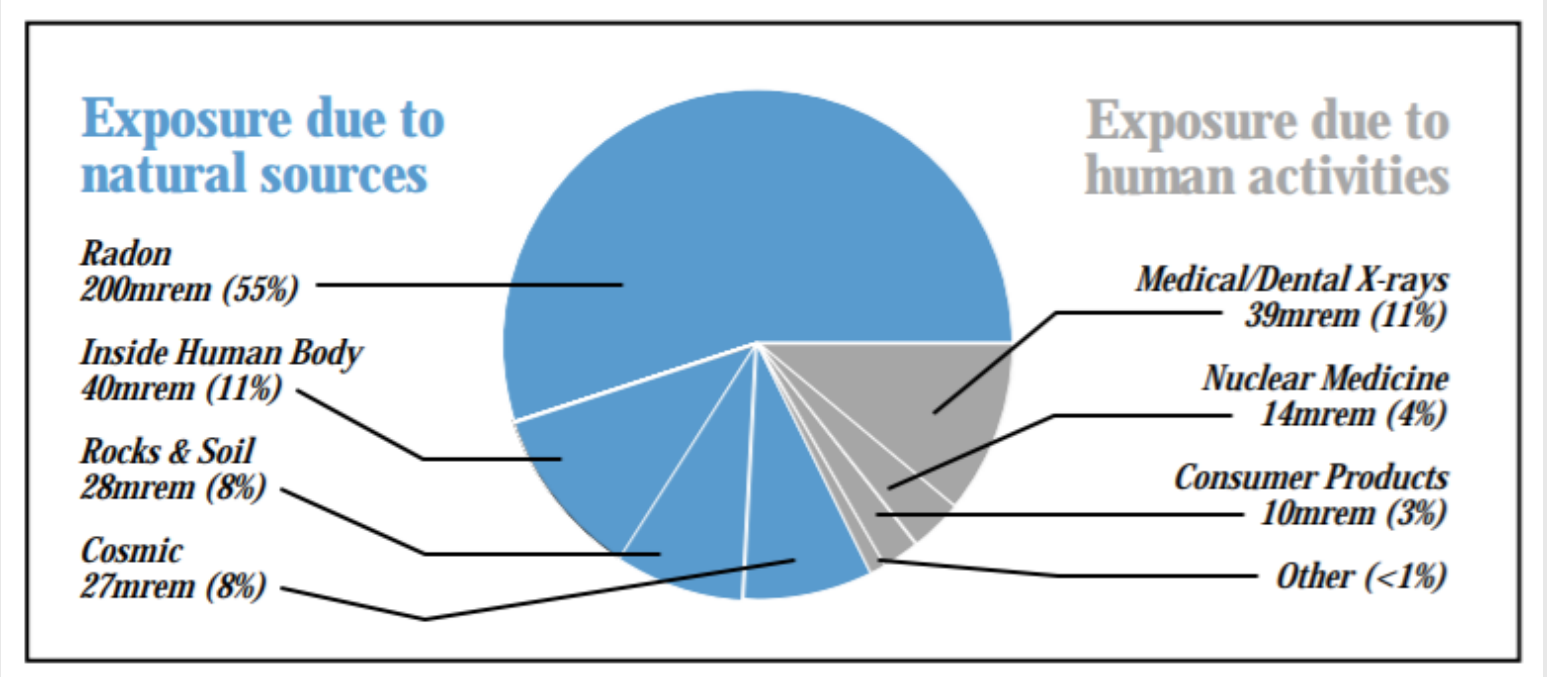
IONIZING RADIATION PART 2

Lecture for 2d gr students

3. The main sources of ionizing radiation

- 1) Natural sources of radiation (background radiation, cosmic radiation, radon gas)
- 2) Artificial sources of radiation (medical x-rays, generating electricity from nuclear power, testing nuclear weapons, and producing a variety of common products such as smoke detectors which contain radioactive materials, can cause additional exposure to ionizing radiation)



