

Magiae Naturalis
by
Giambattista della Porta
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Giambattista della Porta was an Italian nobleman who lived just before the great changes about to occur in science at the beginning of the 17th century. He inspired the pursuit of inquiry in others such as those at the Accademia dei Lincei, and was part of the academic circle at the University of Padua that included Galileo, Santorio, Fabricius, Sagredo, and Sarpi, who believed in the Pythagorean dictum that “the universe is written in the language of mathematics”. They sought to measure time, warmth, humidity, etc.; out of their work came the thermometer, barometer, hydrometer, hygrometer, apart from the telescope and microscope. Della Porta’s book, here abridged, is a mix between obscure beliefs, misunderstood magic, special effects to awe theater goers, and the beginnings of experimentation. It is an excellent introduction to the mysterious period just before the Scientific Revolution ushered in by Kepler and Galileo.

Book I Natural Magic

The Platonists claim that Magic takes its name from the Persian *Magi*, the general name of wise men in that country, begun by Zoroaster and spread to Greece with Xerxes’ campaign. The Persian *magi* became the Greek *philosopher*, the Latin *magus*, the Indian *brahman*, the Babylonian *Chaldean*, the Celtic *druid*, the Jewish *prophet*, etc.

There are two types of Magic: *Sorcery* which consists of detestable incantations, and *Natural* which wise men seek. It is the highest of the sciences, the practical part of philosophy, in which earthly inferiors are subject to heavenly superiors. I say that magic is Nature itself in all its aspects, as studying the Heavens above leads us to understand the hidden secrets of animals, plants, and minerals, for Nature has a force of love that attracts things together.

To be a magus one must be a philosopher, so as to understand the four elements, the cause of rainbows, thunder, comets, earthquakes, and fiery lights at night. He must be a physician, able to compound ‘physic’ for the benefit of others; an herbalist, able to distinguish similar plants, as well as minerals; a distiller who extracts the spirit or humor of things, just like the showers of heaven, even to sublimate the innermost bowels of things. He must be an

astrologer, knowledgeable in mathematics, to learn how the stars move, how the Moon changes phase, how the Sun measures out the Zodiac, how they influence earthly objects. He must be skilful in optics to create apparitions and see what is far away. He must be good with his hands, for knowledge without practice, and practice without knowledge, are worth nothing. If you want your works to appear wonderful, do not expose the cause, lest it appear ordinary. Finally he must be wealthy, for it is not philosophy that makes us rich, rather being rich one may play the philosopher.

The origin of the causes troubled the ancients. Some thought the first seed of everything is fire, or air, or water. But indeed there are four elements that occupy the world beneath the Moon. The lightest, fire, is at the top, then the air surrounding us, sometimes visible when thick as clouds, then water, and lastly earth at the center of all. Parmenides, however, thought that the fundamental principles are hot, cold, moist, and dry, and that the elements partake of two of these in different proportions. Thus fire, which is hot and dry, can meld into air, which is hot and moist, since both contain heat; but it is not easy to turn into water, which is cold and moist. This is why heat brings out the unpure and leaves a smaller simpler body; cold instead congeals, dry makes hard, moist swells. Empedocles added the principles of concord and discord, which bring together or separate these elements.

Aristotle added that a compounds' properties come about from its material composition of elements, and from its form. Secondary qualities, such as thickness, roughness, color, etc., arise from the primary qualities depending on the mixture of the elements that make up the body and the way they work together.

It is God that creates form; he is the active principle acting on matter, which passively receives form. He, the Soul of the World, gave form to the heavens, down to the Elements, and to animals and plants, which he commanded to propagate their form. They form a chain of being from the supernatural powers of the heavens to rational Man to animate Animals to Plants with their vegetative powers to grow.

All creatures have the dual powers of *sympathy* and *antipathy*, i.e. concord and discord. This natural hatred can be made use of in remedies. Vines climb about anything except its enemy, the colewort, from which she turns away; and heating colewort in wine makes it lose its color; colewort is good against drunkenness. Cyclamine, which is also an enemy of colewort, increases drunkenness; whereas Ivy, which is against vines, is also a remedy for drunkenness. The same with other plants: cane against fern; the poisonous rue is cured by hemlock; a bull and a fig tree have sympathy, even as food in meals; elephants vs rams; cocks vs snakes; apes vs snails; man vs serpents, as when a woman aborts if she sees a snake. Man and wolf turn mute when they see each other; now wolves are afraid of urchins, so when one has a wolf's hoarse voice, one can take urchin's blood as a cure. Pigeons are afraid of hawks, and these of kestrels, hence pigeons are calm in the latter's presence. Lodestone disagrees with garlic, for when the former is smeared with the latter, it does not attract iron.

It was the Egyptians, living in a country of clear skies, who first showed that the heavens rule over the mutable. The appearance of stars at certain

times effect changes on Earth. Ptolemy reduced this to an ordered system from which one could foretell events. The Sun, the governor of time, as it winds through the Zodiac, causes plants and animals to generate and decay through the seasons; it is the light of life. Many types of flowers loyally follow the Sun, even though it be cloudy; some trees do the same with their leaves. The Moon rules the moist bodies, the seas and rivers, the tides; crabs, shellfish, etc., are nourished by her when she's full. Farmers say that the state of the Moon when a tree is planted will affect the amount of fruit it bears. As it waxes, it increases moisture, thus fish and ants come to the surface even at night, wood is more liable to rot, onions decay, and cats' eyes are narrower. The stone selenite follows the phases of the Moon. Tthe ancients write that the star Arcturus causes rain when it rises, the dog-star's rising causes dogs to go mad, etc.

Magic is fetching one thing from another, by natural affinity. The world is interconnected just like an organism, each part with its sympathies and antipathies. The Moon draws up fire to it, the Earth moves to the center, the lodestone attracts iron, amber draws chaff, brimstone [sulfur] draws fire, the Sun attracts flowers and leaves, and the Moon the waters. All things being male or female, or both, the magician cunningly arranges for the superior thing to attract the inferior. Just as a paper burns though it does not touch the flame, so the heavenly body works upon its capable matter.

Magic requires the study of Nature, how things generate and decay, how animals heal themselves, build their homes, etc. For example, each bird protects its young from evil by gathering specific grasses, the doves bay twigs, the crows willow twigs, etc. Animals know what to take against poisons: when a tortoise eats a serpent it also eats oregano; the bear having taken poisonous mandrake eats ants to counter it, and so on. They also show what herbs to use on wounds or to purge themselves: elephants seek out aloes, donkeys eat asplenium ferns to purge, hawks eat sowthistle to improve their eyesight, goats with red eyes prick themselves on a thorny bush to let out blood, while bears do the same with bees. Pliny says that a sick belly is cured by placing a duck on it to take its disease.

Seeds, fruits, flowers, leaves, roots, as well as stars, metals, gems, and stones have a likeness to the diseases of the parts of man's body that they cure. For example wallwort, whose roots resemble a scorpion, is good against its sting. The herb marisca and the fruit maripara look like the female's and male's organs and are good for the generation in each. The trillium herb looks like a viper's head and is good against its venomous bite; the saxifrage plant for kidney stones. The milky-colored stone galactite, when placed on a goat or a nurse, encourages her lactation; the wine-colored amethyst is good against drunkenness, etc.

The root of secrets is knowing what things associate together. All kinds of things make others become like itself. Thus, fire burns and consumes some objects; if an object is placed in salt then after a long time it becomes itself like salt; he who converses with a bold or fearful man becomes so himself. Similarly, parts of the body are nourished by like parts. Thus a man's wit is helped by eating the brain of a hen, say, and his liver by eating liver; a woman is made fruitful by eating the wombs of fertile animals such as the hare; to make a man

talkative give him tongues of geese, etc.

Some creatures have natural powerful properties, given to them by the Heavens. For example, some swoon when they look upon a cat or a mouse. Writers mention that specific types of people have particular qualities, for example, thieves are naturally fearful, queens are insolent, harlots are not only impudent but make others so. The lodestone not only attracts a nearby iron, but also other iron rings in a chain. Sometimes it is only a part which has power, such as a basilisk's eyes, or a bat's wings which are avoided by ants.

Whatever power animals may have perishes once they die. So if one must draw out a frog's tongue, or a ray's dart, it must be done while they are still living. This is not always the case as, say, a wolf's skin still scares sheep long after it is dead, and herbs retain their potency after they are dried up.

Plants especially receive their powers from the Heavens and so must be taken in their due season. As the proverb goes, it is the season not the field that brings forth fruit. Thus roots ought to be picked in autumn, flowers in spring, and leaves in summer. Some keep their virtue for years, others decay quickly. Roots are to be picked between full and new moon, when their moisture is highest; seeds are to be picked when they are ripe ready to fall; hot herbs should be picked when Mars and the Sun are lords of the (zodiacal) house.

The place where a plant or metal grows affects their virtues. Thus hemlock is a deadly poison which killed Socrates but is here harmless. There is a type of vine in Achaea that is abortive to dogs but does not taste different from other grapes; some apples in Persia are poisonous. Dioscorides says that herbs grown in dry steep places are more potent than those in humid dark ones. Likewise the climate and the springs allow some plants to grow but not others. There is a town called Ismuc in Africa whose earth kills all beasts. There are places in Lycia with rivers of fire. Likewise waters may be sharp or sour or salty when they run through veins of salt; they may be wholesome or maddening or inebriating. There is a lake in Cappadocia where a reed placed in its water turns slowly into stone. Sheep that drink from the river Astax in the Pontus become black. Some wells kill all that drink from them, one is cold at noon and very hot at midnight. The Nile is so fertile it turns clods of Earth into living creatures.

Mixing simples into compounds makes them more operative. Each simple has a divine property that combine together as a god. For example, the dragonwort, the dragon fish, viper flesh, and the ophite stone, are each strong against venom, but together make a supremely powerful remedy. Compounds are either made of a main ingredient with seasonings added, such as honey or flour to make a bitter base go down pleasantly, or of a powerful ingredient added to a neutral base, such as ground nuts or wine.

But a compound needs to be measured precisely, for only with the correct proportions of each simple does it act well, though one must use experience in judging these things.

The greatest skill is needed in preparing the simples for them to work. The main processes are the following: Steeping means soaking something in a liquid so that its subtle humors are drained out. Boiling does the same, forcing the

slighter vapors out of the center. To dry, burn or roast something and to pound it into a powder removes all its moisture, in preparation for the addition of a liquid. Distillation brings out the waters of greater strength, leaving behind the grosser parts.

Book II The Secrets of Animals

To study Natural Magic, one must first study the natural and mathematical sciences.

The Greek philosophers believed that living creatures form from rotting earth soaked in putrefied water and enlivened by the Sun, springing life forth like a sprouting seed. In the beginning, when the elements settled in their places and the Flood moistened the Earth, this putrefaction brought forth from the hottest clods the birds, from the wettest the fish, from the earthy clods the creeping beasts, and from the average clod the walking beasts. This continued until the Sun grew hotter, after which they procreated by coupling.

Some plants and animals come from seeds and others spontaneously from the earth, such as worms. In Egypt, when the Nile flood subsides, mice are created in abundance from the heated mud. Pliny says that one can see them, still half alive and half mud. This is why so many appear at harvest though they multiply further by coupling; then just as suddenly, they disappear, no one knows where. In summer, one can chance upon frogs forming from the dust and rain, with a lifeless bottom without feet. They form so quickly and suddenly that there is the saying "it rains frogs", often infesting whole villages. Marshes bring forth toads, especially from rotten carcasses. Lately, a pregnant woman brought forth four creatures like frogs; but this is like what Paracletes said, that if you cut a serpent in pieces and place them with mud in a glass vessel, it forms worms that grow into other serpents. By a river in Hungary, three thousand men died because worms grew out of their body. Serpents in general grow from women's hair or horses' manes or men's backbones laid in waters. Pliny says that if you cover basil or a crab with stones it becomes a scorpion, especially if the Sun is in Cancer. Some, like the salamander, have no gender and hence produce no eggs. One can show that a putrefying ox generates flies. Place an ox in a sealed room, cudgel him to death without spilling blood, seal the nostrils, mouth, and eyes with linen and pitch and smear a lot of honey on it. After about a month, nothing remains of it except its horns, bones, and hair. It all turns into maggots and flies. In like fashion, wasps and hornets come from horses, while drones come from mules and beetles from asses or dogs.

Several writers state that birds can emerge from the fruit of a certain tree. As Paracelsus says, that an egg yolk transforms into a bird, so wood cast into the sea gives rise to a multitude of worms that grow into ducks and then geese.

Aristotle says that eels do not lay eggs, nor have a womb, but breed in muddy pools with the coming of the rains. Throw a dead horse or other creature into a standing pool and it brings forth many 'eels'. Similarly sandy fish and a type of mullet breed from sea froth, carp from putrefaction in lakes, and shellfish,

which obviously cannot copulate, breed from mud. Different muds bring forth different types. This was shown in Chios by casting a number of oysters into lakes near the sea, yet they did not reproduce.

Aristotle and Pliny, relating Alexander's tales in India, say that the great mastiff dog is generated from a tiger and a bitch tied to a forest tree. The result is a dog so valorous that it scorns boars and bears and kills lions. Similarly the Arcadian dog is descended from a dog and a lion. There are various dogs in France and Libya, including the *crocuta*, gendered of a tame dog and a fierce wolf; I myself am witness to this. Swift greyhounds come from several generations of pairing dogs with foxes; other breeds of dogs come by mixing mastiffs with greyhounds, etc. Mixing all these animals together would give a dog as powerful, fierce, and crafty as any of them.

Other dogs are like dwarfs among men. The Maltese dog has long been a favorite with the Greeks, who breed it for pleasure. Small dogs must be bred with other small breeds to keep their qualities. A dog and an ape will beget a dog that knows many tricks, such as jugglers' dogs.

To make dogs strong and swift, have them suckle the breasts of other courageous beasts such as lionesses or does. If they suckle sheep's milk they become lazy and weak. In India, they feed bulls' blood to dogs so they become fearless when faced by bulls. To make a larger courageous ass, attach a newborn ass to a mare, replacing its foal in the dark so she doesn't notice.

Mules are the result of a mare and an ass. The *hinnus* comes from a stallion and a large she-ass; it is like a mule but slower and wilder. The best and swiftest mule is that of a wild ass and a she-ass. A fourth type are mules begotten of a bull and an ass, as found in the Maghreb. I myself saw an animal with a bull's head but with knobs for horns.

Turning to the adultery of sheep, there is an animal in Corsica called a "musimones" that comes of a goat and a ram. Similarly the "cinirus" is begotten of a he-goat and a ewe. Although rough and shaggy, with each new generation they become tamer with a softer fleece. A "hybrides" is gendered of a boar and a female pig.

Philostratus writes that lionesses sometimes lie with leopards. They give birth to spotted whelps which the lions seek to tear to pieces, being a bastard brood born of a harlot lioness. The young of a lion and a female leopard or panther also looks like a lion with spots but lacks courage and takes after its mother, as is often the case with such mingled seed. The "crocuta" is the result of a hyena and a lioness, the "hycopanther" of a wolf and a panther, spotted like a leopard but with a wolf's head. The Greeks say that the bactrian camel is gendered of a camel and a boar.

Shamefully, lecherous men also copulate with beasts. Plutarch mentions a shepherd who brought in a babe that had the head of man and the body of an animal, probably the result of his wife and his horse. Then there are the cases of Fulvius Stella and Aristonymus Ephesius who lied down with a mare and an ass respectively, which then brought forth beautiful females. Galen doubts, this questioning how the offspring would eat. But I say it is not inconceivable that there are men and women whose constitution does not differ much from horses

and could be compatible with them. Another child of a man and a goat had a human face and the thighs of a goat. Strabo writes of the city Hermopolis where he-goats mingle with women, and Pliny writes that in India, the men kill the red apes because they lust for their wives.

To pair birds of different type, such as falcons and hawks, you must first enclose them, separated, in one divided room, so they become acquainted with each other, then in spring choose the best male and place it with a female. Place the eggs she lays under a hen until they hatch and grow.

Partridges and hens readily couple together and bring forth birds that resemble both. Similarly pheasants and like-colored hens, in the manner described above. I myself observed how the chickens of a large young pigeon coupled with a hen resembled pigeons with hens' feet; likewise cocks and peahens.

Many varieties of hawks couple with each other. Oppianus says that a male hawk or falcon couples with a female eagle to give the "theocronus". The parent birds often chase their chicks away if they see they are not right, and these, flying away alone to strange lands, commingle and couple with those most like their own. The osprey and raven are, as Pliny attests, mongrels of different sorts of eagles.

It is hard for us to observe underwater fish. But in the light of what we observe in other animals, we may expect commingling in the same manner. However Aristotle says that no two types of fish couple together except for the skates and rays, which engender the "rhinobatos", but I have never seen one.

Monsters are created when different seeds are mixed in the womb. They have two heads or more parts than nature intended; I myself am witness to one such child in Naples. Straton says that this may be due to seed being cast on top of already present seed. Animals that are very fruitful, such as birds and dogs, tend to produce more monsters than horses. In its earnestness to produce life, nature sometimes produces too much or too little: missing legs, or four eyes, or hermaphrodites. In man, monsters are produced from forced copulation when the seed is conveyed in the wrong places, or because twins are pressed together in a small womb. People have observed deer with four horns, oxen with five feet, a dog with three heads, serpents with two heads or tails. But especially birds because their eggs sometimes have two yolks: chicken with four wings and feet. You can try this yourself: by looking at eggs against the sun, select those that have two yolks and let the hens brood over them. In time, one of them will yield a monster.

There is another way to produce monsters. Just as we can fashion fruit into any form by enclosing them in a tight case, say causing a cucumber to take the shape of a serpent, thus similarly with animals. Hippocrates mentions a tribe in Phafis who press the tender skull of newborn infant with bandages to restrict its growth so that their heads take an elongated shape. With time nature became accustomed to this so that their newborns were born this way, just as baldness, myopia, and deformations are often inherited.

Empedocles says that an infant is formed according to what the mother looks at at the time of conception. Damascen writes how a woman brought forth a hairy child, the reason for which was a picture of John the Baptist in

her room. Similarly, fair women may have dark children or vice versa, or with horns or with hare-lips. Their imagination affects their inner spirits, which affect the blood, which leaves an imprint on the tender child in the womb. It is related how Jacob placed a stake made of the light and dark bark of poplar and almond trees next to the watering trough, so that black-and-white lambs were born. Similarly, horse-keepers hang tapestries of bay or gray colors in the stables or on the mare so that the foals turn out the same color; and the same with pigeon-keepers. The peacocks of Norway, surrounded continually by snow, generate white chicks. Thus to procure a shaggy dog, lay out the kennel with thick fleeces.

It follows that if one wants beautiful children, hang pictures of Adonis and Ganymede in the bedroom. I have witnessed this myself, for a woman kept a marble statue of a boy throughout her pregnancy, and it came to pass that she gave birth to a pale boy very much alike to it.

The Greeks had various ideas of how it comes that a child is male or female: hot or cold, thick or weak seed, left or right in the womb, the dominant sex in the parents' families, or just random. Physicians hold that the right hot side leads to males, the left colder side to females (at least it is thus with pigs), and so counsel the woman to turn on the right after coupling. Rams and bulls leap right or left depending on the sex of the young they have conceived. Aristotle tells us to face cows against a fresh northerly wind to beget males and a southerly wind for females.

To create a white spot on a horse, say the forehead, shave off the hair there, possibly with a hot iron. To have the hair at a scar grow the same color as the rest, knead some ground barley with the froth of nitre and salt into loaves, roast them in an oven, and crush them into powder; mix with oil and apply at the scar; the paste cleans and expels the bad humors at the sore. If you make a hole in the thigh of an ox and blow air into him, it will grow fat. Red or black sheep who drink from the river Crathis become white. A lamb's color is the same as the veins on the underside of the ram's tongue. Aristotle says that an egg, if round and thus warm, will hatch into a cock-chick, if long, into a hen-chick. A friend of mine broke the lower beak of a magpie chick such that it was totally dependent on him for food. It grew up very friendly to him, chattering and imitating him in all ways.

Book III The Secrets of Plants

Plants grow from putrified earth and water, warmed by the Sun. The earth in different places naturally generate different plants (if unsown), for example Cretan soil creates cypress and thistles. In general fine earth produces grass and hard soil produces woody herbs. Soil that came from far away places, such as that used in ship's ballast, gave rise to unfamiliar plants. Toadstools grow from putrefying bark, or rotten cloth and rusty iron. Tarentinus says that if you burn an uphill field of stubble just when the clouds are brewing rain, then toadstools will sprout aplenty. Dydimus says that asparagus grows from the

horns of wild ram ground to powder, and ivy from deer horn, but Dioscorides disagrees. Ferns grow in fir trees and pines, where their bark decays into the ground.

Miracles consist of effecting things that are contrary to the ordinary course of nature. Each plant has its own way of propagating, either by sowing the seed, by roots, by planting the stem, or by grafting a branch. If you change this mode, or change their soil or place, the plant that grows will be different from the natural one. For example, the seed of a white vine (which should be propagated by stem) gives a black wild vine; the stone of a fig gives rise to a wild fig; sweet almonds and olives become bitter; the cabbage changes to rapeseed; basil into wild betony. Without man's care, many seeds degenerate in quality. Even the mighty oak, if grown in a poor soil, will grow like a vine.

