MEDICAL CHEMISTRY.

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Appleton.

LABORATORY MANUAL.

MEMORANDA

ON

MEDICAL CHEMISTRY,

BY

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CONTENTS.

SECTION I.

Foods.

General introduction.—1. *Ordinary foods* are easily classified as of vegetable origin and of animal origin. A thorough and critical analysis of foods shows that they are all made up of practically three groups of substances. The three groups are called respectively proteins, carbohydrates, fats; a fourth substance, almost universally present in foods, is water.

The proteins are among the most important. Their characteristic element is nitrogen. The typical protein substance among animal matters is albumen, the white of egg. The term albuminoids is often applied to the whole group of nitrogenous substances found in animal matters. Vegetables contain proteins, of which the gluten of wheat flour may be taken as a type.

Of the carbohydrates sugar and starch are typical examples.

Fats, whether of vegetable origin or animal origin, are usually made up of several different glycerides. The glycerides are constructed on the general type of salts, *i. e*, they are composed of an acid substance combined with a basic substance. The basic substance is always glycerin. The acid substance is one of the so-called fatty acids, of which oleic acid is characteristic of soft fats, stearic acid of hard fats, palmitic acid of fats of intermediate consistency.

As has been stated, most animal and vegetable matters used as food contain considerable quantities of water. It is an incidental constituent of no true food value, although of some aid in the process of digestion.

2. *Special foods*, sometimes costly on account of their rarity, are often valued because of their peculiar flavors. To this class belong certain kinds of high flavored fruits, certain kinds of high flavored vegetables, not costly, like the onion, certain animal foods like oysters. Again there are special foods selected because of the predominence in them or the absence from them of certain constituents. Thus for diabetic patients sugary foods are usually avoided. For patients tending to obesity, foods containing carbohydrates and fats are generally avoided. For such persons, also, certain special foods are now manufactured from cereals by the removal of starch.

Certain *other articles* used more or less in cooking may, perhaps, be classed as foods, although they are generally specified as *condiments*. Of these salt and vinegar may be placed in one class, as substances which probably have some chemical action in aiding digestion. Certain spices, as pepper, mustard, nutmeg, form another class of condiments of no particular nutritive value, but probably of physiological service.

3. There has been a great deal of discussion whether *stimulants* should be classified as foods. Alcoholic stimulants, which may be grouped as malt liquors, wines, spirits, liqueurs, have important uses in medicine, to say the least. A similar question arises with respect to alkaloidal stimulants, as coffee, tea, cocoa.*

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*This last word should be carefully distinguished from two other words of similar spelling.

The chocolate tree (Theobroma Cacao) produces those seeds which, ground and otherwise prepared, afford the preparations known as chocolate and cocoa. They also afford an oil called cacao butter (cacao pronounced kă-kā'ō).

The cocoanut palm (Cocos Nucifera) produces the fruit called cocoanut. The wood of the tree, the fibre, the juice and flesh of the cocoanut and its shell, are most useful products.

The coca shrub (Erythroxylon Coca) produces a leaf which, when dried, is an important drug. The shrub grows in South America, and is largely used by the inhabitants as a stimulant. The leaf contains an alkaloid called cocaine (pronounced kō'kă-in) now largely used in some branches of surgery.

4. The *economic* importance of the question of food supply should not be overlooked. The modern industrial competition of nations must involve the question of the cost of food for the working classes. Cheaper food for all mankind might be afforded if chemists could solve a certain problem, viz.: to change those carbohydrates, like cellulose which are produced in relatively large quantity by living vegetables, but which are indigestible, into other carbohydrates of analogous constitution, like starch, that are produced in relatively much smaller quantity, but which are digestible.

Flour.

Make a complete analysis of flour in accordance with directions in the Advanced Quantitative Analysis.

Determine gluten by Kjeldahl's method. This method, although difficult, is one of very wide application to nitrogenous bodies, the albuminoids.

Milk.

Make a complete analysis of milk as described in the Advanced Quantitative Analysis.

Water.

Reference.—*Wanklyn, J. A.*, Water analysis.
Frankland, E., Water analysis.

Introduction.—The different purposes for which water is tested.

Bacteriological tests.

Experiment.—Test water as described in the Advanced Quantitative Analysis.