Maximum permissible radiation doses

- According to the radiation safety standards:
- For the staff (for professional employees, who have permanent contact with the sources of ionizing radiation) – 20 mSv, but not more than 50 mSv per year
- For other people – 1 mSv, but not more than 5 mSv

Average annual doses from different sources (natural and artificial) of ionizing radiation

The source of ionizing radiation	The dose, mSv (per year)
Background radiation	2
Builder's supplies	1,4
Nuclear-power engineering	0,002
Medical examinations	1,4
Nuclear tests	0,025
Plain flight	0,005
Utility (household) devices	0,04
TV-set and PC	0,001
Altogether (common dose)	5

4. Dosimetric and radiometric control

- Dosimetric control – the system of arrangements with the purpose of radiation control for people who were in contact with the sources of ionizing radiation (or near them)
- Dosimetric control is carrying out in the high-radiation areas or in the case of emergency
- Dosimetric control is perfomed with special device – DOSIMETER
- There are two forms of dosimetric control: individual and group forms
- Group control – for receiving data about average doses of ionizing radiation of some group of people (in the same conditions of radiation hazard)
- Individual control is carrying out for receiving data about personal radiation doses (for each human in the area of radiation hazard)
- For individual control there are individual dosimeters (ID -1, ID – 11) ИД -1, ИД-11, ДКП-50

INDIVIDUAL DOSIMETER (ИД-1)

Personal dosimetric control device

The purpose - to measure absorbed dose of gamma and neutron radiation (in the range from 0 to 500 rads)

The unit of measure – is rad.

Individual dosimeter (ДКП – 50)

- To measure personal exposition dose of gamma radiation (in the range from 0 till 50 roentgens)
- The unit of measure is a roentgen

Radiometric control

- The system of arrangements with the aim of radioactive contamination control of some area (surfaces of objects, clothes, technics, transport vehicles, equipment and etc.)
- The intensity of ionizing radiation characterized by the quantity “the level of radiation”. This is the energy of radiation in the ratio of time (Rad/hour)
- The main device is roentgen radiometer (ДП – 5А,Б,В)
- Allows to measure the level of radioactive contamination of some area (e.g. the surface of clothes, skin, water, food and etc.) in the range from 0,05 rad/h till 200 rad/h

Radiometric control (ДП-5в)

- Allows to measure the level of radioactive contamination of any surface

5. Biological action of radiation

The main features of biological effects of radiation:

- The absence of subjective feelings at the first moment
- The presence of hidden period
- Discrepancy between acute radiation syndrome severity and low quantity of damaged cells at first
- The summing of small doses
- Genetic effects
- Different radiation perceptibility of different organs
- The speed of onset of symptoms is related to radiation exposure
- The cells that are most affected are generally those that are rapidly dividing
- The dose that doesn't cause acute radiation injury: single dose - 50 rad, multiple dose – monthly - -100 rad, annual 300 rad

Acute radiation syndrome

- **Acute radiation syndrome** (**ARS**), also known as **radiation sickness** or **radiation poisoning**, is a collection of health effects due to exposure to high amounts (usually over 1 Gy) of ionizing radiation (gamma-rays, neutrons, X-rays) over a short period of time.
- Severity of ARS depends on the dose of radiation

Dose (Gy):	**The level of severity:**
1-2	Mild
2-4	Moderate
4-6	Severe
Over 6	Extremely severe

- **There is a strict dependency between absorbed dose and clinical manifestation of ARS**

Acute radiation syndrome

- The first description of acute radiation syndrome was made after atomic bomb explosions in Japan during World War II in 1945. Other sources of human data came from radiation accident at Chernobyl nuclear power plant.

