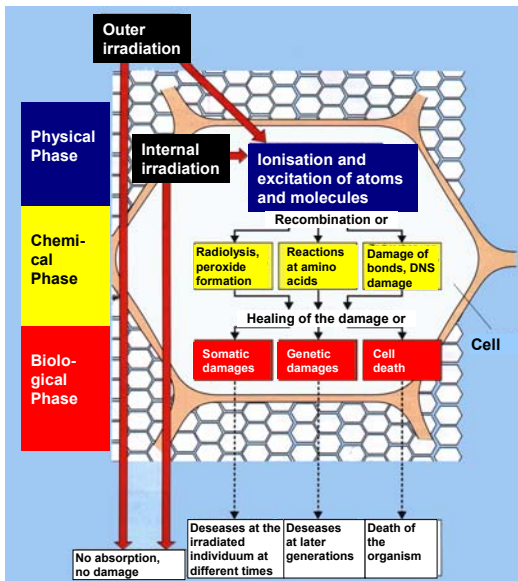


6) Radiation Protection (1)

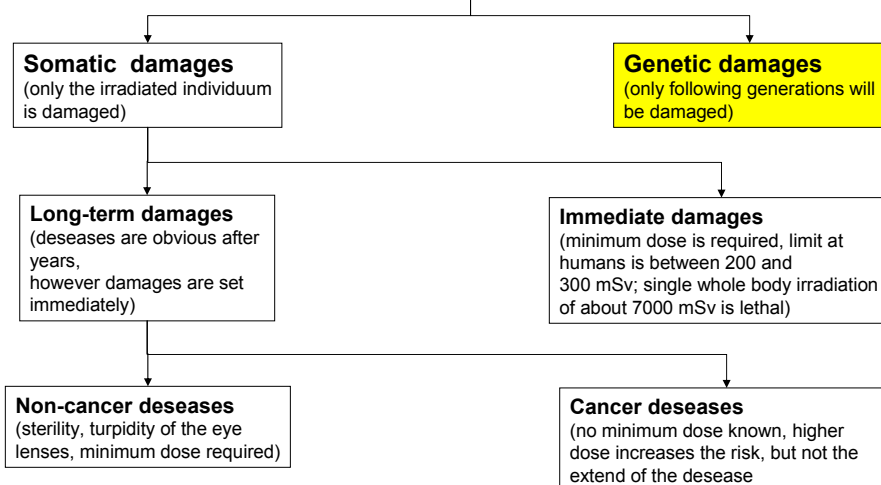
Radiation effects in biological material (cells)

Three phase model of biological effects on organisms:



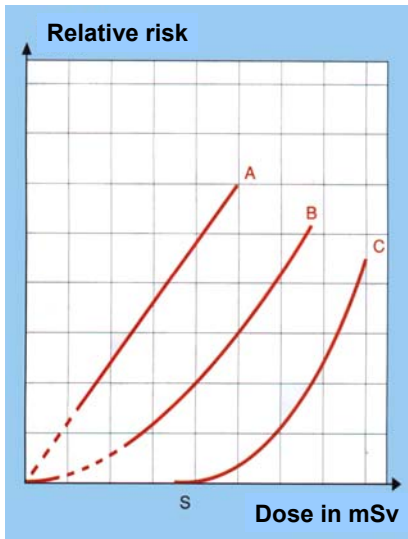
6) Radiation Protection (2)

Radiation effects in biological material (cells)



6) Radiation Protection (3)

Radiation effects in biological material (cells)



Dose-Risk- relationship at exposition with ionising radiation

(Experimental data at high doses, extrapolation at low doses):

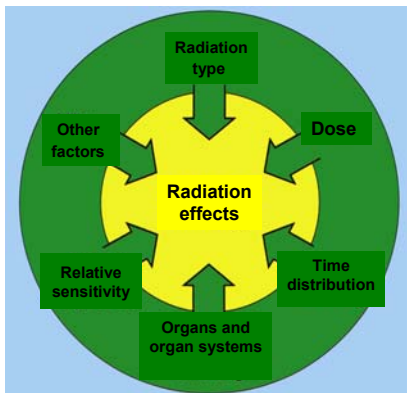
Extrapolation models:

- A linear
- B linear-squared
- C risk slope with lower limit

79

6) Radiation Protection (4)

Radiation effects in biological material (cells)



Influence of other factors

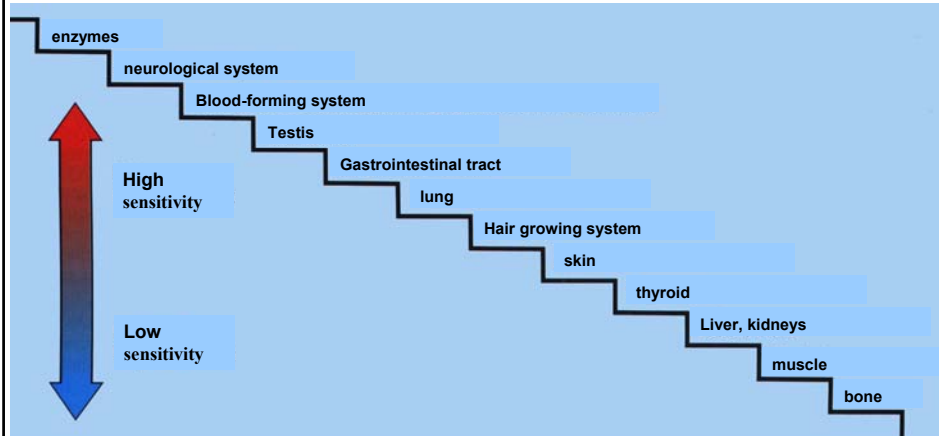
- type of radiation ($\alpha > n > \beta, \gamma$)
- value of the dose: higher dose = more damages
- dose distribution (more small doses are less dangerous than one big of the same overall value (repair mechanisms))
- irradiated organs and organ systems (different sensitivity of tissues)
- other factors (e.g. sensibilisation due to drugs, hormones, O_2 -level of the organism etc.)

