"اللَّهُمَّ لا سَهْلَ إلاَّ ما جَعَلْتَهُ سَهْلاً، وأنْتَ تَجْعَلُ الحَزْنَ إذَا شِئْتَ سَهْلاً "



# Chemical Examination of Urine

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Revised by



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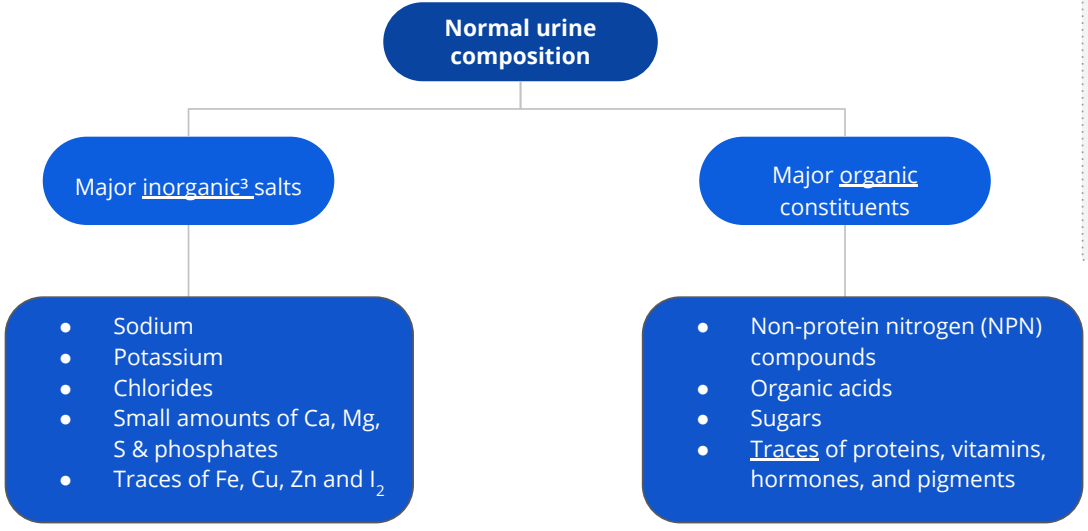
EDITING FILE

# Objectives:

- To understand the normal and abnormal chemical composition of urine in relation to renal diseases and conditions
- To differentiate between pre-renal, renal and post- renal proteinuria with clinical examples of each
- To acquire knowledge on the types of Glycosuria, hematuria and hemoglobinuria

# What's Urine?

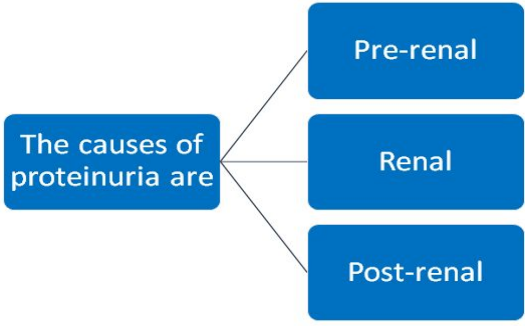
- Urine is a fluid excreted by most animals including humans .
- It is formed in the kidneys (renal glomeruli)
- The fluid undergoes chemical changes before it is excreted as urine.
- Normal urine excretion by a healthy[1] person is about 1.5 L per day.




- Blood & Urine give a broad investigations about body status
- [1]The number might differ depending on physiological or pathological reasons
- [3]Does Not contain a Carbon molecule

**Abnormal composition of urine** ⇨ Proteins

- Normal urine contains very little protein[1] (< 200 mg/day[2])
- More than this level leads to a condition called: **Proteinuria**




[1] Only traces
[2] In a 24h urine sample

In pre-renal and postrenal, the kidney is healthy.

*overview*

When a molecule that is not usually present in the urine, or present in small amounts is suddenly found in the urine or found in high amounts, we say the urine has an abnormal composition.
*Types of Abnormal composition of urine:
- Proteinuria
- Glycosuria
- Hematuria
- Hemoglobinuria

# 1) Prerenal Proteinuria

- Some abnormal conditions increase plasma protein levels before reaching the kidneys.
- Causes increased filtration of these proteins in the kidneys.
- This exceeds the normal re-absorptive capacity of renal tubules
- Results in overflow of proteins in the urine.

The filtered proteins cannot be reabsorbed fully because of their high concentration, so they remain in the urine and are excreted in high amounts.

