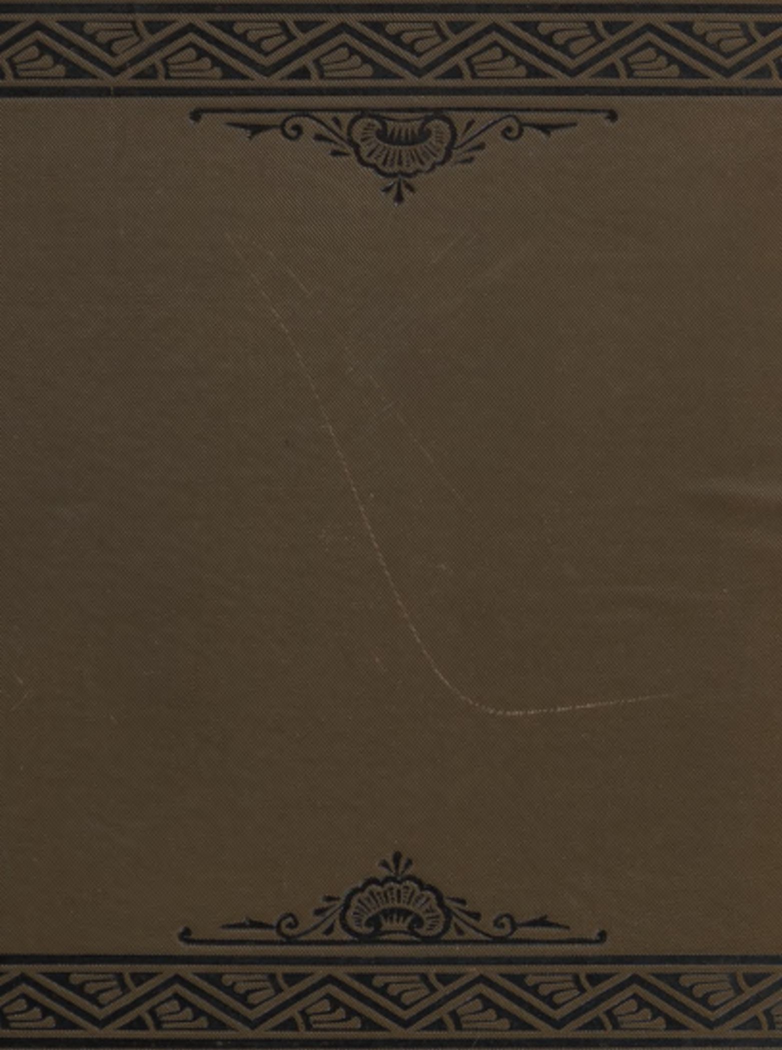

THE

PHYSICIAN'S CHEMISTRY,

BY

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"CLINICAL SIGNIFICANCE OF THE URINE,"
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PREFACE.

The aim of this book is to give much information in as small space as possible. I have tried to simplify Chemical Theory so that the beginner can learn to read and write formulæ without a teacher. Barker, Engel, Simon, and Ralfe, have been, among others, my authorities on Inorganic and Organic Chemistry. The chapter on Urinalysis is the result of my own experience as a teacher; much attention is given in this part of the book to causes of confusion and error likely to arise in testing urine. In Toxicology, Tanner, Woodman and Tidy, and Wormley, have been consulted among many others. Notes on cases of poisoning have been given me by Prof. J. H. Buffum, Prof. A. G. Beebe, Prof. N. B. Delamater, Prof. J. R. Kippax, Prof. J. W. Streeter and Prof. A. W. Woodward; I am also indebted for notes on hospital cases to Drs. Percy Bryant and F. R. Day. Dr. Bryant has kindly furnished me with reports of many interesting cases. Drs. M. J. Bliem, W. B. Clarke, F. H. Foster, and Chas. Gatchell, have also communicated valuable information. Prof. Delamater has contributed two pages on the use of electricity in cases of poisoning.

The author must apologize for the size of the Appendix; the printing of the last half of the book was delayed greatly by fire in the printing-house, so that many new and important items coming up in the meantime could not appear in the book proper. I am greatly indebted to the learning and experience of Mr. J. M. Baker, of Chicago, for hints regarding many new pharmaceutical compounds; such as urethan, iodol, pyridine, etc.; notes on which will be found in the Appendix. My authorities in homœopathic pharmacy are the *American Homœopathic Pharmacopœa* and the *American Homœopathic Dispensatory.*

CLIFFORD MITCHELL.

CHICAGO, February, 1886.

CONTENTS.

PART I.

THEORY.

Page.

- Atom, molecule 9
- Elements 10
- Writing and reading formulæ 11–19

PART II.

INORGANIC, ORGANIC, URINALYSIS.

- Inorganic—
  - Elements 20–31
  - Compounds of non-metals 32–40
  - Compounds of metals.. 41–62
- Organic—
  - Hydrocarbons........63, 64
  - Alcohols 64–66
  - Sugars...............67, 68
  - Phenols, thymols, etc. 69, 70
  - Acids and salts.........70–75
  - Aldehydes 75
  - Ethers 76
  - Amines, amides........ 78
  - Alkalamides 79
  - Alkaloids 80–84
  - Proteids 85–87
- Animal chemistry—
  - Blood 88–92
  - Chyle 92
  - Lymph 92
  - Milk.................93, 94
  - Saliva.................. 95
  - Gastric juice.......... 96
  - Intestinal juices....... 97
  - Degenerations, calculi, etc............ 99–110
- Urinalysis............111–125
  - Objections and precautions 115–120
  - Bedside testing......120–124
  - Quantitative estimates, ... 124, 125

PART III.

TOXICOLOGY.

- General remarks......126–141
- Poisoning by arsenic..142–153
  - opium..............153–160
  - strychnine 160–166
  - acids and alkalies...167–172
  - salts, etc............173–175
  - iodine, phosphoros, mercury, etc............ 176–179
  - anæsthetics............ 180
  - inebriants.......... 181–184
  - delirants 185
  - atropine............187–194
  - convulsants............ 195
  - paralysants............ 196
  - aconite..............196–201
  - prussic acid......... 201–204
  - depressants.......... 205–207
  - asphyxiants.........208, 209
- Miscellaneous—Sewer-gas, gelsemium...........209–215
- Use of electricity......216–218
- Supplement to Toxicology—Cases reported by Drs. Beebe, Bliem, Bryant, Day, etc...............219–228

APPENDIX.

- Table of elements, etc. 229–232
- Tests for drinking water.. 235
- Mineral waters........237, 240
- Methods of manufacture.. 240
- Equations (inorganic).... 240
- Water of crystallization.. 243
- Specific gravities......... 244
- Solubilities 247
- Organic theory.........249–255
- Molecular weights of organic substances....... 256
- Equations (organic)...... 257
- Formulæ (organic)....... 258
- Reactions of oils, sugars, 260–261
- Foods 261–267
- Alkaloids................. 267
- Glucosides, resinoids..... 269
- Cocaine hydrochloride.... 271
- Miscellaneous 273–280
- New remedies.........281–283
- Disinfectants 283–286
- Metric system........286–288
- Thermometry 288–290

THEORY OF INORGANIC CHEMISTRY.

PART I.

1. **Divisions of Matter:** Three divisions of matter are recognized in science: masses, molecules and atoms.

2. A mass of matter is any portion of matter appreciable by the senses.

3. A molecule is the smallest particle of matter into which a body can be divided without losing its identity.

4. An atom is the still smaller particle produced by the division of a molecule.

Examples: The sun and the sand-grain are equally *masses* of matter. The smallest particles of sugar or of salt which can exhibit the properties of these substances, respectively, are *molecules* of sugar or of salt. The still more minute particles of carbon, of hydrogen, and of oxygen, which make up the molecule of sugar, or those of chlorine and of sodium which compose the molecule of salt, are *atoms*. (Barker.)

A mass of matter is made up of molecules, and a molecule itself is composed of atoms.

5. A chemical **element** is a substance which has never been found to contain more than one kind of atoms; as, for example, iron.

6. The more important elementary substances with symbols, are:

Hydrogen, H; fluorine, F; chlorine, Cl; bromine, Br; iodine, I; oxygen, O; sulphur, S; nitrogen, N; phosphorus, P; arsenic, As; antimony (*Stibium*), Sb; bismuth, Bi; boron, B; carbon, C; silicon, Si; tin (*Stannum*), Sn; chromium, Cr; manganese, Mn; iron (*Ferrum*), Fe; platinum, Pt; gold (*Aurum*), Au; mercury (*Hydrargyrum*), Hg; copper (*Cuprum*), Cu; lead (*Plumbum*), Pb; silver (*Argentum*), Ag; zinc, Zn; aluminum, Al; calcium, Ca; barium, Ba; sodium (*Natrium*), Na; potassium (*Kalium*), K; magnesium, Mg.

7. The above elements may be classified electro-chemically as follows: The *metals*, gold, platinum, mercury, silver, copper, bismuth, tin, lead, iron, zinc, manganese, aluminum, magnesium, calcium, barium, sodium and potassium are electro-positive in reference to the non-metals or metalloids, oxygen, sulphur, nitrogen, fluorine, chlorine, bromine, iodine, phosphorus, arsenic, boron, carbon, antimony, silicon and hydrogen.

8. The **elements** may be classified as regards their equivalence or combining power with reference to hydrogen as follows: H, Fl, Cl, Br, I, Na, K, Ag are *monads*, *i. e.*, each atom of them combines with, or exchanges for, just *one* atom of hydrogen; O, S, Ca, Ba, Mg, Zn, Pb, Hg, Cu are *dyads*, *i. e.*, combine with, or exchange for, two atoms of hydrogen; Au, As, Sb, P, N, B, Bi, are *triads*, *i. e.*, with *three;* C, Si, Sn, Pt, are *tetrads*, *i. e.*, with *four;* Cr, Fe, Mn are *hexads*, *i. e.*, with *six*.

9. To denote equivalence, as, for example, of carbon, place Roman numerals above symbol, thus $\overset{\text{II}}{\text{C}}$.

10. To denote the number of atoms in an elemental molecule write Arabic figure to the lower right-hand corner of symbol. Thus H_2 means two atoms of hydrogen.

11. To represent a number of molecules: Inclose symbols in brackets with numeral outside below to right, thus $(H_2)_6$ means six molecules of hydrogen, each of which is composed of two atoms. Sometimes the number is placed before and on a line with the symbol or formula, thus $6HCl$ instead of $(HCl)_6$.

12. A binary compound is one whose molecule is composed of two different kinds of atoms, as common salt, $NaCl$.

13. To name binaries, place the name of the positive constituent first and then the name of the negative, changing termination of latter to *ide.*

14. To name, for instance, a compound of zinc and phosphorus: Referring to paragraph 7, we find zinc to be positive as regards phosphorus, which is negative; therefore the name of the compound is zinc phosph*ide*, the termination of phosphorus, the negative one of the two elements, being changed to *ide.*

15. A rapid method of writing formulæ for binaries may be stated as follows: Write symbol of positive element first, then symbol of negative. Over positive element write its equivalence. Do same over negative. Then transfer the number *over* the positive to *lower right hand* of negative, and the number *over* negative at *lower right-hand* corner of positive. For example, to write formula of zinc phosphide, first write ZnP, then $\overset{II}{Zn}\overset{III}{P}$ then Zn_3P_2. (See 8 for equivalence.)

16. The classification given in 8 is not always used in writing formulæ, but only when the terminations "ic" or "ous" do *not* appear in the names.

17. The terms "ic" and "ous" may be explained as follows: Certain elements vary in equivalence; for instance, sulphur may be either a dyad, tetrad, or hexad. This variation is indicated by the terms "ic" for the highest equivalence, and "ous" for the next lower, and "hypo-ous" for the lowest. Anything higher than "ic" is sometimes called "per-ic." Sulphuric oxide means hexad sulphur and oxygen; sulphurous oxide means tetrad sulphur and oxygen; hypo-sulphurous oxide means dyad sulphur and oxygen.

18. The elements which vary most often in equivalence may be classified as follows: Cl, Br, I, N, P, As, vary *one*, *three*, *five;* that is, chlor*ic*, brom*ic*, etc., means *pentad* chlorine, *pentad* bromine, etc.; chlor*ous*, brom*ous*, etc., means *triad* chlorine, bromine, etc.; Sb and Bi vary *three* and *five;* that is, antimon*ic* means *pentad* Sb; antimon*ous* means *triad* Sb, etc.; C, Sn, Pt, Pb, vary two and four; that is, carbon*ic* means tetrad carbon; carbon*ous* means dyad C, etc.; sulphur varies two, four, six; that is, sulphur*ic* means *hexad* S, etc.

19. There are other peculiarities of equivalence: Certain elements do not act as *true* dyads or hexads; they are then called *pseudo*-monads and *pseudo*-triads. The pseudo-monads are Hg and Cu. The pseudo-triads are Al, Cr, Mn, Fe.

20. The term pseudo-monad may be explained as follows: Mercur*ic* and cupr*ic* mean *dyad* Hg and *dyad* Cu; mercur*ous* and cupr*ous* mean that two atoms of Hg and two atoms of Cu unite with two atoms of hydrogen; arithmetically, then, Hg and Cu vary one and two.

21. The term pseudo-triad may thus be explained: Al, Cr, Mn, and Fe, sometimes unite with H as follows: Al_2, Cr_2, etc., unite with H_6; arithmetically, then, one atom would unite with H_3.

22. In accordance with the above statements, the formulæ for mercuric chloride, silver sulphide, potassium iodide, cuprous oxide, carbonic sulphide, zinc bromide, sulphurous oxide, hyponitrous oxide, phosphoric oxide, stannic chloride, arsenious oxide, antimonic sulphide, may be written as follows:

$HgCl_2$, Ag_2S,KI, $(Cu_2)_2\ O_2=Cu_2\ O$, $C_2\ S_4=CS_2$, $ZnBr_2$, $S_2O_4= SO_2$, N_2O, P_2O_5, $Sn\ Cl_4$, As_2O_3 Sb_2S_5.

23. Other methods of naming chemical compounds are sometimes used: Numeral prefixes are found, especially in English text-books; thus Fe_2O_3 would be called diferric, tri-oxide.

24. Certain compounds do not follow our rules laid down:

Binary compounds of lead are named by some authors as follows: Where lead is a dyad, the compound is called, usually, plumb*ic;* as, for example, $PbCl_2$, which is named *plumbic chloride.* Where lead is a tetrad, the compound is called *plumbic per;* as, for example, PbO_2, *plumbic peroxide.* There is also Pb_2O, called *plumbous oxide*, and $PbCl_4$, *plumbic perchloride.* Compounds of Al, where the latter exerts a pseudo-triad influence, are called by many, *aluminum oxide*, *chloride*, etc. Compounds of Cr, when the latter is a *pseudo-triad*, on the other hand, receive the appellation chrom*ic*, as Cr_2Cl_6, *chromic chloride.* Where Cr is a *dyad*, the compounds are named chrom*ous*, as $CrCl_2$, *chromous chloride;* where Cr is a *hexad*, the terms used are chrom*ic per*, as CrF_6, *chromic perfluoride.* The same is true of compounds of Mn; the compound MnO_2, where Mn is a tetrad, is usually called *manganese dioxide.* Compounds of Fe usually follow the same rules as those of Cr and Mn. Fer*rous* indicates that the equivalence of Fe is *two;* ferr*ic*, *three*, ferric di-, *four*, ferric per- or tri-, *six*.

25. The formulæ then for the following: chromic oxide, chromic perfluoride, chromous chloride, chromic trioxide, manganic chloride, manganous chloride, manganic trioxide, manganese dioxide, ferric chloride, ferrous chloride, ferric trioxide, ferric oxide, plumbic oxide, plumbic peroxide, aluminum chloride, may be written: Cr_2O_3, CrF_6, $CrCl_2$, CrO_3, Mn_2Cl_6, $MnCl_2$, MnO_3, MnO_2, Fe_2Cl_6, $FeCl_2$, FeO_3, Fe_2O_3, PbO, PbO_2, Al_2Cl_6.

26. A **ternary** compound is one containing three different elements.

27. Ternary molecules are divided into two classes according to the equivalence of the element which unites the other two elements: we may have a ternary united by a *dyad* element or by a *triad* element. The most important ternaries, however, are those in which the atom performing the linking function is either *oxygen* or *sulphur.*

28. The varieties of ternaries in which *oxygen* unites two atoms or groups of atoms are called *acids, hydrates,* or *hydroxides,* and *salts.*

29. The terms **acid, hydrate** and **salt** may be defined as follows:

An acid molecule consists of hydrogen, some *negative* element atom or atoms, and oxygen, usually written in the following order: hydrogen, negative atom or atoms, oxygen; there may be *more than one* atom of hydrogen and more than one atom of oxygen. Acids turn blue litmus red.

A hydrate or hydroxide consists of a positive atom or atoms, hydrogen and oxygen. There may be more than one atom of hydrogen and of oxygen. Hydroxide formulæ are often written in the following order: positive atom or atoms, hydrogen, oxygen. A salt or saline molecule consists of a positive atom or atoms, a negative atom or atoms, and oxygen; there may be more than one atom of oxygen. Salt formulæ are usually written in order as follows: positive element, negative element, oxygen.

30, **Acids are named** from equivalence of the *negative* element; as, for example, one containing hexad sulphur we call sulphur*ic* acid, one containing tetrad sulphur sulphur*ous*, etc.

31. **Hydroxides are named** from equivalence of the *positive* element; thus one containing dyad copper we call cupric hydrate or hydroxide.

32. **Salts are named** from equivalence of the *negative* element, the terminations being *ate*, *ite* and *hypo-ite.* according as the negative element is in its highest, next lower, or lowest equivalence. Thus, a salt containing hexad sulphur is called a sulph*ate*, one containing tetrad sulphur a sulph*ite*, one containing dyad sulphur a hyposulphite. The positive element is unchanged in termination unless it is one which varies in equivalence, in which case it receives the terminations *-ic* and *-ous;* thus, mercur*ic* nitr*ate* shows that the positive element mercury exerts its highest equivalence as does the negative element nitrogen.

33. **Rapid Method of Writing the Formula of an Acid:**

1. Write the formula of the corresponding oxide.
2. Reduce if possible.
3. Add H_2O.
4. Reduce if possible.

Thus to write the formula for sulphur*ic* acid first write the formula for the corresponding oxide, *i. e.*, sulphur*ic* oxide. Sulphur*ic* means sulphur with equivalence of *six*, therefore, sulphur*ic* oxide, according to our method of writing binary formulæ, is S_2O_6; next reduce S_2O_6 by dividing both figures by their greatest common divisor and we have SO_3; next add H_2O—we cannot add

H_2 to anything in the SO_3, so we simply write it down H_2; we cannot add the S in the SO_3 to anything in the H_2O, so we write it down next to the H_2, and have thus far H_2S; the O in H_2O may be added to the O_3 in SO_3, in all making O_4; writing this O_4 after the H_2S we have H_2SO_4 as our result, which is the formula for sulphuric acid. H_2SO_4 cannot be reduced further, as there is no number, except one, which will divide *all* of the figures at the lower right hand corner of the symbols.

To write the formula for nitric acid, first write the formula for nitric *oxide*, which is N_2O_5; this cannot be reduced, so next add H_2O and obtain $H_2N_2O_6$; this result can be reduced by dividing by 2 and thus becomes HNO_3, which is the formula for nitric acid.

34. In accordance with the preceding (33), write the formulæ for the following: sulphurous acid, nitrous acid, chromic acid, hypochlorous acid, hyponitrous acid, iodic acid, hyposulphurous acid. *Answers:* H_2SO_3, HNO_2, H_2CrO_4, $HClO$, HNO, HIO_3, H_2SO_2.

35. Rapid Method of Writing the Formulæ for Hydroxides or Hydrates:

1. Write HO in parenthesis, thus $(\overset{I}{HO})$, giving it as one expression an equivalence of one.

2. Write before this parenthesis the symbol of the positive element.

3. [Write equivalence of parenthesis at lower right-hand corner of positive element symbol], and equivalence of positive element at lower right-hand corner of the parenthesis.

N. B.—As the parenthesis equivalence is one, it is not necessary to write it at the lower right-hand corner of positive element symbol.

Thus to write the formula for cupric hydrate first write $(\overset{I}{HO})$; prefix $\overset{II}{Cu}$ and we have $\overset{II}{Cu}(\overset{I}{HO})$; lastly write the II as a figure at the lower right-hand corner of (HO) and we have $Cu(HO)_2$, the formula for cupric hydrate. It may also be written Cu2HO and also CuH_2O_2.

36. In accordance with the above (35), write the formulæ for potassium hydrate, calcium hydrate, ferric hydrate, platinic hydrate, sodium hydrate, aluminum hydrate. *Answers:* K(HO), $Ca(HO)_2$, $Fe_2(HO)_6$, $Pt(HO)_4$, Na(HO), $Al_2(HO)_6$. K(HO) is usually written without parenthesis, thus KHO.

37. **Rapid Method of Writing Formulæ of Salts:**

1. Write formula for corresponding acid.
2. Bracket the non-hydrogen part of the acid formula.
3. Erase the H of the acid formula, carefully leaving any figure at its lower right hand.
4. Put in place of the erased H the symbol of the positive element.
5. Write the equivalence of the positive element after the parenthesis obtained in (1).

It is necessary to know what we mean in (1) by the "corresponding acid"; if we have a salt ending in *ate*, the corresponding acid is an *ic* acid, thus the acid corresponding to calcium sulph*ate* is sulphur*ic* acid; if we have a salt ending in *ite* the acid corresponding is an *ous* acid; if the salt be *hypo-ite* the acid is hypo-ous. Suppose now we write the formula for the salt which we call calcium hypochlorite:

(1) First write formula for hypochlor*ous* acid; hypochlorous oxide+water=hypochlorous acid. $Cl_2O+H_2O =H_2Cl_2O_2=HClO$.

(2) HClO being hypochlorous acid, next enclose all but H and we have H(ClO).

(3) Omit the H, and we have (ClO).

(4) Put in place of H the symbol for the positive element calcium (*calcium* hypochlorite is required), and we have Ca(ClO).

(5) Write equivalence of Ca after parenthesis, and we have $Ca(ClO)_2$.

N. B.—After (5) is performed we may reduce if possible, and where the equivalence of the positive element is one we may remove parentheses at the end. Thus $Ca_2(SO_4)_2$ becomes $CaSO_4$; $K_2(SO_4)$ becomes K_2SO_4. Where the *equivalence* of the positive element is the same as the *number of hydrogen atoms* of the acid, merely substitute; thus calcium sulphate is $CaSO_4$, *i. e.*, $H_2SO_4+\overset{II}{Ca}$, the one atom of calcium being substituted for the two of hydrogen.

38. In accordance with above (37) write the formulæ for sodium nitrate, calcium nitrite, bismuth chlorate, potassium sulphite, barium carbonate, gold chromate, platinic sulphate, zinc iodate. *Answers:* $NaNO_3$, $Ca(NO_2)_2$, $Bi(ClO_3)_3$, K_2SO_3, $BaCO_3$, $Au_2(CrO_4)_3$, $Pt(SO_4)_2$, $Zn_3(IO_4)_2$.

39. **Ortho-acids:** All acid formulæ are not written as in (33). An acid in which all the oxygen has a linking function is called an ortho-acid. Boric acid is an ortho-acid.

40. To write the formula of an ortho-acid: In an ortho-acid there are as many atoms of H and of O, as is equal to the equivalence of the negative element. Therefore proceed as follows:

1. Write $(\overset{I}{H}O)$ as in (35).
2. Prefix the symbol of the *negative* element.
3. Write equivalence of the negative element at lower right-hand corner of the (HO). Thus ortho-phosphoric acid would be $P(HO)_5$, or H_5PO_5.

41. **Formation of Meta-acids:**

To form a meta-acid subtract one or more molecules of water from the formula of the ortho-acid; if we subtract one molecule of water the result is a mono-meta acid, if two $(H_2O)_2$ or (H_4O_2), the result is a di-meta acid, and so on. Thus the formula for ortho-phosphoric acid is, as we have seen, H_5PO_5; subtract H_2O, and we have H_3PO_4, the formula for mono-meta phosphoric acid, which, however, is *not* glacial phosphoric acid, but the acid corresponding to phosphates.

42. When we speak of **phosphoric acid** and of **boric acid** then, we understand:

Mono-meta phosphoric acid, or H_3PO_4, and ortho-boric acid, or H_3BO_3.

43. The formulæ for all acids can be derived in the same way as in 40:

But the rules given in 34 serve most purposes; some few acids are binaries, as hydrochloric, H Cl.

44. There are **ortho-** and **meta-hydrates:**

The usual formula for a hydrate is that of an ortho-hydrate; there are but few meta-hydrates.

45. There are exceptions to the rule given in 37 for writing formulæ of salts. The rules given in 37 apply only to what are called *normal* salts; besides these, there are *acid*, *basic*, and *double* salts. To write the formula for an *acid* salt, first write the formula for the acid, then substitute the symbol of the positive element for as many atoms of hydrogen in the acid as the positive element has equivalence: thus, the formula for acid sodium sulphate would be written as follows: formula for sulphuric acid is H_2SO_4, equivalence of sodium is one; substitute Na for one atom of H, and we have $HNaSO_4$ as the formula for the acid sulphate, bi-sulphate or hydro-sodium sulphate, by all of which names it is known.

The formulæ for double salts are written in the same way, except that all the hydrogen is replaced by several atoms of *different* positive elements: thus, potassium-sodium sulphate would be written $KNaSO_4$.

There may be double acid salts: thus, the formula for phosphoric acid being H_3PO_4, the acid phosphate of sodium and potassium would be $HKNa\,PO_4$.

Basic salts partially replace the hydrogen of a hydrate by a negative element, and will not be considered here.

46. To write the formulæ for **sulpho-acids** and **sulpho-salts:**

Write the formula for the acid or the salt precisely as in 34 and 37; after the formula is written, erase the O, and substitute in its place S, being careful not to erase any figures: thus, the formula for sulpho-carbonic acid would be written as follows: that of carbonic acid is H_2CO_3; substitute S for O, and we have H_2CS_3 as the formula for sulpho-carbonic acid; the formula for sodium sulpho-carbonate would be written as follows: write the formula for sodium carbonate, substitute S for O, and we have Na_2CS_3.

47. The formulæ, directions for writing which have been given in questions 34–45, are not the only ones used in chemistry.

The formulæ thus far written are called empirical or experimental formulæ, being derived from analysis. Rational formulæ are sometimes used, indicating not merely the composition of a body, but the way in which the atoms are arranged: thus, the formula for mercurous chloride may be written $\mathrm{Hg{—}Cl}$, it being composed of

$$\begin{array}{l} | \\ \mathrm{Hg{—}Cl}, \end{array}$$

wo atoms of mercury and two of chlorine; each atom of mercury has an equivalence of two, making four *bonds*, as the lines indicate, two of which unite with the two furnished by the chlorine, and two with each other, as shown by the arrangement of atoms in the formula.

48. **To read formulæ:** First notice whether the formula be that of a binary compound (having two dif-

erent symbols) or of a ternary (having three). If a binary, the name of the first will be unchanged in English, but the second must end in -ide; thus, KCl must be potassium chlor*ide*.

If a ternary, notice whether it begin with hydrogen: if so it is an acid [or acid salt], and if the number of atoms of oxygen be four, it is probably an -ic acid: thus, H_2SO_4, is an acid, and is sulphur*ic* acid. If H_2SO_4 is sulphur*ic* acid, H_2SO_3 will be sulphur*ous*, and H_2SO_2 hyposulphurous. If HNO_3 be nitr*ic* acid, HNO_2 is nitr*ous*, etc. If the ternary begin with a metallic element, followed by HO, it is a hydrate (hydroxide); thus, KHO is potassium hydrate or hydroxide. If the ternary begin with a metallic element, followed by a non-metallic one and oxygen, it is a salt; if the number of atoms of oxygen be four, it is an -ate salt if sulphur, phosphorus, or chromium be the negative element; if the number of atoms of oxygen be three, it is an -ate salt, if nitrogen, chlorine, iodine, bromine, or carbon be the non-metallic element: thus, K_2SO_4 is potassium sulph*ate*, K_3PO_4 is potassium phosph*ate*, but KNO_3 is potassium nitrate, K_2CO_3 is potassium carbonate.

Summary:—

All chlorides end in Cl_n
" bromides " " Br_n
" iodides " " I_n
" cyanides " " $(C\,N)_n$ or Cy_n
" hydrates " " $(H\,O)_n$
" nitrates " " $(N\,O_3)_n$
" chlorates " " $(Cl\,O_3)_n$
" oxides " " O_n
" sulphides " " S_n
" sulphites " " $(S\,O_3)_n$
" sulphates " " $(S\,O_4)_n$
" phosphates " " $(P\,O_4)_n$
" borates " " $(B\,O_3)_n$
" chromates " " $(Cr\,O_4)_n$

n denoting any number.

PART II.

INORGANIC CHEMISTRY.

CHAPTER I.—THE ELEMENTS.

1. **Oxygen** gas may be prepared in various ways :— in the laboratory, by heating 3 parts potassium chlorate by weight with 1 part manganese dioxide to prevent explosion, in a flask provided with a cork stopper, into which is inserted a glass tube to convey the gas wherever desired ; for inhalation, dilute hydrogen peroxide *gently* heated gives off abundant oxygen.

2. Properties and uses of oxygen :

Colorless, odorless, tasteless gas. Almost insoluble. Intensely active ; increases ordinary combustion. Respirable when pure ; quickens circulation.

3. Varieties of combustion :

Combustion is union with oxygen. Quick and slow. Quick combustion is union with oxygen, brought about by heat, and attended by light and heat, as when coal burns ; the carbon of the coal unites with the oxygen of the air. Slow combustion is gradual combination with oxygen, as when iron rusts, forming the oxide. Respiration is an example of slow combustion.

4. Oxygen is found in the body :

Chiefly in the blood, not merely dissolved but, according to Bernard and others, combined chemically.

5. *Ozone* is regarded as condensed oxygen, has strong odor; found free in air, especially after thunderstorm, bleaches strongly, very irritating to mucous surfaces. Destroys impurities. One volume of air containing $^1/_{6000}$

of ozone will purify 540 volumes of putrid air. Is said to disappear from the air during an epidemic.

6. Ozone may be made in large quantities by passing air through a box highly charged with electricity; in small quantities by passing a current of air into a tube containing sticks of phosphorus (covered with water).

7. Properties and uses of **nitrogen:**

Colorless, odorless, tasteless gas, almost insoluble; chemically very inert, incombustible, and extinguishes combustion; irrespirable, though has no injurious effect on tissues; is an essential component of many vegetable and animal substances. *Compounds* formed by nitrogen are the most energetic known; it occurs in nitric acid, ammonia, nitro-glycerine, prussic acid, and in the alkaloids, strychnine, morphine, etc.

8. Properties and uses of **hydrogen:**

Colorless, odorless, tasteless gas. Lightest known substance, being nearly 14½ times lighter than air. Very slightly soluble. Combustible, burning with pale blue flame, evolving very great heat. Does not support respiration nor combustion. On burning forms water, combining with the oxygen of the air.

9. Hydrogen is found free in the body:

In intestinal gases, especially during a milk diet. In the stomach when butyric fermentation is going on.

10. Hydrogen may be made, as follows:

Mix one part sulphuric acid with four parts water; let cool; place fragments of zinc in a two-necked bottle—or in a wide-mouthed bottle having a cork with two holes in it—having a funnel tube, passing nearly to bottom of bottle in the cork, which stops one neck, and a delivery tube set in the cork stopping the other neck. Place the bottle in a dish containing a little cold water, and pour in the cooled acid mixture down the funnel tube. Hydrogen is given off, and escapes through the delivery tube.

11. The average composition of **pure air** is:

Oxygen, 20.8 parts by volume; nitrogen, 79.2. It is not a chemical compound of the two gases, but merely a mechanical mixture, the nitrogen serving as a diluent of the oxygen, which, if pure and unmixed with nitrogen, could not be safely breathed for any length of time.

12. **Chlorine** gas may be made as follows:

Place 20 parts, by weight, of commercial hydrochloric acid (sp. gr. about 1.16) in a flask as in 10, add 8 parts manganese dioxide, agitate, and after a time heat the flask on a sand bath (safety-tube may be used, which is a funnel-tube bent twice on itself).

13. Properties and uses of chlorine:

Yellowish-green; peculiar, suffocating odor; astringent taste; wholly irrespirable; very soluble in water, one volume of the latter dissolving nearly three volumes of chlorine, forming what is called *chlorine water*, decomposing on exposure to light. Powerful bleaching agent and disinfectant.

14. The **halogens** are:

Chlorine, bromine, iodine and fluorine, deriving their name from their origin, sea-water. Chlorine is a gas, and has been already considered (see 12). Bromine is a liquid, iodine a solid, [fluorine probably a gas].

15. Properties and uses of **bromine:**

Brownish-red liquid, irritating odor, emits very heavy red vapors; slightly soluble in water; soluble in ether. Used as a caustic, antiseptic and disinfectant, and as a chemical re-agent, especially in estimating urea. Glass "pearls" containing bromine are used in some processes for estimating the latter. Care must be taken not to inhale the fumes of bromine, as they are very suffocating; stopper of bottle to be removed with great caution.

16. **Iodine** is found in sea-water, mineral waters, cod

liver oil and sponges. Found free in small quantities in atmosphere.

17. Properties and uses :

Solid. Brilliant scales ; gray metallic color ; odor like chlorine and bromine, but not so strong. Gives off violet vapors. Almost insoluble in water. Soluble in alcohol and in potassium iodide. Used externally as irritant and resolvent. Troy ounce iodine to pint of alcohol forms *tincture* of iodine ; deep brown color ; undergoes gradual change when kept ; water precipitates iodine from it. Dissolved in potassium iodide solution, iodine may be used to stain microscopical specimens, as renal tube-casts, (5 parts iodine, 15 parts potassium iodide, 3,000 parts water, all by weight).

18. Test for iodine :

Colors starch blue. Starch paste for testing prepared as follows : Powder a piece of starch size of pea in mortar ; stir up with 25 c. c. of water, and then heat the mixture in dish till it boils. Thin, clear solution is formed. Add a portion of it to about ¼ litre of water, and then a few drops of a solution of iodine, and a deep blue color is formed. Heat a little in a test-tube, and the color disappears ; allow to cool, and color reappears. Starch *paper* is also prepared and used for testing.

19. Difference in testing for *iodine* and for an *iodide:*

In testing for an *iodide* add a drop of sulphuric acid to liberate the iodine from combination.

20. **Fluorine** occurs in the body :

As fluoride of calcium in bones, teeth, brain, urine, milk, blood.

21. The halogens occur in sea-water, etc., chiefly as bromides, iodides, chlorides and fluorides.

22. *Brimstone* is crude **sulphur** found in volcanic earths.

23. Varieties of *sulphur:*—Flowers of sulphur, roll sulphur, washed sulphur (sulphur lotum), precipitated sulphur (sulphur praecipitatum) or lac sulphur.

Flowers of sulphur, made by collecting vapors of sulphur in cool chamber. Generally acid, from presence of sulphurous acid. *Sulphur lotum* is flowers of sulphur washed until no longer acid.

Precipitated sulphur is most assimilable; made by adding an acid (HCl) to a polysulphide solution, as potassium trisulphide; sulphur precipitates, may be removed, washed and dried; is paler than flowers of sulphur, and more finely divided.

Roll sulphur, or roll brimstone, made in same way as flowers, except that receiving chamber becoming hot, sulphur condenses to liquid, and may be drawn off into molds.

24. Properties and uses of *sulphur:*

It has *three* distinct forms, of which the varieties mentioned in 23 are one; second form made by crystallizing from fusion at high temperatures; third form, by heating melted sulphur to 482 ° F., then suddenly cooling by pouring into water. Second form, brown needle-shaped crystals, insoluble in carbon disulphide. Third form, dark brown tenacious mass, insoluble in carbon disulphide. First form soluble in the disulphide. Any form melts at about 240 ° F., becoming pale yellow liquid. Becomes viscid on further heat, then boils. When heated to 500 ° F. takes fire. Gives off dense fumes when burned, (sulphurous oxide).

Valuable as a disinfectant, when burned, and as a parasiticide. Found in albumin, bile acids, taurine, and many other substances in body.

25. **Phosphorus** occurs in the body:

In the various phosphates found in blood, urine, brain, nerves, bones; chiefly, however, as calcium phosphate.

26. Phosphorus may be made by calcining bones and treating cinders with sulphuric acid, yielding acid phosphate of calcium, from which the phosphorus itself may be obtained.

27. Properties and uses of phosphorus:

Freshly prepared, is a pale yellow, transparent solid, soluble in carbon disulphide, very inflammable, very poisonous; must be kept under water. Exposed to light becomes red, opaque, insoluble in carbon disulphide, not so phosphorescent, inflammable, or poisonous as the freshly prepared.

28. Different forms of **carbon:**

Crystalline, graphitoidal, amorphous, as in diamond, graphite, charcoal, respectively.

29. Vegetable charcoal may be prepared: place beech or birch wood in an iron retort and distil; divide the charcoal resulting into lumps size of fist, heat to redness and speedily extinguish in earthen vessel having well-fitted cover; blow off ashes and pulverize finely.

30. Animal charcoal may be prepared: place thick piece ox-hide leather (neat's leather) on red-hot coals and let remain as long as it burns with a flame; when flame ceases, lift off and extinguish at once by pressing between two flat stones. (Hahnemann's method).

31. Properties and uses of charcoal:

Insoluble, infusible, absorbs gases, energetic disinfectant.

32. **Boron** and **silicon** do not occur free in nature.

33. The univalent (monad) metallic elements are:

Sodium, *potassium*, *lithium*, *silver* (rubidium, cæsium, thallium).

34. Metallic **sodium** does not occur free in nature: when prepared from its oxide it is a lustrous, silver-

white, soft metal, of specific gravity 0.98, becoming brittle at 4 ° F. and fusing at 206 °. On exposure to air it rapidly tarnishes, and if thrown on water decomposes the latter with effervescence; if it be prevented from moving, or if the water be warm, it takes fire, burning with a characteristic *yellow* flame.

35. Metallic **potassium** does not occur free in nature: when prepared it is a metal resembling sodium; must be kept under naphtha; thrown on water it instantly decomposes it, evolving so much heat that the hydrogen set free takes fire and burns with characteristic *violet* flame.

36. Metallic **silver** occurs free in nature. It is a very white metal, odorless, tasteless, easily polished, very malleable, ductile, tenacious, melts at 1832 ° F. and will then dissolve oxygen; for practical purposes must be alloyed with copper; is readily dissolved by nitric acid. Chemically pure silver may be obtained by boiling equal parts of silver chloride, glucose and crystallized sodium carbonate together, in three parts of water; the precipitated silver should first be washed with a very dilute solution of hydrochloric acid, and finally with distilled water.

Silver tarnishes when near sulphur or sulphides, forming silver sulphide.

37. The bivalent (dyad) metallic elements are :

Calcium, barium, magnesium, zinc, copper, mercury, lead (cerium, strontium), and many others. (See Appendix).

38. The metals **calcium** and **barium** do not occur in nature ; they are very rare, pale yellow, and decompose water.

39. **Magnesium** does not occur free in nature : when prepared it is very like silver, but not so heavy ; it tarnishes in damp air, burns easily and with a flame of dazzling brightness, volatilizes at red heat, and may be

distilled. Dilute acids dissolve it, forming corresponding salts. Minerals containing compounds of magnesium have a soapy feel.

40. **Zinc** does not occur free in nature: when extracted, etc. from its ores it is a bluish-gray, very malleable metal, which oxidizes in damp air, an oxide or carbonate coating being formed, which preserves it ; it is easily soluble in dilute acids; water, milk, or wine in contact with zinc become charged with poisonous salts of it. Pure zinc may be obtained by passing sulphuretted hydrogen through a strong and slightly acid solution of zinc sulphate, filtering off any precipitate, boiling the filtrate to expel the sulphuretted hydrogen, and precipitating the zinc as carbonate by means of sodium carbonate. Wash the carbonate thus obtained, re-dissolve in pure sulphuric acid, dry, mix with charcoal prepared from loaf sugar, and distill mixture in a porcelain retort.

41. **Copper** exists free in nature as well as combined : when obtained from its ores it is a lustrous metal, flesh-red in color, somewhat softer than iron. It is attacked readily by chlorine, sulphur, and by nitric acid ; weak acids and alkalies, and also saline solutions, act on it slowly. It may be prepared in a finely divided state by boiling a concentrated solution of copper sulphate, not containing free acid, with distilled zinc. As soon as the liquid loses its color the zinc is removed, and the copper powder well boiled with dilute sulphuric acid ; then washed uninterruptedly with water till the washings run free from any trace of the acid ; it is then pressed between folds of bibulous paper, and dried at 167 ° F.

42. **Mercury** occurs free in nature, but is chiefly found in form of a sulphide called *cinnabar:* prepared from this sulphide it is a liquid ; opaque, insoluble, with metallic lustre. Freezes at –40 ° F., boils at 662 ° F. When pure does not adhere to glass. Is slightly volatile

at ordinary temperatures, but does not tarnish. Is not attacked by hydrochloric acid nor by dilute sulphuric, but is dissolved by strong boiling sulphuric, and by dilute nitric. When triturated with bromine, iodine, or sulphur, combines with them ; also with chlorine. Chlorides of sodium, etc., slowly convert it into corrosive sublimate. Pure mercury may be obtained by redistilling the commercial article with a mixture of equal parts nitric acid and distilled water. Separate the mercury from the acid solution, wash well, dry with bibulous paper. Mercury is variously termed hydrargyrum, argentum vivum, mercurius vivus, quicksilver.

43. **Lead** (*Plumbum*) does not occur free in nature : its principal ore is the sulphide. It is found after extraction to be a brilliant, bluish-gray, soft metal. Leaves bluish-gray streak on paper ; oxidizes in the air ; is acted upon by waters containing nitrates or chlorides, but waters containing carbonic acid or sulphates cover it with a coating, preventing further action; in the presence of air and moisture lead is attacked even by vegetable acids. Its best solvent is nitric acid. To procure pure lead in form of powder, the galvanic process of reduction by means of rods of zinc is used. Crystals of acetate of lead are dissolved in one hundred times their quantity of distilled water, and a few polished rods of zinc are put into four or six ounces of this solution in a porcelain dish. The lead is precipitated in form of a dark gray, loose, porous mass, which is carefully washed, laid between layers of bibulous paper, and finally gently rubbed in a warmed porcelain mortar.

44. Trivalent (triad) metallic elements are gold, bismuth, (antimony, arsenic).

45. **Gold** is found native in quartz and in river sand ; it is yellow in color, soft, unalterable, most malleable of the metals, very heavy, insoluble in everything but

chlorine (as obtained in nitro-muriatic acid) and bromine. Jeweller's gold contains 24 parts in all of gold and alloy; if 18 parts are gold it is called "18 carats fine." Pure gold (*Aurum Metallicum*) may be prepared as follows: Thirty grains of gold are dissolved in nitro-muriatic acid; to this solution six gallons of distilled water are added; then two ounces of ferrous sulphate are dissolved in one quart of distilled water, and the two solutions mixed together. Then add solution of potassium chlorate, and let the whole stand till it no longer gives a blue precipitate with potassium ferri-cyanide. Finally add aqua ammonia in excess. Ferric hydrate is precipitated, carrying the fine gold down in suspension in it. Dissolve the ferric hydrate with hydrochloric acid, collect the metallic gold on a filter, thoroughly wash, dry and triturate.

46. **Bismuth** occurs in the metallic state and in many compounds: it is a hard, brilliant, reddish-white metal, in crystalline laminæ, tarnishing in moisture, burning at red heat, soluble in chlorine and in nitric acid.

47. **Antimony** occurs in nature both free and in combination: it is a hard, brittle, silvery metal; unalterable; burns at red heat with odor of garlic, suggesting that of arsenic, and with white fumes. Is oxidized by nitric acid; is soluble in boiling hydrochloric acid, to which nitric acid is slowly added.

Antimonium crudum is a sulphide.

48. **Arsenic** occurs both free and combined. It is a dark, steel-gray, brittle solid, with a metallic lustre. It volatilizes at 356 ° F., its vapor having a garlic odor.

Arsenicum album is an oxide.

49. Quadrivalent (tetrad) metallic elements are:

Tin, platinum, aluminum (palladium, indium, titanium, etc).

50. **Tin** (*Stannum*) occurs in nature chiefly as an oxide: when obtained from this ore it is a white, soft, very malleable metal, crystalline, of a peculiar odor. It can not be pulverized; when bent it has a crackling, called the "cry of tin;" it is unalterable in the air; is not attacked by strong nitric acid but violently by dilute, metastannic acid being formed; hot sulphuric acid attacks it; it is soluble in hydrochloric acid, forming a chloride. For medicinal purposes, tin must be precipitated (*Stannum Precipitatum*) by the galvanic process, when it is obtained in form of powder, which may be triturated.

51. **Platinum** occurs free in nature, though rarely pure, being associated often with six or eight other metals: when purified it occurs as a brilliant white metal, having a bluish tinge; is hard, tenacious, heavy, malleable, ductile, fusible only in the oxyhydrogen flame, unalterable in the air, and soluble only in aqua regia. For medicinal use fit for triturations (*Platina*) it may be obtained by placing polished steel rods in a dilute solution of platinic chloride, upon which the metal will be deposited as a spongy, iron-gray mass without lustre. The precipitate, after being scraped off the rods with wooden scrapers, is to be boiled with hydrochloric acid, then washed well with distilled water and dried.

52. **Aluminum** does not occur free, but in combination is, next to oxygen and silicon, the most abundant element in nature: when prepared from alumina, its oxide, it is a bluish-white, sonorous, malleable, ductile, tenacious, very light, unalterable metal, soluble in hydrochloric acid and in hydrates of the alkalies.

53. Sexivalent (hexad) metallic elements are:

Chromium, iron, manganese (nickel, cobalt, tungsten, etc).

54. **Chromium** does not occur free in nature: when ob-

tained from its ores it is a steel-gray, infusible, extremely hard metal,

55. **Iron** (*Ferrum*) in the free state is chiefly of meteoric origin: when obtained from its ores, which are very numerous, it is a blue-gray, ductile, malleable, tenacious, crystalline metal. When red-hot it decomposes water; exposed to damp air it becomes hydrate of protoxide (rust); it is attacked by most acids, but is rendered passive to their action by strong nitric acid. For medicinal use iron must be prepared by hydrogen (*Ferrum Metallicum*, *Ferrum Redactum*) as follows: First, pure ferric hydrate (from ferric chloride) is prepared; this is dried and powdered; next the ferric hydrate at a red heat is submitted to the reducing action of a continuous stream of pure hydrogen as long as the vapor of water comes off; and finally the stream of hydrogen is continued until the reduced iron has cooled. Iron thus obtained is an odorless, tasteless, fine, *gray* powder, readily inflamed by a lighted match.

56. **Manganese** occurs in nature chiefly as an oxide: when obtained from this ore by reduction with charcoal, it is a grayish-white, hard metal, resembling cast-iron, and very brittle. It oxidizes readily in the air, and dissolves easily in acids. To distinguish it from magnesium the name manganesium was given it. For medicinal use (*Manganum Metallicum*) the pure metal is employed.

CHAPTER II.—COMPOUNDS OF THE NON-METALLIC ELEMENTS.

1. Binary compounds of *hydrogen* with oxygen are: *Water*, H_2O, and *hydrogen peroxide*, H_2O_2, or HO.

2. Properties and uses of **water:**

Limpid colorless liquid, odorless, tasteless, neutral, poor conductor heat and electricity, 773 times heavier than air, standard of specific gravity, unites with positive oxides to form hydrates, with negative oxides or anhydrides to form acids. Enters into composition of many crystalline substances. Its solvent power is very much greater than that of any other liquid.

3. The requisites of potable (drinkable) water are that it be:

Fresh, limpid, odorless, temperature 46° to 59° F, taste feeble, neither insipid, saline, nor sweetish. Should contain gases in solution (30 to 80 c. c. to the litre), should dissolve soap without lumps, and cook beans thoroughly. May contain salts (0.15 grammes to 0.50 grammes to the litre).

4. Simple tests for purity of drinking water are as follows:

Drinking water should not give a white precipitate with nitric acid and nitrate of silver (urine contamination), nor a marked brown precip. with Nessler's solution (ammonia), nor cause the color of permanganate of potassium solution to fade on standing over night (decomposing organic matter).

5. Method of using the permanganate solution:

A simple way is to make a very dilute solution having a light color (dissolving the crystals in pure distilled water), pour an equal amount into two test tubes, add one drop sulphuric acid to each, add to one a certain amount of the water to be tested, to the other the same amount of pure distilled water. Let both stand over night, and notice in the morning whether one is paler than the other. Pure water will not affect the color except so far as dilution is concerned. Impure water may change the color very noticeably. (See Appendix.)

6. Water used in chemical operations is distilled. Ordinary water may be taken, a little lime added to retain the hydrochloric acid (often formed toward the end of the distillation by the decomposition of the chloride of magnesium in presence of water), the first part rejected, which condenses on distillation, and which is apt to contain carbonic acid or ammonia and the distillation stopped when three-fourths of the water has been distilled. Distilled water should be neutral to test papers—that is, not turn blue litmus paper red nor red litmus blue; should leave no residue on evaporation, should give no white precipitate with barium chloride, lime water, silver nitrate, or ammonium oxalate, nor any precipitate with hydrogen sulphide (sulphuretted hydrogen).

7. The distinction between **efflorescence** and **deliquescence** may be made as follows:

As stated in 2, water enters into composition of many crystalline substances. Salts, which on exposure to the air lose their water of crystallization and fall into a white powder, are said to *effloresce.* Substances which in a moist atmosphere attract water and liquefy, are said to *deliquesce.*

8. The purest natural water is rain water. This, however, is somewhat contaminated with matters washed from the air. River and lake waters, especially those found in granitic regions, are the purest *potable* waters. *Mineral* waters are called alkaline, sulphurous, chalybeate, etc., according to prevailing constituents, and contain *usually* large amounts of solids in solution.

Sea water contains about 2,500 grains solids to the gallon; Ypsilanti water 1,205, Ballston lithia, 1,233, Tunbridge chalybeate spring 7 grains only.

9. A remarkable substance, rapidly becoming of great importance, is **hydrogen peroxide,** or $H_2 O_2$.

10. Properties and uses of hydrogen peroxide:

When *pure*, colorless syrupy liquid; harsh, bitter taste, whitens tongue, thickens saliva, dropped on hand turns cuticle white and produces violent itching. Mixed with water, the latter freezes out on exposure to cold, but peroxide does not freeze above 22 ° F. Is seldom sold pure, but ordinarily in 3% solutions. Gives off its oxygen even when heated gently. Is used in the arts, chemistry, medicine and surgery. In the arts for bleaching purposes, especially hair. In chemistry as a re-agent, especially as a test for blood (see Urine), and for pus, with which it effervesces. In medicine chiefly as an inhalation in phthisis. In dental surgery and in general surgery as an antiseptic. Must be acidulated in order to keep its oxygen. Made by action of carbonic or oxalic acid on peroxide of barium. Is both an oxidizing and reducing agent. May give off its oxygen with explosive violence.

11. An important binary compound of hydrogen and chlorine is **hydrochloric acid gas.**

12. Formula, preparation, properties, uses of hydrochloric acid:

HCl, *binary* acid [not ternary, as most acids are]. Called also *muriatic*. Made from common salt and sulphuric acid; transparent, colorless liquid, suffocating odor, very corrosive. Fumes. Stains cloth red, turning to brown. Fumes strongly near ammonia. Is a solution of HCl gas in water. Sp. gr. strongest, 1.21; homœopathic and U. S. P. 1.16. Found free in small amounts in gastric juice.

13. An important binary compound of hydrogen and nitrogen is **ammonia** gas, $H_3 N$.

14. Properties and uses of ammonia:

A gas made by heating sal-ammoniac and quicklime. Given off during putrefaction of animal matter. Found in air, rain water, snow, sea water, soils, under various forms. Also in juice of plants, liquids of the economy, urine, excrements. In solution called ammonium hydrate, Am HO, or NH_4 HO. Local excitant and general stimulant. Volatile, caustic. Powerful odor. Aqueous solution of ammonia gas having sp. gr. 0.959 is called *aqua* ammoniæ; contains 10 per cent ammonia. Stronger ammonia, aqua ammoniæ fortior, contains 26 per cent, and is a powerful corrosive poison.

15. An important binary compound of hydrogen and sulphur is **hydrogen sulphide,** H_2 S, hydro-sulphuric acid, sulphydric acid, sulphuretted hydrogen.

16. Properties and uses of hydrogen sulphide:

Is made by action of dilute acid on sulphide (sulphuret) of iron (ferrous sulphide). Is found free in some mineral springs (so-called "sulphur" springs), in putrefying organic matters, and in intestines of men and animals. Colorless, fetid gas, combustible, soluble in water, readily recognized by its odor (that of rotten eggs), valuable as a re-agent, yields precipitates with salts of many metals. Blackens unsized paper saturated with solution of sugar of lead. Poisonous.

17. **Phosphoretted hydrogen,** hydrogen phosphide, is a binary compound of hydrogen and phosphorus: H_3 P.

18. Properties, etc., of phosphoretted hydrogen:

Results from decomposition of organic matter containing phosphorus, as human bodies. Colorless gas, very poisonous, garlic odor, very inflammable, even spontaneously.

19. A very poisonous binary compound of hydrogen and arsenic is H_3 As, or **arsenietted hydrogen,** hydrogen arsenide.

20. Properties, etc, of hydrogen arsenide:

Colorless gas, with odor of garlic. Easily inflammable. Evolved always when hydrogen is generated in presence of a soluble arsenical compound, or when zinc is acted upon by an acid contaminated with arsenic. Marsh's test for arsenic depends upon the production of this gas. Violently toxic.

21. **Antimonietted hydrogen** is a binary compound of hydrogen and antimony, H_3 Sb, resembling arsenietted hydrogen though not so poisonous, and occurs whenever hydrogen is generated in presence of soluble compound of antimony.

22. **Marsh-gas** is a binary compound of hydrogen and carbon, H_4 C; also called hydrogen carbide, methane, carburetted hydrogen; occurs free in nature, being produced somewhat abundantly by the decomposition of vegetable matter confined under water. It constitutes the fire-damp of miners.

23. **Laughing gas,** N_2O, nitrogen protoxide, called also "nitrous" oxide (really a *hyponitrous* oxide), is a binary compound of nitrogen and oxygen, made by heating ammonium nitrate. The gas given off is collected in salt water, and purified before being used. It is colorless, odorless, has a slightly sweetish taste, and is valuable as momentary anæsthetic.

24. Binary **acids** derived from the **halogens:**

Hydrochloric, hydrobromic, hydriodic, hydrofluoric: not readily obtained free.

Properties and uses of **hydrofluoric acid:**

Hydrofluoric acid, HF, colorless gas, odor and taste very caustic, very soluble in water, yielding a liquid violently caustic, causing severe burns and painful ulcers on the skin, and used to etch glass. Kept in gutta percha flasks; made in leaden vessels.

[Hydrochloric acid has already been considered.]

25. Binary compounds of carbon of importance are two with oxygen, carbon dioxide and carbon monoxide, and one with sulphur, carbon disulphide.

26. Properties and uses of **carbon dioxide:**

Colorless, odorless gas, about one-half heavier than air, slightly acid taste, very soluble in water. Is product of slow as well as quick combustions, of respiration, fermentation, putrefaction. Found in air, water, breath; in milk, urine, etc., in combination. Prepared by adding dilute acid to a carbonate, as hydrochloric acid to limestone. Is narcotic when inhaled, and produces fatal effects in vats, wells, mines, etc.

27. Tests for CO_2:

In gaseous form extinguishes combustion; in solution yields white precipitate (calcium carbonate) with lime water; shown in breath by blowing through tube into lime water, causing turbidity.

28. When excess of carbon is burned in oxygen, there is formed:

Carbon monoxide (carbonous oxide, carbonic *oxide* as contrasted with carbonic *acid*), CO.

29. Properties and uses of CO:

Colorless, insipid, insoluble gas. Combustible (pale blue flame). Very poisonous, cause of charcoal asphyxia, etc.

30. **Bisulphide of carbon,** CS_2, carbonic disulphide, or bisulphide, or bisulphuret; a very mobile, colorless liquid, made by passing fumes of sulphur over red-hot charcoal. Combustible, valuable solvent for iodine, sulphur, phosphorus, oils, fats, etc. Forms sulpho-carbonates with alkaline sulphides. Has never been frozen. Vaporizes at ordinary temperatures, useful as local anæsthetic, but has disgusting odor. Vapors cause headache and general feebleness of muscular forces.

31. Formula, preparation, properties and uses of **nitric acid:**

HNO_3. Called aqua fortis. Distil potassium nitrate with equal weight concentrated sulphuric acid. Officinal acid, specific gravity 1.42. Strongest, 1.52. Colorless, transparent liquid. Very corrosive. Decomposes on exposure to light, and becomes yellow. Stains animal and vegetable tissues yellow. Stain can not readily be removed. Used as caustic for venereal sores, etc.

32. Give tests for **hydrochloric** and **nitric** acids respectively.

HCl is recognized by yielding a white curdy precipitate with silver nitrate, soluble in ammonia (solution).

HNO_3 darkens a pap made by triturating sulphuric acid with ferrous sulphate; it has a violent action on copper, forming a blue solution, and giving off dense brown fumes. Turns brucine an intense red.

33. Metals with which *nitric acid* forms **nitrates:**

Silver, mercury, copper, iron, lead.

34. Metals oxidized by it:

Antimony and tin.

35. Action of this acid on metals:

Varies according to strength, and whether heat be used or not.

36. **Action** of nitric acid or hydrochloric acid **on gold:**

Neither affects it when used singly, but a mixture of the two, called *aqua regia*, dissolves gold; the mixture may be fifteen parts of hydrochloric to four of nitric, and the gold is dissolved by the chlorine resulting, and a chloride of the metal is formed. (Nitromuriatic acid, nitrohydrochloric acid.)

37. Formula, properties, and uses of **nitrous acid:**

HNO_2; yellowish liquid; used in medicine instead of nitric acid as a test for bile in the urine. (See Urine.) Sweet spirit of nitre contains it in combination.

38. Value of **hypochlorous acid:**

Bleaching agent. Its solution in water removes ink stains.

39. Properties and uses of **sulphuric acid:**

Sulphuric acid, H_2SO_4, hydrogen sulphate, oil of vitriol, is not found free in body, but occurs combined in form of sulphates in blood, urine, and all liquids of body. May be made by burning sulphur, and mixing fumes with air, nitric acid fumes, and steam. Colorless, odorless, heavy, oily liquid. Generates heat on addition of water. Very caustic. Stains fabrics reddish, and chars organic matter. Stain removed by ammonia. Valuable for drying gases on account of its affinity for moisture. Immense quantities used for various purposes in commerce. Detected by yielding white precipitate with solution of barium chloride, insoluble in HNO_3. Sp. gr. pure 1.848; officinal 1.843.

