

Ashish Dwivedi · Neeraj Agarwal  
Lipika Ray · Amit Kumar Tripathi *Editors*

# Skin Aging & Cancer

Ambient UV-R Exposure

 Springer

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Editors

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Ambient UV-R Exposure

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## Preface

It gives us immense pleasure to write the first edition of the book entitled *Skin Aging & Cancer: Ambient UV-R Exposure*.

Skin is the largest human organ which offers protection to the body. However, our skin naturally ages with time which promotes skin inflammation, impaired wound repair, and increased risk of skin cancer. Skin aging occurs by multi-factorial processes, involving environmental and genetic factors. One of the major environmental factors causing skin aging is ultraviolet radiation (UV-R) coming through sunlight which damages sun-exposed skin areas and promotes photo-induced aging or photoaging. Chronic UV-R exposures on skin often lead to skin cancer. Incidences of skin cancer are increasing globally, and major causing factors are increased outdoor activities, ozone depletion, genetic alterations, and immune suppression. This book will educate about how UV-R initiates cancer, mechanisms involved, potential therapy, and what protective measures can be taken. In this book, we discuss the role of UV-R-induced skin aging and cancer to provide insights into the pathogenesis and process to reduce photoaging. Furthermore, this book also describes nanotechnology-based therapeutic development of skin cancer in the recent era and bioinformatics explanations of skin aging and cancer.

All the authors in this book are highly skilled researchers with thorough and up-to-date knowledge in the field and are actively doing research in the relevant fields. For all the chapters, we put our best efforts to provide collated information from research articles published so far related to the subject and arranged them in subsections to make them easy to follow. We have tried our best to use the simplified language so that it can be understandable to all levels of readers.

We hope that after reading the book, the reader will have more knowledge, understanding, and awareness about the harmful effects of repetitive or chronic UV-R exposure as well as its interactions with other chemicals and drugs on the skin or inside the body.

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The editors are heartily thankful to all the authors and reviewers for investing their valuable time and hard work in writing and reviewing the chapters for this book. Without their support, this book would not have become a reality. I highly admire that all authors took extra stress to provide detailed information based on their research knowledge and literature from recent publications to make all the chapters in this book up-to-date and more valuable for its readers.

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## Abbreviations

|       |                                               |
|-------|-----------------------------------------------|
| ECM   | Extracellular matrix                          |
| HSPGs | Heparan sulfate proteoglycans                 |
| MMPs  | Matrix metalloproteinases                     |
| TIMP  | Tissue inhibitor of metalloproteinase         |
| NCBI  | National Centre for Biotechnology Information |
| KSCs  | Keratinocyte stem cells                       |
| CPDs  | Cyclobutane pyrimidine dimers                 |
| SCC   | Squamous cell carcinoma                       |
| BCC   | Basal cell carcinoma                          |
| MED   | Minimum erythral dose                         |
| NMSC  | Nonmelanocytic skin cancers                   |
| BCC   | Basal cell carcinoma                          |
| SCC   | Squamous cell carcinoma                       |
| MDR   | Multi-drug resistance                         |
| NCIA  | National Cancer Institute of America          |
| PDT   | Photodynamic therapy                          |
| NGS   | Next-generation sequencing                    |



# Skin Anatomy and Morphology

Neera Yadav, Shama Parveen, Shilpa Chakravarty,  
and Monisha Banerjee

## Abstract

The skin as an outer covering of the body is the largest organ and is obligatory for the support and protection of internal organs to function properly. It varies in thickness depending on its site and role it performs. It contains many appendages and glands to maintain homeostasis and normal temperature of the body. It also contains pigments which act as sunscreen to protect against UV radiation and is the site of vitamin D synthesis which is necessary for normal growth. The skin is divided in many layers based on the cellular structure to communicate in a way so as to function effectively. The cells of the skin contain numerous connecting proteins for transfer of messages across them. Genetic disorders in some of these proteins may lead to serious diseases.

## Keywords

Skin · Largest organ · Homeostasis · Protection · Dermis · Appendages

## 1 Introduction

The human skin or cutaneous covering is the external covering of the body. Its origin is ectodermal. It is the major tissue system of the integumentary system, consisting of the skin and the outer and inner linings of internal organs. The skin protects internal organs, bones, muscles, and other soft structures from harmful environmental agents, chemicals and pathogens, etc. It plays an important role in the synthesis

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of vitamin D, sensation, and temperature regulation of the body. The skin also provides first line of defense from pathogens. The total surface area of the average adult human skin ranges from 1.5 m<sup>2</sup> to 2.0 m<sup>2</sup>. The thickness of the skin ranges from 0.3 to several centimeters. The skin is thinnest at eyelids and thickest at soles and palms. The skin can have weight of about 20 kg. The human skin is usually covered with small hairs. On the basis of hairs, the skin may be hairy or non-hairy. The non-hairy skin is called the glabrous skin. The skin has a property to revive itself continuously; even the severely damaged skin can heal by forming scar tissue which may be faded. Skin, depending on the type of cell and tissues, is divided into different layers. Cells are stacked into multiple layers together with connective tissues to form different configurations within each layer. Deep into the skin, numerous blood capillaries are entrenched to provide proper vascularization. It is well equipped with sensory system. One centimeter square area of the skin typically contains 5 hairs, 6,000,000 cells, 5000 sense end organs, 15 sebaceous and 100 sweat glands, 200 pain sensors, 12 cold and 2 heat receptors, 400 cm nerve fibers, and 100 cm blood vessels. The skin of different locations has modifications according to the need of the site at which it is present. For example, soles have thick epidermis, the face is well furnished with sebaceous glands in bulk, and the scalp is roofed with thick layer of keratinized cells in the form of hairs. Typically, the skin is divided into the outermost *epidermis*, inner *dermis*, *basement membrane zone*, and *subcutaneous* tissue.

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## 2 Epidermis

The word epidermis is made of two different words; i.e., epi means outer and derma means skin. Henceforth, the epidermis is the outermost surface of the skin which is in direct contact with the environment. The epidermis lacks vascular system as it has no blood vessels; this condition is known as *avascular*. It consists of keratinized, stratified squamous epithelial tissue. The epidermis of different locations has different thicknesses of epithelial cell layers, but commonly ranges from four to five. These grounds varied thickness of the epidermis at distinct sites. At distinctive sites such as soles and palms it can go up to 30 cell layers. The skin with up to four cell layers is designated as “thin” skin whereas, beyond it, skin is called “thick.” Except soles and palms, all the skin is thin. On the basis of arrangement of cells, layers have been categorized into four types, viz., *stratum corneum*, *s. granulosum*, *s. spinosum*, and *s. basale* (from outside to inside).

### 2.1 Stratum Corneum

The outermost layer needs resurgence as it is directly pretentious by the environmental wear and tear. This perseverance can be achieved by stratum corneum, the outermost layer of the epidermis. It keeps continuous shedding of multilayer keratinocyte cells (10–30 cell thick) to maintain skin hale and hearty. Keratinocyte cells of the stratum corneum are hardened as a horn of an animal and, thereby, known as