Aufrère, Sydney H., Cale Johnson, Matteo Martelli, and Marco Beretta. "Culture and Science: Gods, Myths, and Religions." *A Cultural History Of Chemistry: In Antiquity*. Ed. Marco Beretta. London,: Bloomsbury Academic, 2022. 117–143. *Bloomsbury Collections*. Web. 26 Apr. 2023. <<http://dx.doi.org/10.5040/9781474203746.ch-004>>.

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CHAPTER FOUR

Culture and Science: *Gods, Myths, and Religions*

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EGYPT

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It is almost impossible for anybody who has had the opportunity to review what remains of the ancient Egyptian text corpus – over 4,000 years of Pharaonic culture – to claim that they can offer the reader a coherent description of ancient Egyptian culture, from both a geographical and a temporal point of view. What was valid in one time period or in one region was no longer valid later or elsewhere, except by contamination from local theologies more powerful than others.

The basis of Egyptian culture rested on a mytho-scientific perception of the world (see Chapter 1) from the infinitely large to the infinitely small. In this culture, knowledge was always associated with gods or other emblematic characters. In fact, the expression of such a culture and the choice of divine or human beings recognized for having forged it varied over time and according to local traditions. In a very early period, considering the gods and the emblematic characters as the precursors of knowledge, the clergy initiated, perfected, and gradually imposed an association with the divine, which varied with their degree of connection with knowledge kept secret in privileged intellectual spheres. Memphis undoubtedly played a leading role in this domain. From a general

point of view, the Greeks considered this traditional knowledge as reflecting the many philosophies peculiar to the Egyptians (Aufrère 2016b).

The origin of this knowledge supposedly transmitted to men was sometimes based either on the intervention of the divine or on a fortuitous discovery. Diodorus Siculus (*Bibliotheca historica*, I 86, 8; see Clement of Alexandria, *Stromata*, VI 4, 36, 1) recorded a legend that, in ancient times, the *Sacred Book* (*hiera biblos*) – the name designating the corpus of religious texts – was brought to humankind by a falcon descending from heaven, which is the reason why the hierogrammatists – the most learned men – bore a frontal head band on which two straight falcon feathers were attached on each temple. This legend already figured in hieroglyphic texts, especially in the temple of Edfu, where the *Divine Book* (*medjat netjer*) – the equivalent of the *Sacred Book* of the Greeks – is said to have fallen from the sky (*Edfou* VI, 6, 4; Sauneron 1983: 84–5). Such legends explain the miraculous discovery of renowned medical formulas. According to the London Medical Papyrus (British Museum, inv. no. EA 10059, l. 25), a formula written on a papyrus, illuminated by a moonbeam (Bardinet 1995: 35), appeared during the night at the bottom of a window of the Temple of Coptos.

That the names of the gods, kings, and men associated with the spread or the mastery of this culture are given hereafter is not to suggest that it was a coherent ensemble, but only to tentatively give meaning to it without going into the complexity of a chronological presentation. The elements gathered here should not lead us to believe in a systematic Egyptian distribution of sciences (Sauneron 1967: 111–70; Aufrère 2016b). As it was extremely difficult to trace the origin and know-how of those techniques used, which were strictly regulated (see Chapter 6, p. 166), humans had to invent gods, wise men, preservers of knowledge, or legends to explain their divine origin. Learned gods and wise men involved in techniques of production were asked to intervene only in specialized circumstances. Likewise, according to traditions often referred to in the texts, sovereigns and “emblematic” characters intervened only as mediators of the knowledge that was inherited from the gods. *A priori* it is not necessary to distinguish between the learned gods and these owners of techniques. Generally speaking, if the gods excelling in creation were polymaths, it is nonetheless possible to highlight the specialized contexts in which they intervened. Beside the abovementioned cultural approaches, the Egyptians also had concepts involving cognitive functions (memory, *phasis*, praxis, *gnosia*, executive functions). These deified concepts underlay creators’ thought, such as Hu (for the creative verb), Sia (for intuition or perception), and Heka (for magic power). The mastery of knowledge, in the Egyptian sense of the word, rested on these three deified concepts. They are at the heart of the theological systems built around creator gods such as Atum-Rē in Heliopolis, Ptah in Memphis, Thoth in Hermopolis, and other creator gods whose clergy had elaborated as many complex philosophico-theological concepts as their predecessors: Amun-Rē of Karnak, Khnum of Esna, Horus of Edfu, and many others.

Like the Greek gods, Egyptian gods were associated with activities of craftsmanship influenced and favored by the theologies in competition with one another. Creative thought was conceptualized under the guise of skilled activities the gods were supposed to have mastered. Craftsmanship, which requires intrinsic qualities and stimulates the intervention of the senses and a knowledge of the interactions between materials and substances, is set up as a model of intellectual activity (Traunecker 2004). Like Ptah and Khnum, other gods dealt with concepts involving biological transformations or alterations. Their role was to control the interaction between the human body and certain substances.

A Memphite tradition specializing in metalwork mentions that Ptah and Sokaris, who the Greeks considered to be the equivalents of the divine blacksmith Hephaestus, were both experts in the manufacture of military equipment (Sauneron 1954) and in goldsmithing. Khnum, worshipped in Elephantine and in Middle Egypt, was known as a land surveyor (Barguet 1953) and a divine potter. As a craftsman god, creating human beings on his potter's wheel, he was a connoisseur of shapes and became a god of sculptors. A local aspect of this god – Khnum of Shashotep – specialized in the creation of animals (Sauneron 1964: 33–7).

The god Min, lord of the Eastern Desert, worshipped in two cities – Panopolis and Coptos – was regarded as an expert on precious metals and minerals. The texts describe him as crossing the deep desert, searching for mines and quarries. In the Greco-Roman period, he became merged with Pan of the Desert, to whom some of his prerogatives were attributed (Cuvigny 1997; Aufrère 1998d).

Anubis, “head of embalmers,” oversaw all operations relating to the preparation of the deceased before burial, an activity that demanded mastery of many chemical processes. His main role was to prevent the putrefaction of the body through the use of products described at length in the *Ritual of Embalming* (Sauneron 1962b; Goyon 1972: 17–84). A recently published papyrus (*P.Louvre*, inv. no. E 32847; Bardinnet 2017: 221–2) testifies to the care given to the preparation of the body by the embalmer, who was seen as a manifestation of Anubis, as this quotation explains:

I am Anubis, the one who heals (in) the Place of Embalming, the divine embalmer in the Secret Place. I came to cover [with strips] the parts of the body at risk of decomposition, to cure the burned parts and to take care of the necrotic parts which occur after the death.

(Bardinnet 2017: 213)

Persons bitten by poisonous snakes or stung by venomous spiders or scorpions were placed under the protection of the goddess Serket. The professional title of “Conjurors of Serket” (Känel 1988) given to these physician–magicians implies

that the goddess inspired the treatment they administered to patients to lessen the toxicity of the venoms; she put at their disposal an important pharmacopoeia along with the recourse to magic evoked in the second part of the ophiological Papyrus Brooklyn Museum, inv. no. 47.218.48 and 85 (Sauneron 1989), as well as in the Papyrus Brooklyn, inv. no. 47.218.138 (Goyon 2012). This latter papyrus also describes how to counteract the potentially lethal toxicity of the venomous bites and stings of serpents, arachnids, and insects.

