Integumentary system

a. Consists of skin (a.k.a. the integument or the cutaneous membrane) and its derivatives (sweat glands, sebaceous glands, nails, hair etc.).

b. Protects us from pathogens, ultraviolet radiation, dehydration, physical and chemical injury.

c. Its blood vessels are the site of vitamin D production.

d. It allows us to be aware of our environment in terms of temperature and the sensation of touch.

e. Its exposure to the external environment coupled with its vascularity provides a site where body heat can radiate away, thus allowing for the control of body temperature.

f. The skin is divided into 2 big layers: the epidermis and the dermis.

g. Epidermis is the superficial layer and is composed of stratified squamous epithelial tissue.

h. The dermis is the deep underlying layer and is primarily composed of areolar connective tissue and dense irregular connective tissue.

I. Epidermis

a. The epidermal stratified squamous epithelium consists of many layers of cells and acts as a barrier to pathogen entry and water loss.

b. The majority of the cells in the epidermis are keratinocytes. They are so named b/c of their production of copious amounts of keratin (Gk. Keras horn) which is the tough, waterproof, bacteria-resistant protein that gives skin its protective properties.

c. Other epidermal cells include melanocytes, tactile cells, and epidermal dendritic cells.

d. Melanocytes produce the pigment melanin (Gk. Melanos black) which provides protection from the damaging effects of UV radiation. Melanocytes have multiple cellular extensions that snake between the keratinocytes. This allows the melanocytes to transfer melanin to keratinocytes. The granules of melanin cluster on the apical side of the keratinocytes. This ensures that they are between the sun’s rays and the cells’ nuclei. This protects the DNA in the nuclei from mutations that UV radiation can cause. Such mutations can potentially lead to skin cancer.

e. Tactile cells are found in the deep epidermis and when compressed stimulate nearby nerve cells. This provides sensory info about what is touching the skin.

f. Epidermal dendritic cells are capable of performing phagocytosis (the ingestion and destruction of invading pathogens). They also take the remains of the pathogens to the lymph nodes and present pathogen fragments to white blood cells in order to prompt an immune response.

g. The epidermis is divided into several named layers (each of which can consist of multiple layers of keratinocytes).

h. In thick skin (found on the ventral surface of the hands and the plantar surface of the feet), there are 5 epidermal layers.

i. In thin skin (found everywhere else), there are 4 epidermal layers.

j. Thick skin not only has an extra layer but its layers are thicker as well. This is logical since the palms and soles experience much more friction and abrasion than other areas of the skin.

k. From deepest to most superficial, the 5 layers of thick skin epidermis are: stratum basale, stratum spinosum, stratum granulosum, stratum lucidum, and stratum corneum.
I. The stratum basale is the basal-most layer and is just superficial to the basement membrane and the underlying areolar connective tissue. This layer consists of a single row of cells that are constantly performing mitosis. The new cells are continually pushed above towards the surface. Additionally, melanocytes are commonly found in the stratum basale.

m. The stratum spinosum is next and it contains several layers of keratinocytes. The desmosomes mechanically linking the keratinocytes are quite visible in slides of the epidermis and are responsible for the name of this layer. These keratinocytes are still alive and have not yet become filled with keratin. Epidermal dendritic cells are common in this layer.

n. The stratum granulosum is next and is a thin layer where the keratinization of the cells really gets going. The keratinocytes here are beginning to die and are accumulating granules of keratin precursors and as a result have a very dark and spotty appearance.

o. The stratum lucidum is superficial to the stratum granulosum but is only found in thick skin. The cells of this thin layer appear somewhat clear (lucidum is from the Latin lux, “light”) in the microscope since they have produced a translucent protein (eleidin) that is a precursor to keratin.

p. The final superficial layer is the stratum corneum (Gk. Cornu horn). It consists of flattened, anucleate, dead cells filled with keratin. It can be up to 30 cell layers thick in thick skin. Its strength and durability give the skin many of its protective qualities. The apical-most cells of the stratum corneum are constantly flaking off and being replaced by new cells from below.

q. The change in keratinocyte appearance as cells move from the stratum basale to the stratum corneum is known as cornification. The process takes about 2 weeks.

III. Dermis

a. Underlies the epidermis and has 2 layers: the papillary dermis and the reticular dermis.

b. The papillary dermis is the upper ⅕ of the dermis and primarily consists of areolar CT. It supports the epidermis and contains abundant blood vessels and nerves. Upward projections of the papillary dermis (dermal papillae (Lat. papilla projection) interlock with downward projections of the epidermis (epidermal ridges) to anchor the 2 layers to one another.

c. The reticular dermis is the lower ⅘ of the dermis and primarily consists of dense irregular CT. This provides the skin with a great deal of structural integrity and resistance to damage.

d. The dermis is heavily innervated and quite vascular. Dermal blood vessels will vasodilate in response to a rise in body T°. This increases blood flow to the skin and allows heat to radiate away from the body. In response to a drop in body T° dermal vessels will vasoconstrict as a means of heat retention.

e. Dermal blood vessels are also the site of initiation of vitamin D production. UV radiation acts on blood chemicals that are then modified by the liver and kidney to yield active vitamin D. Vitamin D has several physiological roles including the maintenance of proper blood calcium levels which is crucial for bone health.

IV. The skin includes several structures that are derived from the epidermis. These skin appendages include: sweat glands, sebaceous glands, nails, hair follicles, and hair.

a. The skin contains 2 main types of sweat glands: merocrine and apocrine. Each is a coiled tube with the secretory portion in the dermis and a duct leading through the epidermis to an opening at the surface (in a merocrine sweat gland) or into a hair follicle (in an apocrine sweat gland).

b. There are roughly 3-4 million merocrine sweat glands. They release sweat via exocytosis onto
the epidermal surface. This sweat is 99% water with only a few solutes (Na+, Cl-, lactic acid, antibodies, urea and ammonia). The primary function of merocrine sweat glands is thermoregulation. The evaporation of sweat on the skin surface removes heat from the skin and thus cools the body. The acidity of sweat is bacteriostatic, i.e. it reduces bacterial growth.

c. Apocrine sweat glands release their sweat into hair follicles in the axillary regions, pubic region, anal region and around the nipples. They release their sweat via exocytosis. This sweat is thick and contains lipids and proteins that are utilized by resident bacteria with the ensuing production of a distinctive odor. These glands become active around puberty.

d. Modified apocrine sweat glands called ceruminous glands are found in the external ear canal lining. Their secretion adds to sebum to yield cerumen (a.k.a. earwax) which helps block entry to the ear canal.

e. Sebaceous glands secrete sebum, an oily bactericidal substance that helps moisturize the skin. They are typically found branching from hair follicles and are absent on the palms and soles.

f. Hair covers the majority of the human body and is abundant on the surface of the head, axillae, and pubic region. It plays a role in sensation and provides some warmth and protection from UV radiation. Hair consists of a hair bulb, a root, and a shaft. The bulb is a swelling of epithelial cells that is deep within the dermis. Deep to the bulb is a collection of CT, blood vessels, and nerves known as the hair papilla. The hair papilla nourishes the bulb and allows distortion of the hair to convey information. The root and shaft of the hair are both composed of concentric layers of dead keratinized cells. The shaft is the visible portion of the hair, whereas the root is within the epidermis and dermis. Surrounding the lower shaft and the root is the hair follicle. Attached to the follicle is a small muscular bundle called an arrector pili muscle. It contracts and causes the hair to stand up in response to cold temperature and fright. There is no functional value to this in humans. In furrier mammals, it helps them look larger and can trap an insulating layer of air next to the skin.