

Biochemistry
Team 434

Chemical analysis of urine

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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 person is about 1.5 L per day**

Normal composition of urine

Major **inorganic** salts:

sodium, potassium, chloride,
small amount of:Ca,Mg, and
traces of Fe,Cu,Zn and I.

Major **organic** constituents:

sugar, organic acids, non-
protein nitrogen compounds
traces of proteins, vitamins,
hormones, pigments

ABNormal composition of urine

Proteinuria.

Glycosuria

Nitrite

Choluria

Blood

It is **important** to know each disease

ABNormal composition of urine

and if its pre-renal , renal or post

renal ★

Proteins

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

- More than this level leads to a condition called **Proteinuria**

Causes

1- Pre-renal 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 (normally all amino acids and glucose are totally reabsorbed unlike

Electrolytes Witch depends on the +ve and -ve charge)(when we have a high

protein level the is will exceed the capacity of the tubules)

- Results in overflow of proteins in the urine.

renal Threshold: the capacity of the renal tubules to reabsorb any substance

Multiple myeloma (causes pre-renal) proteinuria

• A proliferative disorder of the immunoglobulin-producing plasma cells (plasma cells → immunoglobulin production (it has 2 chains light and heavy accumulation of the light chains(Bence-Jones protein) in the blood will excrete it in the urine)

• The serum contains elevated levels of monoclonal light chains antibodies (**Bence-Jones protein**) (also called thermo stable protein)

• Bence-Jones protein is filtered in kidneys in high amounts

• Exceeding the tubular reabsorption capacity

• Hence excreted in the urine.

• The Bence-Jones protein coagulate at 40–60 °C

• Dissolves at 100 °C

• Multiple myeloma cases are diagnosed by using:

- Serum electrophoresis

- Immunoelectrophoresis.

The different between Serum electrophoresis and Immunoelectrophoresis is: (serum is without fluorescent (color) but immuno is with fluorescent).

2- Renal Proteinuria

3- Post proteinuria

- Associated with renal disease

Glomerular proteinuria

- High glomerular permeability
- Causes filtration of high molecular weight proteins (e.g. glomerulonephritis)

Tubular proteinuria

- Low tubular reabsorption with normal glomerular permeability
- Causes excretion of low molecular weight proteins (e.g. chronic nephritis)

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 (bladder cystitis), trauma Tumors and stones (kidney calculi)**

Orthostatic* (Postural) Proteinuria

- Persistent benign proteinuria
- Occurs frequently in young adults due to periods spent in a vertical posture
- 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/day)**

Cannot be detected by ordinary urine testing Needs special tests for detection.

- **Early indicator of glomerular dysfunction** due to uncontrolled diabetes mellitus or hypertension.

Between (20-200) is the gray zone we detect the albumen in spatial test for elderly, diabetic and hypertension to detect early of renal impairment → why detect the early signs?? Because it is irreversible
*random urine sample → measure albumen / creatinine → why use creatinine ?? Because if the urine is diluted the albumen will be low and if it was concentrated the albumen will be high and creatinine will correct the equation

Abnormal composition of urine

<p>Glycosuria (Presence of any sugar in urine)</p>	<p>Ketonuria *: Presence of ketones, acetone, acetoacetic acid & β-<u>hydroxybutyric acid</u> in urine. body will consume fat for energy.</p>
<p>1 - Glucosuria: Presence of <u>detectable amount of glucose in urine</u> (when measured in the plasma we will have 2 scenarios)</p> <p>1st- Uncontrolled DM :The concentration of glucose in the plasma exceeds the renal threshold (<i>glucose in plasma</i>)</p> <p>2nd- Renal glucosuria : <u>Normal plasma glucose concentration</u> with proximal tubular malfunction → <u>↓ renal threshold</u> (gestational diabetes and (Fanconi's syndrome= can be congenital or heavy metal poisoning)</p>	<p>1 – Diabetic ketoacidosis</p> <p>2 – Starvation</p> <p>3 – Prolonged vomiting</p> <p>4 – Unbalanced diet: high fat & Low CHO diet</p> <p>5 – Phenylketonuria (inborn error of amino acid metabolism)</p>
<p>2 – Fructosuria: (<i>Presence of fructose in urine</i>) :</p> <p>-Nutritional cause: High fructose intake</p> <p>- Metabolic : Low fructokinase or aldolase B in the liver.</p> <p>3 – Galactosuria: (<i>Presence of galactose in urine</i>)</p> <p>Nutritional cause: High galactose intake</p> <p>- Metabolic : Low galactokinase or galactose -1- phosphate uridyl transferase in the liver.</p>	<p><u>Nitrite</u> : Positive nitrite test is <u>significant of bacteria in urine .</u></p> <div data-bbox="1373 1153 1901 1405"><p>* Production of ketone bodies is a normal response to a shortage of <u>glucose</u>, meant to provide an alternate source of fuel from <u>fatty acids</u>.</p></div>

