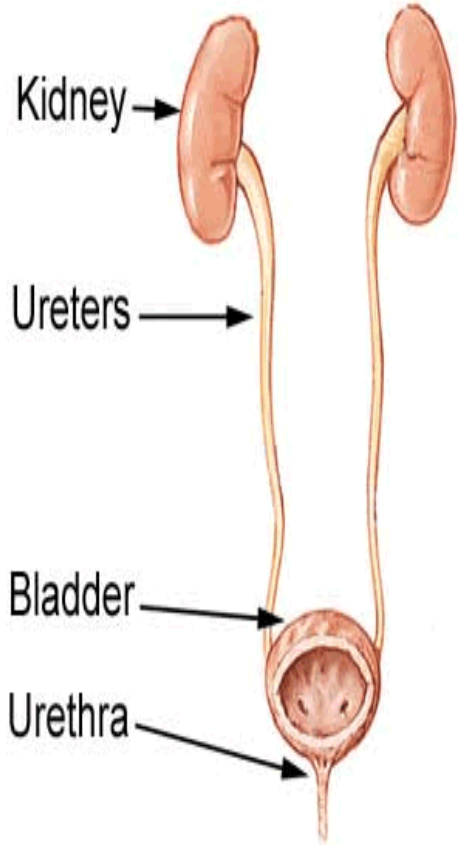
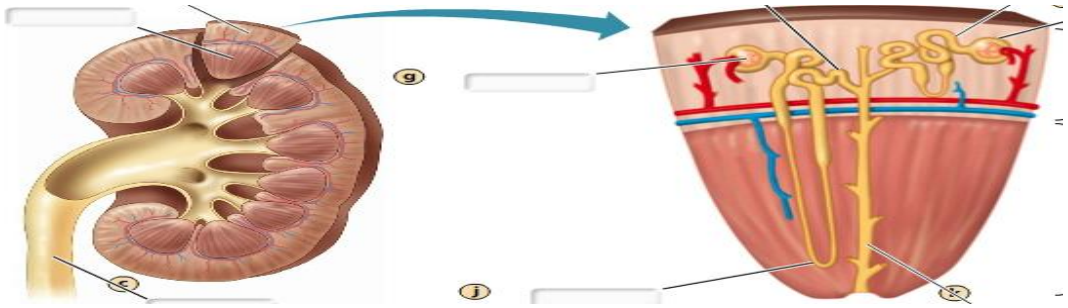
Physical properties and detection of normal constituents of urine

-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.