40. Properties and uses of **sulphurous acid:**

Sulphurous acid H_2SO_3, may be made by burning sulphur and passing the fumes (sulphurous oxide) into water. Colorless liquid; used for bleaching and disinfectant purposes, and (dilute) in skin diseases, etc. Has strong odor of brimstone. Removes fruit and port wine stains.

41. **Phosphoric** acid, properties, etc:

There are two varieties, the *glacial* and the ordinary. The *phos. acid* of the homœopathic pharmacopœia is prepared from the glacial acid (mono-hydrogen phosphate or meta-phosphoric acid). Glacial phosphoric acid, HPO_3, is in colorless ice-like transparent masses, very hygroscopic, soluble in water and alcohol. Is a delicate test for albumen in the urine.

The phosphoric acid found in the body is not the glacial, but tri-hydrogen phosphate, H_3PO_4, occurring combined with various elements. In general, when a *phosphate* is spoken of, a salt of this acid is understood, and not one of the glacial acid. The *acidum phosphoricum dilutum* of the drug stores contains about 14 per cent of this acid. It is a colorless, odorless, sour liquid; H_3PO_4, gives no coagulum with solutions containing albumen, but yields a yellow coloration and ultimately a precipitate with ammonium molybdate in solutions made acid with nitric acid, the reaction being hastened by warming the mixture. This test applies to phosphates also.

42. **Phosphorous oxide** and acid are made :

By burning phosphorus and conducting the fumes into water.

43. Theoretical constitution of **boracic** acid :

Boracic or boric acid is *ortho*-boric acid, $B(HO)_3$ or H_3BO_3.

44. Properties and uses of boric acid :

White solid, feeble taste, greasy touch, slightly soluble in cold water. Soluble in three parts hot water. Valuable antiseptic. Soluble in alcohol and glycerine. Saturated with alcohol burns with green flame.

45. **Silicic acid** is variously termed silica, silicic oxide, or anhydride, *silicea*, silicic acid, SiO_2: occurs pure in nature as quartz crystal. Occurs in many natural waters, especially those of thermal springs; stiffens the stems of cereal grains, and is found in animal tissues. Constitutes sand.

46. Properties of silica :

White, amorphous powder ; scratches glass ; almost insoluble in water and in everything but hydrofluoric acid. The silicates constitute glass.

CHAPTER III.—COMPOUNDS OF THE METALLIC ELEMENTS.

47. Fourteen compounds of **potassium** of importance in medicine are:

Potassium Bromide, KBr; Chloride, KCl; Iodide, KI; Hydrate, KHO; Nitrate, KNO_3; Cyanide, KCn or KCy; Phosphate, $K_3\,PO_4$; Sulphate, $K_2\,SO_4$; Chlorate, $KClO_3$; Chromate, K_2CrO_4; Bichromate, $K_2Cr_2O_7$; Permanganate, $K_2Mn_2O_8$ or $KMnO_4$; Ferrocyanide, K_4FeCy_6; Ferricyanide, $K_6Fe_2Cy_{12}$.

48. **Potassium bromide,** $K\,Br$, is a sedative to nervous system. Made from bromine and potassium hydrate. White; salty taste; very soluble. *Kali Bromatum.*

49. **Potassium iodide,** KI, is used in syphilitic and scrofulous affections. Made by heating iodine with pearl ash. Colorless crystals; saline, acrid taste; very soluble; solution dissolves iodine. *Kali Jodatum.*

50. **Potassium chloride,** $K\,Cl$, is found in animal fluids, in blood cells, and instead of sodium chloride in muscle juice. White, soluble. *Kali Muriaticum.*

51. **Potassium hydrate** is called "potassa" and "caustic potash." White, caustic, very soluble, deliquescent, comes in form of sticks, burns hands, clothing, etc. *Liquor potassæ* is one ounce of it in one pint of water. Has soapy feel to the fingers. *Kali Causticum.*

52. **Potassium cyanide,** KCN or KCy, is very poisonous; used often for purposes of suicide. Useful in solution for cleaning metals. Colorless crystals, soluble. *Kali Cyanatum.*

53. The various **phosphates** of potassium are: K_3PO_4, K_2HPO_4, KH_2PO_4. K_3PO_4, called in medical works *basic* phosphate, and in some works *sub* phosphate, is the normal potassium phosphate; $K_2\,H\,PO_4$, called *neutral* phosphate, is said to occur in all solids and fluids of the body, and to be one of the substances giving alkaline reaction

to the various fluids. It is the Homœopathic *Kali Phos.;* white, deliquescent, soluble. $K H_2 PO_4$, is called *acid* phosphate and *super* phosphate of potassium.

These salts are known also as tri-potassium phosphate, dipotassium hydrogen phosphate, and dihydrogen potassium phosphate, respectively.

54. **Potassium nitrate,** KNO_3, called nitre or saltpetre; used in making gunpowder; white; much more soluble in hot than in cold water. *Kali Nitricum.*

55. **Potassium sulphate,** K_2SO_4, is found in urine and excrements. Obtained artificially, is colorless crystals; soluble, very hard and dry. *Kali Sulphuricum.* Bisulphate, $K H SO_4$, exists also.

56. **Potassium Chlorate,** $KClO_3$, is the least soluble of the salts mentioned, one part in seventeen of cold water. Used as gargle, etc., in solution. Poisonous. Explosive. Must not be triturated carelessly with organic substances. Mixed with sugar deflagrates on addition of sulphuric acid, and gives off green-yellow fumes of agreeable odor. *Kali Chloricum.*

57. **Potassium chromate** is in form of yellow, shining crystals, soluble.

58. The **bichromate of potassium,** $K_2Cr_2O_7$, or K_2CrO_4, CrO_3 (potassium chromate and chromic oxide), is red, soluble. Used in the arts and in medicine. Poisonous. *Kali Bichromicum.*

59. The **permanganate of potassium,** $K_2Mn_2O_8$, or, $KMnO_4$, is in the form of very dark purple crystals, soluble. Solutions, even when very dilute, show decided purple tint. Color of solutions discharged by organic matter, and by oxidizable matters in general. The permanganate can not be triturated with milk sugar, as it decomposes. Solutions must always be made fresh. Solutions can not well be filtered. Very powerful disinfectant. Gives off ozone. As a gargle, valuable in diphtheria. As disin-

fectant for household purposes strength 10 grains to fluid ounce of water. As antiseptic solution, ounce to the pint. Condy's fluid contains 32 grains to the pint. *Kali Permanganicum.*

Theoretical constitution: Permanganic acid, $H_2Mn_2O_8$, may be deemed to be derived from manganese heptoxide (Mn_2O_7) and water (H_2O); potassium permanganate, $K_2Mn_2O_8$, by exchanging the two atoms of hydrogen in the acid for two of potassium.

60. **Potassium ferrocyanide** is composed of the tetrad radicle or group of elements $FeCy_6$ or FeC_6N_6, which takes in combination four atoms of potassium, hence K_4FeCy_6; called yellow prussiate of potash. Yellow, soluble; in solution is used chiefly as test for certain metals, notably iron and copper, and with acetic acid or citric acid as a delicate test for albumin in urine. The ferricyanide is $K_6Fe_2Cy_{12}$ or K_3FeCy_6, red and soluble, and called the red prussiate.

61. **The carbonate and bicarbonate** of potassium: Carbonate is K_2CO_3, called also "salt of tartar"; *Kali Carbonicum.* White, deliquescent, soluble. Occurs in body as bicarbonate chiefly, $KHCO_3$, called *acid* carbonate or hydro-potassium carbonate, white and soluble.

62. Salts of **potassium,** compared with those of **sodium,** show the following differences:

Blood globules contain ten times as much potassium compounds as the plasma. There are more potassium salts in the muscles, white of egg, milk, brain, liver, and saliva, than there are sodium salts in the same. The compounds of potassium are more irritating and poisonous than those of sodium in the same dose.

63. A simple method of **distinguishing** one from another the **different compounds of potassium** thus far named:

Given that the salt is one of those of potassium thus *far named, and that it is in the solid form:* the *hydrate* occurs in sticks, the *permanganate* is purple, the *bichromate* red, the chromate *yellow*, the *ferrocyanide* yellow, the *ferricyanide* red. The chromate is much brighter in color than the ferrocyanide. The other salts are white: add a few drops of H_2SO_4 to crystals of every one of them; the *bromide* gives marked action and turns yellowish red; the *iodide* ditto and reddish black; the *chlorate* gives off chlorous fumes of agreeable odor, turning yellowish red (mixed with sugar deflagrates with H_2SO_4); the *chloride, carbonate, sulphite* and *nitrate* give *no color* with H_2SO_4, but yield fumes; the *sulphate* and *phosphate* no action at all. Dissolve in water fresh amounts of the four, giving action with H_2SO_4, but no color, namely: the *chloride, carbonate, sulphite* and *nitrate;* add the acid to all four, the *carbonate* effervesces. To a fresh amount of the other three add $Ag NO_3$; the *chloride* and *sulphite* yield white precipitates, the *sulphite* precipitate darkening on heating (A sulphite yields fumes having an odor like that of brimstone on being treated in the solid form with an acid.); the *nitrate* remains. Add a fresh amount of it to the "pap" described in Chapter II., 32, and observe dark coloration. The *sulphate* and *phosphate* gave neither color nor fumes with H_2SO_4; dissolve them both in water, add a drop or two of HNO_3 to both, then $BaCl_2$ to both; the *sulphate* yields a white precipitate; to a fresh amount of the phosphate add a drop or two of nitric acid, as before, then ammonium molybdate solution, and warm. A yellow coloration (ultimately a precipitate) occurs.

64. Tests for the *hypophosphite* and *cyanide* may be made as follows:

These have not been included in the list above given. The *hypophosphite* is unstable and deliquescent; when fresh, occurs in white, opaque, confused, crystalline masses, having a disagreeable, bitter taste; very soluble in water and alcohol, but insoluble in ether. Heated over flame burns with phosphorescent light.

The pure *cyanide*, dissolved in water, yields with Ag NO_3, a precipitate insoluble in cold nitric acid, and nearly so in ammonia (the *chloride* precipitate with Ag NO_3 is soluble in ammonia). Precipitate soluble in excess of reagent. (See Appendix.)

65. To ascertain whether a compound be that of potassium or some other metal:

Pt Cl_4 (platinic chloride) yields in neutral or slightly acid solutions a yellow precipitate insoluble in alcohol. Acid tartrate of sodium yields precipitate (shake well). If the salt be in solid form burned in hottest part of Bunsen flame it will give a violet coloration to the flame, best seen by looking through blue glass. (Of these three tests the first two apply to salts of ammonium as well as to those of potassium, hence importance of last one.)

66. Ten salts of **sodium** of interest are:

The chloride, NaCl; the borate, $Na_2B_4O_7$; the hydrate, NaHO; the carbonate, Na_2CO_3; the phosphates, $Na_n PO_4$; the sulphate, Na_2SO_4; the hypochlorite, NaClO; the sulphite, Na_2SO_3; the hyposulphite, Na_2SO_2.

67. **Sodium chloride:**

"Natrum muriaticum," common salt, found in sea and mineral water, in every fluid and organ of the body. Purgative given internally, irritant externally. Equally soluble in hot and cold water. Next to calcium phosphate most abundant salt in body, amount about a quarter of a pound; least of all in muscle juice, blood cells poor in it, cartilage rich; 3½ parts in 1,000 of blood.

68. **Borax:**

Called biborate of sodium (also tetraborate) $Na_2O (B_2O_3)_2 + 10 H_2O$. Is an alkaline, diuretic substance; disinfectant, white, soluble, efflorescent; melts at low heat and swells greatly, at a higher temperature becomes a clear liquid, then a vitreous substance (borax glass). Solution should give no precipitate with barium chloride (sulphate impurity) nor with silver nitrate (chloride impurity). Is often adulterated with alum and rock salt.

69. **Sodium hydrate:**

Caustic soda. [See KHO]. Should be kept in paraffined stoppered bottles. With water forms "soda lye."

70. **Sodium carbonate:**

Na_2CO_3. Carbonate of sodium, "washing soda;" efflorescent crystals; soluble. "Sal-sodæ" *Natrum carbonicum.* Strong alkaline properties.

71. The **bicarbonate of sodium** is:

Sodium acid carbonate, $NaHCO_3$. An alkaline substance much less soluble than Na_2CO_3. Equal parts of it and NaCl make a good application to parts stung by insects.

72. **Sodium sulphate:**

"Glauber's salts." *Natrum Sulphuricum.* Strongly purgative. Found in mineral waters. Bitter, nauseous, efflorescent, soluble. Found in urine.

73. **Chloride of soda:**

Term applied to solution of the hypochlorite, NaClO. In solution removes ink stains, etc. Decomposes urea. (See Fowler's test). Disinfectant.

74. **Sodium sulphite:**

$Na_2 SO_3$. Efflorescent. Used to "keep" cider, etc. Good local application in erysipelas (1 drachm to fluid ounce water). Soluble.

75. **Sodium hypo-sulphite:**

$Na_2 S_2 O_3$. Deliquescent. Very soluble. In solution dissolves chloride, iodide and bromide of silver. Used in photography.

76. The **phosphates** of sodium:

The normal, or *basic*, Na_3, PO_4, is an alkaline purgative substance more agreeable than "Glauber's salts." The *neutral*, $Na_2 H PO_4$, is found in the body, and is the *Natrum Phosphoricum* of the Homœopathic Pharmacopœia, called also "Phosphate of Soda." White, soluble.

77. The **hypophospite of sodium:**

$Na (H_2 PO_2)$. Soluble. Very deliquescent. Prepared in syrup. Solution evaporated has been known to explode with great violence. Used with idea of furnishing phosphorus to tissues.

78. **"Soluble glass":**

"Silicate of soda." Used in syrupy solution for immovable dressings. Renders wood, etc., fire proof.

79. To generalize in regard to compounds of Na:

Nearly all white and soluble. May be used when those of K cause irritation. Found everywhere in body, chiefly as chloride and phosphate, and usually more abundant than those of K.

80. Tests:

For the chlorides, sulphates, etc., same as for those of K (see 63); to distinguish a salt of sodium from that of other metals is not easy, but try re-agents for other metals, and if no precipitates are obtained, *acid pyroantimoniate of potassium* may give a white precipitate, if a salt of Na be present. Yellow coloration to Bunsen flame is imparted by salts of sodium. (See Appendix.)

81. Compounds of **ammonium** of interest:

The hydrate, AmHO or NH_4HO; the chloride, Am Cl or NH_4Cl; the carbonate, Am_2CO_3 or $(NH_4)_2 CO_3$; the hydro-sulphide, AmHS; the nitrate, $AmNO_3$ or $NH_4 NO_3$.

82. The compounds are formed from a hypothetical univalent radicle, NH_4 (abbreviated, Am).

83. **Sal-ammoniac:**

The chloride, AmCl or NH_4Cl. White, soluble solid; bitter, piquant taste. Wholly insoluble in alcohol.

84. The **carbonate:**

The commercial "carbonate" is really a mixture of the acid carbonate and the carbamate (NH_4HCO_3 $NH_4NH_2CO_2$). White, soluble; strong odor of ammonia; turns into bicarbonate (acid carbonate) on exposure to air. Valuable as a vesicant.

85. The **hydro-sulphide:**

Am H S, yellow liquid, called sulph-hydrate, of disgusting odor, valuable as re-agent. In gaseous form given off from privy vaults.

86. The **nitrate:**

Am NO_3 or NH_4 NO_3. Forms freezing mixture with water.

87. To generalize in regard to Am compounds:

Nearly all soluble and volatile. In solution heated with KHO or NaHO, the odor of ammonia is readily recognized. Nessler's solution a delicate test.

88. An important salt of **silver** is:

The **nitrate:** $AgNO_3$, lunar caustic. Used in injections and eye washes. Dissolve pure silver in pure HNO_3, and allow to crystallize. Solutions should be neutral in reaction to litmus. Solid form, crystals or sticks, white; metallic, bitter, styptic taste, very soluble. Blackens on exposure to light and on contact with organic matter.

Salts of silver give white curdy precipitate with HCl. Soluble in Am HO (ammonia), insoluble in HNO_3 (nitric acid).

89. Important compounds of **calcium:**

The carbonate, Ca CO_3; the oxide, Ca O; the hydrate, Ca $(HO)_2$; the phosphate, Ca_3 $(PO_4)_2$; the chloride, Ca Cl_2; the hypochlorite, Ca $(Cl\ O)_2$; the sulphate, Ca SO_4; the sulphide, Ca S; the iodide, Ca I_2; the fluoride, Ca F_2.

90. Described in the order named:

Ca CO_3, *chalk, marble, limestone:* found in bones, egg shells, oyster shells (Calcarea Carbonica), in otoliths, saliva, alkaline urine, in concretions. Insoluble, white, antacid. Soluble in water containing CO_2 (carbon dioxide, carbonic acid).

CaO, lime; quicklime: Heat the carbonate. White, infusible, less soluble in hot than in cold water.

$Ca(HO)_2$, slack lime, slaked lime: Oxide and water, swells, gives off heat. Lime-water is 4 Troy ounces lime in 8 pints distilled water. Alkaline. *Calcarea Caustica.*

$Ca_3(PO_4)_2$, basic phosphate, tri-calcic phosphate, bone phosphate: Found in whole organism, constitutes two-thirds of the teeth, found in bones, calculi; in the ash of albuminous substances; white, insoluble. *Amorphous* sediment in urine. Readily soluble in acid solutions. *Calcarea Phosphorica.*

$CaHPO_4$, neutral phosphate: Occurs in crystalline form ("stellar" phosphate) in pale, weakly acid urine.

$CaH_4(PO_4)_2$, acid phosphate: Gives acidity to urine, but not found as a *sediment* in urine. Occurs in gastric juice.

$CaCl_2$, calcium chloride: Used to dry gases (except ammonia). *Calcarea Muriatica.*

$Ca(ClO)_2$, chlorinated lime, "chloride of lime:" White, soluble, slowly decomposes, disinfectant, "bleaching powder," composed of calcium hypochlorite and chloride. *Calcarea Chlorata.*

$CaSO_4$, calcium sulphate, *gypsum:* Hard, white, nearly insoluble; heated to 300° or 400° F., becomes "plaster-of-Paris," which, powdered and mixed with water, becomes hard again. *Calcarea Sulphurica.*

CaS, calcium sulphide: If pure: white, amorphous, alkaline reaction.

Hepar Sulphur Calcarea is an impure sulphide, having odor and taste of sulphuretted hydrogen, insoluble.

Calcium sulphide is an ingredient of luminous paints.

CaI_2, Calcarea Hydriodica, calcium iodide: Very soluble, deliquescent, white.

$CaFl_2$, calcium fluoride: Found in enamel of teeth, in bones, milk and blood. Fluor-spar. *Calcarea Fluorata.*

91. To generalize in regard to compounds of **calcium:**

The phosphates and carbonates of calcium give hardness and resistance to the parts of the body in which they occur.

To identify a salt of calcium in solution, add solution of soluble oxalate, as oxalate of ammonium; a white precipitate forms, soluble in HCl or HNO_3, but insoluble in acetic acid.

92. Salts of **barium** of interest are:

The carbonate $BaCO_3$, the sulphate $BaSO_4$, the oxide BaO, the hydrate $Ba(HO_2)$, the chloride $BaCl_2$, the nitrate $Ba(NO_3)_2$, the iodide BaI_2.

93. **$BaCO_3$, Baryta Carbonica,** white, insoluble.

$BaSO_4$, Baryta Sulphurica, constituent of heavy spar, formed when $BaCl_2$ is added to H_2SO_4, one of the most insoluble substances known.

BaO, baryta (see CaO). White.

$Ba(HO)_2$, caustic baryta, made from BaO and H_2O. Baryta water contains it; but more soluble than caustic lime. White.

$BaCl_2$, white, soluble. In solution is used as a test for H_2SO_4. **Baryta Muriatica.**

$Ba(NO_3)_2$, white, soluble, poisonous; also test for H_2SO_4.

BaI_2, Baryta Iodata, yellowish-white, hygroscopic, soluble, disagreeable nauseating taste, very poisonous.

94. To generalize in regard to compounds of **barium:**

Soluble salts of barium are poisonous. In solution they may yield precipitate with ammonium oxalate, like salts of calcium, but barium salts also give, with potassium chromate solutions, a yellow precipitate of the chromate of barium insoluble in acetic acid, but soluble in HCl or HNO_3.

95. Compounds of **magnesium** are:

The **chloride,** $MgCl_2$, white, soluble, very bitter. *Magnesia Muriatica.*

The **oxide, Mg O,** calcined magnesia, magnesia, white, infusible. More soluble in cold than in hot water; laxative, antacid, antidote to arsenic and caustic acids. *Magnesia Usta.*

The **sulphate,** $\mathbf{MgSO_4}$, "Epsom salts," white, soluble, very bitter, purgative; found in mineral waters. *Magnesia Sulphurica.*

The *normal* or *basic* **phosphate,** $\mathbf{Mg_3\,(PO_4)_2}$, found along with the calcium phosphate in the body in less amount, except in muscles and thymus gland. White, insoluble in water. *Magnesia Phosphorica* is $MgHPO_4$, neutral phosphate.

The **carbonate,** $\mathbf{Mg\,CO_3}$, magnesia alba, white, insoluble. Found in body with $Ca\,Co_3$. The officinal carbonate, Magnesia Carbonica, is a mixture of the carbonate, hydrate and water.

The **ammonio-magnesium phosphate,** $\mathbf{Mg\,Am\,PO_4}$, "*triple*" **phosphate,** formed whenever HNa_2PO_4, neutral phosphate of sodium comes in contact with a salt of magnesium in presence of a salt of ammonium. Found in alkaline urine, in fæces, especially of typhoid fever, in calculi. Under microscope shows large prisms. Very soluble in acids, insoluble in alkalies.

96. The compounds of **magnesium** are, in general, neutral, colorless and, if soluble, very *bitter* to the taste. They may be detected in solution by adding solution of AmCl, excess of AmHO, and Na_2PO_4 (ammonium chloride, excess of ammonium hydrate—solution of ammonia—and sodium phosphate). A precipitate, white and crystalline, of the ammonio-magnesium phosphate falls.

97. The compounds of **zinc** of interest are: The sulphate, the chloride, the bromide, the oxide, the iodide.

98. The **sulphate, $Zn_4 SO_4$.** White vitriol, white copperas. Astringent, emetic, irritant poison. Small, colorless, transparent crystals, often mistaken for Epsom salts. Caustic, soluble. *Zincum Sulphuricum.*

The **chloride, $Zn Cl_2$.** Caustic, antiseptic. Used to produce healthy granulations in malignant and indolent ulcers, as lupus. Whitish-gray, semi-transparent, deliquescent masses, soft as wax. Soluble in water, alcohol, and ether. Constituent of Burnett's Disinfecting Fluid. *Zincum Muriaticum.*

The **bromide, $Zn Br_2$.** Deliquescent, soluble. Used nervous diseases. *Zincum Bromatum.*

The **oxide, $Zn O$.** Yellow-white, insoluble. Used as dusting powder, and in ointment (80 grams to 400 of benzoin ointment). *Zincum Oxydatum.*

The **iodide, $Zn I_2$.** White, soluble. Used like $ZnCl_2$.

99. The salts of **zinc** are, as a rule, colorless, of disagreeable styptic taste; astringent, caustic and poisonous. They are detected in solution by ammonium sulphide, Am_2S, which yields a white precipitate of ZnS (insoluble in KHO, but soluble in mineral acids). Zinc sulphate may be distinguished from *Epsom salts* by yielding in solution a white precipitate with solution of potassium ferrocyanide, K_4FeCy_6. Zinc salts may be distinguished from those of *aluminium* in that ammonia solution *cautiously* added to solutions of the zinc salts gives a white precipitate, dissolved on stirring, shaking. or adding more of the ammonia. Aluminium salts give a precipitate with ammonia which is insoluble in excess, *i.e.*, persists, even when more of the reagent is added.

100. Compounds of **mercury** are of two kinds: mercur*ic* and mercur*ous*. In mercuric compounds, mercury

has an equivalence of *two;* but in mercurous compounds it is a *pseudo-monad,* and practically, therefore, has an equivalence of *one.* The Homœopathic term "Mercurius" is general and does not distinguish mercur*ic* from mercur*ous* compounds. Among important compounds of Hg, we find the following:

Mercuric chloride: $HgCl_2$, the bichloride, dichloride, deuto-chloride, perchloride, corrosive chloride, corrosive sublimate, Mercurius Sublimatus Corrosivus, "Merc. Cor.," made by subliming a mixture of common salt and mercuric sulphate. White, semi-transparent, crystalline masses, permanent, inodorous, having acrid, styptic taste, soluble in sixteen parts cold water and two of boiling, *more soluble in alcohol* (three parts). Aqueous solution decomposes in light. Organic substances decompose it. Solutions coagulate albumin; coagulum soluble in alkalies. Antiseptic. Very poisonous.

Tests: With ammonia, a white precipitate; with potassium iodide, a scarlet-red precipitate (mercuric iodide), soluble in excess; with potassium hydrate, a yellow precipitate (mercuric oxide); with sulphuretted hydrogen, a reddish-yellow precipitate (sulphide), changing to black (gray or white precipitate, if in small amount) with mottled appearance; with HCl and copper-foil, a coating of metallic Hg on the foil; with stannous chloride, a white precipitate, with excess of stannous chloride deposition of metallic mercury as gray powder.

Mercurous chloride: $Hg\,Cl$, or $Hg_2\,Cl_2$, Mercurius Dulcis, mild chloride, sub-chloride, submuriate, protochloride, calomel. Formed when H Cl is added to solution of an *-ous* salt of mercury.

White, fibrous, crystalline cakes; light buff or ivory-colored powder, tasteless, odorless, insoluble. Darkens on long exposure to light. Boiled with water should give no precipitate with ammonia, indicative of presence of the poisonous mercur*ic* chloride.

Mercuric Iodide: HgI_2, biniodide of mercury, deut-iodide, Mercurius Iodatus Ruber, "Merc Bijod," red iodide; formed when solution of potassium iodide is cautiously added to solution of mercuric chloride. Fine, heavy, crystalline, scarlet-red powder. Nearly insoluble in water, soluble in hot alcohol, in solution of KI (potassium iodide), and of NaCl (sodium chloride). Powerful irritant and caustic.

Mercurous iodide: Hg_2I_2, or HgI, prot-iodide, yellow iodide, green iodide, Mercurius Iodatus Flavus. "Merc. Iod." Triturate mercury, iodine and a little alcohol. Greenish yellow powder, insoluble in water, alcohol and ether. Sunlight turns dark olive green and partly decomposes it. Must not be given with KI, as HgI_2 (mercur*ic* iodide) is formed.

Mercuric oxide: (a) Mercurius Præcipitatus Ruber, red precipitate, red oxide. HgO. Small shining red scales, acrid taste, insoluble, escharotic, stimulant.

Mercuric oxide: (b) Yellow oxide. HgO. Precipitate solution of $HgCl_2$, with KHO (potassium hydrate). Amorphous yellow powder more minute than red oxide, hence better in eye troubles. Insoluble. Turns to red oxide when heated.

Mercurous oxide: Black oxide, sub-oxide. Shake calomel with solution of KHO. Black, odorless, tasteless, insoluble. Decomposes on exposure to light. Used in mercurial fumigations. Least irritating oxide.

Mercuric cyanide: $HgCy_2$, or HgC_2N_2. (See Organic Chemistry.) Mercurius Cyanatus, cyanuret of mercury. Receive hydrocyanic acid in vessel containing red oxide of mercury in water. Permanent, prismatic, white, opaque crystals, soluble in water *but sparingly* *in absolute alcohol;* disagreeable styptic taste; poisonous, like $HgCl_2$, but not so irritating in medicinal doses.

Mercuric nitrate: $Hg(NO_3)_2$. "Acid" nitrate of mercury. In solution used as caustic for venereal sores, etc. Citrine ointment contains it. Solution made by dissolving 1560 grains of red oxide in a mixture of 1740 grains of nitric acid and 6 fluidrachms of distilled water.

The **Sulphates** of mercury: Hg boiled with H_2SO_4 yields mercur*ic* sulphate, forming with water an oxysulphate (Turpeth mineral); mercuric sulphate triturated with Hg yields mercur*ous* sulphate Hg_2SO_4.

The **Sulphides** of mercury: Cinnabar or vermilion occurs in nature; HgS; resists, as paint, all agents. The black sulphide, Æthiop's Mineral, formed, when solution of salt of mercury is precipitated by H_2S, or when Hg and S, are triturated. Purgative and vermifuge.

Ammoniated mercury: NH_2HgCl. Mercur-ammonium chloride. White precipitate, Mercurius Precipitatus Albus. Precipitate solution of corrosive sublimate with ammonia. Perfectly white, insoluble, vermifuge in "white precipitate ointment."

101. Compounds of **Mercury** in general:

The mercuric salts more poisonous than the mercurous. Mercuric salts not precipitated by HCl but by H_2S, sulphuretted hydrogen (black); mercurous salts precipitated (white) by HCl, precipitate blackened by ammonia; mercuric salts precipitated red by KI; mercurous salts precipitated greenish-yellow by KI (Potassium iodide).

102. **"Mercurius solubilis":**

Mercurius Solubilis Hahnemanni, the ammonionitrate of mercury is, according to Kane, dimercurosoammonium nitrate; according to Mitscherlich, trimercuroso-ammonium nitrate. "Mercurius vivus" dissolved in cold, strong nitric acid (requiring many days for its complete solution), the salt formed treated with alcohol, washed, dissolved in water and precipitated (black) with ammonium hydrate (solution of ammonia). Called "black oxide."

103. **"Mercurius nitrosus:"**

Mercur*ous* nitrate, protonitrate of mercury. Made as follows: 20 parts pure mercury, 9 parts concentrated nitric acid (specific gravity 1.2) 27 parts pure water.

104. Compounds of **Copper** of interest are:

Cupric sulphate: $CuSO_4$ blue vitriol, blue stone, blue copperas, Cuprum Sulphuricum.

Astringent, slightly caustic, emetic. Fine blue crystals, effloresce to green-white powder; styptic metallic taste; soluble in water; acid reaction.

Ammonio-sulphate of copper: Properly tetrammonio-cupric sulphate; Cuprum Ammoniatum; $(NH_3)_4$ $Cu\ SO_4H_2O$. Dissolve cupric sulphate in ammonium hydrate. Deep azure-blue powder; soluble, alkaline, crystalline.

105. Compounds of **Copper:**

Found in blood and bile. Poisonous. Tests: In solution precipitated (black sulphide) by H_2S (sulphuretted hydrogen); $K_4\ Fe\ Cy_6$ (potass. ferrocyanide) yields mahogany-colored precipitate. Ammonium hydrate, an azure-blue.

106. In medicine the term **arsenic** is applied to the *oxide* of the metal arsenic.

Arsenic, As_2O_3, arsenious oxide, arsenious acid, arsenious anhydride, white arsenic—Arsenicum Album—occurs in several forms. Condensed from sublimation at 752 ° F., transparent vitreous mass, sp. gr. 3.738. When at temperature slightly less, crystallizes in right rhombic prisms. Vitreous arsenic on keeping gradually becomes opaque and crystalline. When condensed at 392 ° F., it occurs in octohedral crystals, sp. gr. 3.69. This form is also obtained on evaporating saturated aqueous solution. Vitreous arsenic is slightly more soluble than opaque; 100 parts boiling water, dissolve 12 parts of the vitreous; on cooling, about three parts are left in solution. Arsenic is tasteless, soluble in hot HCl, in solutions of alkalies and of tartaric acid. Heated in rĕduction tube with charcoal, metallic arsenic is deposited in form of dark metallic mirror in cooler part of tube. Solutions of arsenic yield lemon-yellow precipitate of the sulphide with sulphuretted hydrogen insoluble in dilute acids, but soluble in KHO (potassium hydrate). Heated to 400 ° F. arsenic sublimes without fusing. Thrown into water in form of powder it forms a white layer on the surface. (See Toxicology.)

107. The principle of the **Marsh test** for arsenic depends on production of hydrogen arsenide (arsenietted hydrogen) whenever arsenic in any soluble form is present in a solution evolving hydrogen. Hydrogen is generated in the usual way, and the stream of gas issuing from mouth of delivery tube ignited. If the gas be hydrogen free from arseniuretted hydrogen, the flame will leave no stain on a porcelain lid pressed down upon it. If, however, a solution containing arsenic be poured in, the color of the flame becomes whitish from presence of arsenietted hydrogen, and it will deposit a dark metallic spot on the porcelain lid. The arsenietted hydrogen is a violent poison, and care must be taken not to inhale it in any way. Marsh's test is interfered with by presence of organic matter or nitric acid.

108. The **arsenites** are formed theoretically from arsenious acid, H_3AsO_3 (like H_3PO_3), as a basis: Fowler's solution contains potassium hydro-arsenite, HK_2AsO_3. Scheele's green, Cuprum Arsenicosum, is arsenite of copper, $CuHAsO_3$, insoluble. Brunswick and Schweinfurth greens are the same with addition of

acetate and carbonate of copper; dangerous poisons. Answer to Marsh's test.

To test **wall-paper** for an arsenite:

Soak a small piece in a little ammonium hydrate solution till blue liquid is formed; add a little HCl; boil with a strip of pure copper, and the latter takes on a steel-gray coating. It is well first to examine the chemicals used for arsenic by Marsh's test.

109. **Arsenic acid:**

H_3AsO_4; a violent poison; more soluble, though less poisonous, than As_2O_3; causes painful ulcers on the skin; very deliquescent prismatic crystals [used to replace tartaric acid in calico-printing, and to furnish, by its action on aniline, the magnificent dye known as "magenta"]. The anhydrous acid is an oxide or anhydride As_2O_5. In solution, neutralized with ammonium hydrate, yields brick-red precipitate with Ag NO_3. Answers to Marsh's test, etc.

The arseniate of sodium: Na_2HAsO_4 (like Na_2HPO_4); arseniate of soda, Natrum Arsenicicum; colorless, efflorescent, soluble, forming alkaline solution. Answers to Marsh's test, and gives brick-red precipitate with $AgNO_3$.

110. Compounds of **antimony.**

Ter-chloride of antimony, $SbCl_3$; very violent caustic, penetrating deeply into tissues; yellowish-white, translucent, becomes like butter in moist air, and called "butter of antimony." To dissolve it, use water having fifteen per cent HCl.

111. **"Antimonium crudum":**

Antimonous sulphide, Sb_2S_3, ter-sulphide or sulphuret.

112. **"Antimonium tartaricum":**

Tartrate of potassium and antimony, "tartar emetic" (see tartaric acid).

113. **Tests** for compounds of **antimony** in solution

Acidify with HCl and add H_2S (sulphuretted hydrogen); there results an orange-colored precipitate, insoluble in ammonia. Compounds of antimony give same reaction as those of arsenic with Marsh's test; the arsenical stain is soluble in calcium hypochlorite solution, but the stain caused by antimony is insoluble.

114. Compounds of **bismuth** are:

Sub-nitrate of bismuth; bismuthyl nitrate, $BiO NO_3H_2O$, pearl-white, magistery of bismuth. Precipitate the nitrate with water; white, insoluble; should not change on exposure to sunlight.

115. **Tests** for compounds of **bismuth:**

Dissolve in dilute acid, add H_2S (sulphuretted hydrogen); there results black precipitate, insoluble in dilute HCl, and in ammonium sulphide.

116. Compounds of **lead** of interest are:—

Acetate of lead: (See acetic acid.)

Iodide of lead, PbI_2, bright yellow, sparingly soluble; precipitate the nitrate with the iodide of potassium. *Plumbum Iodatum.*

Lead nitrate: $Pb(NO_3)_2$, white, permanent crystals, sweetish taste, soluble in water, deodorizing, disinfectant.

Lead oxide: PbO, litharge; yellowish or orange-colored scales, insoluble. Diachylon plaster contains it.

Lead carbonate: $PbCO_3$, *Plumbum Carbonicum*, white lead, white, insoluble; really, carbonate and hydrate together $(PbCO_3)_2$ Pb $(HO)_2$.

Salts of **lead,:** Poisonous, but acute poisoning rare; chronic poisoning common.

117. Tests for salts of **lead:**

With HCl white precipitate, soluble in boiling water; fresh amount acidulated with HCl gives, with H_2S, black precipitate insoluble in ammonium sulphide; fresh amount with KI gives yellow precipitate; fresh amount with H_2SO_4 gives white precipitate; fresh amount with chromate of potassium solution gives yellow precipitate.

118. Compounds of **tin** of interest are:

Stannous chloride, $SnCl_2$, "tin-salt." Grayish-white, translucent, solid. Soluble in a little water acidulated with HCl. Used as a reagent, or rather as a reducing agent (see mercur*ic* chloride).

Stannic sulphide, SnS_2, mosaic gold. Used as a bronze-powder. Made by heating tin-amalgam, sulphur and sal-ammoniac.

119. Compounds of **platinum** of interest are:

Chloride of platinum: $PtCl_4$, platinic chloride, Platinum Muriaticum. Dissolve Pt in aqua regia; reddish-brown needles, soluble.

120. Compounds of **aluminum** of interest are:

Oxide of aluminum: Al_2O_3, alumina; occurs pure in corundum, sapphire, ruby; white, porous, insoluble.

The homœopathic "Alumina" is the hydrate, $Al(HO)_3$, sticks to the tongue, forms stiff paste with water, insoluble.

Alum: There are several kinds: *Alumen* is the sulphate of aluminum and potassium, K_2Al_2, $(SO_4)_4\,24H_2O$; commercial alum is the sulphate of ammonium and aluminum, often called ammonia-alum.

White, sweetish astringent taste, soluble. Heated, melts in water of crystallization, swells, gives off water, and becomes dried alum (*alumen exsiccatum*).

121. **Chromic acid:**

Improper term for CrO_3, chromic anhydride. Deep red crystals, deliquescent, very soluble, caustic; explodes if mixed rapidly with glycerin.

122. Compounds of **Iron** are of two kinds, ferr*ic* and ferr*ous:*

Ferric compounds: Iron as a pseudo-triad. *Ferric* chloride, $Fe_2\ Cl_6$, per-chloride, sesquichloride, chloride of iron, Ferrum Muriaticum; orange-yellow, deliquescent, soluble. *Liquor ferri chloridi*, U. S. P., contains 37.8 per cent, of the anhydrous. "Tincture of Iron" is one part of the *Liquor* to about two of alcohol (Tinctura Ferri Chloridi, U. S. P.); hemostatic, strong chalybeate styptic taste, acid reaction, stains teeth and acts on them. *Ferric Hydrate*, $Fe_2(HO)_6$, hydrated oxide. hydrated peroxide, peroxide, sesquioxide, red oxide, Precipitate ferric sulphate or ferric chloride by ammonia or by sodium hydrate. Reddish-brown powder used as antidote to arsenic; must be freshly made. *Hydrated oxide of iron with magnesia*, U. S. P., made by adding magnesia to a solution of ferric sulphate. *Ferric Sulphate*, $Fe_2 (SO_4)_3$, in solution forming "solution of tersulphate of iron," U. S. P., color reddish-brown. *Ferric Sub-sulphate* (doubtful composition), $Fe_4O (SO_4)_5$, called "Monsel's solution," ruby-red; valuable as a hemostatic, may be taken internally. *Dialyzed Iron*, aqueous solution of about 5 per cent of ferric hydrate with some ferric chloride. Ammonia is used in making it, and the ammonium chloride formed passed through a dialyzer.

Ferrous compounds: Iron as a dyad. Ferrous salts are usually green and alter in the air to *ic* salts. *Ferrous chloride*, $FeCl_2$, protochloride; *ferrous iodide*, $Fe I_2$, protiodide, green, volatile, deliquescent, soluble. *Ferrous sulphide*, FeS, protosulphide, sulphuret of iron, is used to make H_2S (sulphuretted hydrogen). *Ferrous sulphate*, $FeSO_4$, green vitriol, copperas, Ferrum Sulphuricum, dissolve iron in 1½ parts H_2SO_4 diluted with 4 parts water; efflorescent, bluish-green crystals, acrid styptic taste, soluble in water, insoluble in alcohol, astringent, irritant, disinfectant.

124. Tests for compounds of **iron:**

A ferr*ic* compound in solution gives blue precipitate with ferrocyanide of potassium, insoluble in HCl; potassium sulphocyanate produces even in dilute solutions a blood-red coloration not destroyed by HCl, but by solution of mercuric chloride. Ferr*ous* salts give no precipitate with the sulphocyanate, but white precipitate with the ferrocyanide, rapidly becoming blue, and a blue precipitate with the ferricyanate of potassium. Ammonium sulphide is the general re-agent for the salts of iron, yielding black sulphide, soluble in HCl.

125. Compounds of **manganese** of interest are:

Manganese carbonate: Reddish-white insoluble powder. *Manganum Carbonicum.*

Manganese sulphate: $MnSO_4$, (*–ous* sulphate); a pale rose-colored salt; astringent bitter taste, soluble.

Manganese di-oxide (or *binoxide*); useful in preparing gases, for which purpose must be pure. Black, insoluble.

Compounds of **manganese** are found in small amounts in the body, generally in company with iron. Compounds of **manganese** in solution may be detected by ammonium sulphide, as they yield a flesh-colored precipitate, soluble even in acetic acid.

[For equations, molecular weights and processes of manufacture belonging to Inorganic Chemistry see Appendix.]

ORGANIC CHEMISTRY.

Chapter I.

1. Engel's classification of organic substances:

Hydrocarbides, alcohols, acids and salts, aldehydes, ethers, amines, amides, alkaloids, proteids, nitrogenized products.

2. The principal **elements** which occur in organic chemistry are:

Carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus and iron.

3. A **radicle:**

A combination of some two or more of these elements having an equivalence of its own; thus, the radical, methyl, CH_3, is a monad.

4. Important **hydrocarbides:**

Marsh gas, essence of turpentine, benzol.

5. **Marsh gas:**

Methane, hydride of the radical methyl $(C\,H_3)\,H$, found bubbling on the surface of stagnant pools, formed by decay of organic matter where not enough oxygen to form carbonic acid and water; it occurs between layers of coal, and is called "fire-damp;" odorless gas, explodes on application of flame if mixed with $\frac{7}{8}$ its volume of air. After explosion carbon di-oxide is formed, which is called "after-damp."

6. **Essence of Turpentine:**

$C_{10}H_{16}$, procured from turpentine, a viscous exudation; turpentine contains a resin, called colophony *resin*, in solution in an oil, which, when distilled off from the resin is called essence of turpentine, oil of turpentine, terebinthina. Colorless, mobile liquid, having peculiar, aromatic, and disagreeable odor; acrid, caustic taste; does not mix with water; soluble in alcohol; dissolves iodine, sulphur, phosphorus, fixed oils, resins, etc.; exposed to the air absorbs oxygen, becomes thicker, finally resinous. After prolonged contact with air, becomes ozonized.

7. **Benzol:**

C_6H_6, Benzene, belongs to so-called aromatic compounds; is not what is *commercially* called benzine; colorless, mobile, peculiar odor, insoluble in water, but soluble in alcohol and ether; dissolves iodine, sulphur, phosphorus, and much organic matter; burns easily with brilliant smoky flame.

8. "*Benzine*" is not benzole, but a distillation product of petroleum.

9. **Nitro-benzole:**

Benzole added to nitric acid, oily, yellowish liquid, having odor of oil of bitter almonds, and called *artificial oil of bitter almonds*; sweetish taste; very poisonous even by inhalation.

10. **Naphthalene:**

$C_{10}H_8$, coal tar product; resembles camphor, being a white crystalline body, inflammable, insoluble, slowly evaporates, vapor destructive to insects, antiseptic. Yields [with H_2SO_4 and KHO] *naphthol.*

11. Important **alcohols** are:

Spirit of wine, wood spirit, fusel oil. Under this head also classify cholesterin, glycerin, the sugars, starches, gums, phenols.

12. **Common alcohol**:

Ethyl alcohol (C_2H_5) HO or C_2H_6O, hydrate of the radicle ethyl, product of the distillation of fermented liquors; volatile, colorless liquid, peculiar odor and taste; lighter than water; mixes in all proportions with distilled water; burns with a faint bluish flame without smoke; dissolves gases better than water does, but salts (except $HgCl_2$) not so well; dissolves resins, ethers, essential oils, fats, alkaloids, many organic acids, and in general substances rich in hydrogen; precipitates albumin from the urine, has strong attraction for water.

13. **Spirit of wine:**

Homœopathic alcohol is spirit of wine entirely free from fusel oil, re-distilled, and the product reduced to 87 per cent (Tralles), or to a specific gravity of 0.83, by adding distilled water. *Alcohol*, U. S. P., contains 91 per cent of alcohol by weight; *spirit of wine* 84 per cent.

14. **Dilute alcohol:**

Seven parts alcohol, having a specific gravity 0.83 and three parts distilled water, the mixture having a specific gravity of 0.89. *Dilute alcohol*, U. S. P., equal weights water and alcohol. Specific gravity 0.928.

15. **Absolute alcohol:**

Commercial usage accepts as absolute, alcohol of not less than about 99.5 to 99.7 per cent. Its specific gravity at 60 ° F. is 0.7938. Boils at 172.4 ° F.

16. **Tests** for purity of **alcohol:**

Diluted with distilled water in equal amounts should yield no foreign odor, nor show opalescence (oil or resin); when few drops are rubbed between the hands should yield no foreign odor; fresh amount of alcohol, to which *few drops* of solution of $AgNO_3$ (silver nitrate) are added and the mixture exposed to bright sunlight should show no change; to detect fusel oil, add slowly to fresh amount of alcohol its own weight of pure, strong sulphuric acid, and if alcohol is pure it remains colorless, but if fusel oil be present a reddish color will develop; to test absolute alcohol for water, shake with sulphate of copper (which has been made anhydrous by heating till white), and if the alcohol is of proper strength the copper salt will remain white; if it contains water will turn bluish or blue. Another test for absolute alcohol is to mix with an equal volume of pure benzole, and if the alcohol be anhydrous (without water), the mixture will be clear. Lastly, as a test for absolute alcohol it is recommended that a piece of anhydrous baryta be dropped into it, which will remain unchanged if water is absent, but otherwise will fall to a powder.

17. **Wood-spirit:**

$(CH_3)HO$, methyl alcohol, hydrate of the radicle methyl; distilled from wood; called also pyroligneous ether, pyroxylic spirit; wood naphtha is composed chiefly of it. Cheaper than alcohol; disagreeable odor and taste, inflammable, solvent for resins, etc. Methylated spirit is a mixture of spirit of wine with 10 per cent wood spirit.

18. **Fusel oil:**

Amylic alcohol (C_5H_{11}) HO, or $C_5H_{12}O$, hydrate of radicle *amyl*, fusel oil, potato spirit; always a product of the fermentation of sugar along with alcohol; colorless liquid, having a nauseous irritating odor, burning taste, insoluble in water; soluble in alcohol, ether and essential oils.

19. **Cholesterin:**

$C_{26}H_{44}O$, found in solution in bile and nearly all liquids of body. Pathologically in cysts, tuberculous masses, cancer, lens of eye in cataract, in vitreous in Synchisis Scintillans, in biliary calculi; white, odorless, solid, fatty to the touch, crystallizes in plates. Gives red color when treated with H_2SO_4 and a little chloroform; the red color becomes blue, then green, then disappears.

20. **Glycerin:**

$C_3H_5(HO)_3$, found in oils and fats and obtained from them. Thick, syrupy liquid, colorless or straw-yellow, unctuous, inodorous, sharp sweet taste; soluble in oils, alcohol, water; insoluble in ether and chloroform; valuable as a solvent for many medicinal substances, forming *glycerites;* should give no precipitate with ammonium oxalate solution, nor change color on addition of little ammonium sulphide. Emollient and antiseptic. Specific gravity 1.225.

21. To classify the **sugars, starches, etc.:**

Three classes, *glucoses, sucroses, amyloses.*

22. *Important* **glucoses:**

Glucose, $C_6H_2O_6$, raisin sugar, diabetic sugar, grape sugar, dextrose, starch sugar; found in vegetables, fruits, honey, in liver, small intestines, in chyle after eating sugars, in blood, in urine of fœtus during intra-uterine life, in eggs, in urine of pregnancy, confinement and lactation, especially after weaning; in diabetes in the urine, saliva, sweat and nearly all liquids of the body; in urine after puncture 4th ventricle; white, inodorous, soluble in its own weight of water; one third as sweet as cane sugar. [Lævulose (fruit sugar) is a modification turning ray of polarized light to left, while dextrose (grape sugar) turns it to the right; dextrose crystallizes, but lævulose, which is much sweeter, can only be obtained as a syrup.]

23. **Tests** for **Glucose:**

Ferments directly with yeast and with decaying animal matter. Solutions to which liquor potassae is added turn yellow, then red-brown on being heated. Reduces copper salts: add to solution of glucose, caustic potash solution to which few drops of *dilute* cupric sulphate solution have been added, and heat. A red precipitate of cuprous oxide is thrown down. (Trommer's test.) For Fehling's test, etc., see Chap. VII.

24. **Commercial "glucose:"**

The term "glucose" is often applied to starch-*syrup*, the solid glucose being called starch-*sugar* (grape sugar). Both may be made from starch.

25. *Important* **sucroses:**

Cane sugar, milk sugar.

26. **Cane sugar:**

Saccharose, cane sugar, beet sugar, $C_{12}H_{22}O_{11}$, does not occur in the body; white, inodorous, very sweet. Cold water dissolves three times its weight; insoluble in alcohol. Converted by ferments first into mixture of glucose and lævulose, called *invert* sugar. Blackens with H_2SO_4. (Glucose unites with the acid and does not blacken.)

27. **Milk-sugar:**

Lactose, sugar of milk, saccharum lactis, $C_{12}H_{22}O_{11}$ H_2O, one of the constituents of milk of mammals; rarely found in vegetables. Coagulate skimmed milk with a little acetic acid, heat, filter, concentrate filtrate by evaporation, let crystallize, dissolve in boiling water and re-crystallize. Odorless, white, hard, occurs in four-sided, rhombic prisms; taste faintly sweet, gritty between the teeth; soluble in seven parts cold water, one of boiling; insoluble in even sixty per cent alcohol; not charred by H_2SO_4; not directly fermented by yeast, but easily when cheese is added; does not form a syrup with water.

28. **Tests** for purity of **saccharum lactis:**

Must be perfectly white, not hygroscopic, nor have any rancid, musty, sour, or other foreign smell or taste. If adulterated with cane sugar, becomes more soluble and sweeter; if with alum, gives in solution a white precipitate, with a few drops of potassium hydrate solution; if with copper salts, gives reddish-brown precipitate with potassium ferro-cyanide solution; if with chloride of sodium or phosphates, gives white precipitate with nitrate of silver solution; if with sulphuric acid or sulphates, white precipitate with barium nitrate solution; if prepared from sour milk, reddens litmus paper when in solution. If with starch, see Iodine.

29. The **amyloses** are starch, dextrine, gum, etc. **Starch** is found in grains of cereals and in potatoes;

food of plants becoming sugar as they grow; insoluble in cold water, alcohol and ether; in boiling water it becomes gelatinous, but does not dissolve; heated dry it becomes dextrine, which is converted into glucose by action of diastase (a ferment found in cross-spired barley). Tests: See Iodine. Its formula is $C_6H_{10}O_5$.

Dextrin: $C_6H_{10}O_5$, is an amorphous, yellowish-white, soluble substance; does not give blue coloration with iodine; basis of mucilage. Reduces alkaline copper solutions.

30. **Glycogen:**

Found by Claude Bernard to be always present in liver; white, powdery, odorless, very soluble; solutions opalescent or milky, converted into glucose (dextro-glucose) by animal ferments, as hepatic extractive matter. With iodine, gives red violet coloration.

31. **Carbolic acid:**

Acidum Carbolicum, phenic acid, phenylic alcohol or hydrate, phenol (C_6H_5) HO, is the hydrate of the radicle of a series found in coal oils, and is hardly a true acid. Found in the urine of cows, pathologically in that of men; made from distillation of "dead oil" of coal tar Great colorless crystals, disagreeable odor, caustic taste, soluble in twenty times its weight of water, wholly soluble in alcohol, ether and glycerin. The crystals liquefy on exposure to warmth. Light colors it pinkish. Antiseptic, caustic, white stain on tissues. Strongly poisonous.

32. **Tests** for **carbolic acid:**

Gives a blue color with neutral solution of ferric chloride. With bromine water in excess, gives a yellowish white flocculent precipitate.

33. The **sulpho-carbolate of sodium:**

Phenyl-sulphate of sodium, $NaC_6H_5SO_4$, $2H_2O$. Dissolve carbolic in strong sulphuric acid, convert into sulpho-carbolate of barium, and treat with sodium carbonate. White soluble crystals, inodorous, sharp taste.

34. **Picric acid:**

Carbazotic acid, tri-nitro-phenol $(C_6H_2)(NO_2)_3HO$. Dissolve carbolic acid in nitric acid and boil until there are no more vapors. Bright yellow glistening crystals, slightly soluble, bitter tasting; coloring power very great, giving permanent yellow to silk, wool and tissues. It coagulates albumin, peptone, etc. Its salts are used in explosives. *Acidum Picricum.*

35. **Thymols:**

$C_{10}H_{14}O$, numerous. The one found in essence of wild thyme is used in medicine, and may be procured by treating the essence with potassium hydrate; agreeable smelling liquid, insoluble in water, antiseptic.

36. Important **organic acids:**

Acetic, butyric, valerianic, stearic, benzoic, lactic, salicylic, oxalic, malic, gallic, tannic, tartaric, citric.

37. The acid of **vinegar:**

Acetic acid H $(C_2H_3O_2)$, corresponds to the radicle ethyl (C_2H_5). Found in vomited matters during digestive troubles; also, is sweat, muscle-juice, and spleen. Product of fermentation of wine or cider; colorless liquid, piquant odor, corrosive, forms acetates which are soluble and contain the radicle $C_2H_3O_2$. *Glacial* acetic acid is used in medicine, made from sodium acetate, is crystalline below 48° F., containing about 84 per cent of acetic anhydride, hygroscopic, and should be kept in well-stopped bottles; should give no precipitate with solutions of silver nitrate, barium nitrate, or hydrogen sulphide; should not decolorize solution of indigo. Three officinal forms of acetic acid: *Acidum aceticum, Acidum aceticum dilutum, Acidum aceticum glaciale;* contain 36,6, and 99 per cents respectively of pure acetic acid.

38. **Spirit of Mindererus:**

Ammonium Acetate: Am $(C_2H_3O_2)$. Saturate dilute acetic acid with ammonium carbonate and filter. Colorless, pungent, odorless liquid; should be freshly made.

39. **Verdigris:**

Really an oxyacetate of copper—that is, an acetate of cuprous oxide—pale blue-green in color.

40. **"Cuprum aceticum:"**

Acetate of copper, cupric acetate, $Cu (C_2H_3O_2)_2 H_2O$. Dissolve verdigris in dilute acetic acid, evaporate slowly and allow to crystallize; dark bluish-green, soluble in fourteen parts of cold water. Called also *verdigris.*

41. **Sugar of lead:**

Plumbic acetate, $Pb (C_2H_3O_2)_2 3H_2O$. Treat acetic acid with excess of litharge. Colorless, glistening, transparent crystals, efflorescent, soluble, sweetish astringent taste. Aqueous solutions become turbid from presence of carbon di-oxide of the air, causing formation of carbonate of lead which is insoluble. *Plumbum Aceticum.*

42. **Sub-acetate of lead:**

The acetate and oxide, basic acetate, $Pb(C_2H_3O_2)_2(PbO)_2$ Colorless liquid, more poisonous than the acetate. Precipitated by solutions of gum. Used in Goulard's extract, *Liquor plumbi subacetatis*, a 25 per cent solution of the sub-acetate.

43. **Butyric acid:**

$H(C_4H_7O_2)$. Corresponds to radicle butyl; found as glyceric ether in butter and fatty matters. Found in stomach during digestive troubles; remarkable for powerful odor of rancid butter. Gives odor to perspiration, hence disagreeable odor of close rooms.

44. **Valerianic acid:**

$H (C_5H_9O_2)$. Corresponds to radicle amyl, and may be obtained from amylic alcohol (fusel oil); strong odor of valerian; gives odor to the perspiration; forms valerianates which have disgusting odors.

45. **Soaps** and **Fats:**

Soaps are salts of the fatty acids—palmitic, stearic and oleic, and formed in general by adding an alkali to a fat; thus olive oil boiled with potassium hydrate, gives oleate, etc., of potassium, or soft soap; boiled with sodium hydrate gives oleate, etc., of sodium, or hard soap. Hard soap is soluble in water, but insoluble in salt water. True *fats* are compound ethers of glycerin; *pure* are colorless, odorless, tasteless, stain paper, insoluble in water, and difficultly in alcohol, soluble in ether, etc.; some keep when pure; many, however become *rancid* from albuminous impurities causing decomposition. When soaps are formed glycerin is set free.

46. **Benzoic acid:**

Acidum Benzoicum, $H(C_7H_5O_2)$, occurs already formed in benzoin—it may be made from it, and also from the urine of cattle. Permanent, white, feathery, soft, light flakes, insoluble, odorless when pure; should not change color of potassium permanganate solution in five minutes in proportion of one part of acid to fifty of water. Soluble in alcohol; heated, its vapor provokes coughing. Its salts are benzoates, and are soluble, except those of the heavy metals.

Neutral perchloride of iron gives yellowish-brown precipitate of ferric benzoate.

47. **Lactic Acid:**

$H(C_3H_5O_3)$. Found in sour milk, produced by the transformation of the sugar of milk into lactic acid by the influence of decomposing casein. Syrupy colorless odorless liquid, soluble in water and alcohol. No direct test, as most lactates are soluble; hence necessary to obtain crystals of its salts and examine them with microscope. *Acidum Lacticum.*

48. **Lactate of iron:**

Ferrum Lacticum, ferrous lactate, Fe $(C_3H_5O_3)_2$ $3H_2O$. Boil dilute lactic acid with iron filings. Whitish crystalline powder, sweetish metallic taste, soluble in 50 parts of cold water and 10 of boiling. *Ferrum Lacticum.*

49. **Lacto-phosphates:**

Solutions of phosphates in lactic acid.

50. **Salicylic acid:**

Oxy-benzoic acid, Acidum Salicylicum. $H(C_7H_5O_3)$. Made from sodium carbolate and carbon di-oxide, forming sodium salicylate, which yields the acid on decomposition by HCl. Odorless, white and lustrous masses of fine, small, colorless needles, soluble in boiling water and in alcohol; tasteless at first, but afterwards sweet and astringent, causing acridity of the fauces; soluble in cold water containing three parts of sodium phosphate. Antiseptic and disinfectant. Heated dry in a test tube, sublimes in beautiful needles before melting-point is reached, and at higher temperature is dissipated. Carbolic acid adulteration detected with bromine water. Salicylate of sodium is white and soluble, hence better suited for administration; *Natrum Salicylicum.*

51. **Oxalic acid:** $H_2(C_2O_4)$.

Occurs in combination in *Oxalis* and in rhubarb. Made from sawdust by action of caustic alkali. Colorless, transparent crystals, readily soluble, odorless, intensely acid taste. Dangerous poison. Useful for removing ink and copper stains. Test: solutions of lime, forming oxalate of calcium. Also gives white precipitate with nitrate of silver. Mistaken sometimes for Epsom salts. Most oxalates are soluble, except calcium oxalate. *Acidum Oxalicum.*

52. **Malic acid:**

Occurs in rhubarb, in tobacco leaves, berries of the mountain ash, and in many fruits.

