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**URINE FORMATION AND CONCENTRATION**

Filtration, Reabsorption, Secretion Are The Three Steps of Urine Formation

The kidneys filter unwanted substances from the blood and produce urine to excrete them. There are three main steps of urine formation: glomerular filtration, reabsorption, and secretion. These processes ensure that only waste and excess water are removed from the body.

1**. The Glomerulus Filters Water and Other Substances from the Bloodstream:**

Each kidney contains over 1 million tiny structures called nephrons. Each nephron has a glomerulus, the site of blood filtration. The glomerulus is a network of capillaries surrounded by a cup-like structure, the glomerular capsule (or Bowman’s capsule). As blood flows through the glomerulus, blood pressure pushes water and solutes from the capillaries into the capsule through a filtration membrane. This glomerular filtration begins the urine formation process.

2. **The Filtration Membrane Keeps Blood Cells and Large Proteins in the Bloodstream:**

Inside the glomerulus, blood pressure pushes fluid from capillaries into the glomerular capsule through a specialized layer of cells. This layer, the filtration membrane, allows water and small solutes to pass but blocks blood cells and large proteins. Those components remain in the bloodstream. The filtrate (the fluid that has passed through the membrane) flows from the glomerular capsule further into the nephron.

3. **Reabsorption Moves Nutrients and Water Back into the Bloodstream:**

The glomerulus filters water and small solutes out of the bloodstream. The resulting filtrate contains waste, but also other substances the body needs: essential ions, glucose, amino acids, and smaller proteins. When the filtrate exits the glomerulus, it flows into a duct in the nephron called the renal tubule. As it moves, the needed substances and some water are reabsorbed through the tube wall into adjacent capillaries. This reabsorption of vital nutrients from the filtrate is the second step in urine creation.

4. **Waste Ions and Hydrogen Ions Secreted from the Blood Complete the Formation of Urine**:

The filtrate absorbed in the glomerulus flows through the renal tubule, where nutrients and water are reabsorbed into capillaries. At the same time, waste ions and hydrogen ions pass from the capillaries into the renal tubule. This process is called secretion. The secreted ions combine with the remaining filtrate and become urine. The urine flows out of the nephron tubule into a collecting duct. It passes out of the kidney through the renal pelvis, into the ureter, and down to the bladder.

5. **Urine Is 95% Water**:

The nephrons of the kidneys process blood and create urine through a process of filtration, reabsorption, and secretion. Urine is about 95% water and 5% waste products. Nitrogenous wastes excreted in urine include urea, creatinine, ammonia, and uric acid. Ions such as sodium, potassium, hydrogen, and calcium are also excreted.

 **URINE CONCENTRATION**

The final concentration of the urine is very dependent on the amount of liquid ingested, the losses through respiration, faeces and skin, including sweating. When the intake far exceeds the losses, then, in order to maintain homeostasis the rest of the liquid is eliminated through urine. If the fluid intake is low and the losses are high, then the kidney has to concentrate as much as possible the urine in order to maintain homeostasis. As a result the concentration can range from as diluted as 65 to as concentrated as 1200 mOsm/kg. Producing diluted urine is not as problematic as to concentrating it. To achieve the higher concentrations the kidney depends on the juxtaglomerular nephrons that reach deep into the medulla and in the architectural relationship with the vasa recta. The concentration of the interstitial fluid increases in the medulla towards the tip of the renal pyramid. The higher concentrations of the interstitial fluid in the tip of the renal pyramid are achieved because the nephron has the capability of recirculate urea. Urea in the filtrate is not completely reabsorbed and most of it goes into urine. A percentage of the urea in the filtrate diffuses out of the collecting duct into the interstitial fluid. Once in the interstitial fluid urea provides the increase in osmolality that makes the tip of the renal pyramid so concentrated.

**What Is a Urine Concentration Test?**

A urine concentration test determines how well your kidneys are functioning. The test may be used to test your kidneys’ response to:

-too much fluid intake (water loading)

-too little fluid intake (dehydration)

- a hormone that should concentrate your urine, antidiuretic hormone (ADH)

You may take the test several times under different circumstances.

The test itself is painless and all you have to do is provide a clean-catch urine sample. However, the preparation phase may be uncomfortable.

**What is the Purpose of a Urine Concentration Test?**

Your doctor may recommend urine concentration testing if you are urinating too much or too little. The test can help identify specific types of problems with your kidneys.

The main reason this test is ordered is to see if you are suffering from central diabetes insipidus — a disease that causes excessive urination. This form of diabetes can occur when a head injury affects how your brain releases antidiuretic hormone (ADH). ADH normally increases the amount of water the kidneys retain. In central diabetes insipidus, your brain does not release enough ADH.

**A urine concentration test can also be used to evaluate:**

.dehydration

.kidney failure

.heart failure

.other hormone problems

.complications of a urinary tract infection

**How Is the Test Performed?**

The test is based on a lab analysis of your urine.

**Preparing for the Test**

Depending on how the lab plans to analyze your urine, before the test you may be asked to:

.drink excess fluids

.avoid fluids for a period of time

.take ADH (which can be taken in either pill form or a nasal spray).

**Taking a Clean-Catch Urine Sample**

The urine concentration test requires a clean-catch urine sample. The goal of a clean catch is to avoid contaminating the urine sample with bacteria from your skin. You will be given a moist towelette and a specimen cup for the collection.

Wash your hands thoroughly with soap and warm water. Open the collection cup. Place the lid on a clean surface. Be careful not to touch the inside of the cup or the inside of the lid.

Use the moist towelette to clean the area around your urethra. Then begin to urinate into the toilet. After a few seconds, put the cup in your urine stream. Once you have collected enough urine, remove the cup. Finish urinating into the toilet. Then carefully recap the cup, being careful not to touch the inside of the container or lid.

Return the cup as instructed by your doctor. Your urine will be sent to a lab for testing.

**Interpreting the Results of Your Urine Concentration Test**

The laboratory will test how concentrated your urine is. More concentrated urine means that there are more solutes and less water in the sample. Solutes are dissolved particles, such as sugars, salts, and proteins.

Normal values may vary based on the laboratory used. However, typically, your urine is measured in specific gravity — the ratio of the density of your urine to the density of water (1.000). Normal values tend to be in the range of at and slightly above the density of water (1.000 to 1.030). Your urine should be more concentrated after being given ADH.

If your urine is very concentrated, your doctor may suspect one or more of the following conditions:

* dehydration
* diarrhea
* excess sweating
* glycosuria (too much sugar in your urine)
* heart failure
* narrowing of the renal arteries
* inappropriate ADH secretion
* excess vomiting
* fluid restriction

Low urine concentration suggests:

* too much fluid intake
* diabetes insipidus
* kidney failure
* pyelonephritis

Combining multiple test preparations can help your doctor determine if your diabetes insipidus is due to a head injury and a resulting lack of ADH production, or because your kidneys can’t properly respond to ADH (this condition is called nephrogenic diabetes insipidus).

**Potential Side Effects of Taking the Test**

This test is not associated with any adverse side effects. However, refraining from drinking fluids for the test may make you feel dehydrated. Once the test is completed, ask your doctor if you can resume drinking fluids. This will rehydrate your body.