Grafting is to plants what copulation is to animals. Do not believe those who have tried it and failed, for grafting is real. The fig tree can be grafted onto the plane tree, and the mulberry onto the chestnut. This is the origin of the new kinds of fruit. As Palladius says, such trees joined carnally together bear fruit with the two juices of its parents. For this to occur with least trouble, the trees must have the same type of bark, the same season of growth, be young and vigorous (not more than two years growth) and not already grafted. It is helpful to seal the bark-skin of both trees together with loam that they grow into each other and prevent the graft from drying out. To make the loam, place holly vine or elm roots in a pit for twelve days, until they become a clammy slime. Thus we can form a new apple from peach-apples and nut-peaches: first cut the bark mid-way and pull it away gently, then place a bud of the other tree in this space, cover thoroughly with mortar, cut off the nearby branches so that they do not take its nourishment, and protect from the rain. Likewise, oranges and lemons, white and red roses. Some plants that don't have buds, may be cleaved together in their roots.

Another way of grafting, told by Theophrastus, is to bind together tightly a large number of sprigs of different types, bruised at their base, and placed in the ground. If they take up together, they will grow up as one. This way one can form vines with white and black grapes. Yet another way is to place the sprigs in a clay pipe; as they grow, they dissolve into each other to form one trunk, at which point the pipe is broken. I myself have produced grapes that are multi-colored, sweet and sour, though it takes lots of practice.

According to the ancients, a third way is to take the seeds or berries of different trees and sow them wrapped up together. When they spring forth, bind the stalks together with wax so as to form a single trunk. However, I've tried and failed in this matter. Pliny writes that this method happens naturally when birds excrete different types of seeds together. This way plum trees can be joined; lemons; lettuce and parsley; daisies of various kinds, etc.

Diophanes shows that if an olive branch is grafted to a grape at its base, its fruit are some form of olive-grape; similarly a vine grafted into a myrtle, plums into nut or apple trees. Combining buds of different trees, such as peaches and almonds, or oranges and lemons, gives fruit with a sweet nut, or a fruit inside a fruit.

One can graft many trees on others of the same kind to improve their fruit, especially the cherry tree. It is harder to graft an apple onto a lemon, but not impossible. Grafting does not always improve the fruit, for example pears and peaches, or apple on plums.

A magician, by observing nature, can make it his instrument and accomplish many wonderful things. Thus he may bring fruit to ripen before or after their season by making spring seem like winter or winter like summer. To have grapes in spring, one way is to graft a vine into a cherry tree. This you can do by passing a vine branch into a hole in a nearby cherry tree, then after two years, cut off the branch from its mother and the rest of the cherry tree. Cucumbers in spring can be made by planting them in pots before spring, keeping them inside when cold, and watering them with warm water. One can delay the autumn fruit of a fig tree by covering it, then uncovering the tree in springtime when the fruit ripen quickly. If you lay chalk or lime to a cherry tree before it blossoms, it will quickly give cherry before its time, but it will then die. Squill onions, or else pepper, oil, and pigeon dung, cause fig trees to ripen quickly; similarly dung will hasten lentils, melons, and several other fruit and flowers.

Fruit, such as cucumbers, if kept moist away from the sun and wind, will keep fresh for a long time. The lemon tree can give fruit all year long if its fruit is cut and pruned in small batches. To have artichoke, or roses or lilies, for most of the year, sow them in batches from November to March.

To bring fruit which is very late, we must instead use coolers and graft forward trees onto later ones. Thus a certain grafting of cherries, or of a pear on a willow, will produce late fruit. All sorts of fruit can be made late, from grapes to roses. For figs and grapes, shake off the early fruit, to allow late fruit to sprout. Another way is to plant late, such as for cucumbers. For strawberries in winter, pluck the green ones in summer, cover with soil and take them out on a sunny week in winter.

There are several ways to make fruit larger. By experience, I can say that a fruit tree that is grafted onto another of the same kind will bring forth a bigger fruit, e.g. apples, citrons, chestnuts, medlars, apricots; the pomegranate on myrtle, mulberries on fig trees. Another way is to pluck the smaller fruit in a branch so that the juice of the tree strengthens the larger, just like a mother can breastfeed one child more than twins; this works with apples. Yet another way is to dig around the tree, lay dung around and water thoroughly, especially with citrons and pears. For peach trees, apply a pint of goat's milk for three days when they blossom. A good way to produce fertilizer is to take muck and pig's dung, add the lee of wine and barley bran, and keep in a dry place; after a year add some vinegar. Apply it around the roots of trees and cover with earth. For peas and beans, one can soak them in water and even add nitre before sowing them. Theophrastus shows how to make enormous pomegranates: fasten a pot with holes in it around a bud on the bough, bend it down to a hole in the earth and secure it there; the fruit, receiving more moisture than normal, grows to a huge size. In general the seeds from the innermost part of the fruit grow into larger fruit than the others.

We are told that to grow fruit without a kernel, plant branches from which

you have removed its inner pith. But in my experience the plant will die since it is the pith which nourishes it. Another way is through grafting. Take a two-yard willow bough, bore it right through and pass it onto a young peach tree. Next bend the tree so it makes an arc; after a year, cut the plant beneath the joining place. An orange grafted onto a quince tree bears seedless fruit. For seedless grapes, cut a bough right through the middle, carefully remove the inner pith with a stone without damaging the buds, place a squill head inside, bind with paper, and plant in a moist place. In general a wild fruit in a harsh environment has a large hard kernel, but a well nourished tree gives small soft kernels.

The same methods can be used to grow nuts without shells, namely by removing the pith of a nut tree and putting in it a stake of elm to stop the pith from growing upwards. Apply swine dung to the roots, especially just before the nuts start to ripen. By cutting out the bark of the tree, the husk is softer, for the bark corresponds to the shell.

To grow fruit of a certain color, the tree has to be grafted onto a tree of the desired color. Thus red apples should be grafted on a plane tree, red oranges on a red pomegranate, red oranges/apples/pears/figs on a mulberry, white mulberries on a fig tree. In general, without care, plants produce faded whitish flowers and fruit; with care, colors are brighter and darker. Apples are made redder with direct sunshine. If seeds of, say peach or melon, are soaked in a colored liquid, or planted inside a carrot, it will grow of the same color. Lettuce can be whitened by tying the tops of the leaves two days before cutting.

To change the colors of flowers: they say that a carnation grafted onto a chicory stem gives a bluish red flower; I have experienced myself that a white carnation grafted into a carrot gives a sea-blue flower. A rose or jasmine grafted onto a broom gives yellow flowers. If a lily bulb is placed in red ochre, it will give flowers of the same color; or else water them with the lee of red wine. Similarly, white ivy is made by applying white chalky earth, or even brimstone (sulfur).

As with colors, so with smells. A limoncello grafted into a citron gives a very pleasantly smelling fruit. Another way is to soak the branches with musk, cinnamon water, clove-water, or rosewater so they absorb the smell. Or by soaking the seeds, for example, artichokes, lettuce, and melons; or citrons in honey-water, cucumbers in milk, or lettuce in wine.

There are some trees such that if you scar them, the external heat gets down to their roots and they die. Other trees allow to be cut and bored into; they are able to reject hurtful humors, just like bodies that sweat out corruption. For example, almonds, apples, and pomegranates. If a tree has fruit that is too sweet then graft it onto a bitter one to produce a better medley; for example, cherry onto a bay tree, or apples on quince. To produce a non-bitter almond, drive a nail into the lower tree so that its bitter gum oozes out. Alternatively, make a hole in the trunk and fill it with honey. What you feed a tree affects its taste. Watering apple trees with urine improves them, as does endive with salty water, colewort with nitre water. Cropping the tops of lettuce or leeks, the second leaves are sweeter.

How to produce fruit in any shape: Take two halves of a clay pot of the desired shape, such as a man's head, and secure them on a growing apple or

orange; it will grow and take its shape. Moreover one can apply colors to the inside of the pot and they are taken up by the fruit. Cucumbers and gourds especially can grow into any shape, such as a dragon or cup. Africanus says that if you inscribe letters onto the kernel of a seed, the tree will bear fruit with those inscriptions. I myself have tried this: write on the rind of a fruit while it is young and it will grow with that writing enlarged.

The ancients describe many other ways of improving plants. Myrtle grows better in the company of roses; mulberry with wood of turpentine tree wedged into them. Cumin grows better if you curse it while sowing the seeds. These are all worthless. But I had a wonderful tree on which I grafted three different trees, a grape, a peach, and a cherry, causing much merriment.

The ancients mixed wines with various antidotes against poison. Theophrastus wrote that in Heraclia there is a wine that makes men mad and women barren; a wine of Thrasus makes one sleep, and another wine makes one watchful. To make wine that protects against venom, cleave a vine branch, take out the pith and put hellebore inside, then bind it tightly with twigs and clay. Or soak the roots with the antidote. If scammony or hellebore is grafted onto a vine it will produce phthorium wine which kills children in the womb. Similarly figs that are purgative. One can water vine or cucumber, or soak the seeds of gourds with hellebore-water for a week.

Finally how to get a hundred-fold increase in yield (but not always because the cold and heat, worms, birds, and moles destroy some of them — except bitter pulses). The major reason why the yield is not so large is that some grains are not as prolific as the others; God meant them to be eaten. Also the grain is sometimes not sown in the right season. The trick is to pick the middle seeds, not the largest or smallest because those are the weakest. Then wash them, soak them in fat ointment and goat's grease, let them be embraced by warm mould, and plant them in the full moon.

Book IV Household Affairs

After all the care in producing the fruit, we now see how to preserve it. For it would be slothful to let it rot. And first how to preserve it upon its own tree, protecting it from birds and insects and falling off by the wind. Some bind them to the boughs, or even cover them completely with straw mortar; they may be preserved for a year. For grapes, fill a yard-deep pit next to the vine with sand and bind the clusters of grape upon a frame over it, covered to protect from the rain (but it did not work for me). Better, pick the early clusters so that newer ones grow in their stead, then cover these with earthenware such that the grapes do not touch the sides. A way that works is to take a vine growing next to the house and let some branches carefully in through a window; open it when it is fair and close it when cold or windy. Then when spring comes, release it from its prison and it will soon sprout grapes. Another way is to place an earthen pot around one of the branches and fill it with earth; take a second one of water from the bottom of which a little water can seep down to the first pot, keeping

it damp all summer. The shoot will sprout twigs and grapes in no time.

It is harder to preserve flowers because they are frail. If you take a rose bud and enclose it into a reed growing adjacent, it will remain fresh. Similarly, lilies enclosed in a cane.

Why does fruit rot? It is the variable air temperature and moisture caused by the multitude of celestial influences. Combined with the natural heat of a fruit, it causes its moisture to be exhausted and thus withers. Theophrastus mentions some peculiar places such as caves in Cappadocia and Media where meat and fruit preserves naturally for years. Fruits should be hung in 'fruit safes' that should be cold and dry and have windows only to the north. Other fruit like plums should be dried in the sun; wheat should have no sawdust, whose heat putrefies it. Beans and pulses should be thoroughly dried and smoked in a loft. Meat and fish can be preserved for up to a month in very cold dry cellars. I have seen this in a monastery up a mountain.

The best time to pick fruit is when the heat is minimal, that is when the planets augur cold and dry, e.g. the waning Moon. The Sun is hot and dry, and the night cold and moist, so one cannot give a direct rule in this case. Citrons are to be picked with their branches on a moonless night. Pears are to be cut still hard and green between 7 and 10 in the morning or 2 and 5 in the afternoon, with a waning Moon. Grain is to be cut, left in the Sun, cooled for a whole night, then stored in a barn in the early morning. Beans and peas are to be cut just before the New Moon, then left in the Sun to dry.

The first sign of putrefaction is where the stalk attaches to the fruit. Care must be taken that the fruit is not fully ripe and to not let them knock or bruise each other. If one dips the end of the stalk in pitch, the fruit will keep longer. Apples should be laid with the stalk down and not touching each other; especially pears. Just as wine goes bad quickly if it is made of a mixture of grapes, so with fruit. Citrus should be cut with their twigs, figs with their navel.

Fruit that grows in manured soil is liable to spoil, for, surrounded by heat and moisture, they have the rot in themselves so to speak. Otherwise in dry cold places, up mountains, the fruit is hard and preserves. Each country has its fruit that preserves best. For example, dates and palms should be grown in sandy soil.

How to lay fruit in special places to prevent the heat and moisture of the air from harming them. Aristotle says that apples should be placed in closed containers so that the outside air does not start their corruption. Palladius goes further and seals each fruit with mortar and pitch or even a crust of wax. Others place sawdust between the fruit that they remain dry. Beans can be placed in oil and covered over with ashes.

This method keeps the air out but it is still liable to changes in heat and cold. Democritus tried a way of placing the sealed earthen vessel with fruit inside in a vat of wine, or cistern of water, either floating or sunk with the help of weights. Otherwise, place the vessels in pits underground or in a ditch where the water runs continually around it. Even better than earthen pots, are glass vessels closed with cork. I have preserved bees, lizards, hair, etc., forever by

covering them in amber. First place the amber in boiling wax to soften it.

Another way is to immerse the fruit in liquids that defy putrefaction, such as honey, wine, vinegar, or brine. Pure honey in particular is so effective that even an apple which has just started to rot with worm, will be preserved and stop the rot from spreading. Unfortunately, the fruit loses its taste by this means. Having tried this myself, I can say that peaches, grapes, and figs preserve less well than apples and pears, and nuts preserve for a year, because of the lack of moisture inside them.

Fruit may also be preserved in wine. The ancients disagree on whether to use new wine or ordinary wine, or earthenware or barrels. Grapes and cucumbers must be hung on top of the wine or vinegar, not swimming in it. For peaches, one must first close the passage at the stalk with pitch and make the entire vessel airtight. Olives and grapes keep each other if you place them in an alternating pattern. Since wine itself goes sour after a while, it is better to extract its quintessence by distillation so that it is free of putrefaction. I saw a fish in Florence in a sealed glass of distilled wine, preserved for 40 years.

Finally, salt keeps food from decay. Homer called it divine for this reason, and the Egyptians applied it to mummies. Boil saltwater or seawater then place the fruit in it, let the solution cool, take the fruit out and dry them. To use them, soak in fresh water for two days. A little salt added to wine preserves it for a year. Fruit that are naturally salty preserve longer.

Leftover oil is excellent to preserve food and flowers. Cato advises to sprinkle it in barns to preserve grain, and on cloth or shoes, to prevent moths from eating into it.

Sawdust, because of its dryness, is an excellent preserver. Every fruit is best preserved in the dry dust of its own leaves, just as olives are best kept in oil, and grapes in wine. It can also be kept in wool, chaff, straw, dry grass, and such like.

Oranges do not decay when immersed in barley; similarly apples and mushrooms in millet seed, pears in grain.

Quicksilver is a great preserver. Flesh hung on a brass nail keeps long because brass desiccates. To preserve a body, disembowel it, remove its brains, all its inner organs, any fat, and the pith in the backbone. Then hang it by its feet for four hours, wash it with a sponge with vinegar or aquavita. When dry, smoke it with myrrh, rosemary, bay, and cypress for two days. Make a mixture of 5lb lime, 1lb alum, 2lb salt, 1/2lb each of aloe and myrrh, 3oz of spikenard oil, five flowers of rosemary powder, 2 flowers of burnt green brass and chalcantum (blue vitriol), 4 of theriac, 1/2lb cypress dust, 1oz saffron, 3 1/2oz colocynth seeds, 1 1/2oz antimony powder, 5 1/2oz ashes of wine lees, a half dram of musk, 2 drams of amber. Crush them with a mortar to a fine powder and rub it strongly into the body for three days.

Having taken the pains to preserve the fruit of our labor, it remains to see how to use it. I begin with how to make bread, but not of the ordinary kind. Walter caltrop, chestnuts, the beans of a lote or jujube tree, very dry dates, etc., can be ground into flour then kneaded with water or milk.

When grain is expensive, one can make bread from ground roots of wake-

robin or wild arum. Cut the roots into thin slices, boil, throw away the water, and boil again, until the roots do not taste bitter. Hang to dry then grind them into a powder with some wheat flour added in. Similarly, for the roots of asphodels, rapeseed, and turnips. Boil the thick rinds of gourds for a long time; pass through a linen to remove any large parts; and let dry.

Different places make bread from various plants: millet, barley, switchgrass, corn, peas, lentils, beans, acorns, and lupin beans. For the latter, mix the powder well with water, then strain the water away, and repeat three times, until the mixture is not bitter. Leave to dry and add a little boiled rice; add a double amount of wheatmeal with leaven to produce bread.

Now I shall write of how to increase the weight of bread, either by supplementing grain, or by thickening the mixture, or by expanding it. As to the first, it is common to use chalk, rice, millet, and milk. I have also discovered that one can use wheat to increase itself! The trick is to raise the dough not in one go but to keep nourishing its internal heat in three or four batches, each time adding to the previous one.

As Pliny says, just tasting butter, or the sweet plants of licorice and hippace, abates hunger. The Scythians could go for twelve days with just these two herbs. But it is unclear whether 'hippace' refers to cheese made from mares' milk. The West Indians use another herb, the tobacco, to endure hunger. They roll them into balls, place one between the teeth and the lower lip, and suck its juice. Heron mentions the Epimenidian composition, made of sea onion, boiled and dried, sesame, poppy, and honey; one only needs to take a morsel at 2pm and 10pm to pass the day.

Pliny says that in the East they make wine of dates or figs, with a taste of honey. It is made by putting ripe dates in a pitcher with a stopped hole at the bottom and adding three to five gallons of water; leave for ten days. Wine can also be made of peeled pears pressed by weights; or of pomegranates, myrtle berries. But a sort of wine can be made from barley, or millet, or rice. Beer can be made from grain, but in the north they add hops. Of them I've made the best aqua vita. Add eighteen pounds of honey (or raisins) to nine vessels of water in a cauldron, bring to a boil, removing any froth that forms. Then pour into a wine vessel, add two pounds of red wine tartar, and boil to dissolve; add an eighth of a vessel of vinegar to remove the excess sweetness; let it settle for a few days, strain through a cloth, and add some wine to make it right.

After wine comes vinegar. When wine is scarce, vinegar can be made from figs. Gather those that have fallen to the ground in the rain, let them ferment in an amphora until it becomes sharp, and pour out the vinegar in a vessel. Some add water and ripe figs until it tastes like vinegar. Boil the solution and strain out the filth; add some salt to prevent worm growth. Vinegar can also be made from dates, honey, pears, peaches. If you're in a hurry, just add salt, pepper, and sour leaven to wine, and quench a red-hot metal in it. But better is to add a few sour grapes to new wine and it will be ready in seven days. You can double the quantity of any vinegar by adding boiled seawater; then soak some barley and add to the liquid with heated salt; let stand for a week.

Wine easily goes sour. To test the quality of wine, pour it into a new vessel

and smell the original container; if it is a smell of corruption, it is a sign that it easily putrefies. Others take a little wine from the middle, heat it, let it cool, and then taste it; if it tastes of water then it is no good. If a wine starts to breathe heat, that is a sign that it is giving out its soul; you can remedy it by adding aqua vita. One can also keep it cool by placing a glass vial filled with quicksilver in the wine. Or add a layer of oil at the top to stop the spirit from evaporating. Another way is to add an ounce of salt, or a mixture of three well-beaten egg whites with salt; it will clear the liquid in four days.

How to make oil if olives are scarce: Let castor oil beans ripen in the sun until their husk breaks off. Ground the flesh with a mortar and put in a tin-glazed cauldron full of water. Boil the mixture until a layer of oil forms at the top; skim this with a shell. The oil is not edible but good for candles. Alternatively, gather the berries of a lentisk tree into a vessel, leave for a day, pour hot water in and press firmly; the liquid that comes out has a floating layer of oil. Other trees that yield oil are the turpentine tree, bayberry shrubs, sesame seeds, the plane tree berries, sycamore, beech, chestnuts and acorns, all sorts of nuts including walnuts and pistachios, radish seeds, etc.

How to make yarn: The common way is to make it from hemp and flax. Flax is dried in the sun, then bundles of them are left to soak in warm water, and then left to dry again; then they are hammered, separated into yarns, and combed to softens it up. Hemp is used for ropes. Each country has its own plants that yield thread, eg. nettles, agave, etc.

Finally, how to hatch eggs without a hen. Just as it will hatch under any bird, be it duck or pigeon, it will also hatch with the warmth of people. I have seen women keep an egg in their bosom, and when necessary pass it on to each other so it keeps warm. Also, just like the other quadrupeds that lay eggs in the earth, covering hen eggs in dung almost to the top will keep them warm. In Egypt, they make a small oven covered in dung and warmed by a fire. From my own experience, one can cover the eggs with sawdust and the whole oven with a sheepskin, all warmed by a lamp with three to five wicks depending on the season. Place the eggs against the sun to see which ones are rotten. Make a note of when you place the eggs, for on the twentieth day, take them into a pen so that when they hatch the chicken will take care of them.

Book V Alchemy

To start, a word of caution, because the whole subject is looked at with scorn and disgrace thanks to rude men attracted to it by vain hopes of making gold. Instead of transmuting metals, they converted their possessions to nothing, deceiving others. It is a wonderful topic, but I make no promises of gold or philosopher's stones or immortal liquor.

