

Ethnochemical
Knowledge of
Medicinal Metals
and Its Significance
in Modern Medicine

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By

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PREFACE

The intersection of ancient wisdom and modern science has always been a source of fascination and discovery, especially in the realm of medicine. For millennia, various cultures have relied on medicinal metals like gold, silver, copper, and iron to heal and restore health. The knowledge of these metals, passed down through generations, forms a part of the collective ethnochemical wisdom, which is the study of the chemical composition and properties of these metals as used in traditional practices. This book seeks to explore the rich heritage of ethnochemical knowledge in the context of medicinal metals, shedding light on how these substances have been employed in healing practices across the world and how modern scientific research continues to validate and expand upon these traditional uses.

The ethnochemical perspective on medicinal metals not only draws attention to their historical and cultural significance but also provides a deeper understanding of their chemical properties. The therapeutic potential of metals, such as gold and silver, has been recognized for centuries, with uses ranging from the treatment of arthritis and infections to their role in enhancing vitality and spiritual health. By examining the interplay between traditional knowledge and contemporary scientific methods, we are able to appreciate the ways in which these metals interact with biological systems, offering both healing properties and therapeutic advantages.

Through this exploration, we highlight how various cultures, from Ayurveda to Traditional Chinese Medicine, have developed intricate methods to purify, process, and use these metals in their remedies. These techniques, when analyzed through the lens of modern chemistry, reveal a fascinating synthesis of ancient wisdom and cutting-edge scientific advancements. This book also delves into the extraction and processing methods of medicinal metals, exploring sustainable practices used by indigenous cultures, and how these practices can inspire modern-day approaches to the use of metals in medicine.

While the therapeutic properties of these metals have been validated by modern science in many instances, there are still many unknowns. This book touches on the potential of metals in contemporary medical applications, such as in cancer therapies and medical devices,

while also acknowledging the risks associated with the use of toxic metals. The health risks of non-essential metals like lead, mercury, and arsenic, which can lead to organ damage and neurological issues, are critical areas of study as we continue to push the boundaries of their applications.

This work aims to provide a comprehensive overview of the role of metals in medicine, from ancient practices to modern-day applications. As we continue to explore and integrate these valuable elements into contemporary healthcare, we gain not only a deeper understanding of their medicinal properties but also a greater appreciation for the enduring wisdom of traditional medicine. It is through this blending of past and present knowledge that we unlock new possibilities for healing and wellness, bringing us closer to a future where the full potential of medicinal metals is realized.

We invite readers to embark on this journey of discovery, where the ancient meets the modern, and where the potential of medicinal metals continues to unfold in ways that could change the future of medicine.

CHAPTER 1

MEDICINAL METALS AND THEIR ETHNOCHEMICAL PERSPECTIVES

Introduction

Ethnochemistry is the study of the chemical composition and properties of substances used in traditional or indigenous knowledge systems, particularly in medicine, food, and other cultural practices (Semwal and Semwal, 2024). In the context of medicinal metals, ethnochemistry plays a crucial role in understanding how metals, such as gold, silver, copper, iron, and other trace elements, have been utilized in traditional healing practices and how their chemical properties contribute to their therapeutic effectiveness. Historically, various cultures have used metals for medicinal purposes, believing in their healing powers and employing them in rituals, remedies, and therapies. The ethnochemical relevance of medicinal metals lies in the synthesis of traditional knowledge with modern scientific techniques, allowing us to understand the chemical constituents in these metals and how they interact with biological systems (Chibuye and Singh, 2024). The study of medicinal metals from an ethnochemical perspective involves analyzing the chemical properties of these metals, exploring their roles in traditional remedies, and investigating how modern science has interpreted or validated these traditional uses.

Gold, silver, copper, and iron have all been used in traditional medicine for centuries, with gold aiding in arthritis treatment, silver offering antimicrobial benefits in wound care, copper providing anti-inflammatory effects for joint and digestive issues, and iron being essential for anemia treatment, all supported by ethnochemical studies that validate their therapeutic properties. The process of extraction, processing, and application of medicinal metals is another key component of ethnochemistry. By examining the methods used by indigenous cultures to extract these metals from natural sources and process them for medicinal use, ethnochemistry provides valuable insights into the sustainable practices and the chemical transformations that occur in these processes.

For example, ancient civilizations might have used specific methods to purify and prepare metals for use in medicine, techniques that can now be understood through modern chemical analysis.

The modern scientific validation or reinterpretation of the therapeutic uses of medicinal metals is a critical aspect of ethnochemistry. Many traditional uses of metals in medicine have been confirmed by contemporary scientific studies, while others may be subject to reinterpretation based on new chemical and biological evidence. Ethnochemical research continues to explore the potential for these metals in modern therapeutic applications, bridging the gap between historical knowledge and contemporary medical science.

Cultural Significance of Metals

Metals have long held profound cultural significance, both medicinally and symbolically, across various societies. These metals, such as gold, silver, copper, iron, mercury, and zinc, are more than just physical substances; they have been imbued with deep spiritual, therapeutic, and symbolic meanings that have shaped cultural practices and beliefs. In the medicinal context, metals like gold, silver, and copper have been integral to traditional healing systems, often believed to have transformative or healing effects on the body. In Ayurveda and Traditional Chinese Medicine (TCM), gold is revered for its ability to promote vitality, longevity, and energy flow, tied to its symbolism of immortality and purity. Silver, known for its antimicrobial properties, has been used in various cultures to prevent infections and maintain health. Copper, associated with balancing bodily energies, is often worn or used in therapeutic items to relieve conditions like arthritis and inflammation, with many believing it helps restore physical balance and wellness. In some Indigenous American and African healing traditions, copper is used in jewelry or applied externally to enhance energy flow and reduce inflammation. These practices reflect a profound connection between metals, health, and cultural beliefs.

