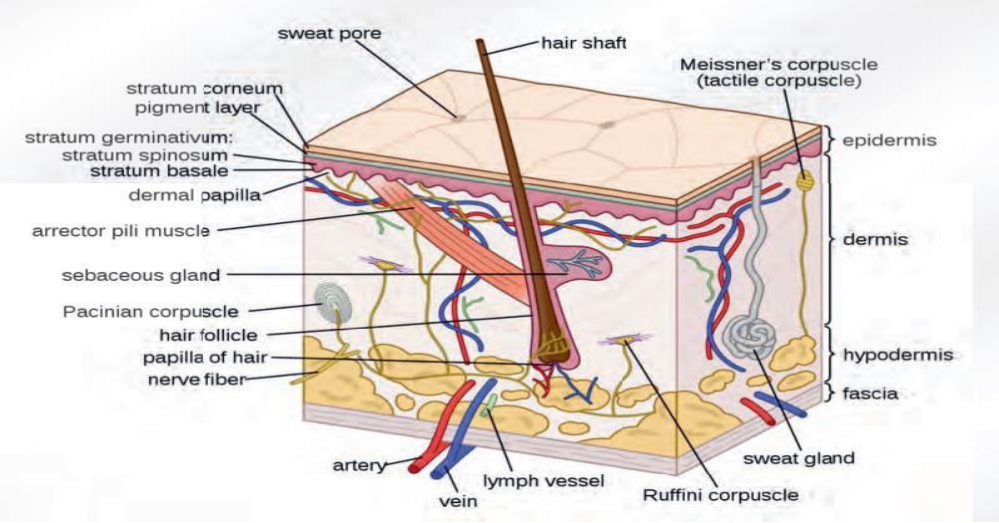
SENSE ORGANS

SKIN

- ❑ The human skin is the largest organ of the body in surface area and weight

The skin:

- ✓ Contains huge variety of sense receptors (touch, temperature, pressure & pain receptors)
- ✓ It permits the sensation of touch, heat and cold
- ✓ Forms a water proof layer around the body
- ✓ Protects against water loss by evaporation and water gain by osmosis
- ✓ protects the body from the entry of bacteria and other pathogens
- ✓ protects the body from damage by UV light
- ✓ is an excretory organ (nitrogenous wastes are lost with the sweat)
- ✓ is vital in controlling the body temperature



- ❑ Skin has three main layers: **epidermis**, **dermis** and **hypodermis**

1) **Epidermis**

- ✓ It is the upper layer of the skin made up dead cells
- ✓ Some important cells found in the epidermis:-
  - **Keratinocytes** –produce keratin (a protein) which is the main component of the skin
  - **Melanocytes** –produce a pigment called melanin
  - **Langerhans cells**-prevent pathogens from getting into the skin

2) Dermis

- ✓ Contains connective tissue, blood vessels, hair follicles, sensory receptors, sweat glands and Sebaceous (oil) glands
- ✓ Closely involved in temperature control in homeostasis and in sense of touch
- ✓ Contains proteins (keratin & elastin) which are necessary for skin health

Collagen and elastin

- ✓ Offer support and elasticity
- ✓ Responsible for awarding of wrinkles and fine lines on the skin
- ✓ Collagen is the most plentiful protein in the skin ,making 75-80% of the skin
- ✓ Overtime environment and aging reduces the body's ability to produce collagen

***3*) Hypodermis -** beneath the dermis

- ✓ Is deeper (or lower) layer made up of fat and connective tissue
- ✓ Acts as energy store and Insulator protecting against heat loss

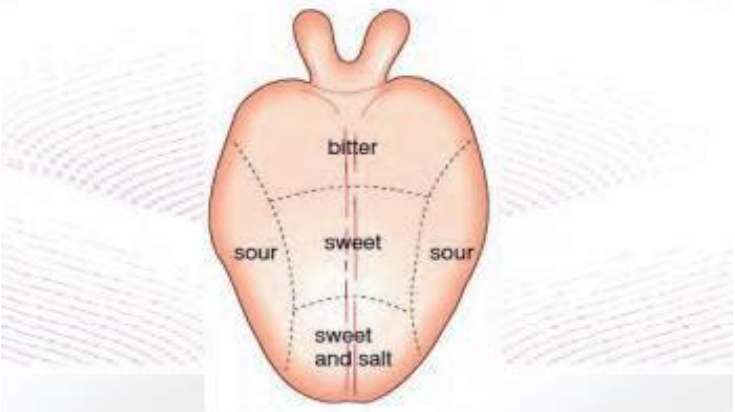
The tongue

- ✓ Is muscular organ in the mouth which is covered by **mucosa** (moist pink tissue)
- ✓ Is vital organ for chewing and swallowing food, as well as for speech
- ✓ **Papillae is** a tiny bump that gives tongue its rough texture
- ✓ **Taste buds** – collection of nerve like cells that connects to nerves running into the brain
- ▪ They cover the surfaces of papillae
- ✓ Tongue is anchored in the mouth by webs of though tissue and mucosa
- ▪ **Frenum**:- tether holding down the front of the tongue
- ▪ On back of mouth it is anchored to **hyoid bone**
- ✓ Sensory receptors of taste (taste buds) are sensitive to certain chemical substances and are located:
- ▪ On the upper surface of the tongue &
- ▪ To lesser extent on the surface of the throat
- ✓ There are five taste sensations **sweat**, **sour**, **bitter**, **salt** and **umami**

  Umami: is a flavor in foods such as meat, cheese, broth and mushroom and is discovered recently

Distribution of taste receptors on the surface of the tongue

- ✓ It was thought that receptors for known five senses had their areas of greatest concentration on different parts of the tongue
- ✓ Currently it is known all of the five taste receptors are spread out all over the tongue



The main taste areas of the tongue that has been taught for many years.

- ❖ When a person speaks of taste sensation they are referring to a compound sensation produced by stimulation of both taste and smell receptors.
- ❖ One reason why hot foods often have more ‘taste’ than cold foods is because they vaporise more.
- ❖ The reason why you cannot ‘taste’ foods well when suffering from a cold is that, with your nasal passages inflamed and coated with mucus, your smell receptors cannot work

Question: Which is the most recently discovered sense of taste?

A. Sweat B. Bitter C. Sour D. Umami

The nose

- ✓ The human nose is a sense organ of smell
- ✓ Smell = olfaction, sensory receptor of smell = olfactory receptor
- ✓ Olfactory receptors are located on the upper surface of the nasal cavity
- ✓ They are sensitive to solutions of certain chemical substances

Functions of the nose

- ✓ One of the important means by which the environment communicates with us through olfaction
- ✓ Allow the passage of air for respiration
- ✓ Conditions the inhaled air by making it humid and warm
- ✓ Filters the inhaled air. Hairs inside the nose prevent large particles from entering the lung

How do you smell?