Choluria : Presence of bile in urine

Blood :

1 – Bilirubin / Bile salts:

Normally **no bilirubin is detected in urine** Bilirubin is detected in:

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

1 - Hematuria: Presence of detectable amount of blood in urine.

- a – Acute and chronic glomerulonephritis**
- b – Local disorders of kidney & genito-urinary tract (Trauma , cystitis , renal calculi and tumors)**
- c – Bleeding disorders (Hemophilia)**

If we find normal rbc in urine, and the test shows that there's a problem that means: (renal problem)
But if we find rbc and we do renal test and the result was normal: (post renal problem).

2 – Urobilinogen*:

- **Normally present in trace amounts In urine** High urobilinogen is found in:
- Hemolytic anemia
- Hepatocellular damage

*Urobilinogen is a colourless by-product of **bilirubin** reduction. It is formed in the intestines by **bacterial** action on bilirubin.

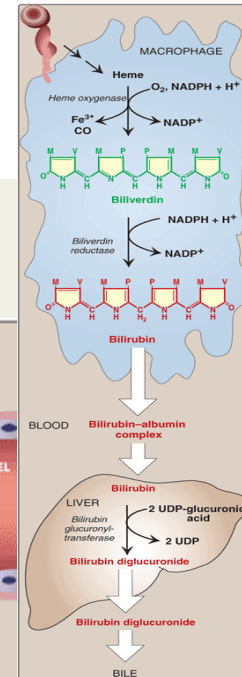
2 - Hemoglobinuria: Presence of hemolysed blood in urine, (it's a pre-renal problem).

- a – Hemoglobinopathies:**
 - 1. Sickle cell anemia**
 - 2. Thalassemia**
- b – Malaria (P. falciparum)**
- c – Transfusion reaction (Bl. Incompatibility)**

