Skin Physiology

The Skin

- 15 - 20% of total body mass, the largest organ of the body
- Functions
    - Physical barrier
    - Thermoregulation
    - Sensation
    - Immunological
    - Vitamin D production
    - Excretion
- Composed of three layers
    - Epidermis
        - The most superficial/outermost layer
        - Provides protection, and is thicker in certain areas e.g. heels
        - Made up of
            - Keratinocytes (85%) – provide a barrier, external covering
            - Melanocytes (5%) – pigment producing cells
            - Langerhans' Cells (2-5%) – immune cells
            - Merkel's Cells (6-10%) – provide sensation
            - Nails – plates of keratinised cells
        - Cells differentiate as they move up the epidermis and are shed/ exfoliated from the top layer
    - Dermis
        - The middle layer
        - Provides tensile strength and stretch
        - The fingerprints are a relationship between the dermis and hypodermis
        - Made up of
            - Collagen and elastin fibres
            - Apocrine sweat glands – empty sweat into hair follicles
            - Sebaceous glands – produce and secrete sebum into hair follicles
            - Nerve endings – for sensation
                - Pacinian – in the deeper dermis in fingertips for pressure changes and vibration
                - Meissner's – in the top of the dermis in lips and palms for touch
    - Hypodermis
        - The bottom layer
        - Subcutaneous fat, superficial fascia
        - Provides anchors to underlying structures, energy storage, insulation
        - Made up of
            - Loose connective, adipose tissue

Acne Formation

- Is the accumulation of shed dead cells and keratin and results from excess sebum production from sebaceous glands
- Features bacterial proliferation, inflammation and potential scarring

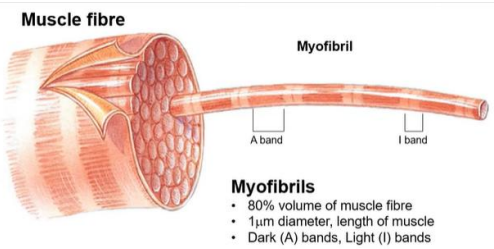
Sunburn Formation

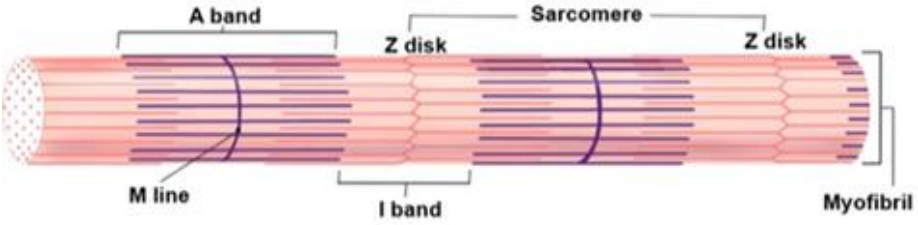
- From exposure to UV light
    - UVA penetrates all the way to the top of the hypodermis but is not ionising, rarely causes cancer (320 to 400 nm)
    - UVB penetrates to the middle of the dermis, is more ionising and carcinogenic (290-320 nm)
- Melanin absorbs and scatters UV light from melanocytes to keratinocytes, preventing cancer
    - Sunburn sensitivity is determined by levels of melanin and skin thickness
    - Fitzpatrick skin guide – I to VI (white to black skin)
        - I is most likely to burn and not tan
        - VI never burns and tans easily

Skeletal Muscle Structure

Skeletal Muscle

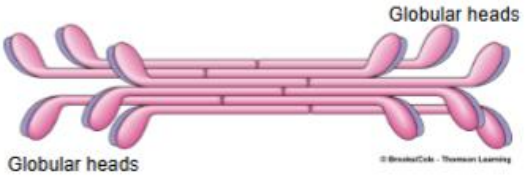
- Is under somatic control by signals from the central nervous system, specifically motor neurons which release acetylcholine (a neurotransmitter) causing the muscle to contract
- Voluntary, striated and accounts for 40% of body weight
- Muscle Fibres
    - Multi nucleated
    - Extend the length of the muscle
    - Made up by myofibrils
        - 80% of muscle fibre volume
        - Extend the length of the muscle fibre
        - Dark (A) bands
            - Thick filaments, supported by M line
        - Light (I) bands
            - Thin filaments, supported by Z line/disk
        - Sarcomere is the area between two consecutive Z lines and the fundamental unit of contraction in muscle





Thick Filaments

- Myosin
- Intertwined pairs of
    - 1 heavy chain (head, neck and tail), 2 light chains
- Globular Head
    - ATPase site
    - Actin Binding Site
- Arranged in bipolar assembly, the tails are attached to the M line and the heads are the furthest away



Thin Filaments

- Actin
    - A glove shaped molecule, double stranded helical polymer
    - Forms a cross bridge with myosin via myosin binding site
- Tropomyosin
    - Covers the myosin binding site at rest
- Troponin – protein complex
    - I – binds actin, inhibits muscle contraction in the rest state
    - T – binds Tropomyosin, facilitates contraction
    - C – binds calcium, triggers the contractile process

Cross Bridge Cycling

- The fundamental mechanism by which skeletal muscle fibres contract
- Depends on the presence of both calcium and ATP and acetylcholine based neuron signalling
- In rest, when intracellular calcium levels are low, tropomyosin sits over the myosin-binding sites on actin, preventing interaction between actin and myosin … when an action potential travels along the sarcomere and into the muscle fibre via transverse tubules (TT), it causes a rapid change in membrane voltage. This change is detected by DHP receptors (voltage sensors) in the TT membrane … these activate adjacent ryanodine receptors located on the lateral sacs of the sarcoplasmic reticulum. Ryanodine receptors open and allow calcium to be released into the cytosol of the muscle fibre. The increased cytosolic calcium binds to troponin C, which undergoes conformational change to displace tropomyosin, exposing the actin's myosin binding sites. This allows the myosin heads, which are in a high energy state due to ATP hydrolysis, to attach to actin filaments and form cross-bridges (shortening the sarcomere). Once attached, the myosin head releases ADP and Pi and performs a power stroke, pulling the actin filament toward the centre of the sarcomere. For the cycle to continue, a new ATP molecule must bind to the myosin head, causing it to detach from actin. ATP is then hydrolysed, restoring the myosin head into its original high energy state, ready to bind again if calcium remains present. Without calcium, tropomyosin returns to its resting position, covering the binding sites on actin and terminating the cycle. Thus, the precise regulation of calcium and ATP is essential for muscle contraction and relaxation through the process of cross-bridge cycling.

Rigor Mortis

- Occurs 3 to 4 hours after death, due to a lack of new ATP, myosin cross bridges remain attached and muscles become rigid