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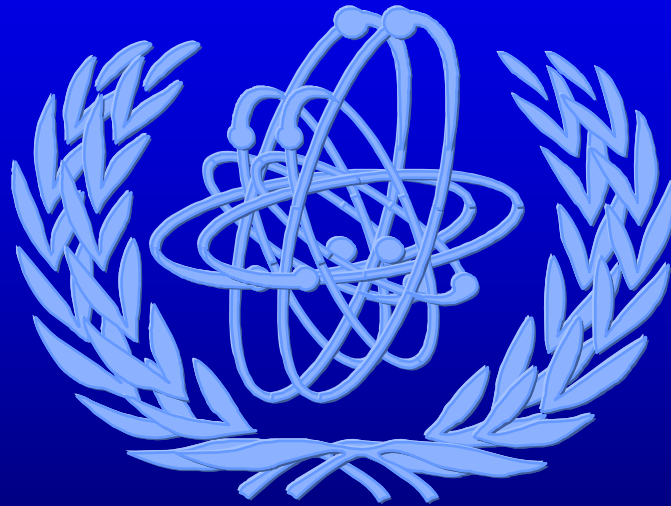
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# Medical and Public Health Preparedness



## Medical Preparedness for Radiation Emergencies - Overview

*Lecture*

# Introduction

- **General objectives of the emergency response:**
  - **To reduce the risk or mitigate the consequences of the accident at its source**
  - **To prevent or reduce deterministic health effects**
  - **Reasonably reduce the risk of stochastic effects**

# Objectives of Emergency Medical Preparedness and Response

- **To perform treatment of life threatening injuries**
- **To implement actions needed to meet general objectives of emergency response**
- **To participate in training, drills, and exercises to update and enhance basic knowledge and skills necessary to meet general objectives of emergency response**

# Fact

**Each member of emergency response organisation needs to understand the basics of radiation medicine to meet the objectives efficiently**

# Content

- **Ionising radiation and human**
- **Health effects of radiation: description, examples**
- **Medical aspects of radiological accidents**
- **Psychological aspects of radiological accidents**
- **Medical response as a part of the overall emergency preparedness and response**
- **Infrastructure and functional requirements for medical preparedness**
- **Summary**

# Overview

Radiation causes ionisation of:

