Skin: Anatomy, Physiology and Wound Healing

Skin is the largest organ of the body. It consists of two layers—the epidermis and dermis—that are supported by a number of underlying structures. Skin has multiple functions. It is a barrier between the external environment and the internal organs, protecting against trauma from water, chemicals, micro-organisms, mechanical stress and radiation. It performs sensory functions related to touch, pressure, heat, cold and pain, and alerts for potential tissue damage. It has a role in exchanging fluids, salts, gases and heat.

Skin health is influenced by various internal and external factors that also influence wound healing. Therefore, to support skin health and wound management, clinicians need to recognize, understand and appreciate both the complex nature of skin itself and what lies beneath. Skin components and underlying structures, their functions and implications for wounds and wound healing are reviewed in Table 1.

Table 1: Anatomy and Physiology at a Glance

Skin Structure	Function	Implications for Wounds
Epidermis **Layers:** ▪ stratum corneum ▪ stratum lucidum ▪ granular cell layer ▪ squamous cell layer ▪ basal cell layer	▪ This outer layer has no blood vessels and gets its oxygen and nutrients from the deeper layers of the skin. It provides protection against trauma, a harmful environment and harmful organisms.	▪ Abrasion occurs if epidermis is damaged.
Dermis **Contains:** ▪ rete pegs ▪ extracellular matrix ▪ arterioles and venules ▪ lymph capillaries ▪ hair follicles, sweat glands and sebaceous glands	▪ This next layer is made up of a tough, supportive connective tissue matrix directly beneath and connected to the epidermis. It provides skin flexibility and strength.	▪ Bleeding occurs and the body's first line of defence is breeched. Healing is multifactorial.
Blood and Lymph Fluid		
Blood is mostly water containing dissolved proteins, glucose, mineral ions, hormones, carbon dioxide, platelets and blood cells. Blood cells make up 55% of blood plasma and include red blood cells (erythrocytes), white blood cells (leukocytes: neutrophils, eosinophils, basophils, lymphocytes and monocytes) and platelets.		
Fluid Type	**Function**	**Implications for Wounds**
Arterial blood ▪ rich in oxygen	▪ Supplies oxygen to the body	▪ Poor arterial flow leads to ischemia and impaired healing.
Venous blood ▪ carries carbon dioxide	▪ Removes metabolic waste products from the body	▪ Venous hypertension leads to edema and interferes with healing.
Lymph ▪ straw-coloured fluid that forms in interstitial spaces	▪ Transports excess tissue fluid; removes metabolic waste and supports immune response and fat absorption from the gut	▪ Often accompanies venous edema. **All chronic edema is lymphedema.** Lymphedema is rarely acknowledged and poorly understood.

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Disclaimer: *This document provides a brief clinical enabler for the content provided in the relevant chapter(s) of Best Practice Recommendations for Skin Health and Wound Management 2025. It is not intended to provide comprehensive information on the given topic(s). For more complete information on specific best practice recommendations, refer to the full publication at: https://www.woundscanada.ca/news/752-bpr-new*

