# Rapid Estimation of Sugar in Blood or Spinal Fluid with Galatest Reagent

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Galatest powder, designed for use as a qualitative test for sugar in urine, is adaptable for quantitative estimations of sugar in low ranges of concentration found in blood and spinal fluid. Such estimations can be made quickly, on 0.1 cc. samples of whole blood or single drops of spinal fluid, with degrees of accuracy quite sufficient for most clinical needs.

*Principle*: The white Galatest powder, according to the manufacturer's description, is composed of bismuth salt, sodium hydroxide and sodium silicate. When treated with drops of solutions which contain reducing sugar in concentrations from 5 to 40 mg. per 100 cc. it develops colors ranging from yellow to light gray and dark gray. Estimations of the sugar content of blood are made by simultaneously comparing colors developed in the powder by drops of protein-free blood filtrate or clear spinal fluid, appropriately diluted with water, and drops of a series of standard solutions of glucose.

## REAGENTS AND APPARATUS

1. Galatest powder, distributed by the Denver Chemical Company, New York. In order to insure a uniform mixture of the powder, empty each newly opened vial into another slightly larger vial equipped with a tightly fitted rubber stopper. Mix by shaking or rotating the vial. In partly emptied original vials the mixing can of course be done without transfer of the powder to a second vial.

2. Standard solutions of glucose in saturated (2 per cent) benzoic acid: 5, 10, 20, 30 and 40 mg. of glucose per 100 cc., prepared by diluting a stock solution of 1 per cent glucose. Keep the solutions in 30 or 50 cc. bottles with dropping pipette and rubber bulb. The pipettes should be selected to deliver drops as nearly uniform as possible. Six bottles (preferably square, for economy of space), including one with distilled water for the control or zero concentration, may be assembled conveniently in a rack, as shown in Figure 1.

3. Pipettes of 0.1 and 0.2 cc. capacity (straight blood sugar pipettes).

4. Tungstic acid protein precipitant, freshly prepared by mixing equal parts of 10 per cent sodium tungstate and 2/3 N sulfuric acid. It is convenient to have each of the two solutions in 50 cc. bottles with pipettes calibrated to deliver 0.2 cc. and rubber bulbs to control the delivery.

5. Vials of 1 or 2 cc. capacity, rubber stoppered, each containing 0.4 cc. of the freshly mixed tungstic acid precipitant.

6. Medicine droppers, with cotton twisted around the tip, to be used as filters. To make the filter moisten the pipette dropper tip slightly (to engage the cotton), then wrap thin wisps of cotton around the tip lightly and tighten by spinning the pipette with one hand while pressing the cotton gently between thumb and finger of the other hand.

7. Pyrex or porcelain plates with 3, 6 or 9 concavities.

8. Testing plates, illustrated in Figure 2 on page 352, designed to facilitate the comparisons of colors. The two charts may be sealed between plastic sheets (Eastman Kodapak, or thin Plexiglass) from which the reagent is easily washed. Or, the tests may be done simply on 4 x 6-inch white cards marked with pencil to indicate the distribution of the standards and dilutions of samples—the cards to be discarded after each test.

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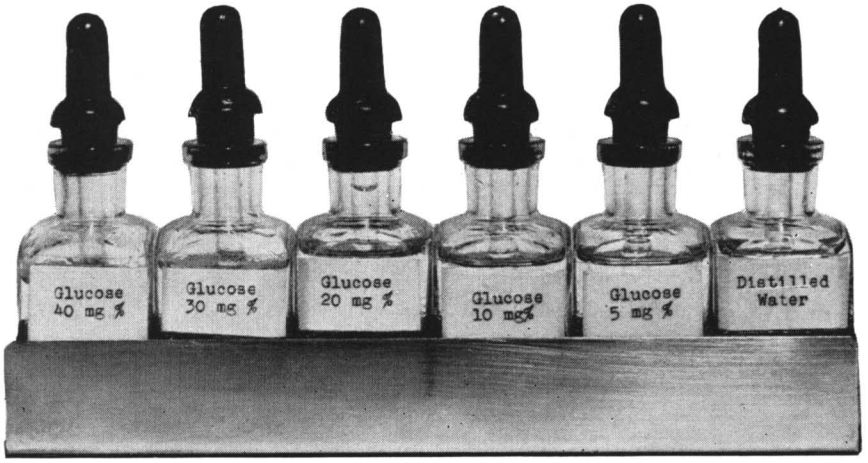