**ATOMS**

which will affect

**MOLECULES**

which may affect

**CELLS**

which may affect

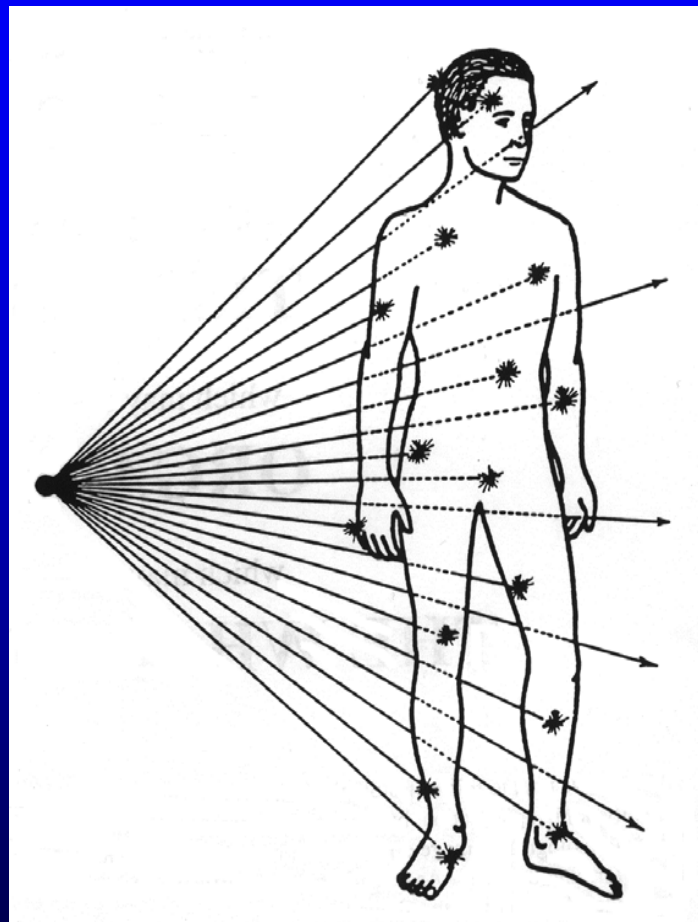
**TISSUES**

which may affect

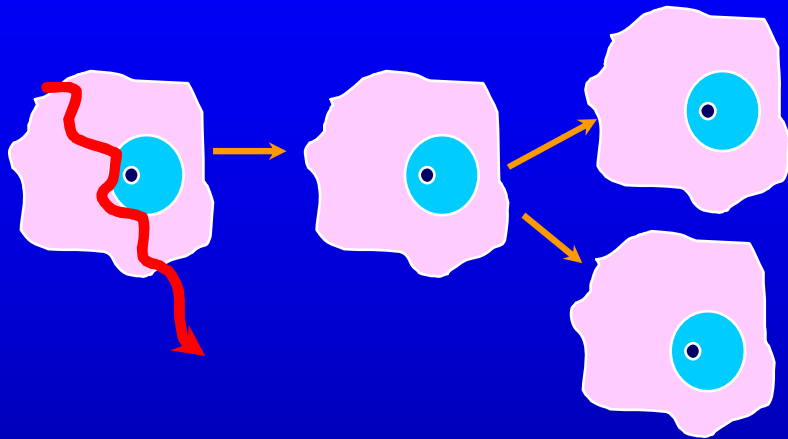
**ORGANS**

which may affect

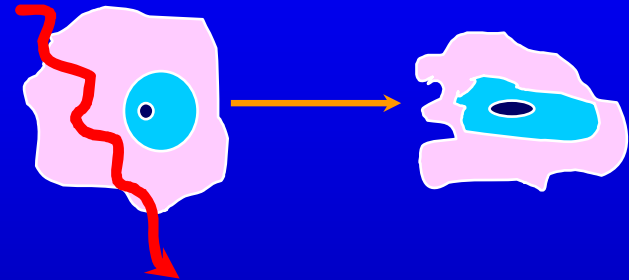
**THE WHOLE BODY**



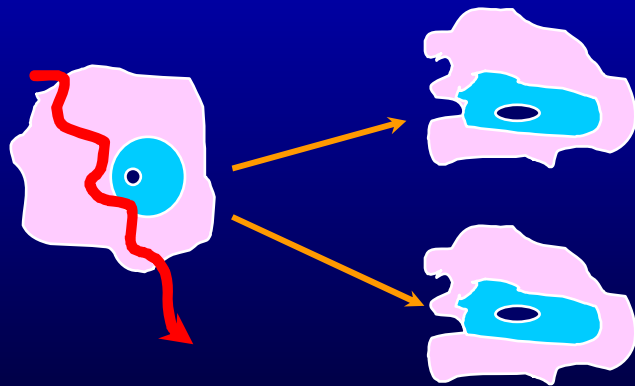
# Ionising Radiation and Human Cellular Level