According to five classical authors, Apis, the sacred bull of Memphis, was considered to be the god of the origin of medicine, thus bringing this art back into the Memphite sector. One of the reasons for this choice was that the sacred animal, venerated in the Serapeum of Saqqara, pronounced oracles in favor of the healing of patients (Aufrère 2001c: 98–9). However, it is worth mentioning that the deceased patient's corpse also required the specific care of the embalmers, thus suggesting that this may have had some influence on the efficiency of the pharmacopoeia. Among the names of its gods or sacred animals (Ptah, Apis) mentioned in connection with medicine, Memphis particularly highlighted men having reached the rank of deity (Imhotep-Asclepius, considered as the son of Apis), and even kings, as will be discussed below. Memphis thus became by tradition the cradle of science and technology.

Several deities related to production are attested as well, among which are Sekhet and Heb, two divine concepts related to field products and those of hunting and fishing, activities that required the implementation of a conservation process (Meeks 1971: 27). Two other deities, Tayt and Hedjhotep (Meeks 1971: 27–8), were responsible for fabrics and weaving, as well as dyes. Two leonine deities, Shesmu and Bastet, were responsible for the manufacture and conservation of perfumes. It may also be that the association of Bastet (𓆎𓅓𓏏𓏏) with perfume was arbitrary, based on the fact that a cylindrical vessel (𓆎 phonetic value *bas*) features at the beginning of her name, a vessel that, since the most ancient times, was used to prepare oils and perfumed ointments. Shesmu, god of the wine press and of grape-treading (𓆎𓅓𓏏𓏏) – depicted by the initial hieroglyph that suggests a traditional device to extract oil or must – also played a role in all activities requiring a treading operation, whence his importance in wine production and in the preparation of oils, ointments, and perfumes (Meeks 1971: 28–30; Cicarello 1976). This explains why the name of this god was often mentioned in the sacred laboratories. The goddess Menket was in charge of the manufacture of beer and of fermented beverages in association with another goddess, Tenmet (Meeks 1971: 30), while crops and harvesting (especially grapes) were under the responsibility of Thermouthis and Neper (Broekhuis 1971; Meeks 1971: 30–3).

The model of the divine savant on whom the other gods depended is unquestionably Thoth, a Greek transcription of the Egyptian name *Djehouty*. As

FIGURE 4.1 Tayt, goddess of the dyeing process. Eastern staircase of the temple of Dendara. © Sydney H. Aufrère.

a scholar, he was the heir of Rē', the original holder of knowledge, when the latter decided to leave earth to flee from humankind and reach the sky. Hence, Thoth, in terms of divine administration, became the vizier of the Sun (Yoyotte 1977; see Diodorus Siculus, *Bibliotheca historica*, I 17, 3; Guilhou 1989: 14; Osing 1998: 173, 174, n. d; Aufrère 2007: 234). That was why he sometimes merged with the Sun in the form of Thoth-Rē'. The inventor of the divisions of time and of the calendar as time master, and consequently of calculation and writing, he was the scholar par excellence. In a country where priests used theological wordplay (Sauneron 1967: 123–7; Aufrère 2018), a fanciful Egyptian etymology given in the texts of the temple of Esna about the name of Thoth associates him with bitterness (Sauneron 1961: 234–5; Sauneron 1968: no. 206, 11, p. 33, 2). It is most likely that Thoth was associated with the idea of separating and recomposing the elements, which he did as master of the divisions of time and the calculation of fractions of bushels of cereals, represented by the different elements composing the eye of Horus (𓃹) (Aufrère 2007: 235–9). Thoth, with his daughter Isis – who then transmitted the knowledge to her son Horus – regulated the natural processes and ensured their coherence and harmony. This was contrary to Seth-Typhon, who caused emotional chaos among the gods

FIGURE 4.2 Text associated with the goddess Tayt. Eastern staircase of the temple of Dendara. © Sydney H. Aufrère.

resulting from the scattering of divine body fluids; these were substances that played an indispensable role in Egyptian thought and showed a parallel with atomism. These divine fluids dispersed by this god of chaos had to be reunited by the upholders of science for the benefit of the other gods (see Chapter 1).

In the Late Period, Thoth was credited with all human knowledge and as the inventor of the properties of plants (*pharmaca*; Aufrère 2007: 246–7). Indeed, Thoth was considered a master in the art of medicine, although Egypt also accepted gods skilled in different types of care, such as Duau and Khentyenirty. Khonsu specialized in the treatment of tumors (Bardinet 2017: 99–209). The animals dedicated to Thoth, the African sacred ibis (*Threskiornis aethiopicus*) and the hamadryas baboon (*Papio hamadryas*), presided over purity, regularity, calculation, and intelligence. Redefining the nature of the sharing of knowledge from one generation to the next, Greek thought provided a model that was more in line with philosophy. Thoth, assimilated by the Greeks to Hermes, was soon regarded as the one who passed on his knowledge to his daughter Isis through apprenticeship – following the Greek educational model (*paideia*) – replacing the traditional Egyptian model in which the goddess stole the knowledge of her father by violence and cunning (Aufrère 2016a). According to Plutarch’s *De Iside et Osiride* (2, 351E; Froidefond 1988: 179), Isis became a goddess philosopher (i.e. a goddess associated with knowledge in general, including philosophy). She presided over *physis* (Latin *natura*; Hadot 2004) after reaching the same level of knowledge as her father, according to the hymn devoted to her. The Greek traditions associating Thoth with writing and science were prefigured in an Egyptian tradition in which Thoth played the role of “ritualist magician” in the divine government or “the assembly of the gods.” This role was that of a “hierogrammat” for the Greeks, a function considered as that of a man of great erudition, well beyond the simple framework of religious knowledge but always under its control (Gardiner 1938).

Scenes depicting offerings made during the Ptolemaic and Roman periods show that in priestly thought the pharaohs were considered as providers of products for cult purposes and acted like the gods they represented. Thus kings, representing prospectors or operators of mines and quarries, acted as if they were the god Min of Coptos, and they represented oleoresins and perfumes as if they were Shesmu.

Nevertheless, some kings were associated with a tradition of important epistemological rupture points. Indeed, in the epitome of one of his works known as *Aegyptiaca*, Manetho of Sebennytyos, an emblematic figure who became a broker of knowledge, presented the history of the Egyptian kings (Waddell 1980), mentioning the names of some relevant sovereigns. King Athothis, of the First Dynasty (3150–2925 BCE), is said to have practiced medicine and written a book on anatomy (Fragments 6–7a–b; Waddell 1980: 30–3). King Tosorthros of the Third Dynasty (2700–2625 BCE; i.e. Djoser, for whom the Step Pyramid in Saqqara was built) was considered to be the inventor of the art of hand-hewed stone building, to have practiced medicine, and to have been skilled in writing.

However, this is a late interpretation, since Egyptian tradition attributed the knowledge of stone architecture to Imhotep, considered in the New Kingdom

as “the inaugurator of the stone” (*up iner*, literally “The one who opened the stone”; Lauer 1985). Imhotep was also associated with writing and the practice of medicine, which is why the Greeks, who transcribed his name as Imouthes, compared him to Asclepius. Moreover, by Ptolemaic times the names of Imhotep – omniscient scholar, able to read the books of the past and foresee the future – and Djoser were already associated by an age-old tradition. Indeed, in the story written in Ptolemaic times by the clergy of Elephantine and reported in the *Famine Stela* located on Sehel Island, they were cited as witnesses of a famine caused by the droughts of the Nile (Aufrère 2003).