Beyond their therapeutic roles, metals hold significant symbolic and spiritual importance. Gold is universally recognized as a symbol of wealth, power, and divine purity. It is used in religious artifacts, royal regalia, and sacred temples, reflecting its status as an enduring and divine material. Silver, associated with the moon, femininity, and intuition, is commonly used in ceremonies like weddings and religious rituals to symbolize prosperity, protection, and sacredness. Copper, often linked with creativity, transformation, and spiritual growth, is frequently featured

in art, jewelry, and spiritual rituals, representing a connection to the earth and a path to personal and collective transformation.

Metals also have a historical medicinal legacy that extends beyond their symbolic meanings. In ancient practices like alchemy, metals were believed to possess mystical properties that could heal and transform. Mercury, despite its toxicity, was used in various healing rituals due to its perceived transformative and mystical powers. Iron was commonly used across cultures to treat anemia and improve blood circulation, with some cultures adding iron filings to food or drink to "fortify" the blood. Zinc has been used in folk medicine, particularly in Ayurvedic treatments, for its healing properties in treating wounds and skin conditions, as well as supporting the immune system. The study of Ethnochemistry explores how these metals interact with the human body on a molecular level, shedding light on both their therapeutic effects and the cultural knowledge that informs their use.

The cultural significance of metals is therefore multifaceted, encompassing both medicinal and nonmedicinal roles that intertwine with spiritual beliefs, healing traditions, and social practices. Through the lens of Ethnochemistry, we can gain a deeper understanding of how these metals, revered across generations, continue to influence cultural identity, health practices, and perceptions of the body and the natural world (Marasinghe, 2013).

Preparation and Application Methods

Traditional knowledge about the preparation and application of metals for medicinal use is deeply rooted in the practices of indigenous cultures, who developed sophisticated techniques to enhance the therapeutic effects of these substances. These methods often involved grinding, melting, alloying, or combining metals with plants or minerals, reflecting a holistic approach to health that blends both material and spiritual elements. For example, gold and silver were often prepared in ways that preserved their purity and potency. In systems like Ayurveda and Traditional Chinese Medicine (TCM), gold leaf was either applied topically or ingested in powdered form to rejuvenate the body, promote longevity, and maintain health. This preparation method was believed to enhance vitality, acting as a catalyst for energy flow within the body. Silver, similarly, was used in finely processed forms such as silver leaf or powder for similar rejuvenating effects, with its antimicrobial properties believed to help maintain balance and health.

In the case of cinnabar (a mercury sulfide mineral), ancient Chinese medicine illustrates a more complex and alchemical approach. Despite its toxicity, cinnabar was processed through grinding and combined with various herbs to treat ailments, as it was thought to possess powerful restorative and energetic properties. This practice, though dangerous by modern standards, was rooted in the belief that the metal's inherent qualities could transform the body and restore health by stimulating energy flows or balancing vital forces.

These preparation techniques, often passed down through generations, reveal a deep understanding of the natural world. They were not only driven by empirical knowledge of materials but were also integrated with spiritual and ritualistic practices. For example, the alchemical processes used in the preparation of metals were often linked to mystical beliefs, which aimed to purify or activate the metals to unleash their healing potential. Though modern science may not always support the efficacy of these methods, the cultural significance of these practices highlights a profound, intuitive knowledge of the substances and their effects on human health and well-being.

Pharmacological Research and Modern Relevance

Modern pharmacology and biochemistry are increasingly drawing upon traditional knowledge to explore the medicinal uses of metals, particularly those used in indigenous practices, to assess their potential in treating a range of ailments. Researchers are investigating the pharmacological properties of metals like gold, silver, copper, and zinc to better understand how they can be used as alternative or complementary treatments to conventional pharmaceuticals. This resurgence in interest is driven by a growing recognition of the therapeutic potential of metals that have been historically used for their antimicrobial, anti-inflammatory, and rejuvenating effects.

For instance, silver, long valued for its antimicrobial properties in traditional medicine, has been extensively studied in modern medicine for its role in preventing infection and promoting wound healing. Silver ions have been found to be effective in combating bacteria, fungi, and viruses, which has led to their use in modern wound dressings, medical devices (such as catheters and prosthetics), and coatings. The use of silver in contemporary healthcare practices draws directly from its historical application in healing, illustrating how traditional ethnochemical knowledge is being adapted for modern medical use. Similarly, gold compounds, once believed to possess curative properties in ancient systems, have found a

place in contemporary pharmacology. Research has shown that gold-based compounds can be effective in treating autoimmune diseases such as rheumatoid arthritis, where gold salts are used to reduce inflammation and modulate the immune system (Balfourier et al., 2020). This modern application reflects the ancient belief in gold's healing potential, particularly in balancing energies and promoting long-term health.

