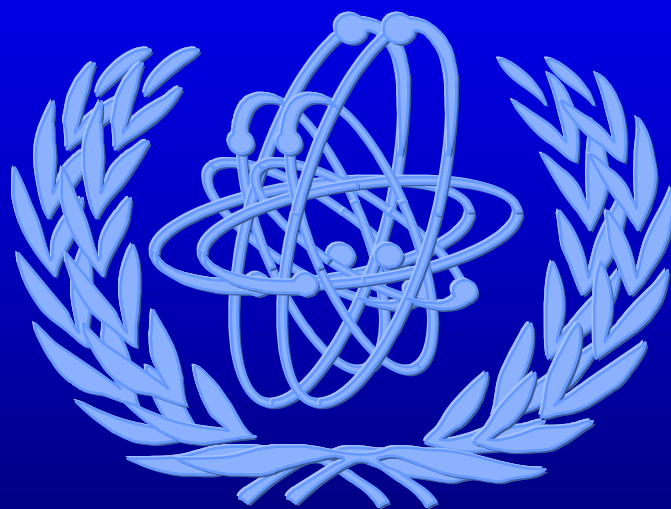




Medical and Public Health Preparedness



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

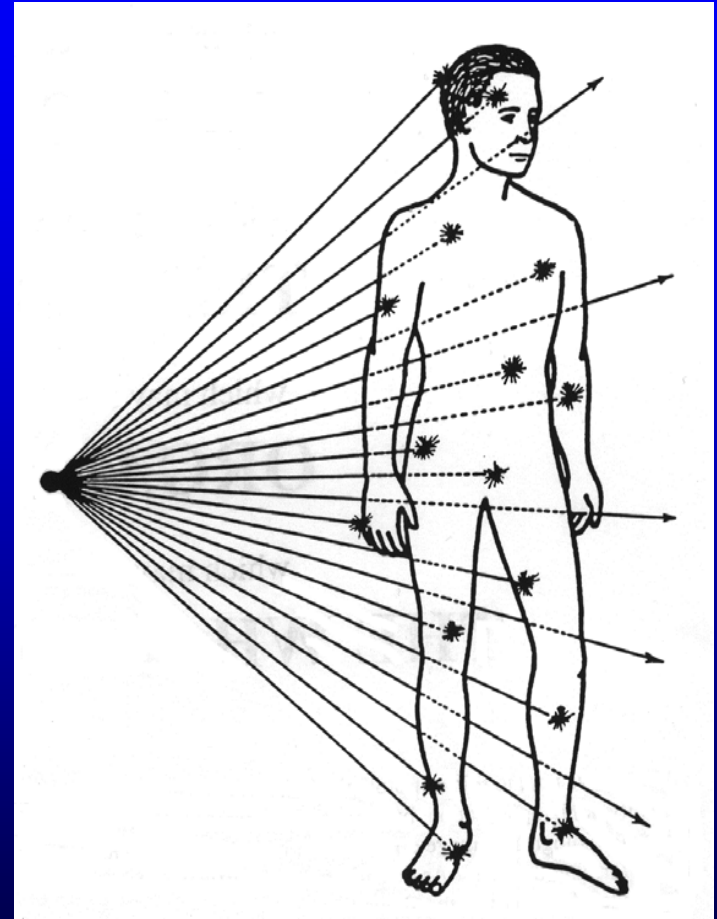
TISSUES

which may affect

ORGANS

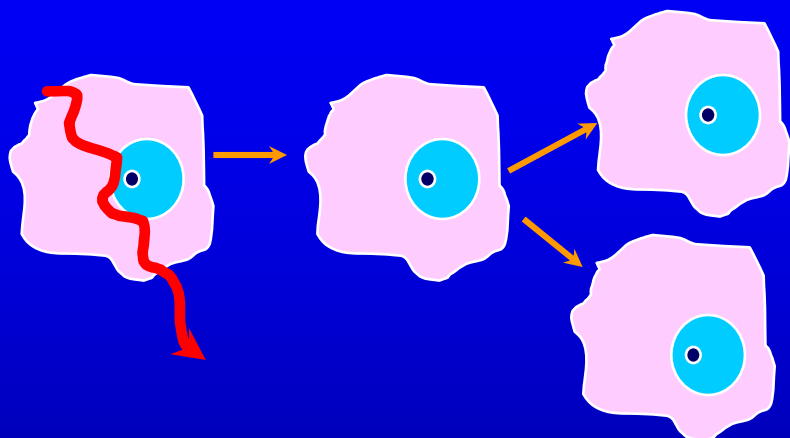
which may affect

THE WHOLE BODY

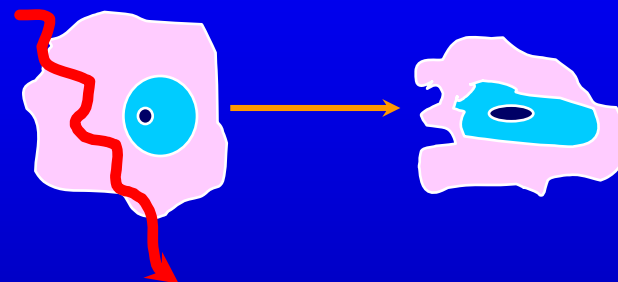




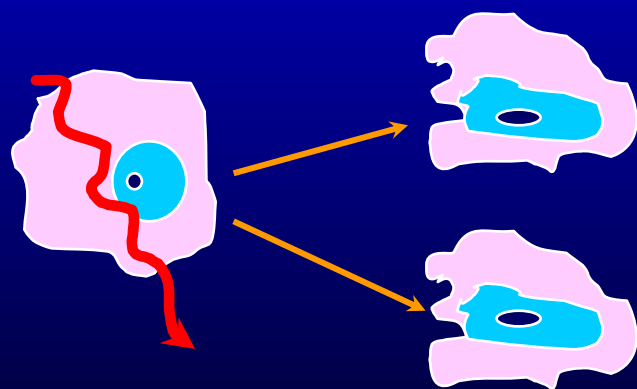
Ionising Radiation and Human Cellular Level



