SCIENCE AND CIVILISATION IN CHINA

BY

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VOLUME 5

CHEMISTRY AND CHEMICAL TECHNOLOGY

PART V: SPAGYRICAL DISCOVERY AND INVENTION: PHYSIOLOGICAL ALCHEMY

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To

KUO PÊN-TAO

formerly Professor of Comparative Religion at the Nanking Theological Seminary

a master in the Tao

—remembering our talks in the
tower of Hua-Hsi University—
at Chhêngtu
1943–1944

and in memory of

ROBERT van GULIK

formerly Minister Plenipotentiary in the Netherlands Foreign Service

a master in the Tao

—remembering our talks from
Basra to Chungking—

this volume is dedicated

LIST OF ABBREVIATIONS

The following abbreviations are used in the text and footnotes. For abbreviations used for journals and similar publications in the bibliographies, see pp.339 ff.

B	Bretschneider, E. (*1*), *Botanicon Sinicum*.
CC	Chia Tsu-Chang & Chia Tsu-Shan (*1*), *Chung-Kuo Chih Wu Thu Chien* (Illustrated Dictionary of Chinese Flora), 1958.
CCIF	Sun Ssu-Mo, *Chhien Chin I Fang* (Supplement to the Thousand Golden Remedies), between +660 and +680.
CCYF	Sun Ssu-Mo, *Chhien Chin Yao Fang* (Thousand Golden Remedies), between +650 and +659.
CHS	Pan Ku (and Pan Chao), *Chhien Han Shu* (History of the Former Han Dynasty), *c.* +100.
CJC	Juan Yuan, *Chhou Jen Chuan* (Biographies of Mathematicians and Astronomers), +1799. With continuations by Lo Shih-Lin, Chu Kho-Pao and Huang Chung-Chün. In *HCCC*, chs. 159ff.
CLPT	Thang Shen-Wei *et al.* (ed.), *Chêng Lei Pên Tshao* (Reorganised Pharmacopoeia), ed. of +1249.
CSHK	Yen Kho-Chün (ed.), *Chhüan Shang-Ku San-Tai Chhin Han San-Kuo Liu Chhao Wên* (Complete Collection of prose literature (including fragments) from remote antiquity through the Chhin and Han Dynasties, the Three Kingdoms, and the Six Dynasties), 1836.
CTPS	Fu Chin-Chhüan (ed.), *Chêng Tao Pi Shu Shih Chung* (Ten Types of Secret Books on the Verification of the Tao), early 19th cent.
EB	*Encyclopaedia Britannica*.
HCCC	Yen Chieh (ed.), *Huang Chhing Ching Chieh* (monographs by Chhing scholars on classical subjects), 1829, contd. 1860.
HCSS	*Hsiu Chen Shih Shu* (Ten Books on the Regeneration of the Primary Vitalities, physiological alchemy), *c.* +1250.
HFT	Han Fei, *Han Fei Tzu* (Book of Master Han Fei), early −3rd cent.
HHPT	Su Ching *et al.* (ed.), *Hsin Hsiu Pên Tshao* (Newly Improved Pharmacopoeia), +659.
HHS	Fan Yeh & Ssuma Piao, *Hou Han Shu* (History of the Later Han Dynasty), +450.
HNT	Liu An *et al.*, *Huai Nan Tzu* (Book of the Prince of Huai-Nan), −120.
ICK	Taki Mototane, *I Chi Khao* (*Iseki-kō*) (Comprehensive Annotated Bibliography of Chinese Medical Literature [Lost or Still Existing]), finished *c.* 1825, pr. 1831; repr. Tokyo 1933, Shanghai 1936.

ITCM Wang Khên-Thang & Chu Wên-Chen (ed.), *I Thung Chêng Mo Chhüan* (Complete Collection of Works on Medicine and Sphygmology), +1601.

K Karlgren, B. (1), *Grammata Serica* (dictionary giving the ancient forms and phonetic values of Chinese characters).

KCCY Chhen Yuan-Lung, *Ko Chih Ching Yuan* (Mirror of Scientific and Technological Origins), an encyclopaedia of +1735.

KHTT Chang Yü-Shu (ed.), *Khang-Hsi Tzu Tien* (Imperial Dictionary of the Khang-Hsi reign-period), +1716.

Kr Kraus, P., *Le Corpus des Écrits Jābiriens* (*Mémoires de l'Institut d'Égypte*, 1943, vol. 44, pp. 1–214).

LPC Lung Po-Chien (*1*), *Hsien Tshun Pên Tshao Shu Lu* (Bibliographical Study of Extant Pharmacopoeias and Treatises on Natural History from all Periods).