Underlying Structures	Function	Implications for Wounds
Subcutaneous tissue ▪ composed of adipose cells ▪ contains connective tissue, larger blood vessels and nerves	▪ Located beneath the dermis; provides protection, cushioning, insulation and energy storage	▪ Poorly vascularized tissue leads to slow healing.
Fascia ▪ strong connective tissue primarily consisting of collagen ▪ extends throughout the body	▪ Gives structure, protection, support	▪ Entry of wound into fascial plane may lead to infection.
Muscles **Types of muscles:** ▪ smooth involuntary muscle (such as in the stomach) ▪ striated voluntary muscle (such as in the arms and legs) ▪ striated involuntary muscle (such as in the heart)	▪ Specialized tissue made up of cells that have the ability to contract and conduct electrical impulses, performing voluntary and involuntary movement	▪ Very vascular, tear easily
Tendons ▪ tough bands of fibrous connective tissue	▪ Attach muscles to bones	▪ Exposed tendons should be kept moist. Tendons are poorly vascularized, leading to slow healing. Loss of tendons means loss of function.
Ligaments ▪ short bands of fibrous connective tissue	▪ Attach bones to bones to form a joint	▪ Exposed ligaments should be kept moist. Ligaments are poorly vascularized, leading to slow healing. Loss of ligaments means loss of function.
Bones ▪ hard, white, dense connective tissue ▪ a periosteum covering that provides an external blood supply	▪ Provide protection, strength and support; continually remodel; produce new bone in marrow	▪ Exposure of bone can quickly result in infection, which can lead to osteomyelitis. Exposed bone (periosteum) should not be allowed to dry out.
Joints ▪ fibrous joints are joined by fibrous connective tissue ▪ cartilaginous joints are joined by cartilage ▪ synovial joints are not directly joined	▪ Facilitate movement and mechanical support where two or more bones make contact	▪ Joint involvement in wounds may lead to osteomyelitis.
Synovium ▪ thin layer of tissue that lines the joints and tendon sheaths ▪ produces a thick, viscous, sticky lubricant called synovial fluid	▪ Lubricates to reduce friction in the joint during movement	▪ Appearance of synovial fluid in wounds indicates exposure to joint cavity.
Cartilage ▪ dense connective tissue found in many areas in the body ▪ does not contain blood vessels	▪ Acts as an intermediate between bone and dense connective tissue	▪ Cartilage grows and repairs more slowly than other connective tissues. ▪ Exposed cartilage should be kept moist. Exposure may lead to osteomyelitis.

For the complete version of Skin: Anatomy, Physiology and Wound Healing, visit here.

Normal Changes and Differences in Skin

Infant Skin

Infant skin differs from adult skin in several ways that place an infant at greater risk for skin damage:

- Thickness of infant skin is 40% to 60% that of adult skin.
- Weak rete ridges provide limited surface attachment to an immature dermis.
- Infant's ratio of body surface area to weight ratio is up to 5 times that of an adult.
- Acid mantle changes from 6.5 at birth to about 5.5 within a few weeks, which isbeneficial for antimicrobial defence through the inhibition of the growth of pathogenic bacteria.

The optimal pH of skin is 5.5, which is referred to as the "acid mantle." The acid mantle provides the body with defence against invading micro-organisms.

Skin Changes in the Adolescent

Adolescence is associated with a surge in the sex hormones estrogen, androgen and progesterone, leading to:

- Stimulation of the sebaceous glands, resulting in increased production of oil, or sebum.
- Development of apocrine glands in the pubic region and armpits, resulting in thick sweat mixed with bacteria on the skin that can cause body odour. At the same time, hair growth occurs in these areas.
- An increase in the lipid content during this time enhances the heat-insulating properties of skin, improving temperature regulation.
- The higher fat content also helps to retain moisture, making teenage and young adult skin less susceptible to drying out.

Skin Changes in the Older Adult

As individuals age, skin goes through many changes based on genetics, environment, lifestyle factors and any existing chronic disease states. Despite individual variations, the normal aging process of all skin causes many predictable changes:

- With increasing age there is a 50% decrease in the turnover of the epidermal layer.
- Skin pH becomes less acidic and more susceptible to bacterial growth.
- Thinning of the outer epidermal layer can cause a 1% decrease in collagen per year. Since collagen gives skin tensibility, this loss leads to wrinkling.
- Langerhan's cells, which serve as macrophage and immune moderators, decrease.
- The dermis becomes increasingly avascular with age.
- Biochemical changes in collagen and elastin, which give the skin its firmness, occur.
- Elastin fibres significantly decrease in size and number, which leads to decreased elasticity and recoil, leading to wrinkling.
- The skin becomes less elastic and drier.
- Older skin has a reduced ability to perceive sensation to pressure and light touch, along with an increased threshold for pain.
- Underlying fatty tissue begins to disappear, and skin begins to sag and become supple. Wrinkles begin to form, leading to atrophy of subcutaneous fat in the hands, face, shins, waist (men) and thighs (women), resulting in sagging and folds. At this stage, skin is more easily injured, heals more slowly and tends to dry out more quickly.
- Melanocytes, the pigment-producing cells, decrease in number. Hair follicles also decrease in number and growth rate, with associated greying due to the decrease and loss of melanin.