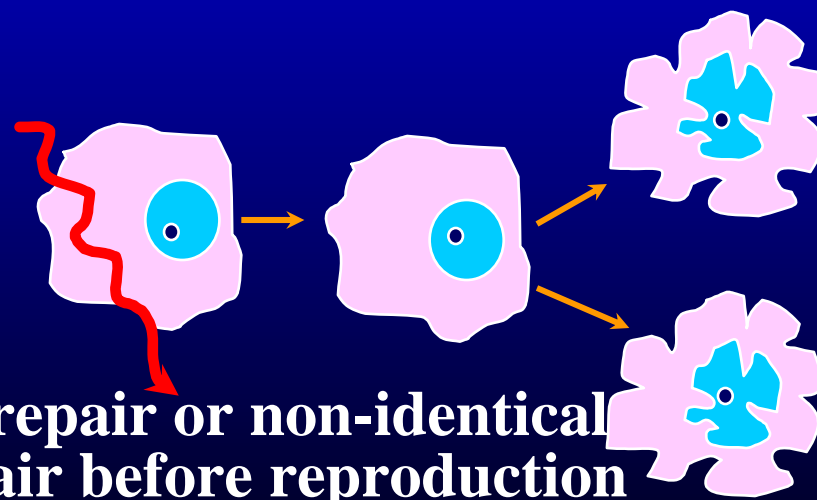
Normal repair of damage



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**





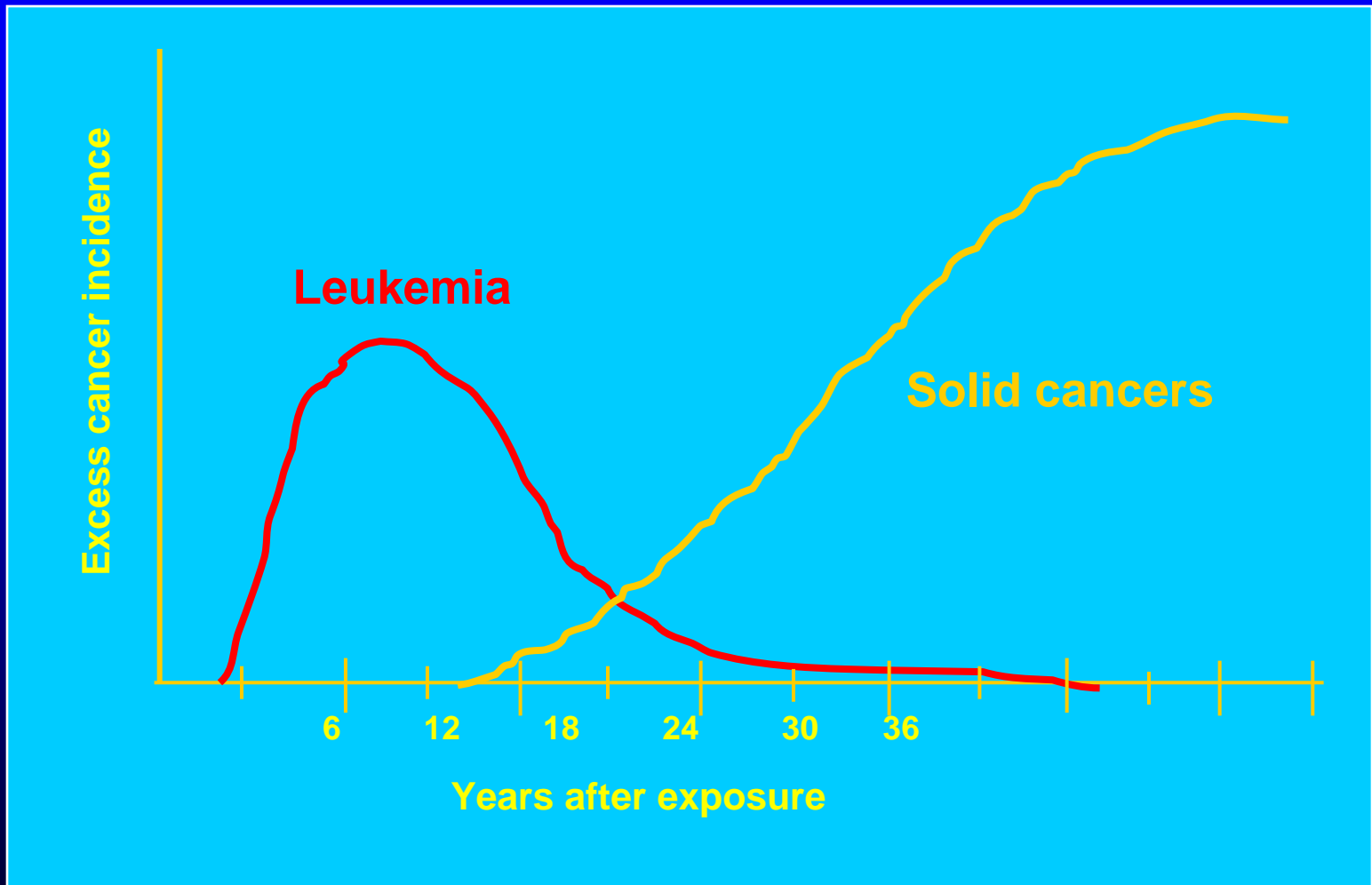
Stochastic Health Effects

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



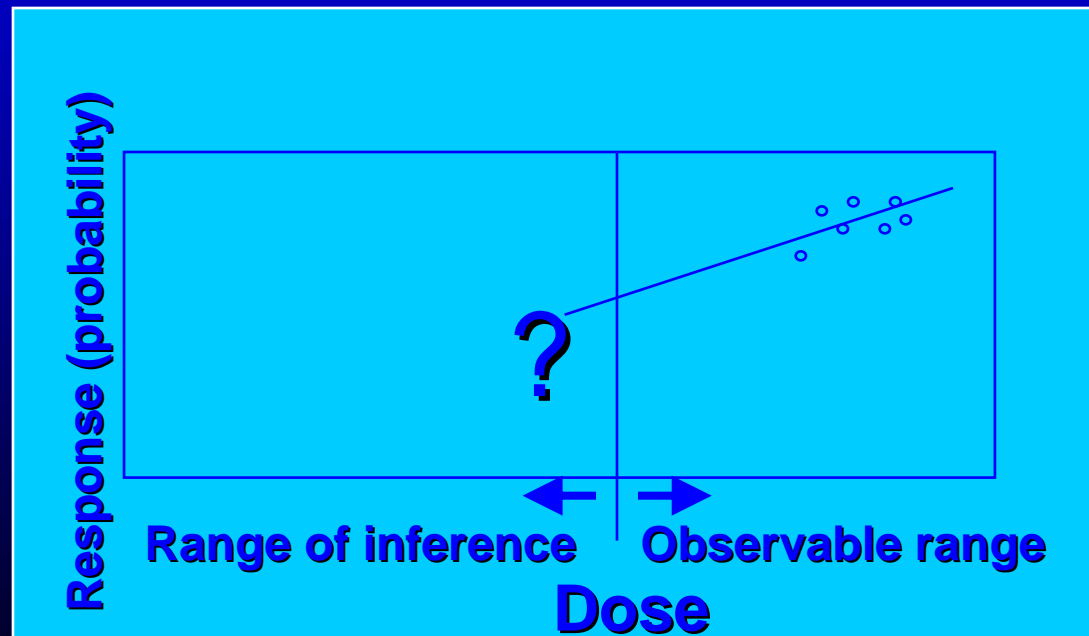