Tin looks somewhat like silver. It alloys with other metals to make them whiter but more brittle (except with lead). What distinguishes tin from silver are a number of accidental qualities: it breaks more easily, it has a dull sound, it has a paler color, and it melts quicker. Removing these qualities makes it pass

for silver. To change its sound, melt and quench it in urine or oil of walnuts, and repeat seven times. To make it harder, first break it into a powder; you do this by melting it until it is very liquid, and as it cools stir it continuously with a wooden pestle to form dust like particles. Pass through a sieve and melt the larger pieces again. Put the powdered tin on a crucible and heat it but, before it melts and starts to assemble into a solid, let it cool then break it up again into a powder; repeat this at least three times. It will look much like lead. Now that it is impervious to melting, put it into a furnace for four days until it is a white ash. Place it in vinegar and bring to a boil until the color changes and it thickens; remove the liquid and pour fresh vinegar; repeat until all the ash is gone. Now distill the vinegar, and to the tin that is left behind add some lead and a fat earth to join them together, for example soap and lime, or saltpeter [KNO_3] and brimstone. The result of the tin joining the lead is a very excellent silver.

That tin is much alike lead was known to the ancients who sometimes called tin “white lead” and lead “black tin”. In fact, one can change lead to tin by removing its earthiness from its quicksilver. You do this by melting it several times. Dioscorides also writes that if one melts and then burns antimony thoroughly it turns to lead. Galen says that if you put lead in damp cellars it swells and becomes heavier. It is easy to change lead into quicksilver: file it into a fine powder, and for every 2lb of lead put 1oz of saltpeter, 1oz common salt, and 1oz antimony powder. Place the mixture in a glass retort surrounded by sand and heat in a furnace, at first on low heat but then at full blast for four hours. The liquid that comes out is quicksilver, an ounce for every pound of lead. The cheap counterfeit quicksilver that one usually obtains is made by taking lead, and for every pound add an ounce of the metal called marchasite. Melt them together, stir, and add four pounds of warm quicksilver; when it is well alloyed, pour into cold water so that it floats on top. It is not true quicksilver, but behaves much like one.

To whiten brass, take the liquids of arsenic or litharge [PbO] or marcasite [FeS_2] or alkali salt (found in Africa under the sand) or saltpeter, and quench red-hot brass in it; or else melt the brass and pour it in. It will become white like silver. But a word of warning: these just change the color by attaching to the surface; they do not last with time and are easily found to be counterfeit by testing with a touchstone. Yet the gloss that they give to the surface is still wonderful. A better way is to melt some lead in an earthen pot, and sprinkle a third of the amount of silver powder in it. After it cools, break the pot and on top there will be a jelly; apply it to molten brass to turn it all white. Alloying silver and brass together is also good but it will blacken with time. Even better is the following: take 6oz of lees of wine, 8oz of arsenic crystal, $\frac{1}{2}$ oz of sublimated quicksilver, 2oz saltpeter, $1\frac{1}{2}$ oz glass; crush the mixture into a powder and sprinkle some into an earthen pot, then add 3oz of thin copper plates, and continue adding the powder; cover and seal the pot with mortar, bind it with iron, and place in a furnace covered with coal for six hours. Let it cool, break the pot, and you’ll find the plates have become brittle. Now melt 2lb of brass and sprinkle this powder into it, then add 1lb of silver; finally throw

it into boiling water with salt and lees of wine to turn the alloy very white. Another method is to take powder of an arsenic mineral of a golden color, mix with an equal amount of brass filings, and place in a little lees of wine; then dissolve some silver in aquafortis and pour over the brass; work the mixture with red marble to form a solid, using drops of oil of sal ammoniac to lubricate it; dry it in a hot sun and repeat adding the oil and drying; place in a glass, submerge in a dunghill, until the mixture dissolves into a jelly; put in the brass pieces and they will get tinged like silver. An easy method is to take equal amounts of sal ammoniac, alum, and saltpeter, with some silver filings, heat strongly, and rub the mixture onto the brass. Better is to dissolve some silver in aquafortis, and add some lees of wine and sal ammoniac; leave to settle, roll the precipitate into balls and rub onto a metal. But note that any sharp liquid such as vinegar will fade the color away.

Iron is full of earthy brimstone that makes it hard to melt and work with. To change it to brass, one needs to remove this earth. It is said that there is a lake in Pannonia such that iron that is dipped in it becomes mud-like, but when it is then baked in fire turns to brass. We can do this artificially by heating iron until it is red hot, sprinkle some brimstone, and when melted pour into a cast. Dissolve it with aquafortis compounded of vitriol and alum. Boil this liquid and the remaining solid, when melted, is brass. To make iron white, first thoroughly clean it by heating it strongly and quenching it in a liquid consisting of strong lye and vinegar with some salt and alum. Then make a plaster of quicksilver and lead, pound it into a powder, and place with the iron in a vessel. Seal the vessel with mortar, and place in a furnace for a whole day; the melted iron will become very white.

How to congeal quicksilver: place it in a vessel and add some water that the blacksmith uses to quench iron. Add also sal ammoniac, vitriol and verdigris, twice the amount of quicksilver. Boil them, always stirring the mixture. Add hot water as it boils away; after six hours it is solid. Alternatively, make two fitting half spheres of brass; pour in the quicksilver together with equal amounts of white arsenic and tartar. Close and seal it, then heat it until it is red hot; open the sphere (you may need to hammer it) and you'll find the congealed quicksilver. Melt it, add three parts of melted brass, to make it appear much like silver. You can also use instead silver and red arsenic with the quicksilver; boil it in linseed oil for twelve hours. Make an earthen vessel six feet long, one foot wide, lined with glass inside and a small retort opening at the top; when red hot, pour in ten pounds of quicksilver, remove the fire and about an ounce of water of mercury will run out of the cap. Dissolve some silver in aquafortis and let it evaporate over a low fire. Distill some water twice and pour it on the thick evaporate. Add a pound of quicksilver; after a day, a most beautiful silver tree springs up from the bottom¹. The same can be made of gold and aquaregis.

To give silver a gold color, melt brass with antimony and add a half part of silver, better with a bit of gold. To tincture silver with gold, first put quicklime into a pot with holes at the bottom and cover with a piece of wood; add hot

¹“Arbor Diana”

water, collect it from the bottom and add it again until the liquid is a sharp lye. Put antimony powder in this lye over a low fire and let it boil and evaporate until it becomes a purple color and dries out. Dissolve it in oil of tartar and cast it on plates of silver and gold; heat it strongly until the alloy looks like gold. If you add three parts of congealed quicksilver, as described before, with a part of silver, it takes a golden hue. To make the color more intense, melt it with an equal part of gold, pour on it a sharp vinegar and boil for six hours. To make gold from silver, heat and melt iron filings in a crucible, add artificial chrysocola or gold's solder and red arsenic, then add an equal amount of silver; add water and the gold will precipitate. Break cinnabar into pieces and add three times the amount of silver in a glass vessel with water; boil for a long time until it takes a leaden color, then add two parts of lead. Smear this fixed cinnabar with beaten egg white, roll it with a third part of silver filings, seal the vessel, and heat strongly for three days; wash it and put a piece of silver, heat gently and the silver will grow hairs.

To extract the life from tin, place tin filings in an earthen pot, with an equal amount of saltpeter. Put seven other earthen pots with holes in them on top of it with a glass vessel at the very top. Heat the whole set and it will emit a sound as its life flies into the pots. Heat a crucible strongly and sprinkle on it antimony, two parts tartar, and four parts saltpeter; cover it as it fumes; continue until all the powder is burnt. When it cools, you'll find at the bottom "regulus", which looks like lead.

How can silver be changed to gold, when the latter is heavier? One can increase the weight of a metal such as gold. Rub silver onto gold; prepare a lye of brimstone and quicklime and add it to the gold in an earthen pot; boil it gently until the color is that of gold. Bring silver to powder using aquafortis and apply it to wet gold so it sticks to it; now add three parts of red vitriol (boiled) and a third of finely powdered salt, all into an earthen vessel; heat strongly in a furnace for six hours, and the gold will become like silver. Now take four parts of verdigris, two parts sal ammoniac, a half saltpeter, and a fourth alum; dissolve in water and wash the gold with it; immediately bring to red hot over a fire and quench it in urine; it will regain its color. Another way: melt two parts of brass with one of silver; also make a powder of saltpeter and vitriol, and put everything in with gold in a vessel; seal it and gently heat it for half a day; its weight will increase. To remove amounts of gold do the following: rub brimstone powder to the golden vessel, and apply a candle; if you strike it with a hammer, gold flakes will come off. For gilded silver cups, make a powder of sal ammoniac and brimstone and apply with oil onto the cup; heat it strongly and strike it with a hammer so the powder comes off with the gold. Quicksilver will do the same. To remove gold from brass, simply heat it and quench it in cold water.

How to part gold or silver from brass without using aquafortis, which is difficult to make. Put a gold-silver alloy in an earthen vessel; heat it until red hot and it melts, then put in an equal amount of antimony, bit by bit, until it all melts; leave it boiling for a couple of minutes. Place the liquid into an iron crucible which has ram's fat at the bottom; shaking it causes the gold to

separate from the silver. Remove it, boil the remaining dregs again, and the silver will remain. Another way is to take 3oz of brimstone powder, add it to 1oz of common oil, heat well then let it cool, and pour into vinegar; the oil will float but the brimstone will fall; pour it into new strong vinegar, boil it and it will take a color. Strain, add more brimstone, boil, and repeat until the lye is very dark. After a night, a white brimstone remains at the bottom. Boil it again with distilled vinegar until a dry powder remains. Repeat this until the powder is very pure. Add it to molten gold-silver alloy and they will separate. To part silver from brass, use the following powder: one part each of brimstone, arsenic, salt, and saltpeter, with two parts of lead powder. Add it to the silver-brass alloy in a strong vessel, melt it, and cast onto the vessel with ram's grease. The metals will separate. To part gold from brass use a powder made from vitriol, alum, salt, brimstone, and half sal ammoniac. Boil them in a lye made from four parts beech ash and one part quicklime, until a dry powder remains, then add one part of lead powder. To the alloy add six parts of this powder, then do as before.

How to part gold or silver from brass using aquafortis. Dissolve a silver-brass or gold-brass alloy in aquafortis. Add to water in a vessel, and place plates of brass. The silver will stick to it. Do not throw the water away; instead heat it until a yellow water remains at the bottom, then distill this water and the water that comes out is aquafortis. Men have become rich using these methods.

Book VI Counterfeit Precious Stones

How to make salt soda: grind the plant called saltwort or soda into a powder and add water, a firkin² for every pound; boil it in a brass cauldron for four hours until a third evaporates. Let it stand for 12 hours until the water clears. Drain it through a linen cloth and add fresh water; boil it again as before, and repeat for a third time. Then simmer it until the water evaporates, leaving behind salt soda, one pound for every five of soda that you start. How to make salt of tartar: tartar is the dried lees of wine; heat it in an alembic until it turns white as chalk (turn it often so that the inner parts are also burnt). Grind it and place in water for 6 hours; boil and filter as for the soda until all the inner salt is dissolved. The salt is that of tartar.

Gems are made either of rock crystal or clear river pebbles. Put the pebbles in a furnace; when they are red hot quench them in water. Dry them and hammer them into a fine powder. Add a little water to separate the finest powder and let it dry again. It is important that no dirt remains in the mixture. Now mix one part of salt of tartar, one of salt of soda, and two of the rock powder, add water to form a paste as big as a walnut. Let it dry well, then place in a furnace for 6 hours until it is red hot. When cool the stone becomes extremely hard.

The furnace should be a small version of a glassmaker's. It should be 8 feet high with two vaults. The lower one should have a little door through which

²A quarter barrel, about 40l

you put wood and a hole in the center top where the flame penetrates up. The upper vault should have plenty of small holes with doors through which you place crucibles with tongs. It takes 6 hours for the heat to reach a maximum, at which point place the paste forms in the crucibles in the furnace. If bubbles form in them, burst them with wires. At intervals, use an iron hook to see if they have become transparent. When they are, place them in hot water to wash off the salt. Place again in the furnace and add a little white lead in the crucible; leave for two days to form a perfect crystal.

How to prepare the colors: Put 4lb of iron filings in water to remove the dirt. Dry it well then put it into a glazed pot together with four gallons of sharp vinegar for four weeks stirring it every 3 hours. Each time collect the vinegar and replace with fresh liquid, until all the iron is dissolved. Boil the vinegar away to leave a dirty film, and keep heating it until a dust called "crocus of iron" remains. For zaffer³, place it in the furnace for 6 hours, then quench in water so it breaks. Pound it into a powder; add water and strain it, break the remaining pieces and repeat until the powder is fine. For copper, add a part of its filings to an equal part of salt. Heat it for a whole day, turning it so it is burnt throughout. To half of it, add more salt and burn it again repeatedly until it is black.

How to color gems: To make sapphire add two drams of zaffer to each pound of crystal glass; boil for 6 hours. To make cyanus, an azure sapphire, pound calcined brass into a very fine powder and add about one dram to each pound of glass. For amethyst color, add a dram of manganese; for topaz, add 3oz red lead and a quarter ounce crocus of iron; for chrysolite, prepare like topaz but add a bit of copper.

There is another secret way to make gems. Cut the head of a cock and take its comb; heat it strongly then quench it in clear water and dry it; repeat twice more and grind it into a powder. You will also need the Philosopher's stone. Put the mixture in an earthen vessel with holes in the middle of the furnace for a whole day; it gives topaz. To make chrysolite, feed the cock flower of Venus; for emerald give him four grains of wheat; for hyacinth, feed him blood stone.

Now I turn to rarer colors, known only to myself. Beat 6 parts stibnite, four of orpin, three arsenic, three sulfur, and two of tutty [ZnO] to a fine powder. Hang the crystal with a wire, apply the powder to its surface, and set in a furnace for four or five hours until it takes a purple or violet color to your liking. To change a sapphire or other gem into a diamond, you need to heat it to fade its color. Place it in lime and cover with coal; keep testing it until it has lost its color. Do not quench it or it shatters. How to make stones of two colors: plaster half of it with chalk, let it dry, then place in a fire as before. I have also found that flour of tin makes a stone look like opal of diverse colors. Lead placed in a hard furnace will turn a hyacinth color. To make an emerald, dissolve silver in aqua fortis, and place some copper plates; apply the powder to the stones in a furnace for a few days. To make carbuncle, grind 4oz of orpin, and heat it in a glass beaker; the smoke rises and sticks to the sides; gather

³the mineral cobaltite

these small particles and melt them to form a larger stone.

The difference between enamel and gems is that the latter are transparent. For white enamel, take 2oz lead, 4oz tin, 8oz glass powders, roll them into balls and place in a gentle fire for a whole night, then melt it. For black smalt, use 1lb glass, 1 drachm manganese, 1 drachm zaffer. You can use different minerals for other colors, for example, copper for green; or add speckles, etc.

For rose colored enamel, melt 10lb crystal, add 1lb of red lead, then 5oz of calcined tin and bright cinnabar, for three hours. Finally add 3oz of vitrified tin. You make the latter by melting tin in a hot furnace; let it cool and on its surface you will find a saffron-colored glass.

Gems can be improved by attaching metal leaves. Cut a copper sheet into pieces of 2 by 3 fingers' width. Beat them out while hot into thin leaves. It is best to enclose the copper within an iron envelope to do this. If they turn black, boil them with water of tartar and salt.

To polish these copper leaves do as follows. Take a rectangular copper plate and bend it into a semi-circle over a wooden cylinder. Fix it there with nails. Wet some very fine chalk powder into a paste and rub it on a copper leaf until it shines.

Let the furnace be made of iron plates, one foot high and in diameter, covered at the top with a plate that has a hole the size of a hand. On top of this place an identical furnace with a hole at its bottom. Burn some coals in another place; when they stop smoking, place them in the lower furnace, half full. Now take the copper leaves, fasten them with an iron ring and place them in the hole of the upper furnace; they will turn purple. Add materials among the coals to make different colors; for example, a goose feather produces a sapphire color. For a silver color, dissolve some silver in aqua fortis, add pure water, and the copper leaves. Now remove the water, wash the silver and let it dry; mix in some tartar and salt, and rub it onto the copper so it takes a silver color.

Melt a half pound of copper with a half crown of gold, add tartar; melt another half pound of copper with a drachm of silver; let them cool and beat them into leaves. Place them on the furnace as above to color them as required. They give a unique color with the mixture of metals.

Book VII The Magnet

The Greeks called it magnet since it comes from Magnesia. There are many kinds: a weak female black stone from Troas; a much stronger one from Ethiopia. There is another mountain in Ethiopia whose lodestones repel iron instead of attracting them. In the North, it is reported that there is a place with such strong lodestones on the coast that they don't use iron nails for their ships lest they are pulled out by them.

The Greeks did not know why the attraction occurs. Epicurus thought that the iron emits atoms that embrace those of the magnet and return, dragging the iron as they do so. But Galen disagrees because iron can be attracted to the *sides* of other iron pieces touching a magnet, so the atoms would not be moving

towards the magnet. Moreover, if a small magnet were to touch several irons it would lose all its atoms. I think that the attraction is caused by a struggle between the iron and the earth inside the lodestone, with the iron calling for help, so to speak, of more iron to aid it. This explains why it does not attract stone, why a lodestone loses its strength if it is not protected by iron filings, and why it loses its soul if it is heated strongly.

Every magnet has two endpoints, one pointing to the north pole, the other to the south pole, if allowed to turn freely, for example by floating it on a small boat of cork on water or hanging it by a thread. One can tell which magnet is strong by the speed with which it turns towards the poles.

If one breaks a magnet across the line joining the endpoints, the new endpoints behave as before: they both turn to the poles, returning to the position in which they were bred in the mine. It is a great wonder that two points that before breaking work together as one, yet after breaking become opposites, pointing to different poles.

This same line is not always in the same position. If a lodestone is split along the line joining the endpoints, the two halves will now have new lines running through their middle. This is wondrous, in that a dead object exhibits a moving living virtue. If the stone is divided in a thousand parts, its forces spread out with them; and if they are again joined together, they form one line again.

The magnetic force is concentrated in this line joining the endpoints. But it is asleep, so to speak, in the middle of the line and awake at the endpoints. You can test this with iron. But if you break the magnet, the new endpoints suddenly become active.

The strength of the endpoints does not change by rubbing them against another lodestone. The greater the stone the more strength it can have, but it will not change that strength by rubbing, so a north will not become a south.

The north endpoint attracts the south point of another magnet, but it makes an enemy of the north endpoint and repels it. This makes sense, for if a lodestone is cut in half, then one endpoint of the second piece will try to rejoin with the point it was attached to. It will repel the other endpoint because it is not the one that it was formed with in the mine. Thus Cardanus is wrong in stating that lodestones do not attract each other. You can try this with large weighty stones, by hanging them by a thread so they can move.

I have often tried this trick on friends: Pound a lodestone into a powder and mix it with sand. Challenge them to separate them easily. You then pass another magnet beneath the powders, covered by a cloth, and the lodestone powder will separate out to their amazement.

The virtue of a large lodestone is diminished if a piece is taken away. Join the pieces together and it will regain its force. I have seen a 1oz stone that is able to attract 2oz of iron, and yet another of 40lb from a different mine that can hardly attract 1oz.

When a lodestone attracts another, it sends forth its own forces through it, so that it can attract another smaller stone; one can hang a whole chain of them. One wonders how this invisible force passes from one to the other.

If you rub one lodestone to another so that they form little filings, they

remain attached to the magnet, sticking out like hairs. If you then pass along a stronger lodestone, it is wonderful to see these hairs turn about towards the other's friendly parts.

The point that attracts does so more strongly than the point that repels. That is, friendly poles will jump a longer distance; unfriendly poles will repel at a closer distance.

If a north and a south are placed close together, they will cease to attract iron. But if one is stronger, its power is diminished by the opposing pole. Hang a lodestone and join it with another lodestone, with opposite poles attracting. Now bring a third lodestone with a contrary pole nearest to the point of joining. The power of the hanging magnet is hindered by the third and the second falls away.

The point where a magnet attaches to another is a pole. You can determine this more accurately by using filings of a lodestone. Where they draw together the closest and strongest, that is the pole. Its force is like a candle, diminishing with distance.

This force of attraction and repulsion penetrates invisibly through wood, metal, or stone. It is wondrous how if you move a magnet under a solid table, it moves a lodestone on the surface with it. But not if the table is made of iron, for then its power is checked.

How to make an army of sand fight in front of you: Place several pieces of lodestone and magnet filings on a table. Then with two strong lodestones in my right and left hands under the table, I can make the pieces move at will, like armies marching and attacking each other with uplifted spears! To the spectators' amazement, I elevated them on a paper held slightly above the table, in mid air, and they still moved. It was wondrous to see, but some thought it was done with the help of the devil.

Hang a lodestone in air and slide a second stone from above it to below it. If at first they attract, say, later they repel. So the magnet will work in contrary ways depending on the situation.

We can measure the virtue of a lodestone as follows: hang it in a weight balance and put an equal weight on the other pan. Now place a large piece of iron underneath the lodestone that they may touch. Add sand on to the pan until the iron and lodestone separate. The weight of the sand is a measure of the lodestone's strength.

What is more sluggish than a dead weight? Yet a lodestone has within it the sense to detect the presence of iron and move to it. What is stronger than hard iron? Yet it submits to the command of the lodestone, embracing it as a bride to her man. Even if it is prevented, it clearly desires to join and kiss it.

The affinity of iron to a magnet is greater than that between two magnets. You can prove this by placing an iron piece and a lodestone of equal weight on a table. Bring a second magnet first to one then to the other. The iron will stir and jump before the lodestone. Or join two magnets together and bring one end to an iron; the middle lodestone prefers to let go of the first magnet and join with the iron. But join the iron with the lodestone and no magnet will separate them.

A magnet does not attract an iron from all points but from a particular point. It is the point where an iron attaches the strongest.

Pliny says, erroneously, that there are two types of lodestones, those that attract iron, and those that repel. What happens is that if iron is in the presence of a magnet for a while, it takes on its virtue. So if the iron is now placed with unfriendly poles to the magnet, it will repel it.