Note.—In preparing the solution for Wanklyn's tests, each student should make *one* of the set of re-agents. Then the entire set may serve for the class.

SECTION II.

Alcohol and its Derivatives.

Reference.—*Allen, A. H.*, Commercial Organic Analysis, v. i. p. 41.

Alcohol itself, as well as its various products, is of great importance in medicine. So also are they in pharmacy: for alcohol and ether especially are valuable solvents for certain medicinal compounds which do not dissolve in water. Iodoform, chloroform and ether, all usually manufactured from alcohol, are also of eminent value because of their power of producing insensibility to pain.

Alcohol.

Reference.—*Remsen I.*, Organic Chemistry, p. 34.

Introduction.—Kinds of alcohol. Preparation of alcohol by fermentation. Influence of bacteria.

Experiment.—Make fractional distillations of alcohol as described.

Iodoform.

Reference.—*Remsen I.*, Organic Chemistry, p. 28.

Introduction.—Its chemical structure.

Experiment.—Prepare a sample.

Anaesthetics.

General introduction.—Various anaesthetics. The use of chloroform, ether, nitrous oxide, chloral hydrate. Alkaloids which produce local insensibility to pain, such as opium products, cocaine, etc. Use of local freezing. The history of the use of anaesthetics.

Chloroform.

Reference.—*Remsen I.*, Organic Chemistry, p. 28.

Experiment.—Prepare chloroform in a large retort by use of alcohol, bleaching powder and slaked lime.

Ether.

Reference.—*Remsen*, *I.*, Organic Chemistry, p. 43.

Introduction.—Theory of etherification. Composition of ether. Kinds of ether.

Experiment.—Prepare ether by sulphuric acid and ethyl alcohol. Test the ether so produced.

SECTION III.

Cotton Preparations.

Reference.—Allen, A. H., Commercial Organic Analysis, v. I., p. 314.

General Introduction.—What are carbohydrates? Cellulose, amylose, saccharose. The nitrating process. Its application to glycerin.

The preparations here referred to are of two distinct classes. Thus absorbent cotton belongs to the same class as lint, viz.: as a form of absorbent material for the dressing of sores or wounds that are discharging.

Collodion represents another different class of substances. It is in effect a kind of varnish, which forms an artificial cuticle, of great importance in cases of severe burns and the like.

Absorbent Cotton.

Introduction.—Uses of lint, etc.

Experiment.—Prepare this substance.

Pyroxyline.

Reference.—Bloxam, C. L., Chemistry, p. 558.

Experiment.—Prepare pyroxyline from cotton. Prepare parchment paper.

Collodion.

Reference.—Bloxam, C. L., Chemistry, p, 564.

Introduction.—Its uses as an artificial cuticle.

Experiment.—Prepare collodion.

SECTION IV.

Narcotics.

A large number of vegetable substances contain alkaloids of greater or less narcotic power. Many of them are of great service as remedial agents. Preëminent among these are opium in its many forms, and the cinchona bark and its many alkaloids. The improper or excessive use of narcotics ought not to be overlooked.

Caffeine.

References.—*Prescott, A. B.*, Organic Analysis.
Morley and Muir, New Edition of Watts' Dictionary of Chemistry.

Introduction.—*Caffeine or theine*, $C_8H_{10}N_4O_2$—It is an alkaloid which occurs in certain vegetables as follows :

Coffee,	1. to 1.3 %
Tea,	2. to 4. %
Guarana, about	5. %
Maté, about	1.5 %
Kola Seeds, (when dried) about	2. %
Cocoa, a small amount.	

Preparation.—Watts gives five methods.

Method A.—Raw ground coffee, five parts, are mixed with moist lime, two parts, and extracted with alcohol, chloroform, or benzene. From the filtrate the caffeine may be crystallized by evaporation.

Method B.—Tea or coffee is boiled with water, and either the whole or else the filtrate is evaporated to a syrup, then mixed with slaked lime and extracted with chloroform as before.

Test.—To the crystals, supposed to contain caffeine, add first a few drops of concentrated nitric acid, and then a little ammonia. There appears a purple color due to murexide.

Nicotin.

Reference.—*Blyth, A. W.*, Poisons.

