Note that Celsus always speaks of bleeding *venae;* he still has in mind that arteries contain air.[179]

Bleeding and inflammation in a wound, in the mind of a modern surgeon, are about as unrelated as leak and a fire on board, in the mind of a skipper; but the Greeks, obsessed with the notion that blood is attracted around the wound and causes inflammation, felt that bleeding *protected* the wound against inflammation. If one remembers this, the following passage of Celsus becomes understandable:

> Against bleeding there is help in the foregoing measures; but against inflammation it lies simply in the bleeding itself. Inflammation is to be feared when a bone is injured or sinew or cartilage or muscle, or whenever there is little outflow of blood compared to the wound. Therefore, in such cases, it will not be desirable to suppress the bleeding early, but to let blood flow as long as it is safe; so that if there seems too little bleeding, blood should be let from the arm as well, at any rate when the patient is young and robust and used to exercise, and much more so when a drinking bout has preceded the wound [*back to the awful practice of bleeding the wounded*].
>
> Now, when bleeding has been suppressed if excessive, or encouraged when not enough has escaped of itself, then by far the best thing is for the wound to become agglutinated.[180]

In other words: once the wound has bled, let it heal (rather than keeping it open to let the bad humors drain out). This wiser choice is stated much more emphatically than in the Hippocratic books.

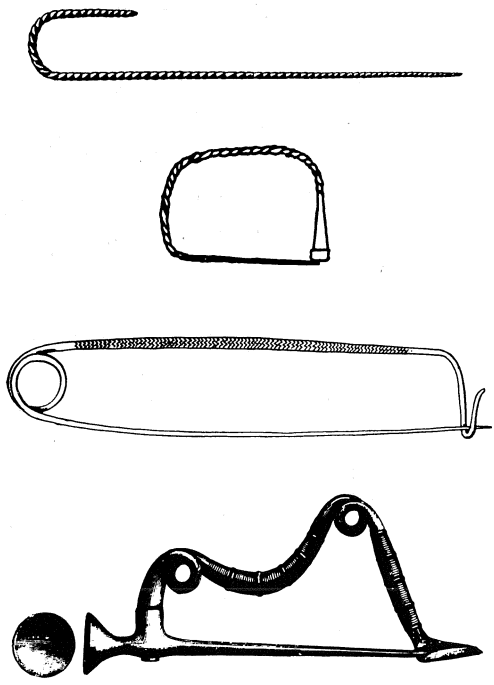
Celsus on Closing Wounds

To close a wound, "there are two treatments. For if the wound is in a soft part, it should be stitched up, and particularly when the cut is in the tip of the ear or the point of the nose or forehead or cheek or eyelid or lip or the skin over the throat or abdomen."[181] Stitching has become much more commonplace. As in Greece, it is recommended mostly for the face. For very fine work, as on the eyelids, Celsus recommends the hair of a woman[182]—a method that has only just died away: the last Deaconess sister to provide her hair for corneal sutures still works at the University Eye Clinic in Geneva (her hair is no longer requested, but I understand that it served the purpose quite well[183]).

Celsus continues:

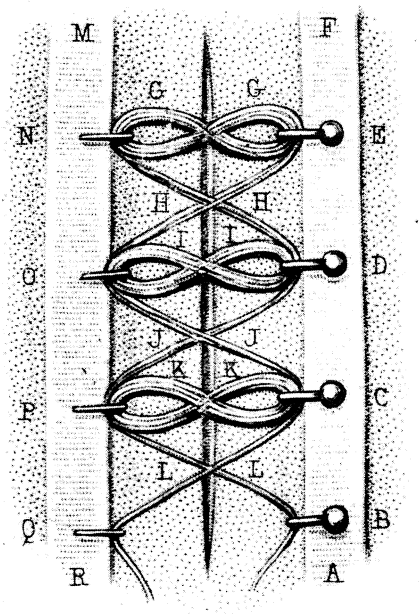
> But if the wound is in the flesh, and gapes, and its margins are not easily drawn together, then stitching is unsuitable; fibulae (the Greeks call them *anctéres*) are then to be inserted, which draw together the margins to some extent and so render the subsequent scar less broad.[184]

Closing wounds with metal pins, *fibulae,* must have been introduced sometime during the four hundred years since Hippocrates—a rather late development, since the method is used among primitive peoples. The very fact that Celsus feels compelled to quote the technical name of *ancteres* points to a



9.21 Stages in the evolution from pin to safety pin (from top). All these shapes were called *fibulae* in Latin. Greek and Mycenaean specimens.

9.22 The simplest fibulae were nothing but small skewers. For surgical sutures they were used essentially as shown here; the tips were snipped off for safety. From a French manual of 1858.



9.23 The same principle as used by Ambroise Paré in 1564 to close a harelip. Here a threaded needle serves as fibula (see detail).

Greek or Alexandrian import, and a useful one too. Fibulae as clothespins must be as old as clothes.[185] In classical Greece and Rome they had evolved to complex safety pins, but these seem to have stayed out of surgery except for fixing the ends of a bandage (Fig. 9.21). Those used for sutures were the simplest, being essentially small skewers (Fig. 9.22), and lasted until recently for the correction of harelip, another facial operation (Fig. 9.23).

Now from the above it can be gathered also whether flesh which is hanging free at one part and attached at another,—if it is still capable of juncture,—demands suture or fibula. But neither of these should be inserted until the interior of the wound has been cleansed, lest some blood-clot be left in it. For blood clot turns into pus [*Celsus really knows his Hippocrates*] and excites inflammation, and prevents agglutination of the wound. Not even lint which has been inserted to arrest bleeding should be left in, for this also inflames the wound [*tweezers handy for picking out foreign bodies came in a variety of shapes; Fig. 9.24*]. The suture or fibula should take up, not only skin but also some of the underlying flesh, where there is any . . . Neither procedure needs any force . . . Generally . . . fibulae leave the wound wider open, a suture joins the margins together, but these should not be brought actually into contact throughout the whole length of the wound, in order that there may be an outlet for any humour collecting within [*this is surgical drainage in its simplest form, already hinted in the Egyptian papyri; the Hippocratic idea of a tin tube apparently failed to catch on*]. If any wound admits of neither of these[*suture or fibula*] it should none the less be cleaned. Hence, upon every wound there is to be applied, first a sponge squeezed out of vinegar; or out of wine if the patient cannot bear the strength of vinegar.[186]

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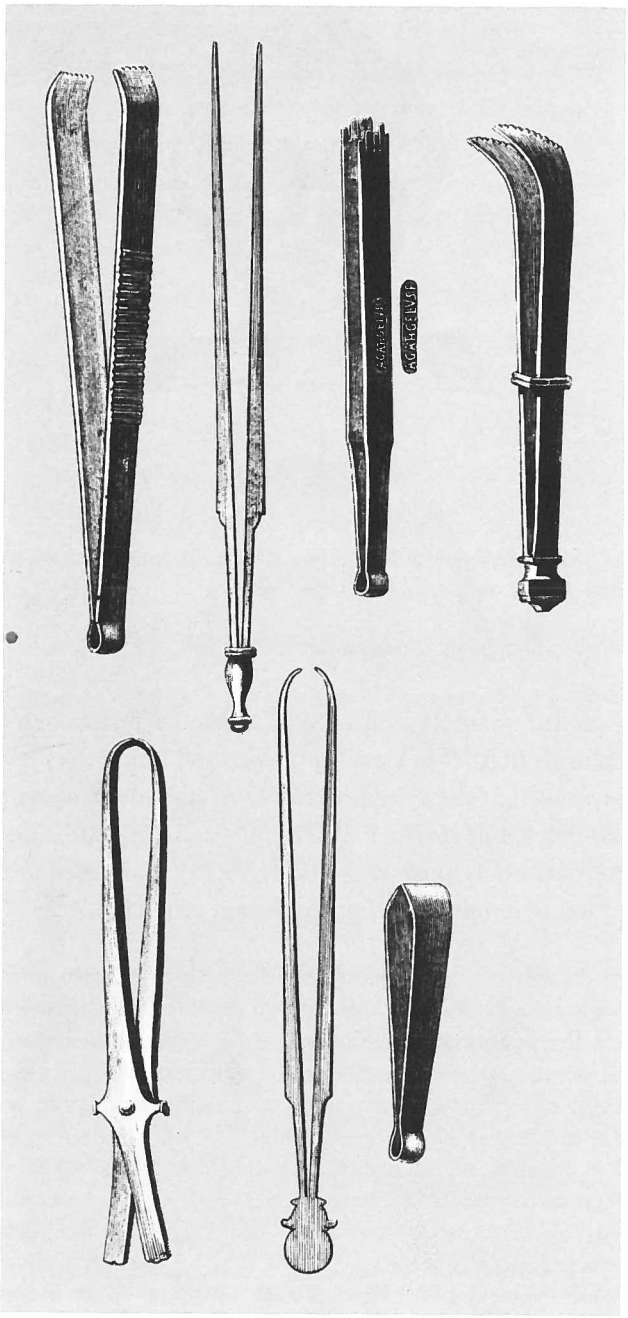
Vinegar is very painful indeed. The closing comment is beautifully chosen: *"And a wound can be treated without foreign and far-fetched and complicated medicaments."*



9.24 Various kinds of tweezers found at Pompeii and Herculaneum. One is marked AGATH[AN]GELUS F[ECIT], "made by Agathangelus"—a Greek name.

To judge from the number of ancient wound-plasters, few were those who appreciated this great truth; it should have been engraved in marble, in the verses of Ovid:

> Curando fieri quaedam majora videmus
> vulnera, quae melius non tetigisse fuerit
>
> We see wounds grow larger by being treated,
> Which would have done better untouched.[187]

The text just quoted continues, for the sake of those who prefer aggressive treatments: "But if any one has not confidence in this treatment, a medicament should be put on, which has no suet in its composition, chosen from those which I have stated to be suitable for bleeding wounds [*the Greek enhemes*] and especially, if it is a flesh wound, the composition called barbarum."[188]

Here is the formula for barbarum, in metric equivalents:[189]

Copper acetate (*scraped verdigris*)	48 gm	Mix with	oil	250 cc
Lead oxide (*litharge*)	80 "			
Alum	4 "			
Dried pitch	4 "		vinegar	250 cc
Dried pine resin	4 "			

Mixed in my laboratory, these ingredients gave a murky, brownish lotion. No need for tests to recognize it as an antiseptic.

This is no accident: Celsus prescribes antiseptics with unmistakable purpose. For wounds he has a list of thirty-four plasters and ointments, all but five of which contain heavy doses of lead and copper salts, and those five, according to Celsus, are especially meant to produce pus.[190] Alum, mercury, and antimony sulphides are also used; the main excipients are resins, pitch, bitumen, wax, oil, and vinegar; and the doses of antiseptic salts are generous indeed, up to ½ or ⅔ of the mixture. An example:

Lead acetate (*cerussa*)	equal parts[191]
Lead oxide (*litharge*)	
Antimony sulphide (*stibium*)	
Wax	
Suet	

With this we reach the height of antiseptic treatment in antiquity—though not without danger, because antiseptics like mercury and lead salts are also anti-people; and Celsus knew it. He gives an "antidote" for poisoning with *cerussa*, lead acetate.[192] And Pliny says of cinnabar (mercuric sulphide) and red-lead (lead carbonate) that, as they are "admitted to be poisons, all the current instructions on employment for medicinal purposes are in my opinion decidedly risky."[193]

Although the amount of lead absorbed through a wound may have been relatively small, the hazard of saturnism was great for the Romans, because they took in lead from several other sources.[194] If they could afford running water, they drank the lead of their plumbing; they definitely sipped it with their wine. A current wine preservative was made with must, which Columella recommends to boil in leaden vessels, because "brazen vessels throw off copper-rust and spoil the flavor."[195] Pliny agrees.[196] More danger came from cosmetics: ladies smeared lead-white on their faces and dusted it onto their hair.[197]

The use of metallic compounds—including rust—on wounds was featured in the myth, popular in Pliny's days, of Achilles treating the wound of Telephos with scrapings from the tip of his lance, "whether he did it with a bronze or an iron spearhead"[198] (Fig. 9.25). Copper acetate (verdigris) was not as dangerous as the lead salts; it gave its green color to several wound-drugs recommended by Celsus and Pliny. An intriguing explanation for this use of copper is offered in Pliny's *Natural History:* "Copper ores and mines supply medicaments in a variety of ways; inasmuch as in their neighbourhood all kinds of ulcers are healed with the greatest rapidity."[199] I wish I knew whether this had any basis in fact. The text continues, "yet the most beneficial is *cadmea,*" which is silicate and carbonate of zinc. Zinc happens to be one of the latest fashions in wound treatment,[200] but it seems that the beneficial effect, if any, is quite small.[201]

For myself, I would probably choose the antiseptic dressing that Celsus recommends for cleansing old sores: *tincta in melle linamenta.*[202] Readers not familiar with Latin will be proud to recognize this wound dressing if I translate it into Egyptian hieroglyphs:

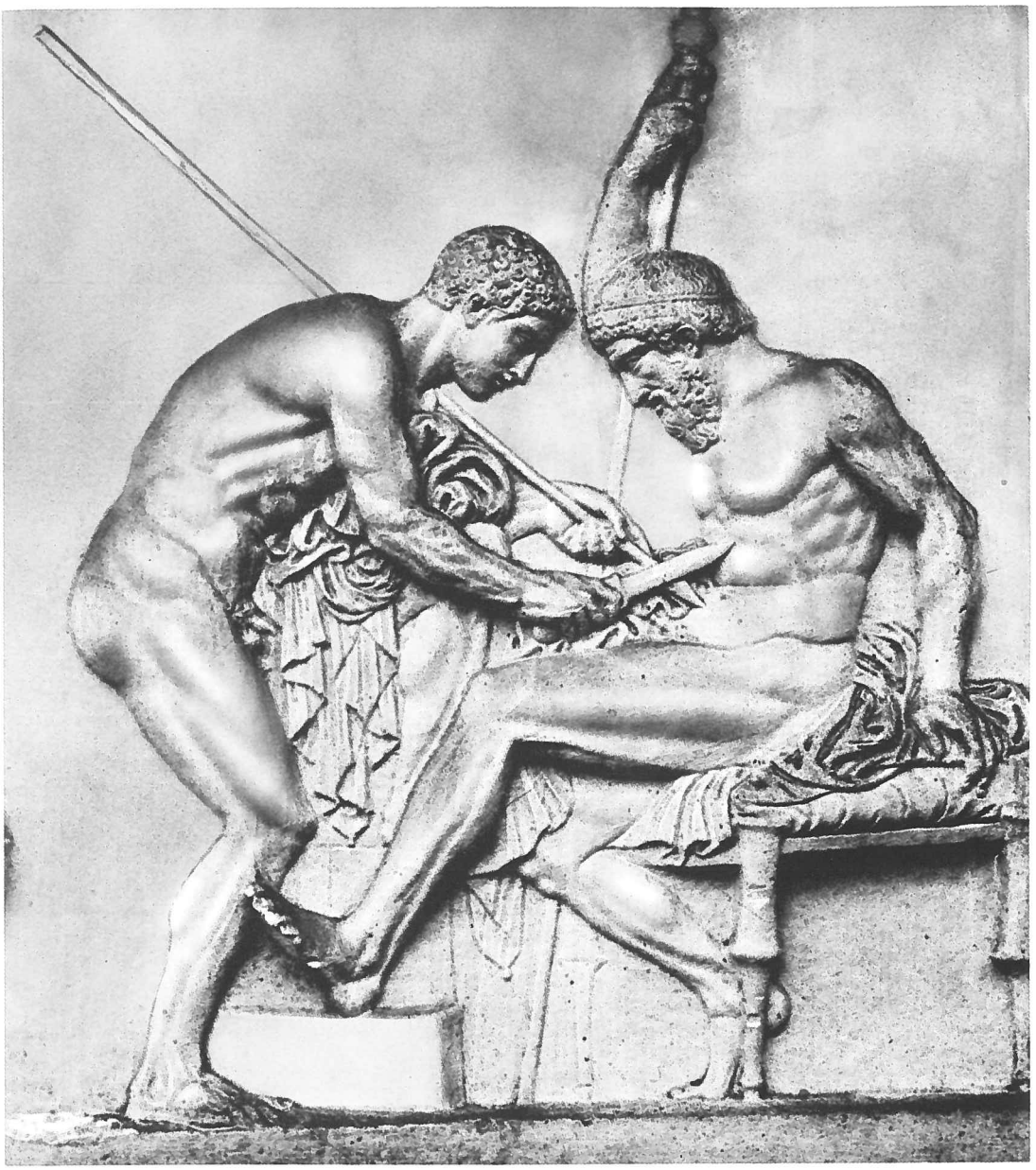
byt and *ftt,* honey and lint, here reappearing a couple of thousand years later![203]

In content as well as in form, there has been progress since Hippocrates; but the road is still long. In the crystal bowl of Celsian Latin you will be served an occasional piece of dung. The thirty-four caustics of Celsus include not only quickline, cantharides, salt, and pepper, but also salamander ash and dung of lizard, pigeon, wood-pigeon, swallow, and sheep.[204] His drugs for "closing a wound" include myrrh, white wine, and vinegar, but also eggwhite, pounded snails, and cobwebs.[205] And pain may call for poppy-tears,[206] but for headache the opium is soaked in bread—and worn like a hat.[207]

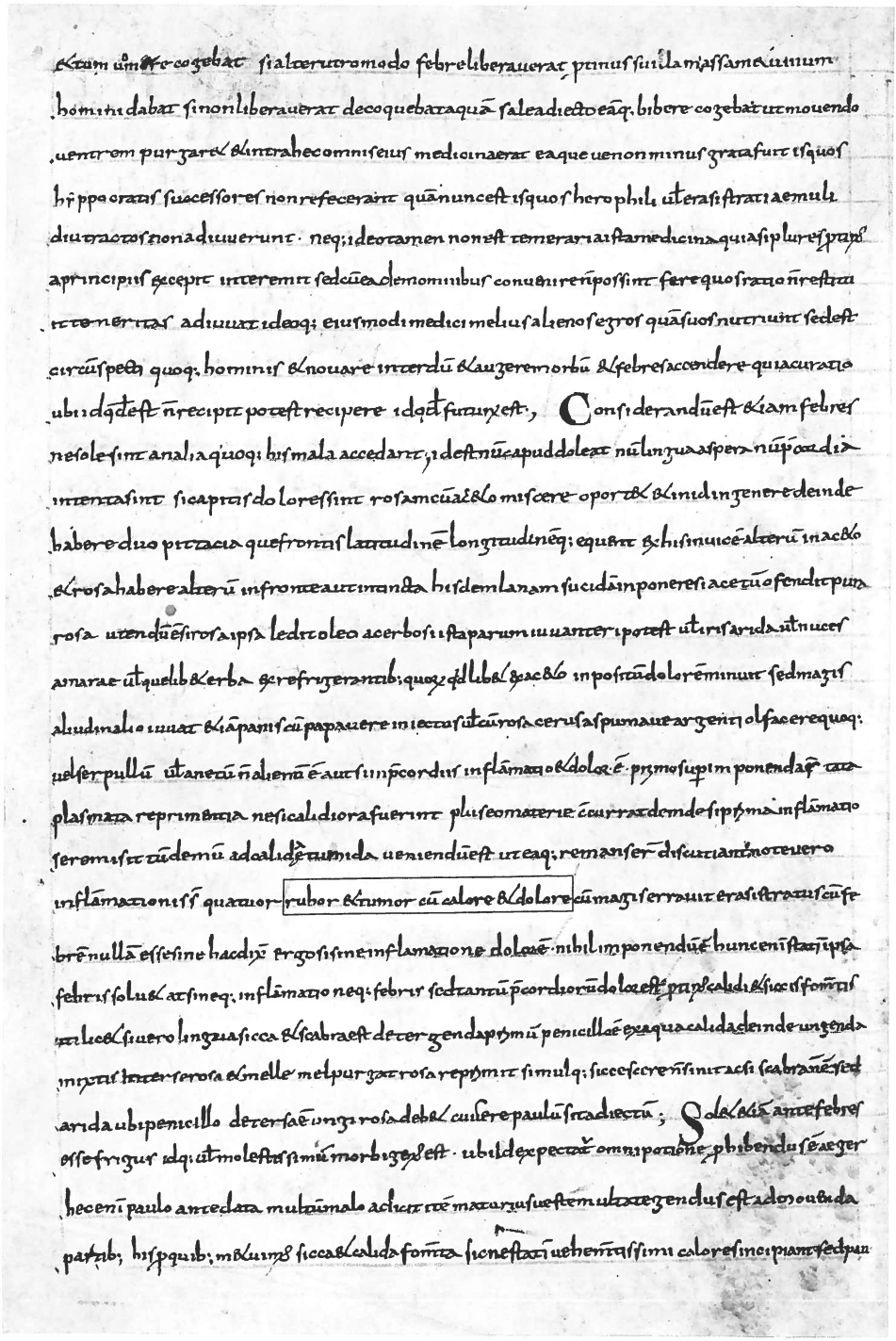
Birth of the Four Cardinal Signs

Thus far, on the subject of inflamed wounds, I have been discussing the practice of Celsus; tradition requires that I also mention his theory about inflammation—or rather his single line about it. Words for "inflammation" had existed ever since the Akkadian  *ummu* and the Egyptian  *shememet,* but nobody had ever bothered, it seems, to define its clinical symptoms. History assigned that role to Celsus.

The famous Celsian passage actually applies only to that variety of inflammation—perhaps the commonest—which is technically known as "acute" and which a layman might consider "typical" (good examples being a boil or an infected wound). Perhaps Celsus lifted his definition from some other work; perhaps he drew it out of his own pen. One thing is sure: on the day that he wrote it he was being assisted by Fortuna, the blindfolded goddess. For



9.25 Achilles treats the war-wound of Telephos with scrapings off his lance. Both "iron rust" and "bronze rust" were supposed to be good for cleansing sores. Telephos was a Mysian wounded in the thigh by Achilles on his way to Troy. The oracle predicted that the wound would not heal except by the lance of Achilles; hence the reconciliation. Rust was recommended for sores much as was verdigris. Pliny agrees but finds it strange that iron should be good for wounds, since "it is with iron that wounds are chiefly made." Pliny could actually have seen this bas-relief, which was buried in Herculaneum in 79 A.D.



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9.26 In tenth century handwriting, the page of *De medicina* that mentions the four cardinal signs of inflammation (box).

he buried it in a paragraph that I find singularly obscure, I daresay un-Celsian (Fig. 9.26):

> But if there is inflammation and pain in the chest, the first thing is to apply to it repressing plasters, lest more diseased matter should gather there, if hotter ones were

applied; next, when the primary inflammation has subsided, and not before, we must go on to hot and moist plasters, in order to disperse what remains of the matter. Now the signs of an inflammation are four: redness and swelling with heat and pain. Over this Erasistratus greatly erred, when he said that no fever occurred apart from inflammation. Therefore if there is pain without inflammation, nothing is to be put on: for the actual fever at once will dissolve the pain. But if there is neither inflammation nor fever, but just pain in the chest, it is allowable to use hot and dry foments from the first.[208]

"Redness and swelling with heat and pain:" if there is one item of information common to all medical students alive (at least in the so-called West), it is that the signs of acute inflammation are four: *rubor et tumor cum calore et dolore* (Fig. 9.27). Deservedly so, for it would be difficult to improve on these four "cardinal signs," which evoke so succinctly the clinical picture.

Notice that Celsus, despite pages and pages on inflamed wounds, slips in his great definition in a context that nowadays seems entirely irrelevant: he is discussing a disease that causes pain *inside the chest,* presumably pleuritis. No modern medical writer would dream of using this as an example of disease that causes a visible inflammation of the skin. But things were different before the advent of antibiotics: pus that had accumulated in the pleural cavity could "come to a head" through the skin (hence the Greek operation for empyema). This is the course of events that Celsus must have in mind when he mentions "repressing plasters" to prevent matter from "gathering" in the skin, in cases of chest pain.

Whatever Celsus had in mind, posterity swept away the fog, rescued the line, and raised it to the status of a medical slogan. Quite a success for Celsus the encyclopedist, who may have been no more a physician than he was a beekeeper, a general, or a grammarian.

I would propose for second prize another beautiful Celsian definition. Granted that *rubor, tumor, calor, dolor* are the signs of acute inflammation, what is the meaning of *acute?* Medical students today learn that it implies a quick pace; the Oxford dictionary says "coming sharply to a crisis" (be it a good or bad crisis). When Celsus says *acutus,* he means exactly the same. He

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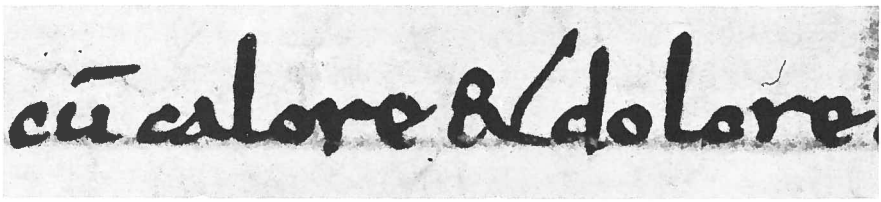


9.27 Detail: RUBOR ET TUMOR CUM CALORE ET DOLORE, "redness and swelling with heat and pain."

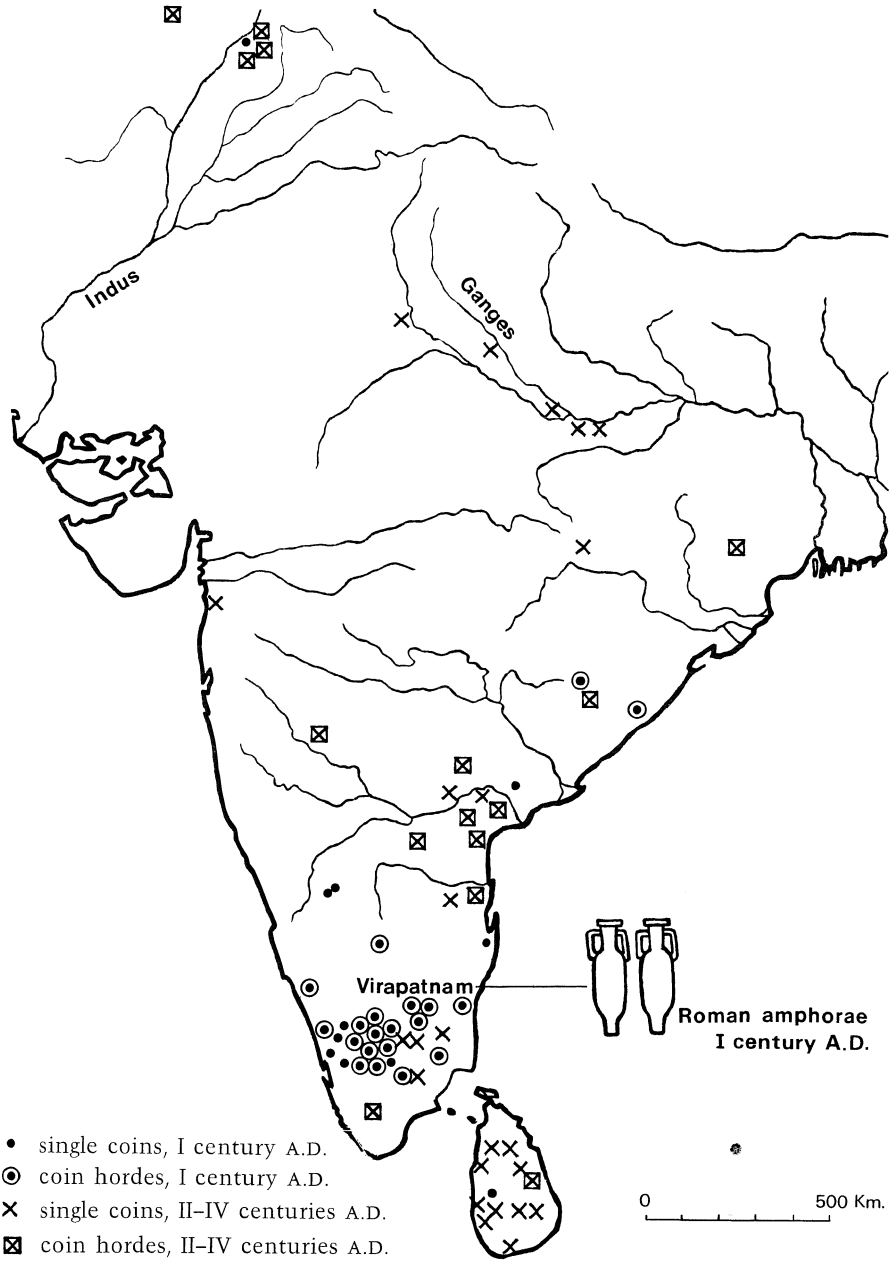
explains the condition with classic elegance but in more concrete terms: acute diseases are those that *cito vel tollunt hominem, vel ipsi cito finiuntur*—"either finish the man quickly, or finish quickly themselves."[209]

Rome's Debt to Indian Medicine

Historical clichés do make life easier, at least for the historian. One of them is to brush off Roman medicine, Celsus and all, as a product of Greek thought. I will submit that this is grossly unfair, at least to the Hindus.

Consider that while Celsus was buying up new scrolls of papyrus for his *De medicina*, or maybe a couple of generations later while Pliny was gazing at the mushroom cloud of Vesuvius, Charaka in India was revising the ancient medical treatise of Agnivesa. Buddha's message had already rung for six hundred years; India had long since shrugged off the Persian and then the short-lived Greek rule; the great Mauryan Empire had come and gone, leaving Ashoka but a memory; and waves of invaders had since poured into the plains through the same old gaps in the northwest. But in the meantime, communication with the Mediterranean world had grown to an established trade. All over the Indian peninsula, local merchants—following the ancient Indian custom of burying treasure[210]—were looking for places to hoard their Roman gold and silver coins (Fig. 9.28). No longer was there anything unusual about the gentleman in Virapatnam who treated his guests to Tuscan wine (bits of his amphorae are there to prove it[211]), or about the Pompeian gentleman who drilled a hole in the head of a little Indian statue, perhaps to make a handle for his wife's mirror (Fig. 9.29).[212] Pliny himself shows how close India had become when he describes it as a huge country, covering "one third of the entire surface of the earth," and extremely populous, the Indians being "almost the only race that has never migrated from its own territory." Its people were known to be "divided into many classes . . . there is a fifth class of persons devoted to wisdom, which is held in high honour . . . and almost elevated into a religion."[213] India was also teaming with marvels, most of them legendary, like the people of the umbrella-foot tribe, who in hot weather lay down on their backs, enjoying the shade of their huge feet; or the Imavi Mountains (the Himalayas), inhabited by people unable to breathe in another climate.[214] But some marvels were true, like the wool that grew on trees (cotton), or the fish that crawled out of the rivers (*Anabas scandens* does exactly that).[215]

The average Roman had more contact with India than does the average Italian nowadays with, say, Canada or Peru. The use of Indian pepper had become commonplace; there had even been attempts to import and grow the pepper plant.[216] For reasons that I do not know, segments of huge Indian bamboo canes were a common sight in Roman temples.[217] Painters used an Indian black and the beautiful purple *indigo*.[218] Wealthy Romans bought Indian pearls.[219] When they spiced their warm wine with expensive *malabathrum* they were actually using two Sanskrit words, *tamala pâtra*, "cinnamon leaves."[220] Some may have ploughed through Strabo's *Geography* far



9.28 Distribution of ancient Roman coins and amphorae found in India.

enough to reach Book 15 on India; for the adventurous who could afford to go there in person, using the newly discovered monsoons, it was advisable to have a party of archers on board, on account of the pirates.[221] Yet the trip had become common enough to warrant publication of a sort of guidebook, called *The Tour of the Indian Ocean*, written by an old salt who had obviously been there.[222]

Under these conditions, it would be strange indeed if no Indian medicine had found its way to Rome. In fact, so many *medicamenta* came from India that Pliny complains about it. Arabia and India, he writes, are

9.29 Tucked away in a Pompeian home was Lakshmi, Indian goddess of beauty and happiness. Carved ivory, height 25cm.

9.30 Tiny pots of eye salve, labeled LYKION (misspelled at top); this is their actual size. The best lycium came from India and was very costly; hence the small capacity of the pots (bottom right). Probably from Taranto, Southern Italy.

supposed to be storehouses of remedies, and nobody looks into his own kitchen garden.[223] The reputation of these drugs was high, for even Pliny had to admit that only one commodity imported from India, myrrh, was of worse quality than that of other countries.[224] Perhaps the most popular Indian drug was *lycium*, a plant extract used especially for eye troubles.

The only medical vases of Greco-Roman times that have come down to us with a label are tiny containers of the precious *lýkion* (Fig. 9.30). There was also a Greek variety, but the best was by far the Indian.[225]

When a drug is imported, it is not only the substance but also the idea that travels. Lycium was an Indian eye medicine, and as such, it was still in use in the 1800s.[226] So here is a definite example of Indian medical practice in Celsian Rome. Of course, not all that came from India was worth the trip; lycium itself may have been perfectly dreadful for the eyes. The point I am making here is that Indian imports existed. For variety, I will now propose an example of a different sort—one that looks to me like typical imported Indian nonsense.

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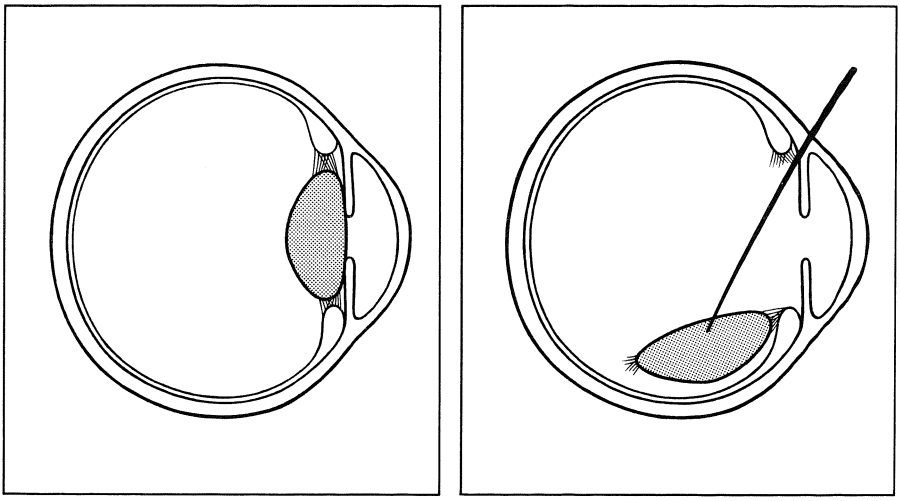
In the year 19 A.D. Germanicus, legate of Emperor Tiberius, came down in Antioch (Syria) with a mysterious illness. He was sure that he was being

slowly poisoned by his enemy Piso, legate to Syria, and he may have been right. When he died, his body was burned on the pyre, as was customary; but those who came to collect the remains found that the heart lay "intact between the bones." Suetonius, who records the event, comments: "it is said that this organ cannot be consumed by fire, when it is soaked with poison."[227] Now the tale of poisoned hearts not burning in fire is mentioned by Sushruta.[228] Most likely the Syrians knew this bit of Indian lore and passed it on to their Roman bosses, who took it seriously enough to discuss it in the trial that followed. Piso seems to have defended himself by submitting the notion (on what evidence is not reported) that *all* sick hearts resist fire, not only those that have been poisoned.[229] Once again, nonsense—but it serves to show how Indian medical ideas, good or bad, could travel across the Roman Empire.

As regards surgery, Celsus does not acknowledge any debt to the land of Buddha; we have to read between the lines. In looking among the surgical novelties since Hippocrates—significant, useful novelties—I find at least three that smack of India.

The first is the operation for cataract. "Couching the cataract" is the established term for the procedure described by Celsus. *Couching* comes from the French *coucher*, "to lay down." The purpose of this operation is to push down and out of the way the crystalline lens in the eye when it has become opaque (Fig. 9.31). This is accomplished with a needle, a lancet, or even a thorn, stabbed sideways into the edge of the cornea; the pain is reported as minimal.[230] If infection does not occur, some vision is restored—even excellent vision if the patient happens to be also extremely shortsighted.[231] It is a bold and tricky operation, which appears suddenly in Celsus.[232] Charaka remarks that there are ninety-six diseases of the eye, but he refrains from discussing them because "full descriptions are laid down in treatises of



9.31 Steps in the operation for "couching" the cataract. When the crystalline lens in the eye becomes clouded (left), the lens is tilted over with the aid of a needle inserted behind the iris (right), like a lid on a horizontal hinge, or is sometimes pushed down completely free. This was most likely an Indian invention.

surgery, together with the methods of treatment."[233] We just have to turn to the classic Hindu treatise of surgery, Sushruta's, and there are the promised descriptions; the chapter on eye diseases is at least four times as long as in *De medicina*, and the operation for cataract is given in much the same terms, including the advice to pierce the right eye with the left hand, and vice versa.[234] Of course, the priority for the discovery of cataract-couching rests, as usual, on the hazy dates of Indian history; but if my tentative dates are right, this was an Indian, not an Alexandrian discovery. Until very recently it was a part of Indian folk medicine.[235]

Another surgical advance that recalls India is plastic surgery. Of this, too, there is no hint in the Hippocratic books. The main example of plastic surgery in Celsus is a simple pattern of incisions suitable for repairing a large gap in the skin.[236] The basic idea is to carve out two pedicle flaps pointing toward each other, and then to draw them together (Fig. 9.32). This is nowhere nearly as imaginative as the Indian pedicle flap, twisted down from the forehead to make a new nose. It rather looks as if the lesson of Sushruta had not quite come through.

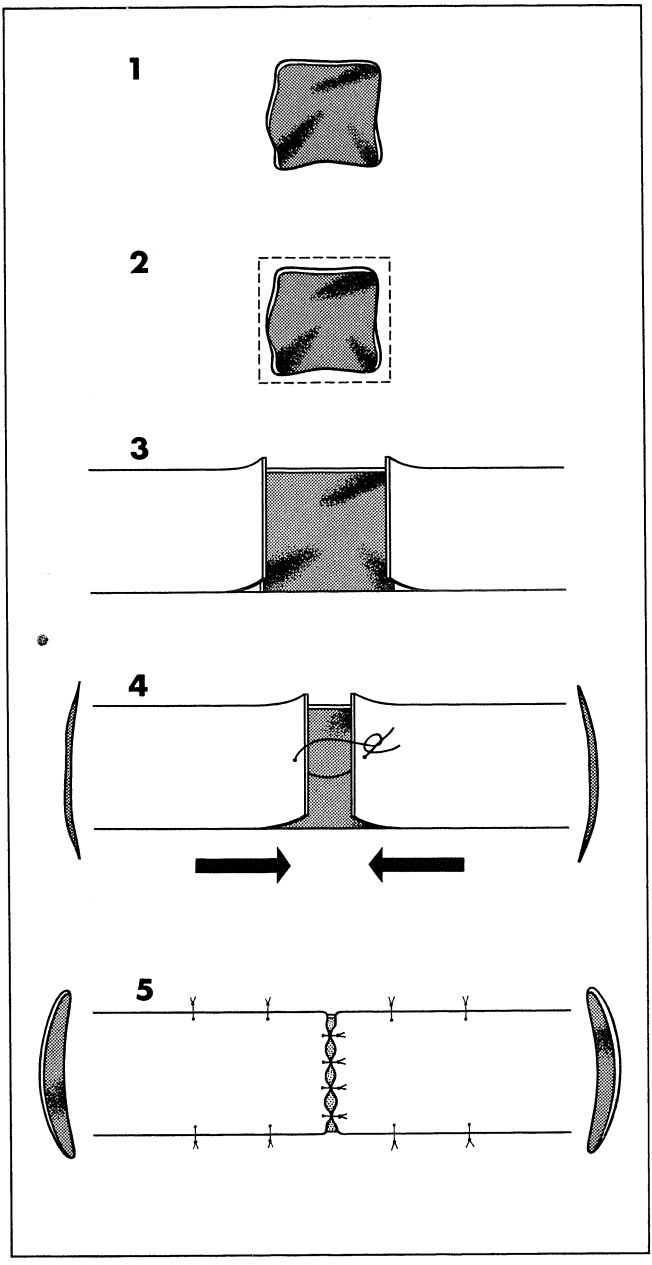
Oddly enough, Celsus also mentions two ways to handle perforated earlobes.[237] If "a man, for instance" wants to get rid of the holes, it is enough to cauterize their edges; thereafter it is easy to make them grow together. "But if the hole is enlarged, as is usually the case with those who have worn heavy ear-rings, the part of the lobule that is in excess should be incised, and the edges above should be made raw with a scalpel. Then the wound is sewn up and covered with a drug that will promote healing." The description is not too clear; I see it as in Fig. 9.33. But again it does not equal Sushruta's reconstruction of a lost earlobe.

On this subject, I was quite surprised to find men in Rome who would perforate and stretch their earlobes. It sounded so unlikely for a people of warriors. However, in searching for documents about perforated ears in antiquity,[238] and in ancient men, I came across this passage in the Old Testament:

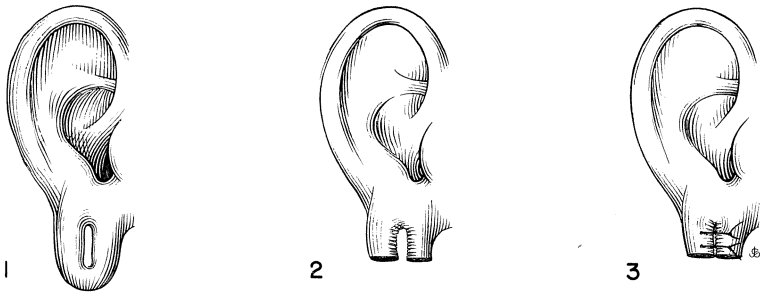
> THE LORD SAID TO MOSES, Say this to the Israelites . . . These are the laws you shall set before them:
>
> When you buy a Hebrew slave, he shall be your slave for six years, but in the seventh year he shall go free and pay nothing . . .
>
> But if the slave should say, "I love my master, my wife, and my children; I will not go free," then his master shall bring him to God: he shall bring him to the door or the door-post, and his master shall pierce his ear with an awl, and the man shall be his slave for life.[239]

Now going back to the passage of Celsus about the man with perforated ears to whom the holes suddenly "become offensive" (*offendunt*), I believe I can piece together a human drama: not the story of a vain young man who wants to keep pace with fashion, but that of a slave become a freedman, who wants to erase the physical traces of his past.

Surgical operations of this kind were not unknown in Rome during the



9.32 The method of plastic surgery described by Celsus for covering a large gap in the skin. (1) A skin lesion that needs to be remedied, such as a sore which refuses to heal. (2) The edge of the sore is cut out so as to leave a regular square. (3) The upper and lower cuts are prolonged horizontally, so as to define two flaps, which are dissected free and lifted. (4) The flaps are drawn together; if stretching is excessive, a curved cut is made at the root of each flap. (5) Flaps are sewn in final position.



9.33 The method described by Celsus for closing up a hole in an earlobe, for people who "change their mind." This is real plastic surgery, although not as advanced as that of the Indians (Fig. 7.22). (1) An earlobe with a large hole. (2) The lobe is cut shorter and the stumps are scraped raw. (3) They are sewed together.

first century A.D. Martial mentions a certain Cinna, a barber, who was an expert in removing brand-marks from ex-slaves, a practice already mentioned in Hammurabi's Code eighteen centuries earlier (p. 43, law 226).[240] Plastic surgery and psychology are allies of old.

The third surgical novelty in Celsus—not mentioned in the Hippocratic books, but treated extensively in both Hindu classics—is the treatment for snake bite. Celsus says:

> The ancients had very various methods . . . for each kind of snake . . . but in all it is the same measures which are most efficacious. Therefore first the limb is to be constricted above this kind of wound, but not too tightly, lest it become numbed; next, the poison is to be drawn out. A cup does this best. But it is not amiss beforehand to make incisions with a scalpel around the wound, in order that more of the vitiated blood may be extracted. If there is no cup at hand . . . a man must be got to suck the wound. I declare there is no particular science in those people who are called Psylli, but a boldness confirmed by experience. For serpent's poison, like certain hunter's poisons, such as the Gauls in particular use, does no harm when swallowed, but only in a wound . . . Anyone, therefore, who follows the example of the Psylli and sucks out the wound, will himself be safe, and will promote the safety of the patient. He must see to it, however, beforehand that he has no sore place on his gums or palate or other parts of the mouth.[241]

The Psylli were an African people with a reputation as snake charmers.[242] Celsus quotes them in relation to the sucking technique, but he does not indicate where he learned about the ligature. Certainly not from Hippocrates; I suspect from India, where snake bite was a daily concern.[243]

Celsus mentions India only in passing, as a source of nard.[244] He probably did not realize that some of his *medicina* was Indian.

Roman Army Hospitals

It is high time to visit the Roman army and see how it dealt with casualties. In the heroic days of the forefathers, when regular doctors were not yet around (let alone hospitals), Rome had a very practical way of dealing with wounded soldiers. Livy tells that in 480 B.C., after a victory over the Etruscans, the consul Manlius, remembering "that policy which he had adopted in the

beginnings of his consulship, of winning the affections of the plebs . . . billeted the wounded soldiers on the patricians, to be cared for. To the Fabii [*a prominent family*] he assigned the largest number, nor did they anywhere receive greater attention." Livy points out that this was a good political investment: "For this the Fabii now began to enjoy the favour of the people, nor was this end achieved by aught but a demeanour wholesome for the State."[245] After another battle, even enemies were "quartered among the citizens . . . until their wounds were healed."[246]

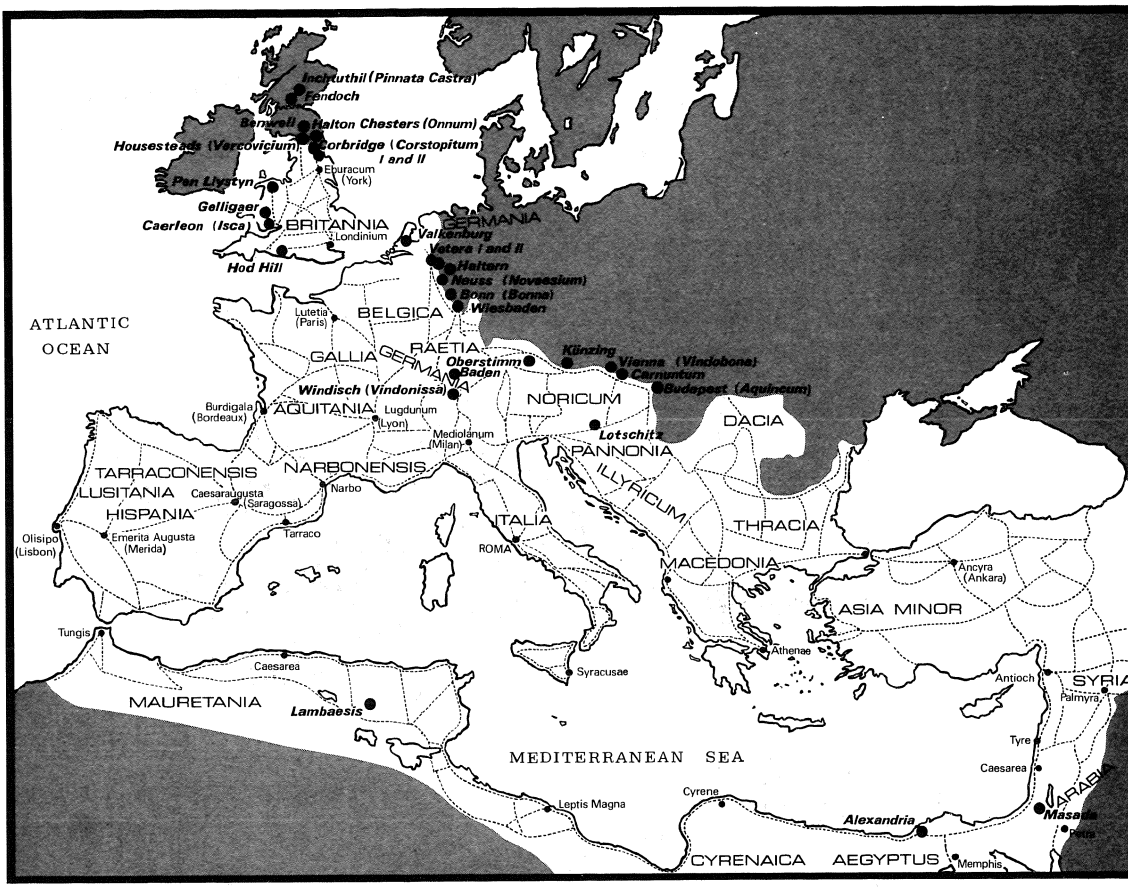
This manner of dealing with mass casualties was revived in the time of Celsus, when a major catastrophe hit the town of Fidenae, five miles from Rome—major enough to recall the emperor from his retreat in Capri. It was 27 A.D. when one Attilius, determined to become popular cheaply and on a large scale, offered the city a gladiatorial contest in a rickety amphitheater that he had built for the purpose, on unsafe ground. The structure collapsed, and over 20,000 people were killed or injured.[247] Tacitus sets the figure at 50,000. Wealthy homes, he says, opened their doors to the wounded, and Rome was a sorry sight, recalling the old days when citizens, in the aftermath of battle, used to care for the wounded.[248]

The method worked as long as battles remained close to home; when the frontiers expanded, sending the wounded back to Rome became unthinkable. They had to be kept at the camp. But sharing quarters with the casualties could be too much to bear even for the tough Roman legionaries.[249] After a battle with the Samnites in 294 B.C., "the soldiers were dispirited; all night long they had been kept awake by the groans of the wounded and the dying. Had the enemy attacked the camp before daylight, their fear would have been so great as to cause them to desert their ranks; as it was, they were . . . as good as beaten."

Eventually, Roman generals afield were obliged to provide special quarters for the sick and wounded, the *valetudinaria*. Remains of at least twenty-five have been found; they are all strung out along the frontier, from Scotland to Palestine (Fig. 9.34), another proof that they were born of a military need, as "islands of hope" at the limits of the empire.[250] *Limes*, "the limit," was the actual name of the frontier; life at the outposts there, weeks and months from home, must have been an exercise in loneliness (Fig. 9.35).

Most of the known valetudinaria sprang up during the first and second centuries A.D. The larger ones, typical of the legionary fortresses, were all built on the same plan (Fig. 9.36), possibly derived from an earlier layout of tents along the sides of a rectangle.[251] This standard plan identifies the hospital at a glance on the map of a Roman camp (Fig. 9.37). In its simpler version the plan corresponds to a single row of small rooms around the sides of the rectangular court; in the more complex version, illustrated here, the buildings are deep enough to have a central corridor running all the way around the quadrangle, with small rooms on either side. Auxiliary forts had smaller hospitals, built of timber. They were rectangular, with a corridor running from one end to the other, and small cubicles on both sides, resembling one wing of the larger legionary hospitals.[252]

MEDICVS



9.34 Roman military hospitals (large dots) were scattered along the borders of the empire, especially along the Rhine, the Danube, and the frontier with Scotland. None were found in Italy.

The Roman legion that was fighting the *barbari* of Scotland around 85 A.D. built a timber hospital of the larger kind at Inchtuthil (Fig. 9.37). Here the central corridor and the two flanking rows of small wards were built as separate units, each with a gabled roof (Fig. 9.38). There were sixty-four wards, one per *centuria* (company), and each could accommodate four or at most five men (Fig. 9.39), which means that the commanders were prepared for a casualty rate of 2.5 to 10 percent.[253] This camp was evacuated in haste (a hoard of almost a million precious new iron nails had to be left behind) and its buildings were dismantled. All that is left of the hospital is a large number of faint traces of holes in the ground.[254] However, the design formed by these holes is a true monument to those who planned it, being a fine example of functional architecture, rational for the patients as well as for the hospital staff.

