

01 Intro, Cavities, Skin, Homeostasis

Monday, 14 July 2025 8:53 am



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Intro/Admin

- Weekly quizzes
- Assignment 1 due week prior to last week of term: Topic of choice, explained to public in way that is accessible to general public; goal is explaining something complex simply
- Assignment 2 in Sem 2 due week prior to last week of term: written assignment ~500 words; critical thinking regarding wellness industry media
- Midcourse test 8th Sep term 3 content
- Weds are PBL days, not mandatory
- Tutorials start W3, four of them, similar to PBLs
- Textbook not mandatory, all info required supplied through lectures
- The tutorials are held in labs but are not labs and do not need lab equip

Summary:

- *Tissues* are groups of cells with common functions
- Organs and organ systems each perform one or more essential complex functions for the organism
- *Organ systems* are groups of organs that perform a common function
- Tissue membranes line body cavities, that is, serous, mucous, synovial, and cutaneous
- The skin is an organ system
- Skin functions: prevent dehydration, protect from injury, defend against microorganisms, regulate body temperature, make vitamin D, and experience sensations
- Skin structure: epidermis and dermis
 - o Epidermal cells are replaced constantly
 - o Fibers in dermis provide strength and elasticity
 - o Accessory structures include hair and smooth muscle
- Multicellular organisms must maintain homeostasis
- Homeostasis is maintained by negative feedback control systems
- Negative feedback system components include the controlled variable, sensor/s, control centre (hypothalamus), and effector/s
- Negative feedback helps to maintain core body temperature

Learning objectives:

- Define the term tissue
- Understand the types and roles of body cavities
- Name the four different types of tissue membranes and discuss the function of each
- List and give a function for the major structures of the integument
- Analyse how negative feedback maintains homeostasis in the human body

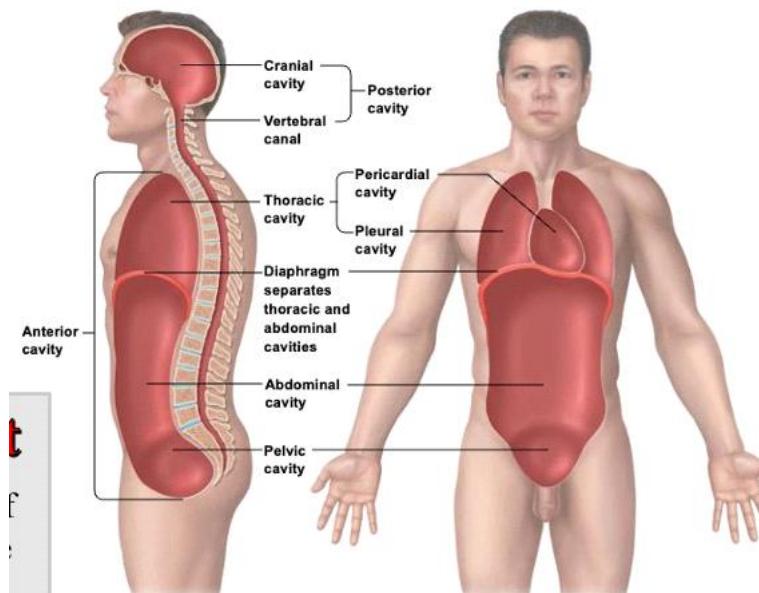
Human bio can be studied on multiple levels of organisation - atomic to biosphere. Our focus is cell to organism, with particular focus on structure and function of organ systems.

Organs and organ systems perform complex functions. Complex functions cannot be performed by a single tissue type alone - a combination of tissue types is necessary.

