Excretion of radioactive substances by the organism

Radioactive substances can be excreted from the body in two ways:

- by natural decay,
- elimination by excretory organs (especially kidneys and liver).

Physical (decay) half-life and biological half-life are used to characterize these elimination events. Total elimination is characterized by an effective half-life.

Physical half-life

For more information see The Fundamental Law of Radioactive Decay.

Physical half-life' (also **decay half-life**, **decay half-life**) $T_{1/2,F}$ is the time interval, after which **will undergo nuclear transformation of half of the radionuclide nuclei contained in the sample**. The absolute number of cores does not matter. The half-life is the same for a particular nuclide regardless of the specific physical conditions (temperature, pressure, mass of the sample, electromagnetic field, chemical bonds around the nuclide, etc.)[note. 1] The intrinsic value of the half-life varies from thousandths of a second to thousands of years. Radionuclides with a very long half-life (on the order of approximately tens of millions of years) are, due to the length of human life, classified as stable nuclides, although from a purely physical point of view this is not the case.

The decay of radioactive elements is a random process. The half-life is actually the length of the section during which exactly half of the nuclei present in the observed sample will probably decay. So, in other words, exactly half of the nuclei will not actually decay during the half-life, but the fact that exactly half of them will decay is the most likely. With a large number of nuclei in the sample, which is almost always the case, the deviations are practically unmeasurable, so it can be safely assumed that exactly half of the nuclei decay in one half-time.

Biological half-life

For more information see Medicine Elimination.

Biological half-life $T_{1/2,B}$ is the time it takes for **half of a substance to be eliminated from the body**. It does not matter whether it is a medicine or a harmful substance. The liver and kidneys are mainly involved in excretion, in some cases other excretion routes can also play an important role. The specific value of the biological half-life depends in particular on the water solubility, the size of the molecule, the enzymatic equipment of the organism and the capacity of biodegradation pathways, interactions with other substances and the overall state of the organism, especially the functional state of the kidneys and liver.

The excretion kinetics of some substances can be complicated by, for example, binding to bone tissue. The free part is thus eliminated relatively quickly, while the bound part is biologically eliminated very slowly.

In contrast to the practically uninfluenceable physical half-life, the biological half-life can be shortened in some cases, e.g. by increasing diuresis.

Effective Half Time

Effective half-life $T_{1/2,ef}$ is the **combination of biological half-life and physical decay half-life**. It characterizes the residence time of the radioactive nuclide in the organism. It is one of the quantities that influence the radiation load caused by a radionuclide during examinations open radiators. The shorter the effective half-life, the more suitable (less burdensome) the radiopharmaceutical is.

The effective half-life ``$T_{1/2,\mathrm{ef}}$ *depends on both physical and biological half-lives. N:*

$$\frac{1}{T_{1/2,ef}} = \frac{1}{T_{1/2,F}} + \frac{1}{T_{1/2,B}}$$

This shape can be adjusted by adding the fractions and dividing the equation on both the left and right sides:

$$T_{1/2,ef} = \frac{\frac{1}{T_{1/2,F}} \cdot \frac{1}{T_{1/2,B}}}{\frac{1}{T_{1/2,F}} + \frac{1}{T_{1/2,B}}}$$

The seemingly complicated relationship results from the fact that the effective half-life, i.e. actually the "effective elimination constant", corresponds to the sum of the decay constant of the physical half-life and the elimination constant of the biological one.

Logically, the effective half-life is shorter than the physical and biological half-lives.

Footnotes

1. In fact, the observed half-life can decay in extreme cases depend on physical conditions. Such extreme conditions are, for example, speeds close to the speed of light, at which relativistic effects begin to apply in a significant way. For example, acceleration is used to "extend the life" of extremely unstable particles in research in nuclear physics.

Links

Related Articles

- Radionuclide
- Radioactivity

References

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