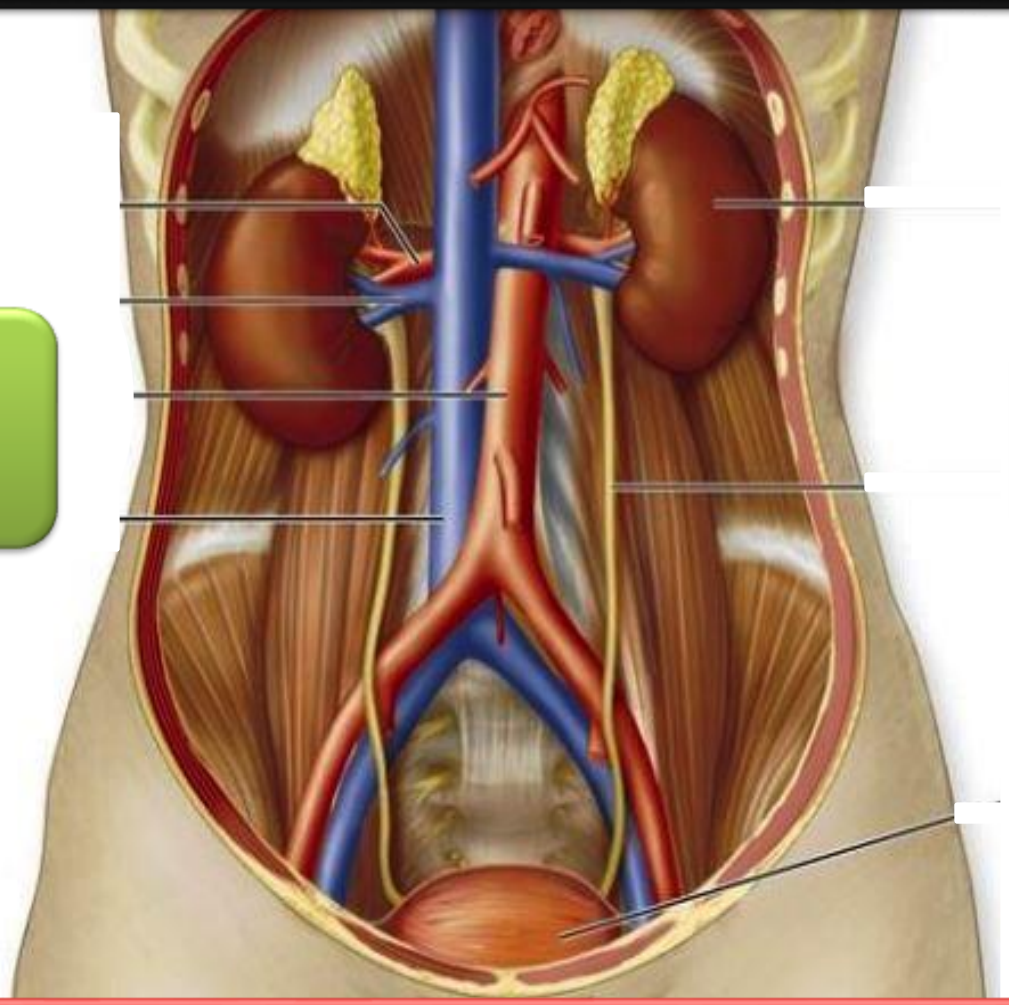
EXCRETORY PHYSIOLOGY

SEM 4

CHAPTER 3



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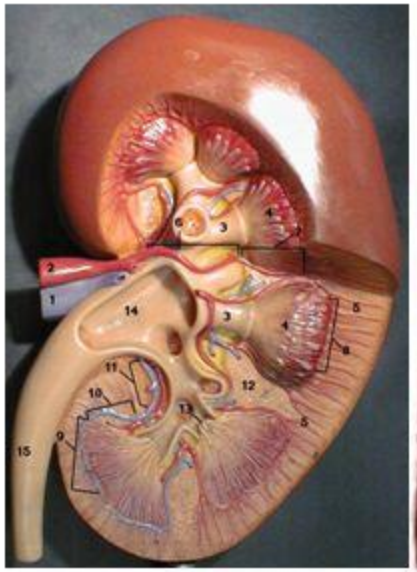
DEPT. OF PHYSIOLOGY

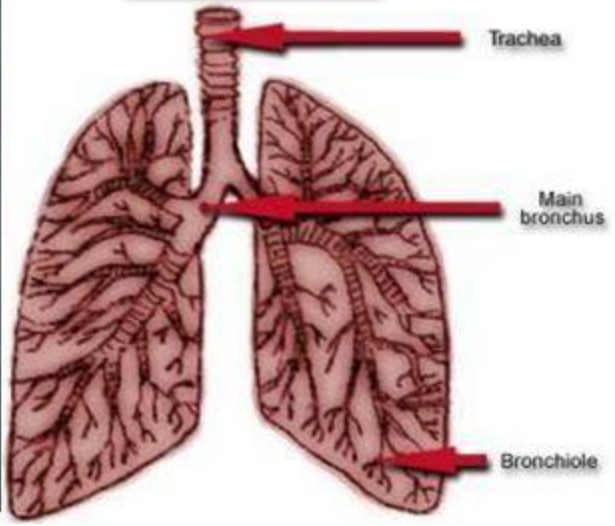
VIJAYGARH JYOTISH RAY COLLEGE

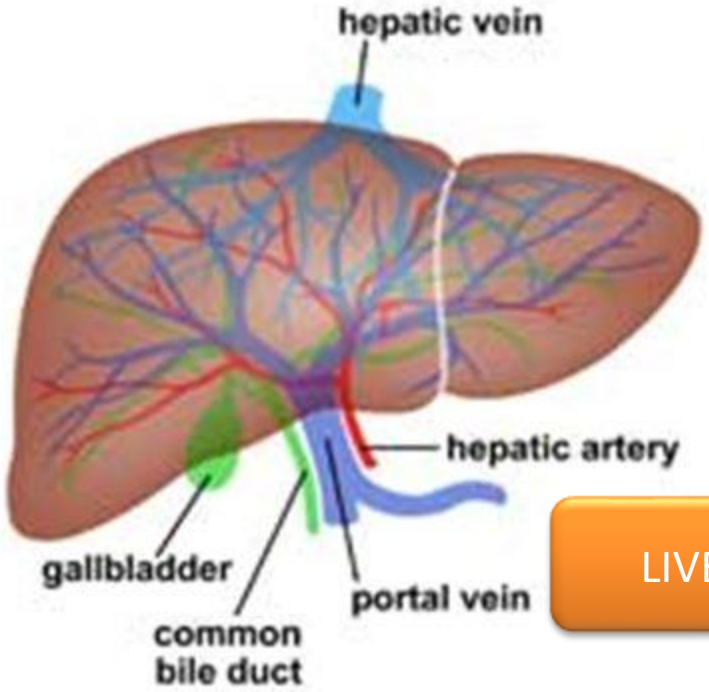
EXCRETORY SYSTEM

KIDNEY



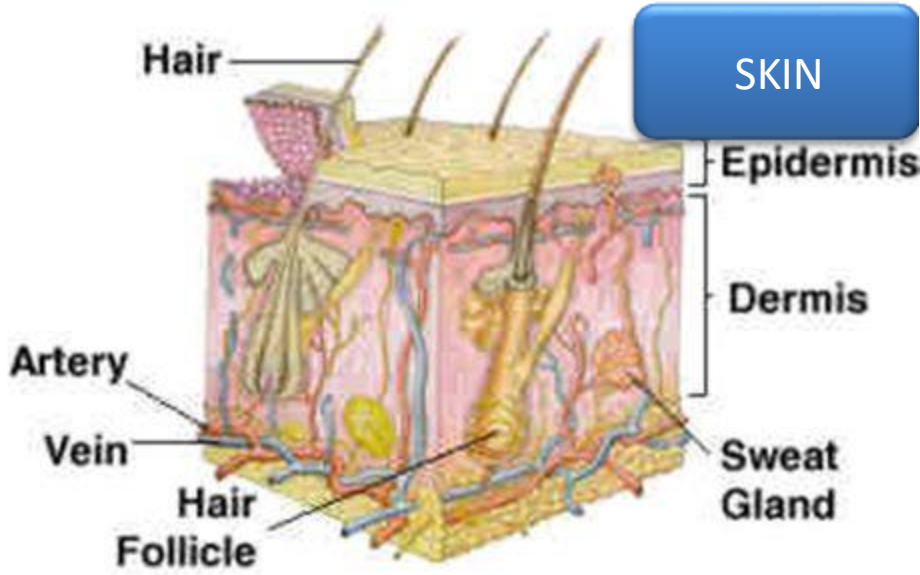
LUNGS





LIVER

SKIN



The biological processes that occur in the bodies of the living organisms are carried out through the chemical reactions that leave some waste products , The living organism must get rid of these waste products as soon as they are formed , otherwise they will cause many problems and infections , this occurs through the process that is called the excretion .

Excretion is the process by which the living organisms get rid of waste products that are produced from the biological processes , The excretion refers only to the materials that leave the body through the plasma membranes.

The important waste products :

Water and CO_2 that are produced from the degeneration of organic molecules .
Nitrogenous waste products (ammonia , urea and uric acid) which result from protein degradation .

There are some materials that are not considered as excretory products, such as :
The undigested food that goes out of the animal body in the form of faeces , because it leaves the body without passing through the plasma membranes .
The nitrogen in the air which enters the lungs in inspiration and leaves them in expiration , because it enters and leaves the body without passing through the plasma membranes .
Functions of the excretory organs in higher animals :
Disposal of damaged and poisonous materials .
Regulation the body content of water and minerals .

Excretion in humans:

The important excretory organs in a human's body are : skin , lungs , kidneys and liver .

➢**The important waste products of human body and the organs that are responsible for their excretion :**

1. The excreted material is carbon dioxide , The excretory organs are lungs .
2. The excreted material is water , The excretory organs are kidneys , skin , lungs .
3. The excreted material are nitrogenous waste products , The excretory organs are kidneys , skin (small percentage) .
4. The excreted materials are salts , The excretory organs are kidneys , skin .
5. The excreted materials are spices , The excretory organs are kidneys , lungs (volatile substances) .
6. The excreted materials are poisonous materials , The excretory organs are kidneys or liver (in which the poisonous materials are transformed into non-poisonous forms in the body or into non-soluble forms) .

Function of the Excretory System

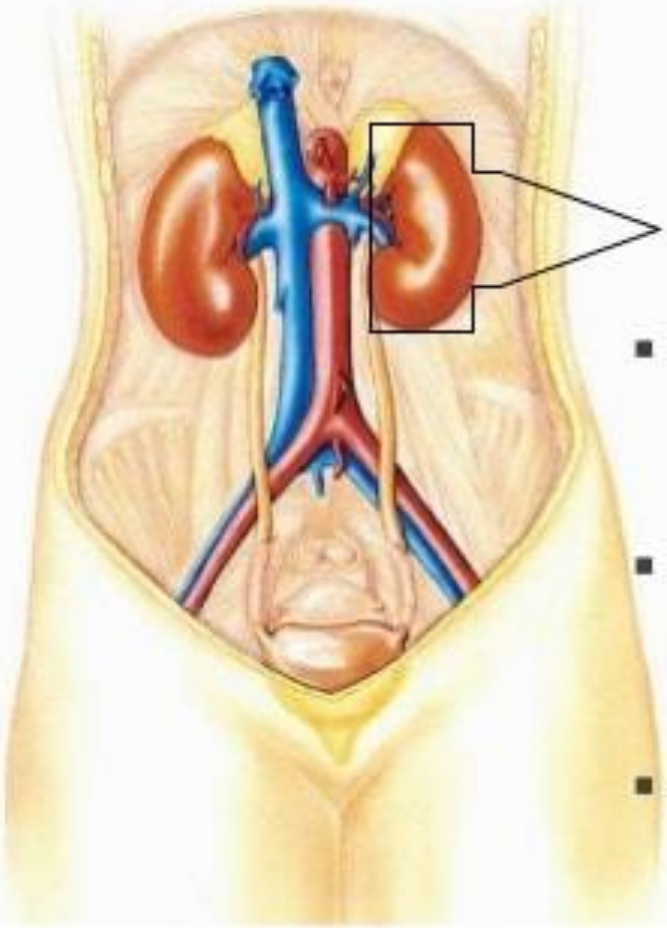
- The human excretory system functions to remove waste from the human body.
- During this process animals get rid of nitrogenous waste products of metabolism, including ammonia, urea, and uric acid.
- Although excretory systems are diverse, nearly all produce urine in a process that involves several steps.

Organs of the Excretory System

Function of the Excretory System

1. Filtration:
   - The excretory tubule collects filtrate from the blood. Water and solutes are forced by blood pressure across the selectively permeable membranes of a cluster of capillaries and into the excretory tubule.
2. Reabsorption:
   - The transport epithelium reclaims valuable substances from the filtrate and returns them.
3. Secretion:
   - Other substances are extracted from body fluids and added to the contents of the excretory tube.
4. Excretion:
   - The filtrate leaves the system and the body.


KIDNEY



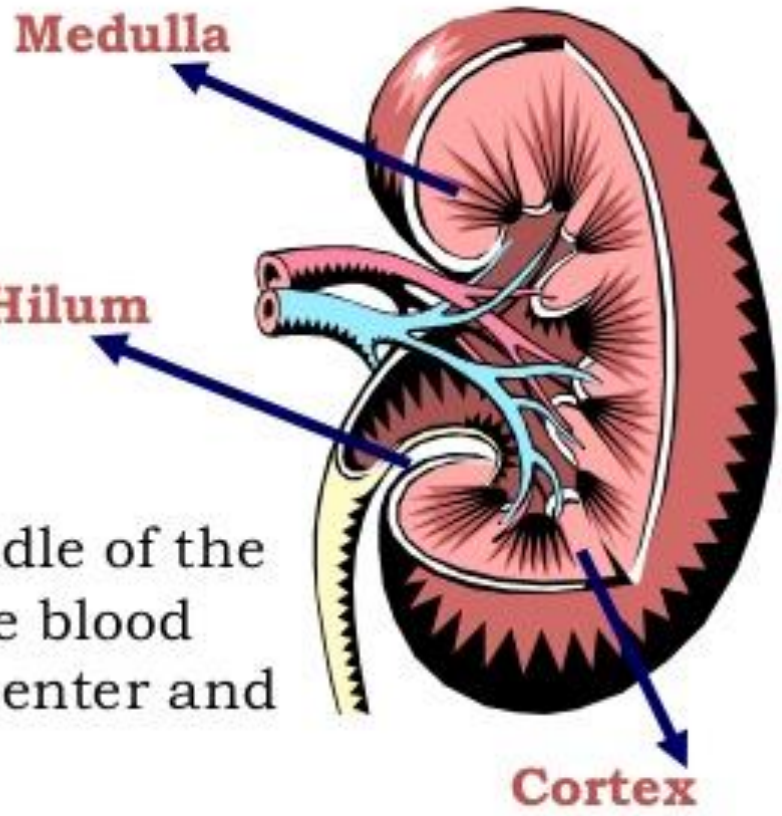
Kidney

- Located both sides of the spine between thoracic and lumbar vertebrae.
- Blood enters the kidneys through renal arteries and leaves through renal veins.
- Tubes called ureters carry waste products from the kidneys to the urinary bladder for storage or for release.

- During urination, urine is expelled from the urinary bladder through the **urethra**.

Kidneys filter about 1700 liters of blood daily in the average adult.

Parts of the kidneys

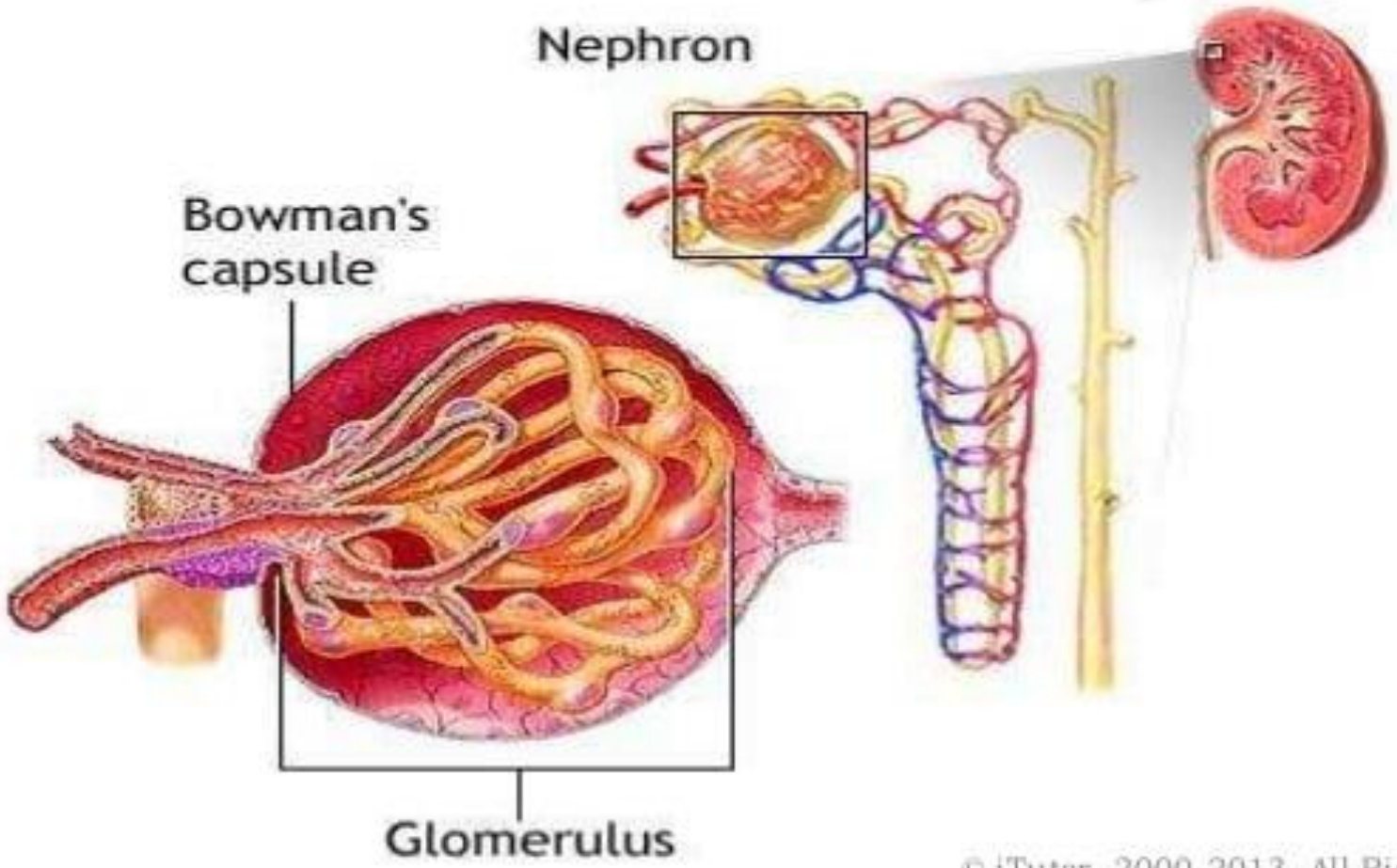


- **Cortex**
  -outer protective portion
- **Medulla**
  -inner soft portion
- **Hilum**
  -a depression located in the middle of the concave side of the kidney where blood vessels, nerves, and the ureters enter and exit the kidneys

- The **cortex** is where the blood is filtered.
- The **medulla** contains the collecting ducts which carry filtrate (filtered substances) to the pelvis.
- The **pelvis** is a hollow cavity where urine accumulates and drains into the ureter.

Nephron

- The functional units of the kidney are called nephrons.
- Nephrons are located in the renal cortex, except for their loops of Henle, which descend into the renal medulla.



