

# Effects of ultraviolet radiation

## Introduction

**UV radiation** is invisible electromagnetic radiation with a wavelength shorter than that of visible light. The natural source of UV radiation is the Sun. If all the sun's UV radiation penetrated to the earth's surface, it would have fatal consequences for life on earth. UV radiation is absorbed as it passes through the Earth's gaseous envelope. Most of it is captured already in the ionosphere, and another part then in the lower layers of the atmosphere, of which the stratosphere is the most involved in capture due to its high ozone content.

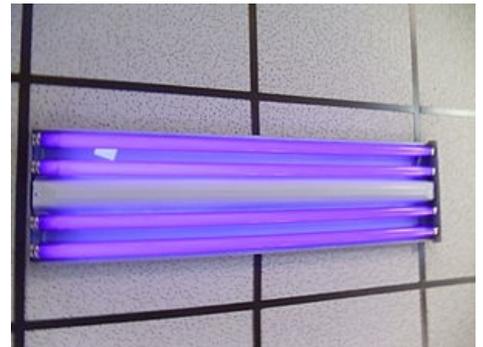
## Role in evolution and positive effects of UV radiation

Although **the effects of UV** radiation on the organism are mostly negative, according to modern theories it can also be attributed a certain positive role in **evolutionary processes**. It acts as a catalyst in the reaction of two neighboring thymines in the DNA double helix to form so-called thymine dimers. A stretch of DNA that contains such a dimer cannot be successfully replicated, which is why the first prokaryotic organisms continued to die out before the ozone layer was formed. Thanks to the selection, only those organisms that were able to create so-called excision repair enzymes survived - i.e. repair enzymes, that could cut out thymine dimers. They thus became the predecessors of today's enzymes, which participate in mitosis and meiosis and correct the errors that arise during them. It can therefore be said that UV radiation gave rise to the first proteins capable of successful replication. Other positive roles of UV radiation are the **participation in the formation of vitamin D in the skin** and the possibility of its **use in the therapy of psoriasis**.

## Types of UV radiation

UV radiation can be divided into individual components according to their wavelength:

- **UVA** has a wavelength range from **315 to 400 nm**. It makes up 99% of the sun's UV radiation that hits the earth's surface; it penetrates deeply and does not cause a tan. UVA has been considered less harmful because it **does not cause DNA damage directly**, unlike UVB and UVC. Today, however, it is known that it **can cause the formation of reactive oxygen species**, which can further react with DNA and damage it.
- **UVB** has wavelengths in the range of **280-315 nm**. It is mostly absorbed by ozone in the stratosphere - the ozone layer. The harmful effects of UV radiation are mainly caused by the UVB component.
- **UVC** - includes wavelengths **shorter than 280 nm**. It has the highest energy from UV radiation and is therefore the **most dangerous**. It has the highest energy from UV radiation and is therefore the **does not pass through the atmosphere**. UVC is used in the formation of ozone, which is formed from molecular (i.e. diatomic) oxygen. It can therefore be said that the oxygen layer captures UVC, and thus it does not reach the ground. However, it is necessary to mention its use for disinfection in so-called germicidal lamps, the use of which may endanger humans.



BlackLightBulb4300ppx2

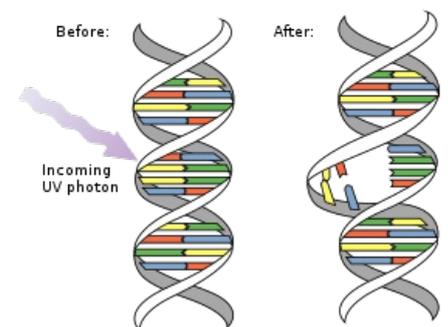
The depth of penetration of UV radiation through the skin increases as the wavelength shortens.

## Biological effects

The effects of UV radiation on humans can be divided according to the point of impact into skin effects, eye effects, systemic effects and environmental effects.

### Skin effects

**The sensitivity** of the human population to the effects of UV radiation **varies greatly** not only according to skin color. People from certain geographical areas, such as the Irish, are more susceptible to skin damage, as they do not tan much in the sun and pigmentation does not act as a protective factor here. However, even within a single nation there are significant differences in response to UV radiation. Excessive exposure to UV radiation causes some typical symptoms such as erythema. Direct pigmentation appears already a few hours after irradiation and is caused by the oxidation of melanin granules in the basal layers of the epidermis, which causes it to darken. Indirect pigmentation, otherwise called late, appears only after the erythema disappears and is caused by the effect of dopa-oxidase on dioxyphenylalanine, which gradually penetrates from the basal cells to the surface layers of the epidermis. Along with skin



DNA UV mutation

symptoms, general symptoms often associated with overheating of the body can also appear during intensive exposure. These are headache, fever and hypotense. In addition to elevated temperatures, an increased level of histamine in the blood also contributes to them. **the most serious consequence** of excessive exposure to UV radiation is **the possibility of skin cancer**. It is reliably proven that skin malignancies, outside of melanomas, are almost exclusively caused by chronic exposure to the UV component of sunlight, and the occurrence of malignant melanoma is highly dependent on UVB exposure. UV radiation has a cumulative effect and there are several mechanisms of action. Dimerization of thymines in DNA occurs in the skin after UVB exposure. Under normal circumstances, this error is corrected and thus the progression of replication enzymes along the DNA helix is enabled. In some genetic diseases, however, the repair enzymes are broken and there is a higher risk of transferring the error to another DNA molecule, and thus a higher risk of cancer. UV radiation is also involved in the development of skin cancers due to its immunosuppressive effect. By destroying a certain type of Langerhans cells in the epidermis, the skin loses its immune response. An increase in the level of corticoids is also immunosuppressive and inhibition of contact hypersensitivity. All these factors contribute to the development of skin cancer.

## Effects on the eye

In the eye, UV radiation is mainly absorbed by the **conjunctiva** resulting in **cornea**, or, in extreme cases **conjunctivitis**, či v extrémních případech i **keratitis**. Intense exposure associated with excessive reflections from bright surfaces (e.g. in skiers without protective glasses) can also cause so-called **snow blindness**, which is manifested by temporary loss of vision, conjunctivitis, corneal damage and, in very severe cases, retinal damage.

## System effects

**Among the overall effects, the effect of UV radiation on the immune system**. has already been mentioned. In addition, UV radiation stimulates metabolism, temporarily increases blood pressure, stimulates the activity of the pituitary gland, thyroid gland and vegetative nervous system. In general, **biochemical changes**, such as the above-mentioned release of histamine, kinins and cytokines, well as cyclooxygenase and arachidonic acid products, also act.



Ericson Type II Conjunctivitis

## Environmental effects

In conclusion, it is necessary to mention a very important problem of today's time. UVB radiation **penetrates the water** very easily up to several meters and destroys the plankton, that is sensitive to it. Plankton is very important both for **the production of oxygen**, and for the **consumption of carbon dioxide**, the excess of which can contribute to **global warming**.

## Health protection

The main protection against excessive solar radiation is to **reduce the length of exposure**, especially in the midday hours, as the intensity of solar radiation is twice as high at noon than at 3:00 p.m. It is also advisable to use **protective equipment** – dark glasses, sunscreen and appropriate clothing. All of these recommendations become more important at higher altitudes.

## links

### Related Articles

- Ultraviolet radiation (hygiene)
- Ultraviolet radiation (biophysics)

### Source

- BENCKO, Vladimír, et al. *Hygiena : Učební texty k seminářům a praktickým cvičením*. 2. přepracované a doplněné vydání edition. Praha : Karolinum, 2002. 205 pp. ISBN 80-7184-551-5.