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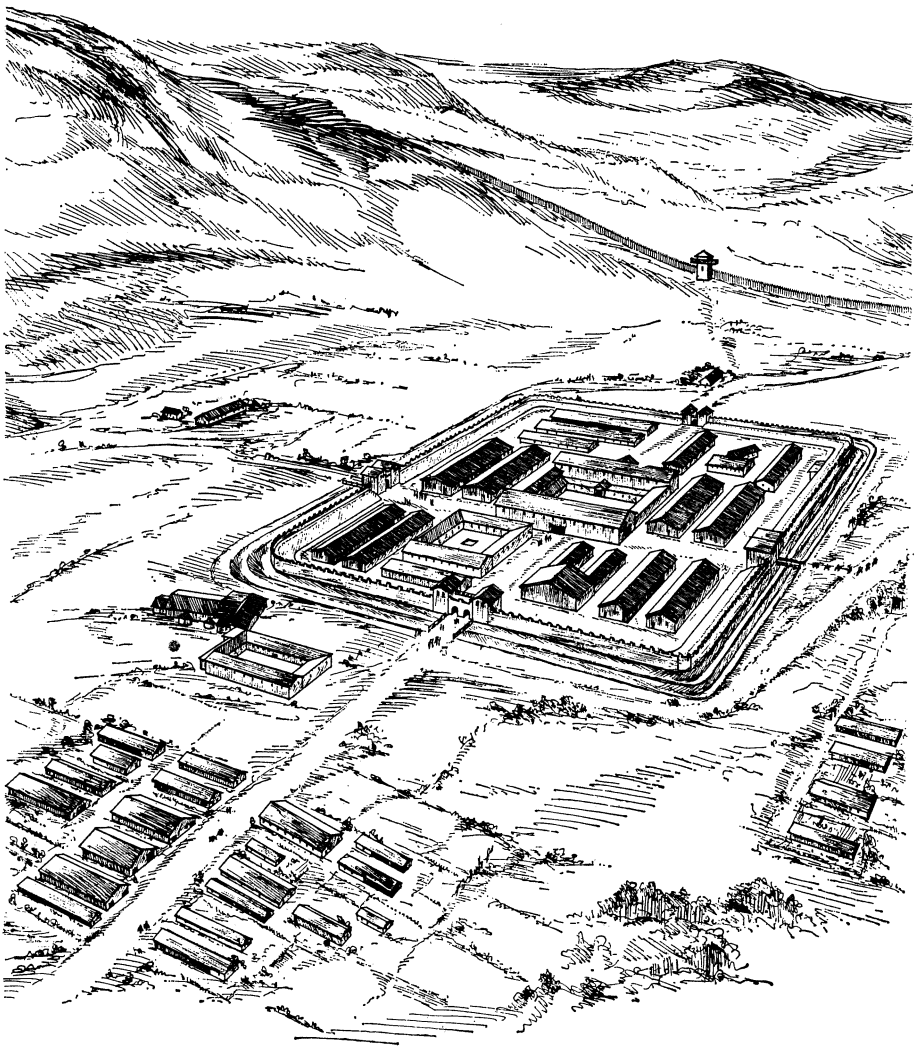
It could be argued that the small size of the wards—in depth—was a matter of structural necessity rather than of hygienic thinking, having been determined by the length of the roof's timbers. Perhaps so; but the partitions were definitely a matter of choice. Evidently the architects disliked the notion of long, narrow wards (such as those that became prevalent in much



9.35 Artist's view of the Roman camp at Saalburg along the northern frontier, with the border stockade in the distance. Army hospitals were a must in this loneliness.

later days), so they cut them up lengthwise, which added to the cost, but also helped morale, fought cold and draughts, and (incidentally?) decreased the spread of infection.

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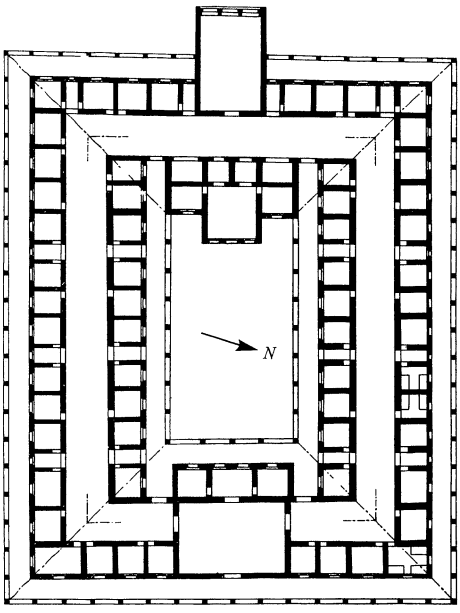
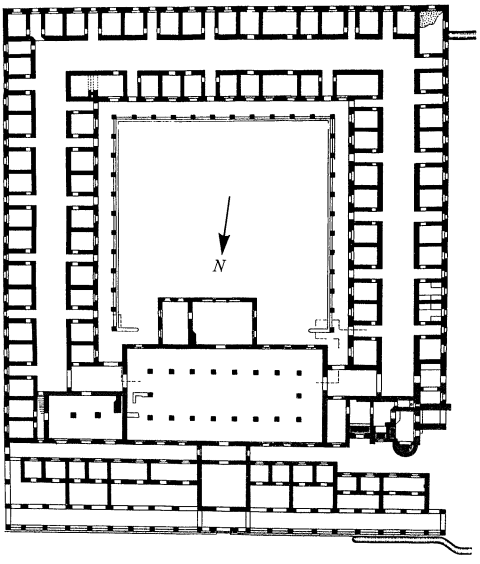
Medical instruments were found in several of these hospitals and actually helped to identify them as such.[255] The valetudinarium of Baden, Switzerland, yielded 120 probes and a pot of ointment: animal fat mixed with a lead salt.[256] At Novaesium (now Neuss on the Rhine) two accidents, millennia apart, added up to a wonderful stroke of luck. First, sometime during the first century A.D., fire destroyed a part of the local Roman army hospital. The roof collapsed, and that section was abandoned. Then in 1962 plans were made to lay a canal through that area, and bulldozers cut a trench two meters deep through part of the known valetudinarium. However unkindly one may look on this enterprise, near the bottom of the ditch



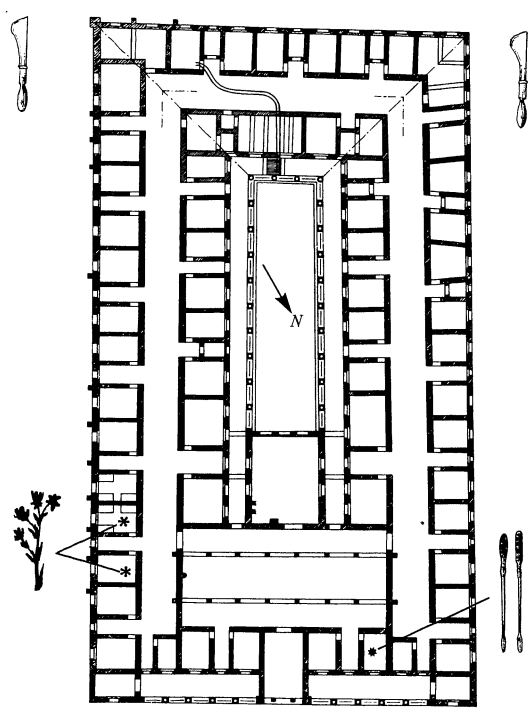
VETERA (II)

10 m.



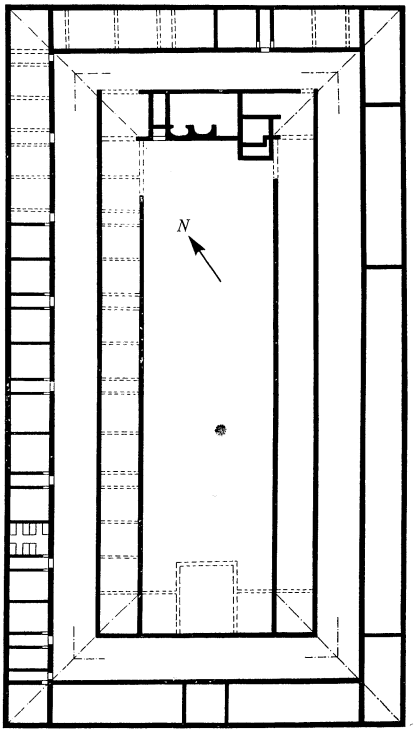
VETERA (I)

10 m.



NOVAESIUM

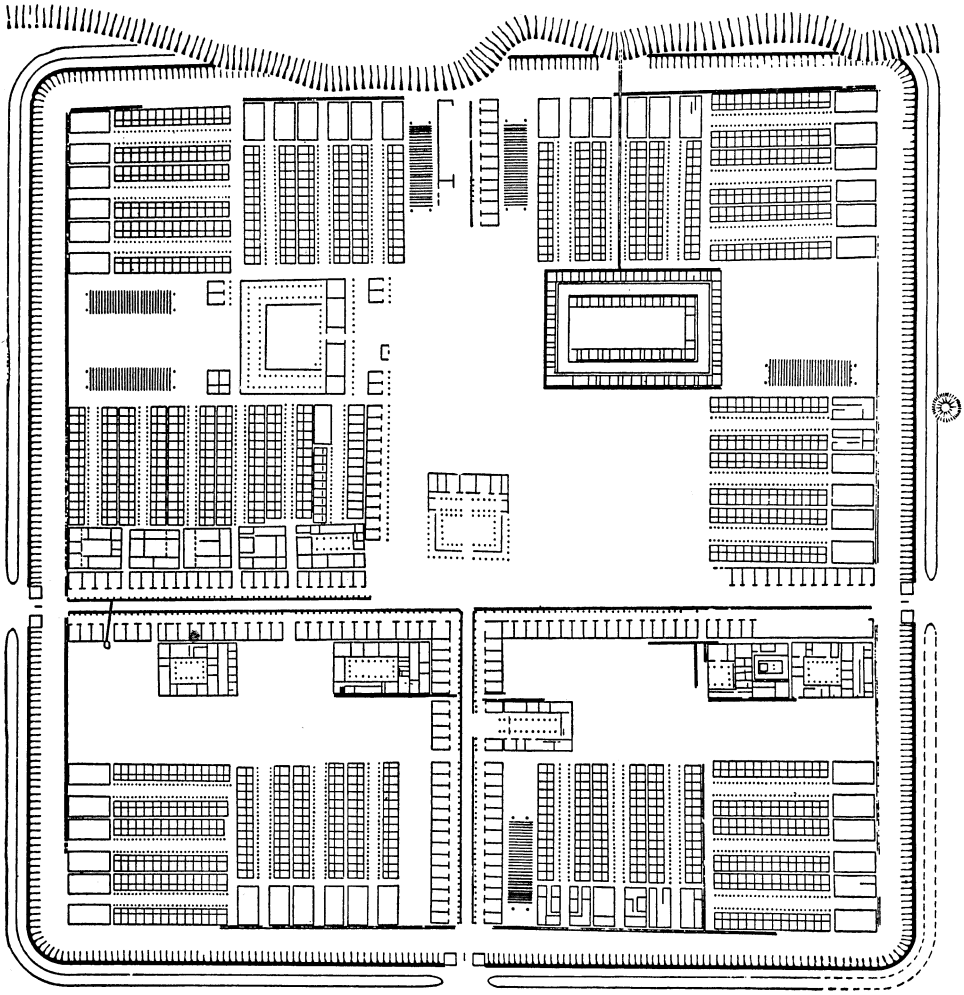
10 m.



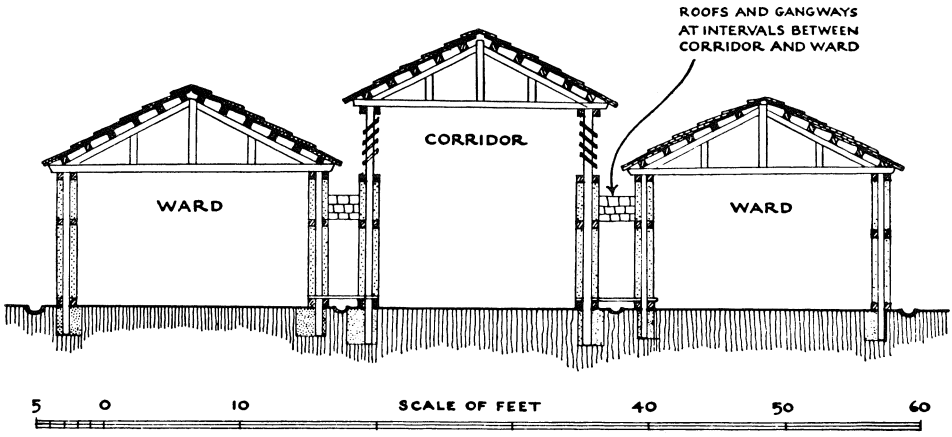
LOTSCHITZ

10 m.

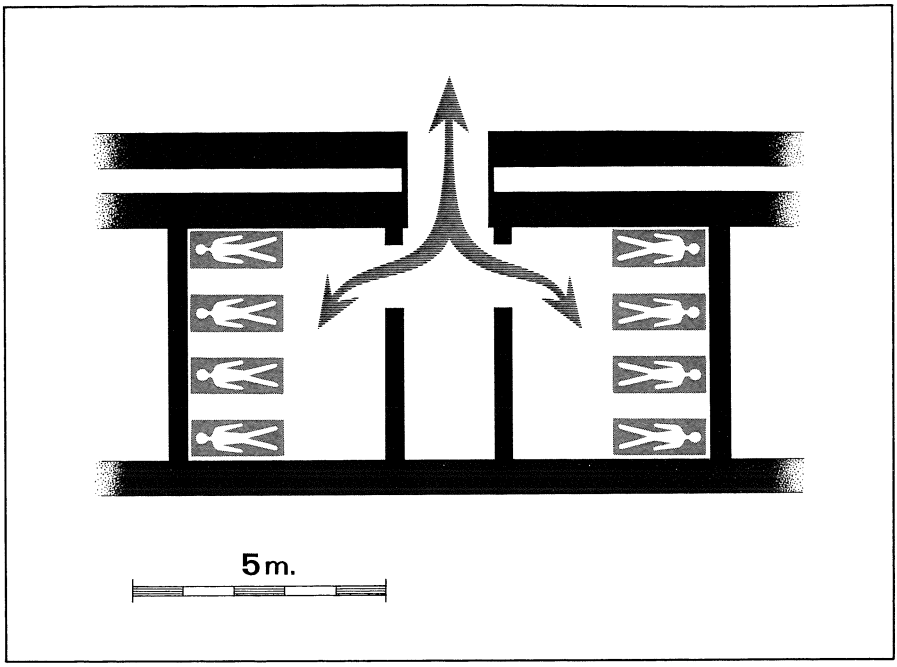
9.36 Plans of four typical stone-built Roman army hospitals. Sets of partitions subdivide each wing into small wards (in the Lotschitz hospital the subdivision appears to be incomplete, but little is left of that building). Instruments and herbs were found in different parts of the Novaesium hospital, where shown.



9.37 A Roman legionary fortress in Scotland, at Inchtuthil. The plan of the hospital building stands out clearly (top right).



9.38 Section through the north wing of the Inchtuthil army hospital, a wooden structure.

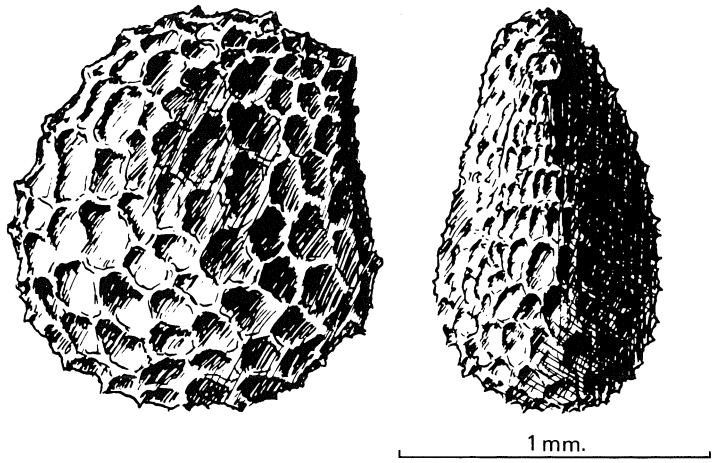


9.39 Functional scheme of the wards at the Inchtuthil hospital. Note the small rooms and rational circulation.

workers came upon a layer of carbonized material mixed with debris of roof tiles; in it were also broken pots, containing carbonized lentils and peas. Nearby was some carbonized wood—and a very black layer of fibrous material a few centimeters thick. The material was collected, dubbed "carbonized hay," and sent to be examined. Then the pipe was laid down and the ditch closed for good.[257]

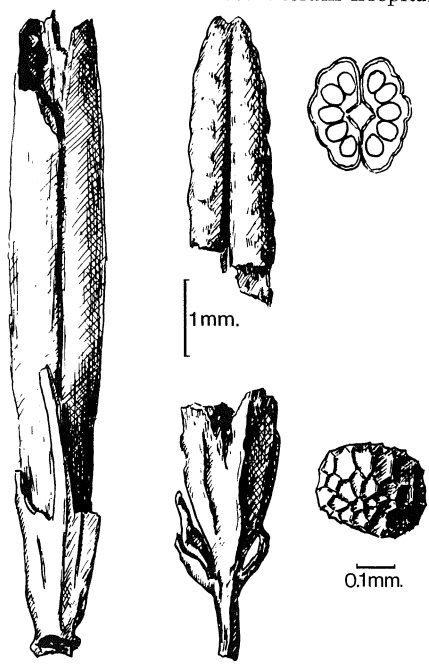
The "hay," loosened in water and examined under the microscope, turned out to be something much more valuable: a stack of selected herbs, including unmistakable medicinal herbs.[258] There were, for instance, thirty-nine seeds of henbane, *Hyoscyamus niger* (Fig. 9.40). Celsus recommends them as a sedative: "some induce sleep by draughts of decoction of poppy and hyoscyamus."[259] Henbane seeds contain scopolamine, which is still used as a preanesthetic medication, inducing drowsiness and amnesia. In high doses, however, it is dangerous, recalling its close relative atropine, which received its name from Atropos, the goddess of fate who cuts the thread of life.[260]

The bulk of the material was made up of carbonized centaury, *Centaurium umbellatum Gilib.* (Fig. 9.41). For centaury, I must use the words of Pliny: "Centaury is said to have been the treatment given to Chiron [*the Centaur*] when an arrow fell on his foot as he was handling the arms of Hercules, who was his guest; for which reason some call it Chironion . . . Its power to cure wounds is so strong that even pieces of meat, they say, coalesce if they are boiled with it."[261] I did not try this experiment but cannot help wondering at the fame of centaury (Fig. 9.42). The herb is practically forgotten except as a source of "bitters:" perhaps this very taste was the cause



9.40 Grains of henbane (*Hyoscyamus niger*) found in the Roman hospital at Novaesium. Though dangerous, they were better than nothing for the relief of pain.

9.41 Centaury (*Centaurium umbellatum Gilib.*) was highly esteemed as a healer of wounds. This specimen was among the remains of one or two hundred centaury flowers found in a room of the Novaesium hospital.



of its ancient popularity, for bitterness was somehow connected with healing properties, in Greek as well as Indian medicine.[262]

No other find like this one has ever been made in Europe, for humidity usually destroys such remains. The herbs of Novaesium were preserved because the part of the hospital where they were stored burned down; the herbs were heated, without burning, then left to carbonize in the rubble.

9.42 Centaury took its name from the Centaur Chiron, who taught Achilles the art of healing with herbs. Here is Chiron on the shield of Achilles. Greek amphora, c.490 B.C.

Another unique discovery was made at the Roman camp of Corbridge in Northumberland, a couple of miles south of Hadrian's Wall. Inside a wooden chest, buried under a room of the valetudinarium, was a peculiar kind of treasure: bundles of iron spearheads, several tools, several hundred nails, a block and tackle, keys, pieces of scrap metal, bronze fastenings, and other objects, often broken. Some were wrapped in cloth or leather. What could have been on the mind of those who buried this chest, why did they choose the hospital, and why did they wrap up bits of scrap metal? I am much inclined to accept the suggestion of R. W. Davies, whose arguments begin, once again, with Pliny. According to the *Natural History*, iron rust as well as verdigris are good for wounds: "Rust of iron is obtained by scraping it off old nails with an iron tool dipped in water. The effect of rust is to unite wounds and dry them and staunch them . . . For recent wounds it is useful diluted with wine and kneaded with myrrh . . . Scale of iron, obtained from a sharp edge or point . . . has an effect extremely like that of rust only more active . . . Its chief recommendation is its use in a wet plaster for cleaning wounds and fistulas."[263] So the purpose of the old chest may have been to make rust and verdigris for the hospital pharmacy.[264] As to the real effect of rust on wounds, infected or not, I have no data.

Roman Army Doctors

For lack of documents, the story of the Roman army and navy surgeons cannot be written; but it is safe to state that under the empire there was a regular medical corps.[265] At least eighty-five army physicians are recorded, mainly because they died and earned an epitaph.[266] Some of their names are Greek; the majority are Latin.

Of their lives little is known. A rare exception is Marcus, who was stationed at Alexandria about 270 A.D. One day, after a local skirmish, he took a piece of papyrus and wrote a letter to his parents, in Greek. Here is part of it:

> Marcus to Antonia, Sarapion, and Cassianos[*grandfather?*], my parents, many greetings. I make obeisance toward you before the gods in the local temple, because nobody can go to make obeisance up the river, on account of the battle that has taken place between the Anoteritae [*?*] and the soldiers. Fifteen soldiers of the *singulares* have died, not to count the legionaries, the *evocati,* and those exhausted.
>
> Now I am writing you to send me as fast as possible the short woollen coat that you are making, so that I may have it here. The palm trees should be watered three times, as is proper at this season . . .
>
> And as in every letter, I write you to shake the dust off my medical books, shake it off and remove them from the window, where I left them on my departure.[267]

Most famous of the eighty-five army physicians was Dioscorides, a native of Cilicia (now Turkey), who followed Nero's army and wrote in Greek the most celebrated herbal of antiquity.

A tacit tribute to the army's foreign medics[268] may be engraved on the famous bas-relief of the Trajan Column in Rome, showing how the wounded were treated on the spot (Fig. 9.43).[269] The five men involved in the first-aid scene are all shod with *caligae,* the sandals of the Roman regulars; but there are two kinds of uniform. The two men at the left wear the armor of Roman citizens, as praetorian legionaries. The three others are dressed as auxiliaries, with the typical scarf and leather jacket; they are non-Romans. In the context of the action, this seems to suggest that blood was shed by Romans (2) as well as by foreigners (5), but that the art of healing was only in foreign hands (4, perhaps also 3).

The Romans did not develop an inferiority complex about Greek medicine, as far as I can tell. Hear Pliny: "Medicine alone of the Greek arts we serious Romans have not yet practiced; in spite of its great profits only a very few of our citizens have touched upon it."[270] The reason, in his words: *Romana gravitas.* Pliny's view of professional medicine must have been low indeed to make him say that the Romans were too serious to join it.

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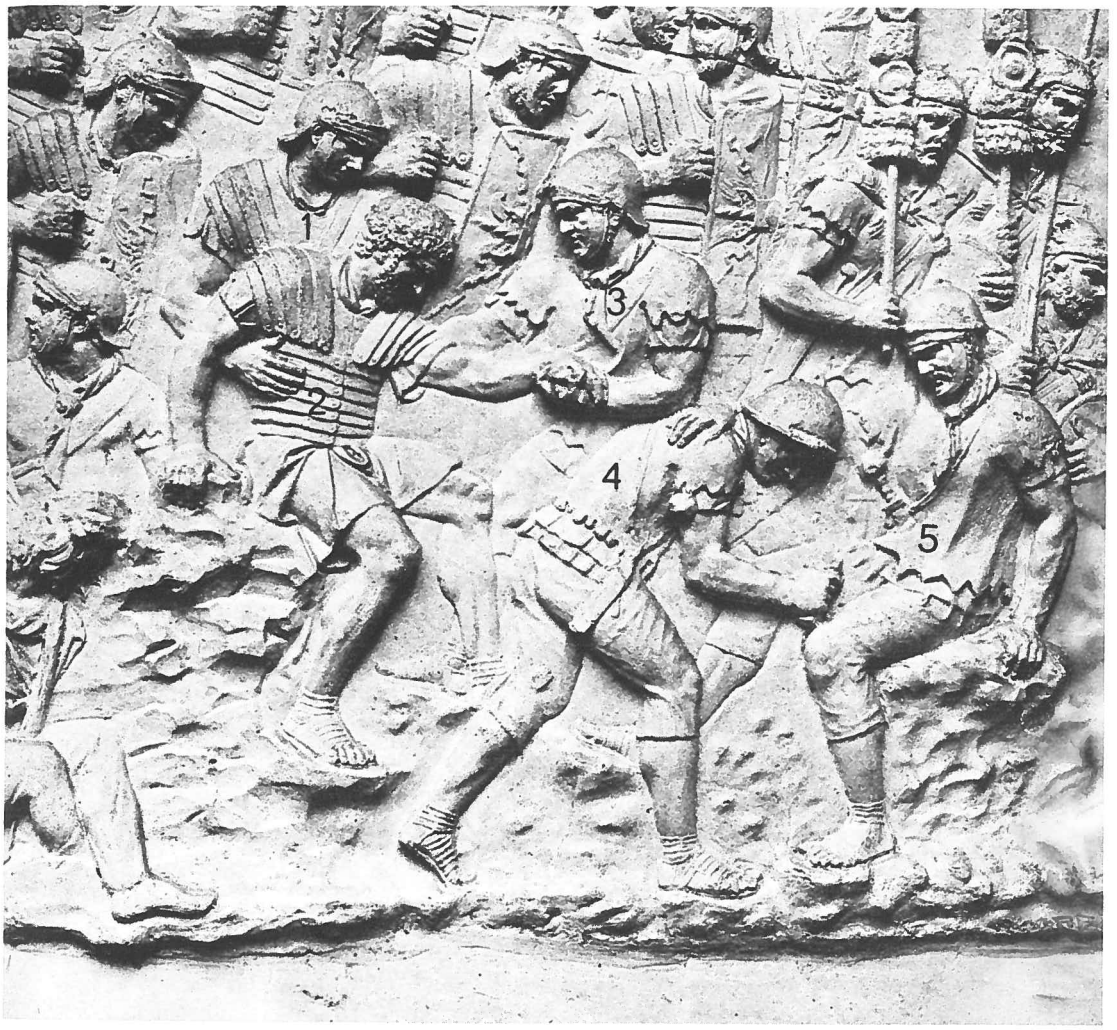
Civilian Infirmaries

Back in the Eternal City there were no hospitals at all; or more precisely, there are no remains, and no records, of any army hospital in Rome. As for civilians—what might have happened, for instance, to a citizen who had been run over by a cart?[271] Anybody who could afford it would surely be taken to



9.43 First aid in the Roman army. This bas-relief from Trajan's column may indicate that medical care was in the hands of non-Romans (see text).

a private physician.[272] Beyond this, the evidence is skimpy. It is possible that an artisan might be taken to the physician of his guild.[273] A slave from a country estate would probably be taken to the infirmary in that household. If badly mangled, he might be patched up and sold, or abandoned on the island of the Tiber, site of the ancient temple of Aesculapius, where Claudius decreed that if they recovered, they must be freed.[274]

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Some of these patients may have been taken over by the public physicians. The Romans had found this institution at work in Greece as well as in Gaul.[275] They had tried it out themselves under the republic, when they hired Archagathus, the wound specialist, and paid for his *taberna*, "workshop," as Pliny calls it, out of public funds. The trouble is that after him there are no further records of Roman public physicians until the decree of Antoninus Pius (137–161 A.D.).

The text of this decree suggests that this good emperor was worried about public physicians because of some current abuse regarding the exemptions

and privileges that came with the office: "The smallest cities may have five tax-exempt [*immunes*] physicians, three sophists and as many grammarians; larger cities may have seven physicians, and four teachers of the above-named branches; the largest cities may have ten physicians, five rhetoricians and as many grammarians. Beyond these numbers, even the largest cities may not confer tax-exemption [*immunitas*] . . . It is not permissible to exceed these numbers . . . for any reason; but it is possible to decrease them."[276] Later these public physicians came to be known, in the Roman Empire, by the Latinized Greek name of *archiatri*, from *archiatrós*, meaning "court physician," "official physician," or more generally, "responsible practitioner."[277] There is little doubt that one of their major duties was the medical care of the poor,[278] but to see this mentioned in the law—and then most emphatically—we have to wait for a Christian emperor, Theodosius, in 368 A.D.[279]

In stating the duty of caring for the poor, this decree rises to the tone of a sermon: "There shall be as many Archiatri [*in Rome*] as there are regions in the city, over and above the two of the Porticus assigned to the Gymnasium and to the Virgin Vestals [*a Christian bow to the waning pagan institution*]. May these physicians, knowing that their annual moneys will come from the people's money, prefer to serve with honesty the poor, rather than the rich with disgrace. We shall tolerate that they accept the fees that those in good health may offer for their services, but not the fees that those in danger may promise for being saved."[280] Ultimately, these public physicians must have become a very popular institution, considering that *archiater* gave the German word for "doctor," *Arzt*.[281]

It is also unclear where these public physicians took care of the citizens. Of archiatric hospitals there is no trace. In the first century A.D., Celsus has a passing comment about "large valetudinaria" (whether public or private, he does not say), but from the context I guess that he himself would never be taken to one of those places. He brings up the matter of large infirmaries only incidentally, in a startling passage in which he discusses the importance of theory versus practice; or rather of medicine as an art, as opposed to empirical healing gestures. And he concludes (hear this) that *there are three kinds of doctors who cannot bother with theory:* "those who treat cattle and horses, since it is impossible to learn from dumb animals particulars of their complaints . . . so also do foreigners, as they are ignorant of reasoning subtleties . . . again those who take charge of large valetudinaria, because they cannot pay full attention to individuals"![282]

Within a few years of these lines, Columella was writing his treatise on farming (*De re rustica*), which tells that infirmaries, again called valetudinaria, were a regular part of large country estates. It is implied, however, that they were for slaves only, perhaps even being run by slaves with medical skills (*servi medici*), and that they were nothing more than rooms set aside for the sick.[283] Visualize them from Columella's own words, in the chapter dealing with the duties of the bailiff's wife: "Then too she will have to see that the kitchen and the cowsheds and also the mangers are cleaned, and she will have to open the sick-wards [*valetudinaria*] from time to time, even if they

contain no patients, and keep them free from dirt, so that, when necessary, the sick may find them in an orderly and healthy condition."[284] Should the farmer's wife find a slave "even pretending to be ill, she must without delay conduct him to the valetudinarium; for, if he is worn out by his work, it is better that he should rest for a day or two under observation than that he come to some real harm by being forced to overwork himself."[285]

To sum up these few data on civilian infirmaries, their general context is cattle, cowsheds, and slaves. Here the question arises whether there was any parallel institution for wealthier citizens. The fairest answer is that we do not know. There are two oft-quoted passages by Seneca, from the first century A.D., in which valetudinaria are mentioned in passing, rather as figures of speech ("If I were to walk into a valetudinarium, or into the house of a rich . . ."[286]). Not much can be squeezed from such lines. Perhaps some medici had nursing facilities where they lived, but wealthy Romans were most likely treated in their own homes.[287]

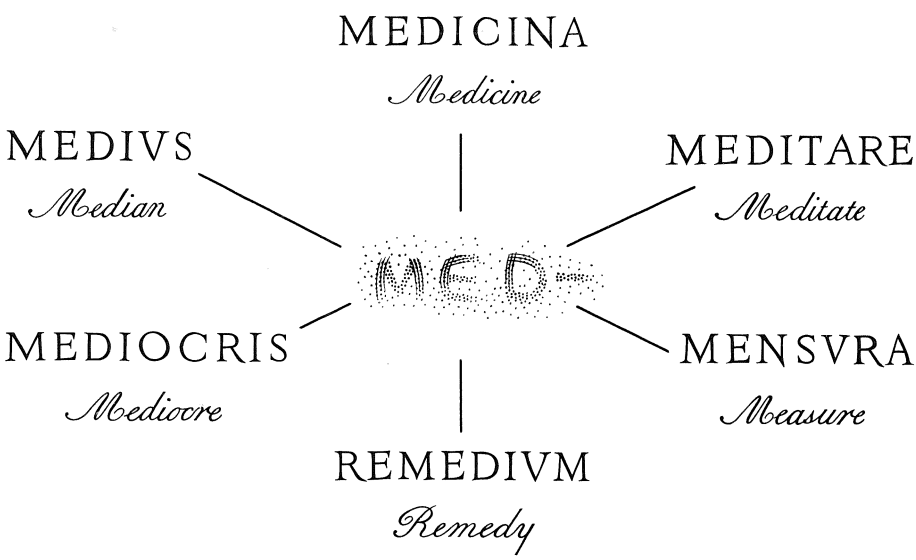
So we are left with good military hospitals, good data on slave infirmaries, and next to nothing on private clinics for the rich. All this appears to fit a logical scheme, which suggests that the rich took care of themselves but made sure that proper care was given to the two groups on which their power depended, soldiers and slaves. If humanitarian considerations were involved, they probably remained in the background; private infirmaries were—like army hospitals—part of good business administration.[288]

The Romans, who insisted on manslaughter as part of their weekly amusement,[289] could not be expected to produce highly philanthropic laws. However, the public physicians were a beginning. From Greece to Rome, to distant China, antiquity recognized—in token form at least—the right of the citizen to medical care.[290]

"Medicina"

The greatest Roman innovation in medicine was perhaps the military hospital. Architecturally, it was almost ideal. Yet after the empire it was forgotten—so thoroughly forgotten that many of today's physicians trained in wards where patients were lined up by the dozen, in two rows. The reason, I assume, has to do with the motivation of the Roman hospital: it was a product of army efficiency. When the army and its efficiency collapsed, the beautiful hospitals went with it.

A different motivation had to arise, either from the law—giving all men equal rights—or from religion. In Rome, the religious motivation came first, as it did in India, where Buddhism had a 500-year headstart over Christianity. About 350 A.D. a wealthy Roman lady, Fabiola, embraced the Christian faith and founded with her own money a home for the sick. Her *nosokoméion,* "sick-tending-place," may not have included medical care as known today, but it reflected a concern for human beings that in the Western world was entirely new, and which ultimately found expression in real hospital care. Saint Jerome tells that Fabiola went herself to pick up in the streets, and carry



9.44 Greek gave us *clinic* and *surgery* (*cheirurgía*), but Latin gave us *medicina*, from the Indo-European root *med-*. Here are some of its relatives. The root *med-* seems to imply the general connotation of "thoughtful action to establish order."

away on her shoulders, wretched beings with "leprous arms, swollen bellies, shrunken thighs, dropsical legs . . . their flesh gnawed and rotten and squirming with little worms . . . How often did she not wash the pus of festering wounds that others could not bear to see?" [291]

So Christ took over the work of Asklepios. If the Christian poorhouses and hospitals of the Middle Ages have precedents, they are not the valetudinaria of the Roman army, but the homely public Roman infirmaries and the special buildings attached to the temples of Asklepios, where the worshippers could live.[292]

It is certainly true that Roman medicine was basically Greek; but Europe's center of gravity had also shifted from Greece to Rome. As the Roman Empire came to embrace practically all of the Western world, the art of healing grew, blending the knowledge of three continents. Hence its name in most European languages (except Greek) was taken from the language of the conquerors: *medicina* (Fig. 9.44).[293]

And the last flash of Greek medicine came from Rome: Galen.

10 Galen—and into the Night

Galen's fame rests on a self-made monument of two and a half million words: twenty-two volumes in the only edition available, a forbidding sight—as illustrated above.[1] All this amounts to two-thirds of what he wrote; the rest is lost.[2]

The next most wondrous fact about Galen is that, today, he is scarcely read at all. There are many reasons for not reading Galen. A simple one is that very few of his works have been translated from the original Greek, except into Arabic, or Latin for the really ignorant.[3] Even in the few that are available in English, the general style is so consistently boring that the sparks of genius tend to be lost in the smoke. To make matters worse, Galen was a very pompous gentleman, and he also wrote that way. A genius he was, of course, or he would not have dominated medicine for nearly fifteen centuries. But the critics of the Renaissance toppled him so effectively that a lasting revival never took place. He is still in disgrace, "doubtless from the extravagant homage formerly paid to him." Somebody even took the trouble of counting his anatomical mistakes.[4] But if Galen's writings could be condensed into two or three books, those books would be full of pearls.

Galen was born in 130 A.D. in Pergamon, on the coast of Asia Minor (Fig. 4.1). His father, a wise and wealthy architect, provided him with the best possible education and independent means for the rest of his life; his mother

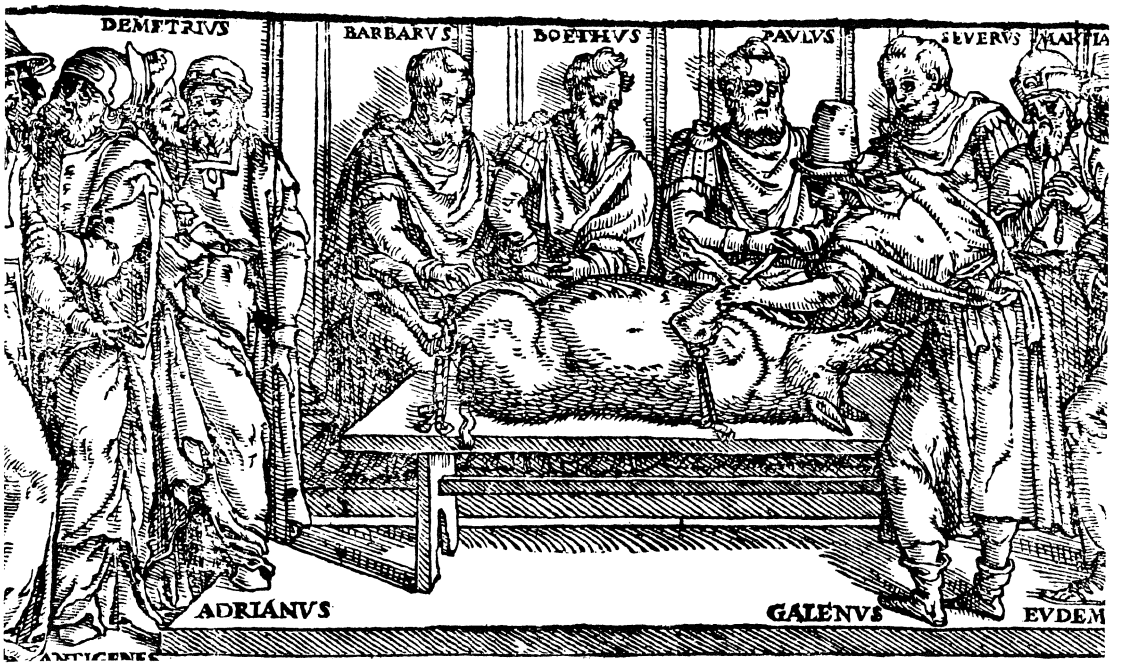
impressed him especially with her vicious character, of which we shall have more to say. Pergamon had fallen to the Romans just three years before Galen's birth. It was a beautiful and intellectual city, famous for its Asklepieion, which drew crowds of pilgrims, and for its library, second only to that of Alexandria. In fact, it was through the influence of the library in Pergamon that parchment (*charta pergamena*) was developed. Pliny explains how it happened: "When, owing to the rivalry between King Ptolemy and King Eumenes [*of Pergamon*] about their libraries, Ptolemy suppressed the export of paper [*papyrus*], parchment was invented at Pergamum; and afterwards the employment of the material, on which the immortality of human beings depends, spread indiscriminately."[5]

Galen's father owned a small farm, where he liked to retire to perform his favorite experiments: anticipating Pasteur's *Etudes sur le vin*, he studied the aging of wine as affected by the heat of the fireplace.[6] Little Galen watched other children play,[7] but wasted no time himself. At the age of thirteen he had already written three books. By twenty he had completed four years of medical study at the school of the Asklepieion, but to him this background was not enough. The best of science was still concentrated in Alexandria, so he went there and stayed several years, studying especially anatomy. When he returned home, he was an accomplished dissector and could boast of twelve years of training. This would be a lot even now, and was surely unique at that time: two Roman epitaphs remember "physicians" who died at the age of seventeen; and a certain Thessalus offered in Rome a medical course of six months![8]

Although his home remained Pergamon, Galen spent twenty-four years in Rome, where he rose to the position of court physician to none other than Marcus Aurelius. In Rome he lived as a haughty Greek; some say that he never even bothered to learn much Latin.[9] He wrote, lectured, gave public demonstrations, and found time for private practice, often ending in verbal fights with his colleagues. Toward the end of his life, when he returned to Pergamon, he had written so many works (perhaps five or six hundred) that he felt the need to write two more books about his own writings. He died in 200 A.D.

Galen had no brothers or sisters, never married, left no pupils, and does not mention any friends.[10] His one and only idol was Hippocrates. The Hippocratic Collection had already gathered five hundred years of dust; he revived it, adopted it as if he were its new messiah—which he surely was—and wrote much about it that is now extremely valuable. Indeed, his comments on the Hippocratic books are usually much longer than the books themselves.[11]

Yet, while his medicine was essentially Hippocratic, Galen had also been to the Alexandrian school; thus, for all his faults, his scientific horizon reached at least one order of magnitude beyond that of Hippocrates: *he practiced dissection and experiment* (Fig. 10.1). Whereas Hippocrates had studied disease essentially as a naturalist, Galen dared modify nature as a scientist. His thirst to understand *The Use of the Parts* (the title of one of



10.1 Galen's systematic experiments on animals were a great advance over Hippocrates. Here Galen is vivisecting a pig, presumably to demonstrate his famous "nerve of the voice." Boethus was a scholarly Roman ex-consul who once paid for a stenographer to record the proceedings of such a demonstration. From a 1609 edition of Galen.

his books) led him to perform experiments on a scale totally unheard of. He opened live arteries and determined that they contained blood, not air (not so easy when everybody maintains the contrary); he tied the ureters of living animals—cruel, but technically a tour de force—to show that urine comes from the kidneys; he severed spinal cords at different levels and described the kinds of paralysis that ensued.[12]

And yet, after this dazzling start, Galen abandoned truth for theory, and dug his own grave as a scientist. In retrospect, the step was a short one, irrational but understandable: anatomy became revelation. It became the tangible proof of an infinitely wise Creator. With this perspective, Galen slipped from dissection into philosophy, to create a system in which every organ, function, and disease made perfect, ultimate sense. So deep was his conviction that he could speak of a nerve as of a religious experience. The following excerpt is an excellent self-portrait, taken from the book *On the Usefulness of the Parts of the Body:*

I want you now to pay me closer attention than if you were being initiated into the mysteries of Eleusis or Samothrace or some other sacred rite and were wholly absorbed in the acts and words of the hierophants [*priests*]. You should consider that this mystery is in no way inferior to those and no less able to show forth the wisdom, foresight, and power of the Creator of animals, and in particular you should realize that I was the very first to discover this mystery which I now practise . . . Ac-

10.2 Galen treating a wounded gladiator in the amphitheater at Pergamon, as visualized by Jan Verhas about 1870. It is likely that Galen had better working quarters than the animal den.

cordingly, even if you have not done so before, fix your mind now on holier things, make yourself a listener worthy of what is to be said, and follow closely my discourse as it explains the wonderful mysteries of Nature.[13]

No pagan was ever more pious. This is the language that allowed Galen to be worshipped, century after century, by Christians, Muslims, and Jews.

Galen's prime interests were science and internal medicine, not surgery. In fact, he never wrote a book on surgery. However, he tended a vast number of wounds during three years as a surgeon to the gladiators (Fig. 10.2), and he left some interesting notes on that experience.[14]

Galen and the Gladiators

Pergamon was a Greek city, and as such, it had nothing to do with gladiators. But when the Romans came, the conquerors could not do without their favorite show. On Greek soil, however, the first reaction was horror, and some Greek cities went as far as forbidding gladiatorial games altogether.[15] The Romans solved the problem by a technique of immunization: they organized combats anyway, but stopped them—at first—as soon as blood appeared. Gradually, the public became accustomed. By the time Galen was twenty-eight, Pergamon had full gladiatorial games and needed a surgeon (Fig. 10.3). This is what Galen has to say about his appointment:

On my return from Alexandria to my native land, while still a young man in my twenty-eighth year, I had the good fortune to work out a successful dressing for wounded nerves and tendons. I demonstrated this to physician friends not only in Pergamon, but in neighboring cities so that they might confirm my findings by exper-

10.3 Galen's patients, the gladiators, wore such helmets. This one was worn in Pompei until 79 A.D.

iment. This treatment coming, I know not how, to the knowledge of the Pontifex of our city [*president of the games*] he entrusted me with the care of the gladiators while still a young man, for I was arriving at my twenty-ninth year . . .

Since many died in previous years [*and*] not one of those treated by me died, the succeeding pontifex appointed me likewise.[16]

The "successful dressing" is more precisely a sauce. It may have been an improvement over local practice, but surely not over the Hippocratic school:

Though previous gladiatorial physicians bathed the wound in hot water and put on a dressing of wheat flour moderately cooked in a mixture of oil and water, I omitted the water entirely and made the dressing of flour cooked in oil and poured an additional small amount of oil over it. The result was excellent, for not one of my cases died, though fatalities were numerous previously.[17]

In Galen's dressings I would not detect the mark of a genius. He seriously believed in dove's dung, on which he has a whole chapter,[18] and was quite happy to pour his favorite fluid, writing ink, onto live flesh.[19] If this was real ink made from the soot of torches, the net effect of the soot was probably that of all foreign materials: favoring infection (although it could be argued that the small amount of tar present in the soot could act as a short-lived antiseptic).[20] If, instead, it was the so-called shoemaker's blacking, made of tannin and iron salts, that was an old wound-drug and perhaps slightly more acceptable as an antiseptic.[21] Luckily there was always wine, the trustiest friend of all wounded Greeks:

As I have previously explained, it is necessary to keep the wound continually moist, because if the dressings dry out, the ulcer becomes inflamed. This is true especially in summer, at which time when the pontifices of Pergamum were celebrating the appointed gladiatorial games, I cured the most seriously injured by covering the wounds by a cloth wet with astringent wine kept moist both day and night by a superimposed sponge.[22]

Technically, as a wound surgeon, Galen could do better than Hippocrates, because he knew more about stopping hemorrhage, and he sutured muscles. Both these methods were already current. On wound healing in general he had nothing new to offer.[23] Fortunately he did recall the sane old Hippocratic principle that pus is not essential to normal healing:

Those who believe that inflammation necessarily follows a wound show great ignorance, since it is possible for anyone to see even large ones reach the stage of being practically healed in two to four days without inflammation, in connection with the countless fighting in a single day in the arena.[24]

Here is a typical case history:

I found one of the gladiators called *horsemen* with a transverse division of the tendon on the anterior inferior surface of the thigh, the lower part being separated from the upper, and without hesitation I brought them together by sutures. I knew that the fleshy parts of muscles had been sutured before, but I had never seen my teachers suture tendons. In fact in wounds of this kind some physicians only stitch together the skin edges, others put the sutures only through the anterior part of the muscle, and the posterior part fails to unite. When the muscular injury is longitudinal, proper bandaging alone will bring the parts together, but when transverse they must be held by sutures or they will remain permanently separated. When the edges of the ruptured tendon were ragged, I trimmed them. Some unskilled surgeons, imitating my work, tear away the membrane covering the muscle, not knowing that this should be included in the stitches.[25]

All this makes good surgical sense, especially the comments on wounds in muscles. When a muscle is split lengthwise, it behaves as if it consisted of two separate muscles, and the damage is not great; the two parts will grow together again even if left unsutured. If, instead, the muscle is cut transversely, the two stumps will pull away from each other, leaving a broad gap; if they are not drawn together by stitches, the muscle becomes useless. It is worth adding that Galen worked this out correctly, despite his total misunderstanding of muscular contraction. In fact, he did not realize that muscles are themselves able to contract; he believed that the pull exerted by the muscle-tendon apparatus was due to a shortening of the tendon—and he interpreted the bulge of a muscle, during contraction, as a passive slackening.[26]

Since Galen's forte was anatomy and dissection, he took his tenure at the games as a prolonged lesson in human anatomy. Like Sushruta, he describes the difficulty of pushing back the intestines when they have slipped out of the belly (how right he is).[27] In one case it was the omentum that had come out; he cut it off and the gladiator survived.[28] Many gladiators were wounded

10.4 Gladiator fights were accompanied by music. The woman (second from left) is playing a water-organ (Fig. 8.12). Beside her is a casket, ready for the next casualty; another casket is at far right (not shown). From a Libyan mosaic, third century A.D.

in the heart. Galen noticed that they died faster if the wound reached into the left cavity. If the wound did not poke through, they could survive a whole day and a night thereafter, then they died "of inflammation. And assuredly, all these maintain their mental faculties as long as they survive, and this phenomenon confirms the ancient principle that the intelligence of the soul does not reside in the heart."[29]

All this official butchering seems to have left Galen relatively cold. He actually despised athletic professions,[30] and he describes the gladiators' wounds as if they had happened to nonpeople. Dr. J. Walsh of Philadelphia, who between 1934 and 1937 wrote a series of essays on Galen, tries to explain the indifference to cruelty that seems to have prevailed in Galen's days:

> We see in our football games the player carried off the field injured or possibly dead, without the spectators knowing or even caring much which, occupied as they are with the irritation produced by the delay. Later they may read of his death in the newspaper with sympathy, particularly if he was a good player, but with little or no sense of horror.
>
> In the year 1935 there were in the United States 30 deaths due to football casualties and about 13,000 players injured. During the same year there were 36,400 deaths due to motor cars and about 1 percent of the population, or 1,250,000, injured . . . Our humaneness does not particularly stand out.[31]

While still regretting Galen's lack of sympathy, I will add that he too had undergone a certain degree of immunization. For thirty-five months he stood by as men whom he personally knew slaughtered each other to the sound of music (Fig. 10.4). Gory details of the proceedings, in full color, are preserved in many mosaics, especially in North Africa. Roman citizens may have been trained to enjoy the show since their early days. On the floor of a Roman villa in Carthage (now Tunis) one can see eight children having fun spearing cats, hares, and the like.[32] And when they grew up to become regular spectators, they behaved accordingly.[33] Sometimes one of them would step forth and

10.5 The *taurobolium*, symbolic rebirth through a blood-bath. This ritual came to Rome from the East and was current in Galen's days.

snatch a piece of liver from a gladiator lying gutted in the dust: gladiator liver, taken nine times, was a cure for epilepsy.[34] Another might come to drink blood from the wounds, for the same purpose.[35]

The ultimate in blood cure, in great vogue at that time, was a ceremony called *taurobolium*. Once in a while in Rome, Galen's peace may have been disturbed by the sound of flutes and a cheering crowd: a leading senator, drenched in blood from head to foot, was returning home after having been "taurobolized." This was a rebirth ceremony connected with the cult of Cybele. The man who wished to be spiritually reborn descended a few steps into a pit covered with stout planks, loosely joined and pierced with many holes. Then above him, a priest sacrificed a bull; the blood trickled down into the pit, to the sound of flutes, and the man soaked up as much of it as he could. Then he walked out at the other end of the pit, as out of a grave, happily reborn (Fig. 10.5).[36]

Galen and Hemorrhage: Still No Tourniquet

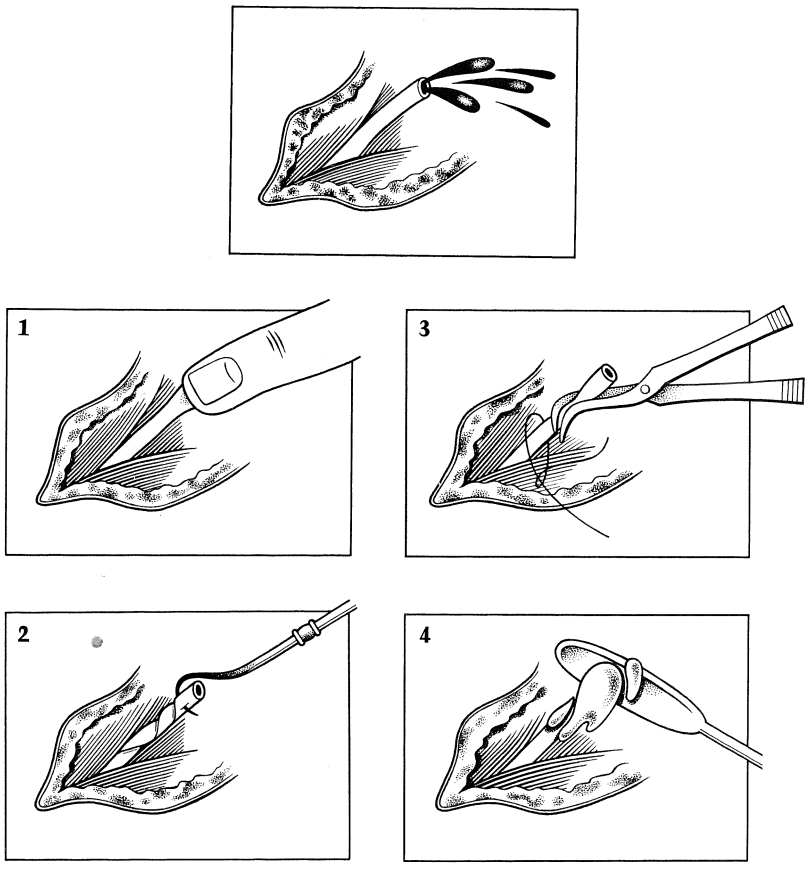
A trusty gladiatorial surgeon should have stood by holding a strip of cloth, ready to use as a tourniquet; but Galen did not.[37] His first aid in case of hemorrhage was essentially to raise the injured part, put a finger into the wound, find the gaping vessels, and compress them "gently, without causing pain."[38] Whether the patients were live apes or gladiators, this was his first device. He added, "very useful is also an assistant who co-operates with you, and in the manner described compresses for you the places in which you are in need of it."[39] Ten fingers could go a long way.

