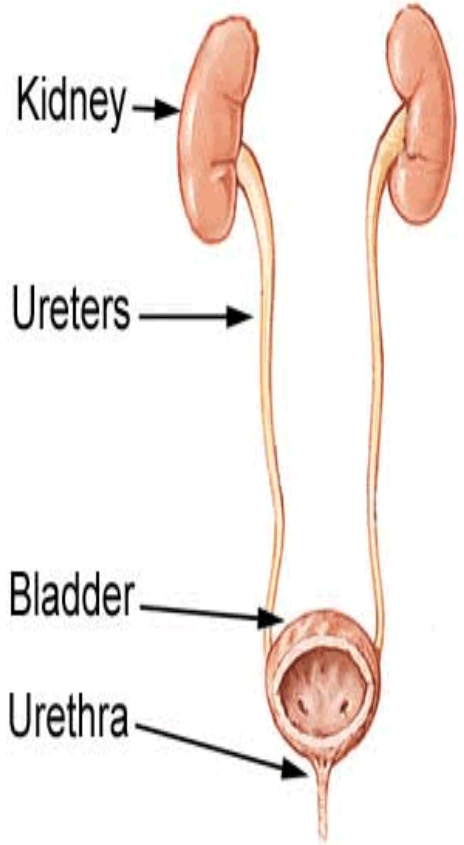
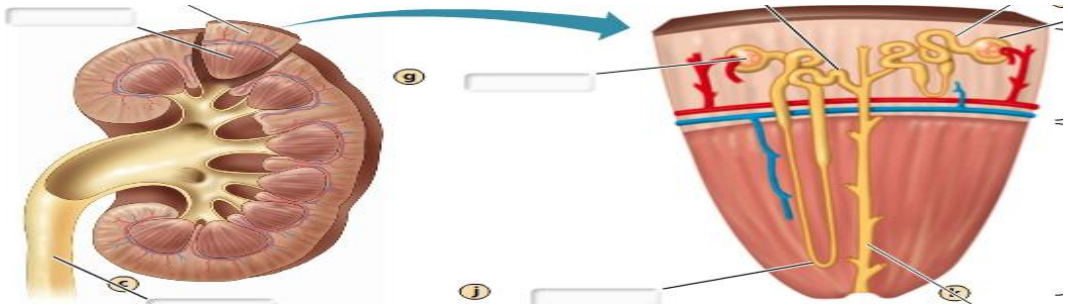
Physical properties and detection of normal constituents of urine

-Urinary system :

- The urinary system works with the lungs, skin and intestines to maintain the balance of chemicals and water in the body.
- The kidneys form urine, which passes through the ureters to the bladder for storage prior to excretion.
- Waste products are excreted selectively , electrolyte levels are controlled and pH (acid-base balance) is maintained by excretion of hydrogen ions .
- The composition of urine reflects **exchange** of substance between the nephron and blood in the renal capillaries.

