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RADIATING HYGIENE

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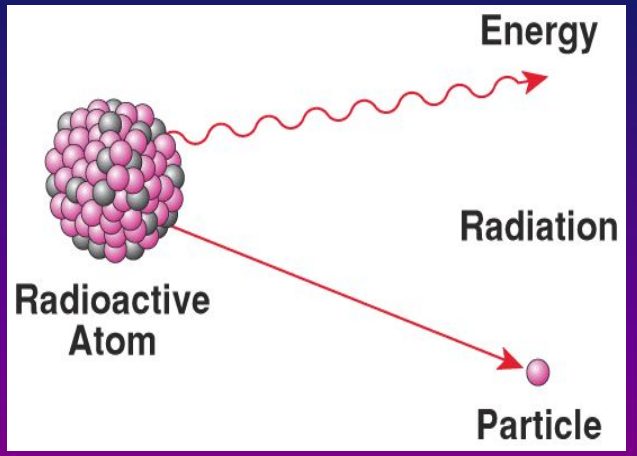
Radiation hygiene - is a branch of hygienic science and sanitary practice, purpose of which is to provide safety for people working with sources of ionizing radiation and for population as a whole.

Tasks of radiation hygiene include:

1) sanitary legislation in radiation factor sphere;
2) preventive and regular sanitary control at objects, that use sources of ionizing radiation;
3) hygiene and protection of personnel working with sources of ionizing radiation;
4) inspection of radiation level of objects of the environment (atmospheric air, air of work zone, water of reservoirs, drinking water, food substances, soil);
5) inspection of collection, storage, removal and neutralization of radioactive waste.

Radioactivity is spontaneous transformation of atoms' nuclei of chemical elements with change of their chemical nature or energy state of nucleus, accompanied by nuclear radiation.



In a qualitative sense ionizing radiations are characterized by:

- **kind of radiation;**
- **energy of radiation;**
- **penetrating power;**
- **ionizing power;**
- **linear density of ionization**

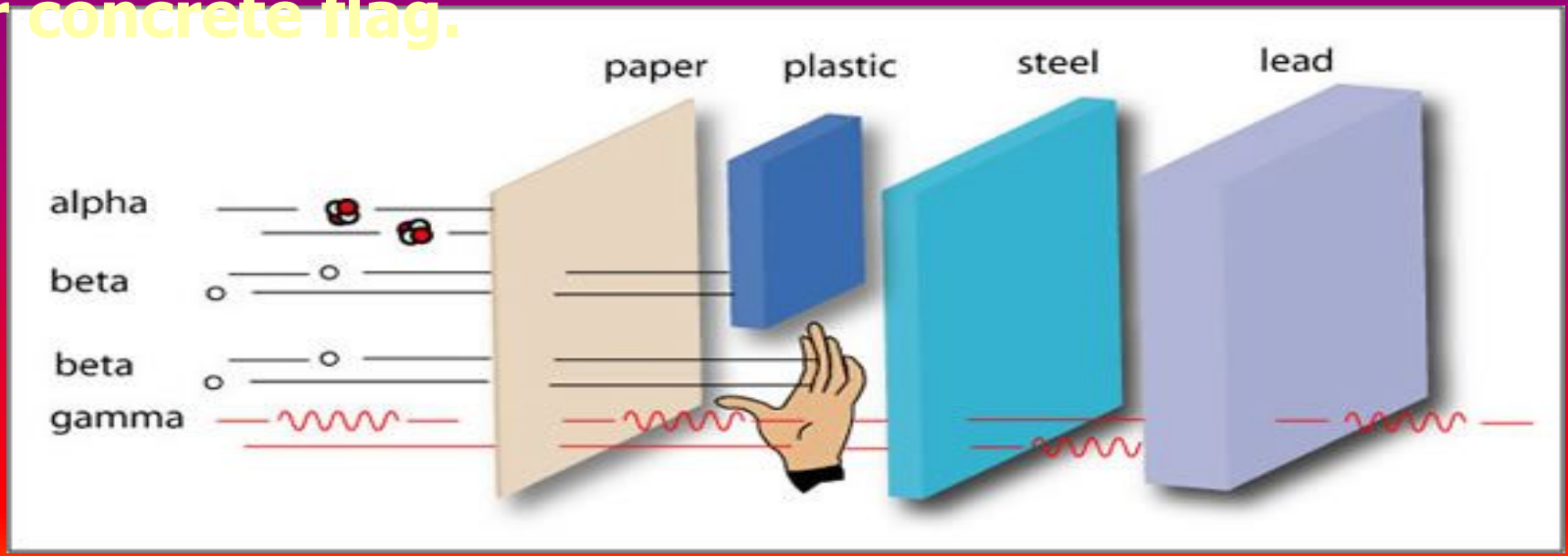
Qualitative characteristics of ionizing radiation are doses (D):