If this did not work, "what is also helpful is a hook with which you grasp the part from which the outflowing blood is coming, and twist it around" (Fig. 10.6).[40] Today, twisting a bleeder is standard technique. It is not quite clear to me, however, whether Galen transfixed the bleeding vessel with the hook, or whether he just "fished" in a pool of blood, hooked up whatever he could, and twisted.

The last step was to tie the vessels, by then already an ancient method. Sometimes Galen tied arteries with Chinese silk ("many rich ladies have it in Roman territories, especially in the large cities"[41]). It was high time for silk to appear in surgery: the Old Silk Road had been open for almost three hundred years, and Galen's master, Marcus Aurelius, had been the first to send a mission of merchants to China.[42]

To stop bleeding, Galen relied heavily on locally applied "styptics." The best of these mixtures, he says, was made as follows: frankincense, one part; aloes, one part; mix with eggwhite to the consistency of honey, and add a pinch of clippings from the fur of a hare.[43] He used it "perfectly safely" on a wound exposing the meninges!

And this is all—which means that even Galen, for all of his science, failed to appreciate the possibilities of the tourniquet for stopping hemorrhage. He must have known of its current use in a different context (for cases of snake bite); and he may even have heard of its sporadic use against bleeding, as we shall presently see.

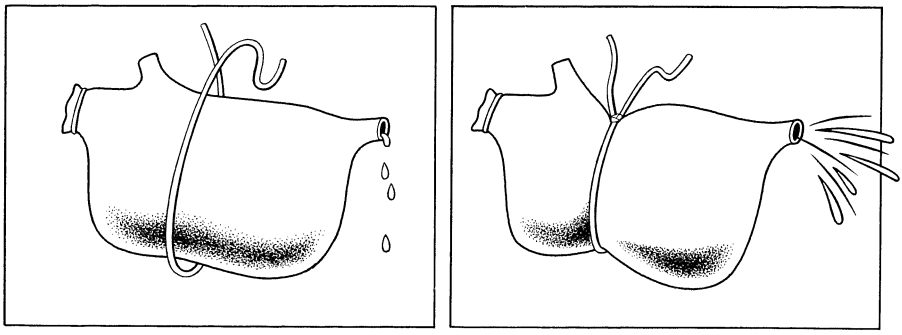


10.6 A severed vessel (*top*) and four of Galen's ways to stop the bleeding: (1) press the vessel with a finger; (2) twist it with a hook; (3) seize it with a forceps, then tie it; (4) apply styptics—or rather, drugs that were *supposed* to be styptics.

I find this failure hard to understand, but one can try to rationalize. First, Galen's crude method of squeezing with the fingers may have worked well enough, especially since he did not worry about the wound being infected. Second, he was preoccupied with the wound itself and did not realize the danger of blood loss as a cause of death, by what is now called hemorrhagic shock. Third, he may have had the wrong mental image of what the tourniquet really does.

I found this "wrong image" forcefully expressed in the homely booklet of Scribonius Largus, presumably written in Rome some 150 years earlier.[44] The passage is precious, because it shows how surgeons could reason about bleeding before they had learned about the circulation of the blood; it shows how the "obvious" is entirely dependent on the point of view; and it reveals incidentally that some form of tourniquet was in use in first century Rome, perhaps as a passing fad.[45] Somewhat shortened, the text reads:

> One should sponge the wound with water or vinegar and prevent the limb from being constricted [*by a tourniquet*], which most doctors do, not realizing that by compressing the muscles they force more blood out of the wound . . . In the same way, if you tie a rope around a skin bag and tighten it, if that bag has a leak, it will of course squirt out its contents (Fig. 10.7).[46]



10.7 An argument against the tourniquet, from Scribonius Largus early in the first century A.D. In his view the tourniquet should make the bleeding worse.

Scribonius finds this so exasperatingly obvious that his language lapses into invective. Referring to those doctors who, in his view, are making hemorrhage worse by applying tourniquets, he concludes: *Et, o bone deus . . .*—"And, good Lord, these are the same physicians who always give the fault to the medicines!"

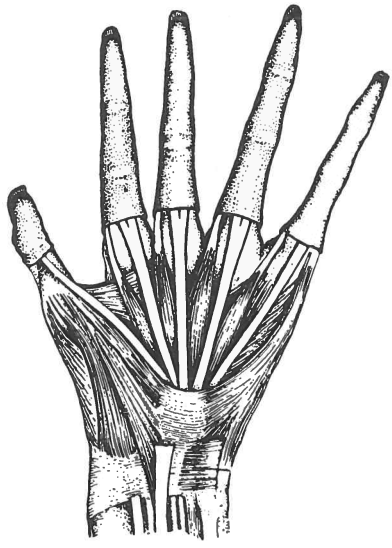
Wounds As Windows

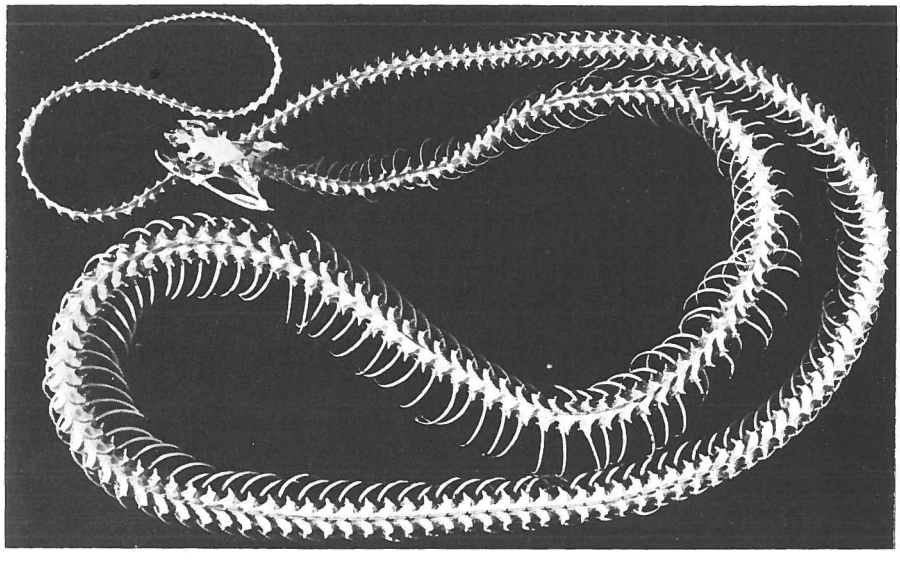
One of Galen's concessions to modesty was to admit that he never dissected ants, gnats, fleas, "and other minuscule creatures."[47] The list of animals that he did dissect remains difficult to match: apes, horses, asses, mules, cows, camels, sheep, lions, wolves, dogs, lynxes, stags, bears, weasels, mice, snakes, a variety of fish and birds, and several elephants.[48] Human bodies he did not dissect, except cadavers "in which all that overlies the bones is decayed and the bones alone remain."[49] He always had at hand "a large number of specially prepared bones of apes." The best way to obtain these, he says, is to bury the ape for four months in moist soil.[50] Surely his laboratory was decorated with skeletons and choice dissected specimens (Fig. 10.8).

Some of Galen's visitors must have cringed at heartrending animal cries. Galen was passionately interested in the functions of the body; and to understand them, he dissected live animals strapped on a board. His favorite animal for dissection was the barbary ape: *Macaca sylvanus,* the only European ape, a little tailless creature that still lives around Gibraltar (Fig. 10.9). But for vivisection, he recommends, use pigs or goats: "leave live apes alone."[51] They were human enough to be a nuisance, even to him.

It was in this manner that Galen worked out the functions of the nerves and the spinal cord:

> But if you cut the marrow [*spinal cord*] behind the first thoracic rib, then that damages the hand of the ape [*so it was an ape anyway!*]. And should the cut follow a line behind the second thoracic rib, then that does not damage the arm, except that the skin of the axillary cavity . . . and . . . upper arm . . . become deprived of sensibility.[52]





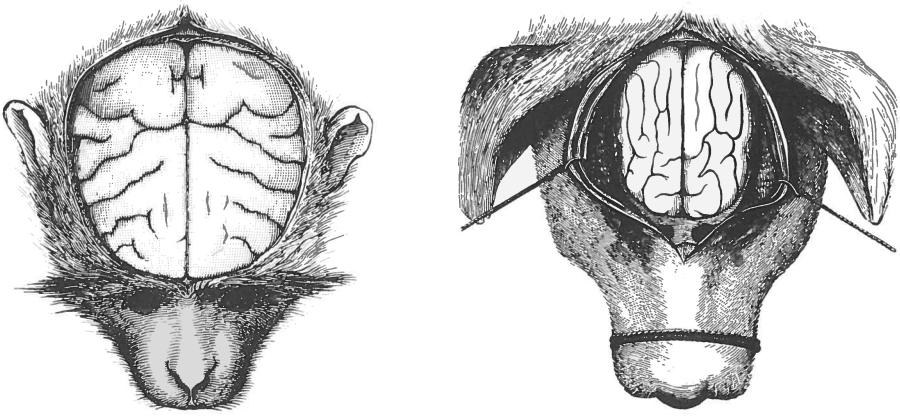
10.8 Galen, who was proud of his dissections on a variety of animals, may have displayed specimens such as these: the hand of an ape (top), the skeleton of a snake.

More inventive yet was his method to detect the function of the optic nerves:

> When you have divided the frontal bone . . . you will be met by two nerves that go to the eye. If you divide the larger of the two, then the visual sense of the animal will be impaired . . . But that the animal can no longer see . . . you can only appraise by deduction, from the fact that you find that it does not blink with its eye at anything which you bring near it, pretending to be about to stab home with it.[53]

Galen put to use even the squeals. To study the brain, "you must procure either a pig or a goat, in order to combine two requirements. In the first place, you avoid seeing the unpleasant expression of the ape when it is being vivisected. The other reason is that the animal on which the dissection takes place should cry out with a really loud voice, a thing one does not find with

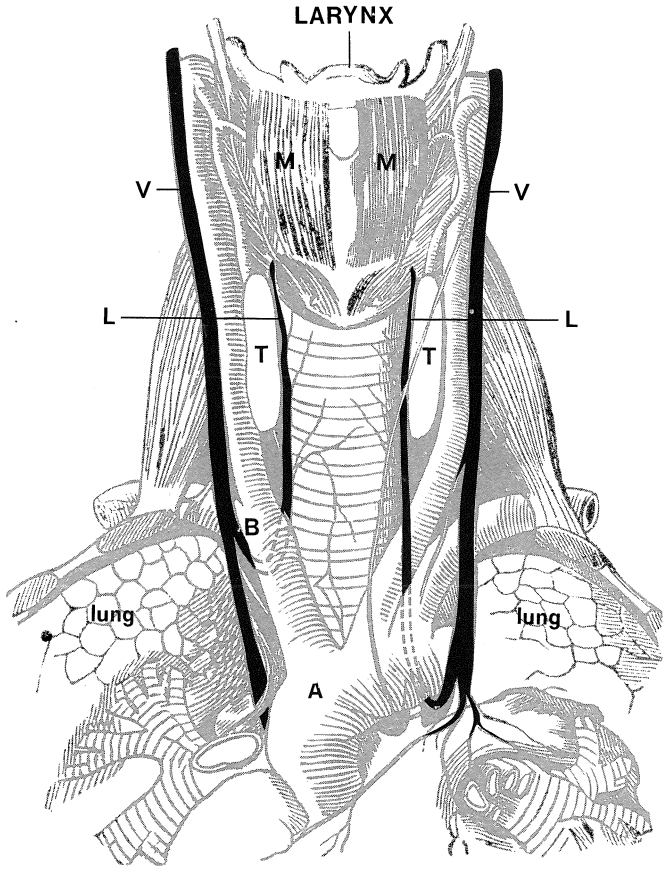
10.9 The barbary ape (*Macaca sylvanus*), Galen's favorite subject for dissection—though not for vivisection.



10.10 Opened heads of a monkey and a dog, from a French manual on vivisection of 1882. Galen, too, dissected the brain; he also exposed it in living animals.

apes."[54] The text goes on to recommend that all cuts should be performed swiftly, without pity or compassion (Fig. 10.10).

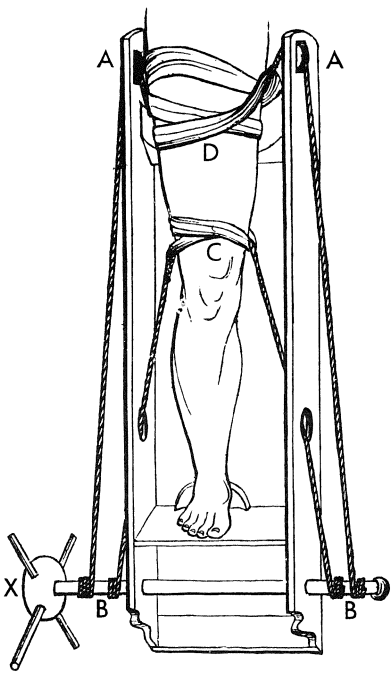
Galen's pitiless approach allowed him to make his most important discovery. He was vivisecting a pig. To find out whether the nerves in the region of the neck had any effect on respiration, he was cutting them one by one. The pig squealed helplessly, despite a slave who tried to muzzle it. Suddenly, as Galen cut one of the two nerves now known as "recurrent" or



10.11 Two U-shaped cords (black) occur on either side of the neck. Each one is formed by the vagus nerve (V), running downward, and by one of its branches, Galen's recurrent laryngeal nerve (L), returning upward. Galen was intrigued by the peculiar course of the laryngeal nerves along this route: instead of taking the shortest path from the brain to the muscle (M) in the larynx, they travel within the vagus down into the chest, turn around a large artery, and come back up to the larynx—(A) aorta, (B) a branch of the aorta, (T) thyroid.

"inferior laryngeal nerves" (there is one on each side), the squealing stopped. The experiment was repeated on dogs, goats, and other animals. The result was always the same: *the recurrent laryngeal was the nerve of the voice.*[55] This was a revolutionary experiment, for it proved beyond doubt that the brain was in charge. According to the ancient theory of Aristotle, mental faculties resided in the heart; that theory was now finished for good.[56]

Galen's scalpel, and Galen's pen, became busier than ever. Knowing his connections with the arena, where wild animals were killed by the thousands, it is not altogether unexpected to read that the nerve of the voice is easily demonstrated in the lion.[57] Whether the lion's roar could also be dampened is left to the reader's imagination; but Galen had several opportunities to see his nerve sectioned, and his theory confirmed, on live people. One of them was a child who had a large goiter removed by another physician (whereby we learn, incidentally, that this operation—already mentioned by Celsus—was being performed routinely). The operation was successful, but the child remained mute: both nerves had been cut.[58]



10.12 The *glossocomion,* for reducing fractures. For a fracture between points *C* and *D,* if the wheel *X* is turned clockwise, *C* and *D* will be drawn apart. In other words, the rope can pull *down* on *C* because it loops around the bar *BB.* In the same way, says Galen, the recurrent laryngeal nerve has to loop down and up around an artery in order to pull at the laryngeal muscles (a blunder, but the analogy made sense in the context of Galen's physiology).

Then Galen went one step too far. He felt compelled to prove that these laryngeal nerves, like all other parts of the body, were laid out in the best possible way; yet here was a very peculiar arrangement to explain. Why would a nerve, coming down from the brain and aiming for the larynx, descend first into the chest, curl around a large artery, and then return upward to the larynx? (Fig. 10.11).

It is all too easy to say, now, that the reason is purely accidental, being due to displacements of organs that take place during embryonic development. Galen's physiology was so primitive that it ignored even muscular contraction; and surely it had no place for accident. So Galen worked out the problem as follows. He pointed out that the muscle, in which the laryngeal nerve ends, runs vertically (Fig. 10.11). Thus, the pull "of its tendons"—in Galen's way of thinking—has to occur vertically. The nerve that causes the pull must therefore line up with the direction of the muscle; so it makes "perfect sense" that it should first run down to the chest, use a large, strong artery as a pulley, and return upward vertically.

To give a practical example of his pulley theory, Galen used the comparison of the *glossocomion,* a machine worked by a crank, vertical ropes, and pulleys, used in his day for reducing fractures of the femur and tibia (Fig. 10.12). Placed side by side, the two situations illustrate well the seduction of analogy. Although hopelessly wrong, Galen had achieved his ultimate purpose: to demonstrate that the use of the parts was, in his words, "a hymn of glory to the Divine Creator of Man."[59]

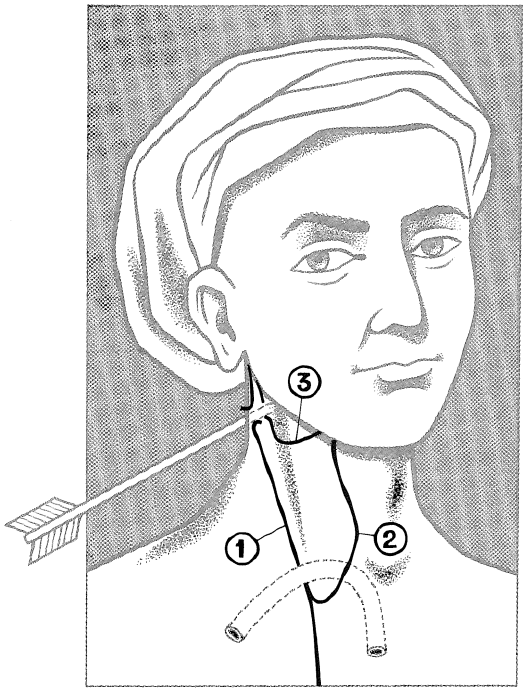
Galen's Nerve and the Hindus

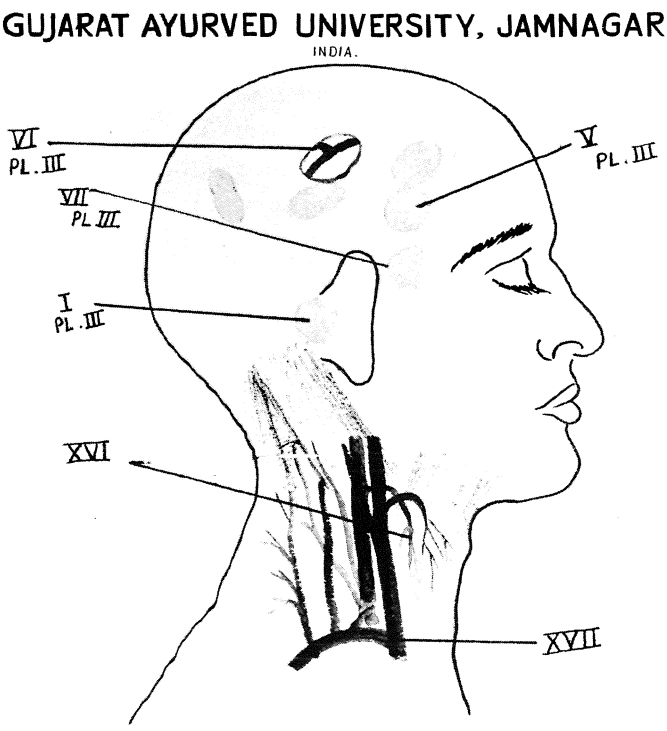
The recurrent laryngeal is now known as *Galen's nerve.* Galen missed no opportunity to repeat that he was the first to discover its function. I wonder what he might have said if a visitor from India had told him that his famous symptom—loss of the voice—had been observed by the Hindus several centuries before, together with another symptom that he never even suspected. A visiting vaidya could have recited the passage from Sushruta's chapter concerning vital points or marmas:

> Now we shall describe the marmas which are situated in the regions above the clavicles . . . There are four Dhamani [*"ducts," nerves as well as arteries*] . . . on either side of the wind-pipe.[60] Two of them are known as *Nila,* and the other two as *Manya.* One Nilá and one Manya are situated on either side of the larynx. An injury to any of them produces dumbness, and change of voice (hoarsness), and also the loss of the faculty of taste.[61]

Galen could pinch his animals to make them squeal; he could threaten them to make them blink; but he could not ask them about taste. The Hindus, on their part, would not vivisect pigs; but they took lessons as they came from war casualties. Translated into anatomical terms, the symptoms they describe for an injury of the two marmas in the neck mean that an arrow, or any pointed weapon, plunging into the neck could sever one of three nerves on that side (Fig. 10.13): the glossopharyngeal, abolishing the

10.13 The hoarse voice, described by Galen after cutting the recurrent laryngeal nerve, had been observed centuries before by Sushruta in India after an injury to one of the vital points or *marmas* in the neck. (1) vagus nerve, (2) Galen's recurrent laryngeal nerve, (3) glossopharyngeal nerve.





10.14 Drawing of the marmas in the neck, from a contemporary Ayurvedic medical school. The number XVI corresponds to Sushruta's *Neela-Manya* marma, which, when hit, causes hoarseness and loss of the sense of taste. The modern topographic correlations are somewhat fanciful, but the marma, anatomically and functionally true, is still there: it preceded Galen's nerve by several centuries.

sense of taste on that side; Galen's recurrent laryngeal nerve, resulting in a hoarse voice; or the main trunk of the vagus nerve, again resulting in a hoarse voice (because this nerve also carries the fibers that branch off further down to become Galen's nerve; the symptoms, however, would be more complex than those resulting from a pure injury of Galen's nerve). If struck by a pointed weapon coming from the side, as illustrated, the victim might come away with a hoarse voice *and* a loss of the sense of taste, but still without a fatal injury to the major vessels that run close by.

Yet Galen could not have read Charaka or Sushruta, for they had never been written: they were just learned by heart in Sanskrit. And no visiting vaidya seems to have come within Galen's orbit.

Since Sushruta's medicine is still alive as Ayurveda, I wrote to India to have the last word on the topic of marmas in the neck. The Gujarat Ayurved University was kind enough to send me lists and charts of marmas, which show a clearcut effort to line up with modern anatomy and its Greco-Latin terminology. In one plate, on the side of the neck, appeared the same vital point described by Sushruta, where wounds cause loss of voice and taste; its name was unchanged, Neela-Manya marma (Fig. 10.14). The names of the deep anatomical structures—which explain the symptoms—were given in modern terms, including the glossopharyngeal nerve, which transmits the sense of taste. Oddly enough, Galen's nerve was omitted![62]

Galen on Inflammation: The True Story

To medical students today, the name of Galen should bring up at least two associations: Galen's nerve and *functio laesa* or "disturbed function," the fifth sign of inflammation. The discussion of Galen's nerve has shown that it was not Galen's alone. The story of Galen's fifth sign is even more heretical: Galen had practically nothing to do with it.

The notion of the fifth sign, as taught in pathology courses, can be summarized as follows. Celsus described the four cardinal signs of inflammation, REDNESS, SWELLING, HEAT, and PAIN; then came Galen, who supposedly added the missing fifth sign, DISTURBED FUNCTION, meaning that an inflamed part does not work as well as it should. I too have contributed to spreading this bit of lore. The concept of a fifth sign is definitely catchy. It is the adventure of a square becoming a pentagon. It sounds like progress. Everybody remembers it. How could a teacher forget it?

Eventually I decided to check the sources, and spent nights leafing through dusty Latin editions of Galen. There were pages and pages on *inflammatio;* but not the slightest hint about the discovery of a fifth sign. Nor was there any trace of the basic four signs, though they had been announced to the world by Celsus some 150 years earlier. Finally I realized that my search was pointless: Galen wore down many a Roman quill, consumed gallons of Roman ink, but took no notice of anything Roman, let alone of a Roman like Celsus, who had chosen to write about medicine in Latin.

The truth is, therefore, that Galen never added a fifth sign. He does mention "disturbed function" here and there—it would be difficult to write about medicine without using these two words—but never specifically as a symptom of inflammation. He never even mentions Celsus. Unnerving as this may sound, I hope the retraction reaches at least some of my former students.

The story of how the fifth sign actually originated furnishes first-rate material to anyone interested in the birth and survival of medical legends. It was another great man, Rudolf Virchow, who first spelled out the functio laesa as a fifth sign. I found the reference by sheer accident, staring out of a page in that epoch-making book called *Cellularpathologie,* "Cellular Pathology," a collection of lectures published in 1858, which was instantly accepted as the cornerstone of modern pathology:

> Nobody would expect a muscle which is inflamed, to perform its function normally . . . Nobody would expect an inflamed gland-cell could secrete normally.
>
> Now there can be no doubt . . . that —a point upon which all the more recent schools at least are agreed—to the four characteristic symptoms [*of inflammation*] *lesion of function* (functio laesa) must be added.[63]

It "must" be added, says Virchow, and it was. His wording shows that the fifth symptom was already in the air; but his authority had the effect of transforming a vague notion into general law. The impact of statements issued by Virchow, their metamorphosis into law, is a unique phenomenon in the his-

tory of pathology. After publication of the *Cellular Pathology*, Virchow's fame became so overwhelming that anything he wrote or said spread throughout the medical world and became absorbed as diffuse, nonspecific medical knowledge. Thus, within six years of 1858, the author of a pathology *Handbuch* quoted the fifth sign, functio laesa, as general knowledge (and gave it no father). Then the fifth sign carried on with varying success until a mutation occurred in 1919: the author of another *Handbuch*, presumably recalling that the functio laesa had sprung up somewhere in the great and nebulous past, skipped from Prussia to Pergamon—and assigned the fatherhood to Galen.[64]

So this is the true story of the fifth sign. But it may come too late to straighten out the textbooks. A brilliant journalist once tried to recall a hoax of his own, perpetrated through the newspapers; he never succeeded: it had become too true in the process.[65] And nobody will ever undo the myth of Galileo dropping cannonballs from the Leaning Tower of Pisa.[66]

Galen on Bites and Poisons: The Theriac Saga

I do not wish to sound destructive, but another undeserved gem in Galen's crown is "Galenic" drugs. A course in Galenic pharmacy is still given at the University of Geneva; it deals with drugs extractable from plants; yet the word *Galenic* cannot be traced back to any particular kind of drug discovered by Galen (*Galenic* has become a loose term, says George Sarton, "the semantic variations of which are difficult to follow.")[67]

Although he did not push back the frontiers of pharmacology, Galen contributed a great deal to the success of the dreadful concoctions called theriacs, creating his own brand which somehow rose to the rank of Top Drug.[68] Its incredible career deserves to be mentioned here, because it betrays the ancient fear of bites and poisons.

Today we can no longer appreciate the ancient concern with being bitten.[69] There was a *Book of Bites* in Egypt. The herbal of Dioscorides, from the first century A.D., mentions bites 329 times.[70] After his chapter on wounds, where a modern treatise might proceed to discuss burns, Celsus continues: "I have spoken of those wounds that are mostly inflicted by weapons. My next task is to speak of those that are caused by the bite, at times of a man, at times of an ape, often of a dog, not infrequently of wild animals or of snakes. For almost every bite has in it poison of some sort."[71]

Note the mention of human bites, and the fear of poison in every bite. Galen informs us that when his mother lost her temper with her servants, she used to bite them.[72] According to Pliny, "the bite of a human being is considered to be a most serious one."[73] Human teeth, he explains "contain some sort of virus [*poison*], for they dim the brightness of a mirror when bared in front of it, and also kill the fledglings of pigeons."[74] The wounds they leave are conveniently treated with ear wax, if possible from the ear of the bitten.[75]

Ear wax apart, Pliny was right: human bites are still a very serious injury, indeed worse then dog bites. Hear this from a modern textbook of surgery:

"The dog bite is considered to be a cleaner wound than the human bite . . . The human bite is a serious injury because of the tremendous number of organisms present within the mouth . . . The secondary infection as a result of the human bite is usually mixed, but the spirochete and the fusiform bacillus are frequently found, and these are thought to be responsible for the gangrenous character of the lesion . . . The patient should be kept under close observation following the human bite, since amputation of fingers, hand and arms may be necessary because of the rapid spread of cellulitis and gangrene."[76]

To return to antiquity, most bites were those of wild animals—in Greek *thería*—especially when Greek and Roman armies began to roam the world. Books appeared, called *theriaká*,[77] about dangerous beasts: snakes, angry mammals, rabid dogs. To cope with this threat, there grew up a special kind of drug, the *theriacs*, which had to differ from drugs for ordinary wounds because most bite-wounds, as Celsus explains in the passage above, were thought to be poisoned. Though worthless as antidotes, except perhaps psychologically, theriacs gave enough comfort to become very popular. By 50 A.D. the Roman traveler relied on his theriac as we now do on vaccination: "For your protection," writes Scribonius Largus, "also whenever you go to the country, I shall set down the making of theriac, a medicament for the bites and strokes of serpents" and scorpions.[78]

What happened thereafter to theriacs is almost incredible. At first they were used against bites, considered poisonous; then they began to be used against poisons in general; and finally they were used against anything. They became all-purpose drugs, mushrooming into one of history's best examples of the power of wishful thinking. They were always surrounded by an aura of legend, related to the gruesome tale of their "scientific" beginnings at the court of a Persian king: Mithridates, king of Pontus (132–63 B.C.).

Mithridates and the Drugs of Fear

It was actually poison, rather than bites, that worried this high-strung monarch. On the world scene he was one of Rome's fiercest enemies, famous also for his terrifying war-chariots, equipped with rotating scythes. A savage tyrant, but also one who passed from history to legend for his knowledge of twenty-two languages and his passion for things medical,[79] he studied poisons on a scale perhaps never matched. His guinea pigs were "criminals," whom he had poisoned or bitten by venomous beasts. Then he tested the effect of antidotes on them, and eventually compounded the best ones into a single drug for his own use. He had, in fact, good reasons to fear that someone might want to poison him. During the fifty-seven years of his thunderous reign he survived by killing four of his sons. In the end, defeated by Pompey and cornered by his fifth son, he had to take his own life; and tradition has it that being immune to all poisons, he was obliged to seek death by the sword.[80]

Pompey was careful to retrieve all of the books and notes that he could find in Mithridates' quarters, and Roman experts began to produce Mithri-

datic antidotes. They, too, had good reasons for being interested in antidotes: poisoning was becoming part of life. Just a century later Nero employed a professional poisoner from Gaul, named Locusta.[81] Meanwhile the *praegustatores* or "foretasters" grew into a guild with its own officials. In this serene environment the call for new and better "antidotes" was inevitably great.

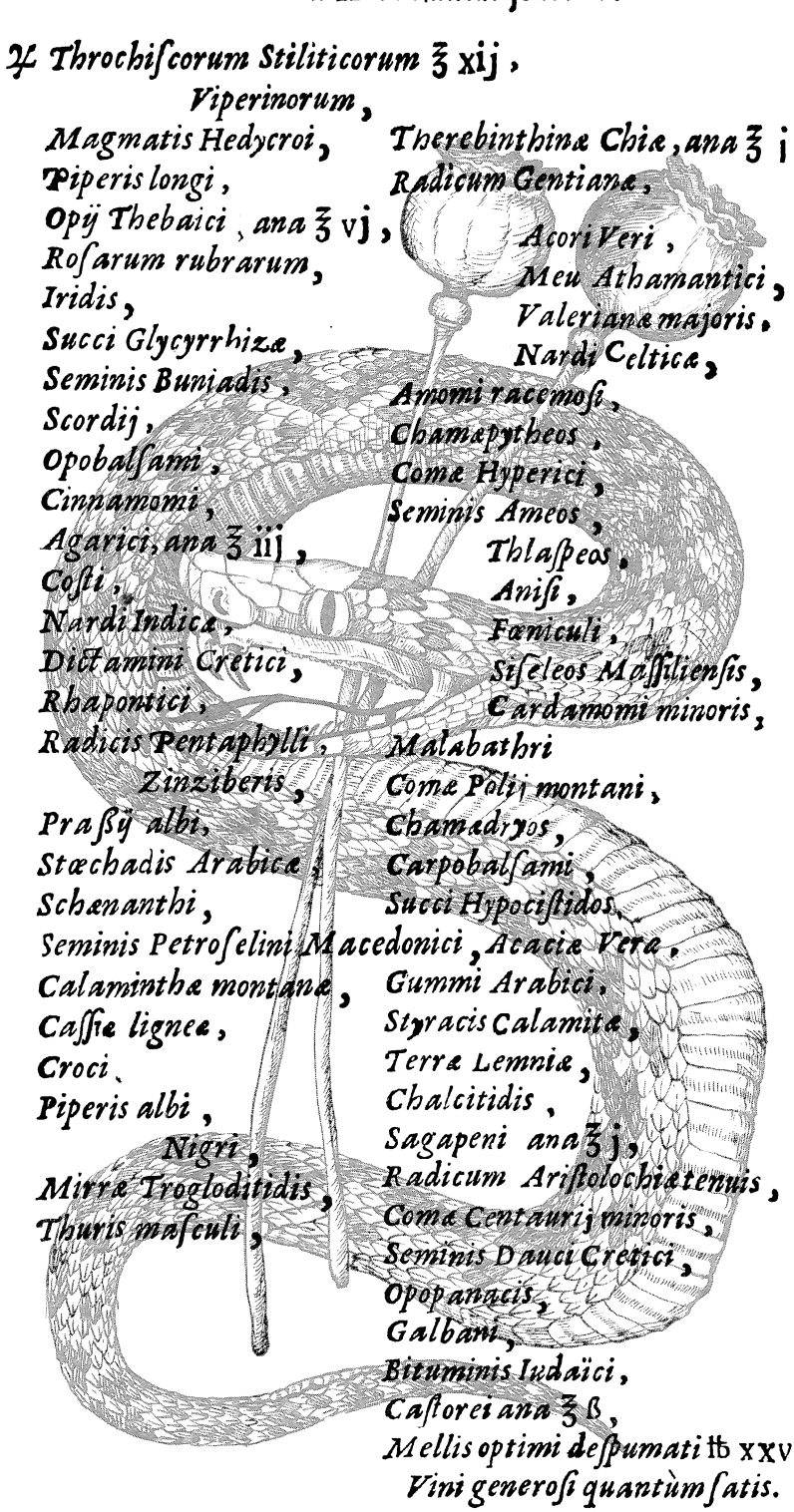
It was then that Nero's physician, Andromachus, delivered his inspirational masterpiece. He started out with a traditional "antidote" called *Mithridatium*, already effective because of its name and fame. Then he raised its level of complexity by bringing the number of compounds to sixty-four, enriched it with chunks of viper flesh, and multiplied the opium content by five. The new theriac truly deserved its name of *galene*, meaning "tranquility" (unrelated to the name of Galen). It was, in effect, an addicting tranquilizer (Fig. 10.15).[82]

From then on galene became the theriac par excellence, known simply as theriac, and there never was a more successful drug.[83] Galen wrote a whole book about it, called *Theriaké*. He accepted the addition of viper flesh as perfectly sound: was it not logical that the antidote, *theriaké*, should contain the *therion*, the beast itself?[84] He personally prepared it for three emperors. Production was a major enterprise, lasting a couple of months. The final product was supposed to mature for years, but Marcus Aurelius liked it fresh and possibly became an opium addict in the process.[85] Those who could afford it gulped down a bean-sized lump of theriac for practically everything from the Black Death to nothing at all, as a preventive. It also went into plasters. When applied over bites, according to Galen, "it drew out the poison like a cupping-glass."[86] Once he tried it over an abscess, because the patient's father was reluctant to allow an operation: "it divided the overlying tissues more quickly than a scalpel."[87]

Skip 1300 years, and the creation of Nero's doctor has become an object of major international trade, being taken to China as a gift to the emperor. The chinese called it *tê-ya-ka* (Fig. 10.16), and it seems that they were not overly enthused.[88] As to the Indians, I found no record of their buying theriac (though they surely did); but they had brands of their own. Charaka mentions an antidote called *Mahagandhahasti* with sixty ingredients, almost the same as its European analog.[89] Sushruta has a similar one with eighty-five ingredients.[90]

Theriac survived even the onslaught of the Renaissance, though there was much discussion about the brand of vipers and whether heads and tails should be included. In several European cities the making of theriac became an official ceremony, preceded by public display of the vipers and the sixty-three other ingredients. A visitor to Venice in 1646 came away with his supply of prized "Venice treacle," but also stayed for the "extraordinary ceremony thereof . . . for 'tis extremely pompous and worth seeing."[91] Theriac became almost synonymous with medicine.

Theriac died, but ever so slowly. The German official pharmacopoeia still included it in 1872, vipers and all; the French in 1884. By then you could order your *Theriaca Andromachi* by telephone (Fig. 10.17).



10.15 The drugs that went into *galene*, the classical theriac, according to a French *Pharmacopée Royale* of 1676. The drawing is a modern addition; it underscores the two most important ingredients: viper flesh, on which the myth of theriac was based, and opium, perhaps the only component that was medically—and commercially—effective.

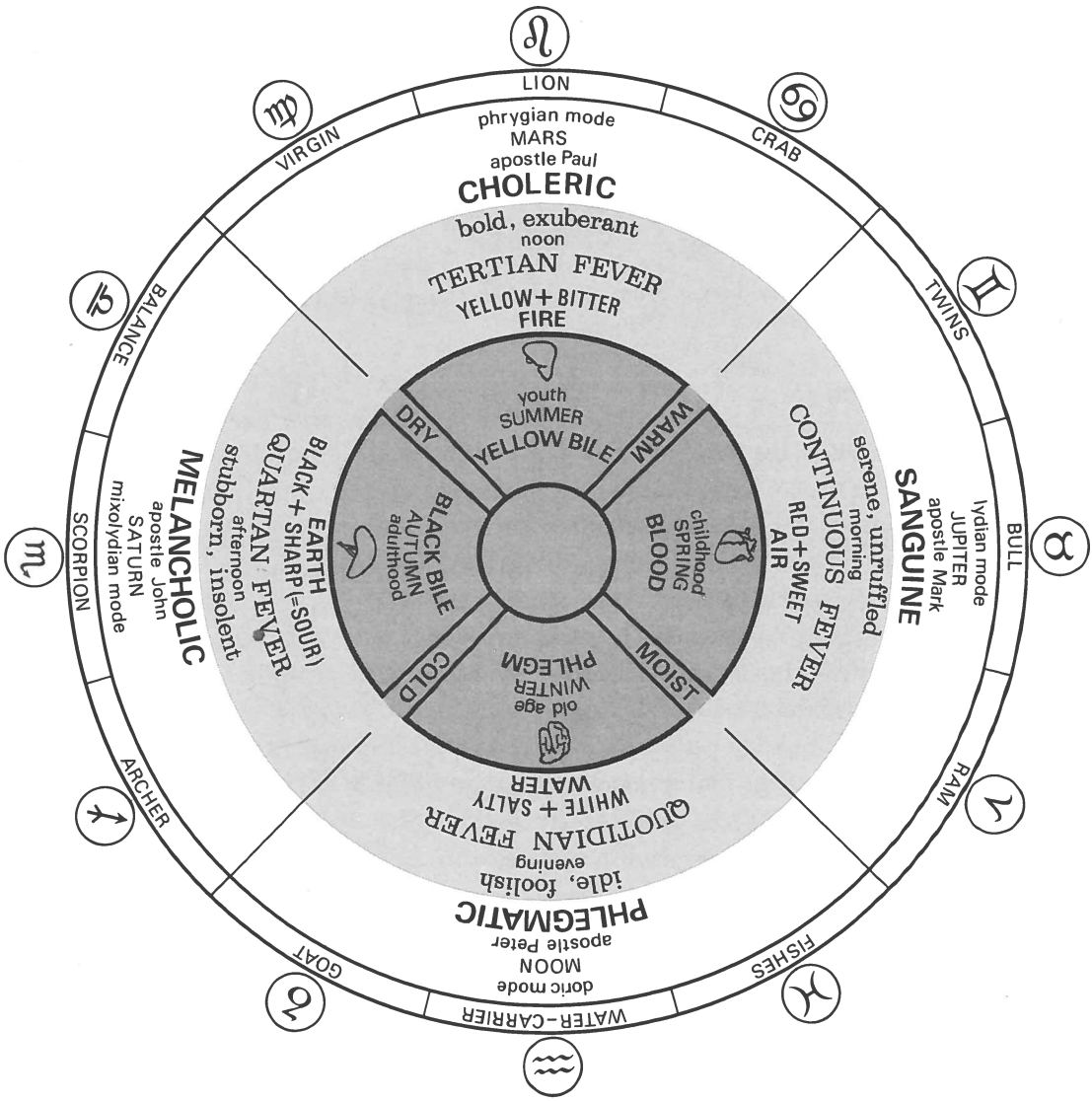
10.16 Theriac went as far as China, where it became *tê-ya-ka* (now *ti-yeh-chia*).

After Galen

After Galen, the history of the wound grinds to a halt for at least one thousand years. Europe sank into the Dark Ages; Indian surgery declined; even in China, where science advanced, surgery made no progress.[92] Only the number of wounds did not decline; for the wound remained, as I fear it always will, a basic means of human communication.

And wounds continued to become sores. For all of his greatness as an experimenter, Galen had left no message, and no surgical dressing, that really helped. His wound biology had moved not one step beyond that of Hippocrates. It could scarcely have been otherwise, for he had totally endorsed the hopeless theory of the four humors, and even built further upon it. Under his influence, during the Middle Ages the theory acquired still new layers, of no advantage to medicine (Fig. 10.18); it simply became an effort to fit man into the universe by a scheme of fours, the same as the Chinese were trying to do by a scheme of fives.

10.17 The theriac contained in this pot may have been on sale one hundred years ago.



10.18 The Hippocratic scheme of the four humors (dark gray ring) and its growth through the ages. Galen added some correlations (light gray ring); others accrued in the Middle Ages (white ring), in an attempt to fit man's microcosmos with the universe. This scheme of fours recalls the Chinese fivefold scheme (Fig. 6.20).

Galen's handling of the wounded patient, as of the sick in general, remained as bad as ever. Even his diets were unhealthy. In this respect he was again following in the footsteps of Hippocrates, whose strong interest in diet, usually hailed as a great advance, was actually a road to vitamin deficiency. The Hippocratics found fault with most vegetables, and fruits were considered even worse. The prejudice against fruit is also echoed by Pliny: spring apples are harmful, pears are indigestible even to the healthy, plums and cherries are bad for the stomach, walnuts poison the brain.[93] The prevalence of bladder stones in children, a condition now almost unknown, was probably due to lack of vitamin A. The risk of vitamin lack was probably greater for the rich, for only they could afford the optimal Greek diet—mainly meat.[94]

Besides the drugs, which were generally useless or dangerous, Galen's treatment rested again on that indefensible Hippocratic triad: STARVING, PURGING, BLEEDING. Galen became, most unfortunately, the apostle of the bloodthirsty school. There was in Rome at that time a group of physicians who followed the conservative line of Erasistratos, opposed to bleeding. They infuriated Galen to such a degree that he wrote the book *On Venesection Against Erasistratos,* besides a pamphlet, *On Venesection.*[95] How could anybody be so thick-headed as not to understand that *ulcers called for bleeding?* Here is a case he gave to prove the point:

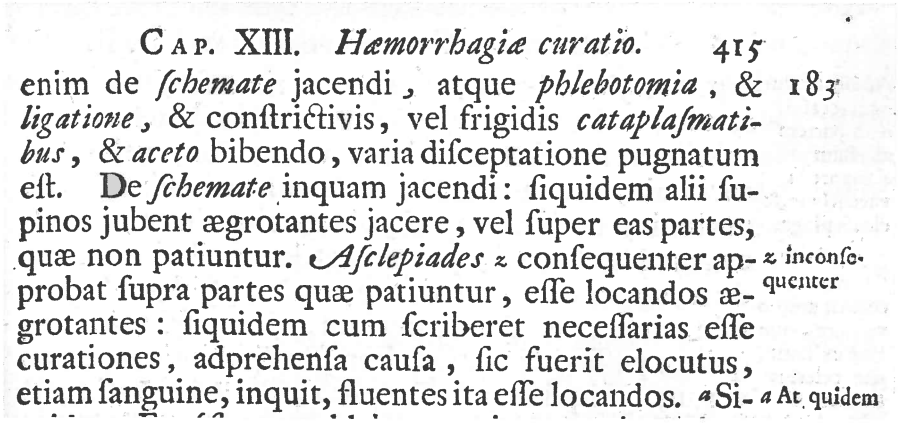
> After a man had an ulcer on his thigh for a long time, the veins lying above it which were varicose, were excised. Immediately the ulcer healed. Yet the incision by means of which the veins were removed did not get well. Later in the year, one of my preceptors at Pergamum, Stratonicus, a disciple of Sabinus Hippocrates, opened a vein at the elbow, and when he saw the escaping blood thick and black he repeated the venesection for four days. In addition he purged the black humor by medicaments, prescribed a nourishing diet, and thus healed the ulcer.[96]

The conservatives lost the battle. Venesection for ulcers was so easy to rationalize: injury attracted blood (everybody could see that); blood stagnated around the injury and decayed (everybody could see the decay too); so blood had to be drained out before it decayed. The Hippocratic books had spelled out the theory; the Alexandrians had reinforced it; Galen, who gave it the final touches, thereby became responsible for rivers of blood—and for cemeteries prematurely full.

Bleeding for wounds and ulcers alone would have been bad enough; but remember that interesting Hippocratic remark to the effect that *every* disease may be considered as a wound of some sort. Galen followed this trend, bled for practically every disease—*and even bled for bleeding.*

This paradox became standard practice; three centuries later we find it recommended by Caelius Aurelianus, an eminent compiler (Fig. 10.19):

10.19 The Hippocratic principle of curing hemorrhage by bleeding, as recommended by Caelius Aurelianus in the fifth century A.D.



CAP. XIII. *Hæmorrhagiæ curatio.* 415

enim de *ſchemate* jacendi, atque *phlebotomia*, & 183
ligatione, & conſtrictivis, vel frigidis *cataplaſmatibus*, & *aceto* bibendo, varia diſceptatione pugnatum eſt. De *ſchemate* inquam jacendi: ſiquidem alii ſupinos jubent ægrotantes jacere, vel ſuper eas partes, quæ non patiuntur. *Aſclepiades* z conſequenter approbat ſupra partes quæ patiuntur, eſſe locandos ægrotantes: ſiquidem cum ſcriberet neceſſarias eſſe curationes, adprehenſa cauſa, ſic fuerit elocutus, etiam ſanguine, inquit, fluentes ita eſſe locandos. a Si-

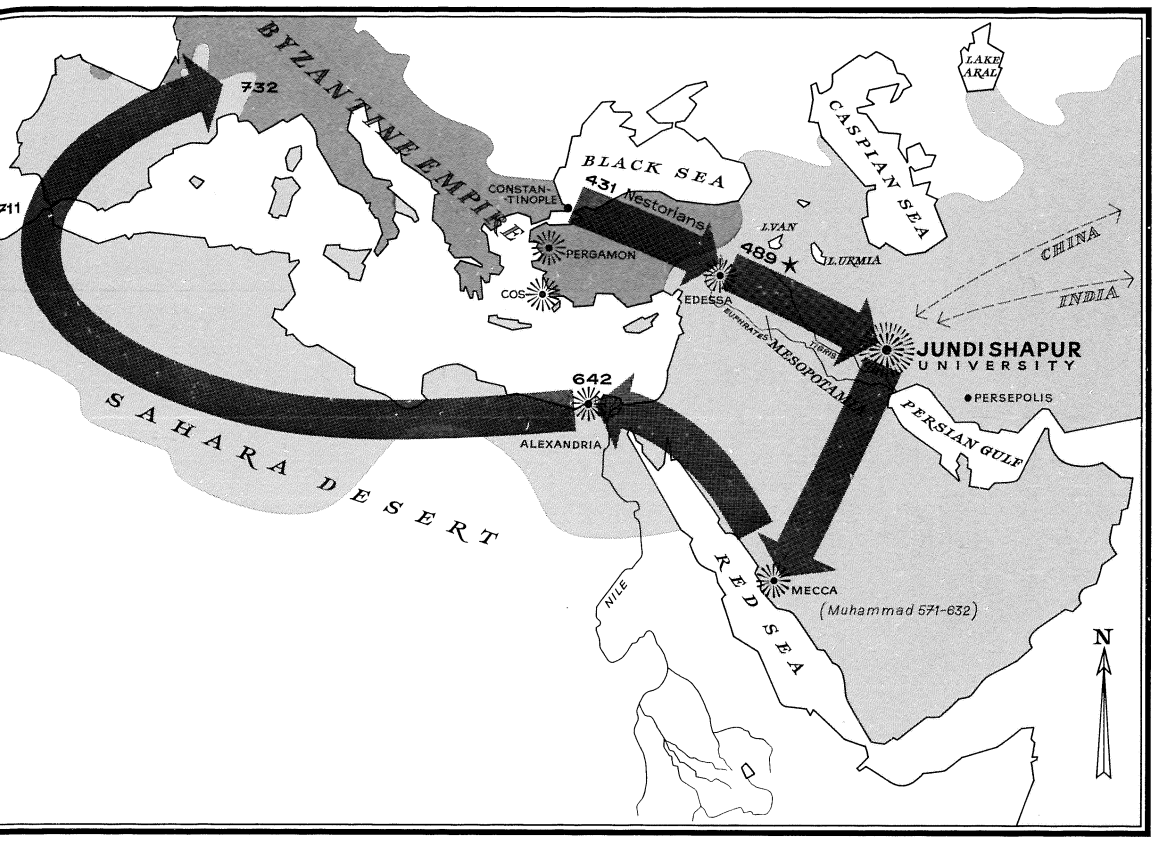
z inconſequenter

a At quidem

under the heading *Haemorrhagiae curatio,* "Treatment for Bleeding," he lists *phlebotomia,* "venesection"! The hemorrhage here meant by Caelius Aurelianus is from the lungs (presumably in tuberculosis), but the reasoning applied to any form of bleeding. The paragraph concludes that not everyone who bleeds should be bled, but those who are not "are deprived of a great help."[97] Medicine never produced a greater absurdity.

All this was, in essence, a revival of Hippocrates. Centuries passed. The Roman Empire broke up. The flame of Greek medicine flickered, but never died out. Three times at least it was revived. The first revival occurred in Persia, between the fifth and tenth centuries; the second took place in Europe when the printing press first made the texts more easily available; the third came in the early 1800s, as a reaction to despair. It happened in Paris, where medicine seemed to have run aground. Operations that had been routine at the time of Hippocrates could no longer be performed, because the patients died of infection. As for drugs, it was more and more obvious that they were worthless.[98] In this gloomy state of affairs a learned physician, Emile Littré, decided that it was time to return to the original sources and make them available to everyone, even to those who could not read Greek or Latin. So he gave twenty-two years of his life to translate all the works of Hippocrates. When he finally came to the last page of the tenth volume, in 1861, it was just too late: Claude Bernard, Virchow, Pasteur had broken the impasse—and the new word was to look forward. Hippocrates and Galen had stepped out of medicine and into history.