Nephron

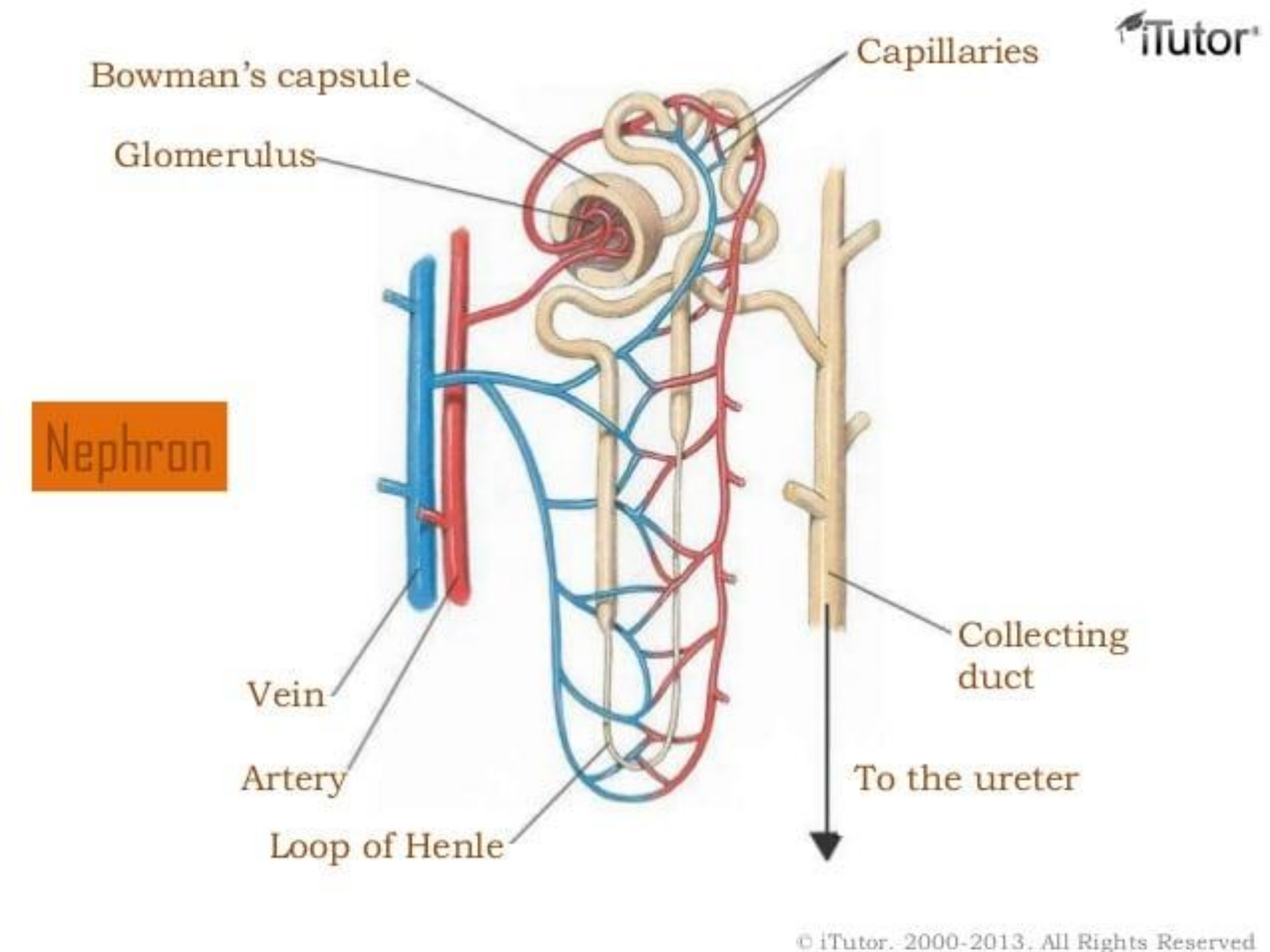
iTutor

Two parts

a. Renal Corpuscle
    1. Bowman Capsule
    2. Glomerulus
        a. *Fenestrae* - pore in endothelial walls of glomerulus.
        b. *Podocytes* - specialized cells.
        c. *Filteration slits*

b. Renal Tubule - Series of single layer tubules
    1. Proximal Convoluted tubule
    2. Loop of Henle
    3. Distal Convoluted tubule

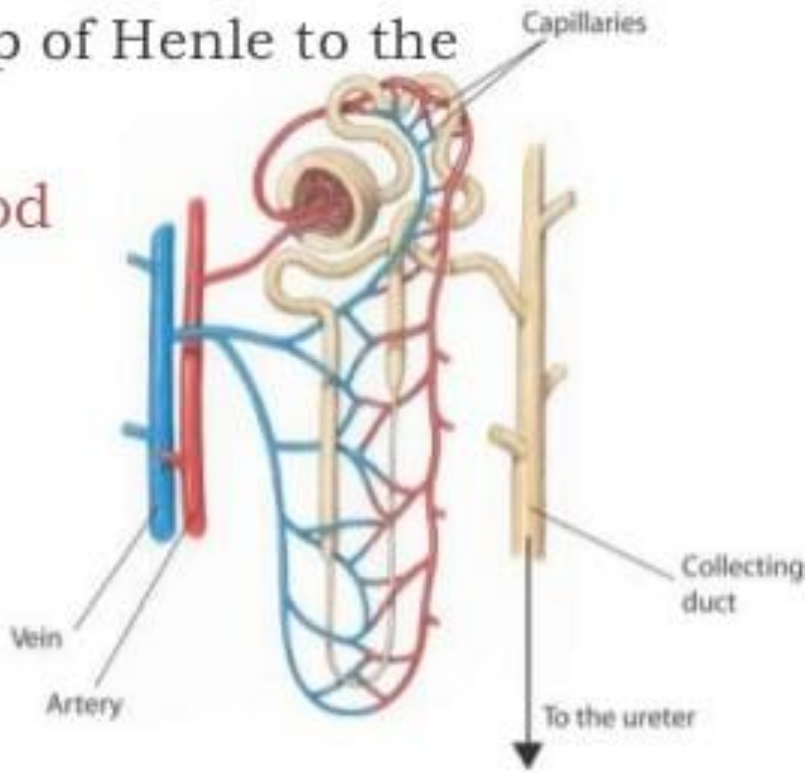
Kidneys are made up of nephrons. Blood enters the nephron, where impurities are filtered out and emptied into the collecting duct. The purified blood leaves the nephron through the renal vein.



- The *glomerulus* is a mass of thin-walled capillaries.
- The *Bowman's capsule* is a double-walled, cup-shaped structure.
- The *proximal tubule* leads from the Bowman's capsule to the Loop of Henle.
- The *loop of Henle* is a long loop which extends into the medulla.
- The *distal tubule* connects the loop of Henle to the collecting duct.

- Each nephron has its own blood supply:
  - An arteriole
  - A venule
  - A network of capillaries connecting them

Each nephron releases fluids to a collecting duct, which leads to the ureter.



Each kidney contains more than 1 million ***nephrons***.

- ***Blood Flow through the Kidneys***

Blood enters through the renal artery → *Arterioles* →

Each arteriole leads to a nephron → *Renal corpuscle*

- The **glomerulus** filters fluid from the blood, and is the first place where urine is formed in the kidneys.
- Blood flows through the glomerulus at a constant rate.
- Each glomerulus is surrounded by a capsule known as Bowman's capsule.
- Blood then passes into the renal tubules where some substances are reabsorbed and the remaining become urine.

Flow of Urine

Glomerulus

↓

Renal Tubules

↓

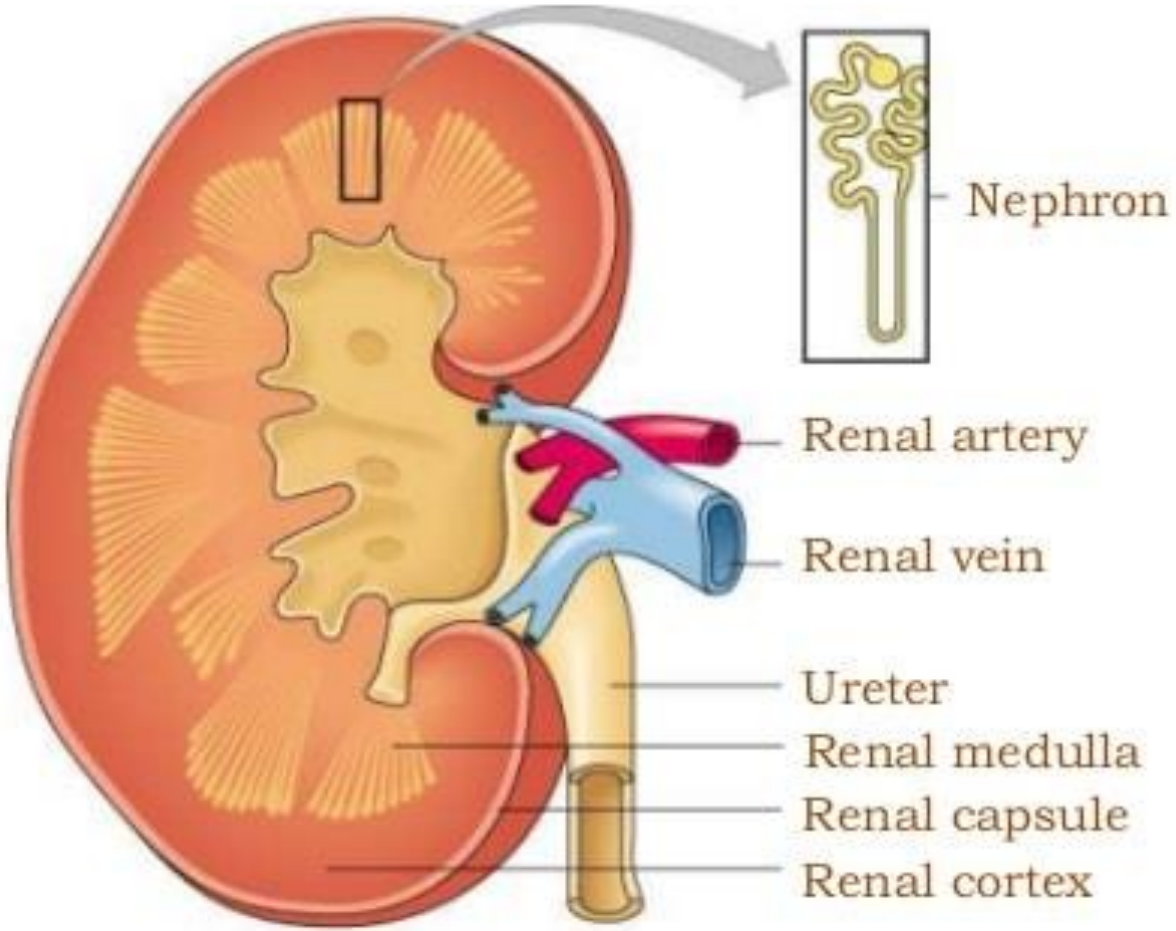
Renal Pelvis

↓

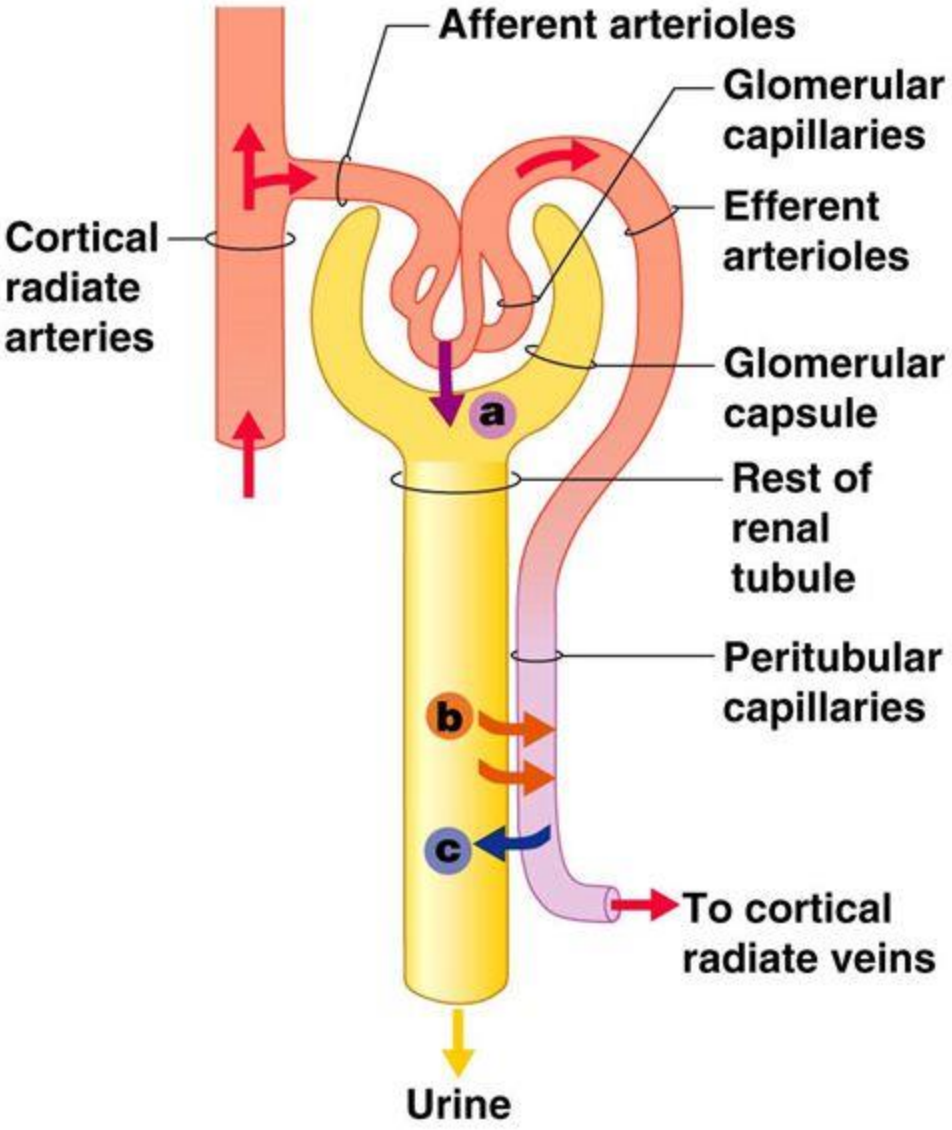
Renal Calices

↓

Ureters



Urine Formation



KEY:

a → **Glomerular Filtration:** Water and solutes smaller than proteins are forced through the capillary walls and pores of the glomerular capsule into the renal tubule.

b → **Tubular Reabsorption:** Water, glucose, amino acids, and needed ions are transported out of the filtrate into the tubule cells and then enter the capillary blood.

c → **Tubular Secretion:** H^+, K^+, creatinine, and drugs are removed from the peritubular blood and secreted by the tubule cells into the filtrate.

1. Glomerular filtration

This takes place through the semipermeable walls of the glomerular capillaries and Bowman's capsule.

The afferent arterioles supplying blood to glomerular capsule carries useful as well as harmful substances. The useful substances are glucose, aminoacids, vitamins, hormones, electrolytes, ions etc and the harmful substances are metabolic wastes such as urea, uric acids, creatinine, ions, etc.

The diameter of efferent arterioles is narrower than afferent arterioles. Due to this difference in diameter of arteries, blood leaving the glomerulus creates the pressure known as hydrostatic pressure.

The **glomerular hydrostatic pressure** forces the blood to leaves the glomerulus resulting in filtration of blood. A capillary hydrostatic pressure of about 7.3 kPa (55 mmHg) builds up in the glomerulus. However this pressure is opposed by the **osmotic pressure** of the blood, provided mainly by plasma proteins, about 4 kPa (30 mmHg), and by **filtrate hydrostatic pressure** of about 2 kPa (15 mmHg in the glomerular capsule.

The **net filtration pressure** is,

Therefore: 55-(30 +15) = 10mmHg.

By the net filtration pressure of 10mmHg, blood is filtered in the glomerular capsule.

Water and other small molecules readily pass through the filtration slits but Blood cells, plasma proteins and other large molecules are too large to filter through and therefore remain in the capillaries.

The filtrate containing large amount of water, glucose, aminoacids, uric acid, urea, electrolytes etc in the glomerular capsule is known as nephric filtrate of glomerular filtrate.

The volume of filtrate formed by both kidneys each minute is called the **glomerular filtration rate (GFR).** In a healthy adult the GFR is about 125 mL/min, i.e. 180 litres of filtrate are formed each day by the two kidneys

2. Selective reabsorption

As the filtrate passes to the renal tubules, useful substances including some water, electrolytes and organic nutrients such as glucose, aminoacids, vitamins hormones etc are selectively reabsorbed from the filtrate back into the blood in the proximal convoluted tubule.

Reabsorption of some substance is passive, while some substances are actively transported. Major portion of water is reabsorbed by Osmosis.

Only 60–70% of filtrate reaches the Henle loop. Much of this, especially water, sodium and chloride, is reabsorbed in the loop, so that only 15–20% of the original filtrate reaches the distal convoluted tubule, More electrolytes are reabsorbed here, especially sodium, so the filtrate entering the collecting ducts is actually quite dilute.

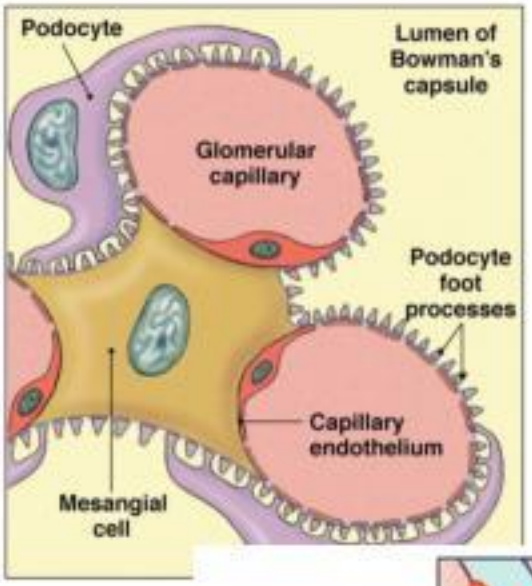
The main function of the collecting ducts is to reabsorb as much water as the body needs.

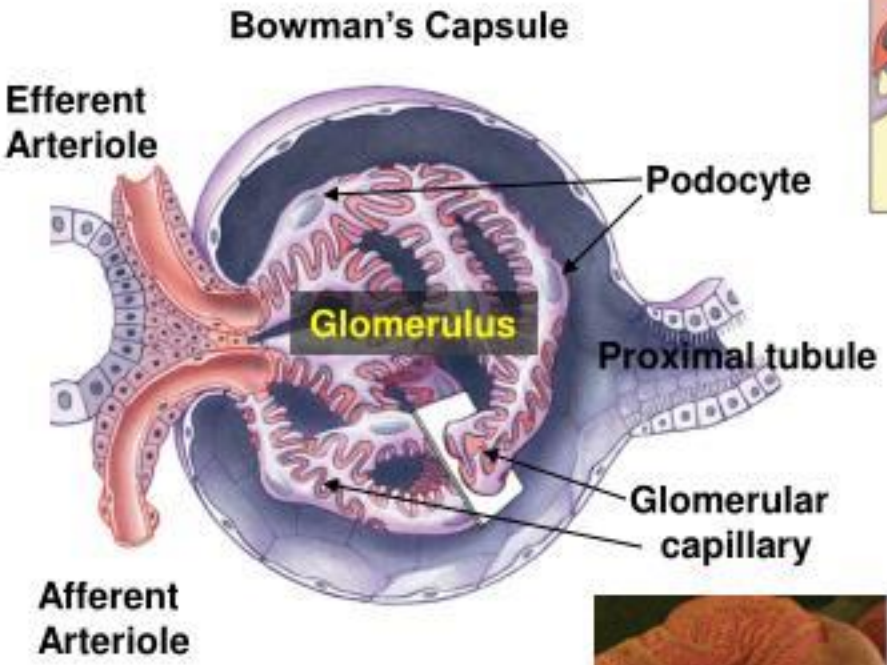
Nutrients such as glucose, amino acids, and vitamins are reabsorbed by active transport. Positive charged ions ions are also reabsorbed by active transport while negative charged ions are reabsorbed most often by passive transport. Water is reabsorbed by osmosis, and small proteins are reabsorbed by pinocytosis.