Excess Cancer Incidence



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



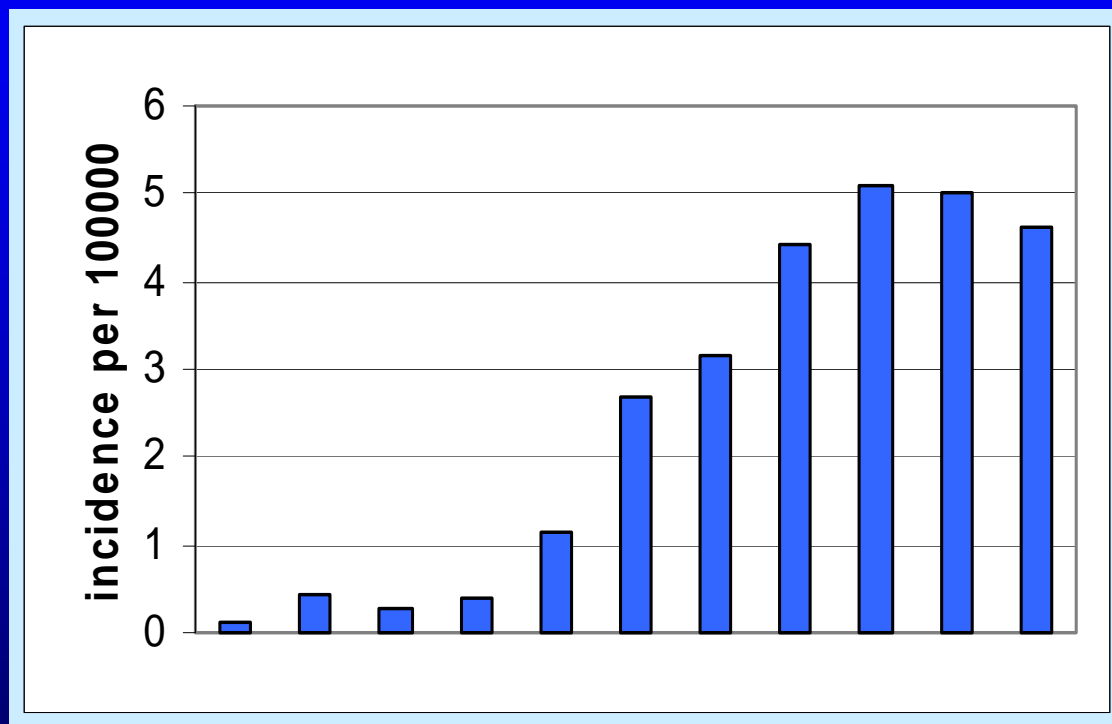


Radiation Induced Cancer

- **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
Reactors (power, research, ship)	Whole body (bone marrow) Skin Thyroid	Gamma Beta Radioiodine
Spent reactor fuel storage or reprocessing	Whole body (bone marrow)	Gamma
Industrial and medical gamma sources (sealed)	Whole body (bone marrow) Skin	Gamma Gamma
Industrial and medical gamma sources (damaged, unsealed)	Whole body (bone marrow) Skin	Gamma Beta
Pu - weapons damage or manufacture	Lung	Alpha