To end, I must pay tribute to the earliest and most important revival of Greek medicine: its reappearance in oriental dress, during the Middle Ages, in one of the most interesting and least known detours of history—the Nestorian epic.[99] In the year 431 A.D., a church crisis ended dramatically at the Council of Ephesos when Nestorios, the tough patriarch of Constantinople, was excommunicated for heresy. He maintained that the divine and human persons were not entirely merged in the person of Christ, and especially that Mary should not be called *Theotókos,* "Mother of God," as was then customary. Nestorios was exiled, and died—probably in Egypt—in 451. His followers, the first Nestorians, were forced to flee. Their first refuge was among the erudite monks of Edessa, in upper Mesopotamia (Fig. 10.20). But the long hand of the church reached them even there and caused them to scatter as far as India and China. One group found permanent asylum in Persia, thanks to its tolerant king. They settled in his capital, Jundi Shapur, an ancient and beautiful city not far from Susa, with a university and a hospital that functioned also as a medical school. Happily transplanted, the Nestorians flourished. Partly through their influence, partly through its fortunate circumstances, the University of Jundi Shapur became one of the leading intellectual centers of the time. Its geographical setting allowed it to become a unique meeting point of cultures—Persian, Greek, Alexandrian, Jewish, Hindu, and Chinese—and its tolerant atmosphere allowed scholars of different creeds to work together in peace, as nowhere else in the world. When the city fell to



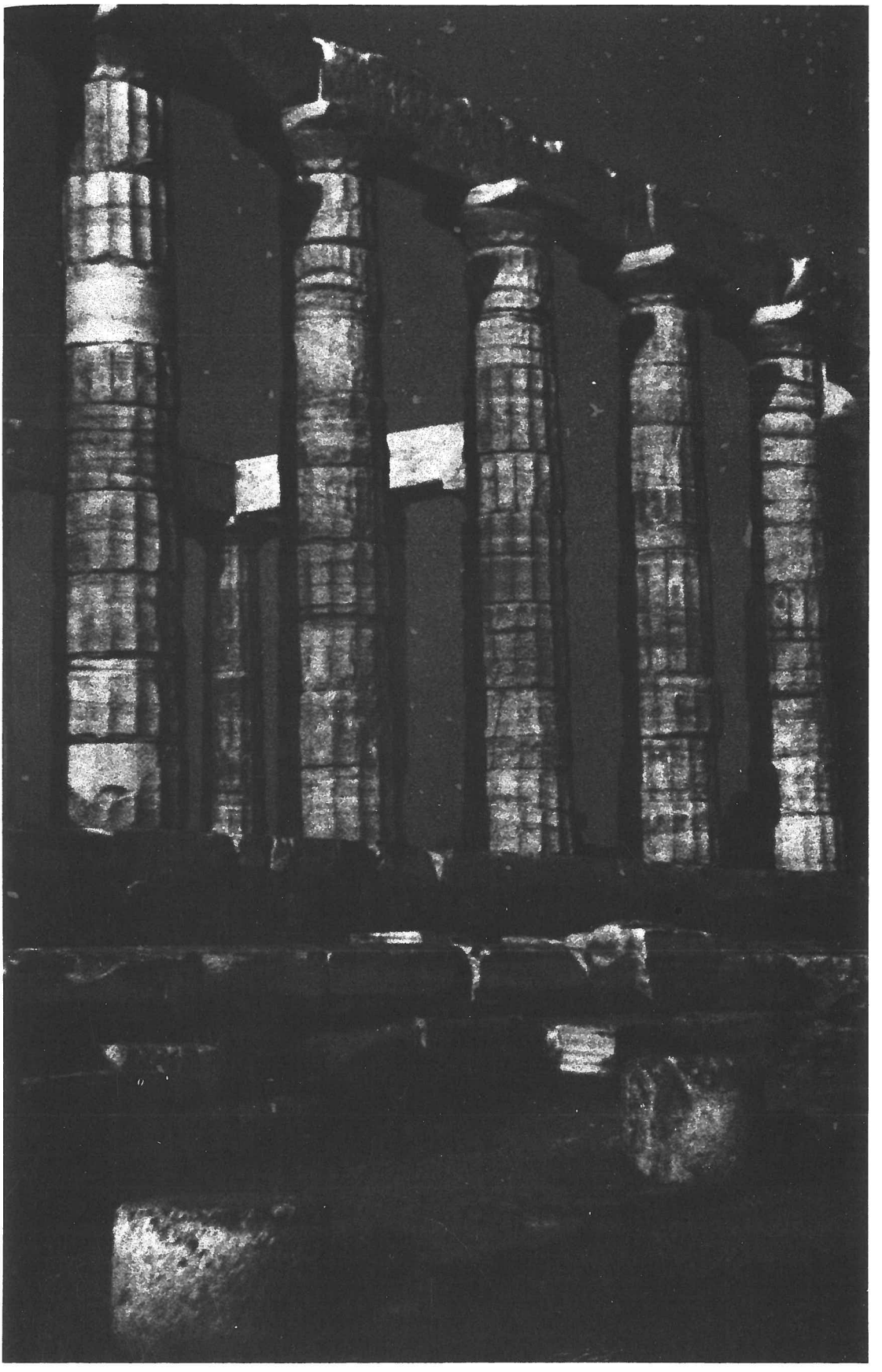
10.20 The route of Hippocratic medicine as it returned to Europe through the Nestorians, via the University of Jundi Shapur, and then the Muslims.

the Arabs in 636, the university was not disturbed; in fact, the conquerors adopted it and made of its medical school their principal training center.[100] Two of the Prophet's physicians were graduates of Jundi Shapur. All the while, the Nestorians were performing a huge bibliographic task: translating Greek books into Syriac, the language of the university. Hippocrates and Galen were among their first translations. Then Muslims worked at Arabic translations of the Syriac. Eventually a large body of Greek literature became available in Syriac and Arabic.

Toward the end of the tenth century Baghdad, having become the capital of the caliphate, began to drain away the talents of Jundi Shapur. The end came fast. Today, nothing is left of that glorious city except for a few vague trenches in the ground.

The adventure of the Nestorians explains why some Greek works have come down to us ultimately as Latin versions from an Arabic text translated from the Syriac. A new book of Galen, in Arabic, was discovered in Constantinople as late as 1931.[101] The Nestorian experience also explains why the great Arabic physicians—Rhazes, Avicenna, Albucasis—not only revered the Greek masters, but spoke their same words, and tempered them with Hindu medicine.

It is not known whether the Nestorians of Jundi Shapur and their colleagues made any original discoveries in the field of medicine. But this is irrelevant, for they were foremost among that crowd of unknown, unsung scholars who, during the so-called Dark Ages, cared to transmit the knowledge of antiquity. Without their labors, some of our roots would have withered—and much of the story that I have shared with you in this book could not have been told.



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2. The Asu

For a general background on Mesopotamian civilization, Oppenheim's *Ancient Mesopotamia* is an excellent eye-opener, expressly written to communicate with non-Assyriologists. It includes a chapter on medicine (see also Meissner 1920; Saggs 1962; Mallowan 1965; Chiera 1966). Oppenheim belongs to the "pessimistic" school of Assyriologists who feel that very little is known about the people of Mesopotamia, hence the subtitle of this book, *Portrait of a Dead Civilization.* Its contents, however, will convince the reader that an awful lot is known; in fact, I was amused to find that in the French translation the subtitle is *Portrait of a Civilization* (Oppenheim 1970). Another book of absorbing interest, in which Akkadians *really* come alive, is Oppenheim's *Letters from Mesopotamia* (1967). Kramer's *History Begins at Sumer,* very much an example of the enthusiastic school, offers a gripping portrait of Sumerian life. On Mesopotamian medicine the papers of Labat, and his *Treatise of Prognoses,* are a must; Contenau's book on Assyrian and Babylonian medicine is useful, though old; so is Sigerist's chapter on Mesopotamian medicine (in which the translations would need to be revised, and the religious aspects of medicine are erroneously emphasized; see Biggs 1969 p. 95). Some of Thompson's pioneer studies have become so outdated as to be dangerous in the hands of a layman. Köcher's several volumes of medical texts in cuneiform may contain treasures, but Assyriologists have not yet come around to translating them. In general, the bulk of data on Mesopotamia is enormous, but that on medicine limited; one is forced to admit that it is inadequate for tracing a real, continuous history over three-thousand years. Without joining the pessimistic school, I believe one should always keep in mind Oppenheim's closing lines: "This material covers only a restricted area and period, permitting but an occasional insight into a perhaps unique situation whose relationship to the over-all picture can well be likened to an accumulation of irregular blotches and short lines meandering from nowhere to nowhere . . ." (Oppenheim 1964 p. 334).

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3. *The Swnw*

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4. The Iatrós

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Abbreviations and Phonetic Notations

ḫ	should be read *ch* as in *Bach*
š	should be read *sh* as in *shell*
ṣ, ṭ	harder sounds than *s* and *t*
ṁ, ṃ	nasalize the preceding vowel (much like *n* in the French *sans*)

A	Adams translation of Hippocrates
AMT	*Assyrian Medical Texts*, Thompson 1923
AUB	Auboyer, *La vie quotidienne dans l'Inde ancienne*, 1961
CAD	*Chicago Assyrian Dictionary*
CB	*Chester Beatty VI Medical Papyrus* (Jonckheere 1947)
CDM	Celsus, *De Medicina*
ChS	*Charaka Samhita*
CU	Chamfrault and Ung Kang-Sam translation of the *Nei Ching*
DB	*Dictionary of the Bible* [*The Interpreter's*]
Eb	*Ebers Papyrus* (+ paragr. + No., as standard in GMÄ)
EE	Edelstein and Edelstein, *Asclepius*, 1945
EG	*Egyptian Grammar*, Gardiner 1966 (+ page)
FH	Flückiger and Hanbury, *Pharmacographia*, 1879
GMÄ	*Grundriss der Medizin der alten Ägypter*, Grapow 1954–1962
IG	*Inscriptiones Graecae*
Il	*Iliad*
K	Kühn edition of Galen (+ vol. + page)
L	*London Papyrus* as quoted in GMÄ
LB	Loeb Classical Library edition (of any author previously mentioned)
LH	Lucas and Harris, *Ancient Egyptian Materials and Industries*, 1962
LS	Liddell and Scott, *Greek-English Lexicon*
LTT	Littré edition of Hippocrates
MEA	*Manuel d'Épigraphie Akkadienne*, Labat 1952
NC-LS	*Nei Ching, Ling Shu*
NC-SW	*Nei Ching, Su Wên*
NEED	Needham, *Science and Civilisation in China*, 1965–
Od	*Odyssey*
PNH	Pliny the Elder, *Natural History*
PW	Pauly-Wissowa, *Realencyclopädie*
Sm	*Smith Papyrus*
SS	*Sushruta Samhita*
Ve	Veith translation of the *Nei Ching*
W	*Wörterbuch der Ägyptischen Sprache*, Erman and Grapow

Notes to the Text

1. Prelude

1. An eminent pathologist, Burt S. Wolbach, wrote, "I get satisfaction in believing that the adaptation of marine creatures to terrestrial conditions was the result of eons of responses in myriads of survivors of non-lethal injuries" (Wolbach 1954). The thought that disease helped life is definitely flattering to a pathologist.

2. Jaeger 1944

3. For more details on wound healing see e.g. Florey 1970 Ch. 2, 3, 17; Ross 1969.

4. Majno and others 1971; Gabbiani and others 1972

5. Guex 1967

6. In Dart's original works the australopithecines of South African caves are estimated to be about 750,000 years old. Means of absolute dating are not available in South African sites. I have adopted the more recent estimations, which assign to the earliest australopithecines an age of about five million years (Howells 1973 p. 51), to those of South African caves about three million (Howells 1973 p. 61).

7. See all refs. to Dart; also Ardrey 1967, a highly readable but now seriously outdated account.

8. Dart 1949 p. 11; Ardrey 1967 p. 192 ff.

9. Dart 1949, 1957; Ardrey 1967 p. 194

10. Ardrey 1967 p. 31: "weapon fathered man." Ibid. p. 186: "a philosophical bomb, a positive demonstration that the first recognizably human assertion had been the capacity for murder."

11. Howells 1973 p. 45

12. A recent poll of opinions among anthropologists, regarding Dart's interpretation of australopithecine "culture," gave this odd result: of fifty scholars, only seven replied, and only one was clearly against (Wolberg 1970).

13. Kortlandt and van Zon 1969; Howells 1973 p. 46

14. Teleki 1973 plate 5

15. As of 1973, I find in Howells' *Evolution of the Genus Homo* (p. 129) this accepted fact: "australopithecines . . . began the expansion of cerebral control of manipulation (with the making of stone tools)."

16. Leakey 1932

17. PNH 11. 159/LB III 531

18. At first a British pathologist diagnosed the lump as a sarcoma (Lawrence 1935). Microscopic sections, however, show a "large number of fragments of lamellar bone, well-organised and scattered throughout the mass." This is not consistent with a malignant tumor, nor is it typical of a simple callus: the likeliest alternative is a fracture followed by osteomyelitis. I am indebted to Dr. P. V. Tobias for allowing me to quote this unpublished story.

19. Some sort of language communication may have started as far back as the australopithecines (Howells 1973 pp. 135, 144).

20. Howells 1973 p. 3

21. Howells 1967 p. 202; Solecki 1960

22. Only the skull of the Shanidar cripple has been published in detail (Stewart 1959); a description of the withered arm should follow (Stewart, personal communication).

23. Solecki 1960 p. 619

24. Solecki 1957 p. 63

25. Solecki 1971 p. 196

26. Solecki 1960 p. 619; 1963 p. 187; 1971 p. 196

27. Stewart 1969 p. 52

28. Solecki 1960 p. 619

29. Wells 1965 p. 48. Arrowheads and spearheads stuck in human bones have been found all over the world. See e.g. Cartailhac 1889; Miller 1913; Rouillon and Baudouin 1924; Morel and Baudouin 1928; Pales 1930; Morel 1951; Underwood 1951; Klindt-Jensen 1957 p. 55; Tasnádi-Kubacska 1962; Wells 1965.

30. Wells 1965 p. 33

31. Lorenz 1952

32. Ackerknecht 1946

33. For the references on apes I am indebted to Dr. Konrad Lorenz and to his collaborator Dr. Margret Schleidt. Bourne (II 273) on chimpanzees adds no new facts. The episode of dental care described later in the text seems to be the only new observation since Miles.

34. Goodall 1965; van Lawick-Goodall 1971

35. Excerpts of personal letters (13 April 1969, 30 November 1973) with kind permission of Baroness van Lawick-Goodall.

36. Miles 1963 pp. 841–842

37. Koehler 1927 p. 308

38. Barbers (or surgeons) wishing to refute the comparison with apes should address their complaints to Prof. Jean Posternak, Dept. of Physiology, University of Geneva. It was he who suggested the link, at first as an after-dinner joke.

39. McGrew and Tutin 1972, 1973

40. McGrew and Tutin 1973

41. Schultz 1939

42. Schultz 1969 p. 195

Notes to pages 8–15

43. Bartels 1893 p. 283; Morice 1901 p. 22; Lindblom 1920 p. 312; Ackerknecht 1946; 1967; 1971 p. 95 ff.

44. Howells 1967 p. 206

45. The oldest bandage from the New World comes from Peru and may be 1500 years old. It is a cotton roll about 1 inch high, which was wound around the skull and held in place by strands of a woollen cord (Moodie 1926).

46. On the historic role of resins see Ch. 5. Neolithic man definitely used resin to fix in place the flint teeth of sickles (LH 1–9; see also Levey 1959 p. 77).

47. Discussed in Ch. 7.

48. Ackerknecht 1967 p. 636

49. The earliest evidence of cauterization is rather shaky: a strange type of lesion found on certain Neolithic skulls and shaped like a *T*, hence called "Syncypital T" (Manouvrier 1904).

50. Hare 1967 p. 115

51. Simpson 1967 pp. 79, 12

52. Barghoorn 1971

53. Correspondence with Dr. J. W. Schopf, author of the electron micrograph shown in Fig. 1.11, convinced me that these tiny bodies are indeed bacteria; color, resistance to mineral acids, electron transmissibility, combustibility, etc., all suggest a biogenic origin (see also Schopf and others 1965; Barghoorn 1971). Previous experience had made me skeptical, for the "fossilized bacteria" (Bradley 1968) of which I requested a photograph turned out to be grains of dust by the time my letter reached the author.

54. Gilmore 1912; Moodie 1923 p. 245

55. Moodie 1923

56. While the evidence for *free* fossilized bacteria is convincing, there is no good evidence of bacteria in fossilized, infected bones (i.e. bones deformed by osteomyelitis). The "fossilized bacteria" described by Moodie in his classic *Paleopathology* (1923) could be a variety of artifacts.

57. Clement 1956; Hengen 1967a, b. The age of the carious teeth as earlier published was 500–600,000 years; I increased it to fit the new data on australopithecines (Howells 1973).

58. Weidenreich 1939

59. Straus and Cave 1957; Gorjanović-Kramberger 1906; Hengen 1969

60. McKenzie and Brothwell 1967

61. Leroi-Gourhan 1971

62. Leroi-Gourhan 1964 p. 95

63. Leroi-Gourhan 1958 p. 390

64. Verbrugge 1956; 1965; 1969

65. Leroi-Gourhan 1967

66. Janssens 1957 p. 320

67. Verbrugge 1969 pp. 237, 240

68. Leroi-Gourhan 1967 p. 110

69. Hands—prehistoric, mutilated, or just artistic—have become an almost full-time calling for Father Verbrugge of Compiègne (Paris), who assembled a vast literature (Verbrugge 1965; 1969; 1970), including a monograph on 4000 hand imprints from Australian caves. In Europe, prehistoric imprints of hands have been found, strangely enough, only in France and Spain; "mutilated" imprints are clearly demonstrable in only 2 of the 22 caves. Some of the facts are certainly intriguing: at Gargas, for instance, of 138 hands, 124 are left hands, and the *left* hands are 67 to 1 on the *left* side of the cave (Verbrugge 1969 p. 62)—but then it might be impossible to tell right imprints from left if some were made backward, as Leroi-Gourhan suggested. One also has to be aware of fanciful interpretations, such as vertical imprints of stumps showing the scar (!) where the finger had been disarticulated (Sahly in Verbrugge 1969 p. 302). Skeletal remains might help, but nothing relevant has been found.

70. Janssens 1957; Verbrugge 1965

71. Sollas 1911 p. 240

72. Gardner 1963; Gardner and Heider 1968

73. For these details I am much indebted to my friend Robert Gardner. When the Dani were visited by the Harvard-Peabody New Guinea Expedition in 1961, they were Neolithic warrior-farmers almost virgin of contact with the outer world. The main body of the expedition departed in August 1961; within two weeks the Dutch police had "pacified" the area (Gardner and Heider 1968 p. xiv).

74. Gardner and Heider 1968 p. 101

75. Mennerich 1968

76. Bössneck 1971

77. Clark 1965 p. 63 ff., 76 ff.; Zeuner 1963 p. 55; Protsch and Berger 1973

78. The problem: not enough bones. Drew and others (1971) found the idea intriguing but could provide no supporting evidence.

79. For trepanation see the chapters by Lisowski and Margetts in Brothwell and Sandison 1967, which includes photographs of contemporary trepanations in Africa. For pre-Neolithic trepanation, see Dastugue 1959.

80. Wells 1965 p. 146

81. MacCurdy 1923 p. 260

82. Muniz and McGee 1897 p. 11; Daland 1936

83. MacCurdy 1923 p. 259

84. MacCurdy 1923

85. Hilton-Simpson 1922

86. Margetts 1967 p. 691

87. Stewart 1966

88. Fischer 1864 p. 598

2. The Asu

1. Gelb 1963. The invention of writing is usually credited to the Sumerians, but according to Oppenheim it is fairly certain that the Sumerians inherited the principle of writing from local, unknown predecessors (Oppenheim 1964 pp. 49, 237, see also Diringer 1968: I 17). Doubts were cast on the Sumerian priority by three mysterious "Tartaria Tablets" found recently in the ruins of a Neolithic village in the Balkans. They bear a few signs similar to those of the earliest Sumerian tablets but could be as many as 1000 years older (Hood 1968; Laki 1969).

2. Jacobsen 1968 p. 137

3. Contenau 1938 p. 1. This is the traditional view, supported by the fact that Sumerian settlements have not been found much downstream of Eridu; but see Parrot 1968 p. 39.

4. *Qanū*, the Akkadian word for reed, has the same root as the Greek *kánna*, the Latin *canna*, and the English *cane*. Many words of this Semitic language have roots that are familiar to us. Fat was *lipû*, which corresponds to the Greek *lípos*, hence the biochemical term *lipid*; *ellu* was oil, in Greek *élaion*.

5. Oppenheim 1964 p. 325

6. Piggott 1968. Wheeled transport seems to have appeared first in Mesopotamia. The event is neatly preserved in the evolution of a Sumerian pictogram, showing at first the royal sledge,  then the same but with two wheels added below  (Salonen 1951; Piggott 1968). Actual carts were found recently a few hundred miles east in Soviet territory (Piggott 1968); they do raise problems of priority, but they are not quite as old as the above pictogram. The Egyptians were unaware of wheeled transport until the Hyksos chariots stormed in about 1700 B.C.

Notes to pages 24–35

7. Oppenheim 1964 p. 282

8. Saggs 1962 p. 152

9. Neugebauer 1957 p. 229

10. Parrot 1949

11. Ceram 1967 p. 223

12. Parrot 1953 p. 78

13. Kramer 1956

14. Not much was thought of this "mythical" deluge until Sir Leonard Woolley made an awesome finding in the remains of Ur, the city of Abraham. His team had dug a deep pit through millennia of stratified debris. Suddenly, at a depth of forty

feet, all trace of human life disappeared: the spades hit a layer of pure clay. At first Sir Leonard thought that he had reached the virgin soil preceding human settlement. Its level, however, did not fit with his estimations, so he ordered the digging to resume, and eight feet deeper more pottery and stone implements reappeared. Presumably these represented people who had been wiped out by a tremendous flood, enough to bury much of Sumer under eight feet of alluvial deposit (Woolley 1965 p. 26; Ceram 1967 p. 309 ff.). Sir Leonard believed this to be the Flood echoed in the seventh chapter of Genesis. But later excavations in the same general area uncovered other deposits of the same kind, so that now we have too many Floods. Sir Max Mallowan recently concluded that Sir Leonard's flood (about 3500 B.C.) is too old; the right one should be another, dated about 2900 B.C. (Mallowan 1964). Others are not so sure (Raikes 1966), but what remains undeniable is that the Book of Genesis has its roots in the Sumero-Babylonian myth. For details see also Lambert and Millard 1969. For the actual Sumerian story of the Flood, see Civil 1969. For flood myths in other parts of the world and a skeptical view on Ut-Napishtim, see De Santillana and Dechend 1969.

15. See Lambert and Millard 1969; Ceram 1967 p. 275.

16. Biggs 1969 p. 102. An oft-quoted set of surgical instruments was first shown by Meyer-Steineg and Sudhoff in an illustration where nothing was said about them except that they were "found at Nineveh"—too little to work with, let alone to conclude that Akkadian surgeons "performed *cystectomies*" [*sic*, Thorwald 1962 p. 158].

17. Most of Assurbanipal's library is now at the British Museum. It is a worrisome fact that the soil of Mesopotamia preserves the tablets better than many museum shelves. Unbaked tablets must be de-salted and baked; otherwise, if they are allowed to dry, crystals form on the surface, break it up, and obliterate the writing. Only the great museums are equipped as required; scores of tablets turn to dust without ever having been read (Neugebauer 1957 p. 61). In any event, only a small fraction of the tablets found so far has been read and published; blame no one, they amount to nearly half a million, with more coming every year (Oppenheim 1967 p. 9).

18. Oppenheim 1964 p. 15

19. Oppenheim 1962

20. Thompson 1923—all in cuneiform!

21. Labat 1966 p. 93

22. Thompson 1907; Labat 1959

23. Labat 1951

24. Ritter 1965 p. 300

25. The exception is Biggs 1969.

26. Köcher 1963; 1964

27. Oppenheim 1964 p. 288

28. Labat 1957 p. 115

29. Thompson 1937 p. 235

30. Thompson 1907 p. 345

31. AMT 74, 11, 23; AMT 23, 10, 8; AMT 16, 5, 7. Trans. courtesy of Prof. Labat and Pablo Herrero.

32. von Soden 1965 p. 169

33. Labat 1964(b)

34. Ritter 1965

35. Thompson 1930 p. 1 No. 4

36. Thompson 1930 p. 2 No. 9

37. *Asû* or *azû* (long *û* but tonic accent on the *a*) is written as shown above the title of this chapter (the two parts stand for *a* and *su*). It does not mean "he who knows water," as usually stated (Contenau 1938 p. 30; Saggs 1962 p. 460). *A* does mean water, but this *zu* is not written like the *zu* that means "to know" (CAD 1968, asû A, p. 344, see also p. 347; Biggs 1969 p. 97).

38. Labat 1953 p. 17

39. Contenau 1947 p. 103

40. Ritter 1965
41. Oppenheim 1964 p. 295
42. Thureau-Dangin 1921; Contenau 1947 pp. 95, 180
43. Biggs 1969 p. 295
44. *Asa-* and *Rapha-* recall the names for physician in the Bible and the Talmud: *âsjâ, assĭa* (Preuss 1923; 1894) and *rōphē*. The name of Rapha, a Biblical figure, was probably also short for Rapha-El (Buttrick 1962). In the episode of the Bible (2 Chron. 16:12), Asa did not live up to his name of "God-heals": being "gravely affected with gangrene in his feet, he did not seek guidance of the Lord but resorted to physicians."
45. Oppenheim 1964 p. 293
46. Labat 1954 p. 207
47. All the techniques of the Akkadian physician, including cutting, have been gathered and analyzed by Pablo Herrero, whose thesis on this subject is forthcoming.
48. Labat 1954
49. Oppenheim 1964 p. 324
50. Scheil 1902
51. Trans. by T. J. Meek in Pritchard 1950
52. Harper 1904; Johns 1905
53. CAD A II 346, 5
54. Labat 1951 p. xxii
55. Labat 1954, Akkadisches Handwörterbuch
56. One silver shekel weighed about 8.5 grams (Hastings 1909 p. 627; Labat 1954 p. 209). To measure what it took to earn 10 shekels, according to law 228 of Hammurabi's Code: "If a builder construct a house for a seignior . . . he shall give him two shekels per sar of house." One sar was 42.2 square yards. According to law 274, if a seignor hired a carpenter, the fee was 4 se per day (one shekel = 180 se; Thompson 1925(b) p. 128).
57. Mendenhall 1954 pp. 32, 35
58. Biggs 1969 p. 100
59. Cardascia 1969
60. CAD Z 126: *ša zigni*, "bearded"
61. Oppenheim 1964 pp. 24, 276
62. Civil 1960; 1961
63. Kramer and Levey 1955; Kramer 1959; Civil 1960
64. The prescriptions from the Sumerian tablet, as quoted, are English versions of Civil's original French, corrected by Civil himself (two plant names had changed).
65. Civil 1960 prescr. 1.7
66. Forbes 1965 p. 277; Röllig 1970
67. Civil 1960 prescr. 3.1
68. Levey 1959
69. Civil 1960 prescr. 1.5
70. Contenau 1938 p. 68
71. Ritter 1965 p. 313
72. Labat 1961
73. Thompson 1924(b) p. 26 No. 28
74. Köcher 1955; Glotz 1968
75. Kramer and Levey 1955 p. 370; Levey 1959 p. 128; Forbes 1965 p. 261
76. Labat 1959 p. 5 No. 20–21
77. Levey 1955; 1959 p. 31 ff.
78. The evidence for soap making in the Sumerian tablet, though mentioned in Kramer and Levey 1955 p. 370, is thin. In Civil's latest translation, prescriptions 3.1 and 3.2 do contain products of the naga plant, which was used—fresh—as a source of saponine or—burned—as a source of alkali (personal communication from Dr. Civil; Civil 1960 pp. 64, 70). Neither plaster includes much fat, but both are followed by rubbing with oil, and the second one may include a resin. Essence is mentioned in prescr. 2.1 (ibid. p. 63).
79. Herrero, see note 47

80. Labat 1954 p. 216
81. Labat 1954 p. 217
82. Littré 1851 p. 227
83. Thompson 1937 p. 234; Labat 1954 p. 212
84. These two Akkadian operations, scraping the skull and cutting into the chest, are amply discussed in the Hippocratic works. Whether the Greeks learned them from the Akkadians is unknown. For actual trepanation of the skull there is no acceptable evidence from Mesopotamia, though instances are known for the first millennium B.C. in Palestine (Biggs 1969 p. 100). It is strange that this operation, which was fairly current in prehistoric times, encountered no favor in Mesopotamia and Egypt (the Greeks made up for it).
85. Labat 1954 p. 215
86. Labat 1954 p. 212
87. Labat 1954 p. 213
88. Isaiah 6
89. Preliminary experiments by Dr. D. Kekessy, Geneva.
90. DB III 592
91. This version of Arad-Nana's letter is a composite of three original translations: Labat's to French (Labat 1953 p. 10) and two others to English (Waterman 1930 p. 73; Johnston 1898 p. 163). The translation of Ritter (1965 p. 319) reads somewhat differently, but the essence remains the same. Unaccountably, "$\frac{5}{6}$ of a double hour" is explained as "80 minutes"; I took the liberty of changing this to 100 minutes.
92. Johns 1904 p. 375
93. Labat 1953 p. 11
94. Labat 1951
95. As translated by Saggs 1962 p. 462
96. Saggs 1962 p. 350
97. Limet 1960 p. 121; von Soden 1965 p. 739
98. Because of a passage in the History of Technology of Singer and others (1965 I 251), I thought for a while that the Akkadian word for inflammation might still be alive in our word *naphtha*, as "the burning thing" (naphtha surfaces spontaneously in Mesopotamia). According to those authors, the greek word *naphtha* goes back to an old Babylonian *naptu*, used as early as 2000 B.C., "from a verb meaning to *flare up, to blaze.*" Alas, they were wrong; there is no such verb. *Naptu* certainly became *naphtha*, but it has no known relationship to *napāḫu*.
99. AMT 35, 2, 2, trans. courtesy of Prof. Labat and Pablo Herrero
100. That *ummu* means the "hot thing" is certain: its first meaning is "heat," and it has the same root as the verb *emému*, "to be hot." There are other words for "fever," such as *la'bu*, *li'bu*, *ḫumṭu*, and *ḫimṭu* (Labat 1964a). Another word that can be rendered as "inflammation" is *ishātu*, originally meaning "fire"; sometimes it may be translated as "abscess" (Labat and Herrero, personal communication). *Kuraru* originally meant "(hot) embers"; when it is a skin disease it is usually translated as "eczema." Note that *carbuncle* is also a former "hot coal" that became a "furuncle."
101. Flower pot: Contenau 1927 p. 444; brasero: Contenau 1940 p. 59.
102. Thompson 1907 p. 345; Labat 1954 p. 212
103. Thompson 1931 p. 54 No. 4, ibid. No. 8
104. Labat 1951 pp. 79, 123
105. Labat 1951 p. xxv
106. Labat 1953 p. 21; 1951 p. xxii; White 1969
107. Labat 1951 p. 229 No. 96
108. Oppenheim 1964 p. 295
109. Labat 1962
110. Waterman 1930 p. 415 letter 586. See also Townend 1938.
111. Denton 1943
112. Labat 1951 p. xxii
113. Oppenheim 1964 p. 176

114. Thompson 1924(a)

115. Labat 1953 p. 18; 1966 p. 102

116. Jastrow 1917 p. 237. The Akkadian way of saying "anything" was "everything that has a name." For the importance of names in antiquity, see Contenau 1947 p. 127.

117. Jastrow 1917 p. 237

118. Labat 1959 p. 5

119. Oppenheim 1964 p. 314

120. Thompson 1924(b) p. 10; Levey 1959 p. 36

121. Levey 1959 pp. 65, 69; Oppenheim 1964 p. 81

122. Levey 1959 p. 69

123. This is the basic problem of antisepsis: to find a poison for bacteria (= bacterial cells) that is less of a poison for human cells. To some extent, all antiseptics are also harmful to the tissues. The best antibiotics have a special key to the bacterial cell. For example, penicillin prevents bacteria from building a new cell wall (a coating that man's cells do not have); thus, existing bacteria are unaffected, but new ones cannot form. A definition of antibiotic is difficult to give, but essentially it is a product of living cells that in low concentrations is able to inhibit the growth of other cells.

124. Thompson 1930 p. 11 No. 3

125. Osborn 1943

126. Nickell 1959

127. Nickell 1959 p. 282

128. Maksymiuk 1970

129. Iványovics and Horváth 1947

130. Flückiger and Hanbury 1879 p. 165

131. Labat 1953 p. 8

132. Ramparts were the distinguishing mark of cities in the Near East (with the possible exception of Egypt) from the third millennium B.C.; "it was the duty of the King to keep the walls in good repair and—correspondingly—to tear down those of conquered cities" (Oppenheim 1964 p. 127). The walls were made of brick, mostly unbaked.

133. Jean 1950 p. 211. For the reading "sling-stone" rather than "stone" as in the original translation, see CAD 1968, I, A, Part II, under *asû* A [a,2'] p. 345.

134. Oppenheim 1962

135. Thompson 1937 p. 235

136. Thompson 1937 p. 235

137. Herodotos I. 195/LB I 251; translation retouched. Whether Herodotos had been to Babylon on one of his travels or wrote about it by hearsay is not known. His remark may mean that physicians in his day were few, so that the man in the street was left to his own means (Saggs 1962 p. 460).

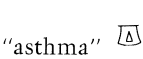
138. Mesopotamian science certainly provided the background for Greek mathematics and astronomy (Neugebauer 1957 p. 145). For medicine a legacy is much more difficult to prove. The Greek concern with prognosis may bear distant echoes of the Akkadian Prognoses (Labat 1951 p. xxviii, xxxv); the notion of "critical days" in the course of diseases has an Akkadian precedent (Labat 1966 p. 1000); and it is possible, but not proven, that some of the 250-odd Mesopotamian drugs were taken over by the Greeks.

Notes to pages 61–67

The little that is said about wounds in the Talmud (which is far more recent, from the third to the fifth centuries A.D.) is in part reminiscent of Mesopotamian practices, as are the names of skin sores, *mursa, simta* (Preuss 1923 pp. 222–223). Local treatments for wounds included lint, binding on a sponge, onion leaves, garlic, and chewed grains of wheat. The people also used pieces of dung. Mar Samuel, the most famous Babylonian physician (165–257 A.D.), treated wounds with oil and water. Buried in the Talmud is also the statement that "the hand can cause inflammation" (Preuss 1923 p. 277 ff.; Lods 1925; Humbert 1964). For a survey of Biblical medicine, see Levin 1970 (although he has practically nothing on wounds and surgery).

139. Oppenheim 1962 p. 105; 1964 pp. 274, 301
140. Jeremiah 51:8

3. *The Swnw*

1. Bell 1948 p. 2
2. Wilson 1946 p. 40
3. Wilson 1946 pp. 41–47
4. Contacts between Egypt and Mesopotamia did of course exist: Sumerian cylinder seals were found in Egypt (Mallowan 1965 pp. 56, 57), and some 400 cuneiform tablets turned up in El Amarna on the Nile. They come from the archives of Pharaoh Amenophis IV (1375–1358), who corresponded with various rulers of the Near East (Mercer 1939). Almost all these tablets are letters; some are long inventories of unbelievably rich and varied presents.
5. Herodotos II 84/LB I 369
6. Whether Egyptian or Sumerian writing came first is not yet settled (Diringer 1968 pp. 29–31). Another mystery is that the Egyptians had plenty of clay, which they used for building but never for writing. And what were the early stages of the hieroglyphs, before the unification of Egypt under the first dynasty? This date too is uncertain: it has slowly shifted closer, from the fourth millennium to 2900 B.C. (Diringer 1968 pp. 29–31).
7. Quibell 1913
8. Hooton 1917
9. Leek 1969
10. Hooton 1917; Ruffer 1921 p. 314
11. Smith 1908
12. GMÄ II 3, 62
13. Ebbell's translation certainly has merit but it is replete with precise medical terms like *Lepra maculo-anaesthetica, Anevrysma arterioso-venosum*—which is about as precise as using sterile instruments to work in mud.
14. Late in Egypt's history the number of hieroglyphs grew to a few thousand (Diringer 1968 p. 146). The 753 most common signs have been classified by shape and species in this standard list (EG 438–548), which makes it relatively easy to look them up individually. Translation is another matter.
15. The hieroglyphs did undergo *some* evolution, as shown in Fig. 3.6. The sign for *axe*, for instance, was brought up to date as the axe changed shape. Also the scribe had some latitude at all times. For example, he felt free to change the sex, headgear, and dress of the sign for *statue* as he fancied. The object represented by a given hieroglyph is often obvious, especially when painted in great detail. In other cases it is obscure, and it was equally obscure to all but the earliest Egyptian scribes, because either the objects themselves or the way they were represented had become obsolete (EG 438, 439).
16. EG 28, 428
17. EG 5, 6
18. EG 512
19. Jonckheere 1958
20. Grapow 1936 p. 65
21. The word *ankh*, usually spelled  (*ankh* + *n* + *kh*) meant "sandal strap" as well as "to live" (EG 508). Hence, the ankh became a symbol of life; this is why Egyptian gods are often clutching it.
22. EG 47, 54
23. "Atemnot," GMÄ VII/1 109. The translation is not absolutely certain. A word that seems to mean "asthma"  has some sort of lizard as a determinant, which Ebbell saw as a reference to the wheezing noise that a chameleon makes when he deflates his lungs in anger! (Lefebvre 1956 p. 121, GMÄ VII/2 922).

24. Lefebvre 1955 p. 19

25. GMÄ VII/2 584; haty can also mean "heart," but then other determinatives are used (GMÄ VII/2 577).

26. In practice, not all conceivable variants were used for each word; some never appeared.

27. EG 465

28. Diringer 1968 pp. 32ff., 146

29. Lefebvre 1955 p. 42

30. There was an even more cursive form of writing, *demotic*, which at the latest count only eight people in the world are able to decipher. Demotic was used as late as 452 A.D.; hieroglyphs had gone out of use some sixty years earlier (EG 11).

31. Jonckheere 1958 p. 149

32. W III 365

33. EG 444

34. Leca 1971 p. 373

35. Jonckheere 1958 p. 97

36. Jonckheere 1958 p. 152

37. EG 34

38. For whatever it is worth, the feminine version of *swnw* is my single original contribution to Egyptology. I cautiously submitted it to an eminent Egyptologist, Dr. Robert O. Steuer, who confirmed it. Beyond this, my ignorance is far too great to understand how a man of the competence of Jonckheere would have missed or disregarded this reading, *swnw-t*. He probably knew too much, and therefore came up with a more far-fetched interpretation as follows (Jonckheere 1958 p. 152). Note first that the same wording occurs three times on the same stele. In two cases the relevant words, *overseer* + *physician*, are side by side, *mr* + *swnw* [+ *t*]; in the third case (Fig. 3.9) they are aligned vertically. Jonckheere suggested that the feminine ending  *t* belonged to *overseer* (which would give  *mr-t*, "overseer-ess") but that each time the *t* somehow slipped sideways, or down, to contaminate the *swnw*. This would be a lot of slipping for even such casual fellows as the Egyptian scribes.

39. Cumont 1937 p. 30

40. Smith 1958

41. For female physicians in Mesopotamia, see Oppenheim 1964 p. 304; Biggs 1969 p. 98. For Greece and Rome, see Gourevitch 1970, who drew from the *Corpus Inscriptionum Latinorum* and from *Inscriptiones Graecae*. The Greeks had several ways of feminizing *iatrós* (ἡ ἰατρός, *iatríne*—ἰατρίνη—etc.), but the use is rare and applied sometimes to a healing goddess (Liddell and Scott 1968, *iatrós*).

42. Sm XIV

43. Gardiner 1935 p. 42

44. Gardiner 1935 p. 41

45. Sm 11

46. GMÄ II 124

47. Cumont 1937 p. 64; Lefebvre 1956 p. 168

48. Jonckheere 1950c p. 219

49. Jonckheere 1950c pp. 220, 221

50. Černý 1927 pp. 186, 191

51. GMÄ VII/2 887

52. Herodotos II 84/LB I 369. Jonckheere and others took the trouble to list all the names of physicians mentioned anywhere (monuments, tombs) in ancient Egypt. They came up with 103 (Jonckheere 1958 p. 17, 169). The list is dedicated to Imhotep, the great architect-physician of the Third Dynasty, later deified and identified by the Greeks with Asklepios (Aesculapius—Hurry 1926), but does not include him because, besides tradition, "no evidence remains to prove that Imhotep had any medical knowledge"!

53. Jonckheere 1958 p. 99

54. Historians searching for the Egyptian surgeon once identified him with the priests of Sekhmet; this is almost certainly wrong (Jonckheere 1950a; 1951).

55. Bronze is copper and tin (about 9:1). The ancient Egyptians had plenty of copper but probably no tin; therefore, their Bronze Age had to be based on imports (LH 217 ff.). For iron in Egypt, see the excellent article by Wainwright 1932; LH 235; Harris 1961 p. 166; Singer and others 1965 p. 592. Bronze surgical knives from Egypt have been described, but their origin is either uncertain (Comrie 1909–1910) or late (Leca 1971 Pl. XI).

56. LH 235

57. In Greek, *síderos* is "iron"; in Latin, *sidus, sideris,* is "star."

58. Budge 1960 p. 246; Otto 1960; Daumas 1965 p. 347

59. I base my discussion of *bya* as "iron" on Wainwright's well-documented article (1932), so captivating as to convince me that it is not delirious to read signs like  as "meteorites on sledges." Gardiner speaks of a "sledge bearing a load of metal (?)" (EG 517). In Erman and Grapow's *Wörterbuch,* Vol. 2 (1928), *bya-n-pt* is "iron" but *bya* is "copper (?)"; however, this translation was done before Wainwright's study; and Gardiner, who wrote later, apparently missed it: EG 517, 492, also has *bya* as "copper."

60. Crum 1939 p. 41

61. LH 240

62. Wainwright 1932 p. 15

63. GMÄ III 104

64. EG 515; GMÄ III 105, VII/2 989

65. GMÄ VII/2 105, 836, 682, 1000

66. Eb 876/Ebbell 1937 p. 127; GMÄ III 105; Jonckheere 1951 p. 41

67. EB 876/Ebbell 1937 p. 127; GMÄ III 105; Jonckheere 1951 p. 41

68. Columella 12.49, 50/LB III 297, 305

69. Wilson 1962; Ghalioungui 1973 p. 89

70. For a discussion of the "tumors" in the Ebers papyrus, see Ghalioungui 1973 p. 81. The "serpentine windings" are in EB 876 = GMÄ IV/1 229; for the reading "varicose veins," see Ghalioungui 1973 p. 83.

71. Ghalioungui 1973 p. 89

72. Sm 22

73. Mustapha Aga's performance was flawless, considering what he might have done. The first recorded find of Egyptian papyri dates from 1778; there were fifty in all. One was bought; the others remained unsold and were eventually burned by the disgruntled natives (Bell 1948 p. 14).

74. The oldest written medical document is the Sumerian tablet mentioned in Ch. 2, which is some five-hundred years older than the Smith papyrus. However, the extant copy of this papyrus reproduces a text that may already have been centuries old when the Sumerian tablet was written.

75. Sm 73

76. Breasted says 3000 and 2500 B.C., but since he wrote, the dates of Egyptian history have been moving closer to us. That medical books did exist during the Old Kingdom is attested by an inscription, in which King Neferkirere (Fifth Dynasty) called for books and physicians in an effort to rescue his dying architect (Breasted 1906; Jonckheere 1945 p. 29).

77. Sm 225

78. The spelling of *ydr* is bizarre. Unfortunately the determinatives, which could be so useful in this case, are of no help (Sm 230). The "ear" may be there for purely phonetic reasons (its name is *ydn*). The other determinative is not understood; EG has "bandage (?)" (EG 527).

79. Sm 227

80. Sm 421

81. Ebbell 1939 p. 11

82. Sm 233

83. Nobody argues about the "two strips"; it is the "adhesiveness" that remains unproven philologically (GMÄ VII/I 2), though it seems almost inevitable medically.

84. LH 5, 7, 316 ff.

85. LH 6
86. GMÄ VI 516
87. Carpendale and Sereda 1965; Alexander and others 1967; Myers and others 1969
88. For the clinical advantages of tapes over sutures, see Connolly and others 1969. For experimental studies (generally in favor of tapes), see Berard and others 1964; Carpendale and Sereda 1965; Ordman and Gillman 1966; Brunius and others 1967; Brunius 1968; Myers and others 1968; Connolly and others 1969; Forrester and others 1970.
89. Sm 139, Case 4
90. Sm 134, 139
91. Wilson 1962 p. 118
92. LH 299
93. Eb 871 (107, 6; 108, 3); GMÄ VI/1 227
94. Eb 872 (108, 3–9); GMÄ VI 227
95. Eb 876 (109, 11–18); GMÄ VI 229
96. Sm 365
97. Sm 415
98. Sm 385
99. Sm 388; GMÄ VII/1 482, 779, 854. See also Gispen 1968.
100. Grapow 1936 p. 64; GMÄ VII/2 1003
101. Budge 1960 p. 318
102. Sm 374
103. Sm 56, 92; GMÄ III 113
104. Ebbell 1939 p. 63
105. Sm 384
106. GMÄ VII/2, 248, 589
107. GMÄ VII/2, 521
108. Sm 84
109. Sm 367; GMÄ VII/1 249; Jonckheere 1947 p. 16 note
110. Sm 368
111. Eb 522 = GMÄ IV/1 205, IV/2 157
112. GMÄ VII/1, 172; Sm 81
113. EG 453
114. Steuer 1948 p. 8
115. Eg 539; Steuer 1948 p. 6 and *passim*
116. GMÄ VII/1 208, 215; VII/2 631
117. EG 539, 540
118. Steuer 1948
119. A "bad-type" wound, determined by  , occurs only once in the Smith papyrus (Sm 298, case VIII 18). It is a simple wound of the ear, to be stitched immediately. When the scribe repeats the word *wound* in the diagnosis, he uses the "clean-type" determinative () (Sm 300 line 19). Had he slipped up the first time?
120. Steuer 1948 p. 18
121. Sm 141 case 4
122. Sm 404 case 45
123. Sm 104 case 1
124. Sm 165 case 6
125. Hagemann 1904
126. Eb 456e; GMÄ IV/1, 8
127. GMÄ III 7, 8
128. Forbes 1965(b) p. 187
129. Singer and others 1965 p. 260. Some remedies were prepared by boiling fat with alkali, but the resulting soap is never mentioned; in fact, there seems to have been no word for it. Real soap was first mentioned in the third century B.C. in Greece, then by Pliny and by Galen, who was the first to state its use to keep man clean (Forbes 1965, p. 187).
130. Sm 422 case 47
131. Van Lawick-Goodall 1971 p. 240

Notes to pages 96–105

132. Sm 96 ff.
133. GMÄ III 49 note
134. e.g. Eb 86 (23, 2–4); GMÄ IV/1 104; Buchheim 1960 p. 103
135. Buchheim 1960 p. 103
136. Buchheim 1960
137. Weigall 1915
138. Griffith 1915
139. Dawson 1929
140. GMÄ VI 526
141. GMÄ VI 883
142. Sm 379
143. Sm 9, 59
144. Salicylic *acid* does have antiseptic properties; in fact, it was once proposed as a substitute for phenol (Gross and Greenberg 1948 p. 5). But *salicin*, which is salicyl alcohol glycoside, is less effective; and it is not known whether it is contained in significant amounts in willow leaves, as recommended here (it is traditionally obtained from the bark).
145. Sm 9, 59
146. GMÄ VI 358 ff.
147. Gabra 1956
148. Trease and Evans 1972 p. 426
149. Daumas 1965 p. 556
150. Merrillees 1962, 1968
151. Gabra (1956) accepts *shepenn* as opium. The word occurs in Eb 782; in Ebbell's translation of this passage (p. 108) *shepenn* is left untranslated. Its meaning is discussed in GMÄ VI 490.
152. This startling discovery (?) of Egyptian morphine is described rather succinctly by Schiaparelli 1927 (note 4 pp. 154–158). I was highly skeptical, but a chemist who specializes in Egyptian materials, Dr. John Winter of University Museum, Philadelphia, assured me that the actual persistence of morphine as described is not impossible.
153. Sm 383
154. Harris 1961; LH 344
155. LH 344
156. Forbes 1965(a) p. 239
157. Harris 1961 p. 143
158. Personal communication from Dr. J. R. Harris, Institute of Egyptology, University of Copenhagen.
159. Harris 1961 p. 102
160. Forbes 1965(a) p. 293
161. Forbes 1965(a) p. 293
162. I owe this information to my friend Dr. R. S. Cotran.
163. Forbes 1965(a) pp. 292–293
164. Harris 1961 p. 224
165. Harris 1961 p. 224
166. Browning 1969 p. 147
167. For pilot experiments I am indebted to Dr. D. Kekessy of the Institute of Hygiene, and for the definitive experiments to Dr. E. Schorer and her assistant Mme S. Dersi, Département de Biologie Végétale, University of Geneva. Forbes wrote that the use of verdigris was unknown in Egypt, though attested for Mesopotamia (in Singer 1965 I, 239). This is inaccurate (personal comm. from Dr. J. R. Harris). It is true, however, that we do not know how the Egyptians made their "copper green." Several ways to obtain it were described much later by Pliny (PNH 34. 110/LB IX 209).
168. Gunther 1934 p. 629
169. Gunther 1934 p. 636
170. The Eau Dalibour (often misspelled D'Alibour) included in the 1972 *Pharmacopoea Helvetica* as "Solutio zinco-cuprica composita": copper sulphate 0.1%, zinc sulphate 0.4%, dissolved in a 0.1% watery solution of camphor. I understand that

some dermatologists leave out the camphor. The original formula included saffron. The Eau Dalibour was saved from oblivion by the French dermatologist Sabouraud, who says that as such it is painful, and that on wounds it should be diluted to $\frac{1}{3}$. For these data I am indebted to Prof. R. Laugier, Head, Dept. of Dermatology, University of Geneva (see Dorveaux 1915).

171. Sm 101; GMÄ VI 210

172. *Ftt* could not be cotton, for the plant did not reach Egypt from India until much later, being first mentioned in papyri of the second century A.D. (LH 147). When used as a contraceptive, the pad of *ftt* was duly enriched: in one case with a salve based on honey and three pounded plants; in another with crocodile dung (GMÄ IV/1 277).

173. Sm 316

174. It is impossible to tell which *mrht* (animal fat or vegetable oil) was meant in each case (GMÄ VI 250–279; Sm 100). Grapow prefers to translate each time "Fett/Oel." Of the twenty-two known animal varieties, goose grease is one of the commonest; cats, fish, crocodiles, and snakes provide their share.

175. Lefebvre 1956 p. 13

176. The proportion of grease to honey may have been too well-known to mention. Once only in the Ebers papyrus, in a remedy for the ear, "when the vessel (*met*) shivers," it is said: "lint, grease $\frac{2}{3}$, honey [?], apply to it many times" (Eb 766 = GMÄ IV/1 61, IV/2 65). The missing fraction for honey was filled in by Breasted, reasonably enough, as $\frac{1}{3}$ (Sm 101).

177. Lefebvre 1956 p. 62

178. Sethe 1916 p. 74; EG 197

179. In six cases grease alone is recommended; in six others, honey alone (Sm 101).

180. Sm 100

181. Lavie 1960 p. 105. This experiment of Lavie does not mean that bees are sterile; they have a rich intestinal flora (Lavie 1960 p. 105 ff.).

182. Sackett 1919

183. Average composition of 490 honeys: water 17.2%, sugars 79.59%, ash 0.169%. Honey is quite acid: pH 3.91 (White, Riethof and others 1962 p. 11).

184. Sestieri 1956

185. Dold, Du, and Dziao 1937; Franco and Sartori 1940

186. White and others 1962; 1963; 1964; Schepartz and Subers 1964

187. Coulthard and others 1945

188. Lavie 1960; 1963

189. Lavie 1960 p. 165; Villanueva and others 1964; Lindenfelser 1967

190. Gonnet and Lavie 1960; Gonnet 1966

191. Villanueva and others 1964

192. Jensen and Sherman 1951

193. Villanueva and others 1964

194. Yang 1944

195. Weber 1937

196. von Gonzenbach and Hoffmann 1936

197. Zaiss 1934; Spöttel 1950; Bulman 1955; Blomfield 1973. Published data on the use of pure honey on wounds are not very critical, and a well-controlled experiment is still missing. However, the procedure seems to be harmless, and reports of successful treatment of ulcers continue to appear. We tried to apply pure honey on wounds in guinea pigs: on the whole, the healing was somewhat delayed, but the experiment was unsatisfactory for technical reasons (the difficulty of keeping honey on the wound without using a stiff corset that interferes with the experiment).

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198. For these bacteriological tests I am indebted to H. L. Wildasin, Ph. D., Director of Laboratories and Quality Control, H. P. Hood & Sons, Boston, Mass., and to Messrs. F. Bridges, F. Hubbard, and A. Frazer, also at H. P. Hood & Sons. Details of the experiments quoted are given in the notes to Figs. 3.27 and 3.28.

199. Lefebvre 1956 p. 113

200. Lavie 1963, 1968 p. 109

201. Simpson 1967 pp. 12, 31

202. In this account I made an arbitrary choice. The letter from Milkili is addressed to "The King," which could have been either Amenophis III or IV. I chose the son, because it was he who built the new capital at El Amarna. But anyway, as far as the episode is concerned, they were both married to the same woman, perhaps Nefertiti (Daumas 1965 p. 90), and the El Amarna letters show that they *both* received myrrh from Tushratta as a wedding gift!

203. Knudtzon 1964 I 833; Mercer 1939 II 681

204. Knudtzon 1964 II 1325

205. LH 316

206. Knudtzon 1964 I 189, 221

207. Dixon 1969 p. 60

208. GMÄ VI 99–104

209. GMÄ VI 452

210. Eb 529; GMÄ IV/1 204

211. Eb 508; GMÄ IV/1 219

212. GMÄ II 13 ff.

213. GMÄ III 94

214. Sm 203

215. This incantation and the following (Eb 1 and 2) are retranslated from the German version of GMÄ IV/1 308 and IV/2 231. The translation is literal almost to the word. Figure of Isis: from an illustration in the Papyrus of Ani (c. 1250 B.C.; about half actual size). By permission of the Trustees of the British Museum, London.

216. EB 499 = GMÄ IV/1 215, IV/2 165. Figures of Thoth and Horus: from an illustration in the Papyrus of Anhai (c. 1150 B.C.; about half actual size). By permission of the Trustees of the British Museum, London.

217. Ghalioungui 1973 p. 14

218. GMÄ III 94, II 12, 20; Lefebvre 1956 pp. 168–170

219. GMÄ IV/2 232

220. L 37 = GMÄ IV/1 158, IV/2 134

221. The Chester-Beatty VI papyrus is an all-anus treatise; it contains forty-one remedies.

222. CB 61

223. Jonckheere 1947 p. 44

224. Herodotos II 77

225. In Grapow's *Wörterbuch der Ägyptischen Drogennamen* (= GMÄ VI) we counted about 660 drug names. Whether 3, 10, or 30 of these drugs may have had a real pharmacological effect is a moot question. Hidden among them should be the cathartics of which Egyptian soil was, and still is, a generous source. The only one that is reasonably well identified is the *dgm* plant, which should be *Ricinus* (the castor oil plant), but there is also a *kaka* plant that might be it (GMÄ VI 583, 526). *Colocynth* is a small gourd "found in immense quantities in Upper Egypt and Nubia" (Flückiger and Hanbury 1879 p. 295); if it corresponds to *djart*, then it was used in many ways that have nothing to do with its typical action. *Aloes* is not well identified and neither is *senna*, until recently a monopoly of the Egyptian government and source of cathartic acid.