- *Organs* are composed of 2+ tissue types connected together that cooperate to perform a specific function or functions
 - o E.g., the heart is composed of muscle tissue (for pumping blood), nerve tissue (presumably to send the signal to pump?), connective tissue (wraps around the heart to hold it together), and epithelial tissue
- *Organ systems* are groups of organs that cooperate with each other to perform a shared crucial biological function
 - o There are 11 organ systems in the human body
 - o If one organ in the organ system fails, it leads to rapid failure of the overall organ system
 - o e.g., the digestive system is composed of the mouth, throat, stomach, intestines, and liver
 - o e.g., the lymphatic system is composed of lymph nodes, tonsils, and the spleen
 - The lymphatic system is important for immune response and for draining excess fluid

Cavities of the human body

Cavities are 'compartments' that house and protect organs, lined by serous membranes. They are not 'holes' - they are packed full of stuff including organs. They are essential for understanding medical imagery and surgery, and help us understand injury risk, inflammation, and organ movement. They also help us understand diseases and locations of the human body.



Anterior cavity (front cavity)

- The anterior cavity is split into the *thoracic cavity* and *abdominal cavity*
- The *thoracic cavity* is split into two pleural cavities (each housing one lung), and the pericardial cavity (houses the heart).
 - o *Pleurisy* : inflammation of the membrane surrounding the lungs (not the pleural cavity membrane but the lung membrane?), caused by infection
- The *abdominal cavity* is at the abdomen, and its lower section is also known as the *pelvic cavity*.
- The thoracic and abdominal cavities are separated by the *diaphragm*, which is just below the nipples.

Posterior cavity (back cavity)

- Quite small in comparison with the anterior cavity
- The posterior cavity is split into the *cranial cavity* and the *vertebral/spinal cavity*
- The *cranial cavity* houses the skull, while the *spinal cavity* houses vertebrae, spinal cord, etc

Tissue membranes

Tissue membranes are layers of connective tissue that protect, separate, and allow communication between body structures. They are often involved when things 'go wrong', and are essential for diagnosing and treating health problems.

- *Serous membranes* line and lubricate internal body cavities (i.e., body cavities closed to the exterior of the body) by producing serum, reducing the friction between organs. Such cavities include the peritoneal, pleural, and pericardial cavities.
- *Mucous membranes* line the digestive, respiratory, urinary, and reproductive tracts, ducts, and regions exposed to the outside world. They are coated with the secretions of mucous glands, thus lubricating tract surfaces and capturing debris such as bacteria, dirt, foreign particles, etc (things you don't want inside your body!).
- *Synovial membranes* line joint cavities (e.g., that of the knee) and produce the lubricating fluid within the joint. These do not contain an epithelial tissue layer.
- *Cutaneous membranes* form the outer covering (i.e., skin)

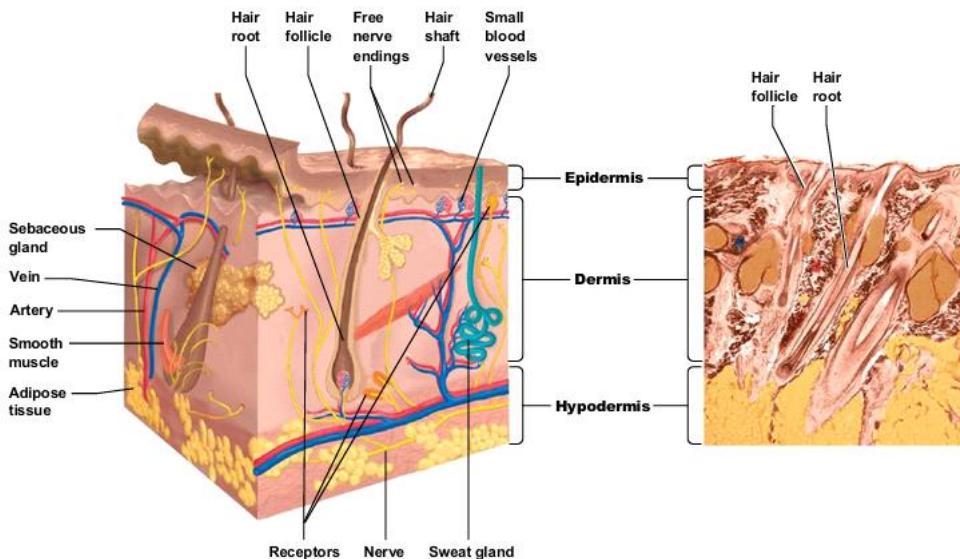
An aside on *epithelial tissue* (source: Wikipedia): epithelial tissue is a thin, continuous, protective layer of cells with little extracellular matrix. It lines the outer surfaces of many internal organs, the corresponding inner surfaces of body cavities, and inner surfaces of blood vessels. Serous, mucous, and cutaneous membranes all contain an epithelial tissue lining, whereas synovial membranes do not. Epithelial tissues lack blood or lymph supply, and are supplied by nerves.