The integration of ethnochemistry with modern pharmacology is not just about recovering ancient knowledge but also considering the environmental impact of these practices. While traditional methods of preparing and using metals have long been intertwined with cultural practices, their extraction and refinement often come with significant ecological consequences. The mining and refining of metals can lead to the depletion of natural resources, habitat destruction, and the contamination of water and soil, all of which can harm ecosystems and biodiversity. These environmental issues have become a major concern as global interest in the medicinal properties of metals grows. In response to these challenges, ethnochemistry offers valuable insights into more sustainable practices for the extraction and use of metals.

Traditional methods often involve less intensive extraction processes and utilize the metals in forms that are more aligned with local ecological knowledge, such as using plant-metal combinations to enhance therapeutic effects. As modern medicine seeks to minimize its environmental footprint, ethnochemical practices offer alternatives that could lead to more sustainable and ecologically responsible methods of obtaining and using metals in medical treatments. However, the metallic content in all herbomineral and related formulations should remain within the permissible limits prescribed by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) (Bhalla and Pannu, 2022). Moreover, alternative materials, inspired by traditional uses of metals, are also being explored in pharmacology and materials science. For example, researchers are investigating plant-based compounds or bio-derived metals that could serve as substitutes for more harmful synthetic chemicals or metals in therapeutic applications. This intersection of ethnochemistry, pharmacology, and sustainability provides a pathway for integrating traditional knowledge with modern scientific methods, offering promising solutions that benefit both human health and the environment. In other words, modern pharmacological research is increasingly revisiting the ethnochemical uses of metals, revealing their potential in healing, disease prevention, and sustainability. The application of metals in modern medicine not only validates ancient beliefs but also opens the door to more eco-friendly and sustainable practices that align with contemporary needs. As we continue

to integrate traditional knowledge with modern science, the future of pharmacology may be shaped by a more holistic approach to medicine and environmental conservation (Zidny et al., 2020).

Conclusion

The ethnochemistry of metals provides a comprehensive understanding of how diverse cultures have utilized metals for medicinal, spiritual, and practical purposes. This field explores the cultural significance of metals, their medicinal applications, preparation methods, and the deep connections between cultural knowledge systems and health. By examining how metals like gold, silver, copper, and mercury have been employed in healing practices across centuries, ethnochemistry highlights the profound relationship between metals and human well-being. Additionally, modern pharmacological research continues to validate the therapeutic potential of these metals, bridging traditional knowledge with contemporary science. As we move forward, the study of ethnochemistry not only uncovers alternative medicinal practices but also offers insights into more sustainable approaches to using metals, ensuring their beneficial applications while minimizing environmental impact. Ultimately, the ethnochemistry of metals enriches our understanding of both ancient healing traditions and their relevance in modern healthcare systems.

References

- Balfourier, A., Kolosnjaj-Tabi, J., Luciani, N., Carn, F., & Gazeau, F. (2020). Gold-based therapy: From past to present. *Proceedings of the National Academy of Sciences of the United States of America*, *117*(37), 22639–22648. <https://doi.org/10.1073/pnas.2007285117>
- Bhalla, A., & Pannu, A. K. (2022). Are Ayurvedic medications store house of heavy metals?. *Toxicology Research*, *11*(1), 179–183. <https://doi.org/10.1093/toxres/tfab124>
- Chibuye, B., & Singh, I. S. (2024). Integration of local knowledge in the secondary school chemistry curriculum - A few examples of ethnochemistry from Zambia. *Heliyon*, *10*(7), e29174. <https://doi.org/10.1016/j.heliyon.2024.e29174>
- Marasinghe, B. (2013). Ethnochemistry and Ethnomedicine of ancient Papua New Guineans and their use in motivating Secondary School Children and University undergraduates in PNG. Goroka: University of Goroka.

- Semwal, D.K., Semwal, R.B. (2024). *Ethnochemistry: From Traditional Knowledge to Modern Chemistry*. Cambridge Scholars Publishing, Newcastle upon Tyne, United Kingdom.
- Zidny, R., Sjöström, J., Eilks, I. (2020). A multi-perspective reflection on how indigenous knowledge and related ideas can improve science education for sustainability. *Science and Education*, 29, 145–185.

CHAPTER 2

ANCIENT ALCHEMY AND ITS ROLE IN MEDICINE

Introduction

Alchemy, often romanticized as a mystical pursuit to transmute base metals into gold, held a far more profound and influential role in ancient medicine. Rooted in the philosophical and spiritual traditions of Egypt, Greece, India, China, and the Islamic world, alchemy served as a bridge between physical health and metaphysical transformation (Ray, 1967). This manuscript explores the evolution of alchemical practices, their foundational theories, and their enduring impact on the development of medicine from antiquity to the Renaissance.

The ancient discipline of alchemy is often mischaracterized as mere proto-chemistry or esoteric fantasy. However, its role in the evolution of medicine is both significant and complex. Alchemists sought to understand not only the material transformation of matter but also the restoration and perfection of the human body and spirit. Their work laid crucial groundwork for later pharmacology, chemical therapies, and holistic healing systems.

Origin of Alchemy

The origin of alchemy can be traced back to ancient civilizations, where the fusion of material experimentation, spiritual philosophy, and mystical practices gave rise to what we now call alchemy. Emerging initially in Egypt, where it was closely linked to religious and esoteric traditions, alchemy spread to Greece, the Islamic world, India, and China, evolving uniquely within each cultural context. The etymology of the word alchemy itself reveals its Egyptian roots (Moon, 2024). The term is derived from the Arabic *al-kimiya*, which in turn stems from the Greek *khemeia*, thought to be related to the ancient Egyptian word *Khem*, meaning the

black land, a reference to the fertile soil of Egypt and possibly to the concept of hidden or dark knowledge.