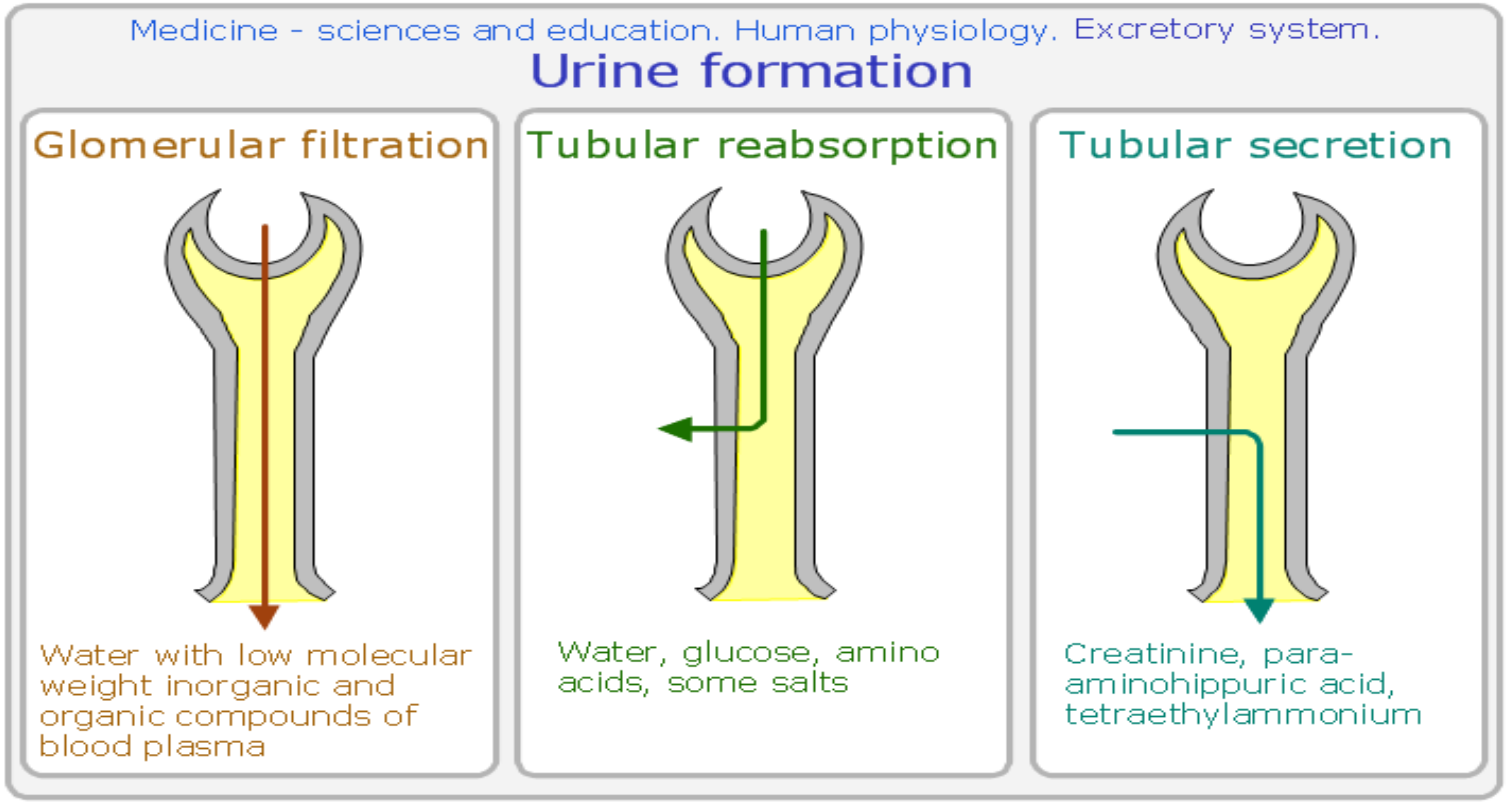




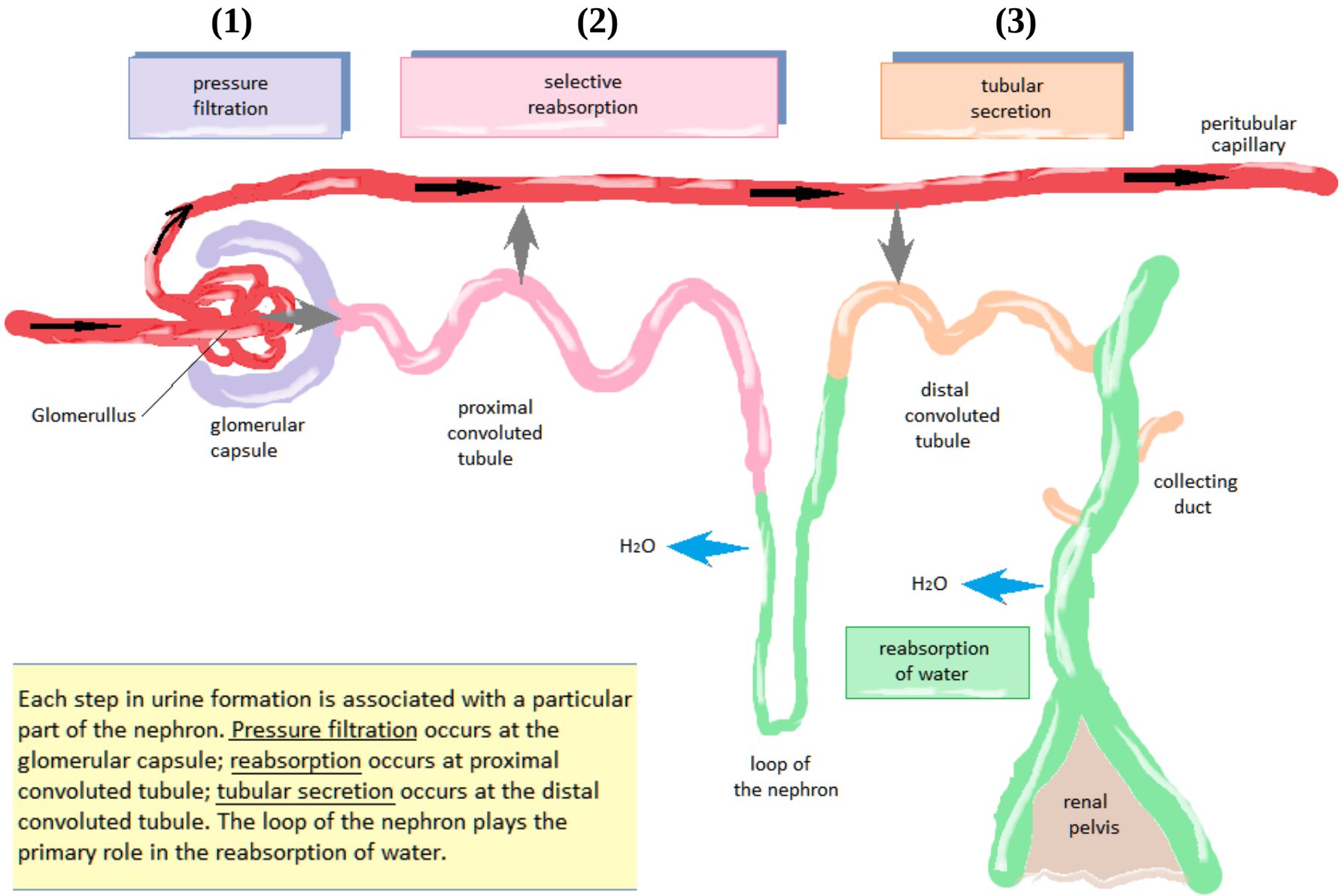
-Urine Formation:

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

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



The three processes of urine formation

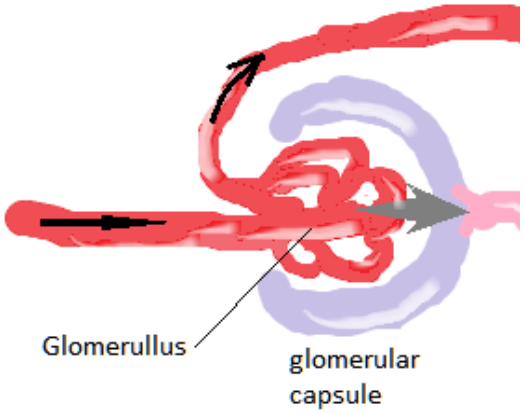


Each step in urine formation is associated with a particular part of the nephron. Pressure filtration occurs at the glomerular capsule; reabsorption occurs at proximal convoluted tubule; tubular secretion occurs at the distal convoluted tubule. The loop of the nephron plays the primary role in the reabsorption of water.

one: Filtration :

