Chap 14

Homeostasis:

Meaning: # The maintenance of constant internal environment

To keep within optimum value.

it fluctuates within narrow limits around the set-point.

Importance:

=) Low Temperature:
- Slowed metabolism
- enzymes are less active.

=) High Temperature:
- Enzyme denatured.

=) Low water potential: water leaving cells so cells shrink. (osmosis)

=) High water potential: water enters cells so cell burst.

Blood Glucose :

1) Low glucose. ——— 1) Slows down or stop respiration

2) High " ——— cell shrink by osmosis

Control of pH important.

Principle of Homeostasis

Temperature change Principle:

⇒ Hypothalumus is a receptor in brain that detects the change in blood temperature.

⇒ receptor sends impulse/action potential to effector.

⇒ Effector carries out response:
↳ found on skin, lower body temp by secreting sweat..

⇒ Blood temperature returns to normal

⇒ negative feedback.

Principle of homeostasis:

⇒ Homeostasis is the maintenance of constant internal environment

⇒ Irrespective of changes in external environment

⇒ Most mechanism depends on negative feedback.

⇒ It involves receptor that detects the change in parameter. (stimuli)

⇒ Actions are taken by effector: (response)

⇒ ~~Rect~~Restoration to the norm or set-point.

⇒ The parameter fluctuates around the set-point.

⇒ Example: glucose / water / temp...

⇒ The infor. transferred by coordination system (nervous + endocrine)

Receptor → detects external or internal stimuli.

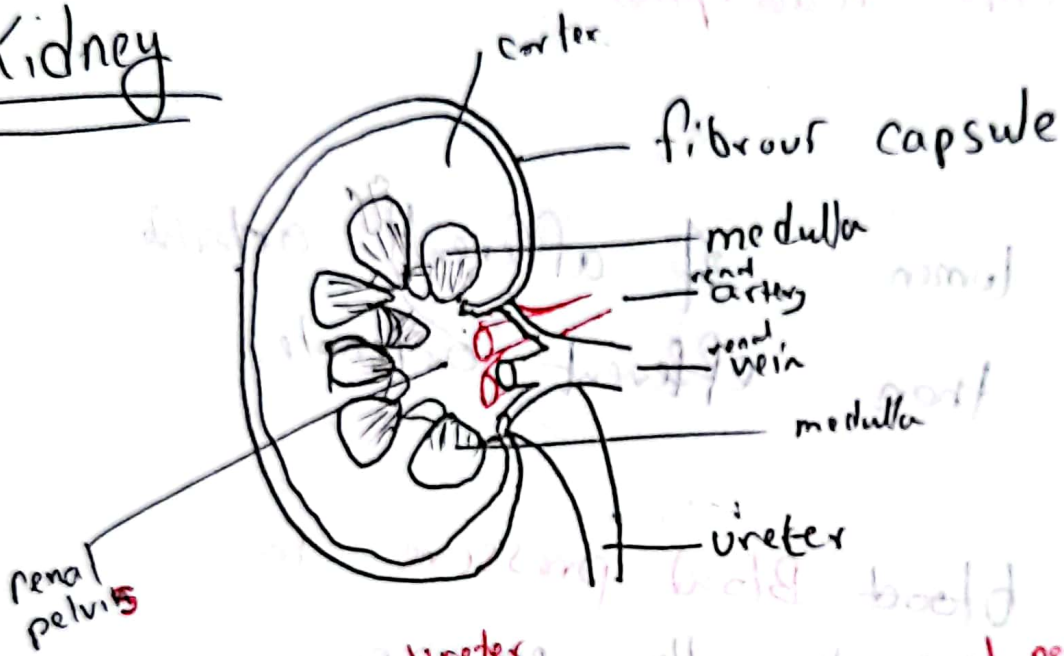
Effector → muscles or glands

coordination system: endocrine & nervous system

Negative feed back.

Urea is produced in the liver from the deamination of excess amino acids.