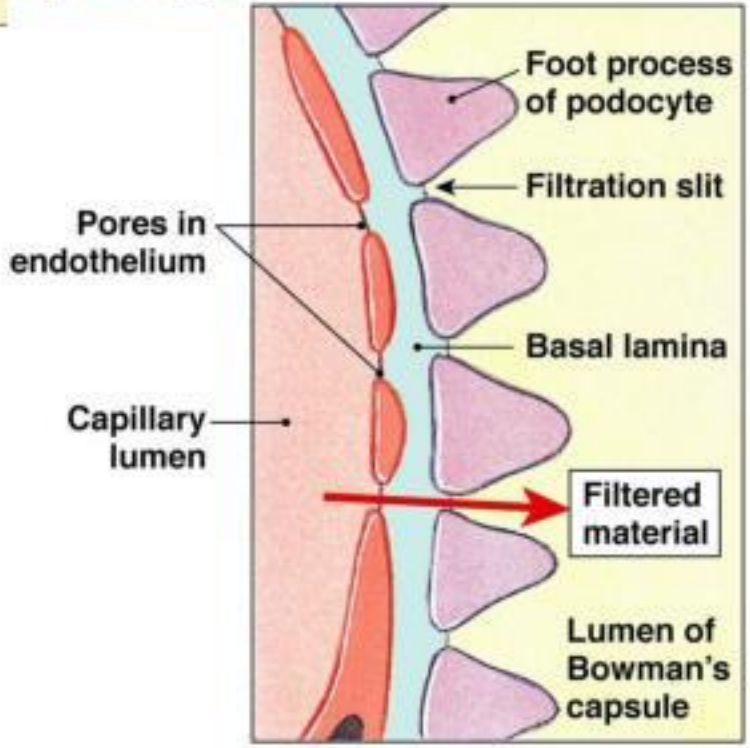
3. Tubular secretion

Tubular secretion takes place from the blood in the peritubular capillaries to the filtrate in the renal tubules and can ensure that wastes such as creatinine or excess H+ or excess K+ ions are actively secreted into the filtrate to be excreted.
Excess K+ ion is secreted in the tubules and in exchange Na+ ion is reabsorbed otherwise it causes a clinical condition called Hyperkalemia.
Tubular secretion of hydrogen ions (H+) is very important in maintaining normal blood pH.
Substances such as , e.g. drugs including penicillin and aspirin, may not be entirely filtered out of the blood because of the short time it remains in the glomerulus. Such substances are cleared by secretion from the peritubular capillaries into the filtrate within the convoluted tubules.
The tubular filtrate is finally known as urine. Human urine is usually hypertonic.

Filtration





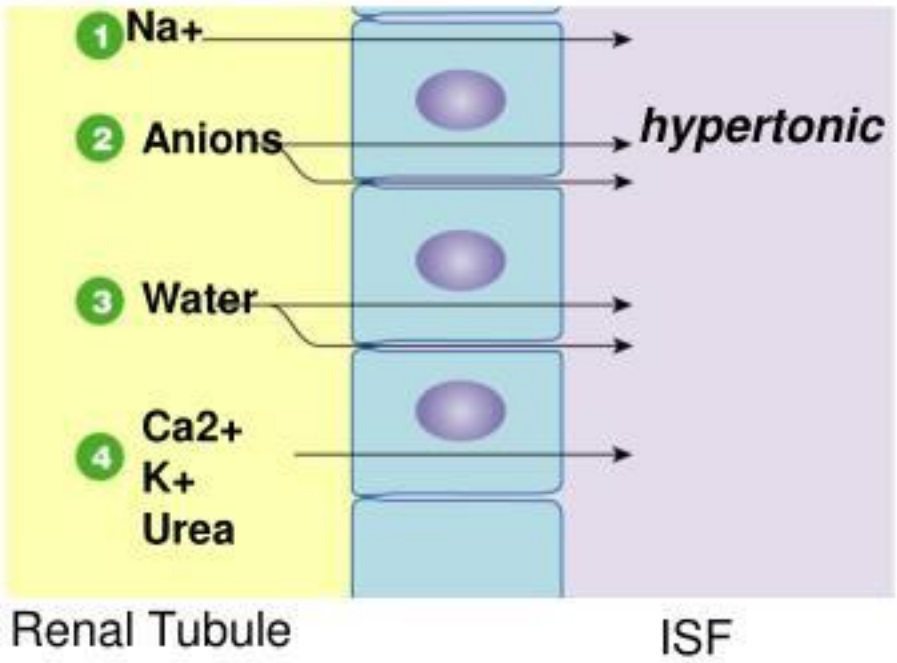


~ 20% PLASMA entering Glomerulus enter NEPHRON by BULK FLOW!

Reabsorption

Active Transport of Na+ DRIVES REABSORPTION!!!!!!!

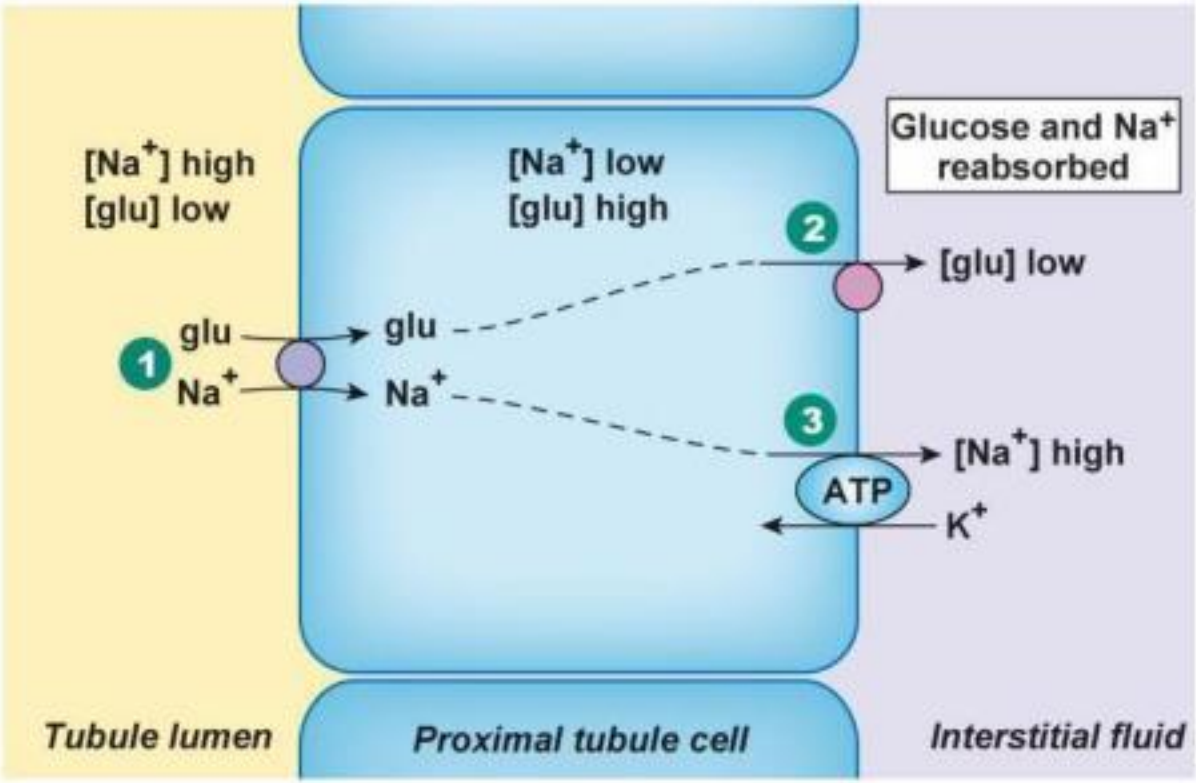
Everything else is DIFFUSION (electrical or concentration gradient)



1. Na+ reabsorbed by Active Transport!
2. Na+ Electrical Gradient
   Anions (-) reabsorbed
3. Osmotic gradient (high ISF)
   Water reabsorbed
4. High Renal Tubule Conc.

   Other molecule diffuse down conc. gradients

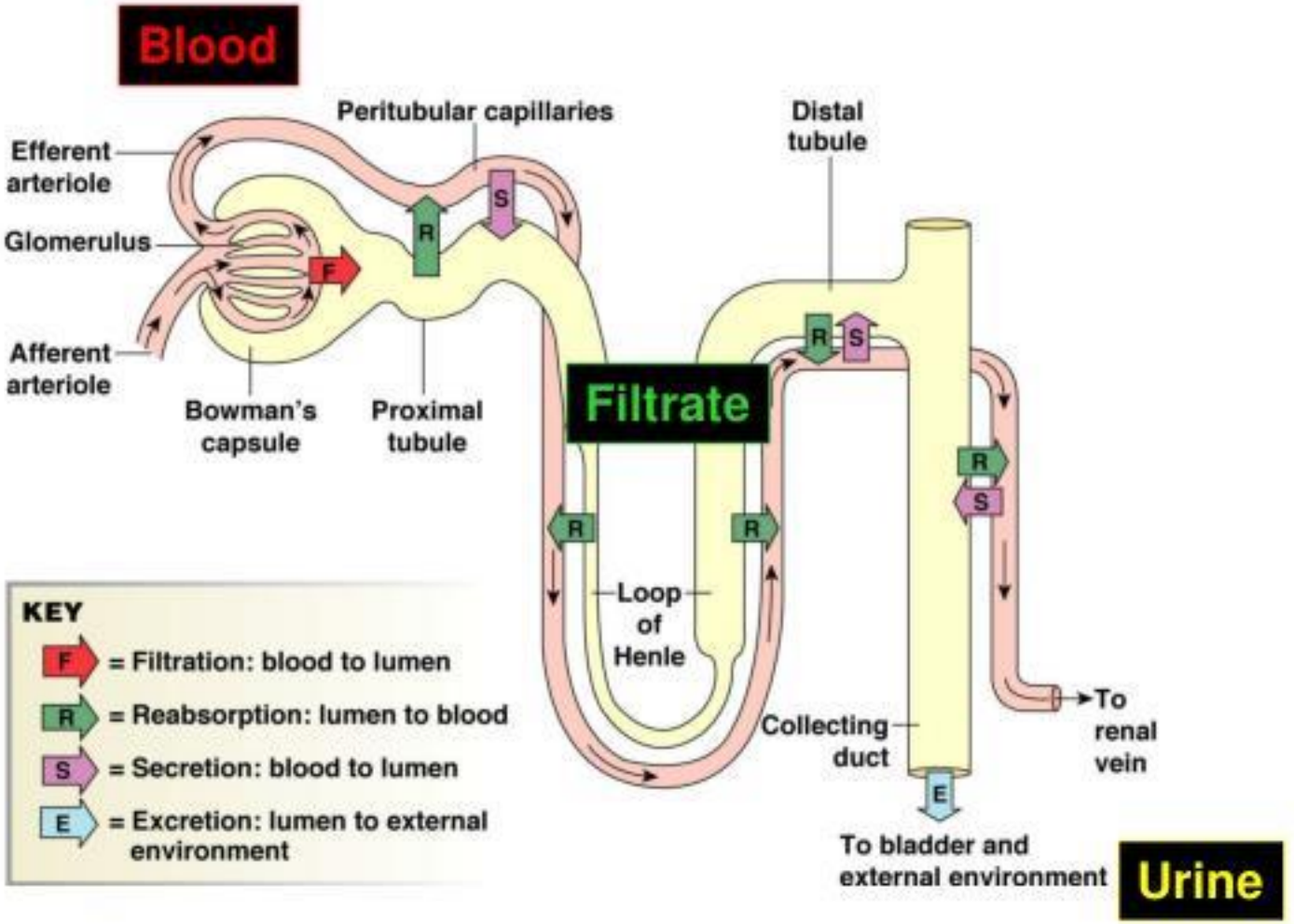
Glucose Reabsorption



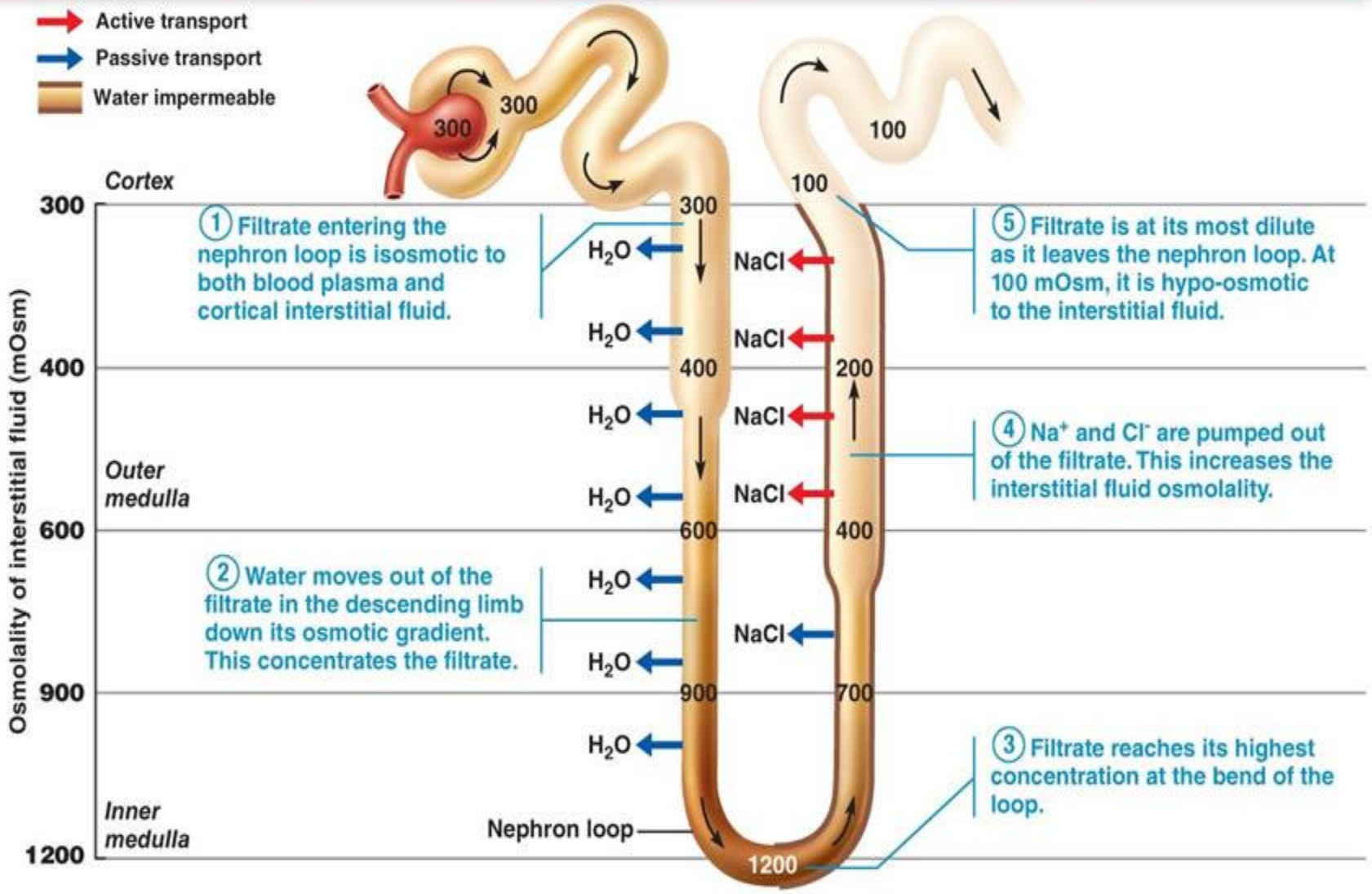
100% of Glucose is reabsorbed @ normal blood glucose levels

Diabetes mellitus > elevated blood glucose >> glucosuria

Nephron: 4 ways substances move



(a) *(continued)* **As water and solutes are reabsorbed, the loop first concentrates the filtrate, then dilutes it.**



Excretory and Non-Excretory Functions of Kidney

The kidneys 5 functions

Excretory Function: Urine Formation

1) Regulation of body fluid volume
2) Regulation of Osmolarity & Ion Balance
3) Regulation of pH
4) Excretion of Wastes
5) Synthesis of Hormones

Non-Excretory Functions

Fluid and Electrolyte Balance

Why does your body maintain fluids and electrolytes in a balanced state?

Na^+ & Water determine blood volume and pressure

K^+ is essential for resting membrane potential in excitable cells

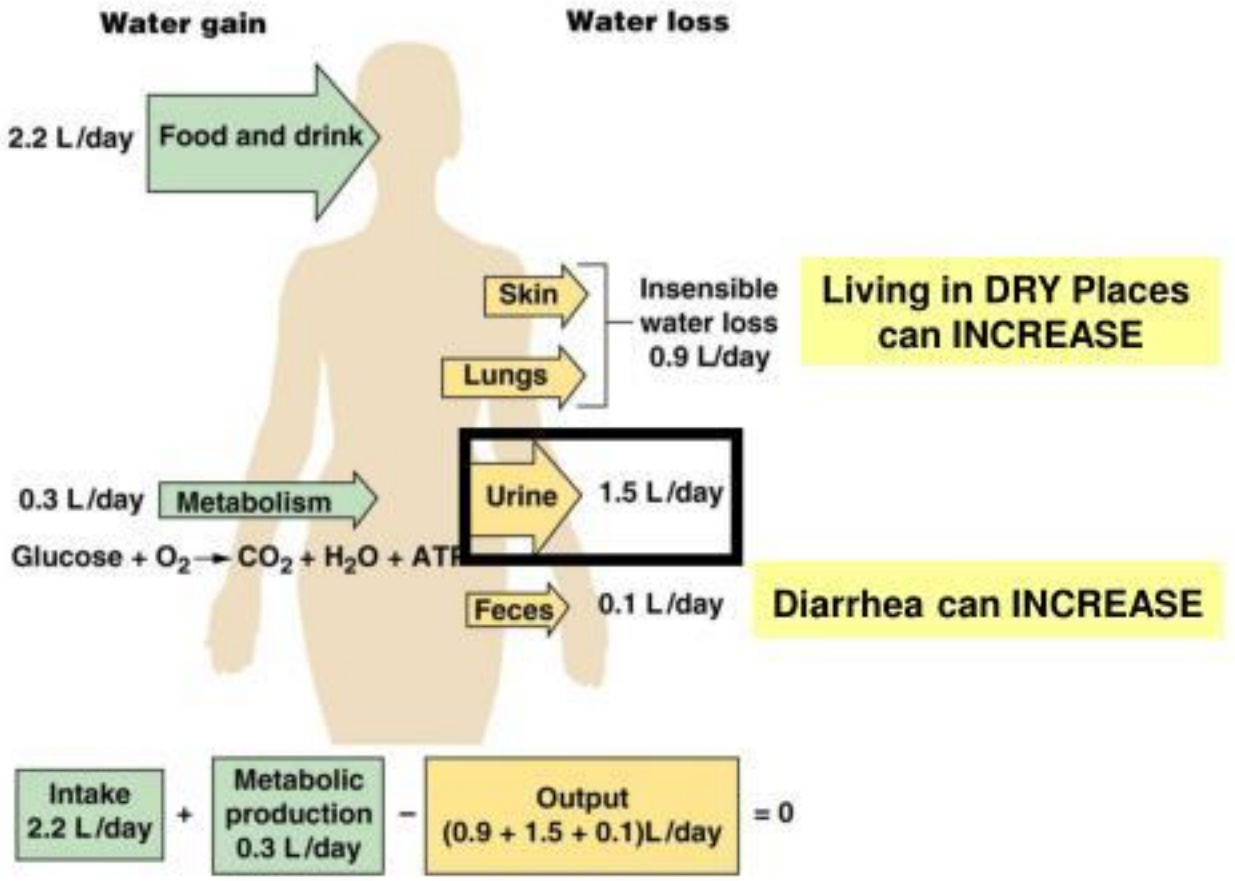
H^+ and HCO_3^- are key in maintaining pH