Nicotin, $C_{10}H_4N_2$.—It is an alkaloid obtained from the seeds and leaves of tobacco. It is ordinarily a liquid, very volatile, highly poisonous. Tobacco appears to contain nicotin in very varying quantities. The amount is variously stated from 1.5 % to nearly 8. %.

Preparation.—*Method A.*—Macerate tobacco leaves with dilute sulphuric acid for 24 hours. Separate the liquid. Then concentrate it somewhat by evaporation. Place it in a retort and neutralize it with potassic or sodic hydrate. Distil. The nicotin distils over as a colorless oil. Its amount may be determined by a careful titration with standard solution of sodic hydrate.

Method B.—Mix 25 gms. of tobacco with milk of lime, and allow the whole to stand for some time or until there is no odor of ammonia. Next exhaust the mixture by petroleum naphtha. This withdraws the nicotin. Next shake the ether for some time with a slight excess of standard sulphuric acid. Finally draw off the sulphuric acid. Titrate back with baryta water.

Quinine.

Reference.—*Prescott, A. B.*, Organic Analysis.

Introduction.—The bark of the cinchonas, especially that of the roots, contains many alkaloids. Prescott enumerates eleven. Some are crystallizable and some are not. The principal crystilizable ones in the bark are quinine and quinidine, cinchonine and cinchonidine. The bark yields approximately as follows, the amounts stated variously by different observers:

Of quinine,	.4 to 11.6 %
Of quinidine,	.8 to .9 %
Of cinchonine,	.4 to 2.2 %
Of cinchonidine,	.4 to 5.2 %

The trees producing quinine are various in size according to the conditions of growth. Sometimes they are only shrubs of 8 or 10 feet; in other cases tall trees.

The alkaloid quinine is of great value in medicine, having remarkable specific power in the cure of intermittent fevers. The use of the bark itself in medicine is now very much diminished. The alkaloids are extracted in a state of greater or less purity, the one chiefly used being quinine, and this in the form of white salt, a sulphate, often called sulphate of quinia.

Artificial preparation of quinine suggested.—It has long been known that quinine under some chemical conditions is decomposed into several substances, one of which is quinoline (C_9H_7N). Now quinoline is found in certain coal tar products. It has also been produced by Skraup from a mixture of aniline, nitro-benzene and glycerin. The suggestion has naturally arisen that if quinine can be broken down into quinoline, perhaps quinoline can be artificially built up into quinine. This idea receives encouragement from the fact that alizarin has been produced artificially from anthracene. Moreover the great importance and value of quinine and the expense of obtaining it from bark, offer a strong stimulus to investigation looking toward its artificial preparation.

Preparation of quinine.—There are many ways of extracting quinine from the bark. They all involve three general principles: First, quinine is an alkaloid and as such combines with hydrochloric, sulphuric or other acids, to form salts; second, when such salt is treated with lime or other suitable alkali, the acid is withdrawn and the quinine is liberated in a form insoluble in water; third, the liberated quinine is removed by solution in some suitable solvent, such as ether, alcohol, chloroform, or other liquid of similar general character.

Prescott, in his full and elaborate account of the chemical relations of the cinchona alkaloids, gives five methods for extracting the alkaloids. (See page 102 from which the following memorandum is quoted.)

"1. The powdered bark is macerated in a mixture of chloroform or ether, with alcohol and ammonia, and an aliquot part of the total liquid is taken (without washing) for the analysis. (Prollius, 1882; De Vrij, 1882; Ph. Germ.)

2. The powder mixed with lime is exhausted with ether in an extracting apparatus, Tollen's or other.

3. The powder mixed with lime is exhausted by digesting with a mixture of amyl alcohol and ether (Squibb, 1882), or amyl alcohol and benzene (Br. Phar., 1885).

4. The powder mixed with lime is exhausted by digesting and washing with alcohol (De Vrij, 1873; U. S. Ph., 1880, p. 78).

5. The acidulous decoction, in a part of the filtrate taken as a fraction of the total solution, is precipitated by picric acid and the dried precipitate weighed (Hager, 1869; given in this work under Alkaloids, p. 49).

The use of an extraction apparatus best adapted to ether as a solvent, is a most rigidly exact and generally satisfactory way in this as in most solvent operations upon plants. But it loads the solution with more coloring and other extraneous matters, and takes longer than the method placed first above."