- absorbed dose;
- exposure dose;
- equivalent dose;
- effective dose.

Alpha-radiation - there is a stream of heavy particles, consisting of neutrons and protons, not able to penetrate even through the sheet of paper and human skin.

Beta-radiation is a stream of the subzero charged particles, through a skin on a depth 1-2 cm.

Gamma-radiation - has the highest penetrable ability. Such type of radiation can detain thick leaden or concrete flag.

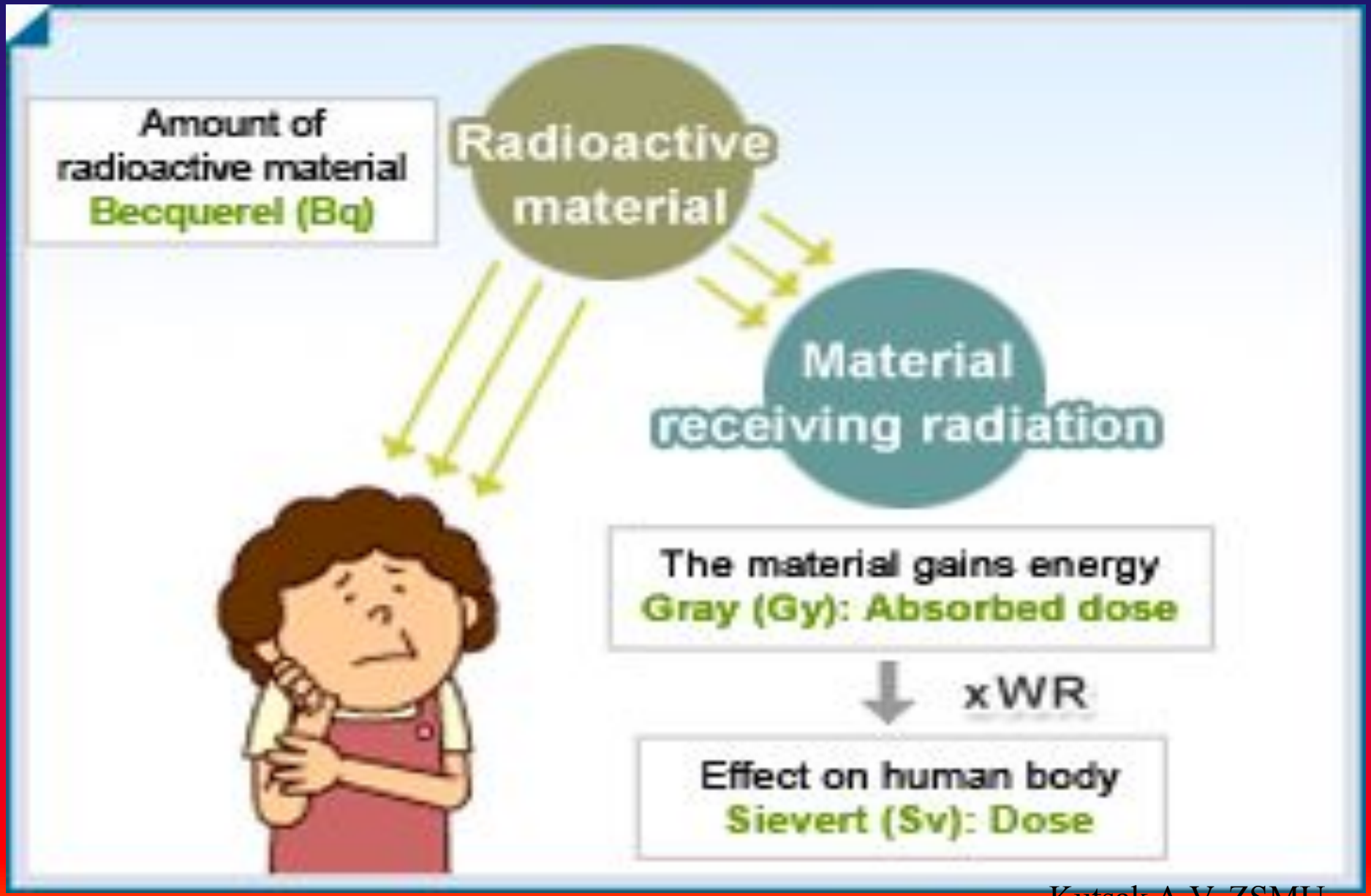


From hygienic and choice of method of radioactive waste decontamination points of view, all radioactive nuclides are divided into:

- short-living ($T_{1/2}$ < 15 days); the short-living are aged in gravity trap until radioactivity decreases, and after that are disposed into sewerage or are removed,

- long-living ($T_{1/2}$ > 15 days); and long-living are removed and buried in special mortuary.

EFFECT ON HUMAN BODY



Ionizing radiation sources name materials, radioactive substances, or technical devices which generate ionizing radiation.

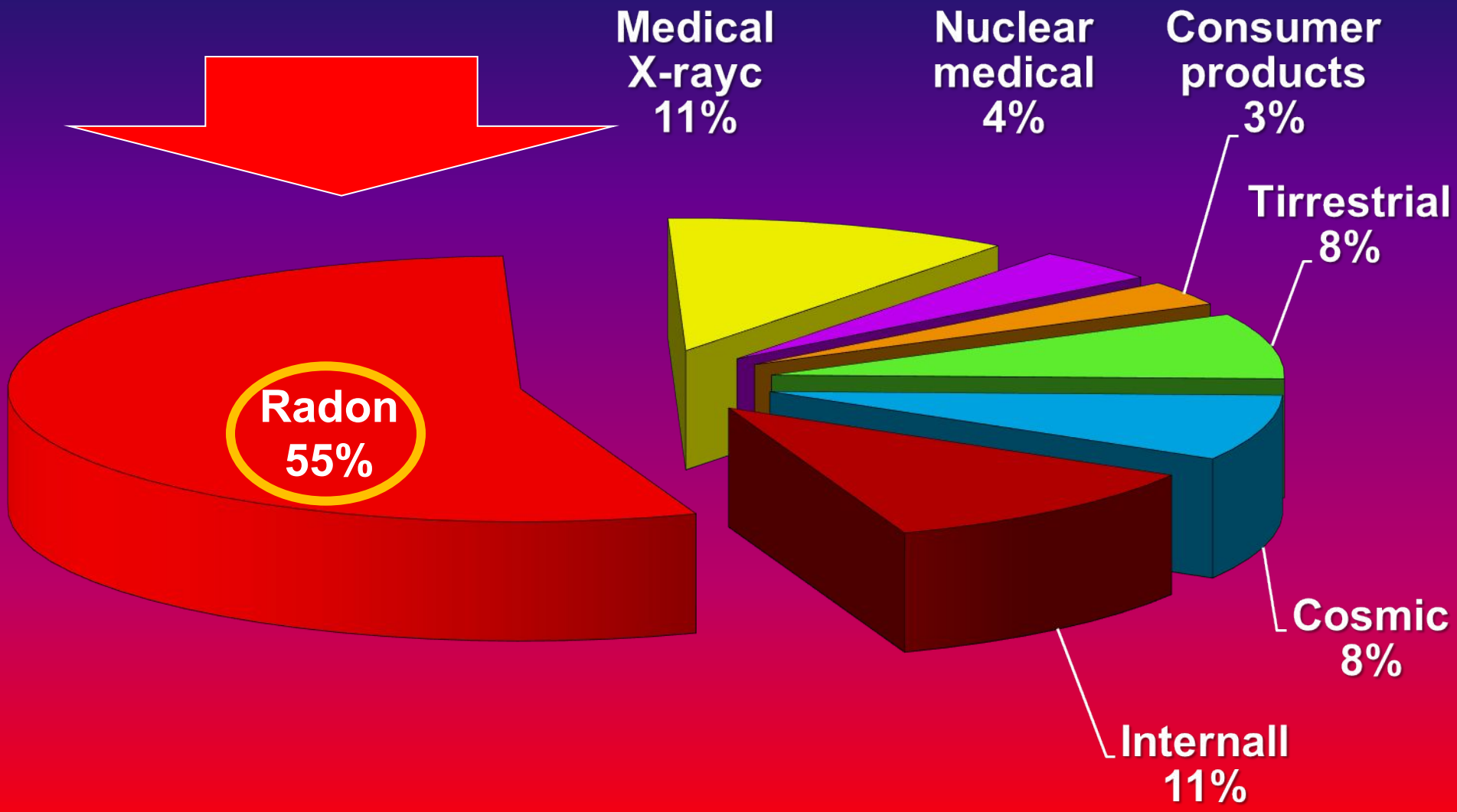
The sources of ionizing radiation are divided into:

- **closed;**
- **opened.**

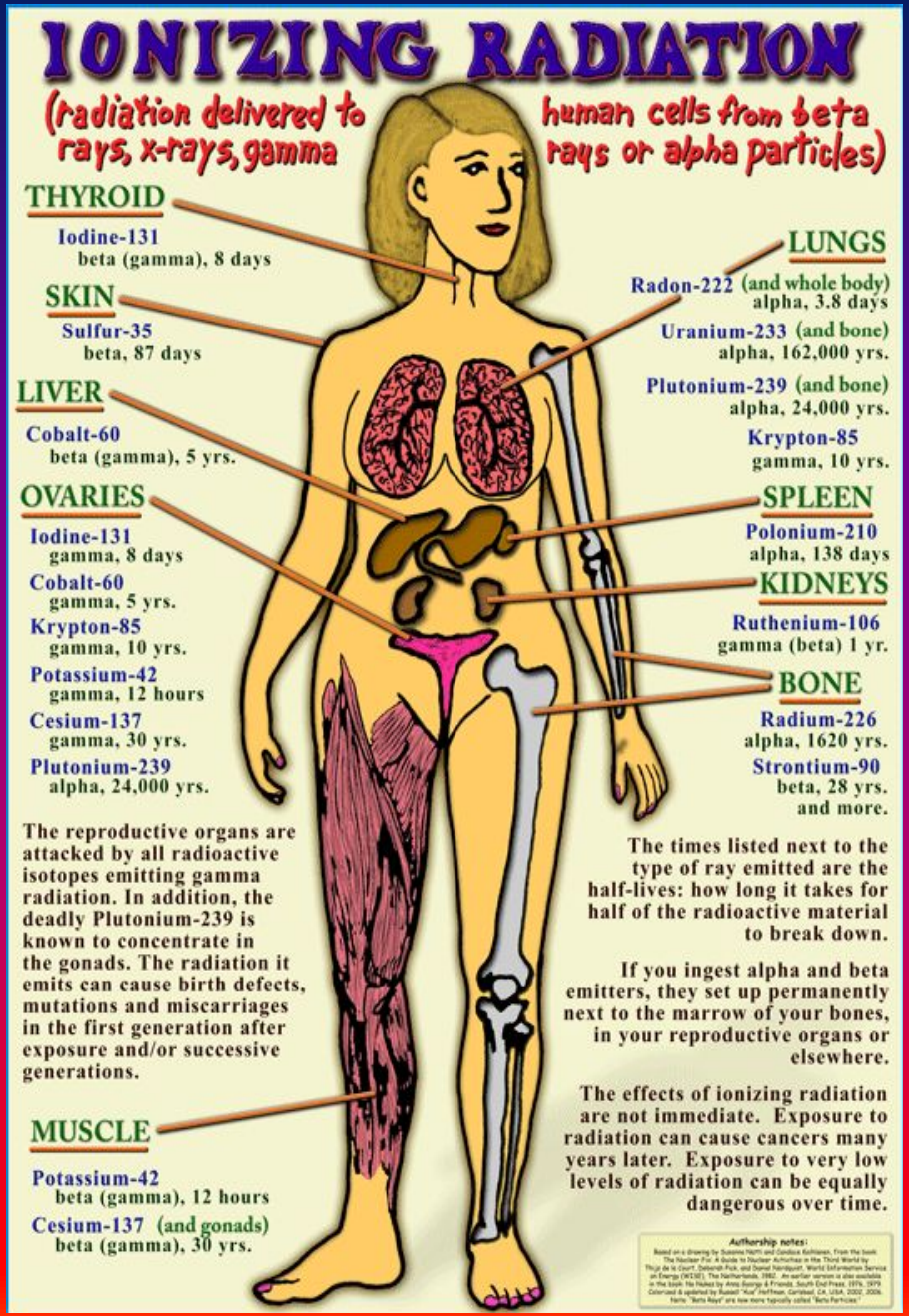
Natural radiating background - constantly operating factor of environment caused by space radiation, earth crust radiation, air, waters, foodstuff and live organisms.

