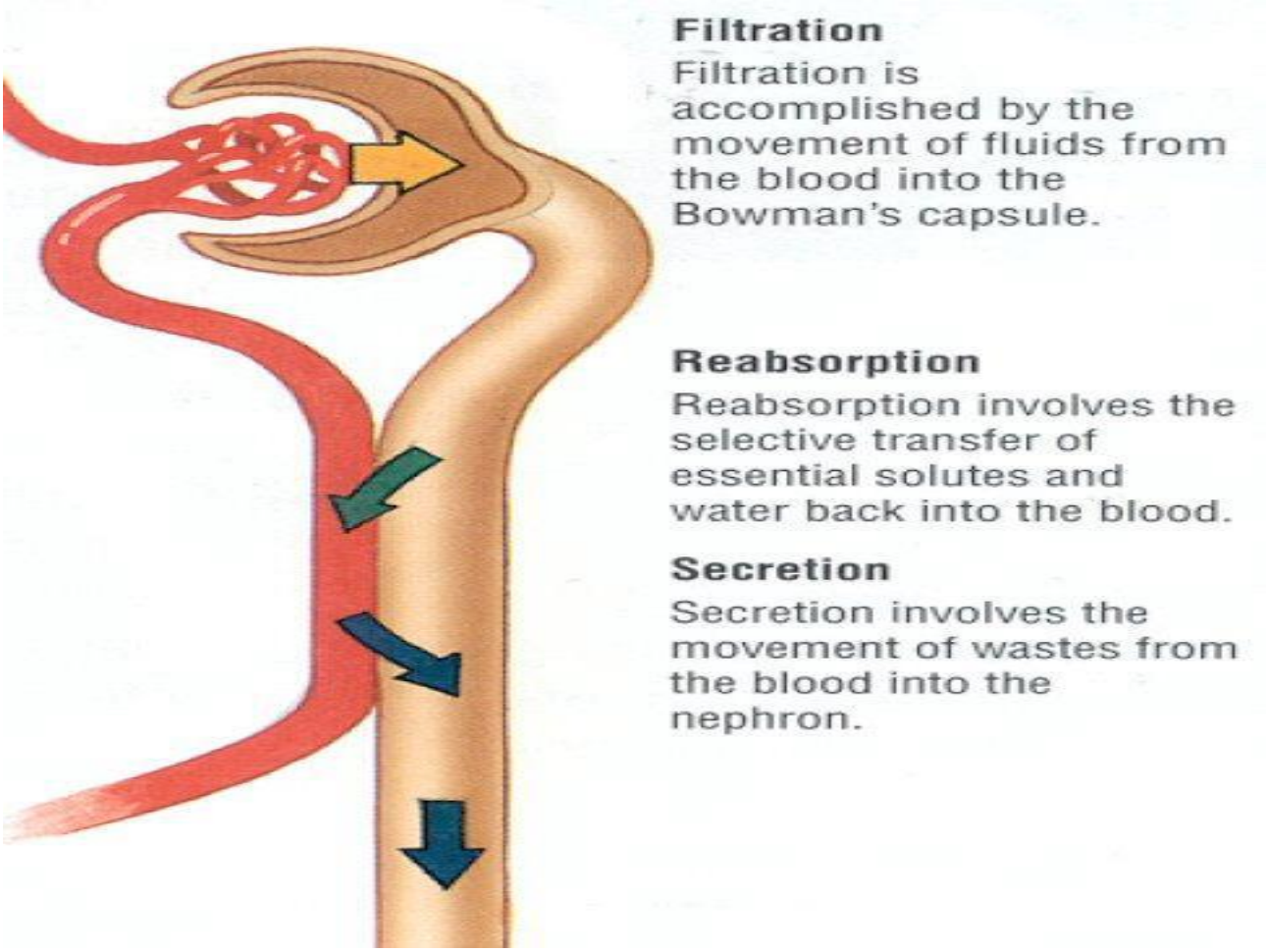
AL-Mustaqbal University Collage.
Department of Pathological Analysis Technique.
Subject: - Advanced laboratory technique
Lecture-No- 3.
General Urine Examination-1.