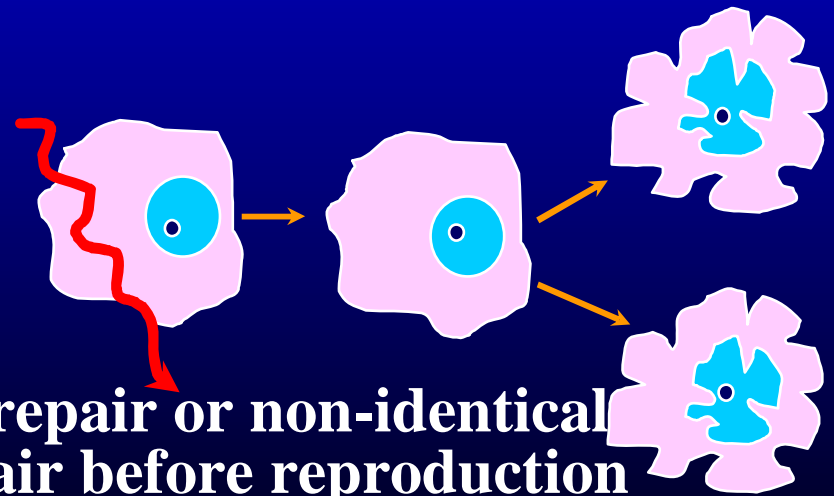
**Normal repair of damage**



**Cell dies from damage**



**Daughter cells die**



**No repair or non-identical repair before reproduction**





# **Ionising Radiation and Human Deterministic Effects**

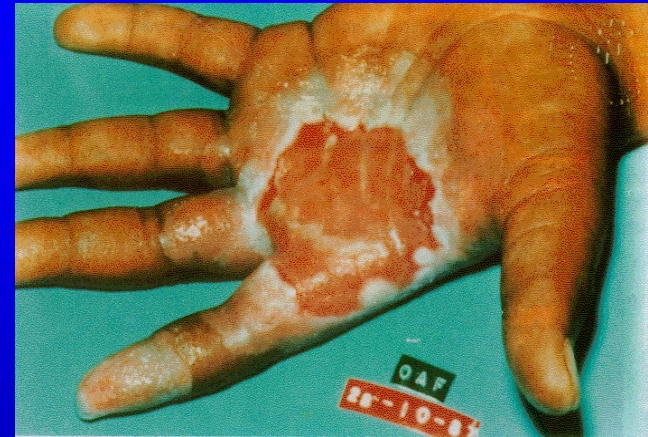
- **A cell that has been hit may destroy itself or may be destroyed while dividing**
- **Cell killing is not equal to health effect**
- **Only massive cell killing leads to health effects**
- **Massive cell killing can occur only after high doses**
- **These are called deterministic effects**



# Deterministic Health Effects

## Description, Examples

- **Early appearance (days to weeks, excl. cataract)**
- **Existence of dose threshold, specific for particular effect**
- **Below dose thresholds - no effect**
- **Above threshold the severity depends on level of radiation dose**



# Deterministic Health Effects

## Description, Examples (1)

- Dose response curve is sigmoid
- At high dose and dose rates
  - **Dose rate has a profound influence on effects**
- Some deterministic effects have characteristics that distinguish them from similar effects due to other causes, which may help to identify the affected individuals
- The occurrence of the initial event has sometimes been detected by the unexpected appearance of deterministic effects
- Need specialized treatment



# Deterministic Health Effects

## Threshold of Occurrence

Organ or tissue	Dose in less than 2 days [Gy]	Deterministic effects	
		Type of effect	Time of occurrence
Whole body (bone marrow)	1	Death	1 – 2 months
Skin	3	Erythema	1 – 3 weeks
Thyroid	5	Hypothyroidism	1st – several years
Lens of the eye	2	Cataract	6 months - several years
Gonads	3	Permanent sterility	weeks
Foetus	0.1	Teratogenesis	-



# **Ionising Radiation and Human Stochastic Effects**

- **If the cell is not killed but the genome is changed, it may give rise to a mutated cell clone**
- **From one of these cells through the chain of possible several mutations after many years the first cancer cell can appear**
- **If any cell, capable of dividing, is hit by radiation, a cancer may arise**
- **If a gamete is hit and the genome is changed and this particular gamete will start a pregnancy, the child may carry a genetic disease**
- **Cancer and hereditary effects are the stochastic effects of radiation**