Natural radiation of a earth's origin is the basic formative a dose the factor of a natural radiating background. **It is formed at the expense of an external and internal irradiation.**

Natural Radiation Background



Ionizing radiation (radiation delivered to human cells from beta rays, x-rays, gamma rays or alpha particles).



At present universal use of sources of ionizing radiation has found the place in the:

- **industry;**
- **medicine;**
- **agriculture;**
- **geology;**
- **a science;**
- **in atomic engineering.**

BIOLOGICAL ACTION OF IONIZING RADIATION

Distinguish two kinds of influence of ionizing radiation on a sell:

- **A straight line at which energy of radiation is absorbed directly in the macromolecules.**
- **Indirect at which energy of radiation is absorbed by water and other low-molecular connections of a sell, and macromolecules then are damaged products of their decomposition.**

All harmful consequences of an irradiation share on the determined (direct) and stochastic (possible) effects.

The determined effects are consequences of an irradiation which arise at an irradiation rather big doses and have a threshold of clinical effects. They are shown in the form of somatic changes or diseases.

Beam burns, a cataract, futility, infringement formation of blood are the most typical display of the determined effects sharp and chronic beam.

Radiation sickness is characteristic display of action of ionizing radiation. Laws of development of radiation sickness are defined by size and capacity of a dose of ionizing radiation; depend on distribution of the absorbed energy of radiation in an organism and radio sensitivity of its bodies, tissue and systems.

- **Radiation illness severity level depends on, whether all organism (the general irradiation) or its separate sites (a local irradiation) have been irradiated; a disposable or chronic irradiation; with intervals behind time (fractional) or continuous irradiation.**

Sharp radiation sickness in its typical form develops at the disposable general external rather uniform irradiation of an organism X-ray or gamma radiation by a dose which exceeds 1 Gy, in rather short term (from several minutes about several days).

Distinguish four basic forms of sharp radiation sickness: marrowy, intestinal, vascular and nervously-cerebral.

The consistency of change of separate pathological displays in an organism which sharpness depends on severity level of the illness connected with size of a dose of an irradiation is prominent feature of a current of sharp radiation sickness.

- **At doses of 1-2 Gy there comes easy degree of radiation illness, at doses of 2-4 Gy - average, at doses of 4-6 Gy - heavy and at doses 6 Gy - the heaviest there are more.**

In the period of formation of illness divided into 4 phases: a phase of the general primary reaction, a phase of feigned well-being (latent), a phase of a heat of illness and (at positive result) a restoration phase.

