

Bioengineering the microanatomy of human skin

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Abstract

Recreating the structure of human tissues in the laboratory is valuable for fundamental research, testing interventions, and reducing the use of animals. Critical to the use of such technology is the ability to produce tissue models that accurately reproduce the microanatomy of the native tissue. Current artificial cell-based skin systems lack thorough characterisation, are not representative of human skin, and can show variation. In this study, we have developed a novel full thickness model of human skin comprised of epidermal and dermal compartments. Using an inert porous scaffold, we created a dermal construct using human fibroblasts that secrete their own extracellular matrix proteins, which avoids the use of animal-derived materials. The dermal construct acts as a foundation upon which epidermal keratinocytes were seeded and differentiated into a stratified keratinised epithelium. In-depth morphological analyses of the model demonstrated very close similarities with native human skin. Extensive immunostaining and electron microscopy analysis revealed ultrastructural details such as keratohyalin granules and lamellar bodies within the stratum granulosum, specialised junctional complexes, and the presence of a basal lamina. These features reflect the functional characteristics and barrier properties of the skin equivalent. Robustness and reproducibility of *in vitro* models are important attributes in experimental practice, and we demonstrate the consistency of the skin construct between different users. In summary, a new model of full thickness human skin has been developed that possesses microanatomical features reminiscent of native tissue. This skin model platform will be of significant interest to scientists researching the structure and function of human skin.

Key words: barrier function; dermis; epidermis; human; methodology; reproducible; skin equivalent; tissue engineering.

Introduction

The skin is the largest organ of the human body, accounting for approximately 16% of the total body weight. It is the primary interface between the internal and external environments which acts as a barrier to protect the body from a range of environmental stressors and maintain homeostasis by preventing unregulated water and electrolyte loss. The anatomy of human skin is well

characterised, and there is a clear relationship between its structure and function. It is therefore essential to consider the structural aspects of skin when developing tissue mimetics to study skin health and disease, to ensure that the *in vitro* model accurately recapitulates the anatomical features of its native counterpart.

The skin is a complex organ with two distinct structural upper layers: the epidermis and the dermis. The epidermis is a stratified keratinised epithelium predominantly made up of keratinocytes, which is subdivided into four layers: basal, spinous, granular, and cornified. The basal layer rests upon a basement membrane at the dermoepidermal junction. It consists of mitotically active columnar cells which proliferate, migrate superficially, and sequentially differentiate to form the stratified epidermis. The basal layer is characterised by the expression of keratin 14, and the daughter keratinocytes undergo a characteristic basal-to-suprabasal

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Accepted for publication 7 January 2019
Article published online 10 February 2019

Bioengineering Of The Skin

RC Schank



Bioengineering Of The Skin:

Bioengineering of the Skin Joachim W. Fluhr, Peter Elsner, Enzo Berardesca, Howard I. Maibach, 2004-08-27

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Spanning the many advancements that have taken place in the field since the First Edition of this book was published this Second Edition emphasizes the imaging of the skin in its entirety rather than focusing solely on surface layers The Second Edition includes new chapters on technologies such as in vivo confocal laser scanning microscopy Rama Bioengineering of the Skin Enzo Berardesca, Peter Elsner, Klaus-Peter Wilhelm, Howard I. Maibach, 2020-07-24 Skin bioengineering is an expanding field of investigative and clinical dermatology This guide describes all commercially available techniques and instruments It provides a thorough overview of methods for noninvasive investigation of skin function Commercially available instruments are reviewed and compared with updated references given for each instrument This book offers a technical analysis of each instrument allowing investigators to understand its biophysical principles and to make better purchases of lab instruments Addresses of manufacturers and worldwide distributors are included making this an essential reference source Chapters are written by international experts Topics include transepidermal water loss hydration the measurement of skin blood flow in Laser Doppler flowetry sebum pH and ions and transcutaneous pO₂ and pO₂ measurements Skin color roughness and elasticity are examined in detail Skin imaging techniques capillaroscopy and fluorescence videomicroscopy are described Instruments for surface microscopy of the skin are also discussed Bioengineering of the Skin explains state of

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Wilhelm, Howard I. Maibach, 1995-09-11 Skin bioengineering is an expanding field of investigative and clinical dermatology This guide describes all commercially available techniques and instruments It provides a thorough overview of methods for noninvasive investigation of skin function Commercially available instruments are reviewed and compared with updated references given for each instrument This book offers a technical analysis of each instrument allowing investigators to understand its biophysical principles and to make better purchases of lab instruments Addresses of manufacturers and worldwide distributors are included making this an essential reference source Chapters are written by international experts Topics include transepidermal water loss hydration the measurement of skin blood flow in Laser Doppler flowmetry sebum pH and ions and transcutaneous pO₂ and pO₂ measurements Skin color roughness and elasticity are examined in detail Skin imaging techniques capillaroscopy and fluorescence videomicroscopy are described Instruments for surface microscopy of the skin are also discussed Bioengineering of the Skin explains state of the art techniques and is valuable reading for anyone who needs to stay abreast of the latest activities in this ever changing field Measuring the Skin Pierre G. Agache, Pierre Agache, Philippe Humbert, 2004-07-15 Measuring the Skin presents all techniques devoted to non invasive normal or diseased skin measurement As opposed other books this text embraces old and new validated techniques for all skin suborgans and functions The book is ideal as a small encyclopedia since it provides the answer to any question concerning skin measurement Each technique is discussed to help select the most appropriate one for each special case Another novel feature is that the book bases the skin investigation on the physiology and anatomy Each chapter is preceded by a compendium of current knowledge on the structure or function dealt with The book may also be used as a research tool It

contains a novel and presently unique list of more than 400 physical and biological skin constants which are all referenced

Bioengineering of the Skin Peter Elsner, Klaus-Peter Wilhelm, Enzo Berardesca, 2019-08-30 Since skin forms the interface between the human body and the environment its mechanical properties are important in health and disease Bioengineering of the Skin Skin Biomechanics gives a thorough introduction in the biological basis of skin biomechanics It explains the non invasive methods that allow measurement of the mechanical properties of the skin focusing on commercially available instruments Written by internationally leading experts in the field of non invasive measurement technology of the skin this volume describes the anatomy biochemistry physiology and pathology of skin biomechanics It explains in detail how to measure skin mechanic properties and how to use these measurements in the development of drugs and cosmetics **Skin**

Bioengineering Peter Elsner, 1998-01-01 Non invasive bioengineering techniques have become indispensable tools both in the development of drugs and cosmetics and in clinical dermatology These techniques enable researchers to study the structure and function of human skin objectively and quantitatively Recent technological developments have brought new techniques into the laboratory and the hospital among them magnetic resonance imaging optical coherence tomography and microdialysis This book describes these state of the art developments details the application of skin bioengineering techniques for clinical purposes shows their use in the testing of pharmaceuticals and cosmetics and provides an overview of the design and legal aspects of skin bioengineering testing It will be essential reading for dermatologists cosmetologists pharmacologists and toxicologists **Bioengineering of the Skin**, 2002 Bioengineering and the Skin R.

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