## Example of pre-renal proteinuria:

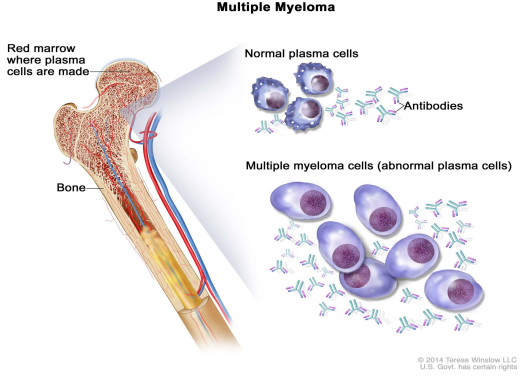
**Multiple myeloma[1] [2]**

- A proliferative* disorder of the immunoglobulin-producing plasma cells
- The serum contains elevated levels of monoclonal "one type" light chains antibodies (Bence-Jones protein)
- Bence-Jones protein is filtered in kidneys in high amounts
- Exceeding the tubular reabsorption capacity
- Hence excreted in the urine

[1] The most famous example of proteinuria
[2] It's cancer of the plasma cells causing an over production of Ig producing plasma cells , these Ig are called monoclonal antibodies
*grow or produce by multiplication of parts

# Cont. Multiple Myeloma

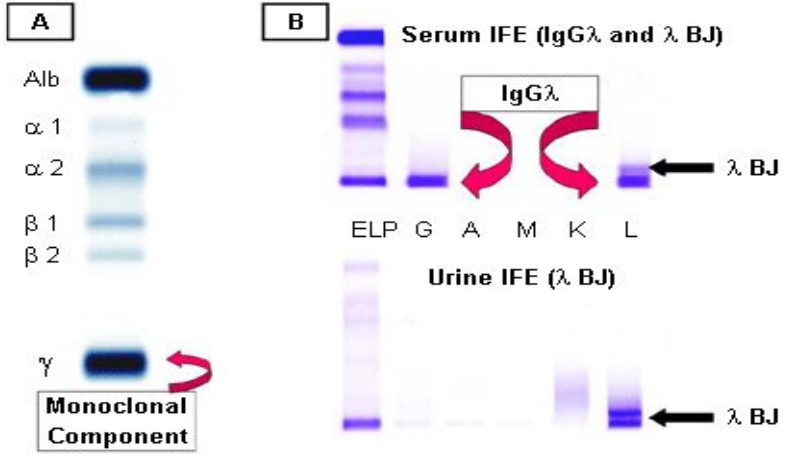
- The Bence-Jones protein coagulate at 40–60 $^{o}$C
- Dissolves at 100 $^{o}$C Which is unusual to all other proteins.
- Multiple myeloma cases are diagnosed by using:
  - Serum electrophoresis
  - Immunoelectrophoresis (more specific)




Extra picture

# Multiple Myeloma

This slide is just for you to have an idea about the technique but you don't need to memorize it.



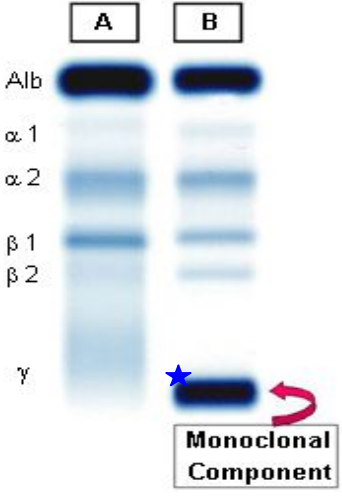

Notice the thickening of gamma and how it differ. It helps us in diagnosis.

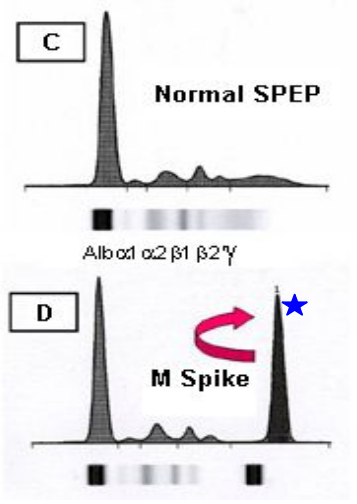
A) Serum protein electrophoresis demonstrating the M component

B) Serum and urine immunofixation electrophoresis
(tells you the type of light chain)

# Multiple Myeloma

This slide is just for you to have an idea about the technique but you don't need to memorize it.




★ The thickening of gamma and the M spike help us in diagnosis.

