Health Effects of Radiation

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Types of Health Effects

Health effects of ionizing radiation upon humans are often broadly classified into two major types:

- **Prompt (short-term) effects** that appear immediately after exposure
- **Delayed (long-term) effects** that appear months or years after exposure.

Prompt (short-term) effects

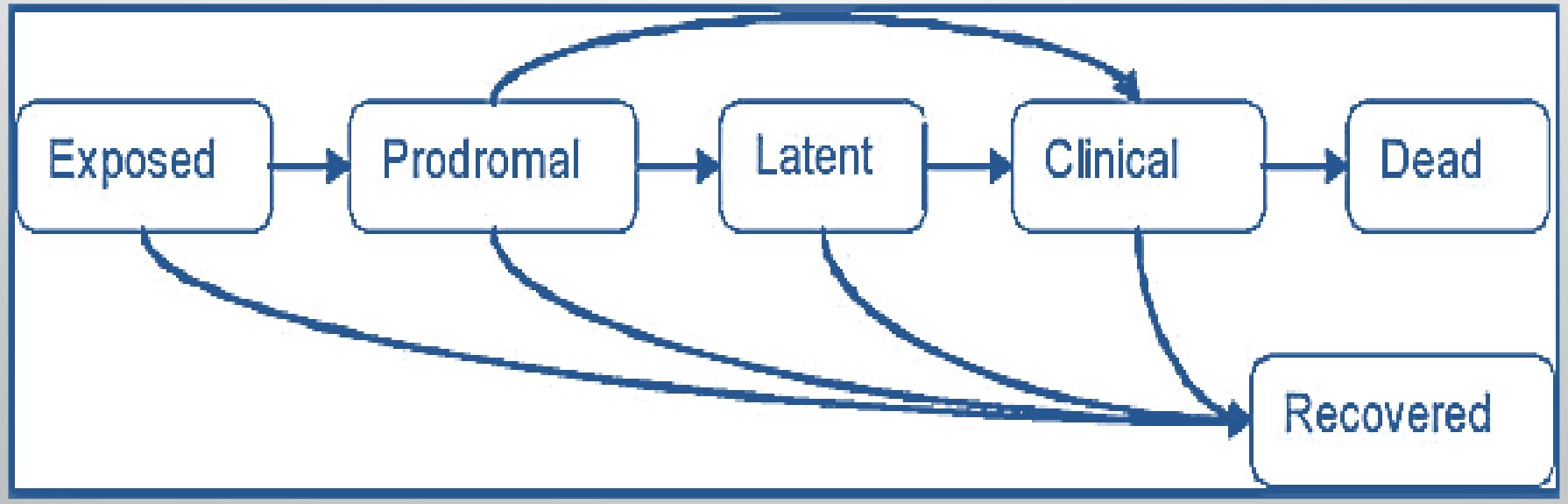
According to the **part of body exposed** and **type of radiation**, it can be classified into:

A. Acute radiation syndrome (ARS)

B. Cutaneous radiation syndrome (CRS).

A. Acute radiation syndrome (ARS)

- It is also known as *radiation sickness* or *radiation poisoning*
- It occurs after *whole or partial* body exposure to deeply penetrated radiation (gamma, neutron) in a very short period of time (usually minutes).
- Total health effects present within 24 hr of exposure & last for several months
- Acute Radiation syndromes progresses in four phases:



Phases of Acute Radiation syndromes

1) Prodromal phase

Symptoms appear in the first 2 days after brief exposure to radiation and include:

1. **nausea**
2. **Vomiting**
3. **Diarrhea**
4. **Abdominal pain**
5. **Fever, and**
6. **Eye burning**

Phases of Acute Radiation syndromes

2) Latent Phase

- Symptoms of illness may subside
- Individual show signs of temporary improvement
- The length of this phase generally decreasing as dose increases.
- It may not be present at all for very large doses.

