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The Story of Alchemy and the Beginnings of Chemistry

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CHAPTER I
THE EXPLANATION OF MATERIAL CHANGES GIVEN BY THE GREEK THINKERS.

For thousands of years before men had any accurate and exact knowledge of the changes of material things, they had thought about these changes, regarded them as revelations of spiritual truths, built on them theories of things in heaven and earth (and a good many things in neither), and used them in manufactures, arts, and handicrafts, especially in one very curious manufacture wherein not the thousandth fragment of a grain of the finished article was ever produced.

The accurate and systematic study of the changes which material things undergo is called chemistry; we may, perhaps, describe alchemy as the superficial, and what may be called subjective, examination of these changes, and the speculative systems, and imaginary arts and manufactures, founded on that examination.

We are assured by many old writers that Adam was the first alchemist, and we are told by one of the initiated that Adam was created on the sixth day, being the 15th of March, of the first year of the world; certainly alchemy had a long life, for chemistry did not begin until about the middle of the 18th century.

No branch of science has had so long a period of incubation as chemistry. There must be some extraordinary difficulty in the way of disentangling the steps of those changes wherein substances of one kind are produced from substances totally unlike them. To inquire how those of acute intellects and much learning regarded such occurrences in the times when man's outlook on the world was very different from what it is now, ought to be interesting, and the results of that inquiry must surely be instructive.

If the reader turns to a modern book on chemistry (for instance, *The Story of the Chemical Elements*, in this series), he will find, at first, superficial descriptions of special instances of those occurrences which are the subject of the chemist's study; he will learn that only certain parts of such events are dealt with in chemistry; more accurate descriptions will then be given of changes which occur in nature, or can be produced by altering the ordinary conditions, and the reader will be taught to see certain points of likeness between these changes; he will be shown how to disentangle chemical occurrences, to find their similarities and differences; and, gradually, he will feel his way to general statements, which are more or less rigorous and accurate expressions of what holds good in a large number of chemical processes; finally, he will discover that some generalisations have been made which are exact and completely accurate descriptions applicable to every case of chemical change.

But if we turn to the writings of the alchemists, we are in a different world. There is nothing even remotely resembling what one finds in a modern book on chemistry.

Here are a few quotations from alchemical writings1:

"It is necessary to deprive matter of its qualities in order to draw out its soul.... Copper is like a man; it has a soul and a body ... the soul is the most subtile part ... that is to say, the tinctorial spirit. The body is the ponderable, material, terrestrial thing, endowed with a shadow.... After a series of suitable treatments copper becomes without shadow and better than gold.... The elements grow and are transmuted, because it is their qualities, not their substances which are contrary." (Stephanus of Alexandria, about 620 A.D.)

"If we would elicit our Medecine from the precious metals, we must destroy the particular metalic form, without impairing its specific properties. The specific properties of the metal have their abode in its spiritual part, which resides in homogeneous water. Thus we must destroy the particular form of gold, and change it into its generic homogeneous water, in which the spirit of gold is preserved; this spirit afterwards restores the consistency of its water, and brings forth a new form (after the necessary putrefaction) a thousand times more perfect than the form of gold which it lost by being reincrudated." (Philalethes, 17th century.)

"The bodily nature of things is a concealing outward vesture." (Michael Sendivogius, 17th century.)

"Nothing of true value is located in the body of a substance, but in the virtue ... the less there is of body, the more in proportion is the virtue." (Paracelsus, 16th century.)

"There are four elements, and each has at its centre another element which makes it what it is. These are the four pillars of the world.... It is their contrary action which keeps up the harmony and equilibrium of the mundane machinery." (Michael Sendivogius.)

"Nature cannot work till it has been supplied with a material: the first matter is furnished by God, the second matter by the sage." (Michael Sendivogius.)

"When corruptible elements are united in a certain substance, their strife must sooner or later bring about its decomposition, which is, of course, followed by putrefaction; in putrefaction, the impure is separated from the pure; and if the pure elements are then once more joined together by the action of natural heat, a much nobler and higher form of life is produced.... If the hidden central fire, which during life was in a state of passivity, obtain the mastery, it attracts to itself all the pure elements, which are thus separated from the impure, and form the nucleus of a far purer form of life." (Michael Sendivogius.)

