CHEMICAL EXAMINATION OF URINE

CHAMICHAL EXAMINATION DIFFERS FROM PHYSICAL EXAMINATION:
PHYSICAL EXAMINATION IT'S FOR EXAMPLE IN PAST THE DIAGNOSIS WAS BASED ON URINE SMELL +COULOIRS WHICH INDICATE SOME DISEASES

Red color means the notes and explanation

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LEARNING OBJECTIVES:

1. TO UNDERSTAND THE NORMAL AND ABNORMAL CHEMICAL COMPOSITION OF URINE IN RELATION TO RENAL DISEASES AND CONDITIONS

2. TO DIFFERENTIATE BETWEEN PRE-RENAL, RENAL AND POST-
RENAL PROTEINURIA WITH CLINICAL EXAMPLES OF EACH

3. TO ACQUIRE KNOWLEDGE ON THE TYPES OF GLYCOSURIA, HEMATURIA AND HEMOGLOBINURIA

- **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 (in the renal tubules it will be secreted or reabsorbed)= يعني تغيرات في المركب نفسه
- **Normal urine excretion by a healthy person is** about 1.5 L per day
- (oliguria –which is usually the end stage of renal disease = when the urine excretion is lower than 1 liter)
- (polyuria = when the urine execration more than 2 liter eg : diabetic pt)

Normal composition of urine

Urine screening test(dipstick)=it's prefer because it's cheep and not invasive .note it is a qualitative test (concern about the substances if it present or not)

Urine contains organic (presence of carbons in the substance) and inorganic(no carbon atoms in the substance) constituents:

- **Major inorganic salts:**
  - **Sodium**
  - **Potassium**
  - **Chlorides**
  - **Small amounts of Ca, Mg, S & phosphates**
  - **Traces of Fe, Cu, Zn and I_2**

- **Major organic constituents:**
  - **Non-protein nitrogen (NPN) compounds (note that is not from the protein ..>>>it may from hormones, catecholamine(eg: norepinephrine) or pyrimidine ..etc)**
  - **Organic acids**
  - **Sugars**
  - **Traces (small amounts) of proteins(usually the normal traces of protein present in the urine is albumin- because it has low molecule weight than the other proteins.. note :the amount of normal traces protein is about 20 mg /day),**
  - **Also traces of vitamins, hormones, and pigments**

Abnormal composition of urine

Proteins:

- Normal urine contains very little protein (< 200 mg/day)

means lower than 200 mg/day is not proteinuria .. it could be :

- **microalbuminuria** : which indicates some diseases (20-200 mg/day)
- **normal** : lower than (20 mg/day)
- More than 200 mg/day leads to a condition called **Proteinuria**

Abnormal composition of urine

Causes:

Pre-renal

Renal

Post-renal

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 reabsorptive capacity of renal tubules

Results in overflow of proteins in the urine

- Note: the proteins has reabsorptive capacity in the tubules (maximum limit of the amount that will be absorbed from the filtered substance) so when serum protein level is normal the filtrate level of it will be normal then the protein reabsorption is fine so no proteins in urine
- But when the serum protein level is high the filtered protein will increase then the protein will be absorbed until it's reached the normal reapsorbitive capicity and the rest will be execrated

Multiple myeloma causes pre-renal proteinuria

- A proliferative disorder of the (immunoglobulin = it's called also paraprotain)-producing plasma cells(specially IGG)...