FIGURE 1.
Rack with set of six dropper bottles, five with glucose standard solutions and one with water.

## PROCEDURE

Deliver 0.1 cc. sample of blood (obtainable by skin prick) into vial containing 0.4 cc. of freshly mixed tungstic acid precipitant: 0.2 cc. of 10 per cent sodium tungstate plus 0.2 cc. 2/3 N sulphuric acid. Stopper, shake and allow to stand 5 minutes for complete precipitation of the proteins. When clear supernatant fluid separates, insert a cotton-tipped medicine dropper into the vial with its bulb squeezed to expel the air, then release the bulb to draw up the filtrate. Withdraw the dropper pipette from the vial, wipe the tip with gauze or soft cellulose paper, removing the cotton tip, and deliver the filtrate (dilution 1:5) into the concavity of a test plate. With a pipette, place 0.2 cc. of water in each of two adjacent concavities. Transfer 0.2 cc. of the 1:5 filtrate to the second concavity, mix with the water, then transfer 0.2 cc. of this 1:10 dilution to the water in the third concavity and mix to make a 1:20 dilution. If the filtrate is scanty, 0.1 cc. portions or even single drops can be used for making the serial dilutions.

On the test plates illustrated in Figure 2, A and B, or on 4 x 6-inch white cards, arrange small piles of Galatest powder in two parallel rows, one of 6 for the standards and one of 3 piles for each sample to be tested. Pour the powder to make conical piles, uniform in size, with bases within circles about 1.2 cm. in diameter. Make a small depression in the powder with the round bottom of a small test tube (1 cm. diameter) or rounded end of a glass rod. If a card is used, mark it with pencil to indicate the distribution of standards and samples to be tested (blood filtrates or spinal fluid), as shown in Figure 2. On each powder in the row for standards place one drop of each solution of glucose: 40, 30, 20, 10 and 5 mg. standards and a drop of water for the zero concentration. On each powder in the row for unknowns place one drop of blood filtrate: 1:5, 1:10 and 1:20 dilutions. Compare and select the colors that most nearly match, with interpolative estimates between the standards where necessary. Tests on clear spinal fluid may be done directly, or after making appropriate dilutions with water (1:2, 1:4 and so on), in concavities of a test plate. Purulent fluids must be deproteinized, as described for blood.

The development of color in the reagent requires heat, developed by the chemical reaction, and is inhibited if the test is done in a cold room or on a cold surface. The test should not be done on glass or porcelain, which conducts heat away rapidly. The amount of powder used should be slightly more than enough to absorb the drop of test solution completely, so that no free liquid is visible when the reaction is complete.

## CALCULATION

Concentration of glucose in the standard x dilution of the sample with color most nearly matching = concentration of sugar in the original sample.

