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Treating the Epidermis

Dr Ahsan Ullah details the function of the epidermal barrier and explains how cosmetic treatments can affect this

'Beauty is only skin deep' – a phrase which originated and evolved from the works of British poet Sir Thomas Overbury in 1613 – "All the carnall beauty of my wife, is but skin deep."[1] Indeed he was correct to a point, but the question arises, how deep? The study of dermatology has revealed complex but vital functions of the skin, which can be classified into three main categories of protection, regulation and sensation[2] and are achieved through the layers of the skin; the epidermis, the dermis and the hypodermis/subcutaneous fat. In this report we will focus on the epidermal layer and its barrier functions.

The epidermis

The epidermal layer comprises four main layers: the stratum basale, stratum spinosum, stratum granulosum and stratum corneum; and it also has a fifth layer (if we include the stratum lucidum found in areas such as the palms and soles). These layers mainly consist of keratinocytes, which produce the protein keratin, and it is the maturation process of the keratin, which is seen across the layers of the epidermis.[3] To discuss the role further, we explore the deepest layer of the epidermis – the basal cell layer.

Basal cell layer (stratum basale)

Keratinocytes populate the majority of the single, often cuboidal to columnar, layer of basal cells, by up to 95%,[4] and provide a highly organised structure. They contain intracellular proteins called tonofilaments in each individual keratinocyte, which form part of the cytoskeleton. These structures are interconnected by intercellular desmosomes and are also attached to the basal lamina via hemidesmosomes. This is important in delivering the strength and stability of the epidermis, preventing the epidermal layer from shedding off completely and subsequently providing the basis of the barrier function of the epidermis. It is this layer that is targeted by some aesthetic procedures, which we will discuss later.[15]

Other cells also present in the epidermis, which are part of the barrier function of the stratum corneum include:[15]

- Melanocytes – which secrete melanin and provide a barrier against UV radiation
- Merkel cells – which provide a sensory role and detect light touch and sensation
- Langerhan cells – which are dendritic cells that initiate an immune response when there is any injury to the skin

Stratum spinosum

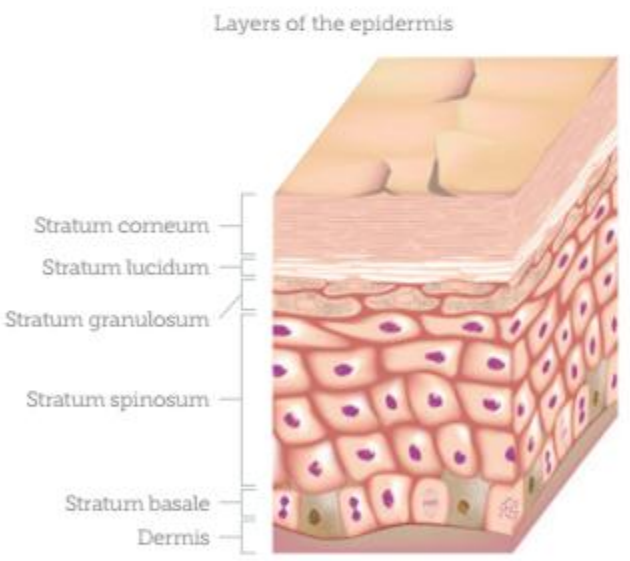
As the keratinocytes undergo mitosis, they travel upwards and form the stratum spinosum consisting of mainly squamous cells. This is the thickest layer of the epidermis and provides strength and flexibility as the keratinocytes become flatter and more condensed. A process known as keratinisation begins in this layer.[14,16]

Stratum granulosum

Cell differentiating continues and the keratinocytes get further compressed and flattened to form a three-to-five cell layer of the epidermis. These granular cells contain keratohyalin, which appears under a light microscope as dark granules and contains two proteins called profilaggrin and involucrin, which play an essential part in the barrier function of the epidermis. The profilaggrin aids keratin aggregation in the stratum corneum and involucrin, whose role is to aid formation of the cell envelope that protects the keratin in the stratum corneum. Lamellar granules, also present, contain lipids and glycoproteins, which help act as an adhesive in the stratum corneum layer.[5]