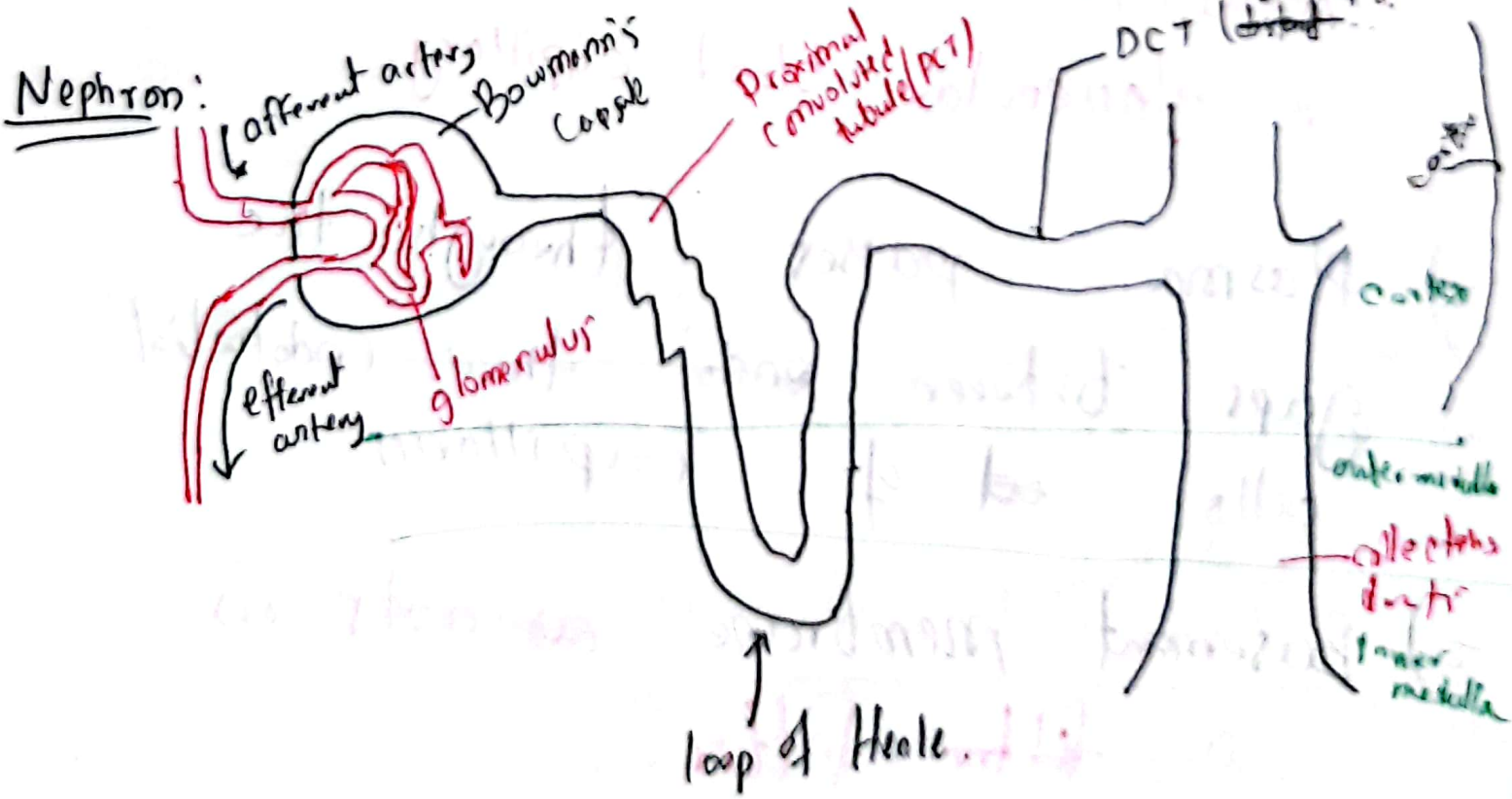
Kidney



Ureter ~~Ureter~~ ~~join~~ joins in renal pelvis
↳ carries urine from kidney to bladder

Kidney made up of nephrons and many blood vessels

Nephron:



kidney make urine in two stages:

(i) Ultrafilfration

(ii) Selective reabsorption.