"Cause that which is above to be below; that which is visible to be invisible; that which is palpable to become impalpable. Again let that which is below become that which is above; let the invisible become visible, and the impalpable become palpable. Here you see the perfection of our Art, without any defect or diminution." (Basil Valentine, 15th century.)

"Think most diligently about this; often bear in mind, observe and comprehend, that all minerals and metals together, in the same time, and after the same fashion, and of one and the same principal matter, are produced and generated. That matter is no other than a mere vapour, which is extracted from the elementary earth by the superior stars, or by a sidereal distillation of the macrocosm; which sidereal hot infusion, with an airy sulphurous property, descending upon inferiors, so acts and operates as that there is implanted, spiritually and invisibly, a certain power and virtue in those metals and minerals; which fume, moreover, resolves in the earth into a certain water, wherefrom all metals are thenceforth generated and ripened to their perfection, and thence proceeds this or that metal or mineral, according as one of the three principles acquires dominion, and they have much or little of sulphur and salt, or an unequal mixture of these; whence some metals are fixed—that is, constant or stable; and some are volatile and easily changeable, as is seen in gold, silver, copper, iron, tin, and lead." (Basil Valentine.)

"To grasp the invisible elements, to attract them by their material correspondences, to control, purify, and transform them by the living power of the Spirit—this is true Alchemy." (Paracelsus.)

"Destruction perfects that which is good; for the good cannot appear on account of that which conceals it.... Each one of the visible metals is a concealment of the other six metals." (Paracelsus.)

These sayings read like sentences in a forgotten tongue.

Humboldt tells of a parrot which had lived with a tribe of American Indians, and learnt scraps of their language; the tribe totally disappeared; the parrot alone remained, and babbled words in the language which no living human being could understand.

Are the words I have quoted unintelligible, like the parrot's prating? Perhaps the language may be reconstructed; perhaps it may be found to embody something worth a hearing. Success is most likely to come by considering the growth of alchemy; by trying to find the ideas which were expressed in the strange tongue; by endeavouring to look at our surroundings as the alchemists looked at theirs.

Do what we will, we always, more or less, construct our own universe. The history of science may be described as the history of the attempts, and the failures, of men "to see things as they are." "Nothing is harder," said the Latin poet Lucretius, "than to separate manifest facts from doubtful, what straightway the mind adds on of itself."

Observations of the changes which are constantly happening in the sky, and on the earth, must have prompted men long ago to ask whether there are any limits to the changes of things around them. And this question must have become more urgent as working in metals, making colours and dyes, preparing new kinds of food and drink, producing substances with smells and tastes unlike those of familiar objects, and other pursuits like these, made men acquainted with transformations which seemed to penetrate to the very foundations of things.

Can one thing be changed into any other thing; or, are there classes of things within each of which change is possible, while the passage from one class to another is not possible? Are all the varied substances seen, tasted, handled, smelt, composed of a limited number of essentially different things; or, is each fundamentally different from every other substance? Such questions as these must have pressed for answers long ago.

Some of the Greek philosophers who lived four or five hundred years before Christ formed a theory of the transformations of matter, which is essentially the theory held by naturalists to-day.

These philosophers taught that to understand nature we must get beneath the superficial qualities of things. "According to convention," said Democritus (born 460 B.C.), "there are a sweet and a bitter, a hot and a cold, and according to convention there is colour. In truth there are atoms and a void." Those investigators attempted to connect all the differences which are observed between the qualities of things with differences of size, shape, position, and movement of atoms. They said that all things are formed by the coalescence of certain unchangeable, indestructible, and impenetrable particles which they named atoms; the total number of atoms is constant; not one of them can be destroyed, nor can one be created; when a substance ceases to exist and another is formed, the process is not a destruction of matter, it is a re-arrangement of atoms.

Only fragments of the writings of the founders of the atomic theory have come to us. The views of these philosophers are preserved, and doubtless amplified and modified, in a Latin poem, *Concerning the Nature of Things*, written by Lucretius, who was born a century before the beginning of our era. Let us consider the picture given in that poem of the material universe, and the method whereby the picture was produced.2

All knowledge, said Lucretius, is based on "the aspect and the law of nature." True knowledge can be obtained only by the use of the senses; there is no other method. "From the senses first has proceeded the knowledge of the true, and the senses cannot be refuted. Shall reason, founded on false sense, be able to contradict [the senses], wholly founded as it is on the senses? And if they are not true, then all reason as well is rendered false." The first principle in nature is asserted by Lucretius to be that "Nothing is ever gotten out of nothing." "A thing never returns to nothing, but all things after disruption go back to the first bodies of matter." If there were not imperishable seeds of things, atoms, "first-beginnings of solid singleness," then, Lucretius urges, "infinite time gone by and lapse of days must have eaten up all things that are of mortal body."