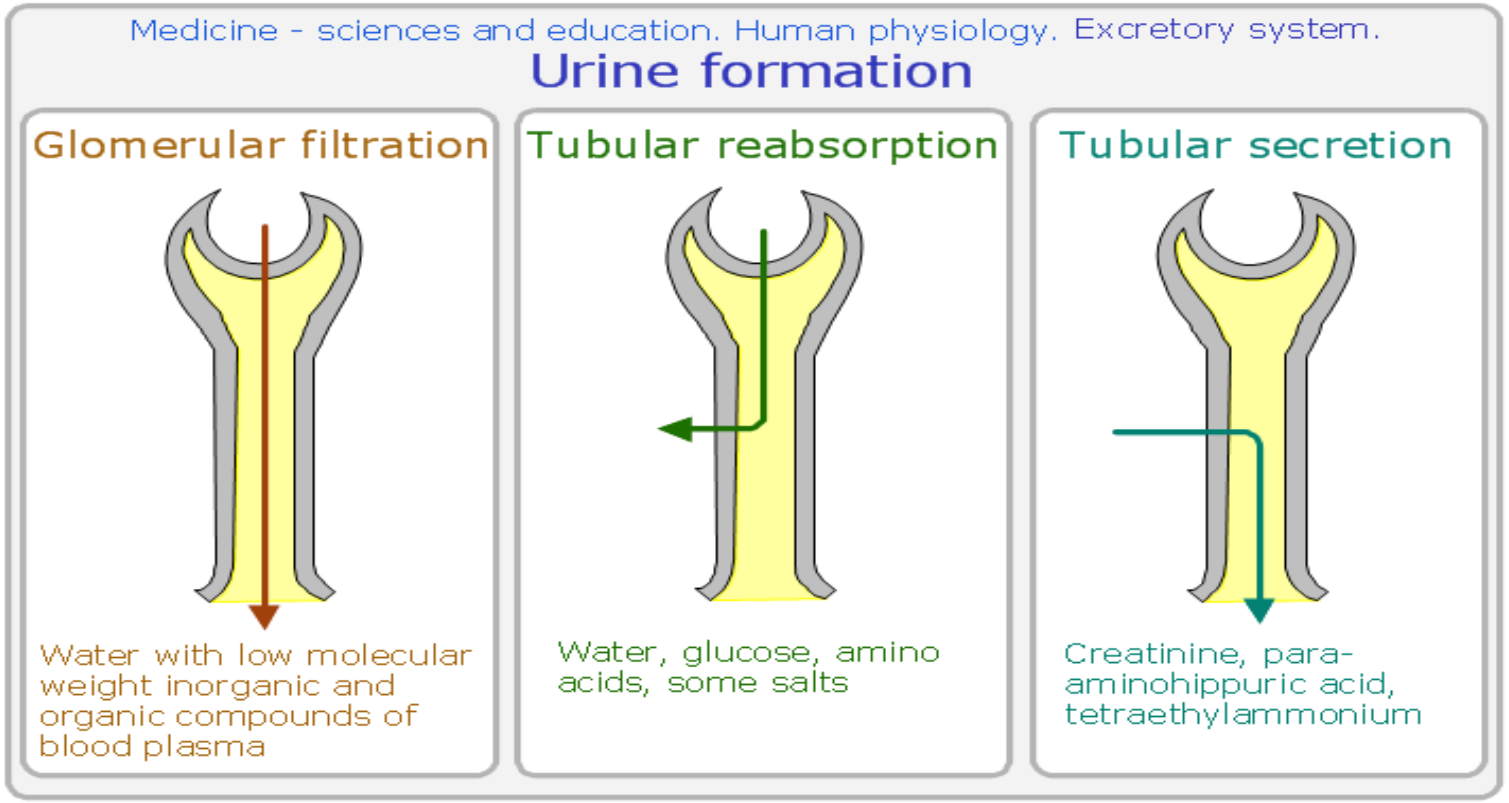




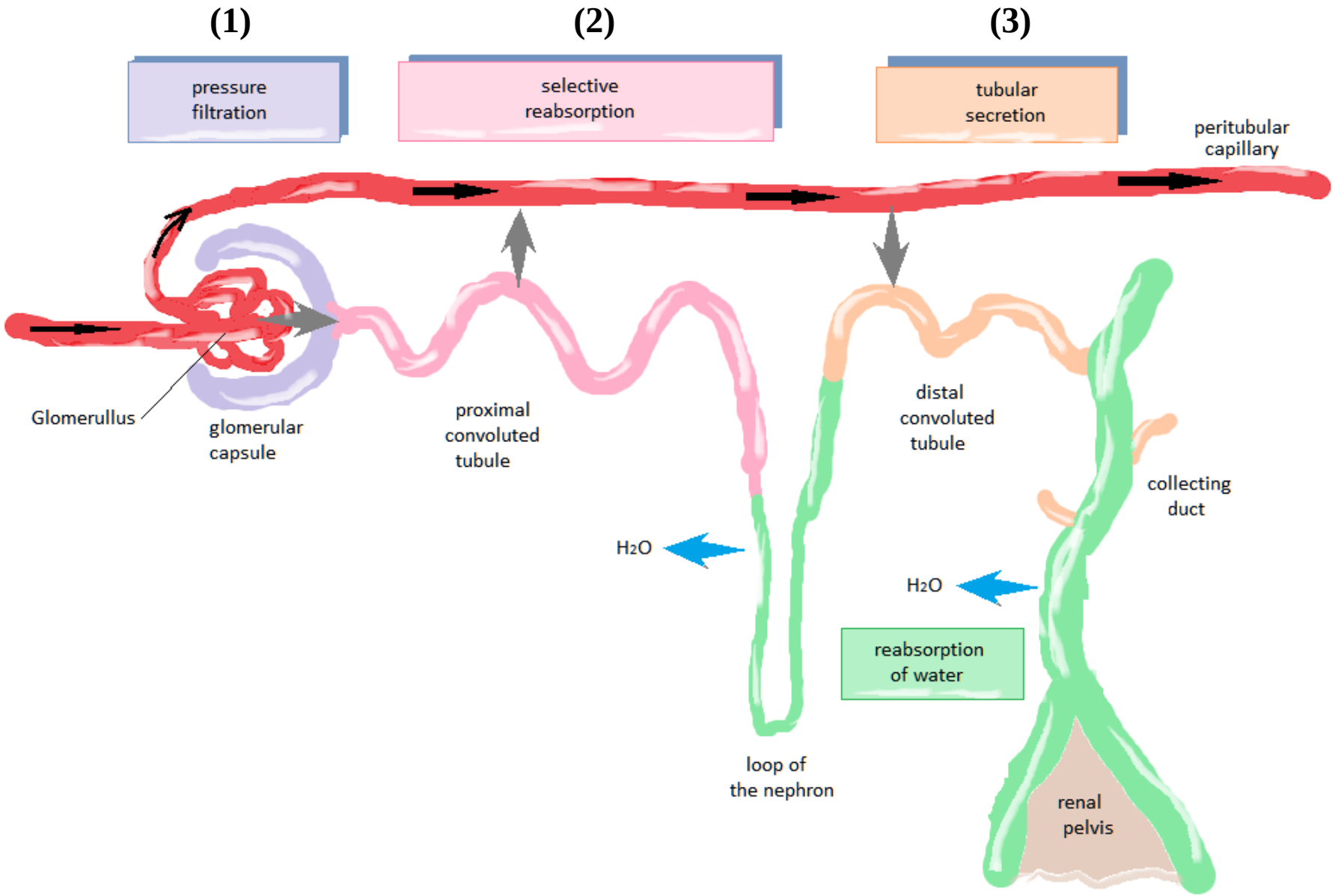
-Urine Formation:

