SUPERPOWERED SKIN

The skin is the body's largest organ and has several, diverse functions. As well as being a physical barrier, it has immune and sensory properties.

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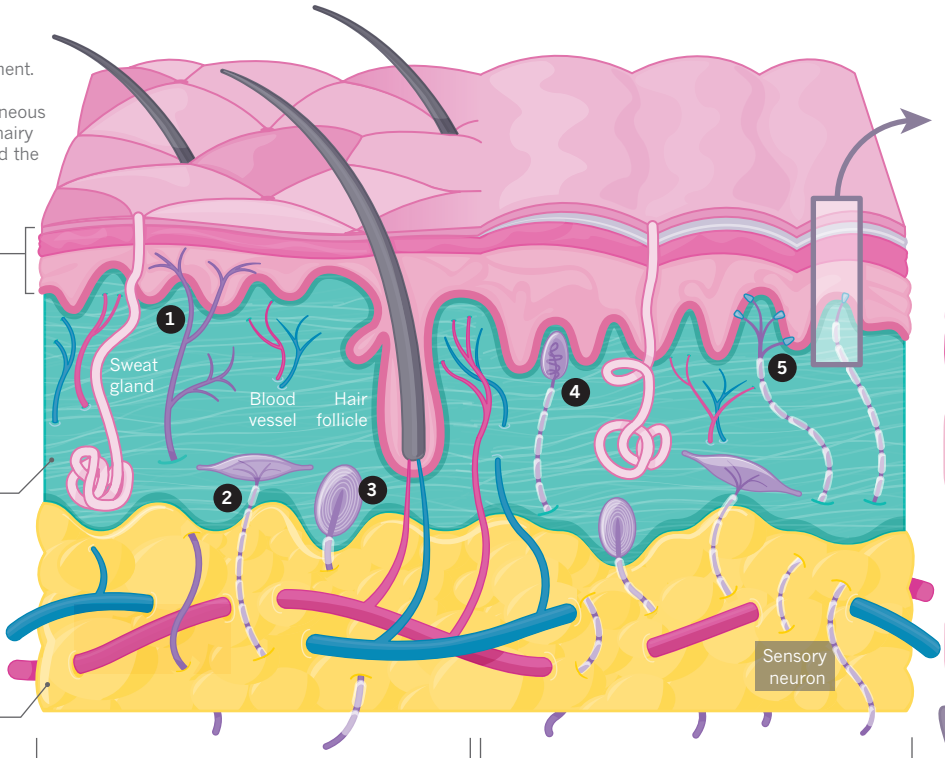
UNDER THE SURFACE

Skin's most important role is to protect the body from the environment. It comprises three main layers: the epidermis, the dermis and subcutaneous fat. Most of the body is covered in hairy skin but the palms of the hands and the soles of the feet are covered in hair-free (glabrous) skin.

Epidermis
The outermost layer of skin acts as a mechanical and antimicrobial barrier, and consists of several layers. Its top part, the stratum corneum, prevents water from leaving the body and toxic substances from entering.

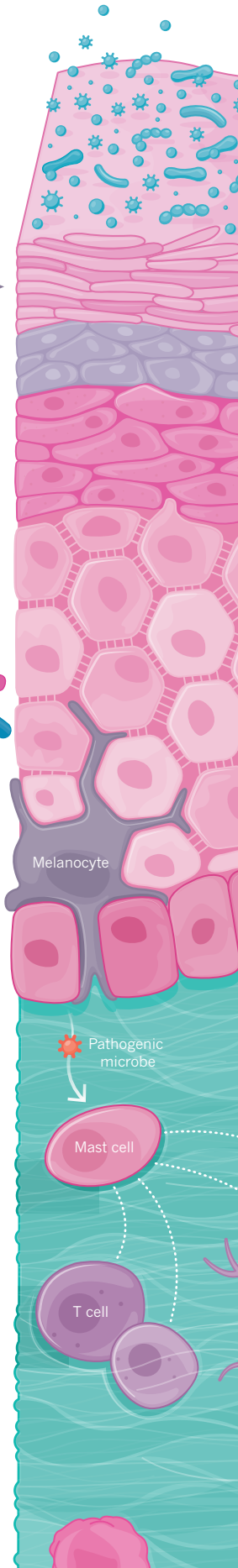
Dermis
Nerve endings in skin's middle layer help people to feel sensations such as itching, pain, pleasure and heat. The dermis produces sweat and oils, and contains hair follicles. It also hosts a variety of immune cells.

Subcutaneous fat
Skin's deepest layer is sandwiched between the dermis and skeletal muscles. Its roles include fat storage, connecting the dermis to muscle and bone, and controlling body temperature.