From the Saite era (Twenty-Sixth Dynasty, 663–525 BCE) onwards, and reconnecting with the distant past, the same Imhotep was revered on several festive days (Gauthier 1918). He was represented wearing the skullcap of the ancient Memphite architects, sitting with dignity on a chair equipped with a splash back, writing on papyrus. This representation gave him an intellectual power related to writing and thinking, like his father, Ptah. According to the Royal Canon of Turin (fragment 40; Gardiner 1959: pl. ix), this character, as evidenced from the Nineteenth Dynasty (1295–1188 BCE) on, was the main craftsman-god of Memphis. Hymns chanted his character as a healing god – often associated with Amenhotep son of Hapu, or, according to the Greeks, Amenotes, another holy revered figure (Sauneron 1963; Kerchoue 2012: 50–1; Quack 2014). Imhotep even figured in demotic Tebtynite documents (second century CE) debating with the king on subjects of common interest, possibly intellectual.

Manetho also identified King Suphis – also known as Khufu, whom Herodotus named Cheops – as, if not the author, at least the one who ordered the compilation of the so-called *Sacred Book* (*hiera biblos*; Jacoby 1923: 3, no. 609, F 3b; Aufrère 2012a: 332), which contained all the ancestral, scientific, and religious knowledge available to the Egyptian priesthood. Thus, next to a tradition recalling the marvelous by describing a book fallen from the sky (cf. *supra*, p. 114), the example of Suphis showed that the acquisition of knowledge resulted from a long process consisting of the compilation of cultural data across many centuries and preserved up to Greek and Roman times. According to Clement of Alexandria, who read the writings of Chairemon of Alexandria (first century CE), an expert on the customs of Egyptian priests, this compilation embraced both religious and technical data. According to Clement and other classical authors, Thoth was considered to be the author of forty-two books. Thirty-six of them dealt with priestly knowledge, under the authority of high-ranking priests. The other six dealt with medicine under the supervision of pastophors, the only ones who could connect with the public. These books fell into the category of the so-called *techne* (Latin *ars*). Moreover, it was not uncommon for traditions to turn to Cheops, claiming that certain cultural facts or legendary events had taken place under his reign (Chassinat 1928; Daumas

1953; Daumas 1973: 7–20), giving him great notoriety. Cheops also appeared repeatedly in the late Hellenistic alchemical literature. The historiographical tradition about Suphis/Cheops in Manetho's work was undoubtedly at the origin of the emergence of the *True Book of Sophe the Egyptian*, sometimes attributed to Zosimos of Panopolis (Mertens 1995: lxvii–lxix), a work that would have dealt with science and wisdom.

We have shown the importance of holy personalities such as Imhotep and Amenhotep son of Hapu, archetypes of the scholar (Wildung cf. *supra*, p. 120). Although they originated from Memphis and Thebes, respectively, they became healing gods of all Egypt. These two intellectual personalities became leading figures of Egyptian culture in the Greek period (Bataille 1952: 98–102). Apart from his status as a writer, Manetho of Sebennytyos was one of those emblematic characters related to Egyptian culture who, for the Greeks, transcended previous models. He acted as an intermediary of Egyptian priestly culture by translating the *Sacred Book* into Greek (Aufrère 2012a; Aufrère 2014). Among the works attributed to him, there is a book entitled *About the Kyphis*, the kyphi being a complex perfume, the recipes for which were known, at least in fragments, by Plutarch and other classical authors (Aufrère 2005a: 246–53). The use of the plural in the title of this work of Manetho seemed to imply that Plutarch, mentioning both solar and lunar kyphis (Plutarch, *De Is. et Os.* 80 383C–4C; Froidefond 1988: 249–51), said to be made of different components, probably referred to this author, and thus indicated that this perfume could have been available in different varieties.

In the Late Period, King Nechepsos or Nechepso, etymologically speaking “Necho-the-scientist” (*Nekau-pa-shesa*), emerged as a “scientist” because his model, Necho II (610–595 BCE), had taken part in the observation of an astronomical event. If Nechepsos was knowledgeable about the astronomical sciences (Fournet 2000; Heilen 2011; Ryholt 2011), it is possible that he may also have mastered other scientific domains. This was true of Petosiris – related to Nechepso (Heilen 2011) – an important personality mentioned in ancient texts without being associated with any technology. Similarly, Cleopatra (VII) (50–30 BCE), recognized for her great learning, was also traditionally known for her mastery of the art of poisons.

Egypt has historically been considered as the land of chemistry and of alchemy (Aufrère 2001d). This tradition stems from the important role played by the abovementioned personalities (Aufrère 2001d). Some believe that the Greek word from which “chemistry” derives, *chēmeia*, may have come from the original Egyptian term designating Egypt, *Kemet*, “the black country.” This phrase refers to the color of the arable soil after the annual flood of the Nile due to the silt deposited by it. This land was constantly an object of astonishment for the authors of antiquity who, favoring the wonderful facts, observed that this country changed throughout the year and was subjected to extreme heat, to

which the virtues of plants were attributed. But the country also provided many magicians and physicians, not to mention its funeral practices, its ointments, and its complex perfumes that, according to immemorial tradition, it perfected in the laboratories of its temples, or the privilege of providing useful substances. It is therefore not surprising that this country was considered par excellence as the region where alchemy – an aspect of technical hermeticism (Aufrère 2021a: 118) – was born.

MESOPOTAMIA

Cale Johnson

All major forms of technical or specialized knowledge in early Mesopotamia were routinely traced back to the gods. This is the starting point for many discussions of the origin of science and technology in early Mesopotamia, including Tikva Frymer-Kensky's still groundbreaking work *In the Wake of the Goddess: Women, Culture and the Biblical Transformation of Pagan Myth* (1992). Where Frymer-Kensky differs from others is in her recognition and emphasis on the earliest history of domestic technologies (including a wide variety of kitchen chemistry and domestic forms of production) and their relationship to an array of female goddesses in early Mesopotamian thought. Whether weaving, brewing, pottery-making, bread-baking, or midwifery, each of these domestic technologies was paired with a goddess and given a fixed place in the universe of Mesopotamian technical knowledge.

Among the most important of the Sumerian literary texts in Frymer-Kensky's account is a decidedly curious conglomerate of mythological vignettes known today as *(The Myth of) Enki and Ninhursag*. Enki is the male deity of fresh water, semen, and technical knowledge, while Ninhursag is the most important of the Mesopotamian mother-goddesses, so little wonder that one of the central preoccupations of the text is birth as a generative device and the womb as the primary site for transformational processes. Enki's ever-fecund semen is the nondescript protagonist that runs through the different vignettes that make up the text. In the key episode Enki impregnates Ninhursag, who easily gives birth in nine days, rather than nine months; Enki then impregnates each subsequent daughter so as to form a matrilineal genealogy. However horrifying this little tale is to us today, it had its purposes in the mythology and reaches its denouement with Uttu, the spider-woman goddess, who is also the goddess of weaving and the domestic loom (not to be confused with the sun-god Utu). Each goddess in the matrilineal line has a smaller "womb" (Sum. *ša₃*) than the one before, and part of the mythology is rooted in a pun or orthographic decomposition of the word for "(agricultural) field" (Sum. *a.ša₃*), which combines the words for "water, semen" (Sum. *a*) and "womb" (Sum. *ša₃*). This pun is combined with a

series of ever-smaller geographical units that are embedded within the names of the female deities – from “mountain range” (Sum. *hur.sag*) in *Ninhursag* down to the logogram for “textile” (Sum. *tug₂*) in *Uttu*’s name – so that the size of each female deity (and consequently her womb) decreases as we move down the genealogy to *Uttu*.

Uttu is special, however: she is the goddess of weaving, which is both the epitome of civilization and domestic production and, more importantly (in the logic of the myth), she is the last of the matrilineal line to be impregnated by *Enki*. With the pregnancy of *Uttu*, her womb is too small to allow for the easy delivery of her female progenitors and *Ninhursag* has to extract *Enki*’s semen from her womb and cast it onto the ground. From this repossessed semen of the god of technical knowledge and subterranean waters, a series of medicinal plants grow. *Enki* and his vizier *Isimud* go about examining the plants: *Isimud* cuts a sample of each plant, *Enki* tastes it, and, in the end, *Enki* confirms that various medicinal properties now reside “within” (Sum. *ša₃*, yet again), and in doing so he “determinates the fate” (Sum. *nam.tar*) of each plant. Some of these plants (or drugs) remain part of the Mesopotamian medical tradition down into the first millennium BCE.