How to make iron leap on a table without magnets: Cut a needle in two, rub the head of one of them with the end of a lodestone, attach a paper head, arms, and legs, and place it on a table. Now, unseen, put the magnet under the table in your hand. The needle will stand upright to the amazement of spectators, and will follow your hand around. Furthermore, turn the lodestone around in your hand and the needle will also turn upside down and move on its head! It is extremely amusing to do this with two needles and two magnets.

A magnet's virtue passes on to the iron, for a needle will attract another to form a chain, as many as the lodestone's strength allows.

Even more wonderful, a magnet will impart its virtue to the iron without touching it. That is if you place a lodestone close to an iron but prevent them from touching, a needle will still be attracted to the iron. In fact a chain of needles can still be formed, and as the magnet is removed slowly, the needles start to fall one by one.

I have endeavored to make an iron needle stay in mid-air by using magnets, but have always failed. The Greeks say that the Temple of Serapis in Alexandria had a statue that hung in the air, but that is false. The only way to do it is to tie the needle to the table by a thin thread and then attract it by a magnet.

A magnet's virtue passes undiminished through wood. For a magnet under a table will affect a mariner's compass on the table. If one places an object between a magnet and an iron, it can be shoved out of the way by their attraction.

An amusing trick: Fill a vessel with water, and float a little boat of wax or wood. Set on the boat a little man of wood balancing on a bristle that goes through him, so that he can easily rotate. Give him oars, and attach a piece of iron for his shoes. Write down the alphabet on the rim of the vessel. So when a woman comes asking some question, the man may row (with the help of a magnet hidden in the hand under the vessel) to the letters to make a word. Another trick that astonishes people is to attach an iron piece to a sheet of paper; ask someone to hold it against the wall. On the other side a boy applies a lodestone opposite it, so that when the person lets go of the paper, it stays there. And if he commands it to move up or down, it does so by itself, even up against the ceiling (using a wooden pole to hold the lodestone).

Only iron can hinder a magnet's attraction. A magnet above or under a sheet of iron will not move a needle above it, as if its virtue is completely taken by the iron sheet.

An iron touched by a magnet behaves like it. If such an iron attracts a mariner's compass held below it, it will repel it when held above it, just like the magnet.

If one rubs an end of an iron bar with the north endpoint of a lodestone, then that end will turn towards the south, unlike what Cardanus said. It makes sense

because the north endpoint will impart part of its virtue to the iron, making it a north and hence the opposite end automatically receives the opposite virtue and turns south. This is how mariner compass needles are made.

When a magnet touches a hanging iron by its south point, the latter turns north. But if you touch another iron to the first iron, it turns south.

Touch an iron end by a south point of a magnet. Now touch it by a north end of a stronger magnet. The iron will change its virtue accordingly.

To demonstrate clearly the endpoints of a magnet do as follows: cut it and polish it so it is a round ball. Now bring it close under a small hanging iron rod which turns to a fixed direction. Mark this line on the ball; turn the ball and repeat to draw several of these lines. You will see that they meet at two polar points, the endpoints of the magnet. Alternatively, place a tiny piece of needle on the magnet, shake it and stir it until it moves to one of the poles where it will stand on end.

How to properly rub a needle by a magnet: Mark its north and south poles as above. Then rub the needle end at one of the poles; the north will rub a south pole on the needle and vice versa. Strike the ends of the magnet with a hammer to leave a few hairs, then touch the needle first at one endpoint then the other to transfer some of the hairs to it. Store the needle in a box of filings, otherwise it loses its force. The iron needs to be pure steel and not sharp at the ends.

The compass is useful not only to point out the north direction, but is used by miners to discover veins, by city planners to lay out the corners of buildings from a paper map, by mine diggers and sappers to keep a constant course, by gunners to guide their cannon both day and night, etc.

It has been observed that a compass does not point to the true north. In Italy it points 9 degrees East, in the Azores it points to true North, whereas in the West Indies it points west of north. Hence it can be used to find one's longitude at sea.

If one brings a compass needle near to the south pole of a magnet and move it around, its north arrow end will turn with it. So in fact the compass always points to the north pole star, but appears to deviate because of its position.

If you touch an iron with a magnet, then later bring the same ends together, the iron will be repelled. For alike poles do not endure each other, like adversaries. Hence it appears that a magnet imparts the opposite pole at the point where an iron touches it, as can be proved by using hanging needles.

Another strange thing: If you hang two needles to a lodestone at the same point, their other ends will abhor each other. The reason is that the magnet imparts the same virtue to them, and like poles repel each other.

The same is true if you first touch a needle with a magnet and float it on water, then bring a second needle touched by the magnet at the same point. They repel in the same fashion as if they were still attached to the lodestone.

We said previously that when a needle touches a magnet it receives its virtue at both ends. But if the needle is too long, no virtue is acquired at the farther end. This is because a lodestone has a limited sphere of virtue. If the other end is beyond this, the force is not able to penetrate that far.

If a long needle is touched in the middle by a magnet, both ends will receive a diminished virtue.

If an iron ring is touched by a lodestone, then that part receives the same virtue, and the opposite end the opposite virtue. Now bend an iron wire into a ring, rub the magnet at the joint, then bend it back straight. The two ends have the same virtue. But with time their force diminishes, with one end becoming north and the other south.

If an iron plate is touched in the middle, the magnet's virtue spreads out like a beam of light to the ends, but it will be very feeble in force.

If you pack iron filings tight in a paper 'box' then the magnet will attract it as a whole, but if the paper is open, the force is lost and confused with the multitude of filings.

Plutarch says that garlic is an enemy of the magnet, and smearing with garlic, loses its power, just as amber loses its force if anointed with oil. But I find this to be false, perceiving practically no difference.

If a lodestone is drunk and has lost its power, then its virtue can be restored by covering it over with iron filings for many days.

Many have tried to make magnets stronger. Some say that a magnet covered in iron filings sucks their power, making them lighter. I have tried this, but the difference I observed was so small that I am doubtful of the truth of it. I also tried several times, like Paracelsus suggests, to quench a lodestone in oil of iron, but its force was lost rather than augmented.

A sure way to make a lodestone lose its virtue is to make it red hot. A bluish black vapor comes out, signifying that its soul is breathed out. Dead, it is in vain to try to revive it.

The same is true of an iron touched by a magnet. When red hot, it dies. When men heat needles red hot in order to better receive the magnet's virtues, are going against nature by driving away the force, only to regain it later.

Others say that the lodestone and diamond are opposite in qualities and hence are antagonists. The diamond prevents the magnet from attracting iron, they say. But I brought a diamond to a lodestone three times smaller, with iron filings attached to it, and it made no difference. For there are many ignorant fellows, who read the ancient writers and invent stuff. The blind leading the blind, they don't know what damage they bring to the commonwealth of knowledge.

Still others say that garlic takes out the power of magnets, but that it is then restored with goat's blood. This they say because the latter has an antipathy with diamond, in that the hard stone will shatter if soaked in goat's blood. But I have determined this to be wrong. For diamond is not as hard as men make them, for they do break with steel and mild heat, and its hardness does not diminish with blood, whether of a goat or camel or donkey.

But by accident, I found that if you rub a steel needle on a diamond it turns north when hung by a thread, but less strongly than if rubbed by a magnet.

Our ancestors wrote much about the love and hate of lodestones and iron. One claimed that to know whether a man's wife is faithful or not, put a lodestone

under her pillow; if not she will be repelled out of the bed. There are many other old wives' tales that I can mention.

Book VIII Medicines

Medicines that cause sleep or ease pain are cold and moist. Dioscorides says that mandrake, which is used by surgeons in their work, induces instant sleep for three to four hours. The Romans report that Hannibal, in one of his stratagems, feigned a retreat leaving a quantity of wine mixed with mandrake in the camp. When the enemy tasted of it, he returned and slew them all. Caesar was once taken by Cilician pirates; they arrived at Miletum, whereupon he arranged for a loan of money with which he paid the ransom and gave them a sumptuous banquet with wine and mandrake, after which he ordered them killed in their sleep. Other plants that have the same dormitive effect are nightshade, belladonna, juice of poppy heads or hemlock, and seeds of henbane. All these rolled together into a ball make a 'sleeping apple' that induces sleep whenever smelled. The distillate of these applied to the nostrils of a sleeping man will prolong his sleep for long hours.

Medicines that make one mad: A little more of the same medicines that induce sleep, make one mad, and a larger dose brings death. For example, put the roots of mandrake in new wine and leave in a warm place for two months. It induces sleep, then raving madness for a day. The seeds of stramonium [jimsonweed] and the roots of belladonna cause people to swim like a fish on the ground or walk like a goose or other such trickery.

How to cause pleasant dreams. The way it works is that hot vapours from meat rise through the veins to the cold moist brain where it condenses and drowns it in deep sleep, and descends to the heart. By the morning, the blood has separated into excrement that settles to the bottom and pure beneficial vapours that rise to induce pleasant visions. So food rich in blood produces monstrous and bloody dreams, while balm, bugloss, or oil of poplar, produce pleasant dreams, as in a garden or meadow. For dark and troubled dreams, give beans, onions, or leeks.

Here is a medicine for eye inflammations. Take two bottles of Greek wine, half a pint of white rosewater, 2oz of celendine, fennel, rue, eye-bright, half ounce of tutty and cloves, a drachm of sugar-candy of roses, half a drachm of camphor and of aloes. Mix the wine and rosewater, heat the tutty and add it in; put the aloes in a mortar with a little of the waters and beat together; then cover the mixture, seal with wax, and leave outside in the sun for forty days, shaking it four times a day. Apply a drop of this water to the patient's eye, twice or thrice a day, and he shall be cured. For pearl in the eye, make a powder of rose sugar-candy, burnt alum, and the bone powder of a cuttle fish; sprinkle this powder on the patient's eye, and apply a drop of the water.

To heal gums: Wash three handfuls of powder of sage, nettles, rosemary, mallows, and the rind of walnut roots; the same of flowers of sage, rosemary, olive and plantain leaves, two handfuls of hypocistis, horehound, and the tops

of bramble, one pound of the flower of myrtle, half a pound of its seed, two handfuls of rosebuds, two drachms of saunders, coriander, and citron pill; three drachms of cinnamon powder, ten of cypress nuts, five green pineapples, two drachms of bole-armenick and mastick. Ground them, add to a red wine, and leave for three days. Pour into an alembic on a gentle fire, then boil the distilled water with two ounces of alum until dissolved. Gurgle it in your mouth and spit it out. The roots and leaves of plantain laid against swollen gums will also heal them.

For headaches, wet a cloth with the red essence of roses, and lay it on the forehead. Vertigo is cured by applying the hoof of an elk. For chapped lips, place the seeds of henbane on burning coal and direct the smoke through a paper tunnel to your lips. For swollen fingers or chillblains, Paracelsus advises to wrap a live earthworm on the finger for an hour until it dies. For lung inflammation, dry and distill some flowers of wild poppy, add a drachm to water to relieve the pain. To cure the cholic, apply the yellow fluid of civet to the navel. For lice, use the dust that falls from a horse comb; better still is mercury precipitate. To dissolve stones, distill a mixture of saxifrage, maidenhair, pellitory of the wall, parsley, pimpernel and ceterach, and take it every other day to pass it in urine. Other effective remedies are mulberry and dried mushrooms. The water of sharp acid springs works wonderfully, just as an egg laid in vinegar softens and dissolves the shell. Even the heaviest metal, lead, and hard pearls are dissolved by vinegar. To prevent vomiting, make an ointment from half a pint of oil, 15lb mint powder, and wormwood. Let them stand for three days in a brass pot, then set on a gentle fire, boil for five hours; repeat for fifteen days until the virtue of the herbs is extracted. Strain them through a linen cloth, and repeat thrice with new herbs until the oil turns green. Finally, make a powder of cinnamon, nutmegs, mastick and spikenard, and a third part of cloves, and add to the oil.

For a woman to conceive, the Egyptians recommended sage and salt. In fact ships at sea are full of mice on account of their enhanced reproduction, even without males; and fishermen's wives are lustful with plenty of children. I have found the best way is to boil a newly layed egg, mix a grain of musk, and sup it up when she goes to bed. Next morning boil five-year-old beans, and let the woman receive the fumes into her private parts for an hour. Then let her take two eggs and sleep again with her husband. Afterwards, mix the whites of two eggs with bole-armenick, sanguis-draconis, and some flax, and apply it to the lower back, and let her hold ginger in her mouth. Repeat for nine days.

Against the pox, take a pound of lignum guaiacum, half a pound of sarsaperilla, 5oz leaves of senna, a handful of agrimony and horsetail, a drachm of cinnamon, cloves, and nutmeg. Pound them, put into twenty gallons of Greek wine, and let stand for a day. When drunk at meals, it purges away all maladies, besides the French pox. For a man to prevent the pox after unclean women, take a drachm of hartwort and gentian, two scruples of sanders and lignum aloes, half a drachm of coral powder, spodium, and burnt harts horn, a handful of sowthistle, scordium, betony, and a half of mercury precipitate, a pint of malmetry, a quart of the waters of sowthistle and scabious. Mix the wine and waters, and

the guaiacum, leave for a day, then add the rest; boil until half is consumed. Strain the solution, soak a linen cloth in it for a night, then dry it in the shade. Do this thrice, and after copulation, wash your yard in it, and wrap the linen around.

Physicians hold that herbs that kill a serpent are an antidote for its poison, for example the herb alkanet. I tried with half a drachm of treacle mixed with aqua vitae; the viper died in half an hour, but the water serpent was only stupefied but not hurt by it. Then I took oil pressed from citron seeds, and it died. Similarly effective are the juice of angelica root, balsam of the West Indies, but the best is earth of the island of Malta. Also the stone chelonite, obtained from the living head of a great old toad, but I have never come across it. Another remedy is 3lb of old oil with two handfuls of the flower of St. Johns wort; leave for two months in the sun, strain out the flowers, and put another 2oz of the flowers; boil in bain-marie for six hours. Close the top and sun it for fifteen days. In July, crush 3oz of the seed, steep it in two glasses of white wine, with two drams each of gentian, tormentil, white dittany, zedoary, carline, red sanders, aristolochie. Leave in wine for three days, then take put them in the oil, boil them in bain-marie for six hours, and strain them in a press. Add an ounce of saffron, myrrh, aloes, spikenard, and rhubarb, and boil for a day. Then add 2oz of treacle and mithridate, and boil for six hours. Leave in the sun for forty days. When poisoned, or during a plague, apply the liquid on the stomach, wrists, and the chest, and drink three drops of it in wine.

Plague is similar to poison. Here is a confection to resist the contagion, found by the Sicilians and Venetians. Take the red clove gillyflowers in May, clip off their green ends, then pound into a fine powder. Take also three times that amount of sugar, melt in a skillet, and boil it with a little orange flower water; put in some beaten egg-whites, skimming off the froth. Then stir in the flowers until it turns red. When it is almost boiled, add two drachms of cloves with a little musk, and a little lemon juice. Another remedy consists of ivy berries, wild poppies, and goats rue. Dry them in the shade, and make them into a powder. One drachm in wine is excellent against infectious diseases. Also effective are the bezoar stone from the West Indies, hung about the neck; and oil from the seeds of citron.

Remedies for wounds and blows: To make oil of Spain take 4oz of wax, 4oz of linseed, 2oz rosemary flowers, bay berries, and betony, 3oz of chamomil flowers, 1oz and half of cinnamon and St. Johns wort, 2oz of old oil. Dry the flowers and herbs in the shade, pound them, and pass through a sieve. Melt and pour the wax on the oils, then stir in the powders; cut into small slices and put into a glass retort, well stopped so the virtue does not vanish away. On a gentle fire draw out a water, then a red oil. It heals wounds, mollifies cold gouts and trembling, helps the quinsy, provokes menstruation, and by rubbing it on relieves any pain. Oil of herons is excellent to allay all cold aches, the gout, sciatica, convulsions, joint pain, and other diseases of moisture and cold. For sores, dissolve lime in water, then strain it; wet a linen cloth in it and apply it to a sore. Tobacco seeds give an oil which allays the pain of gout; when boiled into a syrup, it makes the voice clear and loud. The juice of its leaves kills lice

and cures sores and ulcers.

‘Vulnerary Potions’ cure wounds. Take a handful of pirole, comfrey, aristolochia, feverfew, two of agrimony; boil them in wine and leave the solution warm in dung. Drink in the morning and evening. The “weapon salve” given to Emperor Maximilian by Paracelsus is made so: Take 2oz moss growing upon an unburied dead mans skull, and of the fat of a man, half an ounce of mummy, and blood of man, 1oz of linseed oil, turpentine, and bole-armenick; crush them into an ointment. Wash the wound, and tie up the ointment on it.

How to counterfeit sickness to escape enemies or avoid torture: Amphiretus Acantius was kept in chains by pirates for ransom; he abstained from meat and drank little saltwater. Upon having a bloody discharge, the pirates took off his irons, and he escaped at night. Indian figs or red madder cause urine to be red like blood. Boiled mulberries cause excrement to seem bloody. To look pale, take cumin in drink. To cause sores and blisters, bruise sharp periwinkle or cantharides, and apply to the skin.

There were many stories of Enchanters in antiquity, for example by Virgil. Just because we cannot understand by reason, does not mean they are not true. The evil eye and the evil tongue, have been known to bewitch animals, crops, and young children. Some Illyrians have two pupils per eye and kill by sight, like a cockatrice. They send forth fiery spirits to the hearts of those who have soft bodies and infect the bewitched with a great fever. I myself had such an accident, being cast with red eyes by another. A mirror will reflect and kill the bewitcher. There is another enchantment, of Love, such that a beautiful woman can ensnare a man with poison straight to his heart to torment him with constant images. Old women can enchant with evil. We all know how grief, love, envy, cause the skin to change color. Thus witches strike at the beautiful, set their entrails on fire, make them pale, waste away, and sob continually. Some people can take poison without problems, such as Mithridates, and the beautiful maid that the Queen of India sent to Alexander. Many eat spiders and serpents, without any effects, but shrivel those they touch and breathe on. Women in particular, who eat unwholesome food and purge blood every month, poison those near them. But so do sanguine and choleric men who have large shining grey eyes and live chastely, stir up Love and binds women’s imagination. As they say, Cupid shoots his arrows into the beholder’s eyes, and sets his heart on fire. It may be asked why love only infects a few and does not consume them, or how it can sometimes bewitch a person by reflection in the water — who knows? There are defences against Love: Turn your face away from her eyes and rays, and avoid her company, especially her blood and sweat. Against the envy of witches, burn sweet perfume to purify the air, sprinkle him with water sweetened with cinnamon, cloves, cypress, lignum aloes, musk, and amber, and hang carbuncles, jacinths, or sapphires about his neck, and a ring made from the hoof of a wild ass. Some women apply frankincense smoke to their children.

Book IX How to Adorn Women

What I write here is in order that women might be pleasing to their husbands, so that if they are ashamed of their swart complexions, they may make themselves fair, lest their husbands be offended and turn to other women's chambers. And first, how to dye hair a golden yellow color. To prepare the hair, smear it with honey added to the lees of white whine, and leave it wet all night. Finely chop the roots of celendine and of clivers madder, and add them to oil, together with cumin seeds and a little saffron. Rub it on the head and leave for twenty hours. Then wash it with lye made of cabbage stalks, ashes, and barley or rye straw. Now make lye by putting barley or rye straw into an earthen pot, add feny-graec and wild cumin, quicklime and tobacco powder. Pour on cold water, and let it stand a whole day; open a hole at the bottom, and let the lye run out. Wash the hair with it for a golden color. Some add oranges, broom flowers, and colored tartar to the straw. Others make a strong water out of saltpeter, vitriol, sal ammoniac, and cinnabar, to dye the hair, but this often burns it. The most effective way is to distil honey and apply the yellow oil with a sponge, being careful not to touch the skin.

For red haired people, the yellow color will not match. Boil a powder from Africa, called alchena, in lye until it is colored, and rub the hair with it, but be careful not to stain your finger nails with it. You can also use the red oil of honey that comes out after the yellowish waters are drawn off.

How to dye hair black (as if that will make anyone young again). Rub your hair with leeches that have decayed in the blackest vinegar for sixty days. Or else cut the head and tail of a green lizard and boil it in oil. Another way: Make a lye of quicklime and oak ashes, boil in it litharge of silver and burnt brass; when it bubbles, test it on wool, then wash your hair with it.

How to make a patch thick with hair and a hairy part smooth. A common depilatory consists of four parts of quicklime powder and one part orpiment; boil them, test it on a feather, take care not to touch the skin; apply its fumes to the hair and it will be smooth. You can also boil a toad and rub it on the hair. The salamander soaked in oil will remove hair by the roots. To make hair grow, apply the oil pressed out of henbane seeds, or hemlock. To prevent hair from growing, first soak the part with hot water and pull out the hairs with nippers; then dissolve saltpeter in water (or oil of vitriol) and apply to the area.

To hold on to hair before old age, or make it grow again, heat pith on coals, powder it, and make a paste of it with water, then rub it on the head. A sure way is to apply the first distil of honey. To make hair grow longer and quickly, cut marsh-mallow roots and boil it with hog grease in wine; mix in powdered cumin seeds, mastick, and egg yolks, well boiled. Strain through a linen cloth, let it stand and settle, then rub the head with the fat that floats on top. Alternatively, mix in burnt salted barley bread with bear's grease.

Against the plague and worms of the hair that weaken them so they fall off, boil the flowers of myrtle trees and broom-clary in vinegar until it is consumed, then rub the hair-ends with it. Alternatively, grind bitter lupines and boil in vinegar.