A) Normal serum
B) Multiple myeloma showing M component in the gamma region
C) Densitometry tracing of A showing the 5 zones of the high resolution agarose electrophoresis
D) Densitometry of the M component of B, termed the M Spike

# 2) Renal Proteinuria

| Proteinuria associated with renal disease | | Proteinuria not associated with renal disease |
|---|---|---|
| **Glomerular proteinuria** | **Tubular proteinuria** | **Orthostatic (Postural) Proteinuria** |
| • High glomerular permeability[1]<br>• Causes **filtration** of high molecular weight proteins<br>(e.g. glomerulonephritis)<br><br>[1]Pores of glomeruli are wide. | • Low tubular reabsorption with normal glomerular permeability<br>• Causes **excretion** of low molecular weight proteins (e.g. chronic nephritis) | • Persistent benign (physiological) proteinuria.<br>• Occurs frequently in young adults due to periods spent in a vertical posture. (when they play and stand a lot)<br>• Increased pressure on the renal vein in the vertical position causes orthostatic proteinuria.<br>• Disappears in horizontal posture (or rest). |

***How do we know if the patient has orthostatic proteinuria or proteinuria associated with renal disease?*** We tell the patient to give us a sample of urine before sleeping and when they wake up and compare the two samples.
In case of orthostatic proteinuria, the first sample will have high amounts of protein but the second sample will be normal.

# Microalbuminuria

- Presence of small amounts of albumin in the urine (20– 200 mg/L) "called micro, referring to small amount"
  - Cannot be detected by ordinary urine testing
  - Needs special tests for detection

- Early indicator of glomerular dysfunction due to:
  - Uncontrolled diabetes mellitus or hypertension and elderly people.

# 3) Post Renal Proteinuria

- The urine comes out of the kidney clean, proteins added to the urine as it passes through the structures of the lower urinary tract (ureters, bladder , urethra, prostate and vagina)
- Due to Lower urinary tract infection [1], trauma, tumors and stones.

[1] Most common

***Proteinuria recap:***

- Proteinuria can be either prerenal, renal, or post renal.
- Prerenal is caused by multiple myeloma.
- Renal can be caused by renal disease, which include (glomerular, tubular and microalbuminuria). Or it can be benign with no renal disease like orthostatic (postural) proteinuria.
- Post renal is caused by a problem in the lower urinary tract, like infection, trauma, tumor or stones.

Female doctor said you don't need to memorize the enzymes in this slide.

# Glycosuria: *(Presence of sugar in urine)*

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Normally glucose is not found in the urine, only traces of it should be found.

## 1- Glucosuria: (Presence of detectable amount of glucose in urine)

- **Uncontrolled DM**: The concentration of glucose in the plasma exceeds the renal threshold[1]
- **Renal glycosuria:** Normal plasma glucose concentration with proximal tubular malfunction leading to ↓ renal threshold (gestational diabetes[2] and Fanconi's syndrome[3])

[1] Threshold = capacity, for example a car can only take 5 ppl so this means that this is the car's threshold.
- When the car that used to take 5 ppl is now only taking 2 so threshold decreased.

[2] Gestational diabetes is for pregnant women.
[3] Fanconi's syndrome can be inherited like there's mutation in the proximal tubules and it can't reabsorb all the glucose or due to poisoning e.g lead poisoning.

## 2- Fructosuria: (Presence of fructose in urine)

- Alimentary[1] causes: High fructose intake.
- Metabolic: Low fructokinase or aldolase B in the liver.

- fructose is found in fruit and honey so if someone ate too much they will have fructosuria.
- [1]relating to nourishment

## 3- Galactosuria: (Presence of galactose in urine)

- Alimentary: High galactose intake
- Metabolic: Low galactokinase or galactose-1-phosphate uridyl transferase in the liver.

It's found in the milk so if someone drank too much they'll have galactosuria.

# Ketonuria

Presence of ketones, acetone, acetoacetic acid and β-hydroxybutyric acid in urine.

*The following list is Important*

1) Diabetic ketoacidosis (more common in type 1 diabetes)
2) Starvation "because we start breaking down fats producing ketone bodies"
3) Prolonged vomiting
4) Unbalanced diet: high fat and low CHO diet
5) Phenylketonuria (inborn error of amino acid metabolism) will be discussed in another lecture.

# Nitrite

Positive nitrite test is significant of bacteria in urine.

# Choluria

Choluria is the presence of bile in urine.