- There are three processes involved in the formation of urine:

1. Filtration.
2. Selective reabsorption.
3. Secretion.



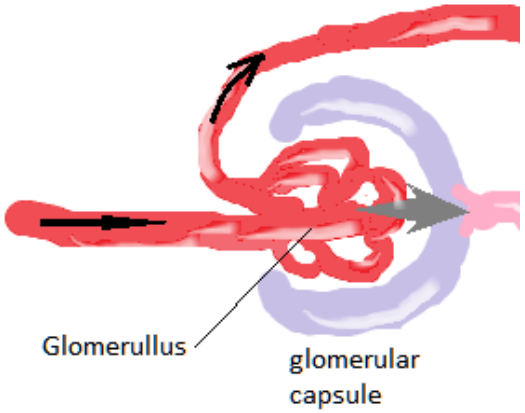
The three processes of urine formation



one: Filtration :

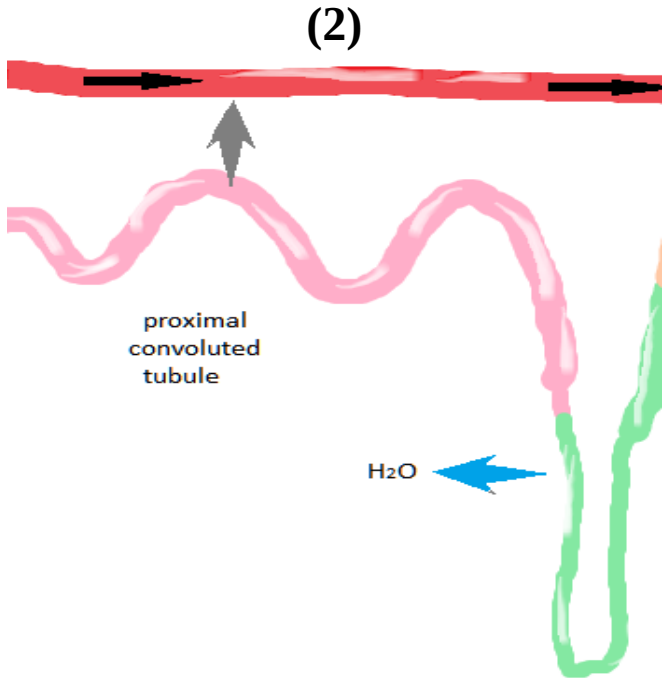
- This takes place through the semipermeable membrane of glomerulus and glomerular capsule (Bowman's capsule).
- Water and small molecules move from the glomerulus to the inside of the glomerular capsule.
- Molecules which have molecular weight **more than** 70,000 Dalton can not pass the glomerulus.
- Blood cells, plasma proteins and other large molecules are too large to filtrate (not filtrated).
- Inside the glomerular capsule now contains glomerular filtrate which is very similar in composition of plasma **except of plasma proteins and blood cells.**
- (Non-selective filtration occurs).

(1)



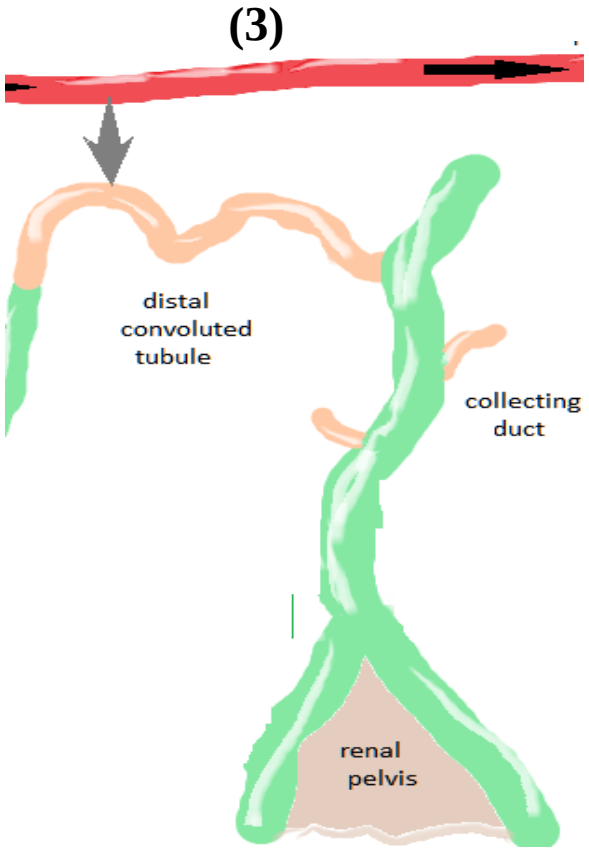
two: Selective reabsorption:

- Is the process of restoration water and some solutes from the tubular fluid and returning them to the blood.
- **Reabsorption** is the movement of water and solutes from the tubule back into the blood.
- As molecules and ions are passively and actively reabsorbed from the nephron into the blood of the peritubular capillary network.
- Nutrients such as glucose and amino acids **return** to the peritubular capillaries almost exclusively at the proximal convoluted tubule.
- Every substance has a **maximum rate of transport.**



three: Secretion:

- Is a second way by which substances are removed from blood and added to the tubular fluid.
- Is a process in which the renal tubule extracts chemicals from the capillary blood and secretes them into the **tubular fluid.**
- Hydrogen ions (H+), creatinine, and drugs such as penicillin are some of the substances moved by active transport from blood into the kidney tubule.
- Tubular secretion is now known to occur along the length of the kidney tubule.