>>it's disease which stimulate the bone marrow production of plasma cells that secrete the(immunoglobulin also called paraprotain) specially IGG

- The serum contains elevated levels of monoclonal light chains antibodies (Bence-Jones protein)(also the heavy chain)
- The IGG level increase which has light chain and heavy chain .. But just the light chain will be execrated after the filtration cuz it's low molecule weight)
- Bence-Jones protein (light chains of antibodies) is filtered in kidneys in high amounts
- Exceeding the tubular reabsorption capacity
- Hence excreted in the urine

- **The symptoms of this disease (myeloma):**
- Bone pain
- Processes in the skin
- Bleeding
- Anemia

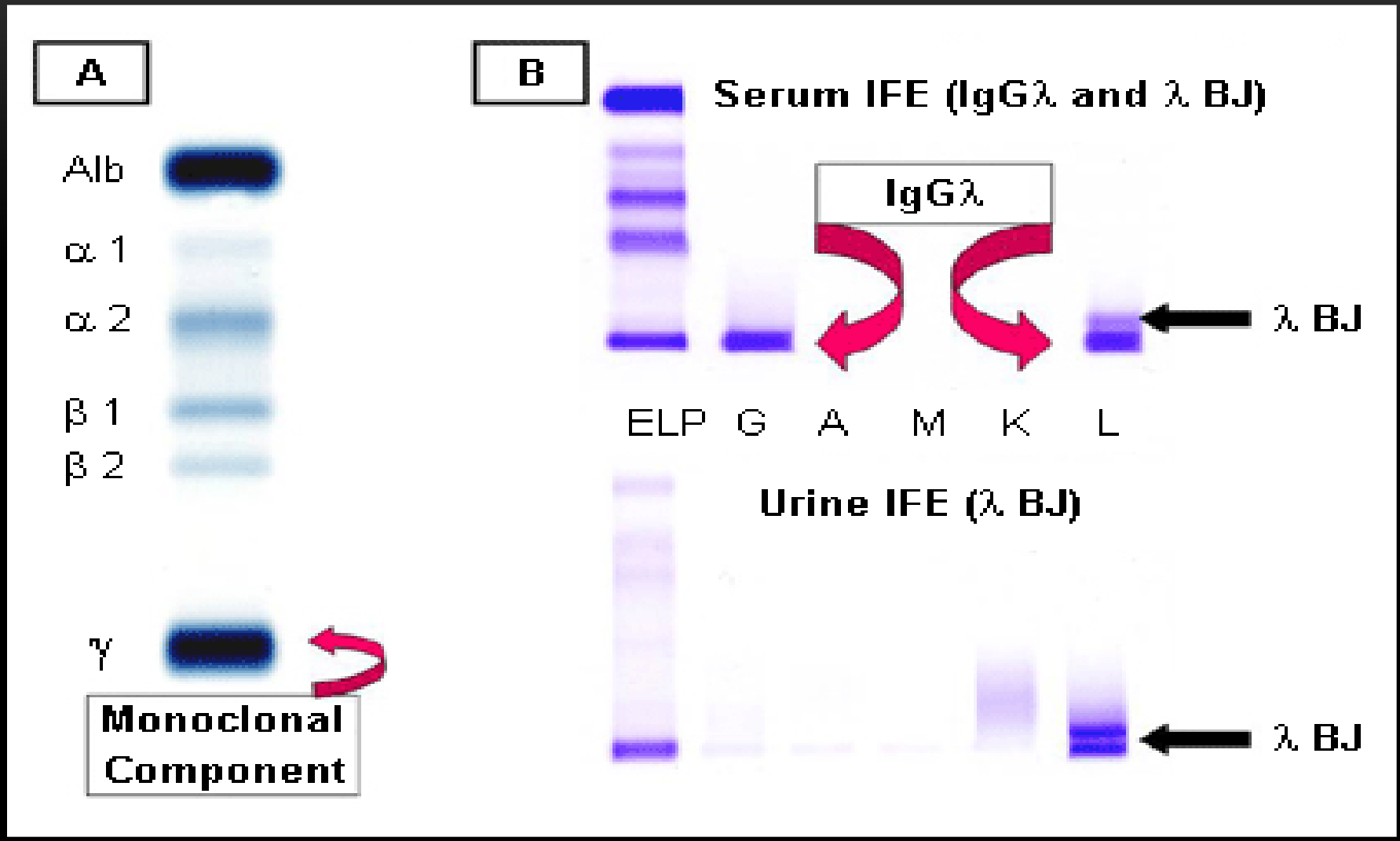
Fatigue

Note:

