An Introduction To Pharmaceutical And Medical Chemistry:

Part I Arranged On The Principle Of The Course Of Lectures On Chemistry

John Muter

AN INTRODUCTION
TO
PHARMACEUTICAL AND MEDICAL CHEMISTRY.

PART I.
(Theoretical and Descriptive).

ARRANGED ON THE PRINCIPLE OF THE
COURSE OF LECTURES ON CHEMISTRY,
AS DELIVERED AT THE
SOUTH LONDON SCHOOL OF PHARMACY.

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(SECOND EDITION—RE-ARRANGED.)

London:
PUBLISHED BY W. BAXTER, SECRETARY, AT THE OFFICES OF THE
SCHOOL, KENNINGTON CROSS, S.E.;
AND
Philadelphia:
PUBLISHED BY PRESLEY BLAKISTON, 1012, WALNUT STREET.

1880.

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PREFACE TO THE SECOND EDITION.

IN issuing the second edition of this work, I determined to collect all the theoretical and descriptive portion together in one part, and the practical portion in another part, so that if deemed advisable it could either be issued in one or could be divided and bound in two volumes, one for home use and the other for the laboratory. Each portion is thus kept distinct with its own index so as to facilitate ready reference, and I sincerely trust that in its altered form the work will at once prove more handy to students, and be received with the same favour as that already extended to the "first" and "revised" editions.

As before, I am indebted to my friend Mr. Joseph Ince for his assistance in proof reading and in compiling the copious indices.

J. M.

WINCHESTER HOUSE,
KENNINGTON, LONDON, S.E.

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CHAPTER I.

INTRODUCTION.

I. MATTER AND ITS VARIOUS STATES OF EXISTENCE.

The subject of Chemistry is matter. By matter we mean everything which we see, feel, taste, or smell; in short, anything which affects our senses. All matter exists in one of three states:—

1. **Solid.**—In which condition the ultimate particles or molecules are closely pressed together, and which is consequently the least porous and mobile form of matter, requiring, as a rule, to be cut or pressed so as to suit its size to any particular vessel in which it is desired to be placed.
2. **Liquid.**—In this state, the molecules are not so closely pressed, but can move freely about each other. Liquids are consequently more porous than solids, and of themselves assume the form of any receptacle into which they are introduced.
3. **Gaseous.**—Matter in the gaseous state is the most porous, and the molecules appear to have so little attraction for each other that they would become altogether dissociated, were it not for the pressure exercised by surrounding bodies. The integral particles of gases are considered as being in continual movement. One solid body placed against another refuses to mix with it except by continual pulverization; liquids mix more readily, with a slight amount of stirring; while gases mix of their own accord. This property takes place by a fixed law, called the *law of diffusion*, which is usually stated as follows:—*Gases mix with each other of their own accord at a rate which is inversely proportioned to the square root of their relative densities.* Thus, the density of hydrogen being 1, and oxygen 16, the square roots are respectively 1 and 4; and by inverse proportion, we see that hydrogen will diffuse itself in oxygen four times as quickly as the latter will mix with hydrogen. Gases also possess in an eminent degree the property of *elasticity*; that is, they may be reduced to a smaller volume by pressure, but immediately on its removal they will assume their original bulk. The greater the pressure the less the volume of gas; and the less the pressure the greater the volume.

There are certain general properties which all matter shares in common.

1. **Extension.**—By this we mean that every body occupies a certain bulk, or that it must have a certain degree of length, breadth, and thickness, irrespective of its form or of how that form may be changed.
2. **Impenetrability,**—which signifies that no two bodies can occupy the same space at the same time.
3. **Indestructibility.**—We may change and decompose matter as we please, but we cannot destroy the minutest particle.