The integumentary system (skin)

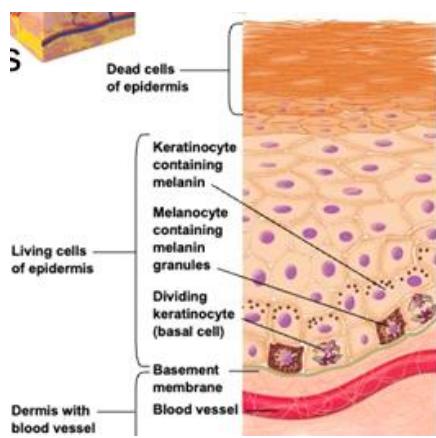
The integumentary system (from *integumentum* - Latin for 'a covering') is an organ system that includes skin, hair, nails, and glands. It has many functions, including protection from dehydration, protection from injury, defending against microorganisms, regulating body temperature, vitamin D synthesis, and providing information about the external environment via sensation. The skin has two main layers - the epidermis and dermis.

An aside on *blisters* : the separation of the epidermis and dermis results in blister formation, where the lymphatic system floods the separated region with fluid to protect underlying cells (including exposed nerve cells).

An aside on *sunburn* : the redness, pain, and swelling associated with sunburn is an inflammatory response to DNA damage caused by UV radiation. When skin is sunburned, the damaged cells are shed via peeling, and replaced.



Epidermis - the outer skin layer



The epidermis contains stratified squamous (multi-layered square-shaped) epithelial cells, and no blood vessels. The inner/bottom layer of cells (basal cells) in the epidermis divide constantly, effectively pushing outer cells further outwards. The outer layer of cells are dead epidermal cells, and are shed. There are two major cell types in the epidermis:

- *Keratinocytes* : produce keratin, a tough rigid waterproof protein. Can absorb melanin produced by melanocytes as a defence/precaution against UV damage.
- *Melanocytes* : produce melanin (a dark pigment) in response to UV exposure.

Epidermal disease spotlight:

- *Basal cell carcinoma (BCC)* : cancerous basal cells caused by UV damage to DNA. Results in uncontrolled tumour growth. Note also that basal cells are actively dividing, and are therefore prone to mutations.

- *Squamous cell carcinoma (SCC)* : cancerous squamous cells caused by UV damage to DNA. Results in uncontrolled tumour growth. More aggressive than BCC because it can metastasise (cancer cells can break off from tumour and propagate elsewhere in body). Note these cells are more vulnerable to DNA damage than basal cells.

Dermis - the inner skin layer

The dermis lies beneath the epidermis, and is comprised primarily of dense connective tissue and skin accessory structures. It supports tissues, and contains collagen and elastic fibres that provide strength and elasticity (helpful to prevent skin ripping as well as abrasion resistance). With age, collagen and elastic fibres degrade (is there an internal repair mechanism?), causing wrinkles. The dermis contains a variety of cells, including fibroblasts (synthesise extracellular matrix and collagen), mast cells and other white blood cells, and fat cells (for insulation)