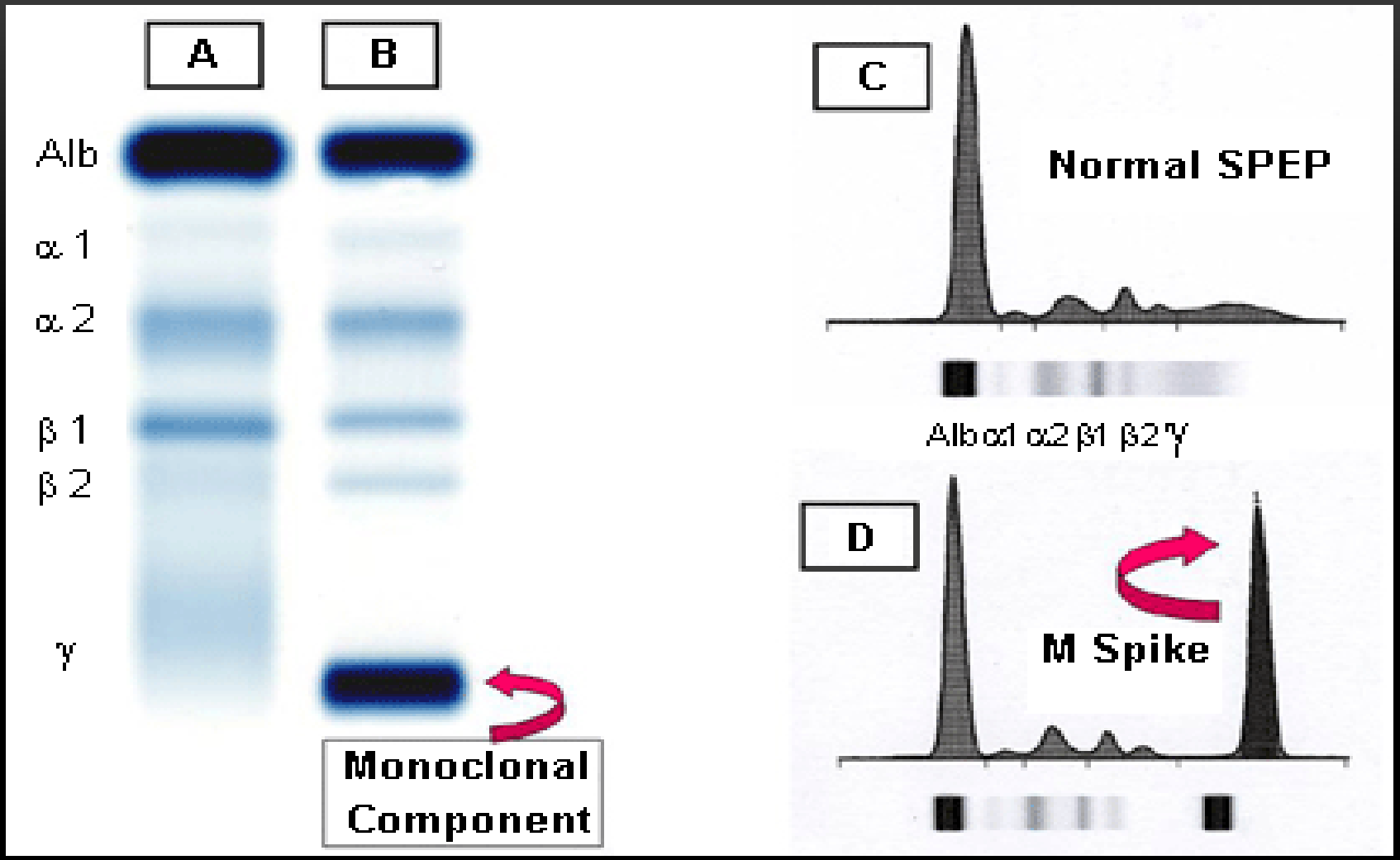
In the urine we will find just the light chain which called **Bence-Jones protein**