General Urine Examination



Urine Formation: -

Urine is continuously formed by the kidneys. It is actually an ultra-filtrate of plasma from which **glucose**, **amino acids**, **water**, and other substances essential to body metabolism have been reabsorbed.

The kidney's ability to clear waste products selectively from the blood while maintaining the essential water and electrolyte balances in the body is controlled in the **nephrons** by: -

A urinalysis is a group of **physical**, **chemical**, and **microscopic** tests.

The tests detect and/or measure several substances in the urine, such as byproducts of normal and abnormal metabolism, cells, cellular fragments, and bacteria.

Urine is produced by the kidneys, two fist-sized organs located on either side of the spine at the bottom of the ribcage.

Glomerular filtration

The first step in urine formation is filtration of blood plasma at the nephrons. In the nephrons cells, proteins, and other large molecules are filtered out of the glomerulus by a process of ultrafiltration, leaving an ultra-filtrate that resembles plasma (except that the ultra-filtrate has negligible plasma proteins) to enter Bowman's space.

Note: - It is called reabsorption (and not absorption) because these substances have already been absorbed once (in the intestines).

Tubular reabsorption

Tubular secretion is the transfer of materials from peritubular capillaries to renal tubular lumen.

Tubular secretion is caused mainly by active transport.

In the distal tubule, secretion is the prominent activity, usually only a few substances are secreted. These substances are present in great excess, or are natural poisons.

Renal threshold

Certain substances appear in the urine when their plasma levels are above certain set-point, or "threshold," levels. High-threshold substances, such as glucose and amino acids, are reabsorbed almost completely. The appearance of a high-threshold substance in the urine is evidence that the filtered load of the substance is exceeding the maximal reabsorption rate of its transport system.

General Urine Examination

The kidneys filter wastes out of the blood, help regulate the amount of water in the body, and conserve proteins, electrolytes, and other compounds that the body can reuse. Anything that is not needed is eliminated in the urine, traveling from the kidneys through ureters to the bladder and then through the urethra and out of the body. Urine is generally yellow and relatively clear, but each time a person urinates, the color, quantity, concentration, and content of the urine will be slightly different because of varying constituents.

Many disorders may be detected in their early stages by identifying substances that are not normally present in the urine and/or by measuring

abnormal levels of certain substances. Some examples include glucose, protein, bilirubin, red blood cells, white blood cells, crystals, and bacteria.

METHODS OF URINE COLLECTION

1-Random collection taken at any time of day with no precautions regarding contamination.

The sample may be dilute, isotonic, or hypertonic and may contain white cells, bacteria, and squamous epithelium as contaminants. In females, the specimen may contain vaginal contaminants such as trichomonads, yeast, and during menses, red cells.

2-Early morning collection of the sample before ingestion of any fluid. This is usually hypertonic and reflects the ability of the kidney to concentrate urine during dehydration which occurs overnight. If all fluid ingestion has been avoided since 6 p.m. the previous day, the specific gravity usually exceeds 1.022 in healthy individuals.

3-Clean-catch, midstream urine specimen collected after cleansing the external urethral meatus. A cotton sponge soaked with benzalkonium hydrochloride is useful and non-irritating for this purpose.

4- Catherization of the bladder through the urethra for urine collection is carried out only in special circumstances, i.e., in a comatose or confused patient. This procedure risks introducing infection and traumatizing the urethra and bladder, thus producing iatrogenic infection or hematuria.

5- Suprapubic trans-abdominal needle aspiration of the bladder. When done under ideal conditions, this provides the purest sampling of bladder urine. This is a good method for infants and small children.

Urinalysis in laboratory: -

A complete urinalysis consists of three distinct testing phases: -

A-Physical examination: - Is process that evaluates the urine colors, volume, PH and concentrations.

B-Chemicals examination: - Is process test use to detect presence 9 substances in the urine sample which provide valuable information about healthy and diseases (normal and abnormal cases) during urinalysis.

C-Microscopic examination: - Is processes that identifies and count the types of cells, crystals, and others components (bacteria, mucous) that can be present in the urine samples.