226. *Ukhedu* is written as a plural, but syntactically it is not a plural (personal communication of Dr. R. O. Steuer, the world expert on ukhedu, who very much regrets the disregard of GMÄ, where *ukhedu* is translated as a plural).

227. GMÄ VII/1 215

228. GMÄ IV/1 208; Eb 130

229. GMÄ I 82

230. GMÄ I 21

231. Sm 112

232. GMÄ VII/1 400 ff.; Sm 99

233. GMÄ I 73

234. Eb 856a; GMÄ IV/1 7

235. Bln 163a; GMÄ IV/1 7

236. For an excellent, critical review of embalming and especially of its chemistry, see Lucas and Harris 1962, Ch. 12 pp. 270–326; see also Engelbach and Derry 1942; Jonckheere 1942; Dawson 1927 (old!). For a summary, see Singer and others 1965 I 256–270. For histological studies, see Sandison 1969.

237. Alum is said to be *astringent*. Chemically, this property depends upon protein denaturation; hence the use of alum in leather tanning (known in ancient Egypt, LH 34). Egypt's alum was much praised by the Greeks (Hippocrates refers to it), and very old mines are known (LH 257).

238. LH 303

239. Columella XII 4/LB III 199

240. LH 283

241. Singer and others 1965 I 264

242. LH 272. See also Engelbach and Derry 1942 p. 263

243. LH 493–494, 263 ff.

244. For this formula I am indebted to Prof. P. Favarger.

245. LH 267

246. LH 291

247. LH 282

248. Engelbach and Derry 1942 p. 239

249. Engelbach and Derry 1942 pp. 255, 260

250. LH 293

251. See also LH 275.

252. LH 293

253. LH 309–312

254. LH 308

255. Rosengarten 1969 p. 15

256. LH 316

257. GMÄ VI 388

258. Wilson 1962

259. Toroptsev 1943; Toroptsev and Filatova 1943

260. Nickell 1959 p. 284

261. Cavallito and Bailey 1944; *Merck Index* 1968 p. 33. There is a large literature on onions in medicine, uncritically reviewed by Heyser 1928. Ambroise Paré, advised by "a certaine old countrey woman," treated burns with onions and found them very effective, which is probably worth investigating (Sigerist 1944).

262. Amonkar and Banerji 1971

263. Smith 1914

264. Smith 1912 p. 84

265. LH 324

266. Smith 1912 p. 110

267. Smith 1912 p. 66

268. Daumas 1965 p. 557

269. Smith 1912 p. 60

270. Engelbach and Derry 1942 p. 260

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271. Smith 1914 p. 191; Sandison 1969 p. 490. In fairness to the embalmers, though they did not improve on nature's process chemically, they did so "aesthetically" with their artificial eyes, stuffing, etc.; and they certainly reached the goal of preventing the total, unsightly decay of the body laid in a coffin rather than in sand.

272. Neolitzky 1911

273. The mouse as a drug, especially for children, has a long, uninterrupted history down to the present day (Dawson 1924). In Pliny's *Natural History* it is quoted dozens of times (see Schneider's index 1967, *Mures*). Pliny also explains that the flooding of the Nile occasions "a marvel that surpasses them all: that is that, when the river withdraws its covering, water-mice are found with the work of generative water and earth uncompleted—they are already alive in a part of their body, but the most recently formed part of their structure is still of earth" (PNH 9.179/LB III 283).

274. Glob 1965; Wells 1964 p. 59
275. LH 34
276. Smith and Dawson 1924
277. Steuer and Saunders 1959 p. 4
278. For this information I am indebted to Prof. C. Maystre.
279. Sm 224
280. LH 26
281. Josephus, *Antiquities,* XIV 7:4; quoted by Levin 1970 p. 147
282. Another view holds that *ammoniacum* is the gum of an African shrub, which comes in drops gritty with sand, in Greek *ammi* (PNH 12, 107; Dioscorides 3, 98/Gunther 1934 p. 331). Yet another view: Mesopotamian tablets mention a "salt of Amanus," which is the name of a mountain range in northern Syria; this salt (which gave its name to today's *ammoniac* salt) was imported into Egypt, and the resemblance with Amon the god is a coincidence (Jastrow 1917 p. 242 note 55).
283. For some of the theories on the origin of the word *chemistry,* see Skinner 1961 p. 101. The name *Chemía,* "Black Land," for Egypt, is mentioned first by Plutarch (*Moralia,* Isis and Osiris 364c): "they call it so for much of it is black as the black of the eye [*the pupil*]." For a possible Chinese origin of the word, see Mahdihassan references in Ch. 6.
284. The Greek word for papyrus was *byblos,* probably a softened version of *papyrus,* which means that the word *Bible* now contains the word *Pharaoh.* For the spelling of *pa-pr-aa,* I am again indebted to Prof. Maystre.
285. Lewis 1934
286. A persistent legend holds that the modern physicians' symbol ℞ has evolved from the Egyptian symbol for the Horus eye,  (cf. Wall 1917, McCord 1965). I have been unable to find the evidence.
287. Formulas found on tombs and statues (Sm 111 note).

4. The Iatrós

1. These are but a few of the modern medical terms that occur in the Greek text of the Hippocratic Collection. Whether any one was new at the time we do not know, but some at least were recent, because Socrates and Glaucon, in a dialog, agree that "breaths and catarrhs are strange and newfangled names," conjured up by the clever sons of Asklepios for the maladies of decadent citizens (Plato, *Republic,* III p. 405). Several medical terms occur in poetry and literature before Hippocrates (Daremberg 1865; 1869; Dumortier 1935), having possibly originated in common speech (Dumortier 1935; Temkin 1952). In most cases the meaning has remained about the same, but there are notable exceptions: *typhos* was sometimes a form of malaria (LB I p. lviii), *stómachos* rather meant esophagus, and a *thrómbos* in the *artería* could have meant a lump in the windpipe!
2. Phillips 1973 p. 182 ff.; Jones 1946; Cohn-Haft 1956; Sigerist 1961 II 84. The existence of an advanced medical art at the time of the Collection is also proven by the criticism in the Collection itself, where the Hippocratic method is presented as a better variant but not as a radical novelty. For example, the cautery for recurrent luxation of the shoulder was used, but "in the wrong place" (*On Joints,* #11/LB III 223 = LTT IV 107); and even the complicated method shown in Fig. 4.20 for reducing the dislocated femur was already being applied, but sometimes for the "wrong variety" of dislocation (*On Joints,* #77/LB III 381 = LTT IV 309).

3. Xenophon, *Memorabilia,* IV II 10
4. Temkin 1952 p. 213
5. Frölich 1879 p. 58; Albarracín Teulón 1971
6. Il. XI, 828. For the *klisíai* see Frölich 1877. The word *klisía* suggests "a place to lie," hence "barracks" (*klíno,* "I lie"); it has the same root as *clinic.* LS, however, translates it "hut."

7. Il. XI 638

8. Plato, *Republic*, III 406/LB I 273

9. Il. XIV 6

10. Il. XI 829

11. Od. XIX 456. The use of charms for hemostasis continued into the Middle Ages. See the *Strassburger Blutsegen* of the eleventh century "ad stringendum sanguinem" (Ehrismann 1918 p. 102) and the Italian thirteenth-century hemostatic formula: "Sangue sta in te come stette Cristo in sè" (Benedicenti 1947 p. 14).

12. Il. IV 123

13. Il. V 393

14. Il. IV 214

15. Il. XI 844

16. The method of pushing the arrow through (*diosmós*) is not clearly mentioned in the *Iliad* (Frölich 1879 p. 61) but is described by Celsus (CDM VII 5; see also Daremberg 1865 p. 79).

17. This is the informed guess of a famous German pharmacologist (Schmiedeberg 1918 p. 6), but without any real evidence. It is true, though, that the onion has antiseptic properties (Ch. 3).

18. Il. V 795

19. E.g. *On Wounds*, #1/A II 794 = LTT VI 401; see also notes 210 and 223 and pertinent text.

20. Galen, *De antidotis*, I v/K XIV 29–30

21. ChS I 313

22. Sigerist 1961 II 27

23. For references on wounds left undressed see note to Plate 4.3. I could find no reference to the scab as a natural dressing; this, too, is too obvious to put in writing!

24. Il. XIII 599

25. *On Diseases of Women*, II 144/LTT VIII 319

26. The second Homeric passage in which a bandage is mentioned refers simply to "binding up skillfully" (Od. XIX 455–457). Slings *as weapons* are not mentioned in Homer (Frölich 1879 p. 54).

27. Il. IV 190, XI 828, XV 393

28. Il. XI 639, XIV 5

29. Kritikos and Papadaki 1967 p. 30

30. Verdelis 1962

31. Beware of excessive enthusiasm: a poppy capsule slit vertically may be difficult to tell from another popular symbol, the pomegranate (Gabra 1956 p. 40 ff.; Kritikos and Papadaki 1967 p. 30). In some cases there is enough detail to leave no doubt, as in the clay model of Fig. 4.4.

32. Od. IV 221; see also Schmiedeberg 1918 p. 9; Kritikos and Papadaki 1967 p. 18

33. Il. IV 217

34. Daremberg 1865 p. 78

35. See Ackerknecht 1970 p. 5. The sucking out of snakebite wounds is mentioned also in the Talmud (Joma 83^{b}, Toseft. Sabb. XIV, 14 quoted by Preuss 1894 p. 265).

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36. Od. I 261

37. Schmiedeberg 1918 pp. 14–25

38. This passage, actually the first to derive *toxic* from *tóxon*, should be found in Dioscorides Mat. Med. Lib. VI 20 (Lewin 1894 p. 87 and Lammert 1938). However, this book VI is probably not by the real Dioscorides (Lammert 1938). I have been unable to lay my hands on it. Pliny proposes an entirely different derivation of *toxic* from the earlier *taxic*, "the yew," which is a very poisonous tree (PNH 16 51/LB IV 421). The yew, *Taxus baccata*, is still associated with danger and mourning, and its leaves do contain poison, but the idea seems far-fetched.

39. Plato: Protagoras 311 B–C; Phaedrus 270 C-E (LB I xxxiii). Aristotle: *Politics VII*, 4 (1326a).

40. The most accepted view is that a century or so after the death of Hippocra-

tes a collection of scrolls, left over from the books of the medical school at Cos, found its way to the great library of Alexandria. Another and rather unsettling view is that a collection of works was arbitrarily ascribed to Hippocrates by the Alexandrian librarians, and that the only reliable testimonies of the historical Hippocrates are the quotation in Plato's *Phaedrus* and a passage in the *Papyrus Anonymus Londinensis,* written in the second century A.D. (Jones 1947 p. 20). See the excellent chapter in Sigerist (1961 II 260); Phillips 1973 p. 34 ff.; Harris 1973 p. 29 ff.

41. Ever since the earliest commentators the Hippocratic books have been subdivided into categories, from the "likeliest" to the "unlikeliest" writings of the Master himself. Littré recognizes eleven classes! (LTT I 293).

42. Phillips 1973 p. 185; Cohn-Haft 1956 p. 26

43. *In the Surgery,* #3/LB III 59 = LTT III 279

44. *On the Physician,* #1/LB 311 = LTT IX 205

45. *Precepts,* #10/LB I 327 = LTT IX 267

46. *In the Surgery,* #4/LB III 63 = LTT III 285

47. May 1968 I p. 74

48. *In the Surgery,* #10/A II 479 = LTT III 305

49. *In the Surgery,* #3/LB III 61 = LTT III 279

50. A II 469 = LB III 53

51. Allbutt 1905 p. 11

52. *Cheirurgía: On the Physician,* #6/LTT IX 212, etc. *Cheirurgéin: Breaths,* #1/LB II 227 = LTT VI 91, etc. *Cheirurgós,* "he who is working with the hand" (but not a surgeon) appears first in Plutarch, first century A.D. (LS 1986).

53. In piecing together each case and its treatment from several Hippocratic works, I chose to disregard the grading of the various books: after all, the entire set reflects the medical practices of the time. For the kinds of patients that Hippocrates may have received see LTT X xxix # xi.

54. *Epidemics II,* #14/LTT V 115

55. *Aphorisms V,* #23/LB IV 165 = LTT IV 541

56. The Hippocratic principle of not applying cold directly to a wound seems to be right: but the data are still fragmentary. The latest work of Sutor and others (1971) showed only that cold water, when applied over a tiny wound 1 mm wide and 1 mm deep, makes bleeding worse. The effect of cold on the surroundings is not discussed. Cold applied around such small wounds does help a little in hemophiliacs (Sutor and others 1970): it halves the blood loss, and bleeding time drops by about 10%. The effect of cold on *larger* bleeding wounds is still unclear, though chilling is often recommended (lit. in papers above). A satisfactory study should distinguish between hemorrhage from large vessels, capable of contracting, and capillary bleeding, an entirely different matter. Gaping capillaries are rapidly plugged by platelets, and cold prevents platelets from aggregating (Kattlove and Alexander 1970).

57. *Epidemics II,* #17/LTT V 131

58. Theophrastus, *Enquiry into Plants,* IX VIII 2/LB II 255

59. *Epidemics VI,* sect. 7 #2/LTT V 337

60. As always with the Collection, it is not to be taken for granted that this practice (wetting the bandage) was universal. However: "[*The bandages*] will not be applied dry, but wetted with the fluid appropriate to each case" (*In the Surgery,* #11/A II 480 [*translation not accurate*] = LTT III 309). Dipping in black "astringent" wine: *On Fractures,* #29/A II 537 = LTT III 515; *On the Use of Liquids,* #5/LTT VI 129. Affusion of wine on dressings or bandages: *On Joints,* #63/A II 634 ff = LTT IV 269 ff. Bandaging in general: passages too many to quote. See esp. *In the Surgery,* 7–12 and LTT X Index 479 ff. Bande, Bandage.

61. *Regimen in Acute Diseases,* [*App.*] #27/LTT II 515; Dierbach 1824 p. 31

62. Il. V 902–904

63. *On Diseases IV,* #52/LTT VII 591

64. LS 1241

65. *Epidemics II,* #14/LTT V 117

66. *On Joints,* #69/LB III 361 = LTT IV 283; repeated in *Mochlicon,* #35/LB III 433 = LTT IV 379

67. Scribonius Largus (discussed in Ch. 10)

68. Paré 1678 p. 303 (a late English edition)

69. E.g. Harvey 1929; Cope 1958; Michler 1968; Kraft 1970

70. LTT I 293

71. *Epidemics II*, sect. 3#14/LTT V 117

72. *Mochlicon* (or *Instruments of Reduction*) #35/LB III 433 = LTT IV 377. The second statement is almost identical, with small changes in wording. In Littré's edition the meaning emerges clearly: "Quant aux sphacèles des chairs, la compression d'une plaie compliquée d'hémorragie qu'on étreint fortement, dans une fracture trop serrée, et dans d'autres constrictions violentes, fait tomber les parties interceptées chez beaucoup de patients." Littré, however, retouched three words to make the text identical with the similar passage in Mochlicon (LTT IV 282 note 21). The Loeb edition preserves the standard text, and the translation becomes somewhat clouded: "As for gangrene in tissues occurring in wounds with supervening hemorrhage, *or* much strangulation . . . the intercepted parts come away in many cases [*italics mine*]" (*On Joints*, #69/LB III 361 = LTT IV 283). In any event, it is clear that the text in both cases means to convey that gangrene can develop in three situations that have in common excessive compression caused by the physician.

73. *On the Surgery*, #13/LB III 73 = LTT III 317

74. *On the Use of Liquids*, #1/LTT VI 121

75. Water on a wound or sore may seem to contradict the oft-quoted beginning of the treatise *On Wounds:* "Avoid wetting all wounds except with wine, unless they are on a joint. For the dry state is nearer to the sound, and the wet to the unsound" (*On Wounds* #1/A II 794 = LTT VI 401). There are two exceptions already in the injunction, and scores of other passages simply ignore this veto against moist applications. The affusion of warm water was definitely used upon the removal of bandages, as fully explained by Galen (*Meth. Med.* xiv quoted in A II 483 note 1). This is but one of the many irksome contradictions that plague anyone trying to draw a single line of thought from the Hippocratic Collection.

76. *On the Use of Liquids*, #1/LTT VI 119; *Aphorisms V*, #19/LB IV 163 = LTT IV 539

77. *On Wounds*, #15/A II 808 = LTT VI 431

78. *On Wounds*/A II 804 #10 = LTT VI 423 #17

79. *On the Use of Liquids*, #4/LTT VI 129

80. *On the Use of Liquids*, #5/LTT VI 129

81. *Of Places in Man*, #38/LTT VI 329

82. *On the Physician*, #5/LTT IX 211

83. *On Wounds*/A II 802 #7 = LTT VI 417 #14. Enheme suggests "bloody" wounds: presumably fresh wounds, as Celsus writes (CDM V 19 1/LB II 33).

84. *Verdigris* (*iós*): I find it rather disturbing—pharmacologically—that dictionaries define *iós* as "rust on iron, verdigris on copper and bronze" (e.g. LS); but on the authority of Francis Adams (*Paulus Aegineta*, III p. 142), the identity of *iós* with *Aerugo Aeris*, or verdigris, "seems indisputable."

85. "Flower of copper" (*ánthos chalkoũ*): first, there is a mistake in Littré's translation; it has *fleur d'argent* (litharge). Littré was obviously misled by the "flower of silver" that actually occurs in the Greek text two lines above. Littré at first defined flower of copper as "grains of copper produced when cold water is thrown on the hot metal ingot" (LTT VI 413 #12; same in Adams 1844–1847 III 404). Later he changed this to copper oxide, adding that the "copper scales" (*lepís* or *pholís chalkoũ*) were another form of copper oxide (LTT IX 144; X page L). His authorities: K. Sprengel, Ad Dioscorid. Mat. Med. V, 88; Dioscorid. Mat. Med. V, 89.

86. *Molýbdaina:* Littré translates as *massicot;* Adams, "plumbago." This is a yellow, amorphous lead oxide, which when heated turns into a reddish crystalline lead oxide, litharge. Littré translates the Greek "flowers of silver" (*ánthos argýrou*) as "litharge."

87. Grease of wool (*óisypos*): Dioscorides gives a good account of it: "The greasinesse of unwasht wool is called Oesypum, which you shall prepare thus. Taking soft wool unwasht, (not) scowred with the herbe Sopeweed, wash in hott water,

withall squeesing out all the filth, and casting it into a broade-mouthed vessell, and powring water thereon, pour it from on high back againe with a great spoone, tumbling it downe forcibly till it foame, or with a stick stir it about lustily, till that much & a foul foame be gathered together. Afterwards sprinckle it with sea-water. And when the fat that did swim upon it, is settled, put it into another earthen vessell, & pouring water into the vessell, stirr it about againe . . . And do this, thill there be no more foam standing vpon it, the greasie matter being spent. Then tempering with ye hand ye Oesypum that is gathered, presently, if it haue any filth (remaining vpon) take it away . . . Put to the tongue, it do not bite, but somewhat bind, and it looks fatt, & cleane, & white, & soe put it vp into an earthen vessell . . . But that is best which is not made cleane . . . & is smooth, smelling of unwasht wool . . . Now it hath the power of warming, mollifying & of filling of ulcers, especially of those about the seate . . ." (Dioscorides II 84 / Gunther 1934 p. 112; see also Wulfsberg 1887).

88. Because applying the bandage tight enough to "dry up" the injury was very much in line with the thinking of the time, this had been the accepted interpretation (LTT III 344 ff.), but the scriptures are again sibylline. The statement, "Make most pressure over the lesion and least at the ends," is perfectly explicit; but four paragraphs above, the text reads "pressure . . . less at the ends and least in the middle" (*In the Surgery,* #12/LB III 73 = LTT III 313; #8/LB III 65 = LTT III 295 and note 18). Littré works his way out of the problem with the help of Galen, who also struggles with the riddle and translates very freely as if it were "especially important to avoid *pain* over the middle." Pressure on swellings is also recommended later, where Galen explains that "inflamed" cases are excluded (*In the Surgery,* #21, 22/LB III 77, 79 = LTT III 327 and note 11).

89. *Regimen in Acute Diseases*/LB II 103 #46 = LTT II 321 #12

90. *On Wounds,* #1/A II 794 = LTT VI 401

91. Paré 1678 p. 705

92. A II 797 note 5

93. I owe the turtle analogy to Dr. Hermes Grillo of the Massachusetts General Hospital, Boston (Dr. Grillo referred to two sets of people holding hands and seen from a helicopter). Although there must be some truth to it, the exact translation from turtles to tissues is not yet available.

94. Watts 1960 p. 560

95. Billingham and Russell 1956 p. 967

96. *In the Surgery,* #3/A II 475 = LTT III 279

97. CDM VII 4/LB III 309

98. *On Diseases,* #47/LTT VII 71

99. *Of Places in Man,* #14/LTT VI 307–309

100. *Coan Prenotions,* #424/LTT V 681

101. *On Diseases II,* #47/LTT VII 71; *On Diseases* III, #16/LTT VII 155. This maneuver, succussion, is still used for the diagnosis of hydropneumothorax. Obviously, to hear a splash, the pleural cavity must contain fluid as well as air, which is a rare combination. The entire passage is a marvel of clinical acumen: "If you hear no splash, but the patient breathes with difficulty, his feet are swollen and he has a little cough, do not let yourself be fooled: assuredly his chest is full of pus."

102. *On Diseases* III, #16/LTT VII 155. The clay method was used also to find collections of pus in the abdomen, which were recognized especially by the pain (how true), "but if potter's clay or something similar is applied on the spot, it dries up rapidly" (*On Diseases I,* #17/LTT VI 171). Celsus misunderstood the method (Ch. 9). A similar one is found in the Sushruta Samhita.

103. *On Diseases II,* #47/LTT VII 71. My translation, using Littré (VII 71) and Lund (1935) as guidelines.

104. "Tent" and "drain" in my translation correspond to one and the same Greek term, μοτός (*motós*), and to the corresponding verb μοτοῦν. Any item of dressing that went into a wound was called a *motós;* it was then specified whether the dressing was of linen, raw linen, etc. It would be tempting to translate the word as "drain," but not knowing what effect the physician had in mind when he introduced

the piece of linen, I twice use the old surgical term *tent*, which has exactly the same meaning as *motós*. Littré, who did the same, could not have used the term *drainage* anyway, because he published his Vol. VII in 1851, a couple of years too early to hear Chassaignac use that new surgical term (Rochard 1875 p. 780). However, the third time the text leaves no doubt as to the purpose of draining: "when the pus is fluid [enough] introduce a *kassiterínon kóilon motón* [*hollow motós of tin*]." This is clearly a tube, and the sense must be a drain.

105. Dr. Margaret Pittman of Harvard Medical School remembered injecting an oily preparation called *Gomenol* (Martindale 1958 p. 631).

106. *Regimen in Acute Diseases*, LB II 57 = LTT II 224.

107. *On Diseases I*, #21/LTT VI 181

108. *On Diseases II*, #47/LTT VII 71; ibid. #61 p. 97

109. Aeschines, *Speeches: Against Timarchus*, 41/LB 37.

110. *Pleurá* or *pleurón* (generally "flank," also of an army) was also used for "ribs." What is now called pleura is a microscopically thin membrane, which the Greeks could not possibly have recognized as a separate entity (Souques 1937 *31* p. 183).

111. The ending *-itis* to mean "inflamed" was a gradual, largely modern development. In classical Greek it had mostly a technical connotation: *ampelítis* = "concerning the upkeep of the vine (*ámpelon*);" *pharmakítis* = "concerning drugs (*phármaka*)" (Chantraine 1933 p. 340). For the veins *hepatítis* and *splenítis* see e.g. *On Diseases* I, #26/LTT VI 195. Ophthalmítis was the epithet for Athena as moon goddess (LS, *ophthalmitis*).

112. After Hippocrates, auscultation was forgotten. Hence, this now famous passage lost its meaning, was incorrectly transcribed, and finally became unintelligible. It was Littré who restored it (LTT VII 1–3, 1851) because he knew about auscultation, which had been rediscovered by Laënnec thirty-two years before (Laënnec 1819).

113. *On Diseases II*, #59/LTT VII 93

114. The assembling procedure of the *sýrinx* or "syringe" is described in detail only once (*On Sterile Women III*, #222/LTT VIII 431), where the bladder was definitely filled through a second opening, as in Heister's model of 1718 (Fig. 4.16); but I have seen medieval representations showing just a bag with a tube emerging from a single opening.

115. Lund 1935 p. 536; Souques 1937 p. 185; Baffoni 1943; Sharpe 1962 p. 185; Bourgey 1953 p. 158; Littré missed it too: LTT VII 1–3.

116. Anatomy in the Hippocratic Collection is, on the whole, the kind that could be learned from the kitchen, the sacrificial altar, the battlefield (Sigerist 1961 II 277), and a study of nudes. Systematic dissection did not begin until about a century later in Alexandria (see Edelstein 1935). One baffling exception is the treatise *On the Heart* (LTT IX 76 ff.; Hurlbutt 1939; Leboucq 1944) which seems to suggest the dissection of a human heart, possibly in Greek Sicily, 400–340 B.C.

117. *On the Nature of Women*, #14/LTT VII 333

118. *On Diseases III*, #14/LTT VII 137. This interpretation of the "fallen lung" is my own; it comes from reading Hippocrates with the eyes of a pathologist. The recoiling of the lung is an everyday observation in the autopsy room. One modern commentator (Baffoni 1943) prefers to read the passage as if the iatrós had fitted the air bag itself into the wound, like a plug, the best "evidence" for this being a modern inflatable rubber gadget, shaped like an hourglass, and used as a plug. I reject this interpretation on several grounds: it is technically unlikely; it makes difficult to understand the final step of introducing a solid plug of tin; it fails to explain the fallen lung and hence the reason to blow air into the chest; and it ignores the two other techniques based on blowing air into the body.

Notes to pages 157–161

119. *Epidemics IV*, #11/LTT V 151

120. Wine for wounds could be red or white. Both wine and vinegar were often used on wounds (LTT X Index 842, *Vin, Vinaigre*).

121. *On Wounds*, A II 797 #2 = LTT VI 405 #4

122. *On Wounds*, #1/A II = LTT VI 403

123. *On Diseases II*, #36/LTT VII 53

124. *On Wounds*/A II 796 #1; 796 #3 = LTT 405 #2; 409 #10

125. Cignozzi 1690 pp. 108–110

126. *In the Surgery*, #7/LB III 65 = LTT III 293

127. *In the Surgery*, #8/LB III 65 = LTT III 295–297 and note 6; Benedum 1970 pp. 53, 55

128. *On Joints*, #35/LB III 265 = LTT IV 159

129. *On Diseases II*, #10/LTT VI 159

130. *On the Physician*, #4/LTT IX 211

131. *On Wounds*/A II 796 #2 = LTT VI 405 #3

132. von Grot 1887 pp. 31–38

133. Hydromel (honey boiled in water) and oxymel (honey and vinegar) were popular refreshing drinks (Sigerist 1961 II 216). Their merits are discussed at length in *Regimen in Acute Diseases*. In hydromel, the proportion of honey could vary from $\frac{1}{3}$ to $\frac{1}{9}$ (A I 299 note 1).

134. *On Affections*, #55/LTT VI 267. For anti-cheese remarks in Hippocrates, see LTT X 615, *Fromage*. Plato joined the chorus, as we saw earlier. Perhaps the opposition to cheese was also a matter of "delicate digestions of at least a great number of otherwise quite normal Greeks" (Jones 1946 p. 74).

135. *On Fractures*, #26/LB III 155 = LTT III 505

136. Actual sutures are mentioned only twice: once on the nose after the nostril has been slit to extract a polyp (*On Diseases II*, #36/LTT VII 53); once in the general statement that purging is good for wounds which require suture (*On Wounds* /A II 796 #2 = LTT VI 405 #3), obviously in the hope of fighting off suppuration. A third instance concerns stitches placed in the upper eyelid when it is abnormally folded inward (*trichiasis; Regimen in Acute Diseases* (*Appendix*), #29/LTT II 517). A transverse fold of the skin is stitched at its base. The method was said to work after a fashion (Anagnostakis 1872 p. 4).

137. I owe this information to Dr. John P. Remensnyder, Department of Surgery, Massachusetts General Hospital, Boston.

138. The bench is described twice in the Collection (see LTT X xii). There is no proof that Hippocrates invented it; but the idea caught on. Five centuries later there were at least seven models, and Celsus noted that they could "rupture the ligaments and muscles" (*De medicina*, VIII 20/LB III 577). In 1924 a real specimen of the *scamnum* was found, in a monastery tucked away in the mountains of central Italy, where it was used as a refectory table. It is now at the Wellcome Museum in London. Its date is uncertain, perhaps early 1500s, by which time it had become almost entirely obsolete (Thompson 1925; D' Arcy Power 1925).

139. *On Joints*, #3/LB III 205 = LTT IV 83

140. *On Joints*, #11/LB III 223 = LTT IV 107

141. *On Joints*, #11/LB III 223 = LTT IV 107

142. *On Joints*, #11/LB III 229 = LTT IV 113

143. Cignozzi 1690 pp. 254–257

144. *Epidemics V*, #16/LTT V 215

145. *On Wounds in the Head*, #10/LB III 21 = LTT III 213

146. *On Wounds in the Head*, #14/LB III 35 ff. = LTT III 235 ff.

147. *On Diseases II*, #13/LTT VII 25

148. The salve probably *was* cobbler's blacking, because for the same operation, Celsus prescribes just that: *atramentum sutorium*. It was made with green vitriol or ferrous sulphate mixed with oak bark or galls. In medicine it had several uses, including the treatment of wounds. It was supposed to be caustic and hemostatic (Spencer 1961 p. xvi, *Aes;* PNH/LB IX 210 note a).

149. A I 440. Greek physicians were very worried about humors seeping into the skull. This seems to be the reason that wounds in the head were left without a bandage, i.e. without compression (*On Wounds in the Head*, #13/A I 457 = LTT III 231): they felt that pressure on a bone could not help to wring out its bad humors and might even push them inward, so it was better to let them ooze out freely (Galen quoted by Cocchi 1754 quoted in LTT III xxx). Trepanation for skull contusions died away in the nineteenth century, although in 1849 Adams tried hard to defend it (see A I 431–442).

150. *On Wounds in the Head,* #21/LB 49 = LTT III 259

151. Theophrastus, *Enquiry into Plants,* V IX 6–7/LB I 473

152. *Epidemics V,* #16/LTT V 217

153. *On Wounds in the Head,* #21/LB 49 = LTT III 259

154. *Epidemics V,* #16/LTT V 217

155. *On Diseases II,* #61/LTT VII 95

156. This historic passage is the clearest of the two that mention auscultation (*On Diseases II,* #61/LTT VII 95; #59 p. 93). Laënnec, who rediscovered auscultation, was an expert on Hippocratic medicine and did acknowledge the priority of Hippocrates (though quite lefthandedly), but he adds that he had forgotten about it before making his discovery.

157. *Prognostic,* #1/LB II 7 = LTT II 111

158. *On Internal Affections,* #23/LTT VII 227

159. Urinoscopy, as this kind of inspection came to be called, played an important role in Greek medicine. The basic idea was right—that urine reflects happenings in the body—but the practice was mostly nonsense (see e.g. LTT X 826).

160. LB II 229 #2 = LTT VI 93

161. *Regimen in Acute Diseases* (*Appendix*), #9 = LTT II 443

162. Ginsburg 1965

163. LTT VII 94 note 7; Laënnec 1819 II 118–119 note a

164. Siegel 1964 p. 293

165. Boiling vinegar occurs e.g. in our case 7 (*On Wounds in the Head,* #14/LB III p. 33 = LTT III 237).

166. Gardiner 1930 pp. 99–116

167. Gardiner 1930 pp. 197–211

168. Plato, *The Laws,* VIII p. 830

169. *On Joints,* #39/LB III 275 = LTT IV 171

170. *On Joints,* #35–39/LB III 265–275 = LTT IV 159–173

171. After the Egyptian fluff (or *ftt,* Ch. 3), this seems to be the world's first mention of *charpie* or lint, which was to become a standard dressing (and source of infection) for millennia. Adams translated the passage, "caddis scraped from a linen towel." The Greek text has "*áchne* [anything that comes off a surface, also chaff] from a *hemitýbion* [a stout linen cloth, actually an Egyptian word]." Cotton, an Indian good, was known but had not yet spread west as far as Greece (LH 147–8). Although wool was handier, it became customary to procure fluff for dressings by the peculiar procedure of scraping cloth.

172. Cerney 1963 p. 354

173. Krause 1841 p. 517

174. Aristophanes, *Fragm. 98*

175. Plato, *Protagoras,* 342–5; see also Dodds 1959 p. 357. Several specimens of broken ears are preserved in sculpture, including, it is said, one of the two colossi, Castor and Pollux, on the Capitol (Winckelmann 1808 p. 430 ff.; 1811 pp. 210–218; Krause 1841 p. 516–518; for ref. in classical literature see LTT IV 332–333). An equivalent of the modern expression "cauliflower ears" may have been the "ear mushrooms" of Tertullian (*De spectaculis* XXIII 7).

176. According to Galen, *syrmaisms* were mild means of evacuation "from above as well as from below" (LTT IV 174 note 3).

Notes to pages 168–175

177. Gardiner 1930 p. 204

178. Whibley 1963 p. 513

179. *On Wounds*/A II 807 #13 = LTT VI 420 #23

180. *On Fractures,* #28/LB III 161 = LTT III 28

181. *On Affections,* #38/LTT VI 249

182. *Aphorisms I,* #22/LB IV 109 = LTT IV 469. See also LTT X 713, *Orgasme.*

183. This celery crown must have been exceedingly perishable, for the *sélinon* that I picked in Selinunte was already fading after ten minutes. There is some evidence that it was still used in the first century A.D., when the Apostle Paul was in Corinth; perhaps this was the "perishable wreath" of which he wrote (I Cor. 9:25; Broneer 1962 p. 16).

184. *On Affections,* #38/LTT VI 249

185. *On the Physician,* #11/LTT IX 217

186. *On Wounds*/A II 808 #13 = LTT VI 429 #23. The Greek has *spodón,* "ashes"; see also note 241.

187. *On Wounds*/A II 796 #1 = LTT VI 405 #2

188. *On Affections,* #38/LTT VI 249, 248.

189. Gardiner 1930; Whibley 1963

190. Jones 1946 p. 41

191. Jones 1946 pp. 28–31

192. *Airs Waters Places* #8/LB I 91 = LTT II 33. Among the fuzzy Hippocratic experiments, the shining exception are the observations on the embryos of "twenty or more hen's eggs given to hatch to two or more hens" (*On the Nature of the Child,* #29/LTT VII 531). Partial reviews of experiments in Hippocratic books: Senn 1929; Bourgey 1953. For rational versus scientific medicine see also Harris 1973 p. 30.

193. Edelstein 1952 p. 307; Joly 1966

194. Jaeger 1944 pp. 30 and 298 note 73; *Epidemics VI,* Sect. 5 #5, LTT V 317

195. Daremberg, see Kitto 1951 p. 190

196. No explicit statement of the doctrine of the four humors exists in the Collection, where definitions altogether are rare. It was Galen who gave it its full formulation and ascribed it to Hippocrates, which is not necessarily correct (Sigerist 1961 II 317 ff.; Bourgey 1953; LB I xlvi-liii; Schöner 1964).

197. *On Diseases IV,* #51/LTT VII 585

198. *On Diseases IV,* #52/LTT VII 591

199. The golden section refers to the division of a segment into two unequal parts in such a way that the ratio of the larger part to the whole is the same as of the smaller to the larger (1 : 1.618). The solution to the problem, which can be expressed $a:x = x:(a - x)$, is found in Euclid's *Elements* (third century B.C.). During the Renaissance the proportion was recognized as a key to Greek aesthetics (Ghyka 1931). The relations between the golden section and a pentagon are many. For example, in a regular pentagon *abcde,* if points *a* and *c* are connected, the segments *ab* and *ac* will be related as 1 : 1.618 (courtesy of Jacques Vicari).

200. The Greeks had three seasons until about 450 B.C., when summer and autumn were separated. Perhaps the separation of black bile and yellow bile was a similar process (Müri 1953; Sigerist 1961 II 334 note 13). For the "fourfold symmetry" in antiquity see Schöner 1964.

201. Schöner 1964 p. 100

202. Plato, *Gorgias,* 464-B

203. For the theory of residues see note 283.

204. I take full responsibility for this reconstruction. It seems to hold together, although it was difficult to assemble because the pieces are scattered over many books. As usual, the Collection takes much knowledge for granted and does not furnish explanations. The reader should keep in mind that these mechanisms of diseases were certainly not the only ones, for doctrines were loose, and different interpretations were possible and even compatible.

205. *The Art,* #11/LB II 209 = LTT VI 21

206. The nerves would be discovered by the Alexandrians. In the Collection, both *néuron* and *ténon* mean "tendon." There may be vague hints of nerves in such statements as "fire is inimical to *néura*" in cauterizing the armpit, where the problem is really the nerve plexus (*On Joints,* #11/LB III 229 = LTT IV 113). But there is an awfully large gap between the "two tendons coming from the brain" (*Epidemics IV,* #2/LTT V 125) and the statement that Hippocrates "gave a crude description of the sympathetic trunk" (Garrison 1969 p. 8).

207. On blood turning into pus: after injury, blood flows to the part and in time becomes pus (*On Diseases IV,* #50/LTT VII 583); clots of blood left in a blood-letting incision cause inflammation and suppuration (*On Wounds*/A II 809 #16 [*thrómbos* = clot] = LTT VI 431 #26); blood spilled into the belly becomes pus (*On Diseases I,* #17/LTT VI 171); if blood spills into a cavity, it must become pus (*Aphorisms VI,* #20/LB IV 185 = LTT IV 569); blood spilled into the lung decays;

the patient spits out pus (*On Diseases I,* #14/LTT VI 163); wound in the chest; blood decays and is expectorated as pus (phlegm does too) (*On Diseases I,* # 15/ LTT VI 167).

208. Galen, quoted in LTT V 569 note 7

209. Spasms played an important role among the symptoms to observe (*spasm* alone has over one-hundred entries in Littré's Index). There was also a vague term *tà spasmódea,* which can only be translated "spastic accidents" (e.g. *Epidemics VII,* #35/LTT V 402, 405). I suspect that cramps observed during gymnastics, which was a central feature of daily life, must have helped to focus attention on "spasms," but I found no text to support this idea.

210. Cold causing spasms: on certain wounds wine causes spasm if too cold (*On Joints,* #63/LB III 353 = LTT IV 271); cold makes blood become denser and causes veins to contract (*On Diseases I,* #24/LTT VI 189); cold makes veins taut (*On Places in Man,* #9/LTT VI 293; also *Aphorisms V,* #17, 20/LB IV 161, 163 = LTT IV 539). Some of these thoughts may reflect experience with severe frostbite (as mentioned in *On the Use of Liquids,* #1/LTT VI 121). For cold on wounds especially see note 223.

211. Spasms by bleeding (convulsions): e.g. the aphorism—*Spasmós* or hiccough supervening on a copious flux of blood is a bad sign (*Aphorisms V,* #3/LB IV 159 = LTT IV 533; see also *Aphorisms VII,* #9/LB IV 195 = LTT IV 581).

212. Spasms from purging were of course the convulsions of hellebore: see e.g. *Aphorisms V,* #1 and 4, where spasms from hellebore or excessive purging are dangerous (LB IV 159/LTT IV 533; see also *Aphorisms VII* #25/LB IV 197/LTT IV 583).

213. *On Diseases I,* #17/LTT VI 171

214. *Of Places in Man,* #9/LTT VI 239

215. *On Diseases I,* #26/LTT VI 195

216. Fatigue as a cause of disease: fatigue causes venules to break (*On Diseases I,* #14/LTT VI 163); fatigue causes blood to become fixed where the strain is greater, causing *pléthos,* "plethora" (*On Diseases IV,* #50/LTT VII 583); fatigue or gymnastics can cause a rupture, the blood is retained and decays (*On Diseases I,* #15/LTT VI 167; the rupture must be of a vessel, not to be confused with the "eruption" of lung abscesses as discussed in LTT V 576–579); fatigue is listed with heat, cold, etc., as a cause of disease (*On Diseases I,* #2/LTT VI 143).

217. *On Diseases I,* #17/LTT VI 171

218. *On Diseases I,* #14/LTT VI 163

219. *Epidemics V,* sect. 3 #11/LTT V 297, 298 note 2, 45

220. Majno and others 1969

221. *On the Use of Liquids,* #2/LTT VI 125

222. *On the Use of Liquids.* #2/LTT VI 123. In the text "tétanoi" is a plural, because tetanus was considered merely as a type of spasm (with three varieties), not a specific disease.

223. See also: cold on open fractures can cause chills, spasms, ulcers (*On Fractures,* #34/LB III 179 = LTT III 537); after cauterizing the armpit, hold the arm close to keep the wounds warm (*On Joints,* #11/LB III 229 = LTT IV 113).

224. *On Wounds in the Head,* #13/A I 457 = LTT III 233 also: the swelling around a wound is due to condensed blood (*On Diseases IV,* #50/LTT VII 583); after injury, blood flows to the part (*On Diseases IV,* #50/LTT VII 583); blood gathers at the site of pain (*On the Nature of Man,* #11/LTT VI 61).

Notes to pages 181–183

225. When the surgeon Francis Adams translated this passage in 1849, he still approved of the treatment and regretted that in his time too many colleagues "stopped the flow of blood as quickly as possible" (*On Wounds* /A II 796 #1 [note 1] = LTT VI 403 #2).

226. *On Fractures,* #26/A II 535 = LTT III 507

227. *On Diseases IV*/LTT VII 583

228. The only English word that comes close to covering both wound and ulcer is *sore.* Classical Greek also had the word *tróma* or *tráuma* (which gave today's *trauma*), referring to wounds caused by external violence; it had nothing to do with the subsequent clinical course and merely suggested the cause. Thus, the treatise on

"*Trómata* in the head" was translated by Adams "Injuries in the Head" (A I 421). The word *tróma* is not used by Homer; before Hippocrates it occurs in Aeschylos; and Herodotos uses it in the sense of "disaster" (Hist. I 18). In modern Greek *trávma* and *hélkos* have come to mean "wound" and "ulcer." *Hélkos* and the Latin *ulcus*, "ulcer," come from the same Indoeuropean root ELK̑-, "wound, tear" (Devoto 1966 p. 444).

229. Cignozzi 1690 p. 15

230. *Ichór* was also—rather surprisingly—the blood of the gods.

231. *Aphorisms VII*, #44/LB IV 203 = LTT IV 591; *Prognostic*, #7/LB II 19 = LTT II 131, and *passim*

232. *On Wounds in the Head* #11/A I 454 = LTT III 221; #15/A I 461 =LTT III 245; *On Fractures*, #26/A II 535 = LTT III 505

233. *On Wounds*/A II 798 #3 = LTT VI 409 #10

234. *Aphorisms V*, #66/LB IV 179 = LTT IV 561; also in *Epidemics II*, LTT V 119 #18

235. It was standard surgical belief—from Hippocrates to the 1860s—that "suppuration prevents inflammation," which makes no sense in today's terms, because suppuration is in fact a form of inflammation. What was meant, on the clinical level, was that abundant suppuration (typically due to staphylococci) usually happened in wounds that did not develop more threatening complications, such as a "spreading inflammation" (typically due to streptococci). The underlying truth was that staphylococci are not as dangerous as streptococci. Adams wrote as late as 1849, "every person acquainted with practice is aware that a healthy suppuration is one of the best means of preventing inflammation" (A II 795 note k). Of course, there was little hope of replacing one type of infection with another, but it remained a Hippocratic principle to "oppose inflammation and favor suppuration" (*On Fractures* #31/LB III 175 = LTT III 531).

236. For *apóstasis* see Bourgey 1953 p. 240.

237. E.g. take the wound as fast as possible through suppuration (*On Wounds in the Head*, #15, 17/A I 461, 462 = LTT III 245, 251; see also *On Fractures*, #26/LB III 157 = LTT II 505).

238. Beware: in Adams' translation this drug does just the opposite: it *prevents* inflammation (*On Wounds*/A II 801 #5). Adams was a busy surgeon, whereas Littré, whose translation came ten years later, was a full-time scholar. It is wiser to follow Littré (ibid. /LTT VI 415 #12). But worse has yet to come, for in Adams this paragraph ends with the sentence: "These things in powder prevent recent wounds from suppurating." This is baffling, because they are not powders, but the general sense seems to confirm a pus-preventing action of the drugs described in the preceding paragraph. Now in Littré's version, the same sentence begins the next paragraph (LTT VI 417 #13), where the drugs discussed are actual powders. Thus, Adams had transformed into pus-preventing all the drugs in the preceding paragraph, which he had to do to achieve consistency, but the result is a mess. Littré's version makes much more sense.

239. *Téresis tou hélkous* (Gärtner 1966)

240. The text also mentions different combinations of these powders, plus a vegetable powder, *aristolochia*. It is striking that all inorganic salts (antiseptics?) should be mentioned together (*On Wounds*/A II 802 #7 = LTT VI 417 #13).

241. The translation of *spodium* (lit. "ashes") is difficult; I chose zinc oxide. Here the text reads *spódoi* from Cyprus, which Littré rendered "ashes of copper," Adams "copper recrement" (a vague word, by which he did not mean slag). Often the text has only *spodium*, which Littré maintained as "ashes of copper," Adams as his noncommittal "spodium" (e.g., *On Wounds*/A II 808 #13 = LTT VI 429 #23). Adams (*Paulus Aegineta*, III 352) believed that the spodium of later authors was impure zinc oxide, whereas in the Collection the word was used more generally "for various recrements of the metals."

242. Chalcitis is an impure form of copper sulphate, formed by evaporation of the water of copper mines (Adams, *Paulus Aegineta*, III 399–404; see also Grot 1887 p. 58).

243. The enhemes were *chemically* antiseptic, but whether they did any good on wounds I do not know. I tried one on rats, with bad results: but the dose may have been excessive.

244. *On Wounds*/A II 802 #7 = LTT VI #14. Quantities of each drug are not given, as usual. Another moist enheme of this series was described in the case of the round ulcer.

245. *On Diseases II*, #33–37/LTT VII 51

246. Singer and others 1965 I p. 565

247. Spencer 1961 p. xxiii; Bailey 1929 I p. 209

248. Kass and Sossen 1959

249. Phillips and others 1968

250. Price 1939 p. 537

251. Ribéreau-Gayon and Peynaud 1961 p. 135

252. Draczynski 1951 p. 26

253. Stucky 1949

254. Ribéreau-Gayon and Peynaud 1961 p. 145

255. The experiments were carried out by Dr. D. Kekessy of the Institut d'Hygiène, University of Geneva. For the samples of Greek wine, I am much indebted to Isabelle Joris and Lise Piguet, who brought them from Crete, and to Dimitrios Nevrakis, who supplied them.

256. Ribéreau-Gayon and Peynaud 1961 p. 136

257. Draczynski 1951 pp. 26, 40

258. Ribéreau-Gayon and Peynaud 1961 p. 124 ff.

259. Masquelier and Jensen 1953 p. 107

260. Ribéreau-Gayon and Peynaud 1961 p. 142

261. Draczynski 1951 p. 37

262. Ribéreau-Gayon and Peynaud 1961 pp. 139, 143

263. Draczynski 1951 p. 32; Ribéreau-Gayon and Peynaud 1961 p. 137

264. Ribéreau-Gayon and Peynaud 1961 p. 145

265. Masquelier and Jensen 1953 pp. 106–107. In the experiment just quoted, the bacteria were still sensitive to phenol at 3.33 g/l, to oenidol at 0.1 g/l.

266. Both the history and the effects of the two hellebores overlap in a most confusing manner. The Collection mentions hellebore 69 times, but adds "black" only 13 times, "white" only 3 times (Schmiedeberg 1918 p. 19 note 77). The "black" kind, *Helleborus*, still mentioned in some pharmacopoeias (Dorvault 1936; Hagers 1958), is practically extinct as a drug. *Veratrum* alkaloids enjoyed a brief revival a few years ago, just in time for the second edition of Goodman and Gillman's textbook, but slumped again in the third (Goodman and Gillman 1965 p. 716): it proved too difficult to use them to lower the blood pressure without unpleasant side effects. In Germany *Veratrum* is called *Nieswurz*, "sneezing root." When Castiglioni wrote in 1935, sneezing powder of *Nieswurz* was still sold in Germany; elsewhere "hellebore" had retreated to the level of a pesticide (Dierbach 1824; Flückiger and Hanbury 1879; Schmiedeberg 1918 pp. 14–25; Castiglioni 1935; Belloni 1956).

267. See e.g. the aphorism: "Convulsion after hellebore, deadly" (*Aphorisms V*, #1/LB IV 159 = LTT IV 533; see also LTT X Index 628, *Hellébore*; 806, *Superpurgation*). The mechanism of spasms caused by *Veratrum* is now well known and physiologically very interesting (Goodman and Gilman 1965 p. 716 ff.).

Notes to pages 185–192

268. Schmiedeberg 1918 p. 23

269. Quoted by Pliny: PNH 25.58/LB VII 179

270. *On Ancient Medicine*/LB I 17 #8/LTT I 575

271. *On Ancient Medicine*/LB I 25 #8/LTT I 587. This passage is rather garbled.

272. *Regimen in Acute Diseases*/LB II = LTT II

273. On Greek diet and its evolution, see Ackerknecht 1970, 1971

274. Herrmann and Woodward 1972.

275. *On Joints*, #69 = LTT IV 283/A II 639

276. *On Joints*, #69 = LTT IV 283/A II 639

277. *On the Nature of Women*, #108/LTT VII 423, and elsewhere.

278. See LTT X Index 692, *Miel*.

279. See LTT X Index 572, *Egypte*.

280. Saunders 1963

281. On the fixation of humors: phlegm and bile, see e.g. *On Affections*, #16/LTT VI 225; *On Hemorrhoids*, #1/LTT VI 437; phlegm, *On Fistulae* #7/LTT VI 455.

282. Concept of *fixation* in Egyptian pathology: the dreaded ukhedu could become "fixed" in the blood of the eye (Steuer 1948 p. 16). Various diseases could become "fixed" in one part of the body or another (GMÄ III 30). Sometimes they are "not yet fixed," e.g. Eb 193 (GMÄ IV/1 90), where feces are not yet fixed, or Eb 593 (GMÄ IV/1 157), where a prescription is given for removing a "blood-nest" that has not yet attached itself (repeated in *Papyrus Hearst* 143; GMÄ IV/1 157).

283. For the theory of residue (*perîttoma*) see Sigerist 1961 II 262 ff.; for its possible connection with the ukhedu see Steuer and Saunders 1959. The Collection never mentions this theory. Besides Aristotle, the main source is the *Papyrus Anonymus Londinensis* of the second century A.D. Concerning possible connections between Egyptian and Greek surgery there is also a paper by Iversen comparing "Wounds in the Head in Egyptian and Hippocratic Medicine" (1953). Since the author seems to have misunderstood the meaning of *hédra* (assumed to be a hole in the skull, "like a puncture in a jar"), and since the paper is largely about the hedra, little can be gleaned from this study.

284. Translations are my own, based on Littré, and checked against the Greek with the precious aid of Mrs. Martine Vodoz. Some cases were recently summarized in Phillips 1973 pp. 70–71.

285. *Epidemics V*, #96/LTT V 257; repeated in *Epidemics VII*, #34/LTT V 403, where the names become Aydellos and Dyschytas

286. *Epidemics V*, #98/LTT V 257; repeated in *Epidemics VII*, #29/LTT V 401

287. *On Sevens*/LTT VIII 616

288. *Epidemics V*, #61/LTT V 241

289. *Epidemics V*, #21/LTT V 221

290. *Epidemics V*, #32, 33, 35/LTT V 231

291. *Epidemics VI*, sect. 8 #26/LTT V 353

292. LB I 141

293. *Epidemics IV*, #11/LTT V 151

294. *Epidemics V*, #26/LTT V 225

295. *Epidemics V*, #97/LTT V 257

296. *Epidemics VII*, #35/LTT V 403

297. *Epidemics VII*, #113/LTT V 461, repeated with slight change in *Epidemics V*, #100/LTT V 257. The word *siegón*, translated as "jaw," might also mean "cheek." A rapidly progressing gangrene of the mouth, cheek, and jaw, usually fatal, is well known under the ancient term *noma*; it occurs most frequently in children debilitated by infectious disease or by malnutrition. The banquets of the ancient rich are well known, but not the meals of the people at large, except that some Greeks ate only once a day (*On Ancient Medicine*, #10/LB I 29 = LTT I 591; Jones 1946 p. 74 note).