Dose (rad)	100-200	200-400	400-600	600-1000	> 1000
Latent Period (day)	> 30	18-28	8-18	< 7	3-5

Phases of Acute Radiation syndromes

3) Manifestation Phase dependent on the dose received:

- Low doses result in hematopoietic syndrome,
- Moderate doses result in gastrointestinal syndrome
- Large doses result in neurovascular syndrome and rapid death

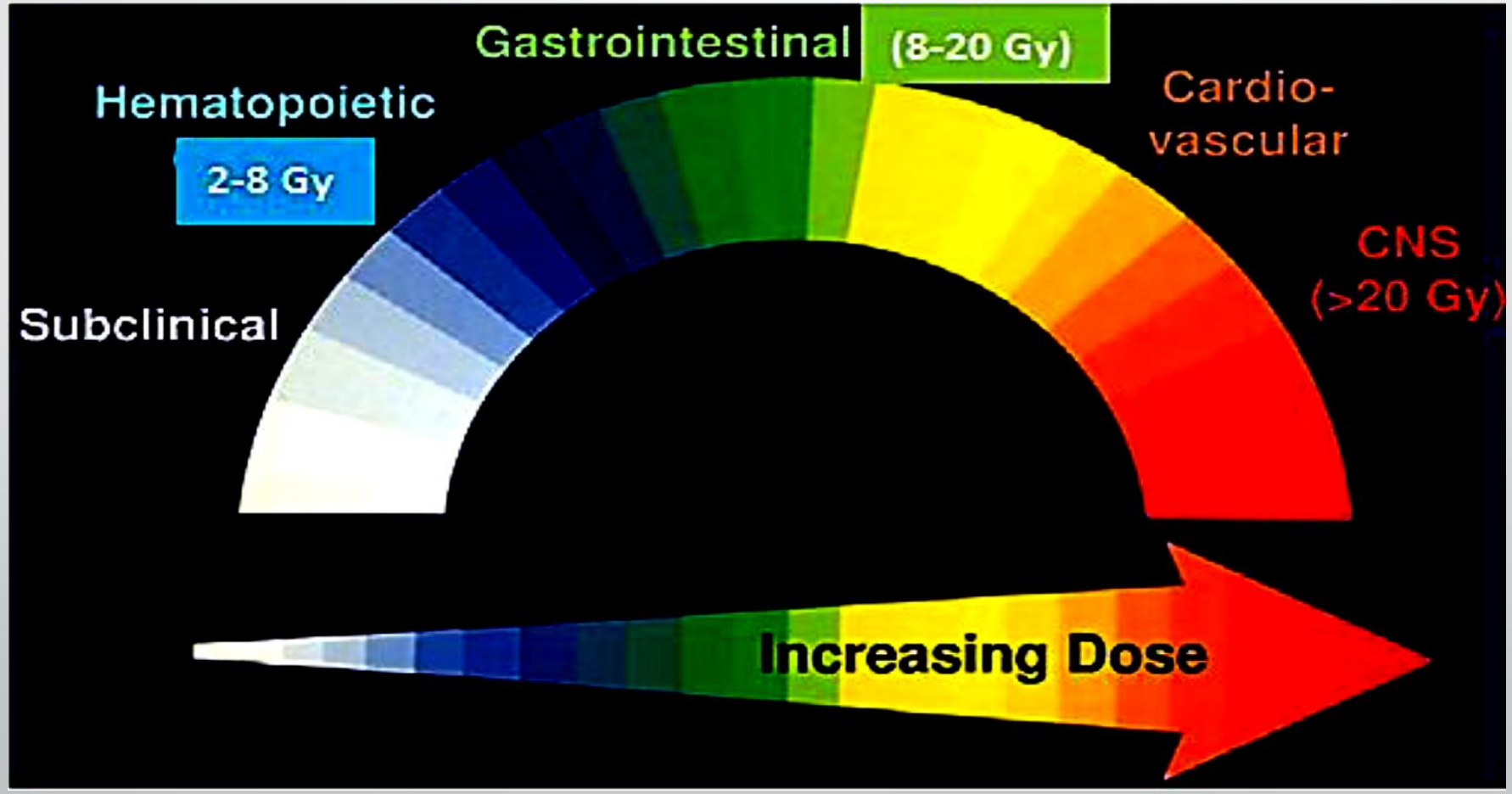
4) Recovery or Death Phase

- ***Recovery*** (dose below 800 rad up to 1,000 rad) (adequate medical care)
- ***Death*** (dose above 1,000 rad)