High-risk situations include:

- nuclear power plant accidents
- nuclear or radiological weapons use
- radiation therapy

Acute radiation syndrome

- **Clinical presentation**
- Within the first days symptoms may include nausea, vomiting, and loss of appetite.
- Classically, acute radiation syndrome is subdivided into three subsyndromes: the hematopoietic syndrome, the gastrointestinal syndrome and the neurovascular syndrome. Classical radiobiology explain the failure of each of these organs by radiation-induced death (cytocidal effects) of a great number of parenchymal cells (target cell theory) but today we know that radiation not only cause lethal effects but also functional and indirect effects in many cells (multi-cellular target theory)

The syndrome has a number of phases:

- prodromal phase: symptoms are non-specific but can include: anorexia, diarrhea, fever, erythema of the skin, nausea, vomiting and headache. This usually appears 1-3 days after exposure.
- latent phase: with an apparent improvement in symptoms and may last hours or weeks.
- symptomatic phase: with a number of possible sub-syndromes occurring such as:
  - hematopoietic symptoms (1-8 Gy): infection, hemorrhage
  - gastrointestinal symptoms (5-20 Gy): diarrhea, electrolyte and fluid disturbances, gastrointestinal bleeding and perforation
  - neurovascular symptoms (>20 Gy): headache, focal neurological deficits, altered level of consciousness
- final phase: either recovery or death depending on the total dose and dose rate received

Acute radiation syndrome

- There are four clinical phases in the development of radiation sickness:
- Prodromal phase: is the initial phase of acute illness. Signs and symptoms appear within 1–3 days after the exposure, characterized by nausea, vomiting, anorexia, fever, headache and early skin erythema. Depending on the dose received these symptoms can be mild viral like or severe. The onset of vomiting is also related with absorbed dose and can be seen within few minutes after a high dose exposure.
- Latent phase: is a delusive phase characterized by improvement of symptoms and an apparent cure. Individuals look and fill good but laboratory tests become abnormal with lymphopenia and granulocytopenia. This phase is also dose dependent and may last hours to weeks.
- Manifest illness phase: in this phase specific signs and symptoms of each syndrome appear depending on the dose. The hematopoietic syndrome develops at doses of between 1 and 8 Gy although slight decrease in blood cell counts can be seen with doses below 1 Gy. The gastrointestinal syndrome occurs at doses of between 5 and 20 Gy and the cerebrovascular syndrome at doses higher than 20 Gy.
- Final phase: recovery or death depending on the absorbed dose, dose rate and the heterogeneity of exposure.

7. Medical protection means

- Preventive medical protection means - to prevent cellular damage due to ionizing radiation.
- **1. Radioprotective substances (agents)** can decrease radiation-related deleterious effects on cells, they decrease sensitivity of the organism to ionizing radiation
- Indralin, cystamine

Cystamine is a part of individual medical kit (radioprotective remedy). Dose - 6 pills (1,2 g). Radioprotective action continues about 4-5 hours.

Indralin is the emergency radioprotective remedy, is destined for emergency prophylaxis

Single dose – 3 pills (0,45 g)

Medical protection means

- 2. Prophylaxis means of first day symptoms. The main purpose is to prevent vomit.
- Aethaperazinum is a part of individual medical kit
- Single dose – 1-2 pills a day, but not more than 6 pills

- 3. Medical protection means in the case of internal radiation exposure hazard
- 1) means (agents) that decrease absorption of radioactive materials (e.g. sorbent agents – they can tie RS and form new non-absorbable compounds)
- 2) means (agents) that increase elimination of radioactive materials from the body (e.g. complex formers – Pentacinum and Unithiol)

Iodine prophylaxis

- **Iodine-131**: with a halflife of 8 days, known to lead to thyroid problems was one of the main radioactive elements released from the Chernobyl disaster.
- Radioactive iodine (I-131) is a by-product of energy production in a nuclear reactor.
- As radioactive iodine decays, it emits radiation and affects the thyroid and the nearby tissue.
- Administration of stable iodide in the form potassium iodine (KI) is considered the most effective preventive radiation management when exposed to high doses of iodine-131 radiation
- A single dose of potassium iodine is 1 pill a day for adults