



Lecture # 8

Skin and the Design of Artificial Skin

Introduction

The skin is the body's largest organ, covering the entire outside of the body, weighing approximately 3 kg, and covering about 5–6 m² of the body's surface. In addition to serving as a protective shield against heat and cold, light, injury, pollution, and infection, the skin also

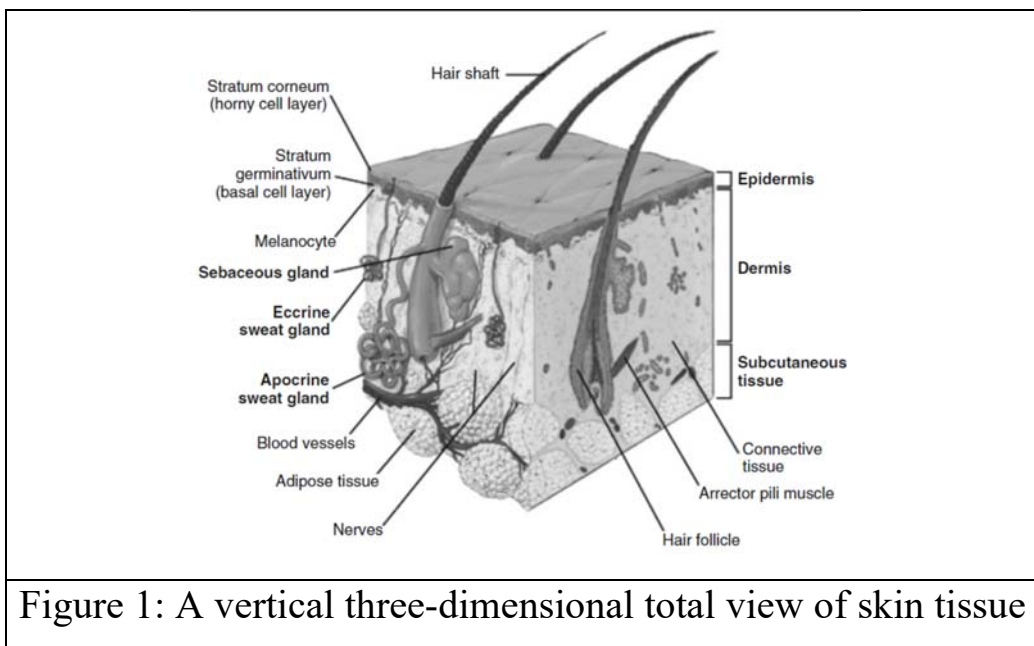
- Regulates body temperature
- Stores water, fat, and vitamin D
- Can sense painful and pleasant stimulation.

Throughout the body, the skin's characteristics vary (i.e., thickness, color, and texture). For instance, the head contains more hair follicles than anywhere else, while the soles of the feet and the surface of the palm contain none. In addition, the soles of the feet and the palms of the hands have much thicker layers (Fig. 1). The skin is made up of the following layers, with each layer performing specific functions:

- Epidermis
- Dermis
- Fat layer.



Epidermis : The epidermis is the thin outer layer of the skin. The epidermis itself is made up of three sublayers: **Stratum corneum (horny layer)** : This layer contains continually shedding, dead keratinocytes (the primary cell type of the epidermis). The keratin, a protein formed from the dead cells, protects the skin from harmful substances. **Keratinocytes (squamous cells)** : This layer contains living keratinocytes (squamous cells), which help provide the skin with what it needs to protect the rest of the body. **Basal layer** : The basal layer is the inner layer of the epidermis, containing basal cells. Basal cells continually divide, forming new keratinocytes and replacing the old ones that are shed from the skin's surface. The epidermis also contains melanocytes, which are cells that produce melanin (skin pigment).





The dermis is the middle layer of the skin. The dermis is made up of the following:

Blood vessels, lymph vessels, hair follicles, and sweat glands. The dermis is held together by a protein called collagen, made by fibroblasts (skin cells that give the skin its strength and resilience). This layer also contains pain and touch receptors.

The subcutis is the deepest layer of skin and is also known as the subcutaneous layer. The subcutis, consisting of a network of collagen and fat cells, helps conserve the body's heat while protecting other organs from injury by acting as a "shock absorber."

Tissue Expanders

Tissue expanders are of great value in maxillofacial, plastic, and reconstructive surgery. Tissue expansion was developed for a specific indication; however, within a very short time, the concept of tissue expansion found wide applicability. The indications for tissue expansion were burns, trauma, and sequelae of previous surgery resulting in massive contraction/contracture/scarring or disfigurement of the local tissue. An expander actually helps in growing the local tissue as required so that the disfigurement can be corrected easily with the same type of tissue. Tissue expansion is a good and safe technique (Fig. 2).

Tissue expansion is a reconstructive surgical technique that allows the body to "grow" extra skin where there has been tissue loss due to trauma or disease. The most common application is in postmastectomy breast reconstruction, but tissue expansion can be used in almost any part of the body following tissue loss due to injury. It is also quite advantageous for reconstruction of the scalp,

because the “new” skin created contains matching hair follicles (as opposed to using skin grafts or flaps from other parts of the body, which may leave bald spots on the scalp).



Figure 2: Tissue expanders of various shapes are placed under the skin and expanded by inserting saline solution under pressure in the small, shaped vessel made of silicone

How Tissue Expansion Works: A balloon-like expander with a silicone shell is inserted under the skin near the area in need of repair. Over time, the shell is gradually filled with saline (saltwater), causing the skin to stretch and grow. Once sufficiently stretched, the



expander is removed with a second surgery, and the excess new skin is then placed over the defect and sutured in place. The expanders are inserted most frequently in the scalp, trunk, back, and neck area, avoiding the important anatomical structures.

Uses

- Revisions of facial scars, blemishes, and moles
- Burn wound and contracture correction
- Postsurgery defects
- Hair loss replacement
- Cleft lip and palate repair
- Correction of an underdeveloped breast
- Postmastectomy breast reconstruction.

Advantages

Expanders offer a near-perfect match of skin color, texture, and sensation. There is less risk of tissue loss because the skin remains connected to its blood and nerve supply. Scars are less noticeable than with a skin graft, and morbidity of the donor area is not a factor.

Disadvantages Expansion can take as long as 3 weeks to 4 months. An expander creates what may be considered an unsightly bulge while in place (fine for breast reconstruction, but undesirable in facial reconstruction), and discomfort sometimes becomes unbearable to the patient, who requires multiple visits for saline injections to further inflate the expander. However, recently we developed a silicone expander where the patient himself will be able to inject additional saline according to the surgeon's advice.