The phase of the general primary reaction **is characterized dispeptition by displays - a nausea, vomiting, a diarrhea, clinical symptoms - infringement of consciousness, the general weakness, a headache, body rise in temperature, hematological deviations - by a lymphocitopenia, neutrophilic leykocitosis, local defeats of a skin and mucous membranes in places of the greatest irradiation.**

After primary reaction there comes a *phase of feigned well-being (latent)* in which symptoms of primary reaction disappear.

The phase at the height of illness **is characterized by increase leuco - both a lymphocytopenia, and connected with it, raised bleeding and infectious complications. All clinical displays sharply accrue.**

In case of favorable result there comes a *phase of restoration* **which proceeds gradually and lasts throughout several months depending on illness severity level. The dream and appetite are normalized, body temperature decreases, the general state of health improves, indicators of peripheral blood are stabilized, hair growth begins.**

Chronic radiation illness

develops as a result of a long irradiation of an organism small doses (0,1-0,5 sGy/day) at a total dose which exceeds 0,7-1,0 Gy.

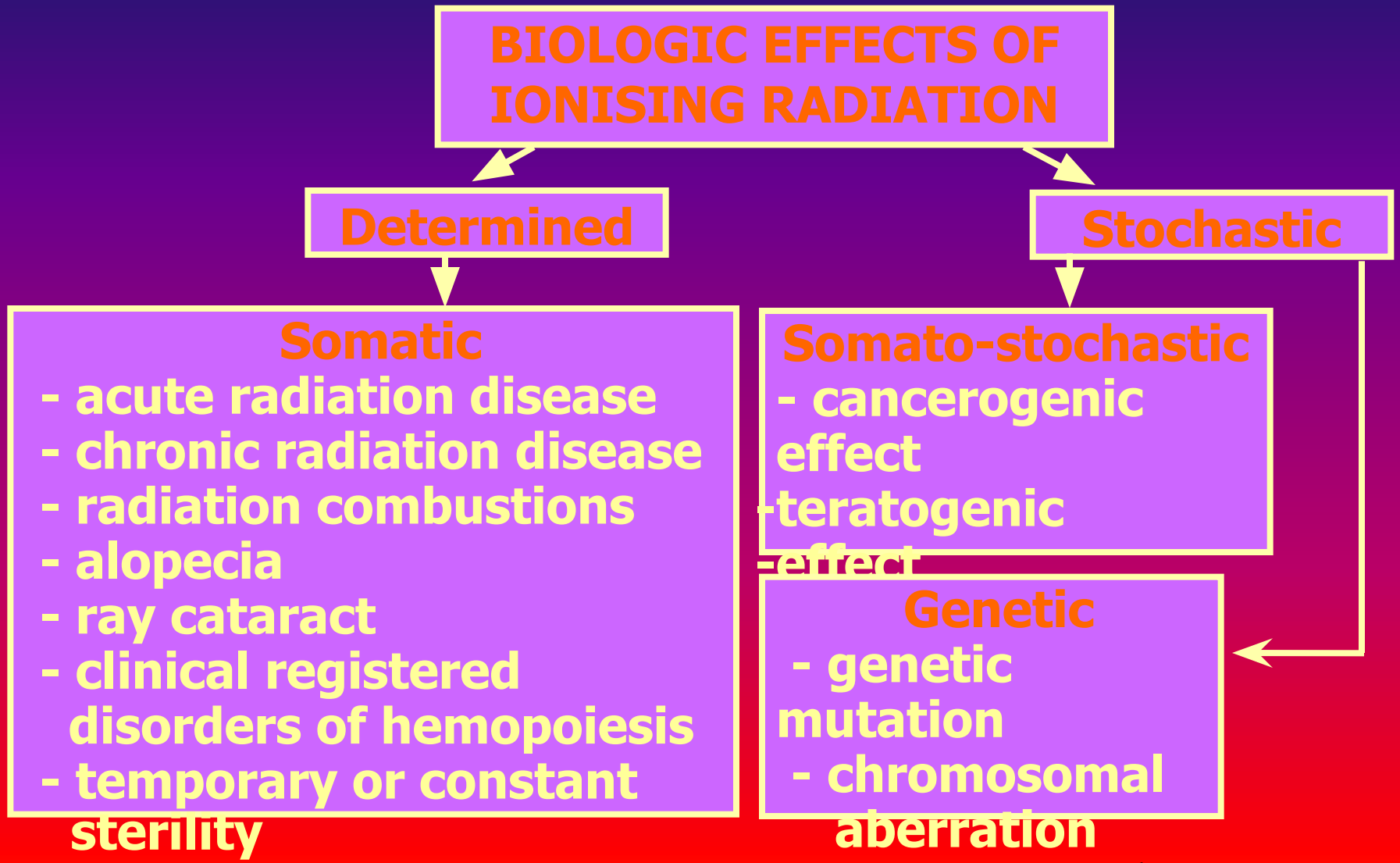
- For chronic radiation illness characteristic there is a slow increase of severity of damages and more long period of rehabilitation.
- The clinical picture is characterized by the expressed aesthenic syndrome and moderated quantity decrease lymphocyte and other uniform elements of blood. At an internal irradiation the consistency of chronic radiation illness depends on distribution radionuclide's in bodies and their radio sensitivity.