Opium and Morphine.

References.—*Blyth*, *A. W.*, Poisons, p. 266.
Prescott, *A. B.*, Organic Analysis, p. 358.

Introduction.—Opium as it appears in commerce is a hardened mass of juice from unripe capsules of the poppy. The supply of the world is derived from Asia Minor, Persia, India, China and Egypt. China is said to consume the larger proportion of the total amount of the opium produced.

Opium and its preparations are among the most important remedial agents known. Their most valuable constituent is morphine, a white crystallizable substance having a bitter taste. Like other alkaloids it is capable of combination with acids to form salts.

Opium contains a large number of alkaloids. Blyth enumerates 21. Of these morphine ($C_{17}H_{19}HO_3$) and narcotine ($C_{22}H_{23}NO_7$) are the chief.

Various kinds of opium vary very much in quality. An average statement of the alkaloids is as follows:

Morphine,	6. to 15. %
Narcotine,	4. to 8. "
Other alkaloids,	5. to 2. "

**Preparation of morphine.*—There have been proposed many different methods for extracting the morphine from opium for analytical purposes. In general the process may be stated as follows:

Sampling.—A careful sample, so as to thoroughly represent the mass of opium must first be selected.

Extracting.—Weigh about ten gms. of the opium. Triturate it with 100 c. c. of water in a suitable vessel. Allow it to macerate in the water over night. Filter the mixture and wash the precipitate with a very small amount of water. Next evaporate the water solution containing the morphine to the bulk of about 25 c. c. Next add 5 c. c. of alcohol and stir until all is dissolved.

Precipitation of the morphine.—Transfer the solution to a suitable flask. Add 5 c. c. more of alcohol and mix the whole. Then add 30 c. c. of ether and wash again. Next add 4 c. c. of a 10 per cent. solution of ammonia (specific gravity .960). Shake the mixture violently, until crystals of morphine appear. Then allow the whole to stand over night.

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*Charles M. Stillwell, American Ch. Jour., vol. 8, p. 295.

SECTION V.

Poisons.

The word poison is extremely difficult of definition. Substances ordinarily recognized as poisons act in many different ways.

Thus broken glass has sometimes been administered in meat and has been called a poison, yet its action must be *mechanical.*

Again, strong acids, like sulphuric acid, have sometimes been classed as poisons and spoken of as *corrosives.* These have a chemical action on the tissues, destroying them and rendering them unfit for their normal action.

Certain poisons, like white arsenic, act as *irritants*, producing inflammation of the mucous surfaces, and then extreme pain, vomiting and purging.

Another class which may be called *neurotic* poisons affect in a narcotic, a deliriant, a convulsive, or less distinct way, the nervous system.

Still another class, like prussic acid, are *exceedingly deadly*, producing fatal effect very quickly by some obscure method of action.

To this list should be added *septic* poisons, that is, organized matter containing those microscopic, parasitic vegetables called bacteria. They are not supposed to be poisonous themselves, but are capable of producing morbid changes in the living animal, whereby a class of poisonous substances called *ptomaines* are formed.

Poisons may be administered accidentally as well as intentionally.

Of late years the detection of poisons has become very certain. This is by reason of the progress in modern chemistry and the extensive study of both organic and inorganic poisons.

In *testing for poisons*, the professional analyst observes most extreme precautions to avoid error. Thus, in some cases, every experiment is performed in the presence of the analyst, so that it would be absolutely impossible for any other person whatsoever to add anything to the apparatus or to take anything from it. In such cases all doors and windows are sealed with a characteristic seal, whenever the analyst leaves the room where the experiments are made. Sometimes entirely new apparatus only is employed. Again in such investigations it is always the custom to make what are called *blank tests*, running parallel with the others. In the blank tests there is employed similar apparatus and every chemical that is used in the examination of the suspected substance. The intention is to prove absolutely that the apparatus and chemicals do not themselves possess any of the suspected poisons.

Arsenic.

Reference.—Blyth, A. W., Poisons, p. 494.

Introduction.— Most arsenical compounds are poisons. Some of them have their poisonous influence somewhat increased by the presence of other poisonous substances. Thus Paris green contains copper in addition to arsenic.

