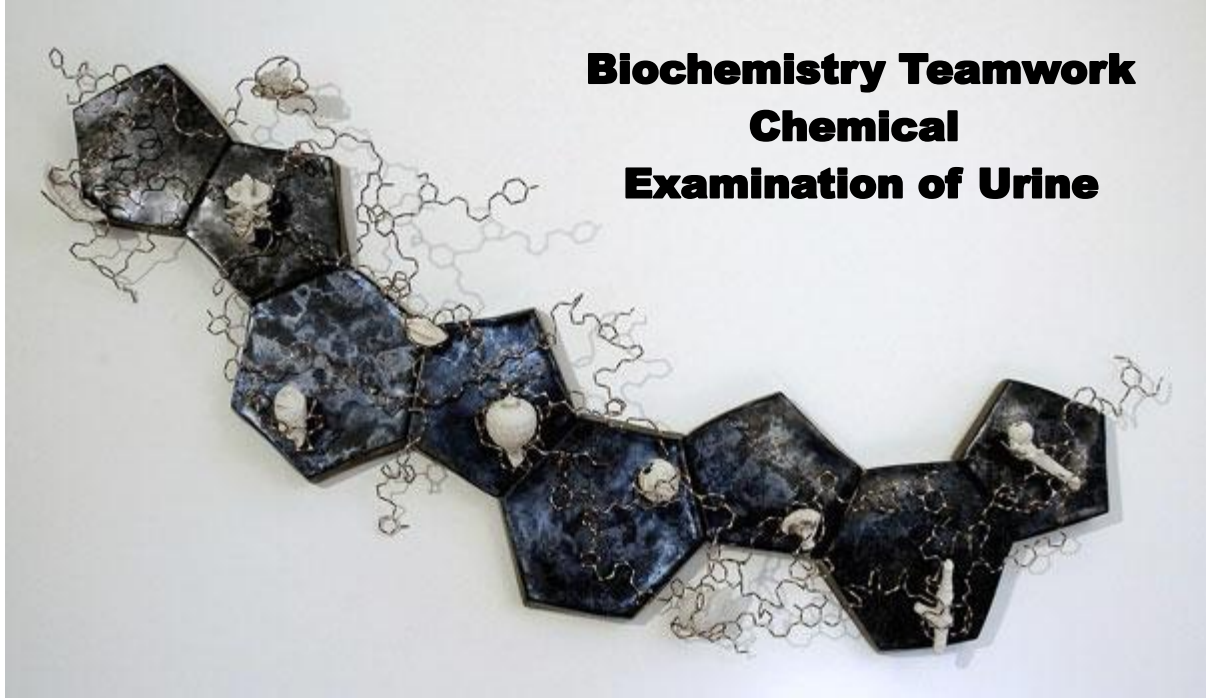


**Biochemistry Teamwork
Chemical
Examination of Urine**



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Urine

So, urine contain:

Water + chemical product

- 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 person is **about 1.5 L per day**

Additional information :

Oliguria → when the urine excretion is lower than 1 liter .

Polyuria → when the urine excretion more than 2 liter.

Normal composition of urine

Urine contains **organic** and **inorganic** constituents:

- **Major inorganic constituents:**
 - Sodium
 - Potassium
 - Chloride
 - Small amounts of Ca, Mg, sulfur and phosphates
 - Traces of Fe, Cu, Zn, I
- **Major organic constituents:**
 - Non-protein nitrogen (NPN) compounds
 - Organic acids
 - Sugars
 - Traces of proteins, vitamins, hormones, pigments

The doctor mentioned in the lecture:

The source of nitrogen in the body is **amino acid** but the nitrogen in these compounds is **not** derived from **protein**.

Traces.

Abnormal composition of urine

Proteins:

- Normal urine contains small amount of protein:
 - **< 200 mg/day**
- Excretion of more than this level causes proteinuria

Proteinuria:

- Excretion of **abnormal amounts of protein in urine**
- Proteinuria has three types:
 - Pre-renal
 - Renal
 - Post-renal

Pre-renal : the disease which cause Proteinuria will be before the urinary system. so, the kidney function is normal .

Renal : the disease will be at the kidney level .

Post-renal : the problem would be at the ureter , urethra Etc. so, the kidney is function normally

Pre-renal proteinuria

- Some diseases or conditions increase plasma protein levels **not involving the kidneys**
- Causes **increased filtration of these proteins in the kidneys**
- This exceeds the **normal reabsorptive capacity** of renal tubules
- Results in overflow of proteins in the urine

Multiple myeloma:

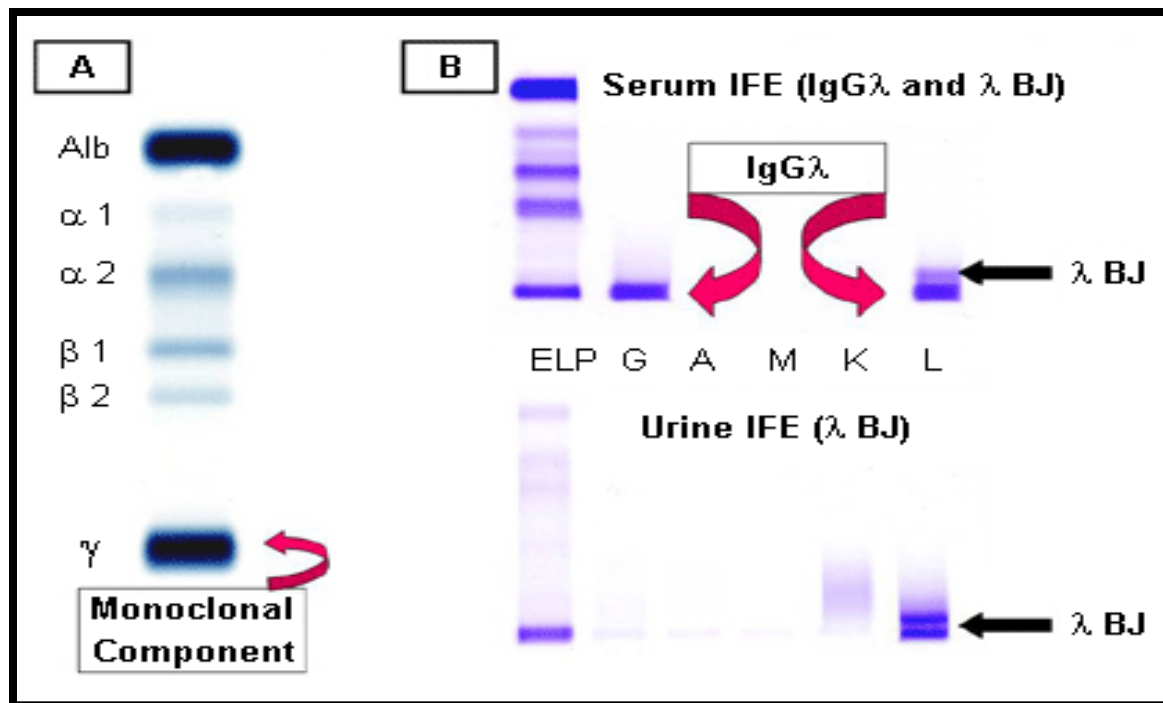
- Cancer of the **antibody-producing plasma cells**
- Causes pre-renal proteinuria
- The serum contains elevated levels of **monoclonal light-chain antibodies** called **Bence-Jones protein**
- This protein is filtered in the kidneys in high amounts
- Exceeding the tubular reabsorption capacity
- Hence excreted in the urine
- Bence-Jones protein **coagulates at 40–60 °C** and **dissolves at 100 °C**

Basically IgG antibody

Multiple myeloma cases are diagnosed by:

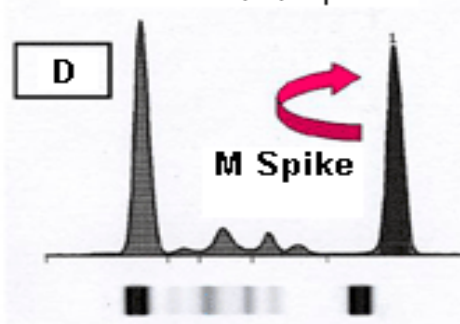
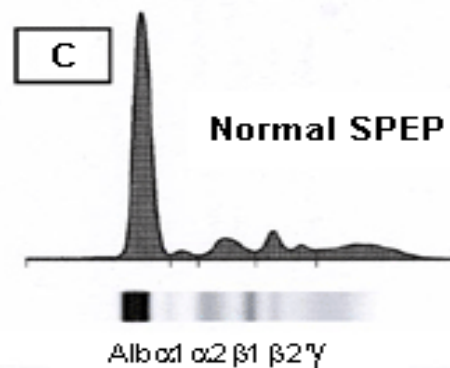
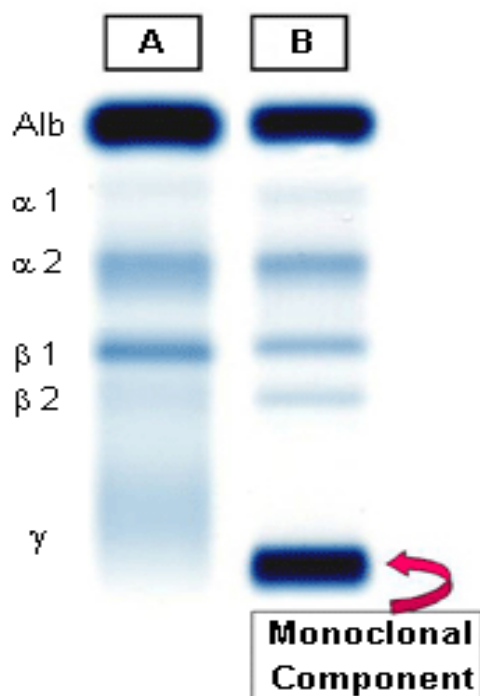
- Serum electrophoresis
- Immunoelectrophoresis

Immunoelectrophoresis is a general name for a number of biochemical methods for separation and characterization of proteins based on electrophoresis and reaction with antibodies.