To stochastic (possible) effects of an irradiation belong without the threshold effects which reliability of occurrence exists at any doses and increases with dose increase whereas relative severity of their displays does not depend on a dose.

To them the remote consequences belong:

- **Malignant new growths which arise at people in some years after an irradiation.**
- **Genetic changes which are shown at their descendants.**

BIOLOGICAL EFFECTS OF IONIZING RADIATION



RATIONING OF RADIATING SAFETY

The international commission of radiating protection (ICRP) at rationing of the radiating factor and an estimation possible adverse for health of the remote consequences of an irradiation had been accepted the concept without threshold linear dependence of emergence of malignant new growths (tumor)and genetic damages.

There are three main principles of radiating protection:

- *Correctness principle*. **Any practical activities connected with use of SIR, should not be carried out, if it does not bring more benefit to the irradiated persons in comparison with damage which it puts.**
- *Principle unexceedings*. **Equal irradiations of the personnel and the population from all SIR in process of their operation should not exceed the established limits of doses.**
- *Optimization principle*. **At use of any SIR put individual doses and quantity of the irradiated persons it should be limited to such low level how much it can be reached taking into account economic and social conditions.**

irradiated persons, concerning sources of ionizing radiation, share on three categories:

- **A category A (personnel) - persons who constantly or temporarily work directly from SIR.**
- **A category B(personnel) - persons who directly do not work from SIR, but in connection with placing of their workplaces in premises and in territory of the enterprise with radiations-nuclear technologies can receive an additional irradiation.**

For all categories of the lighted up persons from industrial sources of radiation levels of annual doses of an irradiation are established in terms of an individual annual effective dose and an equivalent annual dose of an irradiation on separate bodies (tab.)

LIMITS of the DOSE of the IRRADIATION ($mSv \cdot year^{-1}$)

The dose name	Category of the irradiated persons		
	A[a,b]	B[a]	C[a]
Limit of an effective dose	20[b]	2	1
Limits of an equivalent dose of an external irradiation:			
- For an eye crystalline lens	150	15	15
- For a skin	500	50	50
- For brushes and feet	500	50	-

The medical irradiation is an irradiation of the person as a result of medical examination or treatment.

Considering features of this kind of an irradiation, antiradiation protection of patients is based on following principles.

Correctness principle. **The irradiation should be proved, intended only the doctor for reception of diagnostic or therapeutic effect and only in that case when it is impossible to receive expected effect other not beam methods of diagnostics or treatment.**

Optimization principle. **Collective doses of an irradiation which are received by the population at carrying out of radiological procedures, should be as much as possible low, taking into account economic and social reasons.**

Principle unexceedings. **The irradiation dose is established by the doctor individually for each patient proceeding from clinical indications taking into account necessity of prevention of the determined effects for tissue and an organism as a whole.**

For a medical irradiation of border of doses for patients are not established, but entered recommended limiting equal for different categories of the irradiated up patients.