80

6) Radiation Protection (5)

Radiation effects in biological material (cells)

Sensitivity of tissues against radiation



81

6) Radiation Protection (6)

Radiation effects in biological material (cells)

Sensitivity of organisms against radiation

($D_{50/30}$ value = 50% lethal dose within 30 days)

Organism	$D_{50/30}$
Amoeba	1000 Gy
Drosophila	600 Gy
Shellfish	200 Gy
Goldfish	20 Gy
Rabbit	8 Gy
Monkey	6 Gy
Dog	4 Gy
Man	4 Gy

82

6) Radiation Protection (7)

Effects of accidental radiation exposure on man (approximate values)

Whole body irradiation

0.25 Sv	No clinically recognisable damages
0.25 Sv	Decrease of white blood cells
0.5 Sv	Increasing destruction of leukocyte-forming organs (decrease of resistance to infections)
1 Sv	Marked change in the blood picture
2 Sv	Nausea and other symptoms
5 Sv	Damage to the gastrointestinal tract (50% death)
10 Sv	Destruction of the neurological system (100% death)

Irradiation of the hand

2 Gy	No proven effects
4 Gy	Erythema, skin scaling
6 Gy	Skin reddening, pigmentation
8.5 Gy	Irreversible degeneration of the skin
50 Gy	Development of non-healing skin cancer

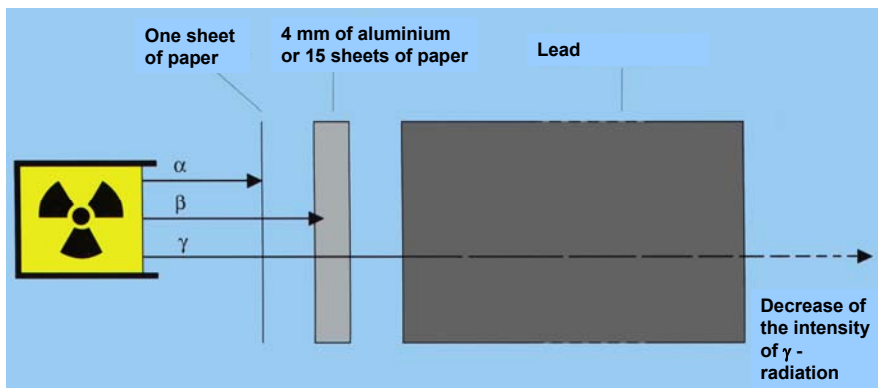
Note ! By German law the dose limit for people who work with a radiation risk is 0.020 Sv/year

83

6) Radiation Protection (8)

Protection against external radiation

Shielding material for certain radiation types (approximate values)



84

6) Radiation Protection (9)

Protection against external radiation

Always use only that amount of radioactivity you need

↓
linear decrease of the exposure

Minimise the time you work near a radiation source

↓
linear decrease of the exposure

Work with a maximum distance to the radiation source

↓
squared decrease of the exposure

Shielding

↓
appropriate materials:

α, β : Plexiglas
 γ : lead, Uranium
 n : special shields

↓
ALARA
As Low As Reasonably Achievable

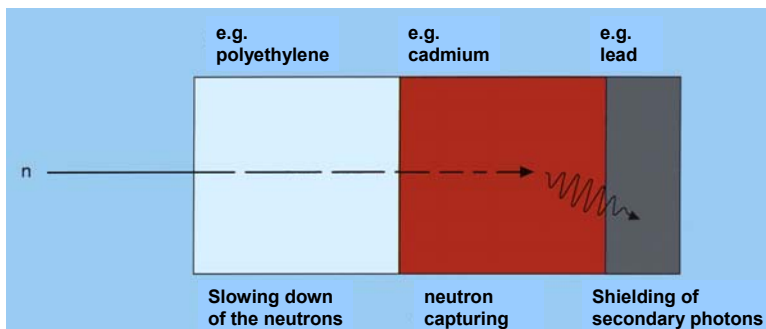
85

6) Radiation Protection (10)

Protection against external radiation

Shielding of neutrons

(principle design of a neutron shield)



- Neutrons lose their energy by elastic and inelastic collisions with light nuclei
- capturing of the slow neutrons by neutron absorbers like cadmium or lead
- shielding of the secondary photon radiation by lead walls

86

6) Radiation Protection (11)

Protection against internal radiation

- **Special care must be taken during work with nuclides emitting α - and β -radiation (direct interactions with cell material)**
- Reduction of the risk of incorporation by:
 - ◆ radiochemical techniques
 - ◆ frequent contamination checks (hands)
 - ◆ special care when handling volatile or gaseous materials