LS Tsêng Tshao (ed.), *Lei Shuo* (Classified Commonplace-Book), +1136.

MCPT Shen Kua, *Mêng Chhi Pi Than* (Dream Pool Essays), +1089.

N Nanjio, B., *A Catalogue of the Chinese Translations of the Buddhist Tripiṭaka*, with index by Ross (3).

NCCS Hsü Kuang-Chhi, *Nung Chêng Chhüan Shu* (Complete Treatise on Agriculture), +1639.

NCNA New China News Agency.

PPT/NP Ko Hung, *Pao Phu Tzu* (*Nei Phien*) (Book of the Preservation-of-Solidarity Master; Inner Chapters), *c.* +320.

PPT/WP *Idem* (*Wai Phien*), the Outer Chapters.

PTKM Li Shih-Chen, *Pên Tshao Kang Mu* (The Great Pharmacopoeia), +1596.

PWYF Chang Yü-Shu (ed.), *Phei Wên Yün Fu* (encyclopaedia), +1711.

R Read, Bernard E. *et al.*, Indexes, translations and précis of certain chapters of the *Pên Tshao Kang Mu* of Li Shih-Chen. If the reference is to a plant see Read (1); if to a mammal see Read (2); if to a bird see Read (3); if to a reptile see Read (4 or 5); if to a mollusc see Read (5); if to a fish see Read (6); if to an insect see Read (7).

RBS *Revue Bibliographique de Sinologie.*

RP Read & Pak (1), Index, translation and précis of the mineralogical chapters in the *Pên Tshao Kang Mu.*

S/ Stein Collection of Tunhuang MSS, British Museum, London, catalogue number.

SC Ssuma Chhien, *Shih Chi* (Historical Records), *c.* −90.

SF Thao Tsung-I (ed.), *Shuo Fu* (Florilegium of (Unofficial) Literature), *c.* +1368.

SHC *Shan Hai Ching* (Classic of the Mountains and Rivers), Chou and C/Han.

SIC Okanishi Tameto, *Sung I-Chhien I Chi Khao* (Comprehensive Annotated Bibliography of Chinese Medical Literature in and before the Sung Period). Jen-min Wei-shêng, Peking, 1958.

SKCS *Ssu Khu Chhüan Shu* (Complete Library of the Four Categories), +1782; here the reference is to the *tshung-shu* collection printed as a selection from one of the seven imperially commissioned MSS.

SKCS/TMTY Chi Yün (ed.), *Ssu Khu Chhüan Shu Tsung Mu Thi Yao* (Analytical Catalogue of the *Complete Library of the Four Categories*), +1782; the great bibliographical catalogue of the imperial MS. collection ordered by the Chhien-Lung emperor in +1772.

SNPTC *Shen Nung Pên Tshao Ching* (Classical Pharmacopoeia of the Heavenly Husbandman), C/Han.

SSIW Toktaga (Tho-Tho) *et al.*; Huang Yü-Chi *et al.* & Hsü Sung *et al.* *Sung Shih I Wên Chih, Pu, Fu Phien* (A Conflation of the Bibliography and Appended Supplementary Bibliographies of the History of the Sung Dynasty). Com. Press, Shanghai, 1957.

STTH Wang Chhi, *San Tshai Thu Hui* (Universal Encyclopaedia), +1609.

SYEY Mei Piao, *Shih Yao Erh Ya* (The Literary Expositor of Chemical Physic; or, Synonymic Dictionary of Minerals and Drugs), +806.

TCTC Ssuma Kuang, *Tzu Chih Thung Chien* (Comprehensive Mirror (of History) for Aid in Government), +1084.

TFYK Wang Chhin-Jo & Yang I (eds.), *Tshê Fu Yuan Kuei* (Lessons of the Archives, encyclopaedia), +1013.

TKKW Sung Ying-Hsing, *Thien Kung Khai Wu* (The Exploitation of the Works of Nature), +1637.

TMITC Li Hsien (ed.), *Ta Ming I Thung Chih* (Comprehensive Geography of the Ming Empire), +1461.

TPHMF *Thai-Phing Hui Min Ho Chi Chü Fang* (Standard Formularies of the (Government) Great Peace People's Welfare Pharmacies), +1151.

TPKC Li Fang (ed.), *Thai-Phing Kuang Chi* (Copious Records collected in the Thai-Phing reign-period), +978.

TPYL Li Fang (ed.), *Thai-Phing Yü Lan* (the Thai-Phing reign-period (Sung) Imperial Encyclopaedia), +983.