Ca^{2+} is a key signaling ion

Integrative, multisystem task; kidney, cardiovascular, respiratory, neural

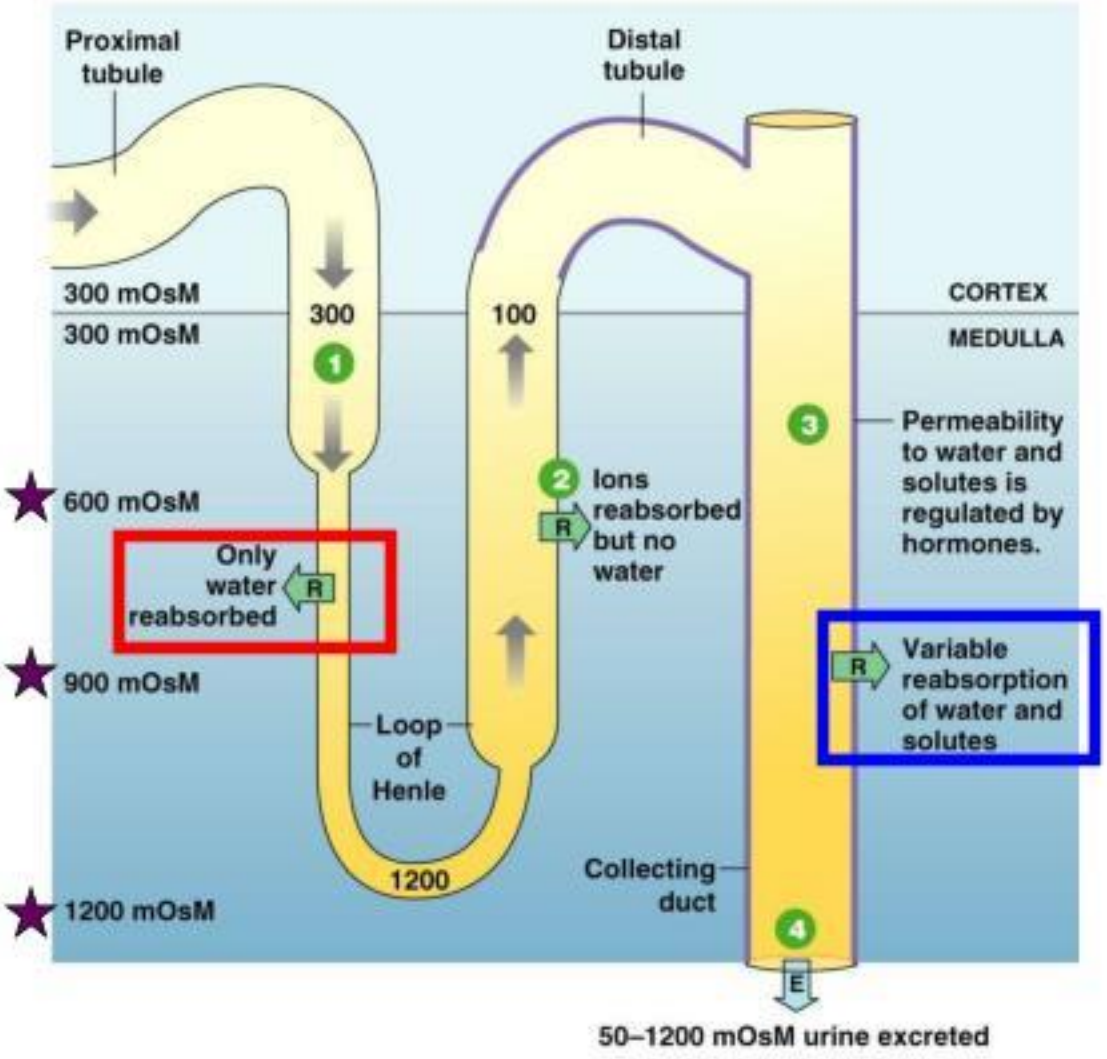
Water Homeostasis

8 – 8oz waters
9 oz from food



You body maintains water homeostasis, PRIMARILY, by altering urine volume!

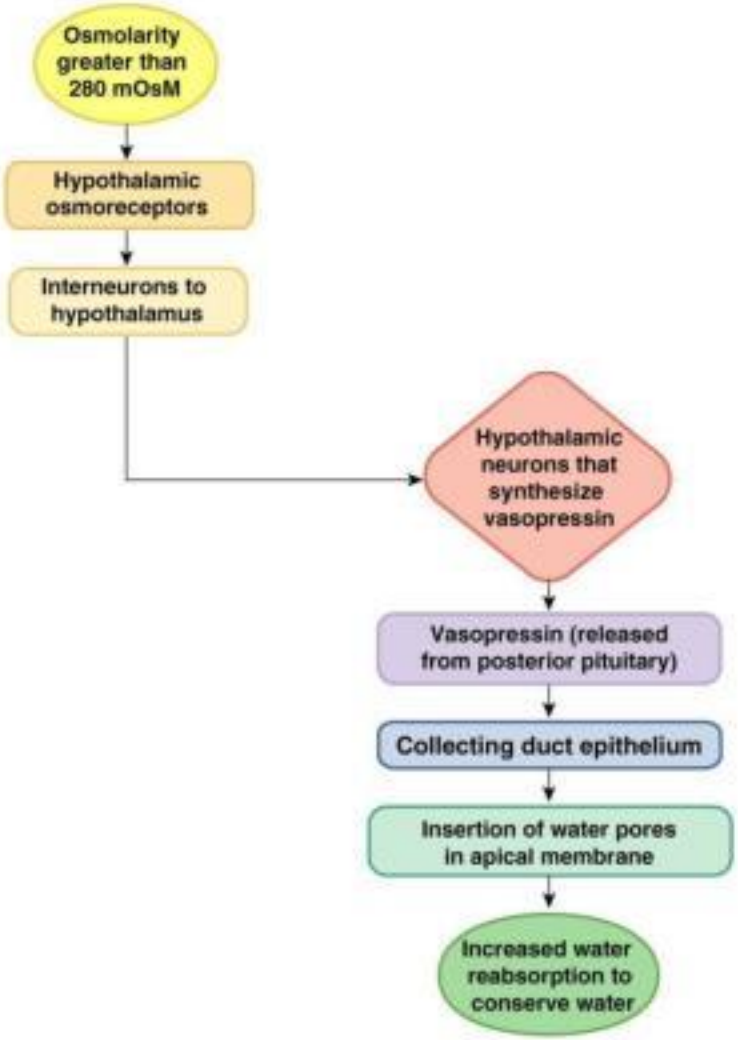
Water Reabsorption

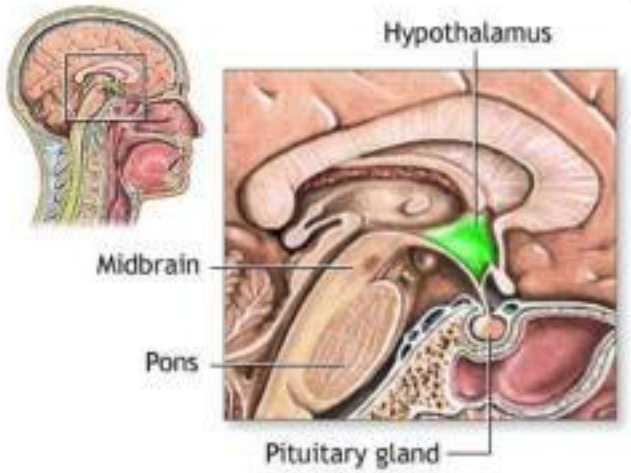


Important: *Water reabsorption in the LOH is ALWAYS on (unless drugs are present)*

Your body ONLY alters water reabsorption in the distal tubule & collecting duct!

What drives ADH release?





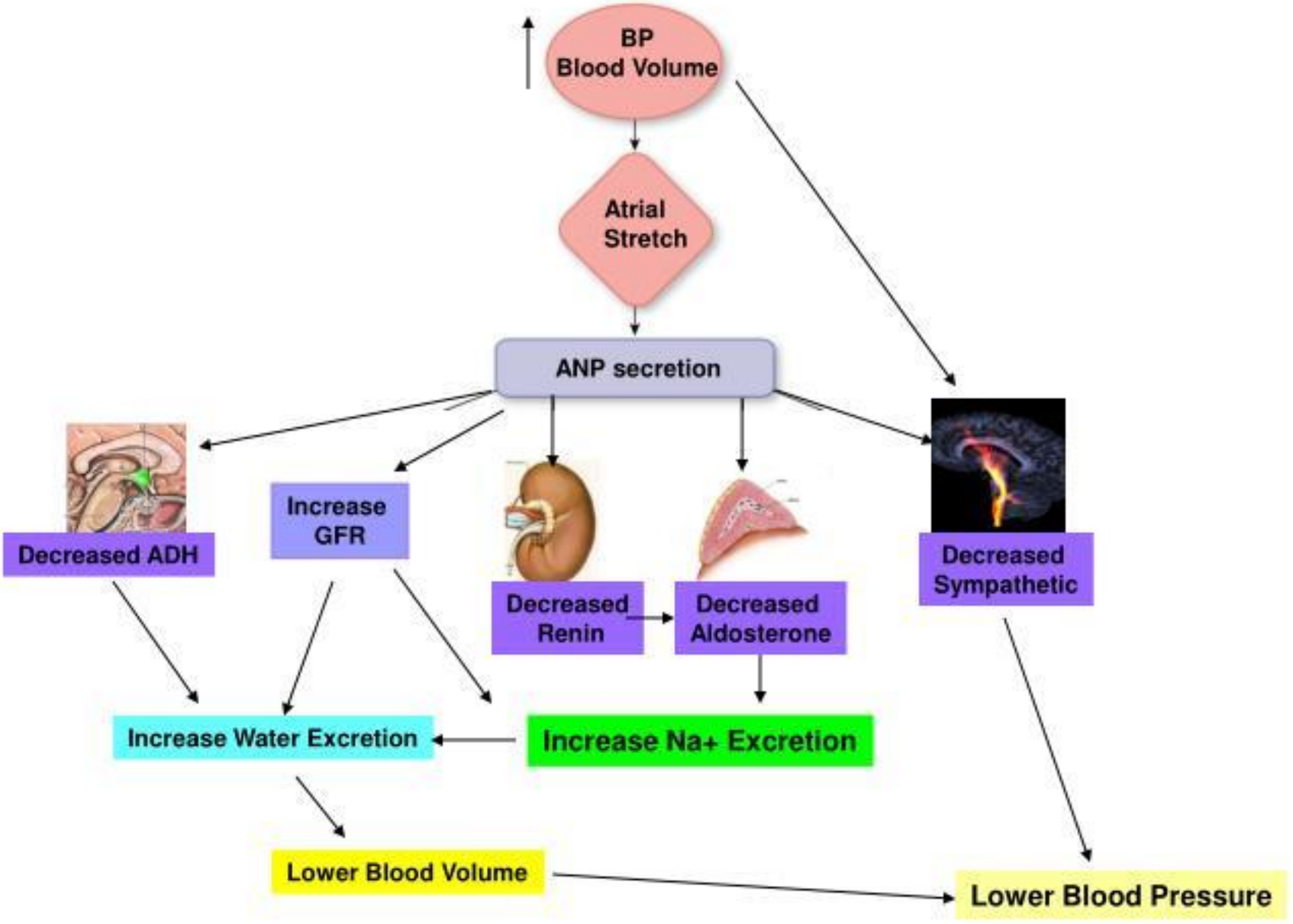
1) Blood Osmolarity

High OSM > Increase ADH
Low OSM > Decrease ADH

2) Blood Volume
3) Blood Pressure

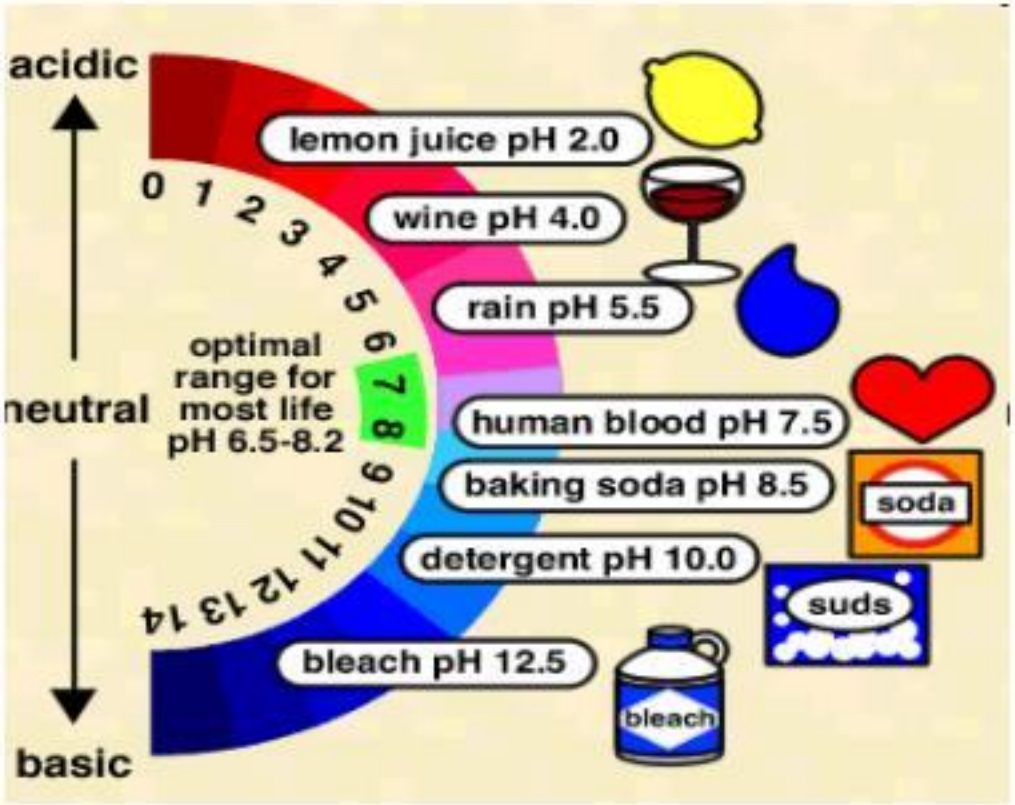
Low BP> Increase ADH
High BP> Decrease ADH

Atrial Natiuretic Peptide (ANP)



pH Review

More H+ ions



Few H+ ions

Acid-Base Homeostasis: pH

pH is affected by the concentration of H+

Your body maintains pH at 7.38-7.43, precisely!

Low pH = acidosis (reduced CNS function)

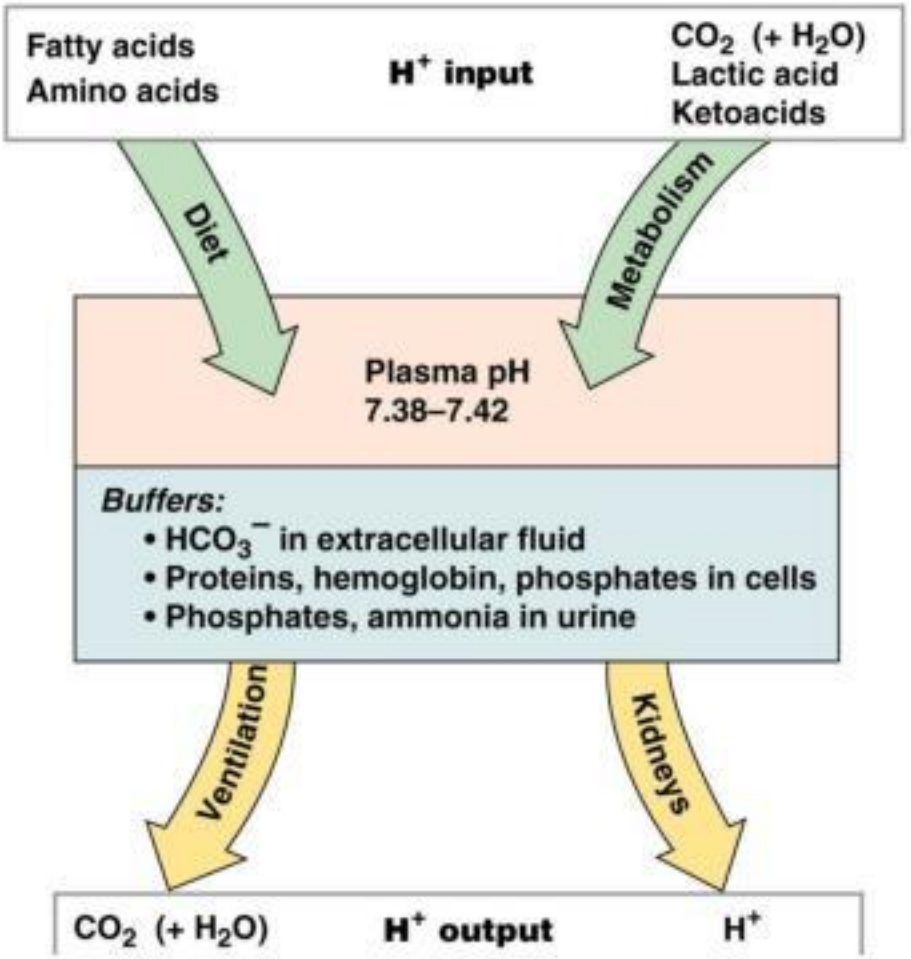
High pH = alkalosis…hyperexcitable membranes (diaphragm arrest!)

3 mechanisms of pH homeostasis

1) **Buffering systems**
2) **Lungs**

75%

3) **Kidneys – 25%**



Loss of any mechanism can lead to ACIDOSIS > lowered blood pH

Normal Constituents of Urine

- Water
- Urea
- Sodium and potassium
- Phosphate and sulfate ions
- Creatinine
- Uric acid
- Calcium
- Magnesium
- Bicarbonate ions

Abnormal Constituents of Urine

- Glycosuria = glucose
- Hematuria = Red blood cells
- Pyuria = White blood cells
- Bacteriuria = bacteria
- Ketonuria = ketones

Abnormal constituents of urine

Glycosuria; It is a term used to refer to the presence of an unusual amount of reducing sugar in urine , once the specific sugar is identified it is given a more specific description glucosuria , fructosuria.

Glucosuria ; This term is used to indicate an abnormal detection of glucose in urine .Normally not more than 10 – 20mg/dl , unusual amounts of glucose can be found in urine after anesthesia , or emotional stress .

-It can be found in cases of uncontrolled diabetis mellitus (most common cause of glucosuria).

-It can also be found in cases of hyperthyroidism .

- Renal glucosuria which is caused by a disorder of the renal tubular function.

Keton bodies (ketonuria); It refers to the presence of unusual amounts of ketone bodies in urine . Normally only 3-15mg are excreted per day .

Ketonuria can occur in cases such as ketosis and in starvation, excess fat metabolism.

Bilirubin; It is not present normally in significant amounts since it is mainly excreted through bile , unusual amounts of bilirubin is detected in urine in cases of obstructive jaundice , and unusual amounts of uribilinogen seen in cases of hemolytic jaundice.

