# A GUIDE TO THE PRACTICAL EXAMINATION OF URINE: FOR THE USE OF PHYSICANS AND STUDENTS

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Trieste

# EXAMINATION

OF

# URINE.

PRACTICAL

# EXAMINATION OF URINE.

## INTRODUCTION.

### SECRETION OF URINE.

The theory which explains the secretion of urine most consistently with the facts, is one which, while it makes the process partly physical, requires also something of the nature of elaboration in the office of the kidney. Nothing can be more attractive at first thought than the theory of Ludwig, according to which the process is purely physical —partly a filtration and partly a diffusion, or osmosis. It is true that in the capillaries of the Malpighian tuft the blood-pressure is relatively greater on account of the resist ance to the exit of the blood through the efferent vessel. As the result of this, a filtration of the watery constituents of the blood, with some dissolved salts, takes place into the Malpighian capsule. Thus the blood is greatly thickened when it reaches the second capillary network embracing the convoluted tubules into which has descended the thin, aqueous filtrate from the Malpighian bodies. Here are the essential elements of a complete osmometer—an animal membrane formed by the thin wall of the capillary and the delicate basement membrane of the tubule, having a dense fluid, the blood, on one side, and a thin saline solution on the other. An interchange now takes place, as the result of which a current sets in, of liquid from the tubules to the blood, and of the products of regressive metamorphosis—urea and salts—to the tubules, concentrating the fluid in the latter, making it, in a word, urine; while the albuminous constituents of the blood are retained in it because of their well-known indisposition to osmosis.

The objection formerly made to the physical nature of the act of secretion of urine, on the ground that we cannot by this method account for the formation of an *acid* fluid from an *alkaline* one, no longer holds, as can easily be shown by a simple apparatus devised by Charles Henry Ralfe. Into one limb of a small, U-shaped tube, fitted with a membranous diaphragm at the bend, he introduced an alkaline solution of sodium bicarbonate, and into the other limb a solution of neutral sodium phosphate. He then passed a weak electric current through the solutions. In a short time the fluid in the limb connected with the positive pole became acid from the formation of acid sodium phosphate, while the fluid in the limb connected with the negative pole increased in alkalinity. The changes are represented by the following formula:—

| Sodium bicarbonate. | | Neutral sodium phosphate. | | Sodium carbonate. | | Acid sodium phosphate. |
|---|---|---|---|---|---|---|
| $NaHCO_3$ | + | $Na_2HPO_4$ | = | $Na_2CO_3$ | + | $NaH_2PO_4$.* |

One important fact, however, remains unaccounted for by this theory, clear and simple as it is. This is, that if

* *Medical News and Library*, October, 1871, from London *Lancet*, July 4, 1871.

the tubules are stripped of their epithelium, as they often are in disease, urea and other products of regressive metamorphosis are no longer so thoroughly removed, but accumulate in the blood, producing the phenomena of the condition known as *uræmia*. We must therefore admit some elaborating action on the part of the epithelium, as originally suggested by Bowman. Doubtless, however a part of the act is physical—a process of transudation or filtration, and of diffusion or osmosis.

The experimental researches of Heidenhain * settled the question in favor of an active elaborating office on the part of the epithelium of the kidney. Heidenhain injected into the blood of animals indigo-carmine, a substance which is promptly separated by the kidneys. He removed these organs at suitable intervals after the operation and examined them minutely. In no instance did he find any of the indigo-carmine in the Malpighian capsules, but the cells lining the convoluted tubules and the looped tubes of Henle were filled with it, as was also the lumen of the tubes, if the animal was killed sufficiently long after the injection. Similar experiments with urate of sodium showed that it is secreted at the same place and in the same manner.

More recent studies of Heidenhain † and J. G. Adami ‡ go to diminish still further the importance of the "mechanical" factor in the secretion of urine, and to assign a selective or secretory office even to the cells of the glomeruli,

* Max Schultze's *Archiv*, vol. x, 1874, p. 1, and Pflüger's *Archiv*, vol. ix, 1874, p. 1.

† Heidenhain, Hermann's Handbuch der Physiologie, vol. v, Leipzig, 1880.

‡ J. G. Adami, On the Functions of the Glomeruli of the Kidney, *The Practitioner*, London, 1888.

in accordance with which they permit certain substances to pass through and prevent others, among the latter albumin. On the other hand, they indicate that even the passage of fluid through the glomeruli is not a mere transudation, but a matter of selection also, though it is influenced greatly also by the rate of flow of blood through them, which again depends (1) on the general blood pressure and (2) inversely on the resistance against which the blood is forced through the kidney.