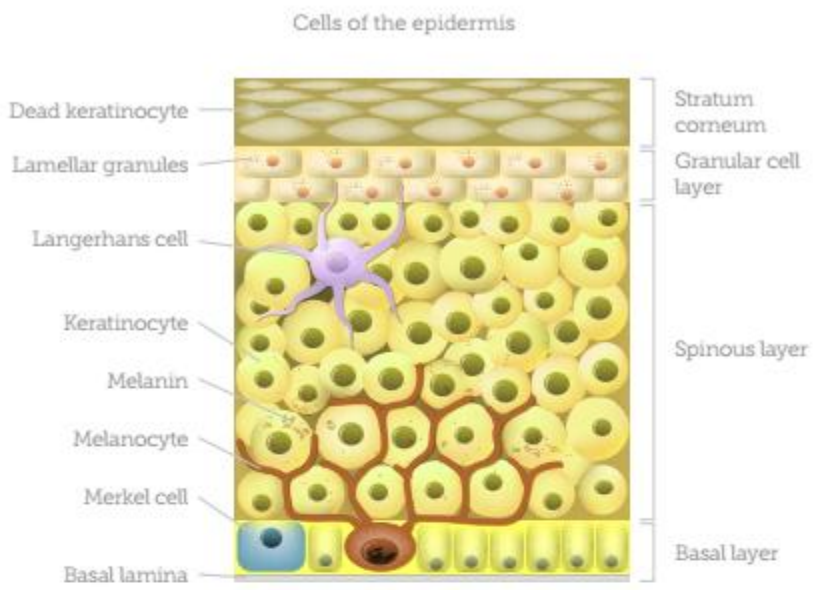
Stratum lucidum

This is a thick three-to-five layer of hyperdense keratinocytes forming an extra barrier against external stressors to the skin, especially seen on the palms and soles.



Stratum corneum

This is the outermost layer of the epidermis and contains closely flat-packed dead cells rich in keratin across approximately 15-20 layers. As mentioned before, lamellar granules from the stratum granulosum layer help 'cement' the cells together in the stratum corneum, providing a semi-impermeable layer that is a major part of the physical skin barrier. The cells in the stratum corneum are considered 'dead' and hence this is the layer that flakes off.[5] As we age this layer becomes more dense and does not flake off as easily, leaving the appearance of dull skin. Subsequently the lower layers



within the epidermis slow down as the top layer of keratinocytes from the stratum corneum have not yet shed, and this cycle slows down the skin regeneration programme and results in ageing of the skin.[5] There are many different aesthetic procedures which help improve the skin by controlled damage of the epithelium and removal of the stratum corneum helps brighten up the appearance of dull old-looking skin.

Aesthetic techniques disrupting the epidermal barrier function

The process of keratinisation from the basal layer to the stratum corneum usually takes about four weeks, however it can be as long as 75 days depending upon the age of the patient and the quality of the skin.[6] With progressive age and environmental factors, the process of keratinisation slows down as the skin is less efficient in the desquamation process, resulting in a build-up of dead cells and reduced skin renewal.[6] This often leads to dull, thicker, less toned and poor quality skin. It is the process of improving the desquamation process that medical aesthetic practitioners aim to achieve. This is provided through various aesthetic techniques that enable the disruption of the epidermal barrier function of the skin, including chemical skin peels, microneedling and microdermabrasion.

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Chemical skin peels

Chemical skin peeling, also known as chemical resurfacing or chemexfoliation, is a process by which various chemical agents are applied topically to the skin to promote a disruption of the skin barrier function, resulting in cutaneous exfoliation and subsequent cellular rejuvenation.[7] This process allows the keratinised epidermal layers to shed off, or 'peel' and promote the epidermis to 'repair' itself by starting the keratinisation process again at the basal cell layer. This action is primarily based on the skin's ability to repair itself after damage, and this type of controlled trauma to the skin allows regeneration of newer cells, resulting in a healthier epidermis.[9] There are three main types of chemical peels: superficial, medium and deep.[8] For the purpose of this report we will focus on the superficial chemical peels, which act on the epidermis.