Besides an etiology of disease and the treatment of illness through medicinal plants, which follows in the next section of the myth (and recapitulates several themes from the Enochic myth of the fallen angels; see Martelli’s discussion in the next section), the real importance of *Enki and Ninhursag* lies in its depiction of *Enki* and his vizier working their way through a list of medicinal plants. The dialogue goes something like this:

(*Enki* says to his vizier): “Which is this one, which is that one?”

(*Isimud*, the vizier, answers): “Master, the wood-plant,” as he plucks it and *Enki* eats it.

(*Isimud*): “Master, the honey-plant,” as he pulls it out of the ground and *Enki* eats it.

(*Isimud*): “Master, the ... plant,” as he plucks it and *Enki* eats it.

(*Isimud*): “Master, the a-numun plant,” as he plucks it and *Enki* eats it.

And on it goes in a perfect rendition, literally *avant la lettre*, of a junior scribe reading a technical vocabulary to his teacher. Lexical lists like this were the central epistemological device (and preoccupation) of Mesopotamian scribes, scholars, and savants in the cuneiform record, and the list of medicinal plants that appears in *Enki and Ninhursag*, lines 190–7, provides the organizing matrix for *Enki*’s assignment of a destiny to each plant, a destiny that represents the function or pharmaceutical effectiveness of each plant/drug. This list also sets in motion, as it were, a series of alignments between medicinal plants, the parts of *Enki*’s body that become diseased as a side effect of ingesting his own semen,

and a series of minor deities that Ninhursag “births” in the process of removing these diseases from Enki’s body. Keith Dickson, building on a model that Bruce Lincoln developed for Indo-European materials, argues that these list-mediated parallels “establish ... what Lincoln calls ‘homologous alloforms’ involving specific things – plant, body part, ailment, divinity – whose correspondences implicitly underwrite a magic-medical pharmacopeia” (2005: 501).

If *Enki and Ninhursag* presents us with a justification or etiology for the pharmaceutical effectiveness of plants (and the prescription recipes that include them), the final section of a mythological text known variously as *Lugal-e* or *The Exploits of Ninurta* offers a quite different picture of the “destiny, fate, or function” (Sum. nam.tar) of stones and minerals. Growing out of a long-standing tradition of dragon-slayer myths in Mesopotamia (Karahashi 2004; Gilan 2013), *The Exploits of Ninurta* pits the male warrior-god Ninurta against a monstrous opponent known as Asag. With the defeat of Asag, his army of stones is cast into a heap and forms the Zagros Mountains, described as a range of mountains (and not incidentally using the same Sumerian term [Sum. hur.sag] that forms Ninhursag’s name – the text is in part an etiology of her name as well). These are the foothills and mountains that run along the northeastern side of the Mesopotamian alluvium; it was through this mountain range, in one way or another, that nearly all stones and minerals reached Mesopotamia. At the end of the text, each of the important types of stone are presented in a litany in which the characteristic features of each stone are described in poetic terms and their fate determined, largely on the basis of whether or not they fought against Ninurta or remained neutral in the fight.

Whereas the powers of medicinal plants were ascribed to earth/netherworld (“chthonic”) or astral deities or both, the stones and minerals participate in a somewhat different apotropaic tradition of preventing ill effects and attacks of all kinds by placing the statues of defeated enemies along the exterior of a temple – the same tradition that locates the famous genii at the entrances of Neo-Assyrian palaces. Within both medical and magical practice, however, these apotropaic stones were gathered into a pouch and placed around the patient’s neck in the hope of preventing illnesses that did not easily respond to pharmaceutical treatment. These descriptions represent one of the earliest catalogs of stones and minerals in human history, but it is equally clear that the “fate” of each stone is also based on its mineralogical properties. The king of the stones, interestingly enough, was the “plant” stone (Sum. ^{na4}u₂), and we can now be quite certain that the “plant” stone is emery, made king of the stones because of its ability, in combination with a metal carrier such as lead or a copper drill bit, to grind away all other forms of stones, particularly in the fashioning of cylinder seals (Gwinnett and Gorelick 1987; Heimpel et al. 1988; Simko 2015).

These two well-known myths – *Enki and Ninhursag* and *The Exploits of Ninurta* – seem to complement one another, providing us with a mythic overview

of the two most important domains of chemical practice in ancient Mesopotamia. Unfortunately, there is no evidence that these two contemporaneous pieces of mythology were in any kind of intertextual dialogue. Both were likely composed in the Ur III period (ca. 2112–2004 BCE), although elements of *Enki and Ninhursag* are far older. The key observation of Heimpel et al. (1988), now updated and extended back to the Ur III period in a recent paper from Simko (2015), is that the depiction of the “plant” stone in *The Exploits of Ninurta* aligns perfectly with the growing use of emery as an abrasive in the Ur III and Old Babylonian periods (ca. 2100–1600 BCE). Unlike the other stones that figure in *The Exploits of Ninurta*, the “plant” stone operates in much the same way as the plants that appear in medical recipes: ground up in various ways, plants/drugs (Sum. u_2 = Akk. *šammu*) were typically soaked in a liquid carrier under the stars to release their pharmaceutical powers and ingested by the patient in one way or another. Likewise, the power of the “plant” stone (viz. emery) is released in its ground form, when it is capable of drilling or polishing harder stones such as hematite. And this intrusion of a medical model of effectiveness into the world of the lapidary also rebounds in the other direction as well, for, like us, “calculi” such as kidney or bladder stones within the human body were also known to the ancient Mesopotamians as “stones” (Sum. na_4 = Akk. *abnu*), and emery is also found as the decisive ingredient in medical recipes for the destruction of “stones” within the human body.

If the mythological models that we looked at a moment ago were meant to explain the effectiveness of plants, stones, and minerals against disease and/or misfortune, the Mesopotamian mythological tradition also carved out distinct domains of technical practice and assigned each of these domains to a specific deity. Older links between domestic forms of technical production and mother-goddesses, as outlined by Frymer-Kensky, may have been the inspiration for this categorization of the technical universe, but there are no direct continuities. The new categorization comes into existence in the Ur III and Old Babylonian periods and is represented by the Sumerian term *me*. The term itself is the stem of the verb “to be” in Sumerian (although it also seems to function as a sign for priestly offices in early cuneiform), but it is reified as a specific domain of knowledge (or even as an emblem standing for such a domain) in Sumerian mythological texts like *(The Myth of) Inanna and Enki*. This is the same Enki who figured centrally earlier in this section, but now paired with Inanna, the goddess of love, war, and chaos, who was left out of an earlier cosmogony of crafts and skills in *Enki and the World Order*. The mythological narrative *Inanna and Enki* tells how Inanna, goddess of the great cosmopolitan center of Uruk, talks a hundred or so of these *me* out of Enki, who represents the even more ancient urban center of Eridu, while they were both deeply inebriated. When Enki wakes from his drunken stupor, he tries to get the *me* back, but to no avail.