## REAGENTS AND APPARATUS REQUIRED FOR QUALITATIVE AND APPROXIMATE ANALYSIS.

It is not a matter of very great importance in what form of bottles reagents are kept. They should hold enough—four ounces is a convenient quantity—and be provided with ground-glass stoppers for the acids, but the alkalies are better kept in bottles with rubber stoppers. Those required are as follows :—

1. Pure colorless nitric acid ($HNO_3$).
2. Nitroso-nitric acid, the brown, fuming nitrous acid of commerce,—nitric acid containing nitrogen tetroxide ($HNO_3 + N_2O_4$, or $NO_2$).
3. Pure hydrochloric acid (HCl).
4. Pure colorless sulphuric acid ($H_2SO_4$).
5. Pure acetic acid ($C_2H_4O_2$).
6. Liquor Potassæ, U. S. P. The sp. gr. is 1065, and it contains .058 of potassium hydroxide (HKO).
7. Solution of caustic potash or caustic soda 1 part to 2 of distilled water, sp. gr. 1330 +, to be spoken of in the text as the "stronger solution of potash." It is the aetzkalilauge (or aetznatronlauge, if soda), of the German Pharmacopœia, and contains from .30 to .31 of the hydrate of potassium (or of sodium).
8. Solution of sodium carbonate, 1 part water and 2 parts of the crystallized salt.

9. Solution of barium chloride, 4 parts crystallized barium chloride, 16 of distilled water, and 1 of hydrochloric acid.
10. Liquor ammoniæ, U. S. P.
11. *The magnesian fluid*, containing of magnesium sulphate and pure ammonium chloride, each 1 part, distilled water 8 parts, and pure liquor ammoniæ 1 part.
12. Solution of copper sulphate, say 1 gram to 30 c.c., or 15 grs. to f℥j.
13. Pavy's or Fehling's copper solutions, made as directed under volumetric analysis for sugar.
14. Solution of silver nitrate, 1 part to 8 of distilled water.
15. Solution of neutral lead acetate (sugar of lead), 1 part to 4 of distilled water.
16. Solution of basic lead acetate, 1 part to 4 of distilled water.
17. Distilled water, a litre or a quart.
18. Alcohol, 95 per cent., half a litre or a pint.
19. Almen's tannin solution, consisting of tannin, 5 grams; 25 per cent. acetic acid, 10 c.c.; 40 to 50 per cent. methylated spirit, 250 c.c.

## *Apparatus.*

A note and drawing-book.

2 dozen test-tubes, assorted sizes, some narrow. Some test-tubes with bases, so that they may stand on a shelf or table, convenient and desirable; see Fig. 5. Some tubes should be graduated in divisions of a centimetre and fractions thereof. They may be used as fluid measures, and to determine the proportion of a sediment, or of albumin after its precipitation by heat.

Test-tube rack and drainer.

4 conical glasses. (Observe that there is not a convexity at the bottom, and the edge should be ground so that they may be covered with ground glass covers and thus made air-tight.)

2 or 3 smooth wineglasses, with broad bottoms, of the kind sometimes known as "collamore" wineglasses.

Red and blue litmus paper; Swedish filtering paper.

Urinometer and urinometer glass.

4 ground-glass covers, assorted sizes.

Spirit-lamp, or Bunsen burner.

3 porcelain capsules.
6 beaker glasses, small and medium sizes.
6 watch-glasses.
3 glass funnels, assorted sizes.
1 long, narrow funnel tube 12 inches long and 1 inch wide, for filtering through animal charcoal.
Glass stirring-rods and plain glass pipettes.
1 large receiving-glass to measure twenty-four hours' urine, with capacity of 2000 cubic centimetres or more.
1 graduating measuring glass holding 500 c.c.
1 wash-bottle with distilled water.
1 retort stand; water bath.
1 or 2 sheet-iron tripods with wire gauze to cover.
1 100-minim pipette; 1 volume pipette for 5 c.c., another for 10 c.c.
Platinum spoon; tongs.
Blowpipe.
Swabs for cleaning test-tubes, etc.
A microscope with two object-glasses, a $\frac{1}{4}$ or $\frac{1}{5}$ inch, and a 1 inch or $\frac{8}{10}$ inch; stage micrometer; camera lucida for drawing; glass slides, thin covers, *shallow cells*; a double nose-piece for quickly changing objectives is very convenient. For the study of bacteria a $\frac{1}{12}$ immersion lens is necessary.

For volumetric analysis are required in addition:—

A full set of volume pipettes, 5, 10, 15, 20, 30, 50 c.c.
1 dropping pipette holding 1 c.c., graduated in $\frac{1}{10}$ths and fractions thereof.
2 burettes of 50 c.c. capacity; burette stand.
A half-litre flask.
Volumetric solutions as directed under Volumetric Analysis.

If the solutions are made by the physician himself, as they may be, he should be provided with a balance which will turn with a milligram, or with $\frac{1}{50}$ of a grain if the English system is used.