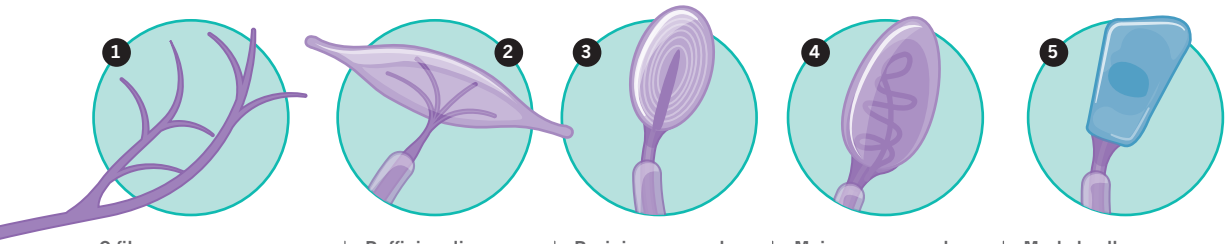
Hairy skin
More than 90% of the body is covered by hairy skin[1]. It is involved in perceiving a variety of tacile sensations, including those that form part of social exchanges, and the ability to detect the presence of foreign objects. In hairy skin, the epidermis is less than 0.1 millimetres thick and the dermis is 1–2 millimetres deep.

Glabrous skin
Hair-free skin is found mainly on the palms and soles. It is innervated by specialized nerves that help us to understand subtle tactile details. Such skin is thicker than hairy skin; the epidermis is about 1.5 millimetres thick and the dermis is about 3 millimetres deep.



SENSATIONAL SENSITIVITY

Skin's somatosensory system comprises more than a dozen subtypes of sensory neuron, but only those involved in tactile sensation are well understood. Such neurons enable skin to react to and interpret myriad stimuli, including temperature gradients, pressure and physical damage.



C fibre
These unmyelinated nerve fibres are found only in hairy skin. Although sensitive to indentation, they are most active when a stimulus moves slowly across the skin's surface.

Ruffini ending
Found in the dermis of both hairy and glabrous skin, these sensory receptors respond optimally to stretching of skin.

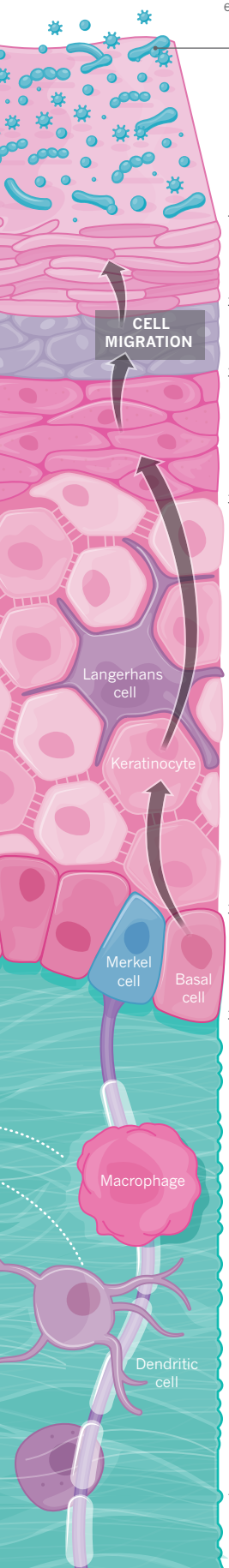
Pacinian corpuscle
Located deep in the dermis of both types of skin, Pacinian corpuscles respond to high-frequency vibration.

Meissner corpuscle
These nerve receptors lie just beneath the epidermis of glabrous skin, where they detect movement across the skin and fluttering touch.

Merkel cell
Part of the stratum basale of the epidermis, these cells help to relay information about the texture, curvature and shape of objects. Merkel cells are most dense in glabrous skin.

PROTECTIVE LAYERS

Skin's epidermis and dermis help to protect the body from microbes, pollutants, ultraviolet radiation and excessive loss or absorption of water.



MICROBIOTA

The harsh environment of skin's surface — dry, nutrient-poor and acidic — houses a mixture of bacteria, fungi and viruses that help to fend off invading species and communicate with immune cells.

EPIDERMIS

Five sublayers continuously rebuild the skin's surface.

STRATUM CORNEUM
A layer of dead, flattened cells filled with the protein keratin that protects the body from friction and water loss.

STRATUM LUCIDUM
Also composed of dead cells, this layer is found only in glabrous skin and is packed with lipid-rich eleiden, which helps to keep water out.

STRATUM GRANULOSUM
A layer made mostly of mature keratinocytes that migrate from the stratum spinosum. It also helps to waterproof skin.

STRATUM SPINOSUM
Keratinocytes — mature basal cells — produce keratin, which comprises the basic structure of skin. Immune cells called Langerhans cells that inform the immune system about invading microbes are also present.

STRATUM BASALE
The deepest layer of the epidermis contains continually dividing basal cells, which push older cells upwards. It also contains melanocytes, which control skin pigmentation. When melanocyte DNA is damaged by ultraviolet radiation, any resulting uncontrolled cell growth can lead to the skin cancer melanoma.

30–45 DAYS
Time it takes for basal cells to mature and migrate to the top of the epidermis[2].

DERMIS

The dermis provides skin with support and elasticity through the proteins collagen and elastin. It also offers protection from pathogenic microbes and toxic substances. Four types of immune cell contribute to this line of defence.

Mast cell
A cell that identifies pathogenic species and then releases chemical signals to attract other immune cells.