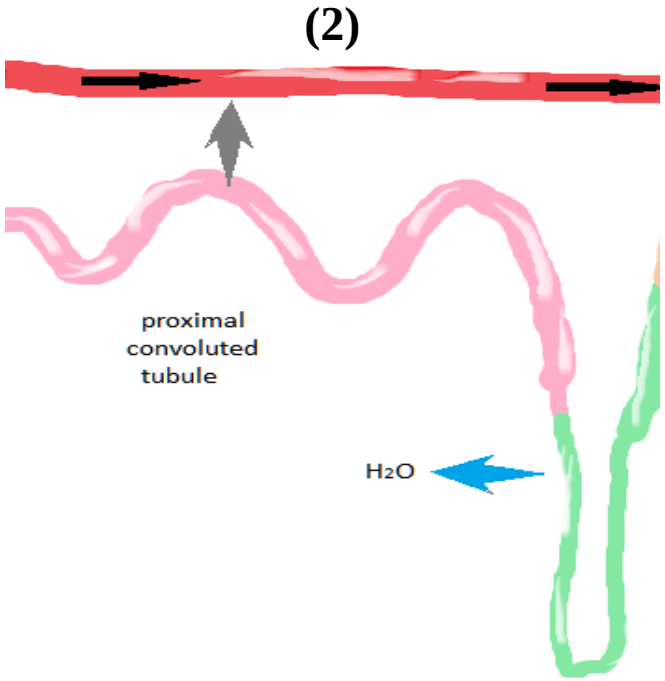
- This takes place through the semipermeable membrane of glomerulus and glomerular capsule (Bowman's capsule).
- Water and small molecules move from the glomerulus to the inside of the glomerular capsule.
- Molecules which have molecular weight **more than** 70,000 Dalton can not pass the glomerulus.
- 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)



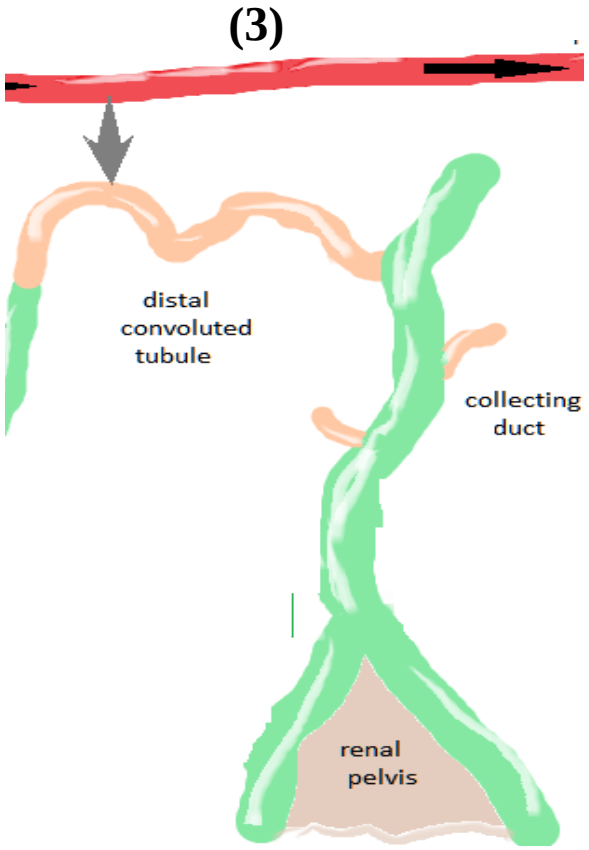
two: Selective reabsorption:

- 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).