- ✓ In order to be detected by smell or taste receptors chemicals must go into solutions in the form of liquid which coats the receptors

The main difference between smell and taste receptors

- ✓ Smell receptors are specialized for detecting vapors coming to organism from distant source
- ✓ Taste receptors are specialized for detection of chemicals present in the mouth
- ✓ Smell receptors are much more sensitive than taste receptors

The eye

- ✓ Eye functions as a sensory organ of vision
- ✓ It transmits visual stimuli to the brain for interpretation

External structures of the eye

- ✓ **Eye brows** – protect the eye by preventing perspiration from running down the fore head, causing irritation
- ✓ Helps shade the eyes from direct sunlight
- ✓ **Eye lids** (upper & lower): are two movable structures composed of skin and two types of muscle (striated & smooth)

Functions of eyelid

- ✓ Protect the eye from foreign bodies
- ✓ Limit the amount of light entering the eye
- ✓ Serve to distribute tears that lubricate the surface of the eye
- ✓ The eyelid join at two points

1. The lateral (outer) canthus
2. The medial (inner) canthus

The medial canthus contains

- ✓ **Puncta**: a small opening that allow the drainage of tear
- ✓ **Caruncle**: small fleshy mass that contain sebaceous glands

- When closed the eyelids should touch
- When open the upper lid position should be between the upper margin of iris and the upper margin of pupil

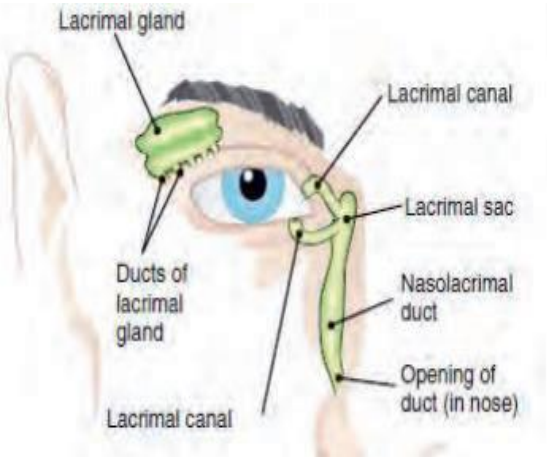
- ✓ **Eyelash** – projection of stiff hair curving outward along the margin of the eyelids

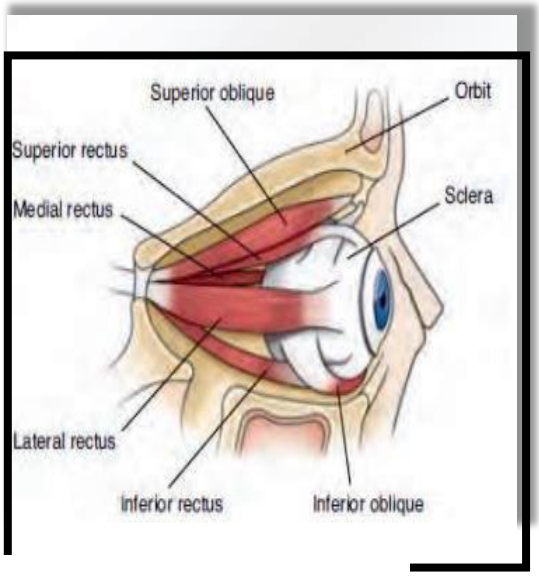
- It filters dust and dirt from air entering the eye

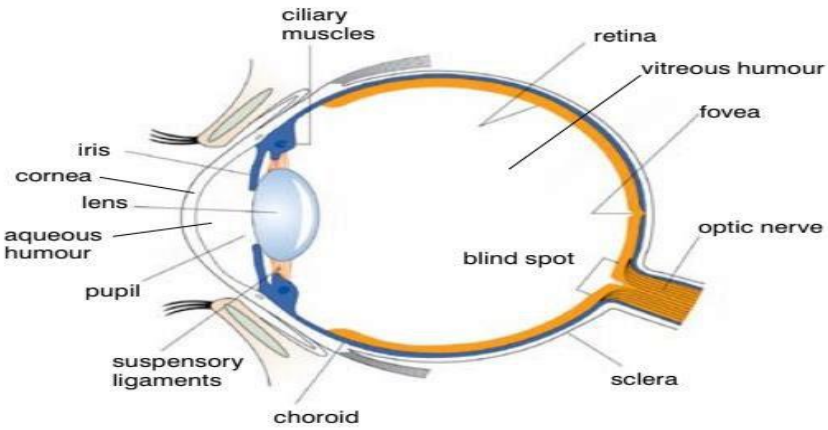
✓ **Conjunctiva** – thin transparent continuous membrane

Divided into two portions

1. **Palpebral portion** – lines inside of the eyelids
2. **Bulbar portion** – covers most of the anterior of the eye







Internal structures of the eye

✓ **Eyeball** is composed of three separate coats or layers

1) The external (protective) layer
2) The middle (nourishment) layer
3) The inner most (photosensitive) layer

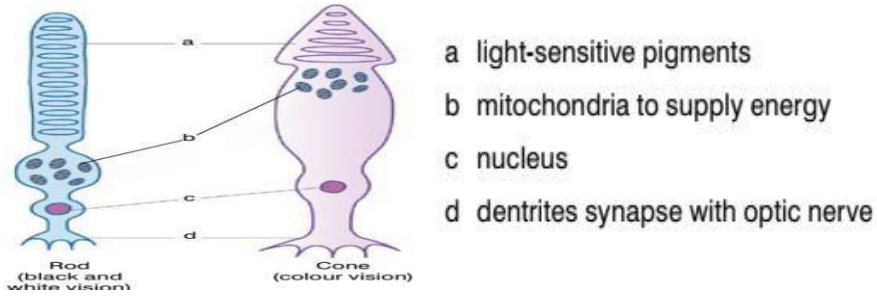
1. **The external layer** consists of sclera and cornea
   - ✓ **Sclera** – though opaque tissue that serves as eye's outer protective layer
   - ✓ It is continuous anteriorly with cornea
   - ✓ **Cornea** ("window of the eye")
   - ✓ Transparent structure over front of the eye that allow the light to enter

2. **The middle layer** – choroid

- ✓ Contain the vascularity (blood vessels) necessary to provide nourishment to the inner part of the eye
- ✓ It also prevents light from reflecting internally
- ✓ Is continuous anteriorly with ciliary body and iris

3. The innermost layer – retina

- ✓ A light sensitive tissue lining the inner surface of the eye
- ✓ It receives visual stimuli and sends it to the brain
- ✓ The retina consists of numerous layer of nerve cells including **rods** and **cons** (specialized nerve cells)
- ✓ Rods and cons are also referred to as **photoreceptors** because they are responsive to light
- ✓ **Rods**- perceive light and movement and work well in **dim light**
- ▪ They regulate black and white vision
- ✓ **Cones**- perceive light and movement and only work in **bright light**
- ▪ Are sensitive to color
- ✓ **Optic disc (blind spot)-**circular area on the retina where the optic nerve enters the eyeball
- ▪ At the point when optic nerve leaves the eye there is no retina, but a blind spot
- ✓ **Fovea centralis:** is retinal depression located adjacent to blind spot
- ▪ It is highly concentrated with cones and forms the area of highest visual resolution and color vision



- ✓ **Iris**-is the colored part of the eye
- ✓ Is made up muscles that contract and relax to control the size of pupil which controls the amount light reaching the retina
- ✓ Circular muscles run around the iris whereas the radial muscles run across the iris like the spokes of bicycle wheal

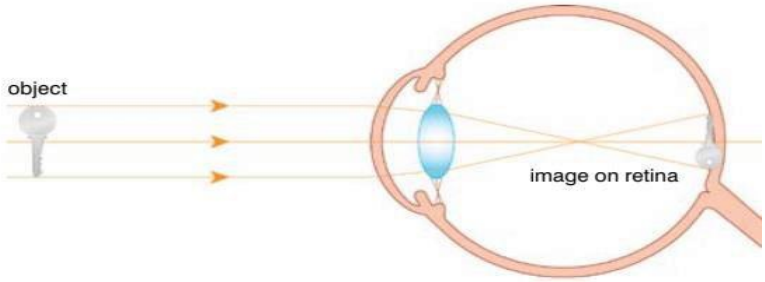
<u>In dim light</u>

- ✓ Radial muscles contract and circular muscles relax
- ✓ The pupil dilates (becomes wider) and a lot f light gets into the eye. This enables as to see in low light conditions

<u>In bright light</u>

- ✓ radial muscles relax and Circular muscles contact
- ✓ The pupil constricts (becomes narrower). This reduce the amount light that goes into the eye, so that the delicate light sensitive cells are not damaged
- ✓ **Lens:** is biconvex, transparent, avascular, encapsulated structure located immediately posterior to the iris