Arsenic is a substance occurring very abundantly in ores. Great quantities of it are incidentally separated in securing the more valuable metals. Again arsenic exists in small quantity but widely diffused in pyrites. When these pyrites are burned—in order to use the sulphur in the manufacture of sulphuric acid—arsenical compounds volatilize along with the sulphur. If then the sulphuric acid containing arsenic is used in certain processes of manufacture, the arsenic itself is liable to make its appearance with poisonous influence. Compounds of arsenic are very largely used in the arts, so that accidental poisoning by it is not uncommon. It is used in wall paper and in some branches of calico printing; also in the manufacture of some kinds of glass; in the preparation of certain alloys, such as britannia metal; in shot; in the bronzing of certain metals; in Paris green; in certain kinds of arsenical soaps; in the stuffing of birds; in certain fly poisons; in several kinds of colored fires used in pyrotechny; in the yellow pigment called orpiment, arsenious sulphide ($As_2 S_3$). In addition to the use as pigments of the two substances last named, it should be borne in mind that in the United States vast quantities of Paris green become distributed over the agricultural lands by reason of the use of this substance as an insecticide.

Tests for Arsenic.—The method of testing for arsenic as well as for other mineral poisons must be varied according to the character of the suspected material.

If the poisonous substance is supposed to be considerable in quantity, and if the material is free from organic matter, the ordinary tests used in qualitative analysis may suffice.

In organic matters, or in organs from the cadaver, special methods have to be employed, whereby the organic matter may be destroyed without loss of the poison.

Tests.

The chief special tests for arsenic are three:

First, *Berzelius's test.*—This depends upon the reduction of white arsenic by means of charcoal in a glass reduction tube. A dark coating of metallic arsenic is collected on the walls of the tube.

Second, *Reinsch's test.*—In this test, strips of clean copper wire are placed in the suspected liquid to which considerable hydrochloric acid is added. The deposited arsenic forms a sort of alloy on the copper. Subsequent tests must be most carefully conducted, in order to make certain that a dark coating on the copper is indeed due to arsenic.

Third, *Marsh's test.*—This test is fully described in Fresenius's Qualitative Analysis. In principle it is this: If an apparatus containing zinc and sulphuric acid, and thereby liberating pure hydrogen, has an arsenical solution introduced into it, a gas called arsine or arseniuretted hydrogen ($As\,H_3$) is promptly liberated. From this gas metallic arsenic is easily separated, on the walls of the evolution tube or on a porcelain saucer, as a lustrous metallic mirror. (Antimony gives similar effects. Special precautions have to be taken therefore to determine that such mirrors are indeed arsenical.)

Experiments.

First.—Weigh 100 milligrammes of white arsenic. Dissolve this amount in hydrochloric acid and water. Dilute the whole solution to the volume of 500 c. c. Use this as a standard solution. Five c. c. of it contain one milligramme of white arsenic ($As_2\,O_3$).

Second.—Try Reinsch's test, using five c. c. of the standard arsenical solution.

Third.—Try Marsh's test, using five c. c. of the standard arsenical solution.

Fourth.—Try Berzelius's test with a piece of white arsenic as big as the head of a pin.

Fifth.—Prepare an organic mixture containing oil and starch, ground first to a fine paste and then made up to an emulsion with water. Divide this mixture into two parts. To each of them add 20 c. c. (representing four milligrams of $As_2\,O_3$) of the standard arsenical solution.

Try Reinsch's test directly. Try Marsh's test after charring the organic matter carefully with pure sulphuric acid.

Antimony.

Reference.—Blyth, A. W., Poisons, p. 544.

The compounds of antimony resemble in certain ways those of arsenic. In testing for antimony the processes for arsenic are closely followed.

The analyst must have constantly in mind the distinguishing of arsenical tests from antimonial.

Copper.

Reference.—Blyth, A. W., Poisons, p. 578.

In solutions, copper may be detected in the ordinary way.

In many cases copper is best detected by precipitation, as metallic copper on clean steel needles, in solutions containing hydrochloric acid. The tendency of the copper to precipitate on the steel may be heightened by the use of a feeble galvanic battery, or even by placing in the suspected solution a piece of platinum in contact with the needles.