53. **Tannic acid:**

$C_{14}H_{10}O_9$. Gallo-tannic acid, tannin. Most tannins are glucosides of gallic acid. Have power to form insoluble compounds with gelatin and albumin, and to throw down ferric salts as a black precipitate, hence leather, and ink. Officinal tannic acid is prepared from nut-galls. Pale and yellow amorphous masses, soluble in water, forming yellow-brown, tolerably clear solution in proportion of one part to five of water. Should make a clear solution in 10 parts of 90 per cent alcohol. Mixed with antiseptic substances does not turn into gallic acid. *Acidum Tannicum.*

54. **Tartaric acid:**

$H_2 (C_4H_4O_6)$, Acidum Tartaricum. Occurs in grapes, pineapples, tamarinds and other fruits as a tartrate. Prepared from crude tartar. Colorless, transparent crystals, soluble in water. Solutions are strongly acid and deposit fungous growth.

55. **Cream of tartar:**

Potassium acid tartrate. $KH(C_4H_4O_6)$, made from argols or crude tartar a deposit on the sides of wine casks; odorless, gritty taste, white, almost insoluble.

56. **Rochelle salt:**

Potassium sodium tartrate, $KNa(C_4H_4O_6)4H_2O$. Large, transparent, colorless, slightly efflorescent crystals, mildly saline and bitter taste, readily soluble.

57. Composition of **seidlitz powders:**

The blue paper contains Rochelle salt and bi-carbonate of sodium; the white paper contains tartaric acid.

58. **Tartar emetic:**

Tartrate of potassium and a radicle called stibyl, Antimonium Tartaricum, Tartarus Stibiatus, potassio-antimonium oxytartrate, $[K](SbO)(C_4H_4O_6)$. Made from potassium acid tartrate and oxide of antimony; colorless, transparent crystals, opaque on exposure to the air; sweetish metallic taste; soluble in fourteen parts of cold water.

59. **Citric acid:**

$H_3(C_6H_5O_7)$; occurs in large amount in lemon juice, orange juice, etc.; colorless odorless very acid crystals; soluble; solutions become mouldy and decompose. Used in urinalysis instead of acetic. *Acidum Citricum.*

Citrate of iron is made by dissolving ferric hydrate in it. Citrate of magnesium is employed only in solution, and is a mixture of solution of carbonate of magnesium in solution of citric acid, and syrup of citric acid, to which are added bi-carbonate of potassium and water. Citrate of iron and quinine is made by dissolving quinine in a hot solution of citrate of iron. Citrate of iron and strychnine is made by mixing a solution of strychnine and citric acid with solution of citrate of iron and ammonium. So-called "effervescing citrates" often contain tartaric instead of citric acid. Lithium citrate made by dissolving lithium carbonate in citric acid.

60. Important **aldehydes:**

Aldehyde, chloral, acetone, camphors. [A derivative of aldehyde, used in medicines, is called paraldehyde, $C_6H_{12}O_3$; is a hypnotic.]

61. Derivation of name **Chloral:**

*Chlor*ine and *al*cohol; made by passing a rapid stream of dry chlorine into pure absolute alcohol and heating; C_2HCl_3O (aldehyde is C_2H_4O and chloral exchanges Cl_3 for H_3); colorless oily liquid; mixed with water, forms a white solid called chloral *hydrate* C_2HCl_3O, H_2O. Chloral hydrate is soluble in water, should be neutral, and give no reaction with $AgNO_3$, nor become moist on exposure to the air; antiseptic, and valuable for preserving anatomical specimens, urine, etc. *Chloralum.*

62. **Acetone:** C_3H_6O:

Colors ferric chloride a dark reddish-brown; probably gives chloroform odor to many diabetic urines.

63. **Common Camphor:**

$C_{10}H_{16}O$; concrete substance derived from camphor-laurel tree; soft tough cakes, easily powdered on addition of a little alcohol; translucent, strong fragrant odor, aromatic bitter cooling taste, volatile, inflammable; lighter than water, slightly soluble, but soluble in alcohol, ether, chloroform; dissolved in alcohol, forms *spirits of camphor*, from which it may be precipitated by water; dissolved in water containing a little alcohol and a little magnesium carbonate, forms *camphor-water;* boiled with bromine, forms *mono-bromated camphor.* Gum-camphor has a rotatory movement in water which is stopped by the least trace of fat. Camphor is a local irritant, stimulant, and powerful poison. *Camphora.*

64. Important **ethers** and their derivatives are:

Ether, chloroform, iodoform, fats and glucosides.

65. **Common ether:**

Ethyl oxide, sulphuric ether, $(C_2H_5)_2O$; made by distilling sulphuric acid and alcohol in a retort; a neutral volatile colorless liquid; burning taste, strong odor, very inflammable; vapor 2½ times as heavy as air, therefore flows and will inflame from contiguous flame; anæsthetic internally and locally; valuable solvent for resins, oils and hydrocarbons. *Æther fortior.* U. S. P. 94 per cent pure ether, 6 per cent alcohol, with a little water.

66. **Chloroform:** Methenyl chloride, $CHCl_3$; trichlor methane.

Distil alcohol with bleaching powder: thin colorless liquid; neutral reaction; peculiar agreeable etherial odor; burning sweetish taste: burns with a sluggish green flame; nearly insoluble in water, soluble in ether; dissolves phosphorus, sulphur, iodine, and many of the alkaloids and their salts. Anæsthetic. Pure chloroform has a specific gravity of 1.502; decomposes under influence of light; addition of one-half per cent alcohol prevents this decomposition, but reduces the specific gravity at 60 ° F. to 1.4936. Should evaporate without residue; shaken with half its volume of pure H_2SO_4 should impart no color, even after twenty-four hours; shaken with three volumes of water, tested with litmus and with silver nitrate solution, should show no change. Heated with KHO should not yield a brown color.

67. **Iodoform:**

CHI_3. Prepared by adding alcoholic solution of potassium hydrate to tincture of iodine, avoiding excess; lemon-yellow, glistening, crystalline plates; greasy feeling, saffron-like odor, sweetish taste, somewhat volatile; insoluble in water, soluble in 75 parts of cold 95 per cent alcohol, but in 10 of boiling. Soluble in ether, chloroform, carbon disulphide, in essential and fatty oils. May be dissolved in liquid cosmoline.

68. A receipt for disguising the odor of iodoform: Carbolic acid, 1 part; iodoform, 2 parts; powder; mix well.

69. **Glucosides:**

Ethers of the glucoses; boiled with dilute acid they take up water and yield glucose. Their names end in -in.

70. Important glucosides:

Amygdalin, from bitter almonds, white and soluble; **salicin,** from willow-bark, white, soluble, very bitter, colored red by H_2SO_4; **picrotoxin,** bitter, poisonous principle of Cocculus Indicus.

71. Substitution ammoniums are shown by terminations: An amine formula is derived from that of ammonia gas as a basis, one or more alcohol radicles being exchanged for the hydrogen.

72. Important **Amines:**

Methylamine, propylamine, neurin, lecithin, aniline, indican, leucin, tyrosin, taurin, creatin, creatinin.

73. **Aniline:**

Phenyl-amine $(C_6H_5)NH_2$, radicle phenyl takes place of one atom of hydrogen in formula of ammonia, NH_3. Reduce nitro-benzole with iron and acetic acid; colorless liquid, disagreeable odor, bitter taste, insoluble in water; yields, when made from crude nitrobenzole, brilliant dyes with oxidizing agents.

74. **Prussic acid:**

Acidum Hydrocyanicum, HCN or HCy, cyanhydric acid. Exists ready formed in juice of the bitter cassava; may be obtained from bitter almonds, kernels of plums and peaches, apple seeds, cherry laurel, etc.; clear, colorless, volatile liquid, peculiar pungent odor. The officinal acid contains about 2 per cent of the anhydrous acid. For homœopathic use the officinal acid is mixed with equal parts by weight of distilled water. The best liquid test is to add sulphide of ammonium and then a ferric salt in solution; after the addition of the latter a deep blood-red color is observed, owing to the formation of sulpho-cyanate of iron.

75. **Amides:**

An amide formula is derived from that of ammonia as a basis, by substituting acid radicles for one or more atoms of the hydrogen of ammonia.

76. Important Amides:

Urea, oxaluric acid, allantoin.

77. **Urea:**

Carbamide, CH_4N_2O, found in the urine of man and of various animals. Pathologically, in considerable quantities, in the blood, and in nearly all the liquids of the body; may be made by heating the cyanate of ammonium; colorless crystals, fresh taste, freely soluble, inalterable, neutral. Tests: (See Urine.)

78. **Alkalamides:**

Bodies whose formulæ are derived from that of ammonia as a basis, by substituting in place of the hydrogen, both alcohol radicles and acid radicles.

79. *Alkalamides of importance:*

Hippuric acid, taurocholic acid, glycocholic acid.

80. **Hippuric Acid:**

Exists in abundance in the urine of herbivora; results from transformation of benzoic acid. Its crystals resemble those of triple phosphate. (See Urine.)

CHAPTER II.—ALKALOIDS.

81. **Alkaloids** are artificial, natural or cadaveric. Artificial alkaloids are the various amines, as methyl-amine, ethyl-amine, etc. Methyl-amine is a gas, ethyl-amine a liquid, propyl-amine a volatile oil.

82. **The Natural Alkaloids:**

A class of substances chiefly of vegetable origin, often active principles of plants, supposed to be like *alkalies*, hence name. Those containing no oxygen are volatile; those having oxygen are non-volatile. As a rule, are soluble in alcohol, ether, chloroform; contain nitrogen, turn plane of polarized ray of light to left (with few exceptions), furnish, with platinic chloride, double chlorides; have bitter taste, resemble alkalies in uniting with acids to form salts, of which the sulphates, nitrates, chlorides, and acetates are usually soluble, and the oxalates, tartrates and tannates usually insoluble; in solution, are precipitated by many re-agents, including iodine dissolved in iodide of potassium; very poisonous.

83. **Volatile Alkaloids:**

Nicotine, also called nicotia, nicotina, nicotylia, nicotin, $C_{10}H_{14}N_2$, exists in seeds and leaves of tobacco. Colorless or slightly yellow, highly liquid, strongly alkaline, sharp burning taste, soluble in water, alcohol, ether; almost insoluble in chloroform and carbon di-sulphide. Exposed to the air, becomes brownish and viscid. Boils at 464 ° F.

Coniine, also called conia, conylia, conin, cicutin, $C_8H_{15}N$. Alkaloid of poison hemlock (Conium Maculatum), colorless, oily liquid, having odor of urine of mice; soluble in alcohol and ether. Very poisonous. Boils at at 414 ° F. Sp. gr. 0.89.

84. The **alkaloids of opium:**

These may be classified as follows: *Toxic*, viz., thebaine, codeine, papaverine, narceine, morphine, narcotine; *convulsive:* those already mentioned; *soporific:* narceine, morphine and codeine.

The alkaloids of opium are non-volatile.

85. **Morphine:**

Morphine, morphia, $C_{17}H_{19}NO_3$, exists as meconate of morphine in opium, which is the concrete, milky juice exuding on incising the unripe capsules of Papaver Somniferum, or white poppy. Morphine is crystalline, transparent or white, alkaline, having bitter taste, soluble in 1200 parts cold water, and 500 parts boiling, and 45 to 50 of cold, and 30 of hot 90 per cent alcohol, in 150 parts of chloroform; almost insoluble in ether, benzole, ammonia and fixed oils, but soluble in the fixed alkalies and in lime water; forms salts with acids, which are white, and *soluble* in water and in alcohol, *insoluble* in ether. *Morphium.*

86. Tests for morphine or its salts: Gives gold yellow color, somewhat slowly appearing, with nitric acid. There are many other tests also.

87. The **hydrochlorate** or **muriate of morphine:** (Should be called hydrochlor*ide*). The alkaloids seem to differ from the alkalies in not replacing the hydrogen of those acids with which they form salts; thus the formula for the salt prepared by neutralizing dilute HCl with pure morphine is $C_{17}H_{19}NO_3,HCl$. *Morphium Muriaticum.*

88. **Sulphate of morphine:** $(C_{17}H_{19}NO_3)_2\ H_2SO_4$, colorless crystals, soluble in 2 parts of water. *Morphium Sulphuricum.*

89. **The alkaloids of Nux Vomica:**

Strychnine, Strychninum, strychnia, $C_{21}\ H_{22}\ N_2\ O_2$. Occurs in seed of Strychnos Nux Vomica, or poison-nut-tree; also in Strychnos Ignatia, or St. Ignatius bean, found as strychnate or acetate. Small colorless crystals, odorless, very bitter, solutions intensely bitter; soluble in 7,000 parts cold water, 3,500 boiling, 200 cold and 20 of boiling 90 per cent alcohol, 1250 of ether, 300 of glycerin, and 5 of chloroform. Almost insoluble in absolute alcohol, but soluble in fixed and volatile oils. Brucine is the other alkaloid and is more soluble than strychnine.

90. *Test for* **Strychnine** *and its salts:* Dissolve a few crystals in a few drops of cold, pure, sulphuric acid, and touch the solution with a crystal of potassium bichromate. There results a purple or a violet coloration, soon fading to red, ultimately to green; if the strychnine contains much brucine it will give a red coloration with nitric acid.

91. *Important salt of strychnine:* The sulphate, "Strychninum Sulphuricum," $(C_{21} H_{22} N_2 O_2)_2$ $H_2 SO_4$, colorless neutral crystals, soluble in 10 parts cold water, and readily in dilute alcohol.

92. The principal **alkaloids of Cinchona:**

Quinine, cinchonine, quinidine, cinchonidine, quinicine, cinchonicine, quinoidine.

93. **Quinine:**

"Chininum purum," Quinia, $C_{20} H_{24} N_2 O_2$. Snow white, odorless, very bitter alkaline powder, soluble in 364 parts cold and 200 boiling water, soluble in alcohol, ether, and chloroform.

94. **Sulphate of quinine:**

Chininum sulphuricum, basic sulphate of quinine, $(C_{20} H_{24} N_2 O_2)_2$ $H_2 SO_4$. Very white loose masses of fine silky flexible needles, odorless, extremely bitter, soluble in about 750 parts cold water, 25 to 30 boiling water, 65 of 90 per cent alcohol, 120 of dilute alcohol, slightly in ether, not at all in chloroform. Solutions are neutral in re-action. Sulphate of quinine is very soluble in acidulated water.

95. **Test** for **quinine** or its salts:

Rub up one part of the powder with 200 parts chlorine water, then add 25 parts of ammonium hydrate solution.

A dark green resin-like precipitate occurs, dissolved by dilute acids with brown coloration. The chlorine water must be *strong* and *freshly* prepared.

96. Tests for **purity** of sulphate of quinine:

Should dissolve in pure colorless H_2SO_4 without effervescence, the solution remaining clear and colorless. One part of the salt should dissolve in 100 parts of absolute alcohol, forming a transparent colorless solution, which, treated with an equal amount of ether, should remain clear. One gramme of the salt heated on a porcelain dish on a water bath for twelve hours should weigh .86 grammes. Heated on platinum foil should first carbonize, then burn, without leaving any residue.

97. A simple method of telling the sulphates of **morphine, strychnine,** and **quinine,** ONE from ANOTHER:

To all three, in powdered form in separate dishes, add nitric acid; morphine gives a red coloration, changing to yellow, rather slowly appearing (strychnine if containing brucine gives a red, rapidly appearing); quinine, no red. To distinguish strychnine from morphine use the sulphuric acid and potassium bichromate test, obtaining a *purple* with strychnine, and a *green* with morphine. To tell strychnine from quinine use same test. To tell morphine from quinine use nitric acid, which gives a red color to the morphine but not to the quinine.

98. Alkaloids having power to dilate the pupil:

The **mydriatic** alkaloids are *atropine*, *hyoscyamine*, and *hyoscine*.

Hyoscyamine is said to be identical with *daturine* and *duboisine*.

99. **Atropine:** Alkaloid of Belladonna, $C_{17}H_{23}NO_3$, used chiefly in form of sulphate.

100. The **sulphate of atropine:**
White crystalline powder, or colorless silky prisms; soluble in 3 parts cold water and in 10 parts 90 per cent alcohol; insoluble in ether, chloroform, and benzole; solutions neutral, of disagreeable bitter taste; no direct test for the salts of atropine except that of dilating the pupil, which property is shared in by hyoscyamine. (Various tests are constantly appearing, and may prove satisfactory.)

101. Alkaloids having power to **contract pupil:**
Pilocarpine the alkaloid of jaborandi, and eserine called also physostigmine the alkaloid of the Calabar-bean. These are called *myotics.* Pilocarpine increases perspiration. (See Appendix for other alkaloids, tests, etc.)

CHAPTER III.—PROTEIDS.

102. **Proteids** are amorphous substances, the basis of all tissues of the body.

103. Ralfe's classification of them: Native albumins, globulins, fibrins, modified albumins, peptones, albuminoids or allied albumins.

104. **Chemical characteristics** of proteids:

Heated with strong nitric acid they turn yellow, and, on addition of ammonia, orange (xantho-proteic reaction); they are precipitated from solutions by acetic acid and potassium ferro-cyanide, by picric acid, by tannin, and by mercuric chloride; acted on by gastric and pancreatic juices, they become soluble and more diffusible.

105. The **native albumins:**

These are serum-albumin and egg-albumin; soluble in pure water; viscid, glairy, neutral; coagulated by a temperature of about 163° F. and also by strong mineral acids, but not by sodium chloride, vegetable acids, or dilute mineral acids; coagulated by heat are insoluble in mineral acids but soluble in alkalies.

106. **The globulins:**

These are (chiefly) globulin, paraglobulin, fibrinogen, hemoglobin. Insoluble in pure water, soluble in dilute neutral saline solutions. *Globulin* (called also crystallin), is a constituent of the vitreous and aqueous humors. *Paraglobulin* (called also serum globulin], fibrino-plastic substance, is a constituent of blood serum and plasma, and of the colorless blood corpuscles of lymph and chyle. *Fibrinogen* is a constituent of blood serum, serous fluids, and many pathological transudations. *Hemoglobin* occurs in globules of arterial blood ; acted on by acids or alkalies yields *hematin*; acted on by glacial acetic acid and mercuric chloride yields *hemin* (hydro-chlorate of hematin).

107. **Fibrin:**

Insoluble in water and in dilute saline solutions. In 1 per cent solutions of HCl does not dissolve but swells, becoming soluble on addition of pepsin. Decomposes hydrogen peroxide with effervescence; gives blue reaction with tincture guaiac and etherial solution of hydrogen peroxide. Coagulates spontaneously; coagulation accelerated by éther, but stopped by sodium sulphate.

108. **The modified albumins:**

These are acid-albumin and alkali-albumin. *Acid-albumin*, called also syntonin and parapeptone, is the first product of the transformation of proteids by the gastric juice. Obtained by heating solution of albumin with one per cent strong HCl. *Alkali-albumin*, called also casein, is obtained artificially by heating solution of albumin with dilute alkali. The modified albumins are insoluble in water and in dilute saline solutions, but soluble in dilute acids and alkalies.

109. **Peptones:**

Peptone, called also albuminose, is soluble, not coagulated by heat, diffusible, passes easily through animal membranes, gives rosy red color with cold Fehling's test liquid, precipitated by picric acid but redissolved when warmed.

110. **The albuminoids** or **allied albumins:**

These are constituents of epithelial and connective tissue. *Mucin*, insoluble in cold water, soluble in alkalies, not precipitated by heat, nor by mercuric chloride, nor by potassium ferro-cyanide and acetic acid. Precipitated by acetic acid, precipitate not dissolved by sodium sulphate. *Gelatin*, insoluble in cold water, soluble in hot, gelatinizing on cooling ; prolonged boiling, or boiling with acids prevents the gelatinizing on cooling. *Chondrin* is soluble in hot water, and gelatinizes on cooling. *Elasticin* is highly insoluble and does not gelatinize.

111. **Nitrogenized products of tissue metamorphosis:**

Uric acid, sarcin, xanthin, guanin, cystin, biliary coloring matters, urinary coloring matters, etc.

112. **Uric acid:**

$C_5 H_4 N_4 O_3$. Found in calculi, urine, blood, exudations, in combination (urates) in articulations of patients with articular rheumatism.

Constitutes urine of serpents and birds. In urine is colored, but when pure is white. Recognized by murexid test: add a few drops of nitric acid, heat gently just to dryness, let cool, add ammonia [one drop]. Beautiful purple color develops.

113. **Biliary coloring matters:**

Bilirubin, biliverdin, bilifuscin, biliprasin; found, somewhat altered, in feces. In icterus found in blood, urine, milk, sweat, saliva. The green color of bile is due to biliverdin, brown color to biliprasin. Recognized by Gmelin's test: slowly mix nitric acid containing a little nitrous acid (formed by adding one drop of sulphuric acid to the nitric acid beforehand) with the biliary matters, when a play of colors will be observed, of which green alone is characteristic of bile pigment. Biliverdin is turned yellow in an alkaline solution by sulphurous oxide. Bilirubin is turned green by influence of oxidizing agents.

114. **Urinary coloring matters:**

Urobilin, deemed hydrobilirubin, formed by action of nascent hydrogen on bilirubin; supposed to give high color to the urine of fevers.

Uroerythrin gives rose-red color to uric acid and urates. (See Urinalysis.)

ANIMAL CHEMISTRY.

CHAPTER I.

Blood: Nutritive and purifying fluid of the body, vermilion-red (arterial) or reddish-brown (venous), saline taste, specific gravity 1045 to 1075, alkaline reaction; consists of a clear liquid holding in suspension three kinds of corpuscles—red, white and transparent—and in solution many substances organic and inorganic.

Average Composition:

In 100 parts: Water, 79.5: solids, 20.5. Solids: Serum albumin, 7.2; fibrin, 0.21; hæmoglobin, 11.5; fatty matters, 0.18; extractives, 0.32; ash, 0.81.

Serum.—Average Composition:

In 100 parts: Water, 90.5; solids, 9.6. Solids: proteids, 8 to 9; fat extractives and salts, 2 to 1.

Corpuscles.—Average Composition:

In 100 parts, wet corpuscles: Water, 56.5; solids, 43.5: hæmoglobin, 41.1; other proteids, 3.9; fats, chiefly cholesterin and lecithin, .37.

Reaction: Alkaline from presence of neutral sodium phosphate HNa_2PO_4, and acid sodium carbonate HNa_2CO_3*. The alkalinity has been found to diminish in gout, Bright's disease and cholera, though no precise observations have been made on it.

Fibrin: Blood drawn from body separates into *clot* and *serum*; the clot is fibrin, holding in its meshes the blood corpuscles. Paraglobulin (*fibrino-plastic* substance) and *fibrinogen* seem to be the antecedents of fibrin in the bloood, the fibrinogen being converted outside the body into fibrin by the action of a third body, *fibrin ferment*. [Chylous urine and sometimes hydrocele

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* The disadvantages of any system of nomenclature which makes *alkalinity* of blood due to presence of *neutral* and *acid* salts, are well seen here.

fluid, on addition of fibrin ferment, may be coagulated like blood.

Coloring Matter: Contained in red corpuscles, called *hæmoglobin*, contains about 0.4 per cent of iron constantly, is combined with an alkali to keep it in solution. The amount of hæmoglobin *decreases* in cirrhosis of liver with epistaxis, chlorosis, leucocythæmia, Bright's disease (granular kidney), large fatty kidney; it *increases* in diabetes mellitus and in phosphorus poisoning. For clinical purposes estimate amount by noting number of blood corpuscles and depth of color. Hæmoglobin has purple color in venous blood, but can combine readily with oxygen to form a bright-red body, oxyhæmoglobin.

Colorless Corpuscles: Two kinds, white and intermediate (hæmatoblasts). Intermediate smaller than white and nucleus more obscured by granules. Acetic acid renders nuclei of colorless corpuscles more distinct; iodine in potassium iodide stains body of corpuscles mahogany-brown, indicating glycogen. Proportion of white corpuscles to red, 1 to 340–350. Proportion increased in leucocythæmia, often to 1 to 8 or 1 to 10. When marrow of bones is affected in leucæmia or pernicious anæmia, there are often found nucleated colored corpuscles, similar to those in blood of embryo.

Blood Serum: Clear, straw yellow, specific gravity 1025–1028, alkaline and more so than equal bulk of blood. Contains fatty matter, extractives, salt, paraglobulin, serum-albumin. Paraglobulin passes more easily through animal membranes than serum albumin; paraglobulin with fibrinogen in presence of fibrin ferment forms fibrin, but fibrinogen is *only* in the blood *plasma*, *i.e.*, in the colorless liquid in the body in which the globules float.

Fatty Matters: Normal blood yields from .18 to .2 per cent of saponifiable fats, lecithin, and cholesterin.

The amount of fat is increased after a full meal and diminished during fasting. In cases of diabetes that have run an acute course, the blood sometimes assumes a lactescent appearance (*lipæmia*), due to presence of excess of fatty matter.

Extractives: These are chiefly urea, glucose, kreatin, hypoxanthine, and uric acid.

Salts: The salts of sodium preponderate over those of potassium, especially in the serum; in the corpuscles we find more potassium than sodium. Chlorides are more abundant in serum, phosphates in corpuscles. The phosphoric acid is combined chiefly with potassium in the corpuscles and with calcium and sodium in the serum.

Toxic Conditions of the Blood: Asphyxia is due to accumulation of *carbonic acid* in the blood, proving rapidly fatal whenever the air-passages are completely blocked and the process of aëration of the blood by means of the lungs is checked. In less severe forms of obstruction *dyspnœa* and *cyanosis* are noticed, the latter due to presence of imperfectly aërated blood in the capillaries. Pallor and *a leaden hue* are noticed in diseases where the number and color-value of red corpuscles are diminished, as in scurvy.

Uræmia supervenes in kidney diseases when the excretion of solids in the urine is considerably diminished. According to Ralfe this condition is due in some measure to the withdrawal of the nutritive matter of the blood or, at least, to the altered percentage relationship between it and the effete (extractive) materials. [Urea may be injected into the veins of animals without inducing uræmia; no ammoniacal odor is perceptible in the breath of persons suffering from uræmia; and, lastly, uræmic convulsions may occur, as in puerperal convulsions, when there is no evidence of any marked diminution in the excretion of urea.] Venesection, apparently by altering the percentage composition of the blood, often proves of immense service in uræmia. (Ralfe).

Jaundice takes place when in diseases of the liver any obstruction is offered to the onward passage of the bile; re-absorption takes place and the bile passing into the blood is deposited in the tissues.

Cholesteræmia is the name given to a condition of the blood in certain forms of liver disease, particularly cirrhosis, in which there is great destruction of liver cells, and when the termination is by coma. Cholesterin, however, like urea, has no toxic influence, and Ralfe ventures to think the coma of hepatic disease is due to a general increase of the excretory matters in the blood.

Acetonæmia is the name given to a condition of the blood found in patients dying of diabetic coma. Free acetone can not be obtained from freshly-drawn diabetic blood, but there is little doubt that a body readily yielding it can be separated from the blood of such patients. Deichmuller and Tollens deem it some compound of aceto-acetic acid. Whenever this substance—which gives a deep-red reaction in the urine with ferric chloride—is found in the urine, there is a peculiar odor like that of acetone noticed in the breath and in the urine. This odor is usually particularly noticed preceding acute diabetic coma. Ralfe's clinical test for this acetone-yielding body in the urine is as follows: To a drachm of liquor potassæ add twenty grains of potassium iodide, and boil; holding the tube inclined cause a drachm of the suspected urine to trickle slowly down the side of the tube; a zone of phosphates will be noticed at the juncture of the urine and the potassa solution, and if an acetone-yielding body be present this zone will become yellow and studded with yellow points of iodoform, which in time will sink through the ring of phosphates and be deposited at the bottom of the test-tube.

Examination of blood stains (Ralfe). The surface or substance of the material must be scraped or cut into small fragments and digested in as little distilled water as possible. A reddish fluid may be obtained, which (1) examine under microscope for blood corpuscles; (2) placed in deep, narrow cell and examined by spectroscopic eye-piece with a low power of microscope, for bands of hæmoglobin; (3) add a few drops of glacial acetic acid and a small quantity of sodium chloride evaporate to dryness at 104° to 122° F. and examine residue for hæmin crystals; (4) place a drachm of tincture of guaiacum in a test-tube and add a drop of the suspected blood solution, then allow an equal amount of etherial solution of hydrogen peroxide solution to trickle down the side of tube held inclined; if blood, a blue ring will form at junction of the etherial solution and the guaiacum.

Chyle: Milk-like fluid during digestion, collected from the stomach and intestines by the lymphatics arising from these organs. One hundred parts of chyle contain, when taken from lacteals in full digestion: Water, 91.8; solids, 8.2. The solids are: proteids, 3.5; fats, 3.3; salts, 0.8; extractives, 0.4; fibrin, 0.2. The proteids are serum albumin, paraglobulin, fibrinogen and peptones. The fatty matters consist of minute spherical globules, and are a mixture of saponifiable fats, cholesterin and lecithin. About 6.6 pounds of true chyle are formed and poured into the blood during twenty-four hours. Chyle is spontaneously coagulable.

Lymph may be regarded as the serum of the blood, which has been transuded into the tissues and reabsorbed and carried back into the circulation by the lymphatics. It is a clear, straw-colored fluid, containing less fibrin and fat than chyle.

Lymph is alkaline, and consists of a fluid, and white corpuscles.

Human milk: in 100 parts; water, 86.86; solids, 13.2. Solids: proteids (chiefly casein*), 2.93; butter, 3.78; sugar (lactose), 5.83; extractives, 0.25; salts, 0.35. Practically, solution of lactose and salts in water, holding in suspension fatty particles, and casein in partial solution. Specific gravity, 1032; reaction, alkaline; quantity in twenty-four hours, 2 to 3 pints. *Colostrum* secreted at about the time of confinement more alkaline and of higher specific gravity, richer in casein and fatty matters.

Composition of milk varies with (i) age of child ; most sugar and least casein when child is youngest ; (ii) food of parent ; butter increased by vegetable and fatty food; casein and sugar by mixed or meat diet ; fasting increases fat and casein, but diminishes sugar and salts ; (iii) complexion of parent : milk richer in brunettes and negresses ; (iv) disease: pyrexia, secretion diminished or suppressed, and quantity of solids, especially of butter and sugar, diminished ; mental emotion : reaction acid ; (v) food and drugs : may unfit milk for use. If decomposed, may contain sulphuretted hydrogen. If of blue color, examine for bacteria.

Analysis: Take specific gravity with urinometer, reaction with litmus paper (double-acting purple paper preferred, turning blue with alkaline fluid, red with acid); observe color, odor, taste, etc., and see Appendix for complete process.

Cow's milk: Rarely encountered in cities. In 100 parts: water, 83 to 87; butter, 3 to 4.5; casein, 3 to 5; albumin, 0.3 to 0.6; sugar, 4 to 5.5; salts, 0.7 to 0.8.

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*Meigs, of Philadelphia, in his analyses, shows less casein and more sugar.

White, opaque, inodorous when cold; slightly sweetish in taste; salts chiefly phosphates; notably calcium phosphate. *Cream:* name given to upper layer of milk on standing; composed chiefly of opaque fat globules seen by aid of microscope. *Butter* results from the agitation of these globules by churning, their contents running together. *Skim-milk* is the lower layer of milk on standing, the cream having been removed; contains lactose and salts in aqueous solution, together with casein and a little fat. *Buttermilk* is the residue after churning, and contains less fat than skim-milk. *Cheese* consists of casein precipitated from the milk by rennet and pressed into moulds; before the casein is removed the mixture of coagulated casein and serum is called *curds* and *whey.*

Milk may be coagulated either by acids or special ferments; the lactose is converted into lactic acid, the reaction becomes acid, and the casein is precipitated. When milk is exposed to the air it sours through the agency of ferments, undergoing *lactic fermentation*, as has just been described; this fermentation is aided by heat, diminution of oxygen in the air, etc., and is noticed before storms and when the air is charged with electricity. Milk sours more readily in metallic vessels. Souring may be prevented by the addition of a very small amount of bicarbonate of sodium; on the other hand, 1 part of rennet will coagulate 30,000 parts of milk. The *composition* of milk varies greatly. The average specific gravity is 1031, the reaction alkaline, the daily amount 4 to 5 gallons, the percentage of cream 12.* Milk from unhealthy cows usually has some peculiarity of taste or smell, or a viscous, unhealthy appearance. Ammonia makes poor milk viscid, and the ash of milk from unhealthy animals usually has increased proportion of calcium phosphate. *Adulterations with different substances not so common as*

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*Seldom do we find any such percentage in cities.

believed, but the double fraud generally and successfully practiced is skimming and watering combined, and perhaps addition of some substance to restore the natural color if possible. Skimming removes the fatty matters, which are lighter than the other constituents, hence *increases* the specific gravity; on the other hand, subsequent addition of water *reduces* the specific gravity to normal. Taking the specific gravity of milk, then, with the urinomer or lactometer is useless. Complete analysis is necessary to reveal the character of the fluid (see Appendix). Analysis of butter is also somewhat complicated.

Saliva: Secretion of several glands, obtained pure with difficulty, turbid, opalescent, viscid, feebly alkaline, low specific gravity (1005).

One thousand parts of mixed saliva yield: water 994.94, solids 5.06. The solids are *ptyalin* [or diastatic ferment] 1.2, mucin 1.3, fatty matters 1.1, salts 1.6.

Ptyalin is somewhat analogous to an albuminoid; its composition has not been accurately determined. It converts starch into maltose and glucose.

The salts of the saliva are chiefly calcium carbonate and phosphate, and as long as the secretions of the mouth remain alkaline, there is a tendency to deposit lime compounds on the teeth [*tartar*]. This protects the body of the teeth, but has an injurious effect on the gums; when, in diseased conditions, the secretions of the mouth become acid, tartar is no longer deposited, and the decay of the teeth is usually hastened. (Leffman.)

Saliva also contains potassium sulphocyanate, KCNS, which, with ferric chloride, gives a red color similar to the acid of opium with this reagent. Mercuric chloride causes the red produced by the sulphocyanide with ferric chloride to disappear, but does not affect the color produced by meconic acid and ferric chloride.

Function of the saliva twofold: diastatic and excitant of gastric secretion.

Reaction of saliva, alkaline; acid in diabetes, acute rheumatism, mercurial salivation; decomposition of organic substances in the mouth may change the reaction to acid.

Quantity of saliva in twenty-four hours, probably about 800 to 990 grammes; decreased in pyrexia and by certain drugs, notably belladonna; increased by dry food, in conditions of debility, and increased by certain drugs, notably mercury, pilocarpine, eserine.

Gastric juice: In 1,000 parts of gastric juice (containing necessarily a certain amount of saliva) we find: Water, 994.6; solids, 5.4. The solids are: pepsin, 3.02; free hydrochloric acid, 0.22; alkaline chlorides, 2.0; phosphates, 0.15. Reaction of gastric juice, acid, and incontestably proved to be due to presence of *hydrochloric* acid. [In morbid conditions, *lactic*, *acetic*, and *butyric* acids are found.] Gastric juice is a thin, glairy fluid, of a yellowish tint and variable composition. Specific gravity usually 1010. Does not coagulate on boiling, and is less liable to putrefaction than other secretions. Quantity, 16 to 31 pounds in twenty-four hours. The principal ingredient is water, but the characteristic and important ingredients are hydrochloric acid and pepsin. *Pepsin* is a nitrogenous ferment resembling albumin, but not identical with it; it is a grayish-white powder, insoluble in water, but very soluble in dilute acids. Pepsin itself has no action on albuminous substances, but in conjunction with dilute acid converts them into *peptones*. Gastric juice dissolves albuminous envelopes of fat cells, and the temperature of the stomach renders solid fats fluid; it has no action on *starchy* food; it dissolves *gelatiniferous* tissues; it coagulates casein (by some ferment, not by the hydrochloric acid), then converts it into peptone.

Digestion is favored by temperatures from 95° to 104° F.; by minute subdivision of the matters by increasing surface to be acted on.

Digestion is interfered with by neutralization or presence of too much acid, by concentration of the products of digestion, by alcohol, strong alkaline mixtures, and salts of heavy metals.

Peptones are obtained by action of gastric juice on proteid substances; they were formerly called *albuminose*. They are white, amorphous, acid in reaction, soluble in water.

Vomited matters: For clinical purposes, discover first, the nature of the acid in the vomit; second, whether any poison be present in it.

To determine whether hydrochloric acid be in excess, or whether organic acids (lactic, butyric, acetic), pour the vomit into a tall cylindrical glass jar and allow to settle. Draw off with pipette, as much of the supernatant fluid as can be obtained, shake with an equal weight of ether in a cylindrical tube, set aside till ether has separated and remove etherial solution with pipette. The acidity of the etherial solution represents the acidity due to organic acids, whilst the acidity of the vomit left behind after removing the ether represents the acidity due to hydrochloric acid. Take the acidity of the vomit, therefore, *before* adding ether and *after* the ether is withdrawn, and if organic acids are in excess, the reduction in the acidity will be marked; if hydrochloric acid is in excess, the reduction in acidity will not be marked. [See Appendix for process.]

To determine whether the vomit contains a poison or not, proceed, in general,* as follows: Elementary anal-

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* See Appendix for complete analysis.

ysis: Place a small quantity of the vomit in a test-tube and warm gently; if *prussic acid* is present its peculiar odor — bitter almonds — will be evolved. To test for *phosphorus*: heat strongly another portion of the vomit in a narrow test-tube, and carry into a darkened room to see if fumes of phosphorus are given off. Take reaction with litmus, and if the vomit turns the paper very red at once, some powerful acid (probably oxalic, sulphuric, hydrochloric, carbolic) is present; if the red paper is soon turned a marked blue, the poison is probably a caustic alkali, or alkaline salt.

If nothing be found by any of the above processes, take a fresh amount of vomit, acidulate with *pure* hydrochloric acid, and dip into it a strip of perfectly clean copper, which has been previously dipped in alcohol. Apply heat to the tube containing the acidulated vomit and copper foil, for about twenty minutes. If the copper is stained black, *arsenic, antimony* or *mercury* is the poison.

To test for poisonous alkaloids take very little of a fresh amount of vomit; make strongly alkaline with sodium carbonate; shake with four times its volume of ether, and let settle. Remove the etherial solution which comes to the top by a pipette, and allow it to evaporate spontaneously on a watch glass and test for *morphine* and *strychnine* (see Alkaloids). Tasting the etherial solution before evaporation will give idea as to its bitterness, and injection of it under the skin of a frog may show an alkaloid to be present.

Bile: Obtained fresh is a thin, transparent fluid of golden-yellow color like that of yolk of an egg, of very bitter taste; alkaline reaction; average specific gravity, 1018. After death, color brownish-yellow. Composition varies; solid constituents range from 9 to 17 per cent; greatest in amount after a meal. Analysis of Frerichs shows in 100 parts: water 85.92, inorganic salts .78, organic matter 13.30. Mixed with oil and fat and shaken with them bile forms an emulsion breaking them up, making them miscible with water and rendering their passage through animal membranes more easy. Bile precipitates solutions of gastric peptones. Quantity of bile discharged daily, forty ounces. Forms soaps with fatty acids; acts as a purgative and antiseptic. Defective secretion of bile one of chief causes of flatulent dyspepsia (Ralfe). Bile contains mucus, pigment, fat, soaps, cholesterin and lecithin, as well as inorganic salts and bile-acid salts. Bile coloring matter contains bilirubin, biliverdin, bilifuscin. Bile acids (in combination) are *taurocholic* and *glycocholic*, of which in man the former is more abundant. The bile fats are cholesterin, saponifiable fats and lecithin. Ralfe holds that cholesterin is not *excreted* by the liver, but that some of the cholesterin formed in the organ is *secreted* with the bile. The chief base of the *salts* is soda in combination with the bile acids; sodium chloride is also present and in abundance, as well as sodium phosphate; the other salts are phosphates of calcium and magnesium, and chloride of potassium. Traces of iron, copper and silica are said to be found in the bile.

The functions of the liver are: formation of bile, formation of glycogen, metabolism of certain albuminous constituents of the body and probably conversion of carbohydrates into fats and peptones into albumins. *Diabetes mellitus* probably depends on some definite lesion of the nerve centres; *glycosuria* from vaso-motor paralysis, consequent on the circulation through the portal vessels of toxic agents, or as an expression of general nervous exhaustion; *lithœmia*, more properly *uricœmia*, is due to a disturbance of the nitrogenous equilibrium brought about by an increase of metabolic processes throughout the body, owing to an intramolecular activity in the cells. (Ralfe).

Pancreatic juice: Solids, 3 to 10 per cent in pancreatic juice of dogs; organic solids, two-thirds of this amount; inorganic, one-third. Organic solids: ferments, serum-albumin, an albumin precipitable by magnesium sulphate, fatty matter, leucin and tyrosin (though latter two not always present). Of inorganic constituents, sodium carbonate is in relative excess. The *ferments* act on *starch*, *fat* and *proteids;* the action on starch is more vigorous than that of the saliva ; fats are split up into glycerin and fatty acids; proteids are converted into peptones, the ferment acting in a dilute alkaline solution, just as the gastric ferment acts in a dilute acid solution. Pancreatic juice is a clear, somewhat viscid fluid, odorless and of marked alkaline reaction, due chiefly to presence of sodium carbonate, sp. gr. 1008, quantity, 5 ounces in twenty-four hours. *Pancreatic digestion differs from gastric:* Proteids do not swell up, become translucent and fibrillate as in gastric, but remain opaque and apparently undergo conversion from the edges by process of erosion (Ralfe); the bye-product resembles alkali-albumin, not acid-albumin ; lastly, the continued action of the pancreatic ferment leads to the breaking up of hemipeptone and formation of leucin and tyrosin.

Intestinal fluid: Yellowish, opalescent, alkaline; specific gravity 1012, 2.5 per cent of solids. Dissolves fibrin and said to convert cane sugar into grape sugar and invert sugar, and to set up lactic acid fermentation. About 10 ounces secreted in twenty-four hours.

Action of digestive fluids: in the stomach most of the diffusible sugars and some peptones pass directly into gastric veins; parapeptone, undigested albumin, starchy principles as yet unconverted, and oleaginous matters, pass into duodenum as *acid chyme.* On reaching the biliary orifice bile is poured in, which precipitates the parapeptone, and with the pancreatic juice first neutralizes the acid, and then renders the contents of the intestine alkaline, the emulsionizing and saponification of fatty matters proceeding in the meantime. The chyme then passes into the jejunum and upper part of the ileum as *chyle;* here the final digestion of the food is effected, the pancreatic juice converting the undigested albumin and some of the gastric peptone into anti-peptone (true peptone, and not further changed) and hemi-peptone (changed further into leucin, tyrosin, etc.). Starch is converted into glucose, and probably also part of any cane sugar present, while a portion begins to undergo lactic acid fermentation. The fats in the meanwhile are thoroughly emulsified and saponified. The peptones, glucose, and a dextrine-like body pass chiefly in the direction of the portal vessels, the emulsioned fat being taken up by the lacteals. As the fluid contents of the intestine pass on they gradually lose their nutritious constituents, till at the lower part of the ileum and large intestine they become of greater consistency, and contain little besides the insoluble residue of the food and the putrefactive products of pancreatic digestion. (Ralfe.)

Fæces: One hundred parts contain approximately water, 77.3; solids, 22.7. The solids are mucin, 2.3; proteids, 5.4; extractives, 1.8; fats, 1.5; salts, 1.8; resinous biliary and coloring matters, 5.2; insoluble residue of food, 4.7. Rich brown, moist and slightly slimy on surface; odor variable—may be very strong and offensive even in the healthy. A small amount of coagulable albumin is always present in normal fæces, increased in dysentery, typhus and cholera. Extractives, among others, are *stercorin* and *excretin.* Fats are saponifiable fats and cholesterin. Inorganic constituents: magnesium phosphate, triple phosphate and calcium phosphate.

Magnesium salts greater in amount than calcium, and potassium than sodium. Odor due chiefly to *indol* and *skatol*.

Analysis of fæces will not be considered here; inspection of stools can conveniently be made by placing them in large, deep, conical vessels and covering the mouth of the vessel with a thick glass plate.

Gases of stomach and intestines: In *stomach:* Oxygen, nitrogen, carbonic acid; oxygen and nitrogen derived from air swallowed with the food, and carbonic acid by diffusion from the blood. In the *small intestine:* Chiefly carbonic acid, nitrogen and hydrogen; on a vegetable diet, chiefly carbonic acid and hydrogen. In the *large intestine:* Hydrogen, marsh-gas, sulphuretted hydrogen. Hydrogen and carbonic acid normally occur in small intestine, due to fermentative changes in which butyric acid, carbonic acid and hydrogen are formed. In the large intestine, where the fermentative changes are so great that the contents become acid in spite of the alkaline character of its secretion, we find marsh-gas and sulphuretted hydrogen from decomposition of albuminous and other sulphur-yielding elements of the food.

Flatus: In disease, fermentation may be such as to lead to production of enormous quantities of gas, or on the other hand, of the organic acids—lactic, acetic and butyric. If wind belched up is inodorous and there is no acidity, it is probably carbonic acid, and generally derived by diffusion from the blood under nervous influences. If flatulency is accompanied by a slight degree of acidity, sets in about an hour after eating, and the risings are merely acid and the eructations comparatively inodorous, acetic acid and carbonic acid fermentation of starchy and saccharine food is indicated. If the risings are *rancid*, lactic acid fermentation is progressing and may continue independently of food by the decomposition of the mucus in the stomach and intestinal canal. Enormous quantities of gas, chiefly carbonic acid, are often discharged through the mouth on a perfectly empty stomach by hysterical and hypochondriacal patients, derived from blood by diffusion. (Ralfe.)

Urinary and renal calculi: The nuclei are formed in the kidney, where they are either retained and form a renal calculus, or pass down with the water into the bladder and become vesical. In regard to the origin of stone, the nature of (a) the precipitated matters and the supply of (b) colloid material must be considered. Highly acid urine precipitates uric acid and urates; urine alkaline from fixed alkalies precipitates calcium phosphate; urine alkaline from volatile alkali (ammonium carbonate derived from decomposition of urea) precipitates triple phosphate; urine in which acid fermentation of mucus is going on in the urinary passages precipitates calcium oxalate (derived also from the system). Besides these substances other material is necessary. As to the nature of the colloid material in which the growth of stone is favored, various opinions exist; the mucus of the urinary passages undoubtedly furnishes the colloid medium by which the *stone* grows, but Ralfe thinks that the colloid medium for the *nucleus* is furnished in some other way. He suggests that the deposition of calculous matter may primarily occur in the cells forming the wall of the renal tubules as the result of some vital impairment, so that the products normally eliminated by them were retained and deposited instead.

(For consideration of Urinary Calculi see "Guide in Urinalysis.")

Biliary calculi: Size varies from grains to masses large as pigeon's eggs; the smaller, the more numerous. Externally usually smooth and slightly greasy. Color from dirty white to yellow-brown or even deep black, but usually sepia, olive-green, russet-brown. Usually soft, except when crust has much lime. They present usually a nucleus, a body and sometimes a crust. The nucleus is chiefly inspissated mucus, with bile pigment and cholesterin. The body, on section either presents an amorphous appearance of brownish-yellow color, the material being arranged in concentric layers round the central nucleus, or else long stratified crystals of cholesterin radiate from the nucleus towards the circumference of the stone.

Analysis of gall stones is made as follows: Separate portions of the crust; the body and the nucleus must be examined. Weigh a fragment, incinerate with blowpipe and weigh the ash; the loss in weight represents the amount of organic matter present; examine the ash for lime salts by dissolving in as small amount as possible of dilute acetic acid and precipitating with ammonium oxalate, which gives a copious white precipitate soluble in acetic acid if lime be present. Take another portion; thoroughly exhaust with ether, decant off the etherial solution, evaporate and test residue for cholesterin by adding a drop of nitric acid, heating and touching with ammonia, when a reddish-brown coloration will be given,

Take the part not affected by ether, treat with chloroform, evaporate, and a brownish powder of bile pigment will be obtained; test this by adding a few drops of nitric acid (to which a drop of sulphuric acid has been added) when a play of colors will be observed, of which *green* is characteristic of bile pigment.

Some biliary calculi are almost wholly composed of pigment, in which case they are small like gravel and have a tarry, blackish lustre, appearing homogeneous when broken across. (Ralfe.)

Pancreatic calculi are oval in shape, their surface often presents worm-eaten appearance of whitish color, acquiring an enamel-like lustre when rubbed; when broken across, their fracture presents a glistening white porcelain appearance.

Intestinal concretions: found chiefly in cæcum and large intestines, vary in size and composition, yellowish inclining to gray or brown, nucleus usually a foreign body, gall-stone, woody fibre, fruit-stone, etc. Some concretions consist of hair, woody fibres, husks of seeds. In people eating oatmeal, concretions composed of fragments of the envelopes of the oat studded or encrusted with triple phosphate crystals are sometimes found.

Intestinal concretions should first be extracted with ether and tested for cholesterin, as in case of gall-stones. After this they may be tested like urinary calculi. If they are of yellow, waxy appearance, and varying in size, they may consist of 60 to 70 per cent fatty matter mixed with earthy phosphates and a substance of a fibrinous nature; in this case first extract with ether to remove the fatty matter, then test the residue with hydrogen peroxide, which will cause effervescence if a fibrinous substance be present. Oatmeal concretions (avenoliths) may be examined with the microscope for triple phosphate crystals.

Salivary calculi are rare and easily recognized from their position, which is usually in Wharton's duct, near the outlet.

Prostatic concretions are of two kinds, small and large; the small ones are chiefly carbonate of lime, and when powdered effervesce strongly with hydrochloric acid; the larger ones contain more phosphate and less carbonate of lime.

Gouty concretions are composed of sodium urate, at first semi-fluid, but soon becoming hardened and chalk-like.

Products of degenerations: in fatty *infiltration* there is excess of fat in the blood; in fatty *degeneration* the fat is not derived directly from the blood, but by retrograde changes taking place in the proteid constituents of the tissues themselves.

Lardaceous degeneration is said to be an infiltration by histologists, but a true degeneration by chemists; the term *lardacein* is now applied to the substance giving the waxy appearance to the tissues (instead of *amyloid*, the term formerly used), as it is a definite nitrogenous body, and related to the proteid group. *Hyaline degeneration* is probably the first step in a process, which, if acute, leads to fatty degeneration, but if chronic, to lardaceous. Amyloid bodies are found chiefly in the prostate, ependyma of ventricles, the fornix, choroid plexus, retina and spinal cord of aged persons; they are apt to become calcified, and when thus met with in nerve centres constitute what is called "brain sand." These bodies have nothing to do with lardacein.

Mucoid and colloid degeneration: in the former we find an increase of mucin in connective tissue elements; in the latter the gelatinous constituents seem to be converted into collagen, which is the substance obtained from the white fibres of connective tissues. The fluids of mucoid degeneration are precipitated by acetic acid; those of colloid, not. In *myxoedema* we find a jelly-like swelling of the connective tissue consisting of an overgrowth of the mucus-yielding cement by which the fibrils of the white element are held together. (Ralfe.)

Calcareous degeneration: calcareous deposits consist chiefly of calcium carbonate, calcium phosphate, magnesium phosphate, traces of soluble salts and, usually, fatty matter and cholesterin. Exhaust with ether to remove fatty matter, and examine the residue for lime by dissolving in acetic acid and precipitating with ammonium oxalate.

Exudations: *Pus* is a pathological product, consisting essentially of a liquid portion, which is exuded liquor sanguinis, and white corpuscles, very much like those of the blood, but still more like those of mucus. The composition of pus has been given as: water, 87; proteids, 8.5; fatty matters, 3.0; extractives, 0.7; salts, 0.8. The corpuscles yield several albuminous substances, as also the *liquor puris.* Pus is usually alkaline in reaction; with ammonia or caustic potash solutions, pus becomes tenacious or jelly-like, thus distinguishing it from mucus, which becomes less tenacious and more fluid with the same reagent. Hydrogen peroxide, when added to pus, causes effervescence, a point of some importance in dentistry, as shown by Harlan, Frank Gardiner and others. The blue color noticed on dry bandages which have been in contact with pus, is due to *pyo-cyanin*, generated by a bacillus, and probably the same one that sometimes gives milk a blue color.

Dropsical fluids, etc.: These are blood serum more or less diluted with water; specific gravity, 1.005 to 1.022; constituents: proteids (sero-albumin, paraglobulin and fibrinogen); a small proportion of fatty matter, in old cases some cholesterin, extractives (urea, glucose, sometimes a little leucin), and blood salts. Hydrocele fluid frequently contains succinic acid and more cholesterin than other fluids.

Cerebro-spinal fluid does not coagulate when heated, but becomes opalescent and gives a flocculent precipitate on addition of acetic acid. Liquor amnii and allantoic fluids are usually clear and colorless, and contain in early period of gestation considerable sugar, which gradually disappears. Allantoic fluid contains a characteristic ingredient, *allantoin.*

Synovia is denser than the fluid of serous sacs, and more viscid from presence of mucin.

Ovarian cyst fluid has been treated at some length by the author, in the *Medical Era*.* May be a clear albuminous serous liquid, or a thick gelatinous substance; specific gravity, from 1.007 to 1.062; it almost always contains a sediment; reaction, alkaline; color, odor, transparency and consistency variable; *A typical ovarian fluid is almost always viscid, its specific gravity higher than that of a broad ligament cyst, and as a rule it does not coagulate spontaneously* (Garrigues). Ovarian fluid consists of water, albuminoids, fats, salts and extractives, and of these constituents the albuminoids are of greatest clinical significance; among the latter we find *paralbumin* and *metalbumin*, two substances whose composition is doubtful. They are probably intermediate products of the transformation of proteid substances into mucoid or colloid matter. Paralbumin contains a body somewhat resembling glycogen. Both paralbumin and metalbumin have been found in renal cysts, as well as ovarian. It is difficult to distinguish, chemically, ovarian cyst fluid from that of cyst of another organ. (Garrigues thinks it can be done microscopically, up to a certain point, by finding columnar epithelial cells, seen in side view, which he contends are not found in any fluids except those from tumors of the ovary, Fallopian tube and broad ligament, and possibly cyst of the pancreas.) Chemical examination may fail to distinguish *ascitic* fluid from ovarian. If the solids be in excess of those of blood serum, we can say positively that the fluid is not ascitic (Ralfe). Garrigues says ascitic fluid "can sometimes be recognized by mere inspection. The specific gravity cannot be used for a diagnosis. As a rule, some spontaneous coagulation takes place, but sometimes not. On the other hand, ovarian fluid may coagulate sponta-

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*See *Medical Era*, vol. 1, page 116.

neously. Scherer's test for paralbumin has no value for the differential diagnosis. It can always be made by the microscope, showing flat endothelium and ameboid lymph corpuscles." Ascitic fluid "arising from cancer of the peritoneum differs, perhaps, from simple ascites by containing large round or pear-shaped endothelial cells, with large nucleus, either isolated or in groups. Ascitic fluid, mixed with ovarian fluid, is full of endothelial cells and flakes, which undergo fatty degeneration. Ameboid lymphoid bodies are found together with columnar epithelial cells. It did not coagulate spontaneously in my cases. Even when there is a long rent in a cyst, the fluid inside and outside the cyst may be different."

Ascitic fluid can then sometimes be differentiated from ovarian, in that it is usually not viscid. Another point of difference is that in ovarian fluids the histological elements are, as a rule, preserved for weeks or months; not so with ascitic fluid or broad ligament cyst fluid. Ascitic fluid, as a rule, coagulates spontaneously and slowly, forming a small coagulum, but this does not always happen; ovarian fluid, as a rule, does not coagulate spontaneously, and if it does the coagulation takes place slowly. Fluid of uterine fibro-cysts *sometimes* coagulates and then spontaneously, promptly, and completely. Both ovarian cysts and cysts of the broad ligament may have serous or colloid contents, but the latter is common in ovarian cysts, rare in extra-ovarian cysts, while watery fluid is common in extra-ovarian, rare in ovarian cysts. The fluid of *cysts in the abdominal wall* differs from that of ovarian by being limpid, serous, and lemon-colored. The fluid of *spina bifida* contains no serum-albumin, *i. e.*, is not coagulated by heat, and no histological elements. Hydatid cyst fluid is limpid, opalescent on standing, reaction 1009 to 1013, no albumin unless inflammation of the cyst wall. Great characteristic is the amount of *sodium chloride*, which will distinguish it from any other fluid even when the "hooklets" are absent.

Fluids from *hydro-nephrotic* cysts is of low sp. gr. (1004), no albumin, reaction faintly acid, often neutral. Urea may be present in large amount or be absent. *Encysted peritoneal collections* never are viscid.

EXAMINATION OF URINE.*

CHAPTER I.

Physical characteristics: Collect total *quantity* in twenty-four hours (except in certain cases hereafter specified); notice whether *color* is pale, normal (amber) or high (dark); notice whether *odor* is normal (urinous), strong urinous or offensive (ammoniacal); notice whether *reaction* is acid, alkaline or neutral; if acid, turns blue litmus paper red; if alkaline, turns red paper blue; if neutral, no effect upon either; take *specific gravity* with urinometer, noticing whether it is normal (1015 to 1025), high (1030 to 1060) or low (1012 to 1002); notice whether the urine deposits a *sediment* on standing.

Abnormal constituents: Albumin, sugar, bile, peptone.

I. Filter entirely clear, fill test-tube half-full of filtered urine, and cause cold nitric acid to trickle slowly down its side: zone of turbidity may indicate presence of some proteid (sero-albumin, peptone).

II. If proteid is thus suspected, take a fresh amount of filtered urine, neutralize (with acetic acid if urine is alkaline, or with potassium hydrate solution if *strongly* acid) and boil. A coagulum shows that the proteid found in I. is sero-albumin, and not peptone or other substance.

III. If no proteid is found in I., do not go through with II.

IV. If sero-albumin has been found as in II., filter the urine from the coagulum and add the filtered urine to boiled sugar test solution, and boil. (Haines's test liquid is pure sulphate of copper 30 grains, pure glycerin two fluidrachms, pure caustic potash in sticks 1½ drachms, pure water six fluid ounces; dissolve the sulphate of

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* For clinical significance, see "Practitioner's Guide in Urinalysis."

copper and glycerin in a portion of the water, and the caustic potash in the remainder, mix the two solutions.) A reddish yellow turbidity indicates presence of sugar. If no sugar be present, dirty white flocks of phosphates may be seen. If no proteid has been found in I., no need of filtering before IV, but merely take fresh amount of urine.

V. Whether or not sugar has been found take fresh amount of urine and again perform the cold nitric acid test as in I., but previously adding to the acid a drop of sulphuric acid. A play of colors at the juncture of acid and urine (green prominent) indicates the presence of bile.

VI. Whether or not serum albumin has been found take cold Fehling's solution and cause fresh amount of urine to trickle down the side of the test tube into it. A rosy red color at juncture indicates the presence of peptones; a violet coloration may be noticed when serum albumin is present.