PHYSIOLOGY OF MICTURITION

FILLING

- The walls of the **ureters** contain **smooth muscle** arranged in spiral, longitudinal, and circular bundles, but distinct layers of muscle are not seen.
- **Regular peristaltic contractions** occurring **one to five times per minute** move the urine from the renal pelvis to the bladder, where it **enters in spurts** synchronous with each peristaltic wave.
- The ureters **pass obliquely** through the bladder wall and, although there are **no ureteral sphincters** as such, the oblique passage tends to keep the **ureters closed except during peristaltic waves, preventing reflux** of urine from the bladder.
- **Expected bladder capacity = [30+ (age in yrs x 30)] ml**

PHYSIOLOGY OF MICTURITION

EMPTYING

- Contraction of the circular muscle, which is called the **detrusor muscle,** is mainly responsible for **emptying the bladder during** micturition.
- Muscle bundles pass on either side of the urethra, and these fibers are sometimes called the **internal urethral sphincter (smooth muscle)** although they **do not encircle the urethra.**
- Farther along the urethra is a sphincter of **skeletal muscle,** the sphincter of the membranous urethra, **external urethral sphincter.**

PHYSIOLOGY OF MICTURITION

BLADDER INNERVATION

- Micturition is fundamentally a **spinal reflex** facilitated and inhibited by higher brain centers and, like defecation, subject to **voluntary facilitation and inhibition**

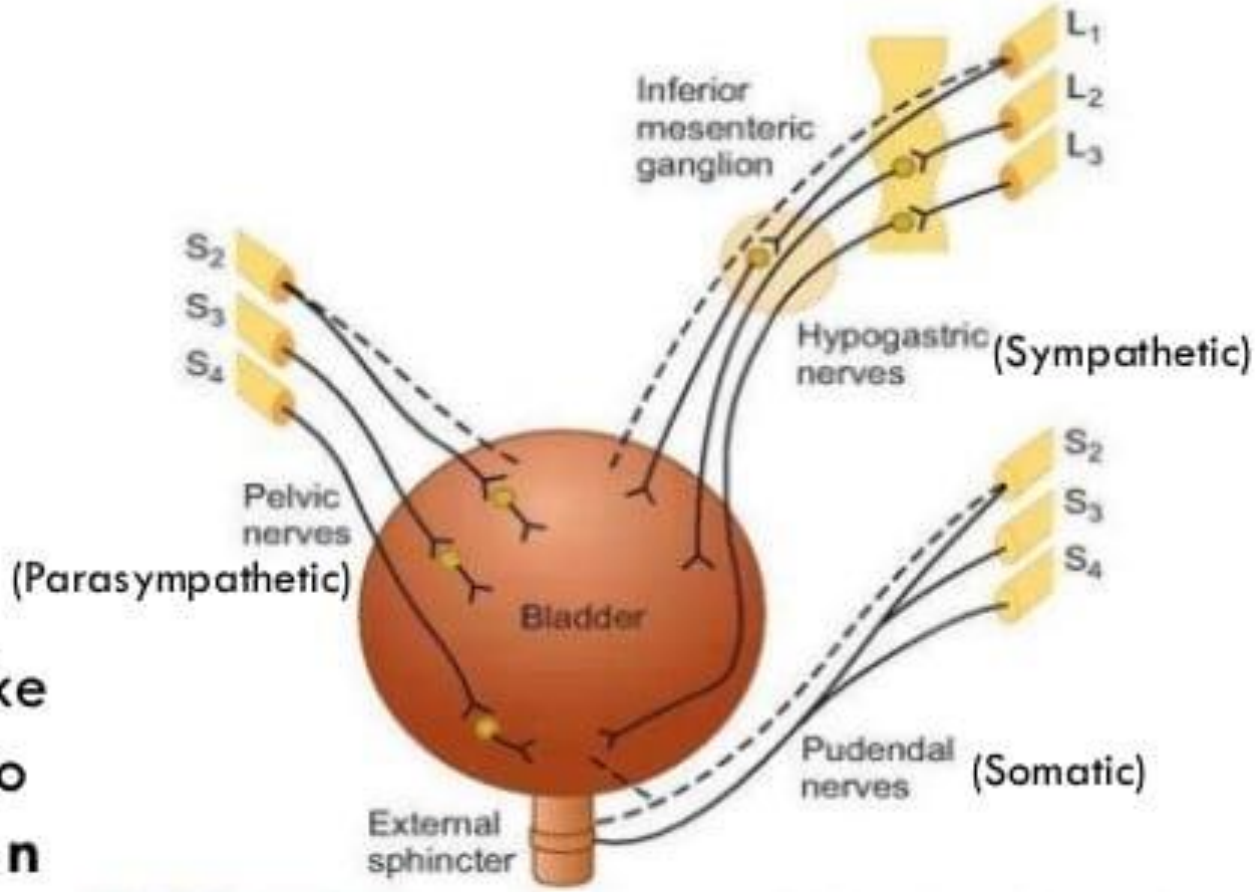
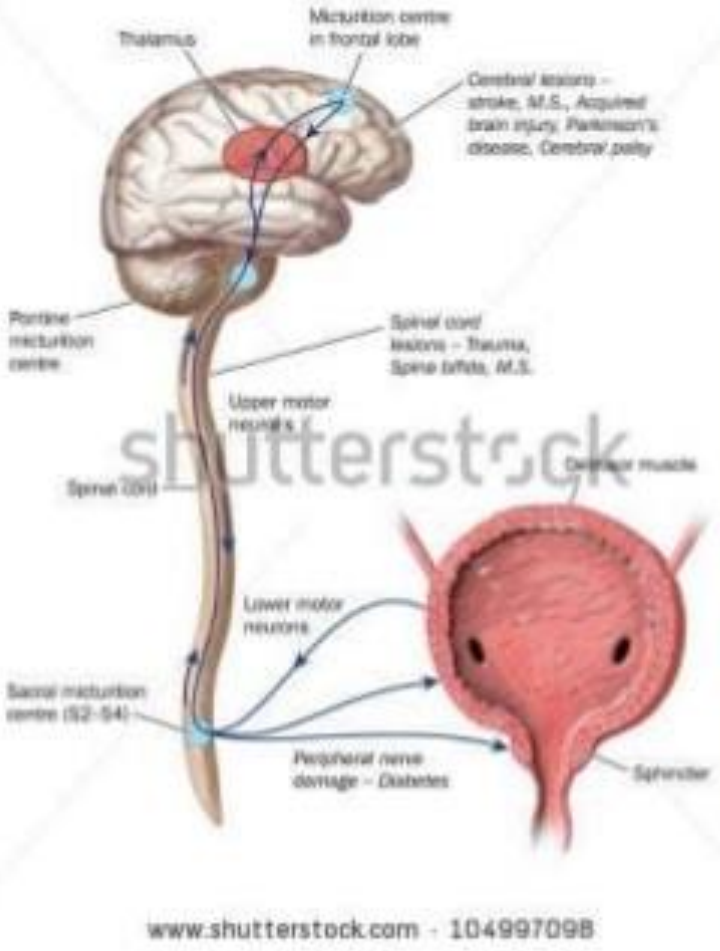


FIGURE 38–20 **Innervation of the bladder.** Dashed lines indicate sensory nerves. Parasympathetic innervation is shown at the left, sympathetic at the upper right, and somatic at the lower right.

TYPES OF NERVES	NERVE FIBRES	ACTION	COMMENTS
SYMPATHETIC	**HYPOGASTRIC** NERVES(L1,L2,L3) INFERIOR MESNTERIC GANGLION	motor to internal urethral sphincter, **inhibitory to detrusor**	**No significant role** in micturition; along wit IUS prevent reflux of semen into the bladder during ejaculation
PARASYMPATHETIC	**PELVIC** NERVES (S2,S3,S4)	motor to **detrusor** **inhibitory to internal urethral sphincter**	Stretch receptors present on the wall of the urinary bladder → Sensory fibers in the pelvic nerve → intermediolateral column of spinal cord → parasympathetic nerves →**Muscarinic receptors** → emptying of urinary bladder
SOMATIC	**PUDENDAL** NERVES (S2,S3,S4)	Voluntary control of **External urethral sphincter**	This maintains the tonic contractions of the **skeletal muscle fibers** of the external sphincter, so that this sphincter is **contracted always.** During micturition this nerve is **inhibited,** causing relaxation of the external sphincter and voiding of urine.
SENSORY	HYPOGASTRIC, PELVIC AND PUDENDAL NERVES	Cortical sensation	

PHYSIOLOGY OF MICTURITION



Cortical center

Second frontal gyrus(paracental lobule)

Inhibitory to pontine center

Brain stem center

Pons- Barrington nucleus

Facilitatory to micturition

Sacral spinal cord (Onuf nucleus)

Parasympathetic (S_2,S_3,S_4)

Reflex evacuation

PHYSIOLOGY OF MICTURITION

- Afferents to Spinal cord → sphincter relaxation
- Afferents to Pons → Contraction of detrusor
- **Spinal center:** Reflex ill-sustained contractions of detrusor – **incomplete evacuation**
- **Pontine center: Coordinating center.** Synchronization and maintenance of sustained contractions to **complete evacuation.**
- **Cortical Center:** Controls pontine center till a suitable socially acceptable situation for micturition is available.

PHYSIOLOGY OF MICTURITION

CORTICAL BLADDER:

Physiologic: Newborns and infants – periodic complete evacuation.

Pathologic:

- Lesion in paracentral lobule (cerebral palsy, multiple sclerosis, trauma, infarcts)
- Uncontrolled evacuation in **socially unacceptable** situations.
- Since pontine arc is intact evacuation is complete, **no residual urine** and coordination is good, **no detrusor sphincter dyssynergia.**
- No VUR, **"Safe bladder."**
- Associated with dementia (frontal lobe).

THE MICTURITION REFLEX

Micturition

- Micturition = the process by which the urinary bladder empties when it becomes full.

- Micturition is a visceral function → under control of the autonomic nervous system.

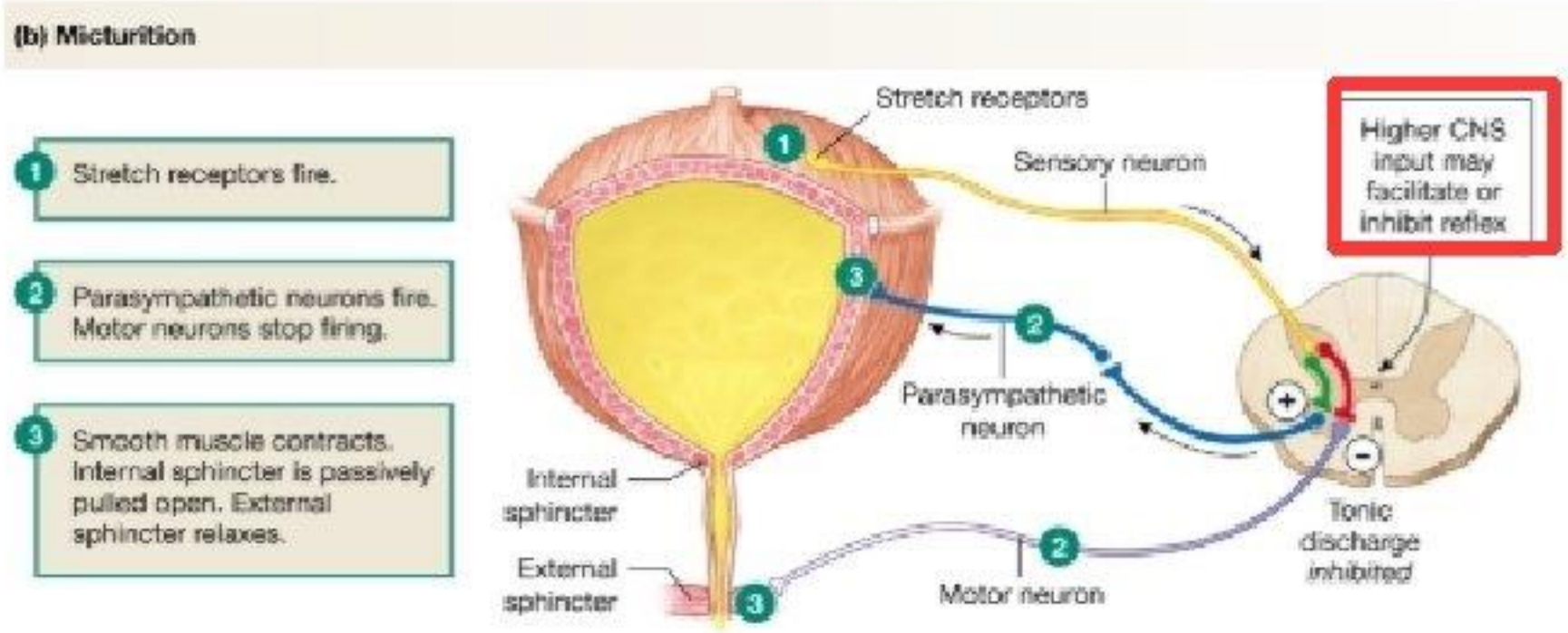
- ***How is micturition different from other visceral functions?***

The Micturition Reflex

Filling of bladder → Stretches the wall → Stimulate stretch receptors

↓

Signals are carried through pelvic nerve to sacral center → Excite parasympathetic efferent and inhibit pudendal discharge



The Micturition Reflex

- It is a autonomic reflex that can be facilitated or inhibited by higher centres.

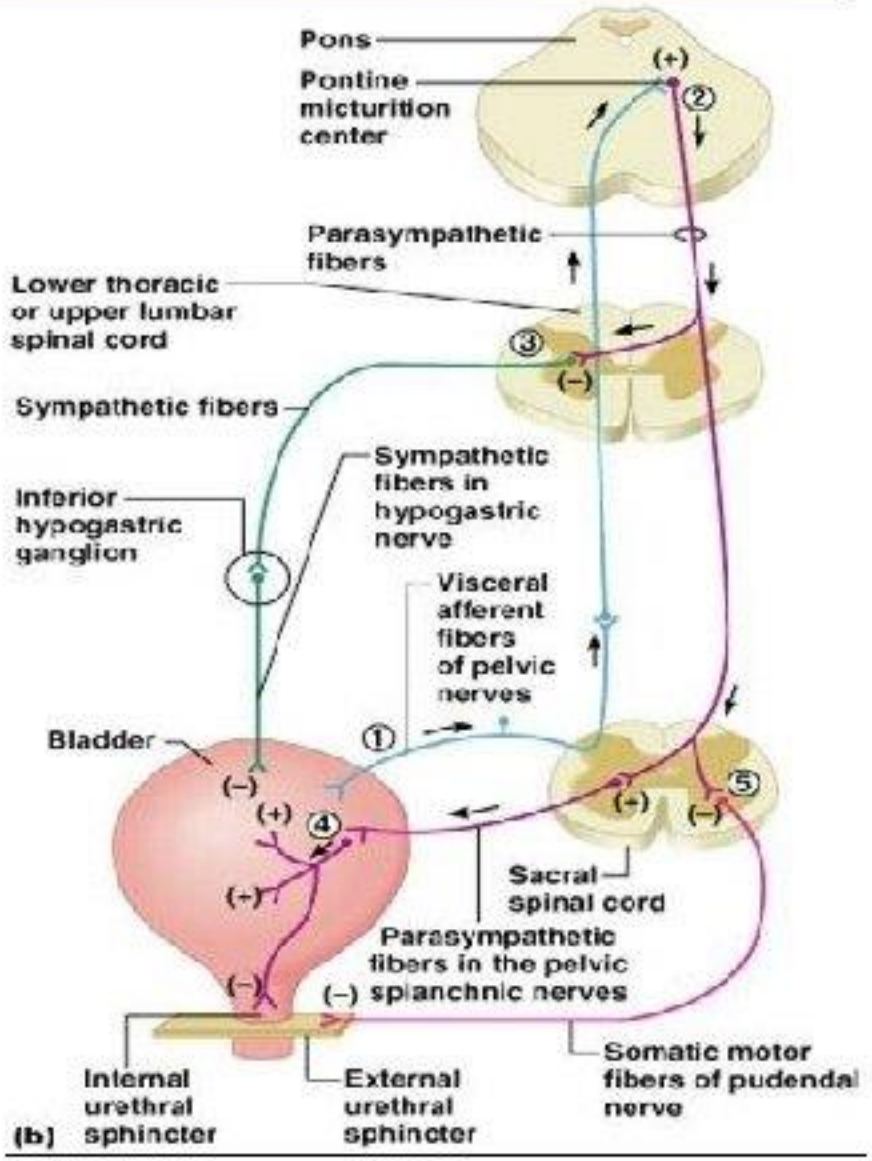
- Occurs in two steps:
  1. Progressive filling of the bladder until a threshold is reached.
  2. At the threshold, a nervous reflex is initiated “micturition reflex” to empty the bladder.

- If the conditions for emptying are favourable → emptying will occur.

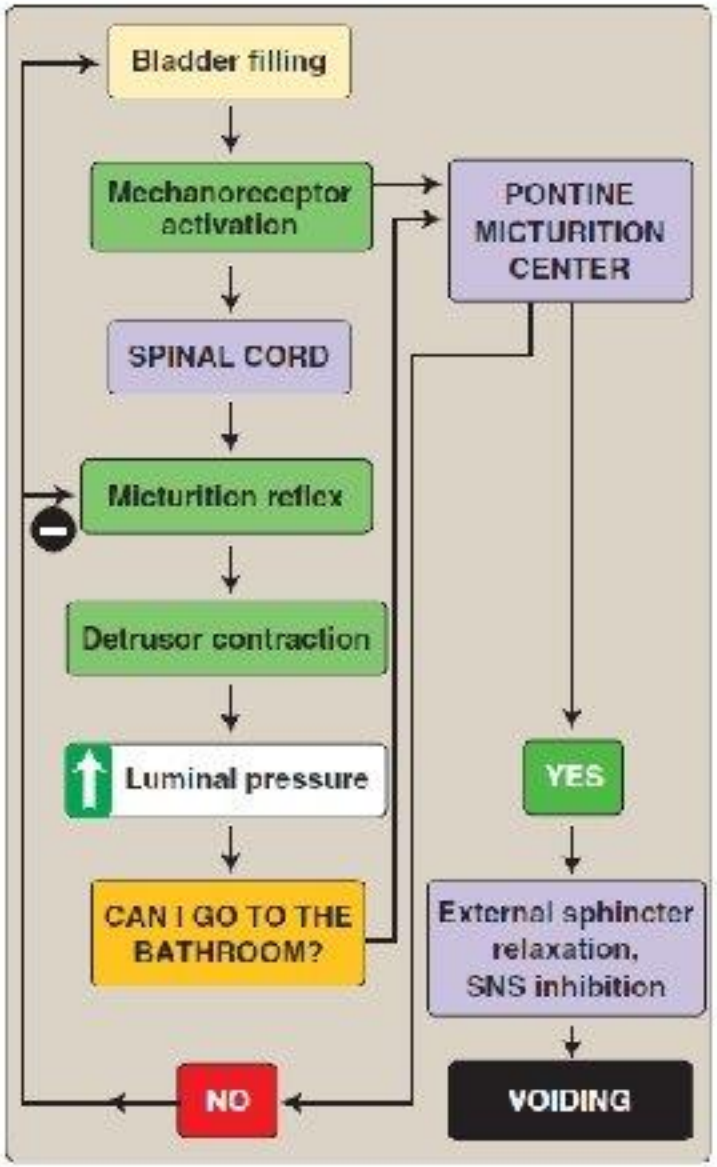
- If the conditions for emptying are unfavourable → reflex is inhibited, however, there is the conscious desire to urinate.