The first-beginnings, or atoms, of things were thought of by Lucretius as always moving; "there is no lowest point in the sum of the universe" where they can rest; they meet, clash, rebound, or sometimes join together into groups of atoms which move about as wholes. Change, growth, decay, formation, disruption—these are the marks of all things. "The war of first-beginnings waged from eternity is carried on with dubious issue: now here, now there, the life-bringing elements of things get the mastery, and are o'ermastered in turn; with the funeral wail blends the cry which babies raise when they enter the borders of light; and no night ever followed day, nor morning night, that heard not, mingling with the sickly infant's cries, the attendants' wailings on death and black funeral."

Lucretius pictured the atoms of things as like the things perceived by the senses; he said that atoms of different kinds have different shapes, but the number of shapes is finite, because there is a limit to the number of different things we see, smell, taste, and handle; he implies, although I do not think he definitely asserts, that all atoms of one kind are identical in every respect.

We now know that many compounds exist which are formed by the union of the same quantities by weight of the same elements, and, nevertheless, differ in properties; modern chemistry explains this fact by saying that the properties of a substance depend, not only on the kind of atoms which compose the minute particles of a compound, and the number of atoms of each kind, but also on the mode of arrangement of the atoms.3 The same doctrine was taught by Lucretius, two thousand years ago. "It often makes a great difference," he said, "with what things, and in what positions the same first-beginnings are held in union, and what motions they mutually impart and receive." For instance, certain atoms may be so arranged at one time as to produce fire, and, at another time, the arrangement of the same atoms may be such that the result is a fir-tree. The differences between the colours of things are said by Lucretius to be due to differences in the arrangements and motions of atoms. As the colour of the sea when wind lashes it into foam is different from the colour when the waters are at rest, so do the colours of things change when the atoms whereof the things are composed change from one arrangement to another, or from sluggish movements to rapid and tumultuous motions.

Lucretius pictured a solid substance as a vast number of atoms squeezed closely together, a liquid as composed of not so many atoms less tightly packed, and a gas as a comparatively small number of atoms with considerable freedom of motion. Essentially the same picture is presented by the molecular theory of to-day.

To meet the objection that atoms are invisible, and therefore cannot exist, Lucretius enumerates many things we cannot see although we know they exist. No one doubts the existence of winds, heat, cold and smells; yet no one has seen the wind, or heat, or cold, or a smell. Clothes become moist when hung near the sea, and dry when spread in the sunshine; but no one has seen the moisture entering or leaving the clothes. A pavement trodden by many feet is worn away; but the minute particles are removed without our eyes being able to see them.

Another objector urges—"You say the atoms are always moving, yet the things we look at, which you assert to be vast numbers of moving atoms, are often motionless." Him Lucretius answers by an analogy. "And herein you need not wonder at this, that though the first-beginnings of things are all in motion, yet the sum is seen to rest in supreme repose, unless when a thing exhibits motions with its individual body. For all the nature of first things lies far away from our senses, beneath their ken; and, therefore, since they are themselves beyond what you can see, they must withdraw from sight their motion as well; and the more so, that the things which we can see do yet often conceal their motions when a great distance off. Thus, often, the woolly flocks as they crop the glad pastures on a hill, creep on whither the grass, jewelled with fresh dew, summons or invites each, and the lambs, fed to the full, gambol and playfully butt; all which objects appear to us from a distance to be blended together, and to rest like a white spot on a green hill. Again, when mighty legions fill with their movements all parts of the plains, waging the mimicry of war, the glitter lifts itself up to the sky, and the whole earth round gleams with brass, and beneath a noise is raised by the mighty tramplings of men, and the mountains, stricken by the shouting, echo the voices to the stars of heaven, and horsemen fly about, and suddenly wheeling, scour across the middle of the plains, shaking them with the vehemence of their charge. And yet there is some spot on the high hills, seen from which they appear to stand still and to rest on the plains as a bright spot."