The list of cultural and technical skills represented by the *me*, now shifted to Uruk, provides us with a unique native picture of how the Mesopotamians conceptualized technical domains at the end of the second millennium BCE. Most of the *me* deal with religious and/or political offices and the insignia and chief concepts associated with these offices, but items 65–72, in Farber-Flügge’s enumeration (1973: 56–9, 112–13), should be familiar from our discussion of the workshops in Chapter 3:

Items 65–72 in the list of *me* in *Inanna and Enki*

65. nam.nagar	“carpentry”
66. nam.tibira	“sculpture, fine metalworking”
67. nam.dub.sar	“tablet-writing, scribalism”
68. nam.simug	“metalworking, smelting”
69. nam.ašgab	“leatherworking”
70. nam.azlag _x (LU ₂ .TUG ₂)	“laundering”
71. nam.šidim	“construction work”
72. nam.ad.kub ₄	“reed work”

All eight of these technical domains are represented by the name of a profession preceded by the *nam- prefix, which marks abstract nouns in Sumerian. Thus, the *me* can be conceptualized as demarcated bodies of technical knowledge that originate with the gods, but over time were devolved to groups of human technical specialists.

The most intriguing way in which Mesopotamians, particularly the scholars and teachers in the Tablet House (viz. the primary locus for training students in cuneiform and Sumerian literature), conceptualized domains of skill or activity, technical or otherwise, in the Old Babylonian period was through the composition of dialogues between two protagonists that subdivide a particular domain: *Hoe and Plough* (agricultural tools), *Summer and Winter* (seasons), *Ewe and Wheat* and *Shepherd and Farmer* (both concerned with agricultural production), and, among a number of others, *Copper and Silver* (metals; see Vanstiphout 1991: 25–6). But when we actually look at the content of these debates, they never delve into technical language or process. The hoe addresses the plough in what is a competition between a simple tool that can do many things (the hoe) and a complex tool that can do only one (the plough), and it is clear that these texts are oriented to the schoolboys in the Tablet House rather than a technically knowledgeable audience.

***Hoe and Plough* 12–15**

You cannot heap up the earth in the basket,
 You cannot press clay or make bricks,
 You cannot lay foundations or build a house,

You cannot strengthen the base of an old wall.

(Mittermayer 2009: 110–11; transl. after Vanstiphout 1984: 421)

And even in *Copper and Silver*, where we might expect a flourish of technical terminology and description, the texts, which are admittedly difficult to construe, do not go in that direction. Overall, then, in the Old Babylonian period at least, it is fairly clear that the technical crafts, which were assigned a *me* in the mythological texts, were not given a place in the nonspecialist surveys made available in the debates. There was, in other words, a clear contrast between specialist crafts that appear in mythological texts (and were devolved from the gods) and ordinary, nonspecialist knowledge, which is not traced back to the gods.

When we turn to the later phases of Mesopotamian history, many of the traditional means of transmitting and categorizing knowledge, which had shown substantial continuity from the end of the Early Dynastic period down into the Old Babylonian period (ca. 2400–1600 BCE), ceased or were fundamentally reorganized at the end of the Old Babylonian period. The dependence of first-millennium BCE scholars on far older intellectual traditions was conceptualized, for the most part, in terms of material “from before the Flood.” References to this idea occasionally occur in the midst of an otherwise unexceptional medical text, such as AMT 105/1, line 22 (Lambert 1957: 8), or in connection with the materials that describe the antediluvian ruler Enmeduranki’s initial receipt of several forms of divination from Šamaš and Adad, techniques that were then passed on to learned families in Sippar (Lambert 1967: 127). It was Assurbanipal himself, however, who made the most famous such claim:

I learnt the craft of Adapa the sage, the hidden mystery (*ni-šir-tú ka-tim-tú*) of the scribal art (*kul-lat ṭup-šar-ru-tú*). I used to watch signs of heaven and earth and to study them in the assembly of the scholars. Together with the able experts in oil-divination, I deliberated upon (the tablet) “If the liver is a mirror of heaven” ... I looked at cuneiform signs on stones from before the flood (*gù.sum ab-ni šá la-am a-bu-bi*).

(Frahm 2004: 45)

Here again we have the Akkadian word for “stone,” but no longer standing for actual stone or the artificial stones from the glassmaking recipes, but rather inscribed clay tablets referred to as stones as well.

The type of scholarship that Assurbanipal claims to have mastered was largely the product of editors and redactors who lived half a millennium earlier in the last few centuries of the second millennium BCE, above all the tradition that culminates in the figure of Esagil-kin-apli, an Akk. *ummânu* “expert” or perhaps “professor” who lived in the eleventh century BCE. Famed for his bipartite editions of technical, scientific, and magical materials such as *The Diagnostic*

Handbook and *The Physiognomic Corpus*, a format inspired by the organizational structure of the Old Babylonian Anatomical Compendium known as Ugumu, the compendial format that Esagil-kin-apli pioneered also likely served as the model for the medical compendia assembled by the scholars of Assurbanipal's Library (Geller 2018: 52). For over half a century, since W.G. Lambert's publication of *The Catalogue of Texts of Authors* in 1962, the following passage has been used to argue that first-millennium BCE Mesopotamian scholars attributed the authorship of a number of key compendia, including *The Diagnostic Handbook* and *The Physiognomic Corpus* (listed below as "physiognomic omens" and "diagnostic omens"), to the god Ea (the Akkadian equivalent of Enki).

Exorcism, liturgy, astrology,
 Physiognomic omens, anomalous births, diagnostic omens (symptoms),
 Cledomancy, Lugal-e, Angim.

[These are] the authorship (lit. "from the mouth") of Ea.

(Geller 2018: 44)

Two decades after Lambert's publication of this text, Rochberg-Halton's classic paper on canonicity emphasized that "divine authorship, placed as it is in the literary catalog in the context of legendary authors, human authors of great antiquity, and descendants of ancestral scribes, fits into a broader pattern of antiquity of authorship. The antiquity rather than the divinity of authorship clearly emerges as the important criterion for a text's authoritative status" (1984: 136). And while Rochberg was already downplaying the divine aspect of Ea's supposed authorship in 1984, Geller's recent paper on Esagil-kin-apli (2018) provides us with a new possibility: with Ea seeming to author many of the texts for which Esagil-kin-apli is most famous, Geller suggests that Ea here is actually a cryptic rendering of Esagil-kin-apli's name. The name itself means "the one who established (my) son (in) the Esagil-temple," and if the son here corresponds to "Marduk," as it almost certainly does, then the bearer of such a name could have been joking referred to as "Ea," Marduk's father. The centrality of the Marduk-Ea Formula (a standard framework for incantations in which Ea provides an incantation and ritual to Marduk) would have quickly turned a playful in-group reference like this into a logical reality, but the unmediated transmission of texts from the gods to human beings was not the norm in Mesopotamia. Time will tell whether Geller's interpretation proves correct, but if so, it would only reconfirm the preeminent status of Esagil-kin-apli as the most important scholarly figure in all of Mesopotamian history.

