

# Physical carcinogenesis

**Cancer** can be defined as the growth of cells that have escaped control of cell division and that proliferate completely autonomously. The essence of tumor growth is mutations in certain genes of the cell. The factors that cause mutations are called **mutagens**.

Mutagenic factors are divided into:

- **physical,**
- **chemical,**
- **biological.**

## Physical factors

### Ionizing radiation (gamma, X-ray)

- Ionizing radiation has high energy and passes through the body's tissues.
- During the passage of radiation, collisions with atoms occur and their electrons are released → radicals and ions (eg  $H^+$ ,  $OH^-$ ) are formed along the beam trace → they can react with other molecules of the cell structure, including DNA.
- Ionizing radiation mainly causes oxidation of bases and disrupts the pentose-phosphate bond in the DNA chain.
- The absorbed radiation dose has a unit of gray ( $Gy = J / kg$ ).
- The mutagenic effect of irradiation depends on the radiation dose, exposure time, cell cycle phase and the quality of repair mechanisms.
- It mainly causes chromosomal breaks and subsequent chromosomal rearrangements.
- It causes leukemia, osteosarcoma, skin tumors, thyroid tumors, etc.
- There is no threshold dose for radiation and even individual quantities of radiation can cause a mutation.
- The most sensitive cells to ionizing radiation are dividing cells (bone marrow cells, lymphatic cells, germ cells, etc.).
- In medicine, high doses of radiation are used in cancer treatment.
- In recent years, X-ray diagnostics has been replaced by ultrasound.
- Natural sources: cosmic rays, solar rays, natural radioisotopes.
- Artificial sources: nuclear weapons, nuclear reactor, radiopharmaceuticals, cesium and cobalt gamma irradiators, Lexell's gamma knife, etc.

### UV radiation

- It has less energy than ionizing radiation.
- It is absorbed by many organic molecules, especially purines and pyrimidines.
- It is a strong mutagen for unicellular organisms, in multicellular animals it damages only their surface cells (epidermis).
- In humans, UV radiation can cause skin neoplasms (carcinomas, melanomas).
- The risk of UV radiation now increases as the ozone content of the ionosphere (ozone hole) decreases.
- UV radiation causes mutations mainly by the formation of hydrates of purines and dimers of pyrimidines (especially thymine).
- Thymine dimers:
  - they disrupt the structure of the DNA double helix and prevent the DNA polymerase from following the template, thereby interrupting DNA replication;
  - during their repair, incorrect base classification may occur.
- **UVC = 100-280 nm - germicidal:**
  - completely absorbed by the ozonosphere → does not harm
  - from artificial sources harms → germicidal lamps (special lamp for sterilization of air and environment, use in healthcare)

- **UVB = 280-315 nm - solar radiation:**
  - absorbed DNA → pyrimidine dimers → skin tumors (carcinoma, melanoma).
- **UVA = 315-400 nm - solar radiation:**
  - DNA is probably not absorbed, but is absorbed by other molecules → free radicals → DNA damage → aging and skin cancer.

## Links

### Related articles

- Radiation disease
- Ionizing radiation

### Externí odkazy

- Ionizing radiation (Wikipedia)

### References

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