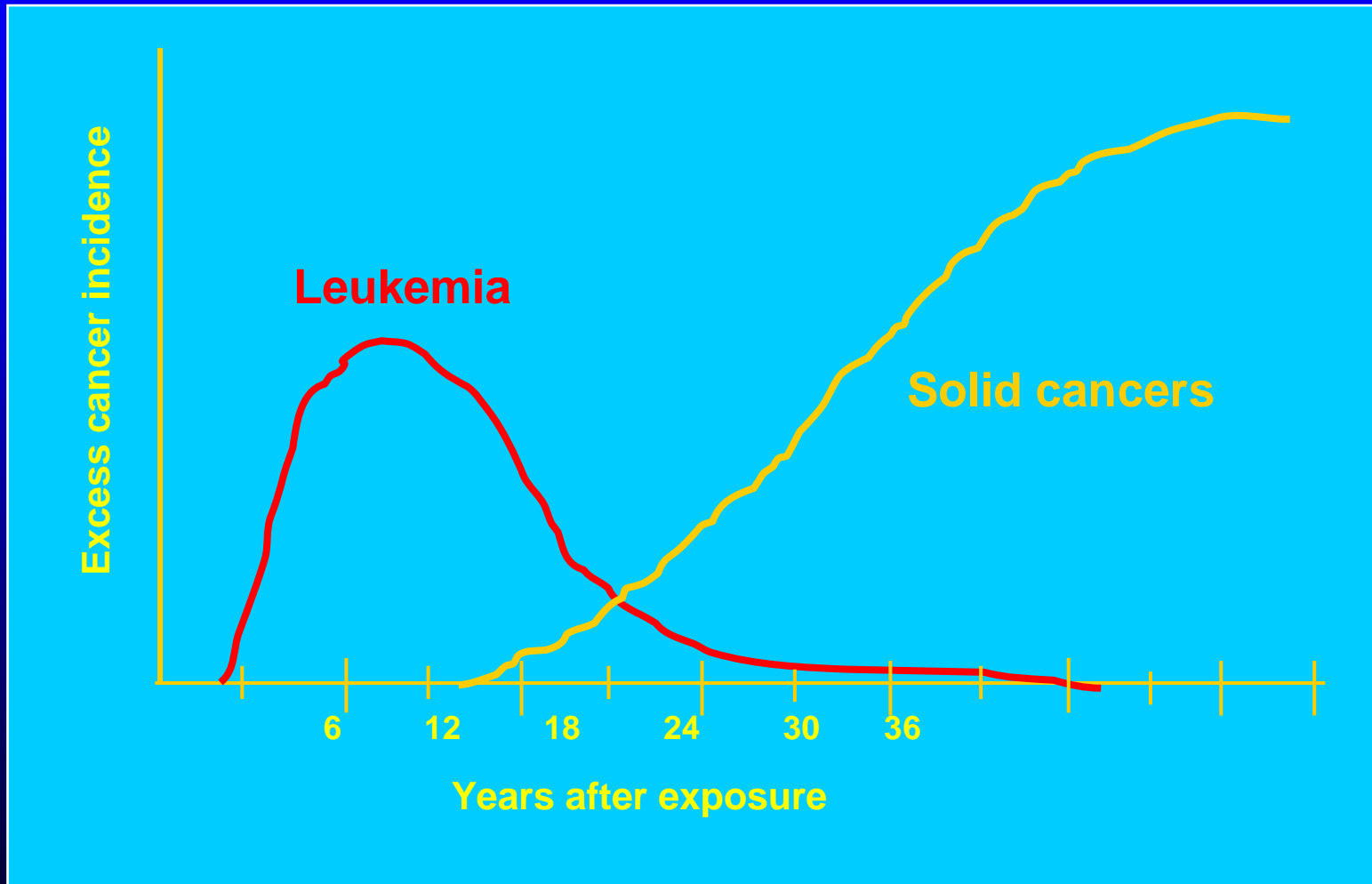
# Stochastic Health Effects

## Description, Examples

- No threshold dose exists
- Assumed no safe dose
- Late appearance (years)
- Latency period:
  - Several years for cancer
  - Hundreds of years for hereditary effects
- Probability increases with the dose
- Degree of severity doesn't increase with the dose



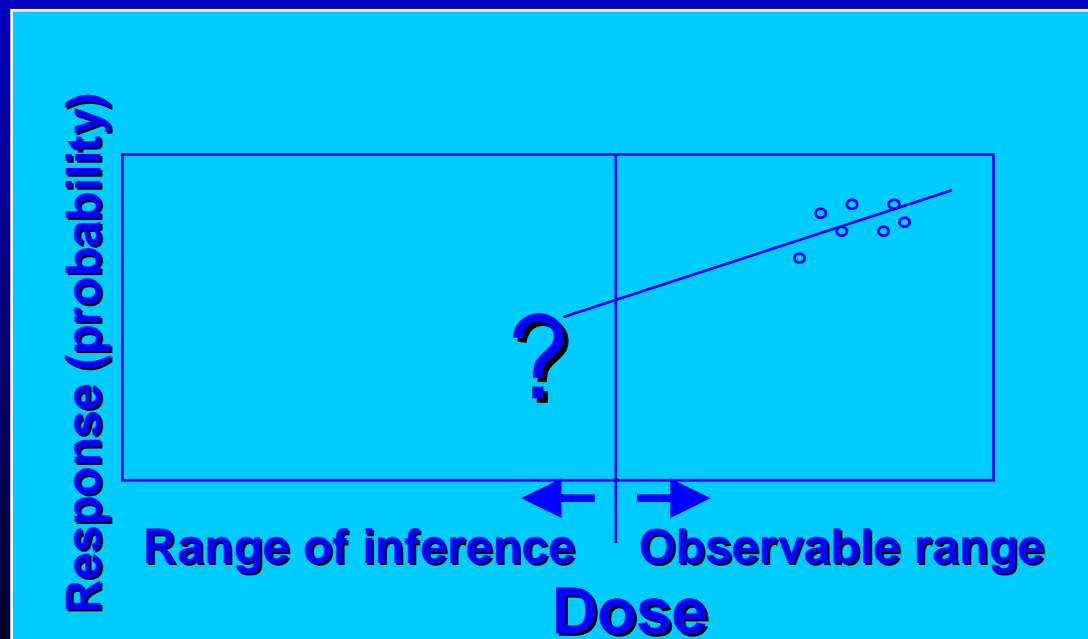
# Excess Cancer Incidence



# Stochastic Health Effects

## Description, Examples

- Dose response is believed to be more or less linear
- Dose rate may have a slight effects on risk
- Indistinguishable from ‘spontaneous’ cancers
- Seen only in epidemiological studies
- Normal treatment