Dose (rad)	100-200	200-400	400-600	600-1000	> 1000
Lethality%	0	0 - 50	20 - 70	50 - 100	100

Subtypes of Acute Radiation syndromes

According to the manifestation phase, acute radiation syndrome (ARS) can be divided into three syndromes:



a) Hematopoietic Syndrome:

- It occurs at doses of 200 - 800 rad (2-8 Gy)
- Killing of precursor cells in bone marrow resulting in ***pancytopenia*** (severe depletion of all types of blood cells which is manifested by:

  1. ***Leukopenia*** (less WBCs) that leads to infections
  2. ***Thrombocytopenia*** (less blood platelets) leads to bleeding
  3. ***Anemia*** (less RBCs)

- This syndrome is often survivable, but death may occurs within 60 days following exposure that can be prevented by:

  1. **Bone marrow transplantation (BMT)**
  2. **Antibiotics therapy**

b) Gastrointestinal Syndrome:

- It occurs after doses greater than 800 up to 2000 rad (8-20 Gy)
- It causes severe damage to mucosal lining of gastrointestinal tract
- Usually results in death at about 1 week after irradiation due to:

  1. infection

  2. diarrhea & vomiting lead to electrolyte imbalance & dehydration.
- Intensive nursing can prevent early death from this syndrome with:

  1. antibiotics

  2. fluid & electrolyte replacement

c) Neurovascular Syndrome:

- It occurs following large doses of radiation >2000 rad (> 20Gy)
- damaged cells of central nervous system
- Patient undergoes a rapid illness that characterized by:

1. disorientation

2. body tremors

3. brain clot

4. shock

5. patient die within 1-2 days.

B. Cutaneous Radiation Syndrome (CRS)

- It occurs after ***partial body exposure*** to high energy ***beta radiation***
- Usually does not penetrate deeply enough in tissue so:
- Can not cause hematopoietic, gastrointestinal, neurovascular syndromes
- only cause skin effect known as radiation burn.
- Phases of CRS are the same as for the ARS (Prodromal, Latent, Manifest Illness, and Recovery) with chronic or late effects, but without death.

- Within a few hours after irradiation, skin ***basal cell*** is damaged causing:
  1. **transient erythema** (reddening of skin)
  2. **itching**
  3. **temporary hair loss**
- Very large doses over 1,000 rad can cause:
  1. ***alopecia*** (Permanent hair loss),
  2. ***damaged sebaceous & sweat glands***
  3. ***skin pigmentation***
  4. ***ulceration or necrosis***
  5. ***desquamation*** (shedding of the skin)