The Micturition Reflex-Adults

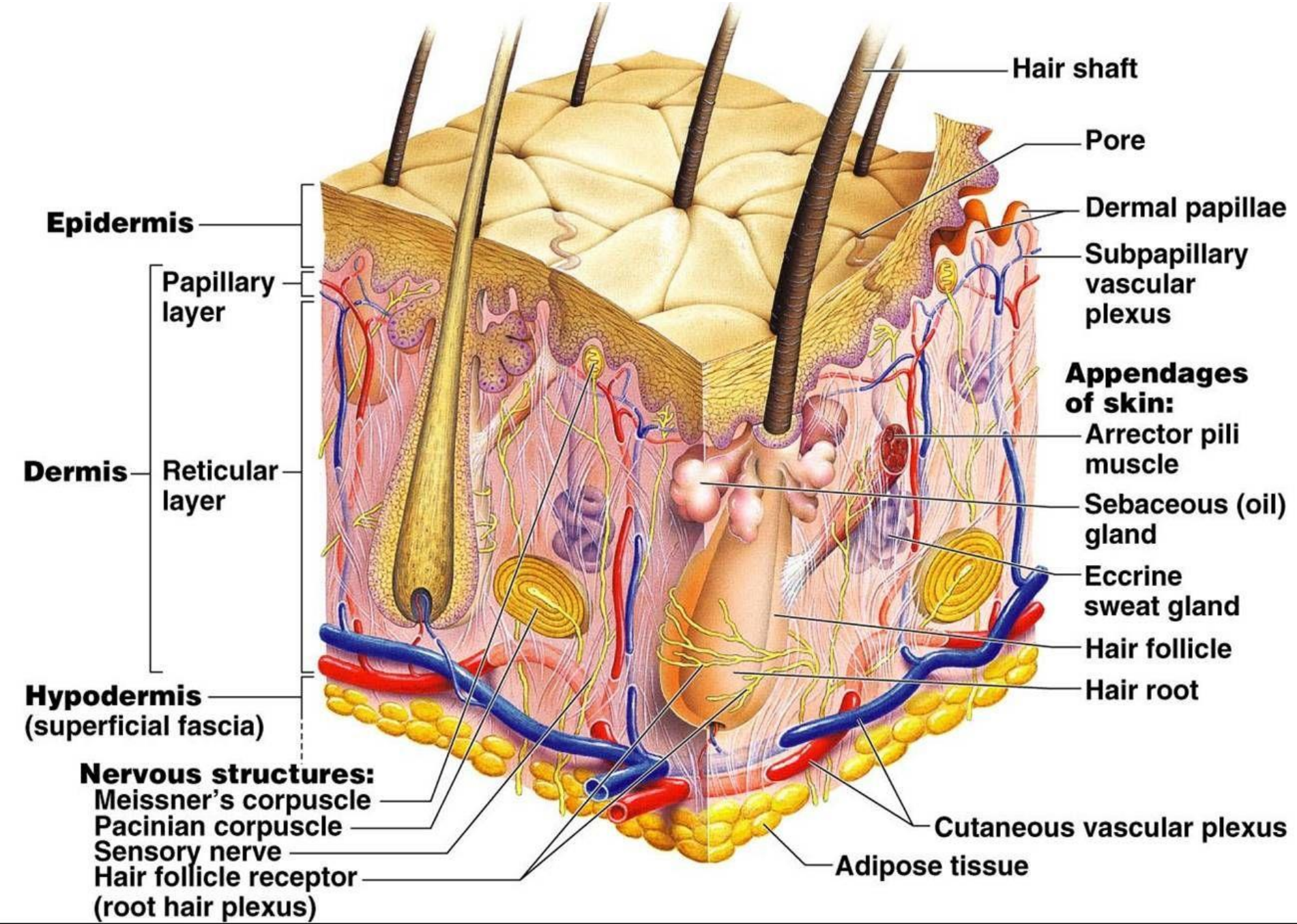
- An autonomic spinal reflex.
- Is controlled by higher CNS centres;
  - Brain stem (Pons).
  - Cerebral cortex.
- Control is either inhibitory or facilitatory.
- Voluntary.



The Micturition Reflex




SKIN


Hair shaft
Pore
Dermal papillae
Subpapillary vascular plexus
Epidermis
Papillary layer
Dermis
Reticular layer
Appendages of skin:
Arrector pili muscle
Sebaceous (oil) gland
Eccrine sweat gland
Hair follicle
Hair root
Hypodermis (superficial fascia)
Nervous structures:
Meissner's corpuscle
Pacinian corpuscle
Sensory nerve
Hair follicle receptor (root hair plexus)
Cutaneous vascular plexus
Adipose tissue

Introduction

- our largest organ
- Accounts for 12% of body weight…it weighs twice as much as your brain!
- Varies in thickness at different parts (< 0.5 mm at eyelids to > 5 mm on middle of upper back)
- Divided into three distinct layers
  - Epidermis
  - Dermis
  - Hypodermis – lies deep to the dermis

Functions

- Barrier against loss of body fluid.
- Protection and excretion
- Sensory function
- Metabolic function
- Temperature regulation
- Adaptation during edema and pregnancy
- Legal and anthropological importance

Structure of Skin

Epidermis - keratinised stratified squamous epithelium

- consist of 5 layers/strata

stratum corneum
stratum lucidum(thick skin only)
stratum granulosum
stratum spinousum
stratum basale (germinativum)

Dermis

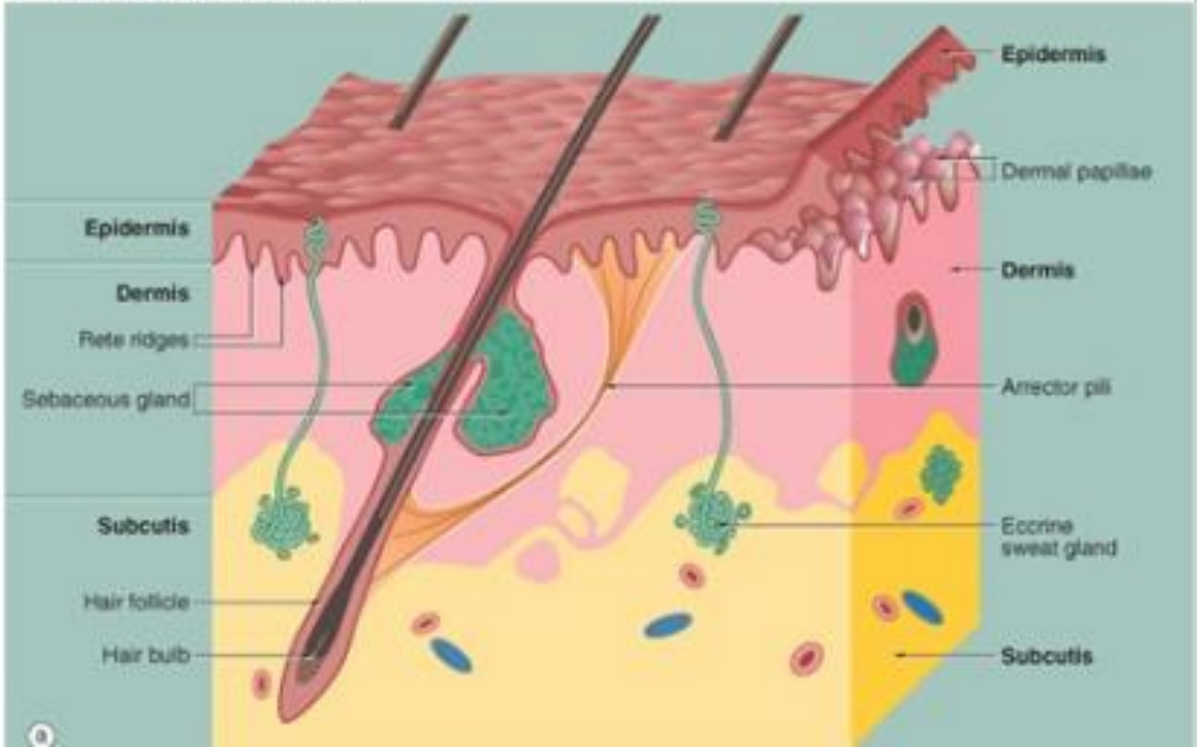
-dense connective tissue

- consists of two layers

Papillary dermis
Reticular dermis

Hypodermis

-connective tissue and adipose tissue



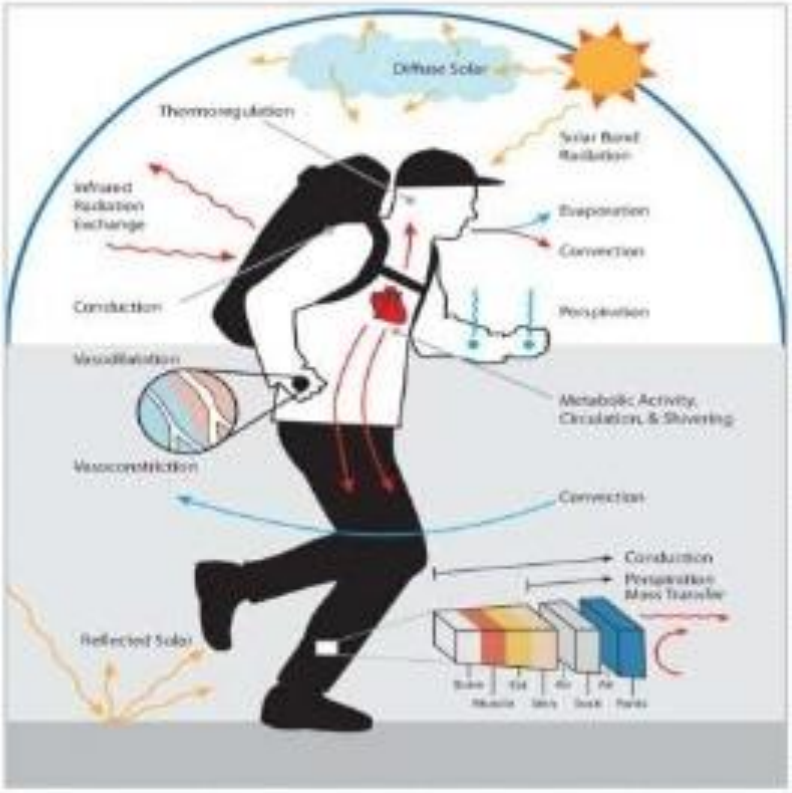
Body Temperature Regulation

- Under normal, resting body temperature, sweat glands produce about 500 ml/day of unnoticeable sweat
  - Called **insensible perspiration**
- If body temperature rises, dilation of dermal vessels can increase sweat gland activity to produce 12 L (3 gallons) of noticeable sweat
  - Called **sensible perspiration**; designed to cool body
- Cold external environment
  - Dermal blood vessels constrict
  - Skin temperature drops to slow passive heat loss

PHYSIOLOGY OF THERMOREGULATION

It is precisely regulated by physiological & behavioral mechanisms in number of ways:-

- **Neural control**
- **Vascular control**
- **Skin in temperature regulation**
- **Behavioral control**



FACTORS AFFECTING BODY TEMPERATURE

AGE

EXERCISE

HORMONAL LEVEL

STRESS

CIRCARDIAN RHYTHM

ENVIRONMENT

Introduction

Homeothermic - maintaining constant internal body temperature

Endotherms - generate their own internal body heat

Why temperature should maintain?

- For normal enzyme activity
- For normal neuronal activity
- Rise in high temp. cause denature of proteins

Body temperature

Body temp:

Core temperature measured in oral or rectal

Skin temperature measured on skin

Normal body temperature:

Oral : 98.6°F (97.3–98.8°F) or 37^{0}C (36.3–37.1°C)

Rectal : 0.5^{0}C more than oral

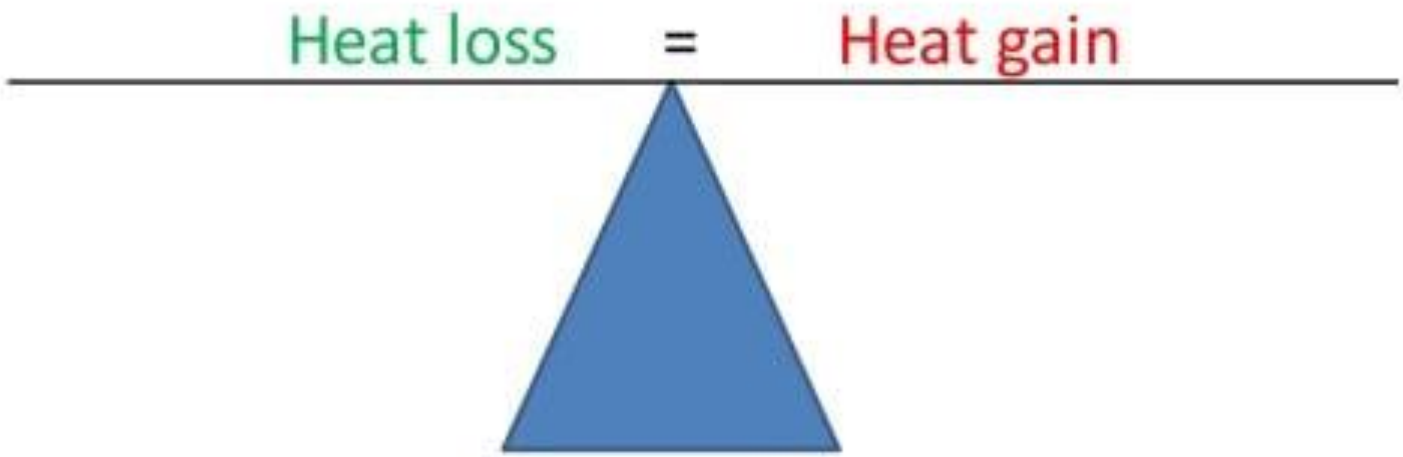
Axilla : 0.5^{0}C less than oral

Skin : depends upon the environment

Exercise : 101° to 104°F

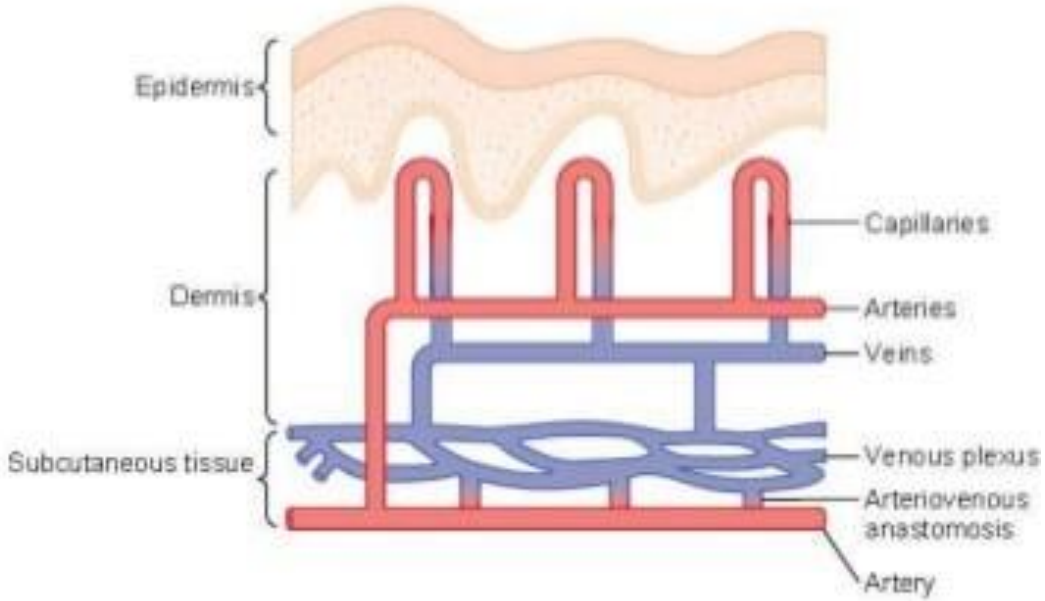
Rectal 0.5^{0}C > oral 0.5^{0}C > axilla

Maintenance of body temp.



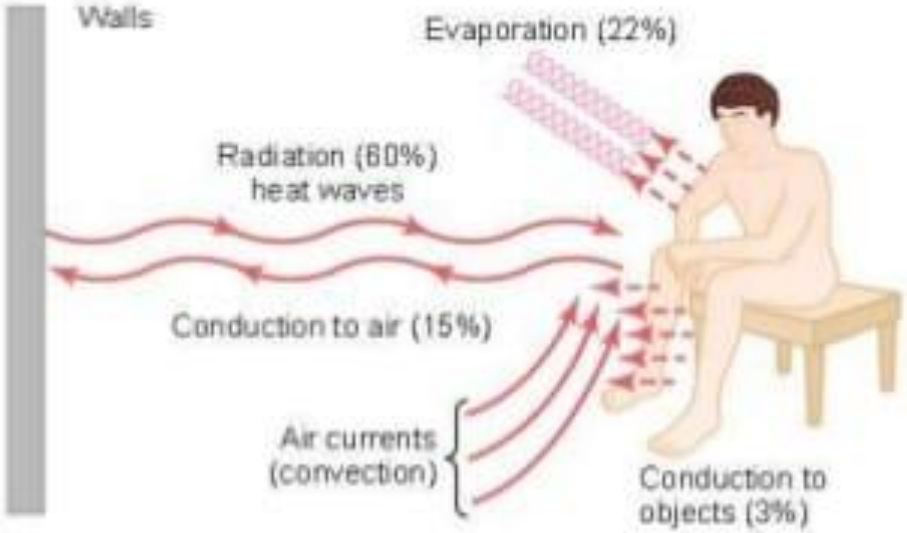
Heat gain mechanism

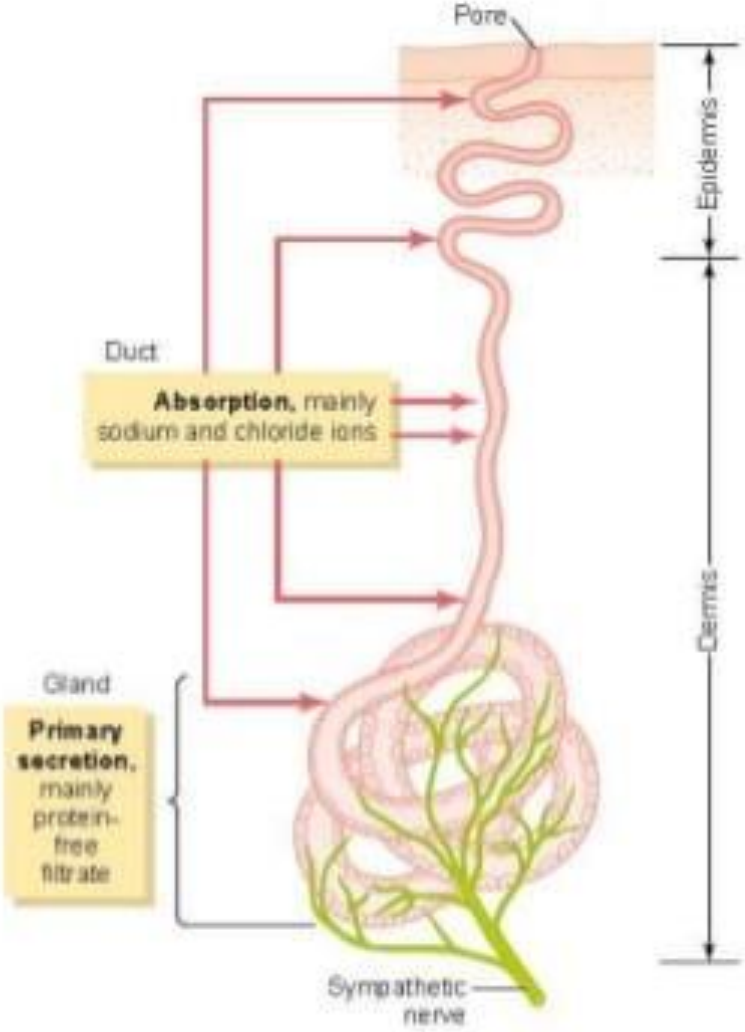
- Shivering
- Increase in metabolism by Epinephrine, nor-epinephrine & thyroxin
- Cutaneous Vasoconstriction



Heat loss mechanism

- Evaporation of Sweat
- Radiation
- Conduction & convection
- Cutaneous Vasodilation
- Decrease in metabolism
- Through respiration