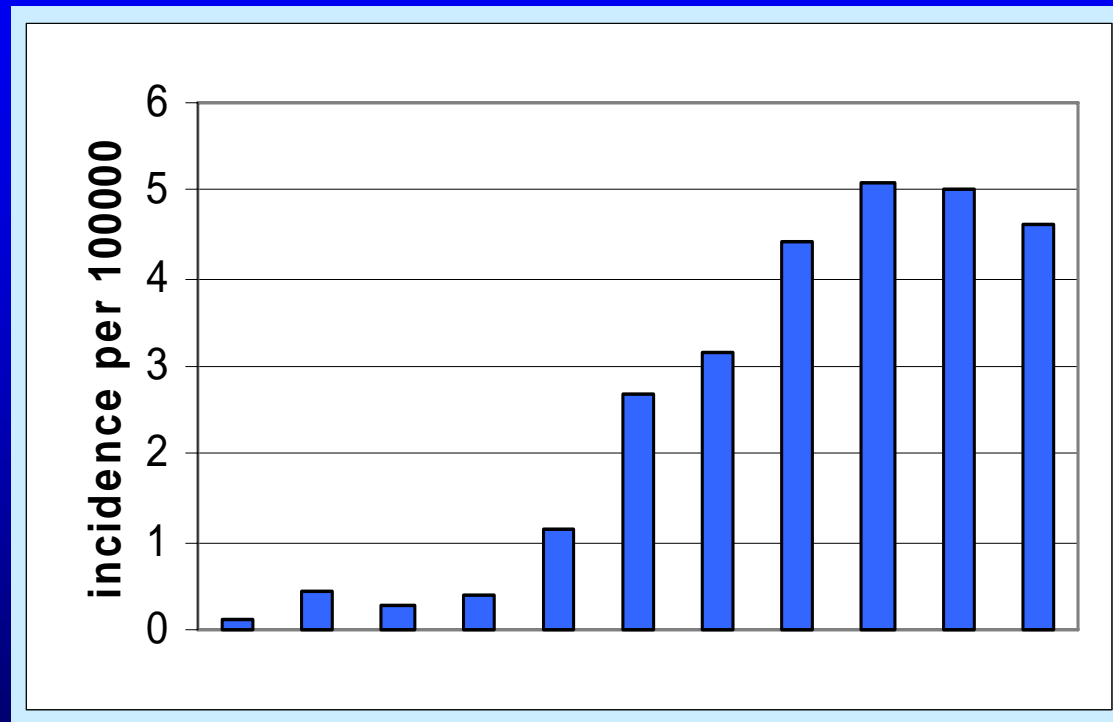




# Radiation Induced Cancer

- **Cancer – the main possible health effect of public exposure**
- **Excess risk as a probability of radiation induced cancer**

# Thyroid Cancer Incidence Rate



**Thyroid cancer incidence rate among children of Belarus exposed to radiation due to the Chernobyl accident**



# Risk Coefficients

## Stochastic Effects

- **ICRP: cancer mortality in a population exposed at low dose rate**
  - **5% per man-Sv**
- **ICRP: risk for genetic diseases in the offspring of an exposed population**
  - **1.3% per man-Sv, all future generations counted together**

# Medical Aspects

Accident	Critical organ	Major source of dose
<b>Reactors (power, research, ship)</b>	<b>Whole body (bone marrow) Skin Thyroid</b>	<b>Gamma Beta Radioiodine</b>
<b>Spent reactor fuel storage or reprocessing</b>	<b>Whole body (bone marrow)</b>	<b>Gamma</b>
<b>Industrial and medical gamma sources (sealed)</b>	<b>Whole body (bone marrow) Skin</b>	<b>Gamma Gamma</b>
<b>Industrial and medical gamma sources (damaged, unsealed)</b>	<b>Whole body (bone marrow) Skin</b>	<b>Gamma Beta</b>
<b>Pu - weapons damage or manufacture</b>	<b>Lung</b>	<b>Alpha</b>