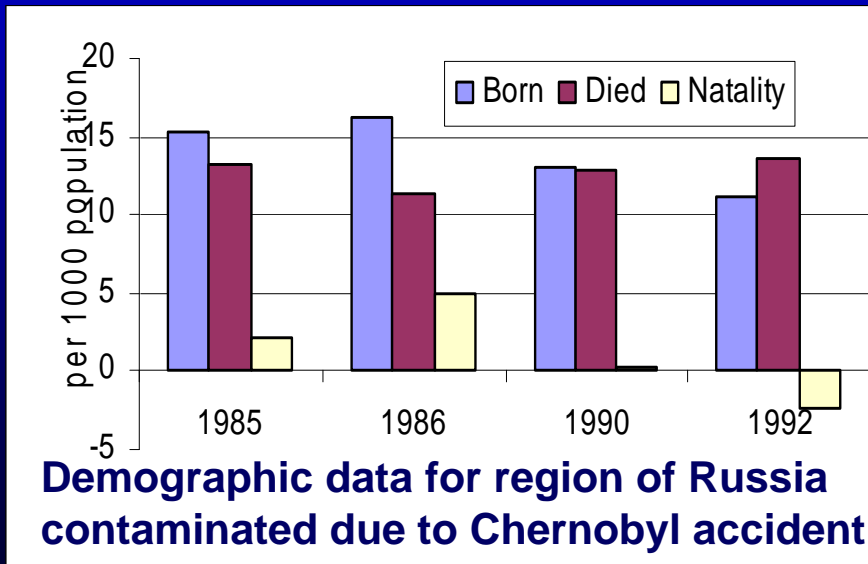


Medical Consequences

- **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**



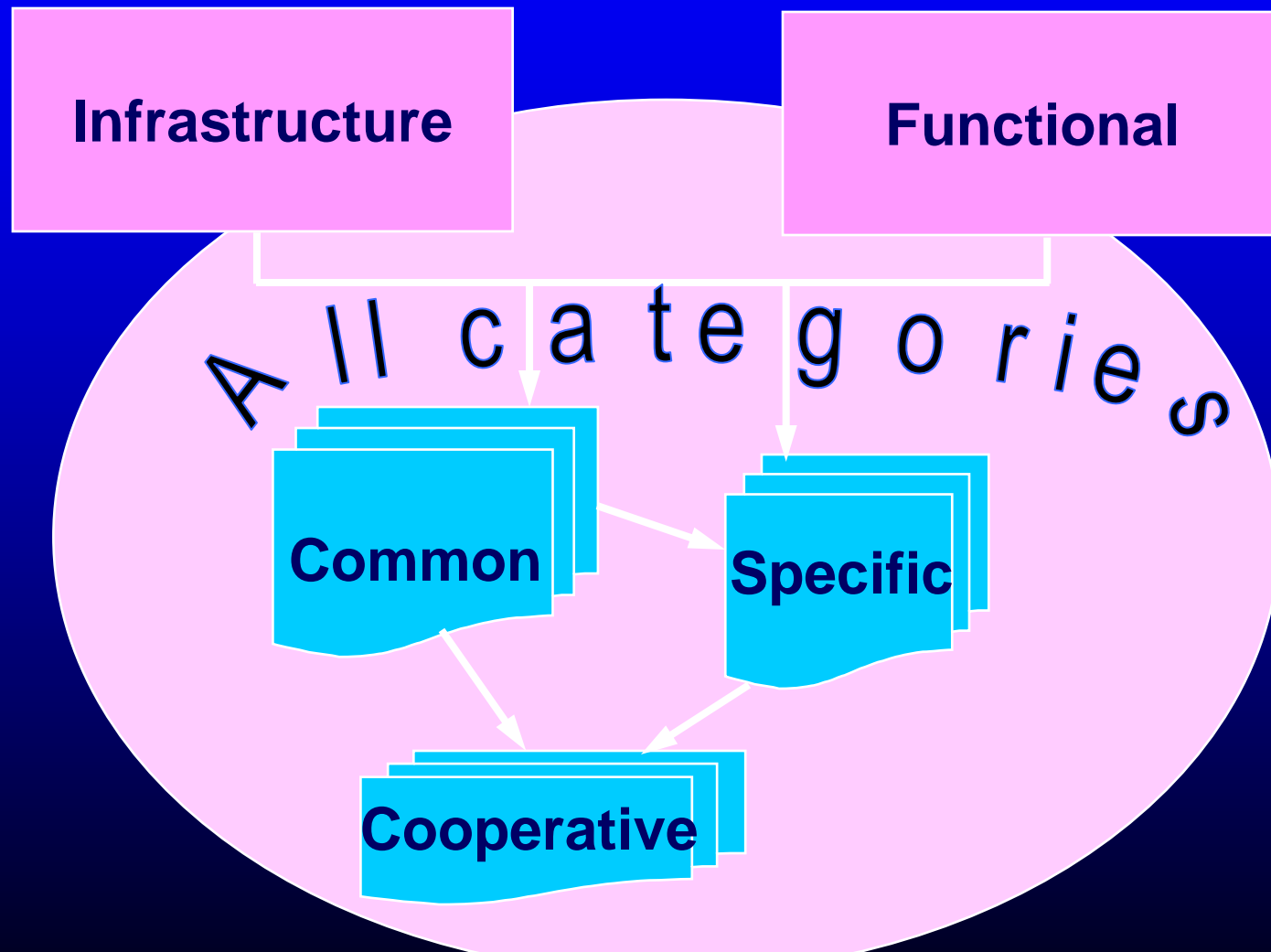


Requirements for Medical Preparedness