- In the end, **urine contains :**

1-Substances that have undergone glomerular filtration (step one) but have not been reabsorbed (step two).

2-Substances that have undergone tubular secretion (step three).

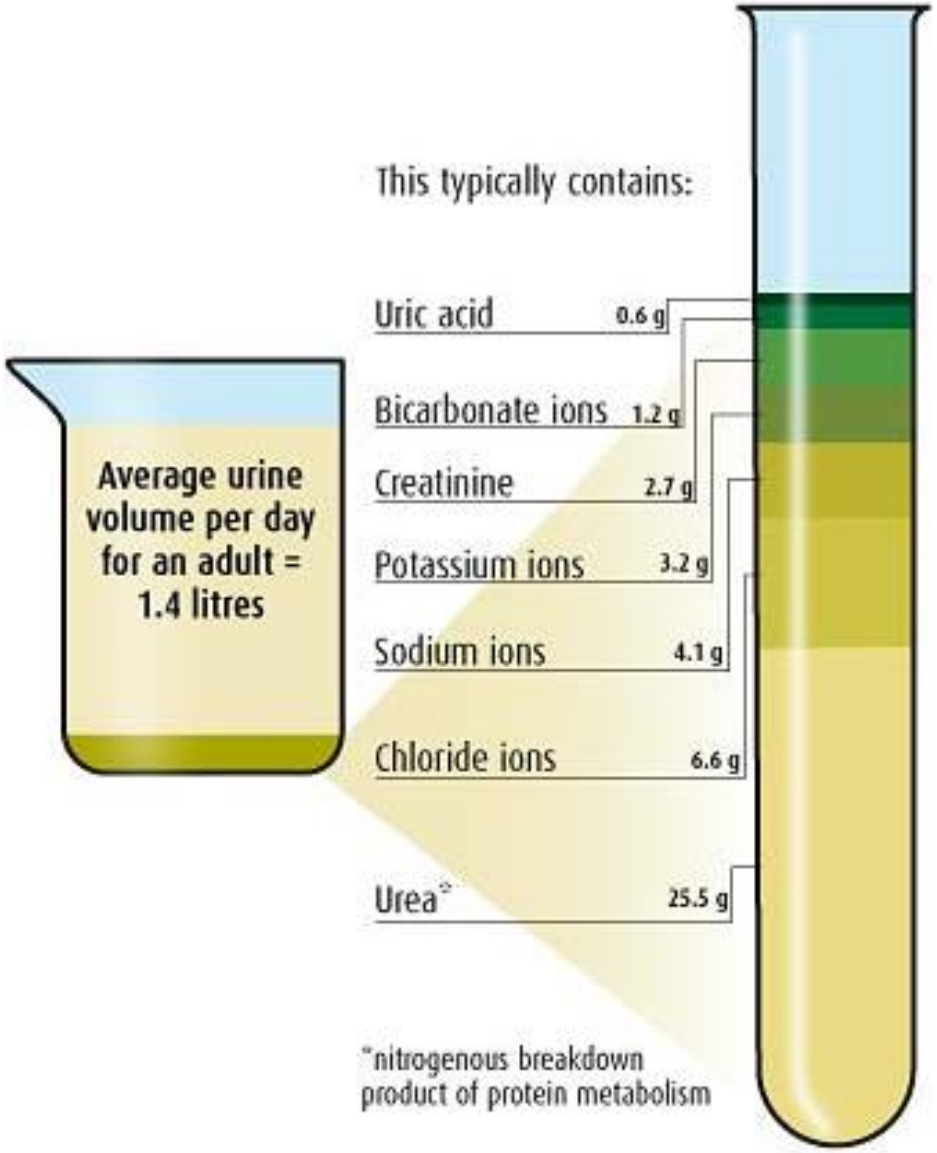
Glomerular filtrate VS Urine

Constituent	Daily Excretion	
	Glomerular Filtrate	Urine
Water	130,000 ml	1500 ml
Sodium	20,000 mmol	150 ml
Albumin	4 g (60 µmol)	0.04 g (6 µmol)
Urea	900 mmol	400 mmol

-Composition of Normal Urine:

- Water 96%
- Urea 2%
- Uric acid
- Creatinine
- Oxalate
- Ammonia
- Sodium
- Potassium
- Chloride
- Phosphate
- Sulphate

2%



-Urinalysis:

- Urinalysis (UA) is one of the most frequently ordered tests.

- Two unique characteristics of urine specimens :

1- Urine is readily available and easily collected specimen.

2- Urine contains information about many of the body's major metabolic functions, and this information can be obtained by simple laboratory tests.