Alchemy in its earliest form was not limited to the transformation of base metals into gold, as popularly believed. It was a holistic system encompassing metaphysical beliefs, natural philosophy, and proto-scientific inquiry. In Egypt and later in Hellenistic Alexandria, alchemical ideas were influenced by Hermetic texts, which emphasized the correspondence between the macrocosm (universe) and the microcosm (human). This laid the groundwork for the belief that physical substances could be transformed as a metaphor, and mechanism, for spiritual purification and immortality.

With the expansion of Islamic scholarship, Arab alchemists such as Jabir ibn Hayyan (Geber) preserved and expanded upon Greek and Alexandrian alchemical knowledge, systematizing chemical processes like distillation, calcination, and sublimation, which would later form the basis of modern chemistry (Ur Rehman, 2023). This knowledge was transmitted to Europe during the Middle Ages and the Renaissance through translations of Arabic texts into Latin. Meanwhile, in India and China, alchemy developed with its own philosophical frameworks. Indian Rasayana focused on rejuvenation, longevity, and spiritual liberation, while Chinese alchemy, rooted in Daoism, sought harmony with the cosmos and immortality through both internal practices (Neidan) and external elixirs (Waidan).

Alchemy and Early Medical Philosophy

Alchemy originated in Hellenistic Egypt, where it merged Greek philosophical thought with Egyptian spiritualism and metallurgical practices. Early texts, such as the *Hermetic Corpus*, proposed that all matter, including the human body, was composed of fundamental elements governed by universal laws. This notion echoed in the four humors theory of Hippocratic medicine and the elemental systems of ancient Indian and Chinese medicine. Alchemy also spread through Islamic culture during the Golden Age, where scholars such as Jabir ibn Hayyan (Geber) advanced the concept of medicinal alchemy. His works described practical chemical techniques (distillation, sublimation) used to create medicinal elixirs, influencing both the Islamic world and medieval Europe.

Indian Alchemy (Rasayana) and Its Role in Medicine

Indian alchemy, known as Rasayana, holds a unique and foundational position within the broader framework of Ayurveda, India's ancient system of medicine. Etymologically derived from the Sanskrit word *rasa* (essence or juice), *rasayana* literally means “the path of essence,” signifying its role in rejuvenation, longevity, and transformation of the body and mind. Historically, it was considered one of the eight primary branches of Ayurvedic medicine. Indian alchemy was not limited to mystical or metallurgical pursuits; rather, it was deeply intertwined with the goal of healing and extending life. As early as the 11th century, Persian scholar Abu Rayhan Biruni documented India's *rasayana* tradition as a science focused on rejuvenation and recovery, especially through plant-based medicines. He noted its unique character, distinguishing it from the metallic transformations commonly associated with Western alchemy.

The ancient chemist Nagarjunacharya, a pivotal figure in Indian alchemy, significantly advanced the field through his experimental work conducted in a laboratory called *Rasashala* (Reddy, 2020). His treatise *Rasaratanakaram* provided detailed methodologies for transforming base metals, particularly mercury, into noble substances such as gold. His stature in science and medicine led to his appointment as Chancellor at the famed Nalanda University. Another noteworthy contributor was Nityanadhiya, whose works further deepened the understanding of alchemical applications in healthcare.

The more technical and metallurgically-inclined branch of Indian alchemy is known as *Rasashastra*, often referred to as the “science of mercury.” This tradition emphasized the processing of metals and minerals, particularly mercury and cinnabar, and their use in medicinal formulations. Yet, it also encompassed the development of powerful herbal tinctures designed to restore balance and enhance vitality. The goals of *Rasashastra* and *Rasayana* extended beyond simple healing. They aimed at achieving longevity, cognitive enhancement, virility, youthfulness, and even mystical or magical abilities. These aspirations were not only spiritual but deeply practical, often reflected in the sophisticated techniques for purifying and combining ingredients, and evidenced in ancient cultural artifacts such as the Ajanta and Ellora murals and Kondivade cave samples.

The essence of *rasayana* therapy lies in enriching the body's primary life-sustaining fluids (*rasa*) with nutrients, which in turn promotes: (1) longevity and youthfulness, (2) enhanced memory and intelligence, (3) physical and sensory vitality, (4) clear speech and complexion, (5)

immunity and reproductive strength, and (6) spiritual insight and mental clarity (Chulet and Pradhan, 2009).

Traditional rasayana formulations often included a wide range of components, from herbs to minerals, gems, and animal products, particularly processed mercury (Wujastyk, 2013). Over time, formulas were named and codified, examples being Amrit Rasayana, Brahm Rasayana, Navratna Ras, Makaradhvaj Vati, Suvarna Malini Vasant, Vasant Kusumakar Ras, Mukta Pancharmit Rasayana, Manmath Ras, and many more. These formulations traditionally incorporated pearl, coral, gold, processed mercury, and precious stones, combined through intricate procedures to maximize efficacy and safety. However, modern restrictions, ethical concerns (e.g., wildlife protection), and cost have led to a decline in the use of such potent classical formulations.