TSCC Chhen Mêng-Lei *et al.* (ed.), *Thu Shu Chi Chhêng* (the Imperial Encyclopaedia of +1726). Index by Giles, L. (2).
References to 1884 ed. given by chapter (*chüan*) and page.
References to 1934 photolitho reproduction given by *tshê* (vol.) and page.

TSCCIW Liu Hsü *et al.* & Ouyang Hsiu *et al.*; *Thang Shu Ching Chi I Wên Ho Chih.* A conflation of the Bibliographies of the *Chiu Thang Shu* by Liu Hsü (H/Chin, +945) and the *Hsin Thang Shu* by Ouyang Hsiu & Sung Chhi (Sung, +1061). Com. Press, Shanghai, 1956.

TSFY	Ku Tsu-Yu, *Tu Shih Fang Yü Chi Yao* (The Historian's Geographical Companion), begun before +1666, finished before +1692, but not printed till the end of the eighteenth century (1796 to 1821).
TT	Wieger, L. (6), *Taoïsme*, vol. 1, Bibliographie Générale (catalogue of the works contained in the Taoist Patrology, *Tao Tsang*).
TTC	*Tao Tê Ching* (Canon of the Tao and its Virtue).
TTCY	Ho Lung-Hsiang & Phêng Han-Jan (ed.). *Tao Tsang Chi Yao* (Essentials of the Taoist Patrology), pr. 1906.
TW	Takakusu, J. & Watanabe, K., *Tables du Taishō Issaikyō* (nouvelle édition (Japonaise) du Canon bouddhique chinoise), Index-catalogue of the Tripiṭaka.
V	Verhaeren, H. (2) (ed.), Catalogue de la Bibliothèque du Pé-T'ang (the Pei Thang Jesuit Library in Peking).
WCTY/CC	Tsêng Kung-Liang (ed.), *Wu Ching Tsung Yao* (*Chhien Chi*), military encyclopaedia, first section, +1044.
YCCC	Chang Chün-Fang (ed.), *Yün Chi Chhi Chhien* (Seven Bamboo Tablets of the Cloudy Satchel), Taoist collection, +1022.
YHL	Thao Hung-Ching (attrib.), *Yao Hsing Lun* (Discourse on the Natures and Properties of Drugs).
YHSF	Ma Kuo-Han (ed.), *Yü Han Shan Fang Chi I Shu* (Jade-Box Mountain Studio collection of (reconstituted and sometimes fragmentary) Lost Books), 1853.

AUTHOR'S NOTE

It is now some eighteen years since the preface for Vol. 4 of this series (Physics and Physical Technology) was written; since then much has been done towards the later volumes. We are now happy to be able to present a further part of Vol. 5 (Spagyrical Discovery and Invention), i.e. alchemy and early chemistry, which go together with the arts of peace and war, including military and textile technology, mining, metallurgy and ceramics. The point of this arrangement was explained in the preface of Vol. 4 (e.g. pt. 3, p. 1). Exigencies not of logic but of collaboration are making it obligatory that these other topics should follow rather than precede the central theme of chemistry, which here is printed as Vol. 5, parts 2, 3, 4 and 5, leaving parts 1 and 6 to appear at a later date.

The number of physical volumes (parts) which we are now producing may give the impression that our work is enlarging according to some form of geometrical progression or along some exponential curve, but this would be largely an illusion, because in response to the reactions of many friends we are now making a real effort to publish in books of less thickness, more convenient for reading. At the same time it is true that over the years the space required for handling the history of the diverse sciences in Chinese culture has proved singularly unpredictable. One could (and did) at the outset arrange the sciences in a logical spectrum (mathematics – astronomy – geology and mineralogy – physics – chemistry – biology – psychology – sociology) leaving estimated room also for all the technologies associated with them; but to foresee exactly how much space each one would claim, that, in the words of the Jacobite blessing, was 'quite another thing'. We ourselves are aware that the disproportionate size of some of our Sections may give a mis-shapen impression to minds enamoured of classical uniformity, but our material is not easy to 'shape', perhaps not capable of it, and appropriately enough we are constrained to follow the Taoist natural irregularity and surprise of a romantic garden rather than to attempt any compression of our lush growths within the geometrical confines of a Cartesian parterre. The Taoists would have agreed with Richard Baxter that ''tis better to go to heaven disorderly than to be damned in due order'. By some strange chance our spectrum meant (though I thought at the time that the mathematics was particularly difficult) that the 'easier' sciences were going to come first, those where both the basic ideas and the available source-materials were relatively clear and precise. As we proceeded, two phenomena manifested themselves, first the technological achievements and amplifications proved far more formidable than expected (as was the case in Vol. 4, pts. 2 and 3), and secondly we found ourselves getting into ever deeper water, as the saying is,

intellectually (as will fully appear in the present part, and in the Sections on medicine in Vol. 6).