-Laboratory testing for routine urinalysis (types of testing):

- First, the **physical characteristics** of the urine are noted and recorded .
- Second , a series of **chemical tests** is run . A chemically impregnated dipstick can be used for many of these tests.
- Third, the urine sediment is examined under **microscopic** to identify components.

Patient Name:_____

Age:_____ ❑ M ❑ F

Physician's Name:_____

Collection Date:_____ Test Date:_____ Tester's Initials:_____

Physical Characteristics:

Color: ❑ colorless ❑ yellow ❑ amber ❑ other ❑ orange ❑ green ❑ red

Appearance: ❑ clear ❑ hazy ❑ cloudy ❑ turbid

Chemical Measurements: (circle one)

urobilinogen (mg/dL)	normal	2	4	8			
glucose (mg/dL)	neg	50	100	250	500	1000	
ketone (mg/dL)	neg	trace/5	+/15	++/40	+++/80	++++/160	
bilirubin	neg		+	++	+++		
protein (mg/dL)	neg	trace		+/30	++/100	+++/300	++++/2000
nitrite	neg	pos (any pink color is considered positive)					
leukocytes	neg	trace	+	++	+++		
blood	neg	trace	moderate	trace	+/small	++/mod	+++/large
		Non-Hemolyzed		Hemolyzed			
pH	5	6	6.5	7	8	9	
specific gravity	1.000	1.005	1.010	1.015	1.020	1.025	1.030

Microscopic Examination:

WBC_____/HPF Crystals_____ Parasites_____

RBC_____/HPF Bacteria_____ Spermatozoa_____

Casts_____/LPF Yeast_____ Artifacts_____

Epithelial Cells_____/HPF Other_____

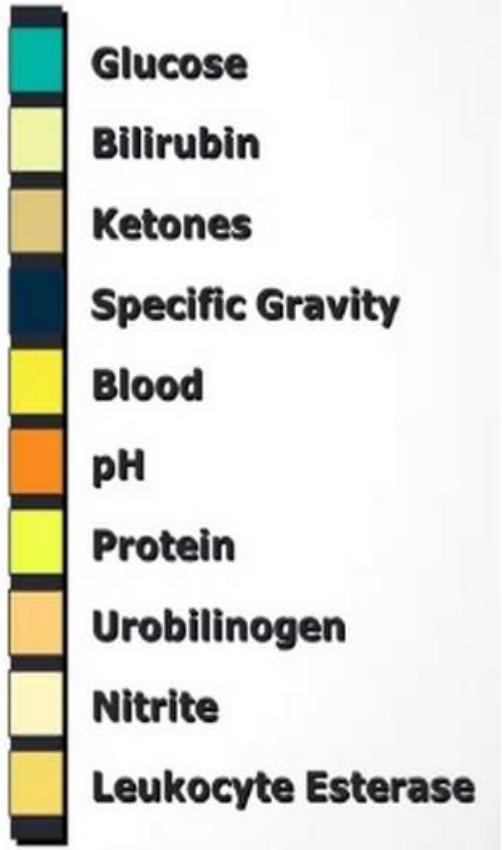
Physical characteristics

Chemical tests

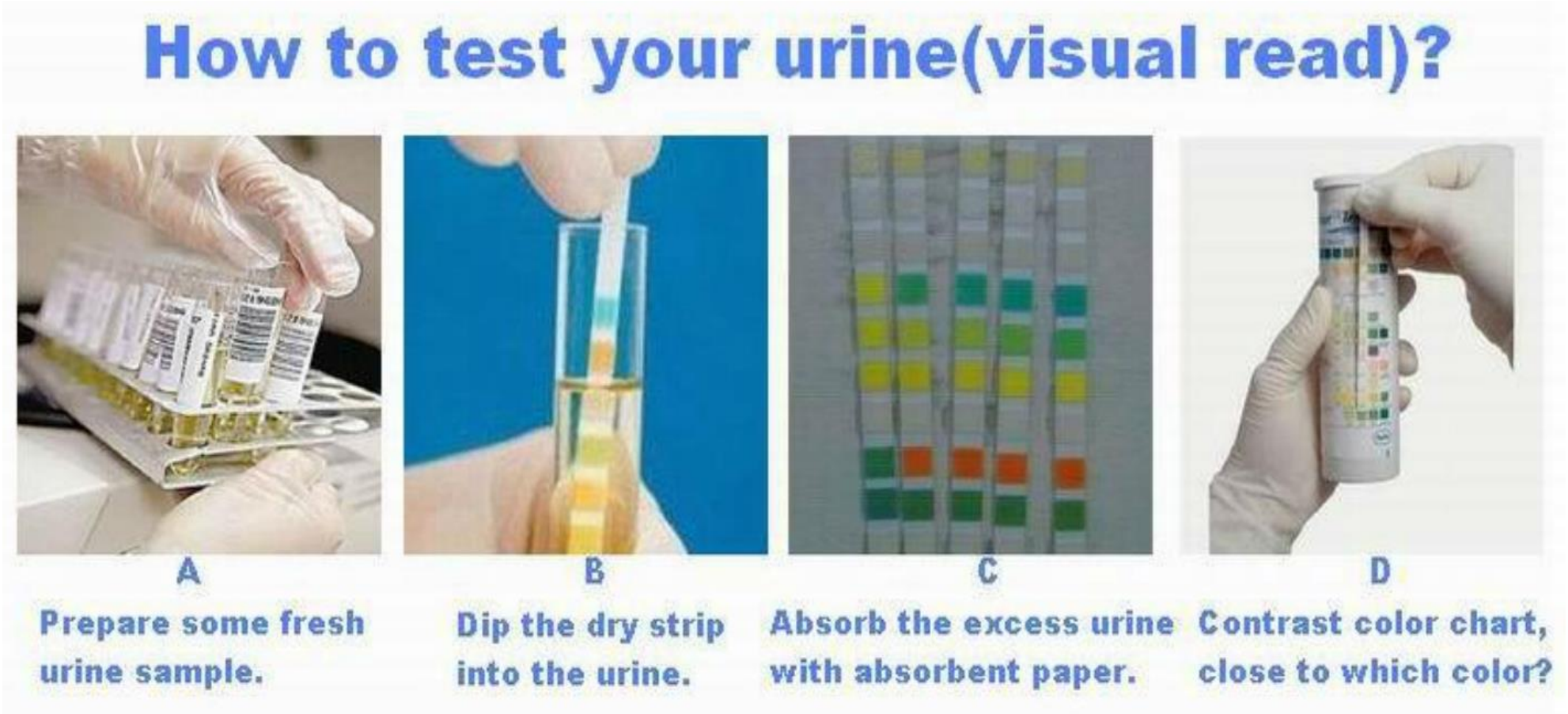
Microscopic examination

Urine dipstick / Urine test strips:

- The test strips consist of a ribbon made of absorbent microfiber cellulose pads attached to it.
- Each pad contains the dried **reagents** needed for a **specific test** that react with the compounds present in urine producing a characteristic colour.
- The depth of color produced relates to the concentration of the substance in the urine.
- It provides quick **Semi-quantitative determinations** of pH, protein, glucose, ketones, bilirubin, hemoglobin (blood), nitrite, leukocyte , urobilinogen, and specific gravity.
- Color changes then matched to the control chart at the correct time after each stick is dipped into the urine specimen.



Urine dipstick / Urine test strips



How to use urine test strips : https://youtu.be/g_4PiTezF6s

Simple Examination of the Urine

Physical Examination

Volume, Specific gravity, Color, Appearance, odor, pH

Chemical Examination

Organic

Uric acid, Creatinine

Inorganic

Chloride, Phosphate, Bicarbonate, Sulphate, ammonia.

Physical Examinations:

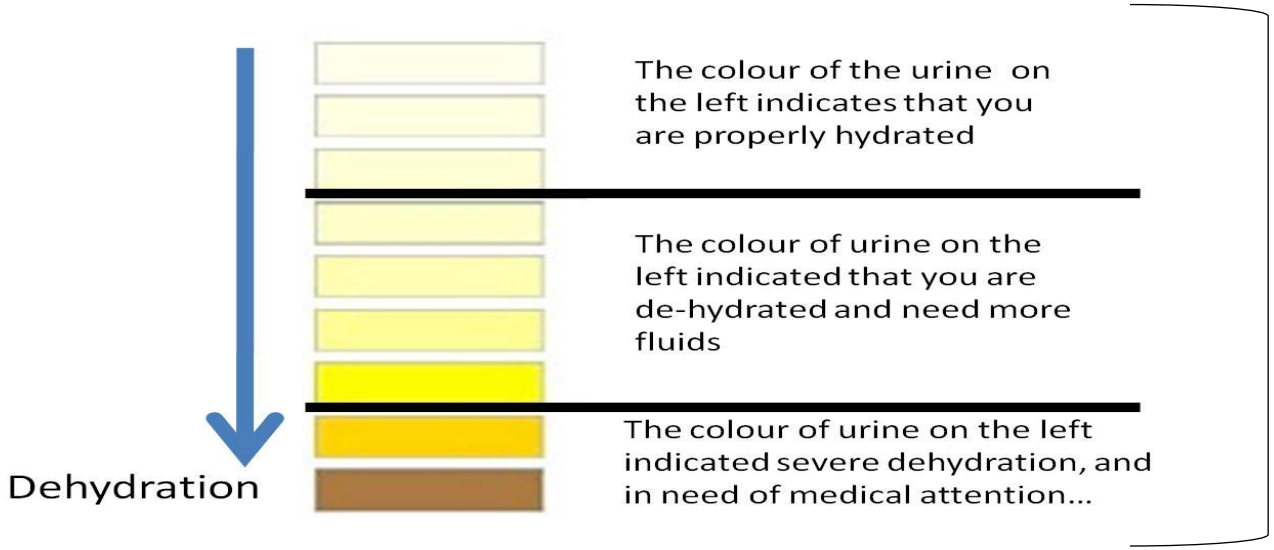
1- Volume:

- The daily output of urine on an average diet and normal fluid intake is between 800-2500 ml with an average of 1500 ml/day.
- Effected by : 1) Physiological factors. 2) Pathological factors.