- The Bence-Jones protein coagulate at 40–60 °C
- Dissolves at 100 °C (it's a special protein ..bcuz it dissolves after the coagulation) =so we can diagnosis the patient using this test
- Other protein is different (remember the egg) it coagulates at 100 c and can't be dissolve)
- Multiple myeloma cases are diagnosed by using:
  - Serum electrophoresis
  - Immunoelectrophoresis

Multiple myeloma 4 our info u will nt ask about it



A: serum protein electrophoresis demonstrating the M component.
B: serum and urine immunofixation electrophoresis



4 ur info

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

Renal Proteinuria

- Associated with renal disease

Glomerular proteinuria

- High glomerular permeability
- Causes filtration of high molecular weight proteins

(e.g. glomerulonephritis)

Note:The permeability is affected here (large pores)so we will find large proteins in the urine

Tubular proteinuria

- Low tubular reabsorption with normal glomerular permeability
- Causes excretion of low molecular weight proteins

(e.g. chronic nephritis)

Note: the glomerular is normal here but the problem in the tubular reabsorption ability so the permeability is good (small pores) so we will find mainly low molecular weight proteins in urine

ORTHOSTATIC (POSTURAL) PROTEINURIA: THE DISEASE OCCURRENCE DEPENDS ON THE POSITION

It’s congenital

Persistent benign protenuria=imp

Occurs frequently in young adults due to periods spent in a vertical posture

Increased pressure on the renal vein (veinoconstriction) in the vertical position causes orthostatic proteinuria

it’s just a hypothesis we don’t know the exact causes

Disappears in horizontal posture

Microalbuminuria:

(It's called micro because the albumin is smaller than the other protein)

- Presence of small amounts of albumin in the urine

  (20– 200 mg/L)

so, when we find protein in the urine in amount around (20-200 mg/l) = most likely it's albumin bcus it has lower molecule weight than other plasma protein so it's execrated more and before them

Cannot be detected by ordinary urine testing= so this is other difference between microalbuminuria and proteinuria

Needs special tests for detection

- Early indicator of glomerular affection due to

  uncontrolled diabetes mellitus or hypertension

3 - Post renal proteinuria:

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, trauma, tumors and stones(stones can slough off our cells when it moves down and (u know that our cells r proteins))

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

Note:

Glycose is the family name and it means any sugar eg: glucose,frectose ..etc)

1 - Glucosuria: Presence of detectable amount of glucose in urine

- Uncontrolled DM (no insulin so the glucose level is high):The concentration of glucose in the plasma exceeds the renal threshold

Normal glucose level in the blood =(3.6-5.8) ... If the glucose level serum is in this amount all the filtered glucose will be reabsorbed

If the sugar is over 6 ..>>>that means the amount of filtered glucose is above the normal so the proximal tubular cells will absorb the glucose in the usual amount then the receptor will stop the reabsorption so the rest will be execrated

- Renal glucosuria : Normal plasma glucose concentration with proximal tubular malfunction → ↓ renal threshold

gestational diabetes:

(congestion سكري الحمل ويكون غالبا بسبب تغيرات في الهرمون او بسبب ال))and Fanconi's syndrome)

Addition notes:

gestational diabetes:

N this condition we find glucose in the pregnant urine
so we thought that she got diabetes mellitus
But actually ,she has normal serum glucose level
However the problem in the proximal tubules receptor malfunction =
it stops the reabsorption before reaching the renal threshold
so the rest of filtered glucose will be execrated

the renal threshold
is the concentration of a substance in the blood
which the kidneys is able remove it into the urine.