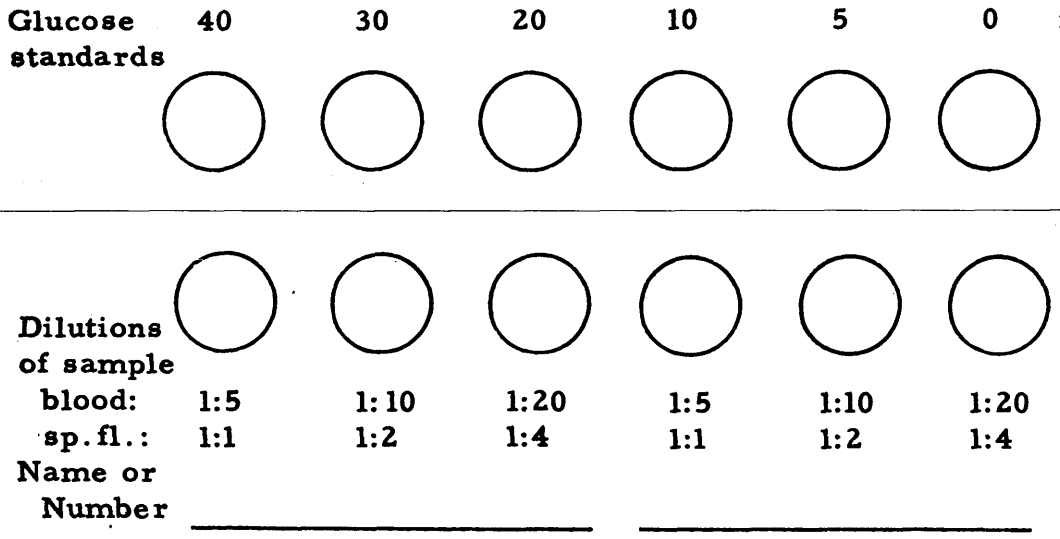
Single tests done with the 1:5 dilution permit estimates of blood sugar within the range from 25, or less, to 200 mg. per 100 cc.; with the 1:10 dilution, estimates within the range 50 to 400 mg. per 100 cc.; and with the 1:20 dilution, 100 to 800 mg. per 100 cc. Tests done on undiluted spinal fluid permit close estimates within the range of the standards, 0 to 40 mg. per 100 cc. Tests done with drops from three dilutions afford confirmatory checks on values in the overlapping ranges and the three values obtained may be averaged.

The method has been subjected to practical tests in several hospitals where comparisons have been made between results obtained by this technic at the bedside and by other standard procedures performed in the

## ESTIMATION OF SUGAR IN BLOOD OR SPINAL FLUID

***Pour Galatest Powder on the circles in conical piles and make a small concavity in each, using the bottom of a test-tube or rounded end of a glass rod. In the row for standards place on each powder a drop of the glucose solution indicated. In the other row place on each powder a drop of the sample, diluted as indicated (protein-free blood filtrate or clear spinal fluid). Compare and select colors that most nearly match.***

**CALCULATION: Dilution of sample x concentration of glucose in standard with matching color = concentration of sugar in the original sample.**




**WARNING: The Galatest powder is caustic. Avoid contact with skin or clothing. Wash into sink with running water.**

FIGURE 2. Test plates for comparison of spot tests done with glucose standards and with sample. The upper plate is for glucose standards and lower one for unknown sample. Several plates for samples permit a series of estimations to be made with one row of standards.

laboratories. The results have usually agreed within 10 mg. per 100 cc. in the low ranges from 0 to 50 mg., within 10 to 20 mg. in ranges 50 to 200 mg. and within 50 to 100 mg. in the high ranges above 500 mg. per 100 cc. This degree of accuracy should satisfy nearly all practical clinical needs for following gross fluctuations in blood sugar levels, particularly for following progressive decreases of blood sugar in patients during recovery from diabetic coma, and for the quick recognition of hypoglycemia attending overdosage with insulin. More definitive data gathered in clinical experience will be reported later.

Single drops of the same protein-free blood filtrate, 1:5 dilution, can be used also for rapid estimations of blood ketones, using sodium nitroprusside spot test reagents designed for the detection of ketones in urine. This procedure will be described separately.

SUMMARY

The procedure described, using Galatest reagent (powdered mixture of bismuth salt, sodium hydroxide and sodium silicate) serves as a simple bedside method for the estimation of sugar in 0.1 cc. samples of blood or spinal fluid.