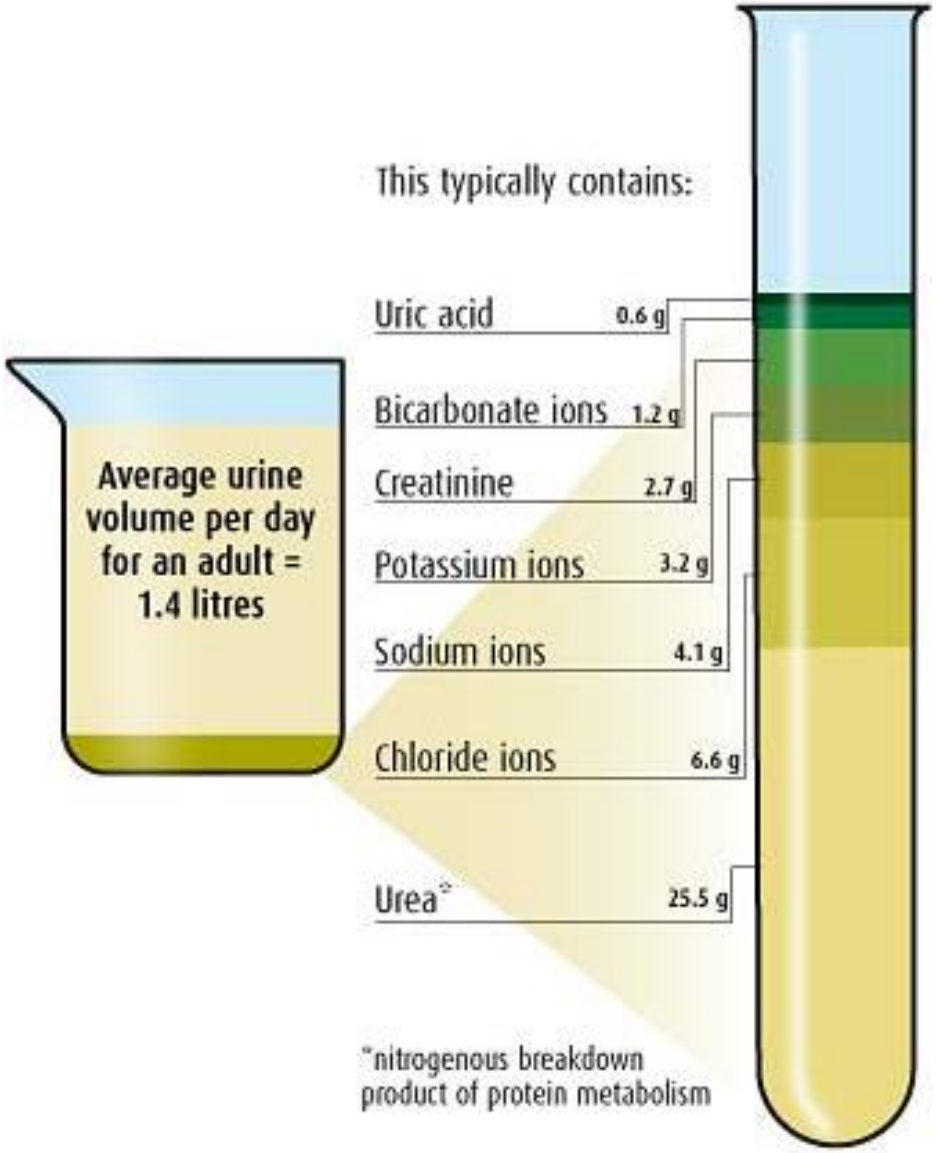
Glomerular filtrate VS Urine

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
- Ammonia
- Sodium
- Potassium
- Chloride
- Phosphate
- Sulphate
- Oxalate

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 (Non-Hemolyzed)	moderate	trace (Hemolyzed)	+/small	++/mod	+++/large
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