- ✓ Suspensory ligament attached to ciliary muscle supports position of the lens
- ✓ Lens functions to refract (bend) light rays on to the retina
- ✓ Adjustment is made on refraction depending on the of the object being viewed
- ✓ The lens bulges (become more convex) to focus on close objects and
- ✓ Flattens (elongates) to focus on far objects



- ✓ The eye ball contains several champers that maintain structure, protect against injury and transmit light rays
- **Anterior chamber-** located between cornea and iris
- **Posterior chamber-** located between iris and lens
- These two chambers are filled with **aqueous humor**
- ✓ **Aqueous humor** – is a clear liquid produced by ciliary body

<u>It helps</u>

- cleanse and nourish cornea and lens
- Maintain intraocular pressure
- ✓ **Vitreous chamber:** area between lens and retina
- It is the largest chamber and is filled with clear and gelatinous **vitreous humor**

Question: Which one of the following eye structure is correctly matched with its function? 2015 EUEE

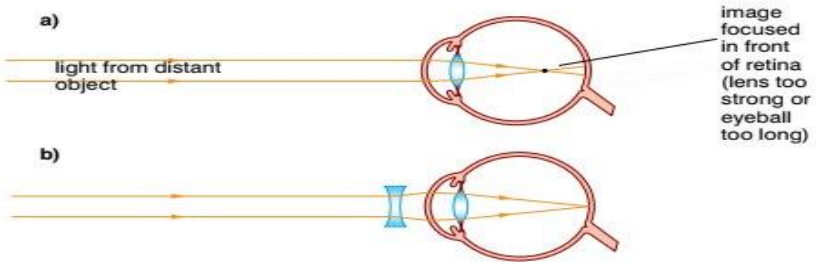
A. Pupil- serves as eye's protective outer layer
B. Iris – controls the amount light entering the eye
C. Cornea – provide nutrition for the retina
D. Choroid – bends the light in to the eyes

Question: During image formation, light is refracted twice before it is focused on the retina. This phenomenon happens at the: 2014 EUEE

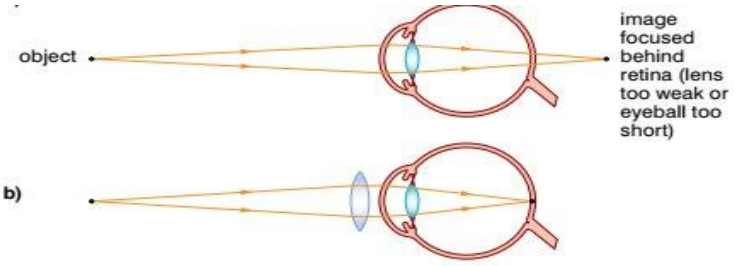
A. Aqueous humour and lens
B. Lens and vitreous humour
C. Iris and lens
D. Cornea and lens

<u>Common eye defects</u>

- ✓ A lens is a piece of transparent material (usually glass or plastic) that has one or more curved surfaces.
- ✓ An outward curve makes a **convex** lens and this will bend the light rays towards each other (a **converging** lens).
- ✓ An inward curve makes a **concave** lens and this will spread the light rays out (a diverging lens)
- ✓ **Short sight:** a short-sighted person can focus clearly on things that are close to them but has much more difficulty with objects in the distance, which appear blurred.
- **Cause**: too strong (too curved) lens or long eye ball
- The image is focused in front of the retina
- ✓ This problem can be corrected using concave (diverging) lenses that spread the light out more before it gets into your eye



- ✓ **Long sight**: a long-sighted person can focus clearly on things that are at a distance but has much more difficulty with objects close to them, which appear blurred
- **Cause**: too weak (too flat) lens or short eye ball
- The image is focused behind the retina
- This problem can be corrected using **convex (converging) lenses** that bring the light rays together more before they reach your eye



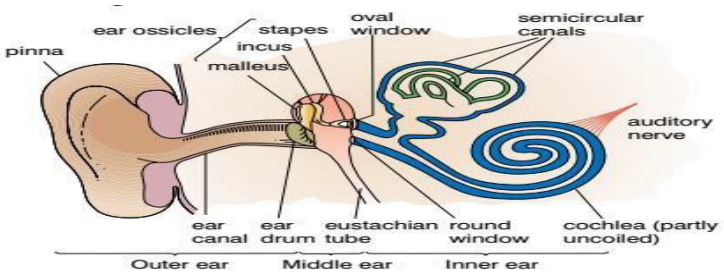
Question: Short sightedness is corrected by a concave lens because the problem arises from 2014 EUEE

A. Weak eye lens that converges light slightly
B. Powerful eye lens that diverges light
C. Weak eye lens that diverges light
D. Strong eye lens that converges light too soon

Question: Imagine you have been out on the beach looking at some friends at the sea .you walk into the shade of palm tree and begin to read a book. What changes would take place in your eyes?

A. Your pupil would constrict, your lens becomes flatter & less convex
B. Your pupil would constrict, your lenses would become rounder and more convex
C. Your pupil would dilate; your lens would become flatter and less convex
D. Your pupil would dilate; your lens would become rounder and more convex

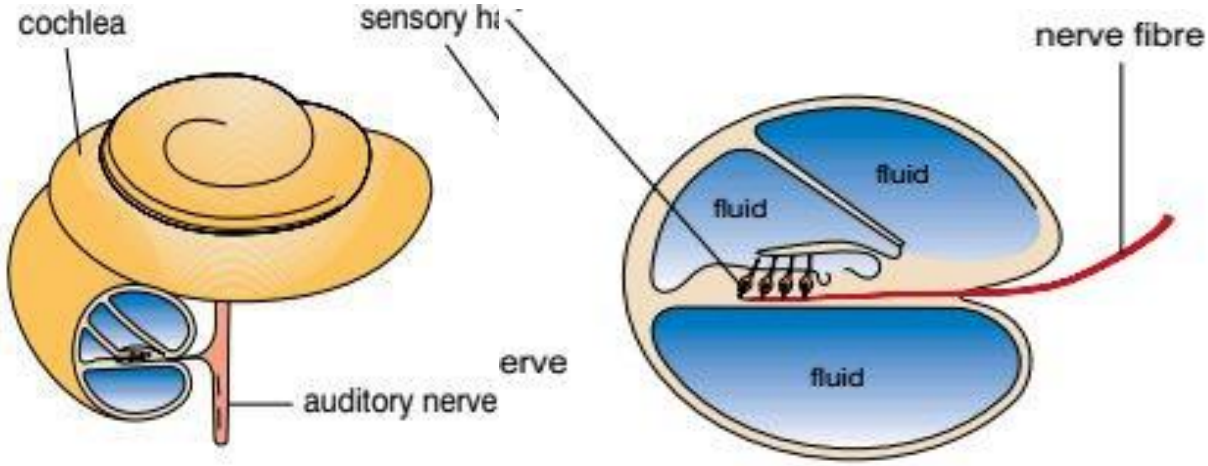
The ear



- ✓ It is specialized organs which enable you to hear sound.
- ✓ also concerned with the balance and position of the body

- ✓ The ear is divided into three regions: the **outer ear**, **middle ear** and **inner ear**.
- ➢ **<u>The outer ear</u>** consists of **pinna, ear canal** and **the eardrum**
- **Pinna** helps to trap and funnel sound into the ear.
- **Ear canal** is a tube leading from the pinna to the eardrum
- **Ear drum (**tympanum) a sheet of very thin membrane at the end of the ear canal that closes the tube.
- At the entrance of the ear canal are a number of small hairs. These filter out dust particles from the air entering the ear canal
- The cells lining the ear canal produce waxy material which traps dust and germs, and lubricates the eardrum.
- ➢ **<u>The middle ear</u>** is an air filled cavity behind the eardrum
- It contains three tiny bones – called the **malleus** (**hammer**), the **incus** (**anvil**) and the **stapes** (**stirrup**) because of their shape – are the smallest bones in your body
- They form joints with one another, with the malleus attached to the eardrum and the stapes to the oval window
- Eustachian tube connects the middle ear with the throat
- This is usually closed but when the pressure in the middle ear increases – when you are flying, the tube opens until the air pressure in the middle ear is equal to that in the throat and therefore to the atmosphere.
- At one end of the middle ear, opposite to the eardrum, there are two openings: the oval window and the round window which are covered by a membrane

- ➢ **<u>The inner ear</u>** consists of a cavity filled with a fluid
- ✓ two sac-like structures called the **sacculus** and **utriculus**
- ✓ three **semicircular canals** and
- ✓ a coiled tube called the **cochlea**
- ✓ A cross section of the cochlea reveals that it is made up of three tubes in one
- ✓ The floor of the middle tube is lined with sensory cells linked to affector neurons.
- ✓ These nerve fibers join to form the auditory nerve which leads to the brain.