Subsequently the red metallic copper should be further tested to make sure of its identity.

Lead.

Reference.—Blyth. A. W., Poisons, p. 560.

Introduction.—Lead poisoning is very common. Blyth remarks that in five years, ending 1830, about 20 per cent. of all the deaths from poisoning in England, were from lead poisoning—but none of these were cases of criminal intent.

Minute quantities of lead are most widely diffused, even in ordinary foods as well as in chemical products.

An important source of lead poisoning is in case of water that has rested in lead pipes.

Tests.

Sulphuretted hydrogen is the common agent in testing for lead. In water suspected to contain lead, sulphuretted hydrogen gives immediately a dark brown or black precipitate. If the amount of lead is very small, one litre of the water may be evaporated to the bulk of a few centimetres and then acidified with pure acetic acid, and now tested with sulphuretted hydrogen.

Lead may be precipitated electrolytically upon platinum and subsequently tested.

Mercury.

Reference.—Blyth, A. W., Poisons, p. 597.

Tests.—Mercury in small quantities is readily detected by inserting in the acidified solution a piece of gold foil or of bright copper foil or wire. The tendency of the mercury to separate may be stimulated by a galvanic battery or some similar arrangement. After the mercury is deposited upon the gold or the copper, the amalgam is dried and placed in a glass tube closed at one end. Upon heating the amalgam the mercury vaporizes, condensing in minute globules farther up the tube. The globules may be recognized by the microscope, if not by the naked eye.

In organic mixtures the method already described is often applicable.

Ludwig's method depends upon the use of zinc dust, even in organic mixtures. The dust is efficient in collecting the mercury. When the test has proceeded far enough, the zinc dust is washed first with water, next with dilute caustic potash, then with alcohol and finally with ether. It is dried and placed in a combustion tube. Then the mercury is volatilized by heat.

SECTION VI.

Urine and Urinary Calculi.

Introduction.—The urine furnishes most important indications of the working of certain of the internal organs. The chemical tests are scarcely more important than the microscopic tests. The practicing physician has rarely time for more than a few simple experiments upon the patient's urine. In all large cities it is customary to send specimens to some analyst who makes a specialty of this branch of investigation.

There are many books on analysis of urine. The one at present in highest esteem is Neubauer and Vogel, "Analysis of the Urine." New York, William Wood & Co.

The student should possess this or some other trustworthy book upon the subject, and should make a thorough study of the book selected.

Special Samples Untrustworthy.—A single sample of urine rarely gives any valuable information unless indeed it contains certain abnormal matters. The most satisfactory results are always obtained by examination of the mixture of the several portions of urine passed during the entire twenty-four hours. A table is here presented, giving an approximate statement of certain of the most important substances secreted in normal urine during twenty-four hours.

TABLE I.

SECRETION IN THE URINE OF AN ADULT IN TWENTY-FOUR HOURS.

(*Neubauer and Vogel.*)

Total Urine,	1. c. c. per hour per 1 K. of weight 40. c. c. “ “ “ 1 M. of height	1200.c. c. to 1600. c. c. in 24 hours
Total Solids,	.041 gm. per hour per 1 K. of weight 1.5 “ “ “ “ 1 M. of height	55. gm to 65. gm. in 24 hours.
Urea,	.015-.035 gm. per hour per 1 K. of weight	25.gm. to 40.gm. in 24 hours.
Uric Acid,	$\frac{1}{27}$ to $\frac{1}{80}$ of amt. of Urea	.707 gm. to .875 gm. in 24 hours.

Chlorine, 6. gm. to 8. gm. in 24 hours.

Sulphuric Oxide (SO_3), about 2. gm. in 24 hours.

Phosphoric Oxide (P_2O_5), about 3.5 gm. in 24 hours.

It must be noted, however, that allowance should be made for the age of the individual and also for his weight and stature. The sex also needs to be considered. On page 24 is given a form of report which itself suggests the most important points to be observed with respect to a given sample of urine.

Comments on the analysis.—The *specific gravity* may be taken by an accurate urinometer, or by the Westphal balance, or by a picnometer.

The *reaction* may be taken by litmus paper.

A hasty general examination for *water*, *organic and volatile* matters and *mineral matters* may be made by evaporating a measured portion of the urine in a platinum dish. The residue is then weighed, and afterwards ignited and weighed again.