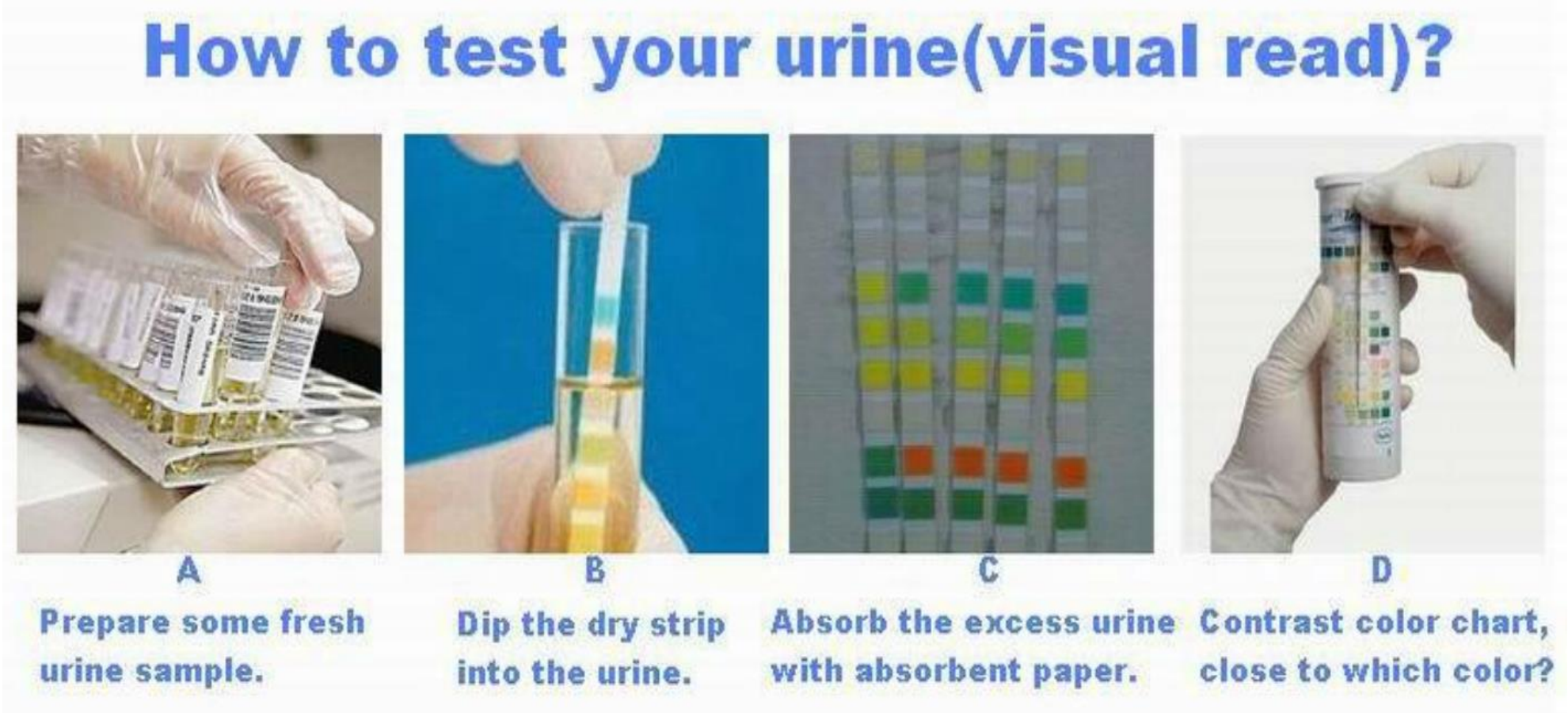
Chemical tests

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



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

Physical Examinations:

1- Volume:

- The daily output of urine on an avarege 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.

Polyurea	Oligurea	Anurea
• 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 haemorrhage or as diarrhea and vomting.	• 100 ml /day. • Stones or tumors in the urinary tract can also cause it by creating an obstruction to urinary flow.

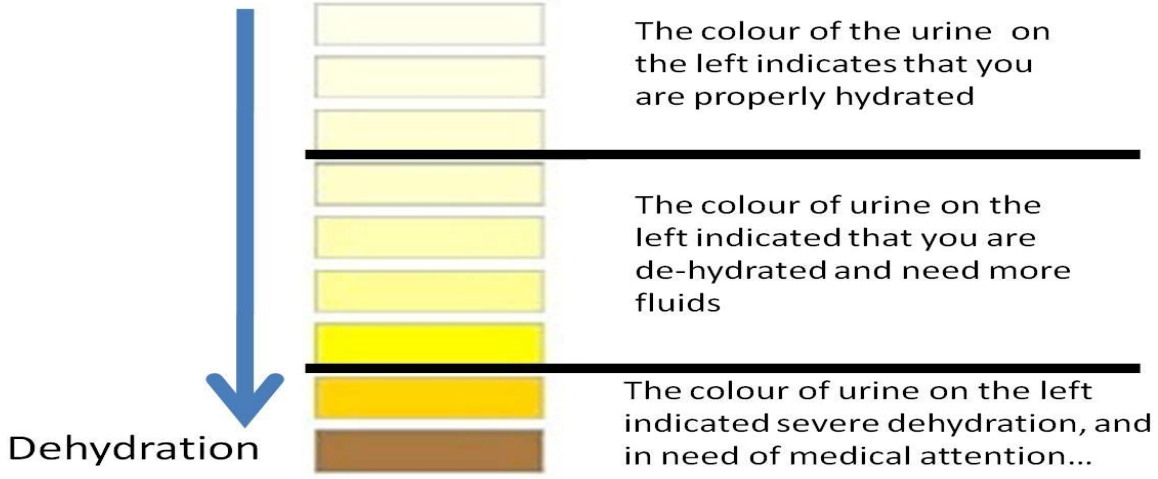
2- Colour and appearance:

- Normally, Urine is clear and amber in color due to the presence of urobilin (urochrome).
- **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.