Here at the end of this section, a few lines should be devoted to counterbalancing the obsession that some nonspecialists have had, over the past century, with the role of "premature or stillborn children" (Akk. *kūbū*)

in the rituals attached to certain first-millennium BCE glassmaking texts. Discussions of how Mesopotamian myths might tell us something about the history of chemistry have focused on Mircea Eliade's *The Forge and Crucible* (1956) and its precursors, several short papers from Robert Eisler in the 1920s. This line of research is entirely the creation of nonspecialists and has been quite severely criticized from its first moments (Darmstaedler 1925; Zimmern 1925; Darmstaedler 1926; Zimmern 1926). There are a number of reasons for doubting Eliade's approach: the Sumerogram that would normally be used to write the Akkadian word *kūbu*, namely Sum. *nigin₃*, is never used in these texts and, in all likelihood, these supposed occurrences of Akk. *kūbu*, at least in the late second-millennium BCE sources, were actually read as Sum. *^dku₃.su₁₃*, a deity associated with torch and censer (Michalowski 1993), which makes much more sense, especially in a ritual for the preparation of an oven or kiln. Variants demonstrate that some scribes in the first millennium BCE believed that *^dku_{1/3}-bu* was the correct reading, but these mistakes should simply be discounted (note as well that the reading BU = su₁₃ largely disappears after the Old Babylonian period, which may explain why the term was misunderstood in the first millennium BCE). Eliade and his followers used the supposed occurrence of "embryos" in the ritual performed before the use of a kiln, in conjunction with similar ideas from other parts of the world, to suggest that non-gold or non-precious metals "grow" in the "womb" of the earth and that alchemical practices were meant to hasten this maturation of base metals into gold (for thoughtful reconsiderations of theories of metal formation since Aristotle, see Norris 2006 and Martelli 2014b). Needless to say, the entire research tradition that culminates in Eliade's book imposes on the decidedly nonmythological Mesopotamian glassmaking texts an anachronistic model of sulfur- and mercury-driven processes that only came to dominate alchemical thought in the Hellenistic and Islamic periods (see Principe 2013: 35–7 and Martelli's contribution below).

GRECO-ROMAN WORLD

Matteo Martelli

Arts and gods are strongly associated in Greco-Roman mythology. Gods were often portrayed as fabulous craftsmen and generous benefactors, who passed their technical skills on to humans. Among the "chemical arts," this is particularly evident for metallurgy. Hephaestus was not only a skillful blacksmith and fine artist, but he also donated his craft to humankind. The Homeric hymn dedicated to him (*Hymn* 20, vv. 2–3) praises the god and Athena who "taught glorious works to earthbound humans, / who used to live like animals in mountain caves" (Rayor 2004: 95).

The gift of the arts is clearly related to the origins of civilization, a theme further developed in ancient myths explaining the technological achievements of humankind. Well known is the figure of Prometheus, the titan who gave fire to humans after stealing it from the gods – Hephaestus and Athena were robbed of their “technical wisdom” (*entechnos sophia*) according to Plato’s *Protagoras* (321d1). For his theft, Prometheus was punished and chained to a mountain in the Caucasus. In the so-called “catalog of the arts” included in Aeschylus’s tragedy *Prometheus Bound* (mid-fifth century BCE), the titan recalls the arts he invented for the sake of human beings: how to mix soothing remedies (vv. 478–83) and how to mine useful metals such as copper, iron, silver, and gold (vv. 500–3).

In the fifth century BCE, the divine origins of the arts were questioned by various philosophers. The sophist Prodicus of Keos postulated that Olympian gods were an invention of primitive men, who deified useful goods and their inventors; wine and the discoverer of fermentation were worshipped as Dionysius, bread and the inventor of leavening as Athena, fire as Hephaestus (84 B5 DK; see Mayhew 2011: 175–94). The origins of religion are explained along similar lines in the first book of Diodorus Siculus’ *Historical Library* (I 8–29; first century BCE), which probably draws on the writings of Hecataeus of Miletus (550–476 BCE; see Henrichs 1984: 147–8). Early men in Egypt granted a divine status to natural elements as well as to ancient Egyptian kings, who were worshipped as the first inventors of various sciences and technologies. Egyptian priests identified the first king with Hephaestus (I 13.3); under the reigns of Osiris and Isis, special honors were attributed to those who discovered how to work the metals extracted from copper and gold mines in the Thebaid (I 15.5). Isis was also depicted as greatly versed in the art of medicine, having discovered many health-giving drugs and, in particular, “the drug of immortality,” which brought her son Horus back to life (I 25.2–3).

Deified culture heroes overlap with the figures of the first discoverers of the arts (*prōtoi heuretai*), a theme discussed in a specific literary genre often referred to as heurematography (Kleingünther 1933; Zhmud 2006: 23–44). Most writings on this topic were lost. However, a rich catalog of first inventors is included in the seventh book of the *Natural History* (VII 191–213; see Beagon 2005), where Pliny attributes, for instance, the discovery of woven fabrics to the Egyptians, and of wool dyeing to the Lydians in Sardis (VII 196). According to Ovid’s *Metamorphosis* (VI 6–11), Arachne (a skillful weaver transformed into a spider after competing with the goddess Minerva) was the daughter of two Lydian dyers from Colophon. Then, Pliny devotes an extended section of his catalog to metallurgy (VII 197–8). Interestingly, each metal is considered separately: for instance, tin is linked to the islands of Cassiterides, while the invention of ironworking is ascribed to the Cyclopes. As for goldsmithing, various inventors are mentioned, such as *Sol* (lit. “the sun”), son of Oceanus, who also discovered how to produce “medicines” from mined ores (*medicinae ex metallis*).

Similar catalogs are relics of a more complex discourse on the origins of civilization and the role played by technology in the process. Accounts on this topic are included in Vitruvius' *On Architecture* (II 1), Lucretius' *De rerum natura* (V 925–1457), or Seneca's ninetieth letter, sources that follow similar patterns (Cole 1967). Technological discoveries allowed early men to overcome their primitive way of living and marked the different passages of their cultural history. The first men were driven by necessity (*chreia* in Greek) to their invention of the arts, whose products were praised by ancient authors for their usefulness and beauty. According to an *Aristotelian Diaresis* (n. 34), the sciences (*epistemai*) were distinguished according to their objects: sciences of useful things included the making of tools and house-building, while sciences of beautiful things encompassed statue-making and purple-dyeing. A third category included sciences of exact things that lead to demonstrations, such as arithmetic and philosophy (new edition of the *Aristotelian Diaireseis* in Dorandi 2016).

Arts belonging to the first category were especially valued by Lucretius, who emphasized how the discovery of metallurgy made it possible to produce tools essential for weaving and farming (Cole 1967: 17–18); on the other hand, he condemned his contemporaries for being too eager for gold and purple (DRN V 1423–4). Seneca dealt with similar topics in his ninetieth letter, where he criticized the middle-stoic philosopher Posidonius (second to first centuries BCE), who, in framing his own *Kulturgeschichte*, attributed technological achievements to ancient wise men and philosophers. Particularly relevant is the case of Democritus, who was credited with the discovery of the arch as well as of technologies for softening ivory and dyeing pebbles, transforming them into emeralds (*Ep.* XC 33).

This transformation of pebbles is strongly related to the emergence of early alchemical literature, which dealt, among other topics, with the making of precious stones. Alchemical authors provided different accounts of the origins of their art. Democritus, for instance, was said to have learned alchemy from the Persian magus Ostanès in the Egyptian temple of Memphis (Martelli 2013: 69–73). Important cultural influences came from the Jewish tradition as well. In particular, the Enochic myth of the fallen angels left a clear mark on early alchemical writings. The myth is fully developed in the first section of the *Book of Enoch* (1*Enoch*, chap. 1–36), an apocryphal text related to *Genesis* (6:4). This section (third to second centuries BCE) is also referred to as *The Book of Watchers*, from the name attributed to a group of angels who, attracted by the beauty of women, left the heavens and taught them secret arts. The revelation ascribed to the fallen angel Azazel (chap. 8) is particularly relevant, as we can read in the Greek version preserved by the Cairo Papyrus 10759 (*Codex Panopolitanus*; Black 1970: 22; on the Aramaic and Ethiopic versions, see Bhayro 2005): “Azazel taught men to make swords, weapons, shields, and breast-plates –

instructions of the angels – and showed them metals and how to work them, armlets, adornments, (powdered) antimony, paint for the eyelids, all kinds of precious stones, and dyes (*baphyka*).”

