

Glucose in the urine

Glucose filtered into the primary urine from the plasma is reabsorbed in the proximal tubules by active transport. The organism protects glucose from unnecessary losses, which is why the kidney tubules have a considerable reserve capacity - under physiological circumstances, the transport system is only about one-third loaded. With hyperglycemia, the use of the transport system increases, and if the blood glucose exceeds values of around 10 mmol/l (the so-called **renal threshold for glucose**), the capacity of tubular resorption is exceeded and glucose passes into the urine. Urine glucose losses greater than 0.72 mmol/24 hours are referred to as **glycosuria (glucosuria)**. Glycosuria is the most common finding leading to the discovery of diabetes mellitus. However, a negative finding of glucose in the urine does not rule out this disease. Therefore, the determination of glucose in urine is not one of the basic biochemical parameters used for the diagnosis and monitoring of DM.

The finding of glycosuria must be evaluated together with the level of fasting blood glucose. Based on glycemia, we distinguish:

- **Hyperglycemic glycosuria**, which is a typical finding in diabetes mellitus. However, with prolonged illness, the renal threshold for glucose increases and glycosuria may even disappear. Therefore, it is only an orientation examination, on the basis of which DM therapy cannot be managed. The so-called "alimentary glycosuria" can also temporarily occur as a result of a diet rich in carbohydrates or during oGTT.
- **Normoglycemic renal glycosuria** in which the concentration of glucose in the blood is not elevated. It is the result of a disorder of the renal tubular cells, which ensure the reabsorption of glucose. It can be a manifestation of an autosomal recessive disease, it occurs more often, for example, with toxic or inflammatory kidney damage affecting the function of the proximal tubule.

Methods for determination of glycosuria

Non-specific chemical reactions or **test strips** can be used to determine glycosuria.

Non-specific chemical reactions are based on the **reducing properties of monosaccharides**. The **Fehling** and **Benedict** assay utilizes the non-specific reduction of the Cu^{II+} chelate complex with citrate or tartrate to Cu^{I+} . In the **Nylander** test, in the presence of reducing agents, bismuth nitrate-oxide $\text{BiNO}_3(\text{O})$ is reduced to black metallic bismuth. These reactions are positive not only for glucose, but also for other reducing saccharides, or substances with reducing properties (eg ascorbic acid). The examined urine must not contain proteins.

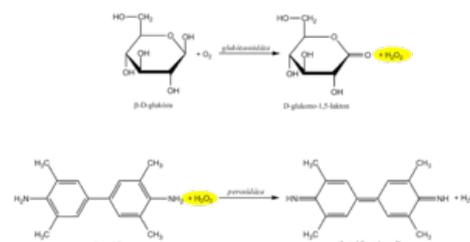
Determination of urine glucose with a diagnostic strip

Diagnostic strips for the detection of glucose in urine are based on the principle of enzyme reactions with glucose oxidase and peroxidase (the same principle as glycemic determination). D-glucose is oxidized by oxygen using glucose oxidase to form D-glucono-1,5-lactone and hydrogen peroxide. In the subsequent peroxidase reaction, hydrogen peroxide oxidizes tetramethylbenzidine or another chromogen to color product. The light yellow color of the reaction surface changes to blue-green when positive. The test is specific for D-glucose, other sugars do not give a positive reaction.

High concentrations of reducing agents such as ascorbic acid slow color development and may lead to falsely lower results. In these cases, it is recommended to repeat the analysis at least 10 hours after stopping vitamin C. Conversely, false positive results may be caused by the presence of peroxidase substrates or oxidizing agents in the sampling container (e.g. H_2O_2 , Persteril®, chloramine B). Urine glucose determination must be performed quickly to avoid bacterial contamination or urine stored at 4 °C.

Interference with ascorbic acid is a frequent source of false negatives. Diagnostic urine test strips from some manufacturers are therefore modified so that the reaction zone is at least to some extent resistant to ascorbic acid. Some diagnostic strips also have a detection zone for ascorbate to alert you to the possibility of a false negative.

Positive glycosuria is an urgent indication for a fasting blood glucose test.



Glucose oxidase and peroxidase reaction