Examination of sediment: Urates, phosphates, pus, mucus, blood, uric acid, calcium oxalate. Before examining sediment let the urine stand until the deposit, if any, has settled; decant the urine from it, and examine it as free from urine as possible.

VII. Heat some of the sediment, gently, in a test-tube, and if it dissolves after warming, *urates* are present. (If no albumin be present in the urine, the warming may be carried to a point just short of boiling.)

VIII. If the sediment does not dissolve on warming, take a fresh amount, add a few drops of acetic acid, agitate well, and if sediment dissolves, *earthy phosphates* are present in the sediment.

IX. If the sediment shows no change with warmth or with acetic acid, take a fresh amount, get as free from urine as possible, drop into it a small fragment of caustic potash, and if after the latter dissolves, the sediment becomes gluey, shown in pouring it slowly from one test-tube to another, *pus* is present.

X. If urates, phosphates, or pus be found or not, take a fresh amount of the sediment and test it for blood; take equal parts of ozonized spirit of turpentine and tincture of guaiac, mix, shake well, and let an equal amount of urine and sediment trickle down the test-tube into the mixture. A blue coloration, very slowly appearing at the juncture of the mixture and the urine, indicates the presence of *blood.*

XI. Examine the sediment closely with the naked eye, holding the bottle above the head and looking up into it: if specks like brown pepper are seen, *uric acid* is probably present; remove some of the specks with the pipette, and examine with the microscope; crystals having marked color are *uric acid.*

XII. If the sediment answers, either not all or only in part, to the above tests, *calcium oxalate* may be present: This sediment is insoluble in acetic acid, but soluble in nitric. By all means confirm with the microscope (400 diameters); colorless crystals resembling reverse of letter-envelope, or possibly dumb-bells, are *calcium oxalate.*

The urine often contains a heavy sediment, not composed of a noticeable amount of any of the above-mentioned substances. This is especially the case in the urine of females, and in albuminous urine. The microscope will show fungi, epithelial cells, oil globules, mucus, and perhaps casts. Spermatozoa must be sought for with the microscope, or the urine tested with Tanret's solution.

Normal constituents:

Urea, urates, urohæmatin, chlorides, phosphates, sulphates, indican.

XIV. If the urine contains serum albumin, remove (neutralize, boil, filter); if not, merely see that the urine is filtered clear. On the clear urine perform the cold nitric acid test, as in I. This may show three things, viz., *excess* of urea, *excess* of urates, *absence*, *presence* or *excess* of urohæmatin: great excess of urea is shown by crystals forming in a ring at line of juncture of acid and urine; the crystals may be so numerous as to fill completely the greater part of the liquid, or they may settle, after some hours, to the bottom of the tube as a yellowish-white sediment (nitrate of urea). On the other hand, excess of urates is shown by the comparatively rapid development of a diffuse turbidity apt to be noticed, first, at the top of the liquid, and extending downwards. This turbidity disappears if the test-tube, held at the bottom, between the thumb and forefinger, be brought in contact with a gas flame. Presence of urohæmatin in normal amount is indicated by a pink-colored zone at juncture of urine and acid; *excess*, by a dark-colored zone; *absence*, by lack of coloration.

XV. Take fresh amount of the filtered urine, add a few drops of nitric acid and some silver nitrate solution; a curdy white precipitate (silver chloride) indicates presence of chlorides. Normal urine should show an abundance of this precipitate.

XVI. Boil a fresh amount of the filtered urine, and add ammonium hydrate solution; a flocculent precipitate shows presence of earthy phosphates; filter, and to the filtered urine add ammonium carbonate solution and magnesium sulphate solution; a white precipitate shows presence of alkaline phosphates. (Excess of earthy phosphates in urine, *free from sediment*, may be detected by a flocculent precipitate after the urine is boiled, and before the ammonia is added. Albumin, of course, must be absent when this test is made.)

XVII. To fresh amount of filtered urine add a few drops of hydrochloric acid, and some barium chloride solution. White precipitate shows presence of sulphates.

XVIII. To fresh amount of filtered urine add hydrochloric acid, letting it trickle down the side of the test-tube. Violet zone shows the presence of *indican*.

2. Objections and Precautions:

Physical characteristics: in certain forms of Bright's disease, where only a small amount of albumin is present, it is advisable not only to examine the urine of twenty-four hours but that voided after *muscular exertion* separately.

In cases where sediments occur, the urine of different micturitions may be collected separately, and the length of time necessary for the sediment to form noticed. The more rapid the formation of the sediment, the greater the danger of calculus.

In observing the color of the urine, filter into a clean beaker; in noting the odor, distinguish carefully between intensified urinous odor, as in fevers, and the pungent odor of ammoniacal urine, as in cystitis. Absence of odor is noticed in some forms of Bright's disease, and a sweetish smell in diabetes mellitus. In taking the reaction, allow the litmus paper to become saturated. In taking the specific gravity, shun cheap urinometers and beakers of small diameter, and see that the urinometer does not adhere to the sides of the beaker.

Abnormal constituents:—in performing cold nitric acid tests, if the acid is trickled into the urine, it is convenient to pour the acid from a test-tube of small diameter into one of larger diameter containing the urine; or at any rate, the lip of the tube containing the acid should be inserted well into the tube containing the urine. Be prepared for the action of nitric acid in detecting other constituents than albumin. Do not mistake generally diffused turbidity, slowly appearing (urates), for the almost instantaneous, well-defined and whitish zone characteristic of a proteid. Remember that, in most specimens of urine, the cold nitric acid causes a color-zone at the juncture of acid and urine, which must not be mistaken for a proteid.

For routine purposes, the finding of a proteid zone with nitric acid is all that is necessary, and II. may be omitted. In all cases it is desirable to ascertain whether the albumin be due to the presence of *pus* or *blood*. The sediment also must invariably be examined with the microscope for tube-casts (see *Guide in Urinalysis*). If for any reason it should be important to distinguish serum-albumin from peptone remember that *heat* is the great test for the former, but in very acid urine the albumin becomes converted into acid-albumin and in alkaline urine into alkali-albumin; it is therefore necessary before applying the heat test to neutralize carefully if the urine be alkaline or *very* acid (the latter shown by turning blue litmus paper bright red). In neutralizing it is convenient to have the urine in a beaker rather than in a test-tube, and if the urine be alkaline, acetic acid may be added drop by drop until the reaction is neutral or slightly acid; if the urine be strongly acid, solution of potassium hydrate may be added cautiously until the reaction be slightly acid; if on boiling after addition of potassium hydrate, a flocculent dirty-white precipitate be noticed, remember *phosphates*, and if a general yellow coloration turning a deep red, remember *sugar*. To identify serum-albumin, then, in strongly acid urine by the process involving neutralizing and boiling, is not always easy; if any doubt occurs, the following process may be used: On filtered urine perform the cold nitric acid test, and, holding the bottom of the test-tube between the thumb and forefinger, subject the turbid zone of proteid to heat, over the gas flame; if the zone disappear under the action of heat, sero-albumin is not present. To decide whether the coagulation caused by the nitric acid was due to presence of *peptone*, fill a test-tube half full of sugar-test solution, and allow fresh amount of the filtered urine to trickle down into it, a rosy red coloration at the juncture indicating that peptones are present.

In testing for sugar it is well to remove serum-albumin (if any) from the urine, by neutralizing if necessary, boiling and filtering. In boiling the sugar-test solution it is well to add beforehand a few clean fragments of a clay-pipe to prevent sudden boiling. Note carefully that urine containing excess of uric acid (usually a high color, high specific gravity, strong acid reaction) *may give a reaction resembling that of sugar.* In case of doubt, try the indigo-carmine test. (See Bedside Testing.) Sometimes various colorations are formed, owing to the mixture of the blue color of the test liquid and the color of the urine; sugar, however, is indicated by a *reddish-yellow turbidity.* Remember that the test liquid makes the urine *alkaline*, and therefore, especially when hot, precipitates the phosphates; the error of mistaking these phosphates for sugar is made so often as to become a standing joke among medical students.

Examination of sediments: Remember that a sediment of urates is not seen until after the urine cools; most urate sediments are reddish in color, but sometimes creamy-white deposits of them are noticed. The urate sediment is often very heavy, and will clear completely with gentle heat. If the urine contains albumin, some care must be exercised in detecting urates in the sediment; the sediment must be warmed gently for a considerable time, the test-tube being not held in the flame, but passed to and fro through it. If the urine does not contain albumin, heat may be applied more directly, and the test made more rapidly, but the sediment should never be boiled, lest any excess of phosphates in solution be thereby precipitated and leave the urine still turbid.

Great confusion exists in the minds of the inexperienced in regard to phosphates. It must be remembered that salts of phosphoric acid are found in the urine normally in solution, viz., phosphate of sodium, phosphate of potassium, phosphate of calcium, phosphate of magnesium. Of these, phosphates of sodium and potassium never occur in the sediment. Nor are they precipitated by making the urine alkaline; we therefore dismiss them from consideration, as they cut no figure either in testing for abnormal constituents or the contents of sediments. On the other hand, the phosphates of calcium and magnesium are precipitated whenever the urine is made alkaline, and especially if in addition it be heated, as for instance in making a test for sero-albumin or for sugar. These phosphates may be in excess in the urine and yet not occur as a sediment if the reaction of the urine be sufficiently acid to keep them in solution. If, on the other hand, the reaction of the urine be feebly acid, neutral, or alkaline, an excess of these phosphates will be at once shown by formation of sediment. If the reaction of the urine be alkaline, a sediment of these phosphates will always be observed, whether they be normal in amount or in excess. A sediment of these phosphates, then, does not necessarily indicate that they are in excess, but merely that the reaction of the urine is not acid enough to hold them in solution. They are detected as a *sediment* by their ready solubility in acetic acid. Where the sediment is heavy, do not be sparing of acid. Excess of these phosphates in solution, where no sediment is present, is determined according to methods which will be shown hereafter under the head of *normal constituents.* Phosphatic sediments are light colored.

Detection of pus is not always easy. Where the sediment is flocculent and does not stick to the glass, the caustic potash test works very well, and the stringy character of the mixture is easily shown. When, however, the urine is alkaline, and *sometimes when not*, the pus sediment may be already stringy and tenacious of itself; in such cases, remove some of the sediment, and treat it with hydrogen peroxide, when a noticeable effervescence will take place. Urine containing pus will almost always show a slight proteid zone with cold nitric acid.

In testing for blood it is highly important that the urine be freshly voided. Instead of the turpentine and guaiac test, ethereal solution of hydrogen peroxide and guaiac is now used.

Uric acid crystals often are found in urate sediments; gentle heat dissolves the latter, leaving the former as brown specks.

Calcium oxalate sediments are insoluble in heat and in acetic acid, but soluble in nitric acid; the latter acid cannot be used in testing when a proteid is present, and moreover changes the color of the urine so as sometimes to confuse the beginner. The microscope is far superior to chemical tests in identifying these oxalate sediments.

The beginner is frequently puzzled by meeting with specimens of urine which contain no sediment settling to the bottom of the glass, but exhibiting at the same time a generally diffused turbidity. Such urines to be filtered clear require three or four thicknesses of filter-paper. The substances causing the generally diffused turbidity do not answer to any of the ordinary chemical tests, and the result of microscopic examination is often more or less unsatisfactory. The urine of females often is of this nature, especially after a tedious labor. In the first grade of cystitis we find also this generally diffused turbidity of the urine; here, however, if two specimens be placed in separate tubes and acetic acid be added to one but not to the other, the former will often become considerably more turbid, indicating presence of increased amount of "mucus."

Urine seemingly perfectly clear, but which on standing deposits a very slight, easily moved, finely flocculent sediment, only perceptible when held between the light and the eye, should be examined with the microscope for spermatozoa.

Albuminous urine often contains heavy sediment consisting chiefly of fungi, etc., not affected by the various tests.

Bedside testing may be made with (i) dry tests, or (ii) test papers.

Dry tests for albumin: We find the chief dry tests to be trichloracetic acid, metaphosphoric acid. These substances are used as follows: Trichloracetic acid is sold in form of crystals; drop one of these crystals into a test tube half full of the suspected urine, and the test is performed—a cloudy zone forming as the crystal dissolves in the urine, if albumin be present. Metaphosphoric acid (glacial phos. acid) may be used instead of trichloracetic; it is sold in the form of white or transparent sticks, and is used by simply breaking these into fragments and dropping one of them into a test tube containing the suspected urine. As the acid dissolves it precipitates the albumin in the form of a dense cloud, which can be diffused by shaking. A fragment the size of a pea is enough for a fluid drachm of urine. It should either be freshly made, or when made kept in a tightly-stopped bottle.

Objections, etc., to the dry tests for albumin: It will be noticed that the substances just mentioned are both *acids.* The objection to trichloracetic and metaphosphoric acids is (i) if the urine be saturated with urates a turbidity will be caused; this, however, disappears on application of *gentle* heat or heat short of boiling; albumin not; (ii) if the urine contains *resins*, a turbidity will be caused but this will be dissolved by alcohol; albumin not. A precipitate of *peptones* is cleared by heat.

Dry tests for sugar: These are sold in the form of test pellets or tablets. Messrs. Wyeth sell compressed chemical tablets representing the solid constituents of Fehling's test solution; in addition to the tablets, caustic soda is used as follows:

First: Dissolve the caustic soda in sufficient water to measure fifteen minims.

Second: Dilute two minims of the solution of soda with twelve minims of water, and, in this, dissolve one of each of the tablets (Nos. 1 and 2) with the aid of heat.

Sixteen minims (1 c.c.) of this solution are decolorized with precipitation of red oxide of copper, by the addition of 1-12 gr. (0.005 gm.) of glucose, contained in urine, etc.

The tablets must be kept in well-stopped bottles and in a dry place.

To detect the presence of sugar: It is sufficient to add a few drops of the test solution to a small quantity of urine contained in a test tube, and *boiling;* the mixture will then assume a turbid appearance, caused by liberation of red cuprous oxide, which will deposit on standing.

To determine the exact quantity of sugar: Dilute 16 minims of the test solution with one fluid drachm (4 c.c.) of distilled water, and in another vessel, dilute 16 minims (1 c.c.) of urine with enough distilled water to measure 160 minims (10 c.c.). Boil the test solution and add the diluted urine, until the blue color is completely discharged. The quantity of the latter employed is divided by 10, and the result represents pure urine, containing 1-12 gr. (0.005) of sugar.

Objections to the use of these pellets are the same as those to Fehling's solution.

Test-papers: The use of test *papers* was first suggested in England by Dr. George Oliver, of Harrogate. Certain new tests for albumin were presented to the physician in the shape of slips of paper impregnated with the various reagents employed.

Messrs. Parke, Davis & Co., now manufacture a pocket case containing these urinary test papers, test tubes, etc., which for cleverness, ingenuity and convenience, leaves little to be desired. The case contains eleven sets of test papers, arranged in slips, so as to be readily torn off for use. The different test papers are *purple* litmus (turning blue with alkaline and red with acid urine), citric acid, picric acid, potassio-mercuric iodide, potassium ferrocyanide, sodium tungstate. The last four are used for testing for albumin in connection always with citric acid. The papers are used as follows: "To test for albumin, a slip of the citric-acid paper is first placed in a small test tube containing about thirty minims of the urine to be tested, and the acid allowed to dissolve. If a cloudiness is produced by the acid, it is due to the presence either of uric acid or of mucin, or rarely of oleo-resins, as in cases where balsam copaiba has been taken medicinally. The urates disappear on warming the urine. Mucin remains, however, and is distinguished from any other constituent of the urine by this behavior. The oleo-resinous precipitate is cleared up by boiling, but quickly returns while the urine is still warm.

After observing the effect of the acid alone, add the albumin precipitant, one of the four papers above named.

As the reagent dissolves, albumin, if present, is precipitated in the form of a distinct cloud, which is rather increased than diminished on application of heat. The most sensitive of these reagents is the potassio-mercuric iodide, but the sodium tungstate and the picric acid are only slightly inferior. Potassium ferrocyanide is decidedly less sensitive; the range of its indications, however, is practically the same as that of nitric acid.

The mercuric reagent and picric acid precipitate alkaloids, such as quinine, which may be present in the urine. The precipitates, however, are readily distinguished from those of albumin by the fact that heat dissipates them; alcohol also dissolves them. All these reagents except potassium ferrocyanide precipitate peptones, but heat clears up the solution. As tests for sugar the series contains: 1st, Indigo carmine—Mulder's reagent. This is the most conclusive and the best single test we possess for glucose. To make the test, an indigo paper with a sodium carbonate paper are placed in a test tube with 30 minims of pure water, one minim of the urine is added, and the pale blue solution is boiled 60 to 90 seconds. It is best not to allow the fluid actually to boil, but to maintain it at the boiling point. No more of the indigo paper should be used than will suffice to produce a distinctly blue solution. If sugar is present, the color slowly changes to purple, red, and finally pale yellow. Where there is less than 2 grains of sugar to the fluid ounce the color becomes simply red or purple, and it is possible to estimate approximately the quantity of sugar by diluting the urine to $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, etc., until the limit of the reaction is reached.

2. Picric acid in combination with sodium carbonate. This test, introduced by Dr. Geo. Johnson, is capable of detecting very minute traces of sugar. A picric acid

paper with two or three grains of sodium carbonate* is put into a test-tube containing 30 minims of water, 5 minims of the urine is added, and the mixture boiled one minute. If sugar is present the solution assumes a reddish color, becoming a deep ruby or garnet red if there is much sugar.

Normal urine always gives an indication of sugar by either of these tests, but if the quantity of urine employed does not exceed one minim, the diagnosis of glycosuria can be made by their means with at least as great certainty as by the use of the familiar copper test."

Specific gravity beads: These may now be used instead of the urinometer, and are included in the case described above. All six of the beads are dropped into the urine: if all sink the specific gravity is 1005 or less; if all float the specific gravity is 1030 or upwards; if three float the specific gravity is about normal.

Sugar test flasks: Little flasks hermetically sealed and containing just enough Fehling's solution to decompose one-fifth grain of glucose are now sold.

Estimation of Urea: The estimation of urea is still far from simple to the ordinary practitioner. Fitch's ureameter, sold by Hodges, of Utica, has much to recommend it, and is used as follows:

Fasten the U tube to burette with rubber bands, place in clamp of stand, and lower so that the mouth of burette nearly touches the bottom of tumbler filled with water.

The temperature of the urine, water and solution of hypobromite should be that of the room, and not below 70° F.

By suction through tube fill the burette with water and close its pinch cock. Place in the bottle 10 c. c. hypobromite solution freshly prepared. Pour into the test

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* The sodium carbonate contained in a single soda paper is insufficient.

tube the urine until it reaches the graduation of 2½ c. c.; if there is an excess it is easily removed, by absorbent cotton on the end of a probe, to the exact measure. Place the tube inside the bottle, taking care that its contents do not mix with those of the bottle. Put in the rubber stopper with pinch cock open. Now close pinch cock, take the bottle in the holder and incline the bottle so that the urine and hypobromite solution can thoroughly mix. After the evolution of gas ceases, read off the number of cubic centimeters of water displaced from burette (reading from top of burette downward), which number represents the parts of *urea* in one thousand parts of urine.

Before each estimation it is well to lift burette above level of water in tumbler. Open pinch cock and blow through burette. Empty the tumbler and refill with fresh water, thus obviating drawing into lungs the gases of previous operation.

Solutions: *Solution Soda.*—Dissolve 40 grms. caustic soda in water until it measures 200 c. c. The glass stopper had better be paraffined so that it can be easily removed from the bottle.

Solution Hypobromite Soda.—Take 50 c. c. solution soda, add to it 2½ c. c. of bromine; shake until bromine is all dissolved. This quantity makes five determinations, but *but must be used the day it is made.*

Quantitative estimation of **Albumin:** Use Tauret's solution, 1 c. c. of which precipitates one-tenth of a gram of albumin. Add carefully and slowly, letting precipitate settle until no precipitate is obtained by adding a drop of the solution to the supernatant liquid. (See Appendix for Tauret's solution.)

PART III.

GENERAL TOXICOLOGY.

CHAPTER I.

Toxicology: Branch of medical science treating of the nature, properties, and effects of poisons.

Definition of poison: No satisfactory definition can be given.

Administration of poison: By mouth, rectum, vagina, lungs, subcutaneously; in form of solids, liquids, or gases, uncombined or mixed with various matters.

Effects: Local and remote; *local* effects are chiefly corrosion, irritation or inflammation, specific effect on sentient extremities of nerves; *remote* effects are *common* (such as constitutional indications of inflammatory fever) and *specific*, as effects of opium in contracting pupil, producing constipation, etc.

Remote effects of particular poisons:

Morphine and alcohol affect brain;
Strychnine affects cord;
Curare affects motor nerves;
Digitalis affects heart;
Stramonium affects lungs;
Antimony and arsenic affect stomach;
Mercury affects the liver;
Cantharides affects the urinary organs;
Ergot affects the uterus.

Shock: Powerful poisons may cause death from shock.

Modification of action: Dose, mechanical state, chemical constitution, mental and bodily condition of patient. Substances deadly in large doses; often useful in small. Gases, as a rule, more active than fluids, fluids than solids; a pure soluble substance more active than one mixed with foreign insoluble materials. The more soluble in water, the more speedy the effect of a compound; substances insoluble in water, but soluble in the gastric juice, more dangerous than those insoluble in the fluids of the body. Maniacs can endure heavier doses of sedatives than ordinary individuals; persons accustomed to a drug can endure heavier doses of it than others, especially in the case of opium.

Diagnosis of poisoning: A person may be supposed to be suffering from the effects of a poison, if, soon after taking food or drink, he be seized with violent pain, vomiting, purging and convulsions; or if he be attacked under the same circumstances with delirium or great drowsiness. [See also **Administration.**]

Post-mortem appearances: Not always characteristic. May be of negative value in showing that a certain poison has not been given. Detection of poison in food or vomit important, but whether mixed by design or not must be considered.

Duties of the physician: Preserve life if possible; if not, forward the interests of justice as follows: Inquire, and write down results of inquiry, as to time any substance was last taken by deceased, the nature of all symptoms, the hour when they began, the precise hour of death. Take possession of all food, medicine, vomited matters, urine or fæces present in the room; put them in new clean vessels, seal and label. Observe position, temperature of the body, appearance of countenance, presence or absence of rigor mortis, nature and warmth of apartment, situation of any marks of violence, condition of inside of mouth and gullet.

Post-mortem examination: Pass a double ligature around the œsophagus, and also around the duodenum, a few inches below the pylorus; cut *between the ligatures*, above and below, and the stomach may be removed without loss of contents. Make a ligature low down in rectum and remove intestines for examination also. Save all possible blood and as much of the liver as possible. In the case of women inspect vagina, ovaries, uterus. Brain, spinal cord, thoracic viscera should be examined, and portions of spleen, kidneys and muscles reserved for analysis. Place all organs, etc., removed, in clean large jars, *without alcohol or any antiseptic or preservative fluid*, seal, number, label and initial.

Behavior of suspected persons: Note any suspicious conduct on the part of those surrounding the poisoned individual before, during, and after death of the patient. (Tanner.)

Household treatment of poisoning: A paper on treatment of poisoning where modern appliances are not at hand or where it is difficult to obtain the services of a skilled physician has been published by Dr. C. W. Dallis in *Lippincott's Magazine*, as follows:

(1.) *If the poison is not known.*—If the patient should vomit at once—which is often the case—this should be encouraged; if not, it must be provoked. The simplest way to do this is to give *large draughts* of lukewarm water, and thrust a finger down the throat. If there be time, and it is at hand, a *teaspoonful or two of ground mustard* may be stirred up in the water, or a half-teaspoonful of powdered ipecac, or a tablespoonful of the syrup of ipecac. Further, let it be remembered that there is no occasion for fastidiousness; any water will do. *Water in which hands*—or dishes, for that matter—have been washed, may by its very repulsiveness act more quickly than anything else; and if soap has been used it will be all the better for that, as soap is an antidote for acid poisons. And the quantity used must be large; the sufferer must be urged to drink and drink, a pint at a time, until he can contain no more, and has been made to vomit over and over again.

After copious *vomiting* give soothing liquids, oil, milk, beaten-up raw eggs, all in moderately large quantities. If the hands and feet are cold, the lips blue, the face pale, and there is a cold perspiration on the forehead and about the mouth, give some stimulant; strong moderately hot tea is the best; strong coffee next. To these may be added brandy, whisky, wine or alcohol, in tablespoonful doses for adults, half as much for a child; or the spirits may be given mixed with a little hot water. Warm coverings should be used, and if the depression be great, hot-water cans or hot bricks wrapped in one or two thicknesses of blanket should be laid by the side of the chest, or a huge poultice placed like a jacket round the body, or a blanket wrung out of hot water and covered with a dry one. In cases of poisoning then:—

1. Send for a doctor.*
2. Provoke copious and repeated vomiting.
3. Give bland soothing fluids: oil, milk or eggs.
4. Stimulate if there be depression.

Acid poisons: There are chiefly *oil of vitriol* (sulphuric acid), *nitric* and *muriatic acids;* they are heavy sometimes yellowish looking fluids, the first not unlike oil in appearance but very heavy in a bottle. The others are lighter and give off extremely pungent irritating fumes. All discolor anything on which they fall; the first blackens pine wood, the others turn it yellow. All burn horribly and leave no doubt of their caustic nature. The *treatment* for poisoning by these acids is to give an *alkali.* If hartshorn be at hand it may be mixed with water (tablespoonful to two teacupfuls of water) and given; or soda, magnesia, lime, whitewash, chalk, tooth paste, whiting, plaster, or soap may be stirred up in water and given; or on a pinch, wood ashes might be used. No time should

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* It will be remembered that these are directions to a household.

be wasted in selecting; the nearest thing should be used at once. As soon as the antidote is down, provoke vomiting, which should be repeated once or twice. Next give bland liquids and afterward secure rest and employ stimulants if necessary. In a word then:—

1. Give alkalies.
2. Provoke vomiting.
3. Give soothing liquids.
4. Secure rest.
5. Stimulate if necessary.

Oxalic acid comes in small, heavy, bright, colorless crystals, causing a clear rattle in a bottle or jar. The best antidote for this is *lime*. Give lime water, whitewash, toothpowder, chalk, whiting or plaster from a wall.

Carbolic acid is usually in solution as a thick, clear or dusky fluid. Taken by the mouth it causes whitening or shrivelling of the mucous membrane with intense burning and numbness. It acts quickly and benumbs the stomach so that it is hard to provoke vomiting. Attempts to provoke vomiting should be made and large amounts of oil or milk given; rest, warmth of body and stimulation must be secured.

Alkaline poisons: These are *ammonia*, always in fluid form (hartshorn), clear, if by itself, and with an unmistakable odor; *potash* and *soda* usually dissolved and sometimes in form of lye. Liniments sometimes contain these substances and are swallowed by mistake. The alkalies usually burn intensely but not so deeply as the mineral acids. *Treatment:* vinegar undiluted and in pint doses; lemon juice may be used. Vomiting should next be provoked, followed by bland, acid or oily drinks; rest and stimulation if necessary. In cases of poisoning by an alkali then proceed as follows:—

1. Give an acid (vinegar).
2. Provoke vomiting.

3. Give acid or oily liquids.
4. Secure rest.
5. Stimulate if necessary.

Acids and alkalies act as direct irritants; other poisons entering the system may cause poisoning in a stricter sense. The commonest are arsenic, sugar of lead, corrosive sublimate and tartar emetic.

Arsenic: This substance comes as a white sweetish powder often used to destroy domestic pests. It usually provokes vomiting and violent pain in the stomach. The vomiting must be encouraged and dialyzed iron* given; this can be procured at any drug store. It should be given freely in tablespoonful doses and each dose followed by a teaspoonful of common salt in a little water. After this, vomiting should again be provoked and a dose of castor oil given. *Paris green* is an arsenical preparation, and if taken as a poison must be treated like simple arsenic.

Sugar of Lead comes in white lumps or in powder. *Treatment* consists in administration of an emetic —magnesium sulphate, milk, eggs, castor oil.

Corrosive Sublimate comes in small colorless crystals or in clear solution; is used to destroy insects. *Treatment* is to give an emetic and tea, afterward eggs and milk.

Tartar Emetic is a white powder. *Treatment*, same as for corrosive sublimate.

Phosphorus: This substance is often chewed off the ends of matches; it acts more slowly than the other poisons. Give 5-grain doses of copper sulphate in water at intervals of ten minutes till vomiting is provoked, then afterward give magnesia.

Opium: This poison may be in the form of opium, laudanum, paregoric, black drop, soothing syrups, pain-

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* See chapter on arsenic.

destroyers, etc. The symptoms are deep sleep, narrowing of the pupil of the eye to a small circle not enlarging in the dark. The *treatment* consists in the administration of emetics so that vomiting may be promptly and persistently brought about; twenty-grain doses of zinc sulphate may be given for this purpose. Strong coffee should be given. Electricity may be necessary to rouse the patient, in which case the current should be applied to the skin of the chest strongly enough to cause pain and provoke efforts at crying. Instead of fatiguing the patient by walking him round, etc., it is better to lay him on a lounge and slap the skin with the back of a brush or with a slipper. Artificial respiration may be resorted to, as follows: Place a roll of cloth under the patient's shoulders, slowly draw the arms away from the sides and round till they meet above the head, then quickly double them and push them down hard against the sides of the chest; it may be practiced eighteen times to the minute.

Chloral comes in the form of damp, colorless crystals, but is usually in form of solution. The *treatment* is the same as for opium.

Strychnine: This is a white powder, having an intensely bitter taste. The symptoms are lockjaw, stiffness of the jaws, and then of the limbs and body. The *treatment* consists in the administration of an emetic and a purgative, thirty-grain doses of potassium bromide, twenty-grain doses of chloral, or both (to an adult). The room should be quiet and dark, with all doors, windows and shutters closed to keep out sights, sounds and draughts.

Aconite: This poison is sometimes found in liniments. The *treatment* is the administration of emetics and stimulants.

SUMMARY.—POISON.

1. **Unknown.** Provoke repeated vomiting; give bland liquids; stimulate if necessary.

2. **Acids.** Give alkalies; provoke vomiting; give bland liquids; secure rest; stimulate if necessary.

3. **Alkalies.** Give acid (vinegar); provoke vomiting; give bland liquids; secure rest; stimulate if necessary.

4. **Arsenic.** Provoke vomiting; give dialyzed iron and salt; repeat several times; secure rest and give stimulants if necessary.

5. **Sugar of Lead.** Give Epsom salts; provoke vomiting; repeat; give bland liquids; give castor oil.

6. **Corrosive Sublimate—Tartar Emetic.** Provoke vomiting; give tea without milk; repeat; give raw eggs and milk; give castor oil; stimulate if necessary.

7. **Phosphorus.** Provoke vomiting; give five-grain doses copper sulphate; give a dose of magnesia, but no oil.

8. **Opium—Chloral.** Provoke vomiting; give strong coffee without milk; keep up the breathing.

9. **Strychnine.** Provoke vomiting once or twice; give purgatives; keep patient absolutely quiet.

10. **Aconite.** Provoke vomiting; stimulate well.

11. **Lunar Caustic** (Silver Nitrate). Give strong solution salt and water; provoke vomiting. Repeat many times.

12. **Alcohol.** Provoke vomiting; give hartshorn and water.

13. **Jamestown Weed, Hemlock, Nightshade, Toadstools, Tobacco.** Provoke vomiting; stimulate well.

14. **Decayed Meat or Vegetables.** Provoke vomiting; give purgative; give powdered charcoal.

To provoke **vomiting** give pint at a time of warm water, with or without ground mustard (tablespoonful to pint), or give ipecac (teaspoonful of the powder or a tablespoonful or two of the syrup), or thrust the finger down the throat of the patient.

Bland Liquids are milk, raw eggs, gruel, oil.

Stimulants are tea, coffee, whisky, wine or hartshorn (teaspoonful to a teacupful of water at a dose). In making tea or coffee mix hot water with the leaves or grounds and give the whole. *Alkalies* (to be used as antidotes to acids) are hartshorn and water (tablespoonful in two teacupfuls), soap and water, lime, whiting, soda, chalk, tooth powder, plaster, magnesia, whitewash, wood ashes. *Acids* (to be used as antidotes to alkalies) are vinegar and lemonade. Never wait for an antidote to dissolve, but stir it up in any fluid at hand, except oil, and cause the patient to swallow it at once.

Instruments: Stomach pump, hypodermic syringe, soft rubber catheter, enema syringe. If no stomach pump is at hand, pass end of *long rubber tube* down the œsophagus and into the stomach. Raise free end above patient's head, attach a small funnel to it and pour in enough water to fill stomach. Next carry free end below level of the stomach, and the contents of the latter will flow out. This process may be repeated indefinitely. In prolonged cases the bladder may be catheterized. If it be necessary to use the *battery*, place one pole at side of neck, the other over pit of stomach or over muscles of the chest; or both poles may be applied to the chest touching each to a different attachment of muscles, using strong current, exciting pain and producing efforts at crying.

Flagellation may be required to combat depression produced by narcotics; slap the skin with wet towels, rub soles of feet with stiff hair brush; do not walk the patient round but lay him on sofa and flagellate.

Douches: May be used to aid in rousing when there is stupor and depression; dash cold and warm water alternately on the head and chest of patient. In apparently hopeless cases, two or three sharp *blows* on chest in quick succession will sometimes restore the heart's action.

Stimulation: If stimulants be required, alcoholic ones may be used if the poison be *not a narcotic;* use coffee where belladonna, opium, and other narcotics are the poison; give an enema of a pint of hot, strong coffee. Ammonia is a stimulant and may be given by inhalation or injected into veins. Strong tea is an excellent stimulant, and also acts as an antidote to many poisons. Whiffs of ether will stimulate heart's action. (Gatchell in "Key Notes.") Aromatic spirits of ammonia is often used.

Procedures on part of the **Chemist:** On receiving stomach, etc., for analysis note in writing:

1. Name of person from whom received.
2. Date upon which received.
3. Place at which delivered.
4. Number of articles with description.
5. Condition in which articles were (whether securely sealed, etc., or not) when received.

The analyst should require the materials sent for analysis to be forwarded by hand and delivered to himself personally.* After receiving the materials the following precautions should be observed:

1. The matters for analysis should be kept under lock and key, no duplicate key being in possession of a second person.

2. The analysis must be conducted by the chemist alone.

3. In opening bottles or jars, the seals should not be broken but cut out unbroken and preserved for identification if necessary, in the witness box.

4. Analysis should be begun as soon as possible owing to volatility of many poisons.

5. Contents of different jars should be examined separately.

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* Not an easy matter to bring about in this country.

6. Every solid should be weighed and every liquid measured.

7. Only one-third or one-half of the contents of each jar should be examined at first, so that in case of accident the process may be repeated.

8. Only apparatus that is thoroughly clean should be used—preferably, that which has never been used before—and such reagents as have been proved by the chemist himself to be pure.

9. Certainty of the presence of a poison can be shown only by results of a combination of tests.

10. Solutions should be concentrated before being tested.

11. The delicacy of tests is interfered with by presence of complex organic mixtures.

12. In all cases the quantity of poison should be estimated.

13. In examining the stomach, the *contents* should be poured into a measuring glass and the quantity noted; next the *stomach itself* should be opened, spread out on a clean white plate and its internal appearance noted in writing; with a hand magnifying glass the surface should be inspected and possibly *fragments* of leaves, fruits, seeds or roots may be noticed or *adherent powders*, like magnesia, calomel, arsenic, or *crystals*, as oxalic acid, or *shining particles*, as cantharides, yellow sulphide of arsenic, orange sulphide of antimony, or *coloring matters*, as in case of vermin killers, or *pieces of matches;* whatever be found should be preserved. The intestines should be examined in a similar manner.

14. In examining *the contents* of the stomach the following points should be noted: The *quantity* by measure; the *odor*, whether of alcohol, chloroform, carbolic acid, prussic acid, opium, etc.; the *color*, whether dark, grumous, charred, as due to mineral acids; the *reaction*,

whether acid or alkaline; the *consistency* and apparent composition; so that an idea may be had of how long before death the person had a meal, and of what the meal consisted. In suspected cases of poisoning in children, note presence or absence of starchy matters, milk, etc. (Woodman and Tidy.)

Letheby's process of **systematic analysis:**

Put stomach and contents into clean, wide-mouthed glass bottle. Stand this in some warm water in a basin, covering mouth of bottle with clean glass plate, upon which a drop of a solution of silver nitrate has been so placed that it will be freely exposed to the vapors arising from the fluid in the bottle. If prussic acid be present, the drop of silver solution will soon turn white from formation of silver cyanide, *soluble* in boiling nitric acid (silver chloride stain *insoluble*). Immediately after removing the glass plate having on it the silver salt, place over the bottle in a similar manner another glass having on it a drop of caustic potash solution. Allow this to remain for a short time, and after removing it, take the bottle at once out of the water and put the stopper in. Touch the spot of potash solution with a drop, on a glass rod, of a mixed solution of ferrous and ferric sulphate,* when, if hydrocyanic (prussic) acid be present, a brownish-green precipitate is produced, which becomes blue (Prussian blue) on the addition of a little dilute sulphuric acid. Next put a portion of the contents into a retort connected with a Liebig's condenser (apparatus for condensing vapors into liquids) and a well cooled receiver and heat the retort by means of a salt-water bath interposed between the naked flame and retort. Distil over about one-sixth of the quantity in the retort and test distillate for hydrocyanic acid. If found, and the stomach contents were *not alkaline*, the acid was present in a free

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*Ferrous sulphate exposed to the air will do.

state, but if the contents were *alkaline* before distillation it must have been present in the *original liquid* as a cyanide no matter how it may have been administered. Continue the distillation into a fresh receiver almost to dryness. In the distillate other volatile poisons will be found, and their presence for the most part may easily be detected by their odor, such, *e. g.*, as the volatile oils, alcohol, chloroform, ether, turpentine, carbolic acid, nitro-benzole, benzole, etc. Appropriate tests may be made for these. If there is no evidence of volatile poisons acidulate contents of retort with a few drops of pure sulphuric acid, and once more distil into a small receiver containing silver nitrate solution (or caustic potash solution), and the silver solution may be tested for cyanide of silver in case of a precipitate.

Whether anything be found thus far or not, if further work is to be done proceed as follows: Treat all the acidulated materials in the retort with about twice their bulk of alcohol, and allow the mixture to stand in a warm place for about twelve hours, occasionally shaking. Filter the liquid through thick blotting-paper and preserve the *solid matters on the filter paper;* examine the *filtrate* first as follows: through one-half of the clear filtrate pass a stream of well-washed sulphuretted hydrogen for some time. If arsenic, sugar of lead, corrosive sublimate, tartar emetic, or any metallic chloride soluble in alcohol be present, a precipitate will be formed, whilst any change of color produced by a minute trace of metallic salts is best noted by comparing the color of that portion of the filtrate through which the sulphuretted hydrogen has been passed with that portion unacted upon by the gas. If there is any sign of a precipitate the gas should then be passed for a considerable time through the whole filtrate. After standing for twenty-four hours the solution should be filtered, and the precipitate on the filter paper examined for the several metals by different approved chemical processes. If, at this stage of the examination, distinct evidence was obtained of the presence of arsenic (yellow precipitate, with sulphuretted hydrogen, etc.), it would be advisable to take the whole of the solid matters, and, if the liquid contents mix with hydrochloric acid, distil in a retort to dryness, fresh hydrochloric acid being afterward poured on the materials in the retort and again distilled. By this means you will obtain a clear distillate containing all the arsenic as a chloride, and rendering the estimation of the quantity present easy. If no results are obtained by passing sulphuretted hydrogen through the filtrate, allow it to stand for twenty-four hours uncovered, so that the gas may escape. Add now to the whole filtrate an excess of a solution of subacetate of lead and filter. A precïpitate occurring contains, besides gummy matters, etc., sulphuric, phosphoric, oxalic, and other vegetable acids, such as meconic acid, in combination with lead. Diffuse this precipitate through water and pass sulphuretted hydrogen through it to complete saturation, judging when it is complete by the fact of the solution blackening lead paper. Filter off the sulphide of lead formed and examine the filtrate for acids, such as sulphuric, phosphoric, oxalic, meconic, etc. Next go back to filtrate obtained in filtering solution containing precipitate produced by the acetate of lead; pass sulphuretted hydrogen through it until all the lead which was added in excess be thrown down. Filter off the lead sulphide, and evaporate the filtrate in a beaker almost to dryness; add to this a drop of acetic acid and about a drachm of water and filter. Evaporate once more the filtrate almost to dryness; add to it a few drops of water, and supersaturate with a solution of pure caustic potash. Put this into a long, narrow test tube and shake up thoroughly with three or four times its bulk of ether, and allow the whole to stand until the ethereal and watery solutions have completely separated. If any difficulty be experienced in causing the ether to separate, either try to break down the vesicles of ether with a glass rod, or else add a little more ether and a little water. Next decant the colorless ethereal solution in the following manner: Fix an elastic india-rubber ball to a pipette of large size, press out the air with forefinger, introduce end of pipette into liquid, *not below* the ether layer; treat watery solution with fresh ether, shake, allow to settle, and withdraw ethereal solution as before, repeating the process several times if necessary. [If *morphia* or other bodies of limited solubility in ether be suspected, use *chloroform* instead of ether in the process.]

Put all the clear ethereal solutions withdrawn by pipette into a small flask fitted with a long tube and connected with a receiver kept perfectly cold, and apply a gentle heat, collecting and saving the ether that distils over. The residue left in the flask should now be dissolved out with a little dilute acetic acid, and filtered, if turbid, so as to separate any fatty matters that may be left. The residue left on the filter paper will as a rule be pure enough to be tested for alkaloids at once, but if not, treat with caustic potash solution again and take up with ether once more. Take the ether distillate, allow to evaporate spontaneously, add a few drops of pure concentrated sulphuric acid, and allow mixture to stand for twelve hours in a warm place, so as to char organic substances. Dilute with water, supersaturate with potassic carbonate, and treat again with ether, let settle, remove ethereal solution, allow to evaporate spontaneously, and test residue for various alkaloids with the color tests. If no reaction be produced by color tests, try effects of residue on frog. (See *Strychnine.*)

Now go back to thick blotting-paper used in first part of the process, take all the solids left on this paper, cut up the stomach itself, and any other solid matters to be examined, into very small pieces, bruise them in a mortar, place them in a large flask, add to them a mixture of two parts water and one part of pure hydrochloric acid, and slowly and by degrees bring the mixture up to the boiling point. Do not, however, let it boil fast, or for more than a few minutes, and afterward set it aside to cool, and when sufficiently cold, filter, preserving the materials on the filter paper. To the clear filtrate, placed in a glass flask, add one or two small pieces (1½ by ¼ in.) of *pure* copper-foil; the copper should be thoroughly cleansed, first by igniting it in a Bunsen burner, then acting upon it for a minute with nitric acid, and afterward thoroughly washing with water. In this way the copper will be rendered perfectly bright, and after cleaning should not be touched with the fingers. Introduce the copper-foil into the clear hydrochloric acid solution, and boil. If the copper becomes coated, then add fresh pieces of copper, piece by piece, until there is no longer any perceptible discoloration of the last piece that was added. Now remove the pieces of copper, and having washed and dried them between folds of bibulous paper, examine the deposit, whatever it may be (mercury, arsenic, antimony, etc.), by the appropriate tests. Lastly take all the materials left on the last filter paper and incinerate in a Berlin porcelain crucible. Act on the residue with nitric acid, and having diluted with water, filter, and pass sulphuretted hydrogen through the filtrate. In this way any lead or other substances not dissolved out by other means, will be discovered.

CHAPTER II.—ARSENIC, MORPHINE, STRYCHNINE.

Arsenic:

SYMPTOMS.—Faintness. Nausea. Incessant vomiting. Burning pain in epigastrium, worse on pressure, and later all over abdomen. Headache (frontal). Diarrhœa. Constriction and heat in fauces and throat. Thirst. Catching, painful respiration. Quick, feeble pulse; depressed action of the heart. Restlessness and anxiety. Cold, clammy skin. Perhaps tenesmus, with heat and even excoriation round the anus. Death within twenty-four hours.

VARIATIONS.—Pains and vomiting absent. Coma present. Twitching or cramps, especially of legs, present. Sometimes tetanus. Remission of symptoms; patient rallies to sink more rapidly. Death from collapse, sometimes from convulsions.

VOMITED MATTERS.—Clear, ropy, red or brown.

POST-MORTEM APPEARANCES.—Acute inflammation of the stomach, often extending along duodenum, small intestines, and colon. Stomach intensely inflamed and containing dark grumous fluid mixed with tenacious mucus, occasionally tinged with blood. On removing contents the mucous membrane is seen to be red and inflamed, especially around *certain spots*, where particles of the poison *may be found adhering*.

TREATMENT.—If poison just taken, use *stomach pump*, otherwise *emetics;* but if there is already vomiting, promote it by giving *raw eggs and milk*, *equal parts oil and lime-water*. When vomiting is over give an ounce of *castor oil*. After thus evacuating stomach give large doses *ferric hydrate* and act on kidneys with *nitrate of potassium*.

FATAL DOSE.—Two and one-half grains.

TIME OF DEATH.—From two to three hours. (Tanner.)

TESTS.—[See Systematic Analysis.] In *solid* state, heated, gives white smoke and is volatilized; heated in test tube, sublimes and small octahedral crystals settle on sides; heated with fresh powdered charcoal in a test-tube, a ring of gray color will be found on cool portion of tube and garlic odor noticed. In *solution:* Evaporate few drops on glass slide and observe octahedral crystals with microscope. To some of the solution add *ammonio-nitrate of silver*, and a rich yellow precipitate falls. To fresh amount add a little *ammonio-sulphate of copper*, and a pale green precipitate falls. To a fresh amount add hydrochloric acid and sulphuretted hydrogen water, a *lemon-yellow precipitate* falls. With a fresh amount try Marsh's test and distinguish from *antimony* by arsenic *flame*, being bluish white, and having slight odor of garlic, and arsenic *stain* being lustrous and soluble in solution of calcium hypochlorite. [Remove *organic matter* by the following process: Cut into shreds. Mix with one-eighth its bulk pure hydrochloric acid. Heat to boiling and from time to time add crystals of potassium chlorate until the solids become a straw-yellow fluid. Treat with sodium bisulphite until a distinct smell of sulphurous acid is given off. Next pass H_2S for some time into it, which will throw down most metallic poisons in the form of sulphides. (*Do not mistake a deposit of sulphur for a precipitate.* If any doubt, collect the deposit, wash well, and to a small amount add ammonium sulphide, which will dissolve the sulphide of arsenic, if such it be, but not sulphur.) N. B.—The Marsh test for arsenic is interfered with by presence of organic matter.]

REMARKS.—**Emetics:**

The use of *apomorphine* as an *emetic* is in general to be recommended, especially when no stomach pump is at hand or when the jaws of the patient are tightly clenched.

(This substance is an alkaloid prepared by heating morphine in a sealed tube to about 300° F. for two or three hours with large excess of hydrochloric acid. Formula $C_{17} H_{17} NO_2$. Colorless, amorphous, *green* on exposure to air, more soluble in water and alcohol than morphine, gives an amethyst tint with ferric chloride—morphine with this reagent a greenish-blue.) In solution (1 part in 50) *subcutaneous injections of from 3 1-2 to 10 minims (1-15 to 1-5 grain) will produce emesis in from two to five minutes,* with one rush, no nausea but violent and visible muscular action of walls of stomach. Said not to produce emesis in cases of chloroform poisoning. Rees puts the amount for subcutaneous injection for an infant at 1-100 grain. *Mustard* does not always work well as an emetic. Finlay reports a case of poisoning by 26 grains of arsenic where the symptoms were collapse, headache, epigastric pain, constriction of the chest; mustard did not produce emesis, and although the stomach pump was used and the stomach well washed, the patient died in an hour.

Precautions in testing:

In making *tests* for arsenic the *ammonio-nitrate* of silver may be prepared by adding a few drops of ammonium hydrate to a solution of nitrate of silver till the brown precipitate first occurring is nearly redissolved; the *ammonio-sulphate* of copper may be prepared by adding ammonium hydrate to a solution of sulphate of copper till the bluish-white precipitate first formed is almost redissolved. In using the *ammonio-sulphate* care must be taken not to add too much to the solution of arsenic or its blue color may overpower the green of the precipitate.

Preparation of antidote, ferric hydrate:

"Ferric hydrate, or the hydrated peroxide of iron, may be readily made by adding strong solution of ammonia (liquor ammoniæ fortior) to tincture of muriate of iron or to the liquor ferri perchloridi ; filter, and turn the filter paper containing the precipitated hydrate into a vessel containing water, shake well and use the precipitate by spoonfuls as it falls to the bottom." (Tanner.)

Post-mortem appearances:

Putrefaction is said to be remarkably retarded. Wormley mentions a case where the body when exhumed at the end of *three years and a half* was found entire and in a remarkable state of preservation.

Vaughan and Dawson show that arsenic injected into the mouth and rectum after death becomes diffused and may be found in the viscera ; hence, processes of embalming may help the criminal and hinder investigators. Wormley, however, shows that diffusion takes place more readily the sooner after death the injection is made.

O. C. de Poucy has localized arsenic, in cases of poisoning, in the brain ; it seems to be substituted for the phosphorus of phospho-glyceric acid, producing an arsenio-glyceric acid. Lecithin is so modified as to contain arsenic instead of phosphorus.

It is thought that arsenic found in the bones is indicative of the habit of arsenic eating. Ludwig, however' holds that arsenic may be found in the bones in *both acute and chronic poisoning.*

The *urine, liver* and *spleen* must be examined for arsenic. The urine voided from 1 to 7 hours after administration will contain it.

Chronic poisoning: Symptoms are loss of appetite, silvery coating to the tongue, thirst, nausea, colicky pains, diarrhoea, frontal headache, languor, sleeplessness, cutaneous eruptions, soreness of edges of eyelids, emaciation, anæmia.

Arsenical butter: Orfila, Fourcroy, Renault hold that arsenic is all the more harmful when given in butter.

Devergie, Blondlot and Girardin deem the fat an antidote. Chapuis finds that where arsenic has been given in butter that spectroscopic examination of the blood will show a black unique ray projecting from the rays D and E and not splitting up under the influence of oxygen except with the greatest difficulty; [in ordinary poisoning from arsenic the black ray splits up.] This is due, in the case of arsenic mixed with butter, to the presence of *arseniuretted hydrogen* in the blood which while the circulation is normal is eliminated, but when the circulation becomes sluggish, sudden death preceded by vomiting, diarrhœa, etc., may take place. The poison *may not* be localized after death.

Arsenic in the arts:

Arsenic, its compounds or derivatives may be used in the manufacture of candles, tapers, sheep-washes, vermin-killers, rat-paste, wall papers, paper collars and cuffs, water-colors, wearing apparel, (socks, feathers, muslin,) fly-water, metal-cleaners, wafers, confectionery, artificial flowers, preservative soaps, embalming fluids, cigarette papers, aniline compounds. It or its derivatives may be used in glass-making, white enameling, in coloring wines, in stuffing birds and animals, in preventing incrustations in boilers, in the various applications of the green pigments composed of arsenic and copper. (Scheele's Green, Paris Green, Brunswick Green, Schweinfurt's Green.) Arsenic or its compounds may occur as an impurity in certain drugs, as for example subnitrate of bismuth, phosphate of iron; in the acids hydrochloric and sulphuric; in commercial sodium carbonate, in tartar emetic. It may occur in some form in mineral waters. Fly-powder is a mixture of white arsenic and metallic arsenic. Certain metals are often contaminated with it as zinc and iron; it has been found in ferric chloride solutions. Chemists must beware of arsenic in their glassware; Fresenius has found it even in Bohemian glass. All alkaline solutions and reagents capable of acting on glass, if kept in glass bottles should be carefully examined for arsenic before being employed in an analysis for this metal. (Wormley.)

Arsenic in Paper:

An article on "Arsenic as a Domestic Poison," by Dr. Edward S. Wood, in the fifth annual report of the Massachusetts State Board of Health, Lunacy, and Charity, charges many cases of disease upon manufacturers of various colored papers. Wall paper is the most common source of domestic arsenical poisoning; green papers are not the only ones, but arsenic is found more commonly in wall paper of other colors. The cost of the paper is not a test, for expensive papers often contain it, while cheap ones may not. The most dangerous of other papers are the glazed and plated, so largely used by children in Kindergarten schools. Some of these papers contain large quantities of arsenic, and are particularly dangerous, because children are inclined to put things in their mouths. Similar colored papers are used for covering boxes which often contain confectionery, and for wrapping it. The green paper used for sassafras lozenges, and the dark red or magenta colored paper used for checkerberry lozenges are highly arsenical. These poisonous papers are also used in the manufacture of theatre tickets, playing cards, and everything else that is made from card board. Green color is not to be relied upon as principally poisonous, for red, brown, and blue are specially arsenical. Arsenic is used in linen glaze and paper collars and cuffs. German fly paper is made by soaking coarse bibulous paper in a strong solution of arsenite of sodium and allowing it to dry. The following articles contain arsenical pigments, dyes or mordaunts within the knowledge of the British National Health Society: Paper fancy and surface colored, for covering cardboard boxes, for labels of all kinds, for advertising of all kinds, for advertising cards, for playing cards, for wrappers and cases for sweetmeats, for the ornamentation of children's toys, for covering books, for lamp shades, for paper hangings, for artificial leaves and flowers, lithographic color printing, book cloth and fancy bindings. Arsenical poisoning is produced by contact with objects containing arsenic, by inhaling the poisonous dust and gas that come from them, and by swallowing the material.—*American Druggist.*

Water colors may contain arsenic. According to Fleck's analysis of the viscera of a mechanical draughtsman, who died suddenly, showed arsenic in the liver, lungs, kidneys and heart. Fleck found arsenic in sepia, burnt sienna, Vandyke brown, bistre, bladder green, brown ochre, Indian red, umber—both raw and burnt—colors which had been used by the unfortunate man.

Compounds of Arsenic: Arsenious anhydride (called also arsenious oxide, arsenious acid, white arsenic) As_2O_3; its salts are called *arsenites*, the salts of arsenic anhydride, As_2O_5, being called *arseniates*. Other compounds are the sulphide, As_2S_2, called *realgar*, ruby red in color; the arsenious sulphide, As_2S_3, called *orpiment*, bright yellow in color; the arsenic sulphide, As_2S_5, bright yellow in color; the arsenious chloride, $AsCl_3$; the arsenious iodide, AsI_3, brick-red in color; arseniuretted hydrogen, hydrogen arsenide, arsine, is a gas of the formula H_3As.

Medicinal preparations containing arsenic or its compounds:

Liquor Potassi Arsenitis (Fowler's solution): Each fluidrachm contains half a grain of arsenious oxide, antidote ferric subacetate; *sodii arsenias*, arseniate of sodium, usually in solution called *liquor sodii arseniatis;*

cigarettes made of paper saturated in this solution* are also used in asthma; *Liquor Arsenici Chloridi*, solution of chloride of arsenic, 64 grains of arsenious acid acted on by 2 fluidrachms of hydrochloric acid diluted with 4 fluid ounces distilled water, until arsenic is dissolved, and in cooling water added to make a pint; *Arsenici Iodidum*, iodide of arsenic, used internally and externally; *Liquor Arsenici et Hydrargyri Iodidi*, solution of iodide of arsenic and mercury, Donovan's solution, aqueous solution of the two iodides.

Homœopathic preparations: *Arsenicum Album*, white arsenic, As_2O_3. *Arsenicum Citrinum*, orpiment. As_2S_3. *Arsenicum Hydrogenisatum*, arseniuretted hydrogen, H_3As. *Arsenicum Iodatum*, iodide of arsenic, AsI_3. *Arsenicum Metallicum*, metallic arsenic, As. *Arsenicum Rubrum*, disulphide, As_2S_2, realgar, sandarach. *Natrum Arsenicicum*, arseniate of sodium, Na_2HasO_4.

Statistics of one hundred cases of poisoning by arsenic:

I find that out of seventy-four cases of poisoning by arsenious oxide itself there are only fourteen in which the ferric hydrate is known to have been given as an antidote. The cases are given by Woodman and Tidy in seventy-two out of the seventy four, the other two being taken from the *Lancet* and *British Medical Journal* respectively for the year 1883. Of the fourteen cases in which the iron antidote was given, recovery took place in ten, involving *sixteen* persons; in four cases death took place in spite of the use of the antidote, the fatal doses in three of the cases being known to be 120, 240, 240 grains respectively. In other words where the iron antidote was used *death occurred in 28 per cent. of the cases.* In the report of the sixty cases where the iron antidote was not used death is said to have occurred in thirty-

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*Two or three times stronger than the officinal solution.

seven instances, or in about *61 per cent.* Without the iron antidote emetics and stomach pump were successful in three cases; no treatment is mentioned in fifteen cases where recovery took place. In one case recovery was due to emetics and nitrate of potassium, although the dose was 300 grains.

In twenty-six cases of poisoning recorded by Woodman and Tidy by other preparations of arsenic, one was by Fowler's solution, two by arsenite of sodium, ten by arsenite of copper, one by arseniate of sodium, five by sulphides of arsenic, one by the chloride, six by arseniuretted hydrogen. Mention of use of the iron antidote in these twenty-six cases is only made in one instance, in which case the patient died on third day of chest affection. In fourteen out of the twenty-six cases death took place; of the twelve other cases recovery took place in five from arsenite of copper, two from sulphides, one from the chloride, two from arseniuretted hydrogen, one from arsenite of sodium, and in one case there is no mention of either death or recovery. In one case where recovery from arseniuretted hydrogen took place, hydrated oxide of magnesia was given.

Summary:—

Total number of cases, - - -	100
Deaths of all poisoned took place in .	55
Recovery of all poisoned took place in -	39
Some died, others recovered - -	4
No record, - - - - - - -	2

Many of these cases undoubtedly had little or no skillful treatment. A record of a similar number of cases in modern times in large cities, where physicians can be quickly summoned, would probably show a gain in the percentage of recoveries over the figures given in this table.

Time of Death: Arsenic has killed in twenty minutes, but in half the cases on record it proved fatal within nine hours. The fatal period has been delayed to ten and sixteen days, and in one case to two years.

Fatal Quantity: While death has taken place from one grain in divided doses, recovery has taken place from enormous doses.

Method of detection recommended by Ralfe:

Portions of the liver and stomach must be divided as finely as possible and placed in a porcelain dish, and a mixture, about twice the quantity of the organic matter employed, consisting of six parts of distilled water to one of hydrochloric acid, is added, and the whole warmed for about an hour. After this, small fragments of potassium chlorate are to be dropped into the mixture from time to time, and the mixture kept constantly stirred, till the solid matter has almost completely disappeared. The mixture is then filtered through fine linen, the insoluble matter left on it being kept for further examination, and the acid filtrate divided into three parts: (1.) Place in the acid mixture a strip of perfectly pure copper and boil for twenty minutes; if there is a deposit on the copper examine for *arsenic*, *antimony* or *mercury*. Remove the strip of copper, wash it with a little distilled water to which a few drops of ammonia are added, dry it between folds of blotting paper, then when quite dry place it at the bottom of a narrow glass tube (German glass), and apply heat to the lower portion of the tube, taking care that the upper end remains cool, and placing the finger lightly over the mouth of the tube, so as to keep the volatilized matters within it. If *arsenic* forms the crust on the copper, then arsenious acid will sublime and be deposited at the upper end of the tube, and this deposit under a low power of the microscope will be found to consist of sparkling octohedral crystals. Break off the portion containing the deposit and boil it in a test-tube for some minutes with distilled water. Test aqueous solution with (*a*) few drops of silver ammonium nitrate, which gives a bright yellow precipitate, soluble in ammonia and nitric acid; (*b*) solution of cupric ammonio-sulphate, which gives a pale apple-green precipitate. If arsenic has been found it will be as well to take a fresh portion of acidulated filtrate and submit it to Marsh's test.