This list of crafts – mentioning metalworking, precious stones, and dyes – shows clear similarities with the areas of expertise covered by Pseudo-Democritus’ four alchemical books and the Leiden and Stockholm papyri. In addition, more explicit Enochic elements were incorporated by other early alchemical authors. A short recipe book entitled *Isis the Prophet to Her Son Horus* opens with a long account that explains how the Egyptian goddess received the revelation on “the preparation (*skeuasias*) of gold and silver” from two angels who descended to the earth (CAAG II 29–30; Mertens 1984: 128–34). Isis, moreover, was asked to swear a sacred oath, thus solemnly promising to reveal the alchemical science only to her son Horus. The goddess swore to heaven, earth, light, and darkness – a formula also used in the Greek magical papyri (PGM IV 1705) – to the four elements, and to Hermes and chthonian deities such as the Egyptian Anubis and Cerberus (Mertens 1988).

In his own account of the revelation of alchemy, Zosimos of Panopolis explicitly mentions his sources, namely the “holy scriptures” – that is, the *Book of Enoch* – and Hermes’ (lost) treatise *Physika* (Bull 2018). The account is extensively quoted by the Byzantine chronicler Syncellus (Mosshammer 1984: 14) and fully preserved in Syriac translation (CMA II 238–9; Martelli 2014a: 11–20). The fallen angels – identified by Zosimos with demons – fell in love with women and, after leaving heaven, taught them the alchemical crafts, which were encapsulated in a book called *Chemeu*, from which alchemy took its name (*chēmeia*). This book, which originally included twenty-four treatises, was then summarized and hidden by the Egyptian priests, who played a key role in Zosimos’ alchemical discourse. In his *First Book on the Final Quittance* (Festugière 1944: 363–8 = CAAG II 239–46), Egyptian priests are presented as the ministers of those demons who wanted to hide the dyeing techniques they had disclosed, thus trying to regain control over them. Through the agency of their priests, they introduced the “auspicious dyes” (*kairikai baphai*), whose success as dyes depended on the right astrological configurations. However, Zosimos strongly recommended his pupils to avoid these practices and free themselves from the control of demons through a deep study of the treatises of ancient alchemists, who explained the natural dyes (*physikai baphai*; Dufault 2019: 127–31).

Zosimos’ alchemical treatises are strongly influenced by gnosticism and hermeticism, which in turn adopted alchemical images and ideas. In the hermetic treatise *Korē Kosmou*, for instance, the Egyptian goddess Isis uses an alchemical vocabulary to describe how God created the substance of souls (Festugière 1967). A model for this account was provided by the Platonic dialogue *Timaeus*, in which a metallurgical lexicon was used to describe how

the demiurge forged the human and the world souls (Brisson 1998: 36–8; see Chapter 1). Likewise, the Coptic treatise *Paraphrase of Shem*, found in the gnostic library of Nag Hammadi (*codex VII*), includes a complex cosmogony that employed metaphors drawn from the metallurgical practices of Greco-Egyptian alchemy (Burns 2015). Scholars have long noted the use of alchemical images in gnostic texts by emphasizing similarities between the gnostic baptism and the alchemical practices of dipping metals, stones, or textiles in dyeing “waters” (*baptein* in Greek; Charron 2005). These dyeing waters are referred to as the waters of resurrection in an alchemical dialogue ascribed to Cleopatra (CAAG II 292–7), while the Coptic *Gospel of Philip* depicts God and the Son of Man as dyers (Charron and Painchaud 2001). Similar references to alchemy occur more broadly in early Christian writings beyond gnostic literature, in order to explain how God can perfect matter and resurrect dead bodies. Gregory of Nyssa refers to the agglomeration of drops of mercury (*On the Making of Man* in *Patrologia Graeca* XLIV 228), while Aeneas of Gaza alludes to glassmaking and to the alchemical making of gold (*Theophrastus* in Colonna 1958: 62–3; Dufault 2019: 102–3). On the other hand, Zosimos himself used vivid imagery to describe alchemical processes in his famous text usually referred to as the *Visions* (Mertens 1995: 34–47). In a series of five dreams, metals and ingredients become living beings – priests, men of copper with lead tablets in their hands, a barber, and a white-haired man – who are skinned, cut into pieces, dismembered, and boiled in altars having the shape of an alembic. During the dreams, Zosimos talks with these characters, who give a preliminary explanation of what he is witnessing; after awakening, the alchemist himself interprets the dreams as referring to specific alchemical operations.

Already in classical antiquity, various “chemical” activities provided philosophers and physicians with various analogies, which they used to elucidate both their epistemologies and their explanations of natural phenomena. If we go back to the Hippocratic treatises of the fifth and fourth centuries BCE and to the *Problemata* attributed to Aristotle, it is possible to find different attempts to explain the effects of drugs on human bodies and their diseases (Stannard 1961; Scarborough 1983). In some cases, the drug acted as a solvent, as a hot substance able to liquefy or melt the pathological material and thus facilitate its expulsion (*Problemata*, I 40, 48; Touwaide 1998b: 260–1). The ideas of heat melting and dissolving appear to be rooted in artisanal practices, also evoked by the author of the Hippocratic treatise *On Regimen*, who describes various crafts (*technai*) to clarify invisible physiological processes (Bartoš 2015: 138–64). Digestion is explained by means of an analogy with the work of goldsmiths, which implies a comparison between vital fire and the fire used in metallurgy and cookery (*On Regimen*, I 20 = VI 494 Littrè):

Men work on gold, beat it, wash it and melt it. With gentle, not strong, fire it is compacted. When they have wrought it, they use it for all [purposes]. So a man beats corn, washes it, grinds it, applies fire and then uses it. With strong fire it is not digested in the body, but with gentle (fire).

(Bartoš 2015: 156)

Moreover, analogies between nature and crafts were used in the explanation of geological phenomena. Early attempts to explain the formation of minerals can be already located in the Peripatetic school; according to Aristotle, for instance, metals and ores are the solidifications of watery or smoked exhalations trapped in the underground (*Meteorology*, III 6, 378a15–87b6; Wilson 2013: 271–7). Similar ideas also emerge in the *Historical Library* by Diodorus Siculus (II 52.1–4), who refers to procedures for dyeing stones dipped in coloring baths (Halleux 1981: 50–1):

For the rock-crystals, so we are informed, are composed of pure water which has been hardened, not by the action of cold, but by the influence of a divine fire, and for this reason they are never subject to corruption and take on many hues when they are breathed upon. For instance, *smaragdi* and *beryllia*, as they are called, which are found in the shafts of the copper mines, receive their colour in a bath of sulphur, and the chrysoliths, they say, which are produced by smoky exhalation due to the heat of the sun, thereby get the colour they have.

(Oldfather 1935: 55)

The contribution of various chemical arts to medicine is evoked by Galen of Pergamon in various passages of his immense *oeuvre*. His *Commentary on Epidemics* (V 1 = XVIIb 299 Kühn = Wenkebach 1956: 257), for instance, lists a number of experts who act as “servants” of medicine. Among them we find cooks and all the people who provide physicians with instruments and substances: blacksmiths who forge metallic surgical instruments, “root-cutters” (*rhizotomoi*), “herbalists” (*botanikoi*), and “those who process minerals and other similar products” (Boudon-Millot 2003: 114–16). Moreover, in a long passage of the sixth book of his work *On the Composition of Drugs According to Places* (VI 2 = XII 905–7 Kühn), Galen explains how, after returning home from his studies in Alexandria, he could infer the medical properties of walnuts by looking at their uses in dyeing procedures. Dyers prepared a juice made out of walnut shells, which could produce a lasting color on wool (see also Plin. *NH* XV 87). Galen is astonished that physicians, even after observing this practice, did not understand the strong astringent “power” (*dynamis*) of the thick liquid. Conversely, he refers to the meager medical talents of dyers, blacksmiths, fullers, shoemakers, and

cooks in his harsh critique of the medical school of Methodism: they were all the students of Thessalos, one of the leading figures of this school, who pledged to teach medicine in six months (*On the Method of Healing*, I 1 and I 3 = X 5 and 19 Kühn). However, behind Galen's sarcastic picture of a medical system that achieved wide popularity between Hellenistic and Roman times, it is possible to recognize the exchange between experts of different arts and Greco-Roman physicians.