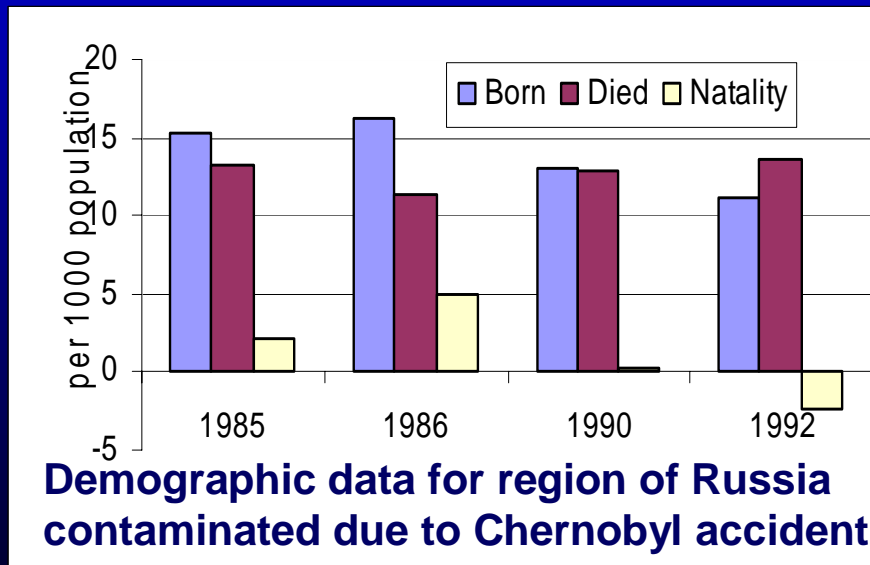
# Medical Consequences

- **Public health effects directly related to radiation exposure**
  - **Deterministic**
  - **Stochastic**
- **Public health effects indirectly related to radiation exposure**
  - **Caused by the accident per se**
  - **Caused by the intervention**



# Indirect Health Effects

- Caused by the accident
  - Psychological
  - Voluntary abortions
  - Demographical



# Indirect Health Effects (cont'd)

- **Caused by the intervention**
  - **Psychological**
  - **Consequences of inappropriate medical care**
  - **Consequences of restriction of food products**
  - **Side effects of iodine prophylaxis – very rare**



# Psychological Effects

- **Psychological effects do not correlate with real exposure but with subjective perception of risk**
- **Psychological effects cover**
  - **Psychic suffering**
  - **Changes in risk perception**
  - **Modification in individual and social behavior**
- **Modification factors:**
  - **Demographic**
  - **Perceptual**
  - **Sociological**





# Psychological Effects (1)

- **Major accidents showed that affected people**
  - **Believe in the threat to their health**
  - **Doubt what has been reported about accident and resulted doses**
  - **Got modification in the life style**
  - **Have somatic complains**
  - **Got substance abuse (alcohol, tranquilizers, sleeping pills)**



# Psychological Effects (2)

- **Any psychological stress had general health effects**
- **Stress symptoms**
  - **Anxiety, depression**
  - **Disturbed sleep, headache, nausea**
  - **Loss of appetite, fatigue, apathy**
  - **Aggression, suicidal acting, drug and alcohol abuse**
  - **Stress symptoms may mimic somatic disease**
  - **Diffuse pain anywhere may be due to stress**



# How to Reduce Psychological Effects

- **Have an ongoing information programme**
- **Give clear, simple and timely advice**
- **Consistent advice and assessment (one official point)**
- **Use international guidance**
- **Ensure protective actions are justified**
- **Correct false information**
- **Consider education and counselling**