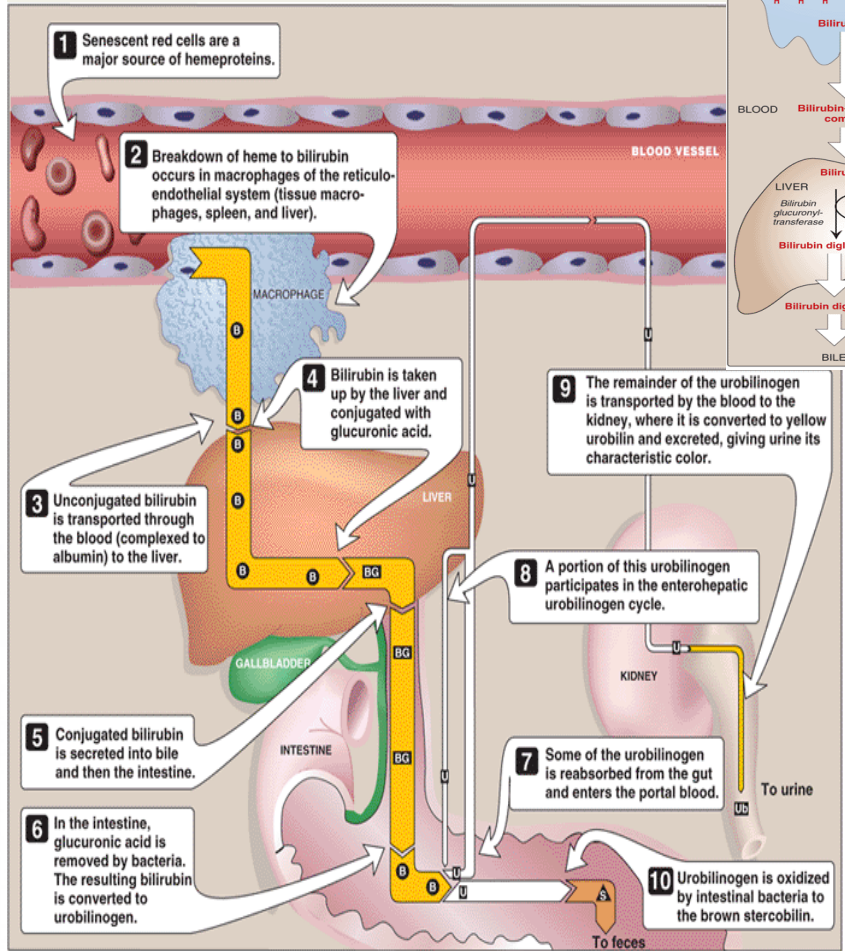
Multiple myeloma

We have to use serum

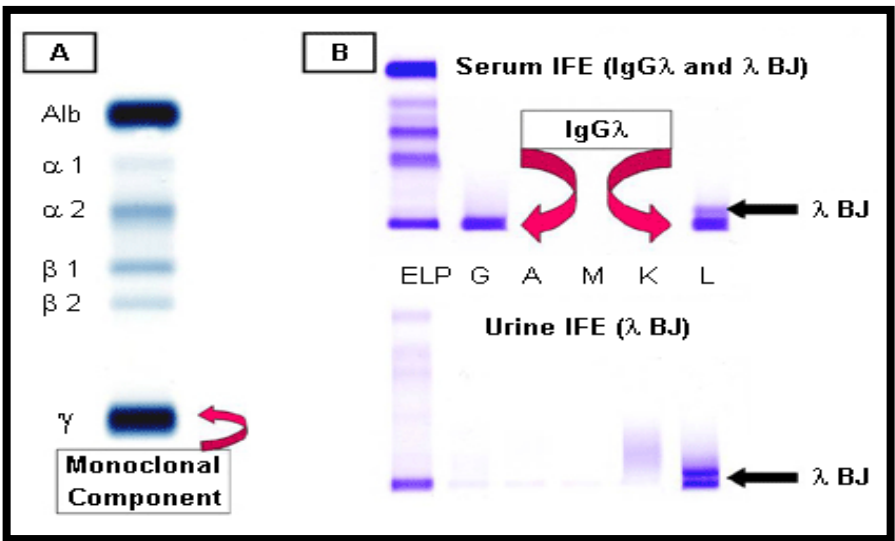
Those pictures are just for your information



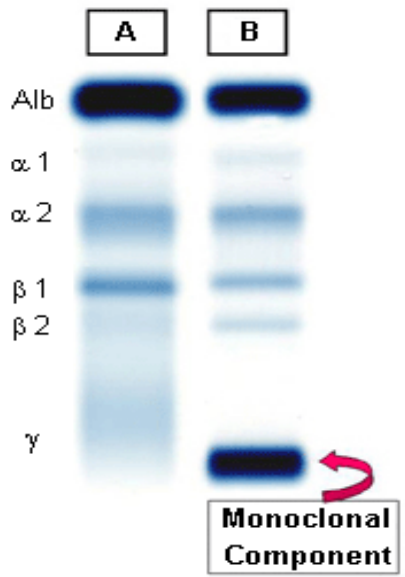
Catabolism of heme B = bilirubin; BG = bilirubin diglucuronide;
U= urobilinogen; Ub = urobilin; S = stercobilin.



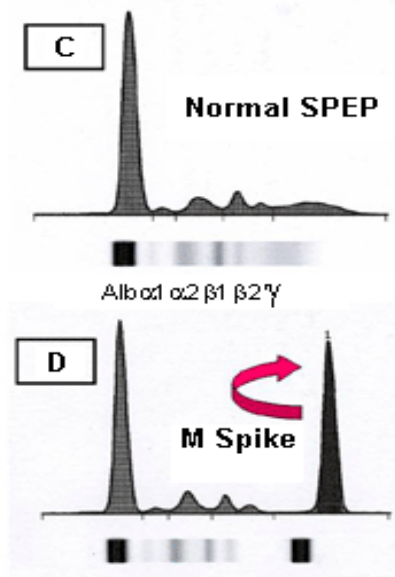
Bilirubin → breakdown of the RBC's
Green color of bruises because of biliverdin