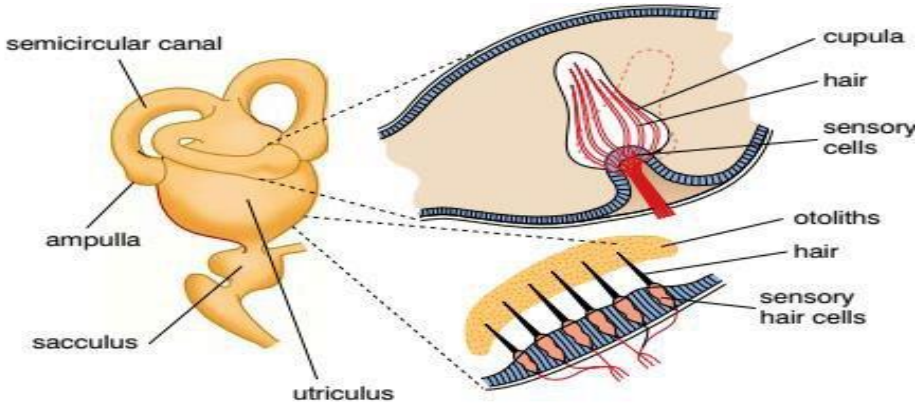
<u>Mechanism of hearing</u>

- ✓ The pinna collects sound waves and directs them to the eardrum through the ear canal sound waves hit the eardrum and causes it to vibrate
  - ✓ The vibration then transmitted through the ear ossicles to the oval window
  - ✓ both eardrum and ossicles amplify the vibrations(make them bigger)
  - ✓ The vibrations of the stapes make the membrane at the oval window vibrate
  - ✓ The vibrations of the oval window are transmitted to the fluid and then spread to the cochlea
  - ✓ Vibrations of the fluid cause the hair-like sensory cells to move.
  - ✓ These movements in turn cause production of nerve impulses in the affector nerve fibers.(auditory nerve)
  - ✓ These impulses are transmitted to the brain for interpretation

- ✓ The human ear is sensitive to vibrations ranging from those of a very low note of about 20 vibrations per second, to a very high note of about 30 000 vibrations per second.
- ✓ High notes are detected in the first part of the cochlea and low notes are recorded in the last part of the cochlea.

The senses of balance and movement

- ✓ The semicircular canals in your inner ear are concerned with the detection of motion
- ✓ **Ampullae** is a swellings on the semicircular canals that contains sensory cells attached to sensory nerve endings.
- ✓ The sensory cells have hairs which are enclosed in a core of **cupula** (a jelly substance)
- ✓ Whenever the body or the head moves, the semicircular canals move with the head. The fluid in the semicircular canals also starts to move but it lags behind in its motion and so it apparently moves in the opposite direction.
- ✓ The moving fluid causes the cupula to tilt, thus pressing the hairs of the sensory cells.
- ✓ The pressing of the sensory hairs creates nerve impulses in the sensory nerve endings and the nerve impulses are transmitted to the brain.
- ✓ The brain then interprets the direction and speed of motion of the body or head.
- ✓ If you spin round and round fast and then stop, you will feel dizzy.
- ✓ This is because the fluid in your semicircular canals keeps on moving after you have stopped.
- ✓ Your ears are telling your brain that you are moving round, but your eyes and other senses are saying you are standing still – and these mixed messages result in **the dizzy sensation**
- ✓ The utriculus and sacculus are concerned with your sense of balance and posture.



Question: Which is the correct order of the bones in the middle ear, from eardrum inwards?

A. Hammer, anvil, stirrup
B. Anvil, hammer, stirrup
C. Stirrup, hammer, anvil
D. None of these

Question: Which one of the following correctly traces the transmission of sound from the external environment to the nerves that carry the signal to the brain to be interpreted?

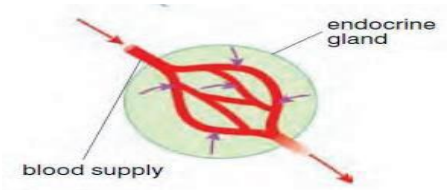
A. Cochlea, tympanic membrane, ossicles, pinna, external auditory meatus
B. Pinna, external auditory meatus, tympanic membrane, ossicles, Cochlea
C. Tympanic membrane, Cochlea, ossicles, pinna, external auditory meatus
D. External auditory meatus, pinna, tympanic membrane, ossicles, Cochlea

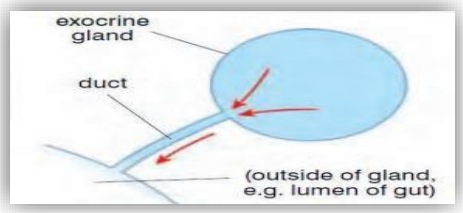
The endocrine system

- ✓ A gland is an organ in the body that secretes substances such as hormones and other useful substances. Ex. enzymes
- ✓ There are two types of glands : **endocrine glands** and **exocrine glands**
- ✓ **Exocrine glands:** release their secretion through a duct or a tube
- ▪ Example sweat glands, salivary glands, pancreas , sebaceous and mammary glands
- ✓ **Endocrine glands:** are also known as ductless glands
- ▪ They secrete hormone directly in to blood stream and the blood carries the hormone to all cells of the body
- ▪ Hormones act as chemical messenger that are produced in one part of the body , but have an effect somewhere different
- ▪ Most hormones affect only certain tissues or organs(their target organ)
- ▪ The hormone is picked up from blood by receptors on cell membranes of target organ cells

Examples of endocrine glands

- ✓ Hypothalamus, pituitary ,thyroid , adrenal glands , gonads , pancreas
  - ❖ **Note :** pancreas is both an endocrine and exocrine gland
  - ✓ Endocrine because it releases hormones(insulin and glucagon) directly to blood which act on target organs such as liver , adipose tissue and muscles
  - ✓ Exocrine because it releases digestive enzymes(pancreatic lipase ,amylase ..) into small intestine through pancreatic duct
  - ▪ **Islets of Langerhans** produce insulin and glucagon
  - ▪ **Acinar** cells produce digestive enzymes





The major endocrine glands

Hypothalamus

- ❑ It connects the nervous system to endocrine system
- ❑ It receives and process signals form other brain regions and translates them into hormones
- ❑ These hormones flow to the **pituitary gland** by the infundibulum
- ✓ Some hormones are stored in the **posterior pituitary** for later use
- ▪ These are **oxytocin** and **ADH**(antidiuretic hormone)
- ✓ Some hormones activate **the anterior pituitary** to release its own hormones
- ▪ These are called releasing hormones
- ✓ Some hormones inhibit the **anterior pituitary** and prevent the release of anterior pituitary hormones
- ▪ These are called inhibiting hormones

Pituitary gland

- ❑ Pituitary is about the size of a pea and found in the brain
- ❑ Because of its location in the brain it is involved in the coordination between the nervous and hormonal system
- ❑ Is sometimes described as the **'master gland'**, because hormones released from pituitary controls the secretion of hormones from other

- Pituitary is divided in to two lobes: **Anterior lobe** and **Posterior lobe**
- ✓ Anterior lobe is 3 times larger than the posterior lobe