Ultrafilfration

=) Diameter of lumen of afferent arteriole is wider than efferent arteriole.

=) ~~The~~ due high ~~blood~~ Blood pressure in renal artery and capillary pressure.

=) Leads to high blood or hydrostatic pressure in glomerular blood capillary.

=) Plasma passes through the gaps between ~~endo thea~~ endothelial cells ~~of~~ of capillaries.

=) Basement membrane ~~act~~ acts as a ~~filtra~~ filter.

=) Red blood cells or large plasma proteins cannot passt through poras ~~to~~ of basemant membrane as they are too large.

=) fluids can pass through podocytes as they have projections, with gaps between them.

=) Glomerulur blood capillary has high blood pressure, but high concen. of solutes ~~that~~ than glomerulus, filtrate in Bowmann's ~~Capsulus~~ capsule, that lowers up. in blood ca--

=) Overall, the effect of differences in pressure ~~of~~ outweighr the effect of difference in solute, so water move down to up gradient into the glomerular filtrate

Why urea concn. higher in Urine than filtrate?

=) More urea in urine than filtrate.

=) Water is ~~reab~~ reabsorbed.

=) other substances reabsorbed.

=) from the collecting duct and DCT / PCT

=) most urea stays in urine.

How Proximal Convoluted tubule is adapted?

=) Microvilli: has large surface area; for increased reabsorption of Na+, glucose, amino acids

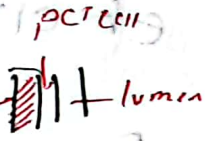
=) Many mitochondria: Provide ATP for sodium-potassium pump in the basal membranes / active transport.

Tight junction: hold adjacent cells together to prevent leakage and fluid cannot pass between cells.

many transport proteins for movement of glucose or amino acid.

aquaporins

folded basal membrane.



Reabsorption process in the PCT:

Selective reabsorption

=) PCT cells have microvilli that increase surface area.

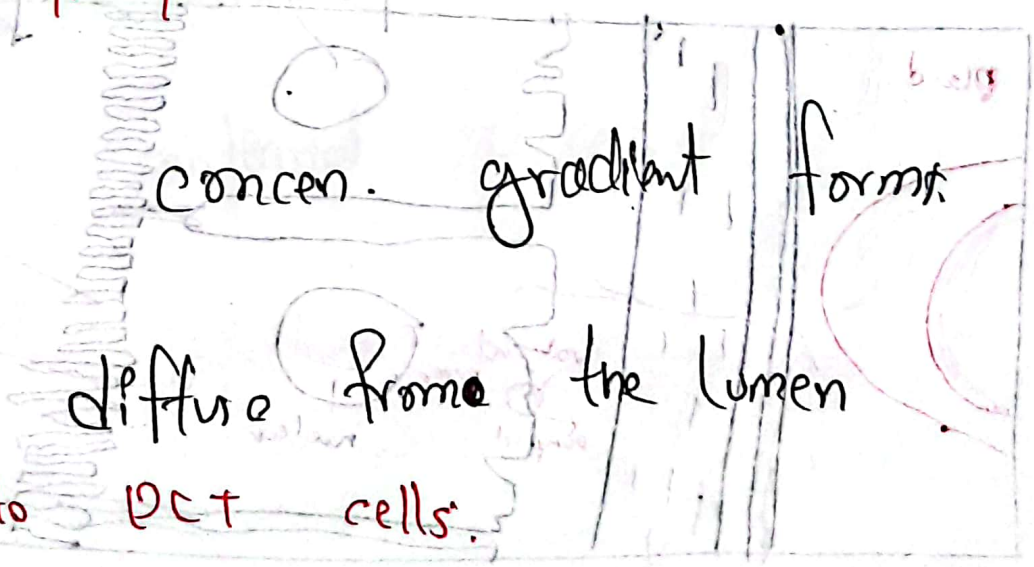
=) PCT cells have many mitochondria.

=) Na^+ ions leave PCT cells into ~~blood~~ blood.

=) by active transport.

=) Na^+ ions concen. gradient forms.

=) Na^+ ions diffuse from the lumen or filtrate into PCT cells.