Dermis accessory structures

- *Hair* : the shaft extends above the skin surface, while the follicle is embedded in the dermis. The cells at the follicle base are constantly dividing, pushing the hair root upwards.
- *Smooth muscle* : small muscles attached to hair follicles, which contract in response to cold/fright, causing hair to assume an upright position (stand on end), and signalling a massive hormonal response in body.
- *Sebaceous (oil) glands* : secrete sebum, which moistens and softens skin and hair, thus preventing the epidermis from drying out and shedding too much.
 - o Pimples result from sebum clogging the hair follicle.
- *Sweat glands* : secrete sweat (contains water, salt, dermcidin, and more) to help with temperature regulation.
 - o Dermcidin helps protect against bacteria - useful property considering sweat glands form pores
 - o Body odour results not from the sweat itself, but the metabolic byproducts of microbes consuming the various compounds in sweat.
- *Blood vessels* : supply nutrients, remove waste/byproducts of cellular metabolism, assist in temperature regulation through contraction/dilation
- *Sensory nerve endings* : skin contains many receptors, allowing us to detect heat, cold, pressure, and vibrations - but not wetness! Wetness is inferred through processing sensory information in the brain.

Homeostasis

Homeostasis is the maintenance of relative constancy of internal environment conditions via a negative feedback control system. A significant amount of metabolic energy is used to detect cues from the external environment and adjust internal conditions accordingly. Thus we can infer it is critically important for the human body to maintain a constant internal environment.

Negative feedback control system : components include a controlled variable), sensor/s, control centre, and effector/s. These components cooperate in a cycle to ensure any deviation from expected conditions can be detected and counteracted.

- *Controlled variable* : any physical or chemical property that might vary and must be controlled to maintain homeostasis (e.g., temperature, blood pressure)
- *Sensor* (receptor) : monitors current controlled variable state/value and sends information to control centre
- *Control centre* : receives input from sensor, compares value to set point, then signals the effector/s if necessary to counteract imbalance
- *Effector* : the site of action, takes action to correct the imbalance, based on information from the control centre. There may be multiple effectors for one controlled variable.

Example: negative feedback helps maintain core body temperature

- Controlled variable = body temperature
- Sensors = temperature sensors in the skin and internal organs. These constantly transmit information to the hypothalamus.
- Control centre = hypothalamus. The hypothalamus also controls hunger, thirst, hormone release etc. The hypothalamus sends out nerve impulses to the effectors.
- Effectors:
 - o Blood vessels - constrict to conserve heat when body temperature is low
 - o Sweat glands - activated when body temperature is high
 - o Skeletal muscles - repeatedly contract/shiver when body temperature is low to generate heat
- *Hypothermia* : hypothermia occurs where the body temperature drops so much that homeostasis is insufficient for restoring body temperature to normal temperature.
 - o Normally when body temperature drops, shivering and vasoconstriction are sufficient to restore normal body temperature.
 - o In hypothermia, these responses weaken or stop, as the core temperature is so low that the negative feedback system stops working.

Problem-based learning questions

1. Which one of the following is TRUE regarding skin?
 - Beneath the dermis is the basement membrane, which separates the dermis from the hypodermis
 - False
 - Apparently the fact we haven't talked about this means we can just write this question off lol
 - The basement membrane separates the epidermis from the dermis
 - Keratin is a protein in the cells of the epidermis that provides strength and waterproofing
 - False: doesn't provide strength, although it does provide waterproofing
 - Melanocytes and keratinocytes are two skin cell types that are prevalent in the dermis
 - TRUE
 - The sebaceous glands and the sweat glands are two types of endocrine glands located in the dermis
 - Endocrine (inside body, circulates stuff within body) whereas these glands are exocrine (release stuff externally)
 - Melanocytes produce calcium, which strengthens the skin
 - False - melanin
2. Each of these organ systems is involved in the homeostatic regulation of body temperature EXCEPT

which one?

- a. Nervous system
 - i. True - sends out nerve impulses to action the effectors
- b. Integumentary system
 - i. True - smooth muscle contracts in response to cold; sweat glands in skin secrete sweat in response to heat
- c. Circulatory system
 - i. True - blood vessels contract in response to cold; blood vessels dilate in response to heat
- d. Muscular system
 - i. True - muscles start shivering in response to cold
- e. Skeletal system
 - i. FALSE