An improvement on the usual method of performing the Marsh test is suggested by the *Moniteur Scientifique* as follows: The liquid to be tested is introduced into the Marsh apparatus and solution of caustic potash (concentrated). Aluminum foil is then added, heat applied, and arseniuretted hydrogen, *but not antimoniuretted*, is given.

Reinsch's Test: A new chance for error in making this test is alluded to by Macallan as follows: "In testing for arsenic by Reinsch's method, there is a serious source of error which seems to have been overlooked; at least, I can find no reference to it in any of the standard works on the subject. I allude to the deposition of free sulphur, together with cupric sulphide, on the copper, and its sublimation when heated. In examining decomposing organic substances, sulphur is frequently deposited, owing to the decomposition of free sulphuretted hydrogen, so much so, sometimes, as to take fire and burn with a blue flame when a lighted taper is applied to the copper. When heated in a tube, the sulphur forms a sublimate having a general appearance and behavior similar to that of arsenious oxide in small quantity, being white and resubliming unaltered. It is mentioned in some works that sulphur cautiously sublimed condenses in rhombic octahedrons, but I have not found it deposit in that form. Under the microscope, it is seen to consist of globules. When, however, these are so small as to render their outlines indistinct, they resemble closely the crystals of arsenious oxide in transparency, lustre and aggregation. When doubt exists, the safest course might be to procure as much of the sublimate as possible, boil down a second time with dilute acid and copper, and examine any sublimate obtained microscopically, and with the usual confirmatory tests."

To Detect Arsenic in Wall Paper: Act on the paper with ammonia until a blue solution is formed; pour a little of this over a crystal of silver nitrate in a white capsule, and note that yellow arsenite of silver is formed on the surface.

Opium:

SYMPTOMS.—Giddiness, drowsiness, stupor, insensibility; slow, stertorous breathing; pulse weak and feeble; countenance livid; pupils greatly contracted and insensible to light; skin cold, livid. Death in from seven to twelve hours.

VARIATIONS.—Pupils dilated, countenance ghastly or placid, pulse unaffected, vomiting, skin bathed in sweat.

POST-MORTEM APPEARANCES.—Not very characteristic. Great turgescence of vessels of the brain, with effusion of serum into the ventricles and at the base. Lungs usually gorged with fluid blood; right side of heart distended with dark fluid blood or clotted blood. (Tanner.)

TREATMENT.—Stomach pump. Atropine, subcutaneously. Enemata of strong coffee. Cold shower bath. Faradic electricity.

FATAL DOSES.—Smallest fatal dose crude opium, four grains; laudanum, two drachms. Average fatal dose, morphine, two grains. Infants more susceptible; 1-12 grain of crude opium (one drop laudanum) has proved fatal.

TIME OF DEATH.—From *three-quarters of an hour* to *twenty-four hours;* if patient survives twelve hours, hope of recovery.

TESTS.—[See Systematic Analysis.] 1. Separate from organic substances, if necessary, as follows: Boil well with distilled water and alcohol acidulated with acetic acid and strain. Add solution of lead acetate to the part which passes through on straining until no further precipitate. Filter. Meconate of lead remains in the filter, morphine goes through filter in solution as an acetate. (*a*) Examine first the meconate of lead by washing it off the filter (by means of wash-bottle) into water, then pass H_2S into the mixture of meconate and water, when the lead will be thrown down as a sulphide. Filter and meconic acid will go through the filter in a state of solution. Evaporate the filtrate carefully to dryness, and add to the residue a few drops of solution of *perchloride of iron;* a blood-red coloration (not affected by gold chloride solution nor solution of mercuric chloride) indicates presence of meconic acid. (*b*) Go back now to the solution of morphine, which went through the filter after adding acetate of lead and filtering. Pass H_2S into this solution for a time, filter, evaporate filtrate over the water bath until well concentrated, then add dilute alcohol, filter, and evaporate filtrate to dryness over the water bath. The residue is acetate of morphine, which may be examined as follows: Add to a few of the crystals a drop or two of nitric acid; an *orange-red* coloration indicates morphine. To a fresh amount of the powder add a drop or two of neutral solution of perchloride of iron, a rich *blue* color is developed—destroyed by nitric acid, with development of *orange-red.* To a fresh amount of the substance add pure iodic acid; iodine is set free, giving a *brown* coloration, becoming *blue* on addition of starch paste.

Remarks.

Treatment of opium poisoning: By all means use the *stomach pump,* washing out the stomach either with an infusion of coffee or green tea, or else water in which finely-powdered charcoal is suspended, using a fresh amount for each injection.

Vomiting must be encouraged, zinc sulphate in five-grain doses, with fifteen minutes' interval, being given; after the emetic has worked, the bowels should be opened.

The patient should be prevented from sleeping by use of douches, flagellation, etc., but should not be exhausted by muscular fatigue. The cold shower bath is advised by some authors. The use of the battery, especially when the coma is profound, is very desirable. Prolonged artificial respiration is of great value.

Antidotes: Belladona is used as a physiological antidote. Administration of fifteen drops of the tincture (U. S. P.), repeated in fifteen minutes if necessary, has been advised; in cases of poisoning by morphine, hypodermatic injections of atropine may be given. In one case subcutaneous injection of 1-35 of a grain of atropine, followed in an hour by another, brought about recovery. (Stuver.) According to Bonaccorsi, there is antagonism between nicotine and morphine, a point to be borne in mind in case the physician finds himself in localities where tobacco is the only substance obtainable. Strong coffee may be given as an antidote in form of enemata.

Electricity: In using this agent, the idea is to give to the patient *shocks* of sufficient intensity to arouse him if possible from coma; the Faradic current is desirable for this purpose and also for artificial respiration. In a very obstinate case, occurring in 1879, Dr. Delamater used the Faradic current continuously both for administering shocks and for artificial respiration, for a space of several days, employing relays of assistants. The patient eventually recovered, although no treatment preceding the use of the battery was of avail. In the case treated successfully by Dr. Wm. B. Clarke, of Indianapolis, the current was graduated on the third "knob" most of the time, a little while on the fourth, the "cylinder" not being drawn out at all.

Strength of Preparations: Woodman and Tidy give the following table of English preparations. One grain of *dried opium* is present in the following quantities of the several preparations named:

In 14.5 m. of laudanum (tinctura opii).

In 14.5 m. of vinum opii.

In ℥*ss.* of paregoric elixir (tinctura camphora composita).

In 96 m. of tinctura opii ammoniata.

In ℥j. of enema opii.

In 5 grs. of pilula saponis composita.

In 8 grs. of pilula plumbi cum opio.

In 10 grs. of pulvis ipecacuanhae compositus (Dover's powder).

In 20 grs. of pulvis kino compositus.

In 30 grs. of pulvis cretae aromaticus cum opio.

In 10 grs. of pulvis opii compositus.

In 13.5 grs. of unguentum gallae cum opio.

In 10 grs. of opium lozenges.

One grain of opium is equivalent to about half a grain of extractum opii.

Other Preparations of Opium (U. S. P.):

Pilulae Opii (pills of opium), each 1 grain of powdered opium.

Confectio Opii (confection of opium), 1 grain of opium to 36.

Trochisci Glycyrrhizae et Opii (troches of licorice and opium—Wistar's Cough Lozenges), each 1-20 grain of extract of opium, or 1-10 grain of opium.

Suppositoria Plumbi et Opii (suppositories of lead and opium), each ½ grain of extract of opium.

Tinctura Opii Deodorata (deodorized tincture of opium), 1 grain of opium to 13 minims or 25 drops.

Acetum Opii (vinegar of opium—black drop), *formerly* 1 grain of opium to 6½ minims or 13 drops, but *now* 1 grain of opium to 9.6 minims.

Vinum Opii (wine of opium—Sydenham's Laudanum), formerly 1 grain of opium in 8 minims; now 1 grain in 10.5 minims.

Liquor Morphiae Hydrochloratis (solution of morphine hydrochlorate), 4 grains of morphine hydrochlorate to the fluid ounce of distilled water.

The 1870 solution of morphine sulphate was 1 grain to the fluid ounce; Magendie's solution used hypodermically contains 16 grains to the fluid ounce.

Suppositories of morphine contain each 1-6 of a grain of sulphate of morphine.

Opium or its preparations may be found in many other preparations, as *Godfrey's Cordial*, *Dalby's Carminative*, *Winslow's Soothing Syrup* (1 grain of opium to the ounce, *Pharm. Journal*, 1872), *Locock's Pulmonic Wafers*, *Chlorodyne*, *Nepenthe*, *Liquor Opii Sedativus*, *Syrup of Poppies* (often made from laudanum), *McMunn's Elixir* (supposed to be about the same as the deodorized tincture).

One Hundred and Twenty Cases of Poisoning by Opium:

Woodman and Tidy quote about 120 cases, of which 60 were by laudanum alone; of these 60, 31 recovered and 29 died. Of the 29 that *died* 6 had thorough and active treatment, belladonna and subcutaneous ammonia being tried unsuccessfully in one case; in another case emetics and galvanism failed to conquer the coma. Of the 31 that *recovered*, the stomach pump and galvanism proved successful in 5 cases, emetics and constant motion in 2, emetics and belladona in 2, galvanism in 2, belladona in 1, stomach pump, ammonia, coffee and galvanism in 1, stomach pump, galvanism and cold affusions, face struck and prolonged remedies in 1, stomach pump alone in 1, emetics, stomach pump, belladona and galvanism in 1, pricking by a pin (!) in 1, emetics alone in 1; in 13 of the cases the treatment, if any, is not mentioned.

Twenty cases were by opium itself or its preparations other than laudanum; of these, death ensued in 9 cases, recovery in 11. In the fatal cases no mention of treatment is made. In the 11 cases where recovery took place, the stomach pump was used in 1 case, emetics in 2, "active treatment" in 1. In accounts of the other cases no treatment is mentioned.

Twenty-five cases were by morphine; of these, 14 died and 11 recovered. Of the 14 that *died*, 1 had treatment of coffee and caffein injected, but no treatment is mentioned in 13. Of the 11 that *recovered*, emetics were used in 2 cases, emetics, belladonna, galvanism in 1, belladonna enema, atropine subcutaneously and galvanism in 1, hydrocyanic acid in 1, emetics, subcutaneous atropine, electricity in 1, and no treatment mentioned in regard to other 5.

Fourteen cases were from such preparations as Godfrey's Cordial, Winslow's Soothing Syrup, etc.; of these, 9 died, 4 recovered, 1 no report.

Summary—Without regard for circumstances of treatment:—

Total number of cases,	121
Deaths,	63
Recoveries,	57
Doubtful,	1

Recent Cases of Opium Poisoning: Stuver (*New York Medical News*) reports a case where eleven grains of morphine were taken; patient comatose; pulse, 100. Treatment, 1-35 grain atropine subcutaneously followed by another in the course of an hour. Recovery.

In the *Cincinnati Lancet and Clinic* (p. 655)), I note a case of poisoning by Mrs. Winslow's Soothing Syrup. Five half-teaspoonful doses, at 4, 8 p. m. and 3, 5, 5:45 a. m. respectively, were given an infant; at 7:45 a. m. marked symptoms of poisoning. Treatment, stomach and bowels emptied, frequent cold sponging with wet cloths on nape of neck, tincture of belladona hourly in aqueous solution. In spite of all efforts of parents to keep him awake, he fell again into a stupor by 6 p. m. The physician recalled; succeeded in arousing him by mechanical means; gave belladonna every half hour. At 11 p. m. pupils widely dilated, and respiration free. Recovery. (The dose of belladonna is not mentioned.)

A child of 18 months died from nervous exhaustion following the application of thirty grains of opium in a salve to a burn. The effects of the opium were neutralized by the efforts of physicians, but the infant was unable to rally.

Fatal Doses:

Children have died from the effects of 1-19 of a grain of opium and 2.5 minims of laudanum; ½ grain of the acetate of morphine has killed an adult.

Time of Death:

Death has taken place in 45 minutes; has been delayed four days. Usual time, nine to ten hours.

Failure to Detect Morphine; Elimination of Morphine:

The action of the living stomach on opium and organic poisons in general is very rapid. Failure to detect morphine or meconic acid in the stomach and its contents has resulted in several cases on analysis.

In the case of an opium eater, Voit failed to detect morphine in the urine, but did detect it in the execretion from the bowels. Nevertheless, the fact of some direct elimination by the urine is proved by the analysis of A. Wynter-Blyth: In the case of an opium eater who had taken thirty-six grains of the acetate of morphine in one day, twelve ounces of fresh urine yielded morphine equivalent to 1.2 grains of morphine acetate; on a day when the same patient had taken twenty-one grains, the same quantity of urine yielded the equivalent of one grain of the acetate. On a day when the same patient took 6½ grains, the same amount of urine yielded 0.18 grain of the salt.

Strychnine:

SYMPTOMS.—Bitter taste. Suffocation. Difficulty of breathing. Stiffness about neck. Sense of impending death. Twitchings of the muscles. Jerkings of the lower limbs. Quivering of the whole frame. Limbs rigid, head bent back, body stiffened and arched, resting on head and heels. Face dusky, eyeballs prominent, lips livid, features assume grin. Thirst, but inability to drink from spasm of jaws. Patient conscious and alarmed. Spasms rapidly succeed each other, and death from *suffocation* or *exhaustion*.

POST-MORTEM APPEARANCES.—Rigor mortis usually persistent. Hands often clenched, soles of feet arched and inverted. Membranes of brain and upper part spinal cord congested, serous effusion under spinal arachnoid. Lungs loaded with dark fluid blood. Heart usually contracted, sometimes right cavities distended with black and liquid blood. (Tanner.)

TREATMENT.—Keep patient warm and quiet. Remove poison by stomach pump if no spasms as yet; if spasms have begun, *emetics*. Chloroform for spasms. Chloral hydrate as physiological antidote. Wormley, and Woodman and Tidy advise free use of chloroform. It may be given internally and by inhalation.

FATAL DOSE.—One-half grain.

TIME OF DEATH.—Five minutes to three hours. Danger usually over in two hours.

Tests.—[See Systematic Analysis.] First separate from organic matter, if necessary, as follows (Stas's process): Acidulate material with HCl. Heat over the water-bath. Filter. (Wash what is left in filter with boiling distilled water and let this filter.] Evaporate and rub residue with distilled water; evaporate again and dissolve again, and so on until a tolerably pure product is obtained. Then neutralize with bicarbonate of sodium, shake up with chloroform, set aside in tall test-tube until the chloroform has risen to top, then withdraw with pipette and allow to evaporate spontaneously, when the alkaloid will be left behind in a state fit for testing. To the crystals add a drop or two of sulphuric acid and a fragment of potassium bichromate. A series of *blue*, *violet*, *purple* and *red* tints is produced if strychnine is present. Wipe the skin of a frog dry and apply to it a few drops of a solution of the crystals; strong tetanic convulsions will take place whenever the animal is touched or irritated.

Remarks.—There is considerable evidence in favor of the *chloroform* treatment of strychnine poisoning. Woodman and Tidy advise the immediate inhalation of chloroform and the injection and withdrawal of powdered charcoal. Wormley favors the internal administration of chloroform. Dr. Dresbach, of Tiffin, Ohio, has administered chloroform internally with success. In one case where three grains of strychnine had been taken, two drachms of chloroform internally brought about recovery in twenty minutes, when given twenty minutes after the poison had been taken. Prolonged internal administration and inhalation (both) of chloroform have proved successful. In one case of recovery two drops were given every five minutes whenever the mouth could be opened, and two pounds consumed in inhalation. In twenty-nine cases of recovery which I have noted, fourteen were due either wholly or in part to the administration of chloroform. There seems to be no chemical antidote to strychnine, except, perhaps, *tannin*, and the general reagent *iodine in potassium iodide.* As *physiological antidotes*, chloral hydrate and paraldehyde have been lauded; opium, conium, ether, cannabis, camphor, calabar bean, atropine, amyl nitrite, bromide of potassium, Beta lutidine have all been used. Hydrocyanic acid is deemed by Parkinson and Ladell a veritable antidote, but dangerous to employ.

Tests for Strychnine:

Mandelin has discovered a reagent for alkaloids in vanado-sulphuric acid, and one particularly suited to strychnine, as the peculiar color reaction obtained with the latter differs from all other strychnine reactions so far known.

The reagent is prepared by dissolving one part of vanadate of ammonium in 100 parts of strong sulphuric acid. It is called, by the author, for short, vanado-sulphuric acid ("Vanadin-Schwefelsaure"), though this name, strictly speaking, would belong to a compound acid.

If strychnine be treated with a few drops of this reagent (even when diluted with an equal quantity of strong sulphuric acid), upon a watch-glass, on inclining the latter so as to let the acid flow on one side, the residue will assume almost instantly a magnificent blue color, which soon passes into violet, afterward into vermilion, red or orange. On adding to the acid, after the vermilion tint has made its appearance, a little soda or potassa, a quite persistent rose-red to purple color is obtained, which is rendered still more handsome by dilution with water. The same color appears even with simple addition of water, and the liquid afterward bears dilution with water without losing its tint.

If the quantity of alkaloid is small, the test is best performed in the following manner: The alkaloid, or the residue obtained in any manner from substances suspected to contain an alkaloid, is put on a watch-glass, covered with a few drops of the reagent, and kept so (for a few moments) until the solid matter appears to assume a bluish tint or begins to acquire color. Then the watch-glass is inclined to one side so that the liquid portion may flow off the solid residue. If there was any strychnine present, the handsome blue color is most vivid at the moment when the acid uncovers the residue. With quantities as small as 1-100 milligramme of strychnine, the color was still quite pronounced, much more so than the color obtained with other reagents for strychnine.—Extract from the author's pamphlet "Ueber Vanadinschwefelsaure." 8vo. St. Petersburg, 1883.

Woodman and Tidy object strongly to the *bichromate test*, preferring finely-powdered *peroxide of lead* or manganese, the order of colors being blue, purple, violet, red, and finally no color.

The intensely bitter taste of strychnine must not be forgotten; one grain of the *pure* alkaloid to the gallon can thus be detected. The salts are not so bitter.

Failure to Detect Strychnine after Death: The longest period in which analysis has furnished positive evidence of the presence of strychnine in the *exhumed human body* is forty-three days after death. (*Ann. d'Hyg.*, April, 1881, 359.) Woodman and Tidy hold that if the fatal dose be a minimum one, and the period between the taking of the poison and death be considerable, it is just probable that complete elimination of the poison may take place, and render its discovery impossible. The poison may often be *inferred* from the bitter taste of the obtained product when chemical tests fail to show its presence. (Wormley.) Woodman and Tidy hold that strychnine does *not* decompose in presence of organic matter.

Detection of Strychnine in the Tissues: In some cases it is advisable to set about testing for strychnine at once without adopting the plan of systematic analysis given in previous pages of this work. Dragendorff, whose method is given in full by Wormley, has claimed to be able to detect strychnine, even if the body has been buried four months. Various Italian observers have, however, objected strongly to his method on the ground that the use of sulphuric acid gives rise to alkaloidal substances due to the decomposing action of the acid on organic mixtures. The method of Rodgers and Girdwood is as follows: The contents of the stomach, and the latter itself cut into small pieces, are to be digested in water acidulated with hydrochloric acid over a water-bath for two hours, then strained through muslin, filtered and evaporated to dryness over a water-bath. The residue is to be digested in alcohol acidulated with hydrochloric acid, filtered and again evaporated to dryness. Again treat with distilled water and filter into a long wide tube. To this first add excess of ammonia and afterward shake up with half an ounce of chloroform. The chloroform having subsided, draw it off with a pipette, and evaporate it to dryness in a small evaporating basin; afterward moisten the residue with concentrated sulphuric acid, and allow the mixture to remain in a water-bath for half an hour. Add to this some distilled water, pouring the solution into a test tube, and thoroughly rinsing out the basin with hot distilled water. When cold, add ammonia in excess, and shake the solution up with three drachms of chloroform. It may be necessary to repeat the charring with the sulphuric acid. Evaporate a few drops of the chloroform solution in a white porcelain dish, and test with sulphuric acid and peroxide of manganese in the manner already described.* If the particles of chloroform do not readily aggregate, the tube must be placed for a few minutes in hot water, and if this does not succeed, the mixture should then be diluted with a large bulk of water. When the *liver*, *spleen*, *kidneys* or other tissues are the subject of analysis, they should first of all be reduced to a pulp by rubbing them well up in a mortar and afterward digested for several hours with acidulated water. The solution should then be boiled and when cold strained through muslin and evaporated over a water-bath, the same process being then adopted as with the contents of the stomach. To obtain strychnine from *urine*, set it aside for a few days until it decomposes and becomes alkaline; filter, shake up with chloroform and purify the alkaloid as already described. If *blood* is being examined, dilute it with equal bulk of water, acidulate with acetic acid and boil for a short time. Filter and evaporate the filtrate nearly to dryness. Treat the residue with alcohol and proceed as before.

Symptoms, Dose, Etc.: The usual time for symptoms to begin is in from ten to twenty minutes, but they may begin immediately or be delayed for an hour, according to the form in which the poison is taken, and the manner of its administration. Death usually takes place within two hours from the time the poison was taken. If a person lives over five or six hours the prognosis is hopeful. A fatal case is recorded from one-quarter of a grain; recovery has taken place from forty grains. Occasionally strychnine acts as a cumulative poison. I have known quinine to act in the same way.

Preparations: Strychnine mixed with coloring

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*Add to the strychnine a drop of sulphuric acid, mixing well with a glass rod, then cautiously stir in a little of the powdered peroxide and the colors will be seen.

matters is used in vermin-killers. The chief medicinal preparation is the *sulphate*, which responds to the tests for strychnine, and may be used for the same purposes and in the same doses.

Seventy-six cases of **strychnine poisoning:** Forty resulted fatally, thirty-five recovered, one not stated. In those that recovered, the following treatment was adopted: In one case chloroform was given for three hours, then emetics; in one case albumen only was given; in one case one and a half drachms of chloral hydrate were injected subcutaneously; in one case ten grains of acetate of morphine were given; in two cases tincture of opium was given, in one of them half an ounce of it; in two cases emetics and chloroform; in two cases emetics only; in one case emetics and stomach pump after one and a half hours had elapsed; in one case chloroform and tincture of aconite were given; in one case (when there was coma) electricity; in two cases stomach pump and chloroform; in one case chloroform for one and a half hours; in one case drop doses of nicotine hourly in whisky punch; in one case chloroform for seven hours; in one case conium and camphor; in one case chloral hydrate and emetics; in one case chloroform and one and one-sixth grains of atropine injected; in one case emetics, cannabis indica and chloric ether; in one case chloroform for four and a half hours; in one case ten drachms of dried tobacco leaves in an infusion; in one case stomach pump and friction over spine with hot turpentine.

CHAPTER III.—CORROSIVE ACIDS, CAUSTIC ALKALIES, VEGETABLE ACIDS.

Corrosive Acids (Sulphuric, Nitric, Hydrochloric):

SYMPTOMS.—*Immediate* violent burning pain in mouth, œsophagus, stomach. *Retching* and *vomiting* of dark-colored liquid, with shreds of mucus and portions of mucous membrane of œsophagus or stomach. *Stains* on lips and mouth: Nitric acid, yellow stain; sulphuric, brown (white at first); hydrochloric, at first white, then discolored. *Bowels* confined. Urine scanty. Great exhaustion. Anxiety. Death with intellectual faculties clear.

TESTS.—See **Inorganic.**

STATISTICS.—Of thirty-seven cases, recovery in thirteen; twenty-five of the thirty-seven due to sulphuric acid, and recovery in nine of these.

POST-MORTEM APPEARANCES.—Mucous coating of mouth, fauces, œsophagus easily detached; stomach and intestines corroded or perforated. [Sulphuric acid blackens tissues; nitric acid makes mucous membranes yellow, blood black, bile green.]

FATAL DOSES.—Sulphuric acid, one drachm; nitric acid, two drachms; hydrochloric, four drachms.

TIME OF DEATH.—Sulphuric, sixteen to twenty-four hours; nitric, twenty-four hours; hydrochloric, eighteen hours.

TREATMENT.—Indication, *promptness;* calcined magnesia or bicarbonate of sodium in milk at short intervals (magnesia, chalk, soap-suds, plaster, lime beaten up in water if bicarbonate not at hand); next *bland liquids* for some time, then treat gastro-enteritis. Give oily enemata.

Caustic Alkalies: Potassium Hydrate, Sodium Hydrate, Ammonia, (Soda Lye, etc.):

SYMPTOMS.—Acrid burning taste. Often cough, hoarseness, dyspnœa; vomiting of altered mucus and blood. Surface of the body cold and moist; great pain in abdomen, with diarrhœa.

TESTS.—See **Inorganic.**

STATISTICS.—Cases of poisoning by caustic potash and caustic soda not so common as by ammonia. In twenty-two cases of the latter, recovery took place in nine.

POST-MORTEM APPEARANCES.—Coats of stomach and intestines stained dark.

FATAL DOSES.—Caustic potash, half an ounce; ammonia, half an ounce of the strong: (two drachms has proved fatal).

TIME OF DEATH.—Death may be rapid. From ammonia, in four minutes up to several months.

TREATMENT.—No pump. Neutralize with dilute vinegar or lemon juice. Oranges, olive oil, milk. Poisoning from inhaling ammonia should be treated by inhalations of acetic or hydrochloric (dilute) acid.

Vegetable Acids, Oxalic, Carbolic:

OXALIC ACID.

SYMPTOMS.—Hot burning on swallowing. Severe burning at stomach. Immediate vomiting of *black* matters. Constriction, suffocation in throat. Lividity. Pain and prostration. Feeble pulse, cold clammy perspiration. Convulsions, death.

TESTS.—See **Organic.**

STATISTICS.—In twenty-seven cases, recovery in thirteen. Death took place *very rapidly* in five cases, as follows: Instantaneously, in three minutes, in ten minutes, in twenty minutes, in twenty-five minutes.

POST-MORTEM APPEARANCES.—Mucous membrane of fauces, œsophagus, stomach: white, soft, brittle; general softening and blanching of mucous membranes noticeable.

FATAL DOSE.—Four drachms.

TIME OF DEATH.—Death very rapid; three minutes to eight hours.

TREATMENT.—*Do not give alkaline carbonates. Do not use stomach pump.* The proper antidote is *lime.* Give abundance of chalk or magnesia in very small quantities of milk, and after the acid is thus neutralized, give emetics if no vomiting. Do not give warm water to induce vomiting. (Woodman and Tidy.) Treat collapse with stimulants. If no lime is at hand "scrape the ceilings."

CARBOLIC ACID.

(Really not an acid, but, for convenience, is so classified.)

SYMPTOMS.—Whiteness of mouth, etc. Coma. Stertorous breathing. Contracted pupils. Urine dark.

FATAL DOSE.—*One ounce.* [See **Statistics.**]

TIME OF DEATH.—Few minutes to ten hours. Usually an hour or two.

REMARKS.—Differentiation from opium by *odor* and *white* color of tissues. Heat develops the odor.

POST-MORTEM APPEARANCES.—Mucous membranes white, movable. Odor of the acid everywhere, even in brain.

TREATMENT.—Emetics, mustard and water or sulphate of zinc. Raw eggs *ad libitum.* Collapse treated by injection of stimulants. Give also magnesia suspended in a mixture of olive and castor oils, lime-water and sugar. Ether subcutaneously. Soluble sulphates internally. [See, however, **Statistics.**]

Statistics, etc.: Carbolic acid is a modern poison, and cases of poisoning from it are now frequent, and recovery rare. In twenty-one cases quoted by Woodman and Tidy death took place in *nineteen*, recovery in one, one doubtful. Barron (*British Medical Journal*, 1883) reports a case *successfully* treated as follows: A girl drank a fluidounce of Calvert's No. 5 (full strength); *cautious* use of the stomach pump (washing out stomach five or six times with warm water, till fluid returning had no odor of the acid) was first made; a thick solution of magnesia was next thrown in and left in the stomach. Hot water and hot plates were applied. Enemata of beef tea, beaten up eggs and milk were given, two tablespoonfuls every four hours. Nothing given by the mouth except a little ice, ice-water or iced milk, just enough to wet the mouth. For ten days the enemata were kept up, and applications of cold water to the charred mouth made with camel's-hair brush. From the tenth to the fifteenth day cautious drinking of beef tea, milk and eggs, etc., and two enemata per day. On the twenty-fifth day, fed in the usual way.

From experiments on animals the theory was started that *soluble sulphates* were the proper antidote. The following case, reported by Reid, in *British Medical Journal*, tends to show that the use of sulphates is not always successful where human beings are concerned: A woman drank four fluidounces of carbolic acid. No pump used, but four drachms sulphate of sodium in five fluidounces of water injected into stomach by catheter. Two hours later three-quarters of an ounce of salt in five ounces of water. Four hours later three-quarters of an ounce of sulphate of sodium in five ounces of water were injected into the stomach. Ether also was injected at the end of the first, third and fifth hour. The patient died in forty minutes after last injection of sodium sulphate.

Costine reports a case where one ounce and a half of the poison was taken internally. No knowledge of the character of the poison being had, apomorphine was used (one-eighth of a grain subcutaneously). In fifteen minutes five ounces of dark liquid, smelling of carbolic acid, was expelled with a gush from the stomach. Olive oil was then injected into the stomach, and recovery followed. The fæces and urine were both darkened.

As to the *dose:* Most authorities put the fatal dose at one drachm, and think recovery after half an ounce to be exceptional. Death has followed the taking of a tablespoonful, and a teaspoonful has killed an infant. Reichert, however, mentions a case where recovery took place after an injection of 145 grains.

As to the *urine:* The darkening of the urine is regarded as a sign that too much of the acid is being used or has been taken. Fussinger has shown that the dark color is due to the presence of two bodies called *hydroquinon* and *pyrocatechin* respectively; there is also an abundance of *sulpho-carbolates* (phenyl-sulphates). *Renal hemorrhage* has followed the use of the Lister spray in ovariotomy.

Carbolic acid is a poison also when used externally. Cases of extreme prostration following the use of carbolic injections after coitus have been noticed. A child of four and a half years died in three and one-half hours from application of carbolic acid to a wound. A woman operated on by Verneuil showed symptoms of poisoning from two injections of carbolic acid solution into the part operated on (rectum), and did not entirely recover until the tenth day after. She absorbed about fifteen grains of the acid. Weiss concludes that cases of poisoning from external use of carbolic acid are most common following uterine, vaginal and vesical injections or the washing of the interior of huge abcesses. Lemaire holds that the vapor of carbolic acid is comparatively harmless. Duret, however, exposed for one and a half hours, during an operation, to the vapors of the acid, was taken suddenly with intense cephalalgia, with a sensation of tightness all over the head, and lack of appetite, rendering further work for that day impossible.

Weiss describes *three* forms of poisoning by carbolic acid: In the first there is a tendency to collapse or to complete coma, very marked *decrease* in temperature, sometimes convulsions; lastly, vomiting and melanuria. The second form presents symptoms like those shown by Duret. The third form has been described by Volkmann and Sonnenburg as consequent upon too long continued use of the acid. The symptoms are fever, nausea, cephalalgia, tendency to adynamia, melanuria.

CHAPTER IV.—SIMPLE IRRITANTS—SALTS OF METALS, ALOES, COLOCYNTH, ANIMAL AND GASEOUS IRRITANTS.

Simple Irritants: Salts of the alkali metals, salts of the heavy metals, vegetable irritants (aloes, colocynth, etc.), animal irritants (fish, meat, etc.), gaseous irritants (chlorine, etc.).

IRRITANT POISONING.

GENERAL SYMPTOMS.—Symptoms of irritant poisoning are: Pains in stomach and bowels, fainting and nausea, purging with straining, bloody evacuations, feeble irregular pulse and cold skin. Death from collapse, convulsions or severe inflammation.

GENERAL TREATMENT.—Emetics, stomach pump, demulcent drinks. [There are no antidotes to nitre, cream of tartar, or liver of sulphur; zinc sulphate and chloride should be treated as above and *tannin* given (tea, oak bark or Peruvian bark decoction); *nitrate of silver*, give common salt and emetics; salts of tin, give magnesia and milk; salts of iron, magnesia and milk.]

BICHROMATE OF POTASSIUM.

This substance is a powerful irritant poison. In acute poisoning we find the usual symptoms abdominal pains, vomiting, purging, cramps in the legs, feebleness of pulse, coldness of surface of body, clammy perspiration, soreness of mouth and throat, excessive thirst. Stools of peculiar clay color; matters vomited are yellowish. The remote effects are shown as follows: Syncope and giddiness, specks before the eyes, dilatation of the pupils, yellowness of the conjunctiva, urine either suppressed or in small quantity and purulent, stupor, hurried or difficult respiration, loss of power in legs. The periosteum generally is swollen and painful. The action of the poison is specially marked on mucous membranes.

CHRONIC POISONING.—Bitter nauseous taste in mouth, great irritation of nasal mucous membrane, incessant sneezing, increased secretion of tears, sometimes conjunctivitis. Later, ulceration and even destruction of septum nasi. Chronic sores on hands, shoulders, feet.

POST-MORTEM APPEARANCES.—Mucous membrane of the stomach inflamed or destroyed, or marked with patches of dark red discoloration, the blood being black and very thin. [No well-marked appearances may be observed.]

FATAL DOSE.—*Two drachms* has caused death. Recovery from *two ounces* has taken place.

TIME OF DEATH.—Few hours.

TREATMENT.—Emetics, if required, and free use of carbonate of magnesium or calcium in milk. In chronic poisoning sponging the throat with nitrate of silver solution, and mercuric chloride internally are recommended.

In seven cases of poisoning by this substance, recovery took place in three instances.

VEGETABLE IRRITANTS.

Aloes, colocynth, jalup, gamboge, scammonium, elaterium, croton tiglium, etc.

SYMPTOMS.—Irritation of intestinal canal, severe pain, vomiting, diarrhœa, tenesmus, collapse, cold sweats, (sometimes) convulsions.

TREATMENT.—Emetics, bland liquids. If copious vomiting, give milk. If poison is in intestines, give castor oil. Combat inflammatory symptoms; give emollient enemata; apply fomentations to abdomen.

ANIMAL IRRITANTS.

Poisonous fish. Poisonous meat, (Ptomaines).

TREATMENT.—Emetics, purgatives, diluents, stimulants, tonics.

REMARKS.—Poisoning by decayed meat—sausages, etc.—often results fatally. Of 155 cases, 84 were mortal; of 400 other cases, 150 resulted fatally. The symptoms are redness of buccal mucous membrane, vomiting, diarrhœa, alternated with constipation, pain on abdominal palpation and often colic, œdema and hyperæsthesia. Pulse infrequent, feeble. Voice hoarse; often aphonia and sometimes coughing. Vertigo, headache, buzzing in the ears, diplopia and pupillary dilatation. Death from four to eight days. Recovery slow. In poisoning by *shell* fish, we may note gastric, exanthematous and (rarely) convulsive and paralytic symptoms, resembling alkaloids.

Ptomaines.—These substances, first noticed by Gautier,* and afterward given prominence by Selmi, are the results of putrefaction of dead bodies. It is probable that poisoning from meat is due to the development of these or kindred substances. The gastro-intestinal irritation and profound toxic symptoms are probably, substantially, processes of alkaloidal poisoning. (Leffman.)

IRRITANT GASES.

Chlorine, sulphurous acid gas, nitrous acid gas, hydrochloric acid gas, ammonia gas.

Chlorine.—Excessive irritation in air passages, cough, difficulty of breathing, inflammation.

Nitrous Acid.—Fumes given off by nitric acid under various circumstances have proved fatal, producing inflammation of lungs and air passages.

Ammonia.—Inflammation of larynx, bronchitis, pneumonia.

Hydrochloric Acid.—Gas given off in manufacture of washing soda.

General Treatment.—Instant removal to fresh air.

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* So claimed. Both Gautier and Selmi announced the discovery at about the same time.

CHAPTER V. — SPECIFIC IRRITANTS — IODINE, PHOSPHORUS, MERCURY, ANTIMONY, LEAD, COPPER, BARIUM, CANTHARIDES.

SPECIFIC IRRITANTS.

These produce local inflammation like the simple irritants, but, in addition, show certain specific signs of their action peculiar and pointing to the poison.

Iodine: The treatment is to encourage vomiting, to give large amounts of arrowroot, starch enemata, flour and water. A recent case was treated successfully with apomorphine, diluents, starch and bicarbonate of sodium.

Phosphorus: The *symptoms* are those of irritant poisoning in general; the vomited matters are luminous in the dark; the breath smells of garlic; there is prostration, diarrhœa, and the stools are bloody. These may subside, and on the third to fifth day *secondary symptoms* may appear. Jaundiced skin, extravasations below skin, enlargement liver, retention and suppression of the urine—what little is passed is albuminous and contains bile—acute delirium with convulsions, coma and death.

POST MORTEM APPEARANCES.—Among others, *fatty degeneration* of the liver, also of kidneys, heart, muscles.

FATAL DOSE.—Averages one grain.

TIME OF DEATH.—Usually third to seventh day.

TREATMENT.—Free vomiting (sulphate of copper as emetic), magnesia in mucilaginous drinks; turpentine* has been recommended.

DETECTION.—Mitscherlich's process is to put matters into retort, acidulate with sulphuric acid, conduct stem into tall glass vessel kept cool with stream of water. Dis-

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* Hager calls attention to the fact that the *crude* oil alone can be regarded as the antidote.

till in the dark, and, as vapors condense in tall glass vessel, a flash of light is seen.

Arsenic: Has already been considered.

Antimony: The most important poisonous compound is *tartar emetic*. The *symptoms* of poisoning by tartar emetic are *metallic taste*, *nausea* and *violent vomiting*, *burning heat* and *pain* in the stomach, *purging*, thirst, cramps, cold sweat, *great debility*, dizziness, insensibility, difficult respiration, utter prostration, violent spasms.

FATAL DOSE.—About a drachm—three-quarters of a grain has killed a child, two grains an adult—large doses may be vomited up.

TIME OF DEATH.—In an adult, shortest, seven hours; has been delayed for one, two and four days, and even for two or more weeks.

TREATMENT.—If vomiting is not present it must be induced by draughts of warm water or by hot milk or by tickling the throat; if these fail, the stomach pump must be used without delay. Liquids containing *tannin*—as tea, nutgalls, or decoction of oak bark—are the proper antidotes.* When the stomach is rid of the poison, strong coffee may be given and opium to allay the vomiting.

Corrosive Sublimate: The *symptoms* of poisoning by this agent are: Acrid *metallic* taste, burning heat throat and stomach, nausea and pain in the stomach with vomiting often of *blood* and stringy mucus, diarrhœa with *bloody* stools, swelling of abdomen, lips and tongue white and shriveled, dyspnœa, pulse small, wiry, frequent, scantiness or entire suppression of urine; death from collapse, coma or convulsions. The symptoms set in *very soon*.

POST-MORTEM APPEARANCES.—Stomach often covered with slate-colored precipitate of finely-divided mercury;

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* It has been denied that these substances serve to neutralize the poison

if life prolonged a few days, rectum and lower bowels intensely congested.

Fatal Dose.—Five grains; death has followed the taking of three grains.

Time of Death.—Three to six days; has happened in half an hour and been delayed to sixteen days.

Treatment.—Give *immediately* white of egg in milk or wheat flour in milk. Encourage vomiting by giving copious draughts of albuminous drinks (white of egg and water). White of egg in milk should be given two or three times daily for some few weeks.

Compounds of Lead: The *acetate* and *sub-acetate* have occasioned death from *acute* poisoning. The symptoms are dryness, metallic taste, thirst, colic relieved by pressure, invariably constipation from paralysis of the intestinal muscular coat, scanty red urine; later, cramps, cold sweats, paralysis lower extremities, convulsions, spasms. Death during colic stage almost unknown.

Fatal Dose of the acetate (sugar of lead) cannot be fixed; 480 grains have not proved fatal. The sub-acetate is more poisonous and deaths in thirty-six hours and seventy-two hours respectively have occurred from its administration, the dose not being known.

Chronic Lead Poisoning is very common; lead is a cumulative poison and may be received into the system by the stomach, lungs or skin. The symptoms of chronic poisoning are *blue line around the gums* (sulphide of lead in minute capillaries), emaciation and pallor, obstinate *constipation, colic, paralysis* (especially of extensors of hand and forearm).

Treatment of Acute Poisoning.—Vomiting or stomach pump, large draughts of milk containing white of egg, sulphate of magnesium in dilute sulphuric acid. Bouchardat recommends hydrated sesquisulphide of iron.

Compounds of Copper: The *arsenite* only will be considered.

Symptoms.—Pain, vomiting of blue or green matters, diarrhœa, jaundice.

Treatment.—Encourage vomiting with warm water, give albumen, followed by milk.

Compounds of Barium: The chloride, nitrate and acetate are soluble and poisonous. Irritant symptoms, cramps and convulsions, and sometimes loss of voice, have been noticed. The fatal dose may be put at half an ounce (one drachm of chloride has killed), and the time of death at two hours. The *treatment* is free use of emetics and administration of soluble sulphates, as those of sodium or magnesium.

Animal Irritants: *Cantharides* gives rise to irritant symptoms, but also affects the genito-urinary system, causing strangury, with passage at most of a few drops of bloody urine, and severe priapism. The *fatal dose* of powder is twenty-four grains, of the tincture one ounce.

Time of Death.—Twenty-four hours to four or even seventeen days. Seeming convalescence not always to be trusted. This poison has proved fatal when used externally.

Treatment.—Promote vomiting by emetics and thick warm liquids, as linseed tea, gum arabic and water, gruel. Emetics, warm baths, camphor and opium were used successfully in the case of a number of soldiers who drank the tincture.

Detection.—Shining particles may be found in the large intestines or in vomit; any particles found must be acted on with ether or chloroform, the solvent poured off, evaporated down, and the extract thus obtained applied to the ear of a rabbit to see whether it is capable of producing a blister. (Woodman and Tidy.) In case of tincture being given, evaporate contents of stomach and act on it with alcohol acidulated with acetic acid, then evaporate and shake up with chloroform as before.

CHAPTER VI.—NEUROTICS—OPIUM, CHLOROFORM, ETHER, ALCOHOL, NITROBENZOLE, ANILINE, PICROTOXIN, CAMPHOR, FUNGI.

Neurotics: Among these we find *narcotics, anæsthetics, inebriants, delirants, convulsants, paralysants, syncopants, depressants, asphyxiants, abortives,* which will be considered in the order given in Tanner.

Narcotics: Opium is the type and has been already considered.

Anæsthetics: Chloroform, ether, chloral, etc. The treatment in cases of poisoning by ether and chloroform is to put the patient where he may have a current of fresh air, apply cold affusions, use artificial respiration, and galvanism to keep up the action of the diaphragm. *Chloral* was for some time not classified among poisons; it is, however, a *very treacherous* one. Recovery has been noted from a mixture of 270 grains of chloral hydrate and 180 of potassium bromide; on the other hand, thirty grains of chloral are said to have caused death. Time of death varies from one hour to three days. The idea that chloral is converted into chloroform in the blood is not now believed. The *treatment* in cases of poisoning by this substance are emetics, stomach pump, free administration of tea, coffee or weak rum, to restore respiration; in desperate cases, transfusion of blood; use of electricity is recommended to arouse the patient. Chloroform and ether may be taken *internally.* Oliver reports a case where three ounces of chloroform were taken. The treatment was as follows: Artificial respiration was employed, one pole of induction coil being applied over the heart and the other to the nape of the neck. Enemata of beef tea with brandy were given, and subcutaneous injections of ether over the cardiac area.

In three hours there was no sensibility to the skin; five drops of amyl nitrite were given by inhalation and respiration began to improve. There was no vomiting; the pupils were contracted when the anæsthesia was most profound, but dilated when respiration almost ceased.

Inebriants: Among these we classify alcohol, nitrobenzole and aniline, cocculus indicus, camphor, mushrooms, etc. *Alcohol:* Acute poisoning by this agent is often noticed in cases where ambitious persons are desirous of imitating the alleged example of Alexander the Great. Twenty-four ounces of whisky have proved fatal in two hours; half a pint of gin has proved fatal to an adult; two wineglassfuls of brandy have killed a boy, seven years old, in thirty hours; two bottles of port (eleven ounces of alcohol) proved fatal to a man in less than two hours. Sixteen ounces of whisky have produced deep stupor, without other premonitory symptoms, then sudden insensibility and death from convulsions. (The latter are by no means a necessary attendant on alcohol poisoning.) Recovery has been noted after a quart of gin and a quart of whisky in adults and after three ounces of rum in a child five years old. *Treatment:* The one great indication in acute poisoning by alcohol is to get rid of the poison, and the stomach pump is better than any emetic. If the bladder is distended use the catheter. Cold affusion should be applied to the *head.* Fresh air is necessary. If the patient be asphyxiated, galvanism may be used. If the stupor be intense, dilute liquor ammoniæ or ammonium carbonate may be given internally. If there is thirst, give strong coffee. Lastly, warmth must be promoted.

Nitrobenzole and Aniline: Nitrobenzole may be used as a substitute for essential oil of almonds, and as such is called "essence of mirbane." Workmen engaged in its manufacture may show symptoms of chronic poisoning;

it is used largely for making aniline, and is made from the rectified products of coal tar and nitric acid. In twenty-three cases of acute poisoning noted by Grandhomme the symptoms appeared in from fifteen minutes to an hour; in two cases, immediately. General malaise, weakness, headache, livid countenance, blue tint to the skin (particularly of the face and extremities), hands and feet cold and icy, nails of a dull blue tint, are the symptoms most often noted. Death from coma. The patients have a characteristic odor of essential oil of bitter almonds. The *cyanosis* and *odor* are most important points. In forty-four cases noted, death took place in fourteen. The fatal dose was known in five cases and varied fsom a few drops to a teaspoonful. Fatal cases have been known where the nitrobenzole was sucked into the mouth and immediately spit out. A case is reported where a child died in five hours from seventy-five grains of it. *Treatment:* The stomach pump should be used at once, and if used the chances for recovery are good, as the poison is insoluble and but slowly absorbed. Cold affusion and ammonia are useful. Stimulants may cautiously be given, and the treatment persevered in. Nitrobenzole is said to be converted into aniline in the body. Aniline swallowed or inhaled produces the *blue* or *purple* discoloration of the body, especially of the *lips* and *nails.* *Aniline dyes* have been found of late to produce injurious effects; they are not so harmless as heretofore supposed. Poisoning from aniline administered internally has been treated successfully by administration of emetics, ether subcutaneously, and sinapisms. Leloir has had experience with cases of poisoning from *external* use of aniline. Compresses, wet with a solution containing five grammes of aniline hydrochlorate, and applied to parts of the skin affected with psoriasis, brought about nausea, icy coldness, cyanosis, cramps, dyspnœa, somnolence. The urine contained fuchsine. Workmen in establishments where aniline is manufactured are subject to *epileptiform convulsions.* Lailler has observed in two cases of psoriasis that applications of the hydrochlorate caused cephalalgia, agitation, dyspnœa, cyanosis, icy coldness, dark-red urine; the symptoms passed off rapidly.

Cocculus Indicus: Contains in its kernel a principle called *picrotoxine.* Symptoms: Vomiting, purging. stupor, loss of voluntary power with a consciousness of passing events. In some cases convulsions and an eruption like that of scarlatina. Picrotoxine is used sometimes as a substitute for hops. It may be detected in beer by shaking forty ounces of beer with 400 grains of salt and filtering. The filtrate may then be exhausted with ether, evaporated, the residue treated with alcohol and water, to which a drop of sulphuric acid has been added; warm, let cool, filter, shake up with ether, let evaporate and test residue, which, with cold sulphuric acid, gives no color, but when the acid mixture is warmed the orange tint is very distinct.

Camphor: The symptoms are giddiness with imperfect sight, cramps, numbness of extremities, apparent intoxication, difficulty of breathing, thirst, and sometimes convulsions. *Treatment:* Emetics and castor oil. Recovery usual. Thirty grains have killed a child one and a half years old, and 360 grains have been taken in a day without bad results.

Fungi: *Poisonous* fungi usually grow in clusters in woods and in dark damp places; are usually of a bright color; have tough, soft, watery flesh; change to a brown, green or blue tint when cut and exposed to the air; juice often milky; odor powerful and disagreeable; taste either bitter, astringent, acrid or salt. This differentiates the *common* edible mushroom from poisonous ones, but there are species of fungi not poisonous which answer to the above description, and some that are poisonous which do not answer to it. The symptoms are either irritant, narcotic or both. *Treatment:* Emetics, stomach pump, castor oil.

CHAPTER VII.—NEUROTICS (CONTINUED)—BELLADONNA, STRAMONIUM, HYOSCYAMUS, ETC.

Delirants: Among these we find belladonna, stramonium, hyoscyamus, solanum.

Belladonna: The most constant *symptoms* are: Dryness of mouth and throat, difficulty of deglutition, dilatation of the pupils, impaired vision, thirst which nothing will allay, delirium generally of a pleasing character, but sometimes of a furious nature, succeeded by drowsiness and stupor. In fatal cases, death is usually preceded by coldness of the extremities, a rapid and intermittent pulse, deep coma, and sometimes (though rarely) convulsions. In atropine poisoning, the symptoms begin sooner and are more severe.

FATAL CASES.*—(*a*) Adult ate pie made of *berries* of belladonna at dinner; died the following morning; child to whom a portion of the pie had been given died the same day. (*b*) Child ate *berries;* death in nineteen hours, with a temperature of 110° two hours before death. (*c*) Boy of sixteen took a drachm of the *extract;* death in three hours and forty-five minutes. (*d*) Injection of *decoction of the root;* death in five hours. (*e*) Belladonna *plaster* applied to sensitive surface. (*f*) Child of five ate a few ripe *berries;* death in a few hours. (*g*) Adult and child of three ate pie made of *berries.* (*h*) Female; death in twenty-nine hours. (*i*) Child of five ate a quantity of berries; death in fifteen hours. (*j*) Female of twenty-seven used *decoction* of four scruples of the root as injection; death in five hours. (*k*) Adult swallowed *extract* of belladonna; death on seventh day. (*l*) Man of seventy-five took some of the *extract;* death

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* Woodman and Tidy, and Wormley.

in seventeen hours. (*m*) Boy of sixteen took two drachms of extract; death in three and one half hours. (*n*) Female of sixty-six took one drachm of belladonna liniment; death in sixteen hours. (*o*) Female of forty-eight took the liniment; death in five hours.

RECOVERIES from poisoning by belladonna are common. (1) Child of less than three recovered from 8 to 12 grains of the extract; (2) child of less than three, from five grains of the extract; (3) male adult, from fifty berries; (4) boy of fourteen had violent delirium from eating two berries, but recovered; (5) boy of fourteen recovered from eating thirty berries; (6) male adult, from two drachms of the leaves taken as infusion; (7) female, from three drachms of extract in a liniment given by mistake; (8) from forty grains of the extract; (9) female of forty-one, from fifteen grains of the extract; (10) female of twenty-two, from two and a half drachms of extract of belladonna, taken by mistake for confection of senna. Besides these, there are many others given by Woodman and Tidy.

TREATMENT.—Emetics, as zinc sulphate, and, when the patient is a little better, a good dose of castor oil and strong coffee. Morphine is recommended as a physiological antidote. Pilocarpine subcutaneously has also been advised. In a case reported by G. H. Browne, the stomach pump was used first to wash out the stomach, then to pump in a little brandy and water. A hypodermic of one thirty-second of a grain of morphine was given, and the abdomen, which was tympanitic, rubbed with brandy. Chloroform was used (partial anæsthesia) during the spasms. An enema of warm water was given. In two hours another hypodermic of morphine. Rawson, in poisoning by belladonna and stramonium, administers chloroform for about fifteen minutes until the patient is in a slumber. In a case where emetics, opium and stimulants failed, heavy doses of chloral restored consciousness.* In the case of a child of two and one-half years, which took an unknown amount, the treatment adopted by J. W. Band was milk, brandy, lime-water and a hypodermic of 9 mg. (not quite one-sixth of a grain) of *pilocarpine*. Recovery took place on the next day. Duffin reports a case of a man of thirty who took belladonna in a beverage of some kind shortly after a meal. The treatment, which was successful, consisted of emetics, stomach pump, bromide of potassium, subcutaneous morphine, administration of chloroform. A drop of this man's urine, when concentrated, caused notable dilatation of normal pupil.

Atropine: Fatal dose, internally, *two grains;* recovery from 0.5, 0.6, 1.0 and 1.5 grains. Cases of poisoning from the use of atropine sulphate in collyria have been reported. Lutaud draws the following conclusions: "1. Collyria and eye-washes containing atropine may reach the pharynx and alimentary tract through the lachrymal ducts. 2. The symptoms are in general of short duration, and remarkable both for their intensity and for their rapid disappearance. 3. Collyria containing heavy percentages of atropine should be administered by physicians only, and never by the patient himself. 4. When instillations are made, pressure should be applied to the internal angle of the eye in order to prevent the toxic fluid from reaching the pharynx." (See, however, Beauvais's inferences.) *Death* has been noticed in one case: A child of four months died in convulsions on the first day of the use of a collyrium containing two centigrammes of atropine to ten grammes of water.† (Galezowski.) In a case of double interstitial keratitis in a child of four years, reported by Tanzler,

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* This case is reported by Decaisne to have been treated by "le docteur Smith"!

† About one grain to the fluidounce.

the use of collyria developed symptoms causing treatment to be suspended for a time; on renewing the treatment, suddenly one morning the child awoke with a temperature of 105 (nearly), pulse 140, regular. The skin presented here and there large, bright red, irregular, indefinite spots, disappearing on pressure. and not itching. Laryngeal mucous membrane strongly injected and tumefied; headache, dry cough. The next day the pulse and temperature were still higher, and the eruption, which had become paler, reappeared in the evening and on the next day. Discontinuance of atropine treatment led to slow recovery; some seven days afterward the atropine was given again, and in a few weeks the child had another rise in temperature, an eruption on the face, uneven respiration, *clonic and tonic convulsions, with loss of consciousness, ptosis* (*left side*), *difficulty in swallowing* and *anuria.* Subcutaneous injections of pilocarpine caused these symptoms to disappear in two days. In another case where a child of eight years had had for two months three instillations a day into each eye, the first symptoms noticed were *difficulty in speaking, confusion of ideas and of words*; the abdomen, thighs and lower limbs showed a *scarlatiniform eruption*, while the neck and upper limbs were marked with *red spots*, disappearing on pressure, arranged in form of islets. *Excessive mydriasis, dryness of the pharynx, violent thirst* were present. The child became practically an idiot, but was in a continual state of excitement, constantly making aimless movements, almost like those of chorea,and was unable to recognize anyone; subcutaneous injections of pilocarpine, at first three of 0.02 gm. each, then two of 0.01 gm. each, were administered. Complete recovery took place on the next day, intelligence being wholly restored.

Beauvais reports a case of iritis, where the patient, an adult, applied atropine solution (four and one-half grains of the sulphate to the fluidounce) to his eyes hourly during one night without pressure of the internal angle. When found in the morning the following symptoms were noticed: Delirium, complete blindness, eyes staring, conjunctivæ injected with bluish vessels, heart tumultuous; the breathing was short, hurried, irregular, stertorous; the skin cold and clammy. Three centigrammes (0.45 of a grain) of morphine were administered subcutaneously. Recovery was complete by four in the afternoon.

Buffum (Diseases of the Eye, p. 46) says: "Where care is not used in its application, the symptoms of *atropine poisoning* may occur. These are usually, first dryness of the throat, then flushing of the face, headache, palpitation of the heart, acute mania, delirium, retention of urine, urging to urinate, nausea, and prostration. On the occasion of any of these symptoms, the use of the atropine should be stopped and draughts of black coffee administered until vomiting takes place, or morphia and brandy may be given if the prostration is great. If the atropine is dropped into the eye, near the outer canthus, and the head held to that side for a few moments, or pressure made over the lachrymal sac, the poisonous effects are not likely to prove troublesome."

Beauvais (Annales d'Hygiene, Jan., 1881) quotes nearly a dozen cases of poisoning by application of atropine solutions to the eye, and is inclined to think that, in some cases at least, absorption of the poison by the conjunctiva is responsible for the symptoms.

Fatal Cases of Atropine Poisoning:* (*a*) Female of forty-three took three grains; death in fifteen hours. (*b*) Physician took *one-twelfth* of a grain; death in thirty hours. (*c*) One-thirtieth of a grain subcutaneously;

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* Woodman and Tidy, and Wormley.

death in five minutes. (*d*) Ointment of 15 parts atropine sulphate to 700 parts of lard applied to a blister on a man's neck; death in two hours. (*e*) Two grains of atropine taken before going to bed by male adult; death some time in the night. (*f*) Child of four months, collyrium one grain atropine to the fluidounce; death on the first day. (Galezowski.)

Stramonium: Treatment same as for belladonna.

Hyoscyamus: Symptoms are dilated pupils, unmanageble delirium, generally of great violence, alternating with or ending in coma. Treatment same as for belladonna. A woman took eleven drachms of the tincture; tincture of galls, milk and effervescent drinks were administered and recovery took place. A case of poisoning by *hyoscyamine* is reported by Gibbons: In the case of a woman of seventy-five with paralysis agitans, one-eighth of a grain of hyoscyamine in form of pill, together with two grains of quinquinia, was administered. In six hours the woman was found on the edge of her bed cold, almost unconscious, incapable of articulating any words distinctly, and almost entirely deprived of muscular power. Hot fomentations, a small amount of wine, with ten drops spirit of camphor and one-twelfth grain morphine sulphate, were administered, and she slept well the rest of the night. Twenty-four hours afterward the symptoms reappeared with greater intensity; everything around her seemed *red* in color. By the next morning after that all symptoms of poisoning had left her.

Duboisine: This alkaloid is said, by Ladenburg, to be identical with hyoscyamine. Berner (Schmidt's Jahrbucher, Band 189, No. 1) has observed a case of poisoning following the instillation of a solution of duboisine, 1 in 100, into the right eye. The symptoms came on in ten minutes, and were dilatation of the pupil, accommodation impossible, photopsy, etc. Most of the symptoms disappeared in four hours. Another case reported by J. H. Buffum was that of an elderly woman who, in half an hour after the instillation of a four-grain to the ounce solution, became entirely unconscious and showed symptoms of collapse; relieved in six hours by hypodermic injections of brandy. In another case reported by the same physician, an adult man suffered partial loss of consciousness, and showed symptoms of approaching collapse; brandy was successfully used in this case as before. *Hyoscine* is chiefly used in form of the hydrobromate. Toxic symptoms are said to follow the use, in ophthalmological practice, of solutions stronger than 1 in 200. Internally 1-40 of a grain is deemed the strongest medicinal dose, or 1-250 to 1-320 subcutaneously.