Alchemy and early chemistry, the central subjects of the present Volume, exemplified the second of these difficulties quite well enough, but they have had others of their own. At one time I almost despaired of ever finding our way successfully through the inchoate mass of ideas, and the facts so hard to establish, relating to alchemy, chemistry, metallurgy and chemical industry in ancient, medieval and traditional China. The facts indeed were much more difficult to ascertain, and also more perplexing to interpret, than anything encountered in subjects such as astronomy or civil engineering. And in the end, one must say, we did not get through without cutting great swathes of briars and bracken, as it were, through the muddled thinking and confused terminology of the traditional history of alchemy and early chemistry in the West. Here it was indispensable to distinguish alchemy from proto-chemistry, and to introduce words of art such as aurifiction, aurifaction and macrobiotics. It is also fair to say that the present subject has been far less well studied and understood, either by Westerners or Chinese scholars themselves, than fields like astronomy and mathematics, where already in the eighteenth century a Gaubil could do outstanding work, and nearer our own time a Chhen Tsun-Kuei[1], a de Saussure, and a Mikami Yoshio could set them largely in order. If the study of alchemy and early chemistry had advanced anything like so far, it would be much easier today than it actually is to differentiate with clarity between the many divergent schools of alchemists at the many periods, from the −3rd century to the +17th, with which we have to deal. More adequate understanding would also have been achieved with regard to that crucial Chinese distinction between inorganic laboratory alchemy (*wai tan*[2]) and physiological alchemy (*nei tan*[3]), the former concerned with elixir preparations of mineral origin, the latter rather with operations within the adept's own body; a distinction hardly realised in the West before the just passed decade. As we shall show in this present part, there was a synthesis of these two age-old trends when in iatro-chemistry from the Sung onwards laboratory methods were applied to physiological substances, producing what we can only call a proto-biochemistry.

Let us now, as an introduction to pt. 5, take a look backward over the way we have come. First, then, we had to write a very careful preamble (Sect. 33*b*, in Vol. 5, pt. 2, pp. 9 ff.) on concepts, terminology and definitions; because once one has obtained a clear idea of the distinctions between aurifiction, aurifaction and macrobiotics everything that one encounters in the proto-chemistry and alchemy of all the Old World civilisations falls into place. There is a parallel here with the history of time-keeping, for the radical gap between the clepsydra and the mechanical clock was only filled by half-a-dozen centuries of Chinese hydro-mechanical clockwork. So in the same way the radical gap between

[1] 陳遵嬀 [2] 外丹 [3] 內丹

Hellenistic aurifictive and aurifactive proto-chemistry at one end, and late Latin alchemy and iatro-chemistry at the other, could only be explained by a knowledge of Chinese chemical macrobiotics.

After that beginning the argument developed in several directions, among which the reader might take his choice. How could belief in aurifaction ever have arisen when the cupellation test had been known almost since the dawn of the ancient empires? Look at Sect. 33*b*, 1–2, especially pp. 44 ff. in pt. 2. What was the position of China in this respect, and what were the ancient Chinese alchemists probably doing experimentally? Read 33*b*, 3–5; and *c*, 1–8 (pt. 2, pp. 47 ff., 188 ff.). Why were they so much more occupied with the perpetuation of life on earth, even in ethereal forms, than with the faking or making of gold? We tried to explain it in Sect. 33*b* (pt. 2, pp. 71 ff.). Such an induction of material immortality was indeed the specific characteristic of Chinese alchemy, and our conclusion was that the world-view of ancient China was the only milieu capable of crystallising belief in an elixir (*tan*[1]), good against death, as the supreme achievement of the chemist (see especially pt. 2, pp. 78, 82, 114–15).

This was the nub of the argument, and in the last part (Sect. 33*i*, 2–3 in pt. 4, pp. 323 ff.) we followed the progress of that great creative dream through Arabic culture and Byzantium into the Latin Baconian and Paracelsian West. Differences of religion, theology and cosmology modified it but they could not stop its course. There can be no doubt that it was born within the bosom of the Taoist religion, and hence the reader was invited to participate in a speculation that the alchemist's furnace derived from the liturgical incense-burner no less than from the metallurgical hearth (Sect. 33*b*, 7, see pt. 2, pp. 128 ff., 154). Finally something was said on the physiological background of the ingestion of elixirs (Sect. 33*d*, 1, see pt. 2, p. 291); why were they so attractive to the consumer initially and why so lethal later? Here belongs also the conservation of the body of the adept after death, important in the Taoist mind in connection with material immortality (Sect. 33*d*, 2, see pt. 2, pp. 106 ff., 294 ff., 303–4).