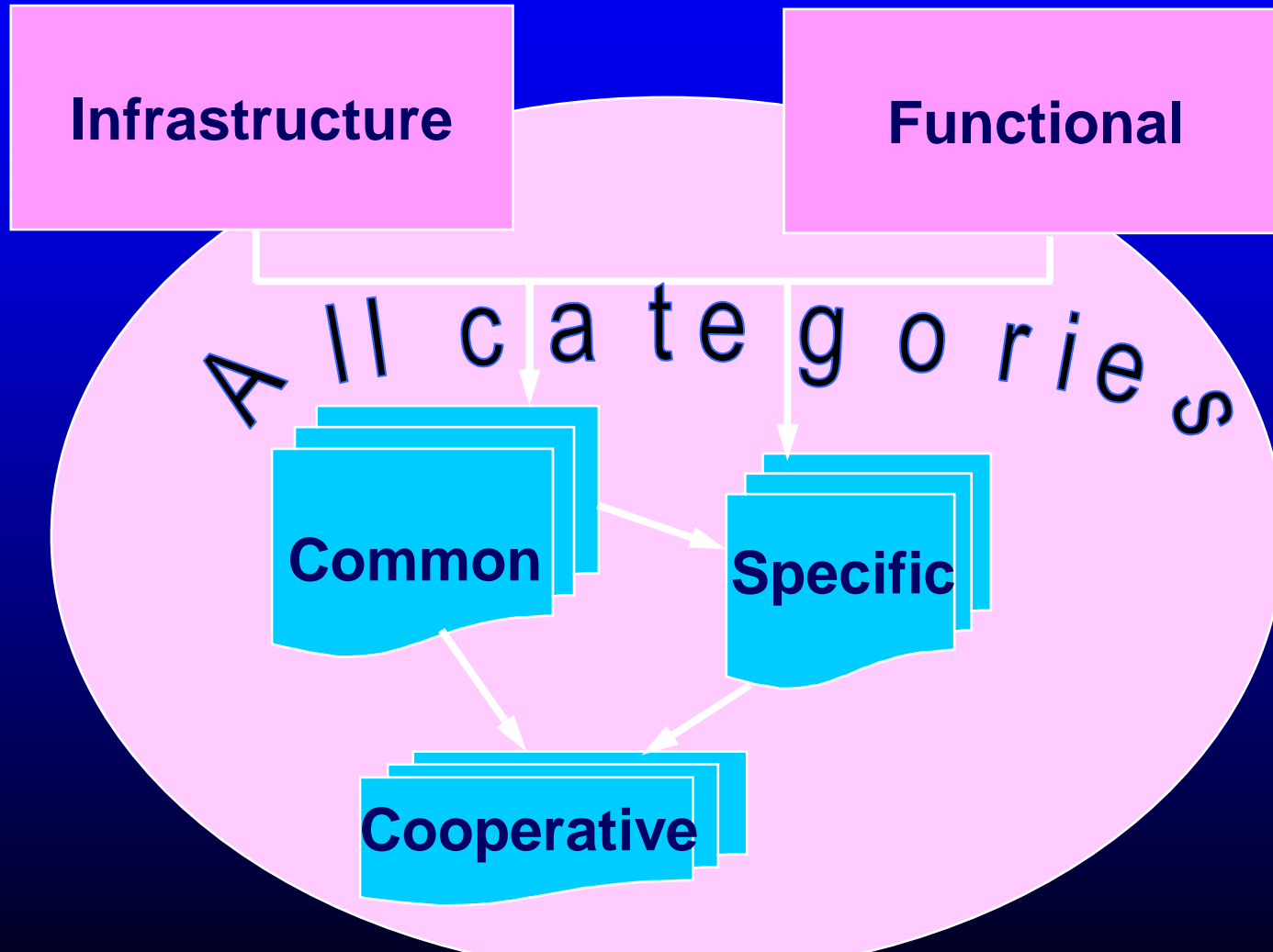


# Requirements for Medical Preparedness

- **Infrastructure**
  - **Must be in place to ensure that the functional requirements of a response can be performed when needed**
- **Functional**
  - **Should be fulfilled to achieve the response objectives**



# Requirements for Emergency Preparedness and Response



# Requirements – Infrastructure

- **Authority**
- **Organization**
- **Co-ordination of emergency response**
- **Plans and procedures**
- **Logistical support and facilities**
- **Training, drills and exercises**
- **Quality assurance and programme maintenance**



# Requirements – Functional

- **Establishing emergency management operations**
- **Identifying, notifying and activating**
- **Performing mitigatory actions**
- **Taking urgent protective actions**
- **Providing information and issuing instructions and warning to the public**
- **Protecting emergency workers**
- **Assessing the initial phase**



# Requirements – Functional (1)

- **Managing the medical response**
- **Keeping the public informed**
- **Taking agricultural countermeasures, countermeasures against ingestion and longer term protective actions**
- **Mitigating the non-radiological consequences of the emergency response**
- **Conducting recovery operations**



