

Biological Effects of UV Radiation

Effects of UV Radiation (UVR)

The effects of UV radiation can be on:

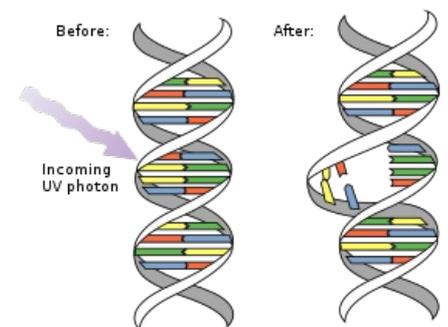
- Skin
- Eyes
- Systemic

Characteristics of UVR

- UV-A radiation comprises the majority of UVR reaching the surface of the Earth (~90% at midday), therefore it accounts for a large percentage of the immediate and long-term cutaneous effects of UVR;
- UVR can normally penetrate the skin only about 0,6mm deep and affects mostly epidermal cells in Malpighian layer (both stratum basale and spinosum in epidermis);
- In the eye UVR is predominantly absorbed by the conjunctivae but also partly by the cornea.
- Among general/systemic effects, the following are included: stimulation of metabolism and temporary increase in BP, stimulation of the activity of hypophysis, thyroid gland and ANS, non-specific reaction of the Seeley's adaptation syndrome with subsequent production of corticosteroids increasing non-specific resistance.
- All these reactions are dose-dependent
- UVR of **215-310nm** also stimulates the cutaneous synthesis of biologically active vitamin D3 from provitamin (7-dehydro-cholesterol and similar steroids) by photoconversion

Clinical findings and pathophysiology

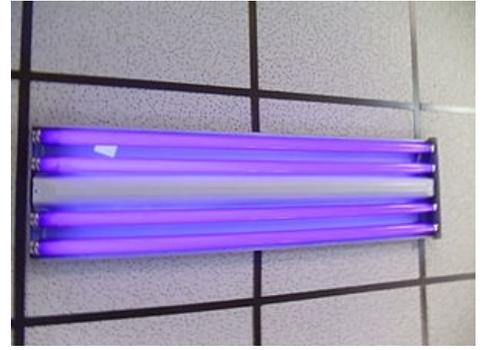
- The sensitivity to UVR damage is given genetically and differs significantly among populations and individuals;
- Dark skinned people are about 10 times less sensitive than the light skinned people;
- Fair skinned individuals with blond hair and blue eyes are the most sensitive;
- Exposure of skin to UVR may lead to acute sunburn or solar erythema;
- Less intense or shortened duration exposure results in an increase in skin pigmentation - tanning, which provides some protection against further UVR;
- With repeated exposure to UVR, the skin thickness, primarily due to epidermal hyperplasia with thickening of the stratum corneum;
- Snow blindness (UV keratitis and UV keratoconjunctivitis) may be caused by unprotected or long exposure to high intensity UVR particularly at high altitudes; exposure to UV radiation reflected off snow, ice or water and viewing of solar eclipses;
- General symptoms such as fever, chills malaise, irritation, nausea or vomiting, headache and decrease of blood pressure (BP) appear in more severe cases of excessive UVR. These symptoms are evoked mainly by increase of histamine levels in blood and also by disintegration products of protoplasmic proteins;
- The most important histopathological change is the reduction of Langerhans' cells of epidermis (LCs). The dose 100J/cm² UVA or UVB radiation reduces drastically all cells, which carry to the surface Ia antigens, that means in epidermis, exclusively LCs;
- UVR also causes ultrastructural changes in the endothelium of peripheral capillaries, accompanied by swelling, changes of immunity, and changes in function of cell surface receptors. The dilation of capillaries itself is caused by creation of histamine from histidine;
- Biochemical changes, include release of histamine, cyclooxygenase, products of arachidonic acid, cytokine. Epidermal cells may be the place which immunosuppression is selectively initiated. On the other hand, this selective immunosuppression contributes to the development of skin cancer induced by UVB-radiation;
- It has been reliably proved that skin malignancies, except melanomas, are nearly exclusively caused by chronic exposure to UV component of sunshine and the occurrence of malignant melanoma is considerably dependent on the exposure to UVB. After exposure to UVB, pyrimidine and thymine of DNA bond to form dimers, which inhibit DNA replication and RNA creation. This dimer is broken after exposure to UVA-radiation or daylight. This reparation is an important protective mechanism against the development of skin cancer.



UVR effects on DNA.

Curative and bactericidal effects

- UV radiation, most often UVA, produced by modified UV lamps, applied locally or on the whole body is widely used in dermatology in the treatment of various skin diseases, most often in combination with systemic or topic chemotherapy;
- The treatment of psoriasis with UVA together with psoralens is a typical example;
- Substantial bactericidal effects of UVC are used in health facilities for disinfection as the 2nd degree after chemical disinfection, e.g. in labs and operations theaters, or dissecting rooms.



UVC lamp.

Prevention and protection

- Limiting the time of exposure;
- Use of lotions with effective sun filters (lotions protect against skin cancer but there is doubt about their effectiveness in protecting against premature skin ageing);
- Use of eye protection (dark glasses).

Links

Related articles

UV Radiation Types, Ozone Layer Depletion, Prognosis of its Evolution

Bibliography

- BENCKO CHARLES UNIVERSITY, PRAGUE 2004, 270 P, V, et al. *Hygiene and epidemiology. Selected Chapters*. 2nd edition. Prague. 2008. ISBN 9788024607931.