=) through carrier proteins (facilitated diffusion)

=) Na+ cotransport glucose, amino acids, vitamins, ~~eth~~ Cl- ions, into PCT cells ~~into~~.
(indirect active transport)

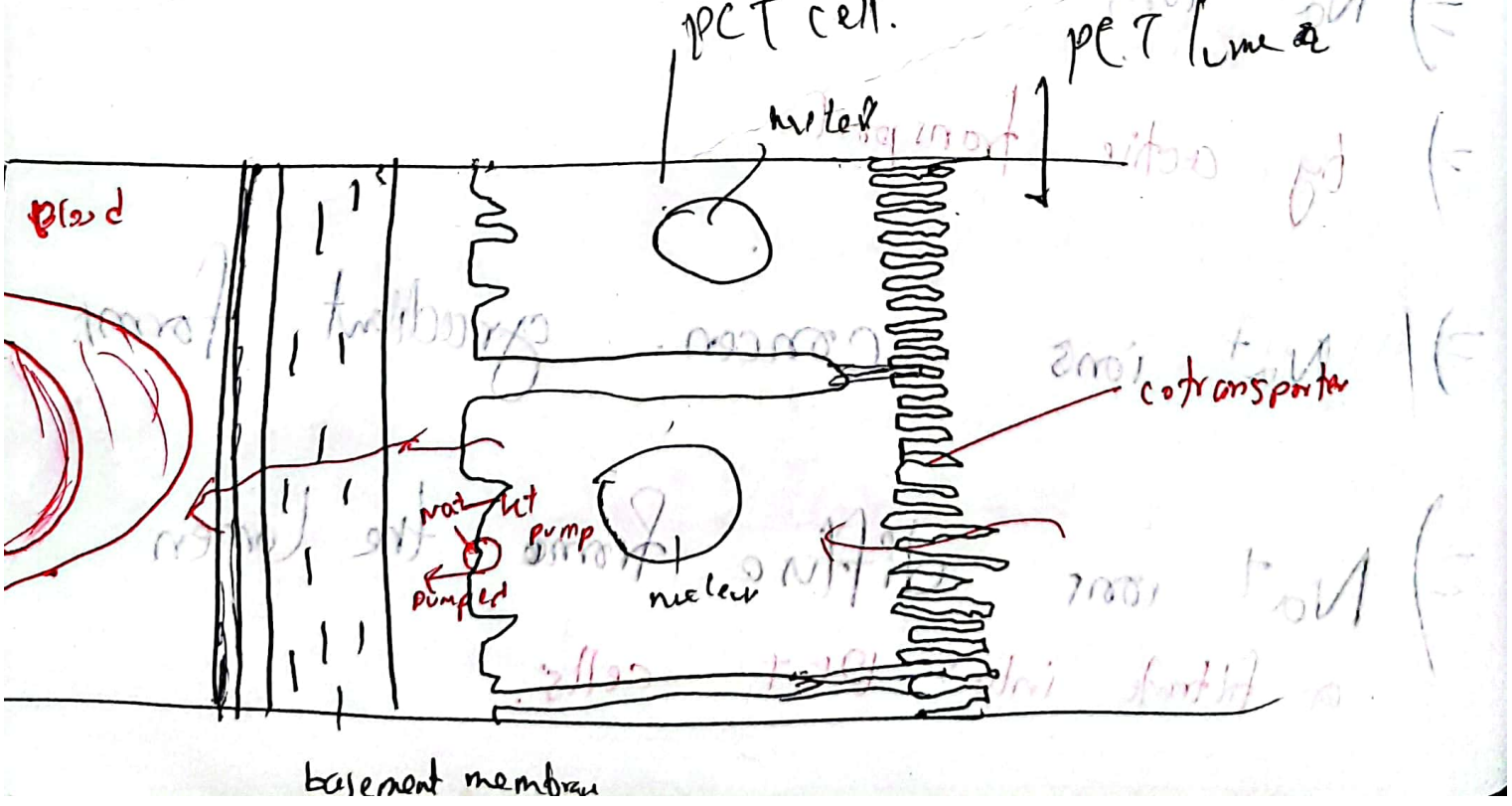
2) from PCT cells to intercellular fluid.