- 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).

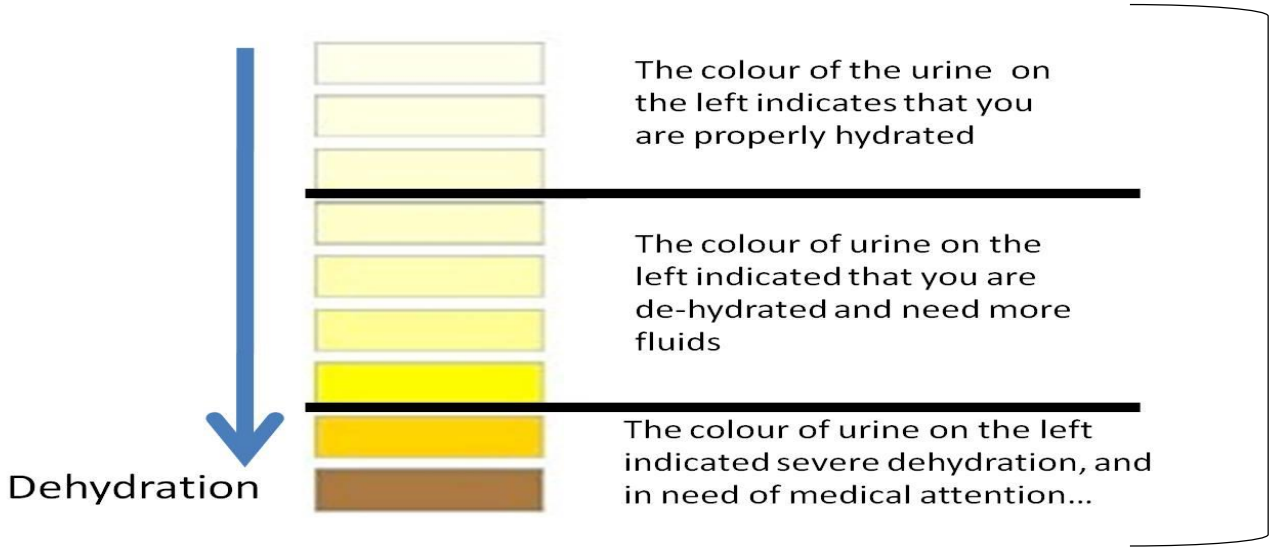
- **Coloured urines** occur in certain diseases or metabolic disorders, and after the



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

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.