- **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**



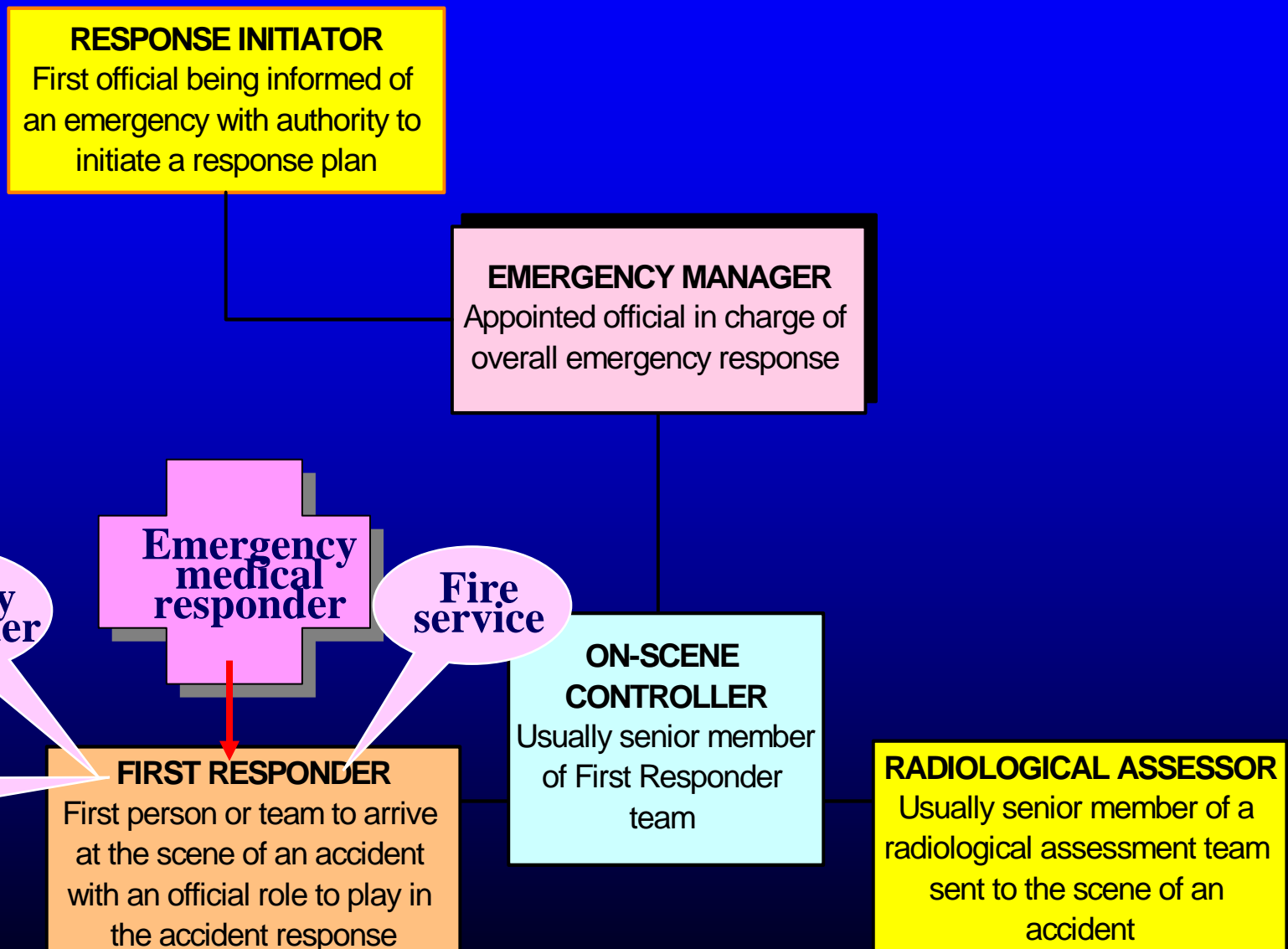


Medical Assistance

- **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**