To make curly hair, as many women do, boil maidenhair with smallage seed in wine, and add oil. Or, put daffodil roots in wine; or roots of dwarf elder in oil. Do it on shaven skin, so it curls the more.

How to make the eyebrows black: Take a black pigment, like burned black earth, or ox bone marrow, beaten with soot; or the well-burned kernels of dates, or rose leaves. Mix with eye salves, and apply. Another way is to make a thick ointment from labdanum in wine and oil of myrtles. You can fry galls in oil, ground them with sal-ammoniac, and mix with vinegar, in which the pills of mulberry and bramble have been boiled. Apply it for a whole night, then wash it off with water.

How to make the face white, starting with the white simples. Washing the face morning and evening with distilled water of lilies makes it white. Similarly the withywind flowers and boiled water of ivory. Mix melanthium powder with the juice of lemonhours, let it dry, then add an egg with the shell, and let it dry. Apply it to the face not directly but with a fine white wet linen cloth. For an even whiter look, boil a half ounce of litharge of silver in strong vinegar; add a half pound of boiled clear water to produce a milky white precipitate. Pour off the water, leave it in the sun until solid, and make small balls out of it. When needed, wet them with water and apply to the face. There are other recipes, but I use this: Whip an egg white, beat in half an ounce of honey, and add two corns of wheat and powdered mercury sublimate. Wash your face with it and let it dry before sleeping; in the morning wash it off and the face remains white.

Before applying anything to the face, it must be made very clean to receive it. Bind barleymeal bran in a linen cloth, and insert into a pot of water. Boil it until a third part remains, then press out the juice. Wash your face with it and let it dry. Mix chopped myrrh with an egg white, burn it on red hot tiles, and receive the fumes through a tunnel towards the face, covered with a napkin. After a while, rub your face with a linen cloth and the juice.

After face color comes tenderness, which is procured by fatty stuff like milk. Nero's wife bathed in the milk of five hundred asses, to remove all wrinkles. Soak breadcrumbs in six glasses of milk for five hours and press the water out. Now cut ten lemons into thin slices, whisk ten eggwhites, finely cut 1oz of camphor, mix in 2oz of alum sauharinum, and distil them. You can add other fatty materials such as young pigeons.

How to make the face clear and shiny. There is an herb called wild tansey, silver on the backside, whose distilled water is good against facial spots. Snails that leave a silver trail are also sought after; draw the water out of them in a still and apply it to the face. Also seashells with a silver or pearl color within, like oysters; the best is the oil that comes from pearls dissolved in sharp juices.

Beat a silver lodestone in a mortar, place in an earthen pot and cover; seal the pot well and leave in the sun to dry. Place in a furnace; when the fire has died down, break the vessel; the stone should be calcined white. Grind it into powder, place in a humid place until it turns into a watery lime. This humor will exceedingly beautify the face.

There is nothing better than quicksilver to cleanse women's faces. Mix 3oz of it with 2lb of mercury sublimate; when it turns black, add 3oz of salt, then

sprinkle 2lb of boiling water and wait until the muddy part sinks. Decant the water and pour in fresh, repeating five times until a pure white powder without dirt remains. Make little cakes of it, and dry them. Some add camphor, borax and ceruse.

But quicksilver is known to hurt the teeth and skin. So some use only the water extracted from quicksilver. Put cleansed grease of swine or barley into a lye of sweet water; after fifteen days, drown it with the sharpest vinegar and seal the mouth with a plate of lead to contain the fumes. Every fortnight, check the cover and remove the ceruse that forms. Place the ceruse in water that the dregs may float; replace with fresh water until only the pure ceruse remains, then dry it.

To make the face clean and soft, mix together 1oz of ceruse ready washed, half as much mercury sublimate, gum traganth, and 1oz of tartar, all powdered. Put them into a young pigeon, washed and disembowelled, and sew them in. Boil it in an earthen pot full of distilled water until the flesh melts from the bones. Distil the water and wash the face with it. Another way is to seal 3lb of bean cods, 2lb of honey, 1lb of rosin of turpentine in a vessel, let it ferment eight days in dung, then add 4lb of asses' milk; use the oil that comes forth. You can also add the distilled waters of flowers such as those of oranges.

How to make the face rose colored. Cast the raspings of red sanders into twice-distilled vinegar, boil and add a little alum. To make it sweet smelling, add a little musk, civet, cloves, or any spice. Another liquid is the juice of clove-gilliflowers, made red by adding lemon juice; put it in spirit of wine and add alum. To color the whole body, boil nettles in water, and wash your body with it; or distil strawberries.

Now, how to fade the face when it is too red. Ground 4oz of peach kernels and 2oz of gourd seeds so that an oily liquid oozes out. Wash the pimples with it, morning and evening. Alternatively wash the face with a mixture of violets, eggshells, saunders, and camphor in water. The distilled water of white lilies is also effective.

In summer, the sun can burn the skin brown. I found, by experiment, how to prevent this. Wash your face at night and in the morning with 1oz of sugar candy added to ten beaten egg-whites. Rubbing the skin with melon rinds improves it.

The remedy for spots that disgrace women's faces, is to use detergents. Anoint the face with tartar oil, let it dry, but do not wash it off; do this for ten days, then wash it with a lixivium. Another way is to stir in quicklime with hot water for ten days, then pour the clear water into a bronze vessel. Rub a little sal ammoniac until the water becomes a sky-blue color. Wet linen cloths in this water, and apply on the spots. One can also mix 2oz of rosin of turpentine and 2oz of ceruse with an egg-white; or the distilled water of pimperl with camphor; or distilled mulberry leaves with mercury sublimate, verdigris, borax, and the fine powder of cockle shells. For black marks, wash them with the juice of the roots of thapsia made into cakes, or any oil from the seeds of flowers, or vinegar, honey, or garlic.

To remove red or white pimples, use oil extracted from burnt paper. Alter-

natively, use the liquor extracted from twenty hard-boiled eggs, with their yolks removed and replaced by oil of almonds and rosin of turpentine. Or use two beaten eggs, lemon juice and mercury sublimate. Or boil three parts of sowbread roots, 2 of barley, 1 of calcined tartar, 2 of cucumber roots, and wheat bran until a third is consumed.

Ringworms will so deform a face that one can do nothing against it, and a stinking water drops forth that fouls clothes. Against this, distil water from the roots of sowredock, and to every pound add a half ounce of pompions and saltpeter, and 2oz of tartar of white wine; let them soak for some days, then distil them, and wash your face with it. At night, apply oil of tartar and almonds, mixed with oil of eggs. A stronger remedy is the following: Boil a glass of sharp red wine with a drachm of mercury sublimate; apply morning and evening for four days.

Against warts, the ancients used the juice of the greater spurge with salt. There is also a kind of beetle whose oil removes warts.

To remove wrinkles from the forehead, use the dregs of linseed oil or olive oil. Add a little gum arabic, mastick, and champire. Or cut hard boiled eggs in half and replace the yolks with myrrh powder. Put the halves together again and bind them with thread. Place them hanging from the mouth of a glazed earthen vessel, and place in a chest in a well, hanging one foot from the water. With time, the myrrh dissolves in the egg. Rub your face with it. Other ointments are the juice of green canes of pine trees; kidney beans soaked in malmsey and distilled with lemons and honey; flowers of mullens and roots of Solomon's seal soaked in Greek wine and distilled. To remove belly wrinkles after childbirth, boil unripe services, mix in the whites of eggs and gum arabic dissolved in water. Or mix the powders of burnt harts' horn, amanthys, sal ammoniac, myrrh, frankincense, mastick, and honey.

How to whiten teeth: There is nothing more ugly than for a woman to laugh and thereby show her spotted teeth, all rusty from using mercury sublimate. To polish the teeth, make a toothpaste from the shells of purples, or burnt arabian stone, or pumice; but red coral, harts' horn, etc., will do. One needs to wash them every morning with fountain water. Another way is to burn the crumbs of barley bread, sprinkle a little salt, and add honey. There is a distilled water of alum and salt that whitens the teeth, and especially the oil of sulfur rubbed on with a tooth scraper; but do not touch the gums, for it burns them.

After childbearing, women want round, small, solid breasts, not flagging or wrinkled. For this, make a poultice with finely cut hemlock and vinegar, and apply to the breasts for several nights. Another way: To hot vinegar add powdered white earth, eggwhite, sour galls, mastick, and frankincense. I myself use the juice of the leaves of ladies mantel; as well as distilled water of green pineapples, or pills of pomegranate, etc.

To make hands white and soft, one needs to apply the white milk of almonds or melon, etc. Make cakes of cut almonds blanched in hot water, pine kernels, and breadcrumbs, with gum traganth soaked in barley water. Use it as a soap to wash the hands. Add the lesser dragon, deer suet and honey if you will, and stir gently on a fire. To make the hands soft, one needs fat. Wash fresh butter

in water, add scented rosewater, mix in white wax, and a good quantity of oil of sweet almonds. Apply to the hands and wear gloves all night. Another way: Make a hole in a lemon, put in sugar-candy and butter, and plug the hole; wrap it in wet hemp and boil it on hot embers.

Stinking armpits of women are disgusting, especially if they are fat. To cure this, the ancients used liquid alum with myrrh, or dried myrtle leaves, artichoke roots, or even urine. But I wash them with vinegar in which is boiled 1lb of litharge of gold or silver.

If a woman's matrix is too open, due to childbirth or some other reason, make a powder of sour galls and cloves, and boil them in sharp red wine; or use distilled water of starwort; wet a woolen cloth in it, and apply to the part, or cast them through a reed. For they are excellent in gluing fresh wounds, that whores cannot be distinguished from maids. How to make a deflowered woman a virgin again: Make pills of the fine powder of burnt alum, mastick, with a little vitriol and orpiment. When dry, apply to the mouth of the matrix and change every six hours for four times. Midwives apply a leech to make a scab.

Now for some merriment, how to show up women who adorn themselves. If you want to know if a face is painted, chew saffron in your mouth and breathe on her; the paint turns yellowish. Alternatively, burn brimstone in the room, and if she has ceruse or mercury sublimate on her face, the smoke make her black. If you chew grains of cumin or garlic cloves, any ceruse on her face will decay. If she drinks stellio in wine, her face will be covered in red spots. Avicenna says that a decoction of chameleon, if placed in a bath, will color the skin green for a long time. To make a man's hair and beard fall off, apply the vomit of salamander.

Book X Distillation

Geber defines distillation as the elevation of moist vapors in a vessel and declares three types, by ascent, by descent, and by filtration. One needs a pear-shaped glass and an upper vessel fitting into it, having a beak and pipe going into another vessel, called the receiver. All the vents must be stopped with mortar or rags of linen to prevent the spirits leaking out. When the lower vessel is heated, the enclosed matter gives out a dewey vapor that ascend to the top, where, meeting with the cold head, condenses into drops. These run down into the pipe to the receiver. But if the matter is of a vaporous nature, the receiver needs to be larger, otherwise the spirit, finding itself confined by the small vessels, tears them to pieces and injures bystanders. Plants give out three moistures. The first is pure water, the second is more dense and is what makes the parts join together, the third is oily, wherein lies its strength. Also, some bodies exhale first a hot thin vapor, and then a moist thick one. Others first exhale a phlegmatic earthy spirit, then an inner hot and fiery one.

The simplest is the extraction of sweet waters from plants, such as roses, orange flowers, myrtle, lavender, and basil. One should increase the heat slowly else they burn. The plants that are suitable for such distilling are those that

have their flavor throughout the leaves and flowers. You can test this: If by rubbing them the scent remains the same, then they are suitable for distilling, otherwise if the odor stinks, then the fragrance is only on the surface. For gilliflowers, musk, roses, violets, jasmine, and lilies, first extract their juice in a baine marie; do not leave them too long but take out the liquid and put in fresh flowers until you have enough. Now, because sometimes the lower parts get burnt and leave a stink, use a very gentle fire. It also happens that the head becomes hot and prevents droplets from forming; in that case pour cold water around the head. You can surround the head with water-tight iron plates and a tap so that you can pour in fresh cold water. This way one produces a greater quantity of distilled water.

How to extract aqua vita: Take strong wine growing in dry places, as on Vesuvius; distil a third part of this in a glass retort with cinders, and reserve the rest as a sharp vinegar. Then distil it again and again, always drawing off a third part. Distil it one last time in a longer vessel. Only the thinnest spirits of the wine pass through to the end. You will know that no phlegm remains when a drop of it burns away and leaves nothing behind. To help the condensation some make a winding brass pipe at the cap and insert it in a barrel of cold water. Some make several heads, with the topmost giving the purest spirit.

One can distil without using fire, since a great heat can alter the nature of things. The summer sun can extract the water even better than fire, because it has less force. One must board the receivers so they do not receive warmth. Pick, wash, and dry your herbs, and put them in the still. Place the receivers in dishes of water to condense the vapors.

We now turn to oils, which require more ingenuity. First, there is the method of expression: blanch and dehusk the almonds, then ground them to a powder. Sprinkle them with wine, and set on a fire, stirring all the while. When they begin to shed a little oil, take them out, wrap them in a wet linen cloth, and place them between two iron plates, hot enough that it makes a drop of water hiss. Collect the oil that comes out; sprinkle more wine and repeat. Others press the cloth by twisting it hard. To draw oil out of nutmegs, press the oil out of them but then distil it five times to make it more fluid. Oil of seeds of citrons, poppies, coloquintida, and nettles is extracted in the same way. For oil of eggs, hard boil fifty eggs, peel them and place the yolks in a tin over warm coals until all the moisture evaporates. Increase the fire and, stirring continually lest they burn, oil will ooze out; put the eggs in a press to extract all their oil.

Since oil is so dense that it ascends with difficulty, it requires a great heat to draw it out. But as aromatic herbs are delicate and burn easily, they need the assistance of water vapor to carry their oils up high in the still. The seeds need to be just ripe; let them soak water and distil them in a strong fire. Use water that has been distilled thrice to make it sharper: out of 135lb take 40lb, out of these 15lb, and of these 5lb. Cut the cinnamon in this water and distil it; the flow is a milky mixture of water and oil that can be separated. The oil of cloves, nutmegs, mace, pepper, aniseed, fennel, coriander, etc., can be extracted in the same way. The dried flowers of rosemary and lavender yield no oil this way; one needs to put them in the hot sun for a month, at which point add water and

distil them. For juniper or cypress wood dust, put them in water for a month and then distil them.

How to separate the oil from the water: One way is to distil the mixture over a gentle fire; the water will evaporate to leave the clear oil. There is also an ingenious vessel with an orifice half way up. Stop the opening with your finger and slowly let the water out until only the oil remains. Another way is to add water, thus raising the oil which then runs out of the orifice. If the water floats on top of the oil, then do the other way round.

I have devised an instrument to draw out great quantities of oil without danger of burning. Prepare an egg-shaped vessel the size of half a barrel, tinned within; set a foot-high brass head fitting on top of it, with a fifteen-foot pipe ending in another vessel similar to the first. Fix a head upon this also, with a pipe of the same length, ending inside a receiver in a barrel of cold water. Put your leaves or seeds in the brass pot, and cover them five fingers high with water. Seal all the joints well, then make the pot boil, increasing the heat slowly.

There are two other instruments that I have devised to extract delicate oil without burning it. The first consists of an egg-shaped brass vessel, two feet high, divided in the middle. The upper part serves as a cover; the lower part has a copper plate with three holes to receive three glass retorts. The side of the vessel has three holes through which pass the necks of the retorts. Fill the retorts with the flowers or leaves and seal any joints through which may pass the vapors. Fill the vessel with water almost up to the plate and cover everything. Kindle the fire until it becomes vehement. The vapors, which make a terrible noise, produce first water, then water and oil. The second instrument is the descendatory, whereby the oil descends down. An oval brass vessel has a hole at the bottom with a pipe jutting out, and a cover. A special furnace heats the vessel from the sides. Pass a glass retort through the hole, fill it with the flowers but tie them with string so that when the retort is inverted, they do not fall through. Fill the vessel with water, put on the cover, seal the joints, and start the fire; the water vapor heats the glass which extract the water and oil from the flowers and fall down the pipe into a receiver. You can extract oil out of rosemary flowers, citrus peels or flowers, roses, musk, and amber. It is better to cut the flowers and let them soak in water before distilling.

To extract oil of gums, such as benjamin, one can apply the same procedure. There is another way to do it. Cut the benjamin in rosewater, put in a retort, which is placed in a pot full of sand coming up to the sides; let the water distil with a low heat, then increase the heat moderately so the oil flows out. Storax requires a more gentle fire, turpentine and olive oil even more so as they can catch fire themselves; laudanum needs to soak in aqua vita for two weeks.

Some oils, upon heating, are sublimed and do not form a vapor; others are burned. For example, one cannot extract oil out of honey directly, for it simply falls into the receiver unchanged. Put the honey into a glass with a short wide neck, and wrap it with a thick layer of flax. At first water will collect in the receiver; when it starts to become colored, replace the receiver to collect the new oil. For oil of camphor, ground it into a powder and put in aqua fortis made from saltpeter. Set the pot in a bath for half a day, and a clear bright oil

will float on the water. Pour it off and clarify it in a retort to produce a thin sweet oil. For oil of paper, roll it into a pyramid, set it on fire and as it burns, hold it down over a broad dish so the smoke does not blow away. A yellow oil forms at the bottom of the dish. For oil of wheat, place the grains on a marble mortar, cover them with an almost red hot iron plate, and press hard; a yellow oil flows out.

Make a pipe of tough clay with the bottom full of holes; set upon another earthen pipkin with a wide mouth, and seal them well. Fill the upper one with wood dust, such as *lignum gaudiacum*, juniper, cypress, or *lignum aloes*; cover and seal it, then dig a hole, place the pipkins there, pack around them with sand, and apply a gentle fire from above, increasing the amount for a whole day. The oil descends down to the bottom vessel. Distil this oil to purify it from filth. These medicines are not to be swallowed but to be applied externally only.

We now turn to the extraction of quintessences, which are the spirit or life of a body, separated from its elementary impurities that are void of all power. They contain its medicinale properties to the highest degree, being freed of the gross parts. The strength of an essence determines how strong its action is. Thus the essence of juniper is of the first degree because it only purges the blood; the essence of amber is of the second because it purges the heart, lungs, and organs. Antimony is of the third, because it purges the whole body. But gold alone is of the fourth degree, since it has the power to purge and renew the body. The way to extract them depends on whether they are oil, salt, or water. Essences ought not to be compounded, or polluted with anything, but to be pure, simple and immaculate. For example, to extract the essence of civet, musk, or amber, take oil of almonds, add the musk and beat well; leave in a glass bottle in the sun for ten days; strain the dregs, add aqua vita and distilled water if it is of an odoriferous nature; let it digest for six days; then distil it to obtain the essence; you may put it on a baine marie to evaporate the water. To extract essence of flesh, take some chicken, remove their guts, let them boil for a day until all flesh and bones dissolve, strain the liquid through a linen cloth; place over a gentle bath and the essence remains at the bottom. It has a great strength of nourishment for sick people who haven't eaten for days. To extract essence of salts, lay salt powder in a moist cellar, let it dissolve and ferment for a month; distil it with a gentle fire, keep the liquid that remains in the bottom, ferment for another month, and distil again; what remains at the bottom is the essence. To extract essences out of herbs, ground the herbs, let them ferment for a month in a bottle, then distil them, and repeat for six days, circulating the water that comes out with the herbs. For the essence of aqua vita, ferment some old wine for two months in large closed bottles, then distil it; keep the spirits, but ferment and distil the dregs again; wash the honey-like material that remains and burn it in a furnace to reduce it to white ashes; add a little water to turn them to salt, the essence of aqua vita; adding a little of it on red hot plate should evaporate it completely.

A magistry is what can be extracted out of things without separating the elements, but losing the color of the original. To extract the magistry of gems or coral, ground them, calcine them in a hot fire, mix with an equal quantity

of saltpeter, and dissolve them in aqua vita. What remains, calcine again and dissolve. Now put on a hot furnace until the moisture evaporates. What remains is the magistry. For pearls, use vinegar or lemon juice. The magistry of gum is extracted by dissolving it in aqua vita, let it digest for a month, then evaporate over a fire. The magistry of the guaiacum wood or of lignum aloes, a remedy against the pox, is extracted by laying its dust in aqua vita for a whole day until it turns red; then boil it till the moisture is consumed, leaving the gum magistry behind. For the magistry of wine, commonly called the spirit of wine, take a sealed bottle of it, set it to fire for three months, then let it freeze in the winter, open the bottle and pour out the liquid part, which is the spirit.

A tincture is the pure and active color of a body, free from its other elements. To extract the tincture of gold, the noblest color of all, the most tempered mixture of elements, the restorer of youth, is not possible. I have put it to fire for three months without the least change. The only way is to dissolve it in a water stronger than aqua fortis, namely aqua regia. For the tincture of roses or other flowers, cut the petals into small pieces and put them in aqua fortis; put fresh flowers after three hours; when the water evaporates, the tincture remains. For the flowers of the orange tree, place them in aqua vita until the water is yellow and scented. For coral, ground it to a powder, turn it to salt with a strong fire, add an equal amount of saltpeter, then aqua vita to bring out its tincture.