298. *Epidemics V*, #45, 46/LTT V 235. This is a remarkable passage: in the Collection arteries and veins are in a highly confused state (see e.g. LTT X 489, *Artères*; Fredrich 1899 p. 57 ff.). One case of *artería* is a definite trachea (*On the Nature of Bones*, #13/LTT IX 185), but in the treatise *On the Heart* there is reference to real arteries (LTT IX 91 #11). In another case the trachea is called *brónchos* and its branches are *arteríai* (*On Places in Man*, #14/LTT VI 303–305); in yet another the aorta becomes "the hollow vein" and all its branches are veins (*On the Flesh*; Fredrich 1899 p. 70). At this stage one wonders how to take the startling promise of "another book" in which "the communications between arteries and veins will be discussed in detail" (*On Joints*, #45/LB III 289 = LTT IV 191).

299. *Epidemics V*, #95/LTT V 255

300. PNH 77:198/LB III 557

301. *On the Sacred Disease*/LB II 181 #20 = LTT VI 393 #17; *On Virgins*, #1/LTT VIII 469

302. *Epidemics V*, #47/LTT V 235

303. Opisthótonos, which is a symptom of tetanus, was considered to be a disease of its own; or rather, one of three kinds of tetanus: tetanus from wounds; opisthotonos, which happens "when the tendons in the back of the neck are ill" (*On Internal Affections*, #53/LTT VII 301); and tetanus that occurs by falling on the back of the head (convulsions due to cerebellar injury?) (*On Internal Affections*, #52–54/LTT VII 299–303). The treatment for "tetanus and opisthotonos" is warmth, including warm fluids "by the nose" in case of lockjaw (*On Diseases III*, #12, 13/LTT VII 133; *On Internal Affections*, #53, 54/LTT VII 301); but "if you wish," you can also try cold water on opisthotonos (*On Diseases III*, #13/LTT VII 135).

304. The Greek text here is, "he caught a sprain at the big finger, below." Littré's version is, "he had a sprain at the lower part of the thumb." Since Greek has no special word for toe, I tried to change "below the thumb" to "the thumb below" and proposed to my Hellenist adviser the translation "stubbed his big toe," which better fits with tetanus. It was vetoed. The Greeks would have said "the thumb of the foot."

305. *Epidemics V*, #74, 75/LTT V 247, repeated with small changes in *Epidemics II*, #36, 37/LTT V 405

306. Eckmann 1966 p. 100

307. *Epidemics II*, #37/LTT V 405

308. *Epidemics V*, #76/LTT V 249; repeated with insignificant changes in *Epidemics VII*, #38/LTT V 407

309. *Epidemics VI*, sect. 5 #1/LTT V 315

310. EE I 423 #30

311. EE II 169

312. See EE I vii; II 139; Phillips 1973 p. 197.

313. EE II 154, 140

314. *Regimen IV* [*On Dreams*], #87/LB IV 423 = LTT VI 643

315. *Decorum*, #6/LB II 289 = LTT IX 235

316. EE II 158, 233, 193. The Asklepieia included, besides the temple, a whole precinct. It is often claimed that they became health resorts. They did include a source (Herzog 1931 p. 155), and the two most famous ones, those of Epidauros and Pergamon, did rise in magnificent surroundings; but the statement is not accurate, for the main requirement was that they be on a sacred site. In one case at least, this site was a swamp.

317. The connection between the snake and health goes back at least as far as the Sumerian myth of Gilgamesh. The Mesopotamian god Ninazu ("Lord-God") had a son, Ningizzida, whose symbol was a rod with two intertwined serpents (Oppenheim 1966 p. 460; Thorwald 1962 p. 155). Explanations for the association of the snake with health are many: the snake may have represented rejuvenation (from the shedding of its skin), shrewdness, sharp-sightedness, vigilance, and healing power as such, since it was used as a remedy. *Elaphe longissima* also stood for mildness: it rarely strikes at man, and when it does, it is not dangerous (see EE II 227 ff.). As to the dog, one myth had it that the baby Asklepios was suckled by a bitch (ibid.).

318. Whibley 1963 p. 664; see also Sigerist 1961 II 60–61.

319. Herzog 1931 p. 6

320. Asklepios asked little but did not like to be cheated. When Echedorus kept for himself a gift that Pandarus had asked him to deliver to Asklepios, the god had him come to the temple and marked his face with the marks of Pandarus (EE I 231 #7). There is a parallel punishment in the Old Testament (Phillips 1973 p. 199).

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321. EE I 423 #30

322. EE I 423 #40

323. EE I 235 #32

324. EE I 233 #177; *Inscriptiones Graecae* 1929 pp. 70–73 lines 113–119

325. "When Rome was troubled by a pestilence in 292 B.C. the envoys dispatched to bring over the image of Asclepius from Epidaurus to Rome fetched away a serpent which had crawled into their ship and in which it was generally believed that the god himself was present. On the serpent's going ashore on the

island of the Tiber, a temple was erected there" (Livy, *Periocha,* XI; EE I p. 431 No. 846, p. 432 No. 848).

326. Aristophanes, *Plutus,* pp. 676–681; EE I 179 #490

327. *Pepsis* and *sepsis* are explained by Aristotle as two stages of "breakdown": pepsis occurs in the upper belly, and the residue putrefies by sepsis in the lower. This was a perfect summary; the two processes are still called *peptic* and *septic,* one enzymatic, the other bacterial (Steuer and Saunders 1959 p. 9).

328. The ultimate catharsis of the four humors took place with "sense of humor."

329. Joly 1966 pp. 243, 130 ff. An excellent monograph on the "rational" versus "scientific" value of Hippocratic medicine.

330. Edelstein 1952

331. Plato, *Charmides,* 155–156/LB 15–21

5. *The Perfumes of Arabia*

1. The cosmetic use of cinnamon is well documented in the Bible and in Pliny. See also FH p. 519; Burkill 1935 p. 543; Moldenke 1952 p. 75; Rosengarten 1969 p. 188.

2. Dictionaries translate *arómata* as "herbs" or "spices," but the word has a broader meaning. E.g., Theophrastus, *Concerning Odours,* lists myrrh under aromata (#34/LB II 357).

3. The use of spices for endearment was no more bizarre than today's use of *honey* for the same purpose (see Lewis and Short under *cinnamomum*).

4. A readable, well documented book on the role of perfumes in antiquity is Détienne's *Les Jardins d'Adonis.*

5. Singer and others 1965 I p. 286

6. Proverbs XXVII 9

7. Plutarch, *Life of Alexander,* 4/LB VII 233; Détienne 1972 p. 28

8. Déonna 1939

9. Harley 1941 p. 177

10. See e.g. Pauly-Wissowa under *Rauchopfer;* Rudhardt 1958 pp. 293, 297. The idea recurs in Hindu religion and in China (Moldenke 1952 p. 57).

11. The word *perfumum,* however, came very late; it does not exist in classical Latin. The smoke in the word *perfume* is probably that of churches (incense), but it might also have something to do with the smoking of foodstuffs.

12. Détienne 1972 p. 95

13. On perfume and the gods see also Singer 1965 I p. 289

14. Aristophanes, *Birds;* Lucian, *Icaromenippos,* 26

15. According to the same passage, it was still common to offer as a sacrifice "fragrant woods cut in pieces" (Theophrastus, *On piety,* fragm. 2).

16. Lederer 1941

17. Trease and Evans 1972 p. 156

18. FH p. 164

19. CDM xxxviii. The peculiar method of harvesting ladanum is not unique. One modern technique of collecting *charas,* the resin of hemp, is to scrape it off the leather garments of men sent wandering in the plantation (FH p. 550).

20. LTT X Index 617

21. Ammonia is something of a language puzzle. There are two North African products of entirely different nature but with similar names: *ammoniacum,* a resin (FH 324) and salts of ammonia (see Ch. 2, 3; and p. 487 note 282).

22. PNH 12.77/LB IV 57

23. See FH; Trease and Evans 1972

24. Egyptians chewing papyrus: PNH 13.72/LB IV 143. In antiquity, the habit of chewing plant gums and resins is well documented (e.g. PNH 22.45/LB VI 323). Even nowadays, "the children in eastern lands often spend their coins for this material (mastic, from *Pistacia lentiscus*) which they use like chewing-gum" (Moldenke 1952 p. 177).

25. PNH 14.124/LB IV 267

26. See e.g. Smith's report on the Royal Mummies (1912): a "spicy odor" and "a strong pungent aromatic odor" (pp. 1, 110) alternate with horrible smells. Also LH p. 315.

27. The episode, told by Pliny (PNH 12 111/LB IV 79), refers to the shrubs that give Mecca balsam, *Commiphora opobalsamum*. These shrubs "paid tribute to Rome together with the race to which they belonged," the Jews; so the *Commiphorae*, in the end, meant more to either party than just balsam.

28. The name has nothing to do with bursae of resin; it was given "in memoriam Joachimi Burseri."

29. Until recently the history of pre-Muslim Arabia had been almost completely lost, also because after Mohammed this time was referred to as "period of ignorance" (Ryckmans 1951 p. 7; van Beek 1961 p. 230). For bibliography see note 105.

30. DB IV 405; Moldenke 1952 pp. 84, 85; van Beek 1958(b) p. 146

31. Van Beek 1958(b) p. 151

32. Van Beek 1958(b); Ryckmans 1957 pp. 86, 88. Reference to *the* Incense Route should not be taken literally; there were alternate pathways (Bowen 1958(a) p. 38).

33. PNH 12.32/LB IV 45

34. In 24 B.C., Augustus sent Aelius Gallus to Arabia on a campaign "to win wealthy friends or conquer wealthy enemies" (Strabo 16. 4. 22). Bad planning, disease, and the Nabataean guides led the expedition to disaster.

35. The destruction of Aden by "Caesar" is reported in the Periplus. This was doubted by Schoff (1912 p. 115), who read "Charibael" for "Caesar," but accepted by Miller 1969 p. 14 ff.

36. Carter 1848; also quoted in FH p. 138

37. In Greek, the word for incense is *ho líbanos*, or *libanotós* (Masson 1967 p. 54).

38. "Olibanum softens in the mouth; its taste is terebenthinous and slightly bitter, but by no means disagreeable. Its odour is pleasantly aromatic, but is only fully developed when the gum-resin is exposed to an elevated temperature. At 100° C, the latter softens without really fusing, and if the heat be further raised decomposition begins" (FH 138).

39. Günther 1950 p. 344

40. Masson 1967 p. 54. The similarity of the roots *mrr* and *mur*, "bitter," with the Latin *amarus*, is thought to be coincidence, amarus being probably related to the Sanskrit *amláh*, "sour" (Ernout and Meillet 1959, *amarus*). Words that travel usually represent material objects, not abstract ideas (Masson 1967).

41. The English text in the Loeb collection translates the last word freely as "ointments," but the Greek has "myrrh." See also LS *smyrna*.

42. This figure refers to all uses of myrrh, not only on wounds. In Littré's index of Hippocrates (LTT X), gums and resins are mentioned in prescriptions at least 131 times, probably an underestimate. I counted the number of times that each of 10 gums and resins was used: ammoniacum, 1; incense, 24; galbanum, 10; "gum," 4; ladanum, 1; myrrh, 54; opoponax, 1; "resin," 23; styrax, 5; turpentine, 8.

43. CDM V 27/LB II 125

44. Jeremiah 8:22, 46:11

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45. This analogy has been suggested for the use of resin in Indian medicine (Filliozat 1949 p. 110).

46. Theophrastus, *Concerning Odours*, 8.35 (LB II 359).

47. Sophocles, *Philoctetes* 782, 890/LB II 429, 439

48. Trease and Evans 1972 p. 488

49. My warmest thanks to Dr. Elisabeth Schorer and Sylvie Dersi, who tested samples of myrrh from three different suppliers. These tests, to be reported elsewhere, showed that all three samples had bacteriostatic properties toward gram-positive bacteria, not toward the gram-negative. An alcohol-soluble principle could also be demonstrated.

50. Trease and Evans 1972 p. 488

51. Vogel 1970 p. 219

52. Trease and Evans 1972 p. 438

53. Monardes 1574, quoted by Vogel 1970 p. 218
54. Trease and Evans 1972 p. 447
55. Pories and others 1967
56. Trease and Evans 1972 p. 448
57. I owe this information to Dr. P. S. Statkov.
58. LTT X Index 817
59. Rosengarten 1969 p. 439
60. Thorwald 1963 p. 65
61. Professor P. Favarger, Head of the Dept. of Biochemistry, University of Geneva, was kind enough to test the smoke of frankincense (gum olibanum) and myrrh, both obtained from Fritsche, Dodge & Olcott, Inc., New York. The smoke was bubbled through an alkaline solution, so as to trap the phenol, and then tested by several reactions (ferric chloride, diazotation, uranyl nitrate). Phenol was detectable but in very small amounts; a rough estimate from the ferric chloride reaction showed that 10.5mg of frankincense yielded about 15mg of total phenols.
62. Rosengarten 1969 p. 188. Another source of confusion as regards cassia is a well-known but wholly unrelated *Cassia fistula*, a leguminosa, also growing in India; it produces long pods, commonly used to make a laxative. This double use of the name *cassia* goes back as far as Hippocrates, who mentions cassia (bark) as well as cassia pods (*kassíe karpós*, LTT VII 357, VIII 405).
63. Burkill 1935 p. 548; Samarawira 1964; Trease and Evans 1972 p. 386; Rosengarten 1969 p. 188
64. Miller 1969 pp. 153–172
65. Hennig 1939 p. 327. Cinnamon was used in aromatic wines (PNH 14.107/LB IV 257), but strangely enough, there is no reference to its use on solid foods in antiquity. In the famous cookbook of Apicius (*De re coquinaria*) I found neither cassia nor cinnamon, as bark. The leaves were used as a spice, known as *malabathrum*; but in the Mediterranean world of antiquity it was not realized that the two were parts of the same Indian plant, so malabathrum was not considered as a kind of cinnamon.
66. Exodus 30:22–32
67. Hippocrates, *On Diseases of Women II*, #51/LTT VII 111
68. Trease and Evans 1972 pp. 511–512
69. Burkill 1935 p. 543; FH p. 510
70. Trease and Evans 1972 p. 394, but with no reference. I have come across innumerable statements concerning the antiseptic properties of spices, but have not yet unearthed bacteriologic data, which surely exist.
71. The parallel with medicine is implied in the terminology of wine makers, who speak of *infected wines* and *wine diseases*. In a standard treatise on wine making (Ribéreau-Gayon 1947 p. xv), the first function of oenology is said to be *avoiding wine diseases*.
72. PNH 14.137/LB IV 277
73. The ABC of wine science was explained to me, with great patience and kindness, at the Swiss Federal Agronomic Station of Lausanne by Messrs. J. F. Schoepfer and A. Dufour. I am much indebted also to Silvio Cavallero, Geneva.
74. Columella XII 20.8/LB III 237
75. The oldest use of sulphur in wine making was to prepare the vats by burning a "mèche" or wick of sulphur inside them. This method of disinfecting the vats, still used, was the only one at the time of Pasteur (1866 p. 132). Perhaps this was the procedure that Pliny had in mind when he made his cryptic statement about "sulphur" in wine making. Exactly where and when the method originated is not known, but according to Mr. Schoepfer of Lausanne, it must be at least as old as the use of wooden casks in wine technology (the first centuries A.D.), because such casks cannot be used unless they are first disinfected inside. The method works well, but it is empirical and not sufficiently reliable. The "scientific" use of SO_2 came about only after 1899 (Garoglio 1959 p. 251). SO_2 is a colorless gas, responsible for the characteristic smell of burning sulphur. It can bleach a flower held above it; some wines are decolorized by it. In wine it is partly combined with sugars and aldehydes, but only the free SO_2 is antiseptic.

76. Wine is spoiled by exposure to air because: *Acetobacter* can only work in the presence of oxygen, which it needs in large amounts; exposure to air causes various oxidative reactions that spoil the bouquet; new bacteria drop into the wine; and the SO_2 is lost. Some evaporates, some becomes oxidized to sulphuric acid, which is much less antiseptic (Ribéreau-Gayon 1947 p. 323 ff.).

77. Maximum daily intake of free SO_2 admitted by the World Health Organization, in mg per kg of body weight: unconditional acceptance, 0-0.35; conditional acceptance, 0.35–1.5. Maximum amount of free SO_2 allowed in wine by USA standards: 70mg per liter (Schanderl 1956). For a 70kg adult, one bottle is therefore a large dose of SO_2. The lethal dose for rats, in 50% of the animals tested: 1040mg/kg (Lanteaume *et al.* 1969). But the problem transcends wine; for SO_2 in high doses is also used for the preservation of many other foods, especially dried fruits (WHO Report, 1971, pp. 33–40).

78. See e.g. *Etat actuel des techniques pour le remplacement de l'anhydride sulfureux*, 1971:*481*, p. 238; 1971:*488*, p. 926. There seems to be hope in purely physical methods, like pasteurization. It should not be forgotten that some wines can take care of themselves, i.e. fight off bacteria without outside help, especially the sweet wines, like Sauterne.

79. Columella 12.19 ff./LB III 229–235

80. PNH 14.131/LB IV 273

81. PNH 14.92/LB IV 249

82. Mark 15:23. "Drugged wine" is a free and inaccurate translation, as I have on the authority of Prof. R. Martin-Achard. For a study of *vin myrrhé* see André 1951.

83. The addition of resin to wines was perhaps born of the observation that wines from resinated casks kept better. Pasteur himself discussed the ancient use of resin and pitch as wine preservatives, whose effect was to cause "considerable disturbance to the development of wine parasites" (Pasteur 1866 p. 132).

84. PNH 14.107/LB IV 257

85. The "new wood" was boiled in the must, which presumably was then fermented (PNH 14.112/LB IV 261).

86. Columella 12.18/LB III 227; PNH 14.134/LB IV 275

87. PNH 14.129/LB IV 271

88. PNH 35.177/LB IX 391

89. Pliny also mentions a wine that had been kept for nearly two-hundred years, but it was "reduced to the consistency of honey with a rough flavor" (PNH 14.55/LB IV 223). The empirical Roman antiseptics have become obsolete, but several other Roman techniques are still used in wine making, such as chalking to correct the acidity, or saving a wine on the verge of turning into vinegar by making it ferment on lees of good wine (personal communication, Prof. C. Tarantola, Experimental Institute of Oenology, Asti, Italy; see also Marescalchi and Dalmasso 1937 pp. 307–320).

90. PNH 14.57/LB IV 225

91. Marescalchi and Dalmasso 1937 p. 317

92. Pasteurization of wine is still performed on a large scale. In France it is known as *thermolisation*, used mainly on ordinary wines. About half of the Italian wine produced is pasteurized, by showering the bottles with water of increasing temperature (personal communication Mr. J. F. Schoepfer, Lausanne).

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93. As early as 1860, after his experiments on spontaneous generation, Pasteur had dropped the highly significant remark: "It would be most desirable to push these studies further, and to open the way to serious research on the origin of various diseases." But his work on human infections did not begin until about 1873, when he was fifty-one, after he had completed his studies on beer, wine, vinegar, and the silkworm (Vallery-Radot 1900 pp. 110, 298).

94. The ancient Egyptians have no reputation as sailors (Rawlinson 1916 p. 10), despite their naval jaunts down the Red Sea to the Land of Pwnt, like that of Queen Hatshepswt.

95. Herodotos III 107/LB II 135

96. Herodotos III 107/LB II 135; 109/LB II 137

97. Herodotos III 110/LB II 137
98. Herodotos III 111/LB II 139
99. Aristotle, *Historia Animalium*, IX 13 616–617
100. PNH 12.42/LB IV 63
101. PNH 12.42/LB IV 63
102. The tale of Ethiopia producing cinnamon caught on so well that in many old maps the name "Regio Cinnamomifera" can be found on the Horn of Africa (Drake-Brockman 1912 pp. 5–9; Schoff 1912 p. 87).
103. According to the Periplus, the secret of the monsoons was discovered by one Hippalus about 45 A.D. (Schoff 1912 pp. 227–230). Another blow to the economy of South Arabia came when the same Greco-Roman ships were stopping over at the South Arabian harbors and draining the Incense Route, so to speak, into the sea (Ryckmans 1957 p. 87). Commercial competition was fierce even in those old days. Witness the story told by Strabo of the Phoenician captain who was sailing to the "Tin Islands," the secret source of Phoenician tin (probably the Scilly Isles off the coast of Cornwall). Finding himself followed by a Roman vessel, he chose to shipwreck rather than to show the way; and when he eventually managed to return home, a grateful Phoenician government refunded his loss (Strabo 3.5.11/LB II 157).
104. The drainage of Roman gold is a matter of fact; just how critical it was is disputed (Needham 1965 I 183; Miller 1969 pp. 242 ff.).
105. The Marib dam was probably built around 750 B.C. (Bowen 1958(b) p. 75). South Arabia was greener and more populous in the distant past (Ryckmans 1957 p. 76; Bowen 1958(b); van Beek 1961; 1958(b)). Archeology of this area is just beginning; until 1951, only three Europeans had reported seeing the fabled Marib dam (Bowen 1958(b) p. 70). For literature see Bowen and Albright 1958; Phillips 1955; see also Ryckmans 1957; van Beek 1952; 1958(a, b); 1961; Pirenne 1956; 1960 (discussed by van Beek 1961); Harding 1964; Wissmann 1968.
106. Bowen 1958(a)
107. The expression "spice curtain" is my own, but the fact of Arabian secrecy in the spice trade is well established (see e.g. van Beek 1958(b) p. 147; 1960 p. 91). It must have implied the connivance of the Phoenicians, whose ships had a lot to do with the spice market. According to Herodotos, the name *kínnamon* or *kinnámomon* was "taught to the Greeks by the Phoenicians" (Herodotos III 111/LB II 139). The Phoenicians themselves might have made up the word from the Malaysian *kayu manis*, "sweet wood" (Burkill 1935 I p. 544).
108. Herodotos III 113/LB II 141
109. PNH 12.41/LB IV 61

6. *The Yang I*

1. Historians were a typical feature of Chinese courts (NEED I 74): hence the unmatched series of twenty-four official dynastic histories since 90 B.C. (Needham 1965(b) p. 282).
2. For the booklets of bamboo or wood, see NEED I 86, 111, 112. Silk was also used (ibid. p. 111).
3. Chinese writing seems to date from the beginning of the second millennium B.C. (Diringer 1968 p. 67; also Yang 1973). It was therefore developed much later than either cuneiform or Egyptian hieroglyphs.
4. NEED I 95
5. For book titles and dates I follow NEED I and II.
6. Lu Gwei-Djen and Needham 1967 p. 7; NEED I 86, II 307
7. NEED I 95; 500 to 250 B.C.
8. The *Lun Yü*, now known as the "Analects," were certainly compiled soon after the death of Confucius in 479 B.C. (NEED II 5). Translation: Waley 1938. The five-element theory was systematized by Tsou Yen about 350–270 B.C. from ideas that had been "floating about . . . for not more than a century at most before his time"

(NEED II 232). Instead of "five elements," Porkert (1973 p. 43 ff.) prefers "five Evolutive Phases."

9. NEED II 232 ff.

10. The yin-yang concept is probably not older than the sixth century B.C. (Needham and Lu Gwei-Djen 1962 p. 430). As philosophical concepts, the words appear in the early fourth century B.C. (NEED I 153–154, II 273 ff.). Oddly enough, the yin-yang equivalence male/hot–female/cold is typical also of Greek medicine (Bourgey 1953 p. 49; Siegel 1968 p. 230).

11. NEED II 277

12. NEED II 312–321; Wong and Wu 1932 p. 9

13. The *I Ching* probably originated from omen compilations in the seventh or eighth century B.C. but did not reach its present form before the end of the Chou dynasty, 221 B.C. (NEED II 307).

14. The *I Ching* was translated into German by R. Wilhelm; this version was then rendered into English by C. F. Baynes (1950). C. G. Jung was asked to write a foreword. Not being an expert on China, Jung had a brilliant idea: since the *I Ching* was an oracle book, he performed what he called an experiment and asked the book whether he, Dr. Jung, should accept the task of presenting it to a Western audience (R. Wilhelm 1950 p. vi). The *I Ching* replied: "There is food in the caldron . . . The handle of the caldron is altered. One is impeded in his way of life. The fat of the pheasant is not eaten." Jung took this to mean that the wisdom of the *I Ching* was going to waste in the West, being unusable in Chinese, and he wrote the preface. He also wrote, incidentally, a book entitled *Psychology and Alchemy* (Jung 1944).

15. NEED II 335. See also the recent attempt to edit the *I Ching* for the "Western man of affairs" (Siu 1968).

16. NEED II 310

17. Having read the *I Ching*, I find the words of Needham very descriptive: "the abstractness of the symbolism gives the book a deceptive profundity" (NEED II 304). However, it is interesting to see the impact that it had on H. Wilhelm (son of the translator), who published a series of lectures about it (H. Wilhelm 1960).

18. R. Wilhelm 1950 I 107

19. R. Wilhelm 1950 I ii

20. R. Wilhelm 1950 I 261

21. Needham and Lu Gwei-Djen 1962 pp. 438–439

22. NEED II 304

23. The compilation of the *Chou Li* must be considered a work of the early Han (2nd century B.C.), but much of the material may well date from the Chou period (Lu Gwei-Djen and Needham 1967 p. 6).

24. Biot 1851 p. 495 ff. I used the French translation of Biot 1851, which in modern Sinological circles is considered excellent.

25. Biot 1851 p. 8 ff.

26. Creel 1970

27. The four commentators are from the first, second, eighth, and twelfth centuries A.D. (Biot 1851 I lx [= 60]).

28. Thus in Needham and Lu Gwei-Djen 1969 p. 256; but in Wong and Wu (1932 p. 7) it is implied that Confucius still refers to a "priest-doctor." In Waley's translation the passage reads (Waley 1938 p. 177 No. 22): "Without stability a man cannot even make a good *shaman* or witch-doctor." The same passage occurs in another ancient text, the *Li Chi*; there the witch-doctor is replaced by a "diviner by the yarrow-stalks" (Waley 1938 p. 177 note 4).

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29. Wong and Wu 1932 p. 7

30. Creel 1970 p. 17; also Lu Gwei-Djen and Needham 1963 p. 64

31. Creel 1970 p. 19 note 64; Needham and Lu Gwei-Djen 1969 p. 268

32. The evidence is gathered by Cohn-Haft 1956 p. 57. Vague hints about the procedure are found in Plato, *Gorgias* 455B, 456B, 514D-E and in Xenophon, *Memorabilia*, 4.2.5. See also Drabkin 1944 p. 344; Bourgey 1953 pp. 116, 120

33. The Chinese consider the color of their skin to be white (Needham 1968). In the tables of correlations by "fives," there is a different color for each of five rulers, and Huang Ti corresponds to yellow (NEED II 263).

34. NEED I 98

35. See Needham and Lu Gwei-Djen (1969 p. 263), who propose "The Yellow Emperor's Manual of Corporeal [Medicine]." This should be opposed to "magico-religious medicine," and in fact there had been such a book, now lost: *Huang Ti Wai Ching*, "The Yellow Emperor's Manual of Incorporeal (or Extra-Corporeal) [Medicine]" (ibid.).

36. Huang Wên 1950 (this paper, though not to be relied on for depth of scholarship, contains useful summaries of the *Nei Ching*); Lu Gwei-Djen and Needham 1967 p. 11

37. Breasted 1930 p. 61

38. The partial English translation is by Ilza Veith (1949; 1966), abbreviated henceforth as Ve; see the critique by J. R. Hightower (1951).

39. The French translation is by A. Chamfrault and Ung Kang-Sam 1957, abbreviated henceforth as CU. The passages quoted here are CU 75, 163.

40. Porkert 1973

41. CU 60; Ve 151

42. CU 64; Ve 155

43. The *Nei Ching* consists of two parts, each with 81 chapters: *Su Wên* (meaning uncertain, perhaps "Simple Questions and Answers") and a shorter *Ling Shu* ("Mysterious Pivot"), which is mainly a treatise on acupuncture. There is some confusion of names: the title *Su Wên*, for example, is sometimes applied to the whole. To compound the confusion, in the French version the two parts are correctly named in the preface, but in the text they are entitled *Su Wên* and *Nei Ching* (*Sou Ouenn, Nei King*). The English version covers only chs. 1–34 of *Su Wên*. In my text, quotations are from the English version; abbreviations are as follows: NC = *Nei Ching*; *SW* = *Su Wên*; number = chapter (disregarding the subdivision into books); LS = *Ling Shu*; CU = Chamfrault and Ung Kang-Sam version (+ page); Ve = Veith version (+ page). When the content of the two versions is generally comparable, the concordance is given as = ; otherwise as = ? It is possible that the original Chinese editions were not the same. Sometimes even the short summaries of Huang Wên (1950) have no precise equivalent in CU or Ve.

44. NC-SW 1/Ve 97 = CU 17

45. NC-SW 12/Ve 147 = CU 56

46. NC-SW 2/Ve 102 = CU 20

47. NC-SW 26/Ve 220 = CU 108

48. NC-SW 2/Ve 105 = CU 22

49. NC-SW 4/Ve 111 = ? CU 28

50. NC-SW 14/Ve 152 = ? CU 61

51. NC-SW 3/Ve 107 = ? CU 23–25 (?)

52. NC-SW 5/Ve 117 = CU 32: almost the same!

53. NC-SW 13/Ve 151 = ? CU 58 ?

54. NC-SW 14/Ve 152 = ? CU 60

55. The reconstruction is based almost entirely on the *Nei Ching* and the *Chou Li*, for other sources on wounds and ulcers are not available in translation. The next step should be to consult two anonymous, untranslated works of Han times: *Chin-ch'uang tsung-chih fang*, a treatise on wounds (ref. courtesy of Dr. Nathan Sivin), and *Chin-Ch'uang Hsi Ts'ang Fang*, a collection of recipes for wounds caused by weapons and dog bites (Huard and Wong 1959(a) p. 139).

56. NC-SW 77, 78/CU 293, 297 = Huang Wên 1950 p. 18

57. Quotations from Huang Wên pp. 6 (#7), 8 (#18, 19), 14 (#48)

58. NC-SW 10/Ve 144; CU 52 is different. . .

59. Huang Wên 1950 pp. 31, 33. *Tu quoque*, Huang Wên! It is a wild suggestion that the ancient Chinese had trained their fingers to detect "what the electro-cardiogram showed of changes in the heart." This kind of "mastery" was largely an exercise in self-deceit.

60. The *hot disease* is discussed at length in the *Nei Ching* (e.g. NC-SW 31–34/Ve 239 ff. = CU 120 ff.). Wong Man and Chamfrault translate it as "fever," but from the text I infer that it also covered "local heat" (inflammation). If it did not, there would be no mention of "local heat" in the whole book, a very unlikely

omission. In Chamfrault I, Index (*Traité de Médecine Chinoise*, largely based on the *Nei Ching*), the term *inflammation* is almost ignored, being used only once in relation to the kidneys. Inflammations of the skin are called "swellings"; on suppurations there is very little. It seeems that in ancient Chinese practice, as judged from the *Nei Ching*, today's syndrome of inflammation is rather broken down and de-emphasized.

61. For this fundamental piece of information—the lack of venesection in ancient China—I am once again deeply indebted to Prof. Needham. In his summary of the *Nei Ching* (p. 17) Huang Wên used the word *venesection;* but the surgical act must have been more like a puncture, Chinese style. See e.g. "puncture the point Ta-Tchong-4-kidneys . . . and make it bleed. After half an hour, if the patient is not relieved, puncture the opposite point" (NC-SW 63/CU 229). Other passages of the *Nei Ching* indicate that *some* blood was drawn; e.g. "Nowadays it is known that in order to cure completely the suffering of hand and foot, of yin and yang, one must first remove blood; and by such means one also removes the ailment which can then be examined" (NC-SW 24/Ve 210 = CU 104). However, there is no indication that veins were slit and that correspondingly large amounts of blood were drawn,—except in a passage of the English version, where blood is drawn by the *pint* (NC-SW 7/Ve 130). This is a mistranslation; the French version is altogether different (CU 42).

62. Porkert 1973 p. 167

63. Huang Wên 1950 p. 30

64. In NC-SW 27 the concept is translated as "draining" (Ve 224), "extraction" and "purging" (Huang Wên 1950 p. 10), or "dispersion" (CU 111). The basic idea remains the same.

65. E.g. Huard and Wong 1964 p. 8; Pálos 1971 p. 40. The fact that the needles were stone also suggests the Stone Age.

66. CU throughout

67. Ung Kang-Sam in Chamfrault II 14

68. For the nine needles see NC-LS/CU 305; for the choice of the flint needle in case of ulcers of the ankle see NC-LS 81/CU 560, 559 note 1; for the 365 points see NC-SW 58/CU 198.

69. CU p. 9

70. NC-LS 67/CU 519; NC-LS 1/CU 308

71. For an "abscess" on the inside of the ankle the *Nei Ching* recommends a flint needle on the "*Iu* point of the corresponding meridian" (NC-LS 81/CU 560).

72. Huard and Wong 1958(a) p. 8

73. For literature on the moxa see Veith 1966 p. 58 ff.; Huard and Wong 1958. Notice there on p. 12 the practice (how old?) of actively delaying the healing of the burn, as was common in Greek medicine.

74. Information from Dr. Chong Yu-ming, acupuncturist, Taipei, Taiwan; see also Pálos 1971 p. 121 ff.

75. Hume 1940 p. 94

76. Hints at purging in the *Nei Ching* are few but clear: "one should restore their bodies and open the anus, so that the bowels can be cleansed" (NC-SW 14/Ve 153; ibid. CU 61 has "purifier les entrailles"). "When a patient has been ill for more than three days, one can bring about [abdominal] dispersion" (NC-SW 31/Ve 241 = CU 122: "il faut purger au quatrième [jour]").

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77. Perhaps the most famous Chinese drug is Ma Huang; for the world career of this drug see Ch. 9.

78. NEED II 264

79. Biot 1851 I 97

80. Needham and Lu Gwei-Djen 1962 p. 436. Incidentally: the *yang* of *yang i* is unrelated to the yin-yang couple.

81. The information (largely unpublished) contained in this paragraph was graciously provided by Prof. Needham. Western literature about ancient Chinese surgery contains many mistakes (such as the alleged use of opium and hemp for anesthesia), often due to erroneous readings of the Chinese. Regarding anesthesia: tradition maintains that Hua T'o improved methods that were already in use four

hundred years earlier by Pien Ch'io (Hume 1940 p. 88; Hartner 1941 p. 247), who is a semi-legendary figure (NEED II 54; Huard and Wong 1959(a) p. 139).

82. One passage is as follows: "weigh and consider carefully removal, as well as cutting and scooping out exposed and spoiled particles" (NC-SW 14/Ve 153; missing in CU). The disease is incomprehensible, but this is clearly minor surgery. The second surgical passage: "if a toe becomes red and black from suppuration [gangrene?] one should not hesitate to cut it off" (NC-LS 81/CU 560).

83. NC-SW 25/Ve 53 = CU 106; but CU reads rather differently, as if giving five precepts for the practice of acupuncture.

84. CDM VII *Prooemium*/LB III 295

85. Huard and Wong 1957 p. 15; 1960 p. 65

86. Hume 1940 p. 102 ff.

87. Wong and Wu 1932 p. 113

88. The use of wine for anesthesia should have come about naturally; consider the vast number of "Wine-Men" on the Chou staff and the opening paragraphs of the *Nei Ching* about wine intoxication.

89. Lucian, *De dea Syria*, § 51

90. Kleine Pauly I, *Castratio*

91. Jeanselme 1917 p. 85. The event occurred under Emperor Justinian (*Novella CXLII* in: *Corpus Iuris Civilis*, III, R. Schoell and G. Kroll, Berolini, apud Weidmannos, 1954, p. 7055).

92. Juvenal, *Saturae*, VI 366–378; also *Eunuchus* in PW Suppl. III.

93. NEED I 105

94. Translation courtesy of Prof. Needham.

95. Biot 1851 p. 97 note 7

96. Cinnabar (mercuric sulphide), though not mentioned in the Hippocratic books, was used in Roman medicine for cleansing sores; Celsus mentions it also as "erodent" (see CDM/LB II xliii, *Minium*). "Minium" is now lead oxide, but in antiquity it referred to several red pigments, including cinnabar (Singer and others, *History of Technology*, 1957 II 361).

97. Huard and Wong 1957 p. 23

98. "Important remedies have been made by the profit-seeking Greeks even with human offscouring from the gymnasia; for the scrapings from the bodies soften, warm, disperse" (PNH 28.50/LB VIII 37; also PNH 15.19/LB IV 301). Celsus agrees (CDM V 11/LB II 11). For Western examples of bizarre and revolting drugs, if necessary, see Pliny's home remedies, Ch. 9.

99. Chamfrault III 29

100. NEED I 203, II 350

101. See e.g. the use of resin to make lacquer. The lacquer tree of China and Japan is *Rhus verniciflua* (Burkill 1935 II 1904).

102. Burkill 1935 I 117 ff.

103. Trease and Evans 1972 p. 43

104. The Indians called storax by the Sanskrit name *rasamala*, "excrement." The Chinese were apparently skeptical (Burkill 1935 I 117; NEED I 203 note a). For Arabic tales about cassia and cinnamon see Ch. 5.

105. Data on the Han tomb courtesy of Peking Television. The tomb, found in Ma-wang-tui (Hunan), was thought at first to contain the wife of Li Tsang, who was made marquis of Tai in 193 B.C., but the identity of the lady is uncertain (see Hall 1974). The wealth of objects (over 1000) recalls the treasure of Tutankhamun.

106. Peking Review 1973 no. 32 p. 17

107. Biot 1851 I 111

108. According to Dr. Donald Tipper, Head, Dept. of Microbiology, University of Massachusetts Medical School.

109. Other factors that contributed in a major way to the preservation of the body were exclusion of air (and hence oxygen), prevention of evaporation, and cold (about 13°C). I learned from Prof. Needham that another possibility was discussed in recent Chinese publications. The coffin complex contained large amounts of methane, probably originating from the decay of food placed in the spaces between

coffins. It has been hypothesized that the low temperature may have favored the methane-forming bacteria while holding in check the bacteria of putrefaction. As for the mercury, the main compound was mercuric sulphide. See also the recent article by Hall (1974).

110. NC-SW 46/CU 173

111. Sharma 1972 p. 14

112. For comparison between the Greek and the Chinese element-theories see NEED II 245.

113. Veith 1966 p. 89

114. From the second to the fifteenth centuries A.D. China was technologically far in advance of Europe (Needham 1964 p. 174). For a long list of Chinese firsts, including paper (second century A.D.), printing, the magnet, gunpowder, and rockets, see NEED I 242.

115. NEED I 150 ff.; Filliozat 1949 p. 215

116. NEED I 83

117. Hudson 1931 p. 22

118. NEED I 183, 199

119. NEED I 195, 210

120. This historic voyage ended in 124 B.C. Chang Ch'ien returned home with much news and many novelties, including the grapevine (*Vitis vinifera;* Hudson 1931 p. 53 ff.; NEED I 172 ff.).

121. NEED I 176, 181

122. NEED I 191

123. NEED I 193–194

124. NEED I 195

125. Cassia trees grow wild throughout Indo-China and are cultivated in China (Burkill 1935 I 548). Cassia bark is an ancient and favorite Chinese drug, *kuei* (e.g. Hartner 1941 p. 244). The Chinese province of Kuei-lin means "Cassia forest" and has been so named since 216 B.C. (Miller 1969 p. 42).

126. I said a *faint chance*—but there is a chance. The name of *cassia* has been given three possible pedigrees: from the Chinese *kuei-shu,* "Cinnamon tree" (I have already discussed the near-synonymous use of cassia and cinnamon); from the Khasya Mountains in eastern Bengal, where the bark is also produced (FH 528; Miller 1969 p. 42); and from "a Semitic root meaning *cutting up, peeling,* and thus definitely Phoenician" (Lassen 1867 I 329). Burkill (1935 I 545) mentions "an untenable theory that Chinese bark reached ancient Egypt," but it is not untenable at all in view of the exploits of the Malaysian double outriggers in the second millennium B.C. (Fig. 5.4). I am also tantalized by a possible link between the Bengali *taj* for "cassia" or "cinnamon bark" (McCrindle 1885 p. 220) and the ancient Egyptian *tj-šps,* "perhaps cinnamon" (GMÄ VI 549); and between the Egyptian *khisit* ("equivalent to the Greek *kinnámomon,*" Hennig 1939 p. 328) and *kwei-shu* + the feminine ending *t.* Spice names travel well: of the two or three words of Chinese that have penetrated into European languages, one is *tea* (Forrest 1948 p. 123; also Mahdihassan 1952; 1959; 1960).

Notes to pages 257–261

7. *The Vaidya*

1. Arrian, *De expeditione Alexandri,* VI 1/LB II 103–104

2. The mouthwash, "called the Indian preparation," was made by pounding anis, dill, and myrrh in white wine (*On Diseases of Women II,* #185/LTT VIII 367). Mouth hygiene received much attention in ancient Indian writings (e.g. ChS I 60; SS II 480). Teeth were to be brushed twice a day (ChS I 60). Buddha planted one of his *dântakachta* (toothbrush twigs), and it became a tree (Beal 1869 p. 72).

3. Hippocrates, *On Diseases of Women* II, #205; I, #81/LTT VIII 395; 203

4. Data on Mohenjo-Daro: Renou and Filliozat 1953 p. 665. Origin of the word *Aryan:* other theories derive it from the Sanskrit *arya,* "noble," or from *ari,* "stranger," as a reference to the great hospitality of these "strangerly" people. (Courtesy of Gopal Sukhu).

5. AUB 227

6. ChS I 105. The word *vaidya*, however, is not the ancient Vedic word for "physician," although it is attested as early as the "epic" period of Sanskrit. The Vedic term is *bhiṣhaj* (*bhiṣhak-* and *bhiṣag-* in composite words). In classical Sanskrit, *bhiṣaj* and *vaidya* coexist, much as "physician" and "doctor" in modern Indo-European languages (information courtesy of Prof. H. Frei).

7. SS II ii ff.

8. *Sam-hita*, too, means "together-put." Both these classics are written in prose mixed with verse. Sushruta (whose name means "he who was well heard") comes to about 1700 pages; Charaka to twice as many. They are well preserved and agree in many points. The English translations are somewhat old and not wholly free of bias, but no others exist. For comments on the translator of Sushruta see notes 98, 280. An eminent French scholar called his work "unsure" (Renou 1946 p. 125). The translator of Charaka, a practitioner of Hindu medicine, stated in the preface that he needed help in the translation, because his knowledge of English was insufficient. For a critical study of the contents of Charaka see Rây and Gupta 1965.

9. ChS I 847

10. Smith 1920 p. xviii

11. SS I intro. i

12. SS I foreword 5

13. Smith 1920 p. xiv

14. AUB 20

15. Smith 1920 pp. 85–86

16. The main passage (Strabo 15.60) says that Indian physicians cure mainly by diet and plasters, use few drugs, practice fortitude and patience, and have charms that can bring about numerous offspring (male or female as preferred). Unfortunately, no mention is made of surgery. For fragments of Megasthenes' work, see McCrindle 1877.

17. Smith 1920 p. 95

18. Kosambi 1965 p. 157

19. Smith 1901 pp. 116, 114

20. Zimmer 1948 p. 173

21. Mukhopadhyaya 1913 I 8

22. Bloch (1950 p. 94) has "deux secours médicaux, secours pour les hommes, secours pour les bêtes." Hultzsch 1925 p. 52 has "two kinds of medical treatment . . . for men . . . for cattle."

23. Smith 1901 p. 115

24. Ironically, Ashoka's concern for animals caused such discontent that it may ultimately have contributed to the breakup of the empire after his death (Smith 1920 p. 107).

25. Smith 1920 p. 84

26. Sushruta's dates are a reasonable assumption because: modern criticism allows the *Sushruta Samhita* to have been composed perhaps "as far back as the last centuries B.C." (Renou and Filliozat 1953 p. 147); the Indian translator (admittedly not unbiased) argued for the sixth century B.C. (SS I iv); and Sushruta, much like Hippocrates, did not create his own surgery but largely codified the existing art, which was necessarily older (all the background works are lost). Note also that around 326 and 300 B.C. two Greeks, Alexander and Megasthenes, were impressed with Indian medicine.

27. Sushruta's opening paragraph explains that the work was "dictated to Sushruta" by the holy sage Dhanvantari (unlike the Hippocratic authors, Sushruta never appears in the first person).

28. ChS I 955

29. Bandits were a recognized pest in ancient India. There was even a special caste of outlaws (AUB 77 ff.).

30. SS I intro. xiii

31. Skill in archery was useful even in procuring a wife, through a contest (AUB 46).

32. SS I xiii 336

33. SS I 16
34. SS I 16
35. SS I 18
36. Teaching by recitation was and still is a typically Indian practice (AUB 225). Great stress is laid on learning first just the syllables (even backward!), then the meaning. I was told by Prof. J. Filliozat that still today the children of some Brahmans, between the ages of about five to eight, are given—to begin—a whole Sanskrit dictionary to learn by heart. Later, they are taught Sanskrit; and then they discover that a whole dictionary is available to them! For "oral reciters" see Whitney 1962 p. lxvi,
37. SS I 341
38. SS I 339
39. Steel was known in ancient India, but its beginnings cannot be dated (Forbes 1965 p. 597). It was probably made by the technique still used in Ceylon: melting pieces of iron in a crucible in the presence of bits of wood (Coomaraswamy 1913 p. 137). The British were much intrigued by this simple, unorthodox, and very effective method. The famous Damascus blades were made of Indian steel.
40. AUB 259
41. For bamboo shoots as probes see SS II 250; for facing north while gathering herbs see SS I 337; ChS II 1920
42. SS I 16
43. ChS I 422
44. Hippocrates, *The Physician*, LB II 311/LTT IX 205
45. SS I 71
46. SS I 242
47. SS I 74
48. SS I 270
49. SS I 270
50. SS II 723
51. SS I 76; ChS I 109
52. SS I 258. The two methods (pulling the arrow back or pushing it through) are not specifically Indian. See e.g. the Akamba people of East Africa (Lindblom 1920 p. 312) and the Romans (CDM VII 5/LB III 317).
53. SS I 258
54. SS I 259
55. Sushruta, who is meticulous in describing equipment, mentions no gadget of this kind. Yet it is hard to believe that the ancient Hindus, so familiar with arrow wounds, did not invent something like the spoon of Diokles. Mukhopadhyaya (1913 p. 110) does mention two such instruments, *pañcamukha* and *trimukha*, but they are more recent; they are described in Vagbhata's *Astangahrdayasamhita*, c. seventh century A.D.
56. SS I 261
57. SS I 261
58. SS I 260
59. E.g. pure honey-butter salve, made with clarified butter, was used on burns by the cautery (SS I 91), after extraction of a foreign body (I 260), and on wounds (II 240, 262).
60. Though clarified butter or *ghee* lasts longer than butter (almost indefinitely, like oil), Prof. Filliozat tells me that it has a rather rancid taste. Clarified butter "matured" from eleven to one hundred years was said by the Hindus to ward off monsters; beyond one hundred years it was called *Kumba Ghritam* (Great Clarified Butter) (SS I 443). Ghee made of woman's milk "should be regarded as the prototype of divine ambrosia on earth" (SS I 442). A traveler in the late 1600s speaks of tanks of ghee four hundred years old! (Schoff 1912 p. 177).
61. Jee 1896 p. 58
62. SS I 60, 66
63. SS I 57
64. SS II 250

65. SS I 252

66. SS I 252

67. Fragrant sandalwood is another typically Indian material. It is used for fine woodwork; distilled it gives an oil used in perfumes; as a powder or paste it is used in the pigments used by the Brahmans for their distinguishing caste-marks. It is now used extensively wherever Buddhism prevails.

68. SS I 251. A less attractive paste for this purpose was made of beans, wheat, barley, and cow dung (ibid.). The method was also used for a longevity test: "Men, on whose bodies sandal paste and similar preparations begin to dry up from the head downward . . . should be looked upon as persons endowed with an uncommonly longer duration of life" (SS I 309).

69. SS I 254

70. SS I 257

71. SS I 63

72. SS I 63

73. SS I 258

74. SS I 248. I have searched many a museum in vain for an Indian arrowhead of this kind.

75. SS I 169. The Hippocratic passage that has been interpreted as advising not to tie the knot over the wound is quite garbled (*On the Surgery*, #8/A II 478 and note 2 = LTT 296–297 and note 6).

76. SS I 176

77. SS I 179

78. SS I 180

79. SS I 180

80. SS I 180

81. SS I 182, 185; ChS II 1776

82. SS I 181

83. SS I 181

84. SS I 181

85. SS I 181

86. SS I 178

87. SS I 182

88. SS I 40. There were several ways to fumigate, e.g. by pouring over a hot brick sour gruel (SS II 558) or clarified butter and certain resins (SS II 255). See also the nadi-sveda below. The pain-killing was surely psychological.

89. SS I 44

90. SS I 44

91. See e.g. Read 1926 p. 18

92. SS I 305, II 263; ChS I 102

93. ChS I 130

94. SS I 3

95. ChS I 287; for list of Charaka's main principles see ChS I 276–289

96. SS II 172

97. It is a poor excuse that dogs do have a bone in the penis. Equally mystifying is Charaka's vaginal bone (ChS I 805). Neither of these skeletal anomalies appear in Sushruta. The neglect of the lungs (Zimmer 1948 p. 161) is remarkable, since consumption was described (ChS I 979). The share of fancy in Hindu anatomy is clearly apparent in Sushruta's account (SS II 159 ff.). However, remember that Aristotle believed in a heart-bone: "in horses and in a certain kind of ox . . . the heart has a bone for support" (*De partibus animalium* 666b 18–21/LB 241). Also remember that for all of their anatomic ignorance, the Hindus somehow knew enough about the eye to operate on cataracts.

98. SS II 191 ff. The literal meaning of *dosha* is not "principle" but "defect;" in fact *dosha* is related to the Greek *dys-*, "ill-" as in "ill-advised."—The comparison between the Hindu and the Greek four-humor theories is the subject of a classical study by J. Filliozat (1949). The Hindu theory is usually referred to as the *tridosha* (literally "three-defect" or three-principle) theory, but in reality

there were three principles plus blood—as in the Greek system. Filliozat's excellent book also deals with the relations between Greek and Indian cultures in general. Sushruta's translator, Dr. Bhishagratna, wrote at length to prove the absolute originality of the Hindu *doshas*, "principles": though they are often translated as air, bile, and phlegm, he warned, "nothing could be more misleading" (SS I xxxix). He treated Hippocrates as a confused plagiarist of Hindu medicine, but obviously knew nothing about his theories (SS I i note). On this score, he is not a reliable witness. (For Hindu medical theories see also Rây and Gupta 1965).

99. Bagchi 1968 p. 1328

100. The peccant humors—vayu, pitta, kapha—are in fact mentioned in Sushruta and Charaka at every step. I underplayed them in this chapter for fear of boredom.

101. Filliozat (1949 p. 215) concludes: if the Greek and Hindu ways of thinking had points of contact, "c' est qu' en sous-oeuvre ils communiquaient." Joseph Needham refers to the same phenomenon when he speaks of "capillary" exchange between ancient China and the West (NEED I 191).

102. SS II 181

103. SS II 173; ChS I 808

104. SS II 184

105. SS II 175

106. SS II 179

107. SS II 187

108. SS II 180, 176. Sushruta gives yet another explanation for death by injury in a marma (SS II 178): sometimes "The Vayu [wind] aggravated by an injury to the Marma, blocks up [the four classes of vessels] . . . throughout the organism and gives rise to great pain . . . all over the body." Note that death was sometimes expected to occur many days after the injury to the marma; this must have reflected past experience with infections, such as tetanus.

109. Kosambi 1965 pp. 73, 79

110. Wilson 1857 p. 48. For a list of marma in the *Rig Veda* see Grassmann 1873; also Filliozat 1949 p. 133.

111. I owe these details to Dr. G. Sambasivan, World Health Organization, Geneva.

112. SS II 172

113. The Greek "eye of the mind" occurs first in Hippocrates (*On Breaths* [also called *On Winds*] 3/LTT VI 95): "ἀλλὰ μήν ἐστί γε τῇ μὲν ὄψει ἀφανὴς, τῷ δὲ λογισμῷ φανερός." Galen uses the expression several times.

114. SS I 74

115. SS I 77

116. SS I 77

117. ChS II 1632 (*arishta*); SS II 715

118. SS II 700

119. ChS I 264

120. ChS II 1632

121. SS II 716

122. AV VI 12/Whitney 1962 I 289

123. SS II 704

124. SS II 715; ChS II 1632

125. SS II 706

126. ChS II 1653; SS II 707

127. ChS II 1653; SS II 707

128. SS II 715; ChS II 1667

129. SS II 715. One could also fill the mouth with barley meal, dust, or ashes (ChS II 1631).

130. The text says "one Muhurta," the thirtieth part of the day.

131. ChS II 1632

132. Sushruta says that incision, cauterization, and sucking should be highly recommended in *all* cases of snake bite (SS II 715). A note by the translator of Charaka

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says that the cut (puncture) is made "in case the bitten part cannot be tied" (ChS II 1631). Cauterization, prescribed by both classics (ChS II 1632; SS II 715), was presumably applied with an iron rod; I assumed the vaidya had no cautery with him, and therefore used the red-hot coal method described in the *Kausika Sutra* (a catalog of rituals and gestures that had to accompany each magic formula found in the *Atharva Veda:* a sort of practical manual of the Atharvan priests). Note the reassuring gesture of "throwing away the poison" (KS 32. 20–25/Caland 1900 p. 106). In another ritual of the *Kausika Sutra* the bite is rubbed with grass, then the grass is lit and thrown toward the snake (KS 29.6/Caland 1900 p. 92).