1) **Bilirubin and bile salt:**

   Normally NO bilirubin is detected in urine,

   bilirubin is detected in:

   - Hepatocellular damage
   - Obstruction of bile duct:
     - Extrahepatic (stone)
     - Intrahepatic (hepatic tumors)

If the bilirubin is only in the urine we call it “bilirubinuria”.

2) **Urobilinogen:**

   Normally present in trace amounts in urine.

   **High** urobilinogen is found in:

   - Hemolytic anemia
   - Hepatocellular damage

Urobilinogen gives the brown colour of the stool.

This slide is for your information
To better understand choluria

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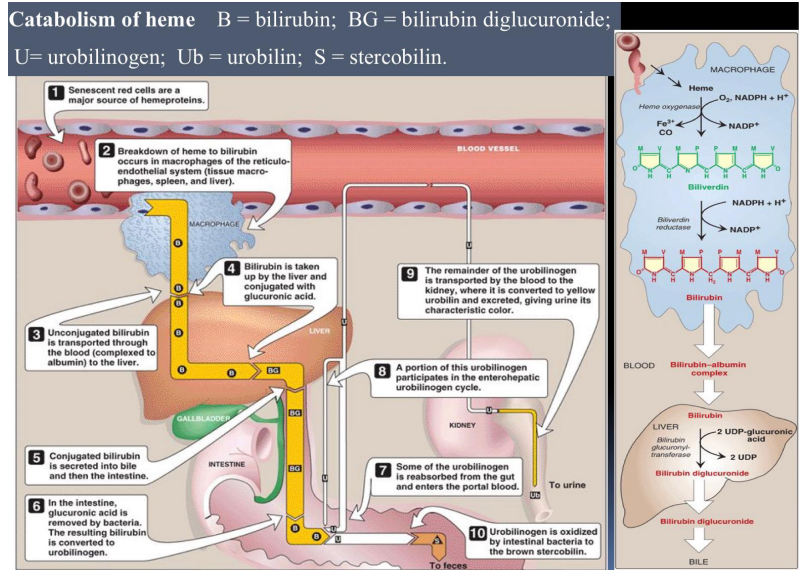
1) RBCs rupture —> bilirubin
2) Bilirubin carried by albumin to the liver
3) Bilirubin converted to bilirubin diglucuronide (conjugated bilirubin)
4) Excreted in the bile and then the intestine.
5) In the intestine glucuronic acid is removed by bacteria
6) Resulting bilirubin to be converted to urobilinogen
7) Urobilinogen is excreted through the kidney in the urine as urobilin (gives the yellow color to the urine )



# Blood

1) **Hematuria**: presence of detectable amount of blood in urine (intact RBCs "not ruptured")

   A. Acute and chronic glomerulonephritis
   B. Local disorders of kidney and genitourinary tract (trauma, cystitis, Renal calculi and tumors)
   C. Bleeding disorders (hemophilia)

2) **Hemoglobinuria:** presence of hemolysed blood in urine (ruptured RBCs)

   A. Hemoglobinopathies: sickle cell anemia and thalassemia
   B. Malaria ( P. falciparum )
   C. Transfusion reaction (Blood group Incompatibility)

# MCQs:

**1- The presence of intact RBC in urine is termed as:**

A) Hematouria
B) hemoglobinuria
C) Choluria

**2- One of the clinical presentations of hepatocellular damage is:**

A) Urobilinogen
B) Hemoglobinuria
C) Glucosuria

**3- A child was presented with Increased pressure on the renal vein in the vertical position and proteinuria:**

A) Multiple myeloma
B) Microalbuminuria
C) Orthostatic (Postural) Proteinuria

**4- Multiple myeloma is a:**

A) Pre-Renal proteinuria.
B) Renal proteinuria.
C) Post-renal proteinuria.
D) none of the above.