Anterior lobe

- Also known as adenohypophysis
- Anterior lobe makes 6 peptide hormones whose secretion is regulated by hypothalamus
- Hypothalamus makes releasing hormones which encourage secretion of anterior pituitary hormones

Hypothalamus also makes inhibiting hormones that slows secretion of anterior pituitary hormones

- The hormones of anterior pituitary play major role in the control of metabolic function through out the body
- Anterior pituitary hormones include **GH**, **ACTH**, **TSH**, **Prolactine** and **gonadotropins**(**FSH** & **LH**)

Growth hormone (GH)

- Promotes the growth of the entire body by affecting:
- ✓ Protein formation
- ✓ Cell multiplication
- ✓ Cell differentiation
- Its quantity is greatest during childhood and adolescence when most body growth occurs
- **Pituitary dwarfism** – small stature
- ✓ Occurs if little GH is produced during childhood
- **Gigantism** – excessive growth and height
- ✓ Occurs if too much GH is produced during childhood
- ✓ Individuals with gigantism often have diabetic mellitus ,because GH has secondary effect on blood glucose level
- **Acromegaly**
- ✓ Occurs if GH is overproduced in adult
- ✓ Only face , feel and face becomes large because these portions of the body can respond to GH , but large bones are not responsive to GH in adults

Adrenocorticotropic hormone (ACTH) – Corticotropin

- Control the secretion of some of the adrenocortical hormones which affect metabolism of glucose , protein and fat
- So ACTH acts on adrenal glands

Thyroid stimulating hormone(TSH) – thyrotropin

- Control the secretion rate of thyroxine and triiodothyronine from thyroid glands
- Thyroid hormones control the rate of most intracellular chemical reactions in the body
- So TSH acts on the thyroid glands

Prolactin

- Stimulates milk production in women's breast after she gives birth
- So prolactin acts on mammary glands of breast

Gonadotropins- FSH & LH – follicle stimulating hormone and luteinizing hormone

- Control growth of ovaries and testes as well as reproductive activities

Question: Which of the following endocrine gland secretes a hormone that directly affects the metabolic rate of the body? Text new

A. Pituitary gland B. Ovary C. Thyroid D. Pancreas

Question: Which of the following reproductive hormone is produced by the pituitary gland?

A. Estrogen B. Testosterone C. Follicle stimulating hormone D. Progesterone

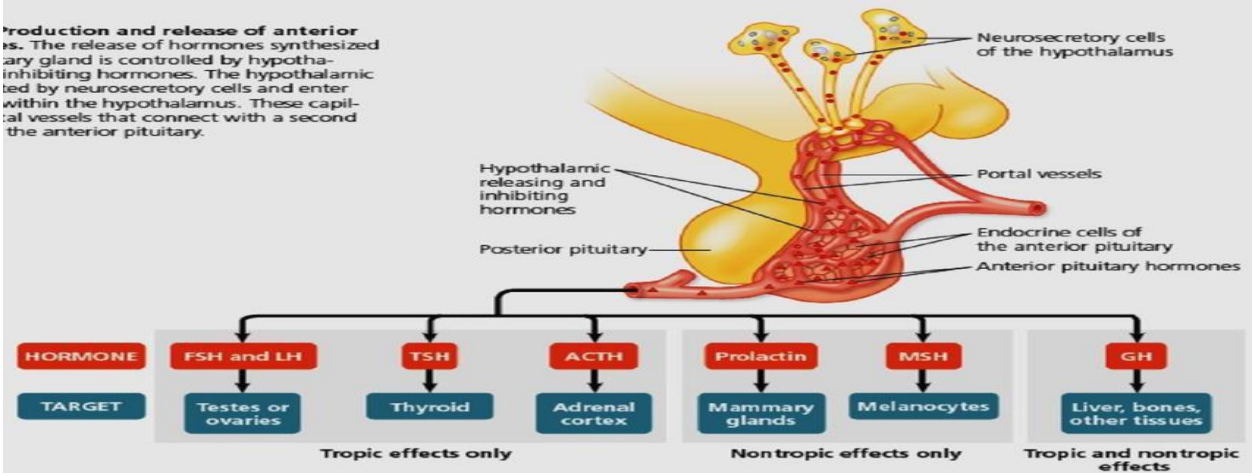


Figure 5.37 hormones secreted by anterior pituitary gland

Posterior pituitary

- ❑ Stores hormones which are produced by hypothalamus & releases when needed
- ✓ These hormones are **Antidiuretic hormone(ADH)** and **oxytocin**

ADH – also called vasopressin

- ❑ Controls the rate of water excretion in the urine
- ❑ It helps the control of water concentration in the body fluid
- ❑ When the amount of water in the body decreases ADH causes the water to be reabsorbed back from kidney tubules to blood

Oxytocin

- ✓ Helps express(eject) milk from glands of breast to nipples
- ✓ Also helps the delivery of baby by the end of gestation

Thyroid gland – thyros =‘butterfly ‘

- ❑ Is a small butterfly shaped gland located inferior to larynx (voice box) attached to trachea
- ❑ It is subdivided into two lateral lobes
- ❑ It produces **thyroid hormones** (**T3**, **T4**) and **calcitonin**

Calcitonin

- ❑ lowers blood calcium and phosphate
- ❑ Both hypo and hypersecretion of calcitonin affects normal balance of calcium and phosphate

Thyroid hormones(T3, T4)

- ❑ Thyroid follicles produce thyroglobulin(TGB) by utilizing iodine
- ❑ TBG is then stored in the colloid
- ❑ When stimulated by TSH, thyroid follicles convert TGB into thyroid hormones
- ❑ Thyroid hormones are thyroxine(T3) & triiodothyronine(T4)
- ❑ This hormones promote normal metabolism and control the rate of most intracellular chemical reactions

Malfunctions of thyroid gland

- ❑ Hypo secretion of thyroid hormone causes hypothyroidism which results in **goiter, cretinism and myxedema**
- ❑ Hypothyroidism in childhood and infancy can cause cretinism

Cretinism

- ❑ Condition characterized by retarded mental & physical development
- ✓ When diagnosed early it can be treated with thyroid hormone & prevented

- ✓ Adults suffering from hypothyroidism shows the following signs
  - Feels like sleeping all the time
  - Has little energy
  - Is mentally slow and confused

Goiter: is an enlargement of thyroid gland

- ✓ It can be caused by hypothyroidism
- ✓ Decreased level of iodine in the body caused hypothyroidism ,because thyroid hormones are made from iodine

✓ Decreased T3 & T4 causes the pituitary to release high amount of TSH
✓ High level TSH stimulates thyroid gland whose cells enlarge to produce more thyroid hormone.
✓ Without iodine the gland keeps getting bigger and bigger
✓ Hyper secretion of thyroid hormone causes hyperthyroidism which results in **graves' disease**

Parathyroid glands

- ❑ Are four oval shaped glands at the back of thyroid gland
- ❑ They secrete PTH which controls the calcium level in the blood stream
- ❑ PTH acts on the kidney, intestine and bones to increase calcium level in the blood

How?