Polyuria	Oliguria	Anuria
• More than 2500 ml/day. • Diabetes mellitus. • Chronic renal insufficiency.	• Below 500 ml /day. • In case of deficient intake of water or excessive loss of fluids by other routs like hemorrhage or as diarrhea and vomiting.	• Below 100 ml /day. • Stones or tumors in the urinary tract can also cause it by creating an obstruction to urinary flow.

2- Colour :

- Normally, Urine is amber in color due to the presence of urobilin (urochrome).
- Pale urine has a **low** specific gravity, a dark line has a **high** specific gravity (a **direct relationship** between the colour and the specific gravity).
- **Coloured urines** occur in certain diseases or metabolic disorders, and after the administration of many drugs.



The more that your body is dehydrated , the more the urine is dark

Change in the color or odour is a warning sign!

Pale yellow or clear
- healthy and hydrated

Bright yellow
- an excess of B vitamins

Red
- blood in urine
- eating beetroot or blackberries

Purple
- porphyria, a rare metabolic disorder

Brown
- certain antipsychotic drugs
- certain antibiotics
- phenytoin (Dilantin)
- sennoside laxatives

Green
- drugs containing phenol
- some antidepressants
- dyes in food
- biliverdin, a bile pigment
- certain infections

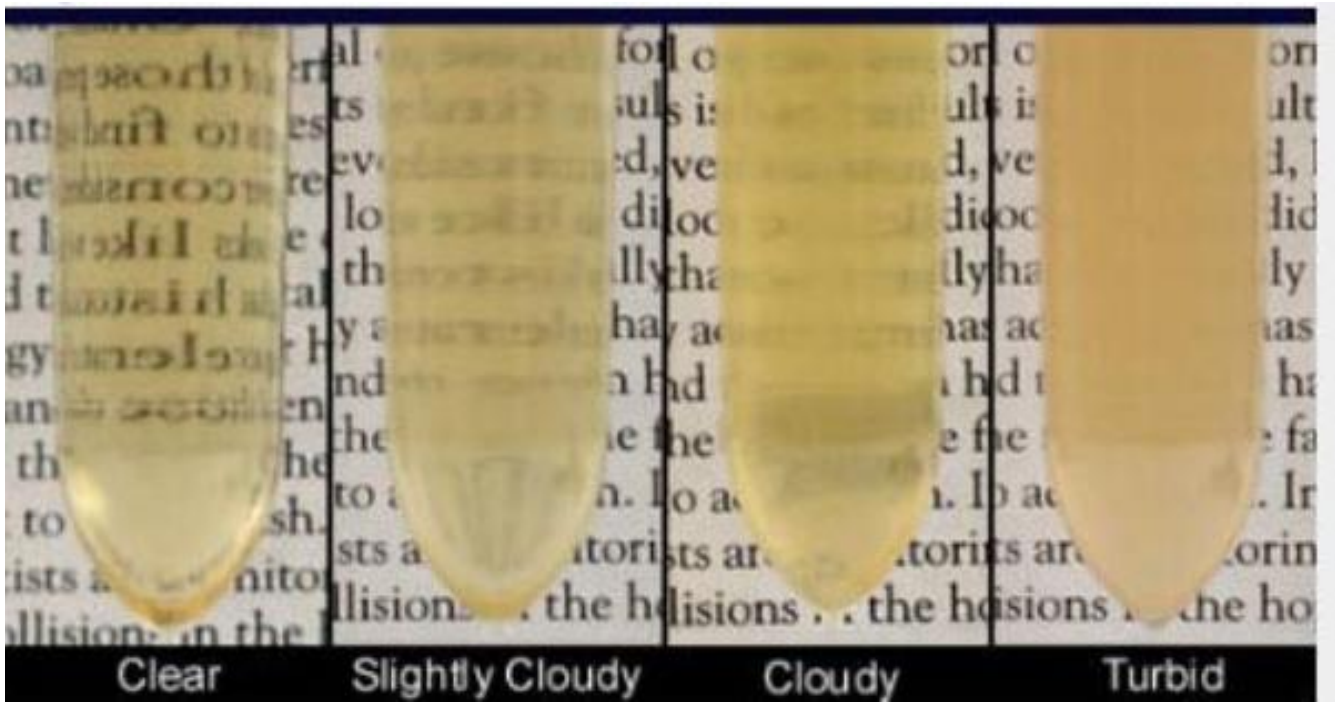
Orange
- dehydration
- certain drugs and medications
- dietary factors, such as eating lots of carrots

3- Appearance :

- Normal urine is clear.

- **Urine clarity is typically classified as:** clear, mildly cloudy, cloudy, or turbid.

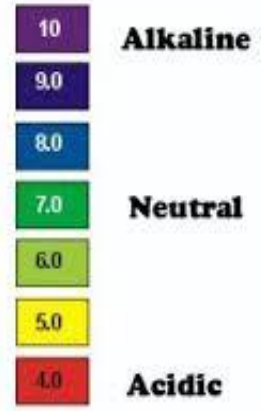
➔**Note:** cloudy or turbid urine can indicate dehydration, urinary tract infection or presence of RBCs, WBCs, epithelial cells or bacteria.