4. **Porosity.**—All bodies, no matter how hard in appearance, are nevertheless porous; consequently we can alter and modify their shape and size by heat, pressure, and other means.
5. **Inertia.**—By this term is indicated the fact that matter is incapable of either setting itself in motion or arresting its own progress when in movement.
6. **Divisibility.**—All substances are capable of separation into minute particles, and the extent to which this division may be carried with some compounds is remarkable. For instance, a pail of water holding two gallons may be distinctly coloured with *one grain* of indigo dissolved in sulphuric acid, and yet each grain of the water in the vessel will only contain $\frac{1}{140000}$ part of a grain of the pigment. Here the question arises, Is matter really infinitely divisible, or is there a point at which divisibility ceases? The latter view is in the present state of science most commonly held to be the correct hypothesis; all matter being conceived as the aggregate of certain inappreciable particles named **molecules**, which in turn are derived from the union of infinitely more minute portions of elements called **atoms.** The *atom of an element is therefore held to mean the smallest quantity capable of existence, and is considered absolutely indivisible.*

Matter in the condition in which it is perceptible to our senses is said to be in the *free state;* and since, previously to its detection by our organs of perception, it must consist of myriads of atoms, it is believed that *atoms cannot exist in this free state, but that they must be combined with other atoms of the same or of a different element in order to form molecules, which alone can assume that condition.* If, therefore, we wish to express that an element,—hydrogen, for example,—is in a free state, we must not write simply H, but H_2; thus intimating that *at least two atoms have coalesced to produce a molecule capable of existing in the free state.*

II. ANALYSIS AND SYNTHESIS. ELEMENTS AND SYMBOLS.

With regard to matter, the chemist makes two inquiries; 1st: What are its ingredients? and 2nd: Having isolated such constituents, how are they to be combined so as to reproduce the original substance? The process by which an answer is obtained to the former question is called **analysis**; and to the latter, **synthesis.**

Analysis is the chemical pulling to pieces of a substance in order to discover its component parts; whilst synthesis is the building up of a compound from its ingredients. For example: If we take a piece of alum and submit it to analysis, we can prove that it contains oxides of aluminium and potassium, sulphuric anhydride, and water. If we then take these substances and separately analyze them, we find that they in turn consist of aluminium, potassium, sulphur, oxygen, and hydrogen; but a further attempt to analyze this last group ends in failure. We have reduced our alum to certain ingredients which defy our best efforts to ascertain of what they are composed. The result of analysis, therefore, has been to acquaint us with a certain number of simple bodies which we call "*elements,*" by the mutual combination of which all matter is formed. When we use the term "simple bodies," the student must understand that the elements are not really to be so considered in the fullest sense of the word. They are only so regarded, because our present state of knowledge fails to enable us to discover their ultimate composition.

There are about sixty-five of these simple bodies or elements known; but as many of them have no practical or commercial use, the pharmacist has really to do with only about thirty-eight.

By universal consent, each element is represented by an appropriate letter, or a combination of letters, so that chemists adopting this arrangement may invariably understand what element is meant by a written **symbol**. The conception of expressing simple bodies by means of symbols is by no means modern, but dates back to the days of the alchymists. Thus, gold was represented by a rough drawing of the sun; while an equally uncouth sketch of a half-moon denoted silver.

The names of the elements at present are purely arbitrary, and have been bestowed by the discoverers from some fancied special property: such as the designation *hydrogen*, derived from two Greek words, signifying "to beget water." The following is a list of the elements used in Pharmacy with their symbols, the committing of which to memory is the first duty of the learner:*

ELEMENTARY BODIES.	SYMBOLS.	ELEMENTARY BODIES.	SYMBOLS.
Aluminium	Al.	Iron (*Ferrum*)	Fe.
Antimony (*Stibium*)	Sb.	Lead (*Plumbum*)	Pb.
Arsenic	As.	Lithium	L.
Barium	Ba.	Magnesium	Mg.
Bismuth	Bi.	Manganese	Mn.
Boron	B.	Mercury (*Hydrargyrum*)	Hg.
Bromine	Br.	Nitrogen	N.
Cadmium	Cd.	Oxygen	O.
Calcium	Ca.	Phosphorus	P.
Carbon	C.	Platinum	Pt.
Cerium	Ce.	Potassium (*Kalium*)	K.
Chlorine	Cl.	Silver (*Argentum*)	Ag.
Chromium	Cr.	Sodium (*Natrium*)	Na.
Copper (*Cuprum*)	Cu.	Sulphur	S.
Gold (*Aurum*)	Au.	Tin (*Stannum*)	Sn.
Hydrogen	H.	Zinc	Zn.
Iodine	I.		