Dyers and pharmacists certainly shared habits in the ways they manipulated natural substances. For instance, both Galen and Dioscorides often mention the dyeing properties of the simple drugs they describe in their pharmaceutical handbooks. In the second part of the alchemical papyrus of Leiden, its compiler included the description of eleven mineral substances taken from Dioscorides' pharmaceutical treatise *De materia medica* (Halleux 1981: 109). Artisans such as dyers, metallurgists, and fullers were certainly experienced in handling specific sets of "chemicals" employed both in their own arts and in medicine. The term *pharmakon*, indeed, had different meanings and could refer to a medicine, a dye, or a poison. The same semantic spectrum is maintained in its derivatives, such as the word *pharmaxis*. This term is used by Plato with reference to a medical treatment (*Philebus*, 46a9) and by Plutarch with reference to the treatment of metallic alloys by means of *pharmaka*. The beautiful metal statues of Delphi displayed a patina very different from verdigris or rust. Shining with a deep blue tinge, the color of their metallic alloy (bronze) was the result of a chemical treatment of their surface, a *pharmaxis* in Plutarch's words (*De Pyth. Orac.* 395b; Jouanna 1975).

An increasing interest toward the effects of toxic and poisonous substances allowed for the further exploration of the properties of *pharmaka*. As observed by the fourth-century BCE physician Diocles of Caristus (fr. 177 in Eijk 2000: vol. 1, 286–9), the bites of very little insects (e.g. scorpions, spiders, and vipers) had a lethal effect on the whole body, despite the small quantity of the injected venom (Touwaide 1998a: 196–8; Eijk 2001: vol. 2, 334–41). A similar idea also emerges in the earliest alchemical literature. In his book *On the Making of Gold*, Pseudo-Democritus emphasized how a small amount of some natural drugs could bring about great transformations: "a drop of oil can remove much purple and a pinch of sulfur can burn many species" (CAAG II 48,1–2 = Martelli 2013: 96–9). These powerful, almost divine, properties of *pharmaka*, however, cannot be properly assessed by those alchemists who do not spend their time in testing the drugs as physicians do (Martelli 2013: 95–9). Already in the Hellenistic period, the physician Herophilus – who defined drugs as the hands of the gods (fr. 248b in Von Staden 1989: 417) – and his followers greatly contributed to the development of pharmacology and to the study of toxic substances. Pseudo-Dioscorides' treatise *On Deleterious Substances and Their Prevention* (Sprengel 1830: 1–41), for

instance, inherited this scientific legacy, showing a certain awareness of the toxicity of various drugs (Touwaide 1983; Touwaide 1992). Of the minerals, the author devotes specific chapters to white lead (§ 22), gypsum (§ 24), litharge (§ 27), mercury (§ 28), and lime, along with arsenic ores (§ 29). These observations certainly relied on the experience of physicians, but also on that of various experts dealing with these substances in different fields (see Chapter 5, pp. 154–5). The ancients, for instance, were aware that metallic vessels could alter the taste of the cooked food. Pliny (NH XXXIV 160) recommends coating copper cooking pots with tin, since they could spoil the taste of the meals because of their “poisonous verdigris” (*virus aeruginis*; presumably the taste of copper comes directly from the reaction between the metal and acid in wine or food; Halleux 1977: 563–8; Healy 1999: 319). Columella (*On Agriculture*, XII 19.1 and 20.1) and Pliny (NH XIV 136) advocate the use of lead vessels for boiling must and producing grape syrups, such as *sapa*, often used to sweeten wine. According to Waldron (1973: 393), lead has the property of inhibiting enzyme activity, “so it is not surprising that the Romans and Greeks found that *sapa* prevented fruit souring and fermenting and used it extensively as a preservative.” Trimalchio preferred serving wine in glass cups rather than in cups made of the precious Corinthian bronze, since glass does not smell (Petronius, *Satyricon*, 50). Vitruvius, on the other hand, specifies that the taste of water conveyed in earthen pipes is better, while warning that lead pipes – widely used in Rome’s impressive aqueducts – could poison the water they carried (*On Architecture*, VIII 6.10–11). Pseudo-Dioscorides describes the toxic effects produced by these mineral substances only when ingested or drunk. In fact, most of these minerals did have medical uses, often being applied to the body externally, or they could serve as cosmetics. For instance, the author claims that it is not possible to hide the ingestion of white lead since it whitens the palate, tongue, and teeth (Sprengel 1830: 32). Indeed, in antiquity, white lead was largely used by women to whiten their faces. On the other hand, each chapter of Pseudo-Dioscorides’ treatise lists various substances that could counteract the effects of each intoxicating drug. This feature reflects an important tendency in Hellenistic and Roman pharmacology, often devoted to the search for powerful antidotes, which led to the growth of the so-called polypharmacy (Totelin 2004: 7). Complex antidotes, including more than forty ingredients, are recorded in ancient sources. The *Mithridatium* was named after Mithridates VI, King of Pontus (120–63 BCE), who was credited with its discovery: he both immunized himself by taking small quantities of poison on a daily basis and developed the *pharmakon* named after him. This medicine was then modified by the physician Andromakos the Elder (first century CE), who thus created the famous theriac, a kind of universal antidote and panacea (Boudon-Millot 2002; Totelin 2004).

CONCLUSIONS

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Over the 4,000 years of history covered by this volume, the interrelations between different cultures and chemical arts have naturally changed considerably, and it would be impossible to characterize them within a homogeneous frame. In spite of these differences, there are a few essential elements that have remained constant. In ancient Egypt, culture and science were both associated with gods, and this common ground projected onto gods the role of precursors or founders of specific branches of knowledge. This characteristic, shared by the Mesopotamians and, later, by the Greeks, identified specific gods, such as Ptah, Kunum, Thoth, and Anubis, as the founders and the superintendents of arts and crafts. In Mesopotamia, these roles were principally played by Enki, the male deity of fresh water, and Ninhursag, the mother-goddess, thus placing the generation of things at the center of theoretical speculation. Another important myth was that of the war opposing the god Ninurta against the monstrous opponent Asag, which resulted in the victory of the former and the formation of mountains, stones,

FIGURE 4.3 Scene of filling the Udjat-Eye. Eastern Osirian chapels, inner courtyard, southern wall. Detail of the procession. Temple of Dendara. © Sydney H. Aufrère.

and minerals. In Greece, the role of mythology in the justification of the chemical arts was equally important, and it was influenced in no little degree by Egyptian culture. Hermes, Hephaestus, and other Olympian gods were mere translations of Egyptian deities. The mythological origins of the arts bridged the gap between nature and artifice. Technical achievements and inventions were celebrated by the Greeks by resorting to intermediate figures between gods and men and to a literary genre – the *heurmatography* – in which the lists of the first inventors were given. By a gradation of roles, gods were followed by heroes and by inventors. This hierarchy legitimized a progressive autonomy of the artisans. Conversely, the central importance of the *technai* in Greco-Roman culture was a source of inspiration in philosophy, medicine, and other branches of natural philosophy. It is therefore not surprising to see that many chemical terms played a significant role also in other disciplines.