**5- Monoclonal band in the gamma region is present in which of the following diseases?**

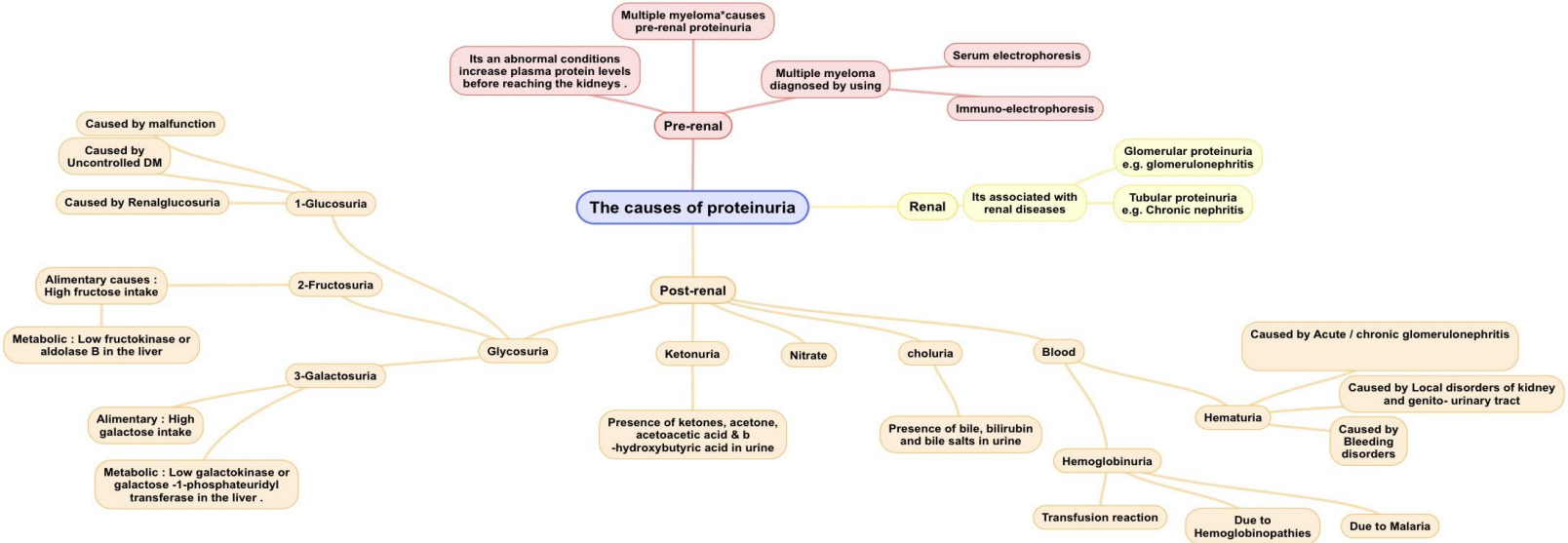
A) Glomerulonephritis.
B) chronic nephritis.
C) Multiple Myeloma.
D) Lower urinary infection

**6- In case of Lower urinary tract infection, which of the following can be found in the urine?**

A) Post renal proteinuria.
B) Nitrate.
C) Blood.
D) Both A and B.

1- A
2- A
3- C
4- A
5- C
6- D

# Summary


Multiple myeloma*causes pre-renal proteinuria
Its an abnormal conditions increase plasma protein levels before reaching the kidneys .
Multiple myeloma diagnosed by using
Serum electrophoresis
Immuno-electrophoresis
Pre-renal
Caused by malfunction
Caused by Uncontrolled DM
Caused by Renalglucosuria
1-Glucosuria
The causes of proteinuria
Renal
Its associated with renal diseases
Glomerular proteinuria e.g. glomerulonephritis
Tubular proteinuria e.g. Chronic nephritis
Alimentary causes : High fructose intake
2-Fructosuria
Metabolic : Low fructokinase or aldolase B in the liver
Glycosuria
3-Galactosuria
Alimentary : High galactose intake
Metabolic : Low galactokinase or galactose -1-phosphateuridyl transferase in the liver .
Post-renal
Ketonuria
Presence of ketones, acetone, acetoacetic acid & b -hydroxybutyric acid in urine
Nitrate
choluria
Presence of bile, bilirubin and bile salts in urine
Blood
Caused by Acute / chronic glomerulonephritis
Hematuria
Caused by Local disorders of kidney and genito- urinary tract
Caused by Bleeding disorders
Hemoglobinuria
Transfusion reaction
Due to Hemoglobinopathies
Due to Malaria

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## Team leaders

- رهام الحلبي
- معاذ الحمود

## Boys team

- محمد الصويغ
- فيصل الطحان
- طارق العميم
- أنس القحطاني
- صالح الوكيل
- عبد الملك الشرهان
- سعيد القحطاني
- محمد الاصقه
- نواف اللويمي
- معن شكر
- عبدالرحمن التركي

## Girls team

- رهف الشنيبر
- شهد الجبرين
- لينا الرحمة
- منيرة المسعد
- ليلى الصّباغ
- العنود المنصور
- أرجوانة العقيل
- ريناد الغريبي
- رزان الزهراني
- ليان المانع
- مشاعل القحطاني
- شيرين حمادي
- مجد البراك

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