✓ In kidney –PTH stimulates calcium reabsorption from filtrate into blood and causes vit –D activation which promotes calcium absorption from intestines
✓ In bone – PTH causes calcium release into blood
✓ In intestines – active vit-D increase calcium absorption from food into bloodstream

- All the above activities causes calcium level in the blood to increase
- Calcium is important the body especially for muscle and nerve

- ❑ **Hypo secretion** of PTH causes **tetany**: involuntary muscle contraction
- ❑ **Hypersecretion** of PTH causes **osteitis fibrosa cystica (Muscle disorder)**

Adrenal glands

- ❑ Also called suprarenal glands
- ❑ Are triangular shapes glands located on top o each kidney
- ❑ Are composed of two parts : cortex and medulla

Adrenal cortex

- ❑ is the outer portion of the adrenal gland
- ❑ Is divided in two three regions from outside to inside zona glomerulosa, zona fasciculate and zona reticularis
- ❑ Adrenal cortex produces steroid hormones crucial for normal homeostasis

Adrenal medulla

- ❑ Is the outer portion of the adrenal gland
- ❑ Is made up of modified nerve cells (Chromaffin cells) which produce epinephrine (adrenalin) and norepinephrine (noradrenalin)
- ❑ Adrenalin is fight or flight hormone
- ❑ If you are stressed , angry ,exited or frightened adrenal glands release adrenalin which causes pupil dilation, increased heart beat(fight or flight action)

Pancreas

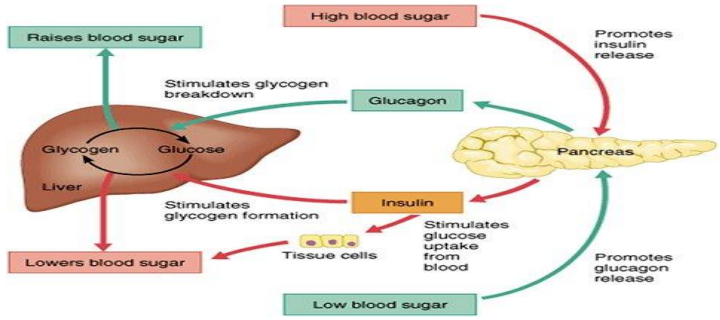
- ❑ Is a small pink organ found bellow the stomach
- ❑ It is both exocrine and endocrine organ

Acini (exocrine aspect)

- ❑ Makes 99% of mass of the gland
- ❑ Release digestive enzymes and fluid in to small intestine through pancreatic duct

Islets of Langerhans (endocrine aspect)

- ❑ makes 1% of mass of the gland
- ❑ Secrete hormones to regulate blood glucose level
- ❑ **Alpha cells** secrete **glucagon** which increases blood glucose level
- ❑ **Beta cells** secrete **insulin** which decreases blood glucose level
- ❑ **Delta cells** release **GHIH (growth hormone inhibiting hormone) (somatostation)** which inhibits glucagon release



- ✓ Insulin decrease blood glucose level when its concentration increases above normal. It does this by:
  - ✓ Increasing the conversion of glucose in to glycogen & deposition in liver and muscle
  - ✓ Increasing rate of conversion of glucose into fat and its deposition in adipose tissue
  - ✓ Also regulate the rate at which amino acids are catabolized into H2O and C2O

Diabetes mellitus

- ❑ A condition characterized by blood sugar level
- ❑ **Type 1 Diabetes -** pancreas can no longer produce insulin
- ✓ Can be caused by autoimmune which targets beta cells of the pancreas
- ❑ **Type 2 Diabetes -** is due to insulin resistance
- ✓ That means the pancreas can synthesize insulin but the target cells do not respond to insulin
- ✓ Can be caused by obesity, overeating and lack of exercise
- ✓ Insulin resistance can be corrected by:
- ✓ Decreasing caloric intake (dietary control)
- ✓ Regular exercise

Glucagon

- ❑ Has opposite effect to insulin. It increase blood glucose level
- ❑ Production and secretion of glucagon are stimulated by:
- ✓ decreased blood glucose concentration
- ✓ Elevated blood level of amino acid
- ✓ Exercise

- ➢ Glucagon is important to maintain normal blood glucose level, especially as the neurons(brain) can only use glucose for fuel
- ➢ Glucagon increases blood glucose level by:
- ✓ stimulating breakdown of glycogen stored in the liver
- ✓ Stimulating gluconeogenesis(creating glucose from non-carbohydrate substance)
- ✓ Enhancing triglyceride breakdown , thus providing fatty acid as a fuel for most cells and sparing glucose for neurons(brain cells)

The Gonads: Ovaries and Testis

- ❑ The gonads are the endocrine glands which produces some of the sex hormones
- ❑ They become active at the time of puberty.

- ❑ During puberty big physical changes takes place, boys and girls look very different (their body takes its adult form)
- ❑ The changes come about in response to hormone released by the brain (FSH, LH) and by the gonads themselves(progesterone, estrogen)

The role of the ovaries

- ❑ Ovaries are two walnut-sized organs found low I the abdomen in either side of the uterus
- ❑ Ovaries produce eggs and hormones.
- ❑ Girls often go into puberty slightly earlier than boys, between the age of **8-14**
- ❑ Puberty in girls controlled by hormones in the ***pituitary*** and from the ***ovaries***
- ❑ ***FSH*** from the brain stimulates the ovaries to become active and start producing hormones

Estrogen

- ❑ The hormones produced by ovaries are:- ***estrogen*** and ***progesterone***
  - ➢ Secreted by the follicle cells of the ovary
  - ➢ Its secretion is stimulated by FSH from anterior pituitary
  - ➢ Promote the maturation of the ovum in the ovarian follicle
  - ➢ Stimulates the growth of blood vessels in the ***endometrium*** (lining) of the uterus in preparation for a possible fertilized egg
- ❑ The 2dry sex chxcs in Women also develop in response to estrogen
- ❑ Female **secondary sexual characteristics** include:
- ❑ growth of the duct system of the mammary glands
- ❑ growth of the uterus
- ❑ the deposition of fat subcutaneously in the hips and thighs

Progesterone

- ❑ Progesterone is secreted by **corpus luteum (**which also secretes estrogen**)**
- ❑ This is stimulated by **LH** from the anterior pituitary
- ❑ mature ovarian follicle becomes **corpus luteum** after it releases the ovum
- ❑ Progesterone promotes:
  - ➢ The storage of glycogen and the further growth of blood vessels in the endometrium, which thus becomes a potential placenta
  - ➢ The development of **secretory cells** of the mammary glands

The role of the testes

- ❑ Testis is the male sex organ (produces sperm) that also serves as an endocrine gland
- ❑ Testes contains **interstitial** cells (or **leydig's cells**) that secrete testosterone which is responsible for development of male secondary sexual characteristics
- ❑ Puberty in boys usually begins somewhere between the ages of 9 and 15 years old
- ❑ **Pituitary gland** produces increasing amounts of **FSH** which stimulates the testes to begin developing and producing the male sex hormone **testosterone**
- ❑ The rising levels of testosterone trigger the many changes which affect the body during puberty, causing the development of the secondary sexual characteristics

Source	Ovaries		Testes
Hormone	Progesterone	Estrogen	Testosterone
Type	Steroid	Steroid	Steroid
Target cells	Uterine lining, hypothalamus, pituitary, other tissues	Uterine lining, hypothalamus, pituitary, other tissues	Sperm-producing cells, hypothalamus, pituitary, other tissues
Major responses	Regulates menstrual cycle, prepares body for pregnancy	Regulates menstrual cycle, maintains secondary sex characteristics in females	Promotes sperm development, maintains secondary sex characteristics in males

Figure 5.47 hormones secreted by ovaries and testes

Pineal gland

- ❑ Pineal gland is pine cone shaped located deep in the cerebrum
- ❑ It secrets **melatonin** to regulate **circadian rhythms**
- ❑ Circadian rhythms are:
- ✓ Body's physiological response to 24 hour day-night cycle
- ✓ Necessary to keep track of day or night cycles, sleep/wake rhythm, menstrual and ovarian cycles
- ✓ driven by an internal (endogenous) circadian clock, although they can be modulated by external factors
- ❑ Melatonin secretion is suppressed by bright light (principally blue wavelengths) and hence its level increase during night
- ❑ Melatonin promotes sleep in humans
- ❑ During sleep necessary physiological changes occur in body temperature, brain wave activity and hormonal production