T cell
A white blood cell that remembers microbes encountered previously.

Dendritic cell
Presents parts of pathogenic microbes to other immune cells.

Macrophage
Helps to clear cellular debris.

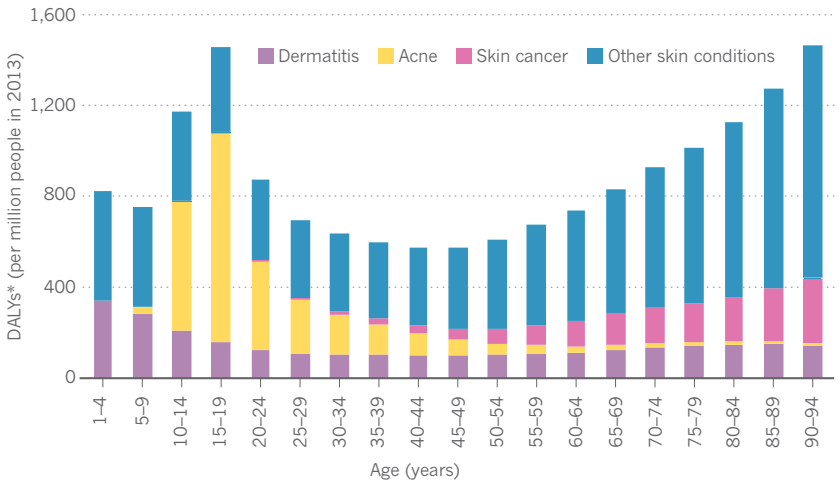
BARRIER BREAKDOWN

Despite its many superpowers, the skin is not infallible. Because of its visibility, diseases that affect the skin can have psychological as well as physical effects.

US$75 BILLION
Cost of treating skin disease in the United States in 2013 (ref. 3).

BURDENSOME BOUNDARY

Skin disease's worldwide burden can be quantified in terms of the disability-adjusted life year (DALY), which reflects a lost year of healthy life. The main burden falls on people aged 15–19, mostly owing to acne vulgaris. From the age of 50, there is a slow increase in burden as skin loses function and the incidence of skin cancer rises. Dermatitis, including eczema, persists throughout life; people tend not to outgrow the condition but learn to better manage it.



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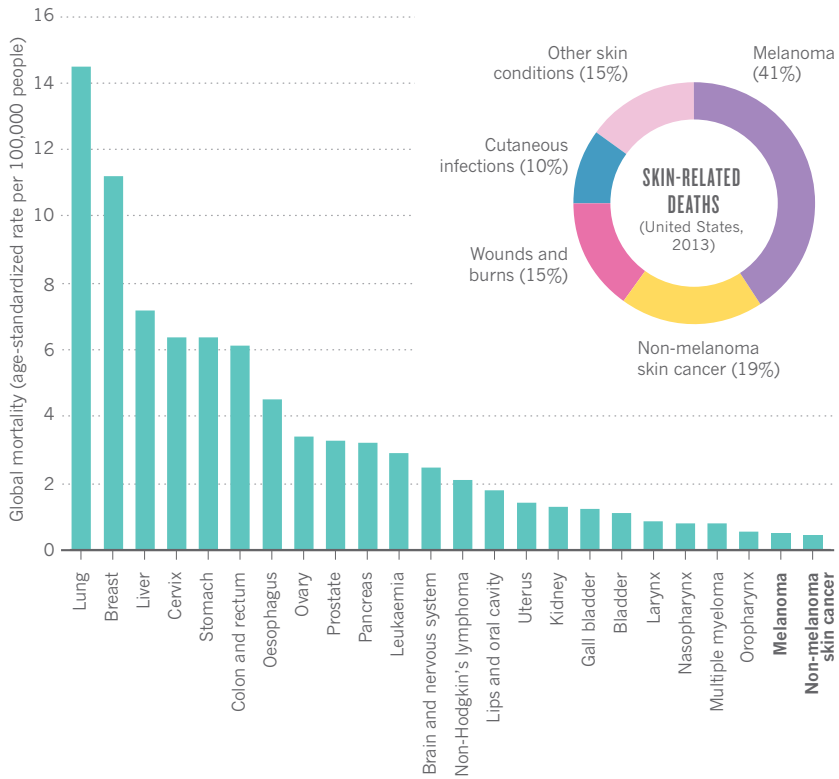
*DALYs for a condition comprise the total years of life lost plus the years lived with disability owing to the condition.

CANCER COMPARISON

Melanoma kills more people worldwide than does non-melanoma skin cancer, even though non-melanoma is much more common. However, deaths from melanoma are dwarfed by those from other cancers. Skin cancer was responsible for about 60% of US skin-related deaths in 2013.



REF. 3

IARC

Sources: 1. Zimmerman, A., Bai, L. & Ginty, D. D. **346**, 950–954 (2014). 2. US National Cancer Institute. *Layers of the skin* https://training.seer.cancer.gov/melanoma/anatomy/layers.html (US National Institutes of Health, 2018). 3. Lim, H. W. *et al. J. Am. Acad. Dermatol.* **76**, 958–972 (2017).