Today, rasayana retains its relevance through herbal-based formulations that align with contemporary scientific understanding and safety standards. Key herbal ingredients now commonly used include Amla, Haritaki, Bibhitaki, Ashwagandha, Guduchi, Shatavari, Long pepper, and Brahmi. These ingredients offer adaptogenic, antioxidant, and rejuvenating properties. The shift toward plant-based rasayanas has made these therapies more widely accessible and acceptable in modern integrative and preventive medicine.

In addition to the above Rasayana ingredients, Shilajit, a naturally occurring mineral-rich resin, is among the most common Rasayana. It is widely recognized in Ayurvedic medicine for its rejuvenating and therapeutic properties. While much of the focus has been placed on its organic constituents like fulvic acid and dibenzo- α -pyrones, Shilajit also contains a significant array of metallic elements that contribute to its biological activity. Traditionally, these metals are believed to enhance its efficacy as a rasayana, aiding in tissue nourishment and systemic balance. The metallic composition of Shilajit varies based on its geographical origin, but trace elements such as iron, copper, silver, zinc, lead, and gold are commonly found. Among these, iron is particularly predominant and forms the basis for the most commonly used variety of Shilajit, known as the iron ore type. This type is considered especially potent in balancing the doshas (vata, pitta, and kapha) and is used in treating a wide range of conditions including fatigue, anemia, and diabetes.

Ancient Ayurvedic texts describe different types of Shilajit based on the ores found in the mountains from which it exudes, suvarnaja (gold-bearing), rauopyaja (silver-bearing), tamraja (copper-bearing), and lohaja (iron-bearing). Each type is attributed with specific therapeutic actions; for example, gold-bearing Shilajit is associated with enhancing vitality and

treating disorders related to heat and wind (vata-pitta imbalances), while copper-bearing varieties are believed to alleviate respiratory issues such as asthma.

Modern analytical studies have confirmed the presence of these metallic elements, which often occur in trace but biologically active amounts. These metals may be present in ionic or complexed forms, and they interact with organic molecules like fulvic acid, enhancing bioavailability and cellular uptake. In traditional formulations, this synergistic combination of metals and organics is thought to potentiate the health benefits of Shilajit (Wilson et al., 2011; Carrasco-Gallardo et al., 2012).

Chinese Alchemy and Its Role in Medicine

Chinese alchemy, known as liandanshu, meaning “the method of refining cinnabar,” represents a profound fusion of medicine, spirituality, and cosmology within the traditional Chinese worldview. Rooted in Daoist philosophy, Chinese alchemy focused primarily on longevity, health, and the purification of the body, mind, and spirit. This tradition was not solely about the transformation of base metals into gold but more deeply about aligning the practitioner with the Tao, the ultimate natural order of the universe (Pregadio, 2005).

According to foundational texts such as the Cantong qi, the human body was seen as a microcosm of cosmological processes governed by the Five Elements (Wuxing): Wood, Fire, Earth, Metal, and Water. The observation and internal cultivation of these forces through practices like Qigong, dietary regulation, and alchemical meditation were believed to lead to spiritual harmony and even immortality. Alchemical medicines, known as elixirs, played a crucial role in this pursuit. These substances, including jindan (golden elixirs), were carefully prepared using combinations of minerals, herbs, and animal by-products, with cinnabar (mercury sulfide) and gold being the most revered (Meng, 2021). Due to their resistance to decay and weathering, these materials were thought to transfer their essence of permanence to the human body, thereby extending life or achieving physical immortality.

Chinese alchemy is divided into two main schools of practice: Waidan (external alchemy) and Neidan (internal alchemy). Waidan involves the preparation of physical elixirs through complex laboratory processes, including the refining of minerals like mercury, arsenic, and sulfur, often blended with botanical and animal ingredients. These practices required not only technical knowledge but also ritual discipline,

purification, and adherence to esoteric rules. On the other hand, Neidan emphasizes internal transformation through breathwork, meditation, visualization, and bodily postures. It centers on cultivating the Three Treasures, Jing (essence), Qi (vital energy), and Shen (spirit)—which reside in specific organs and energy centers called dantians. The aim was to harmonize these internal energies, promote spiritual elevation, and ultimately attain a form of immortality from within.

Symbolism was deeply embedded in Chinese alchemical thought. Cinnabar, for instance, symbolized the yang aspect of transformation due to its red color, which in Chinese culture represents life force, vitality, and imperial power. The process of roasting cinnabar to produce quicksilver (liquid mercury) and then reverting it back again was seen not only as a chemical feat but also as a metaphor for the cyclical, transformative nature of life and spirit.

Women also played an active role in Chinese alchemy. Historical records mention several female alchemists such as Lady Fang, who lived in the first century BCE and was credited with techniques for turning mercury into silver. Others, like Keng Hsien-Seng and Sun Pu-Eh, contributed significantly to the development of alchemical knowledge, demonstrating the inclusive and artistic nature of alchemy as both a science and spiritual path.

Despite its lofty aspirations, Chinese alchemy carried significant risks. Many elixirs were toxic, containing substances like arsenic or mercury that could lead to serious health issues or death. However, death itself was often interpreted within the tradition as a potential spiritual transition rather than failure. Some legends describe adepts whose corpses emitted a sweet fragrance or vanished completely, signs that they had attained a higher, immortal state.

Over time, Chinese alchemical practices informed and evolved into key aspects of Traditional Chinese Medicine (TCM), particularly through the processing of herbal and mineral medicines (Pao zhi). Alchemy's legacy continues in practices such as Qigong, internal martial arts, herbal pharmacology, and modern Daoist spiritual cultivation.