133. SS II 719, 716
134. SS II 724
135. SS II 717
136. AUB 245
137. The ancient use of *Rauwolfia serpentina* for snake bite is mentioned by Vakil (1961 p. 97), who was responsible for bringing it to the West as a tranquilizer (Goodman and Gilman 1970 p. 171). Dr. Vakil mentioned Charaka as a source, but I was unable to find *Rauwolfia* (*Sarpagandha* in Sanskrit) in the chapters on snake bite in either of the Hindu classics; nor is *Rauwolfia* mentioned in the list of Charaka's plant-drugs (Rây and Gupta 1965 pp. 52–77). For the history of *Rauwolfia* see Schlitter and others 1964; Pelt 1971 p. 54.
138. Goodman and Gilman 1970 p. 170. *Sarpagandha* means "serpent fragrance."
139. SS I 77
140. SS II 707
141. SS II 711
142. ChS II 1627
143. ChS I 405
144. SS II 717
145. ChS II 1655
146. Sushruta has a whole chapter on antipoison drums (SS II 727). Dr. Bhishagratna, who translated it, should have known the topic. However, the translator of Charaka regarded this as an error of interpretation: in his opinion, it is true that drums are beaten to keep the patient awake, but the drugs are smeared on the patients, not the drums (ChS II 1640 note)!
147. SS II 702
148. SS II 716
149. Reid 1968 p. 614
150. Navmed 1966 p. 123
151. SS I 420
152. SS I 337; ChS II 1920
153. Although the Hippocratic Collection includes a passing reference to the principle of the hemostatic tourniquet, it never describes its application, for either bleeding or snake bite. As to a possible historical correlation between the two tourniquets, I have no data. However, it is tempting to speculate: someone *could* have noticed that a tight ligature for snake bite was also able to stop the bleeding.
154. Minton and Minton 1969 p. 69
155. SS II 673–762; ChS II 1624–1668; AV X 4/Whitney 1962 II 575 ff. and index.
156. Vogel 1926 p. 6
157. Aelian, see McCrindle 1901 p. 145
158. Arrian, *Indica,* VIII 15/LB II 353
159. Deoras 1971 p. 26
160. ChS II 1655; 1627
161. Harley 1941 p. 105 ff.
162. Harley 1941 p. 103
163. Harley 1941 pp. 98–104
164. AUB 216
165. SS III 141
166. SS I 141

167. SS I 141
168. Coomaraswamy 1931; AUB 200 ff.
169. SS I 141
170. SS I 143 (wording changed to the first person)
171. These famous caves, twenty-nine in all, are Buddhist temples and retreats carved into a cliff and decorated with paintings dated from the second century B.C. to the sixth century A.D. (Yazdani 1930–1955).
172. Stretched earlobes also existed in ancient Egypt, where they left traces in art and on mummies, not in medical history. See e.g. the large holes in the ears of the Egyptian head in Plate 3.5; Nefertiti and Akhenaton both had their earlobes pierced and somewhat stretched (Fig. 3.30). In a mummy of the Twenty-second Dynasty "the ears are pierced and the lobules drawn into long strings (16 cm.)" (Smith, *The Royal Mummies* [Cairo 1912], p. 109). In life, these ears must have looked much like those of the Indian girl in Fig. 7.19.
173. Having seen some Swiss male peasants wearing a ring in the right ear only, I learned from Prof. Jean Babel, Head, Dept. of Ophthalmology, University of Geneva, that worried mothers sometimes consulted him to find out whether they should have the ears of their children pierced, to protect their eyes against disease.
174. SS I 142
175. SS I 143
176. SS I 142–143
177. Basham 1954
178. Bühler 1886
179. Sharma 1972 p. 77
180. See also McDowell 1969
181. AUB 50
182. SS I 151
183. SS I 147
184. The vaidyas were positively unimpressed by the Brahman anathema against wine (ChS I 295, 363), though they realized that it was a cause of disease (ChS II 1668–1696!): "Wine is poison, but poison administered duly promotes nutrition" (ChS II 1676).
185. AUB 50
186. SS I 147
187. AUB 41
188. SS I 147
189. Converse 1964 p. 1118
190. SS I 147, 37
191. SS I 147–148
192. Hindu surgery was made known in Europe in the Middle Ages by the great Arab physicians (Rhazes, Avicenna, and others). It surely was related to the making of new noses in Sicily in the early 1400s and ultimately to the publication of Tagliacozzi's famous book *De curtorum chirurgia* in 1497 (Gnudi and Webster 1950).
193. SS I 153 ff.; Converse 1959 p. 339. I am much indebted to Dr. Denys Montandon, plastic surgeon, for advice on these topics.
194. Dibbell 1970

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195. ChS I 168–171. Charaka also describes a lying-in room that should be built before the ninth month (ChS I 844 ff.). Otherwise, he never refers to the place where the patients are treated.
196. ChS I 901
197. ChS II 2145
198. ChS II 2060
199. This interpretation of Charaka's "hospital" as an infirmary built into a rich home is also that of Mukhopadhyaya (1913 I 8).
200. NEED I 120, 207
201. Beal 1869 pp. 3, 18
202. Beal 1869 p. 107
203. AUB 173

204. SS II 63
205. SS II 188
206. SS I 160
207. AUB 253. Charaka speaks often of the virtues of wine. His list of wines "that are beneficial to mind and body" comes to eighty-four (ChS I 291). Ashoka's edicts, which insist on meat prohibitions, never mention wine (Basham 1954 p. 214).
208. SS I 457–466
209. The preoperative meal was skipped before certain operations, e.g. on the mouth or anus (SS I 39). Anesthesia with wine is mentioned only once, in this passage.
210. SS I 160, italics mine.
211. The short Hippocratic treatise *On the Use of Liquids* (LTT VI 116) discusses wine only as a surgical dressing and as a vehicle for cathartics (ibid. pp. 129–131).
212. AUB 259
213. The place for the operation is my guess. Sushruta too never says where the patients are treated.
214. SS I 37–38
215. SS I 67–68
216. SS I 38
217. SS I 39
218. SS I 40
219. SS I 162
220. SS II 560
221. ChS I 160
222. ChS I 160
223. SS II 559–560
224. SS II 559 note; see also ChS I 160
225. Chs I 58
226. SS I 43–44
227. SS II 63
228. SS II 243–245
229. SS I 44
230. SS II 245
231. SS I 398
232. SS II 262, I 358
233. SS I 359
234. SS I 358
235. SS I 466
236. ChS I 27
237. SS I 467
238. SS II 260
239. SS II 627 ff.; see also ChS II 2036 ff.
240. SS II 207, italics mine; see also ChS I 259
241. AUB 195
242. The text merely says "two tubes open at both ends" (SS II 284). Tips for enema tubes were made of bamboo or bone (ChS II 2038).
243. SS II 284
244. SS II 284
245. Sharma 1972 p. 74
246. For *vraṇa* see SS II 241; for "instant ulcer" see SS I 240 (the transliteration *brana* in Chakravorty 1969 is less current). As *vraṇa* corresponds to the Greek *hélkos*, *sadyovraṇa* is equivalent to the Greek *tróma*, "recent wound due to violence." Sushruta observed very astutely that after one week there is no point in making the distinction between *sadyovraṇa* and *vraṇa*, because by that time the clean "instant sore" has become "associated with deranged Vayu, Pitta or Kapha" (= infected!), "hence at that stage the medical treatment of both forms of ulcer is (practically) the same" (SS II 240).

247. SS II 268
248. SS I 241
249. SS II 267
250. This is only one of several hemostatic charms (AV I 17.4/ Whitney I 18). Ancient commentators believe that the gesture accompanying the charm may have been to sprinkle sand or gravel on the wound as a "dam." Whitney and others rather believe that a sandbag was used (ibid.). Compare with the Homeric episode in the *Odyssey* (Ch. 4).
251. SS I 44
252. SS I 267 ff.
253. SS I 217
254. SS I 224
255. SS I 268. Lack of pain is indeed typical of many cancerous ulcers.
256. SS II 261
257. SS II 261
258. SS III 338 ff.
259. SS II 261
260. SS II 243
261. SS I 267
262. SS I 225
263. SS II 262
264. SS II 260
265. SS I 166
266. SS I 269
267. SS II 201
268. SS II 201
269. Sushruta leans over backward in compiling lists of accidents due to treatment: emetics have fifteen, enemas a whole chapter (SS II 577, 599). Sometimes he overdoes it; not all the troubles he describes seem iatrogenic.
270. AUB 133
271. SS II 180
272. SS II 189
273. SS I 69
274. SS I 241
275. SS I 19
276. SS I 339
277. SS II 189, 188
278. SS II 188
279. SS II 680
280. SS II 673. Dr. Bhishagratna actually believed this: "The poison operates through the perspiration, proving almost instantaneously fatal through the act of dalliance" (SS II 673 note). He also believed that the effect of planets on infectious diseases is "almost a proved fact" (SS I lxv), and that "Marriages with girls of prohibited description have been known . . . to have ushered in an epidemic which devastated a whole town or a country" (SS I 52 note). But these shortcomings must be seen in perspective, for Dr. Bhishagratna was a busy practitioner who undertook a huge work. His labor of love in translating Sushruta remains admirable.

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281. SS II 253
282. SS II 676, 679
283. ChS II 2145. Elephant medicine was one of the ancient Hindu specialties (Sharma 1972 p. 101; Renou and Filliozat 1953 p. 138). On enemas for elephants, the position of the elephant, etc., see Mukhopadhyaya 1913 I 131–132.
284. SS II 254
285. SS III 169–211
286. SS III 170
287. SS III 210–211
288. SS III 170; ChS I 941

289. SS III 182

290. SS III 188

291. SS III 204. Charaka suggests the same erotic treatment but makes less fuss about it (ChS I 1140).

292. SS III 204

293. SS II 273

294. SS II 272

295. Ackerknecht 1946, 1967; for a review of insect sutures see Gudger 1925. For guidance in the world of ants I am indebted to Dr. Arthur T. Hertig, Harvard Medical School, and Dr. Marshall Hertig, University of Illinois.

296. Wheeler 1910 p. 10

297. Beebe 1921 p. 178

298. The entomologist was Dr. C. Baroni-Urbani, Museum of Natural History, Basel, Switzerland, to whom I also owe the following information: the ants used by the Hindus belonged most likely to the genus *Odontomachus*, found all over India. Recent news from Central Africa is that ant sutures are still a common and successful practice in the former Congo, possibly with termites. Dr. A. Raignier heard similar reports.

299. Wheeler 1910 p. 217

300. Doflein 1905

301. Ant sutures in Europe still bear a question mark. European surgeons of the Renaissance often mention them (Gudger 1925), but one cannot tell whether they really tried them or just repeated what they had read in Albucasis, who was quoting Sushruta. An ant suture was apparently witnessed in Smyrna on the Turkish coast in 1895 (Burr 1939 p. 222). If the report is true, this territory—and the ants—were within the range of Hippocrates. According to Dr. C. Baroni-Urbani, the best candidate in Europe would be *Camponotus vagus* (the carpenter ant is *Camponotus pennsylvanicus*), whose jaws cannot compete with *Eciton* or *Odontomachus*, but match *Oecophylla;* for small wounds they might do. Ant heads clinging by their jaws to the eye or in the throat can be a medical nuisance (Chalmers and Marshall 1919).

302. Dart 1955 p. 331

303. Judges 15:15–17

304. Furnari 1845

305. Lu Gwei-Djen and Needham 1967 p. 7

306. NC-SW 19/Ve 180 = CU 84

307. Filliozat 1949 pp. 64, 154 ff.

308. ChS I 222

309. Also translated *On Breaths* (LTT VI 88–115). A similar theory appears in Plato's *Timaeus* 85, where it is said that tetanus is due to air that enters from without and causes the sinews to swell and strain.

310. ChS II 1677

311. A comparative study of the two doctrines, so far as I know, has not been made; in fact, I have never seen a suggestion that the two may be related.

312. The *Zend-Avesta* is the sacred book of the ancient Persian religion called Mazdeism, Magism, or Zoroastrianism. Little is left of it since the impact of Mohammed. The *Zend-Avesta* cannot be accurately dated; it reflects the religious thought prevailing in Iran from roughly 500 B.C. to 800 A.D., with influence from the Koran, the Talmud, and the Gospels (Darmesteter 1892).

313. The text quoted is taken (with one retouch) from the first, 1880 translation of J. Darmesteter, generally considered obsolete, but this passage is almost identical in the improved 1892 French version (*The Vendîdâd* VIIa, 1880 p. 83; 1892 p. 105). The single change: in 1880 the penalty was "the same as for wilful murder"; in 1892 it was explained that the literal translation is "wilful injury"; a commentator adds that the corresponding penalty was the amputation of six fingers.

314. AUB 40

315. Singhal and Gaur 1963

316. ChS I 554

317. The operation for cataract, perhaps the most spectacular surgical feat of antiquity, is discussed in Ch. 9.

318. Veith (1961) says that there are 760 "healing plants" in Sushruta. For Charaka the figure varies from 500 (Neuburger 1910 p. 54) to "2,000 vegetable drugs plus a few mineral and animal remedies" (India Committee Report 1948 p. 538). A modern list of Indian *materia medica* has roughly 1000 plants (Giboin 1949). I prefer to adopt the figures of Rây and Gupta (1965), who compiled laborious tables of Charaka's drugs, and report a total of 582 (341 from plants, 177 from animals, and 64 mineral substances).

319. Notably lacking among the inorganic drugs are the various salts, more or less poisonous, that the Greeks powdered onto wounds as *énaima*. The Hindus also used powders, but made of plant products (SS I 242, II 252, 254). Copper, so important in Greek surgery, has little use in ancient Hindu medicine, like all the drugs of the inorganic group that are mentioned briefly by Sushruta (SS I 530). It is used in an eye salve as copper sulphate (SS III 53). There is also the passage: "Proper drugs or articles (such as sulphate of copper, etc.) powdered and pasted with honey should be applied for destroying soft marginal growths of an ulcer" (SS II 256). I suspect the parenthesis of being an addition of the translator. Copper had the reputation of being a poison (ChS I 12) and was used as an emetic (ChS II 1665). I found no mention of copper acetate (verdigris).

320. The caste system was of course another expression of this tendency to classify. Recently the number of castes was of the order of 4000 (Smith 1920 p. 37; Senart 1896). Incidentally, the Hindu skill with numbers produced something that is not widely recognized, the ancestors of "Arabic" numerals, which are really Hindu-Arabic. *Zero* comes from the Sanskrit *sunya*, "empty" (Menninger 1969 p. 400).

321. SS II 240 ff.

322. Ayurvedic medicine is officially practiced and taught by vaidyas in many institutions (India Committee Report 1948). It is now only one of three "Indigenous Systems" alive in India. One of the others stems from the Arabic influence. Ayurvedic medicine reached its peak in antiquity, then declined, especially in its best branch, surgery (Mukhopadhyaya 1913 I viii ff.).

8. *Alexandria the Great*

The title of this chapter, an obvious pun on Alexander the Great, is borrowed from André Bernand's *Alexandrie la Grande.*

1. Plutarch, *Lives,* 51 2–6/LB VII 373. Strictly speaking, Alexander was a Greek (definitely so by education). However, Macedonians spoke a dialect of their own and thought of themselves almost as barbarians in comparison with the Greeks. This inferiority complex is openly expressed in Plutarch's *Life of Alexander.*

2. Tarn 1948 pp. 232, 455

3. Plutarch, *Lives,* 26 1–5/LB 299–300

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4. Plutarch, *Lives,* 8.2/LB VII 243

5. Bernand 1966 p. 27 ff.

6. Bernand 1966 p. 49

7. There was e.g. a museum in Athens (Sarton 1927 I 158). The Greek *mouseia* (museums) were sanctuaries for all activities of the mind, under the auspices of the nine Muses: such is the noble ancestry of today's museums. For the Alexandrian Museum see Jones 1971; 1972; Bernand 1966 pp. 112–122. As regards the ancestry of Greek museums, it is well to remember that the notion of "center of scholarship" had a very ancient and important precedent on Egyptian soil: the *Houses of Life* attached to the temples (see P. Ghalioungui 1973, *The House of Life,* Amsterdam, B.M. Israel, p. 28 and elsewhere).

8. Bernand 1966 p. 90

9. Measuring the earth's diameter was the feat of Erathosthenes (Jones 1971); but in all fairness the accuracy of the figure depends on the value selected today for the ancient measuring unit, the stadium (see Sarton 1927 p. 172).

10. No screws seem to have existed before Archimedes (287–212 B.C.), so he may well have been the first to cut a spiral groove in a round peg (Drachmann 1967 p. 25). He probably was at the the Museum about 260 B.C., then returned to his native Sicily (Jones 1971). Pliny's account of that great novelty, the Greek wine press (written about 75 A.D.), shows that a screw, in his time, was still unusual: "In the old days people used to drag down the press-beams with ropes and . . . by means of levers; but within the last 100 years the Greek pattern of press has been invented, with the grooves of the upright beam running spirally . . . an arrangement which is very highly approved" (PNH 18 317/LB V 387).

11. NEED I 95

12. NEED I 127

13. Bell 1948 p. 54

14. The system of *written accents* was another Alexandrian first; and the sciences of bibliography and literary criticism, in the West, started here (Bell 1948 p. 54).

15. Bernand 1966 p. 119

16. Bell 1948 p. 13

17. Thus, the fascinating science of papyrology should really be called Greek papyrology. Its materials, practically all Egyptian in origin, are mostly documents preserved on papyrus. Those written on potsherds, wood, and vellum are included; those on stone and bronze are not (Bell 1948 p. 19), and neither, as a rule, are those written in the Egyptian language. As to the *óstraka*, a most interesting collection of 1624 pieces has been published by Wilcken (1899). The word *óstrakon* referred originally to the shell or carapace of animals (cf. *oyster*, Ital. *ostrica*); later it was applied also to potsherds, since they too are "hard and convex" (ibid. p. 3). Because potsherds were so cheap, Athenians used them on a large scale as voting ballots, when they came to *ostracize* an unwanted citizen.

Geographically, most of the Greco-Egyptian papyri come from upper Egypt, where the soil is almost ideal as a preserver of documents. Unfortunately the whole region of the Delta is too damp and its west side is slowly sinking (Bernand 1966 p. 29), so that the level of ancient Alexandria is now underwater and hopeless (Bell 1948 p. 10). Not a scrap of papyrus has ever been recovered from it. The finds are usually made in ancient rubbish heaps, ruins and tombs. Many papyri are still unpublished. Discoveries of new sources are dwindling; but the science of Papyrology has grown to the extent of producing such specialized aids as a *Namenbuch* (list of personal names found) and the *Konträrindex* (Bell 1948 p. 19). The world at large does not realize that a poem, a tax law, a fact about Greek history may have turned up in a dump or in the mummy of a sacred crocodile (ibid. p. 19).

18. David and van Groningen 1952 p. 2

19. David and van Groningen 1952

20. This tax was levied on the priest, it seems, because private offerings represented a profit (Grenfell and Hunt 1906 p. 307).

21. *Fayûm Papyri* 97, 25, 5–15. For other scars see e.g. *Fayûm Papyri 24*, 18; *29*, 19; 36, 22; 39, 24, 26, 27; for *ásemos* see ibid., *28*, 13, 14; *96*, 8; *97*, 9; etc. Many other examples of both labels are in the *Oxyrhincus Papyri*.

22. Scars are mentioned in a "high proportion" of legal documents—thus I am informed by an eminent papyrologist, Prof. Jean Rudhardt, University of Geneva. Precise figures are not available.

23. Kenyon 1893 p. 48; Sudhoff 1909 p. 260

24. To spoil the fun, an earlier papyrologist reads *iatrokáystes* instead of *iatroklýstes*, and therefore "the cauterizing physician" (Sudhoff 1909 p. 260).

25. Sudhoff 1909 pp. 238–239

26. Sudhoff 1909 pp. 248–249

27. Sudhoff 1909 pp. 249–250

28. *Hibeh Papyri* pp. 277–278

29. The *iatrikón* or physician tax, paid in support of public physicians, existed also in Greece (Wilcken 1899 p. 375; Greenfell and Hunt 1906 pp. 276–278; Préaux 1939 p. 132 ff.). There was also a *hetairikón* or prostitute tax (Wilcken 1899 p. 217), but that was paid *by* the prostitutes rather than to support them.

30. Wilcken 1899 p. 747

31. *Hibeh Papyri* pp. 276–277

32. Sudhoff 1909 p. 255

33. Drachmann 1968. The cult for robots certainly goes back to the third century B.C., when Philon of Byzantium, author of another *Pneumatics*, wrote a whole play for an "automatic theatre." Philon spent some time in Alexandria and must have been impressed by the lighthouse, because it was he who started the tradition of the seven wonders of the world (Schmidt 1899(b) pp. 8, 10).

34. Woodcroft 1851 p. 109

35. Did the huge statue on top of the lighthouse really rotate like a weathervane? Thiersch did his best to work out a system of counterweights. For this statue see Picard 1952 pp. 71, 74.

36. Picard 1952 p. 75

37. For the dates of Ktesibios I follow Drachmann 1968 p. 3 (300–230 B.C.).

38. This passage is unclear: how could *one* lead ball run down several tubes? Prof. Drachmann preferred to ignore the ball and visualize a channel of square section, made of wooden planks (Drachmann 1967 p. 9, and personal communication). If we read the text to mean "one weight per tube," implying a battery of parallel tubes, the whole setup becomes so clumsy that Ktesibios would squirm in his tomb. Another translation renders *tubuli* as "small piping" (Morgan 1914 p. 273). This encouraged me to solve the riddle by taking the text literally: a *single* weight runs down *a series of tubes* aligned one above the other (Fig. 8.9). An advantage of this interpretation is that a slit between two segments could have worked as the outlet that produced the fateful sound.

39. Vitruvius, *De architectura*, IX viii 2–4/LB II 257. Vitruvius, who "writes an atrocius Latin, but knows his business," wrote *De architectura* around 25 B.C. Since he took his information from a book written by Ktesibios himself, we may accept his account as authentic (Drachmann 1963 p. 12; 1968 p. 3).

40. Drachmann 1963; 1967; 1968

41. Drachmann 1968 pp. 80, 81

42. *Pyulcus* comes from *pýon*, "pus," and *hélko*, "I pull." The invention of the syringe is often credited to the Arabs. I traced this mistake back as early as Gatenaria, a medieval Arabist, who apparently describes the syringe as an *instrument à clystères* but gives the credit to Avicenna. Malgaigne is sure that this is false modesty and concludes that the discovery of the syringe is Gatenaria's and deserves "imperishable fame" (Malgaigne 1840 p. xcix)!

43. Eco and Zorzoli 1963 p. 83

44. Paré 1678 p. 316

45. The Egyptians were giving themselves enemas well before the Alexandrian syringe: their clyster kit must have consisted of a tube, an animal bladder or skin, and a piece of string (Fig. 4.16), an assembly that did its job until the nineteenth century (Milne 1907 p. 105), competing with the real syringe. But in a dictionary published in 1675 (Blancard 1697) the syringe properly appears as "an Instrument which is used in injecting Liquors into the Fundament, Womb, Ears, etc."

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46. The charge of human vivisection against the Alexandrian anatomists has caused much ink to flow. It rests mainly on the testimony of Celsus and Tertullian, but Galen's silence throws much doubt on the reliability of their sources, and there the matter lies (Finlayson 1893; Sarton 1927 p. 160).

47. The birth date of Erasistratos is placed between 310 and 300 B.C. (Wellmann 1907); Herophilos is usually taken to be slightly older (Finlayson 1893 p. 324; Wilson 1959 p. 297).

48. Wellmann 1907 cols. 333–350

49. Finlayson 1893 pp. 333–334

50. The comparison with a *calamus scriptorius* shows again that these Alex-

andrian scientists were Greeks, not Egyptians. Egyptian writing pens, as now seen in museums, were solid reeds. The Greeks introduced the *kálamos*, a hollow pen split down the middle, perhaps not long before Herophilos. The oldest known was found in an Aegean island, in a tomb of the third century B.C. (Ogg 1940 p. 39). Galen says that it was current in Alexandria (Finlayson 1893 p. 338). Another structure named by Herophilos is still known by (some) medical students as *Torcular Herophili;* for a delightful discussion of this cryptic name see Finlayson 1893 pp. 336–338.

51. Fuchs 1892. It is my impression that this count, taken from Fuchs's Latin thesis on Erasistratos, is an underestimate. Galen, who worshiped Hippocrates, had two major gripes against Erasistratos: he dared to ignore the four humors, and even opposed such a helpful treatment as venesection. It is true that Erasistratos belonged to the school of Cnidos, the rival of Cos, and therefore may have felt more free to depart from the teachings of Hippocrates (Finlayson 1893 p. 342). But when Galen goes as far as "doubting that Erasistratos ever read a single book of Hippocrates" (K II 132, X 159), he is merely being consistent with his own grouchy disposition.

52. Caelius Aurelianus, *De Morbis Chronicis,* III 65/Amman p. 454

53. *Papyrus Anonymus Londinensis*/Jones 1947 p. 127

54. Sprengel 1815 I 451; Phillips 1973 p. 155

55. Celsus was a brilliant compiler, not a surgical wizard, so the new operations cannot possibly be his own. Alexandria is the likeliest source; but one should not forget the East, especially India, either directly or through Alexandria.

56. See Harris 1973

57. *Perì kardíes,* #10/Hurlbutt 1939 p. 1112 = LTT IX 89; my translation. It is sometimes said that the same treatise recognizes the atrioventricular valves, which is probably not correct. There is a fuzzy reference to other membranes and structures like spiderwebs (certainly the A-V valves and their *chordae tendineae*), but they are vaguely interpreted as part of the "beginning of the aortae," not as another set of valves. See Lonie 1973 I 11–15.

58. A recent critical study places the treatise *On the Heart* no earlier than 350 B.C., more likely in 300–250 B.C., and somewhat before the work of Erasistratos (Lonie 1973 II 152).

59. Singer 1957 pp. 19–20; Lonie 1973 I 8, 11. Aristotle, too, came too early to hear of the pump: if he died in 322 B.C., that was perhaps 50 years too early.

60. Herophilos was for active contraction; Galen for active expansion, which caused a suction (Wilson 1959 pp. 296, 304).

61. See Harris 1973 p. 108

62. Wilson 1959 p. 295

63. Fårhaeus 1957; Harris 1973 p. 93

64. Tricuspid = *triglochín. Glochín* or *glochís* was any projecting point, hence also the end of a yoke strap, and the barb of an arrow (LS p. 353).

65. Lonie 1973 II 137. Galen's passage: *De placitis,* K V 548–550

66. If Wellmann and Drachmann (already quoted) are right, Ktesibios and Erasistratos were about the same age. I find the same guess in Lonie 1973 II 139 note 42.

67. Siegel 1968 p. 48 ff.

68. The branching "nerves" may possibly have been tendons ("sinews") (Wellmann 1907 col. 337 #30; Harris 1973 p. 220). In any event, they too were hollow, like vessels (Wellmann 1907 col. 337 #20). This famous passage is in Galen, K III 538 (Dobson 1927 p. 827; Harris 1973 p. 196 ff.).

69. Galen, K XIV 697; see discussion in Harris 1973 p. 217 ff.

70. For Erasistratos' theories see Wellmann 1907; Dobson 1927; Fuchs 1892; and esp. Harris 1973 ch. 4; Phillips 1973 ch. 6. For the *horror vacui* theory in Alexandria see Phillips 1973 p. 150.

71. Hippocrates, *On Joints,* #45/LTT IV 191

72. Hippocrates, LTT X index, *Pléthore*

73. Fuchs 1892; Harris 1973 p. 204

74. See discussion in Harris 1973 p. 204 ff. Erasistratos was almost unique in neglecting the four humors as a cause of disease (Wellmann 1907 col. 344).

75. Erasistratos has been mistakenly regarded as recommending the tourniquet

for hemostasis: e.g. he "employed ligatures upon the arteries . . . for haemorrhage" (Dobson 1927 p. 831). As for the invention of the ligatures, Caelius Aurelianus attributes the method to both Herophilos and Erasistratos (Caelius Aurelianus, *De Morbis Chronicis,* II 186/Amman p. 416; see also Michler 1968 p. 13).

76. I owe this information to Prof. Pierre Duchosal of Geneva.

77. Harrison 1966 p. 793.

78. For the hasty reader who might overestimate the intellectual gifts of King Ptolemy I and his progeny: Claudius Ptolemaeus of Alexandria, the mathematician, astronomer, and geographer, who worked in Alexandria during the second century A.D., had nothing to do with the ruling dynasty.

79. Jones 1972

80. The popular story of the Arabic sacrilege against the library has come under serious criticism (Bushnell 1928; Parsons 1952; Jones 1972). History has also cleared Julius Caesar of some of his guilt, for it seems that he did not really send the library up in flames, as usually stated. Perhaps only some dockyard warehouses of books awaiting shipment perished (Jones 1972).

81. Bernand 1966 p. 116

82. Bernand 1966 p. 108

9. The Medicus

1. PNH 29.16/LB VIII 193. Pliny specifies that the Roman forefathers lived "without physicians . . . but not without physic" (*sine medicis . . . nec tamen sine medicina;* PNH 29.11/LB VIII 191). As for the Etruscans, almost nothing is known of their medicine, except that they seem to have used gold on teeth as early as the seventh century B.C. (Tabanelli 1963 pp. 90–96; Trisolieri 1969 p. 83).

2. PNH 20.81/LB VI 49

3. Lighting fires to chase away an epidemic was an ancient method (whether the rationale was to purify the air, to frighten off evil influences, or both). According to Galen, this is how Hippocrates drove off an Ethiopian plague that was threatening Greece; flowers, unguents, and perfumes were burned in the fires (*De theriaca ad Pisonem,* 16/Coturri 1959 pp. 94–95). There is no record of this in the Hippocratic books.

4. The story is told by Livy and others (Edelstein and Edelstein 1945 I 431 ff.).

5. The thirty-five books of Livy are strewn with bloody battles, but physicians are never there to tend the wounds. The word *medicus* occurs only once, during the Punic Wars, and in a peculiar context (Livy 22. 18.9/LB V 261). Fabius, the general, is in Rome pleading for his famous delaying tactics. Livy makes him say that "*medici* also, at times, find it better to keep quiet rather than moving and acting." If Fabius really spoke those words, they would be evidence that *medici* were an established profession in the Roman world in 217 B.C., just two years after the arrival of Archagathus. However, Livy was writing two hundred years later, and he may well have put his own words in the mouth of Fabius. It is therefore impossible to quote this passage, as is often done, to prove that the Romans already had physicians during the Punic Wars.

Notes to pages 336–341

6. PNH 29.13/LB VIII 191

7. PNH 29.14/LB VIII 191

8. Green 1955 pp. 121, 125, 111

9. Cato's treatment is not quite so absurd as my ancient and beloved master, Prof. Arturo Castiglioni, reports it. Cato recommends binding on a reed (*harundo*); Castiglioni makes it a swallow (*hirundo;* Castiglioni 1936 p. 182; Cato, *On Agriculture* 160/LB 153). The superstition of the green reed is still alive (McDaniel 1972).

10. PNH 29.11/LB VIII 189

11. PNH LB I intro. vii

12. PNH preface 17/LB I 13

13. PNH preface 18/LB I 13; Pliny the Younger, *Letters,* III 5/LB I 173

14. For instance, Pliny quotes treatments that exist also in Dioscorides, and by comparing the texts it is clear that Pliny must have confused *oúla* (gums) with *oulé* (scar), and *óta* (ears) with *ostá* (bones) (PNH LB VI intro. xix).

15. PNH preface 17/LB I 13

16. Pazzini 1967 p. 155

17. The mushroom cloud was "best expressed as being like a pine," in the words of Pliny the Younger, who lived to tell about it. He obviously meant the Mediterranean umbrella pine.

18. The tradition that Pliny the Elder was asphyxiated is based on the account of his nephew, who had not been an eyewitness. A careful study of the facts takes some of the punch out of the drama: it was probably a heart attack (Bessone 1969).

19. These personal letters are highly worth reading. Two contain first-hand accounts of the eruption (Pliny the Younger, *Letters,* VI 16 and VI 20/LB I 425 and 439). Another fascinating letter describes the working habits of the elder Pliny (ibid., III 5/LB I 173).

20. PNH 2.8/LB I 175

21. PNH 2.5–6/LB I 173

22. PNH 2.142/LB I 279

23. PNH 31.33/LB VIII 397

24. PNH 7.189/LB II 635

25. PNH 2.14/LB I 179

26. PNH 7.5/LB II 511

27. PNH 7.2/LB II 507

28. PNH 7.7/LB II 511

29. PNH 15.49/LB IV 321

30. PNH 10.171/LB III 401

31. PNH 7.1/LB II 507

32. PNH 13.68/LB IV 139

33. PNH 23.26/LB IX 23

34. PNH 14.4/LB IV 189; PNH 14.5/LB IV 189

35. PNH 34.5/LB IX 129

36. PNH 34.46/LB IX 161

37. PNH 23.33/LB VI 437

38. PNH 33.5/LB IX 5

39. PNH 19.24/LB V 435

40. PNH 37.49/LB X 201

41. PNH 22.14/LB VI 305

42. PNH 14.90/LB IV 247

43. PNH 7.63/LB II 547. This was a common belief in antiquity, mentioned by Plato (*Timaeus,* 91 C).

44. PNH 12.84/LB IV 63

45. PNH 28.76–77/LB VIII 55

46. PNH 13.3/LB IV 99

47. PNH 13.20/LB IV 111

48. PNH 23.85/LB VI 471

49. PNH 13.20/LB IV 111

50. PNH 23.41/LB VI 441. Modern rationale certified by Prof. M. Demole, Professor of Dietetics, University of Geneva.

51. PNH 31.88/LB VIII 433

52. PNH 12.29/LB IV 21

53. PNH 10.52/LB III 325

54. PNH 13.39/LB IV 121

55. PNH 12.32 /LB IV 23

56. PNH 28.133/LB VIII 93

57. PNH 9.168/LB III 277

58. PNH 32.64/LB VIII 503

59. PNH 31.40/LB VIII 401. At the court of the Chou emperors, whose rule ended almost three centuries before Nero, there was an Ice Service with about one

hundred employees in charge of cooling everything from wine to the body of the dead emperor (Biot I 10, 105).

60. PNH 14.130/LB IV 273
61. PNH 23.31–32/LB VI 435
62. PNH 3.43/LB II 35. For Roman mile see Sandys 1963 p. 437
63. PNH 3.122/LB II 91
64. PNH 36.77/LB X 61
65. PNH 36.83/LB X 67
66. PNH 7.210/LB II 647
67. PNH 6.84–85/LB II 401
68. PNH 16.203/LB IV 521
69. PNH 7.192/LB II 635
70. PNH 2.118/LB I 259
71. PNH 9.46/LB III 461
72. PNH 11.117/LB III 505
73. PNH 11.5/LB III 435
74. PNH 10.194/LB III 415. I owe this information to Prof. Eric G. Ball, Emeritus, Harvard Medical School. One of the leads for this development came by word of mouth: commercial fishermen in Florida, who caught sharks mainly for their livers, maintained that if they threw the carcasses overboard, eventually the sharks left the area and the boats had to seek new fishing grounds. "At any rate we found that decayed dogfish flesh was a good repellent to dogfish."
75. PNH 27.43/LB X 197
76. PNH 37.164/LB X 297. In the 1682 edition of Castelli's *Lexicon medicum* the *glossopetrae* are still said to have excellent medicinal properties, whether applied externally or internally. The man who recognized them as fossilized shark teeth was the Danish bishop-scientist Nicolaus Steno (Niels Stensen, 1638–1686), who also described "Stensen's duct" of the parotid (Scherz 1969 p. 20 etc.).
77. PNH 34.112/LB IX 211. The experiment shown in Plate 9.1 was performed by Dr. Isabelle Joris, with her usual love and care. Pliny used a sheet of papyrus "steeped in an infusion of [oak] gall," a rich source of tannin. Although his short account is garbled, it is easily reconstructed, because the reaction involved was the one to make shoemaker's blacking in his day: green ferrous sulphate plus tannic acid (from oak bark or galls) gives a black product. It remained one of the basic ways to make ink. Green copper acetate plus tannic acid gives a brown spot product (for the reagents see CDM II xvi, *Aes;* PNH/LB IX 210 note a).
78. PNH 33.63/LB VI 457
79. PNH 10.221/LB III 427
80. PNH 28.10/LB VIII 9. Pliny is quite ambivalent about magic. He reminds me of a prominent Italian lawyer who once told me, "The evil eye does not exist, but I believe in it."
81. PNH 28.23/LB VIII 17
82. PNH 28.29/LB VIII 23
83. PNH 30.17/LB VIII 289. For the Magi see PNH VI intro. xx
84. PNH 30.1–3/LB VIII 279
85. PNH 28.49/LB VIII 37
86. PNH 29.82/LB VIII 237
87. PNH 30.13/LB VIII 287
88. PNH 30.98/LB VIII 341
89. PNH 2.147/LB I 283
90. PNH 2.209/LB I 341
91. PNH 7.17/LB II 517
92. PNH 7.24/LB II 563
93. PNH 9.267/LB III 601; PNH 9.70/LB III 209
94. PNH 10.110/LB III 363
95. PNH 7.85/LB II 561
96. PNH 10.172/LB III 401
97. PNH 11.144/LB III 523

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98. PNH 7.180/LB II 627
99. PNH 7.91/LB II 565
100. PNH 11.11/LB III 439
101. PNH 9.16/LB III 173
102. PNH 11.222/LB III 573
103. PNH 12.38/LB IV 29
104. PNH 13.31/LB IV 117
105. PNH 36.174/LB X 139
106. PNH 7.73/LB II 553
107. PNH 36.199/LB X 157
108. PNH 2.235/LB I 361
109. PNH 11.247/LB III 587
110. PNH 23.44/LB VI 445
111. PNH 23.45/LB VI 445
112. PNH 28.58/LB VIII 43
113. PNH 22.99/LB VI 365
114. PNH 16.194/LB IV 515
115. PNH 26.1/LB VII 265
116. PNH 7.172/LB II 621
117. PNH 7.171/LB II 621; PNH 29.4/LB VIII 185
118. PNH 24.1/LB VII 3
119. PNH 36.202/LB X 159
120. PNH 24.5/LB VII 7
121. PNH 29.18/LB VIII 195
122. PNH 29.4–8/LB VIII 185–187; for minimum living wage see van Beek 1960 p. 87
123. PNH 29.17–18/LB VIII 195. The Latin is beautiful: "adeo blanda est sperandi pro se cuique dulcedo." The little we know about medical education in Pliny's time is discussed in Ch. 10.
124. PNH 22.15/LB VI 305
125. PNH 1.24/LB I 15
126. PNH 16.4/LB IV 389
127. PNH 7.130/LB II 593
128. PNH 28.9/LB VIII 9
129. PNH 29.29, 31, 39, 41/LB VIII 201, 203, 209; PNH 30.115/LB VIII 353; PNH 24.15/LB VII 13; PNH 28.242/LB VIII 163; PNH 24.48/LB VII 41; PNH 23.4/LB VI 417; PNH 28.241/LB VIII 163; PNH 29.58, 59/LB VIII 221; PNH 29.91/LB VIII 243; PNH 30.80/LB VIII 329; PNH 30.118/LB VIII 355; PNH 28.63/LB VIII 47
130. PNH 27.79/LB VII 437; Goodman and Gilman 1965 p. 1068
131. PNH 30.112/LB VIII 351
132. PNH 28.239/LB VIII 161
133. PNH 28.258/LB VIII 173
134. PNH 26.132–134/LB VII 365
135. Goodman and Gilman 1965 p. 507
136. Dr. Carl F. Schmidt was kind enough to write to me—with unabated enthusiasm, half a century later—the details of his trip to China, and the adventure of his discovery of ephedrine through *ma huang*. Without his studies, Pliny's precious infusion of "a plant that some call ephedron" might never have been revived.
137. Dioscorides IV 46/Gunther 1934 p. 438
138. NEED I 197
139. PNH 6.54/LB II 379
140. Charaka does not list *Ephedra* among the herbs recommended for asthma; in fact, he declares that cough and asthma are incurable. He would not have said this if he had known of *Ephedra* (ChS II 1476 ff.). Sushruta's chapter on asthma (SS III 319) contains a vast number of Sanskrit drug names, but the long list of English equivalents at the end of the volume (app. pp. 65–81) does not mention *Ephedra,* and the same is true for the list of Charaka's plant drugs compiled by Rây and Gupta 1965 pp. 52–77.

141. De Pasquale 1965; La Floresta 1940; Du Chaliot 1943. For the literature on Italian *Ephedrae* I am indebted to Prof. Antonio Imbesi, Faculty of Pharmacology, University of Messina, Italy. As a folk remedy, *Ephedrae* have been used all over the world, and of course not only in the "proper" way but for practically any disease, from syphilis to rheumatism (Chen and Schmidt 1930 p. 4 ff.).

142. Among the minor sources: Scribonius Largus wrote a small book of *Compositiones* (prescriptions), and Pliny the Younger wrote another booklet bearing the more pretentious title *De medicina libri tres.* It too is a collection of prescriptions, grouped by diseases, whose purpose is to save time and trouble for travelers who fall into the hands of incompetent doctors! Oddly enough, this work of Pliny the Younger—which I found in Geneva in a 1875 edition—is not mentioned in any bibliography or history of medicine that I know; I plan to investigate its authenticity.

143. For data on Celsus, see Spencer 1926; Allbutt 1921; Wellmann 1913; Marx 1915 (in Latin); Sabbadini 1900 (on the codices). The initial "A." of Cornelius Celsus is usually interpreted as Aulus, but according to Pazzini (1967) it should be Albinovanus. Whether Celsus was a physician is not certain; the question has been much debated (Pazzini 1967).

144. PNH 39.17/LB VIII 195

145. *Vir mediocri ingenio* in the words of Quintilian (Quintilian X 1, 123/Marx 1915 1 I). Elsewhere Quintilian makes up for this remark by saying that Celsus had written on philosophy "not without culture and elegance" (*non sine cultu ac nitore;* Quintilian X 1, 123/Marx 1915 2 XI). For other ancient references to Celsus see Pazzini 1967.

146. Pazzini 1967

147. PNH 29.1/LB VIII 183

148. Allbutt 1921 p. 202

149. Sabbadini 1900 pp. 310–311

150. Greek and Roman debts to Indian medicine are not usually acknowledged; it is customary to search instead for Greek influence in India. See e.g. Scarborough's recent book on Roman medicine, p. 37.

151. CDM *Prooemium* 25–36/LB I 15

152. CDM *Prooemium* 23–24/LB I 15

153. Sarton 1959 p. 133

154. This passage of Celsus has been a classical trap (Spencer 1926 p. 132). Another scholar fell into it recently (Phillips 1973 p. 141). Since Celsus begins by presenting the case for Alexandrian vivisection, the first paragraph may be mistaken for the author's own opinion.

155. CDM *Prooemium* 43/LB I 25. This method of learning anatomy as a by-product of accidental violence explains the casual remark of Celsus that the brain has no sensation (CDM IV 1.10/LB I 361). He says the same of the marrow and of the omentum. But some parts of the omentum are surely sensitive. As to the bone marrow, he may be referring to the diploe (deep part of the skull bone), which is in fact not sensitive.

156. CDM *Prooemium* 74–75/LB I 41, my translation

157. Pazzini 1971. Celsus must be quoting once again from Alexandrian sources rather than describing what was actually happening in Rome.

Notes to pages 352–355

158. Galen, *De anatomicis administrationibus,* II 3/K II 289; Pazzini 1971 p. 148. The original Greek for *vulneraria speculatio* is τραυματικὴ θέα.

159. CDM VII 1/LB III 295; CDM VII 4/LB III 297

160. It is interesting to compare the three descriptions of the perfect surgeon—Greek, Indian, and Roman— as an expression of three cultures.

161. The actual proportion of Greeks among Roman physicians is impossible to assess. Pliny makes clear that medical fashion and practice in Rome were essentially Greek. I tried to draw more precise conclusions from the names of the eighty-five know physicians of the Roman army, but Prof. R. W. Davies kindly pointed out to me that this is both dangerous and inadequate.

162. PNH 39.17/LB VIII 195

163. For Roman surgical instruments see Milne 1907; Meyer-Steineg 1912;

Tabanelli 1958; Deringer 1954; Liebl 1902 (bas-relief); Liversidge 1968 p. 323 ff.; Davies 1970(d) pp. 89–91; Deneffe 1896; Dollfus 1958; 1964; Como 1925; Vulpes 1847; Senn 1895. More refs. are in Scarborough 1969 p. 203 note 4. Crişan (1957)—in Rumanian—describes a rare medical kit of the box type.

164. The fallen "surgeon" is described by Maiuri (1964 pp. 199–200). Maiuri, an archeologist of great renown who was in charge of the excavations at Pompeii, gives no further reference. A search for photographs at Pompeii and in Naples was fruitless.

165. The collyrium stamps found to date are usually called "oculist stamps." This would mean, however, that there were some 250 Roman oculists—surely far too many. A misunderstanding arose through the changed connotation of the word *collyrium:* because it now refers to eye medicine, the stamps were misnamed "oculist stamps"; they should be called "collyrium stamps" (Olivier 1944). The name *kollýrion* seems to mean "little roll," being the diminutive of *kóllyra,* probably the same as *kóllyx,* "roll of bread" (LS p. 972). Another suggested origin is from *kolobè ourá,* "truncated tail," on account of the conical shape. Hippocrates mentions kollyria as pessaries. As sticks for exploring wounds, Celsus mentions them twice (CDM VII 4/LB III 306; CDM V 28.12/LB II 158). Remains of many collyrium tablets (but not of the conical confection) have been found and analyzed (Deneffe 1896 p. 46 ff.). The best summary of collyria in antiquity is in the Adams translation of *Paulus Aegineta,* III 548–557. For chemical analyses see Sédille 1956; Dollfus 1966; Oxé 1941.

166. CDM VII 5.3A/LB III 319

167. Congratulations to my German colleague, for I myself would have been unable to understand the description of Celsus. As translated by W. G. Spencer (CDM VII 3B/LB III 318), it becomes even more confused, because the supposed spoon is described in a footnote as "similar to the present-day midwifery forceps."

168. CDM V 26.20/LB II 77

169. CDM IV 12/LB I 401

170. PNH 28.198/LB VIII 133

171. The Alexandrian physicians who performed autopsies might *possibly* have recognized gastric ulcers.

172. CDM V.21 ff./LB II 81 ff.

173. CDM V.21/LB II 81

174. PNH 31.125/LB VIII 457

175. CDM V.26 21C/LB II 81, my translation. In particular, I prefer to render *venae* as "veins," not "blood vessels," for Celsus probably believed that arteries contain air.

176. CDM VII 31.3–33/LB III 469

177. Paré 1678 p. 304

178. Deneffe 1896; Sédille 1956; Dollfus 1966. These "oculists" who used hemostatic forceps were more probably regular physicians and surgeons; the misunderstanding that led to calling them "oculists" was explained above.

179. This was still the current belief, reported by Pliny (PNH 11.219, 220/LB III 571), who adds that if an artery is severed, the part of the body concerned is paralyzed—a notion presumably derived from the fact that arteries and nerves often run together.

180. CDM V 26.22/LB II 83

181. CDM V 26.23/LB II 83

182. CDM VII 7.8C/LB III 339

183. I was told this by Prof. Jean Babel, who witnessed the sutures with hair.

184. CDM V 26.23/LB II 83

185. For fibulae see Déchelette 1910; Blinkenberg 1926; Catling 1964; *Reallexikon der Vorgeschichte,* Berlin 1925, *Fibel.*

186. CDM V 26.23/LB II 85, 87

187. Ovid, *Ex Ponto,* III epist. VII 25–26/LB 417. In the context, Ovid is complaining about moral wounds, and alludes to bodily wounds as a metaphor.

188. CDM V 26.23/LB II 87

189. CDM V 19/LB II 33

190. The thirty-four preparations are given in CDM V 19 1–28/LB II 33–45. The five plasters free of metals are nos. 9, 10, 13, 14, and 17 (numbering mine). They are essentially mixtures of resins (turpentine, myrrh, frankincense), pitch, wax, oils, fats, and soda. Plasters "for drawing out pus" are sometimes called by Celsus *epispastics*, from the Greek *epí-spáo*, "towards-draw." A precious dictionary of Celsian drugs, with comments, appears in the Loeb edition of Celsus (II xv–lxvii). It indicates that lead was used as an oxide (*spuma argenti*, "litharge"), as basic acetate (*cerussa*, "white lead," made with lead and vinegar), as sulphide (*plumbum combustum*, "galena," the Greek *molýbdaina*), and even as slag (*plumbi recrementum*). Copper was used as scales (*aeris squama*), as calcined ore (*aes combustum*), as acetate (*aerugo*, "verdigris"), as basic carbonate and sulphate (*chalcitis*, "copperas or green vitriol"), as red oxide (*flos aeris*), as black oxide (*squama aeris*, "chipped-off molten copper"), and in several other forms.

191. CDM V 19.28/LB II 45—no. 34 of the series

192. CDM V 27.12B/LB II 123; see also CDM/LB II xlviii (intro.)

193. PNH 33.124/LB IX 95

194. For lead poisoning in antiquity see Hofmann 1885; Kobert 1909. On lead in bones see also Jaworowski 1967; Becker and others 1968; Anon. 1971; Ball 1971. Gilfillan 1965 suggests that the fall of Rome may have been due largely to lead poisoning. However, the promised analyses of lead in Roman bones never followed. Correspondence with the author convinced me that lead poisoning surely existed but that the above theory is a flight of fancy. Water was delivered to many wealthy homes through lead pipes, a practice that was current until recently, as witnessed by the word *plumbing* (from *plumbum*, "lead").

195. Columella XII 20/LB II 233

196. PNH 14.136/LB IV 277

197. Pliny says of *sandarach*, red sulphide of arsenic: "it is useful for giving women a fair complexion; but like scum of silver [*lead oxide*] it is a deadly poison" (PNH 34.176/LB IX 255). *Cerussa*, basic lead acetate (white lead) was made by leaving pieces of lead in jars full of vinegar. The Greeks called it *psimýthion*. It was a popular white face-powder (Theophrastus, *On Stones*, pp. 55–56; Plato, *Lysis*, p. 217 d, etc.; see also LS p. 2024).

198. PNH XXXIV xiv, 152/LB IX 239

199. PNH 34.100/LB IX 201. For the technology, adulteration, and uses of verdigris and other copper compounds see PNH 34.110–127/LB IX 209–221; see also Davies 1970(b).

200. Pories and others 1967

201. Elias and Chvapil 1973

202. CDM V 26/LB II 97

203. Of course, the Roman dressing need not have been inspired by its Egyptian predecessor.

204. CDM V 8/LB II 9

205. CDM V 2/LB II 5

206. CDM V 25/LB II 59

207. CDM III 10/LB I 273

208. CDM III 10.2/LB I 273

209. CDM III 1/LB I 219.

210. Auboyer 1961 pp. 77, 146, 177, 204

211. The amphorae came from a known factory in Arezzo, Tuscany. They are described by Wheeler 1946 and discussed by Filliozat 1956 p. 15 ff.

212. Maiuri 1938; Filliozat 1956 p. 15

213. PNH 6.56 ff./LB II 379 ff.

214. PNH 7.23/LB II 521; PNH 7.11/LB II 513. Trust Pliny to record such marvelous tales; but many originated with the Indians themselves (Rawlinson 1916 p. 26).

215. PNH 13.90/LB IV 153; PNH 9.71/LB III 209

216. PNH 12.26 ff./LB IV 19 ff.; PNH 16.236/LB IV 477

217. PNH 16.162/LB IV 493

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218. PNH 35.43, 46/LB IX 293, 295

219. PNH 9.106/LB III 235

220. Regarding *malabathrum:* the Greek ear, hearing *tamala pâtra,* probably separated *ta-mala,* interpreting *ta-* as the Greek article, neuter plural, *tá.* Another possible derivation of *malabathrum: mâlâ,* "garland," and *pâtra* (Schoff 1912 p. 220). The curious fact about malabathrum is that no secret was made of its Indian origin, whereas the source of the bark of the same tree, cinnamon, was kept secret (presumably because more lucrative). Romans never made the connection between the two (ibid.).

221. PNH 6.101/LB II 415

222. This fascinating book is usually known as *The Periplus of the Erythraean Sea.* It was written in Greek by an anonymous sea-captain, perhaps from Alexandria. Pliny may have drawn from it (Schoff 1912). For Roman trade relations with the East during this period see Miller 1969.