Tests for Atropine: The physiological tests are of greatest importance, and the action of the residue obtained from vomit or from the tissues or urine when dropped into the eye or injected under the skin of a rabbit should always be noticed. Merely dropping the urine of the patient into the eye of a rabbit suffices in some cases to cause dilatation of the pupil at once.

In order to find the poisonous principles of most plants, other than opium or nux vomica, Woodman and Tidy recommend the following method: Place the contents of the stomach and intestines in a clean wide-mouthed bottle, and having rendered them acid with a few drops of acetic or hydrochloric acid, treat them with a considerable quantity of alcohol and put them aside for some hours in a warm place, occasionally giving the bottle a shake. Filter the materials through thick blotting paper and treat the filtrate with excess of sub-acetate of lead (Goulard's extract) and filter off the precipitate formed. Sulphuretted hydrogen must now be passed through the clear filtrate until the liquid shows by its action on lead paper that complete saturation has been effected. In this way any excess of lead added will be thrown down and may be filtered off. Evaporate the clear filtrate to dryness and dissolve the residue in a few drops of water acidulated with acetic acid. It may be necessary to filter this. Supersaturate this alcoholic extract with bicarbonate of potash, and extract from this the alkaloid, either by ether or chloroform, in the manner already indicated. Tasting the residue from time to time should never be neglected.

After obtaining the alkaloid, tests for atropine may be made as follows:

1. KHO or NaHO give with strong solutions a white and at first an amorphous precipitate, which ultimately becomes crystalline, and is insoluble in excess of precipitant or in strong acids. *Ammonia* gives similar precipitate, but it is soluble in very slight excess.

2. HBr saturated with free bromine gives a *yellow* precipitate soon becoming crystalline, insoluble in either acetic acid, mineral acids or caustic alkalies.

3. Iodine in solution of KI gives reddish-brown precipitate insoluble in caustic potash or acetic acid.

4. Chloride of gold gives a citron-yellow precipitate, insoluble in potash, sparingly soluble in acids.

5. Picric acid gives yellow crystalline precipitate soluble in acids.

6. Tannin gives a white amorphous precipitate soluble in caustic alkalies and in acids.

7. Atropine dissolves slowly in strong H_2SO_4 without change of color; if this solution be warmed till it becomes slightly brown and then a few drops of water are added, an agreeable odor is evolved resembling that of sloe blossom or of the orange. On further treating the odor is intensified.

8. When some drops of strong H_2SO_4 are heated with

a fragment of bichromate of potassium and then some atropine, with two or three drops of water, are added, the odor of oil of bitter almonds or of *spiræa ulmaria* is produced.

9. Gerrard's color test: Add to a very small quantity, say one-half to one milligramme, of the suspected alkaloid or the alkaloidal substance obtained from complex mixtures, two cubic centimetres of a five per cent. solution of corrosive sublimate in fifty per cent. alcohol, and warm very gently. If atropine was present, a red (or yellowish-red) precipitate will be produced. Hyoscyamine might under certain conditions be mistaken for atropine, while this test is applied, but from the following it will be seen that they may be clearly distinguished. If one milligramme of hyoscyamine is treated with two c.c. of the above reagent, the red precipitate does *not* make its appearance, either immediately on warming, or after standing for hours. But, if only *one* to *two drops* of the reagent are added to the hyoscyamine, a short warming produces the same red precipitate as in the case with atropine. Gerrard's test is, of course, useless when inorganic alkalies are present, since they produce the same kind of precipitate. And finally it should be stated that the above reaction occurs only in solution of the alkaloids themselves, and not in that of their salts. (American Druggist.)

None of the other alkaloids, except daturine, hyoscyamine, duboisine and homatropine, gave the red precipitate.

Atropine when dissolved in strong H_2SO_4 may be told from morphine by yielding no coloration with nitric acid; from strychnine, by none with potassium dichromate. Prolonged contact with potassium dichromate causes the solution to turn green.

Picric acid does not yield the precipitate mentioned in

(5) with the *salts* of atropine. It is well, before applying tests for atropine, to rule out other alkaloids, as many give precipitates resembling those of atropine. The physiological test is of the most value, although "it must be borne in mind that the property of dilating the pupil is also possessed by daturine, hyoscyamine, duboisine and certain other alkaloids." (Wormley.)

Vitali finds that out of sixty-four alkaloids atropine and its congeners are the only ones that respond to his test, which is as follows: Place atropine or any of its salts in the solid state in a porcelain capsule, heat with a few drops of *nitric acid*, evaporate at a moderate temperature, touch the cooled colorless residue with a drop of concentrated solution of alcoholic potassium hydrate, when a splendid violet or purple color will appear. A marked purple coloration may be obtained from even the 1-50000th of a grain of the alkaloid, especially if the alkaline alcoholic solution be added to the nitric acid residue while still warm.

CHAPTER VIII.—NEUROTICS (CONTINUED)—NUX VOMICA, CURARE, ACONITE, HYDROCYANIC ACID, PHYSOSTIGMINE, CONINE.

Convulsants: Nux vomica, strychnine, brucine. Thirty grains of the powder of *nux vomica* in a doubtful case and half an ounce in well-recorded instances have caused death; so have also *three grains* of the alcoholic extract. Death may occur in from fifteen minutes to twelve hours. Nux vomica has been called a *cumulative poison* from cases noticed. *Strychnine* has been already considered. *Brucine* resembles strychnine, but is less powerful. It gives a *red* with nitric acid, thus distinguishing it from strychnine. It does not decompose iodic acid and is thus told from morphine.

Paralysants: Curare, physostigma, conium. The symptoms of *curare* are complete muscular paralysis, slowing of heart's action and diminished respiration till life is extinct. Has little effect when swallowed, being chiefly active when introduced under the skin. Treatment is artificial respiration.

The symptoms of physostigma or calabar bean are as follows: Giddiness, passing to paralysis of voluntary muscles, muscular twitches of a convulsive nature, myopia, *contraction* of the pupil. Death from paralysis of respiratory muscles. Treatment consists in use of emetics and stomach pump. The alkaloid is called *physostigmine* or *eserine;* it is told from atropine and hyoscyamine by its power to contract the pupil.

Conium: The symptoms are headache, imperfect vision, loss of power to swallow, extreme drowsiness, pupils dilated and fixed, pulse variable and often intermittent, gradually complete paralysis of extremities with great muscular weakness and loss of power. Death from apnœa. If death be delayed, convulsions, coma, frantic delirium, salivation, involuntary discharge of urine and fæces. The alkaloid is *conine;* its fatal dose, one drop, and time of death one to three hours. Treatment: Emetics (especially mustard), stomach pump, castor oil. After this, stimulants. Tests: Conine is a *liquid* having a "mousy" odor; crystals are formed when it is treated with or exposed to vapor of hydrochloric acid; if hydrochloric acid be added in great excess to the alkaloid a pale red tint is produced which gradually deepens in color; nitrate of silver gives a white precipitate, turning dark on exposure to light. Rubbing with caustic potash causes the odor of mice to become apparent in any substance containing conine.

Hyposthenisants or Syncopants: Aconite, prussic acid.

Aconite: The symptoms most common are heat, numbness and tingling in mouth and throat, giddiness, abolition of muscular power, pupils dilated, skin cold, pulse very feeble, patient is conscious though numb and paralyzed; death due to shock or sudden and complete collapse or asphyxia. (Tanner.) Symptoms appear in from a few minutes to one or two hours; death usually in three or four hours. In one case delayed for twenty hours, in another took place in twenty minutes. Fatal doses: One drachm of the root, four grains of the alcoholic extract, one ounce of the tincture.

The alkaloid *aconitine* is probably the most powerful poison known. In the opinion of Stevenson it is fatal in doses of one-thirteenth of a grain. In the case of Percy John, poisoned by Lamson with this alkaloid, there was vomiting and retching and dreadful pain (morphine was given), the boy became unconscious and remained so until he gradually sank and died. Soon after taking the poison he complained of *heartburn*, that his *skin was all* *drawn up*, that his *mouth was painful*, and that his *throat burned* much. Later he complained that the *skin of his face was all drawn up*, of a sense of *constriction in his throat*, and of being *unable to swallow*. He died in *four hours*. *Post-mortem examination* showed congestion of brain and membranes, dilatation of the pupil, lips and tongue pale (lungs congested at lower part, indicative of old inflammation), heart healthy, but empty and flaccid; liver and spleen congested and stomach greatly congested, and showed eight or ten patches (described as of recent inflammation).

The *treatment* is to administer an *emetic* at once; finely-powdered *charcoal* may be given, but should be removed by stomach pump immediately. *Stimulants* (as ammonia and brandy) and strong *coffee* and *tea* should be administered freely. *Liniments* and *friction* to the limbs and spine, *mustard plasters* to pit of stomach and slight galvanic *shocks* through heart are recommended by Woodman and Tidy. Nux vomica and digitalis have been successfully used as antidotes.

Tests: It gives *no precipitate* with platinic chloride and this is characteristic, but there is no distinctive chemical test for it; the physiological action of the alkaloid constitutes its chief test; *rubbed inside the gums it produces a sense of tingling and numbness.* In the Percy John case the fluid in the stomach yielded a residue which, when touched to the tongue, produced a peculiar burning as if a hot iron had been passed over it, and a desire to expectorate was caused; there was a taste of the alkaloid in the urine, which brought on the burning sensation. Extracts from the stomach fluid, from the liver, spleen and kidneys killed mice in twenty-two minutes, with symptoms of poisoning. Dr. Stevenson testified that while acquainted with from fifty to eighty alkaloids, aconitine differed in taste from all;

twenty-two experiments in regard to the taste of cadaveric alkaloids never gave him any taste like that of aconitine. The sensation on Dr. Stevenson's tongue lasted three hours.

Preparations of aconitine vary in strength. A case in point is given by Tresling (*Schmidt's Jahrbucher, B. 189, No. 2, 1881*): A physician prescribed solution of nitrate of aconitine, in strength 0.2 in 100, dose twenty to sixty drops, every hour. The patient took five drops the first day; the next day twenty drops, felt a burning in his mouth and throat and vomited almost immediately. He made three more trials to take twenty drops and vomited each time. Finally in the evening he managed to retain twenty drops, but all night had oppression, and was seized with an icy cold feeling, although *within* he experienced a sensation of heat. The physician—to prove that the symptoms were not due to the aconitine—took *fifty* or *sixty* drops of it. In *fifteen minutes* the effects of the poison showed themselves, and at the end of four hours Tresling found him manifesting the following symptoms: *Pallor; small, irregular,* but *not accelerated pulse;* cold skin, *contracted pupils;* sensation of *burning* in the mouth, *contraction* from the throat to the abdomen; precordial anguish, heaviness and feebleness of the limbs, especially of the legs. The pupils dilated suddenly and vision was lost, but came back again when the pupils contracted. Vomiting of fragments of food colored red. Later congestion of the brain, convulsions and stertorous breathing; deafness and buzzing alternately in both ears. Ether was given subcutaneously and electricity used to stimulate the respiration, which became slow and laborious, but the patient could not be restored to consciousness; the pupils dilated and became insensible to light, the heart grew feebler and feebler in its action, and death took place *five hours* after taking the poison. Autopsy showed great paleness of the skin and great congestion of internal organs. In this case doubtless a more poisonous aconitine was dispensed than was intended, though not specified, by the practitioner in his prescription.

Regarding the *symptoms* produced by aconite, the researches of Terchet and Tucker show that of forty-one cases of aconite poisoning there was *difficulty in swallowing* in forty one, *salivation* in one, *increased secretions* in one, *involuntary lachrymation* in two, *dryness of the throat* in three, *intense thirst* in four, *constriction of the pharynx* in one, *nausea* in three, *vomiting* in seventeen—the vomited matters varying greatly in character, having sometimes the odor of *camphor*, sometimes of *alcohol*, and being sometimes *mucous*, sometimes *bilious* —*diarrhœa* in six cases, *involuntary stools* in two cases, *tympanitis* in one case, *diuresis* in one case. The nervous phenomena were equally variable. Certain symptoms were worthy of note. In some cases there was a very marked jactitation with *violent movements of the head* or *of a limb.* In one patient the eyes protruded almost from their sockets. Some experienced *delightful dreams* resembling those produced by haschisch. The *pulse* and *respiration* were in general remarkable for their *slowness*; in certain of the patients respiration was only five or six to the minute and the pulse twenty. Tucker's cases were fifty-three in number; recovery took place in twenty-eight instances, death in twenty-five. Time of death varied from one hour to six days. Woodman and Tidy, out of thirty-three cases of poisoning by aconite, report eighteen deaths and fourteen recoveries; by aconitina, out of four cases, three recoveries, one death; the recoveries in the latter cases were two from two and a half grains of aconitina, and one from one ounce and a half of an alcoholic solution; the one death was from too frequent applications of neuraline.

Regarding the *time of death*, Prof. J. W. Mallet communicated the following to Prof. Wormley: In six fatal cases which occurred at the Western Lunatic Asylum of Virginia in 1883, death took place respectively in *eight minutes, ten minutes, thirteen to fifteen minutes, one hour and a quarter, two hours and a quarter* and *four days.*

Variations in strength of aconite and aconitine are often noticed. Four grains of one alcoholic extract have proved fatal and six grains of another have produced no effect whatever; in one case twenty-five minims of a tincture of aconite root with twenty minims of tincture of belladonna proved fatal in three hours; most alarming symptoms have followed two doses of the tincture of six drops each taken at intervals of two hours. Five drops of Thayer's fluid extract of aconite root have produced violent symptoms. Recovery has been known from two teaspoonfuls of the tincture and from an ounce and a half of an alcoholic solution.

Headland thinks that one-tenth of a grain of pure aconitine would be a fatal dose. Pereira mentions that one-fiftieth of a grain nearly proved fatal to an elderly lady. Recovery has taken place from two grains and a half of aconitine. Petit's crystallized aconitine nitrate is according to Plugge 170 times more active than Friedlaender's preparation; one-seventh of a grain of Petit's preparation caused violent symptoms in one case, and in another one-sixteenth of a grain proved fatal. Eight grains of Merck's aconitine have proved fatal. About two grains of Morson's aconitine killed Percy John. According to the *New Remedies*, Petit's nitrate of aconitine is eight times stronger than Merck's, and Merck's twenty to thirty times stronger than Friedlaender's.

According to Wormley, aconitine is usually amorphous and more or less colored, and very variable in strength, some of the samples being almost wholly inert. Pereira has met with a French preparation, of which he took one grain without perceiving the least effect, either on the tongue or otherwise. Of three samples prepared by different German manufacturers examined by Wormley, one contained a mere trace only of the alkaloid, and the other two appeared to consist entirely of foreign matter. Morson's and Duquesnel's aconitine have about the same solubility, viz., one part in 1,783 of water. Aconitine is often adulterated with delphinine and aconelline.

Morson's crystallized aconitine and Duquesnel's crystallized aconitine have been found by Wormley to be about equally potent, 1-3000th grain, subcutaneously, killing large mice. A sample of Morson's ordinary aconitine was somewhat less active than Duquesnel's crystallized, as was also a sample of Trommsdorff's aconitine. Aconitine is more readily extracted from aqueous mixtures by chloroform than by ether.

Hydrocyanic Acid: In large quantity this poison kills before any well-marked symptoms are noticed. During the act of swallowing a large dose the patient experiences a hot, bitter taste, and is either immediately or within a very few minutes seized with complete loss of muscular power and of consciousness. The face and skin will be bathed in cold, clammy perspiration; the hands violently clenched; the eyes fixed, prominent and glistening; the pupils widely dilated; the breathing stertorous, convulsive and gasping; the odor of the poison noticeable in the breath; the pulse almost imperceptible. Death takes place with a forcible expiration. If death be delayed, convulsions, with spasmodic closure of the jaw, are usually noticed. The *fatal dose* has been given as forty-five minims of the officinal acid. The smallest dose that has killed would appear to be a solution containing *nine-tenths of* *a grain* of the *pure* acid. Similar quantities of prussic acid do not always produce the same results as regards the *time of death*, which varies from two minutes to an hour, the average being half an hour.

The *U. S. Pharm.* acid should contain two per cent. of the pure acid; Scheele's acid sometimes contains five per cent., usually less. Recovery from a mouthful of the British Pharm. acid (2 per cent.), two drachms of Vauquelin's (3.5 per cent.) have been noted, as well as from other doses larger than the dose here stated as fatal.

The fatal dose of the cyanide of potassium is from three to five grains. Essence or oil of bitter almonds contains ten per cent., and would probably be fatal in from ten to thirty drops. Cherry laurel water has killed in a dose of two ounces.

The *post-mortem appearances* are as follows: Body livid, countenance pallid or sometimes livid and bloated, jaws firmly closed, hands clenched, blood or froth about the mouth, eyes prominent and glistening, often an odor of the acid about the body, more perceptible on opening the stomach. Brain shows great vascular turgescence, with serous effusion into the ventricles, the odor of the poison often being distinctly recognized. Lungs, liver, spleen, and kidneys invariably gorged with blood. Bile often deep blue tint. Venous system gorged with dark colored blood. Arterial system empty. Blood may be black or oily or of a cochineal-red, sometimes fluid, sometimes coagulated; it often exhales the odor of the poison, and should be preserved for analysis, as the acid may frequently be distilled from it. In some cases no morbid appearances have been found after death. *Treatment:* immediately use the *cold douche* and apply *ammonia* or *chloride of lime* to the nostrils. Keep body dry and warm by friction with hot towels. Tickle the back of the throat with a feather, and if the jaws can be opened use the stomach pump or else give sulphate of zinc or mustard and salt. Give as an antidote the following mixture: Tincture of the muriate of iron, to which liquor ammoniæ fortior has been added, filter, throw filter paper into water, shake well, and use the precipitate by spoonfuls as it falls to the bottom.

Tests: The odor may be detected in the stomach sometimes when nowhere else; it has been observed eighteen, twenty-two and thirty hours after death, and, in one case, four days. There may be no odor at all, owing to various circumstances. The *bitter* taste of the acid may be detected when the substance is applied to the back of the tongue. Place contents of stomach and other solid matters in a clean, wide-mouthed bottle; test, first of all, their acidity or alkalinity. If alkaline, add dilute sulphuric acid until the reaction is acid. Stand the bottle in a basin containing a little warm water and expose on clean glass plates a drop of the following and note action of vapor evolved on them: nitrate of silver, weak solution caustic potash, ammonium sulphide. The nitrate of silver will give a white opaque film not soluble in a little nitric acid; the potash solution is allowed to remain some time; place the glass slide subsequently on white paper, touch with a solution of sulphate of iron exposed to air, then with a drop of dilute sulphuric acid and the characteristic blue color will be developed; let the ammonium sulphide slide stand five or ten minutes, then remove and evaporate slowly to dryness. Touch with a drop of persulphate of iron and a blood-red color is formed.

Hydrocyanic acid in solution is readily identified by the nitrate of silver test, which is also of value in the case of soluble cyanides; from these solutions the silver nitrate solution throws down a white amorphous precipitate of silver cyanide, AgCy, which is insoluble in the fixed caustic alkalies (potassium and sodium hydrate, etc.)

and only sparingly soluble in ammonia, *but readily soluble in alkaline cyanides.* It is, however, insoluble in cold nitric acid, but soluble in the hot concentrated acid; hydrochloric acid decomposes it with formation of silver chloride and evolution of hydrocyanic acid. Nitrate of silver also produces white precipitates in solutions of free hydrochloric acid, of chlorides, carbonates, phosphates, tartrates and some other salts, and also with various kinds of organic matter. These precipitates, however, except that from chlorine, are readily soluble in strong nitric acid, in which they differ from the cyanide compound. The chloride of silver readily darkens when exposed to the light, whereas the cyanide remains unchanged in color; again the chloride is readily soluble in ammonia, while the latter is not, unless present only in very minute quantity. Tolerably strong solutions of iodides and bromides, and of their free acids, hydriodic and hydrobromic, yield with nitrate of silver yellowish-white precipitates; from dilute solutions, however, these precipitates, in regard to color, might readily be mistaken for the cyanide compound, especially when they are obtained from organic mixtures; like the cyanide deposit, they are nearly insoluble, or dissolve with difficulty, in cold nitric acid. The cyanide of silver is readily distinguished from all other precipitates produced by this reagent in that when thoroughly dried and heated in a narrow reduction tube it undergoes decomposition with the evolution of cyanogen gas, which, when ignited, burns with a rose-colored flame. If this decomposition be effected in a small tube, which, after the introduction of the dried cyanide has been drawn out into a very narrow capillary neck, beginning something less than an inch above the cyanide compound, the 1-100th of a grain of the salt will yield satisfactory results. It is essential that the cyanide be thoroughly dried before being introduced into the tube. (Wormley.)

CHAPTER IX.—NEUROTICS (CONCLUDED).—ASPHYXIANTS, MISCELLANEOUS.

Depressants: Digitalis, tobacco, lobelia, colchicum, veratrine.

The symptoms of *digitalis* are, among others, great slowness and irregularity of the pulse. Violent vomiting and extreme depression may also be noted. The alkaloid *digitaline* is probably poisonous in doses of from one-quarter to one half a grain. The action of the digitalis is uncertain and dangerous; by some it is regarded as a cumulative poison. Death rarely in less than twenty-two hours. Recovery slow. Treatment: patient must lie in recumbent position for days. If no vomiting, use stomach pump and emetics. Tea and coffee freely. Stimulants and perhaps galvanism at region of heart.

The symptoms of poisoning by *tobacco* are giddiness, confusion, trembling of the limbs, faintness and depression, anxiety of countenance, cold sweats, nausea, purging, violent abdominal pains, pulse weak, quivering, imperceptible, breathing more and more difficult, vision impaired, paralysis, convulsions, death. Time of death: fifteen minutes from tobacco enema, three minutes from nicotine are recorded as the most rapid. The alkaloid nicotine is one of the most rapid and deadly poisons known. Death has followed the use of injections and decoctions of tobacco; in one case only half a drachm in an injection and in another a drachm. Death from smoking has occurred. Two men smoked at one sitting seventeen and eighteen pipes respectively and died. Rabot reports a case (Journal de Pharmacie et de Chimie, Sept., 1884) of a gardener who took fifty grammes of a preparation of tobacco juice for killing insects, etc., representing about six grammes or nearly one hundred grains of nicotine. The symptoms were vertigo, very severe abdominal pain, nausea, retching but no vomiting, great pallor, convulsions, abundant evacuations; death in about fifteen minutes. Forty cigarettes and fourteen full-sized cigars smoked in a period of less than twelve hours caused death on the evening of the following day. The treatment consists in the speedy removal of the poison and the administration of stimulants. Opium may sometimes be found useful to allay the excessive vomiting.

Colchicum: the symptoms are rarely delayed beyond three hours, and in some cases are those closely resembling malignant cholera. Death usually within twenty-four hours. One ounce of the wine,forty-eight grains dried bulb, teaspoonful seeds, two ounces cooked leaves and a handful of flowers have severally caused death. Recovery from an ounce of the wine and an ounce of the tincture. Colchicine, the alkaloid, is fatal in less than half a grain. Treatment consists in emetics, purgatives and stimulants.

Veratrum: The alkaloids of hellebore have been the subject of considerable investigation. *Veratrine*, $C_{37}H_{53}NO_{11}$,has been found in *Veratrum sabadilla* and in *cevadilla*, the seeds of *Asagræa officinalis;* also in *Veratrum album*, or white hellebore, and *Veratrum viride*, or American hellebore. According to Wright and Luff, *Veratrum album* contains but very little *veratrine*, its alkaloids being *jervine, pseudojervine, rubijervine* and *veratralbine*, while *Veratrum viride* contains, in addition to these, *cevadine* (Merck's veratrine).

The *symptoms* of poisoning by *white hellebore* root are, as a rule, sense of burning heat in the stomach, with feeling of constriction and heat in mouth and throat, great anxiety, nausea, violent vomiting, purging, tenesmus, pain in the bowels, trembling of the limbs, great prostration, cold sweats, small and feeble pulse, vertigo, dilated pupils, loss of sight, impaired speech, coldness of the extremities, convulsions, insensibility; these are never, perhaps, all present in the same case. Twenty grains of the powdered root of veratrum album have proved fatal, as has also a less quantity. The time of death is from three to twelve hours. *Veratrum viride* (Indian poke) has produced fatal results in a few instances, the symptoms being somewhat similar to those produced by *Veratrum album* in some six cases which have been noted. The fatal doses of *Veratrum viride* have been thirty to forty drops of the tincture (child), two doses of Tilden's fluid extract (adult female), sixty drops, in ten-drop doses every three hours, of Norwood's tincture (female of sixty), thirty-three minims of the tincture (adult man with pneumonia), teaspoonful of officinal tincture (patient convalescing from typhoid fever). The fatal dose of veratrine may be put at one-tenth of a grain. The *treatment* in cases of poisoning by the veratrums is its speedy removal from the stomach and the administration of stimulants. Opium has in several instances been found highly beneficial; in some instances purgatives may be found highly useful (Wormley). *Tests: Veratrine* (*pure*) if touched with a drop or two of cold concentrated *sulphuric acid* assumes a yellow color, then a reddish tint, and slowly dissolves to a pinkish solution, which after several minutes acquires a deep crimson-red color. If *jervine* be treated in a similar way it will assume a yellow color, quickly dissolve to a yellow solution, which, becoming reddish yellow, then dirty brown, will finally assume a bright *green* color. In poisoning by either veratrum viride or veratrum album the *jervine* of the plant is more readily recovered from complex mixtures than the veratrine. According to Wormley, no alkaloid is so readily recovered in its crystalline state from the blood, when carried to this fluid by absorption, as jervine.

Asphyxiants: Carbonic oxide, carbonic acid, sulphuretted hydrogen, carburetted hydrogen. Fires give off *carbonic oxide*, CO, especially if the combustion is imperfect. It forms a remarkably stable compound with the blood, so that the latter cannot exchange the carbonic oxide for oxygen, hence the patient exposed to its vapors manifests certain marked symptoms.

Carbonic acid is formed from burning fuel, from calcination of limestone or chalk, and is a product of respiration. If these gases be breathed *pure*, death follows instantaneously; if the gas be more dilute, *loss of muscular power* is very marked. The patient dies in a state of complete coma. The treatment is removal to pure air, cold affusions, stimulants to chest and extremities, galvanism, artificial respiration, friction, and, where the countenance is bloated, moderate venesection. Putrefaction after carbonic-acid poisoning is slow, and there is great persistence of animal heat and rigidity. An air containing 5 per cent. of carbonic acid and 0.5 per cent. of carbonic oxide is said by Leblanc to be rapidly fatal to animal life; a taper will burn in air proving thus fatal.

Water gas, which is used extensively now in many of our cities, contains, according to Dwight, more carbonic oxide than coal gas. His analyses show the gas to have the following mean composition in 100 parts: Carbonic acid, 5.60; *carbonic oxide, 35.7;* Marsh gas and nitrogen, 57.7; air, 0.9.

Sulphuretted hydrogen is prepared in chemical laboratories as a reagent; is formed when sulphur is heated with hydrogen; spontaneously whenever a soluble sulphate remains in contact with decaying organic matter in limited supply of air, as in sewers and cesspools. If it be breathed in the *concentrated* state, death is immediate; if somewhat diluted, insensibility and death. Workmen in sewers often have giddiness, nausea and weakness from breathing it. Its rotten-egg odor makes it less dangerous than carbonic acid, which is odorless. The treatment is fresh air and cold affusions; the patient should breathe from out of a bottle containing a small quantity of chloride of lime. Hot brandy and water is recommended.

Coal Gas: The fate of individuals who "blow out the gas and go to bed" furnishes food for reflection both to the reporter and to the toxicologist, but seemingly to no one else, since cases of this kind are astonishingly common in spite of professional warnings. The odor of coal gas makes it recognizable when in the proportion of 1 in 8,000 of air. Mice will die in an atmosphere containing seventeen per cent. of it. The symptoms are headache, giddiness, vomiting, loss of memory,* unconsciousness, convulsions, loss of muscular power, complete asphyxia. The treatment is fresh air, cold affusion, stimulants, artificial respiration.

The *British Medical Journal* (March 4, 1882) reports a case where *coma, dilatation of the pupils, redness of the face, vomiting, acceleration of the pulse*—"the usual signs of poisoning by illuminating gas"—were observed, and death took place in spite of cold affusion, fresh air and diffusible stimulants.

Miscellaneous—Sewer Gas: *Acute* poisoning from gaseous constituents, as sulphuretted hydrogen, ammonium sulphide, carbonic acid or oxide; *chronic* poisoning not always referable to these, but to its action as a whole on the system; symptoms are developed bearing no analogy to those of any chemically known substance, gaseous or otherwise (De Varona.) Tests: papers moistened with solutions of acetate of lead and of sodium nitroprusside respectively; the lead paper is blackened by sulphuretted hydrogen, the nitroprusside turned red by

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* This seems to be a marked symptom *beforehand* in many cases!

ammonium sulphide. Hogg's sewer-gas indicator, in shape like an aneroid barometer, is much more reliable than these papers, which give no reaction unless the above-mentioned gases are present. Sewer gas is often deoxygenated air with excess of carbonic acid (Thenard), in which case the papers would be valueless for its detection.

Gases of Privy Vaults: Among these are ammonium sulphide and sulphuretted hydrogen. The symptoms of ammonium sulphide poisoning resemble those of sulphuretted hydrogen. Increased secretion of tears is noticed. In a case reported by Eckridge, in the *Medical Times*, of Philadelphia, poisoning by privy gases was cured by intravenous injections of ammonia *repeated twelve times*; all other measures had previously failed to restore the patient.

Inhalations of Oxygen: Loysel recommends inhalations of oxygen in treatment of poisoning by chloroform, ether, chloral, opium, sulphuretted hydrogen, carbonic oxide, prussic acid. He argues that it is never contra-indicated in these cases, and should be used first either alone or together with other means of treatment.

Odor of Prussic Acid: This odor (bitter almonds) is *not* as easily recognized by all individuals as the odors of sulphurous acid, ammonia and ether respectively. (Vibert and L'Hote.) An autopsy, where this odor really exists, if made in the presence of several persons, will often give rise to difference of opinion. Moreover, the odor is not always most marked when the stomach is first opened, but will be more so after this organ and its contents have remained in a closed vessel for some little time; agitation of the liquid contents aids in the production of the odor. Perception of the odor is facilitated by *swallowing* immediately after breathing the emanations. In a case reported by Vibert and L'Hote *there was no* *rigidity at the end of forty-eight hours and putrefaction had begun; in spite of putrefaction they could find the acid in the contents of the stomach thirty-five days after death.* (Annales d'Hygiene, May, 1883.)

Spectroscopic Examination of the Blood in Poisoning by Gases: Yvon and Descoust, examining the blood of an asphyxiated patient, proceeded as follows: First, examination with the spectroscope showed the two normal bands of oxygenated hemoglobine, but there was *no band of reduction*, therefore *no sulphuretted hydrogen*; second, adding a little ammonium hydrosulphide to the blood, the two bands disappeared and gave place to the unique band of Stocke, therefore *no carbonic oxide.* Chemical examination had then to be relied upon to demonstrate the presence of *carbonic acid*, which was eventually found.

Chlorate of Potassium: Marchand, in *Virchow's Archives, LXXVII*, gives a resume of poisoning by this agent. He has observed four cases in children, three to seven years of age, who took ten, twelve and even thirty-five grammes* in less than a day, or at most thirty-six hours. The *symptoms* rapidly appearing were *vomiting*, urine scanty and bloody, yellow coloration of the skin even icteric, rapid debility and loss of power, then cerebral phenomena, delirium and coma. Three out of the four died. *Post-mortem appearances:* Blood remarkable for its chocolate-brown tint, persistent even on exposure to air; kidneys brown in color; on their surface showed the canaliculi of the medullary substance distended with brownish granular cylinders, evidently derived from the disintegration of the red globules. The spectroscope showed disappearance of the ray of hemoglobine and a new ray of absorption in the red. According to Binz, the chlorate of potassium oxidizes the

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* About 154, 185, 543 grains respectively.

hemoglobine of the blood, and in consequence the globules show a great tendency for agglutination; the altered globules accumulate in the various organs, especially in the kidneys, forming then brownish granulations, or granular conglomerations, eliminated by the urine. If their quantity is considerable they present an obstacle to the urinary secretion.

Poisoning by Copper Arseniate: I published in the *American Observer* (June, 1880) the following, translated from the *Annales d'Hygiene:*

A girl of seventeen took, Dec. 7, 1878, 750 grains of a preparation called "Mittis Green," which is copper arseniate. Vomiting began half an hour after the poison was taken, and was promoted by administration of an emetic. The next day she was taken to the hospital.

The vomiting was incessant; she had cold extremities, prostration, small and feeble pulse.

Epigastric pain was very pronounced; the stools were loose and yellowish.

She complained of obscurity of sight, but the poison produced neither its characteristic eruption nor yet paralysis.

Death supervened on the evening of Dec. 12; the prostration had become greater since the first day, but delirium did not supervene until twelve hours before death. Vomiting and diarrhœa had ceased sometime before death.

The autopsy held Dec. 14, at the hospital, showed an *absolute integrity* of the mucous membrane of the digestive tract.

There was merely slight congestion of the pharynx, without ulceration.

The mucous membrane of the stomach was pale and in appearance entirely normal; the same was true of the intestines.

The liver showed a yellowish color, indicative of fatty degeneration, which was demonstrated afterward by the microscope.

In the other viscera, there was *no lesion* at all apparent.

REPORT OF THE CHEMISTS.

“The viscera, the dejections and the urine, being subjected to analysis, the result was as follows:

Brain:—	
Arsenic	2.4 grammes.
Copper	1.81 “
Stomach and Pancreas:—	
In 42 grammes	Arsenic 0.4 gm.
In 47 “	Copper 0.2
Liver:—	
Total weight	950 grammes.
Arsenic	13.3 “
Copper	9.02 “
Heart:—	
Total weight	216 grammes.
Arsenic	traces.
Copper	0.51 gm.
Lungs:—	
In 100 gm	Arsenic 0.7.
In 100 gm	Copper 0.47.
Intestines:—	
In 100 gm	Arsenic 0.5.
In 100 gm	Copper 0.30.
Kidneys:—	
Total weight	380 gm.
Arsenic	1.5 gm.
Copper	0.76.
Hair:—	
In 9 gm. Arsenic	0.1 grammes.
In 4 gm. 428	Copper 0.00.

Mammary Glands:—

In 60 grammes	Arsenic 0.2 gm.
In 64 "	Copper 0.3.

Muscles:—

In 40 gm	Arsenic 0.1 gm.
In 55 gm	Copper 0.12.

The researches of the experts showed a general diffusion of the arsenic throughout the organism, although localized the poison was particularly in the liver, this viscus containing 13.3 grammes (about 206 grains).

The liver contained also an abnormal amount of copper. The analysis of the vomited matters and of the urine, resulted as follows:

Vomited matters:

Total weight, 286 gm.

In 100 mg. of this, arsenic was found in amount 0 gm. 1 copper, 0 gm. .09; the vomited matters were pale and very acid.

Urine:

Total volume, 69 c.c.

In 20 c. c. was found

Arsenic	0 mg. .05.
Copper	traces.

Urine very acid in reaction.

It was concluded that the girl had absorbed:

Arsenic (nearly)	11 gm. 32.
Copper	7 gm. 46.

Constituents of 50 gms. of "Mittis Green."

The questions asked the experts were three:

1. Had the girl absorbed any of the poison? A. Yes. Absorption proved by the finding of arsenic and of copper in the different organs.

2. Is the "Mittis Green" in the dose in which it was taken, or in less quantity, of such a nature as to cause death? A. Yes. Arsen*ious* acid kills in doses of from

two to three decigrammes. In the fifty grains of "Mittis Green" there were 17 gm. .36 of arsen*ic* acid, which, being more soluble, acts with greater energy than arseni*ous;* therefore, the quantity taken was more than sufficient to cause death.

3. Is the death of the girl to be attributed to the absorption of the poison? A. Yes. The girl died after manifesting a series of symptoms, among which were noted vomiting, diarrhœa, prostration, vertigo, extreme depression, loss of voice, coma, and finally death. There was no illness, other than from poisoning, which could account for such symptoms. If, on the one hand, no alteration in the mucous membrane of the intestinal tract took place, yet the autopsy showed a fatty condition of the liver and kidneys, which is brought about in the greater number of cases of acute poisoning.

Gelsemium: The *symptoms* are impaired sight, double vision, and sometimes total blindness, with falling and loss of control of the upper eyelids; the face is congested, the lips livid; the face may be pale. Pupils dilated and usually insensible to light; the eyes fixed and more or less staring. There may be falling of the lower jaw, the mouth being sometimes wide open. Speech is impaired or entirely lost, and the tongue appears thick. The gait is staggering; the skin warm and moist, with occasionally free perspiration. The pulse is small, feeble, irregular and intermittent, but it has been observed full and strong. There is great muscular relaxation with general prostration and diminished sensibility, and the extremities are cold. The breathing is slow, labored, spasmodic, and sometimes stertorous. Violent spasms of the throat resembling those of hydrophobia, have been noticed in a few cases. The mind usually remains clear, but unconsciousness has been present even where recovery followed. Time of death: in thirteen cases the fatal period varied from *one hour* to *seven hours and a half.* Fatal quantity: Twelve minims of the fluid extract in one case (child) and in another thirty-five drops of the tincture have proved fatal. A teaspoonful of the fluid extract proved fatal, to a young woman. Two teaspoonfuls of the fluid extract in divided doses proved fatal to a young man. Eight grains of "gelsemin," in two-grain doses every three hours, proved fatal to a strong woman. The *treatment* consists in the evacuation of the stomach, and employment of internal and external stimulants. Electricity has been found very useful. Morphine subcutaneously has proved valuable in one or two cases. Tests: In poisoning by gelsemium preparations, chemical examination should be directed to the recovery of both *gelsemic acid* and *gelsemine. Gelsemic acid* when treated with a drop of nitric acid dissolves with a yellow color to a yellow or reddish solution, the final color depending upon the relative quantity of the organic acid present. On treating this solution with excess of ammonia, it acquires a permanent deep or blood-red color. These results may be obtained from the 1-1000th of a grain of the acid, and even 1-50000th grain will yield, under the action of ammonia, a marked reddish coloration. This, although a delicate test, does not distinguish gelsemic acid from œsculin; it may, however, be distinguished from œsculin by the fact that *hydrochloric acid*, which readily dissolves œsculin, has no effect on gelsemic acid. *Gelsemine* is dissolved by nitric acid with little or no color, but on spontaneous evaporation of the liquid a permanent bluish-green stain is left on the porcelain. (Wormley.)

Electricity:* This is the most important remedy in the treatment of lead paralysis. If the diseased muscles

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* These notes on the use of electricity have been kindly supplied me by Prof. Delamater and Dr. F. R. Day.

respond to faradic stimulation, this current should be applied daily, and of sufficient strength to produce marked contractions, the seances to last about fifteen minutes. If the degeneration is too great for the faradic current, then an interrupted descending galvanic current of sufficient strength to produce contractions should be employed, the positive pole at the back of the neck and the negative pole over the paralyzed muscles. Daily treatments, of six minutes' duration, may be given. In all cases it is well to apply a constant galvanic current of ten cells to the cervical enlargement of the spinal cord, a large sponge attached to the positive pole being placed over the cervical vertebræ, while the negative pole rests upon the sternum. After the current has been flowing for about two minutes the direction of the current should be reversed and allowed to flow for two minutes more. In those cases that do not respond to faradism at first, a few applications of the galvanic current will usually restore them, and then the faradic current may be substituted for it.

Prof. Delamater has used electricity in the treatment of a few cases of chloral poisoning. While it has usually helped them, to a certain extent, yet the effects were not sufficiently great to warrant him in relying on it alone, or to consider it an antidote to that drug.

Use of Electricity in Asphyxia from Coal-Gas, Chloroform, Opium, etc.: Stimulate the phrenic nerves with a strong faradic current. For this purpose it is well to have a forked electrode attached to the negative pole of the battery. The two prongs are placed in the supra-clavicular fossæ in close proximity to the posterior orders of the sterno-clido-mastoid muscles. A large sponge electrode attached to the positive pole of the battery is placed at the epigastric notch. The current is allowed to flow for two seconds, then the positive electrode is removed for two seconds. In this way the diaphragm is contracted rythmically and artificial respiration aided. It may be kept up for hours at a time, but should never be relied upon alone in desperate cases. Never forsake artificial respiration by manipulating the arms where there is profound asphyxia.

In chloroform poisoning, an interrupted galvanic current applied to the right pneumogastric is more valuable than the faradic current; the positive pole placed behind the angle of the lower jaw and pressed firmly toward the spinal column, the negative poles at the epigastrium. A current of twenty or thirty cells may be used for ten or twenty minutes.

The Treatment of Ptosis by Electricity: The interrupted galvanic current should be used; the positive pole placed on the temple, while the negative pole is held over the affected lid. A current of from four to six cells is sufficiently strong, and the daily or tri-weekly treatment should be of five to six minutes' duration.

Hints:

1. Use mild galvanic currents about the head. Never produce vertigo. Six to eight Stohrer's cells is as much as should be used in ordinary cases.

2. Galvanization of the neck should be accomplished with mild currents.

3. The faradic current is best adapted in disorders of the abdominal viscera.

4. A galvanic current of from ten to thirty cells may be used on the spine and extremities.

SUPPLEMENT TO TOXICOLOGY.

Since the previous chapters on toxicology were written, through the kindness of many physicians in Chicago and vicinity, I have learned of numerous cases, which I believe have not been heretofore presented to the profession in text books or in journals.

To Dr. F. R. Day I am indebted for an account of the following cases, treated at Cook County Hospital:

1. **Arsenic** (fatal): The patient was supposed to have taken some rat poison containing arsenic the night before he was admitted to the hospital. *Symptoms:* Profound prostration, face blue and with pinched expression to features, cold perspiration, intense retching of glairy mucus, great pain but no movement of bowels. *Treatment:* Stomach washed out with stomach pump, emetics (thirty grains in all of zinc sulphate, mustard and water). Brandy hypodermics when he showed signs of failing. Strong Faradic current to angle of jaw and epigastrium. Shocks and artificial respiration. *Result:* Death in about twelve hours from time poison was taken. *Post-mortem appearances:* Stomach coated with whitish powder found, on analysis, to contain arsenic. Usual signs of poisoning by this substance.

2. **Coal-Gas** (non-fatal): Two female servants brought to the hospital in the morning after sleeping all night in a room where a defective stove poisoned the air with coal-gas. *Symptoms:* Profound coma, irregular, jerky respiration. *Treatment:* Artificial respiration and, when the breathing was fuller, inhalations of hartshorn and hypodermics of brandy, irritation of the surface by slapping chest with wet towels.

3. **Opium** (non-fatal): This case is remarkable for the successful *treatment* used. After all the usual meth-

ods had failed, the patient was restored to life, after breathing had ceased, by pouring a small steady stream of ice water from a height of about seven feet on the chest. A gallon of the ice water was poured in this manner on the chest of the patient, who was then covered with warmed blankets, hot water cans being applied to his feet, and artificial respiration tried. After the first gallon of water had been poured on, the patient gasped faintly and breathed a few times, but the breathing could not be kept up. After the second gallon had been poured on he again gasped, began to breathe, and this time the breathing was sustained and recovery took place.

Dr. Percy Bryant has furnished me with information concerning the following hospital cases, some of which were treated by himself:

4. **Oil of Tansy** (non-fatal): A girl of twenty-two took some oil of tansy to induce miscarriage. *Symptoms:* When brought to hospital at 2:30 p. m. she had tonic and clonic convulsions, opistholonos, the eyes turned backward and toward the corners, the face was burning and congested, there was grinding of the teeth and foaming at the mouth, yellowish froth being noticed; there was spasm of the muscles of the throat, a choking and rattling sound being heard. The eyes were injected pupils widely dilated and immovable. The spasms came on every alternate minute, being followed by a minute of rest. The body was warm. *Treatment:* Five drops tincture of belladonna hypodermically; in two minutes a slight diminution in the severity of the spasms was noted. Pulse, 100. In two minutes amyl nitrate was administered by inhalation. In ten minutes a change for the better took place; the patient asked for water and after drinking it vomited undigested food. The hypodermics of belladonna were continued every half hour.

She became conscious and said she had taken some medicine to cause miscarriage. One-fourth of a grain of the sulphate of morphine was then given. Vomiting was the next symptom, with slight spasms; pain in lower part of the abdomen, over uterus and ovaries and extending to the loins. The pain was griping and expulsive in character. When the patient was first brought in she was insensible to the prick of a pin all over the body, but the conjunctiva was still sensible. At 7 p. m. she was vomiting food and suffering much pain. At 10 p. m. there was vomiting, and slight spasms of the cervical muscles were noted. Strychnine sulphate 2x in solution was given hypodermically. Hot applications were made to the abdomen. Her thirst being intense, she was given ice to eat. At 12 midnight hypodermics of morphine and atropine were given; also gelsemium. At 1 a. m. a rectal injection of spirits of camphor was given. At 3 a. m. the spasms began again, when fifteen drops of gelsemium and half a grain of morphine were given. There was vomiting of a little blood. At 6 a. m. she was slightly improved, and a nourishing enema was given; she afterward became weak, the heart and respiration began to fail, and hypodermics of whisky were given every half hour. At 9 a. m. there was pain and vomiting. The lips were pale, the pupil contracted, the pulse weak, the heart fainter. At 12 noon the symptoms were about the same. At 2:30 p. m., twenty-four hours after the admission to the hospital, the pulse was almost imperceptible, respiration ten to the minute and very light. Aromatic spirits of ammonia was given and there was immediate improvement. At 3 p. m. a hypodermic of one-thirtieth grain of strychnine in solution was administered, followed in fifteen minutes by fifteen drops more of the same. The impulse of the heart was now better, the pain was less, the vomiting limited. There was thirst, but no water was allowed to be given her. At 4 p. m. she was much better; pulse, 84; the pain was nearly gone, and she asked for food. From then on there was gradual recovery.

5. **Opium** (non-fatal): Patient took twenty-five cents' worth morphine sulphate. Conveyed to the hospital three hours after taking the poison. The *symptoms* were as follows: Drowsiness, pupils small and contracted; the patient was, however, easily aroused. He had vomited twice, the last time immediately after entering the hospital. The *treatment* by Dr. M. J. Bliem consisted in the administration of one-fortieth grain of atropine hypodermically, the stomach being washed out with stomach pump. The patient was kept moving till late at night. Recovery next day.

6. **Opium** (fatal): Woman in third stage of morphine poisoning. Admitted in the evening; artificial respiration kept up till morning; battery used continuously for six or seven hours; atropine given hypodermically. Breathing and consciousness were restored. She died, however, from asthenia three days afterward.

7. **Opium** (fatal): Another case in the third stage. The stomach pump, artificial respiration and stimulants were used. The patient lived for a week, but then sank away and died.

8. **Opium** (fatal): A man forty-five years of age was found in a room where he had been twenty-four hours without help. Conveyed to the hospital at midnight. His face was cyanotic, the extremities cold; there was spasms; the breathing was stertorous, the tongue dry, the pupils dilated; he could not be aroused. *Treatment* by Dr. Percy Bryant: The stomach pump having brought up matters smelling strongly of opium, artificial respiration was tried, but without avail; the battery was used and flagellation, the latter rousing the patient

somewhat. Hypodermics of whisky were given, as was also atropine, subcutaneously, one-twentieth of a grain in all, and aromatic spirits of ammonia. The patient died at 6 a. m.

9. **Opium** (fatal): A woman of fifty. When brought to the hospital was cyanotic and cold; breathing stertorous and rather rapid; mouth open; pupils contracted; pulse very weak. The treatment was by Dr. Bryant. The stomach pump was used, but brought up nothing of consequence; hypodermics of whisky were administered, and three hypodermics of atropine (about one-twentieth grain in all). A ten-cell galvanic battery, connected with the helix of a faradic, gave shocks which would cause the patient to cry out, jump and breathe better. (Previously flagellation with wet towels had had no effect.) The effect of the shocks gradually decreased and, in spite of hypodermics of whisky and ammonia, she died rather suddenly at four in the afternoon, four hours after being admitted.

From cases six, seven, eight and nine will be seen the difficulty of treating opium poisoning successfully when in the last stage, case three being a remarkable exception. Case five is a good illustration of what may be done when the patient is taken in hand soon after swallowing the poison. Case four is rather unusual, and the notes of it have been given in full.

The following cases in alphabetical order of poisons occurred outside of hospital practice. Notice of them is made as brief as possible:

10. **Aconite** (non-fatal): Dr. Charles Gatchell is my authority for the following: He took thirteen drops of the pure homœopathic tincture of aconite; the result was coldness of the surface of the body, severe aching pains in all the muscles, tingling in the posterior part of the throat, nausea, vomiting, slow pulse, scanty urine,

restlessness. Symptoms subsided in four or five hours. No treatment necessary.

11. **Atropine** (non-fatal): Dr. F. H. Foster has kindly fu;nished me with notes on the following: Girl of fifteen, after one instillation of a four-grain-to-the-ounce solution of atropine, manifested violent symptoms; there was furious delirium, during which she tried to jump from the window, to tear her clothing, etc., etc. Strong infusion of coffee brought about recovery.

12. Little girl of five used a two-grain solution for recurrent corneal ulceration. The symptoms were, frequent desire to urinate, urination accompanied by great pain, urine scanty and very red. Same symptoms appeared when one-grain solution was used.

13. **Atropine** (non-fatal): A child of three or four years ate seven or eight powders out of ten, into which one-fortieth grain of atropine had been divided. The symptoms of poisoning soon subsided. (Reported to me by Dr. A. G. Beebe.)

14. **Belladonna** (non-fatal): Dr. A. W. Woodward calls my attention to a case where four drops of the homœopathic tincture produced abdominal symptoms in an adult. There were no cerebral or cutaneous symptoms, but the abdomen became tympanitic.

15. **Belladonna** (non-fatal): Dr. J. W. Streeter saw a case where inspissated belladonna had been taken by mistake for licorice. Emetics being administered, recovery took place.

16. **Carbolic Acid**—externally—(non-fatal): Dr. F. R. Day reports to me that a five per cent. solution used as a bath to destroy vermin has caused, in one case, fainting, dizziness, fullness in the head, and almost syncope; symptoms lasted three-quarters of an hour; irritation of the stomach was noticed.

17. **Carbolic Acid** (non-fatal): Dr. Charles Gatchell

furnishes me with the following particulars: Child of five drank unknown amount of ninety-five per cent. acid. The mouth was well cauterized and whitened. In about three-quarters of an hour there was vomiting of matters containing some little blood. There was no coma. Dilute ammonia was given and subsequently white of egg plentifully. Recovery took place in about a week, the child being fed on milk.

18. **Chloral** (non-fatal): Dr. Beebe knows of two cases, in one of which 100 grains of chloral were taken and in another 200, where recovery took place. In his judgment chloral does its greatest harm when morphine is given with it. Several cases have terminated fatally when, after prolonged use of chloral, hypodermics of morphine have been administered.

19. **Chloral** (non-fatal): Dr. J. W. Streeter has furnished me with the particulars of the following case: Patient took from 100 to 120 grains of chloral in all, and when found was rigid and with jaws set. The *treatment* was ammonia, coffee, and heat externally. Recovery took place, but there was prostration for two or three weeks.

20. **Chloroform** (fatal): That chloroform in extraordinarily small quantity will sometimes cause death of an unaccountable nature is well known to toxicologists. Woodman and Tidy speak of a case where 15 minims (inhaled) proved fatal. Dr. A. G. Beebe some years ago had experience with a case of this kind. Very little of the anæsthetic had been administered when the patient suddenly died. No cause for death could be found.

21. **Coal-Gas** (non-fatal): Dr. Gatchell reports a case where a mother and child were poisoned from a stove in an adjoining room. When found were unconscious, breathing lightly, pulse feeble. Fresh air and artificial respiration restored consciousness in about an hour.

22. **Creasote** (fatal): Dr. Gatchell has heard of a case where creasote, used as an application to a tooth, and probably swallowed, caused inflammation of the stomach and death.

Nitric Acid (non-fatal): "Health normal, pulse 78, full and regular; 11:30 a. m., took ten drops concentrated acid in half a tumbler of water; soon pressure and heaviness in forehead, with darting pains in ears and vertigo; can walk straight only by an effort of the will, attended by chilliness and nausea; 12 m., nausea increased into vomiting, with pains in mouth, throat and stomach, vision obscured, eyes feel hot and excoriated, feeling of intoxication continues; vomited only once, but made repeated attempts, with retching afterward; 12:15, vesical irritation and desire to urinate—urine scalding; 12:30, urinated again—scant and hot; during the repeated urination odor pungent; toward evening drawing pains in back and loins; pulse 68, and weak; desire for stool, but no relief; evening, difficult, pasty stool, with tenesmus and burning in rectum afterward. Second day, felt restless and uneasy, with pain in head and neck, chilliness and shuddering even when near the hot stove; passive, epistaxis of dark blood; desire for stool, but slight relief; urinary symptoms continue, rheumatic pains and drawing in legs, running up the inner side of leg to groin, with soreness of testes, indisposed to read or study; cannot apply the mind. Third day, pulse slow and irregular; feel very languid, with continual chilliness; two diarrhæac stools during morning, with tenesmus, occasional loose cough. Fourth day, papular eruption (dark red) in clusters on various portions of trunk and neck, with soreness and itching, continued upward of a week."

The preceding is the experience of one of the class at the Chicago Homœopathic Medical College. I am indebted to Prof. A. W. Woodward, M. D., for the notes of the proving.

23. **Opium** (non-fatal): Child of three years took one grain of morphine sulphate in sugar-coated pills. When seen by Dr. A. G. Beebe, six hours afterward, was not yet comatose, but had strong desire to sleep. An emetic of mustard and water and, as antidote, tincture of belladonna, brought about recovery.

24. **Opium** (fatal): Dr. J. W. Streeter gives me the following particulars: A patient took six doses of twenty drops of laudanum each, and also a seventh dose the amount of which is unknown. Vomiting took place after the fourth dose and also after the fifth and sixth. When seen by physicians there was loss of consciousness and death soon followed. In the short time between the arrival of the physicians and the death of the patient electricity was used.

25. **Opium** (now fatal): This case is also communicated by Dr. Streeter: Sixteen quarter-grain pills of the sulphate of morphine were taken. Tincture of lobelia hypodermically and mustard and water provoked vomiting, after which capsicum tea was given.

26. **Podophyllin** (non-fatal): Dr. Percy Bryant took on an empty stomach three grains of crude podophyllin by mistake for the homœopathic podophyllin. In one hour and a half after eating breakfast, vomiting, suddenly and without warning, took place. The matters thrown up were not biliary in character. Violent headache followed and great weakness. Four hours afterward he began to vomit biliary matters very frequently; purging, vomiting, cold sweats and weakness were prominent symptoms until evening, when the vomiting and diarrhœa ceased.

27. Dr. A. W. Woodward has called my attention to the poisonous nature of *potassium bichromate*, as shown

by the experience of provers of this drug. Half a grain of the first decimal trituration in some cases has caused symptoms of gastro-enteritis lasting four days.*

28. **Strychnine** (non-fatal): Dr. Beebe reports a case where a patient taking strychnine vomited and had spasms. The vomiting being kept up by emetics, the patient recovered.

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* Bartholow gives the dose of the crude drug as from one-fifth to one-half grain.

APPENDIX.

PART I.

Notes on Inorganic Chemistry:

TABLE OF ELEMENTS.

	Symbol.	Atomic weight.
Aluminium	Al	27
Antimony	Sb	120
Arsenic	As	74.9
Barium	Ba	136.8
Beryllium	Be	9
Bismuth	Bi	210
Boron	Bo	11
Bromine	Br	79.8
Cadmium	Cd	111.8
Cæsium	Cs	132.6
Calcium	Ca	40
Carbon	C	12
Cerium	Ce	141
Chlorine	Cl	35.4
Chromium	Cr	52.4
Cobalt	Co	58.9
Copper	Cu	63.2
Didymium	Di	144.6
Erbium	E	165.9
Fluorine	Fl	19
Gallium	G	68.8
Gold	Au	196.2
Hydrogen	H	1
Indium	In	113.4
Iodine	I	126.6
Iridium	Ir	192.7
Iron	Fe	55.9
Lanthanum	La	138.5
Lead	Pb	206.5
Lithium	Li	7
Magnesium	Mg	24
Manganese	Mn	54
Mercury	Hg	199.7
Molybdenum	Mo	95.5
Nickel	Ni	58
Niobium	Nb	94
Nitrogen	N	14
Osmium	Os	198.5
Oxygen	O	16
Palladium	Pd	105.7
Phosphorus	P	31
Platinum	Pt	194.4
Potassium	K	39
Rhodium	Rh	104.1
Rubidium	Rb	85.3
Ruthenium	Ru	104.2
Scandium	Sc	44
Selenium	Se	78.8
Silicon	Si	28
Silver	Ag	107.7
Sodium	Na	23
Strontium	Sr	87.4
Sulphur	S	32
Tantalum	Ta	182
Tellurium	Te	128
Thallium	Tl	203.7
Thorium	Th	233
Tin	Sn	117.7
Titanium	Ti	48
Tungsten	W	183.6
Uranium	U	238.5
Vanadium	V	51.3
Ytterbium	Yb	172.7
Yttrium	Y	89.8
Zinc	Zn	64.9
Zirconium	Zr	90

—(From Simon's Chemistry).

Equivalence of the Elements:

	VAR.
Monads:—	
Hydrogen	
Fluorine	
Chlorine	I, III, V, VII.
Bromine	I, III, V, VII.
Iodine	I, III, V, VII.
Lithium	
Sodium	I, III.
Potassium	I, III, V.
Rubidium	
Cæsium	
Silver	I, III.
Thallium	I, III.
Triads:—	
Nitrogen	I. III, V.
Phosphorus	I, III, V.
Arsenic	I, III, V.
Antimony	III, V.
Bismuth	III, V.
Boron	
Gold	I, III.
Pentads:—	
Columbium	
Tantalum	
Vanadium	III, V.
Also (V_2)viii and (V_2)iv	
Dyads:—	
Oxygen	
Sulphur	II, IV, VI.
Selenium	II, IV, VI.
Tellurium	II, IV, VI.
Calcium	II, IV.
Strontium	II, IV.
Barium	II, IV.
Magnesium	
Zinc	

	VAR.
Dyads:—	
Cadmium	
Glucinum	
Yttrium	
Cerium	
Lanthanum	
Didymium	
Erbium	
Mercury	$(Hg_2)''$, II.
Copper	$(Cu_2)''$, II.
Lead	II, IV.
Tetrads:—	
Carbon	II, IV.
Silicon	
Titanium	II, IV.
Tin	II. IV.
Thorium	
Zirconium	
Aluminum	(Al_2)vi
Platinum	II, IV.
Palladium	II, IV.
Indium	
Hexads:—	
Molybdenum	II,IV,VI.
Tungsten	IV, VI.
Ruthenium	II, IV, VI.
Rhodium	II, IV, VI.
Iridium	II, IV, VI.
Osmium	II, IV, VI.
Chromium	II, IV, VI.
Manganese	II, IV, VI.
Iron	II, IV, VI.
Cobalt	II, IV.
Nickel	II, IV.
Uranium	II, IV.