Alchemical Medicine and Techniques in Ancient Remedies

Alchemical medicine, rooted in both mysticism and proto-science, represented a profound synthesis of philosophy, spirituality, and early medical practice. Its practitioners believed that disease arose from imbalances not only within the four classical humors, blood, phlegm, black bile, and yellow bile, but also from disturbances in the spiritual or

energetic essence of the human being. Thus, healing was not merely a physical process but a deeply transformative one, akin to the transmutation of base metals into gold. This concept of internal alchemy, or the purification and harmonization of body and soul, lay at the core of ancient medicinal alchemy.

The Philosopher's Stone and the Pursuit of Immortality

Central to the alchemical worldview was the philosopher's stone, often misconstrued in popular imagination as a literal agent for creating gold. In the context of medical alchemy, it symbolized the ideal remedy, a substance capable of restoring health, extending life, and achieving spiritual perfection. The philosopher's stone was considered a metaphor for ultimate healing, representing a unification of the material and divine within the human body. Alchemical elixirs, particularly the elixir vitae or elixir of life, were intended to mirror this ideal, promoting rejuvenation and even immortality.

Techniques of Alchemical Medicine

Despite its esoteric language, alchemy involved real laboratory techniques that pioneered modern chemistry. Alchemists perfected distillation, calcination (heating to decompose substances), sublimation, filtration, and crystallization. They designed specialized apparatus, such as crucibles, retorts, alembics (distillation stills), athanors (self-feeding furnaces), and more. Islamic and European alchemists “developed a basic set of laboratory techniques, theories, and terms, some of which are still in use today”. For example, many early perfumes, alcohols, acids, and pigments were first made by alchemists. Their naming of acids (e.g. aqua fortis, aqua regia) and procedures (e.g. distillation of fermented wine into distilled spirits) influenced later chemists.

In practice, an alchemist's day might involve grinding minerals, heating mixtures, condensing vapors, and watching for color changes or precipitates. Experimental results were recorded in notebooks (often coded with symbols). This empirical approach, though mixed with mysticism, advanced practical chemistry. By the 16th–17th centuries, alchemical techniques had also influenced industry (pharmacy, dyeing, metallurgy). Many names are still used, including alcohol, alkali, elixir, tincture, even alchemy itself, come from this tradition.

processes laid the groundwork for the extraction and refinement of medicinal substances, a practice later adopted in pharmaceutical chemistry.

Elixirs and Tinctures

Elixirs such as aqua vitae were designed to restore vitality and treat diseases of both body and spirit. Many of these concoctions involved herbs, minerals, and occasionally metallic compounds, prepared through intricate procedures that aimed to liberate their hidden, healing essences. The spagyric method, as elaborated by Paracelsus, involved fermentation, distillation, and cohobation to concentrate the therapeutic properties of a substance.

Use of Metals and Minerals

Influenced by the tria prima doctrine, mercury (spirit), sulfur (soul), and salt (body), alchemical physicians believed that these elements formed the essence of all matter, including the human body. Compounds containing mercury, antimony, and arsenic were experimented with as medicines, foreshadowing modern pharmaceutical chemistry, albeit with often dangerous results due to lack of dosage control.

Paracelsus and Iatrochemistry

A pivotal figure in the transition from mysticism to early empirical medicine was Theophrastus von Hohenheim, known as Paracelsus (1493–1541). A controversial but visionary thinker, Paracelsus rejected the classical humoral theory of Hippocrates and Galen, advocating instead for a chemical basis of disease and healing. He proposed that illness was the result of chemical imbalances and introduced the concept of iatrochemistry, the application of alchemical substances to medicine (Michaleas et al., 2021).

Paracelsus revolutionized medicinal thinking by introducing the idea that “the dose makes the poison” (*Dosis sola facit venenum*), a core tenet of modern toxicology. He prepared and prescribed chemical remedies that included mercury, lead, and antimony, which later became standard entries in early pharmacopoeias. His work not only influenced European medicine but also legitimized the use of chemically derived treatments, setting the stage for modern pharmaceutical practices.

Influence on Eastern Medicine

In Eastern cultures, alchemy developed along parallel but distinct lines. In China, two major branches evolved: waidan (external alchemy), which involved creating elixirs from minerals like cinnabar (mercury sulfide), and neidan (internal alchemy), a meditative practice emphasizing breath control, visualization, and cultivation of inner energy (qi). Together, these traditions formed the backbone of Daoist medical alchemy, blending physical health with spiritual transcendence.

In India, the ancient discipline of Rasa Shastra, a specialized branch of Ayurveda, integrated alchemy and medicine. Rasa Shastra used purified mercury (rasa) and sulfur (gandhaka) in complex preparations aimed at rejuvenation, disease treatment, and longevity. Classical texts such as the Rasaratna Samuccaya detail elaborate detoxification processes to render these substances safe for consumption. The goal, akin to Western alchemy, was not just physical healing but spiritual upliftment and vitality enhancement.

Critique and Transition to Chemistry

Over time, the limits of alchemy became clear. Critics from within the tradition pointed out its inconsistencies. Even in the Islamic world, scholars like Al-Razi (Rhazes) and Avicenna argued against transmutation of metals. In Europe, as the Scientific Revolution progressed, the idea of a literal philosopher's stone fell out of favor. Scientists such as Robert Boyle and later Antoine Lavoisier pursued pure experimentation and elemental theory, leaving behind alchemical dogma. By the 18th century, chemistry had emerged as a separate science: the mystical aims were abandoned for measurable reactions.