A-Physical examination: -

During the visual examination of the urine, the laboratorial observes the urine's color and clarity. These can be signs of what substances may be present in the urine. They are interpreted in conjunction with results obtained during the chemical and microscopic examinations to confirm what substances are present.

However, red-colored urine can also occur when blood is present in the urine and can be an indicator of disease or damage to some part of the urinary system. Another example is yellow-brown or greenish-brown urine that may be a sign of bilirubin in the urine.

"Normal" urine can be clear or cloudy. Substances that cause cloudiness but that are not considered unhealthy include mucus, sperm and prostatic fluid, cells from the skin, normal urine crystals, and contaminants such as body lotions and powders.

Other substances that can make urine cloudy, like red blood cells, white blood cells, or bacteria, indicate a condition that requires attention.

1-Volume: - The normal volume during 24-hour urine volume of an adult is between 600-2000 ml. It varies greatly with the fluid intake (which is usually a matter of habit) and on the loss of fluid by other routes (sweetening due to the physical activity and external temperature). The volume of urine is less in summer than in winter.

1-Oliguria (<500 ml).

2-Anuria.

3-Polyuria or Diuresis.

4-Nocturia.

2-Ph: - On a normal mixed diet the urine is usually acidic (5~6).

-A vegetarian diet causes a tendency to alkalosis, thereby produces alkaline urine, since the oxidation of food produces salts of inorganic acids as sodium lactate and sodium iodate.

-Urine PH decrease after a meal because of the increased secretion of HCL in to the stomach for digestion.
-**Alkaline urine** occur in renal disease such as chronic glomerulonephritis because of decrease glomerular filtration, which causes a diminished excretion of phosphate, sulfate, and other acidic buffers.
-Urine PH decrease at the early morning or after any fairly prolonged period of sleep because of the mild respiration acidosis occurring with sleep and the renal compensation to acidosis.
-The normal urine becomes alkaline on standing because of the conversion of urine to ammonia by bacteria action.

Urine Reaction

Overview:

pH is a measure of the acidity or basicity of a solution. It is defined as the co logarithm of the activity of dissolved hydrogen ions (H+).
The pH is an indicator of the renal tubules ability to maintain normal hydrogen ion concentration in the plasma and extracellular fluid.
The kidneys maintain normal acid-base balance primarily through re-absorption of sodium and tubular secretion of hydrogen and ammonium ions.

Importance: -

Precipitation of urine crystals in supersaturated urine is highly dependent on urine pH (e.g. struvite will precipitate in alkaline not acidic urine).
Knowledge of the urine pH is important in interpreting urine sediment findings for example: erythrocytes, leukocytes, and casts tend to disintegrate in alkaline urine (pH > 8.0 some medications are more effective in acidic or alkaline environments. For example, streptomycin, neomycin, and kanamycin are more effective in treating urinary tract infections when the urine is alkaline. Control of urinary pH is important in the management of several diseases, including:

- The urine should be kept acid during treatment of UTI or persistent bacteriuria
- The urine should be kept acid during management of urinary calculi that develop in alkaline urine.

Procedure:

Using chemical strip testing.
The test is based on the double indicator (methyl red/bromthymol blue) principle that gives a broad range of colors covering the entire urinary pH range. Colors range from **orange** through **yellow** and green to **blue**.
Interfering Factors with prolonged standing, the pH of a urine specimen becomes **alkaline** because bacteria split **urea** and produce **ammonia**.

Normal:

The pH of normal urine can vary widely, from **4.6** to **8.0** (The average pH value is about 6.0 (acid).

Note: *The pH of urine never reaches 9, either in normal or abnormal conditions. Therefore, a pH finding of 9 indicates that a fresh specimen should be obtained to ensure the validity of the urine analysis.*

Interpretation:

*Acidic urine (pH <7.0) occurs in diabetic ketosis prolonged diarrhea starvation UTIs caused by Escherichia coli gout.

*Highly concentrated urine, such as that formed in hot, dry environments, is strongly acidic and may produce irritation.