In the sub-section giving the straight historical account of Chinese alchemy from beginning to end, *chi shih pên mo*[2] as the phrase was (Sect. 33*e*, 1–8) in pt. 3, no passage was really more significant than any other. Yet special interest did attach to the oldest firm records of aurifiction and macrobiotics expounded in (1), pp. 12 ff. and to the study of the oldest alchemical books in (2) and (6, i), pp. 50 ff., 167 ff. Now and then the narrative was interrupted by passages of detail, especially in (1), (2), (3, iii) and (6, vii) which readers not avid for minutiae may have liked to pass over; such is the wealth of information not previously available in the West. The sub-sections in the next part on chemical laboratory apparatus and alchemical theory (Sects. 33*f*, *g*, *h* in pt. 4) explained themselves from the contents table, and again no passage stood out as crucial; though many matters of considerable importance for the history of chemistry revealed themselves on the way. One thinks of the earliest tubular cooling devices (pp. 26

[1] 丹 [2] 紀事本末

ff.), the radical differences between the Chinese, Hellenistic and Indian types of still (pp. 80 ff.), the fascinating story of the first appearance of 'ardent water' (strong alcohol) whether by freezing-out or by distillation (pp. 121 ff.), the many ramifications of the term 'nitre' (*hsiao*[1]) in the history of the recognition and separation of soluble salts, leading to the isolation and use of saltpetre and copperas (pp. 167 ff.), and the industrial precipitation of metallic copper from its salts by iron (pp. 201 ff.).

Outstanding theoretically was the relation of the Chinese alchemist to time (33*h*, 3–4, pt. 4, pp. 221 ff., 242 ff.). His was indeed the science (or proto-science) of the Change and Decay Control Department as one might say, for he could (as he believed) accelerate enormously the natural change whereby gold was formed from other substances in the earth, and conversely he could decelerate asymptotically the rate of decay and dissolution to which human bodies, each with their ten 'souls' (*hun*[2] and *pho*[3]; cf. Fig. 1306 on p. 91 of pt. 2), were normally subject (cf. Fig. 1516 on p. 244 in pt. 4). Thus in the words of the ancient Chinese slogan (33*e*, 1, pt. 3, p. 27) 'gold *can* be made, and salvation *can* be attained'. And the macrobiogens were thus essentially time- and rate-controlling substances – a nobly optimistic concept for a nascent science of two thousand years ago.

The historical narrative in pt. 3 was drafted in the first place by our collaborator Prof. Ho Ping-Yü[4] of Brisbane, who also had a large part to play in the epic of Chinese chemical and alchemical apparatus; and the study of the theory of Chinese elixir alchemy in pt. 4 was essentially the work of another collaborator, Prof. Nathan Sivin, then of the Massachusetts Institute of Technology, now of Philadelphia. All of us are agreed that the most important single source for Chinese alchemy, whether chemical or physiological, is the Taoist patrology, the *Tao Tsang*[5]. During the second world war I was instrumental in securing for the Cambridge University Library copies of the *Tao Tsang* and its Szechuanese version the *Tao Tsang Chi Yao*[6], which is much more than the collection of excerpts suggested by its title. Most of the alchemical books and tractates in these vast compilations were then microfilmed for the East Asian History of Science Library, and somewhat later (1951–5) Dr Tshao Thien-Chhin[7], then a Fellow of Caius, made a valuable study of them. After his return to the Biochemical Institute of Academia Sinica, Shanghai, of which he has been for a number of years past Vice-Director, these notes were of great help to Dr Ho and myself, forming the basis for the sub-section in Vol. 5, pt. 4 on aqueous reactions (*g*). Still later, Prof. H.B. Collier of Edmonton, Alberta, who had taught chemistry for many years at the West China University at Chhêngtu in Szechuan, presented to our Library the alchemical books in the *Tao Tsang Chi Yao* which he had collected there, and these proved of great use to Dr Lu Gwei-Djen[8] and myself since many of them deal with physiological rather than laboratory alchemy. Again, before he left