Nevertheless, the break with alchemy was gradual. As late as the 17th century, "alchemy" and "chemistry" were often used interchangeably. Boyle himself engaged in alchemical experiments (even writing on transmutation) before adopting a mechanistic approach. The 12th-century translator Robert of Chester had noted that alchemy was new to Europe, but by the late medieval era alchemists were widely trusted as metalworkers and physicians.

Gradually, skepticism grew: the elusive goal of gold-making was never achieved, and many alchemical processes produced failures (or poisonings). In the 19th century, atomic theory finally explained why transmutation was practically impossible without nuclear reactions. Yet even today, historians acknowledge that "this late medieval tradition of

alchemy played a significant role in the development of early modern science (particularly chemistry and medicine)". In other words, alchemy's laboratories and methods laid the foundation for modern chemistry and pharmacology.

Legacy of Alchemical Medicine

Alchemy's impact on medicine was profound, especially from the late medieval period onward. In East Asia, the integration of alchemy and medicine was already evident: Chinese alchemists often saw their elixirs as medical treatments. Taoist doctors prescribed metallic compounds (like cinnabar, a mercury ore) hoping to prolong life (tragically, these were sometimes poisonous). In India, rasayana practitioners compiled mineral and herb formulas. Texts like Nagarjuna's Rasendramangalam and Rasaratnakara (10th–13th centuries) gave detailed recipes for preparing metals and compounds as medicine, blending Hindu, Buddhist and Jain ideas.

In Europe, the turning point was Philippus Theophrastus Paracelsus (1493–1541). Rejecting medieval humoral theory, Paracelsus famously wrote that alchemy should not be for gold or silver, "its aim is to consider only what virtue and power may lie in medicines". He pioneered iatrochemistry, using chemicals and minerals to treat disease. Paracelsus taught that the body was a chemical system: illnesses arose from imbalances of sulphur, mercury and salt (his tria prima), and could be cured by the right substances. In practical terms, he introduced preparations of arsenic, mercury, antimony, zinc and other compounds as drugs (for example, preparing cinnabar for syphilis treatment). He even invented medical laudanum (an opium tincture) and used distilled spirits in medicine. His work marked a major shift: the physician became akin to a chemist, dispensing tinctures and elixirs as cures. The Smithsonian notes that Paracelsus "pioneered the use of chemicals and minerals in medicine" and stressed a balance of minerals in the body.

Under Paracelsus and his followers, alchemical medicines spread through Europe. Many Renaissance alchemists were also court physicians or apothecaries. They prepared medicaments from distillation of plants, extraction of metals, and fermentation—techniques learned from alchemy. Panaceas and panacean waters (like aqua vitae) were marketed as universal healers. Although many claims were unscientific or outright frauds, some alchemical remedies were genuinely effective – for instance, distilled spirits and herbal tinctures could sterilize or pain, and some metal salts treat skin diseases. Alchemists' experimental approach also led to early

pharmacological knowledge (the systematic study of drugs). In this way, the quest for the philosopher's stone indirectly advanced drug-making.

Conclusion

In retrospect, alchemy was a bridge between ancient lore and modern science. Its medical legacy is mixed: on one hand, the search for elixirs led to tragic poisonings (e.g. mercury cures) and quackery; on the other hand, it introduced systematic experimentation in pharmacy. Distillation and extraction techniques developed by alchemists are still basic to making modern medicines. The concept of a panacea, though mythical, inspired chemists to find broad-spectrum drugs (we still seek vaccines or antibiotics with “cure-all” effects).

Alchemical thought also lives on culturally. Many alchemical emblems (like the ouroboros or the six-stage magnum opus diagrams) remain potent symbols of renewal and psychological transformation. Psychologist C. G. Jung noted that alchemy's spiritual message – the idea of inner purification and wholeness – continues to resonate: he interpreted alchemical images as illustrations of the psyche's journey toward self-realization. In literature and art, alchemists appear as archetypes of the wise (or foolhardy) seeker.

In sum, ancient alchemy shaped early medicine by expanding the pharmacopoeia, refining laboratory craft, and merging healing with holistic philosophy. Although alchemy's legendary goals were never reached literally, its blend of experiment and mysticism set the stage for chemistry and modern pharmacology. It reminds us that science often grows out of even the strangest quests for knowledge.

References

- Carrasco-Gallardo, C., Guzmán, L., & Maccioni, R. B. (2012). Shilajit: a natural phytocomplex with potential procognitive activity. *International Journal of Alzheimer's Disease*, 2012, 674142. <https://doi.org/10.1155/2012/674142>
- Chulet, R., & Pradhan, P. (2009). A Review on Rasayana. *Phcognosy Reviews*, 3(6), 229-234.
- Meng, S. (2021). Chinese Alchemy. In: Jiang, X. (eds) *The Origins of Sciences in China. History of Science and Technology in China*. Springer, Singapore. https://doi.org/10.1007/978-981-15-7853-3_15
- Michaleas, S. N., Laios, K., Tsoucalas, G., & Androustos, G. (2021). Theophrastus Bombastus Von Hohenheim (Paracelsus) (1493-1541):