The atomic theory of the Greek thinkers was constructed by reasoning on natural phenomena. Lucretius constantly appeals to observed facts for confirmation of his theoretical teachings, or refutation of opinions he thought erroneous. Besides giving a general mental presentation of the material universe, the theory was applied to many specific transmutations; but minute descriptions of what are now called chemical changes could not be given in terms of the theory, because no searching examination of so much as one such change had been made, nor, I think, one may say, could be made under the conditions of Greek life. More than two thousand years passed before investigators began to make accurate measurements of the quantities of the substances which take part in those changes wherein certain things seem to be destroyed and other totally different things to be produced; until accurate knowledge had

been obtained of the quantities of the definite substances which interact in the transformations of matter, the atomic theory could not do more than draw the outlines of a picture of material changes.

A scientific theory has been described as "the likening of our imaginings to what we actually observe." So long as we observe only in the rough, only in a broad and general way, our imaginings must also be rough, broad, and general. It was the great glory of the Greek thinkers about natural events that their observations were accurate, on the whole, and as far as they went, and the theory they formed was based on no trivial or accidental features of the facts, but on what has proved to be the very essence of the phenomena they sought to bring into one point of view; for all the advances made in our own times in clear knowledge of the transformations of matter have been made by using, as a guide to experimental inquiries, the conception that the differences between the qualities of substances are connected with differences in the weights and movements of minute particles; and this was the central idea of the atomic theory of the Greek philosophers.

The atomic theory was used by the great physicists of the later Renaissance, by Galileo, Gassendi, Newton and others. Our own countryman, John Dalton, while trying (in the early years of the 19th century) to form a mental presentation of the atmosphere in terms of the theory of atoms, rediscovered the possibility of differences between the sizes of atoms, applied this idea to the facts concerning the quantitative compositions of compounds which had been established by others, developed a method for determining the relative weights of atoms of different kinds, and started chemistry on the course which it has followed so successfully.

Instead of blaming the Greek philosophers for lack of quantitatively accurate experimental inquiry, we should rather be full of admiring wonder at the extraordinary acuteness of their mental vision, and the soundness of their scientific spirit.

The ancient atomists distinguished the essential properties of things from their accidental features. The former cannot be removed, Lucretius said, without "utter destruction accompanying the severance"; the latter may be altered "while the nature of the thing remains unharmed." As examples of essential properties, Lucretius mentions "the weight of a stone, the heat of fire, the fluidity of water." Such things as liberty, war, slavery, riches, poverty, and the like, were accounted accidents. Time also was said to be an accident: it "exists not by itself; but simply from the things which happen, the sense apprehends what has been done in time past, as well as what is present, and what is to follow after."

As our story proceeds, we shall see that the chemists of the middle ages, the alchemists, founded their theory of material changes on the difference between a supposed essential substratum of things, and their qualities which could be taken off, they said, and put on, as clothes are removed and replaced.

How different from the clear, harmonious, orderly, Greek scheme, is any picture we can form, from such quotations as I have given from their writings, of the alchemists' conception of the world. The Greeks likened their imaginings of nature to the natural facts they observed; the alchemists created an imaginary world after their own likeness.

While Christianity was superseding the old religions, and the theological system of the Christian Church was replacing the cosmogonies of the heathen, the contrast between the power of evil and the power of good was more fully realised than in the days of the Greeks; a sharper division was drawn between this world and another world, and that other world was divided into two irreconcilable and absolutely opposite parts. Man came to be regarded as the centre of a tremendous and never-ceasing battle, urged between the powers of good and the powers of evil. The sights and sounds of nature were regarded as the vestments, or the voices, of the unseen combatants. Life was at once very real and the mere shadow of a dream. The conditions were favourable to the growth of magic; for man was regarded as the measure of the universe, the central figure in an awful tragedy.

Magic is an attempt, by thinking and speculating about what we consider must be the order of nature, to discover some means of penetrating into the secret life of natural things, of realising the hidden powers and virtues of things, grasping the concealed thread of unity which is supposed to run through all phenomena however seemingly diverse, entering into sympathy with the supposed inner oneness of life, death, the present, past, and future. Magic grows, and gathers strength, when men are sure their theory of the universe must be the one true theory, and they see only through the glasses which their theory supplies. "He who knows himself thoroughly knows God and all the mysteries of His nature," says a modern writer on magic. That saying expresses the fundamental hypothesis, and the method, of all systems of magic and mysticism. Of such systems, alchemy was one.

