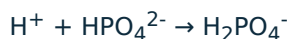


urine pH

The kidneys are the organ where the adjustment of the acid-base balance is carried out by the elimination (or retention) of H^+ . In the glomerular filtrate, the pH is the same as in plasma. Urine acidification occurs when passing through the renal tubular system.

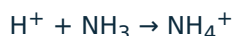
The concentration of free protons in urine is negligible compared to other ions; we can therefore say that H^+ is eliminated by the kidneys in two forms:

- bound to the anions present, e.g. to phosphates (conversion of hydrogen phosphate to dihydrogen phosphate)



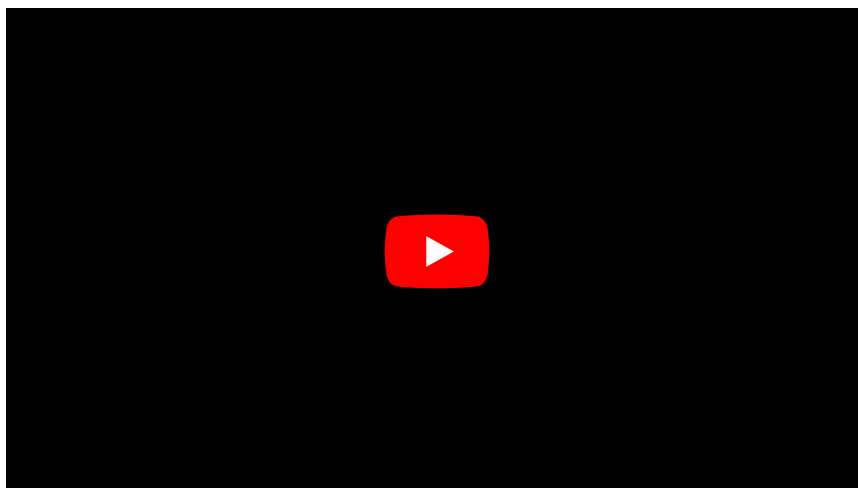
or to the anions of some organic acids. This proportion is referred to as the so-called titratable acidity, which under normal conditions represents 10-30 mmol/24 hours. It can be determined by titration with sodium hydroxide.

- as the ammonium cation, which represents the most important system.



The amount of NH_4^+ excreted in the urine varies between 30-50 mmol/24 hours.

RTA:



Urine pH depends on: on the composition of the diet

In a healthy person, the pH of urine is most influenced by the composition of the diet. A lacto-vegetarian diet causes alkalization of the urine. Conversely, a diet rich in protein (meat) is accompanied by acidification.

on the state of acid-base balance

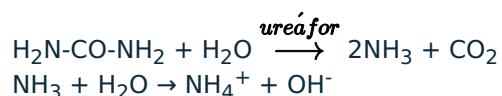
Under pathological circumstances, urine pH reflects disturbances in acid-base balance. Changes in urine pH are a manifestation of the compensatory and corrective activity of the kidneys. Aciduria is the result of metabolic correction and respiratory acidosis compensation, alkaliuria is at the beginning of respiratory compensation and metabolic alkalosis correction. However, the excretion of acidic urine in acidosis and alkaline in alkalosis applies only to mild disorders and well-functioning kidneys. The simultaneous finding of aciduria and ketonuria indicates starvation. A combination of aciduria, ketonuria and glycosuria is common in diabetes mellitus decompensation.

The most common factors affecting urine pH

Acid pH	Basic pH
protein diet	vegetarian diet
dehydration	renal tubular acidosis
diabetic ketoacidosis	respiratory and metabolic alkalosis
metabolic and respiratory acidosis	bacterial urinary tract infection
starvation	

Persistently *alkaline* urine pH can signal:

- '*Infection* of the kidneys or urinary tract with urease-producing bacteria. Enzymatic hydrolysis of urea produces ammonia, which alkalizes the urine. A similar situation exists with bacterially contaminated urine, in which bacteria have multiplied over a longer period of storage.



- **Renal tubular acidosis of the distal type**, which is a renal tubular cell disorder characterized by the inability of the distal tubule to excrete H^+ .

The main benefit of urine pH testing is in **diagnosis and treatment of urinary infection and urolithiasis**'. Permanent variations in urine pH can be one of the factors contributing to the formation of urinary stones.

- Calcium oxalate stones are common in *acidic urine*. *At an acidic pH, uric acid stones are easily formed. Urine alkalinization above a pH value of 7.0 can, under favorable circumstances, slowly dissolve uric acid stones and prevent their formation. Cystine also precipitates more easily in acidic urine.*
- In *alkaline* urine, phosphates are poorly soluble, and at pH above 7, ammonium-magnesium phosphate falls out of the solution (struvite - $\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$) and a mixture of phosphate and calcium carbonate ["carbonate apatite" - $\text{Ca}_{10}(\text{PO}_4\text{CO}_3\text{OH})_3 (\text{OH})_3$].

Urine pH determination

Urine pH must always be tested in *fresh urine*. *It is usually determined by **diagnostic strips**'. Accurate determination of pH can be done pH-meter.*

The physiological pH of urine is in the range of 5.0–6.5, extreme values are 4.5–8.0. Extreme values in the acidic or alkaline range raise suspicion of non-compliance with urine collection instructions.

Examination of kidney acidification activity

The basic test to assess the acidifying activity of the kidneys is the pH test of the morning urine sample. The pH determination needs to be done immediately and it is recommended to use a pH-meter. In a healthy adult, the pH of a morning sample is less than 6.0. With a higher value, there is a suspicion of a disorder of the acidification ability, and if there are no contraindications (e.g. significant limitation of kidney function), it is possible to perform an **acidification test** after a load of NH_4Cl or CaCl_2 (in patients with impaired liver function). We give the patient ammonium chloride (2 mmol per kg of body weight). 3 hours after ingestion of the test substance, urine is collected in 3 one-hour intervals, and immediately after collection, the acidity in the urine samples is measured with a pH meter. If the acidifying function of the kidneys is intact, the pH of the urine should fall below 5.5.

The acidification capacity is impaired in patients with renal tubular acidosis of the distal type.

In the event of an ambiguous result of the acidification test, the alkalizing capacity of the kidneys is investigated after an oral or intravenous sodium bicarbonate load.

Links

Related Articles

- pH
- pH of strong acids and bases
- pH of weak acids and bases
- pH-metry
- PH measurement
- pH of buffers
- pH of salts