

Skin Lipids: An Introduction and Their Importance

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It is my intense and outmost pleasure to welcome you to this exciting project on lipids and skin in the form of an academic textbook for the very first time. Although the very first baby steps of lipids and skin together took place about 50 years ago in the laboratories of skin lipid pioneer scientists such as professors Downing, Strauss, and Nicolaides, nowadays it seems that together they could rapidly turn into one of the most emerging and intriguing fields of dermatology, lipid science, and metabolism.

Skin is the largest and the most visible—to us and to the others—organ of the human body but in addition to that, the most desired to be understood by the average consumer. Is it perhaps my biased opinion or perception? The jury is out to discover the truth and the validity of this statement. On the other hand, the majority of academic focus has been on cardiovascular health, metabolic diseases, and cancer which pose the most serious threats to our society and pose socio-economic issues far more severe than any disease that stems from the skin (perhaps melanoma being the most aggressive, which is, however, also classified as cancer). Certainly, academic laboratories can secure more funding from NIH, NSF, and private funding institutions to work towards curing devastating diseases responsible for the loss of many human lives, such as the multiple forms of cancer, diabetes, multiple sclerosis, and autoimmune diseases, rather than wrinkles, pimples, and age spots for the sake of an example. Perhaps one can agree that the majority of the healthy population that is not concerned daily with issues such as famine or clean water is focusing more on skin conditions than on any other disease. However, we are still far from solving completely all issues with devastating diseases in order to allocate even more resources in quality of life, prevention, and wellness, which certainly gain more ground as the years go by.

Skin, however, constitutes our wall to our environment. This wall is perhaps as important as the immune system since it is constantly repelling and confronting any chemical, physical, and microbiological invasion. Our skin though, as every other

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wall, is somehow composed of certain “bricks” which are stuck together by a special “mortar”; a very popular model used to describe the outer layer of the epidermis (the stratum corneum). In the case of skin, though, that specific mortar is nothing other than a mixture of lipids; and sure enough the better and stronger that mortar is, the better and stronger the wall becomes. So these are the epidermal lipids made by the epidermal cells, the keratinocytes and somehow as you would read in this book they are extruded out of the cell to possess the extracellular milieu and keep the differentiated corneocytes together and form that rigid wall that is called epidermis.

That alone can outline the importance of lipid synthesis in skin since the skin will never offer the good barrier properties unless it has the proper lipid mixture. However, lipids are also found on the surface of the skin as a result of the sebaceous gland activity. Once considered the appendage of skin, the sebaceous gland is now considered one of the major endocrine sites of the skin, potent enough to synthesize an amazing diversity of hormones, growth factors, and transcriptional factors. The sebaceous biology is remarkable, complex, and unique, can hardly be compared to the biology of any other cell type. Nowadays we know that sebum is not there only to trouble us with acne but also to condition the skin and offer an extra lipid layer of protection; hopefully in the future more studies would fully decode its role.

Of course there is the third and forgotten layer of skin: the subcutaneous layer or hypodermis that is mainly composed of fat cells, the adipocytes, which are grouped together in lobules separated by connective tissue. Although it is believed that this layer serves roles as padding or as an energy reserve, providing some minor thermoregulation as well, many aspects remain unexplored, especially on how this layer communicates with the dermis and its cell types. This could especially be useful to understand cellulite. So far the major components of this layer, the differentiated adipocytes, have only been explored for facial volume loss; as autologous fat grafting has become popular to restore facial volume loss in addition to other facial fillers.

The field of lipids and skin took only baby steps in our fast-paced scientific society since any advancement was impaired by the analytical limitations and challenges that these extremely hydrophobic molecules offer. Not having excellent spectroscopic properties and being more hydrophobic than other tissue lipids, they posed many analytical challenges. Even nowadays outdated technologies such as thin layer chromatography are still used to analyze them and offer valuable solutions whereas modern technologies still need stringent validation. However, better analytical techniques are being developed and they would help to increase our understanding on their role and clarify their complexity. For example, it was only few years ago that the classes of ceramides were expanded from 6 to 9; with new and modern analytical techniques they became 12 and more than 360 species of skin ceramides were identified. Therefore, the field of epidermal surface lipids is still open for many new discoveries and is constantly enhanced by advances in analytical techniques.

It is not by coincidence that in an era where genomics is the past and proteomics and metabolomics the present, the near future is for lipidomics, even though it still poses challenges to most biologists and analytical chemists. Undoubtedly, future scientists will find themselves in need to incorporate all the acquired learning from

the various “-omics” fields to advance further the new era of lipidomics. Once scientists decode the role of lipids by more efficient, accurate, and reliable analysis, the academic community will eventually shed light not only on intriguing dermatological diseases such as acne, atopic dermatitis, ichthyosis, and psoriasis, but also aging and many more conditions that scientists so far do not currently associate with the epidermal surface lipids.

On the front of cell biology we have seen a tremendous effort and progress in skin lipids since more and more laboratories generate immortalized cell lines previously unavailable (as sebocytes) and hopefully in the near future we would see even more of them and perhaps even better 3D models that will be able to incorporate a variety of cells besides epidermal and dermal cells, such as sebocytes, immune system cells, and even preadipocytes.

Skin lipids contribute to normal skin functions as the barrier function and the maintenance of healthy skin and hair. Consequently, they contribute not only to many diseases, but also to aging as well as the conditioning and defense status of this organ. This book constitutes an effort to sum up all the primary and relevant references that one needs to review to understand the complex and diverse roles of lipids in skin. May this book inspire scientists, dermatologists, nutritionists, and people from all medical disciplines to invest more time in connecting the two areas of research, in lipids and in skin, for more books and research to come and bridge any possible gaps of knowledge.

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