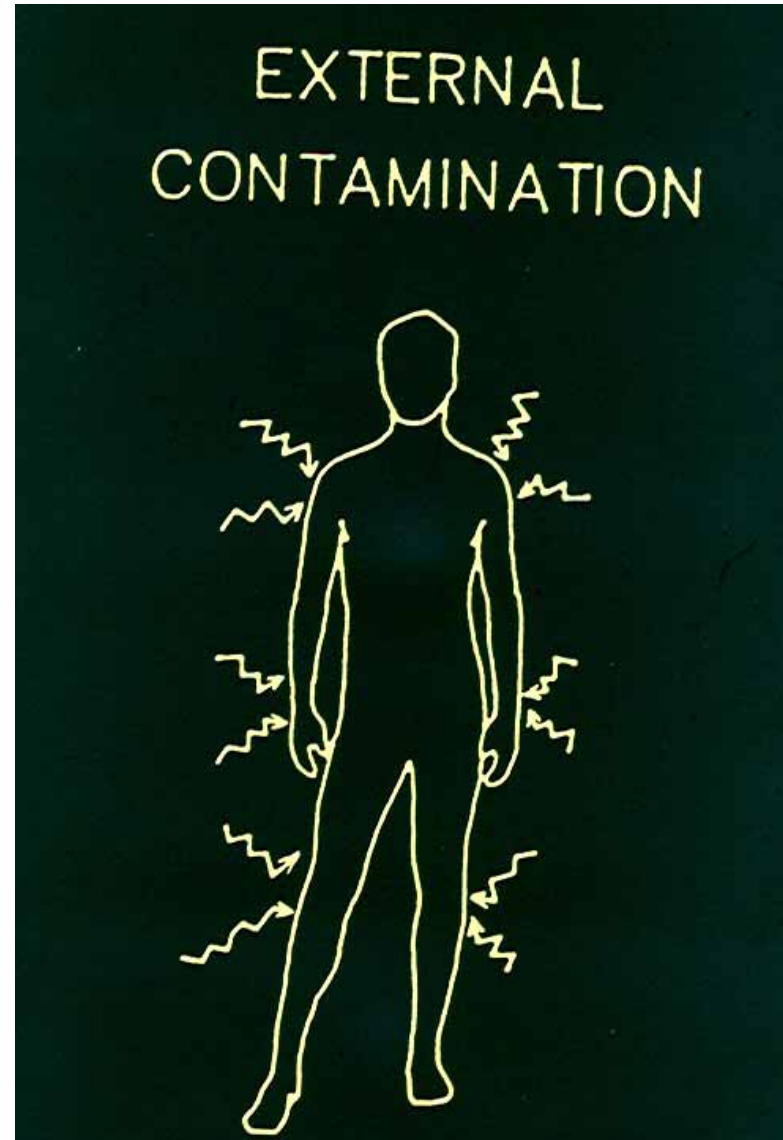
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- ◆ Exposure may be known and recognized or clandestine as:
 - >large radiation exposures, such as a nuclear bomb or catastrophic damage to a nuclear power station
 - >small radiation source emitting continuous gamma radiation producing chronic intermittent exposures(such as radiological sources from medical treatment)