The amount of *urea* is very important, because this substance represents the principal form in which nitrogenous matter is eliminated from the system.

Uric acid represents about 1-27 to 1-80 of the urea. This amount, therefore, is not ordinarily large. As it is not easily soluble in water, it often separates in the form of brick dust deposit when its quantity is excessive.

Albumen is detected by boiling the urine or by addition of nitric acid, or both. The coagulated mass affords a simple test.

Sugar is detected by an alkaline copper solution according to Fehling's test. The copper is precipitated as a red deposit called cuprous oxide ($Cu_2 O$).

Chlorine, *phosphoric oxide*, *sulphuric oxide*, are determined by methods but slightly varying from those ordinarily employed.

Urinary deposits.—Urinary deposits are obtained by placing a quantity of urine in a wine-glass. Allow it to subside for some time. All insoluble matters heavier than the urine gather at the bottom of the wine-glass. From this narrow space they may be caught in a pipette. They may be then transferred to the glass slide and examined under the microscope. The latter instrument is that chiefly employed in the recognition of urinary deposits.

Urinary concretions.—calculi, gravel, etc.—Calculi, whether in large masses or in minute grains, may consist of organic matter or mineral matter, or mixtures of the two. The larger calculi frequently have a nucleus of a given substance coated with stratified layers of various substances.

Of organic matters the chief substance in gravel or calculi is *uric acid.* It is sometimes recognizable by its appearance under the microscope. Again a portion placed in a platinum dish and subsequently ignited is found to disappear entirely. This is an instructive test, although not conclusive.

Ammonium urate entirely disappears when ignited on platinum. It may be tested for ammonia by adding sodic hydrate to it. If ammonia gas comes off, it may be recognized by means of a drop of Nessler reagent on the end of a glass rod.

Urates of sodium, calcium and *magnesium* sometimes occur as constituents of calculi.

Calcium oxalate is a common constituent of calculi. In order to detect it, test a portion for carbon dioxide before ignition: negative results should be obtained. Try the same experiment on another portion that has been ignited. Carbon dioxide should now be obtained. The calcium may be detected by the regular tests.

Ammonio-magnesic phosphate is a common constituent of calculi. Calculi containing it do not disappear on burning: on the other hand they fuse to a white enamel. The residue after this ignition dissolves in nitric acid without the effervescence noted in oxalic calculi. Moreover the nitric solution may be tested for phosphoric acid by ammonic molybdate.

TABLE II.

FORM FOR URINE REPORT.

(*Refer to Neubauer, C., and Vogel, J.: Analysis of Urine; New York, Wm. Wood & Co.*)

Date................ Name.................... No.........

	NORMAL.
Amount in 24 hours................................	1200-1600 c. c
This sample passed,	

THIS SAMPLE.	NORMAL.
Sp. Gr..	1.005 to 1.030
Reaction..	acid.
Color Yellow Reddish Brown	
Odor..	
Water..................................	94.5
Organic and volatile matters......... }	
Mineral matters...................... }	
Total solids.............................	5.5
	100.0
Organic. Urea................................	2.5-3.2 %
Uric acid..........................	
Albumen............................	
Sugar..............................	
Inorganic. Chlorine..........................	
P_2O_5..............................	
SO_3................................	

Deposits.		Sketch of Deposits.
Non-organized.	Uric acid...............	
	Calcic oxalate..........	
	Earthy phosphates.....	
Organized.	Epithelium	
	Mucus..................	
	Pus....................	
	Blood..................	
	Casts..................	
Accidental.	....	

TABLE III.

Approximate Composition of Human Urine.

*Analysis by Miller.**

Water			95.637 %
Urea		1.423	
Uric acid		.037	
Other organic matters, including Creatine	.125	1.505	
Creatinine	.150		
Mucus		.016	
Total organic matters			2.981 %
Sodic chloride		.722	
Potassic oxide		.192	
Sodic oxide		.053	
Magnesic oxide		.012	
Calcic oxide		.021	
Phosphoric oxide		.212	
Sulphuric oxide		.170	
Total mineral matters			1.382 %
			100.000 %

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*The amount of Urea is usually considered as averaging 2.5 to 3.0 per cent.