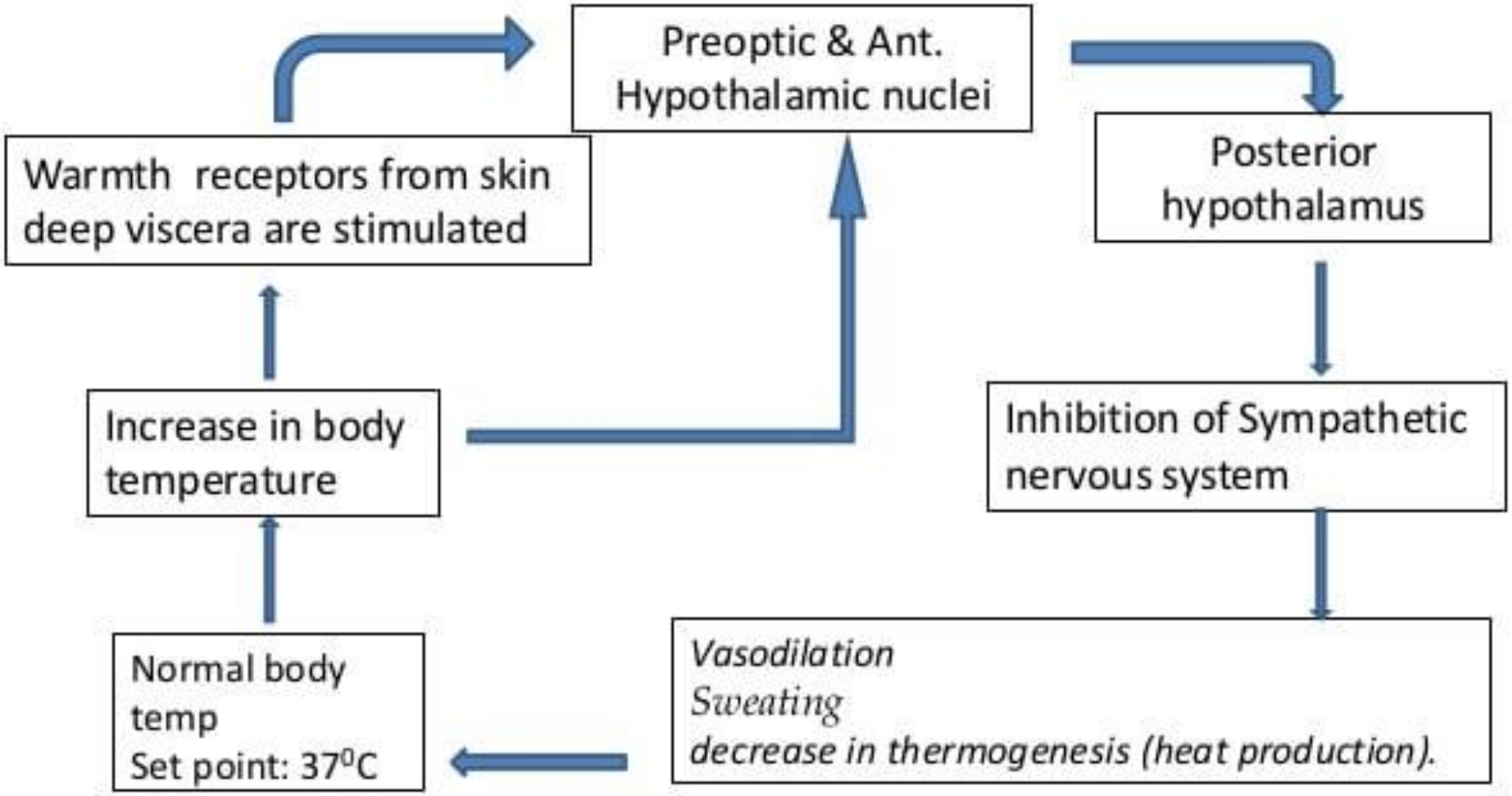




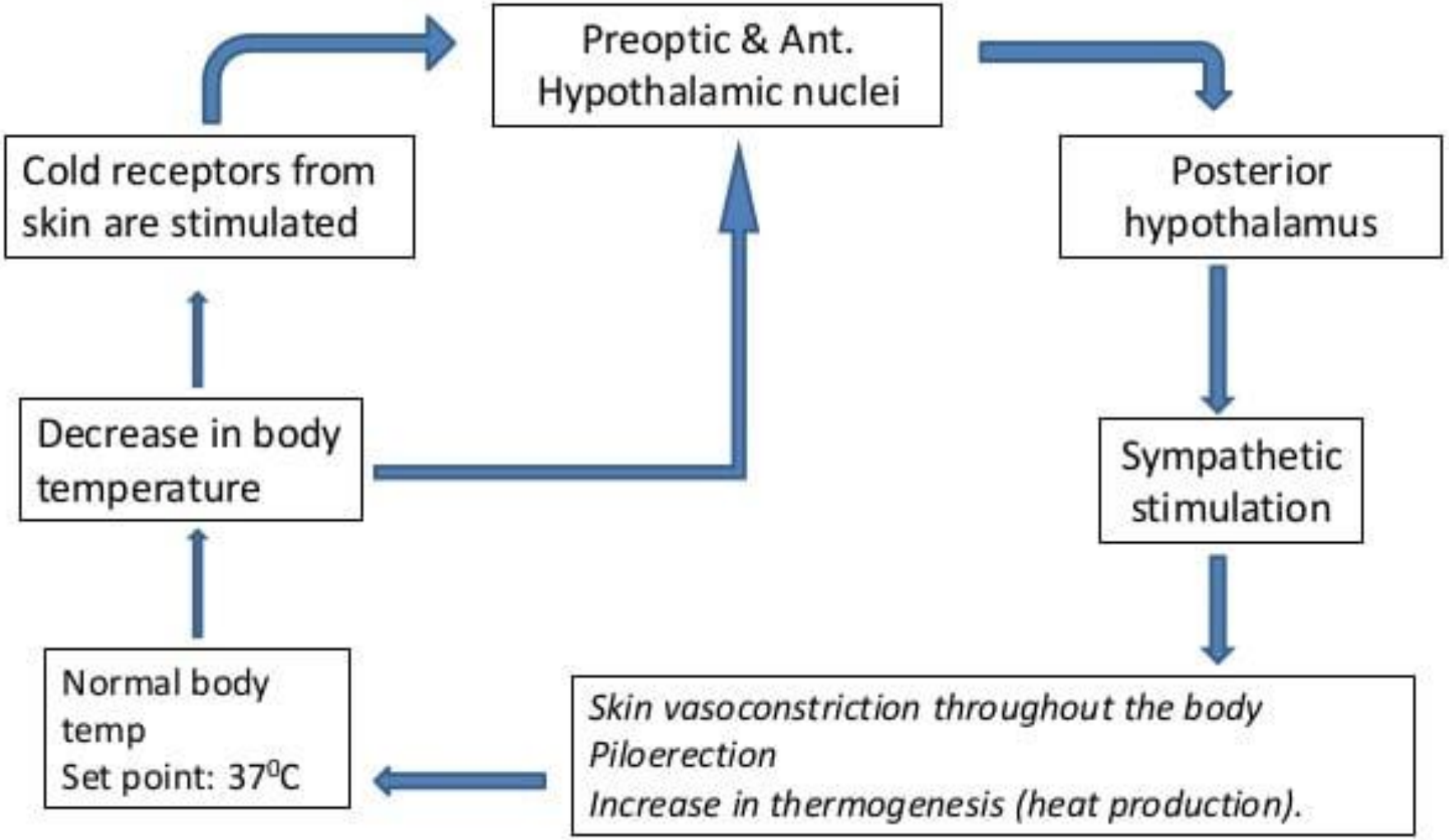
Regulation of Body Temperature - Role of the Hypothalamus

- Receptors: warmth & cold receptors from skin, deep tissues, spinal cord and hypothalamus
- Heat loss center – Preoptic & Anterior hypothalamic nuclei
- Heat gain center - Posterior hypothalamus
- Set point: 37^0C in hypothalamus
- ± 0.1^0C cause hypothalamus to activate heat loss or heat gain mechanism

Temperature-decreasing mechanisms when the body is too hot



Temperature-increasing mechanisms when the body is too cold



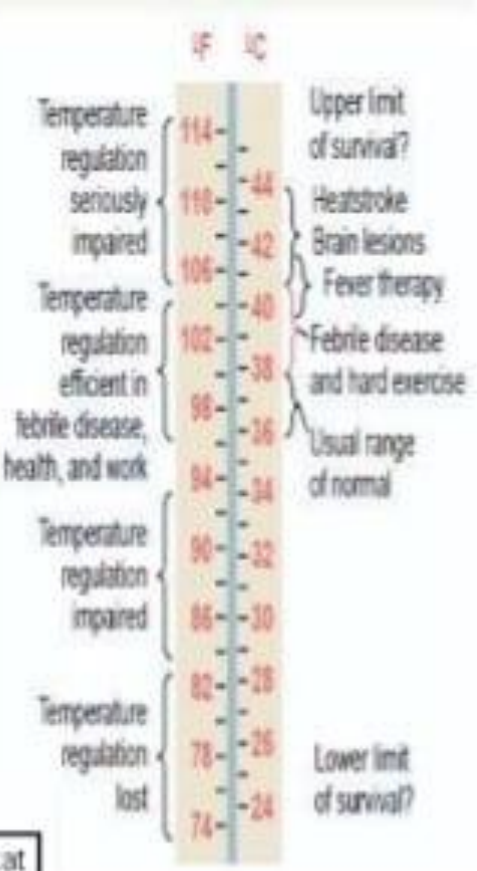
Abnormalities of body temperature regulation

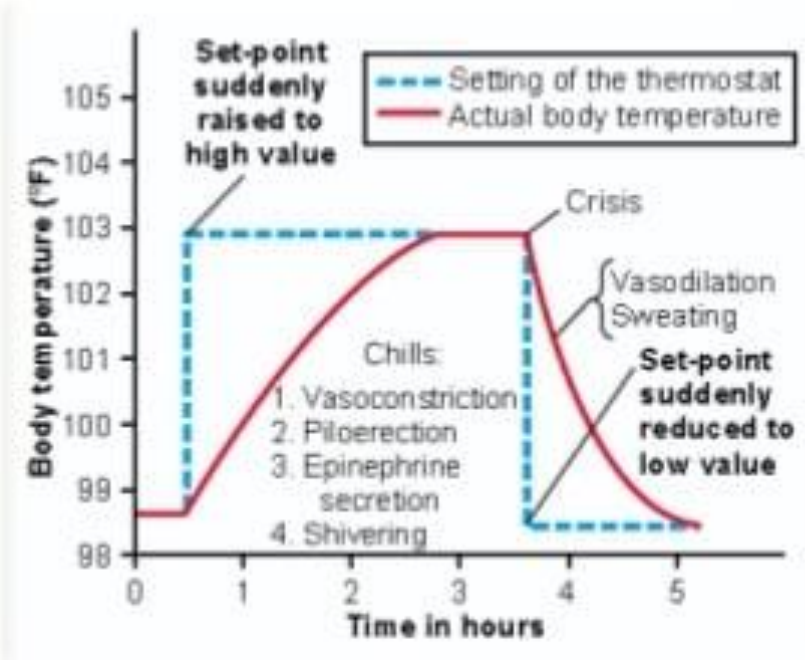
Hypothermia: decrease in body temp below normal range

Hyperthermia: increase in body temp above normal range

Hyperthermia - Fever

- Increase in body temp above the normal
- Due to rise in set point of hypothalamus by Pyrogen
- Pyrogen: any substance that rise the set point of hypothalamus
  - Bacterial endotoxins , cell memb proteins & breakdown products
  - IL-1
  - Inflammatory mediators: kinin, bradykinin, prostaglandin E
- Characteristic of febrile condition:
  - Crisis
  - Fever
  - Crisis or flush
- Antipyretics: aspirin blocks PG-E





Heatstroke

Occurs when body temp rises beyond the critical temp ranges from 105 to 108^{0}F

Symptoms:

- Dizziness
- Abdominal distress,
- Vomiting
- Delirium
- Loss of consciousness
- Circulatory shock
- Death

Hypothermia

- person exposed to ice water for 20 to 30 minutes ordinarily dies because of heart fibrillation

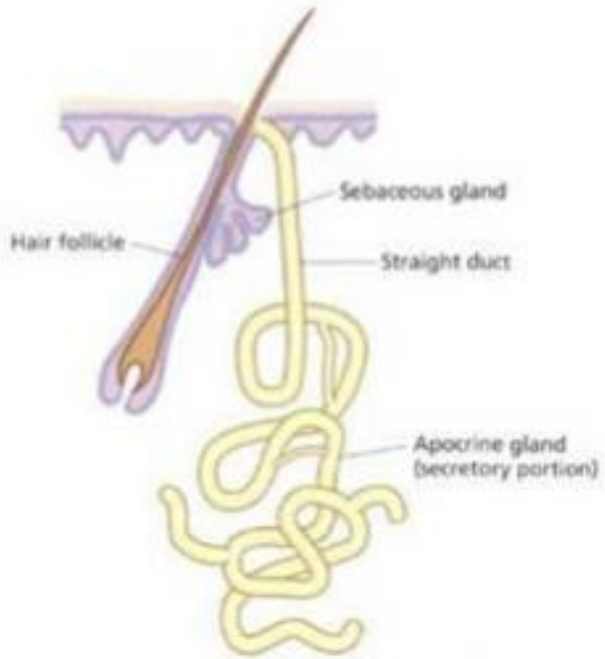
- the body temperature has fallen below 85°F, the ability of the hypothalamus to regulate temperature is lost

Frostbite

- When the body is exposed to extremely low temperatures, surface areas can freeze; the freezing is called *frostbite*.
- especially in the lobes of the ears and in the digits of the hands and feet

Sweat glands

Apocrine gland



Eccrine gland

Sweat

Sweat is the watery fluid produced and excreted by the sweat gland .

Sweat glands; They are simple tubular glands found in almost every part of the skin(There are two to four million sweat glands distributed all over our bodies).

Each gland consists of two parts;

1- A secretory portion which lies deep in the dermis, where the tubule is twisted into a fairly compact tangle.

2- A duct portion passing outwards through the overlying dermis and the epidermis.

Sweating control and stimulation;

Sweating is controlled from a center in the hypothalamus where thermosensitive neurons are located .

Sweat glands are stimulated in response to; 1-high temperature .

2-exercise.

4- hormones.

3-emotional stress (emotionally induced sweating is restricted to palms ,soles , armpits and forehead while temperature induced sweating causes sweating throughout the body).

Sweat glands

There are two types of sweat glands ;

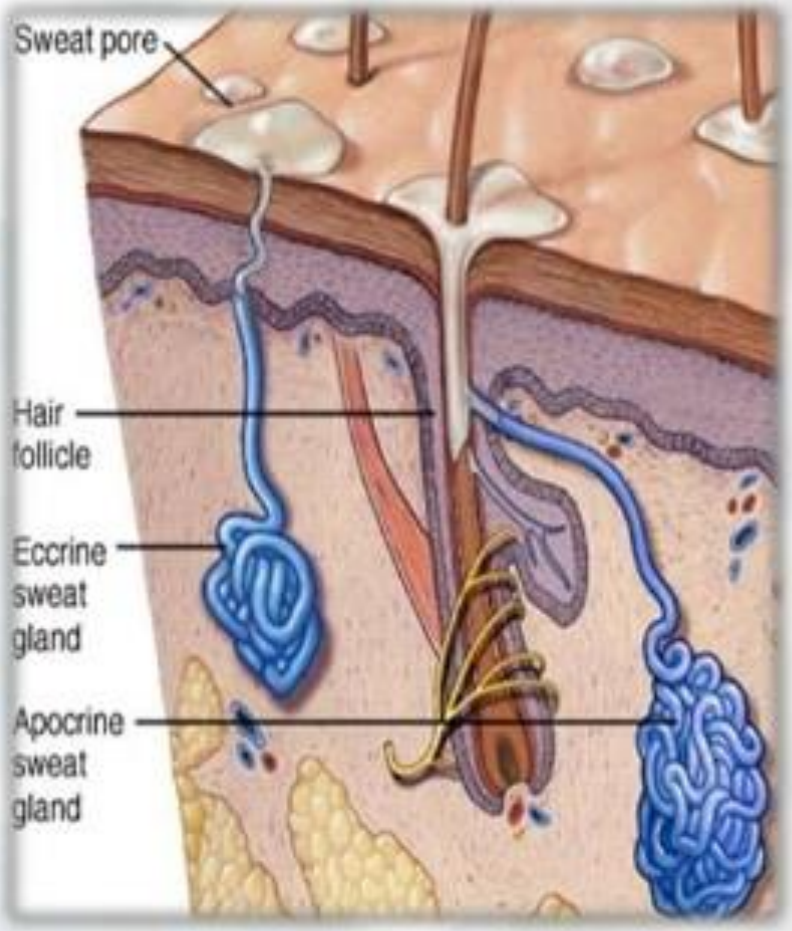
1-**TheECCRINE SWEAT GLANDS ;** They are located over the entire body surface except for the lips,nipples and part of the external genial, and are innervated by sympathetic nerves. The tiny ducts of the eccrine glands pass through the dermis and epidermis open up and empty directly on to the skin . They are active since birth producing an odorless, clear fluid which is sweat and is mainly a mixture of water and salts .

2- **The *Apocrine* sweat glands** ;

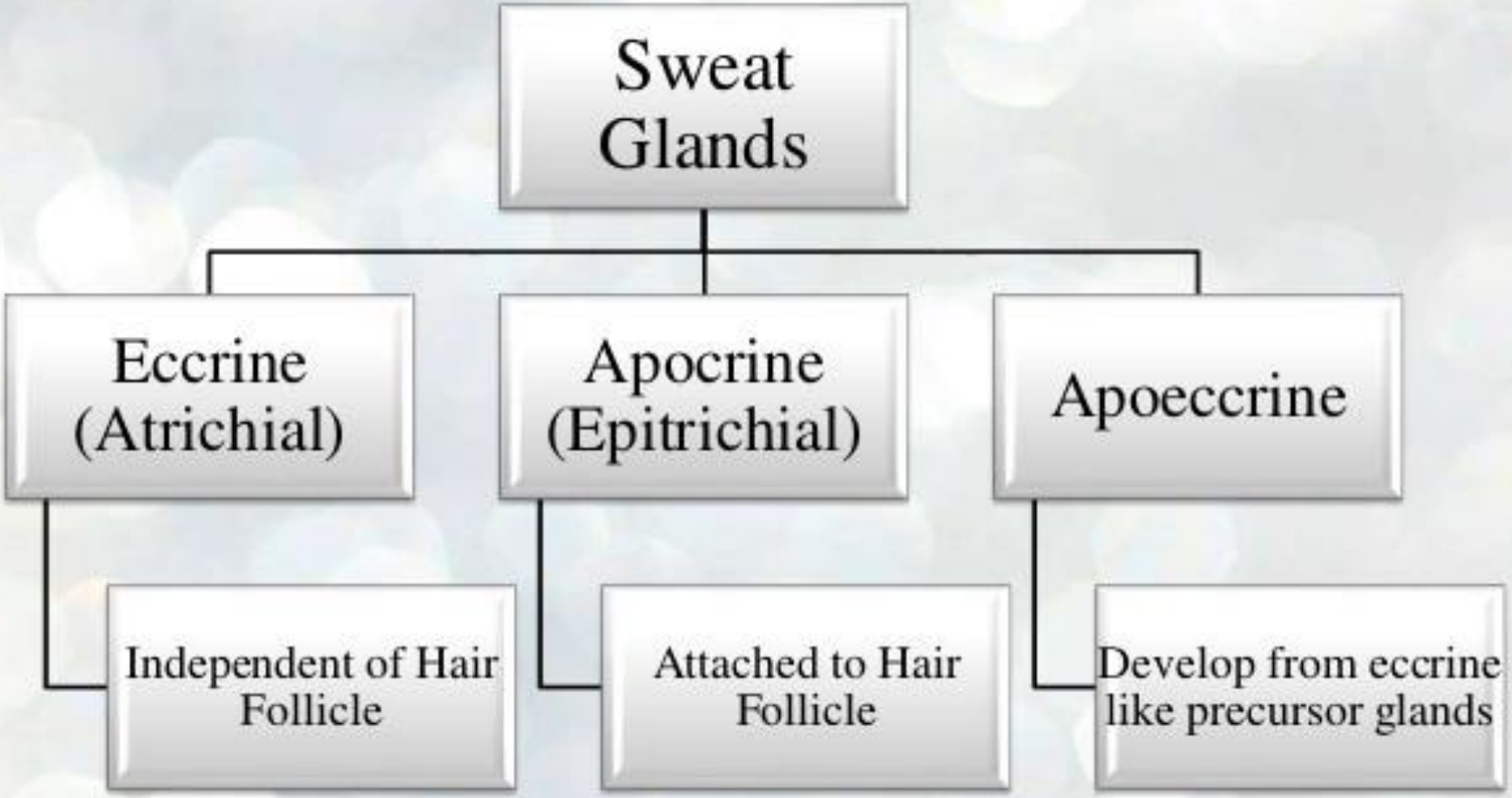
- They are limited in their distribution to axillary, pubic, and perianal region , and armpits (less than eccrine glands).
- They are larger in size compared to the eccrine sweat glands.
- They become active with the onset of puberty.
- They are associated with hair follicles and open up at the hair follicles.
- They produce a thick fluid, which in contact with bacteria on the skin's surface, produces a characteristic potent "body odor".