THE RECOMMENDED PERMISSIBLE LIMITING IRRADIATIONS OF PATIENTS

Category of patients	Effective dose ($mSv \cdot year^{-1}$)
Category AD	100
Category BD	20
Category CD	2
Category DD	1

Category AD. Patients with oncological and precancer diseases, with a congenital cardiovascular pathology, and also urgention patients.

Category BD. Patients with not oncological diseases at researches for the purpose of specification of the diagnosis or a choice of tactics of treatment.

Category CD. Persons who work with harmful factors on industry at professional survey passage, and also patients after radical treatment of oncological diseases.

Category DD. Persons who take place all kinds of preventive inspection, except for the persons, carried categories BD.

For persons of categories the AD and a BD is in addition entered restriction of equivalent doses of an irradiation of the most radio sensitive organs and tissues:

- An eye crystalline lens - 150 mSv /·year^{-1}.
- Female gonads - 200 mSv /·year^{-1}.
- Man's gonads - 400 mSv /·year^{-1}.
- A red marrow - 400 mSv /·year^{-1}.

AT INDUSTRIAL ACTIVITY

Decrease in levels of an external and internal irradiation of the personnel is provided by use of remote toolkit, filters, automation of works, equipment hermetic sealing, use of means of individual defense.

At work with the opened SIR installed standalone inflow-outflow ventilation.

At use radionuclides sources a radioactive waste can be formed.

Radioactive waste - a kind of radioactive materials which now and in future will never be used in practical activities.

- On a consistence on liquid and solid.
- On activity degree - on highly active, middling active and low active.
- On a half-life period - on short-living and long-living.

At Radioactive waste processing two methods are applied:

- Exposure at which a waste remains in conditions, safe people for health, long time up to full disintegration radionuclide.
- Dilution at which a waste is diluted with inactive materials to as much as possible low.

MAINTENANCE OF RADIATING SAFETY AT APPLICATION OF SOURCES OF IONIZING RADIATION IN MEDICINE

- Control of observance of sanitary-engineering requirements in x-ray and radiological departments.
- Control over observance of requirements of radiating safety by the personnel of x-ray and radiological departments.
- Control over observance of requirements of radiating safety of patients at carrying out of radiological and radiological researches.

Main principles on which personnel protection at use of sources of radiation in medicine is based is:

- Reduction of an operating time with a source.
- Use of stationary and individual protection equipment.
- A choice of optimum techniques of research which resolve at sufficient quality of diagnostics to lower a dose of an irradiation of the personnel.

The monitoring system of doses provides calculation and the account of a dose of each patient and individual dosimeter of the personnel. The analysis of doses of an irradiation of patients at the expense of radiological researches can be carried, using average sizes of effective doses (table).

AVERAGE EFFECTIVE DOSES OF THE IRRADIATION PATIENTS AT X-RAY PROCEDURES

Name of procedures	Dose (mSv)
X-rays scopy:	
Organs of pectoral cavity	0,9
Gastro-enteric highway	1,65
Other	0,8
X-rays graphia:	
Organs of pectoral cavity	0,25
Gastro-enteric highway	1,2
Bone-arthral system	1,0
Other	0,5
Flyuorografiya	0,5

RADIATING CONTROL

The purpose of radiating control are receptions of the information on doses of an irradiation of the personnel and the population, and also about radioactive environmental contamination, foodstuff and water.

By kinds RC divided into planned, inspection, selective and laboratory.

«Radiating control» is included into the general concept four kinds of control at carrying out of any radiation dangerous works: a dosimetric, radiometric, individual radiation control and spectrometer measurements.

According to it and all equipment of radiating control according to the destination divide into four basic groups:

1. **The dosimetric devices intended for measurement of a dose and capacity of a dose.**
2. **Radiometric devices with which help define radioactive pollution of working surfaces, the equipment, vehicles, clothes, integuments, and also specific activity of products, raw materials, water and other objects of environment.**
3. **The portable dosimeters intended for definition of an individual dose of an irradiation for a certain time interval.**
4. **Spectrometer installations which resolve behind a spectrum radionuclide, characteristic for each isotope to define its specific activity.**

At present spectrometer installations define gamma


Thanks for attention!
Zaporozhe State Medical University