- The eminent physician and pioneer of toxicology. *Toxicology reports*, 8, 411–414. <https://doi.org/10.1016/j.toxrep.2021.02.012>
- Moon, Junseo, Alchemy in Ancient Egypt (January 31, 2024). Available at SSRN: <http://dx.doi.org/10.2139/ssrn.4946259>
- Pregadio, F. (2005). Great Clarity: Daoism and Alchemy in Early Medieval China. Stanford University Press.
<https://doi.org/10.2307/j.ctvr0qrvf>
- Ray, P. (1967). Origin and Tradition of Alchemy. *Indian Journal of History of Science*, 2(1), 1-21.
- Reddy, R.G., Sangvikar, S., Potbhare, B., Sharma, S., Shinde, P., Wakode, V (2020). Contribution of Acharya Nagarjuna in Susruta Samhita. *International Journal of Ayurveda and Pharma Research*, 8(3), 79-83.
- Ur Rehman, M.F., Ahmad, M., Noor, M., Kashif, H.M., Ajmal, M., & Gulnaz, H.S. (2023). Contemporary Significance of Jabir Bin Hayyan's Services. *Journal of Positive School Psychology*, 7(6), 1503-1521.
- Wilson, E., Rajamanickam, G. V., Dubey, G. P., Klose, P., Musial, F., Saha, F. J., Rampp, T., Michalsen, A., & Dobos, G. J. (2011). Review on shilajit used in traditional Indian medicine. *Journal of Ethnopharmacology*, 136(1), 1–9.
<https://doi.org/10.1016/j.jep.2011.04.033>
- Wujastyk, D. (2013). Perfect Medicine: Mercury in Sanskrit Medical Literature. *Asian Medicine*, 8(1), 15-40.
<https://doi.org/10.1163/15734218-12341278>

CHAPTER 3

ROLE OF ESSENTIAL METALS IN HUMAN BODY AND THEIR USE IN MEDICINAL PRACTICES

Introduction

Metals have long been integral to medicinal practices, with their role spanning both traditional and modern healthcare. Essential metals are necessary for the proper functioning of the body, and deficiencies can lead to various health conditions (Jomova et al., 2022). In contrast, non-essential metals serve no known beneficial role in the body and may be harmful if exposure occurs in high amounts, often leading to toxicity or other health complications.

In ancient healing systems, metals like gold, silver, copper, and iron were cherished for their therapeutic properties, used to treat conditions such as arthritis, infections, and anemia, while also being associated with spiritual beliefs and vitality (Galib, 2011). Over time, modern medicine has expanded on these traditional uses, incorporating scientific advancements to enhance their applications. Metals such as platinum, titanium, and palladium have become central to cancer therapies, surgical implants, and medical devices.

At the same time, essential elements like zinc, magnesium, and calcium continue to support critical functions in the body, particularly in the maintenance of bone, skin, and muscle health. This progression underscores the ongoing importance of metals, both in ancient practices and contemporary medicine, in promoting healing and addressing a wide array of medical conditions. These metals, many of which are needed in trace amounts, play crucial roles in physiological processes such as enzyme activity, oxygen transport, nerve signaling, and maintaining bone health. The following provides a concise overview of the medicinal roles that various metals play in human physiology.

Iron (Fe)

Iron is one of the most essential metals in the human body, playing a critical role in several physiological functions, especially in the transport of oxygen. It is a core component of hemoglobin, the protein found in red blood cells that is responsible for binding oxygen in the lungs and releasing it throughout the body's tissues and organs. This process is fundamental for cellular respiration, enabling tissues to produce energy and function optimally. Without iron, hemoglobin would be unable to perform its vital function, leading to insufficient oxygen supply to the body's cells (Abbaspour et al., 2014). In addition to hemoglobin, iron is a crucial element in myoglobin, a protein found in muscle cells that stores and releases oxygen during periods of physical activity. Myoglobin plays a pivotal role in ensuring that muscles have the oxygen needed for sustained contraction, particularly during exercise or strenuous physical tasks. This makes iron indispensable not only for basic cellular function but also for maintaining muscle function and stamina.

Iron also plays a significant role in the citric acid cycle (also known as the Krebs cycle), a key metabolic pathway responsible for energy production in cells (Figure 1). During this cycle, iron-containing enzymes help convert nutrients into ATP (adenosine triphosphate), the primary energy source for cells. This energy production is critical for maintaining the body's metabolism and fueling all physiological processes (Oexle et al., 1999).

Several key enzymes of the citric acid (Krebs) cycle are iron-dependent, notably aconitase and succinate dehydrogenase. Aconitase (aconitate hydratase) contains a [4Fe-4S] iron-sulfur cluster that is essential for catalyzing the reversible isomerization of citrate to isocitrate. Succinate dehydrogenase (Complex II), which functions at the interface of the citric acid cycle and the electron transport chain, harbors multiple iron-sulfur (Fe-S) clusters and a heme group that facilitate the oxidation of succinate to fumarate and the subsequent transfer of electrons to the respiratory chain. Collectively, iron in these enzymes serves as a critical cofactor for catalytic activity and electron transfer, thereby supporting cellular energy production and redox balance. In addition to its catalytic role, the iron-sulfur cluster of aconitase also participates in the regulation of cellular iron homeostasis (Morrison, 2021; La Rosa, 2022; Alabduladhem and Bordoni, 2022).