Salts retain great penetrative virtues, which are undiminished by fire. To extract the salt of lemons, distil their peels, retain the water and dry the rest; seal them in a pot and calcine in a strong fire, then dissolve the powder in water, boil it in a strong lye, purify it from the dregs, and let the moisture evaporate. Only the salt remains in the bottom. For the salt of the Spanish pellitory weed or cumin, burn the dried roots in a sealed pot for three days until they are reduced to ashes; add water, distil it, and calcine it again for three times; finally boil with an egg-white until a white salt appears. The salt of saxifrage protects from the poisons of bread or meat, and from pestilential air. Other salts protect from venereal diseases, dropsy, and so on, but one must not take them every day, lest they become food and lose their power.

Elixirs conserve a body in the same condition, protect from corruption, not by bettering the state but by preserving it. They work especially on the heart and brain, the residence of the spirits. There are three kinds of elixirs: metallic, those of gems, and of plants. An elixir is compounded of many things but not of oil. To make an elixir of pimpernel, put powder of its roots, flowers, and seeds into an alembic, draw out its water and oil, and separate the former. There are many useless recipes but they will likely fail. This one I have tried myself: Take 1.5oz of the flowers of sage, oregano, mugwort, savory, elder, sage leaves, white mint, rosemary, basil, marjoram, pennyroyal, rosebuds, roots of betony, pellitory, snake-weed, white thistle, aristolochy, Cretan dittany, currants, pineapples, dates, citron pill; 3 drachms of ginger, cloves, nutmegs, zedoary, galangal, white and long pepper, juniper berries, spikenard, mace, cubebs, parsley seed, cardamoms, cinnamon, staechados, germander, granes, rose of Jerusalem, doricum, ammoniac, opoponax, spodium, schaeinanthus,

bdellium, mummy, sagapenum, camphor, mastick, frankincense, aloes, powder of ebony, bole-armenick, treacle, musk, galls, mithridate, lignum aloes, and saffron; 13lb of sugar, 2lb of honey; powder up everything together and put in a blind alembic with 12lb of aqua vita. Let it circulate in baine marie for a month. Skim off the yellow oil, which is the quintessence, and add a drachm of musk and amber. The remainder, distil into a clear yellow water.

A clyssus is the extract of the spirits of the root, leaf, flower, fruit, and seed of a plant. It penetrates the remotest passages of the body. To prepare it, cut all of these parts when they are fresh and full, distil them separately to extract their essence, then mix them together. Some put them in a special alembic with three containers and distil them together.

I have already show how to extract oil. Now I show how to do it out of salts. To extract oil of tartar, burn the tartar, reduce it to a salt, leave in a moist place, and in a few days it turns to oil. You can also add an equal amount of saltpeter before burning it. For oil of sal soda, dissolve the salt in water, dry it, and leave in a moist place. For the oil of talcum, put the fine powder in a strong furnace for three days until it is perfectly white; then leave in a damp room until it becomes an oil. For the red oil of sulfur, mix it with oil of tartar, boil them for 3 hours, then set over a gentle fire until it is a red thick liquid; again, dry it and leave in a moist cellar. For oil of myrrh, take out the yolks of hard-boiled eggs, and replace with myrrh; leave in a cellar.

Finally, there are distillations which draw out a mix of oil and water. First, how to draw aqua fortis: Place pit-salt in a glass retort, heat strongly, pour water on the dregs and distil again, and repeat a third time until all the salt is turned to liquid. For the water that dissolves silver, put equal amounts of saltpeter and calcined alum powder in a glass retort, heat from all directions for six hours, and collect the spirits. For the water that dissolves gold, use saltpeter, alum, and vitriol, in equal amounts; the water is so strong that it corrodes even the tincture of gold. One can also add a small amount of sal ammoniac. To purge the phlegm from these waters, heat it with a little dissolved silver and remove the dregs from it. To make oil of vitriol, dissolve vitriol in an earthen pan, let the water evaporate, then increase the fire until a fourth part is consumed and it turns red. Distil for three days in a strong fire, until an oil collects. It is so strong that it instantly burns a piece of wood. To make oil of sulfur, hang a vessel with sulfur on a fire; the sulfur will smoke up where it condenses and produces an oil. I have found that the salt extracted from this oil is nothing but sal ammoniac!

Every compound consists of four elements, usually with one of them predominant. For example, water lily is mostly water. We can extract the principle water of it, not literally but figuratively. Thus some materials have air in the sense that they can fill vessels with it and easily burst them. To separate the elements of a metal, dissolve it in aqua fortis, and draw it out in a bath, until it turns to ruby red oil, which is the earth and fire of the metal. Add more aqua fortis, and let it digest for a month; distil it gently until the water is drawn out, collect it and distil again. Different metals may give different colors. In tin only, the water is first drawn out, then the fire, and the earth, leaving the air. For

herbs, cut and digest the leaves, then distil them: the fire ascends first, then the water. One can know which element a plant is rich in by weighing it before and after distillation.

Book XI Perfumes

I now turn to teach how to compound sweet waters and flowers to make perfumed waters. Take 3lb of damask roses, musk, and red roses, 2lb of flowers of oranges and myrtle, 0.5lb of garden claver, 1.5oz of cloves, 3oz of nutmegs, and ten lilies; place three parts musk, one amber, half one of civet in an alembic, and seal its neck with a rag; distil with a gentle fire. Another perfume: Take 2lb rosewater, 0.5lb lavender, 13 drachms of wine, 0.5lb of the flowers of gilliflowers, roses, rosemary, jasmine, marjoram leaves, wild betony, savory, fennel, and basil, 1oz of lemon peel, a drachm of cinnamon, benjamin, storax and nutmegs; mix them, leave in the sun for four days, then distil them. For aqua nanfa, take 4lb rosewater, 2lb of flowers of oranges, 1lb of myrtle, 3oz of sweet trifol, 1oz of lavender, 2oz of benjamin, 1oz storax, labdanum beans, mace and cloves, a drachm of cinnamon, sanders, lignum aloes, and spikenard. Ground and boil over a gentle fire for an hour; strain them through a linen cloth; but of the remaining dust you can make pills to be used for perfuming. If you want the water to be clear, set it over a baine marie until it clarifies.

Water is not the best liquid to keep scent, being cold by nature and fine and thin that the odour flies away. Oil and distilled wine are better. How to make musk water so it receives the scent: Take a strong aqua vita, add some grains of musk, amber and civet, seal the vessel, and set them in the sun for some days. Water of jasmine, musk roses, gilliflowers, violets, and lilies, is extracted in aqua vita in the same way, but too much heat will destroy their delicate fragrance.

To make oil of ben, take 1oz of ben, a drachm of musk, amber, half as much of civet; seal them in a glass bottle and leave in the sun for twenty days. Another: blanche almonds, lay them between two rows of flowers in a leaden box; renew the flowers if they lose their scent; then squeeze out the oil with a press.

To make a sweet water out of gums, such as storax, benjamin, and labdanum, mix them with the oil of almonds, and let them digest on a baine marie for a month; draw out the oil with a retort to yield a most fragrant odour.

How to perfume leather. But first how to wash skins: Let them lie in wine for several hours; dry them, and wash them again if necessary. Then wash them in sweet water, namely rosewater, myrtle, orange flowers, and lavender, for a day. When they are almost dry, stretch them and smooth them to remove any wrinkles. One can also rub them with oil, preferably of eggs, perfumed with the flowers in season, from violets in spring to jasmine in winter. Best is musk, amber, and civet. Rub them into the leather. To remove a scent from gloves, boil a little aqua vita and put them in it for a while.

How to make sweet powders. Cyprian powder: Take oak moss, wash it well, then dry it; soak it in rosewater for two days, and dry it again. Repeat this

several times. Grind it into a powder, then put it into a sieve; boil sweet water and let the fumes rise through the sieve to be absorbed by the powder.

How to make sweet balls, such as rosary beads: Take 1oz Cyprian powder, and benjamin, 0.5oz of clover, a quantity of Illyrian iris; melt some gum traganth in rosewater, and add to the powder to make little balls. Then dissolve four grains of musk in rosewater, and wash the balls with it. Let them dry, and repeat until they have a pleasant smell. You can use other powders, such as amber, labdanum, etc. For washing balls of soap, purify the fat of a goat with boiled lye for an hour; strain it through a linen cloth. Make the lye from the ashes of the ceruse tree, lime, and alum. Perfume them by putting them in rosewater for ten days until they are soft. Then add half a drachm of musk, civet, and cinnamon.

Perfumes are made either of waters or powders. For the former, take four parts of storax, three of benjamin, one of labdanum, lignum aloes, and cinnamon, an eighth of cloves, musk and amber. Grind them and put them in a pot with 1.5oz of rosewater or aqua nanfa. Bring to a simmer and let it evaporate to strengthen. Other ingredients one can try are nutmeg and orange flower water. To perfume a chamber, add a drop of this liquid to warm rosewater and place over warm ashes. To make a scented pomander, take 1.5lb of coal dust of willow, 4oz of labdanum, 3 drachms of storax, 2 of benjamin, 1 of lignum aloes; dissolve gum traganth in rosewater and drop it slowly on the mixed powders. You can shape them into forms and dry them. When you burn them they give off sweet smelling fumes.

Now I show how to discern fake perfumes, which have tiny amounts of musk. Black musk is counterfeited with roasted blood; but this blood is discerned by its brightness when broken. To mask it well, add pigeons' blood and dry the mixture, then wet them with rosewater and dry again, several times, so that the blood is well mixed in. Others replace most of the musk with civet, or roots of angelica.

Book XII Artificial Fire

Vitruvius says that man discovered fire when trees, rubbing against each other in the wind, took fire, and people preserved it. Theophrastus tells how to rub wood together to kindle fire: one has to be 'hot' type such as the bay tree, buckthorn, holm, or piel, and the other a soft dry type such as the ivy, vine, but not the olive tree or trees that grow in the shade. One should place dried leaves or mushrooms beneath them to receive the fire. The West Indians bind two dry sticks together and turn with their hands another stick between them. But man has found a stone that starts a fire even with moisture. Take brimstone and saltpeter, quicklime and twice camphor, ground them to a fine powder and place in a linen bag in an earthen pot. Seal it with clay and straw and let it dry in the sun. Put them in an oven so that they fuse together into one stone. Just adding water to it causes it to catch fire. I have tried it and it didn't work, but I've seen others do it.

Thucydides says that when the siege engines failed, the Greeks would use fire. They would lay bundles of wood with brimstone and pitch and burn down the wall with its huge flames. An earthen pitcher, bound with iron plates and filled with burning coal will crack a wall if vinegar is sprinkled on it. Burning arrows are shot from crossbows at enemy ships, and these easily catch fire, with their sails, pitch, and wax. Marcellinus describes firedarts made of hollow cane with iron between the shaft and head, and filled with combustible material — brimstone, saltpeter, oil, grease, turpentine, glue, etc. But the cunning ancients invented a fire against ships, called Greek fire, that would burn even in water. It consists of willow coals, salt, spirit of wine, brimstone, pitch, Ethiopian wool, and camphor. Constantinople was saved with this fire in the time of Emperor Leo.

We should first speak of gunpowder, though it is so common. It is made of four parts pure saltpeter, with one part each of brimstone and willow coals, well powdered and mixed. The saltpeter is the force and the brimstone and coal receive the fire. To have gunpowder that makes a great noise, use six or eight parts of saltpeter, very well mixed together. For less noise (and slightly less force), use less saltpeter and add some glue and butter of gold, but I will not divulge how lest men do mischief by it.

Heron describes great fire-throwing engines against the defenders of walls. When Antipater the Macedonian besieged the Megarenses, he set hogs on fire and wreaked havoc among the elephants. To make a simple fire rocket, make a 3-foot hollow stick, the wood a finger thick and the hollow four fingers. Strengthen it with iron hoops and iron plates on the outside. Fill the hollow with three parts gunpowder, half a part of colophonia resin, tutia, and brimstone, wetted with linseed oil. Press them well with a stick, then seal with waxed and pitched linen. Make a hole in the cloth and fasten a cotton fuse. For army level rockets, use equal parts of turpentine, rosin, liquid pitch, varnish, frankincense, and camphor, a third and a half part of brimstone, two parts of saltpeter, three of aqua fortis, naphtha, and gunpowder. Pound them together to make 1oz fireballs. Put the balls in the pipe in between layers of gunpowder; some put lead powder, salt, or glass powder, so that they stick to armor, others put lead bullets. I saw a ten foot rocket like aboard a ship, transported with ropes, that destroyed almost all the enemy's galleys. I now describe a new invention: a brass gun that fires ten bullets one after the other. Put in layers of black powder and balls in the gun up to its rim, and lastly put in the clammy powder. Light it at its mouth and it will fire out the bullets one after the other.

How to make fireballs that stream like falling stars. Take 1lb of gunpowder, a third part of saltpeter, 2oz of brimstone and colophonia. Mix them and sew them in a ball of thick cloth; put them into hollow half spheres of wood, and pack them tight with a wooden hammer. Then bind them with cords, dip them in tar, so they do not break apart in the blast of the cannon. Lastly, use a sharp stick to make three small holes and fill them with gunpowder. To use them, prepare the light, throw the ball in the gun with your right hand, and fire the touch hole with your left; the ball is thrown up in the air and flies wildly up and down. Similar compositions are used to make fireballs that burn clothes,

even armor, which cannot be put out.

Philosophers have sought the reason why there are waters under the earth that are always hot. The cause is bitumen, that once lit, will not be put out; rather if you add water it will burn the more; only earth will quench it. The mountain Chimaera burns day and night, consuming even stones and sand, burning even in water. There are different kinds of bitumen: the liquid type is called naphtha or oil of Peter, and has a great affinity to fire. A second type is called maltha, as seen in the lake near Comagenes Samosata which sends forth sticky burning mud. Other types are camphor, pissaphaltum, which is harder than bitumen, amber and jet, which burn slowly. To make a ball that burns under water, prepare a fine gunpowder; for every seven parts of it, add two parts of colophonia, three of saltpeter, one of brimstone; some add varnish, turpentine rosin, petroleum, linseed oil, and aqua vita; mix and sprinkle naphtha or liquid pitch to make a paste. Wrap it in linen rags, dip in scalding pitch, and let it dry. Make a little hole in it, put in gunpowder, and put fire to it. Immediately throw it in the water; it will form a quantity of black smoke and appear to burn vehemently, as if fighting the water, until it is exhausted and floats to the top. Another way is to place in pots a mixture of gunpowder, saltpeter, brimstone, pitch, pine tree gum, varnish, etc., with naphtha, liquid varnish, and turpentine, to be cast among enemy ships.

There are balls of metal, filled with gunpowder, which explode with violence. Make a ball of brittle metal, the width of a hand and the thickness of half a finger. The metal consists of 3 parts brass, 1 part tin, shaped in two hemispheres, screwed together, with a thick nail in the middle so that it does not break from the joint. Make also a hollow pipe the width of a finger that enters the ball to its centre and sticks out; it should be narrower at the centre, and soldered to the ball. Fasten wires and iron pieces to the nail. Fill the ball with good gunpowder, and the pipe with powder that burns slowly. Light it and throw it among enemies, so it breaks into a thousand pieces. One ball can wound 200 men. Before throwing it, try an empty ball to see how long the fuse takes to burn. A similar type but with holes in the spheres are thrown at cavalry, such that the thunderous flames that come out of them cause the horses to break ranks.

It takes time to dig mines under city walls, so they are often discovered by the enemy. To make mines in open ground where armies meet, fill the plain with pits three feet deep during twilight. Place gunpowder balls in them and dig shallow trenches from one to the other in which are placed cotton fuses inside earthen pipes. Bury everything. During the battle, when the enemy stands upon the ground, light up one of the fuses and the whole ground will presently burn with fire, cruelly slaughtering the enemy, limbs flying in the air and bodies burnt with horrible flames. A fuse is made by boiling aqua vita or oil of linseed with gunpowder until it grows thick; roll the cotton in it and let it dry. To make underwater mines, fill some hollow beams with gunpowder, cover them well with pitch, but leave a place where to light the match. Sink them with weights and when the enemy galleys are over the place, release them and light them. I have tried this in ponds – it performed better than I imagined.

I now show how to quench fires. Vitruvius says that larch wood burns very slowly, being full of water and earth and without pores. But this is not true; in fact, being oily, once it catches fire, it is difficult to put out. The ancients also report that liquid alum withstands fire; but our alum does not have this property. They also mention vinegar as quenching fire, and egg white to protect wood; they used fresh leather to protect siege engines. Thick juices are good against fire, for example egg white mixed with vinegar and alum.

There are different types of fiery compositions. One, authored by Gracchus, is kindled by the sun: oil of rosinous turpentine, quicksilver, juniper, naphtha, linseed, colophonia, camphor, pitch, saltpeter, duck's grease, refined aqua vita. Ground and mix them, and let them ferment for two months in dung. Then distil them in a retort, and thicken the liquid with gunpowder. Smear it over wood and it lights by itself in the summer sun. Pigeon's dung is known to kindle in the sun. An easily ignitable oil is linseed oil distilled several times, for it catches fire even if a candle burns from a distance. There is a fire that is quenched with oil but kindled with water. It is a mixture of brimstone with naphtha and camphor, and is used to dip wicks in them. How to make a smokeless fire: Fill an earthen pot neatly with rope, cover and seal it well. Make a fire under it until it is red hot, and leave it to cool. Open the pot and cut lengths of the black cord. When lit it emits neither smoke nor smell.

Now for some unusual fires to impress others. How to make a whole room catch fire suddenly: Dissolve camphor in a great quantity of aqua vita and let it evaporate over coals. Close all the windows of the room. When a man enters with a lit candle, the whole chamber will be ablaze. How to make an exceedingly combustible water: To some strong red wine add quicklime, tartar, salt, and brimstone; distil it to produce a water that burns very readily, yet it will not scald you. One can smear paper with it and, burning as it falls, create serpents in the air. Another way is to distil balls of quicklime and salt in common oil; add more salt and quicklime and distil again; repeat four times. The 'infernal oil' that is produced makes a pleasant fire, used at the theatre. Hold in one hand some fine powder of colophonia, frankincense, and amber, and in the other a candle; throw the powder in the air and quickly pass the candle under it to produce a huge flame. How to light many candles at the same time: boil brimstone and orpiment in oil, and dip in a length of thread. After letting it dry, tie this thread to the wicks of the candles, so that when one is lit, the flame runs quickly to the others. Also, let a man eat sugar candy, then as he breaks it with his teeth in the dark, sparkles will fly out of his mouth.

Now for some of my own experiments that may give occasion to think of greater matters, but I write cryptically so wicked men do not have opportunity to do mischief. So that bullets enter a wall deeper, let the ball go into the hollow of it, slight, then wide; wet it with oil or lard before you put it in. The oil prevents the air breathing on the bullet. For all bents being stopped, the flames striving within, cast forth the bullet with more violence. How to shoot a man with a bullet and leave no trace of it: What things are heavy, are solid, and so subtle, that they will penetrate and leave no marks where they entered or came out. And they will do the same, though they be united, as if they

were disjointed. And every part will act by itself alone, as it would do being united. How a gun may discharge twice with one charge of powder: Wrap a paper three times about the rammer of the gun, fill the barrel with powder and bullet. Cover it tightly with the paper so no vent may reach them; put another measure of powder on top and stamp in a second bullet, pushing it enough that the powder reaches the touch-hole. With the first firing the upper ball is fired; thrust in a sharp point to pierce the paper, so that with the second firing, the first bullet is discharged. How to blind one's eyes with smoke, if the wind is in their face: Fill the gun first with gunpowder then a paper lantern filled with a mixture of euphorbium, pepper, quicklime, vine ashes and arsenic sublimate.

Finally, how to have a candle that cannot be put out. It is related that on an island near Naples, a sepulchre dating from before the coming of our Savior, was opened in the year 600 and a lit candle was found in it. Some say that oil of metals remains alight for long, but this is false. The wick of the oil of the incombustible stone does not wither, yet that does not mean that its light will last forever. Others think that adding common salt to oil will double its life, which is true. But to have an oil that burns perpetually is impossible. Some think that the oil in the vial was such that when it came in the air, it caught fire. This may be true, for something similar happened to me a while ago. A friend says that he boiled litharge, tartar, quicklime, and cinnabar in vinegar, until it evaporated, then sealed the vessel, set it in a furnace and left it for months. When he opened it, a flame suddenly flew out. But the ancients put in candles so they light the resting dead. If it is possible, it must be because nature abhors a vacuum; a frame will sooner break than allow such a thing. If it were possible to light a flame while shut up in a glass and all the vent holes shut tight, say, by using a burning glass, then it would last continually because the air cannot enter from anywhere to fill up the emptiness in the vial, so the oil that turns to smoke has nowhere to go and kindles again.

Book XIII Tempering Steel

It is well known that iron hardens when tempered, but it can also be made softer. The ancients thought quenching was done by superstition, and swore by their river water. When I investigated it, I found that it does not matter whether hot, cold, dry, or moist things are added. Instead the most important thing is the liquid that the red-hot iron is plunged into; it grows hard by contrary water, and soft by friendly oil. First the oil softens the iron that it is not brittle, then it is quenched in water, so it is hard enough to cut iron like lead.

Iron grows softer if it is often made red hot and left to cool in fire, unless you beat it hard. Alternatively, apply oil or wax to the iron, cover with straw and dung, and dry it; make it red hot on coals and let it cool. You may use instead, three parts brimstone, four parts clay in oil; or tallow and butter.

To temper and sharpen iron, it all depends on the quenching. It should not be quenched when it is white hot, else it would be consumed. It should be of a yellow or red color. For swords, the color has to be violet; for bread knives with

a soft temper, it should be ashen color. Rub the knife with soap and its edge with oil of olives until it grows cold. For iron fit to cut wood, heat until it is violet, then plunge it in water until it is ashen, then plunge in cold water. For blood knives, quench it in oil; for a scythe, heat it to a gold color, then quench it in oil and smear with tallow.