[1] 硝 [2] 魂 [3] 魄 [4] 何丙郁 [5] 道藏 [6] 道藏輯要 [7] 曹天欽 [8] 魯桂珍

Cambridge in 1958, Dr Wang Ling[1] accomplished a good work by making an analytical index of the names of chemical substances mentioned in the *Shih Yao Erh Ya*[2] (Literary Expositor of Chemical Physic; or, Synonymic Dictionary of Minerals and Drugs), written by Mei Piao[3] in the Thang (+806), one of the most valuable alchemical books in the *Tao Tsang*. It still helped Dr Lu and myself even for the present part, because so many concepts of physiological alchemy were fond of hiding themselves under chemical nomenclature. Lastly, when we were facing the interesting but difficult study of the evolution of chemical apparatus in East and West (Sect. 33,*f*), Dr Dorothy Needham put in a considerable amount of work, including some drafting, in the intervals of her own work on the history of muscle biochemistry. And she has continued to read all our pages – perhaps the only person in the world who ever does so!

If there is one question more than any other raised by this present Section 33 on alchemy and early chemistry, now offered to the republic of learning in these volumes, it is that of human unity and continuity. In the light of what is here set forth, can we allow ourselves to visualise that some day before long we shall be able to write the history of man's enquiry into chemical phenomena as one single development throughout the Old World cultures? Granted that there were several different foci of ancient metallurgy and primitive chemical industry, how far was the gradual flowering of alchemy and chemistry a single endeavour, running contagiously from one civilisation to another?

It is a commonplace of thought that some forms of human experience seem to have progressed in a more obvious and palpable way than others. It might be difficult to say how Michael Angelo could be considered an improvement on Pheidias, or Dante on Homer, but it can hardly be questioned that Newton and Pasteur and Einstein did really know a great deal more about the natural universe than Aristotle or Chang Hêng[4]. This must tell us something about the differences between art and religion on one side and science on the other, though no one seems able to explain quite what, but in any case within the field of natural knowledge we cannot but recognise an evolutionary development, a real progress, over the ages. The cultures might be many, the languages diverse, but they all partook of the same quest.

Throughout this series of volumes it has been assumed all along that there is only one unitary science of Nature, approached more or less closely, built up more or less successfully and continuously, by various groups of mankind from time to time. This means that one can expect to trace an absolute continuity between the first beginnings of astronomy and medicine in Ancient Babylonia, through the advancing natural knowledge of medieval China, India, Islam and the classical Western world, to the break-through of late Renaissance Europe when, as has been said, the most effective method of discovery was itself discovered. Many people probably share this point of view, but there is another one which I may associate with the name of Oswald Spengler, the German

[1] 王鈴 [2] 石藥爾牙 [3] 梅彪 [4] 張衡

world-historian of the thirties whose works, especially *The Decline of the West* (1), achieved much popularity for a time. According to him, the sciences produced by different civilisations were like separate and irreconcilable works of art, valid only within their own frames of reference, and not subsumable into a single history and a single ever-growing structure.

Anyone who has felt the influence of Spengler retains, I think, some respect for the picture he drew of the rise and fall of particular civilisations and cultures, resembling the birth, flourishing and decay of individual biological organisms, in human or animal life-cycles. Certainly I could not refuse all sympathy for a point of view so like that of the Taoist philosophers, who always emphasised the cycles of life and death in Nature, a point of view that Chuang Chou[1] himself might well have shared. Yet while one can easily see that artistic styles and expressions, religious ceremonies and doctrines, or different kinds of music, have tended to be incommensurable; for mathematics, science and technology the case is altered – man has always lived in an environment essentially constant in its properties, and his knowledge of it, if true, must therefore tend towards a constant structure.

Nevertheless, in presenting to the world this part of Volume 5, we are conscious that it is rather different from those which have gone before it and from those which will follow it. In order to understand the physiological alchemy of China, one has to enter a world of natural philosophy entirely unlike that of Western tradition, and to attune oneself to a theology and a realm of religious feeling quite foreign to the common presuppositions of the 'Peoples of the Book'.[a] The sheer un-European-ness of Chinese physiological alchemy deeply impresses. True, it had some connections with Indian thought and belief, yet it was very clearly itself and nothing else, essentially materialist in character because it conceived of the enchymoma of immortality as a real chemical substance formed from the juices and *pneumata* of the body, psychosomatic perhaps but certainly not psychological alone. In view of the deep contrasts between Western and Eastern spirituality, a leap of sympathetic understanding is required in approaching Chinese physiological alchemy, a readiness for new experience of the 'other', as was so well seen by C.G. Jung in the passage which we have quoted on our half-title page.