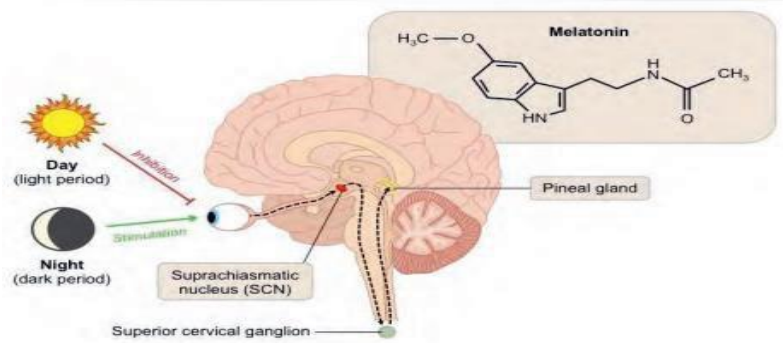


Figure 5.49 Pineal gland

Thymus gland

- ❑ Thymus gland is a diminishing gland (over time) located between the lungs
- ❑ It secretes a group of hormones, such as **thymosin**, to affect the production and maturation of lymphocytes in body defenses

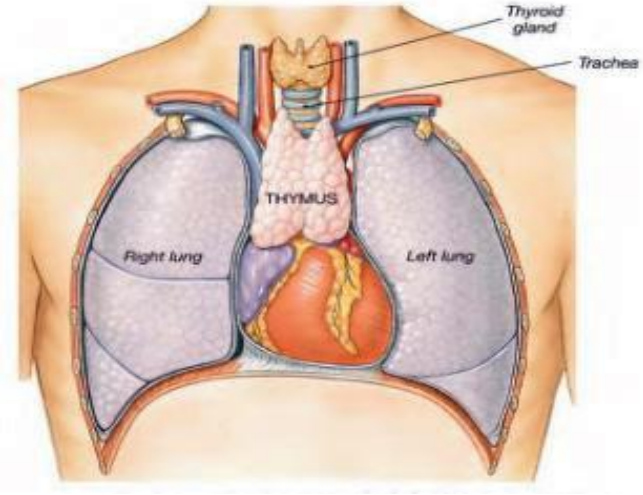


Figure 5.50 Thymus gland

Homeostasis in the human body

The structure and function of the human kidney

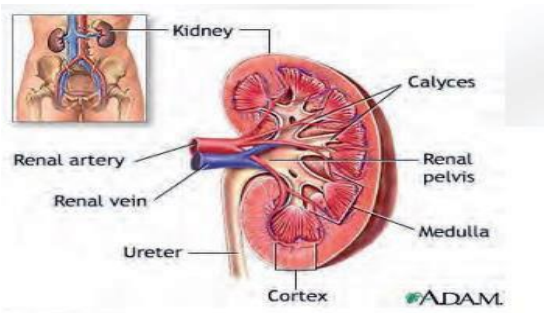
- ❑ **Kidneys:** pair of bean-shaped organs just above the waist
- ❑ Are important organs in the body and have the following functions
- ✓ Filtering blood and producing urine
- ✓ Reabsorbing mineral ions
- ✓ Producing hormones – ex. erythropoietin
- ❑ The kidney has three regions

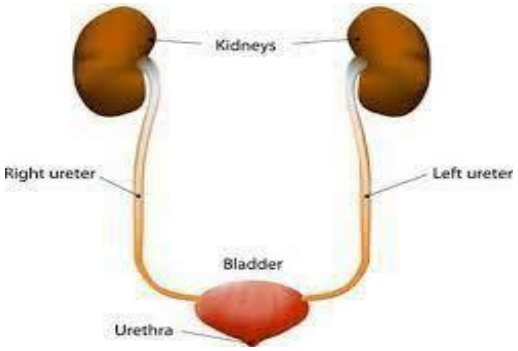
I) Cortex – outer part

II) Medulla – in the middle

III) Renal pelvis – expanded end of the ureter

- ➢ Collects the urine and leads to the ureter on the outside of the kidney
- ➢ **Ureters** – are urine bearing tubes that exit the kidney and empty into the urinary bladder

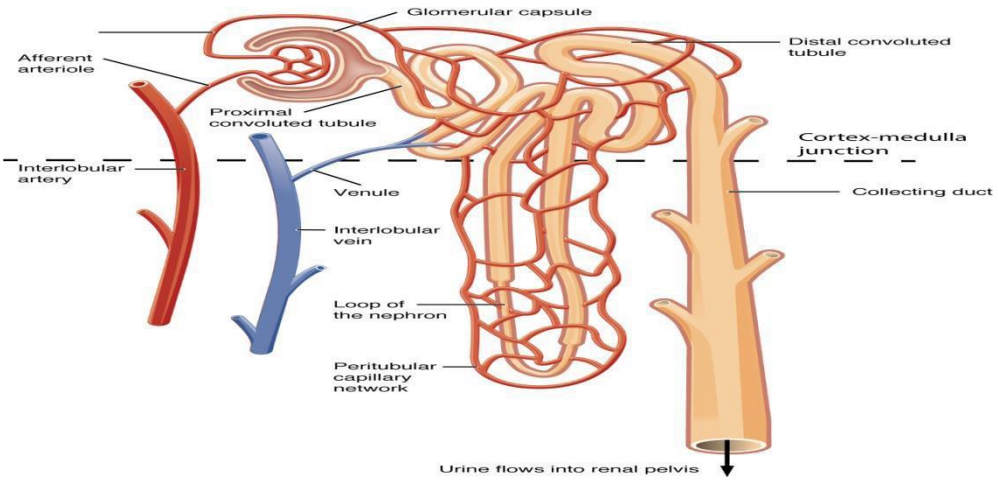




- ❑ Blood flows into the kidney through **renal artery** and then get filtered
- ❑ So fluid containing water, salt, urea, glucose and many other substances is forced out in to the nephron tubule
- ✓ Then evert thing the body needs is taken back, including
- ✓ Water, all sugar, all amino acids and mineral ions needed by the body
- ✓ The amount of water reabsorbed depends on the need of the body
- ✓ The waste product (urea), excess ions and unwanted water of the body are lost as urine

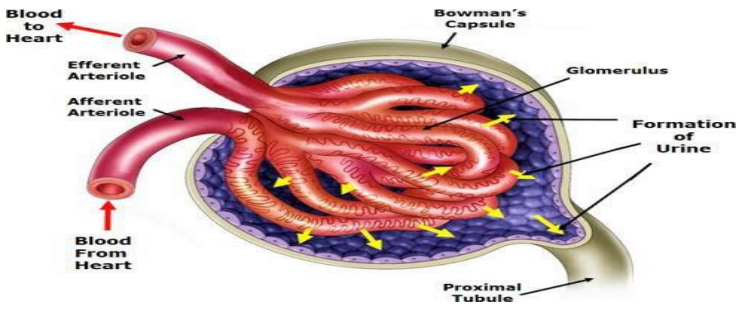
Parts of a nephron and their functions

- ❑ **Nephron**-the functional unit of the kidney
- ✓ Are tiny microscopic tubules where all filtration and reabsorption takes place
- ✓ Each kidney is made up of millions of nephrons
- ✓ A nephron has these structures: **bowman's capsule**, **1st coiled tubule**, **loop of Henle**, **2nd coiled tubule** and **collecting duct**



Bowman's capsule - The site of ultrafiltration of the blood

- ❑ **Glomerulus**: is knot of blood vessels (capillaries) in the bowman's capsule
- ✓ Blood in the capillaries is under high pressure, because vessels feeding into capsule are wider than the vessels leaving the capsule
- ✓ Wall of the blood capillaries and wall of the capsule have small gaps which acts as filter
- ✓ Blood cells and large blood proteins can't leave the blood vessels, because they are too big to fit through the gaps
- ✓ Whereas Water, glucose, amino acid, urea, and many other substances are forced out into the 1st coiled tubule