Causes of proximal tubule malfunction:

-congenital

-acquired: eg: poisoning by minerals

In Fanconi's syndrome three components will not be absorbed :

HCO_3

Amino acid

glucose

phosphate

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

- Alimentary causes(meaning from outside=from food) : High fructose intake

- Metabolic(inborn error of metabolism) :

Low fructokinase or aldolase B in the liver

3 – Galactosuria: (*Presence of galactose in urine)*-

Alimentary : High galactose intake

- Metabolic : Low galactokinase or galactose -1-phosphate uridyl transferase in the liver

- Addition notes:

Deficiency in galactokinase or galactose -1phosphate uridyl transferase means :

that the glactose will not be degraded into smaller molecules such as.. water and co2 and energy or glucose (the person will suffer from hypoglycemia) Also the person will suffers from condition called glucose intolerance= (eg: the baby can't drink the milk) (bcuz the milk consists of the glactose and glucose) ..so the glactose will accumulate in the body because the enzyme which is responsible of there metabolisms are absent they accumilate specially in the brain and Couse mental retardation or in the eye andCouse cataract)

Ketonuria : Presence of ketones, acetone, acetoacetic acid & β - hydroxybutyric acid in urine

1 – Diabetic ketoacidosis

In uncontrolled diabetic the insulin level is low which is important to transfer the glucose from blood to the cells to metabolize it and get the energy so it will shift to (lipid metabolism instead of glucose metabolism to generate the body energy) the end results r : energy and fatty acid ..>>the fatty acid will be converted in the liver into ketonacid then execrated

2 – Starvation:

The glucose level is low(the glucose storage is empty) so the metabolism shifted to the lipid results in the end ketonacid

3 – Prolonged vomiting

4 – Unbalanced diet: high fat & Low CHO diet..(carbohardates are important as a source of glucoses)

5 – Phenylketonuria (inborn error of amino

acid metabolism)

Choluria : Presence of bile in urine

1 – Bilirubin / Bile salts:

Normally no bilirubin is detected in urine

Note: Conjugation : bind the insoluble molecule to the glucuronic acid to make it soluble and easily excreted

Normally:

The bilirubin goes to the liver and undergoes the conjugation then it goes to the small intestine via bile >>in small intestine the bacteria converte it to the urobilinogen wich will normally be found in the urine

Bilirubin is detected in:

- **Hepatocellular damage**

- **Obstruction of bile duct:**

  Extrahepatic (Stone)

  Intrahepatic (hepatic tumors)

Here the liver is normal but the problem in the pathway between the liver and intestine .. The liver will do the conjugation to the bilirubin and make it soluble but there is an obstruction on the bile so it will take another pathway to be excreted (just if the a serum bilirubins r in the large amount) so in this condition will find bilirubin in the urine instead of urobilinogen

2 - Urobilinogen:

- Normally present in trace amounts in urine

High urobilinogen is found in:

- Hemolytic anemia

The heme of RBC contains biliribin so the destruction of RBCS will rise the level of bilurbin then urobilinogen indirectly

- Hepatocellular damage

Nitrite :

Positive nitrite test is significant of bacteria in urine

Blood :

I - Hematuria: Presence of detectable amount of blood in urine (the RBCS will be intact in urine –not destroyed)

a – Acute and chronic glomerulonephritis

b – Local disorders of kidney & genito-urinary tract (Trauma , cystitis , renal calculi and tumors

c – Bleeding disorders (Hemophilia)

II - **Hemoglobinuria:** Presence of hemolysed blood in urine :

Distructed RBC in the urine so the urine contains HB

a – Hemoglobinopathies: 1. Sickle cell anemia

2. Thalassemia :absence of the gane that respensble of alpha or beta sub-unit

b – Malaria (P. falciparum)

c – Transfusion reaction (Bl. Incompatibility)

Important:
The present of proteins in the urine could be:

Less than 20mg/day= normal (traces)
20-200 mg/day= microalbuminria
More than 200mg/day= proteinuria