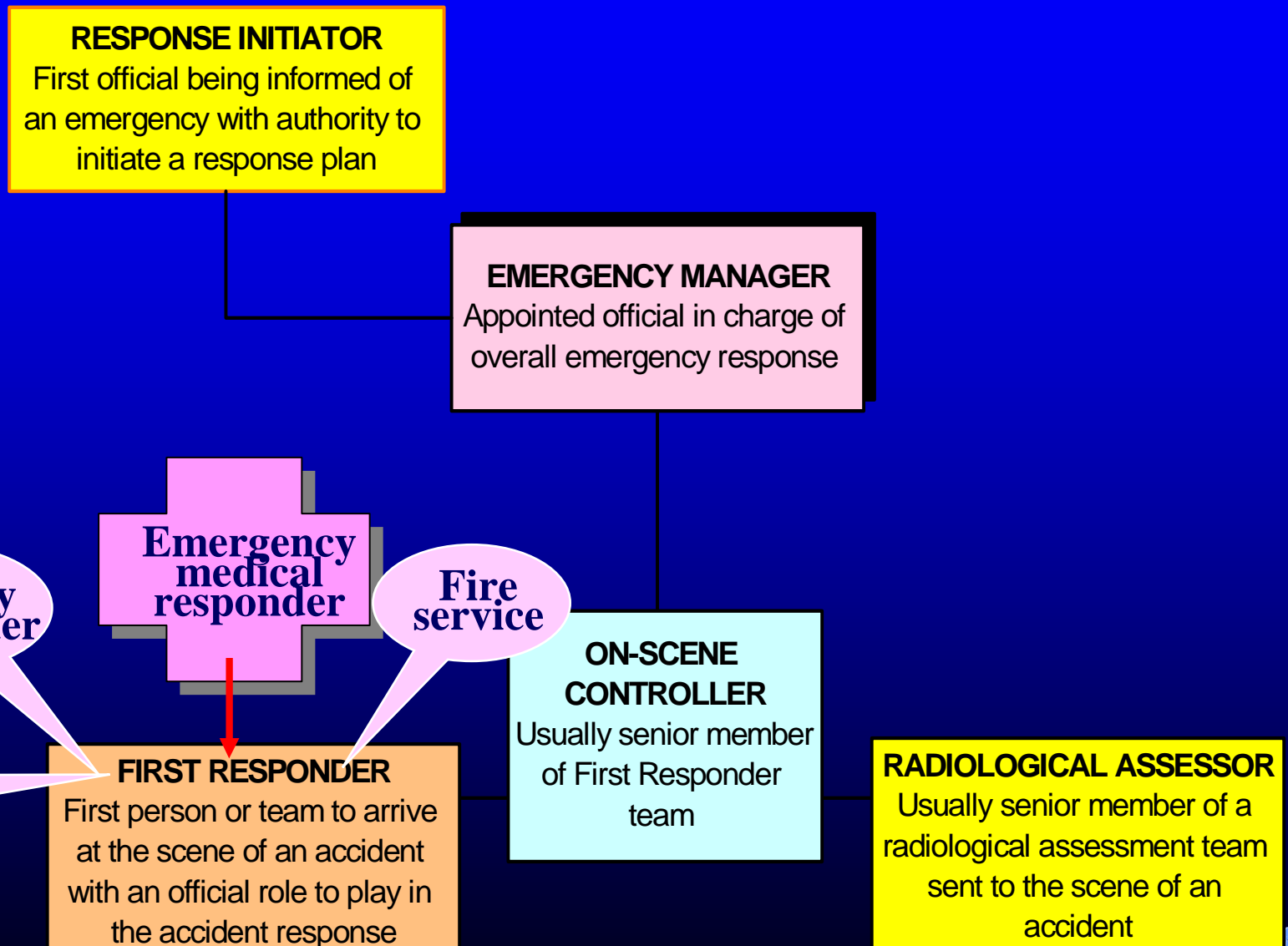


# Medical Assistance

- **Establish a capability to provide immediate on-site first aid during an emergency**
- **Develop guidelines for the decontamination of injured persons**
- **Provide means to transport and initially treat a limited number of highly contaminated or exposed and injured individuals from the site**
- **Develop agreement to treat highly exposed persons at an existing institution having the capability to provide specialized treatment of overexposed personnel**
- **Make plans to treat radiation exposure among the public that concentrate on means of triage and use of existing medical facilities most effectively**



# Generic Response Organization



# Summary

- **This lecture presented overview of medical management**
- **The following topics were covered in the lecture: health effect of radiation, direct and indirect effects of radiation exposure, objectives and requirements for emergency medical preparedness and response**
- **Comments are welcomed**

# Where to Get More Information

- **UNSCEAR, Sources and Effects of Ionizing Radiation, 2000 Report to the General Assembly with Scientific Annexes, United Nations, New York (2000)**
- **Ricks, R.C., Pre-hospital Management of Radiation Accidents, ORAU 223, Oak Ridge Associated Universities, Oak Ridge, TN, 1984**
- **Medical management of radiological casualties. Handbook. Ed. D. Jarrett., AFRRI, Bethesda, MD, 1999**