Alpha hydroxy acids

Alpha hydroxy acids, also known as AHAs, are hydrophilic/water-soluble, and are some of the first used chemical peels derived from natural substances such as fruits (malic), nuts (mandelic) and milk (lactic).[6] These substances pass into the stratum corneum and cause destabilisation of the desmosomes, which results in desquamation.[9] The outcome is a compromised epidermal barrier which starts shedding or 'peeling', and consequently triggering cell regeneration. These types of peels are recommended for patients with thickened, sun-damaged skin.[10] A study conducted by Okano *et al,* investigated the effects of an AHA (glycolic acid) on the skin and revealed accelerated collagen synthesis occurs through keratinocyte degradation.[11] As the degradation takes place, the epidermal barrier is compromised as it is expected to regenerate faster than it is naturally expected to do, and hence causes shedding of the skin and subsequent damage to the epidermal barrier, often referred to as the 'peel' or 'peeling process'.[11] This speeds up the keratinisation process resulting in a more youthful appearance to the skin, as older cells are able to shed revealing the younger and fresher cells.[11] This cosmetic enhancement allows brighter and plumper looking skin giving a youthful appearance. It also has other advantageous effects, such as depigmentation treatments, however they affect the deeper layers.

Beta hydroxy acids

These acid peels, also known as BHA, are lipophilic/fat-soluble and hence penetrate the epidermal barrier to dissolve sebum and help exfoliation of the epidermal layer. Salicylic acid peels are an example of BHA, and are recommended in patients with oily, acne-prone skin.[10]

Jessner peels

Jessner peels, named after the famous American-German dermatologist Dr Max Jessner, use a combination of the alpha and beta hydroxy acids at a lower dose to help achieve an overall chemical exfoliation of the epidermal layer and even deeper, to allow maximum generalised peeling.[19] These peels achieve an overall aesthetic improvement to the skin but are obviously not as strong as their independent peels. It is thought that Jessner peels are able to achieve desmosomal destruction as well as dissolve sebum, causing the epidermal barrier function to be compromised and thus resulting in the 'peeling effect' of the skin.[20]

Microneedling

Collagen induction therapy (CIT) or microneedling, has been around for many hundreds of years, but only recently over the past

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Summary

In this article, the pathophysiology of the epidermal barrier function, the different layers involved, and the functions of each of those layers has been explained. How three different techniques, chemical peels, microneedling and microdermabrasion, can affect the epidermal barrier function to achieve aesthetically pleasing results has been explored. Chemical peels chemically damage the layers of the epidermis, causing deeper chemical burns to the cells involved in the stratum basale causing instability in the epidermal layers resulting in the skin 'peeling off'. Microneedling, where the deployment of skincare products can reach lower into the epidermal layers and even into the dermis, provides increased efficacy of skincare products as well as resulting in neocollagenesis and neovascularisation of the deeper layers improving overall strength of the skin. Microdermabrasion physically exfoliates the epidermal layer resulting in erythema of the skin, but can achieve the exfoliation effects at a fraction of the price when compared to other procedures.

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few decades has it found its niche in the aesthetic market. This process involves the use of microneedles, which penetrate the epidermal stratum corneum barrier and cause micro-trauma to the localised tissues. This in turn causes the tissues to activate due to the direct trauma and release growth factors, which stimulate the collagen and elastin in the papillary dermis.[12] In my experience, this technique also allows it to form as a delivery service for useful topical cosmeceutical agents or treatments, such as vitamin A and C, which can result in a higher uptake as the epidermal barrier has been penetrated, increasing cellular absorption at a deeper layer, resulting in neocollagenesis and neovascularisation.[21] As the skin heals it becomes tighter and stronger.[21]

There are a variety of needle lengths that can be used to rejuvenate the skin for aesthetic results; finer lines are usually treated with smaller needles, disrupting the epidermal skin barrier, and deeper acne scars are usually treated with longer needles, penetrating the dermal layers.

Microdermabrasion

This is a procedure which uses a mechanical medium, such as exfoliating crystals or diamond flakes, which cause damage to the epidermal layer, allowing it to cause superficial damage by mechanical force, damaging the desmosomes and hemidesmosomes.[13] This process damages the epidermal barrier function, and the resulting suction from the microdermabrasion device causes lifting of the 'dead skin' from the stratum corneum revealing cleaner, brighter looking skin. This aesthetic procedure is minimally invasive and can achieve excellent aesthetic results if used on the correct patient.[18] This technique is excellent for those with older aged or sun damaged skin where the stratum corneum doesn't shed off adequately and thus prevents the upward migration of keratinocytes from the stratum basale. The aim of this procedure is to indirectly increase the keratinisation process, allowing fresher smoother looking skin to surface.

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