To make an iron that is extremely hard, fit to be used on other iron, such as a file or shield, it must be made of the best steel; first prepare a powder made from oven-dried ox hoofs, common salt, beaten glass, and chimney soot. Cover the file with this powder inside a chest; cover and seal with clay, then surround it with coal that it becomes red hot. When all the powder is burnt, plunge the files in very cold water. To make it extra strong, bathe it in vinegar before heating.

Iron is softened by fatty things, which open its pores, and hardened by contrary cold things that shut them. To make a saw hard enough to cut iron, plunge the red hot iron in water with alum and piss, take it out, then when its color is violet, put it back in the liquid until it is cold. For fish hooks that need to be small yet strong, reheat and plunge them twice in water. Albertus Magnus says that iron should be tempered with the juice of radish and earthworms, but I found this to be false. To make the best steel, cover the iron pieces with a powder made of borax, oyster shells, and cuttle bones, before heating them in the fire and quenching in water. For less hardness, quench the iron when it is red hot in water, remove it; when it is yellow, quench it again and leave it in the water.

It is a dishonor that we neglect, in our times, the discoveries of our ancestors who knew well how to temper their tools to easily cut porphyry stone. For, if the chisel is too hard, it fractures, and if too soft, it bends. With many experiments and trials, I have finally recovered this method by chance. The trick is the color of the iron, which must be between silver and gold, and the water which must be very cold. Quench it at this time, remove it, then dip it again when it is a violet color. Distilled vinegar with sal ammoniac, or distilled urine, or dissolved quicklime with salt of soda, are also excellent for hardening. The salt gives force and the fat toughness.

Some engrave porphyry without a chisel, using only strong corroding water. Distil a little mercury sublimate with sal ammoniac; then distil for three times the powder of verdigris, calcined tin, firestone, sal gemma, sal ammoniac, and common salt. Smear the porphyry with a thick layer of goats' suet, but only those parts that are not to be engraved. Pour on the corroding liquid which will eat into the exposed parts; replace with fresh liquid until your work is done.

Many seek to create an iron that resists gunshot. Breast plates are shot through because of the flaws in the iron, hardly visible to the eye. The solid parts always bend without breaking. When I investigated the cause of the flaws and small cavities, it is that smiths are not careful with coal dust that they add to the steel, which is mingled with tiny grains of stone and chalk. Put the coal dust in a bowl of water; the coal specks float, while the stone sinks; separate and dry them. With them, I have seen breast plates that are musket proof.

To renew the worn marks on damask knives, polish it with powder of emril

and oil, clean it with chalk, and wet it with lemon juice mixed with tanners' vitriolic water; it will be as new. To make new marks, cover the knife with chalk paste; make the marks as required, then smear with vitriolic water. It will stain the blade where there was no chalk.

Finally, to preserve iron from rust, cover it with oil of ceruss, or with deer suet, or the fatty substance in the hoofs of oxen.

Book XIV The Art of Cookery

I now turn to cookery, not to encourage gluttony, but to prepare great banquets. The ancients said that the flesh of animals killed by the enemies they fear is very tender, such as a sheep killed by a wolf, but they understood this not. I think it is because the fear of death drives their blood to their heart, leaving the flesh very tender; animals killed by the gun have a harder flesh. So, for tender pheasant or geese, fly hawks at them; for tender ox flesh, set a multitude of hounds on them; set hens on a high tower that they are consumed by fear; we used to hang turkeys by the bills, that by the end of a journey they are dead and tender.

Wild cocks bound or hung from a fig tree, grow tame and tender because of its strong digesting vapor and juices. The same is true of bulls. Add the stalks of wild fig trees to the pot when boiling flesh. Similarly, pulse is strangled in a boiling pot by the antipathy of chokefitch, and meat by dock weed or nettles.

Other ways to make flesh tender: hang the meat in air, but not so long that it is corrupted. Thus peacock for two days, stretched by weights on their feet, especially in moonlight.

How to make crabs and other shell-fish tender: fishermen catch them when they moult in the summer, and leave them for ten days, changing their water daily.

Meat is more savoury if the animal is "crammed" and fattened, especially males in winter as they have no young. To do so, shut five month old hens in small cages with only two openings, for their head and their tails. Feed them with barleymeal three times daily, remove the head feathers so they don't breed lice, and lay soft hay under them. In two to four months they will be full. For four-legged animals, keep them hungry for three days, then feed the sow barley, millet, acorns, figs, etc., varying their diet. Don't let them wander about, and add salt to their feed that they eat the more. One can put a calf to two cows, to be fed in abundance.

To fatten a goose's liver, feed them some old figs or wild radish, soaked in water, for twenty days. Others feed them barley and weak wine, and in the end mallows with leaven, water, and honey. When the goose is killed, quickly cast its liver in cold water to make it solid, then fry it in grease, seasoned with spices. Figs are also the best for pigs' livers.

On the contrary, to make flesh bitter, feed animals venomous things. Thus deer in summer is not to be eaten, since they feed on adders and serpents. Partridge that eat garlic have stinking meat; or birds that eat black hellebore,

gooseberries, or snails on briars and shrubs. Even milk can be poisonous when cattle eat all sorts of unsavoury weeds; or honey when bees feed on wormwood; and eggs when the hens feed on dung.

How to roast a hog, according to Athenaus: kill the animal by a small wound under his shoulder, wash its intestines with wine, fill it with barley flour, and roast the whole with much pepper in a gentle oven that it be neither burnt nor raw. Remove the guts of a cockerel, fill half of him with broth, and put him in an oven; the upper half is roasted, the lower boiled. How to fry, boil, and roast a lamprey all at once; take out its bones and entrails, put him on a spit, wrapped three times with filets, part of it made wet with wine, parsley, etc., and part with oil for the fried parts.

How to set up a boiled peacock to seem alive: Cut its skin from its throat to its tail, and pull it off aside, working around its legs. Roast the flesh on a spit, stuffing the body with spices and herbs. When done, put it back into its skin and thrust an iron wire through its legs and neck, that it may seem upright and alive. To roast a goose alive: Pull all the feathers out, except from his head and neck. Smear it with suet and lard all over and surround him with a ring of fire and pots of water with salt and meum herb. When he begins to roast, he will drink; moisten his heart and heart with a cool sponge. When he runs mad, fasten him on a table for your guests and eat him before he is dead.

How to fry fish on paper in case of need: Shape the paper as a pan, put in oil, and set on burning coals. To roast a chicken while travelling, put a steel rod in a fire, then stick it into the chicken covered well with cloths. Eggs get roasted if laid in quicklime; if there is no salt, flesh can be kept with honey. Red wine stains can be washed away with salt.

To serve wine that smells of musk, add a little musk to aqua vita and leave for two weeks in the summer sun. Then add a drop of this to a gallon of wine. For hippocras wine, take four vials of very sweet wine, add 2lb of sugar, 4oz of cinnamon, pepper, and grains of paradise; leave for one day, strain them, and add a touch of musk. How to make frozen wine: put wine in a vial, add a little water; take a barrel of snow, add saltpeter, and congeal the wine in it. If water is boiled in brass kettles and the water poured into bowls in frosty cold air, it will freeze very hard and last a long time.

Now, how to make your guests merrily drunk, and keep them safe. The fruits of arbute, dates, seeds of ricinus, sowbread with wine, musk, all increase drunkenness. If someone has drunk too much wine, Cato advises to eat five tops of raw or boiled coleworts. Africanus tells us to eat four bitter almonds before meat, to dry out the wine's moisture. Also, lettuce, leeks, saffron, etc., all hinder drunkenness. To cure one who drinks too much wine, put three live eels in wine, let them die there, and give the wine to him; he will not want to see wine again. To protect a son from this vice, give him an owl's egg, rare, before wine, and he will always hate it.

How to drive parasites and flatterers from great men's tables: Beat vitriol and galls into a fine powder and apply it to a towel; give it to the parasite when he needs to wash his hands and face, and it will make him as black as coal. Superstitious people tell us to put a needle that is used to sew corpses' shrouds

under a table to prevent men from eating meat. But these are old wives' tales. Put a drachm of belladonna root in wine three hours before serving him meat. Otherwise sprinkle the powder of wakerobin roots on his meat; it will burn his tongue and he will make a fool's show of himself. To get rid of a stinker, rub his knife with the juice of coloquintida; it leaves such a bitter taste that he has to leave the table. Or else, smear his cup with the milk of figs and gum traganth; when he drinks it will stick to his lips and cannot pull it off. A hilarious way: boil hares' blood and dry it; also cut harp into tiny strings; sprinkle both on his meats that it looks bloody with moving worms!

Book XV Hunting

Animals are allured by baits of meat and love. Sturgeon and whales are baited by the roasted lungs of a bull. Seabream are attracted to salted mousefish; each fish has its own delicacy, ranging from gnats to dainties. An excellent general purpose bait consists of 4 drachms tunny liver, 8 of sea-squills, 4 of sesame seeds, 8 of ground beans, and 2 of raw dogfish, all ground and pasted with wine.

How to allure animals with love: release a female cuttle fish, and presently all the males come about her, to be easily caught. To catch carp and parrotfish, bind a fat female to a long pole on the shore and arrange nets on the side; as the male swim towards her, the fishermen throw their nets on the seaside, trapping them in. How elephants are caught: four females are kept in a pit and a wooden bridge is lowered to the bottom; when the males cross it, men remove the bridge. To catch a nightingale, place a female in a cage, to which the males come to see her, thus falling into the net.

Seabream love goats so much they leap in joy at seeing their shadow. Opianus relates how a fisherman, putting on a goat's skin with horns with the sun behind his back, and throwing a paste with goats blood, catches an abundance of them. Similarly, partridges are caught using a deer disguise, and bustards using a horse disguise. Cuttle fish delight in the olive tree or fig tree; just lower a weighed-down branch, and within a short time, it is covered with these polyps.

Noises and music also draw animals. Dolphins love the harp, as Herodotus relates; wolves love a flute, and horses become tame when they hear it; stags and boars like the pipe so much they forget where they are and are ensnared; the ray is so taken by music that it comes to the surface.

Fish are allured by light at night. I made an underwater light to attract fish as follows: make a pillar of brass, three feet in diameter with iron hoops to keep it vertical, and with about six glass windows in the middle, made water-tight with pitch; there should be a hollow pipe leading from them to the surface, two feet above the surface; place candles in the windows and sink the pillar into the deep.

Animals may also be drawn in by reflections of themselves. The cuttlefish grabs a glass reflecting his image and is thus ensnared. Jackdaws love mirrors; a fowler, on seeing them, makes a small pool of oil so when they come down to see their reflection, they get smeared with oil and are unable to fly. Quail can

be caught by placing a trap in front of a mirror.

Other animals follow odours. Unicorns are said to grow tame with the smell of young virgins. Weasels follow the gall of a dragon lizard or chameleon; mice go after the smell of lees of oil only to be stuck by it. To get rid of fleas, smear the fat of hedgehog on to a staff and place it under your bed. Frogs follow the gall of a goat.

Now, how to make them so drunk you can catch them with your hands. Dogs and crows get drunk with the root of the aenothera herb, according to Athenaus. Hemlock makes asses senselessly drunk; henbane seed with barley stupefies horses into a deep sleep; both apes and elephants get drunk on wine. Against the birds that eat grain, throw a certain boiled garlic, called alum, in the field, which stupefies them. Partridges and ducks get drowsy by eating meal soaked in wine, or with burdock seed, or boiled tormentil in wine, etc. Even fish can get drunk on sowbread.

A venom that kills dogs, pigs, mice, and even heifer, is that mixture of white chamaelion herb wetted in barley flour. Dogs bane, and nux vomica with butter, also kill a dog. 2oz black hellebore, 1oz yew leaves, 1.5oz beech rind, glass, quicklime, and yellow arsenic, 3oz almonds, all mixed in honey, make a powerful poison. The herbs aconitum, stavesacre, and roots of daffodil, kill mice. The aegoethros herb kills goats; the powder of venomous fish found in America, when strewn in the forest, kills beasts like deer and boar; sal ammoniac with corn kills weasels; water with rhododendron kills cattle; seeds of broom kill hens; etc.

Fish are killed by the root of birthwort, mixed with lime; or by finely cut tithymal roots; pellets made of oriental galls, cheese, bean meal and aqua vita.

To change a dogs' colour, paint it with boiled quicklime in litharge. A dog will not run from you if you smear him with butter all over. If you keep a bitche's membrane or hair of hare, or carry a hyena's skin, or keep a dog's tongue in your shoe, a dog will not bark at you. To encourage a hawk, give him a bit of wine or vinegar with his food.

Book XVI Invisible Writing

There are several ways of writing invisible letters. First, I shall write about writing that can be read by dipping in water. Dissolve vitriol in boiling water, and dilute it until it is clear. Writing with this liquid produces clear letters. If desired, write between the lines with an ink made from burned straw and vinegar. To read, wipe it with a sponge soaked in white wine with boiled galls. Alternatively, write with powdered galls soaked in water and diluted, and read by dipping in dissolved vitriol. Another way is to write with dissolved alum on cloth; then read by dipping in water. Write with lemon juice, and read with a liquid made by boiling vinegar with powdered litharge. You can also write on a stone with goat fat; to read, dip the stone in vinegar.

Now, writing that is made visible by fire. Some liquids that behave like this are: citrus or onion juice; other fruit juices, such as cherry, sow-bread; sal

ammoniac. The following liquids can only be read if the paper is burnt: mix quicksilver in vinegar and an eggwhite; lime or salts. Or, write with ceruse (white lead) and gum traganth, then read by placing the paper against a light.

Next, writing which is read by rubbing with dust. Write with vinegar, or urine, or with fat or tallow, or milk of the fig tree; read by rubbing with soot or burnt paper. Dissolve gum arabic in water, write with it on a crystal or glass; then read as before. Rub a paper with goat suet dissolved in turpentine; place a paper on it and write with an iron point to pick the fat from beneath.

How to write on eggs, since these are not stopped by the papal inquisition. Roll the egg in wax and make letters with an iron point; soak the egg overnight in aqua fortis or lemon juice, then remove the wax. To read, hold the eggshell against a light. Alternatively, hard boil the egg, cover in wax, and write with an iron point; soak in water with alum and powdered galls; to read, leave in vinegar, which will eat into the eggshell. Or, dissolve vitriol in water, write on the shell and dry it; to read, soak the egg in galls dissolved in wine. Or write with lime water, and soak in lye with brasil; or write with suet, then soak in water of vitriol, then read by soaking in wine. Another way: soften the egg by putting it in vinegar for four hours; write on a tiny piece of paper, then insert it through a small cut, to lie between the outer shell and inner skin; then repair the cut with lime and gum, and harden the egg by soaking it in cold water.

Next is writing that is visible but hidden. How to write on a belt: It is said that Archimedes invented this method. Two long and round sticks are made identical; one was given to the army general, the other was kept in the senate. When needed, a belt was wrapped around one stick and words written from top to bottom; unwrapping it leaves a jumble of words that cannot be read if intercepted. How to write secrets on parchment: if a candle is applied to the letters, they crumple and cannot be read; but if it is made moist, the wrinkles disappear and the words reappear. On books, one can turn back the pages and write across a corner such that when the page is put back in its place, nothing is amiss. Similarly, one can arrange playing cards in some particular order and write across their edges; they only appear as strange marks and can only be read if placed in the same order. One can write on wood and not be suspected: stamp letters on a soft poplar wood with printers' dies; then cut the wood with a hatchet leaving marks the depth of these letters, so that it all appears confused. When placed in water, the wood swells out and the letters become apparent.

Theophrastus writes how one can make a cut in the bark of a tree, make a small hollow, write some religious letters, then bind it again so the bark heals; it amazes people when they eventually find them and come to believe them. But one can do this on a dry trunk and join the bark again with common glue. The ancients resorted to hiding letters in cakes, dead animals, coat pockets, shoes, etc. To hide words in stones, mix finely powdered flint with twice the amount of colophonia in water; insert lead plates with letters on them, then tie the lump in a linen bag and sink it in cold water until it grows hard.

The ancients disguised their messengers as animals, or affixed their messages to arrows shot over walls. Today we can do the same by wrapping paper inside lead shot and firing them by gun. Pigeons have also been used, because they

return to their home, especially if they are taken from their young in their nest. It is related how a king of Egypt had a crafty rook which would take messages to wherever it was instructed to fly. Sometimes, however, such birds are intercepted and the message is replaced by a contrary one.

Our ancestors invented another art, that of sending messages with unsuspecting people. Since enemies search everything from head to toe, and even torture messengers, it is best that they know nothing of it. Thus, Hestiaus, pretending to cure a servant, shaved his hair, wrote some letters on his head, then when his hair had grown again, sent him to Aristagoras with instructions to shave his hair again when he arrived. One can make the letters indelible by inserting colophonia powder inside the skin; or by ulcerating the skin with corroding water. Another simple way is to write on one's back with one of the invisible inks.

Letters that decay and disappear can be made in two ways. Mix oil of vitriol with ink, and in a few days up to a month, it will corrode the paper with the ink. One can also use a strong lye, oil of tartar, alkali, soda, aqua regia, or the strongest aqua vita. A good corroding liquid consists of chrysocolia, sal ammoniac, and alum, boiled a little in a strong lye of quicklime. If, on the contrary, you want letters that will appear after a while, use citrus juice, for they appear green after twenty days; or sal ammoniac written on brass.

To take letters off a paper, wipe them with aqua fortis if they are written in gall and copras. Or rub with balls of alkali salt and sulfur. If you then want to write in the erased space, wet it with alum water to prevent the ink from running. To read letters that are decayed, boil galls in wine and wipe over the letters.

How to open letters and then reseal them with counterfeits: Melt sulfur and pour into ceruse powder; apply this hot paste on the seal and let it cool; take it off and it will have the seal's imprint. Another way: pour vitriol and verdigris in a pot of vinegar; boil on a fire and put iron plates in the solution; scrape off the rust that appears until you have enough of the substance; make a paste with quicksilver and while it is soft, apply to the seal until it hardens. Or, apply a little oil on the seal and surround it with wax, then pour isinglass gelatin dissolved in water; heat it and when it cools after 3 hours, prize it out. To imitate the handwriting, lay a sheet of paper on the letter, and lay them on a glass with a light shining underneath; copy the letters as needed. To open and close a letter without suspicion, use gum tragacanth dissolved in water to repair a small tear.

To communicate with absent people: One way is to speak along a circular wall that is not broken by windows or columns; the voice passes clearly as in an echo, but someone in the middle cannot hear the words properly. In Mantua, there is a great gallery that has this effect. For sound reflects like light. I once heard someone speaking in a boat a mile away, their voice reflected by the smooth water surface. Alternatively, make a long pipe of lead from one room to another: the undiminished sound carries very far, more than 200 paces. Perhaps if one can capture a sound in a circular pipe, it may be heard later at will.

One can communicate at night by fire and during the day by smoke. Many

a Greek legend involves fire signals from towers. Letters can be represented by a number of torches, as Polybius shows. Divide the letters in rows, say, three rows of seven each. Raise one torch so many times to signify letters in the first row, thus once for A, twice for B, and so on; raise two torches for letters in the second row, etc.

Book XVII Strange Glasses

Now we come to the mathematical sciences and experiments with catoptric glasses. I shall begin with plain glasses, made of clear transparent crystal. When a little color is added to the glass, such as yellow, the face will look jaundiced; if red drunkard or angry, etc. If the backside of the glass has a ridge down the middle, then the foil laid down, the face that looks on the glass will seem divided in the middle. If the glass is all warped, then the face will look like an ass's or dog's snout, or with shrimp eyes. The plain glass has to be put in the furnace to bend it slightly. Make two glasses that are thick on one side but taper to nothing on the other; put them on top of each other and lay the foil on the bottom part. Two faces will appear under each other. The more layers you put, the more faces, but it will not be discovered why. To cast letters on a wall, make them with wax or black ink on a mirror, and reflect the sun's rays on to the wall.

How to invert the body with the head at the bottom: Join two mirrors at right angles; when you place them just right, the head will be upside down. If the angle at which they join is sesquialter, that is, one and a half, then many images are projected at once, changing with the angle. Also as one image get near, the other goes farther away. To look around without suspicion, place two mirrors against a window, one of them inclined downward, the other reflecting to your eye. This way you can see hidden places. An inclined mirror will show not one's face but some other image, much to his surprise. If two large mirrors are placed, one horizontal, the other inclined, and a man steps on the first, he will see himself in the other mirror as if flying in the air.

How to make a theater-glass. Divide a semi-circle into a number of equal arcs. Attach vertical mirrors upon the lines joining the arcs. A person at the center of the circle will see several copies of himself all around. That is the ancient way. For a better modern way, add more vertical mirrors except for one panel through which the person looks in to see innumerable faces. And if you place warped or colored mirrors, so much more wonderful the sight. Also, take a circle of diameter two and half feet and divide the circumference into fourteen. Erect richly decorated pillars at these points except for one; and mirrors between them. The person now sees a vast multitude of pillars, not persons. Similarly, a treasury is a chest whose inside is covered with mirrors with boundaries of flowers, pearls, and precious stones.