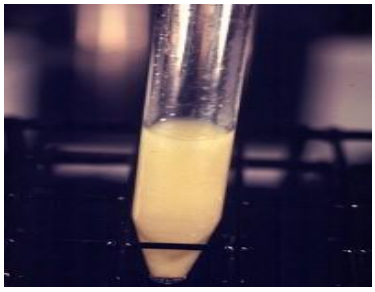
During sleep, decreased pulmonary ventilation causes respiratory acidosis; as a result, urine becomes highly acid.

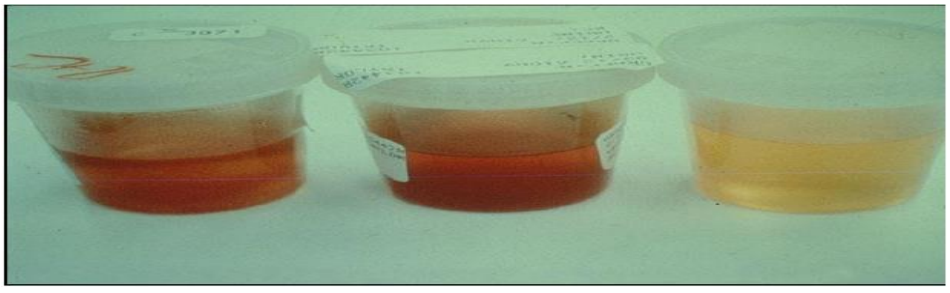
Alkaline urine (pH >7.0) occurs in **Post-prandial alkaline tide**

Alkaline urine after meals is a normal response to the secretions of hydrochloric acid in gastric juice (usually starts within 15-20 minutes after eating food).

UTIs caused by urea-splitting bacteria (Proteus and Pseudomonas) (Persistent alkaline urine suggests urinary tract infection) prolonged vomiting

3-Colour: - The color of the urine is affected by many components (concentration, food, pigment, dyes, medication, and blood). The intensity of the color of normal urine depend on the concentration of the urine. The yellow or amber color of normal urine is due to the presence of a yellow pigment, urochrome. Usual causes of urinary colors are shown in the following table: -





4-Smell or Oder: - Fresh urine is usually aromatic. On standing the decomposition of Acetone may be detecting as fruity odder.

5-Specific gravity: -

Most laboratories measure specific gravity with a refractometer (Urinometer).
Specific gravity between 1.002 and 1.035 on a random sample should be considered normal if kidney function is normal.

Specific gravity: -is defined as the ratio of the density of a given solid or liquid substance to the density of water at a specific temperature and pressure. Substances with a specific gravity greater than one are denser than water, and so will sink in it, and those with a specific gravity of less than one are less dense than water, and so will float in it.

Urine specific gravity measures urine density, or the ability of the kidney to concentrate or dilute the urine.

The USG is influenced by the number of molecules in urine, as well as their molecular weight and size.

Note: urine specific gravity is directly proportional to urine osmolality which measures solute concentration

Procedure:

The urinometer (hydrometer)

Principle: -

It is most widely known but least accurate method.

It consists of a bulb-shaped instrument that contains a scale calibrated in SG readings.

Urine (10 to 20 ml) is transferred into a small cylinder, and the urinometer is floated in the urine.

The **SG** is read off the urinometer at the meniscus level of the urine.

Interference.

Temperature of urine specimens affects SG; cold specimens produce falsely high values using the hydrometer.

For correcting the urinometer reading we can use the following formula: Sp. Gr at 25C = (Room Temp - 25) / 3 + Reading

Note: if urine sample is little, dilute urine then measure specific gravity then multiply the last two digits by the dilution factor

Normal

The range of urine SG depends on the state of hydration and usually between 1.015and 1.025

Interpretation:

Reduced specific gravity (Hyposthenuria) (1.001 -1.010).

- Diabetes insipidus.
- excess fluid intake.
- Pyelonephritis.
- Glomerulonephritis.

- Treatment with diuretics.

Raised specific gravity (Hypersthenuria) (1.025 -1.035).

- Diabetes mellitus.
- Adrenal insufficiency.
- Congestive cardiac failure (related to decreased blood flow to the kidneys).
- Excessive sweating.
- Excessive water loss (dehydration, fever, vomiting, diarrhea).
- Toxemia of pregnancy.
- Cystitis - products of inflammatory reaction are added to the urine.