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

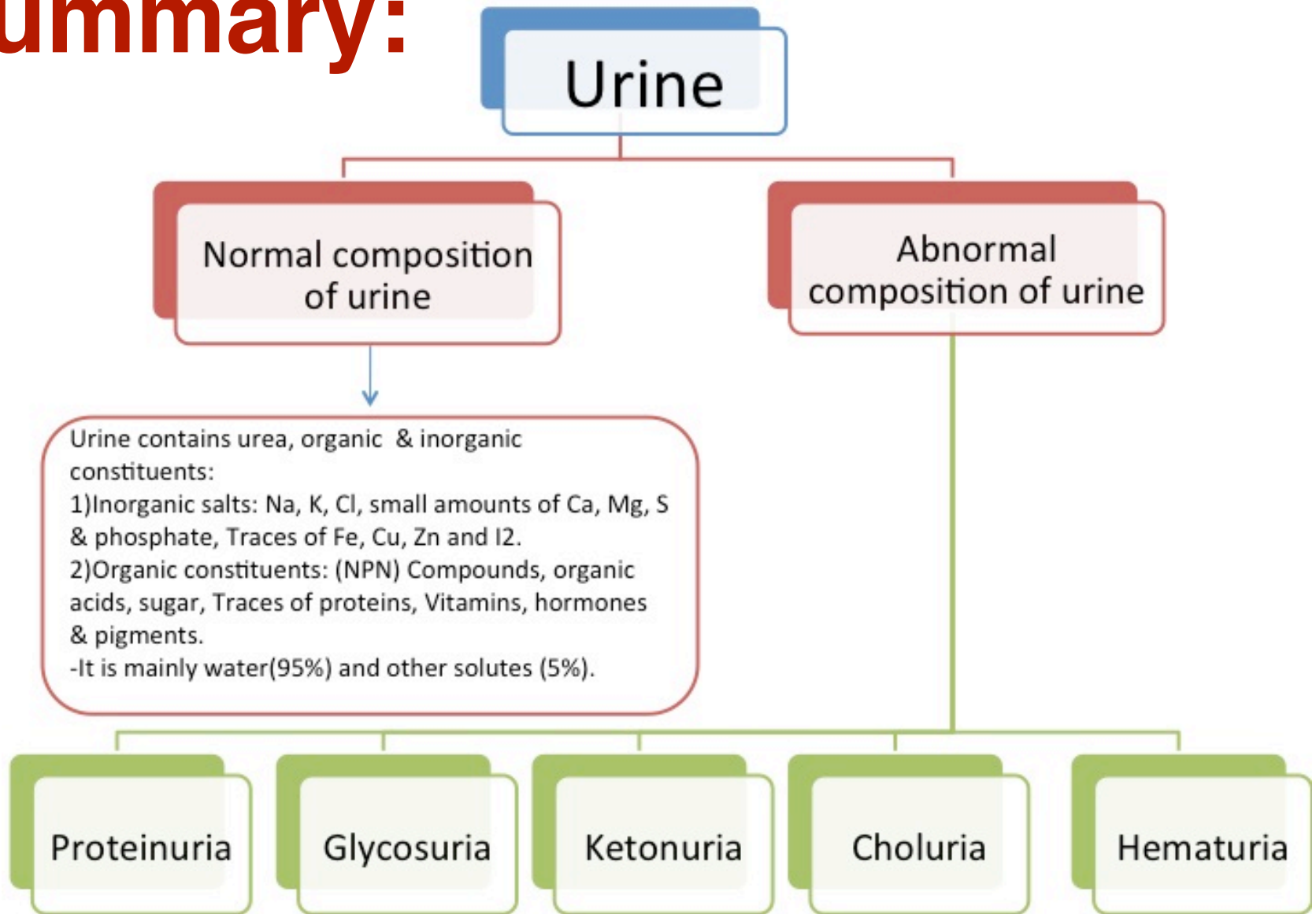


A: normal serum.
B: multiple myeloma showing M component in the gamma region.