The techniques which the physiological alchemists believed they could use for their purpose will be described in due course, the control of respiration, the mastery of neuro-muscular coordination and the effects of particular forms of bodily rest and movement, the recognition of sexual activity as part of the Tao of the sage and the adept, the utilisation of bodily exposure to light, and the management of the mind in methods of meditation and mental concentration. Today the younger generation, the people in the 'counter-culture', are

[a] A phrase used by Muslims to denote Jews and Christians as well as themselves, all those in fact deriving from ancient Hebrew monotheism.

[1] 莊周

rediscovering and re-exploring many of the ways of altered consciousness which the *nei tan* experts were seeking,[a] so that the present time is appropriate enough for a pioneer survey of their systems as extensive as we have had time and space to make it, even though the subject is far from exhausted and there remains still much to be done.

Yet physiological alchemy was not wholly antithetical to modern science, as has sometimes been thought. It is but a truism to say that the Yang and Yin principles are present wherever there is positive and negative electricity today, and this means in the very foundations of the natural world, the sub-atomic elementary charged particles, the protons and electrons. The Five Elements can reasonably be taken to prefigure the states of matter recognised today, the solid, the liquid and the gaseous; and they served as a symbolic language for expressing subtle inter-relationships manifested in natural phenomena. There may be nothing in modern science exactly corresponding to the Taoist emphasis on reversion, counter-current flow, regeneration and return, but it does evoke the many and pressing mysteries of growth, differentiation, de-differentiation and re-differentiation, seen for example in insect metamorphosis, and well known in modern biological science. It is not impossible that with greater knowledge of enzymology, and especially physiological genetics, we may hope to arrest the ageing process and even retrace its steps; already rejuvenation is not an ostracised word, for the process can be seen to be real in tissue-cultures of plant and animal cells. The conservation of secretions seems strange to us at first, but we shall ultimately suggest that it meant the retention of many substances, from amylases to prostaglandins and other hormones, which might benefit the body. The three 'primary vitalities' of the Taoists are not precisely translatable into terms of modern science – no characteristically medieval formulations ever are – but *shen*[1] did some justice to the mental components of man, while *chhi*[2] denoted the dissolved gases in his body-fluids, and *ching*[3] those fluids themselves; only the solid structures had little representation here. *Chhi* also included all those invisible processes like diffusion and the nervous impulse; and it was a penetrating insight to see that *shen* depended upon *chhi* and *ching*. A tripartite division of vital force came into Western physiological thought by the time of Paracelsus and Glisson; it was prominent in the Naturphilosophie movement, and even as late as Claude Bernard. We suspect that the three primary vitalities of China were not unconnected with it. Then long before Freud and Jung the Chinese physiological alchemists understood the importance of sexual health for the integrated personality, and made it a part of their macrobiotic programme. And there are many other physiological priorities to be assigned to China beyond what can appear in this book, for example the discovery of circadian rhythms in bodily

[a] Neither dietary techniques nor psychotropic drugs were really part of physiological alchemy. On the former see pt. 3, pp. 9 ff.; on the latter see pt. 2, pp. 116 ff., 121 ff., 150 ff.

[1] 神 [2] 氣 [3] 精

function, both normal and pathological; and the discovery and codification of the viscero-cutaneous reflexes.[a]

For all these reasons, we believe that most of physiological alchemy merits the name of proto-science rather than pseudo-science. Of particular interest here are the theoretical convictions voiced by so many of its practitioners, for example that 'man's fate is in his own hands, not those of Heaven'; and they speak also of 'robbing Nature's workshop to accomplish good for humanity'. Strangely Promethean words, these, from a culture which even some of its own interpreters have believed bound to the view that ethical self-discipline alone mattered. 'The Chinese philosophers', wrote Fêng Yu-Lan[1] long ago, 'had no need of scientific certainty because it was themselves that they wished to know; they had no need of the power of science, because it was themselves that they wished to conquer.'[b] It is true, as we shall see, that some philosophers, such as the Neo-Confucians, were unhappy about the audacious proto-scientific programmes of the alchemists and other technologists, but death itself was what these men intended to conquer, and selfhood was only one obstacle on their way of certainty and power to the sagehood of the Holy Immortals.

The truly proto-scientific character of their endeavour appears moreover at the end in that *tour de force* of medieval achievement, the preparation of active hormones from urine, worked up in almost manufacturing quantities.[c] Here the synthesis of iatro-chemistry, starting several centuries before Paracelsus, transcended the *wai tan* elixirs and the *nei tan* enchymomas by applying *wai tan* methods to *nei tan* materials. In later volumes we expect to return to similar achievements of the iatro-chemists, but here this forms a fitting concrete conclusion to the description of a tradition which might at first sight seem to have been no more than wishful thinking.