A: Serum protein electrophoresis showing the **M component**

B: Serum and urine immunofixation electrophoresis



A: Normal serum

B: Multiple myeloma (**M component in g region**)

C: Densitometry of "A"

D: Densitometry of "B" (**M component is called M Spike**)

Renal proteinuria

- Associated with renal disease

Glomerular proteinuria:

- High glomerular permeability causes filtration of **high molecular weight proteins**
 - Example: glomerulonephritis

Tubular proteinuria:

- **Low tubular reabsorption** with normal glomerular permeability
- Causes **excretion of low mol. wt. proteins**
 - Example: chronic nephritis

Orthostatic (postural) proteinuria:

- A form of **benign** or physiological proteinuria
- Occurs frequently in young adults due to periods spent in a vertical posture (body position) or during muscular exercise
- **Increased pressure on the renal vein** in the **vertical position** causes orthostatic proteinuria
- **Disappears in horizontal posture**

Microalbuminuria:

- Presence of small amounts of albumin in the urine
 - **20–200 mg/L**
 - Cannot be detected by ordinary urine testing
- Needs special tests for detection
- Early indicator of glomerular dysfunction due to:

- Uncontrolled diabetes mellitus
- Hypertension

Post-renal proteinuria

- Proteins are added to the urine **after kidney filtration**
- While passing through the lower urinary tract (ureters, bladder, urethra, prostate, vagina)
- Due to:
 - Lower urinary tract infection
 - Trauma
 - Tumors
 - Stones

Glycosuria

Presence of sugar in urine

Glucosuria:

Presence of detectable amount of glucose in urine

- Due to diabetes mellitus
 - Plasma glucose level exceeds the renal threshold
- Due to renal disease (renal glucosuria)
 - Normal plasma glucose level with proximal tubular malfunction
 - Decreased renal threshold as observed in gestational diabetes and Fanconi's syndrome

is a disease of the proximal renal tubules of the kidney in which glucose, amino acids, uric acid, phosphate and bicarbonate are passed into the urine, instead of being reabsorbed.

is a condition in which women without previously diagnosed diabetes develop diabetes during pregnancy

Fructosuria:

- Presence of fructose in urine
- Nutritional (Alimentary) cause: High fructose intake.
- Metabolic cause:
 - Low fructokinase or aldolase B in the liver

Galactosuria:

- Presence of galactose in urine
- Nutritional (Alimentary) cause: high galactose intake.
- Metabolic cause:
 - Low galactokinase or galactose -1- phosphate uridyl transferase in the liver

Ketonuria

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

Due to:

- **Diabetic ketoacidosis**
- **Starvation**
- **Dietary imbalance: high fat and low CHO diet**
- **Phenylketonuria (PKU)**

For example you are not eating for days so, you are starving so, when you are starving you will use more fatty acid oxidation because of your glucose level will last only for one day. So, your body will switch to fatty acid oxidation which will produce more ketone bodies

It is a genetic disease because of increase level of amino acid phenylalanine

Choluria

- Presence of bile, bilirubin and bile salts in urine

It is a product of hemoglobin degradation

Bilirubin:

normally **no bilirubin is detected in urine**

- It is detected in:
 - Hepatocellular damage
 - Obstruction of bile duct due to stones (extrahepatic) and hepatic tumors (intrahepatic)

Urobilinogen:

normally present in trace amounts

- High urobilinogen is found in:
 - Hemolytic anemia
 - Hepatocellular damage

In the intestine the bilirubin is converted into urobilinogen by bacteria and some of it enters the blood.

Nitrites:

- Positive nitrite test indicates bacteria in urine

Hematuria

- Presence of detectable amount of blood in urine

Due to:

- Acute / chronic glomerulonephritis
- Local disorders of kidney and genito-urinary tract
 - Trauma, cystitis, renal calculi, tumors
- Bleeding disorders
 - Hemophilia

Hemoglobinuria:

- Presence of hemolysed blood in urine

Due to:

- Hemoglobinopathies
 - Sickle cell anemia
 - Thalassemia
- Malaria
- Transfusion reaction (Blood group incompatibility).

Questions

A) Hematuria is due to?

- 1) Sickle cell anemia.
- 2) Malaria.
- 3) Hemophilia.
- 4) Thalassemia.

B) Fanconi's syndrome resulting from?

- 1) Galactosuria.
- 2) Glucosuria.
- 3) Fructosuria.

C) Multiple myeloma is?

- 1) Pre-renal proteinuria.
- 2) Renal proteinuria.
- 3) Post-renal proteinuria.

Answers:

A)3.

B)2.

C)1.