Electro-Chemical Series of the Elements:

NON-METALS: NEGATIVE.

Negative End.

Oxygen.
Sulphur.
Nitrogen.
Fluorine.
Chlorine.
Bromine.
Iodine.
Selenium.
Phosphorus.
Arsenic.
Chromium.
Vanadium.
Molybdenum.
Tungsten.
Boron.
Carbon.
Antimony.
Tellurium.
Tantalum.
Columbium.
Titanium.
Silicon.
Hydrogen.

METALS: POSITIVE.

Positive End.

Gold.
Osmium.
Iridium.
Platinum.
Rhodium.
Ruthenium.
Palladium.
Mercury.
Silver.
Copper.
Uranium.
Bismuth.
Tin.
Indium.
Lead.
Cadmium.
Thallium.
Cobalt.
Nickel.
Iron.
Zinc.
Manganese.
Lanthanum.
Didymium.
Cerium.
Thorium.
Zirconium.
Aluminum.
Erbium.
Yttrium.
Glucinum.
Magnesium.
Calcium.
Strontium.
Barium.
Lithium.
Sodium.
Potassium.
Rubidium.
Cæsium.

Molecular Weights:

The molecular weight of a compound substance is the sum of the weights of its constituent atoms. The following table shows the most important:

Water	18
Hydrogen peroxide	34

Hydrochloric acid	36.4
Ammonia gas	17
Sulphuretted hydrogen	34
Marsh-gas	16
Nitrous oxide	44
Hydrofluoric acid	20
Carbonic acid (dioxide)	44
Carbonic oxide (monoxide)	28
Carbon disulphide	76
Nitric acid	63
Sulphuric acid	98
Sulphurous acid	82
Phosphoric acid (glacial)	80
Boracic acid	62
Silicic (Silica, SiO_2)	60
Potassium bromide	118.8
iodide	165.6
carbonate	138
hydrate	56
nitrate	101
cyanide	65
phosphate ("Kali Phos.")	174
sulphate	174
chlorate	122.4
dichromate	294.8
permanganate	314
hypophosphite	104
Sodium chloride	58.4
hydrate	40.0
carbonate	286.0
bicarbonate	84.0
sulphate	322.0
sulphite	252.0
hyposulphite	248.0

phosphate ("Nalr Phos.")	358.0
nitrate	85.0
Ammonium	18.0
Ammonia gas	17.0
Ammonium carbonate	157.0
"Ammonium carbonicum"	236.0
Ammonium chloride	53.4
Silver nitrate	169.7
iodide	234.3
oxide	231.4
Calcium carbonate	100.0
oxide	56.0
hydrate	74.0
phosphate ("Calc. Phos.")	306.0
Bone phosphate	310.0
chloride	111.0
sulphate ("Calc. Sulphurica")	172.0
iodide	294.0
hypophosphite	170.0
Barium carbonate	197.0
chloride	244.0
iodide	427.0
Magnesium oxide	40.0
sulphate	246.0
carbonate	484.0
Zinc sulphate	286.9
chloride	135.7
bromide	224.5
oxide	80.9
iodide	318.1
carbonate	546.5
phosphide	256.7
Mercuric chloride	270.5
iodide	452.9
oxide	215.7

cyanide	251.7
subsulphate	727.1
Ammoniated mercury	251.1
Mercurous chloride	470.2
iodide	652.6
Copper sulphate	249.2
ammonio sulphate	245.3
Arsenious iodide	454.7
oxide	197.8
Arseniate of sodium	311.9
Antimony oxide	288.0
terchloride	226.2
trisulphide	336.0
Bismuth oxynitrate	306.0
Lead iodide	459.7
nitrate	330.5
oxide	222.5
carbonate	773.5
Aluminum oxide	102.0
hydrate	156.0
trihydrate ("Alumina")	78.4
chloride	267.0
"Alumen" (potash alum)	949.8
Chromic acid	100.4
Ferric chloride	540.2
hydrate	213.8
hypophosphite	501.8
Ferrous sulphate	277.9
Manganese sulphate	222.0
dioxide	86.0

Empirical Formulæ: On page 18, section 47, under Theory, mention is made of empirical formulæ. For more thorough explanation, see "Notes on Organic Chemistry" in this Appendix.

Homœopathic Terms: The homœopathic terms for the metals silver, zinc, copper, lead and bismuth in the pure state for medicinal use are: Argentum, zincum, cuprum, plumbum, bismuthum metallicum.

Drinking Water: A good drinking water contains on an average from one to three parts of solids (chiefly carbonate of lime and common salt) in 10,000 parts of water and about one volume of carbon dioxide in 100 volumes of water. It should be fresh, limpid, odorless, of a temperature of from 46 deg. F. to 59 deg. F.; its taste should be feeble, neither insipid, saline, nor sweetish.

Method of Using the Permanganate Solution for Testing Purity of Water: To 100 c.c. (3½ fluid ounces) of water add 10 c.c. (about three fluid drachms) of diluted sulphuric acid; boil and add enough solution of potassium permanganate (one part by weight of the latter to 1,000 of water) to impart to the liquid a decided rose-red tint; this tint should not be destroyed by boiling for five minutes.

Other Tests for the Purity of Distilled Water may be made as follows: the presence of organic matter may be demonstrated by evaporating about two pints of it in a small porcelain or platinum dish over a water bath (a vessel, usually of copper, in which water is heated to the boiling point and on top of which the dish containing the liquid to be evaporated may be set). The residue represents the total amount of solids in the water and is usually of a white color. If this, on being scraped out and further heated in an iron spoon over a flame, turns *black*, the presence of organic matter is indicated.

According to Dr. Wynter Blyth, paralysis, colic, gout, rheumatism, kidney disease, blindness, and even insanity, may all come from drinking water with *lead* in it. His test for lead in water is merely the addition of a little tincture of cochineal, which, if there be the least trace of lead in the water, will color it blue instead of red.

The taste and odor of water cannot be wholly relied upon. Sulphuretted hydrogen, which gives water the taste of rotten eggs, does not make it necessarily unwholesome. A few years ago the Boston water became almost undrinkable, owing, probably, to the presence of some vegetation, but no increase of sickness was noticed; on the other hand, water containing a large amount of organic matter and contaminated with leakage from a neighboring vault may be clear and pleasant to the taste. (*Boston Journal of Chemistry.*) A very simple household test for organic matter in water is the *sugar* test: Add ten grains of pure granulated sugar to a half pint of the water, corking it up in a bottle and letting it stand for a few days in a warm room. If the water be very impure, numerous whitish specks will appear in a day or two, which after some time will adhere together and settle down to the bottom of the bottle.

Aqua Destillata: The purest natural water is rain water. This, however, is somewhat contaminated with matters washed from the air. River and lake waters, especially those found in granite regions, are the purest *potable* waters. But to obtain water pure enough for chemical operations and medicinal uses recourse is had to the process of distillation.

Mineral Waters: These are spring waters containing one or more substances in such quantities as to impart to the water often a peculiar taste and generally a decided medicinal action. *Carbonated waters* contain excess of carbon dioxide, are cold, sparkling in appearance, and redden litmus; *alkaline waters* contain a larger quantity of sodium bicarbonate, as well as common salt and Glauber's salt; *sulphuretted waters* contain, among other constituents, sulphuretted hydrogen; *saline waters* are either magnesian, chlorinated or ferrous: the magnesian waters contain sulphates and carbonates of sodium, calcium and magnesium; the chlorinated waters contain chlorides, as for example sea-water; the ferrous or chalybeate waters contain usually carbonate of iron. Some few saline springs contain salts of lithium; *silicious waters* are those containing alkaline silicates.

The mineral springs of the United States are many in number: New York, Virginia, Kentucky and Wisconsin are abundantly supplied, to say nothing of Missouri, California, and several other states and territories of the far west. The most famous springs of New York State are the Ballston, Saratoga, Richfield and Sharon.

Ballston has several *saline* springs, one of them containing lithium; Saratoga has a number of *saline* springs, of which the Congress, Hathorn, Geyser, and Vichy are well known; Richfield and Sharon have *sulphuretted* springs. The State of Pennsylvania has a number of springs. At Cresson, on the Pennsylvania railroad, there is a noted *saline* spring; at Bedford the water is *purgative*; at Gettysburg, *saline.* In Virginia the White Sulphur Spring, on the Chesapeake & Ohio railroad, is famous; its water contains *sulphuretted hydrogen.* There are many other springs in Virginia: the Bath Alum, *chalybeate;* Capon, *alkaline;* the Sweet Springs, *carbonated.* The Buffalo Lithia Springs are in Virginia. Kentucky is noted for the Blue Lick *sulphuretted water* and the Harrodsburg *purgative.* At Waukesha, in Wisconsin, there are several springs, as a rule *alkaline* and *calcareous.* Some of the Waukesha springs have the advantage of being valuable for *table waters.* Colorado has numerous springs, while California and Oregon are well supplied with alkaline, sulphuretted and chalybeate waters. *Thermal* springs are those whose water is of elevated temperature.

Mineral springs vary greatly in the amount of solids contained. Sea water has about 2,500 grains to the gallon; the spring recently opened at Ypsilanti, Mich., 1,205; Ballston Lithia 1233; on the other hand, the Tunbridge chalybeate spring in England has only seven grains to the gallon, and several of the Waukesha springs in this country contain very small amounts.

CONSTITUENTS OF MINERAL SPRINGS.

The following table shows the constituents of many of the Saratoga Spring waters:

Compounds as they exist in Solution in the Waters.	Champion Spouting Spring.	Congress Spring.	Empire Spring.	Excelsior Spr.*	Geyser Spouting Spr.	Hath'rn Spring.	High Rock Spring.	Pavilion Spring.	Red Spring.	Star Spring.	Triton Spring.	Saratoga Vichy.
Chloride of sodium.....	702.239	400.444	506.630	370.642	562.080	509.968	390.127	459.903	83.530	378.962	238.500	128.689
Chloride of potassium.	40.446	8.049	4.292	7.000	24.634	9.597	8.497	7.660	6.857	9.229	16.980	14.113
Bromide of sodium.....	3.579	8.559	0.266	....	2.212	1.534	0.731	0.987	....	55.650	1.800	0.990
Iodide of sodium......	0.234	0.138	0.006	4.235	0.248	0.198	0.086	0.071	....	8.000	0.042	Trace.
Fluoride of calcium...	Trace.	Trace.	Trace.	....	Trace.	Trace.	Trace.	Trace.	....	....	Trace.	Trace.
Bicarbonate of lithia...	6.247	4.761	2.080	....	9.004	11.447	....	9.486	0.942	....	5.129	1.760
Bicarbonate of soda...	17.624	10.775	9.022	15.000	71.232	4.288	34.888	3.764	15.327	12.662	67.617	82.873
Bicarbonate of magnes.	193.912	121.757	42.953	32.333	149.343	176.463	54.924	76.267	42.413	61.912	70.470	41.503
Bicarbonate of lime...	227.070	143.399	109.656	77.000	168.392	170.646	131.739	120.169	101.256	120.549	40.260	95.522
Bicarbonate of strontia	0.082	Trace.	Trace.	Trace.	0.425	Trace.	Trace.	Trace.	....	....	Trace.	Trace.
Bicarbonate of baryta.	2.083	0.928	0.070	....	2.014	1.737	Trace.	0.875	....	....	0.992	0.593
Bicarbonate of iron....	0.647	0.340	0.793	3.215	0.979	1.128	1.478	2.570	....	1.213	1.557	0.052
Sulphate of potassa....	0.252	0.889	2.769	....	0.318	Trace.	1.608	2.033	....	5.400	Trace.	Trace.
Phosphate of soda.....	0.010	0.016	0.023	1.321	Trace.	0.006	Trace.	0.007	Trace.	....	....	Trace.
Biborate of soda.......	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	....	....	....	Trace.
Alumina	0.458	Trace.	0.418	....	Trace.	0.131	1.223	0.329	2.100	....	Trace.	0.473
Silica	0.699	0.840	1.145	4.000	0.665	1.260	2.260	3.155	3.255	1.283	1.280	0.758
Organic matter........	Trace.	Trace.	Trace.	....	Trace.	Trace.	Trace.	Trace.	....	....	Trace.	Trace.
Total per U. S. gallon, 231 cu. in..........	1195.582	700.895	680.436	514.746	991.546	888.403	628.039	687.275	254.719	615.685	544.627	367.326
Carbonic acid gas......	465.458	392.289	344.669	250.000	454.082	375.747	409.458	332.458	....	407.550	361.500	383.071
Density	....	1.096	....	....	1.011	1.115	1.092	1.075	....	....	....	....
Temperature	49 deg.F.	52 deg.F.	48 deg.F	....	46 deg. F.	....	52 deg.F	....	....	....	40 deg.F	50 deg.F

* The Excelsior water was analyzed by the late R. L. Allen, M. D., of Saratoga Springs.

Potassium Permanganate: Page 42, 59.

Solutions of this substance are decomposed by paper, hence cannot be filtered; they should, therefore, be allowed to settle and then decanted; solutions of the permanganate should be kept from the light.

Nessler's Solution: Page 48, 87.

Dissolve 550 grains of potassium iodide in five fluid ounces of water; dissolve 220 grains of mercuric chloride in five fluid ounces of water; dissolve 900 grains of potassium hydrate in five fluid ounces of water; add the iodide solution to the chloride solution, then add the potassium hydrate solution; make up to twenty ounces of water, let settle, decant.

Zinc Sulphide: Page 52, 99.

When a compound of *iron* is present as an impurity in zinc the precipitate with ammonium sulphide may appear *greenish-white* in color.

Processes of Manufacture, Equations, etc.:

Oxygen: Heat potassium chlorate with ten per cent of manganese dioxide. $KClO_3 = KCl + O_3$.

Hydrogen: Action of zinc on dilute hydrochloric acid. $Zn + (HCl)_2 = ZnCl_2 + H_2$.

Hydrogen Peroxide: Action of carbonic acid on barium peroxide suspended in water. $BaO_2 + H_2O + CO_2 = BaCO_3 + H_2O_2$.

Nitrogen: Remove oxygen from confined air by burning phosphorus in it.

Ammonia: Mix sal-ammoniac with calcium hydrate and heat. $(NH_4Cl)_2 + Ca(HO)_2 = CaCl_2 + (H_2O)_2 + (NH_3)_2$.

Laughing Gas: Heat ammonium nitrate. $NH_4NO_3 = (H_2O)_2 + N_2O$.

Nitric Acid: Decompose sodium nitrate by sulphuric acid. $(NaNO_3)_2 + H_2SO_4 = (HNO_3)_2 + Na_2SO_4$.

Carbon Dioxide: Lime burning. $CaCO_3 = CaO + CO_2$.

Carbon Monoxide: Pass CO_2 over red-hot coal. $CO_2+C=(CO)_2$.

Sulphuric Acid: Pass vapors of sulphur dioxide, nitric acid and steam simultaneously into large leaden chambers, together with atmospheric air. $SO_2+O+H_2O=H_2SO_4$.

Sulphuretted Hydrogen: Act on ferrous sulphide with dilute sulphuric acid. $FeS+H_2SO_4=FeSO_2+H_2S$.

Phosphorus: (*a*) Convert calcium phosphate into acid phosphate; (*b*) heat the acid phosphate forming the metaphosphate; (*c*) act on the metaphosphate with charcoal and sand at red heat. (*a*) $Ca_3(PO_4)_2+(H_2SO_4)_2=CaH_4(PO_4)_2+(CaSO_4)_2$; (*b*) $CaH_4(PO_4)_2=Ca(PO_3)_2+(H_2O)_2$; (*c*) $[Ca(PO_3)_2]_2+SiO_2+10C=(CaSiO_3)_2+10CO+4P$.

Phosphoric Acids: Phosphoric oxide and water. $P_2O_5+H_2O=H_2P_2O_6=(HPO_3)_2$, $P_2O_5+(H_2O)_3=H_3PO_4$ (ortho-, glacial).

Hydrochloric Acid: Decompose chloride of sodium with sulphuric acid. $NaCl+H_2SO_4=HCl+NaHSO_4$.

Bromine: Treat magnesium bromide in mother liquor (remaining from evaporation of sea water) with chlorine. $MgBr_2+(Cl_2)=MgCl_2+Br_2$.

Iodine: Wash vitrified ashes of sea weeds with water and treat mother liquor (remaining after evaporation, etc.) with manganese dioxide and hydrochloric acid.

Potassium Iodide: Add iodine to solution of potassium hydrate till dark brown color no longer disappears. $(KHO)_6+(I)_6=(KI)_5+KIO_3+(H_2O)_3$.

Potassium Permanganate: Decompose the manganate with sulphuric acid. $(K_2MnO_4)_2+(H_2SO_4)_2=MnO_2+(K_2SO_4)_2+K_2Mn_2O_8+(H_2O)_2$.

Potassium Bichromate: Act on the chromate with sulphuric acid. $(K_2CrO_4)_2+H_2SO_4=K_2Cr_2O_7+K_2SO_4+H_2O$.

Sodium Carbonate: (*a*) Make the salt cake (sulphate) from common salt and sulphuric acid; (*b*) mix the sulphate with coal and limestone and heat. (*a*) $(NaCl)_2+H_2SO_4=(HCl)_2+Na_2SO_4$; (*b*) $Na_2SO_4+4C+CaCO_3=CaS+Na_2CO_3+(CO)_4$.

Ammonium Chloride: Saturate liquor of gas-works with hydrochloric acid and evaporate.

Ammonium Carbonate: The commercial article is obtained by subliming a mixture of the chloride and calcium carbonate. $(CaCO_3)_2+(NH_4Cl)_4=NH_4HCO_3NH_4NH_2CO_2+(CaCl_2)_2+H_2O+NH_3$.

Calcium Oxide (lime): Heat limestone. $CaCO_3=CaO+CO_2$.

Chlorinated Lime (bleaching powder): Act on calcium hydrate with chlorine. $[Ca(HO)_2]_2+Cl_4=(H_2O)_2+Ca(ClO)_2+CaCl_2$—chlorinated lime.

Aluminum Chloride: Expose a heated mixture of the oxide and carbon to the action of chlorine. $Al_2O_3+C_3+Cl_6=(CO)_3+Al_2Cl_6$.

Iron: Heat the carbonate or oxide with coal, limestone and sand. $Fe_2O_3+C_3=(CO)_3+Fe_2$; $FeCO_3+C=CO+CO_2+Fe$.

Reduced Iron: Pass hydrogen gas over ferric oxide, heated in a glass tube. $Fe_2O_3+H_6=(H_2O)_3+Fe_2$.

Ferrous Sulphate: Dissolve iron in sulphuric acid, evaporate and crystallize. $Fe+H_2SO_4=H_2+FeSO_4$.

Zinc Carbonate: Mix and boil solutions of equal quantities of zinc sulphate and sodium carbonate. $(ZnSO_4)_5+(Na_2CO_3)_5+3H_2O=(CO_2)_3+(Na_2SO_4)_5+(ZnCO_3)_2[Zn(HO)_2]_3$.

Bismuth Subnitrate: Decompose the nitrate with water. $[Bi(NO_3)]_5+(H_2O)_8=(BiONO_3H_2O)_4+Bi(NO_3)_3+(HNO_3)_8$.

Mercuric Oxide (red): Heat mercuric nitrate. $Hg(NO_3)_2=HgO+(NO_2)_2+O$.

Mercurous Chloride: Sublime a mixture of mercuric sulphate and mercury with sodium chloride. $HgSO_4+Hg+(NaCl)_2=Na_2SO_4+Hg_2Cl_2$.

Mercuric Chloride: Mix mercuric sulphate with sodium chloride and sublime. $HgSO_4+(NaCl)_2=Na_2SO_4+HgCl_2$.

Arsenious Oxide: Heat ores containing arsenic in a current of air.

Arseniuretted Hydrogen: Bring an arsenical compound into contact with nascent hydrogen. $As_2O_3+12H=(AsH_3)_2+(H_2O)_3$.

Water of Crystallization:

On page 32, 2, mention is made of the fact that water enters into the composition of many crystalline substances. It is here called *water of crystallization* and is driven off on heating usually to 212 deg. F. The following table shows how many molecules of water enter into the composition of certain compounds:

Potassium carbonate (U. S. P.)	$(K_2CO_3)_2.\ 3H_2O$
Potassium sulphite	$K_2SO_3.\ 2H_2O$
Sodium carbonate	$Na_2CO_3.\ 10H_2O$
Sodium sulphate	$Na_2SO_4.\ 10H_2O$
Sodium hyposulphite	$Na_2S_2O_3.\ 5H_2O$
Sodium phosphate	$Na_2HPO_4.\ 12H_2O$
Sodium borate	$Na_2B_4O_7.\ 10H_2O$
Magnesium carbonate	$4(MgCO_3).\ Mg2HO.\ 5H_2O$
Magnesium sulphate	$MgSO_4.\ 7H_2O$
Potassium, aluminium sulphate	$K_2SO_4, Al_23SO_4, 24H_2O$
Ferric chloride	$Fe_2Cl_6.\ 12H_2O$
Ferrous sulphate	$FeSO_4.\ 7H_2O$
Manganous sulphate	$MnSO_4.\ 4H_2O$
Zinc sulphate	$ZnSO_4.\ 7H_2O$
Cupric sulphate	$CuSO_4.\ 5H_2O$
Bismuthyl nitrate	$BiONO_3.\ H_2O$

Bismuthyl carbonate	$(BiO)_2CO_3.\ H_2O$
Mercuric sulphate (*yellow subsulphate*)	$HgSO_4.\ 2HgO$

The figure in each case before the H_2O shows how many molecules of water of crystallization enter into the compound: thus, $ZnSO_4.\ 7H_2O$ means that zinc sulphate has for its formula $ZnSO_4$, but in addition to this that there are seven molecules of water; the entire molecule of the compound then consists of one *atom* of zinc, one of sulphur, four of oxygen and seven molecules of water (or fourteen atoms of hydrogen and seven of oxygen), which latter may be expelled on heating leaving, $ZnSO_4$ as a residue.

Specific Gravities:

The following tables show the specific gravity of many substances:

SPECIFIC GRAVITIES OF METALS AS 15.5 DEG. C. (60 DEG. F).

Lithium	0.593	Manganese	8.00
Potassium	0.865	Cobalt	8.54
Sodium	0.972	Molybdenum	8.63
Calcium	1.57	Cadmium	8.70
Magnesium	1.75	Nickel	8.80
Strontium	2.54	Copper	8.96
Aluminium	2.60	Bismuth	9.90
Barium	4.00	Silver	10.50
Arsenic	5.88	Lead	11.45
Antimony	6.80	Mercury	13.59
Zinc	6.90	Gold	19.50
Tin	7.29	Platinum	21.50
Iron	7.79		

SPECIFIC GRAVITIES OF LIQUIDS.

Nitric acid	1.42 U. S. P.
Hydrochloric acid	1.16
Sulphuric acid	1.848 Pure.

Ammonia	0.959
stronger	0.900
Bromine	2.99
Sea water	1.026
Carbon disulphide (at 32 deg. F.)	1.263

SPECIFIC GRAVITIES OF OXIDES.

Arsenious	3.75	Transparent.
Arsenious	3.65	Opaque.
Alumina	4.00	
Caustic potash	2.1	
soda	2.0	
Calcium oxide	3.2	
hydrate	2.08	
Chromic	5.2	
Cuprous	5.8	
Mercuric	11.3	

SPECIFIC GRAVITIES OF SALTS.

Potash alum crystallized		1.73
Silver nitrate		4.36
Potassium	bichromate	2.603
	chlorate	2.35
	carbonate	2.27
	chloride	1.95
	chromate	2.64
	ferrocyanide	1.83
	iodide	3.06
	sulphate	2.66
Sodium	carbonate (crystal)	1.45
	chloride	2.16
	sulphate (crystall)	1.5
Calcium	carbonate (arragonite)	2.9
	chloride (fused)	2.21
	phosphate	3.18

sulphate (gypsum)	2.33
Mercurous chloride	7.2
Mercuric chloride	5.42
Arsenic sulphide (realgar)	3.55
(orpiment)	3.48

Solubilities: I am indebted to Prof. W. Simon for the following most excellent table:

SYSTEMATICALLY ARRANGED TABLE SHOWING THE SOLUBILITY AND INSOLUBILITY OF INORGANIC SALTS AND OXIDES IN WATER.

The dark squares represent insoluble, the white soluble compounds.

		Carbonate.	Phosphate.	Arseniate.	Arsenite.	Oxide.	Hydrate.	Sulphide.	Iodide.	Chloride.	Sulphate.	Nitrate.	Chlorate.
Potassium	Alkalies.												
Sodium													
Ammonium													
Calcium	Alkaline Earths.	■	■	■	■								
Barium		■	■	■	■						■		
Strontium		■	■	■	■						■		
Magnesium		■	■	■	■	■	■						
Aluminium		■	■	■	■	■	■						
Ferric	Iron Group.	■	■	■	■	■	■	■					
Ferrous		■	■	■	■	■	■	■					
Zinc		■	■	■	■	■	■	■					
Chromium		■	■	■	■	■	■	■					
Nickel		■	■	■	■	■	■	■					
Cobalt		■	■	■	■	■	■	■					
Manganese		■	■	■	■	■	■	■					
Stannic	Arsenic Group.	■	■	■	■	■	■	■					
Stannous		■	■	■	■	■	■	■					
Arsenic		■	■	■	■			■	■				
Arsenious		■	■	■	■			■	■				
Antimony		■	■	■	■	■	■	■	■				
Gold		■	■	■	■	■	■	■	■				
Platinum		■	■	■	■	■	■	■	■				
Copper	Lead Group.	■	■	■	■	■	■	■	■				
Bismuth.		■	■	■	■	■	■	■	■				
Cadmium		■	■	■	■	■	■	■	■				
Mercuric		■	■	■	■	■	■	■	■				
Mercurous		■	■	■	■	■	■	■	■	■			
Silver		■	■	■	■	■	■	■	■	■			
Lead		■	■	■	■	■	■	■	■	■	■		

Barker arranges the solubilities in the following table:

SOLUBILITIES OF CHEMICAL COMPOUNDS.

	Platinic.	Auric.	Mercuric.	Mercurous.	Plumbic.	Arsenic.	Antimonic.	Stannic.	Stannous.	Silver.	Bismuth.	Cupric.	Cadmium.	Ferric.	Aluminum.	Chromic.	Cobaltic.	Nickelic.	Manganous.	Zinc.	Barium.	Strontium.	Calcium.	Magnesium	Sodium.	Ammonium	Potassium.	Hydrogen.
Hydrate	A	A	A	A	A	(W)	A–I	A–I	A	A	A	A	A	A	A	A–I	A	A	A	A	(W)	(W)	(W)	A	W	W	W	W
Nitrate	W	W	W	W	W	—	—	W	—	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Carbonate	A	—	A	A	A	—	—	A	A	A	A	A	A	A	—	A	A	A	A	A	A	A	A	A	W	W	W	W
Acetate	—	—	W	(W)	W	—	—	W	W	(W)	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Oxalate	W	—	A	A	A	—	A	W	A	A	A	A	A	A	A	W	A	A	A	A	A	A	A	A	W	W	W	W
Cyanide	(A)	W	W	W	A	—	A	—	—	(A)	A	A	(W)	W	—	A	A	A	A	A	W	W	W	W	W	W	W	W
Chloride	W	W	W	A	(W)	W	W	W	W	I	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Bromide	W	W	(W)	A	(W)	W	W	W	W	I	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
Iodide	A	A	(A)	A	(W)	(W)	A	(W)	(W)	I	A	—	W	W	—	W	W	W	W	W	W	W	W	W	W	W	W	W
Fluoride	W	W	W	A	A	W	W	(W)	W	W	W	(W)	(W)	W	A-I	W	(W)	(W)	A	(W)	A	A	A-I	A	W	W	W	W
Sulphide	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	W	W	W	W	W	W	W	W
Sulphite	W	—	A	A	A	—	A	W	(W)	A	A	W	(W)	(W)	A	W	A	A	A	(W)	A	A	W	W	W	W	W	W
Sulphate	W	W	W	W	A-I	—	W	W	W	(W)	W	W	(W)	W	W	W	W	W	W	W	I	I	(W)	W	W	W	W	W
Phosphate	—	A	A	A	A	W	W	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	W	W	W	W
Borate	—	—	(W)	—	(W)	—	—	—	(W)	(W)	(W)	(W)	(W)	(W)	(W)	(W)	(W)	W	(W)	(W)	(W)	(W)	(W)	(W)	W	W	W	W
Silicate	—	—	—	—	—	—	—	—	—	—	—	A	—	A	A-I	—	—	—	A	A	A	A	A-I	A-I	W	—	W	(W)I
Arsenite	—	—	A	A	A	—	W	A	A	A	—	A	—	A	—	—	A	A	A	—	(W)	(W)	A	—	W	W	A	W
Chromate	A	—	A	A	A	—	A	A	A	A	A	(W)	A	A	—	A	(W)	W	W	W	A	(W)	(W)	W	W	W	W	W

W, means soluble in water.
(W), hardly soluble in water.

A, freely soluble in acids.
(A), hardly soluble in acids.

I, insoluble in water and acids.

Notes on Organic Chemistry:

Prof. Simon having kindly given me permission, I take occasion to insert the following epitome of organic theory abridged from his "Manual of Chemistry." I have condensed it greatly on account of lack of space, and the student will do well to consult the original, which is probably the best arrangement of this very difficult subject ever offered to a beginner.

Organic Theory:

1. *Organic Chemistry* is the chemistry of carbon compounds.

2. The *elements* contained by organic compounds are, besides carbon, chiefly hydrogen, oxygen and nitrogen, sometimes sulphur and phosphorus.

3. *The general properties* of organic compounds are as follows: Combustible (except CO_2 and its salts); solids usually when carbon atoms predominate in their molecule; liquids or gaseous when hydrogen predominates; easily volatilized gases or liquids when a small number of atoms in the molecule; liquids of high boiling points or solids when number of atoms in the molecule is large.

4. *Quantitative* analysis more important than qualitative to establish identity of organic compound. If the elements of an organic substance are determined, the analysis is called *ultimate* or *elementary;* if different organic substances when mixed together are separated, the analysis is called *proximate.*

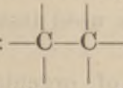
5. The presence of *carbon* in a combustible form will prove a compound to be organic; hence, if a substance burns with generation of carbon dioxide (shown by passing the gas through lime-water), the organic nature of this substance is established. The presence of *hydrogen* may be shown by allowing the gaseous products of combustion to pass through a cool glass tube, when drops of water will be deposited. To show presence of *nitrogen,*

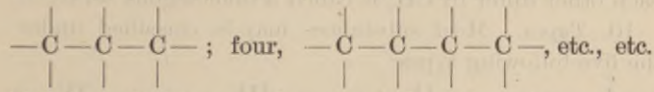
heat with a mixture of two parts calcium hydrate to one part sodium hydrate (soda lime); the nitrogen is converted into ammonia, recognized by its odor and action on paper moistened with copper sulphate solution.

6. A chemical *formula* is called *empirical* when it gives the simplest expression of the composition of a substance; this formula, however, does not necessarily denote the actual number of atoms in the molecule, which may be two or three times the number given in the empirical formula; thus, the empirical formula of acetic acid is CH_2O, but the actual molecular formula contains twice the number of atoms, or $C_2H_4O_2$. Besides empirical and molecular formulæ, others called *rational*, *constitutional*, *structural* or *graphic* are used. The molecular formula of acetic acid is $C_2H_4O_2$, but the formula $HC_2H_3O_2$ shows that acetic acid, like nitric acid HNO_3, is monobasic, containing one atom of hydrogen, which can be replaced by an atom of a metal; hence $HC_2H_3O_2$ is called a *constitutional* formula.

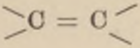
7. *Radicles* or *residues.* These are expressions for unsaturated groups of atoms known to enter as a whole into different compounds, but having no separate existence. Water H_2O is a *saturated* compound that is the one atom of oxygen—which is a dyad, and may be said therefore to have *two* points of attraction—combines with two of hydrogen; and therefore has both its points of attraction satisfied. If now one atom of H be taken from H_2O, there is left the group of atoms HO, which is called a radicle, as it consists of an atom of oxygen, in which but one point of attraction is actually saturated, the second one not being provided for; moreover, this group HO occurs in many compounds—as, for example, in the hydrates, as potassium hydrate KHO, etc. The *equivalence* of radicles depends upon the number of points of attraction unprovided for: carbon requires four

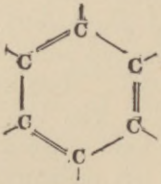
atoms of hydrogen to provide for its points of attraction; therefore, CH_3 would be a *monad* radicle, CH_2 a dyad, CH a triad.

8. *Chains.* The equivalence of an atom of an element may be indicated *graphically.* Thus the fact that oxygen is a dyad, or has two points of attraction, may be shown as follows: —O—. Two atoms of oxygen may be written —O—O—. The two interior bonds have united to form one, or have satisfied each other, while the two exterior ones are left unsaturated. The expression *chain* then, denotes a *series* of atoms, like the two of oxygen above, held together in such a manner that affinities are left unsaturated. The atoms of the series must have a greater equivalence than one, i. e., must be dyad, etc. The formula for hydrogen peroxide is H_2O_2; this may be represented by taking the oxygen chain shown above and saturating each free affinity with an atom of hydrogen, thus: H—O—O—H. The existence of such an enormous number of carbon compounds is greatly due to the property of carbon to form these chains (Simon). Carbon is a tetrad, hence two atoms would form a chain as follows:  $-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-$; each atom has four bonds, one of which unites with one of the other, leaving in this particular chain six free affinities. Three atoms of carbon would be:

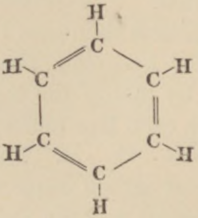


$$-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-;\ \text{four,}\ -\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-,\ \text{etc., etc.}$$

The free affinities may be saturated with various atoms or radicles, hence the almost unlimited number of possible combinations. Atoms are not always united by one affinity. When they are united by *two* the expression for two atoms of carbon would be  $>C=C<$; if by three $-C\equiv C-$. In the so-called *closed chain* of C_6 we have the atoms united partially by double and partially by single union:



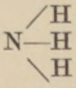
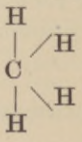
Benzine C_6H_6 would then be represented as follows:



It is easy to see from these two diagrams the origin of the term *skeleton*, which is sometimes used instead of chain.

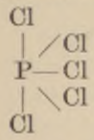
9. *Homologous series.* Any series of organic compounds the members of which preceding or following each other differ by CH_2 is called a homologous series.

10. *Types.* Most substances may be classified under the five following types:

I.	II.	III.	IV.
Hydrogen.	Water.	Ammonia.	Methane.
$H-H$	$H-O-H$	 $N\begin{array}{l} \diagup H \\ -H \\ \diagdown H \end{array}$	 $\begin{array}{c} H \\ \vert \\ C \\ \vert \\ H \end{array}\begin{array}{l} \diagup H \\ \\ \diagdown H \end{array}$

V.

Phosphoric chloride.



Almost any compound may be classed in one of these types by replacing the constituents of these types by other elements or radicles of the same equivalence.

10. *Substitution.* Replacement of an atom or group of atoms by other atoms or groups: $C_6H_6+HNO_3=C_6H_5NO_2+H_2O$. Here for one atom of hydrogen in benzine (C_6H_6) has been substituted the group NO_2.

11. *Derivatives.* Chloroform $CHCl_3$ is a *derivative* of marsh gas CH_4 because it may be obtained from the latter by replacement of three atoms of hydrogen by three of chlorine. The term is applied to bodies derived from others by some kind of decomposition, generally by substitution.

12. *Isomerism.* Two or more substances having the same elements in the same proportions by weight, or having the same percentage composition, and yet, being different bodies with different properties are called *isomeric* bodies. When two or more substances have the same molecular formulæ they are said to be *metameric* with one another; thus CN_2H_4O is either urea or ammonium cyanate; hence, urea is said to be metameric with ammonium cyanate. Sometimes structural formula will serve to distinguish two substances metameric with each other When a substance contains some multiple of the number of each of the atoms contained in the molecule of the other it is said to be *polymeric* with it; thus acetic acid, $C_2H_4O_2$, is polymeric with grape-sugar, $C_6H_{12}O_6$.

13. *Decomposition.* A molecule may undergo various changes; its atoms may re-arrange themselves; it may split up into two or more molecules; two molecules may unite to form one; atoms may be removed from it without replacement by other atoms; atoms may be removed and replaced by others. Organic bodies decompose readily under the influence of heat or chemical agents. Heat will volatilize some organic bodies without decomposition; whilst others are decomposed by it with generation of volatile products. *Dry or destructive* distillation is the term applied to the process of heating non-volatile organic substances in such a way that the oxygen of the air has no access and to such an extent that decomposition takes place.

14. *Combustion and decay.* In common combustion, provided an excess of atmospheric air be present, the carbon of an organic substance is converted into carbon dioxide, the hydrogen into water, sulphur and phosphorus into sulphuric and phosphoric acids, and the nitrogen set free. In decay, which is slow oxidation, the compounds mentioned above are finally produced, but many intermediate products are also generated. Alcohol when burned forms carbon dioxide and water; exposed to the air, it undergoes slow oxidation, forming aldehyde first, then acetic acid.

15. *Fermentation and putrefaction.* An organic substance, under favorable temperature and during the presence of moisture and of a substance termed a ferment, undergoes a peculiar kind of decomposition, during which its molecule is split up into two or more molecules of a less complicated composition.

16. *Difference between fermentation and putrefaction.* The term *fermentation* is used in those cases where the decomposing substance contains carbon, hydrogen and oxygen only. When it contains these three, and also

nitrogen or sulphur, or both, the term *putrefaction* is used. Sugar, $C_6H_{12}O_6$, ferments: albuminous substances, containing nitrogen and sulphur, putrefy, and the nitrogen and sulphur being evolved as ammonia and sulphuretted hydrogen, an offensive odor is noticed. Ferments are prevented from action by the presence of the so-called *antiseptic* agents (carbolic acid, salicylic acid, salt, etc.) If air be excluded, ferments are excluded, inasmuch as the atmospheric air is filled with millions of minute germs of organic nature, which germs may act as ferments when in contact with organic matter under otherwise favorable conditions. By enclosing substances in air-tight vessels which when filled are heated sufficiently to destroy any germs which may have been present, the action of ferments is counteracted (Simon).

17. *Action of various agents on organic matter.* Chlorine and bromine usually remove or replace the hydrogen of an organic substance. Sometimes they combine directly with it, and sometimes, in presence of water, act as oxidizing agents by combining with the hydrogen of the water and liberating oxygen. Nitric acid either forms (i) salts with organic matter (ii), oxidizes it or (iii) substitutes NO_2 (nitryl) for hydrogen. In the latter cases the additional quantity of oxygen added renders the compounds highly combustible, or even explosive. Substances having a great affinity for water, as, for example, sulphuric acid, act on many organic substances by removing hydrogen and oxygen, leaving dark or black compounds consisting mainly of carbon. Alkalies may combine directly, form salts, form soaps, oxidize, or evolve ammonia from nitrogenous compounds. Reducing agents, especially nascent hydrogen, either combine directly, remove oxygen or replace oxygen.

Molecular Weights of Organic Substances:

Marsh-gas	16.0

Nitro-benzole	123.0
Alcohol	46.0
Wood-spirit	32.0
Fusel-oil	88.0
Glycerine	92.0
Lactose	360.0
Sucrose	342.0
Starch	162.0
Carbolic acid	94.0
Acetic acid	60.0
Acetate of lead	378.5
copper	199.2
Benzoic acid	122.0
Lactic acid	90.0
Salicylic acid	138.0
Salicylate of sodium	338.0
Oxalic acid	126.0
Tannic acid	322.0
Tartaric acid	150.0
Tartar emetic	664.0
Cream of tartar	188.0
Rochelle salt	282.0
Citric acid	210.0
Ether	74.0
Chloroform	119.2
Iodoform	392.8
Hydrocyanic acid	27.0
Urea	60.0
Morphine	303.9
sulphate	758.0
hydrochlorate	355.9
acetate	363.0
Strychnine	334.0
sulphate	892.0
hydrochlorate	794.4

nitrate	397.0
Quinine	378.0
sulphate	872.0
hydrochlorate	396.4
Atropine	289.0
sulphate	676.0
Caffeine	212.0

Equations, Processes of Manufacture of Organic Substances:

Alcohol: Ferment solution of grape sugar. $C_6H_{12}O_6=(CO_2)_2+(C_2H_5HO)_2$.

Chloroform: Act on alcohol with bleaching-powder and calcium hydrate. $(C_2H_6O)_4+(CaCl_2O_2)_8=(CHCl_3)_2+[Ca(CHO_2)_2]_2+(CaCl_2)_5+(H_2O)_8$. Alcohol and calcium hypochlorite=chloroform, calcium formate, calcium chloride and water.

Tartaric Acid: Boil calcium tartrate with sulphuric acid. $CaC_4H_4O_6+H_2SO_4=H_2C_4H_4O_6+CaSO_4$. Calcium tartrate and sulphuric acid=tartaric acid and calcium sulphate.

Tartar Emetic: Dissolve freshly-prepared antimonious oxide in a solution of potassium acid tartrate. $KHC_4H_4O_6)_2+Sb_2O_3=(KSbOC_4H_4O_6)_2+H_2O$.

Oil of Bitter Almonds: Action of a ferment called *emulsine* on a glucoside called amygdaline in presence of water. $C_{20}H_{27}NO_{11}+(H_2O)_2=(C_6H_{12}O_6)_2+HCN+C_7H_6O$. Amygdaline+water=glucose+hydrocyanic acid +oil of bitter almonds.

Salicylic Acid: Decompose sodium salicylate with HCl.

Ether: Act on alcohol with sulphuric acid. (*a*) $C_2H_5HO+H_2SO_4=C_2H_5HSO_4+H_2O$; (*b*) $C_2H_5HSO_4+C_2H_5HO=H_2SO_4+(C_2H_5)_2O$. Alcohol+sulphuric acid=ethylsulphuric acid+water; ethylsulphuric acid+alcohol=sulphuric acid+ether.

Amyl Nitrite: Distill equal volumes of pure pentyl alcohol (fusel oil) and nitric acid until the temperature rises to 212° F. Purify distillate by agitating with solution of potassium carbonate and hydrate, separating the upper layer of the liquid and redistilling it; the liquid passing over between 204.8° F. and 212° is amyl nitrite—a clear, pale yellowish liquid of an ethereal fruity odor, aromatic taste, and neutral or slightly acid reaction. Sp. gr. 0.872. Boiling point, 204.8° F.

Soap: Boil a fat with an alkaline hydroxide. $C_3H_5(C_{18}H_{33}O_2)_3+(NaHO)_3=(NaC_{18}H_{33}O_2)_3+C_3H_5(HO)_3$.

Pyroxyline: Act on cellulose with nitric acid of various strengths. $C_6H_{10}O_5+HNO_3=C_6H_9(NO_2)O_5+H_2O$. Cellulose+nitric acid=mono-nitro cellulose and water. $C_6H_{10}O_5+(HNO_3)_2=C_6H_8(NO_2)_2O_5+(H_2O)_2$=pyroxyline and water. Pyroxyline dissolved in a mixture of ether and alcohol forms a solution known as *collodion.* $C_6H_{10}O_5+(HNO_3)_3=C_6H_7(NO_2)_3O_5+(H_2O)_3$=gun-cotton and water.

Hydrocyanic Acid: Distill potassium ferrocyanide with dilute sulphuric acid. $(K_4FeCy_6)_2+(H_2SO_4)_6=K_2Fe_2Cy_6+(KHSO_4)_6+(HCy)_6$.

Formulæ of Many Organic Compounds with Water of Crystallization:

Chloral hydrate	$C_2HCl_3OH_2O$
Sodium acetate	$NaC_2H_3O_23H_2O$
Lead acetate	$Pb2(C_2H_3O_2)3H_2O$
Cupric acetate	$Cu2(C_2H_3O_2)H_2O$
Potassium tartrate	$2(K_2C_4H_4O_6)H_2O$
Potassium sodium tartrate	$KNaC_4H_4O_64H_2O$
Antimony potassium tartrate	$2(KSbOC_4H_4O_6)H_2O$
Ferric citrate	$Fe_22(C_6H_5O_7)6H_2O$
Ferrous lactate	$Fe2(C_3H_5O_3)3H_2O$
Sodium sulphocarbolate	$NaC_6H_5SO_42H_2O$
Sodium salicylate	$2(NaC_7H_5O_3)H_2O$

Milk sugar	$C_{12}H_{22}O_{11}H_2O$
Brucine	$C_{23}H_{26}N_2O_44H_2O$
Caffeine	$C_8H_{10}N_4O_2H_2O$
Morphine	$C_{17}H_{19}NO_3H_2O$
acetate	$C_{17}H_{19}NO_2HC_2H_3O_23H_2O$
hydrochlorate	$C_{17}H_{19}NO_3HCl3H_2O$
sulphate	$(C_{17}H_{19}NO_3)_2H_2SO_45H_2O$
Quinine	$C_{20}H_{24}N_2O_23H_2O$
sulphate	$(C_{20}H_{24}N_2O_2)_2H_2SO_47H_2O$
acid sulphate	$(C_{20}H_{24}N_2O_2)H_2SO_47H_2O$
hydrochlorate	$C_{20}H_{24}N_2O_2HCl2H_2O$
hydrobromate	$C_{20}H_{24}N_2O_2HBr2H_2O$
valerianate	$C_{20}H_{24}N_2O_2C_5H_{10}O_2H_2O$
Strychnine	$C_{21}H_{22}N_2O_2$
sulphate	$(C_{21}H_{22}N_2O_2)_2H_2SO_47H_2O$
Atropine	$C_{17}H_{23}NO_3$
sulphate	$(C_{17}H_{23}NO_3)_2H_2SO_4$
Potassium ferrocyanide	$K_4FeCy_63H_2O$

Color--Reactions of Oils:

OIL.	One or Two Drops of Strong Sulphuric Acid to Twenty of the Oil.	
	Before Stirring.	*After Stirring.*
Vegetable Oils:		
Almond oil	Colorless or yellow.	Dark yellow, olive or brown.
Castor oil	Yellow to pale brown.	Nearly colorless or pale brown.
Cotton-seed oil, crude	Very bright red.	Dark red, nearly black.
Cotton-seed oil, refined	Reddish brown.	Dark reddish brown.
Earth-nut oil	Yellow to orange.	Reddish brown.
Linseed oil, raw	Hard brown or greenish-brown clot.	Mottled, dark brown.
Linseed oil, boiled	Hard brown clot.	Mottled, dark brown.
Mustard oil	Dark yellow and orange streaks.	Reddish brown.
Niger-seed oil	Yellow with brown clot.	Reddish or greenish brown.
Olive oil	Yellow, green or pale brown.	Light brown or olive green.
Poppy-seed oil	Yel'w spot, with orange strks or rgs.	Olive or reddish brown.
Rape oil, crude	Green, with brown rings.	Bright green turning brownish.
Rape oil, refined	Yellow, with red or brown rings.	Brown.
Animal Oils:		
Cod-liver oil	Dark red spot, with purple streaks.	Purple changing to dark brown.
Lard oil	Grnish yel'w, or br'n'h with brn strks.	Mottled or dirty brown.
Seal oil	Orange spot, with purple streaks.	Bright red changing to mottled brown.
Sperm oil	Pure brn spot, with faint yellow rg.	Purple changing to reddish or drk brn.
Tallow oil	Yellow spot, with pink streaks.	Orange-red.
Whale oil	Red turning violet.	Brownish red, turning brown.
Hydrocarbon Oils:		
Petroleum lubricating oil	Brown.	Dark brown with blue fluorescence.
Shale lubricating oil	Dark reddish brown.	Reddish brown with blue fluorescence.
Rosin oil, brown	Bright mahogany brown.	Dark brown with purple fluorescence.
Rosin oil, pale	Mahogany brown.	Red brown with purple fluorescence.

The above is from Allen, and shows the effect produced on placing a drop or two of sulphuric acid in the center of about twenty drops of oil, and observing the color both before and after stirring. It is very desirable to examine specimens of oils of known purity side by side with the suspected oil, instead of trusting too implicitly to the reactions described in the table. The colors produced by different samples of the same kind of oil are liable to considerable variation.

Table of Reactions of the More Important Sugars:

1. Moisten the solid sugar with water and stir in the cold with concentrated sulphuric acid (1.85 sp. gr). Glucoses—Not affected when pure. Cane sugar—Chars.

2. Triturate the solid sugar with caustic soda, or boil with a 3 per cent. solution of caustic soda for one minute. Glucoses—Brown coloration. Cane sugar—Not affected. Milk sugar—Not affected.

3. To the neutral solution add Fehling's solution and heat to the boiling point. Glucoses—Deep blue liquid, giving yellow or red precipitate on heating. Cane sugar—Deep blue liquid unchanged by heating. Milk sugar—Deep blue liquid, giving yellow or red precipitate on heating.

4. To a few drops of Fehling's solution add caustic soda and ammonia, heat to boiling, and add the liquid to be tested for sugar. Glucoses—The solution is decolorized. Cane sugar—No change. Milk sugar—The solution is decolorized.

5. Boil the solution for two minutes with 1 c.c. Glucoses—Red precipitate of cuprous oxide. Cane sugar—No change. Milk sugar—No change.

Composition of Cereals, Foods, etc.:

The average composition of cereals, according to Graham, is as follows:

	Old Wheat	Bar-ley.	Oats.	Rye.	Corn.	Rice.
Water................	11.1	12.0	14.2	14.3	11.5	10.8
Starch................	62.3	52.7	56.1	54.9	54.8	78.8
Fat	1.2	2.6	4.6	2.0	4.7	0.1
Cellulose	8.3	11.5	1.0	6.4	14.9	0.2
Gum and sugar......	3.8	4.2	5.7	11.3	2.9	1.6
Albuminoids	10.9	13.2	16.0	8.8	8.9	7.2
Ash..................	1.6	2.8	2.2	1.8	1.6	0.9
Loss, etc.............	0.8	0.2	0.2	0.5	0.7	0.4
	100.0	100.0	100.0	100.0	100.0	100.0

Church gives the following table:

	Buck-wheat.	Peas.	Haricot Beans.	Lentels.	Earth-nuts. Shelled.
Water............	13.4	14.3	14.0	14.5	7.5
Albuminoids, etc..	15.2	22.4	23.0	24.0	24.5
Starch, etc.......	63.6	51.3	52.3	49.0	11.7
Fat	3.4	2.5	2.3	2.6	50.0
Cellulose & lignose	2.1	6.5	5.5	6.9	4.5
Mineral matter...	2.3	3.0	2.9	3.0	1.8
	100.0	100.0	100.0	100.0	100.0

	Pota-toes.	White Tur-nips.	Car-rots.	Beetroot (red).	Yam.
Water	75.0	92.8	89.0	82.0	79.6
Albuminoids	2.3	0.5	0.5	0.4	2.2
Sugar	......	......	4.5	10.0	16.3
Starch	15.4	......	......	....	
Dextrin, gum and Pectose	2.0	4.0	0.5	3.4	
Fat	0.3	0.1	0.2	0.1	0.5
Cellulose and lignose.....	1.0	1.8	4.3	3.0	0.9
Mineral matter..........	1.0	0.8	1.0	0.9	1.5

Rich albuminous foods, according to Ranke, Payen, Letheby, etc.:

	Ln. Raw Meat.	Fat Raw Meat.	Roast Meat.	Lean Mutton	Fat Mutton.	Veal.	Fat Pork	Dried Bacon.	White Fish.	Salmon.	Oysters.	Eggs.
Nitrogenous matter	19.3	14.8	27.6	18.3	12.4	16.5	9.8	8.8	18.1	16.1	14.01	14.0
Fat	3.6	29.8	15.45	4.9	31.1	15.8	48.9	73.3	2.9	5.5	1.51	10.5
Salines, etc	5.1	4.4	2.95	4.8	3.5	4.7	2.3	2.9	1.0	1.4	4.09	1.5
Water	72.0	51.0	54.00	72.0	53.0	63.0	39.0	15.0	78.0	77.0	80.39	74.0

Composition of beef, veal and pork. (Moleschott.)

	Soluble alb'm'n and hematin.	Mysoin, etc.	Gelatins	Fats	Extractives.	Kreatin.	Ash.	Water.
Beef	2.25	15.21	3.21	2.87	1.39	0.07	1.6	73.39
Veal	2.27	14.36	5.01	2.56	1.27	....	0.77	73.75
Pork	1.63	15.50	4.08	5.73	1.29	....	1.11	70.66

The yolk of an egg as compared with the white is as follows:

	Nitrogenous Constituents.	Fat.	Salines.	Water.
olk	16.0 per cent.	30 per cent.	1.3 per cent.	52 per cent.
White ...	20.4 “	....	1.6 “	78 “

Analysis of bread and biscuit:

	Flour Bread.	Biscuit.
Carbohydrates	51.0	73.4
Nitrogenous constituents....................	8.1	15.6
Fats....................................	1.6	1.3
Minerals................................	2.3	1.7
Water	37.0	8.0

Analysis of fruits. (Fresenius):

	A'pl's. White.	Pears. Sweet red.	Green Gages.	Cher's Sweet red	Gr'pes White.	Gooseberr's. Lrg rd	Strawberries.
Sugar.........	7.58	7.94	3.4	13.11	13.78	8.06	7.57
Free acid......	1.04	Trace.	0.87	0.35	1.02	1.35	1.13
Albuminous sub	0.22	0.24	0.40	0.90	0.83	0.44	0.36
Pectous subs. and pectose.	3.88	5.10	12.52	3.73	1.43	1.26	1.12
Ash...........	0.44	0.28	0.39	0.60	0.36	0.31	0.48
Insol'ble matter	1.8	3.51	3.89	5.9	2.59	2.99	1.96
Water.........	85.04	83.01	79.72	75.37	79.99	85.56	87.47

One pound of *mixed vegetables* contains about 420 grains of carbon and 14 grains of nitrogen.

Potatoes compared with bread are as follows: One pound of bread is equal to two and one-half pounds of potato, as far as carbon is concerned, and to three and one-half pounds in nitrogen.

Tea cannot be regarded as a nutriment in the sense of supplying material to maintain structure and generate heat; it rather tends to excite vital activity, particularly acting as a respiratory stimulant. With sugar and milk it becomes a useful food.

Analysis of Tea. (Peligot.)

	Per cent.		*Per cent.*
Theine	2.0 to 3.0	Fat	4.0
Casein	15.0	Vegetable fibre	20.0
Gum	18.0	Minerals	5.0
Tannin	26.25	Water	5.0
Starch	0.75		

Coffee also excites the nervous system, but not to the same degree as tea, at the same time somewhat depressing the respiratory function. It exerts a marked sustaining influence under fatigue and privation. According to Roux, the theories regarding its diminution of tissue waste, etc., are doubtful.

Vegetables may be classified as follows:

1. *Those rich in albumen and nitrogen:* Cabbage, asparagus, cress, mushrooms and truffles. These are all very nutritious.

2. *Those rich in mucilage and salts:* White beet, lettuce and endive.

3. *Those rich in acids:* Sorrel, tomato, rhubarb, asparagus. They are useful as excitants of digestion.

4. *Those containing little or no starch:* Lettuce, endive, spinach, asparagus, artichoke, leeks, white onions and parsnips.

5. *Those rich in sugar:* Beetroots, Jerusalem artichokes, carrots, ripe fruits.

Fruits may be classified as follows:

1. *Those containing much sugar:* Pears, apples, peaches, apricots, prunes, melons, oranges, strawberries, figs, grapes, etc. When ripe, easy of digestion, and usually contain such vegetable acids as malic, citric, tartaric, etc.

2. *Acid fruits:* Lemon, gooseberry, tamarind, etc.

3. *Starchy fruits:* Chestnuts, bread fruit.

4. *Oily fruits:* Nuts, sweet almonds.

As to *alcohol*, it must be said that the weight of evidence is in favor of the theory that it acts more or less as an aliment. In large amount it lowers the temperature, particularly when abnormal, as in fevers. Given in a state of health, it tends to diminish muscular power on the one hand, but on the other its effect may be to increase it by improving the tone of the system through the appetite and digestion of food. Wines and beer taken in moderate quantity diminish slightly the carbonic acid exhaled, but favor the secretion of the gastric and pancreatic juices, and there is a gentle excitation of the nerve centers, and at the same time an undoubted addition is made in the form of salts, fats, glycerine and albuminoids—beer not only being stimulating and tonic, but also nutritious. Of alcoholic drinks, beers occupy the first place as foods; then come cider and perry, and then wines, and, according to E. Smith, as they sustain and increase vital action they must be regarded as true foods. According to Voit, also, alcohol must be regarded as a food, as under its influence fewer substances are decomposed in the body.*

Summary in Regard to Foods:

Nitrogenous foods: Required for the construction and maintenance of the tissues. They supply the nitrogenous

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*These statements regarding alcohol are from no less an authority than T. Cranstoun Charles, M.D.

waste, form one of the great sources of fat in the economy, and excite the metabolic activity of the body.

Fats and carbohydrates (starch, sugar, dextrin, etc.): May to a certain extent replace the nitrogenous foods. Evolve energy most largely and efficiently, and of high dietetic value as force-producers; are the ultimate, though not necessarily the direct, sources of heat and of muscular energy.

Water: Required to maintain the due bulk of the blood and other animal tissues; useful in mastication and digestion, and in keeping up the constant outpourings and reabsorptions of great volumes of liquid in the alimentary canal and in the tissues generally, by which the body fluids, and particularly the blood, are maintained in normal condition. It keeps different substances in solution or suspension in the body, and serves as a vehicle to carry away waste products, and at the same time regulates the temperature of the body by its evaporation at the surface.

Salts: Required to maintain the constitution of the tissues, and are essential in keeping up the diffusion streams in the organism. *Special uses:* Hydrochloric acid of gastric juice formed at expense of chlorides; alkaline carbonates and alkaline salts of vegetable acids neutralize the sulphuric and phosphoric acids formed in the system by the oxidation of the sulphur and phosphorus of the proteids; the salts of sodium probably play a similar *role* to the latter. (Charles.)