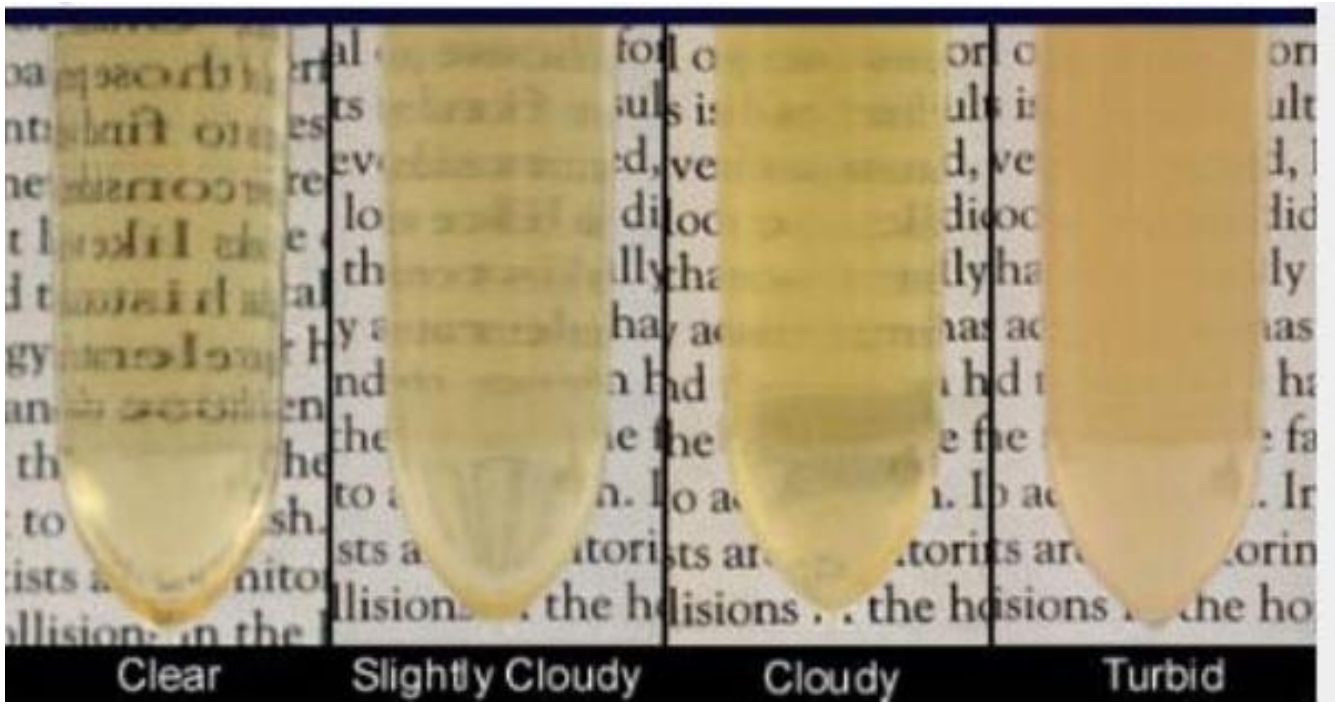
The more that your body is dehydrated , the more the urine is dark

3- Appearance :

- Normal urine is clear.

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

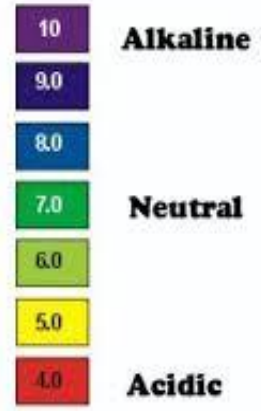
➔**Note:** cloudy or turbid urine can indicate dehydration, urinary tract infection or presence of RBCs, WBCs, epithelial cells or bacteria.



4- Odour:

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

5- pH:



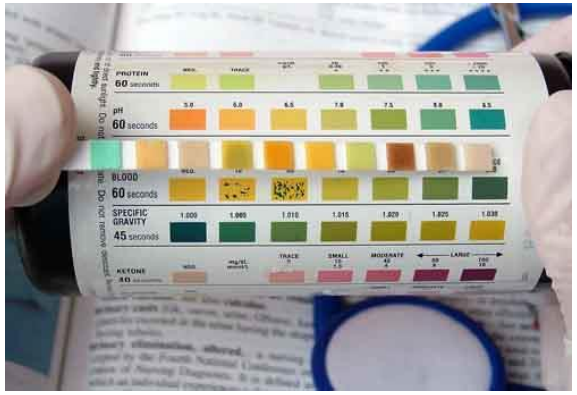
- On a normal mixed diet the urine is **usually acid**, generally varying in pH between **5.5 and 8.0**, with a **mean of 6 in 24 hours.**

- 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 relation ship** 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 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 sodium 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 CO2 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

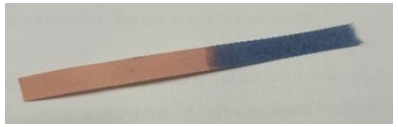
➔ A white precipitate sulphate is precipitated as of barium sulphate is formed.

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	CO2 bubble appeared
Sulphate	White precipitate
Ammonia	Litmus paper turns to blue