First coiled (convoluted) tubule

Glomerular filtrate = a fluid which enters the first coiled tubule

- ✓ 1st tubule is where much of reabsorption takes place
- ✓ It has many microvilli to increase the surface area for reabsorption
- ✓ Reabsorption= movement of substances from nephron tubules to the blood
- ✓ All glucose ,67% of sodium ion and 80% of water in the glomerular filtrate are taken back to the blood in 1st tubule

Loop of Henle

- ✓ Part of the nephron where urine is concentrated and more water is conserved

2nd coiled (convoluted)tubule

- ❑ Is a place where main water balancing is done
- ❑ If the body is short of water, more is reabsorbed into blood under the influence of ADH
- ✓ ADH = antidiuretic hormone
- ✓ Diuresis means passing urine and antidiuretic means reducing urine flow
- ❑ Ammonium ions and some drugs are secreted into the 2nd tubules
- ✓ Secretion = movement of substances from blood to nephron tubules
- ❑ By the end of 2nd coiled tubule all salt needed by the body has been reabsorbed and the excess is lost with most of the urea

Collecting duct

- ❑ Is part of nephron where urine is collected
- ❑ Contains 1% of the original water with no glucose at all
- ❑ If the body badly needs more water , it can be reabsorbed from collecting duct under the influence of ADH
- ❑ The amount of salt in the urine will depend on the amount of salt consumed .if you consume more you will lose more in the urine
- ❑ Urine is constantly formed in the kidney and drips down through ureters in to the bladder
- ➢ **Bladder**:- muscular sac which can hold between 600 – 800 ml. we usually empty it when it contains only 150-300ml
- ➢ The amount of water lost in the urine is controlled by negative feed back mechanism which involves the hormone ADH
- ➢ If water concentration of urine becomes too low (i.e. high blood salt concentration)
- ➢ Osmoreceptors in the brain detect this change and stimulate the pituitary to release ADH
- ➢ ADH makes 2nd coiled tube more permeable to water.as a result more water is reabsorbed back to the blood

This means:-

- ✓ Less water is left in the kidney(tubules) and concentrated urine is formed
- ✓ Amount water in the blood increases and concentration of salt in the blood returns to normal (decreases)
- ✓ If water concentration of blood becomes too high (i.e. Decreased blood salt concentration)
- ▪ Pituitary releases less ADH and kidney reabsorbs less water back to the blood

This means:-

- ✓ More water is lost from the kidney and large volume f dilute urine is formed
- ✓ Amount of water in the decreases and concentration salt in the blood returns to normal (increases)

Note: if water concentration of blood fall, high amount of ADH is released and if water concentration of blood rises, less ADH is released

- ❖ Kidney filters **180 L** of blood per day but only about **1.5 L** is lost as urine. So more than 99% of filtered liquid is returned to the blood

Question: Which of the following areas is NOT part of the nephron (kidney tubule)?

A. Bowman's capsule
B. Urinary bladder
C. Loop of Henle
D. First coiled tubule

Question: What will happen if water content of the blood is too high? EUEE 2014

A. The second tubule of the kidney becomes more permeable
B. Antidiuretic hormone secretion decreases
C. Osmoreceptors stimulate pituitary to release ADH
D. The kidney reabsorbs more water back into the blood

Question: Which of the following sentence is correctly matched with the function kidney structures? 2015 EUEE

A. Bowman's capsule – acts as filter to produce urine
B. Cortex – monitors the osmotic pressure of the blood
C. Glomerulus- concentrates urine and conserves water
D. Loop of Henle – involved in ultrafiltration

Question: Which of the following statements is true about ADH? EUEE

A. ADH is a hormone produced in the brain which affects the second coiled tubules of the kidneys, making them more permeable so more water is reabsorbed back into the blood and little, concentrated urine is formed.
B. A DH is a hormone produced in the brain which affects the first coiled tubules of the kidneys, making them more permeable so more water is reabsorbed back into the blood.
C. ADH is a hormone produced in the kidney which affects the coiled tubules of the kidneys, making them more permeable so more water is reabsorbed back into the blood.
D. ADH is a hormone produced in the brain which affects the second coiled tubules of the kidneys, making them less permeable so less water is reabsorbed back

Thermoregulation

Internal (core) body temperature

- ✓ is the temperature deep inside the body
- ✓ Internal (core) body temperature must be kept stable
- ✓ wherever we go and whatever we do our core body temperature is maintained at the temperature (around 37 °C) at which our enzymes work best.
- ❑ It is not the temperature **at the surface** of an organism which matters as the skin temperature can vary enormously without causing harm
- ❑ **Homeotherms** –organisms with constant internal body temperature
- ❑ the body temperature is controlled by a number of physiological and behavioral mechanisms which work together to allow gain or lose of heat

Osmoregulation

- ✓ The balance of water and salts in the body is very important because the concentration of the body fluids changes, water will move into or out of the cells by osmosis and they could be damaged or destroyed
- ❑ **Osmoregulation:** controlling water and salt balance of the body
- ✓ Water and ion(salt) balance is maintained by the **kidney** we gain water when we drink and eat
- ✓ We lose water when we breathe out (water evaporates into the air in the lungs and is breathed out)

we exercise or get hot(we sweat and lose more water)

- ✓ If we are short of water we produce very little urine and most water is saved for use in the body
- ✓ if we have too much water then our kidneys produce lots of urine to get rid of the excess
- ✓ We take in mineral ions with our food. Some are lost via our skin when we sweat excess mineral ions are removed by the kidneys and lost in the urine.

Chemical regulation

- ✓ **Liver** is the largest individual organ in the body that makes up around 5% of the body mass
- ✓ The liver cells are very active in carrying out a wide range of functions, many of which help to maintain a constant internal environment.
- ❑ The liver has a very special blood supply in addition to the usual artery and vein (hepatic artery and vein)
- ❑ **Hepatic portal vein:-** comes to the liver directly from the gut and brings the products of digestion to the liver to be dealt with
- ❑ ***Liver plays a part in all of the following functions:***
- ✓ It controls the sugar levels in the body (through stored glycogen in the liver itself)
- ✓ It controls and balances the fats that you eat and the cholesterol levels in the blood
- ✓ It carries out the breakdown of worn-out red blood cells - in particular the red pigment hemoglobin
- ✓ it is vital organ for the formation of **bile**
- ✓ It is used to control temperature.
- ✓ It controls toxins. The liver breaks down most of the poisons you take into the body, including alcohol.
- ✓ This is why the liver is so often damaged when people drink heavily.
- ✓ It is an important organ where protein metabolism takes place
- ✓ If you eat more carbohydrate or fat than you need in the diet the body simply stores the excess energy as fat
- ✓ If you eat too much protein the body cannot store the excess amino acids or simply convert protein to fat
- ✓ Instead the amino acids are broken down in the liver by deamination

Deamination:- the process of removing the amino group from amino acids

- ✓ The removed amino group is converted to ammonia and then urea
- ✓ The rest of the amino acid can be used in cellular respiration or converted to fat for storage
- ✓ The regulation of tissue oxygenation is another typical example for chemical regulation in the body
- ✓ The respiratory chemoreceptors work by sensing the pH levels of their environment through the concentration of hydrogen ions
- ✓ Most carbon dioxide is converted to carbonic acid in the bloodstream and chemoreceptors are able to use blood pH as a way to measure the carbon dioxide levels of the bloodstream
- ✓ The main chemoreceptors involved in respiratory feedback are:

1. **Central chemoreceptors**: are located in the brain and detect changes in PH of spinal fluid
2. **Peripheral chemoreceptors**: These include

- ✓ **aortic body**-detects changes in blood oxygen and carbon dioxide, but not in the pH
- ✓ **carotid body**-detects changes in blood oxygen, carbon dioxide and pH changes in the levels of O_2, CO_2 and H^+ in the blood cause compensatory changes in the level of ventilation.

Question: Which of the following is not an example of homeostasis? EUEE

A. control of the blood sugar levels
B. control of the body temperature
C. control of the water content of the blood
D. control of the length of the limb