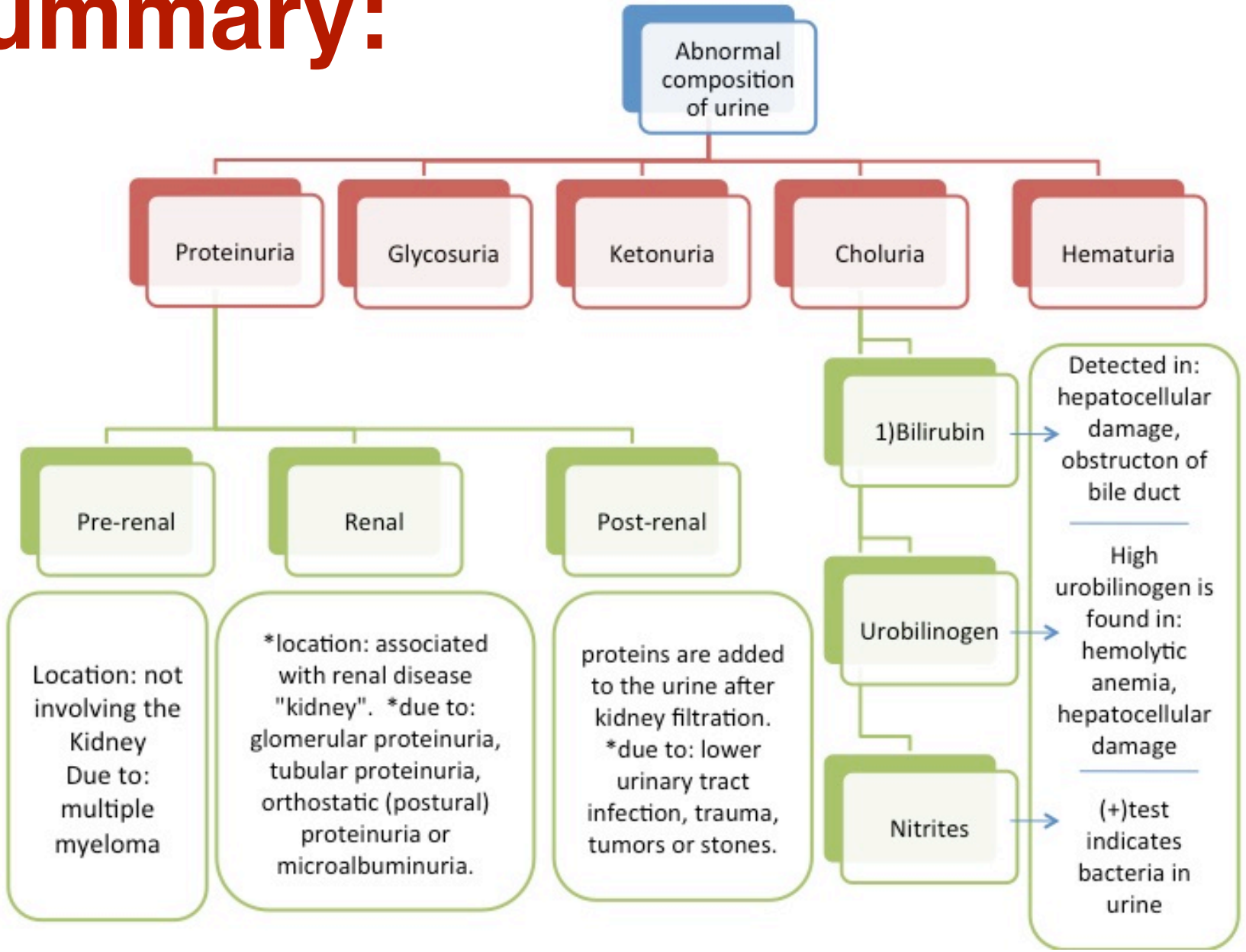


C: densitometry tracing of A showing the 5 zones of the high resolution agarose electrophoresis.
D: densitometry of the M component of B, termed the M Spike