=) then facilitated diffusion into blood.

=) normally all glucose reabsorbed.

=) Some water reabsorbed also.

also urea



Osmoregulation : Control of water

Water potential : tendency of water molecules to move from one region to another.

=) Sensory ~~neurones~~ neurones (osmoreceptor) in the hypothalamus detect the water potential in the blood.

=) Posterior pituitary gland releaser ADH hormones.

ADH = Antidiuretic hormone

Role of hypothalamus & Pituitary gland

=) Hypothalmus detects water potential in Blood.

=) using osmoreceptor.

=) if water potential decreases

=) ADH is produced.

=) Nerve impulses are sent along the neurones ~~(neurose)~~.

) which extend into posterior pituitary gland.

) ADH released from posterior pituitary gland.

enters blood steam and affects kidney.

=) negative feedback.

Role of ADH

=) Affects collecting ducts cells.

=) Binds to receptors on cell surface membranes.

=) increase ~~the~~ membrane permeability to water ~~and~~ by move water channel.

=) Activates a series of enzyme-controlled reactions.

=) ending with the production of ~~act~~ active phosphorylase enzyme.

=) which causes vesicles with aquaporins (water channels)

=) to move to and fuse with plasma membrane.

⇒ more water flows out of collecting duct. down the conc grad → into the blood.

⇒ Urine is more concen and reset the feedback.

Controlling Blood Glucose

⇒ ~~islet~~ islet of Langerhans

⇒ Scatted throughout the pancrease

⇒ contain: α cell & β cell

⇒ α-cells secrete glucagon

⇒ β-cells " insulin.

⇒ Blood carries away the hormone

Blood Glucose increased

=) Homeostasis the maintenance ...

=) irrespective to ....

=) The Stimuli is increased blood glucose concen.

=) Detects by B cells and α cells in islet of Langerhans pancreas

=) Insulin is released by β-cells; α-cells stop glycogen secretion.

=) Response: Insulin binds to specific receptor (effector) on the cell surface membrane (of muscle cell or liver cell)

=) Vesicles with GLUT4 proteins are moved to cell surface membrane and fuse with it.

So ~~facilate~~ facilitate the movement of glucose, so increased uptake of glucose.

=) insulin stimulates the activation of enzyme glucokinase and phosphofructokinase.

=) Glucokinase traps glucose inside the cell, so cannot pass out.

=) Glycogenesis increased
Glucose ⟶ glycogen.

=) increased use of glucose in respiration.

In diabetes,
WP decreases as Blood glucose increases, detected by osmoreceptor so feel thirst.

Blood Glucose concen. decreased

=) Hom...
=) 2 nek...
2) ne...
} Principle of homeostasis.

=) Stimuli is the glucose concen. decreased

=) Receptor: α and β cell in the (...) detect the stimuli

=) α cells secrete glucagon and β cell stop insul... secretion.
(Effector: Liver)

=) rate of uptake of glucose decreased, decreased respiration.

Response:

=) Glucagon binds to a specific receptor on the cell membrane of liver cell.

) Receptor changes conformation.

⇒ G-proteins are activated.

⇒ leading to stimulation of adenyl/ ~~et~~ cyclase enzyme

⇒ formation of the secondary messanger, cyclic Amp ~~cAMI~~ cAMP.

⇒ Activation of protein kinase A by cAMP.

⇒ Leading to the initiation of an enzyme cascade.

⇒ Enzyme cascade causes the amplification of the ~~ori~~ original signal.

=) So activation of more and more glycogen phosphorylase.

=) catalyser the breakdown the glycogen to glucose.

=) Concentration of glucose increase inside cell.

=) Diffusion → from the cell ~~the~~ to blood by ~~GLUT2~~ GLUT2 transporter.

=) ~~Stim~~ Stimulater the ~~conversation~~ conversion of glucose from amino acids, glycerol and lactate.

28.2023 28.2023 6.2023 2023

Measuring glucose concen.