Concave glasses [mirrors] are far more curious. The first thing to discover is its point of inversion. Hold the mirror against the sun; where the beams unite is the point of inversion. To see it more clearly, breathe a thick vapor from

your mouth. If you put your face or your finger at this point, it will appear enormous. It unites beams so strongly that it will kindle a flame, even melt a small amount of lead or tin; some have even managed with gold and silver. Outside the point of inversion, the head or candle will appear upside down. If a candle is placed at the inversion point, it will offend the eyes with its light and heat and its parallel beams will light very far off at night; if you put snow, the cold also will be reflected. If you speak from this point and the mirror is turned to see the face of a friend, then he can hear the words clearly though standing far behind. Thus, a few lamps with concave mirrors can light up a whole theater. On a moonless night, you can see by reflecting Venus' rays. To blow up a tower, set up a large concave mirror to reflect the morning sun on the bottom of the wall; at night lay fuel or gunpowder there, and the next morning it will blow up by itself.

To kindle fire far away, align a far-off plain mirror with a concave mirror next to the fuel or gunpowder. To magnify letters, use a concave mirror facing the letters and a plain mirror to reflect them back. The same combination but with the plain mirror farther back gives images that seem to hang in the air. If you look at the plain mirror and reflect it back in the concave mirror, you will see your face the wrong way round.

Shut all the windows and all other holes, but make one hole of the width of a hand, and over it place a lead plate which has a hole the width of a finger; opposite it set white paper upon which you can see all that happens outside in the sun. If you put a small lenticular crystal glass to the hole and adjust its place, you shall see all things clearer, including flying birds – all the world on a sheet of paper. By this means, it is easy to draw a perfect copy of any picture that is placed by the window. To see these images the right way up, you need to put a concave mirror to reflect upon the paper. Also, one can make a whole scene appear on a chamber wall. Arrange the whole scene outside as in a theater, and whoever is inside can see the same on the wall. This way also, one can safely see a solar eclipse.

One may use torches instead of the sun to light up the chamber. For an amusing effect, make a small image over the hole, raise a white sheet in the dark, before the audience, then light up the torches outside the hole; the spectators will suddenly see, to their terror, an image hanging in mid air.

The ancients did something similar with mirrors and glasses. Shall I write down how to make an image appear in the middle of a room without any glasses at all? Take a cylinder which descends down to a square, and place it in the middle of a completely dark room. The rays that come in will follow the fashion of the first glass, covered as in a pit, then as the beams meet the image is seen. There, I will not make it any plainer; let him who understands, rejoice.

Take a circle and cut off parts from its circumference to make part of a pentagon and of a hexagon. The pentagon will be hollowed into the table, the hexagon bulging out. Model the exterior with wax, then make the glass of steel from it, polish it, and it will show a diversity of images, some correct, some upside down, or distorted. By varying the convex or concave parts, a variety of images can be made. A convex cylindrical mirror kept upright shows the face

deformed in length, but kept horizontal it shows nothing but teeth. A concave cylindrical mirror shows your inverted head. Similarly, a conical mirror.

A lenticular crystal produces many effects, both concave and convex. They are used by many in spectacles. A convex lens behaves like a concave mirror: it kindles fire and melts lead even more readily; a candle behind it casts parallel light to a great distance at night that you can read by it at night. If you place your eye behind it, it will show things far off as if they are near. And if you place several lenses, you can even read small letters from a hundred paces off. Concave lenses show distant things clear, and convex lenses nearby things, depending on your sight. Combining a convex with a concave lens, you can see both things far off and things nearby. If you place an object behind a convex lens, it will appear in front of it. A painter can use a concave lens to draw a small scene. If you make spectacles of thick glass worked to form pyramids (either convex or concave), you will see multiple images, Argus faces with several eyes, and so on.

Ptolemy mentions a glass by which he can see enemy ships from six hundred miles off. It is not to be explained too easily. Let the strongest sight be in the center of the glass, where it shall be made, and all the sunbeams are most powerful dispersed, and unite not, but in the center of before mentioned glass. In the middle of it, where diameters cross one the other, there is the concourse of them all. Thus is a concave pillar glass made with sides equidistant. But let it be fitted by those sections to the side with one oblique angle; obtuse angled triangles must be cut here and there with cross lines, drawn from the center, and so will the spectacle be made.

Consider a dark chamber with a window, having a mirror on its inner side and a glass on the outer. When someone looks in the window, whatever is set outside the window, be they statues and the like, will appear as far inside the room as they are outside.

A crystal pillar can also kindle fire; it has burned blankets when the sun shines through it in a chamber. Just like the convex lens, it can show an image hanging in the air. If the pillar is made round only by fire, not with a wheel, then the light refracted from a candle will show infinite rainbows, very pleasant to behold.

Fire can be kindled by a concave glass. Make a ring of glass with a concave lower edge. It will bend the rays far from it. So can a concave crystal pillar, or pyramidal, but more weakly.

The most powerful mirror is that of parabolical section, lighting anything combustible with its multitude of fiery darts. A spherical mirror only focuses by a hexagon's angle from the centre, but a parabolic section focuses all beams. Despite all the legends about Archimedes and Cardano's mirrors, one can hardly burn anything ten feet away. To make such a glass, let the burning point be AB ; double it to ABC , draw a right line DA continued to DAE such that DCE is a right angle. Draw a parallel HCI to DE of length twice CD , and another parallel FBG of length twice AC . Join the points $HFAGI$ with a curve, the required parabola. Add more points to make it more accurate.

The above mirror only works directly opposite the sun. To burn at an angle, one needs an oblique parabolic section. Take a line AB eighteen feet long. Draw

lines at right angles to AB , first a fourth part of AB at A ; at the point C two feet from A , so take twice 72, its square root 12 is the required length. The distance BC is then 20 feet. Let CG be two thirds of a foot along AB . Now begin from AC as 60 parts, to which add four zeros 0000, so that when we take roots we don't lose accuracy. Make a table of sinus versus, starting from 60 to 80: the parts of AE being 72 times 30, so 2160; multiplied by AC to get 129600; then its root is 360, to which we add the cyphers signifying the tenth parts of a foot, as 360.0.0. The root of the sinus of 80 is then 415.6.9. Hence draw lines at right angles to AG , with 60 corresponding to A and 80 to G , each with length as per table, so A has length 0 and the line at G has length 56, these being the differences from 360. Affix pins at these points and place a wire along them, hence cut a thick brass table in this shape. Then take a 12 foot iron rod with the brass plate fixed to it, so that when it is turned around with the other end fastened to a spike, it will cut a clay ring of parabolic section. Then create another smaller ring, and fill the gap with liquid metal.

It is written how Proclus burned the enemy ships of Constantinople with burning glasses. But I will show you an invention that exceeds these of the ancients and of our age also. For this glass burns at an infinite distance and everything in between. It is unworthy to divulge it to ignorant people, so I will speak in riddles. Take a cylindrical section, that it sends back again obliquely the sun beams far from the surface. When they are reflected by a parabolic mirror and pass through a narrow window, they burn at the center for a large distance. Let the glass be a finger thick and the tin foil of purged antimony and lead, as they make in Germany. One may use this wonderful artifice to send letters far in a full moon, perhaps even to the Moon itself.

How to make a burning glass using circles. Take a line AD , which will be the diameter of a circle with center B . Draw other circles with center B , dividing the line BA into many parts. Take compasses extended to the semi-diameter BA and draw an arc with center A , cutting the circle at a point G . Then a ray LG coming in parallel to AB will be reflected towards B because the angle LGA equals GAB which equals BGA , since triangle ABG has equal sides. Repeat this for the other parts: for each point C on AB , draw an arc with center C and semi-diameter AB to cut the circle with center B through C at the point H . Join the points GH and all the other points to form the section.

Now I shall speak of burning glasses by refraction. One can say the same things as for reflecting glasses. A cylindrical glass will kindle fire in a line, a pyramidal glass also, but better is a crystal sphere. It is wonderful to do it with a round vial of water, thereby getting fire from cold water. Best of all is a crystal parabolic glass, which can light a fire even far away.

One can make many faces appear in a glass. Make a hollow glass a little concave with a foil laid on it. Thus a man looking at it will see an upright image of something else, but catching at it finds nothing but air. Also, take thirty glass plates, a foot and a half long, two fingers wide, a third of a finger thick but tapering to a sharp edge. Place them together in such a way that they stand together in a circle. Paint a picture carefully in such a way that only by reflection in the mirror can one see it. I have described how to do this

in my Optics. Place them in a table and put a mirror on top of it such that when someone comes to see his reflection he sees another thing that is nowhere visible.

How spectacle glasses are made: Glass balls of diameter a foot are made in Germany, cut into small circles and brought to Venice. Here they are melted into spherical molds to make convex lenses. To make a concave lens, white powder called *saldame* is strewn on a large polished cannon ball and the glass is softened on it to take its shape; this repeated on both sides. More polishing is needed to make it into a perfect glass.

Now I'll write about how mirrors are made. First they take melted glass and blast it into an empty cylinder; they open it with tongs onto a flat iron plate, and reheat it to take its shape. After it cools, they sprinkle white sand, and rub it with water until it is perfectly flat on both sides. The artisan then makes a tin foil of the same size as thin and flat as he can. He wipes it with quicksilver, applies a white paper on it, and quickly sets it on the clean glass, pressing the glass and removing the paper at the same time; he leaves it with a weight on the glass for some hours until the foil binds fast to it. To apply a foil to a concave glass is harder. It is laid slowly on the convex side to take its shape, and a moist gypsum is formed around it; when it hardens, wipe it with quicksilver, put paper on it, then press on the glass, taking away the paper.

Metal mirrors are made another way. Draw a parabolic line on a brass table; file away the outer part. Turn it upon an axis to form the concave shape out of clay. When it is dry, sprinkle a layer of ash on it and apply another layer of clay on top of it. After hardening, the layers will part because of the ashes. In a pot, melt 2lb of tartar and white arsenic, then 50lb of brass and 25lb of English pewter, and finally 2oz of borax. Pour it in the space between the forms and let it cool. Finally rub it with pumice and emeral powder until it is perfectly polished. Make it bright with burnt tin.

Book XVIII Experiments on Things Heavy and Light

Heavy are those objects that descend, and heavier when they descend quicker. Light are those that ascend, and lighter that ascend quicker. Vacuum is more abhorred by nature than anything else. Water, normally heavy, will not flow out of a glass vessel turned upside down on water. It cannot do so because the water beneath is at least as heavy, and there cannot remain a vacuum in the vessel. But if it is possible for air to come in, it would replace the heavier water. Wine on top of water will also not flow down, because it is lighter. Hence the trick of dripping wine to float on water; and the other one where to cool a vial of wine it is placed upside down in cold water. Also, why they first pour wine, then water, so they mingle well.

Let there be a cup like a tunnel, with a broad mouth and narrowing like a cone, joined to a glass ball by a narrow mouth. Pour in water until the ball is filled, then add wine slowly so it floats on top. Give it to a friend: he shall taste nothing but water. If he challenges you to drink with him, pour first wine

in your cup then water; hold him with talk until the water sinks down. Hence it is that when wine vessels are placed in cool water, the smallest chink in the stopper allows the water to drive out the wine.

Let a vessel of water be placed upside down in red wine. The two liquids replace each other without mixing. Hence how to part water from wine sold by deceitful country people: estimate how much wine is in the vessel, then bring another vessel with a small mouth filled with this much water and submerge its mouth in the wine. The water will sink down and the wine will ascend. If the taste of what remains is very watery then the wine was mixed.

Another way: make a vessel out of ivy wood, which is porous. Pour in wine with water and the water will drain out, leaving the more corpulent wine in. This is contrary to what the ancients wrote. They also write of another test: apply a sponge dipped in oil and incline the wine bottle; if there is any water it will come out.

Place a linen tongue dipped in the wine and hanging outside it. The red wine ascends the tongue, bringing along the water after it. Vintners say the contrary, though.

To see whether light matter is mixed with heavy. As Archimedes had written, an object floats on top of water by as much as it is lighter, so vessels sink in rivers more than in the sea, by reason of their salt. Hence an apple (or some use a locust) sinks in good wine but it will float in wine mixed with water. But new wine is thicker than water because its dregs have not sunk yet. A question arises whether, when wine is pressed, it is the top half or the bottom half that is better. It is clear that the lighter wine comes out first, and the second half contains more water, unless the wine is run out from the bottom.

There are other ways to part wine from water, for example by distillation. The spirit of wine will rise before the water. Another way is to place the wine in a glass vial and freeze it. If the wine is pure, it will take longer to freeze; and as it warms, the wine melts first and so can be parted; you can thus estimate how much water has been added.

To detect whether a metal is mixed with others, such as gold in brass. Archimedes cried Eureka when he found how to do it: he made equal weights of gold and silver, placed them in water and measured how much volume each displaced. Then he put in the crown and found that its volume was more than for the gold. But now we can detect even small differences. Take a perfect balance, place a pure metal on one side and the metal on the other until they balance. Now place both pans in water and they do not remain in balance. The lighter impure metal rises, because the pure metal weighs more. Bring them to a balance, and the added weight is that of the impurity. For example, a lead bullet weighing 31 oz in air, weighs 27 in water; Turkish ducat gold weighs 34 in air, 32 in water; French crown gold 67 in air, 60 in water.

Book XIX Wind Instruments

I have read that there are brass statues which sound a great trumpet blast during violent winds. Albertus Magnus is said to have made a head that speaks by magic arts, but I don't believe this. Only impostors and mountebanks make believe in these things. Sound does not travel instantaneously. The flame of a gun a mile away is seen minutes before the noise is heard. Echoes are the rebound of sound off a wall. Perhaps if a sound is trapped in a pipe, then when the mouth of the statue is opened, the voice may be heard. I shall try this out.

In Nero's time there were water instruments, but of what type no one knows. I have tried to make one by mixing water with air but it makes a warbling sound without a tune. A better way is to have an organ with pipes leading to a chest half full of water with air blown in by bellows; when the keys are depressed, the air comes out in a wind to make a pleasant sound.

Boil a little water in a glass vessel with a long neck; place the neck in water and presently it will suck all the water in. Some say that this is how water is drawn up mountains to form streams. Put water in a brass sphere that has a small hole; when it is boiled, it will blow strongly through the hole. Fill a conical vessel a third full with water, then blow air in as hard as you can; before you remove your mouth, incline the glass so the water stops the air, then aim it away from you and the rarified air will push the water into a fountain. You can heat the air for a better effect. Drunkards make a tiny hole at the bottom of a casket, then blow hard into it so it comes gushing out. How to make water rise to the top of a tower: make a lead pipe that goes all the way up to a sealed vessel, then out from the bottom all the way down; one end is placed in water, the other end is placed lower into a vessel, which should be filled with water and stopped perfectly that no air enters. When the tower vessel's lower hole is turned on, its water will run out but will suck up as much water. Another way is to have a brass vessel at the top of the tower with a pipe going down; heat the vessel and let the air run out; then as it cools at night, the water rises to fill the vacuity.

To make a water dial, take an inverted glass with a tiny hole at the top and a vertical ruler fixed to it, and place it in an earthen vessel full of water, so that as it very slowly sinks down, it will mark the time. To reset it, fill it with air using a bent pipe. Alternatively, place the vessel in water and suck out the air through the hole; as the water slowly descends, its surface will mark the time.

How to make a fountain of water by compressed air: Pass a pipe through a hole in the top of a sealed vessel almost to the bottom; the upper surface should be like of a drum. A second short pipe should pass through the drum, with an end covered with leather valve such that air can go in but not out. Pour in water through the first pipe and close it, then blow air hard into the second pipe and close it; when the first pipe is opened a fountain of water will fly up all by itself without force. How to fire a bullet without fire: Take a smooth handgun and push in a piston that no air comes out; put in a bullet; when you let go of the stick, the air casts out the bullet and stick alike. Join together a pewter vessel with a conical vessel such that its end is close to the bottom of

the pewter vessel. Fill the bottom with water up to the top, yet the rest of the pewter vessel is filled with compressed air. Then when a man drinks from it, it will spurt out the liquid into his face. How to make a bottle that no one can drink from it except the owner. Make a metal bottle, full of large holes down to the middle; make also a pipe from the bottom up through the handle to a small secret hole at the top near the brim. Under the handle make a second secret hole that can easily be stopped by a finger. Pour water in the vessel. Whoever tries to drink cannot because of the holes; you can drink by closing the lower hole and sucking through the other. If the other man tries to suck he cannot.

How to make freezing gusts of wind in a room: Make a deep pit with a pipe running up from it through the walls into the room, and with a tunnel coming from a source of running water. When the water is let in to fill the pit, the air comes gushing out into the room. In Rome I saw a cellar closed on all sides, such that when a quantity of water is poured in, the air comes out of a little hole with such violence that it will serve as bellows for furnaces.

Book XX Miscellaneous Experiments

How to make seawater potable, for example on long sea voyages or on islands where there is little water, such as Malta. Aristotle says that sea water is salty because the sun draws out earthly exhalations to the surface where they are burnt to salt. Streams are fresh because only the hotter parts of seawater rise, strained, to the top of mountains. Fill a hollow long-necked vessel with seawater; boil it and gather the dew that forms in the neck into a receiver. Every 3lb of sea water gives 2lb of fresh. Do not use a lead alembic because Galen says that its water will excoriate the intestines. At sea, one can hang fleeces of wool to absorb the sea water, then press the sweet water out of them. Another way: Fill great vessels with earth, one on top of another; pour sea water on top, that it drains to the lower. I tried this with ten vessels, but the salt remained. Perhaps one needs to use clay or fine sand. Aristotle made an experiment where he took a hollow vessel of wax and dipped it in the sea; it filled with fresh water. But I have tried this with fine clay and found salt water inside. Even ivy wood, that can separate wine from water, cannot part salt from it. Aristotle gives another way: boil salt water then cool it again; it will be less salty because part of the salt is left at the bottom. But I tried this and found that the water is yet more salty. If water breeds worms, cast in quicklime or gypsum, and they will die.

One can also make water from air, as nature does. We see how dew forms on cold vessels or windows. So take a large brass vessel, fill it with saltpeter and ice, and plentiful drops of water can be gathered.

How to disguise your face: Spies working for great men have a need to remain unrecognised. We start with dyeing the flesh. For a temporary change, steep walnut shells and pomegranates in vinegar for four days, press them, and dye the face to make it black. Oil of honey makes it yellow, brimstone fumes give a sickly discoloration. For a longer period, use water of depart made from

salt peter and vitriol, first applied to silver. We have spoken before about dyeing the hair. An unguent made of orpiment and quicklime will make a bald patch; if it is applied to the eyebrows, the face will change completely. To grow more hair, use water of honey with horse fat. To make scars, apply caustic herbs or bee stings, or milk of tithymal, water of cantharides; boiled turbith causes swelling, but especially yew powder.

If a trochite stone or alabaster or the colored Lowsie stone is placed on a plain stone and vinegar is poured on it, it will move and tumble by itself. Probably vapors try to come out but are held by the stones.

An instrument to hear men from miles away. For inspiration, we must search for fearful animals, such as the hare and deer. They have large ears facing the front. Hence take a large open conical instrument made of ivy wood placed at the ear.

How wicked men mingle water with oil without detection: They use water from wood or gum traganth, leaving them in water for two days. Silk is made to weigh more by leaving it in steam or wetted with honey water. Honey, similarly, is augmented with meal of millet chestnuts. Wax has bean meal added. Soap can be added with ashes of oxen bones. Fake pepper is mixed with dry juniper berries, or black vetches. Placing a vessel of water in wheat will increase its weight.

All living things are charmed by music, from dolphins to swans, as many Greek legends attest. A harp made with strings of the antagonists sheep and wolves, is not musical. Horses will run away if they hear drums made of their enemies' skin – elephant, camel, or wolf. Contrariwise, I've heard that bears have been driven away by drums of horses' skin. Flutes are said to pacify Libyan horses. Fiddles made of viper strings will cause miscarriage in women. Poplar instruments cure sciatica, and vine cures the plague; juniper wood defends against viper venom. Music can make you sleepy or wakeful. Try this: take two similar strings; if one is struck, the other answers. A deaf person may hear sound by biting the instrument tight. A strong wind makes harps and flutes play the most pleasant music.

How impostors feign to discover treasures using forked or dowsing rods. The way they hold them makes them appear as if they are free to rotate by a supposed attraction, but a small tremble in their hands is enough to control them. A paper trick: take three scrolls of paper, of increasing length; when the longest is in the middle standing up on a table, and then they are turned about, the shortest changes place with the middle paper without being touched. Another trick by impostors involves money that turns about; what is used is an ear of oats that twists when wet. To discover theft, some put dry powder into bread and whoever is so stricken by fear that he cannot eat it is the thief; or they write the suspects' names on paper and cover them with clay, so that when placed in water the first one that opens up and releases the floating paper is the thief; but this all depends on how tight the clay is bound. The mullens tree [hybiscus] has an amazing trick: if you shake it in the morning all its flowers fall down. More trickery: They set a lamp with hare's fat, light it up and mumble some words, upon which the women cast off their clothes and start dancing

all naked. This must be some maddening effect of the fat. Another conjuring trick is to stick an awl into a cock's head then remove it and it is as if nothing happened. I checked this and found that if you do it exactly in the middle of the head, the point goes through the middle between the two parts of the brain and it is not hurt.

To make bystanders as black as Ethiopians at night, put cutles ink into your lamps. If green copperas powder is added, it makes them green. To make them pale, boil some old wine with salt on coals, and light the fumes that come out; one can also burn brimstone for the same effect.

How to make the Flying Dragon: Make a rectangle of reeds in the proportion 2 is to 1, with two diameters on the opposite parts. Bind with a string and join with two others from the head of the engine, and cover with paper. On a slightly windy day, let go from a tower. Some place a lantern in it to light the night, others put in gunpowder lit by a fuse, yet others bind a cat to hear it cry. Some have tried themselves to fly this way.

Reference:

http://www.mindserpent.com/American_History/books/Porta/jportah.html