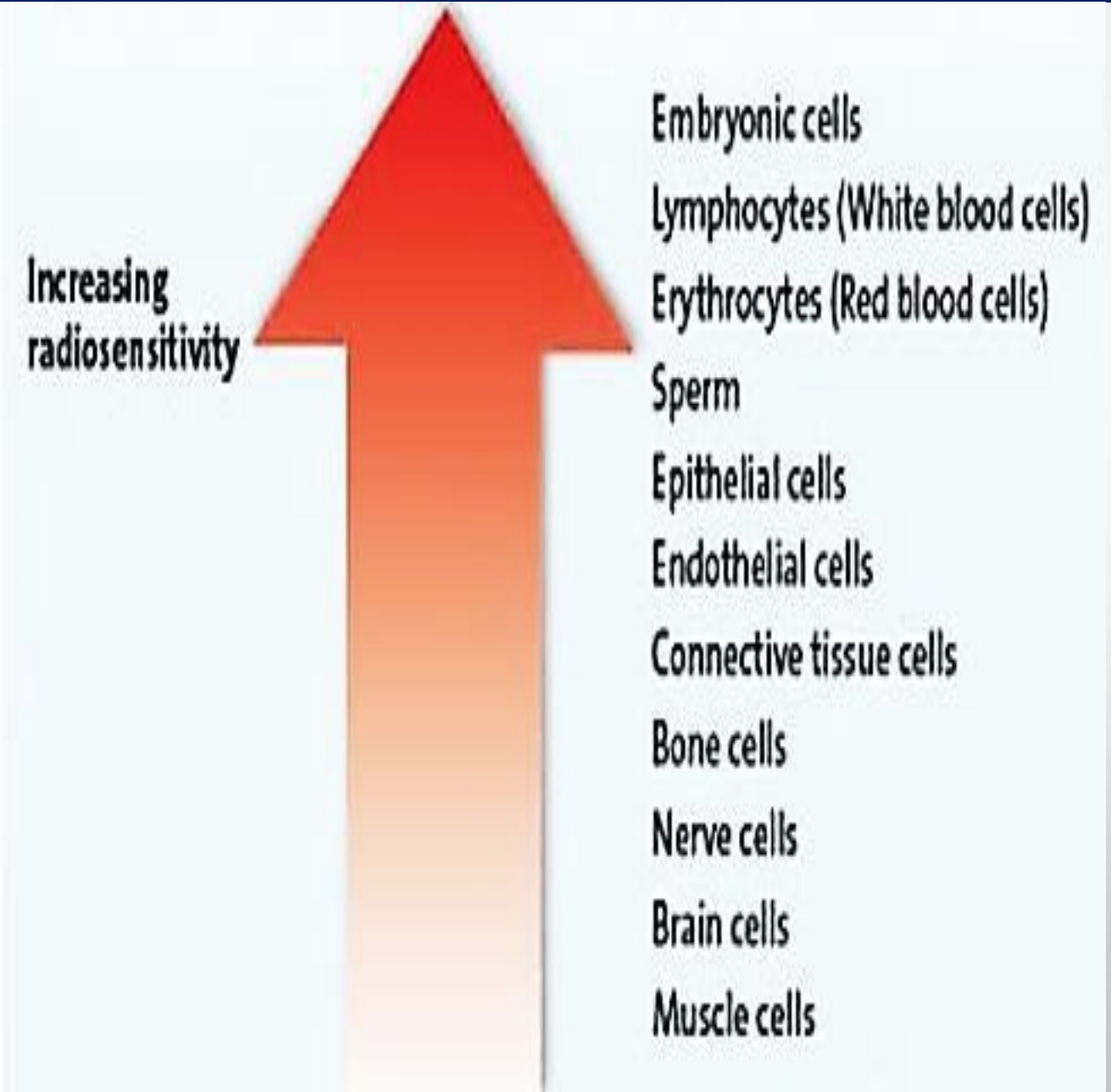

THANK YOU

Determinants of Radiation Effects

1. Type of radiation
2. The radiation dose
3. The dose rate of radiation
4. Species Sensitivity (*LD50/30*)

Organism	LD_{50} (rad)	Organism	LD_{50} (rad)
Dogs, pigs	300	Cattle, rats, horses	630
Goats	350	Rabbits	800
MAN	400	Chickens	1000
Mice, monkeys	450	Insects	5000
Sheep	540	Turtles	15000
Fish	550	Bacteria/viruses	100000

Determinants of Radiation Effects



5. Cell Sensitivity *(Bergonie & Tribondeau Law)*

Radio-sensitivity of a tissue is *directly* proportional to the ***rate of proliferation*** of its cells, and *inversely* proportional to the degree of ***cell differentiation***.

Determinants of Radiation Effects

6. Part of the body exposed

Extremities (hands or feet) are able to receive a greater amount of radiation with less resulting damage than blood forming tissues found in the bone marrow.

7. Age of individual

As a person ages, cell division slows and body is less sensitive to effects of radiation.

8. Area exposed

The larger the area exposed, the greater the overall damage. Therefore, radiation therapy doses should be delivered to very limited areas (to tumor sites) rather than whole-body irradiation of the same dose.