- Glucose oxidase immobilised
- Struck onto pad or dip stick.
- The pad is lowered into blood or urine.

- oxidiser glucose.
- make it gluconic acid
- H_2O_2 produced.
- react to a chromagen on pad.
- produces colour
- Darkness of colour proportional to the concen. of glucose.

- only detects glucose

glucose + Oxygen $\xrightarrow{\text{glucose oxidase}}$ gluconic acid + H_2O_2

H_2O_2 + chromagen (colorless) $\xrightarrow{\text{hydrogen peroxidase}}$ oxidised chromagen (coloured)

Biosensor

=) Pad has glucose oxidase

=) Glucose oxidase enzyme react with glucose in blood.

=) Glucose molecules enter the active site.

=) The enzyme catalyser to produce H_2O_2 and gluconic acid.

=) Oxygen detected

=) electric current generated.

=) detected by electrode, give numerical value of blood glucose concen.

(*) Biosensor give actual and accurate reading

(*) re-usable.

Dipstick : Cheap and easy to use

- Homeostasis in plants

Stomata

Stomata respnd to changer in environment = condition by opening and closing and that regulation of Stomatal aperture balances the need for CO_2 uptake by diffusion with the need to minimise water loss by transpiration.

Stomata ~~has~~ have daily ~~ty~~ rhythm of opening and closing.

Environmental Stimuli causing stomata to open	Stimuli causing stomata to close
increasing high light intensity	Darkness
• Low CO_2 concen. in air space within the leaf.	• high CO_2 with at leaf • low humidity • high temperature so dry condition • ~~St~~ water stress, so supply ↓

water from the roots is limited and high rates of transpiration.

=) Stomata open and close in a daily rhythm
=) Even when plant is kept in constant light or darkness.

=) When stomata closes,
=) reduce transpiration rate
=) so conserve water
=) retains turgidity of cells
=) prevents ~~turgi~~ wilting.

Structure of guard cell

:) Each Stoma is surrounded by two guard cells.

=) Guard cells have the following features:

Thick cell walls facing the air outside the leaf and the stoma.

Thin cell walls facing the adjacent epidermal cells.

Cellulose microfibrils arranged in bands around the cell.

Cell walls have no plasmodesmata.

Cell membrane folded and has many channel and carrier

proteins.

=) Cytoplasm has a thick density of Chloroplast and mitochondria.

=) ~~Chtrop~~ Chloroplast has thylakoids but with few grana.

=) ~~Mito~~ Mitochondria have many cristae.

=) Several small vacuoles rather than one large vacuole

Mechanism to open and close stomata :

Opening

=) proton pump in cell membrane of guard cells

=) pump H^+ ion out of cells by ATP.

=) lower H^+ ion concen. inside cell.

=) inside the cell more negative than outside

=) K^+ channels open

=) K^+ move into cell.

=) by facilitated diffusion down the electrochemical gradient

=) Cl^- and NO_3^- also enter to maintain the electrical balance.

=) Water potential of the cell decreases

=) water moves into cell by osmosis

=) through the aquaporins in the membrane.

=) Volume of guard cells increased

=) Guard cells become turgid

=) and Stoma opens.

Closing

=) the proton pumps in the guard cell membrane stops actively transporting H^+_{ions} out of the guard cell.

=) The K^+ ions leave the guard cells

=) The water potential gradient reversed

=) so water leaves the guard cells by osmosis

=) and guard cells become flaccid; Closing stoma.

Role of abscisic acid :

=) Plant secreter abscisic acid in very dry conditions; at time of water stress.

=) Abscisic acid binds to receptors

=) on cell surface membraner of guard cells.

=) stops proton pump

=) High H^+ ions concen. inside cell.

=) abscisic acid stimulates Ca^{2+} influx. (inflow)

=) Ca^{2+} acts as second messanger

=) activate channel proteins to allow negetively charged

ions to leave the guard cells.

=) encourage K+ efflux

2) ↓ ψp of cell increases

=) water moves out of cell by osmosis

=) ~~of~~ guard cells become flaccid.

2) ~~Stomata~~ Stoma closes.