Alkaloids, Glucosides, etc.:

The following table shows important alkaloids:

Liquid and Volatile:

Conine, $C_8H_{15}N$	Conium maculatum
Nicotine, $C_{10}H_{14}N_1$	Tobacco plant

Solid and Fixed Alkaloids:

Morphine, $C_{17}H_{19}NO_3$,	10.00 per cent. in opium on an average
Codeine, $C_{18}H_{21}NO_3$,	0.25 per cent. in opium on an average
Thebaine, $C_{19},H_{21}NO_3$,	0.15 per cent. in opium on an average
Papaverine, $C_{21}H_{21}NO_4$,	1.00 per cent. in opium on an average
Narcotine, $C_{22}H_{23}NO_7$,	1.30 per cent. in opium on an average
Narceine, $C_{25}H_{29}NO_9$,	0.70 per cent. in opium on an average
Quinine, $C_{20}H_{24}N_2O_2+3H_2O$	In cinchona bark
Cinchonidine, $C_{19}H_{22}N_2O$	In cinchona bark
Quinidine, isomer to quinine	In cinchona bark
Cinchonidine, isomer to quinine	In cinchona bark
Strychnine, $C_{21}H_{22}N_2O_2$	In nux vomica
Brucine, $C_{23}H_{26}N_2O_4+4H_2O$	In nux vomica
Solanine, $C_{43}H_{17}NO_{16}$	In solanaceæ
Atropine, $C_{17}H_{23}NO_3$	In solanaceæ
Hyoscyamine, $C_{15},H_{23}NO_3$	In solanaceæ
Veratrine, $C_{32}H_{50}NO_9$?	Veratrums
Aconitine, $C_{30}H_{47}NO_7$?	Aconitum napellus
Colchicine, $C_{17}H_{23}NO_6$	Colchicum autumnale
Berberine, $C_{20}H_{17}NO_4$	Berberis vulgaris
Piperine, $C_{17}H_{19}NO_3$	Pepper
Emetine, $C_{30}H_{46}N_2O_7$	Ipecacuanha root
Sinapine, $C_{16}H_{23}NO_5$	White mustard seed
Physostigmine, $C_{30}H_{21}N_3O_4$	Calabar bean
Pilocarpine, $C_{11}H_{16}N_2O_2$	Pilocarpus
Caffeine, $C_8H_{10}N_4O_2+H_2O$	Coffee, tea
Theobromine, $C_7H_8N_4O_2$	Seeds of theobroma cacao
Opianyl, $C_{10}H_{10}O_4$	Opium, formerly called *meconine*
Jervine, $C_{26}H_{37}NO_3$	Veratrum album or viride

Gelsemine, $C_{12}H_{14}NO_2$	Gelsemium sempervirens
Cytisine, $C_{20}H_{27}N_3O$	Cytisus laburnum
Apomorphine, $C_{17}H_{17}NO_2$	Derived from morphine
Cocaine, $C_{17}H_{21}NO_4$	Erythroxylon coca
Homatropin	Artificial alkaloid
Kairin	Artificial alkaloid
Antipyrin, $C_{20}H_{18}N_4O_2$	Artificial alkaloid
Quinolin	Artificial alkaloid
Thallin	Artificial alkaloid
Aspidospermine	Quebracho
Hydrastine	Hydrastis
Hyoscine, $C_{17}H_{23}NO_3$	Hyoscyamus
Muscarine	
Napelline	Aconitum napellus
Pelletierine	Pomegranate bark
Sanguinarine	Sanguinaria
Doliarine	Ficus doliaria
Doundakine	Doundake (west coast of Africa)
Delphinine	Aconitum napellus

The following table shows important glucosides:

Amygdalin, $C_{20}H_{27}NO_{11}$	Bitter almonds, etc.
Arbutin, $C_{25}H_{34}O_{14}$	Arbutus uva ursa
Cathartic acid, $C_{180}H_{192}N_4SO_{82}$?	Senna
Carminic acid	Cochineal
Colocynthin, $C_{58}H_{84}O_{23}$?	Colocynthis
Digitalin, $C_{27}H_{45}O_{15}$?	Digitalis
Elaterin, $C_{20}H_{28}O_5$	Cucumber fruit
Gentiopicrin, $C_{20}H_{30}O_{12}$	Root of gentiana
Glyceyrhizin, $C_{24}H_{36}O_9$	Licorice root
Helleborin, $C_{36}H_{42}O_6$	Root of Hellebore
Indican ?	Indigo plant
Jalapin, $C_{31}H_{50}O_{16}$	Jalan resin
Myronic acid, $C_{10}H_{19}NS_2O_{10}$	Seeds of black mustard
Picrotoxin, $C_9H_{10}O_4$	Cocculus indicus
Salicin, $C_{13}H_{18}O_7$	Bark of willow

Santonin, $C_{15}H_{18}O_3$	Worm-seed
Scammonin, $C_{34}H_{56}O_{16}$	Resin scammony
Solanin ?	Solanaceæ
Tannins, $C_{14}H_{10}O_9$	Many barks, leaves, etc.
Adonidin	Adonis vernalis
Cannabin	Cannabis indica
Convallamarin	Convallaria majolis
Populin	
Phlorizin	
Esculin	
Quercitrin	

The following table shows many other active principles, neutral principles, etc.:*

Agaricin	White agaric, Boletus laricis
Cotoin	Coto bark
Papain	Papaw juice
Papayotin	Papaw juice
Paracotoin	Coto bark
Piscidin	Piscidia erythrina
Taraxacin	Dandelion
Sclerotic acid	Ergot
Podophyllotoxin	Podophyllum peltatum
Glycyphyllin, $C_{26}H_{14}O_{12}3H_2O$	Smilax glycyphylla
Asebotoxin	Andromeda japonica
Asebotin	Andromeda japonica
Chrysarobin (chrysophanic acid)	Goa powder

Eclectic physicians have brought into use a line of preparations called "Resinoids." These consist of precipitates in the form of powder obtained by mixing a strong alcoholic tincture of any given plant or part thereof with three or four times its bulk of water. Some of the more important are:

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* Many of these are as yet really unclassified. Some may be split up into several principles.

Apocynin	Apocynum cannabinum
Baptisin	Baptisia tinctoria
Caulophyllin	Caulophyllum thalictroides
Euonymin	Euonymus atropurpureus
Helonin	Helonias dioica
Irisin	Iris versicolor
Leptandrin	Leptandra virginica
Macrotin	Cimicifuga racemosa
Podophyllin	Podophyllum peltatum

Many of these eclectic preparations have the same name, or nearly so, as the alkaloids, and serious errors are likely to follow in consequence; the alkaloids are now spelled with an "e" at the end in all cases; thus, aconitine is the alkaloid, aconitin being the name of the eclectic "resinoid." The resinoids are different in action and dose from the alkaloids.

Cocaine and its Hydrochlorate:

Cocaine, the alkaloid of *erythroxylon coca*, Lam., was discovered by Niemann in 1860, and afterward studied by W. Lossen (1862), who assigned to it the formula $C_{17}H_{91}NO_4$.

Niemann prepared cocaine by exhausting coca leaves with 85 per cent. alcohol, containing one-fiftieth of sulphuric acid, supersaturating the alcoholic solution with lime, then neutralizing carefully with diluted sulphuric acid, separating the precipitated sulphate of calcium, and distilling off the alcohol. The residuary liquid is supersaturated with soda and then shaken repeatedly with ether, which dissolves out the cocaine. On evaporating the ethereal solution, cocaine remains behind in an amorphous condition, but soon becomes crystalline. It is somewhat purified by washing with a little strong alcohol (?), and then recrystallized from highly dilute alcohol.

Lossen extracts coca leaves with rain-water, precipitates with acetate of lead, removes the excess of the latter remaining in solution by means of sodium sulphate, filters and adds soda to the filtrate in slight excess. On shaking this mixture with ether, only *cocaine* passes into solution, while *hygrin* remains in the alkaline liquid. The crude cocaine obtained after the evaporation of the ether is dissolved in very dilute hydrochloric acid, and this solution dialyzed, the cocaine passing through parchment paper, while most of the accompanying coloring matter remains behind. From the dialyzed acid solution the alkaloid is then precipitated with soda, and obtained pure by several times recrystallizing it from alcohol.

Lossen obtained, in the most favorable case, 4 parts per 1,000, and from poor material, only 1.6 parts per 1,000.

Cocaine crystallizes in four or six sided monoclinic prisms. It is soluble at 12° C. in 704 parts of water; easily soluble in alcohol, and still more so in ether. It melts near 92°.

From a dilute aqueous solution of hydrochlorate of cocaine, the alkaloid is precipitated by caustic alkalies and their carbonates, also by ammonia and ammonium carbonate, though the latter cause a considerable portion to be retained in solution. Bicarbonate of sodium and potassium yield a precipitate only in its concentrated solution. Sulphocyanide of potassium renders its solution but slightly turbid. So also tannic acid, provided free hydrochloric acid is present. Stannous chloride causes a white precipitate soluble in much nitric acid; mercuric chloride, a copious precipitate rapidly becoming flocculent, soluble in alcohol and hydrochloric acid; picric acid, a pulverulent, yellow precipitate soon becoming resinous; phosphomolybdic acid, a yellowish white flocculent precipitate; iodine water, or iodized iodide of potassium, a kermes-brown precipitate.

Dilute acids do not alter cocaine, but concentrated acids (sulphuric, etc.) change it into *ecgonin*, benzoic acid, and methyl alcohol, or rather the ether of the latter. Ecgonin is a product of the decomposition of cocaine, and not a natural constituent of coca leaves.

Cocaine combines easily with dilute acids, forming easily crystallizable salts, which are soluble in alcohol, but *insoluble in ether*, have a bitter taste, and leave a transient sensation of insensibility upon the tongue.

Hydrochlorate of cocaine, $C_{17}H_{21}NO_4HCl$, separates from its aqueous solution in short transparent prismatic crystals which are permanent in the air.

Acetic acid dissolves cocaine readily, but on evaporation the base separates again in crystals. Niemann took these for the acetate.

Nitrate of cocaine crystallizes with great difficulty.

Neutral sulphate of cocaine is a transparent gummy mass, becoming only slowly crystalline.

Cocaine is accompanied, in the coca leaves, by a volatile and liquid alkaloid, which remains behind when the aqueous extract, supersaturated with soda, is shaken with ether. It may be separated by distilling the aqueous liquid, or by distilling the leaves with water. It has an odor resembling that of trimethylamine, has a bitter taste, and an alkaline reaction, but is not poisonous. *New Remedies:* Besides the hydrochlorate, or muriate, as it is also called, various other salts of the alkaloid are now used as the citrate, hydrobromate, oleate and salicy late. The crystallized hydrochlorate has given the best satisfaction, although the crystallized hydrobromate is highly lauded.

Detection of Impurities and Adulterations in Food, Drugs, etc.:

This is a subject of great importance and cannot be fairly treated in so small a volume as this. The reader is referred to Hassall and to Blyth; also to the manuals of Attfield, Simon and to the larger works on chemistry. A few simple tests which have recently come under the observation of the author are as follows:

To Distinguish Artificial from Genuine Butter: Mr. John Horsely, F. C. S., in the London *Chemical News*, gives this method: "Have ready two small but wide-mouthed glass test-tubes, about four inches high, with feet attached. Into one put a piece of butterine or oleomargarine (about the size of a hazel-nut), and cork this tube; into the other put a similar-sized piece of pure butter, and cork that tube. Next take one in each hand at the bottom; in ten minutes the butterine melts into a clear oily fluid by the mere heat of the blood (98° F.). Pure butter takes twice as long to melt as butterine, and even then is not so clear and oily as butterine, which is a noteworthy difference between them. This is the physical test. For the chemical test, after the tubes have stood to cool for a few minutes, pour on ether to about one-third of the tube, and cork well. Agitate the tubes —one in each hand—clasping them well. The butterine readily dissolves into a clear liquor, which the addition thereto of twenty or thirty drops of spirit of wine does not disturb or precipitate; but a similar experiment with pure butter produces a voluminous white precipitate. Hereby we can easily distinguish one from the other. Even butter adulterated with a portion of oleomargarine may be detected by a precipitate being formed."

Santonin, according to Dr. Hager, is sometimes adulterated with stearic acid. This may be detected by heating some of the crystals on paper to 100° C. If a grease spot results, the santonin is adulterated with this or some other fatty acid. Santonin itself will not melt below 196° C.

Detection of Tartaric Acid in Citric Acid: Vulpius dissolves five-tenths of a gram of the sample in question in ten grams of distilled water and adds five drops of the solution, drop by drop, to fifteen grams of lime-water. If the citric acid contains mere traces of tartaric acid, in a few moments there is produced a distinct turbidity, which increases on adding more of the acid solution and stirring. In this manner one per cent of tartaric acid can be detected. M. Push puts one gram of the sample, ground up, in a dry test-tube, along with ten grams of pure, colorless, sulphuric acid, and suspends the tube in a beaker containing water, which is kept at a temperature close upon boiling. If the citric acid is pure, the liquid takes and retains a lemon-yellow color. But if only one-half per cent of tartaric acid is present, the mixture becomes brown in twenty-five to thirty minutes.

Testing Beeswax: When the wax is chewed, it should have no disagreeable taste, and must not stick to the teeth. In an adulterated wax, the nature of the foreign material can generally be detected by the taste; the addition of fat can generally be readily detected. If it sticks to the teeth, the presence of rosin may be assumed. A simple method for detecting the presence of fat in wax consists in melting it, and placing a drop on a piece of woolen cloth. After it is perfectly cold and solidified, a few drops of thirty-three per cent alcohol are poured on, and the cloth is rubbed between the hands. The wax will be converted into dust, and will easily separate from the cloth, if it contains no fat, and will leave no stain; when it contains fat it will leave grease spots. In examining wax candles they should be broken to see whether the interior is of the same material as the surface; because adulterations of this kind occur quite frequently.

Alum in Flour or in Bread: On a portion of adulterated flour being placed in a small quantity of chloroform the flour floats, while the alum or other mineral matter sinks to the bottom. In a similar way alum in bread may be instantly detected by placing a small piece of the suspected loaf in a solution of logwood and carbonate of ammonia; if alum be present, the bread will turn blue.

To Distinguish Genuine Cod-liver Oil from Other Liver Oils:

Pour ten or fifteen drops of the respective oils on watch glasses, then slowly pour in from the side two or three drops of fuming nitric acid, sp. gr. 1.500, when the several oils will exhibit the following reactions:

1. Genuine cod-liver oil (from *Gadus Morrhua*) turns *red* at the point of contact; when afterward stirred with a glass-rod it becomes fiery rose-red, soon passing over into pure lemon-yellow.

2. Coalfish oil (from Gadus Carbonarius) turns intensely *blue* at the point of contact; when stirred, it turns brown and remains so for two or three hours, when it finally passes likewise into a more or less pure yellow.

3. Japanese cod-liver oil behaves like the preceding, except that red streaks are sometimes observed along with the blue ones on the addition of nitric acid.

4. Seal oil at first shows no change of color and becomes brown only after some time.

[A *liver* oil may be told from a *non-liver* oil by the color-reaction for biliary acids.]

Mixtures of genuine cod-liver oil with the other liver oils may be told by this reaction with fuming nitric acid. For complete detection of adulterations in cod-liver oil, see *American Druggist* (April, 1885), translation of article by Hager.

To Detect Aloes in Beer:

H. Bornträger, in the *Zeit. f. Anal. Chem.*, proposes a method of detection. Add to the suspected beer a double volume of benzin, shake, let it settle, decant the benzin, and add a few drops of ammonia. If aloes are present a violet-red color will be developed.

To Detect Soda in Milk:

Add three or four c.c. of tannin solution to about fifteen c.c. of (alkaline) milk. A green color will appear after eight to twelve hours if soda is present. Dilute acetic acid will then turn the color to an unstable red.

To Tell Cotton-seed Oil from Olive Oil:

The Italian government has ordered the custom-house officers to use the following test for detecting cotton-seed oil in olive oil: Two cubic centimetres of pure nitric acid are to be mixed with five cubic centimetres of the oil. A piece of pure copper, in form of a wire, is then introduced, and the whole stirred with a glass rod. If any cotton-seed oil was present, the liquid becomes red in the course of half an hour.

Tests for Adulterated Sugar:

Casamajor suggests that a sample of the suspected sugar be placed in a beaker-glass or teacup and an equal quantity of sugar known to be pure in a similar vessel. On adding a little water to each and placing the vessel in hot water the adulterated sugar will melt much sooner than the other and appear more like molasses. On allowing the two solutions to cool, the pure cane sugar will become solid again, while the adulterated article will remain a syrup. In a sample sent to him to test he found that about 20 per cent of crystalline glucose had been added. The form of the crystals in the anhydrous glucose were, he said, easily distinguishable from either cane sugar or ordinary hydrated glucose by means of the microscope. The quantity can only be determined by optical means.

Testing Water for Industrial Purposes:

To know whether water is hard or soft, dissolve a little white soap in alcohol, and add a few drops of water under investigation. If the alcohol turns milky, the water is hard; if either unaltered or simply cloudy, it is soft.

To detect a copper percentage, add a little filing dust of soft iron to the water, leave them in for a few minutes, and add a few drops of sal ammoniac. A blue colorization betrays the presence of copper.

For detecting carbonic acid, a small quantity of water is mixed with a like quantity of lime water. If carbonic acid is present the fluid turns milky at once. Hydrochloric acid causes the turbidity to disappear.

Sulphur combinations are detected by adding a little water to the mercury in the bottle; this is closed and left to stand for a few hours. If the mercury assumes a darker surface, and upon shaking, separates into gray powder, it is a sign that the water contains sulphur combinations.

Dissolved pure lime is proven by adding one or two crystals of oxalic acid to the water. A milky precipitate betrays the presence of lime.

Sulphate of lime (gypsum) is recognized by the white precipitate caused by chloride of barium in the solution. The precipitate is not redissolved by nitric acid.

Alkalies and alkaline earths are detected as follows: Blue litmus paper is colored feebly red in dilute vinegar, and dipped in the corresponding water. If the former blue color is restored, the water is alkaline.

An iron percentage is recognized by a few drops of nutgall decoction, which are added to the water. If iron is present, the water assumes an inky gray to black color. Also, one drop of solution of ferrocyanide of potassium colors ferruginous water blue.

To detect magnesia, the water is to be heated to boiling, and the point of a knife full of carbonate of ammonia and a little phosphate of soda are added. If the magnesia is present, it is precipitated.

Acids are ascertained by dipping a small piece of litmus paper in the water. A red colorization betrays their presence. (Industrial Record.)

Detection of Watered Milk:

It is an exceedingly simple matter for a chemist to determine the exact quantity of water in milk; but since all milk contains a very large quantity of water, and that a varying quantity, the chief difficulty has been in distinguishing between the water naturally there and the water added fraudulently. Uffelmann attempts to solve this problem by looking for those substances which are always present in well-water, and never in pure milk, such as ammonia and nitrous and nitric acids. For this purpose he first precipitates the caseine from 350 c.c. of milk with dilute acetic acid, and filters it out. He then adds three drops of hydrochloric acid to the first filtrate, *a*, heats to boiling, and when cold filters it. Fifty c.c. of this second filtrate, *b*, is rendered slightly alkaline with caustic potash, filtered, and the last filtrate, *c*, is distilled. The distillate is tested for ammonia with Nessler's solution. Another 50 c.c. of above filtrate, *d*, is tested directly for ammonia (after adding caustic soda in a solution of the pure carbonate) with the same reagent. In this way the author succeeded in detecting 0.007 milligram of ammonia. About 150 c.c. of filtrate *a* is boiled and filtered. Each 30 c. c. of filtrate is tested for nitrites with diamido-benzol and with iodide of cadmium and starch. The remainder is tested for nitrate as follows: A piece of diphenylamine as large as a lentil is put in a white porcelain dish, and dissolved in 1½ c.c. of concentrated sulphuric acid, and three or four drops of filtrate *a* run into it. If nitric acid is present, the blue streaks will appear sooner or later, according as there are more or less nitrates present. If it does not make its appearance at all, the filtrate *a* is evaporated to one-third of its volume, filtered, and tested again in the same manner. If the results are still negative, it is again evaporated and tested. If the tests show the presence of all three, nitrous and nitric acids and ammonia, it is proof that water has been added; but, if the tests give negative results, it is not proof positive that no water has been added. When water has been added, these tests give no indication of the amount added unless the quality of the water is likewise known; but it does prove that it is adulterated.

Testing Gold:

For testing gold make up a liquid consisting of nitric acid, 1 ounce; water, 2 drachms; muriatic acid, ½ scruple. Mix the ingredients well and keep the solution in a bottle with a glass stopper. With a glass rod which had been dipped in the mixture touch the metal and watch the action. If no effect is produced on the metal it is either gold or gold plated. If the "gold" is very low or less than 9 karat the acid will boil green, and base metal is at once detected by the mark left by the acid. To test silver apply a drop of a solution of nitric acid, 3 ounces; water, 1 ounce, and bichromate of potash, ½ ounce, and wipe off the drop immediately with a sponge and water. If a blood-red mark results the metal is silver or the article is silver plated.

PART II.

Notes on the Chemistry of Certain New Remedies.*

Urethan: This substance was described by Kobart; its formula is $NH_2CO_2C_2H_5$; it was first used medically by Von Jaksch, of Vienna. It is a hypnotic. White crystals readily soluble in water.

Terpine: The hydrate of terpine, $C_{10}H_{16}H_2O+Aq$, is now used in pulmonary troubles, Bright's disease, etc. It is made from oil of turpentine, alcohol and nitric acid. White crystals soluble in 200 parts cold water, 22 of boiling water, 7 of alcohol, very soluble in ether and in fatty oils. In poisonous doses it produces rapid and irregular breathing, great bodily heat and excitement and violent vomiting of blood. Albuminuria and hæmaturia are also among its symptoms. The phosphates in the urine are increased by large doses. *Terpinol* is produced by the action of sulphuric and hydrochloric acids on terpine. *Terebene*, $C_{10}H_{16}$, is produced by the action of sulphuric acid on oil of turpentine.

Iodol: This substance, now a rival of iodoform, is obtained from pyrrhol (a product of the destructive distillation of proteids). Iodol is properly tetra-iodo-pyrrhol; it is a powerful antiseptic, having an anæsthetic action and promoting the granulation of wounds. It is a brownish crystalline powder, not decomposing at 212° F., but when heated above this point evolves vapors of iodine. It is soluble in ether, chloroform and alcohol, but nearly insoluble in water. It contains nearly 90 per cent. of iodine, 7 per cent. less than iodoform.

Sparteine: Sparteine is an alkaloid obtained from a kind of furze named Sparticum scoparium. Germain Sée uses the sulphate of this alkaloid in heart disease.

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* Kindly supplied me by Mr. J. M. Baker, of Gale & Blocki, Chicago.

Arsenite of Bromine: This compound of bromine and arsenic is now used in Diabetes Mellitus. White, very deliquescent, readily soluble in water.

Brucine: This alkaloid, though long known, has been therapeutically neglected until of late. It is now found to be much less poisonous than strychnine, and if a prescription fall into the hands of an inexperienced or careless dispenser, the danger of making a death-dealing mistake is very greatly obviated if brucine rather than strychnine be prescribed.

Ergotinine: This substance is the alkaloidal active principle of ergot. So sensitive is this alkaloid, that it is necessary to prepare it in solution rendered antiseptic, preferably, by bichloride of mercury (1 in 5,000).

Cannabin tannate: A salt derived from Cannabis Indica, useful as a hypnotic. Not a narcotic. Amorphous brown powder, soluble in water.

Ichthyol: A substance obtained from a bituminous rock found in the Tyrol. The ichthyol sulphonate of sodium is preferable to ichthyol in skin diseases.

Mercury tannate: This salt of mercury is now used by the Germans in the treatment of syphilis. In appearance it somewhat resembles iron filings; sparingly soluble in water.

Papayotin: This substance, prepared from the juice of the Carica papaya, has the remarkable property of digesting fibrin, and in a much higher degree than pepsin. It will peptonize 200 times its own weight of pressed blood fibrin.

Pelletierine tannate: Pelletierine, $C_{16}H_{15}NO_2$, is, as has already been stated (p. 269), an alkaloid from the bark of the pomegranate root. In the form of tannate it is now used as a tænifuge; yellow crystalline powder soluble in water.

Hippurates of lithium, etc.: Hippuric acid has been described (p. 79). Its salts are called hippurates. The hippurates of sodium, calcium and lithium are now used in urinary troubles.

Cocaine: manufacture: The process of preparing cocaine from coca leaves is given in full in Squibb's Ephemeris (Vol. II., No. 7), and in the *Druggists' Circular* of May, 1885. It is too long for insertion here.

Pyridine: C_5H_5N. This alkaloid is formed in the dry distillation of nitrogenous organic compounds, such as bones, coal, some of the alkaloids, etc. It is always present in tobacco smoke, especially in that of cigarettes. Colorless liquid, having an odor aptly described as that of the breath of a man who, after drinking cheap whisky, has eaten plentifully of onions. It is readily soluble in water. It has been used by inhalation in the treatment of asthma.

Disinfectants, Germicides,* Antiseptics, Deodorizers:

The presence of odors and organized "germs" in the air, often require the use of one of the above agents. *Disinfectants* are a class of bodies which are supposed to destroy the germs, and thus prevent them from causing their specific action either upon the human body or in decomposable organic bodies or solutions.

The most efficient of these is heat. Organized germs may be filtered from the air by passing it through cotton wool; or they may be removed by inclosing the air in an air-tight box or chamber, the insides of which are moistened with glycerine. (Tyndal.) Ozone, chlorine, bromine, iodine, sulphurous oxide, mercuric, zinc, aluminium, magnesium and calcium chlorides, potassium chlorate, potassium permanganate, carbolic, boric, cresylic

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* A *germicide* is an agent which has the power of killing the germs, and thus preventing their growth. A disinfectant destroys the infectious properties of a septic matter, whether this be due to germs or some other agent.

and sulphuric acids, thymol, menthol, camphor, etc., are among the disinfectants most used.

Antiseptics are agents which retard or entirely prevent putrefaction or growth of microscopic germs and organisms. While *disinfectants* destroy the cause of infection, *antiseptics* prevent the development of these causes. Low temperature retards putrefaction, and is, therefore, an antiseptic agent. These two terms are frequently used interchangeably.

Asepsis is a condition of entire absence of any germs or cause of infection. *Deodorizers* are bodies used to destroy offensive odors. They may be either solid, liquid or gaseous. *Solids*—dry earth, lime, charcoal, ferrous sulphate, carbolates of calcium, sodium and magnesium. *Liquids*—solutions of plumbic nitrate (Ledoyen's fluid), zinc chloride (Burnett's fluid), potassium or sodium permanganate (Condy's fluid), a mixture of copper and zinc sulphates (Lanande's disinfectant), solutions of ferric chloride, of ferrous sulphate, hypochlorites, etc., are among the best known. *Gases*—pure air, ozone, chlorine, bromine, and sulphurous oxide are those most effective. Fumigations with tar, herbs, and various aromatic substances, only disguise the offensive odors, but do not destroy them.

The ordinary offensive odors are due to hydric sulphide (H_2S), ammonium sulphhydrate (NH_4HS), phosphoric hydride (PH_3), and complex ammonium compounds. Chlorine, ozone and nitrous oxides will destroy these gases by oxidation, and thus destroy the odor.

It should be remembered that these odors, in themselves, may not be in any degree injurious to health, when in small quantity, but they serve to warn us of the presence of other products of putrefaction which accompany them, and which are injurious. The fact that efficient disinfection of the air can prevent the spread of the contagion of disease is well known. Chlorine and sulphurous oxide are the two agents most in use, and of these the former is very much to be preferred, but the latter is used for furnished rooms, because of its less destructive action on articles exposed to it.

It is doubtful whether organized germs can be destroyed in the air by any disinfectants, except in tightly closed rooms. The attempt to disinfect the air of rooms with the various so-called "disinfectants" of the market is worse than useless. It engenders a feeling of security where there is none. These floating germs can certainly stand as much, and in most cases more, than man, and therefore no room can be disinfected while it is occupied by human beings. Bartley has found, by experiment, that most of the ordinary antiseptics, when diffused through the air of an ordinary room, are almost without action on putrefactive bacteria, unless the quantity be great enough to make the air irrespirable.

The following table shows the amount of water it is necessary to add to one part of the substance named, which barely permits the development of bacteria in meat infusions, according to M. Jalan de la Croix:

1 Part.	Water, Parts.	1 Part.	Water, Parts.
Alcohol	30	Oil of mustard	5,734
Chloroform	134	Sulphurous acid	7,534
Borax	107	Aluminium acetate	7,535
Eucalyptol	308	Salicylic acid	7,677
Phenol (Carbolic acid)	1,002	Mercuric chloride	8,358
Thymol	2,229	Calcium hypochlorite	13,092
Potass. permanganate	3,041	Sulphuric acid	16,782
Picric acid	3,041	Iodine	20,020
Borated sodium salicylate	3,377	Bromine	20,875
Benzoic acid	4,020	Chlorine	34,509

(Bartley.)

List of Commercial Disinfectants: (Sternberg.)

NAME.	Per cent. in, which active in two hours.	Per cent. in, which failed in two hours.
Little's Soluble Phenyle	2	1
Labarraque's Solution (U. S. P.)	7	5
Liquor Zinci Chloridi (Squibb's)	10	7
Feuchtwagner's Disinfectant	10	8
Labarraque's Sol. (Frere, Paris)	15	10
Phenol Sodique	15	10
Platt's Chlorides	20	15
Gerondin Disinfectant	25	15
Williamson's Sanitary Fluid	25	20
Bromo-chloralum	25	20
Blackman's Disinfectant	30	20
Squibb's Impure Carbolic Acid	..	50
Bouchardat's Disinfectant	..	50
Phenol Sodique (Paris)	..	50
Listerine	..	50
Hypochlorite of Sodium or Calcium. Available Chlorine	0.25	..

Metric System---French and American Measures:

MEASURES OF LENGTH.

1 millimeter = 0.001 meter = 0.0394 inch.
1 centimeter = 0.01 meter = 0.3937 inch.
1 decimeter = 0.1 meter = 3.9371 inches.
1 meter = 39.3708 inches.
1 decameter = 10 meters = 32.8089 feet.
1 hectometer = 100 meters = 328.089 feet.
1 kilometer = 1000 meters = 0.6214 mile.

MEASURES OF CAPACITY.

1 milliliter = 1 c.c. = 0.001 liter = 0.0021 U. S. pint.
1 centiliter = 10 c.c. = 0.01 liter = 0.0211 U. S. pint.
1 deciliter = 100 c.c. = 0.1 liter = 0.2113 U. S. pint.

1 liter	=1000 c.c.=	= 1.0567 U. S. quart.
1 decaliter	= 10 litres=	2.6418 U. S. gallons.
1 hectoliter	= 100 litres=	26.418 U. S. gallons.
1 kiloliter	=1000 litres=	264.18 U. S. gallons.

WEIGHTS.

1 milligram =	0.001 gram =	0.015 grain Troy.
1 centigram =	0.01 gram =	0.154 grain Troy.
1 decigram =	0.1 gram =	1.543 grain Troy.
1 gram	=	15.432 grains Troy.
1 decagram =	10 grams=	154.324 grains Troy.
1 hectogram=	100 grams=	0.268 pound Troy.
1 kilogram =	1000 grams=	2.679 pounds Troy.

COMMERCIAL WEIGHTS AND MEASURES OF THE U. S. A.

1 pound avoirdupois=16 ounces.
1 ounce=437.5 grains.
1 gallon=231 cubic inches.
1 gallon=4 quarts=8 pints.

1 pint of water weighs 7291.2 grains at a temperature of 15.6° C.

TROY WEIGHT.

1 drachm=60 grains.
1 ounce=8 drachms=480 grains.

—(Simon.)

Prescription Writing by the Metric System:*

For the purpose of prescription writing the following statement of the relative values of apothecaries' and metric weights will be found sufficient. Approximate rather than exact equivalents should be used:

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* From a circular sent me by Parke, Davis & Co.

Grammes.		Grains.	Grammes
1=	15.432 grains	1-64=	.001
2=	30.864 grains (ʒ ss)	1-32=	.002
4=	61.728 grains (ʒ i)	1-16=	.004
32=	493.824 grains (℥ j)	1-8 =	.008
C.c.		1-6 =	.011
1=	16.231 m	1-4 =	.016
2=	32.462 m (f ʒ s)	1-2 =	.032
4=	65.925 m (f ʒ i)	3-4 =	.048
32=	519.397 m (f ℥ j)	1 =	.065
		℈i =	1.30
		ʒ i =	4.00
		℥ i =	32.00

To reduce grains to grammes, divide by 10 and substract from the quotient one-third. Or divide by 3 and multiply by .2.

To reduce drachms to grammes, multiply by 4.

To reduce ounces to grammes, multiply by 32.

EXAMPLE.

	Gm.	C.c.
℞ Ferri pyrophosphatis ʒ ii	8.	
Quininæ sulphatis ʒ iiss	10.	
Strychninæ sulphatis gr. j	.065	
Morphinæ sulphatis gr. jv	.26	
Syrupi zingiberis ℥ iijss		112.
Aquæ font. qs. ad. ℥ viij		255.

M. Sig.—A teaspoonful (4 grammes) 3 time a day.

Liquids should be prescribed in fluid grams or cubic centimeters, one fluid ounce being considered, for convenience, equal to 32 fluid grams. This is better than to attempt to prescribe fluids by weight. It is better to write the fluids in a separate column.

Thermometry:

In Fahrenheit's thermometer the freezing point is 32° and the boiling 212°, the number of intervening degrees being 180. In the Centigrade or Celsius thermometer the freezing point is placed at *zero*, and the boiling point at 100°, the number of intervening degrees being 100.

It will thus be seen that one degree in the Centigrade or Celsius scale is equal to 1.8° of Fahrenheit. The product of the degrees of the former, multiplied by 1.8, will give the number of degrees above the freezing point of Fahrenheit. By adding 32° to this product we get the equivalent in Fahrenheit. Thus 30° C. x 1.8+32= 86° F.

The number of degrees between any point on the Fahrenheit scale and the freezing point,divided by 1.8 (or multiplied by 0.55), will give the equivalent in C. Thus 100° F.—32÷1.8=37.8° C.

COMPARISON OF CENTIGRADE AND FAHRENHEIT DEGREES.

Cent.	*Fahr.*	*Cent.*	*Fahr.*	*Cent.*	*Fahr.*	*Cent.*	*Fahr.*
— 40	— 40.0	— 5	+ 23.0	+ 30	+ 86.0	+ 65	+ 149.0
39	38.2	4	24.8	31	87.8	66	150.8
38	36.4	3	26.6	32	89.6	67	152.6
37	34.6	2	28.4	33	91.4	68	154.4
36	32.8	— 1	30.2	34	93.2	69	156.2
35	31.0	0	32.0	35	95.0	70	158.0
34	29.2	+ 1	33.8	36	96.8	71	159.8
33	27.4	2	35.6	37	98.6	72	161.6
32	25.6	3	37.4	38	100.4	73	163.4
31	23.8	4	39.2	39	102.2	74	165.2
30	22.0	5	41.0	40	104.0	75	167.0
29	20.2	6	42.8	41	105.8	76	168.8
28	18.4	7	44.6	42	107.6	77	170.6
27	16.6	8	46.4	43	109.4	78	172.4
26	14.8	9	48.2	44	111.2	79	174.2
25	13.0	10	50.0	45	113.0	80	176.0
24	11.2	11	51.8	46	114.8	81	177.8
23	9.4	12	53.6	47	116.6	82	179.6
22	7.6	13	55.4	48	118.4	83	181.4
21	5.8	14	57.2	49	120.2	84	183.2
20	4.0	15	59.0	50	122.0	85	185.0
19	2.2	16	60.8	51	123.8	86	186.8
18	— 0.4	17	62.6	52	125.6	87	188.6
17	+ 1.4	18	64.4	53	127.4	88	190.4
16	3.2	19	66.2	54	129.2	89	192.2
15	5.0	20	68.0	55	131.0	90	194.0
14	6.8	21	69.8	56	132.8	91	195.8
13	8.6	22	71.6	57	134.6	92	197.6
12	10.4	23	73.4	58	136.4	93	199.4
11	12.2	24	75.2	59	138.2	94	201.2
10	14.0	25	77.0	60	140.0	95	203.0
9	15.8	26	78.8	61	141.8	96	204.8
8	17.6	27	80.6	62	143.6	97	206.6
7	19.4	28	82.4	63	145.4	98	208.4
— 6	+ 21.2	+ 29	+ 84.2	+ 64	+ 147.2	99	215.2
						+ 100	+ 212.0
110	+ 230	+ 210	+ 410	+ 310	+ 590	+ 410	770
120	248	220	428	320	608	420	788
130	266	230	446	330	626	430	806
140	284	240	464	340	644	440	824
150	302	250	482	350	662	450	842
160	320	260	500	360	680	460	860
170	338	270	518	370	698	470	878
180	356	280	536	380	716	480	896
+190	374	290	554	390	734	490	914
+290	+ 392	+ 300	+ 572	+ 400	752	+ 500	+ 932
+500	+ 932	+ 800	+1472	+1100	+2012	+1400	+2552
600	1112	+ 900	1652	1200	2192	1500	2732
+700	+1292	+1000	+1832	+1300	+2372	+1600	+2912

—**Barker.**

ERRATA AND ADDENDA.

Page 19, second line: after "English" supply "except where there is variation in equivalence."

Page 24, tenth line: for "precipitates" read "is precipitated."

Page 27, fourth line from bottom: for "prepared" read "made."

Page 34, line 16: for "as an" read "for."

Page 45, line 8: for "appendix" read "toxicology."

Page 46, line 7: for "paraffined stoppered bottles" read "bottles whose glass stoppers have been paraffined."

Page 47, line 8: for "used" read "administered."

Page 48, line 8: for "sulph-hydrate" read "sulphydrate."

Page 50, line 14: for $Ba(HO_2)$ read $Ba(HO)_2$.

Page 55, line 13: for "as" read "in."

Page 62, line 6: for "ferricyanate" read "ferricyanide."

Page 63, line 4: after "products" supply "of tissue change."

Page 79, line 2: for "urine" read "urinalysis."

Page 82: No. 92, after "alkaloids" supply "and derivatives."

Page 93: omit "see Appendix, etc."

Page 95: " " " "

Page 128: for "Dallis" read "Dulles."

Page 163, line 16: after "1883" supply "*Am. Druggist.*"

Page 217, line 9: instead of "minutes'" read "minutes."

Page 217, fourth line from bottom: for "orders" read "borders"; for "clido" read "cleido."

Page 218, 2d line: for "rythmically" read "rhythmically."

Page 220, line 20: for "opistholonos" read "opisthotonos."

Page 233, line 1: for "Nalr" read "Natr."

Page 233, line 15: for "Bone" read "bone."

Page 240, last line: for "lime burning" read "burn limestone."

Page 241, line 14: for "SiO_2" read $(SiO_2)_2$.

Page 241, fifth line from bottom: for $(K_2MnO_4)_2$ read $(K_2MnO_4)_3$.

Page 242, line 16: read $[CaClO_2 + CaCl_2]$.

Page 244, line 7: for "entire molecule" read "entire crystal."

Page 257, line 8: for "processes" read "methods."

Page 257, line 14: instead of $[Ca(CHO_2)_2]_2$ read $[Ca(CHO_2)_2]_3$.

Page 267, last line, for $C_{10}H_{14}N_1$, read $C_{10}H_{14}N$.

Page 268, 5th line: for C_{19}, read C_{19}.

Page 269, 13th line: supply Agaricus Muscarius.

Page 269, seventh line from bottom: for "Glyceyerhizin" read "Glycyrrhizin."

Page 270, 8th line, supply Poplar bark.
Page 270, 9th " " Apple-tree bark.
Page 270, 10th " " Horse chestnut.
Page 270, 11th " " Black oak.

Page 270, line 21: for $C_{17}H_{91}$ read $C_{17}H_{21}$.

INDEX.

Page.
Preface 3
  Part I.—Theory (Inorganic) 9–19
  Part II.—Chemistry (Inorganic) 20–62
  Part II.—Chemistry (Organic) 63–110
  Part II.—Urinalysis, 111–125
  Part III. — Toxicology, 126–228
Appendix—
  Part I.— 229, 280
  Part II.— 281–290
Errata 291–292
Abnormal constituents —
  Urine 111
Acetates 71
Acetone 76, 91
Acetonæmia 91
Acids—
  Acetic 70
  Arsenious 57
  Arsenic 58
  Benzoic 72
  Boracic 17, 40
  Butyric 71
  Carbolic 69
  Carminic 269
  Cathartic 269
  Chromic 60
  Chrysophanic 270
  Citric 75
  Hydrobromic 36
  Hydrochloric 34
  Hydrocyanic 78
  Hydrofluoric 36
  Hydriodic 36
  Hydrosulphuric 35
  Lactic 72
  Malic 73
  Meconic 139
  Molybdic 40
  Myronic 269
  Nitric 38
  Olaic 72
  Oxalic 73
  Phenic 69
  Phosphoric 17, 39
  Picric 70
  Prussic 78
  Salicylic 73
  Sclerotic 270
  Sulphuric 39
  Sulphurous 39
  Sulphocarbolic 69
  Sulphocarbonic 37
  Sulphocyanic 62
  Tannic 74
  Tartaric 74
  Uric 87, 113
  Valerianic 71
Acids, theory of 14
  organic 70
Aconitine 196, 200
  poisoning by 196
Adulterations, beer 183
  foods and drugs 285
  milk 95
  oils 260
Air 22
Albumins 85, 86, 111, 112
Alcohol 266
  amyl 66
  ethyl 65, 266
  methyl 66
Alcohols 64 to 70
Aldehydes 75
Alkalamides 79

Alkaloids.........80, 256, 268
    cinchona........ 82
    convulsive....... 81
    mydriatic........ 83
    myotic.......... 84
    nux vomica...... 81
    opium........... 80
    soporific........ 81
    tables of.....256, 268
    volatile.......... 80
Alum................. 60
Alumina.............. 60
Aluminum............. 30
Aluminium............ 30
Amides............... 78
Amines............... 78
Ammonia, gas.........35, 168
    liquor........... 35
    poisoning by 168, 175
Ammonium, acetate...... 71
    benzoate..... 72
    chloride..... 47
    carbonate.... 48
    cyanate...... 253
    hydrate...... 35
    nitrate...... 48
    sulphide..... 48
    valerianate.. 72
Amygdalin............77, 257
Amyl, hydrate............ 66
    nitrite............. 258
Analysis, elementary...... 249
    proximate...... 249
    systematic..... 137
    qualitative..... 137
    quantitative.. .. 121
    ....124, 125
    ultimate........ 249
    urinary........ 111
Aniline...............78, 181
    poisoning by..... 181
Antimony............... 29
    poisoning by... 177
    tartrate........ 74
    terchloride..... 58
    trisulphide..... 58
Apomorphine........... 144
Arsenic, metallic......... 29
    poisoning by.... 142
Arsenious oxide.......... 56
    poisoning by... 142
Arseniates............58, 146
Arsenites.............57, 147
    of bromine...App., Part II.
Ascitic fluids............. 109
Atoms...................... 9
Atropine.................. 83
    formula.83, 257, 268
    poisoning by... 187
    solubility...... 84
    sulphate....84, 187
    tests.......... 191
Aurum.................... 28
    chloride.......... 29
Barium................... 26
    acetate.......... 179
    chloride........50, 179
    hydrate.......... 50
    iodide........... 50
    nitrate.......... 179
    poisoning by..... 179
    sulphate......... 50
Bedside testing, urine.... 120
Benzole.................. 64
    nitro..........64, 181
    poisoning by..... 181
Berberine............... 268
Bile..................... 98
    acids............... 99
    in urine............ 112
Binary compounds....... 11
Bismuth.................. 29
    subnitrate....... 59
    subcarbonate.... 244
Blood.................... 88
    coloring matter.... 89
    salts.............. 90
    serum.............. 89
    tests............92, 113
Borax.................... 45
Boron.................... 25
Bromine.................. 22
Brucine...............83, 195
Butter................... 94
Buttermilk............... 94
Caffeine................. 268
Calabar bean..........84, 268
Calcium.................. 26
    carbonate........ 48

- chloride 49
- fluoride 50
- hydrate 49
- iodide 50
- oxalate 113
- oxide 49
- phosphate 49
- sulphate 49
- Calculi 103, 104, 105
- Camphor 76
- Cannabin, tannate Appendix, Part II.
- Carbon 25
  - bisulphide 37
  - dioxide 37
  - monoxide 37
- Carbonic acid 37
  - oxide 37
  - poisoning by 208
- Cellulose 258
- Cerium 229
- Chains 251
- Chloral 75
  - hydrate 75, 180. 225
  - poisoning by 180, 225
- Chlorine 22, 175
- Chloroform 76, 180, 225
  - poisoning by, 180, 225
- Cholesteræmia 91
- Cholesterin 66, 91
- Chromium 30
- Chyle 92
- Cinchona, alkaloids 82
- Cinchonicine 82
- Cinchonidine 82
- Cinchonine 82
- Citrates 75
- Cocaine 271
  - hydrochlorate 271
  - muriate 271
  - oleate 271
- Codeine 80
- Colchicine 206
- Collodion 258
- Combustion 254
- Compounds 9
- Conine 80, 196
- Copper 27
  - acetate 71
  - ammonio-sulphate 56
  - arsenite 57
  - hydrate 56
  - poisoning by 178
  - sulphate 56
  - sulphide 56
- Cheese 94
- Cream 94
- Daturine 83, 193
- Deaths from poisoning, 149, 158, 166, 169, 174, 181, 185, 187, 189, 200, 205, 225, 226, 227 228
- Decompositions 254
- Degenerations 106
- Deliquescence 33
- Derivatives 253
- Dextrine 69
- Dextrose 67
- Dialyzed iron 61
- Digestion 97, 101
- Digitaline 205
- Dropsical fluids 107
- Duboisine 83, 190
- Efflorescence 33
- Electro-chemical table 10, 231
- Elementary substance 9
- Elements 20, 31
- Emetics 144
- Emetine 268
- Empirical formulæ 234
- Emulsine 257
- Equivalence 10, 230
  - difficult 13
  - variations in 12, 230
- Ergotinine. Appendix, Part II.
- Eserine 84, 96
- Estimations, quantitative—Albumin 125
  - sugar 121, 123
  - urea 124
- Ether 65
  - sulphuric 65
- Ethers 65
- Ethyl, alcohol 64
  - ether 65
  - hydrate 64
  - oxide 65
- Excretin 101
- Extractives 90

Exudations 107
Fæces 101
Fats 72, 89
Fermentation 94, 254
Ferments 255
Ferric chloride 61
  citrate 75
  hydrate 61
  hypophosphite 61
Ferricyanogen 43
Ferricyanides 43
Ferrocyanogen 43
Ferrocyanides 43
Ferrous chloride 61
  iodide 61
  lactate 73
  sulphate 61
  sulphide 61
Ferrum 31
Fibrin 85, 88
Fluorine 23
Foods 261, 266
  albuminous 263
  alcohol 266
  bread 264
  carbohydrates 262, 267
  cereals 262
  coffee 265
  eggs 264
  fats 267
  fruits 264, 266
  nitrogenous 263
  salts 267
  tea 265
  vegetables 265
Formulæ 11–19
  acids 15–17
  binary 11
  empirical 250
  graphic 250
  hydrates 15
  hydroxides 15
  meta-acids 16
  ortho-acids 16
  rational 250
  reading 18
  salts 15
  structural 250
  substitution 253
  sulpho-acid 18
  writing 11–19
Gases 20, 21, 36, 37, 63, 102, 175
Gastric juice 96
Gelsemic acid 216
Gelsemium 215
Gelseminine 216
Globulins 85
Glucose 67
Glucosides 77, 268
Glycerin 66
Glycocholic acid 99
Glycosuria 99
Gold 28
Gun-cotton 258
Hæmaglobin 89, 92
Hæmatin 85
Halogens 22
Hippuric acid 79
Hippurates, calcium, lithium, sodium—Appendix, Part II.
Homœopathic terms 235
Homologous series 252
Hydrates 14
Hydrocarbons 63, 64
Hydrogen 21
  arsenide 35
  monoxide 32
  peroxide 34
  sulphide 35
Hydro-nephrotic cysts 110
Hydroxides 14
Hygrin 272
Hyoscine 83, 191
Hyoscyamine 83
  poisoning by 190
—"Ic" 11
Ichthyol (sulphonate of sodium) Appendix, Part II.
Indican 113
Intestinal fluids, etc. 100
Iodine 22
Iodoform 77, 92
Iodol, Appendix, Part II.
Iron 31
Iron, salts (see ferric, ferrous.)
Isomerism 253
Jaborandi 84
Jaundice 91
Jervine 207, 268
Kali (see Potassium.)

Lactates 73
Lactose 68
Lead 28
  acetate 71, 178
  carbonate 59
  chloride 59
  chromate 60
  iodide 59
  nitrate 59
  poisoning by 178
  oxides 59
  sub-acetate 71, 178
Lithaemia 99
Lithium 229
  benzoate 72
  citrate 75
  hippurate .... App., Part II
Liver 99
Lymph 92
Magnesium 26
  carbonate 51
  chloride 51
  oxide 51
  phosphate 51
  sulphate 51
Manganese 31
  black oxide 62
  dioxide 62
  peroxide 62, 165
Manganous, carbonate 62
  sulphate 62
  sulphide 62
Marsh test 57, 143, 152
Mercury 27
  ammoniated 55
Mercuric chloride 53
  poisoning by 177
  cyanide 54
  iodide 54
  nitrate 55
  oxide 54
  sulphate 55
  sulphide 55
Mercurous, chloride 53
  iodide 54
  nitrate 56
  oxide 54
"Mercurius solubilis" 55
Mercury tannate, App., Part II
Meta-acids 16
Methane 63
Methyl, alcohol 66
  hydrate 66
  hydride 63
Milk 93
  cow's 93
  human 93
Mineral waters 33, 236, 239
Molecule 9
Molecular wts 231, 255
Monobromated camphor 76
Monsel's solution 61
Morphine 81
  acetate 157
  formula 81
  hydrochlorate 81
  muriate 81
  preparations 157
  solubilities 81
  sulphate 81
  tests 81
Mydriatics 83
Myotics 84
Naphthalin 64
Narceine 80
Narcotine 80
"Natrum" (see Sodium).
Nessler's solution 240
Nickel 229
Nicotine 80
  poisoning by 205
Nitre 42
Nitrobenzole 64
  poisoning by 181
Nitrocellulose 258
Normal constituents of urine 113
  urine 111
Oil 72, 260
  almond 257, 260
  castor 260
  cod-liver 260
  color reactions 260
  fusel oil 66
  olive 72, 260
  reactions 260
  turpentine 63
  vitriol 39, 129, 167

Organic chemistry 63
  theory 249
Ortho-acids 16
Ovarian cysts 108
Oxygen 20
Ozone 21
Pancreatic juice 100
Papaverine 80
Papayotin..Appendix, Part II.
Paris green 57, 146, 212
Pelletierine 269
  tannate, App., Part II.
Pepsin 96
Peptones 86, 97, 117
Phenol 69
Phosphorus 24
Physical characteristics, urine 111
Physostigma 84
Physostigmine 84
Picrotoxin 77
Pilocarpine 84
Piperine 268
Platinic chloride 60
Platinum 30
Poisoning and poisons... 126
  acids 129, 167
  aconite 132, 196, 223
  action 126
  administration 126
  alcohol 133
  alkalies 130, 168
  aloes 173
  ammonia 175
  analysis (systematic)... 137
  anæsthetics 181
  animal irritants 179
  anilines 181
  antidotes 155
  antimony 177
  appearances, post-mortem 127
  arsenic 131, 142, 219
  atropine 187, 224
  asphyxiants 208
  barium 179
  behavior of suspected parties in poisoning cases 128
  bland liquids in cases of poisoning 134
  belladonna 185, 224
  bichromate of potassium, 173
  camphor 183
  carbolic acid...130, 169, 224
  carbonic acid 208
  chloral 132, 225
  chlorine 175
  chloroform 180, 225
  coal gas 209, 219, 225
  cocculus 183
  colchicum 205
  colocynth 173
  conium 195
  convulsants 195
  copper 178
    arseniate 212
  corrosive sublimate. 131, 177
  creasote 226
  croton oil 174
  decayed meat 133
  definition 126
  delirants 185
  detection ....
    137, 151, 152, 153, 162, 164
  depressants 205
  diagnosis 127
  digitalis 205
  duboisine 190
  duties of physician..... 127
    chemist 135
  elaterium 174
  effects 126
  electricity in treatment, ... 155, 217
  emetics 128, 143
  examination, post-mortem 127
  failures to detect...159, 163
  flagellation, as treatment 134
  gamboge 174
  gases 175
  gelsemium 215
  household treatment... 128
  hyoscyamus 190
  hyposthenisants 196
  hydrocyanic acid... ... 201
  hemlock 133

  - instruments used in poisoning cases 134
  - iodine 176
  - inebriants 181
  - irritants 173
  - jalap 174
  - jamestown weed 133
  - lead, sugar of 131, 178
  - lobelia 205
  - lunar caustic 133
  - narcotics 180
  - neurotics 180
  - nightshade 133
  - nitro-benzole 181
  - nitric acid 226
  - oil of tansy 220
  - opium 131, 153, 222, 227
  - oxalic acid 130, 168
  - oxygen (in treatment) 210
  - paralysants 195
  - phosphorus 131
  - potassium chlorate 211
  - prussic acid 201, 210
  - ptomaines 174
  - scammonium 174
  - sewer-gas 209
  - stramonium 190
  - spectroscope in cases 211
  - stimulants 134, 135
  - symptoms 127
  - strychnine 132, 160, 228
  - sulphuretted hydrogen 208
  - sulphurous acid 175
  - syncopants 196
  - tartar emetic 131
  - toadstools 133
  - tobacco 133, 205
  - urine in poisoning 171
  - veratrine 206
  - water gas 208
- Potassium 26
  - acid carbonate 43
  - acid tartrate 74
  - arsenite 57
  - bichromate 42
  - bromide 41
  - carbonate 43
  - chlorate 42
  - chromate 42
  - cyanide 41, 202
  - ferricyanide 43
  - ferrocyanide 43
  - hydrate 41
  - hypophosphite 44
  - iodide 41
  - nitrate 42
  - oxalate 73
  - permang'n'te 42, 240
  - phosphate (Kali Phos) 41
  - sodium tartrate 71
  - sulphate 42
  - sulphocyanate 62
  - sulphite 44
  - tartrate 74
- Processes of manufacture, etc 240
  - alcohol 257
  - aluminum chloride 242
  - ammonia 242
  - ammonium carbonate 242
  - ammonium chloride 242
  - amyl nitrit 258
  - arsenious oxide 243
  - arseniuretted hydrogen 243
  - bromine 241
  - bismuth subnitrate 242
  - calcium oxide 242
  - carbon dioxide 240
  - carbon monoxide 241
  - chlorinated lime 242
  - chloroform 257
  - ferrous sulphate 242
  - ether 257
  - hydrocyanic acid 258
  - hydrogen 240
  - hydrogen peroxide 240
  - hydrogen sulphide 241
  - iodine 241
  - iron 242
  - laughing gas 240
  - mercuric chloride 242
  - mercuric oxide 242
  - mercurous oxide 243
  - nitrogen 240
  - nitric acid 240
  - oil of bitter almonds 257
  - oxygen 240
  - phosphorus 241
  - phosphoric acid 241

potassium bichromate .. 241
iodide 241
permanganate 241
pyroxyline.... 258
reduced iron........... 242
salicylic acid.......... 257
sodium carbonate...... 242
sulphuric acid......... 241
soaps.................. 258
sulphuretted hydrogen.. 241
tartaric acid........... 257
tartar emetic........... 257
Pseudo-monad........... 12
-triad 12
Ptomaines.............. 175
Ptyalin...... 95
Purity of water.......... 235
Putrefaction.............. 254
Pyroxyline............... 258
Quinicine................ 82
Quinidine............... 82
Quinine..... 82
solubility......... 82
sulphate.......... 82
tests............82–83
Quinolin............... 269
Radicle 250
Realgar................. 149
Residues............... 250
Rochelle salt............ 74
Galley 5
Salicin...... 77
Salicylates.... 73
Saliva.................. 95
Salt, epsom............. 51
glauber 46
Salts, solubility.. ....247, 248
theory 14
Santonine.............. 270
Scheele's green.......... 57
Schweinfurth green...... 57
Sediments, urinary.......
...........112, 117, 118, 119
Silica....,.............. 40
Silicon.................. 25
Silver.................. 26
chloride........... 48
nitrate 48
poisoning by...... 173
Skim-milk.............. 94
Sinapine 268
Soaps 72
Sodium....... 25
arseniate..... 58
borate............. 45
carbonate....... ... 46
bicarbonate 46
chloride 45
hydrate 46
hypophosphite. ... 47
hyposulphite....... 46
phosphate......... 46
salicylate.......... 73
sulphate 46
sulphite 46
sulphocarbolate.... 69
Solanine...... 268
Solubilities.......... ....247, 248
Sparteine sulphate.......
App., Part II
Specific gravity, beads.... 124
liquids .. 244
solids ... 245
tables ... 244
Spina bifida............. 109
Stannic, sulphide......... 60
Stannous, chloride....... 60
Stannum................ 30
Starch.................. 68
Stearine 72
Stercorin............... 101
Strontium.............. 229
Strychnine............. 81
formula 81
poisoning by.. 160
solubility...... 81
sulphate.. ..82, 166
tests 82, 83
Substitutions............. 253
Sugars 67–69, 261
glucose 67, 261
lactose 68, 261
sucrose 68, 261
reactions.......... 261
in urine...........
...... 111, 116, 117, 123
Sulpho-salts. 15
Sulphur 23
dioxide 39
Symbols 10

Tables, atomic wts....... 229
elements......... 229
formulæ.. ....243, 258
metric....App., Part II
molecular wts. 231, 255
solubilities........ 248
specific gravity... 244
water of crystallization.. ....243, 258
Tannate, cannabin, mercury, pelletierine....... App., Part II
Tannin.................. 74
Tartar, cream of......... 74
emetic........... 74
poisoning by..... 177
Taurocholic acid.......... 99
Terebene....Appendix, Part II
Ternary................. 14
Terpine.....Appendix, Part II
Terpinol ....Appendix, Part II
Test papers...........23, 122
Thebaine................ 80
Theine 268
Theobromine 268
Theory, inorganic........9–19
Thymols 70
Tin 30
Toxic conditions, blood.. 90
Toxicology 126
Turpentine.............. 63
Types................... 252
Uræmia 90
Urates 112, 113, 114, 116, 117, 122
Urea.........78, 113, 114, 124
Urethan ....Appendix, Part II
Uric acid.....87, 113, 117, 119
Uricæmia 99
Urinalysis 111
Urinary coloring matter 113, 115
Urine 111
physical characteristics 111
quantity........111, 115
color.......111, 114, 115
odor............111, 115
reaction.........111, 115
specific gravity..111, 115
sediments...111, 112, 113, 117, 118, 119, 120
abnormal constituents..111, 115, 116, 117
normal constituents, ...113, 114, 118, 124
tests, albumen ...111, 115, 120, 122, 125
sugar......111, 116, 117, 121, 123
bile........... 112
peptone....... .....112, 117, 121
urates......... 112, 114, 117, 121
phosphates 112, 114, 118
pus........112, 119
mucus 120, 122
blood......113, 119
uric acid...... .....113, 117, 119
calcium oxalate, ... 113, 119
urea 114, 124
chlorides 114
urohæmatin 114
sulphates 115
indican 115
fungi 113
epithelial cells. 113
oil 113
casts..........113
spermatozoa 113, 120
Variations in equivalence, ...12, 230
Veratrine 207
Vomit 97
Water.................. 32
of crystallization... 243
tests for purity.... 235
Zinc 27
bromide.............. 52
chloride 52
ferrocyanide......... 52
hydrate 52
iodide.............. 52
oxide 52
poisoning by........ 173
sulphate 52
sulphide 240