4- Odour:

- Normally Urine smells **aromatic** due to the presence of volatile organic acids.
- The urine of patients with diabetes ketoacidosis may have a fruity (acetone) odor **because of ketosis**.
- Urine which is infected with Gram-negative organisms often has a distinctive unpleasant smell (fish-like odour).
- Certain drugs impart a typical odour.

5- pH:



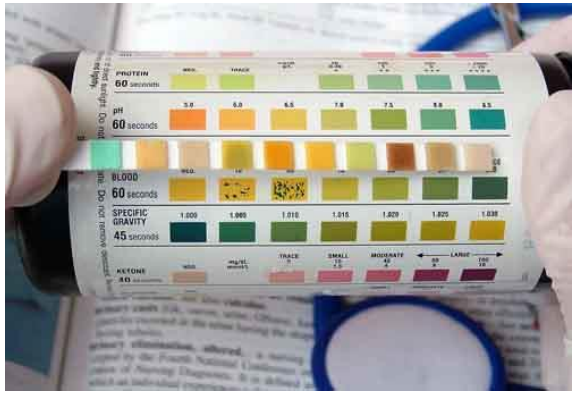
- On a normal mixed diet the urine is **usually acid**, generally varying in pH between **5.5 and 8.0**, with a **mean of 6 in 24 hours.**

- Acidic Urine :

- Diabetic ketosis, urinary tract infection, diarrheal and starvation.

- Alkaline Urine:

- A vegetarian diet which causes a tendency to alkalosis.
- It may also be grossly increased by bacterial infection of the urinary tract.



6- Specific gravity (SG):

- The normal specific gravity (correctly called relative density) of a pooled 24 hour urine sample is between **1.010 and 1.025.**
- There are **direct relationship** between concentration of substance in urine (concentration of urine) and SG.

➔The concentration of urine is highest in the a morning specimen (overnight urine) and is lowest in a specimen passed an hour after much fluid has been taken.

Practical Part

-Objectives:

1. Simple physical examination of urine.
2. To detect some of the normal organic constituents of urine (Qualitative) .
3. To detect some of the normal inorganic ions present in urine (Qualitative) .

- **Note:**

All the examination in 24 hour collection of urine.

Physical Examinations:

method:

1- Volume:

-Measure the volume of the 24 hour collection of normal urine.

2- Odour:

- State whether it is normal urine like ammonical, or not.

3- Colour:

- Visually examine its colour.

4- Appearance:

- State whether it is clear, cloudy or whether deposits or precipitates are present.

5- pH:

- Record the pH of the sample by test strips.

6- Specific gravity:

- Record the specific gravity of the sample by test strips

Chemical Examinations:

Principle: Each test based on the chemical properties of the substance + test strip.

1- Organic:

A. Uric acid:

- Uric acid is the end product of purine metabolism.

-Method:

1. To 2 ml of urine add 1 ml of Bendect reagen.
2. Then heated in a boiling water bath for three minutes .
3. Changes to the white precipitate indicates the presence of uric acid.

B. Creatinine:

-Method:

1. To about 5 ml of urine add a few drops of a saturated solution of picric acid.
2. On rendering the solution alkaline with a few drops of 10% sodium hydroxide solution, a deep red color or orange due to creatinine picrate appears.
3. On acidification, with 2N HCl, the color changes to yellow.

Chemical Examinations cont':

1- Inorganic:

A. Chloride:

-Method:

Add 5 ml of Urine +5 drops of 2N nitric acid+ 2N silver nitrate solution

➔A white precipitate of **silver chloride** is formed (Silver chloride is precipitated in the presence of nitric acid and silver nitrate).

B. Phosphate:

-Method:

Add 5 ml of urine +5ml nitric acid+4 ml of ammonium molybdate, then heat in water bath.

➔ A yellow crystalline precipitate of **ammonium phospho-molybdate** appears.

C. Bicarbonate:

-Method:

Add 4 drops of concentrate hydrochloric +5 ml of urine.

➔ A slight effervescence occurs due to **CO_2 evolution**. Test the gas evolved with lime water.

D. Sulphate:

-Method:

To Acidify add 10 ml of urine with 1ml dilute hydrochloric acid + 4 drops of 5% barium chloride solution

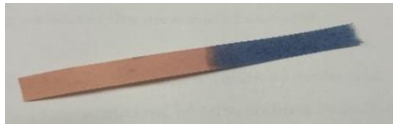
➔ A white precipitate sulphate is precipitated as of **barium sulphate** is formed.

E. Ammonia:

-Method:

Add 1 ml of 10% sodium hydroxide solution +5 ml or urine, then heat in water bath.

➔ The evolved **ammonia** may be detected its occur in confirmed by turning the moist red litmus paper to blue.



Summery:

Physical examination	
The normal constituent of 24 hour urine	
Volume	800-2500 ml with an average of 1500 ml
Color	Amber in color
Appearance	Clear
Odour	Urine like
pH	5.5 - 8.0, with a mean of 6
Specific gravity	1.010 - 1.025
Chemical examination	
Chemical	Positive result
Uric acid	White precipitate
Creatinine	Deep orange color
Chloride	White precipitate
Phosphate	Yellow precipitate
Bicarbonate	CO_2 bubble appeared
Sulphate	White precipitate
Ammonia	Litmus paper turns to blue