

# Genotoxic Substances

**Genotoxic substances** (mutagenic) are substances that, after inhalation, ingestion or skin penetration, can cause or increase the frequency of genetic damage. Mutagenic substances cause a change in the genetic code of cells. A mutation is a permanent change in the amount or structure of genetic material in an organism, which results in a change in the characteristics of the organism. Changes can involve a single gene, a block of genes, or an entire chromosome.

## Occurrence of genotoxic substances

These are substances that are contained all around us - in the *air, soil, water, food* and *in our home environment*. In addition, the mutagenic effect was proven for *a number of drugs* - antibiotics, cytostatics and disinfectants. They can occur naturally, but are more often *the products of human activity*.

Can be detected in *food*:

- **naturally genotoxic substances:** flavonoids (quercetin, rutin) and tannins (their contribution to damage is minimal);
- **mycotoxins:** (aflatoxin B1 – produced by the fungus *Aspergillus flavus*, paulline, ochratoxin): products of fungi arising from improper storage of food (cereals, nuts, beans);
- **substances of artificial origin:**
  - nitrates, nitrites and nitrosamines – in meat, cold meats and cheeses; pyrolyzates of amino acids are created by inappropriate heat treatment of meat;
  - **polycyclic aromatic hydrocarbons, polyhalogen hydrocarbons** (PCB/TCDD/F), **pesticides** – DDT, HCH (these substances accumulate in fat tissue);
- **metals with a genotoxic effect** – arsenic, hexavalent chromium, nickel, cadmium, lead.

The following can be detected in *water*:

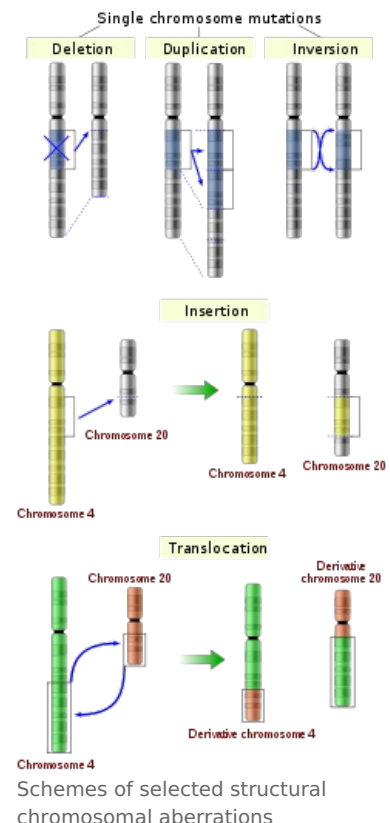
- products for disinfection of drinking water by chlorination (chloroform, dichlorophenols, dichlorobenzene);
- styrene and formaldehyde.

We find a number of substances in *the air* that are tied to local activity:

- **metals and their compounds** (arsenic, chromium, nickel, lead, cadmium);
- **organic compounds** (benzene, formaldehyde).

In *the domestic environment*, substances are released from building elements, furniture and textiles:

- formaldehyde, styrene, acrylates, phthalates, vinyl chloride.



## Types of mutations and their health significance

- **Gene (point) mutations** – arise by changing the sequence of nucleotides in the DNA molecule. They affect individual genes, are transmitted to subsequent generations of cells and offspring, and represent a serious burden on the gene pool of the population. Gene mutations are not detectable under an optical microscope.
  - congenital metabolic disorders (phenylketonuria, galactosemia)
  - chondrodystrophy, hemophilia
- **Chromosome (chromosome aberrations)** – are changes in the structure of chromosomes. The condition is a chromosome break followed by a faulty connection or the loss of a part of the chromosome. They are usually not passed on to the next generation. They pose a serious risk to the affected individual. They are detectable in an optical microscope.
  - oncogene activation at the break point
  - degenerative disease (atherosclerosis)
  - accelerated aging of cells and tissues
- **Genomic (aberration of the number of chromosomes)** – this is a change in whole multiples of the haploid number of chromosomes (triploidy, tetraploidy, polyploidy). They are detectable in an optical microscope.
  - Down syndrome, Turner syndrome, Klinefelter syndrome

## Primary prevention of late effects of chemical substances

1. genotoxic activity testing – new genotoxic substances are prevented from entering the environment
2. environmental monitoring – detection of genotoxic substances in the environment (chemical methods, Ames

- test)
- 3. exposure monitoring – detection of genotoxic substances and their metabolites in the human body
- 4. monitoring of the biological effect - monitoring the reaction of the organism to the action of genotoxically active substances (genetic toxicology, immunological, biochemical methods)
- 5. monitoring the occurrence of genetically determined defects

## Links

### Related articles

- Toxicogenetics

### References

- BENCKO, Vladimír, et al. *Hygiene : Textbooks for seminars and practical exercises*. 2. revised and supplemented edition edition. Prague : Karolinum, 2002. 205 pp. pp. 18-31. ISBN 80-7184-551-5 .
- Czech republic. Ministry of Industry and Trade. Current chemical legislation. 2008. Available from <<https://www.mpo.cz/dokument27543.html>>.