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Differences between Male and Female Skin

Skin is affected by sex hormones: estrogen increases collagen and skin moisture and promotes wound healing, while testosterone stimulates oil production and the growth of facial hair. Men and women have *both* these sex hormones; skin is able to convert testosterone to estrogen, and ovaries produce a small amount of testosterone.

Women's skin is generally thinner and less oily than men's skin, and women are more likely to experience wrinkles because thinner, drier skin is more prone to damage from the sun and cigarette smoke. Women also sweat less than men do and thus are more likely to suffer heat stroke. During menopause the loss of sex hormones accentuates wrinkles, and estrogen-deprived skin thins, loses collagen and slows down its cell renewal.

The rate of the loss of skin firmness and elasticity differs from individual to individual, depending on genetic makeup, general health, amount of sun exposure, skin care regimen (or lack thereof) and other factors.

Wound Healing

Skin's Response to Damage

To heal, the wound environment must be optimized so the wound can fill in from the bottom up and then in from the sides. When skin is damaged (wounded) it attempts to regenerate itself to continue to protect the larger organism. Research on acute wounds in animal models shows that wounds heal in four phases. (Note: some authors combine the first two phases.)

1. Hemostasis
2. Inflammation
3. Proliferation (also known as Granulation and Contraction)
4. Remodeling (also known as Maturation)

Dean Kane created a wound repair analogy that compares wound healing to the repair of a damaged house. As with the rebuilding of a house, the process relies on the right materials (cells) being delivered to the site (wound) in the right order (see Table 2 on page 5) and at the correct time. A successful rebuild also depends on access to the damaged areas with the high-quality materials (adequate blood supply and an active immune system) necessary to get the job done well.

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Table 2: Phases of Wound Healing and the Kane Analogy

Phase of Healing	Time Post Injury	Cells Involved in Phase	Function or Activity	Analogy to House Repair
Hemostasis Blood vessels constrict in response to injury.	Immediate	▪ Platelets	▪ Clotting	▪ Cap off broken utilities
Inflammation Presents as erythema, swelling and warmth often associated with pain. Inflammation is a normal response to trauma.	Day 1 – 4	▪ Neutrophils ▪ Macrophages	▪ Phagocytosis	▪ Unskilled labourers clean up the site
Proliferation Observed by the presence of pebbled red tissue or collagen in the wound base as well as contraction of the wound.	Day 4 – 21	▪ Macrophages ▪ Lymphocytes ▪ Angiocytes ▪ Neurocytes ▪ Fibroblasts ▪ Keratinocytes	▪ Fill defect ▪ Re-establish skin function ▪ Closure	▪ Contractor/ supervisor ▪ Specific labourers ▪ Plumbers ▪ Electricians ▪ Framers ▪ Roofers and siders
Remodeling In **acute** epithelialization thin layers of scar tissue form and thicken over time: deep pink in colour, changes to bright pink. In **chronic** epithelialization scar tissue may be hypertrophic, keloid or hyperkeratotic.	Day 21 – 2 yrs	▪ Fibrocytes	▪ Develop tensile strength (will never be as strong as non-injured skin)	▪ Remodelers

Defining the Wound Repair Process

Not all wounds heal in the timeframe as indicated in Table 2, and when that is the case clinicians need to determine why healing times are slow or even stalled.

- Acute wounds heal in a normal, orderly sequence of repair as described above. This usually occurs because the cause of the wound has been removed and an optimum environment for healing has been created. Note: time to heal will also depend on the dimensions of the wound.
- Non-healing wounds are wounds that have failed to progress through a normal, orderly and timely sequence of repair due to unresolved factors that interfere with healing. These wounds may eventually pass through the repair process without restoring sustained anatomical and functional results. This usually occurs when the cause(s) or cofactors of the wound have not been corrected and an optimum environment for healing has not been established.

Summary

Knowledge of the anatomy and physiology of skin and the wound healing process is essential for healthcare professionals to effectively prevent, assess, treat and manage wounds of all types.

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