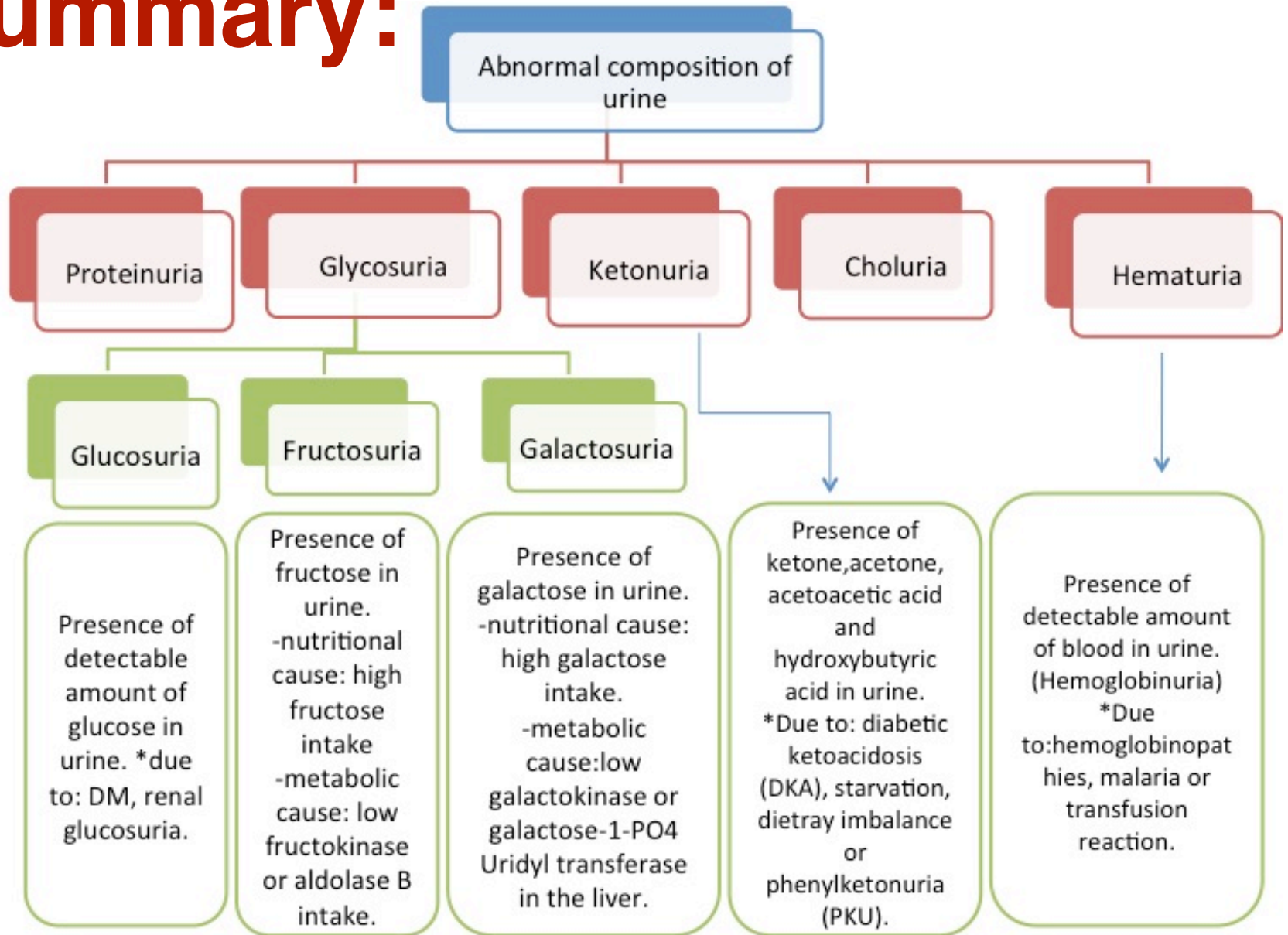
Summary:



Summary:



Summary:



MCQs

1- which of the following is an indicator of uncontrolled diabetes mellitus when found in the urine ?

- A. Light chains antibodies
- B. Low molecular weight proteins
- C. Glucose with normal serum concentration
- D. Acetoacetic acid

2- Presence of detectable amount of blood in urine is an indicator of :

- A. Malaria
- B. Sickle cell anemia
- C. Hemophilia
- D. Bile duct obstruction

3- Which of the following pairing is wrong ?

- A. Choluria _ liver damage
- B. Bence Jone proteins _ multiple myeloma
- C. Orthostatic proteinuria _ long time standing
- D. Nitrate in urine _ sterilization

4- What is expected to be seen in a patient who had a car accident and hemorrhage corrected by transporting blood to him intravenously ?

- A. Pre-renal proteinuria
- B. Hemoglobinuria
- C. Choluria
- D. Galactosuria

SAQs

1- What are the possible causes of the presence of insoluble bilirubin in urine?

Hepatocellular damage
Bile duct obstruction

2- What are the clinical applications of detecting Microalbumin in urine ?

Early indicator of glomerular dysfunction due to uncontrolled diabetes mellitus or hypertension

3- What are the methods used to diagnose multiple myeloma ?

Serum electrophoresis
Immunoelectrophoresis



Videos :

1- <https://youtu.be/TS6qGt1rN5A>

Answers:

1- D

2- C

3- D

4- B

Done by:

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