CHAPTER II.
A SKETCH OF ALCHEMICAL THEORY.

The system which began to be called *alchemy* in the 6th and 7th centuries of our era had no special name before that time, but was known as *the sacred art, the divine science, the occult science, the art of Hermes*.

A commentator on Aristotle, writing in the 4th century A.D., calls certain instruments used for fusion and calcination "*chuika organa*," that is, instruments for melting and pouring. Hence, probably, came the adjective *chyic* or *chymic*, and, at a somewhat later time, the word *chemia* as the name of that art which deals with calcinations, fusions, meltings, and the like. The writer of a treatise on astrology, in the 5th century, speaking of the influences of the stars on the dispositions of man, says: "If a man is born under Mercury he will give himself to astronomy; if Mars, he will follow the profession of arms; if Saturn, he will devote himself to the science of alchemy (*Scientia alchemiae*)." The word *alchemia* which appears in this treatise, was formed by prefixing the Arabic *al* (meaning *the*) to *chemia*, a word, as we have seen, of Greek origin.

It is the growth, development, and transformation into chemistry, of this *alchemia* which we have to consider.

Alchemy, that is, *the* art of melting, pouring, and transforming, must necessarily pay much attention to working with crucibles, furnaces, alembics, and other vessels wherein things are fused, distilled, calcined, and dissolved. The old drawings of alchemical operations show us men busy calcining, cohobating, distilling, dissolving, digesting, and performing other processes of like character to these.

The alchemists could not be accused of laziness or aversion to work in their laboratories. Paracelsus (16th century) says of them: "They are not given to idleness, nor go in a proud habit, or plush and velvet garments, often showing their rings on their fingers, or wearing swords with silver hilts by their sides, or fine and gay gloves on their hands; but diligently follow their labours, sweating whole days and nights by their furnaces. They do not spend their time abroad for recreation, but take delight in their laboratories. They put their fingers among coals, into clay and filth, not into gold rings. They are sooty and black, like smiths and miners, and do not pride themselves upon clean and beautiful faces."

In these respects the chemist of to-day faithfully follows the practice of the alchemists who were his predecessors. You can nose a chemist in a crowd by the smell of the laboratory which hangs about him; you can pick him out by the stains on his hands and clothes. He also "takes delight in his laboratory"; he does not always "pride himself on a clean and beautiful face"; he "sweats whole days and nights by his furnace."

Why does the chemist toil so eagerly? Why did the alchemists so untiringly pursue their quest? I think it is not unfair to say: the chemist experiments in order that he "may liken his imaginings to the facts which he observes"; the alchemist toiled that he might liken the facts which he observed to his imaginings. The difference may be put in another way by saying: the chemist's object is to discover "how changes happen in combinations of the unchanging"; the alchemist's endeavour was to prove the truth of his fundamental assertion, "that every substance contains undeveloped resources and potentialities, and can be brought outward and forward into perfection."

Looking around him, and observing the changes of things, the alchemist was deeply impressed by the growth and modification of plants and animals; he argued that minerals and metals also grow, change, develop. He said in effect: "Nature is one, there must be unity in all the diversity I see. When a grain of corn falls into the earth it dies, but this dying is the first step towards a new life; the dead seed is changed into the living plant. So it must be with all other things in nature: the mineral, or the metal, seems dead when it is buried in the earth, but, in reality, it is growing, changing, and becoming more perfect." The perfection of the seed is the plant. What is the perfection of the common metals? "Evidently," the alchemist replied, "the perfect metal is gold; the common metals are trying to become gold." "Gold is the intention of Nature in regard to all metals," said an alchemical writer. Plants are preserved by the preservation of their seed. "In like manner," the alchemist's argument proceeded, "there must be a seed in metals which is their essence; if I can separate the seed and bring it under the proper conditions, I can cause it to grow into the perfect metal." "Animal life, and human life also," we may suppose the alchemist saying, "are continued by the same method as that whereby the life of plants is continued; all life springs from seed; the seed is fructified by the union of the male and the female; in metals also there must be the two characters; the union of these is needed for the production of new metals; the conjoining of metals must go before the birth of the perfect metal."