Although the other parts of Vol. 5 are not yet ready for press we should like to make mention of those who are collaborating with us in them. Much of the Section on martial technology for Vol. 5, pt. 1 has been in draft for many years now,[d] but it has been held up by delays in the preparation of the extremely important sub-section on the invention of the first chemical explosive known to man, gunpowder, even though all the notes and books and papers necessary for this have long been collected.[e] At last we can salute the advent of a relevant draft of substantial size from Dr Ho Ping-Yü at Brisbane, recently Visiting Professor at Keio University in Tokyo, aided by Dr Wang Ling (Wang Ching-Ning[2]) of the Institute of Advanced Studies at Canberra. Meanwhile Prof. Lo

[a] On these subjects see Lu Gwei-Djen & Needham (5), as also in due course Vol. 6, pt. 3.

[b] Quoted by Needham (47), p. 301. [c] Sect. 33*k*, 1–7.

[d] Including an introduction on the literature, a study of close-combat weapons, the sub-sections on archery and ballistic machines, and a full account of iron and steel technology as the background of armament. The first draft of this last has been published as a Newcomen Society monograph; Needham (32), (60).

[e] A preliminary treatment of the subject, still, we think, correct in outline, was given in our article in the *Legacy of China* eleven years ago; Needham (47). This has recently been re-issued in paperback form.

[1] 馮友蘭 [2] 王靜寧

Jung-Pang[1], of the University of California at Davis, spent the winter of 1969–70 in Cambridge, accomplishing not only the sub-section on the history of armour and caparison in China but also the draft of the whole of Section 37 on the salt industry, including the epic development of deep borehole drilling (Vol. 5, pt. 6). Other military sub-sections, such as those on poliorcetics, cavalry practice and signalling, we have been able to place in the capable hands of Dr Korinna Hana of München. About the same time we persuaded Dr Tsien Tsuen-Hsuin (Chhien Tshun-Hsün[2]), the Regenstein Librarian at the University of Chicago, to undertake the writing of Section 32 on the great inventions of paper and printing and their development in China; this is now completed. For ceramic technology (Section 35) we have obtained the collaboration of Mr James Watt (Chhü Chih-Jen[3]), Curator of the Art Gallery at the Institute of Chinese Studies in the Chinese University of Hongkong. The story of these marvellous applications of science will be anticipated by many with great interest. Finally non-ferrous metallurgy and textile technology, for which abundant notes and documentation have been collected, found their organising genii in two other widely separated places. For the former we have Prof. Ursula Martins Franklin assisted by Dr Hsü Chin-Hsiung[4] at Toronto; for the latter Dr Ohta Eizo[5] at Kyoto and Dr Dieter Kuhn in Cambridge. When their work becomes available, Volume 5 will be substantially complete. This by no means exhausts the list of our invaluable collaborators, for many others are concerned with Volumes 6 and 7; but they will be introduced to readers in due time.

As has so long been customary, we offer our grateful thanks to those who try to keep us 'on the rails' in territory which is not our own; Prof. D.M. Dunlop for Arabic, Dr Sebastian Brock for Syriac, Prof. E.J. Wiesenberg for Hebrew, Dr Charles Sheldon for Japanese, Prof. G. Ledyard for Korean, and Prof. Shackleton Bailey for Sanskrit.[a]

Three or four years ago it became clear that our working library and its operations had grown so much in size and complexity that a full-time Amanuensis (*chêng chen shu tshao*[6]) or Librarian was needed. For this we first recruited a physical chemist, Dr Christine King (Ting Pai-Fu[7]), who gave us much assistance; being succeeded after some time by a valued former associate, the Japanologist Miss Philippa Hawking. Her organising abilities stood us in good stead during the moves of the library mentioned below. The best Librarians are born, not made, and she is of that company.

Next comes our high secretariat – Miss Muriel Moyle, who continues to give us impeccable indexes; Mrs Liang Chung Lien-Chu[8] (wife of another Fellow of Caius, the physicist Dr Liang Wei-Yao[9]), who has inserted many a page of well-

[a] For further advice on linguistic and cultural matters we are also indebted to Dr Edith Jachimowicz, Prof. R.B. Serjeant and Dr Felix Klein-Franke.

[1] 羅榮邦 [2] 錢存訓 [3] 屈志仁 [4] 許進雄 [5] 太田英藏 [6] 正眞書曹
[7] 丁百馥 [8] 梁鍾連杼 [9] 梁維耀