



## Mechanisms and Risks of Skin Cancer Induced by Ultraviolet Radiation

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### DESCRIPTION

Photocarcinogenesis is the process by which exposure to ultraviolet radiation from sunlight or artificial sources contributes to the development of skin cancer. This field of study explores the biological, molecular and environmental mechanisms by which ultraviolet light damages skin cells and promotes malignant transformation. The skin serves as the first line of defense against environmental insults, yet it is particularly vulnerable to the effects of ultraviolet radiation due to its direct exposure. Understanding Photocarcinogenesis is essential for developing strategies to prevent skin cancer, which is among the most common forms of cancer worldwide.

Ultraviolet radiation is divided into several types, including long wavelength, medium wavelength and short wavelength radiation, each with distinct effects on skin tissue. Long wavelength radiation penetrates deeply and damage indirectly by generating reactive oxygen species that disrupt cellular components. Short wavelength radiation is highly energetic and causes direct damage to the genetic material of skin cells. Both types of damage can result in mutations in critical genes that control cell growth and division, including those responsible for repairing errors and regulating cell death. These mutations accumulate over time and can trigger uncontrolled proliferation of abnormal cells, ultimately leading to tumor formation.

The skin contains multiple cell types, including keratin producing cells, pigment producing cells and immune cells, all of which respond differently to ultraviolet exposure. Keratin producing cells are the most common origin of non-melanoma skin cancers, while pigment producing cells give rise to melanoma, which is typically more aggressive and prone to metastasis. Ultraviolet induced damage also affects the local immune response in the skin, suppressing the ability of immune cells to recognize and destroy abnormal cells. This immunosuppression creates an environment in which mutated cells can survive and multiply, further increasing cancer risk.

Environmental and behavioural factors strongly influence the risk of photo-carcinogenesis. Geographic location, altitude and

season determine the intensity of ultraviolet radiation exposure. Individuals living near the equator or at high elevations are exposed to stronger ultraviolet radiation and have a higher incidence of skin cancer. Behavioural factors such as prolonged sunbathing, outdoor occupations, use of tanning beds and inadequate protection with clothing or sunscreen further increase the risk. The cumulative effect of repeated ultraviolet exposure over years is a major determinant of skin cancer development, emphasizing the importance of preventive measures throughout life.

Genetic susceptibility also plays a critical role in photo-carcinogenesis. Variations in skin pigmentation, the ability to tan and cell repair capacity influence how an individual responds to ultraviolet damage. Fair skinned individuals with light hair and eye colour have less melanin, which normally absorbs ultraviolet radiation and reduces its harmful effects. In addition, inherited defects in genes responsible for repairing ultraviolet induced nucleic damage, such as those involved in certain rare disorders, dramatically increase susceptibility to skin cancer. Understanding these genetic factors helps identify high risk populations and tailor preventive interventions accordingly.

Prevention of skin cancer resulting from ultraviolet exposure relies on a combination of behavioural, educational and medical strategies. Limiting direct sun exposure during peak hours, wearing protective clothing, using broad spectrum sunscreens and avoiding artificial ultraviolet sources are proven methods to reduce risk. Public health campaigns play a vital role in raising awareness about the dangers of ultraviolet radiation and promoting sun safety, particularly among young populations who are often exposed to high levels of ultraviolet light. Early detection through regular skin examinations also improves outcomes by identifying cancers at a stage when they are more easily treated.

Despite progress in understanding photo-carcinogenesis, challenges remain in reducing the global burden of skin cancer. Environmental changes such as ozone depletion and increased outdoor activity contribute to rising ultraviolet exposure. Additionally, variations in individual behaviour, access to

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protective measures and genetic susceptibility complicate the development of universal prevention strategies. Ongoing research into molecular mechanisms, biomarkers for early detection and novel protective agents continues to expand our knowledge and offers hope for more effective prevention and treatment approaches.

In conclusion, photo-carcinogenesis represents a complex interplay between ultraviolet radiation, genetic susceptibility and environmental and behavioural factors that lead to the development of skin cancer. The accumulation of ultraviolet induced nucleic damage, immunosuppression and molecular

alterations underlies the transformation of normal skin cells into malignant ones. Preventive strategies including sun protection, public education and early detection are essential to reduce the incidence and impact of ultraviolet induced cancers. Continued research into the mechanisms of photo carcinogenesis will further enhance our ability to protect populations and manage skin cancer more effectively, highlighting the importance of both scientific understanding and proactive health measures in addressing this growing global concern.