III. PRELIMINARY NOTICE OF FOUR TYPICAL ELEMENTS.

All the elementary bodies will be duly considered, and carefully described in their proper places, but meantime, the student may familiarize himself with a few preliminary facts about the most common elements as follows:—

1. **Oxygen.**—Take a few crystals of potassium chlorate, and having gently rubbed them to powder in a clean mortar, place the powder in a perfectly clean and dry test-tube, and apply the heat of a Bunsen burner. The contents of the tube will fuse and then the liquid will be seen to effervesce, and a colourless gas will be given off. This is the element oxygen in the free state, and its presence may be shown by holding the end of a piece of stick in the gas flame until it is well burned, then blowing out the flame and holding the incandescent point just over the mouth of the tube. Oxygen being the great supporter of the combustion of organic bodies, the spark will glow

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* The entire list of elements will be found in the Appendix.

with great brilliancy, and once more burst into flame. It is to the fact of oxygen being a constituent of the air we breathe, that we owe the support of our life, which is, after all, only a slow combustion. When we inhale air into our lungs the oxygen passes into the blood, and unites with some of the carbon to form carbonic acid gas, which is then exhaled. Oxygen is colourless and inodorous; and, although it supports the combustion of carbonaceous matter, it will not itself inflame in contact with the air. It can only be reduced to a liquid under an immense pressure, and even then only appears as a fog in the tube when the pressure is suddenly released so as to produce intense cold.

2. **Hydrogen.**—Place a few fragments of zinc in a small bottle, add a little water and then some sulphuric acid, when a powerful effervescence will take place, and a colourless gas will be evolved. This is the element in question in a free state. Now procure a cork which will well fit the neck of the bottle, and by means of a round file, make a hole through it. Into this hole a short glass tube, drawn out so as to form a jet, is tightly fitted, and the bottle is then closed by the cork so that the gas issues from the jet, and when the whole of the air has been expelled from the bottle, cautiously apply a light. Perfect safety may be ensured by first collecting portions of the gas in a small test-tube placed upside down over the end of the jet. Apply a light to ascertain the presence of the gas. Faraday recommended that the bottle should not be too large, so that the atmospheric air might easily "be swept out of the space above the water." The hydrogen will take fire and burn with a very feebly luminous bluish flame. This flame depends on the union of the hydrogen with the oxygen of the air to form steam, which fact can be proved by holding a cold glass shade over the flame, when the steam produced will be condensed into water and form in drops on the glass. The flame of hydrogen, although feebly luminous, is exceedingly hot, as may be seen by holding a fine platinum wire in it, when it will become intensely incandescent. A small fragment of lime will also be strongly heated, and it is thus that the lime light is produced, with the exception that oxygen and hydrogen are mixed just before combustion, and the flame urged upon the cylinder of lime by pressure. Hydrogen is colourless and inodorous; and, although it will thus burn in the air, a lighted match suddenly plunged into a bulk of the pure gas will be extinguished. With regard to ordinary combustion, hydrogen is thus exactly the reverse of oxygen. Like oxygen, it can be liquefied, but at a pressure even more extreme.

The elements just described are respectively the types of the two great classes into which elements are divided. As will be afterwards more fully explained, we have :—(1) The metallic elements, typified by hydrogen, which usually form the basylous or electro-positive portion of compounds; and, (2) The non-metallic elements, or metalloids, which, either by themselves or when united with oxygen, form the acidulous or electro-negative part of compound matter. Just as hydrogen and oxygen are typical of the opposing forces of elementary matter, so is the water produced by their combination typical of compound matter, made up by the union or mutual saturation of the opposing elementary forces.

3. **Nitrogen.**—Take a soup-plate and nearly fill it with water. Put a fragment of phosphorus in a small porcelain crucible and carefully float it on the surface of the water. Apply a light to the phosphorus, and quickly invert over it a receiver or a large beaker. The phosphorus will continue to burn until all the oxygen of the air in the beaker is

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