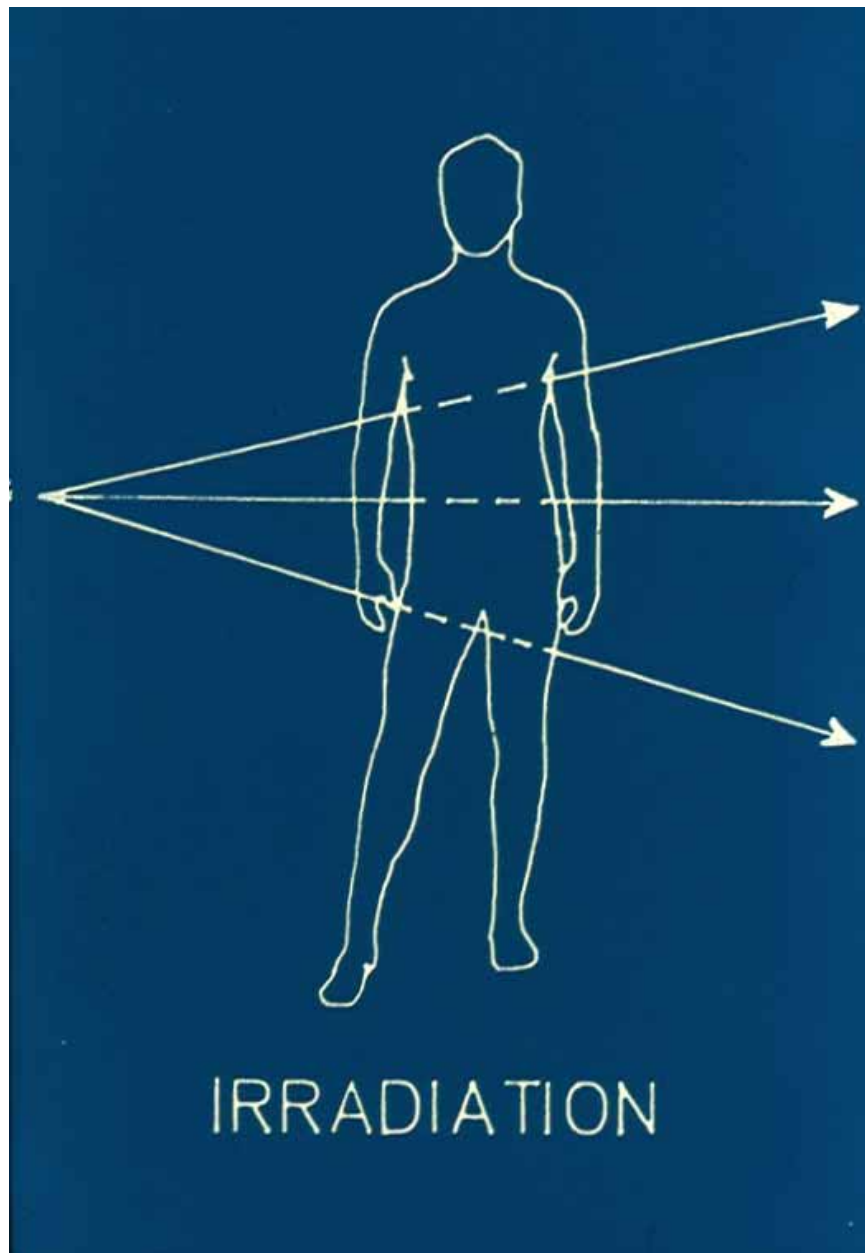
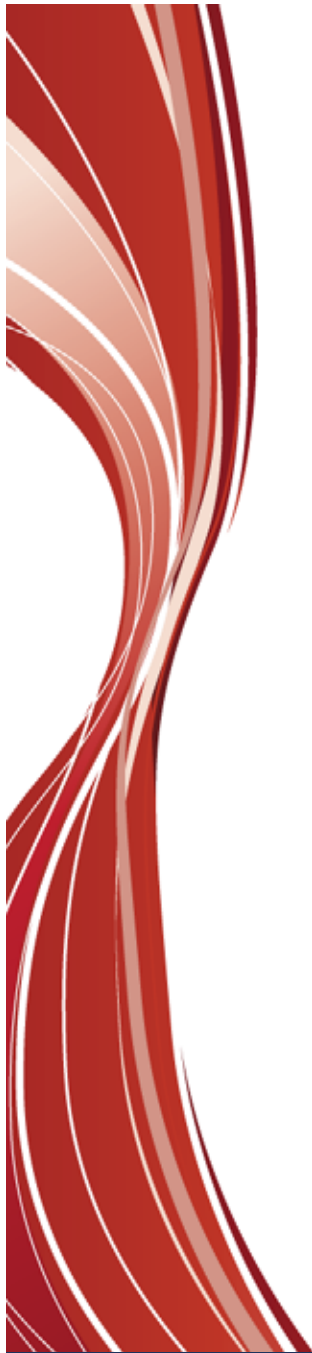


Understanding Exposure Cont'd

- >skin contamination with radioactive material (“external contamination”)
- >internal radiation from absorbed, inhaled, or ingested radioactive material (“internal contamination”)

External Contamination





Internal Contamination

INTERNAL
CONTAMINATION



Modes of Exposure

◆ Internal

Avoid:

- >Inhaling It
- >Absorbing It thru Your Skin
- >Eating It
- >Getting Punctured by a Contaminated “Sharp”

“ Enough Said ... ”