INTRODUCTION

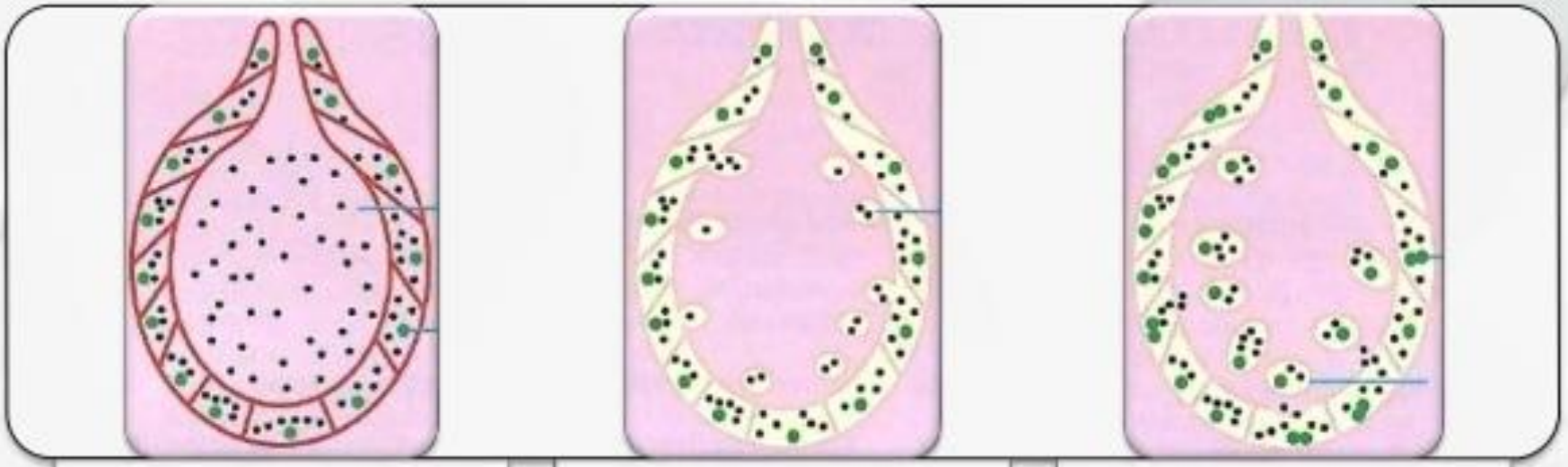
- Sweating is one of the most visible physiological events we experience everyday
- On average, 1.6 to 4 million sweat glands on the body
- Major function – Regulation of body temperature
- Failure can lead to heat exhaustion, heat stroke, hyperthermia and death



TYPES OF SWEAT GLANDS



TYPES OF SECRETION



Merocrine

- No breakdown of cellular material during secretion

Apocrine

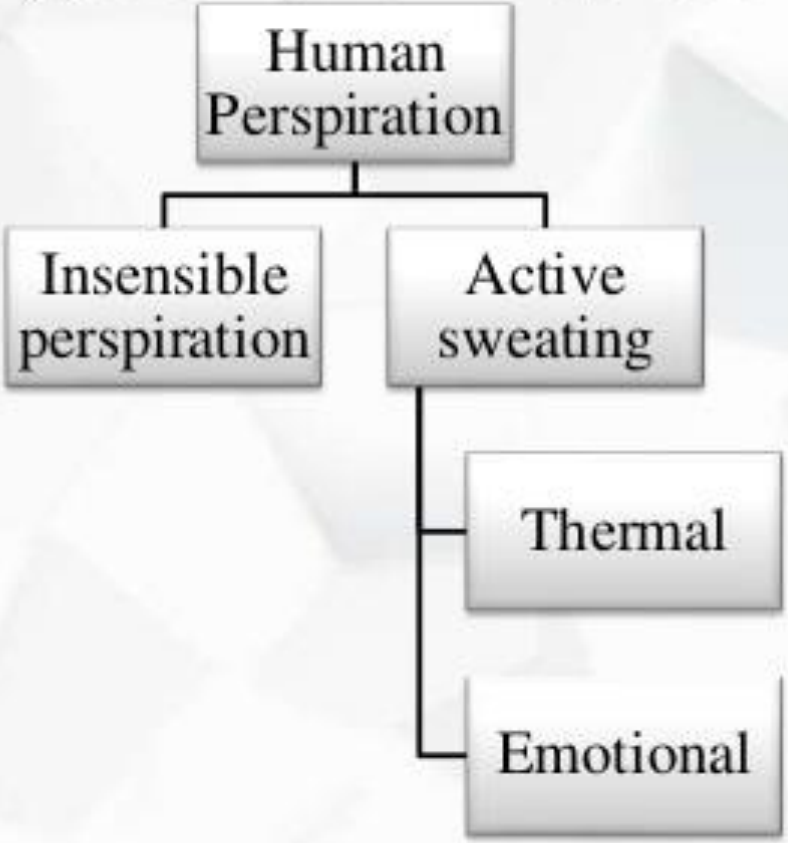
- A small amount of cytoplasm is pinched off

Holocrine

- Mature cell disintegrates and become secretory product

PHYSIOLOGY OF SWEATING

Types of Human Perspiration

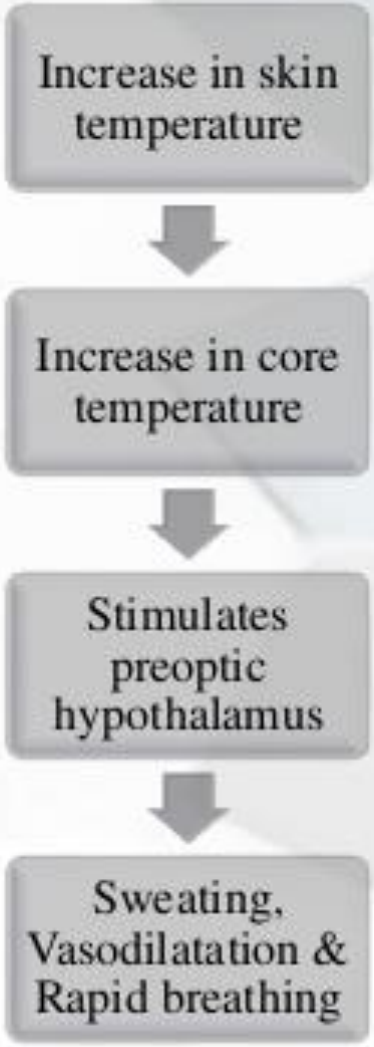


Emotional Sweating

- Palms and soles
- Shorter latent period for its onset
- Immediately attains a rate of secretion that corresponds to intensity of stimulus
- Subsides quickly after the end of stimulus

CONTROL OF ECCRINE SWEATING

- 10*C increase in local skin temperature – triples local sweating rate
- Increase in internal temperature – 9 times more efficient than increase in mean skin temperature in stimulating sweat center



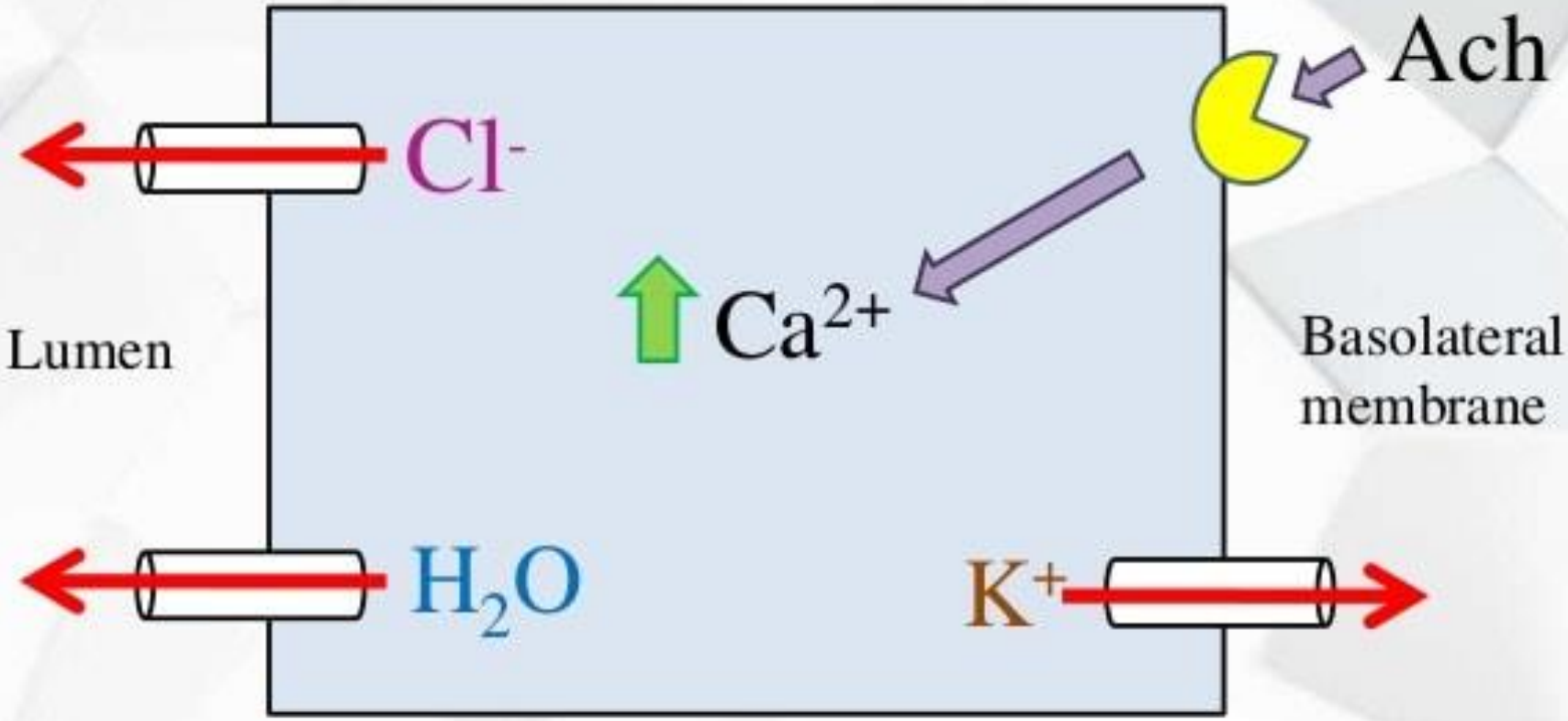
INNERVATION OF ECCRINE SWEAT GLAND

- Sympathetic and cholinergic
- Major neurotransmitter is Acetylcholine
- Respond to cholinergic agents, α and β adrenergic stimulants
- Other – ATP, catecholamine, vasoactive intestinal peptide, atrial natriuretic peptide, calcitonin gene related peptide and galanin

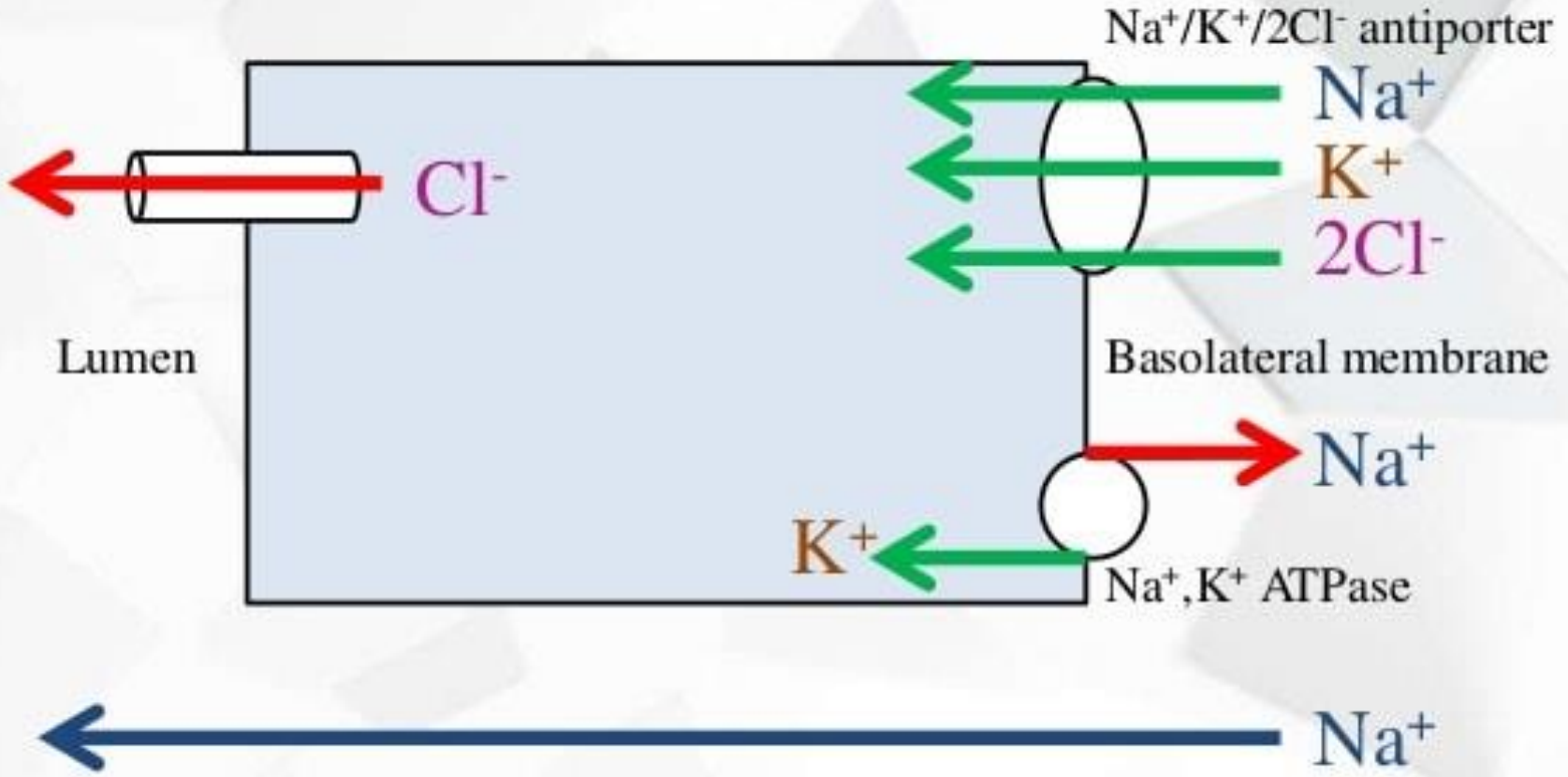
PART	ROOT
Face and eye lids	T1 to T4
Upper limb	T2 to T8
Trunk	T4 to T12
Lower limb	T10 to L2

Ratio of maximal secretory rates		
Cholinergic	α-adrenergic	β-adrenergic
5	1	1

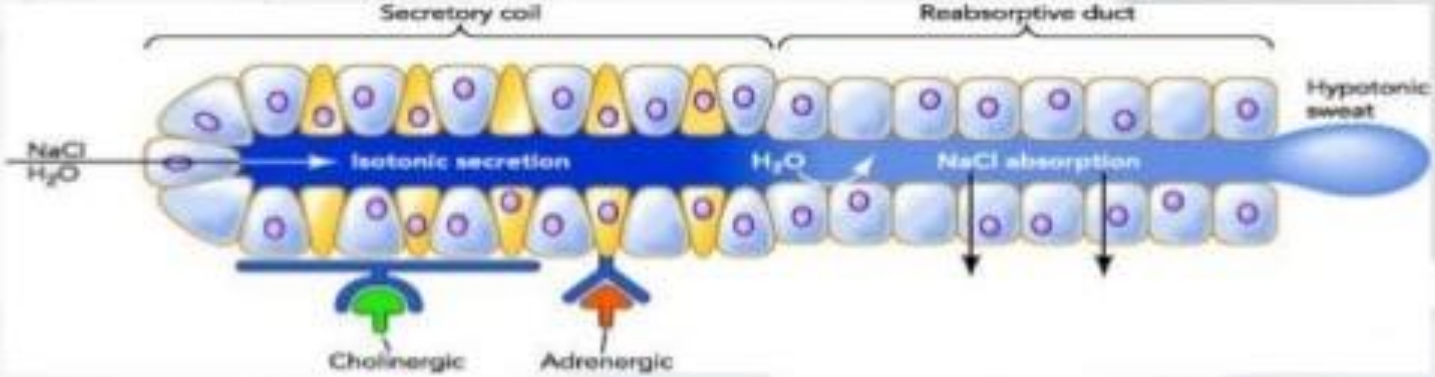
MECHANISM OF SWEAT SECRETION

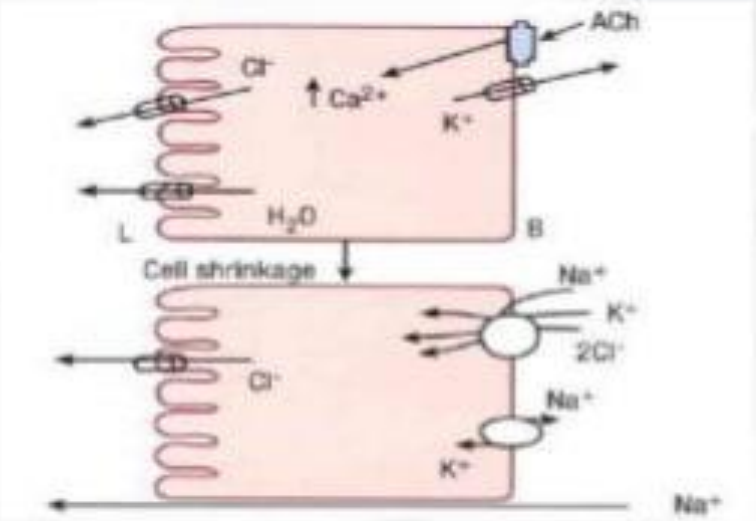


MECHANISM OF SWEAT SECRETION

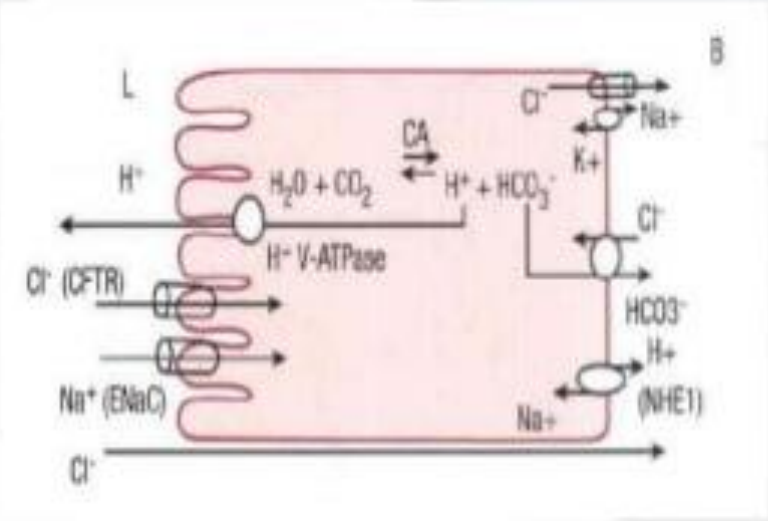


MECHANISM OF SWEAT SECRETION





Net fluxes – H_2O, Cl^- and Na^+ flow into the lumen (isotonic and neutral pH)



Net fluxes – H^+ secretion and Na^+ and Cl^- reabsorption (hypotonic and acidic)