Overview

• **Integumentary System** – consists of the skin and its accessory organs
  – hair, nails, and cutaneous glands

• skin is the most vulnerable organ
  – exposed to radiation, trauma, infection, and injurious chemicals

• receives more medical treatment than any other organ system

• **dermatology** – scientific study and medical treatment of the integumentary system
Figure 6.1

Structure of the Skin
Skin and Subcutaneous Tissue

• the body’s largest and heaviest organ
  – 15 % of body weight

• consists of two layers:
  – epidermis – stratified squamous epithelium
  – dermis – connective tissue layer
Functions of the Skin

• resistance to trauma and infection
  – keratin
  – acid mantle

• other barrier functions
  – waterproofing
  – UV radiation
  – harmful chemicals

• vitamin D synthesis
  – skin first step
  – liver and kidneys complete process

• sensation
  – skin is our most extensive sense organ

• thermoregulation
  – thermoreceptors
  – vasoconstriction / vasodilation

• transdermal absorption
  – administration of certain drugs steadily through thin skin – adhesive patches
Epidermis

- *epidermis* – keratinized stratified squamous epithelium

  - dead cells at the surface packed with tough protein – *keratin*

  - lacks blood vessels

  - depends on the diffusion of nutrients from underlying connective tissue

  - sparse nerve endings for touch and pain
Cells of Epidermis

- **five types of cells of the epidermis**
  - **stem cells**
    - undifferentiated cells that give rise to keratinocytes
    - in deepest layer of epidermis (stratum basale)
  - **keratinocytes**
    - great majority of epidermal cells
    - synthesize keratin
  - **melanocytes**
    - occur only in stratum basale
    - synthesize pigment melanin that shields DNA from ultraviolet radiation
    - branched processes that spread among keratinocytes
  - **tactile (merkel) cells**
    - in basal layer of epidermis
    - touch receptor cells associated with dermal nerve fibers
  - **dendritic (langerhans) cells**
    - macrophages originating in bone marrow that guard against pathogens
    - stand guard against toxins, microbes, and other pathogens that penetrate skin
Cell Types and Layers of the Epidermis

Figure 6.3
Stratum Basale

• a single layer of **stem cells** and **keratinocytes** resting on the basement membrane
  – **melanocytes** and **tactile cells** are scattered among the stem cells and keratinocytes

• **stem cells of stratum basale divide**
  – give rise to keratinocytes that migrate toward skin surface
  – replace lost epidermal cells
Stratum Spinosum

• consists of several layers of keratinocytes

• thickest stratum in most skin
  – in thick skin, exceeded by stratum corneum

• deepest cells remain capable of mitosis
  – cease dividing as they are pushed upward

• produce more and more keratin filaments which causes cell to flatten
  – higher up in this stratum, the flatter the cells appear

• dendritic cells found throughout this stratum
Stratum Granulosum

• consists of 3 to 5 layers flat keratinocytes
Stratum Lucidum

- seen *only in thick skin*

- *thin translucent zone* superficial to stratum granulosum
Stratum Corneum

• up to 30 layers of dead, scaly, keratinized cells

• form durable surface layer
  – surface cells flake off (exfoliate)

• resistant to abrasion, penetration, and water loss
Life History of Keratinocytes

- **keratinocytes** are produced deep in the epidermis by stem cells in **stratum basale**
- newly formed keratinocytes push the older ones toward the surface
- Flake off in **30 - 40 days**
- in **stratum granulosum** three important developments occur
  - keratinocyte nucleus and other organelles degenerate, **cells die**
  - release a protein **filaggrin** which binds the keratin filaments together
  - membrane-coating vesicles release lipid mixture that spreads out over cell surface and **waterproofs** it
Dermis

- **dermis** – connective tissue layer beneath the epidermis
- composed mainly of collagen with elastic fibers, reticular fibers, and fibroblasts
- well supplied with **blood vessels, sweat glands, sebaceous glands**, and **nerve endings**
- **hair follicles** and **nail roots** are embedded in dermis
- smooth muscle (**piloerector muscles**) associated with hair follicles
  - contract in response to stimuli, such as cold, fear, and touch – **goose bumps**
Dermis

• **dermal papillae** – upward fingerlike extensions of the dermis
  – **friction ridges** on fingertips that leave fingerprints

• **papillary layer** – superficial zone of dermis
  – thin zone of areolar tissue in and near the dermal papilla
  – allows for mobility of leukocytes and other defense cells should epidermis become broken
  – rich in small blood vessels

• **reticular layer** – deeper and much thicker layer of dermis
  – consists of dense, irregular connective tissue
Structure of the Dermis

(a) Reticular layer of dermis

(b) Papillary layer of dermis

(c) Reticular layer of dermis

Figure 6.5

Hypodermis

- subcutaneous tissue
- more areolar and adipose than dermis
- pads body
- binds skin to underlying tissues
- drugs introduced by injection
  - highly vascular & absorbs them quickly
- subcutaneous fat
  - energy reservoir
  - thermal insulation
  - 8% thicker in women
Skin Color

• **melanin** – most significant factor in skin color
  – produced by *melanocytes*

• people of different skin colors have the **same number of melanocytes**
Evolution of Skin Color

• UVR has two adverse effects:
  – causes skin cancer
  – breaks down folic acid needed for normal cell division, fertility, and fetal development

• UVR has a desirable effect:
  – stimulates synthesis of vitamin D necessary for dietary calcium absorption
Hair and Nails

- **hair, nails, and cutaneous glands** are accessory organs of the skin.

- **hair** and **nails** are composed of mostly of dead, keratinized cells:
  - pliable **soft keratin** makes up stratum corneum of skin
  - compact **hard keratin** makes up hair and nails
    - tougher and more compact due to numerous cross-linkages between keratin molecules
Skin Cancer

- skin cancer – induced by the ultraviolet rays of the sun
  - most often on the head and neck
  - most common in fair-skinned people and the elderly
  - one of the most common cancers
  - one of the easiest to treat
  - has one of the highest survival rates if detected and treated early
- three types of skin cancer named for the epidermal cells in which they originate
  - basal cell carcinoma, squamous cell carcinoma, and malignant melanoma
Basal Cell Carcinoma

- most common type
- least dangerous because it seldom metastasizes
- forms from cells in stratum basale
Squamous Cell Carcinoma

- arise from keratinocytes from stratum spinosum
-- chance of recovery good with early detection and surgical removal
- tends to metastasize to lymph nodes and may become lethal
Malignant Melanoma

- skin cancer that arises from melanocytes
- often in a preexisting mole
- less than 5% of skin cancers, but most deadly form
- treated surgically if caught early
- metastasizes rapidly - unresponsive to chemotherapy - usually fatal
- person with metastatic melanoma lives only 6 months from diagnosis
- 5% - 14% survive 5 years
UVA, UVB and Sunscreens

• both increase risk of skin cancer
• Damage DNA and affect protein function