223. PNH 24.5/LB VII 5

224. PNH 12.71/LB IV 53. India is not now a producer of myrrh, and *Balsamodendron myrrha* is not described among the Indian flora (Giboin 1949). Arabian myrrh is now bought by Indian merchants, who process it and distribute it to the world markets. Prof. R. L. Cleveland of Regina University, Saskatchewan, one of the few historians expert on this topic, never heard of Indian myrrh (personal communication). However, a *Boswellia* ("Indian olibanum") is mentioned among the plant-drugs of Charaka (Rây and Gupta 1965 p. 72 #265).

225. The excellence of Indian lycium is testified by Pliny (PNH 24.125/LB VII 91), Scribonius Largus (#19), Galen (*De simplicibus medicamentis* K VII 64), and about 400 A.D. by Marcellus Empiricus (VIII) who draws from Scribonius.

226. J. Y. Simpson, Professor of Midwifery in Edinburgh, writes in 1854 that lycium "is still used extensively by the native medical practitioners of India, under the Hindu name of *Rusot* or *Ruswut* chiefly for inflammations of the eyes." It is prepared from the wood and roots of various species of *Berberis.* Whether it really works, I do not know; Prof. Simpson tried it on one eye, in patients with bilateral inflammation, and found it "interesting" that lycium worked better than the *usual treatments:* leeches and blisters applied to the other eye! (Simpson 1854 p. 417). See also Adams' comments in *Paulus Aegineta* III 234. The drug is still sold in Indian bazaars (Giboin 1949 p. 81).

227. Suetonius, *Caligula,* 1/LB I 405

228. SS III 701

229. PNH 9.187/LB III 549; D'Erce 1969

230. Elliot 1918 p. 15

231. Normally the light rays converge onto the retina thanks to the cornea and the crystalline lens. If the lens is removed, the image forms too far behind the retina—unless the eye is sufficiently elongated, as it is in the shortsighted.

232. CDM VII 7.14 ff./LB III 349 ff.

233. ChS II 1744

234. SS III 76

235. The Indian operation for couching was the subject of the Hunterian Lectures of 1917. The author, R. H. Elliot, a famous ophthalmologist, worked twenty-five years on the topic, spent much time in India, supervised one Indian ophthalmic hospital, and left his name to another—but evidently never heard of Sushruta or Charaka! He studied 550 patients who had been "couched." In 10.59% vision was $\frac{1}{3}$ or better; some vision was restored in a total of 38.33%; the other patients became permanently blind. Since a cataract means blindness anyway, it is obvious that, *before modern eye surgery, about four patients in ten could thank their vaidya.* The main causes of failure are infection and sometimes loss of eyesight in later years through an increase of intraocular pressure—glaucoma—for unclear reasons. See also Duke-Elder 1969 XI 63, who recognizes the priority of Sushruta. The incidence of cataract, I am told, is very high in some parts of India.

236. CDM VII 9.1/LB III 363. This method of Celsus was discussed by Daremberg 1847.

237. CDM VII 8.3/LB III 361

238. One of the devices used in ancient India for stretching the earlobes were fish vertebrae of increasing size (Casal 1950). A set found in a tomb of the second century B.C. is exposed at the Musée Guimet in Paris. Small fish vertebrae, allegedly found in a tomb on the Palatine Hill in Rome, were also interpreted as earlobe dilators of Indian style (ibid. p. 146). Details on the find were not given. Until then, I prefer to adopt the suggestion of Prof. R. W. Davies that the Roman fish may have been food for the afterlife.

239. Exodus 20:22–21:6

240. Martial VI 64/LB I 399: ". . . if I brand you with the heat of my wrath, Cinnamus . . . will not erase the marks."

241. CDM V 27 3A/LB II 115

242. It is highly unusual for Celsus to acknowledge the priority of foreigners in matters medical, especially an African tribe (CDM/LB II 114 note b).

243. Ligature for snake bite is also known nowadays by African people (Harley 1941 p. 98).

244. CDM/LB II 195, 201. Celsus also mentions lycium and malabathrum, but without reference to India (CDM/LB II xl, xli).

245. Livy II xlvii/LB I 381

246. Livy II xiv/LB I 267

247. Suetonius, *Tiberius*, 40/LB I 351

248. Tacitus, *Annals*, IV 63/LB III 113

249. Livy X xxxv/LB IV 491

250. Scarborough 1968 p. 259. References on military hospitals will be found in the note to Fig. 9.34. For help on military hospitals I am indebted to Prof. R. W. Davies of Sunderland College and Dr. J. K. S. St. Joseph, Director in Aerial Photography, Cambridge University.

251. Nutton 1969 p. 266 note 39

252. Davies 1970(d) pp. 93–98 and fig. 14.

253. The estimate is 3% in Richmond 1968 p. 66; it was later raised to 5%, possibly 10% in times of emergency (personal communication, Dr. J. K. S. St. Joseph). For calculations on number of beds per cubicle see also Davies 1970(d) note 150. The use of bunk beds could have doubled the number of occupants (personal communication, Prof. R. W. Davies).

254. Personal communication, Dr. J. K. S. St. Joseph.

255. Watermann 1970

256. Anon. 1900[?] p. 15

257. Knörzer 1963 p. 311

258. Knörzer 1965, 1970

259. CDM III 18.12/LB I 297

260. Goodman and Gilman 1965 p. 524 ff.

261. PNH 25.66/LB VII 185

262. See Ch. 4 (Homeric medicine). *Centaurium umbellatum* is not mentioned even in Flückiger and Hanbury, *Pharmacographia* (1879) and in Trease and Evans, *Pharmacognosy* (1971). *Centaurium umbellatum* = *Erythraea centaurium* = *Centaurium minus* (Imbesi 1964 p. 251) = the french *petite centaurée.*

263. PNH 34.153, 154/LB IX 239

Notes to pages 379–390

264. Davies 1970(b)

265. The organization of medical care in the Roman army has been much debated recently. The rather negative view of Scarborough (1968) that there was no regular corps of doctors has been effectively refuted by Vivian Nutton 1969; see also Davies 1969; 1970(a, c, d).

266. Davies 1969 p. 95 ff.; 1972; 1973

267. The text of this letter is in Zereteli and Jernstedt 1966 pp. 1–8. It is discussed in Roberts 1950; Davies 1969 pp. 93–94. Translation revised with the aid of Mrs. M. Vodoz.

268. It is often reported that in 46 B.C. Julius Caesar, pressed by the need of physicians, granted Roman citizenship to the Greeks of that profession. In fact, he gave this right wholesale to all foreigners teaching any liberal art in Rome (Suetonius, *Divus Iulius*, 42.1/LB I 59).

269. This subtle (but still debated) observation was made by a fellow pathologist from Milan, Dr. Lino Rossi, an expert on the Roman army and author of a book on the Trajan Column (Rossi 1969; 1971 pp. 152–153). For the use of the scarf (*focale*) by the auxiliaries see Paribeni 1926–1927 p. 224.

270. PNH 39.17/LB VIII 193

271. The problem of public medical care in Rome has made little or no progress since Briau's studies almost a hundred years ago. These works are indispensable, but on one point they baffle me. On the one hand, the Romans were utterly unable to conceive of free medical care for the poor (Briau 1869 p. 5); on the other, there is no doubt that the archiatri cared for the poor (Briau 1877 p. 64). The overall conclusion is that "somehow, almost everybody was looked after" (Briau 1869 p. 108). For public physicians in Greece see Cohn-Haft 1956.

272. Pliny complains about the high fees of physicians (PNH 29.7, 29.22/LB VIII 187, 197).

273. The evidence for guild physicians is meager: two inscriptions on stone (Briau 1869 pp. 79, 85 ff.).

274. "Sell worn-out oxen, blemished cattle, blemished sheep . . . and old wagon, old tools, an old slave, a sickly slave, and *whatever else* is superfluous" (Cato II 7/LB 9). Legally, slaves were objects, not people. For sick slaves abandoned on the island and decree of Claudius see Suetonius, *Claudius*, 25/LB II 49.

275. Cohn-Haft 1956; Briau 1877 p. 64

276. The decree of Antoninus *regulates* the office of public physician in the provinces; Briau interprets this as suggesting that this office already existed but needed the firm hand of the law because it had entailed administrative abuse (Briau 1877 p. 55 ff.). Though Antoninus does not yet call these physicians *archiatri*, their function is the same. For the decree of Antoninus see Briau 1877 pp. 57–58; *Corpus Iuris Civilis*, L tit. IX; XXVII tit. I.

277. The name *archiatrus* is not well explained, however. Names with *arch-* usually meant "chief-," but then it is not clear of what they were chiefs. A less likely meaning is "physician-of-the-chief (= emperor)" (Briau 1877 pp. 14, 15).

278. Briau 1877 p. 64

279. Mommsen 1934

280. See Briau 1877 pp. 84–85; *Codex Iustinianus*, VI 43.3

281. Kleine Pauly 1964 I 506

282. CDM *Prooemium* 65/LB I 35. In this sweeping comment on dumb foreigners (*exterae gentes*) Celsus seems to forget the notoriously subtle Greeks; but maybe he did not mean to include them, since Greece, after all, was then a part of the Roman Empire.

283. These *servi medici* are attested on inscriptions (Briau 1869 p. 66 ff.), and in a late edict their price is set three times higher than for ordinary slaves (Chiappelli 1881 p. 17; *Codex Iustinianus*, VI 43.3).

284. Columella 12 III 8/LB III 193

285. Columella 12 III 7/LB III 191

286. For Seneca and valetudinaria, see Seneca, *Ep.* 27.1; *De ira* I, 16.4; *Quaest. nat. I. Praef. ante med.* 6. These passages, and the question of civilian infirmaries in general, are well discussed by Harig (1971).

287. Minuscule evidence for "private infirmaries" appears in a comedy of Plautus. Says the *medicus*, talking about a madman: "See that he is taken to me [*to my place*]." "Do you mean it?" "By all means: there I shall be able to cure him as I please" (*Menaechmi* V 946–949/LB II 461). Plautus was writing this about 200 B.C., so he could have had in mind the story of Archagathus and of the private office financed for him by the city. But he could also have lifted the idea from a Greek original, with no Roman relevance. It is sometimes said that Vitruvius mentions *hospitalia* in his books *On Architecture*, written about 25 B.C. Sure—but for him the word meant "places for guests" in homes and theaters (Vitruvius, *De architectura*, V 6, 7/LB I 284, 288).

288. Harig 1971

289. As evidence of Roman cruelty, Briau (1866 p. 28) quotes this gladiator's oath: "By the words of Eumolpius, we swear that we shall suffer to be burned, bound,

beaten, and killed by the iron, and anything else that Eumolpius might order. As regular gladiators, we most solemnly entrust our bodies and souls to the master" (Petronius, *Satyricon*, 117). The cruel status of the gladiators is not to be disputed; however, the *Satyricon* of Petronius can scarcely be quoted as a historical source.

290. How available it was, in any given time and place, is not in the books, as far as I know. Drabkin also notices that there are in antiquity "innumerable literary, epigraphic and papyrological evidences of the employment of doctors by the state to treat patients without charge" (Drabkin 1944 p. 347); but of course episodes do not make statistics.

291. St. Jerome, *Epistulae*, LXXVII, *Ad Oceanum De Morte Fabiolae*/LB 323

292. Edelstein and Edelstein 1945 II 176, I 739. Buildings attached to Asklepieia, to house the pilgrims, are known for Pergamon and other sites. In Pergamon the addition came under the Romans, as attested by Pausanias, who wrote in the second century A.D.: "The Epidaurians about the sanctuary were in great distress, because their women were not allowed to bring forth under shelter, and their sick were obliged to die under the open sky. To remedy the inconvenience he [*the Roman senator Antoninus*] provided a building where a man may die and a woman may give birth to her child without sin" (EE II 176, I 739).

293. The root of *medicina* was taken up by Russian and the other Slavic languages, as well as by Albanian, a separate language of Indo-European origin; but *not* by Finnish and Hungarian. See the excellent study by Benveniste (1945).

10. Galen—and into the Night

1. The famous Kühn edition of 1821–1833 (as illustrated above the title). Though not complete, this edition includes the Latin translation: so the photograph may somewhat overplay Galen's graphomania.

2. Walsh 1934 p. 1

3. English translations of Galen up to 1954 are listed in Sarton 1954 pp. 101–107; see also Duckworth 1962; Brock 1963; May 1968. I consulted the original text on many occasions, with the invaluable help of Mrs. Martine Vodoz; but I must confess that when it came to Galen I broke my own rule: I did *not* read the twenty-two volumes of the Kühn edition.

4. Siegel 1968 p. 29

5. PNH 13.70/LB IV 141

6. K XIV 17

7. K II 17

8. Gourevitch 1970 p. 7. Briau tries to make a case for the existence of a medical school in Rome during the first century (1877 p. 101 ff.), his evidence being two undated inscriptions in stone, one mentioning a *Tabularius scholae medicorum* and the other, a *Scriba Medicorum* (secretary to the medical school, secretary to the physicians). There the matter rests. Galen's tirade against Thessalus (K X 4) surely proves that medical education in Rome was not formalized. Galen likes to contrast the depth of his own preparation (e.g. K XIX 59) with the superficiality of his colleagues' (e.g. K X IX 804).

Notes to pages 393–398

9. Sarton suggests that Galen knew Latin perhaps as well as a "European officer in Egypt" might have known Arabic (1954 p. 81). Although Seidmann says that Galen mentions learning Latin, he gives no reference (1936 p. 400), and I found none.

10. There is one possible exception (Sarton 1954 p. 79): the individuals to whom Galen dedicated his works must have been somehow close to him; but warmth was not his lot.

11. Phillips 1973 p. 172.

12. For Galen's experiments on the nervous system see Dalton 1873. For his ligature of the ureters see Brock 1963 p. 59.

13. May 1968 I 367

14. Walsh 1937 p. 35; see also Scarborough 1971
15. Daremberg and Saglio II 1565; Walsh 1936 p. 39
16. K XIII 599/Walsh 1937 p. 34
17. K XIII 600/Walsh 1937 p. 36
18. K XIII 633–644
19. K XII 226
20. Plain chimney soot was used as a wound disinfectant in 1870 by the French army besieged in Metz, upon the advice of one Dr. J. Jeannel, pharmacist of the Guard (information courtesy of Colonel Ferry, Service Historique de l'Armée, Vincennes, France). Dr. Jeannel may have based his suggestion upon the similarity between soot (obtained by burning coal in air) and coal tar (obtained by heating coal in the absence of air). Coal tar was then a common disinfectant.
21. Shoemaker's blacking (ferrous sulfate + tannic acid) is recommended by Celsus for cleansing sores and as a caustic (e.g. CDM V 2 and 8/LB II 5 and 9). Writing ink, made with the soot of torches, he recommends for bald spots (CDM VI 4/LB II 183): a harmless substitute for black hair.
22. K XVIII(2) 567/Walsh 1937 p. 40
23. Galen's treatment for wounds and ulcers is summarized in two German theses (Prüsmann 1900; Schröder 1901). Unfortunately both lack references in the text.
24. K X 378/Walsh 1937 p. 40
25. K XIII 601/Walsh 1937 p. 36
26. Walsh 1926 p. 183
27. K X 410 ff./Walsh 1937 p. 42
28. May 1968 I 215. After he lost his omentum, this gladiator remained very sensitive to cold, kept himself wrapped in wool, and "could not bear to have his abdomen uncovered." True or not, these symptoms misled Galen into concluding that the function of the omentum was to keep the intestines warm.
29. K VIII 304
30. K I 1–39/Walsh 1937 p. 50
31. Walsh 1937 p. 39
32. Charles-Picard 1965 p. 79
33. Human sacrifice in Rome, according to Pliny, had been abolished only in 97 B.C. (PNH 30.12/LB VIII 287).
34. Scribonius Largus, *Conpositiones*, 17/Helmreich p. 11
35. PNH 28.4/LB VIII 5
36. For the *taurobolium* see Duthoy 1969. One such pit (*fossa sanguinis*) was found at Ostia (Calza 1953). A well-preserved one is on display at Novaesium [Neuss] (Wortmann 1971). See also von Petrikovits 1961.
37. Dr. Walsh (1937 p. 44) was seriously mistaken here: Galen did not use the tourniquet. The word that he translates as "tourniquet" (K X 318) is *ánkistron*, "fishhook" or simply "hook." The text leaves no doubt: "hook the vessel, pull, and twist." Galen uses the same method for vivisection (Duckworth 1962 p. 16).
38. K X 318
39. Duckworth 1962 p. 16
40. Duckworth 1962 p. 16
41. K X 942
42. NEED I 197
43. K X 320
44. If the Latin of Celsus is compared to a glass of sparkling wine, that of Scribonius is not far from dishwater.
45. That Scribonius is really talking about a tourniquet seems certain: the words are *artus constringere*, "to constrict the limb."
46. Scribonius Largus, *Conpositiones*, 84/Helmreich pp. 85–86
47. K II 537
48. Walsh 1937 p. 54
49. Duckworth 1962 p. 182. As for autopsies on "fresh" human cadavers in Rome, it is very unlikely that Galen ever performed any. Physicians may have felt

the need to dissect human bodies (Celsus says so quite clearly) and the law was not specifically against it; but custom was, and it seems to have prevailed (Pazzini 1971). Human autopsies were performed, if anywhere, in Alexandria. See also Temkin 1973 pp. 115, 136–140.

50. Duckworth 1962 p. 182
51. Duckworth 1962 p. 87
52. Duckworth 1962 p. 24
53. Duckworth 1962 p. 29
54. Duckworth 1962 p. 15
55. Walsh 1926; 1937 p. 52
56. Walsh 1926; Daremberg 1854 I 498
57. Duckworth 1962 p. 207
58. K VIII 55. Accidental injury to the recurrent laryngeal nerves is still a hazard during operations for goiter.
59. Walsh 1937 p. 55
60. The translator's comments here are misleading (SS II 185). To the "four Dhamani" he appends "arteries." But the sense of *Dhamani* is obviously more vague, for in his glossary he gives Dhamani as "vessel, artery, or duct" (SS III Appendix p. 46). There he also refers to SS II 209, where Dhamani is translated first "ducts," then "arteries," and finally "nerves." So it is false precision, and of no help, to label the four Dhamani in the neck as arteries; the sense actually points to nerves.
61. SS II 185
62. According to the original legend the Neela-Manya marma corresponds to the following structures: "*Superior* laryngeal–glossopharyngeal–hypoglossal–superior thyroid–lingual" [italics mine]. Galen's nerve is of course the *inferior* laryngeal.
63. From the translation of *Cellularpathologie* 1863, 2nd ed., reprinted in 1971, p. 430. The first edition (1858) has the same passage. The "more recent schools," said by Virchow to "agree" with the necessity of a fifth symptom, remain a question mark.
64. Quoted perfunctorily from textbook to textbook, the four cardinal signs of inflammation (plus one) have undergone a hilarious series of mistakes and permutations, well summarized by Dr. Rather (1971). Still missing in this delightful essay is the real father of the fifth symptom; the earliest and still "fatherless" mention that Dr. Rather could find was in Uhle and Wagner's *Handbuch* of pathology, 1864.
65. On Dec 28, 1917, H. L. Mencken published in the New York *Evening Mail* a completely fake account of the invention of the modern bathtub as it was supposed to have occurred in Cincinnati in 1842: "Alas . . . they swallowed it as gospel, gravely and horribly." The story ended up in reference books and encyclopedias, becoming undistinguishable from established fact. "*Despite all this extravagant frenzy for the truth, there is something in the human mind that turns instinctively to fiction*" (Mencken 1958 pp. 15–16).
66. Rather 1971
67. Sarton 1954 p. 65
68. For an excellent history of theriac see Watson 1966.
69. Today's figures are still high: in the U.S. alone, an estimated 2 million people are bitten by animals each year; of these, about .5 million are bitten by dogs, 3000–6000 by snakes; deaths by snake bite average 14 per year (Schwartz 1969 p. 165 ff.).

Notes to pages 405–414

70. For the thankless job of counting bites in the Gunther edition of Dioscorides I am indebted to Lise Piguet.
71. CDM V 27/LB II 111
72. K V 41
73. PNH 28.40/LB VIII 31
74. PNH 11.170/LB III 539
75. PNH 28.40/LB VIII 31
76. Schwartz 1969 p. 165 ff.
77. Watson 1966 p. 13
78. Scribonius Largus, *Conpositiones*, 163/Helmreich p. 67.

79. PNH XXV iii/LB VII 141

80. Watson 1966 p. 35

81. Tacitus, *Annals,* XII 66, XIII 15/LB III 413, IV 25; Watson 1966 p. 86

82. The similarity between *galene* and Galen is accidental. *Galenós* meant "calm"—a peace surely not unrelated to opium.

83. Some people, however, remained skeptical. Hear Pliny on *Mithridatium:* it is "composed of 54 ingredients, no two of them having the same weight . . . Which of the gods, in the name of Truth [*the goddess*], fixed these absurd proportions?" (PNH XXIX 24/LB VIII 1999).

84. K XIV 232/Watson 1966

85. Watson 1966 p. 87

86. K XIV 280/Watson 1966 p. 63

87. K XIV 219/Watson 1966 p. 63

88. NEED I 205

89. ChS II 1638

90. SS II 740

91. Watson 1966 p. 104

92. This statement is made with the usual reservations that apply to any data on China (meaning that it is third- or fourth-hand information), but it is generally believed that with Hua T'o, a contemporary of Galen's, Chinese surgery reached its peak.

93. PNH VI 23.100–147/LB VI 481–513

94. For Greek diet see Ackerknecht 1970 p. 170 ff.; 1971

95. K XI 147–378; K XIX 519–528

96. K V 119/Walsh 1934 p. 14

97. Caelius Aurelianus, *De morbis chronicis,* II. xiii. 183/Amman p. 415

98. Ackerknecht 1970 p. 109 ff.

99. Literature on this major episode is amazingly scant. See Whipple 1936; Elgood 1938; Major 1954 p. 227, on which I based my account. For the sad lot of today's Nestorians see Atiya 1968.

100. The tolerance of the early Muslims should be emphasized. They found little difference between their creed and that of the Nestorians; and to the Nestorians, the Islamic message did not sound very different from their own (Jargy 1969).

101. *On Medical Experience,* a ninth-century copy of the original Arabic translation by Ḥubaish of the Syriac version by the Nestorian scholar Hunain. The book had been written by Galen at the age of nineteen!

Notes to the Illustrations

FIGURES

1.1 Found in the Chubut Valley, Patagonia (Collection de la Vaulx, No. 12.282; see Pales 1930 p. 97). Black background added. Courtesy of the Musée de l'Homme, Paris.

1.4 Specimen found at Sterkfontein and published in Dart 1949 Plate 3 No. 26, as "endocranial cast" (i.e. a natural fossil cast of the inner cavity of the skull) of *Plesianthropus transvaalensis Broom*, which is the obsolete name given by Broom to *Australopithecus africanus* (see Ardrey 1967 p. 181). Courtesy of Prof. Phillip V. Tobias, Dept. of Anatomy, University of Witwatersrand Medical School, Johannesburg, South Africa, and of The Wistar Press.

1.5 Profiles of mandibles: *Gorilla*, Howells 1967 p. 91; *Kanam Fragment*, Tobias 1962 p. 345; *Sapiens and Pekin man*, Wells 1958 (in Howells 1962 pp. 460–465).

1.6 Though actual photographs of similar specimens are easily obtainable, this old drawing was chosen because the bony reaction is particularly well shown. Redrawn from Cartailhac 1889 p. 254. No date given.

1.7 These pictures are eight photographic steps removed from the original color slides (lost), hence their relatively poor quality. Dr. Miles is Emeritus Professor of Psychology, Yale University Medical School. Reproduced with permission from Dr. Miles and from the National Academy of Sciences.

1.8 Courtesy of Dr. W. C. McGrew and Miss Caroline E. G. Tutin, Gombe Stream Research Centre, Kigoma, Tanzania, and of the American Dental Association.

1.9 See 1.8

1.11 The fossil-bearing rock was polished, etched with acid, and covered with an ultramicroscopic layer of carbon; this carbon film was then floated off and examined. Hence the picture shows a replica of the bacteria, not the bacteria themselves. From Schopf, J. W., and others, Science 1965: *149*, 1365. Courtesy of Dr. J. W. Schopf and of Science. Copyright 1965 by the American Association for the Advancement of Science.

1.12 Skeleton of *Dimetrodon*, courtesy of Mr. Gilbert Stucker, American

Museum of Natural History, New York. Latest dating: 230 million years. Background retouched. With permission from The American Museum of Natural History. Single bone: Plate XVa from Moodie, *Paleopathology*. Bone section: Plate XXI, ibid.

1.13 Upper left second molar of *Paranthropus crassidens*, Swartkrans. Estimated age 800,000 years according to the original publication, but these figures must be increased as explained in the text. From Clement, Brit. Dental J. 1956: *101*, 4; rephotographed with permission from the British Dental Journal and slightly retouched.

1.14 I owe this striking electron micrograph to Prof. R. M. Frank of the Centre de Recherches Odontologiques, Equipe de Recherche Associée au C.N.R.S., Faculté de Médecine, Strasbourg, France (for the electron microscopy of caries see Frank and Brendel 1966).

1.15 Original in reddish brown, height about 20 cm. The figure as reproduced in H. Breuil (1920 Plate III, detail) is a drawing of the original, not a photograph. Breuil interprets it as a man seen from the back, seemingly hit by eight arrows, and shown as if trying to "pull out the lines that pierce him" (p. 21). Courtesy of Masson and Co., Editors, Paris.

1.16 Rephotographed and enlarged from Fig. 11 in Malvesin-Fabre and others 1954. With permission from E. Privat, Editor, Toulouse.

1.17 Reproduced and slightly modified from Leroi-Gourhan 1967. With permission from Prof. A. Leroi-Gourhan and the Bull. de la Soc. Préhistorique Française.

1.18 Courtesy of Prof. A. Leroi-Gourhan (1964 Fig. 9D) and of the Presses Universitaires de France.

1.19 Redrawn from the color photographs in Howell 1970 pp. 184–185, with permission of the photographer, Prof. Irven DeVore. The original hand-signs, twenty-one in all, are extremely effective and should be seen in the original. Profiles of animals taken mostly from Smithers 1966 Plates 2, 6, 10. The choice of a female lion was my own liberty.

1.20 Rephotographed from a paper by R. Virchow, Zeitschr. f. Ethnol. 1886: XVIII, 221. The little girl is on Plate V Fig. 2; she missed the last phalanx of both little fingers (p. 224), but the drawings of hands correspond to two young males: N'Fim N'Fom, perhaps twenty-four (Fig. 2 p. 234) and N'Ko, nineteen (Fig. 1 p. 234). Virchow makes no comment on the missing phalanges.

1.21 Courtesy of Robert G. Gardner, Film Study Center, Harvard University; Random House, Inc.; and Alfred A. Knopf, Inc. (Figs. 253 and 23 in Gardner and Heider 1968).

1.22 See 1.21

1.23 Courtesy of Drs. G. Mennerich and J. Bössneck. (Unlike people, bovines have only one, large metacarpal per foot: the so-called *cannon bone*).

1.24 From Lisowski 1967 p. 661. Courtesy of Dr. F. P. Lisowski and of C. C. Thomas, Publisher, Springfield, Illinois.

1.25 Skull from Patallacta, Peruvian highlands (MacCurdy 1923 Plate XXVI and pp. 242–243). Courtesy of the American Journal of Physical Anthropology and of The Wistar Press.

1.26 Skull No. 283 from Moodie 1927 Fig. 19B and 1929 Fig. 8D. The vertical crack runs down the middle of the frontal bone; at top left, the coronal suture.

1.27 Courtesy of Prof. Enrico Atzeni, Cagliari, Sardinia. From the remains of a robbed grave.

1.28 Courtesy of Dr. T. D. Stewart, Dept. of Anthropology, U.S. National Museum, Washington, D.C.; of the Bull. of Med. History; and of the Johns Hopkins Press (Stewart 1966 p. 307).

Ch. 2 title page: the two cuneiform symbols stand for *a-su*, Akkadian for "physician" (see note 2.37).

2.1 Redrawn from Bishop 1939 p. 46, with permission from the American Oriental Society.

2.2 This aerial view comes from the eastern rim of Mesopotamia (Ghirshman and others 1966 Plate I). This area belonged first to Elam (now Iran) and was later conquered by the Assyrians (Ghirshman and others 1966 p. 8). The modern name of Dur-Untash is *Tchoga Zanbil*, "[upside-down] basket hill," from the aspect of the dilapidated Ziggurat (Ghirshman and others 1966 p. 10). The river is the Âb-è Diz, tributary of the Karun, which now joins its waters with those of the Tigris and the Euphrates in the Shatt-el-Arab, but once opened independently into the Persian gulf. With permission from Prof. R. Ghirshman.

2.4 Courtesy of Miss M.-L. Vollenweider, Musée d'Art et d'Histoire, Geneva. Hematite cylinder, No. 12688; actual dimensions 22 x 12 mm. Interpretation in Vollenweider 1967 p. 44 (No. 38).

2.5 Redrawn from examples chosen in MEA pp. 146, 230, 176, 240, 158, 90, 54, 150.

2.6 With permission from Prof. R. Ghirshman. From Ghirshman and others 1966 Plates II, IV.

2.7 See 2.6

2.10 Courtesy of the Trustees, British Museum, London.

2.11 Courtesy of The Mansell Collection, London.

2.12 Known as the "Plaque des Enfers," height 14.5 cm. Courtesy of the Louvre Museum, Paris.

2.13 Photograph of the dagger courtesy of the Trustees, British Museum, London. The specimen came from the Royal Cemetery at Ur and is now in Baghdad. Montage and drawing by Mr. P. Duvernay.

2.14 The three Sumerian pictograms are redrawn from MEA pp. 46, 162, 98.

2.15 In my original plans, a cloaked Paris policeman should have posed next to the Code (actual height 225 cm) for scale. No live policeman would be allowed into the Louvre. Courtesy of Service de Documentation Photographique, Louvre Museum, Paris.

2.16 I identified this law on the monument by using Scheil's original photographs, transcription and translation, as well as Harper's edition. The law is in Col. XXXIV, 55 ff.; it is on the rear right, at about eye-level, and is written downward in the archaic style; the text should be turned 90 degrees counterclockwise to conform with the other cuneiform writings illustrated. Courtesy of Service de Documentation Photographique, Louvre Museum, Paris.

2.17 Transcription and translation courtesy of Pablo Herrero, Collège de France, Paris.

2.18 Courtesy of Dr. S. N. Kramer, University Museum, Philadelphia, Neg. 6783. Actual size: 150 x 97 mm.

2.19 Courtesy of Dr. F. Köcher and of Akademie-Verlag, Berlin (Köcher 1955 p. 77).

2.20 From Oeder, G. C., *Flora Danica* . . . , Havniae [Copenhagen], typis Claudii Philiberti, Vol. 2, pp. 1765–1767.

2.21 This presumed "distillation vessel" was found at Tepe Gawra, northern Mesopotamia. Such pots were found at levels IX to XI, i.e. at depths going back to about 3500 B.C. (Levey 1959 p. 33); the pottery wheel seems to appear just below, at level XII (Parrot 1953 p. 194). Actual dimensions of the pot: max. width 530 mm, height 480 mm, capacity 37.3 liters, capacity of the rim 2.1 liters. Others of this kind were found; some, which have the inner rim perforated, could also have been used as extraction apparatus (vapor trickling into the rim could have extracted material placed therein). There is a tablet describing perfumery operations about 1200 B.C., compatible with the use of such double-rimmed pots (Levey 1959 p. 36). Lids were not found; perhaps they were made of wood and glazed inside (Levey, personal communication). Much later Arabic apparatus for distillation and sublimation is based on similar double-rimmed containers with tall conical lids (Levey 1959 p. 40). Photograph courtesy of the University Museum, Philadelphia (neg. 44456). The scheme is my own but based on published data (Levey 1959 pp. 40–41).

2.22 The tablets are rephotographed from Thompson 1923; the numbers (3, 4, 5) are my own, adopted because they correspond to the explanations in Prof. Labat's

letter (Fig. **2.23**): 3 = *18*, No. 3 (tablet K 10535); 4 = *22*, No. 2 (tablet K 3550, obverse); 5 = *21*, No. 2 (tablet K 6196). Slightly reduced. Minimal retouches on some defective lines and signs. Thompson's translations are found in *Assyrian Medical Texts.* Proc. Roy. Soc. Med. 1924: *19;* 3 = p. 52, 4 and 5 = p. 56. (With permission of the Clarendon Press, Oxford, and of the Trustees, British Museum, London.)

2.23 Reproduced with kind permission of the late Prof. R. Labat.

2.25 Redrawn from MEA pp. 110–111.

2.26 From Contenau 1927 p. 444 (with permission of Editions A. et J. Picard, Paris).

2.27 Redrawn from MEA pp. 112–113.

2.28 Redrawn from MEA pp. 67 and 175.

2.29 P. XIX of Thompson's *Assyrian Herbal.*

2.30 From Regnault, F., *La Botanique . . .*, Tome III, Paris, 1774.

2.31 The slingers are from a bas-relief found in Kouyounjik (ancient Nineveh) and dating from the period of Sennacherib, 705–681 B.C. Courtesy of the Trustees, British Museum, London (Relief No. 124775).

Ch. 3 title page: the three hieroglyphs spell the word *swnw*, "physician."

3.1 Based on Bengtson and Milojčić 1963 p. 26.

3.2 Courtesy of the National Aeronautics and Space Administration (NASA); kindly reproduced by EROS Data Center, Geological Survey, U.S. Dept. of the Interior (Scene Identification No: NASA ERTS E-1039-08001-7).

3.3 Ages of medical papyri acc. to GMÄ I. All dates prior to 2000 B.C. are uncertain (in recent years the First Dynasty has moved from 3500 to 2900 B.C.).

3.4 Courtesy of Henry Riad, Chief Curator, Egyptian Museum, Cairo. Letters added.

3.5 From Smith 1908 Fig. 7. The published reproductions were poor and had to be heavily retouched. With permission of the Editor, British Medical Journal.

3.6 From Petrie 1927 Plate VII, rearranged.

3.7 From p. 27 of A. Gardiner's *Egyptian Grammar,* with permission of Chicago University Press.

3.8 Parts of Plates XIII and XIII-A of Breasted 1930 Vol. II (reversed, left to right). With permission of Chicago University Press.

3.9 From Hassan 1932 Fig. 143.

3.10 Courtesy of the Museum of Fine Arts, Boston (Fourth Dynasty). The usual name *Mycerinus* is the ancient Greek rendering (Latinized) of Pharaoh Mn-ka-re.

3.11 My simplified summary of papyrus technology, from Lewis 1934, and especially Pliny the Elder as quoted in text. Width of one papyrus sheet about 40 cm.

3.12 Siderolite found in Texas. Courtesy of Prof. Marc Vuagnat, Institut des Sciences de la Terre, University of Geneva.

3.13 Courtesy of the Trustees, British Museum, London. Papyrus of Hunefer. For explanations see Budge 1960 p. 248, Daumas 1965 p. 313.

3.14 From Breasted 1930 I; part of Plate IV. Courtesy of Chicago University Press.

3.15 From Goffres, *Précis iconographique de Bandages* etc., Paris, 1858 (Plate 74).

3.16 Data on "flaming hieroglyphs": Wiedemann 1920 p. 190.

3.17 From Griffith 1898 Fig. 80 Plate V. In the text (p. 26) the instrument is "mistakenly explained as a bow drill" (Wiedemann 1920 p. 187). Courtesy of the Egypt Exploration Society, London, and of Routledge and Kegan Paul, Ltd., London.

3.18 Courtesy of Jane van Lawick-Goodall and of W. Collins Sons and Co., London. Phot. Hugo van Lawick (van Lawick-Goodall 1971 Fig. opp. p. 240).

3.19 From a relief in the Cairo Museum, Nineteenth Dynasty, as redrawn in Weigall 1915 Fig. 1.

3.20 Courtesy of Mrs. D. Darbois, Paris.

3.21 Courtesy of Dr. R. S. Merrillees, Australian Mission to the United

Nations, N.Y.; Prof. H. S. Smith, Dept. of Egyptology, University College of London; and the Editor of Antiquity.

3.22 Experiment by Dr. Elisabeth Schorer and Mme S. Dersi, Dépt. de Biologie Végétale, University of Geneva.

3.23 See 3.22

3.25 Experiments by Mrs. Jean M. Thurston, Harvard Medical School.

3.26 See 3.25

3.27 Experiments by Dr. H. L. Wildasin and coll. (see note 3.19). Honey: Florida Orange Blossom Honey, raw, kindly provided by R. B. Wilson, Inc., New York. Butter prepared from cream allowed to sour naturally overnight. Pathogenic bacteria kindly provided by Dr. E. H. Kass, Channing Laboratories, Boston City Hospital. Butter-honey mixture (with or without bacteria) blended by hand, then with a Waring blender, and kept at room temperature. Bacterial counts performed on solid media. In the case of *E. coli* the count included whatever members of the coliform group may have been present initially in the butter-honey mixture (i.e. in the soured cream).

3.28 See 3.27

3.29 From Chauvin 1968 III p. 109 Fig. 39. Beehive pattern added. Courtesy of P. Lavie and of Masson and Co., Editors, Paris.

3.30 New Kingdom, Seventeenth Dynasty; 15.7 x 21.6 cm. Courtesy of the Brooklyn Museum. Gift of the Estate of Charles Edwin Wilbour.

3.31 Original bas-relief: Temple of Deir el Bahari (Naville 1898 Vol. XVI Plate 74). Drawing rephotographed from Schmidt 1924 Taf. I, with permission from J. A. Barth, Publisher.

3.32 From Singer and others 1965 pp. 264–265 Figs. 164, 163, 165; p. 269 Fig. 170. Courtesy of Dr. T. I. Williams, Managing Editor for C. Singer and others, *A History of Technology.*

3.33 See 3.32

3.34 From Smith 1912 Plates 56, 29, 22, 68, and frontispiece plate. With kind permission of H. Riad, Chief Curator, Egyptian Museum, Cairo.

3.35 See 3.34

3.36 Published by permission of the Danish National Museum, Copenhagen; phot. Lennart Larsen.

Ch. 4 title page: the Greek letters spell the word *Iatrós,* physician.

4.2 One of very few weapons found in the Homeric (VII-a) layer of Troy, in 1935; "possibly one of the missiles discharged during the fighting that resulted in the burning of the town" (Blegen 1958 Vol. IV Part 1 p. 51 and Part 2 Fig. 219, invent. No. 35-486). Courtesy of Prof. J. L. Caskey, Dept. of Classics, University of Cincinnati, of Prof. Carl W. Blegen, American School of Classical Studies, Athens, and of Princeton University Press. Actual length 38 mm.

4.3 Coin: a *hékte,* courtesy of Franke and Hirmer (from Franke and Hirmer 1964 Plate 179, top right). Reconstruction of the headband: modified from Krug 1968 p. 134 ff. (Dr. A. Krug kindly agreed that the thin ends should be longer than in her own scheme of Plate I-9).

Illustrations

4.4 From Solygeia. Capsule is represented without slits. Fig. 18 in Kritikos and Papadaki 1967, slightly retouched. Courtesy of Dr. P. G. Kritikos and of the United Nations Bull. on Narcotics.

4.5 Poppy heads photographed in the dried state. Courtesy of Mr. D. Mack, Dépt. de Biologie Végétale, University of Geneva.

4.6 Courtesy of Editions "Cahiers d'Art," Paris (in Zervos 1956 Figs. 774, 775). Data in Kritikos and Papadaki 1967 p. 23 ff., Caskey 1962 pp. 224–225.

4.7 Apollo shooting arrows at the sons and daughters of Niobe. From a chalice dated 500–450 *B.C.* (G 341), courtesy of the Louvre Museum, Paris, and of M. Chuzeville, photographer.

4.9 Evidence that Achilles made a mistake in applying this bandage should be a loose end of the bandage under his left hand; this is shown in Singer's drawing (1921

Fig. 6), but is not well apparent on the original photograph of the vase as I obtained it from the Berlin Museum. Prof. K. Vierneisel, Director of the *Antikenabteilung*, kindly assured me that the white tip of the bandage is clearly visible on the vase: hence I took the liberty of retouching it slightly on this figure. Courtesy of Staatliche Museen, Preussischer Kulturbesitz, Berlin (#F 2278). Another "mistake" in this vase: the wound represented is not mentioned by Homer! (Daremberg 1865 p. 82).

4.10 Petri dishes with just enough commercial milk to cover the bottom (about 2 cc). With fresh cow milk the effect was identical.

4.14 The thread hanging from the drain is not mentioned in the text, but I added it because the linen "tents" inserted in the same position do have this safety device (*On Diseases II*, #47/LTT VII 71).

4.16 Drawing based on the following passages concerning ancient bladder-type syringes: manner of assembly, *On Barren Women III*, #222/LTT VIII 431 (confirmed by Heister 1782 II Plate XXXIIII Fig. 12 and pp. 265–266); silver model for gynecologic use, ibid.; feather shaft, *On Fistulae*/A II 819 #5 = LTT VI 453 #6.

4.17 My interpretation.

4.18 From Adams 1849 Vol. II Plate VII.

4.19 For details see Gardiner 1930 Fig. 156 and p. 187, where this throw is called a "flying mare." Courtesy of the Trustees, British Museum, London (*se-oi-nage* means "shoulder-lift-throw").

4.20 From LTT IV 311 and LTT X xiv. In discussing the first figure, Littré adds that for accuracy the ties on the ankle should extend all the way down the leg, and those on the thigh should be wider. He was not yet aware of the lateral levers (second figure); hence Adams calls this figure erroneous and adds the levers (A II Plate V 1). Note that with two cranks and two levers, it took four people to work the bench.

4.21 Plates IV and IX from H. Schöne 1896 (*Apollonius von Kitium*). With permission from B. G. Teubner Verlagsgesellschaft, Leipzig.

4.22 See 4.21

4.23 Drawing based on the description in *On Joints*, #11/LB III 223 = LTT IV 105.

4.24 Courtesy of Römisch-Germanisches Zentralmuseum, Mainz, Germany. Provenance uncertain, but acceptable as "Roman." Longest = 165 mm. Greek specimens are very much the same.

4.25 The twenty-odd dents in this skull were probably due to stones (sling-shot) or to the fearful Inca star-shaped war club (Daland 1935 p. 555). Three were full-blown depressed fractures, i.e. worse than simple *hédrae*. Moodie calls this man The Thickheaded Village Fool (Moodie 1927 p. 286).

4.27 From Adams 1849 Vol. I, Plate I Nos. 6, 7, 8. Adams, in turn, lifted these drawings from Guido Guidi (Vidus Vidius): *Chirurgia e Graeco in Latinum conversa, Vido Vidio interprete, Lutetiae Parisiorum* pp. 117–119 (1544).

4.28 Courtesy of Dr. Jean Ginsburg, Royal Free Hospital School of Medicine, University of London, and of the American Physiological Society (Fig. 1 in Handbook of Physiology Sect. 2 Vol. III).

4.29 Attic kylix (discussed in Gardiner 1930 p. 197 ff. and Fig. 173) and panathenaic amphora, Archonship of Pithodelos (discussed in Gardiner 1930 p. 187 ff. and Fig. 175; modern drill-holes retouched). Courtesy of the Trustees, British Museum, London.

4.30 From Guido Guidi (Vidus Vidius) *De Chirurgia* Lib. III p. 56 Fig. LIII. Courtesy of Biblioteca Nazionale Braidense, Milan.

4.31 Courtesy of the Soprintendenza alle Antichità, Rome.

4.32 Courtesy of Hirmer Verlag, Munich (Franke and Hirmer 1964 Plate 66).

4.33 Sources for ancient number-schemes: Schöner 1964; Ghyka 1931, 1971.

4.34 Actual Greek monument; redrawn from E. Mössel, *Die Proportion in der Antike und Mittelalter*. Munich, C. H. Beck, 1936 (p. 66). With kind permission from C. H. Beck Verlag.

4.37 Data redrawn from Fig. 3 and Fig. 9 of Draczynski 1951. Wines were ten to eleven years old; pH 3.12 (white) and 3.60 (red); alcohol tested at pH 7.48. If the

alcohol was tested at pH 3.26, it killed the bacteria much faster (two hours), though not as fast as wine (ibid. Fig. 9). With kind permission of the author and of J. Diemer Verlag, Mainz.

4.39 From Mattioli, P. A., *Commentario alla Materia Medica di Dioscoride*, Venezia, 1568. Courtesy of Prof. Luigi Belloni.

4.40 See 4.39

4.41 Coin kindly selected by Mr. G. K. Jenkins of the British Museum and Mr. N. Dürr, Musée d'Art et d'Histoire, Geneva (publ. in L. Anson, *Numismata Graeca*, 1910 Part V/v Plate XIV 605). From Apollonia (Mysia). Courtesy of the Trustees, British Museum, London.

4.42 Courtesy of Mr. A. Küng, Observatoire de Sauverny, Geneva.

4.43 Courtesy of PhotoThomke, and of the Stadtverwaltung, Bingen am Rhein. Background retouched.

4.44 Courtesy of the Trustees, British Museum, London (Kylix E 86).

4.45 Bronze weapon inscribed PHILIP OF MACEDONIA (the father of Alexander). Found at Olynthus, besieged and sacked 348 B.C. Courtesy of the Trustees, British Museum, London (No. 1912 4–19 x).

4.46 From C. Bell, *The Anatomy and Philosophy of Expression As Connected with the Fine Arts*, London, G. Bell and Sons, 1890 (7th ed.), p. 146: a soldier wounded at the battle of Corunna in 1809, drawn by the author.

4.47 Courtesy of Mrs. H. Papadaki, Athens.

4.48 The beautiful photographs of this stele are the fruit of a complex task organized through the kindness of Mrs. R. Andreadi of Athens: Mr. N. Gialouris gave the permission of the Archeological Service and dispatched an archeologist (Dr. M. T. Mitsos) and a photographer (Mr. M. Vernardos) from Athens to Epidauros. To all—and to Martine Vodoz who alerted me to the existence of the stele—go my warmest thanks for this labor of love.

4.49 From Rollinat 1934 Fig. 5. With permission from Librairie Delagrave, Paris.

4.50 See 4.48 above.

4.51 From "the first German Calendar, Augsburg, about 1480" (Klibansky and others 1964 p. 299 Figs. 85, 87, 89a and b). Courtesy of Prof. R. Klibansky and of T. Nelson and Sons, Ltd., London.

Ch. 5 title page: drugs oozing from wounded trees. After a quaint woodcut of a wounded sandarach-tree, reproduced at the end of this chapter (from J. Meydenbach's *Ortus sanitatis*, Moguntiae, 1491, a popular herbal in its time).

5.1 From *Beni Hasan*, Plate XVII (Griffith 1900). Some details removed.

5.2 From Schäfer 1902 p. 38. Explanations added (kindly checked by Prof. C. Maystre). With permission of Akademie-Verlag, Leipzig.

5.3 Bas-relief from the temple of Deir el Bahari. Scale: the heap in the original is about 32 inches high (Naville 1898 Plate LXXIX).

5.4 Map based on van Beek 1958 (b) p. 152 (also Pirenne 1960; von Wissmann 1964; Miller 1969 map 5; Hepper 1969 Plate XIV). Present distribution of trees kindly confirmed by Prof. Ray L. Cleveland (personal communication). Range of Malaysian outriggers: Miller 1969 pp. 171–172 and map 7; Hornell 1946 last map.

Illustrations

5.5 From color plate in Marchand 1867 (Plate 1).

5.6 Photographed in 1960 by Prof. Ray L. Cleveland, Dept. of History, University of Saskatchewan, Regina, Saskatchewan, to whom I owe these rare documents. Najd region of Dhofar, Sultanate of Oman. Height of tree shown in first photograph is 2–3 m; it was just north of the Qara mountains.

5.7 See 5.6

5.8 From Drake-Brockman 1912 p. 303; a Somali specimen ("Didin, the source of Guban myrrh"). With permission of Hutchinson Publishing Group Ltd., London.

5.9 Courtesy of Walther Paulsen GMBH, Hamburg, Germany, and of Fritsche, Dodge & Olcott Inc., New York.

5.10 Courtesy of Mr. M. Hartmann, Archéologue Cantonal, Brugg, Switzerland. Published by Wiedemer 1966. Actual dimensions c. 45 × 20 × 6 mm

5.11 Experiment performed by Dr. Elisabeth Schorer and Mme. Sylvie Dersi of the Dépt. de Biologie Végétale, University of Geneva. Myrrh was used in a concentration of 1 g/5 ml H_2O. Prediffusion was allowed to occur for six hours at room temperature.

5.13 From Rosengarten 1969 p. 197. Courtesy of F. Rosengarten Jr.

5.14 Cultures kindly provided by Dr. Elisabeth Schorer, Dépt. de Biologie Végétale, University of Geneva. *Saccharomyces cerevisiae* (1936 Fendant, Valais; phot. in dark field), and *Acetobacter aceti* (LBG-B 4106, Inst. Microbiol., Zürich; smear, negatively stained with nigrosine).

5.15 From Pasteur's book on diseases of wine (1866); Fig. 3, labeled "Maladie de l'acescence du vin (*Mycoderma vini* et *Mycoderma aceti* réunis.). La maladie est à son début . . ."

Ch. 6 title page: the Chinese characters read *Yang I*, "Ulcer Physician" or "Physician for External Diseases."

6.1 Redrawn from Bengston and Milojčić 1963 I c.

6.2 From the film of the discovery of the Han tomb (see Fig. 6.22).

6.3 From NEED I 86.

6.4 The map of China corresponds very roughly to the Warring States period; based on NEED I 92 Fig. 12 (beginning of third century B.C.). The walls were many more than sketched.

6.5 See e.g. Wong and Wu p. 11, NEED II 257.

6.6 Ancient forms: *Yin*, Wieger 1924 p. 246 No. 101 B; *Yang*, Wieger 1924 p. 232 No. 93 C. Modern forms: calligraphy by Mr. Lee Kwok-wing.

6.8 From *The I Ching* or *Book of Changes*, trans. by Richard Wilhelm, rendered into English by Cary F. Baynes, Bollingen Series XIX (copyright © 1950 and 1967 by Bollingen Foundation), Fig. I. Reprinted by permission of Princeton University Press and of Routledge and Kegan Paul, London.

6.9 From *Change: Eight Lectures on the I Ching*, by Hellmut Wilhelm, Bollingen Series LXII (copyright © 1960 by Bollingen Foundation), Fig. 2. Reprinted by permission of Princeton University Press.

6.10 Top: calligraphy by Mr. Lee Kwok-wing; (a) from NEED II p. 228; (b', b") from Lu Gwei-Djen and Needham 1967 p. 3 #1; (c, d, e) ibid. #2/1, #5/1, #3/2.

6.13 From Kan 1920 Fig. 21 (Sketches of Confucius, With Illustrations; Shanghai, Commerical Press Ltd.).

6.14 From Cowdry 1921(b) Fig. 13.

6.15 Character as reported in Ve 239, 247, redrawn by Mr. Lee Kwok-wing.

6.17 From Morse 1934 p. 147 (source not given).

6.18 Photographs courtesy of Dr. Chong Yu-ming, Acupuncturist, Taipei.

6.19 From Wong and Wu Fig. 21; no details given, but a common Chinese vignette.

6.20 Most data from NEED II 262–263. Such tables are in practically all works on Chinese history.

6.22 From frames of a film produced by Peking Television on the discovery of the Han tomb, 1972. Courtesy of Peking Television.

6.23 Schuchhardt 1891 p. 53; see also Schliemann 1885 pp. 300–304.

Ch. 7 title page: the Sanskrit characters read *vaidya*, "physician."

7.1 From an old print, courtesy of Jacques Vicari, Geneva.

7.2 Adapted from Schulberg 1968 p. 75, plus another site mentioned by Schlumberger and others 1958.

7.3 From Smith 1901 Plate II. Courtesy of The Clarendon Press, Oxford.

7.4 Courtesy of the Office du Livre S. A., Fribourg, Switzerland (Fig. 143 in Hallade and Hinz 1968).

7.5 Courtesy of J. Auboyer and of Presses Universitaires de France. From Hackin 1954 Fig. 105, text p. 233, redrawn by J. Auboyer (1955 Plate VI).

7.6 From Tennent 1860 I p. 499. The method is mentioned by Arrian, *Indiká,* XVI (II cent. A.D.) in relation to Alexander's expedition. For Alexander's wound: Plutarch, *Lives: Alexander,* 63/LB VII 405.

7.7 These drawings represent methods described by Sushruta, but details are of course wholly imaginary (only source: SS I 71–72). An effort was made to draw the instruments according to Hindu models—but those too are reconstructions (Mukhopadhyaya 1913 II). Butcher-bird: ibid. II Plate XIV 6.

7.8 Based on Sushruta's description (SS I 261).

7.9 Composite from Mukhopadhyaya 1913 II Plates XI–XIV.

7.10 Mukhopadhyaya 1913 II Plate XIII, text Vol. I p. 103.

7.11 From Paré 1564 (repr. 1964, p. 4).

7.12 Redrawn after SS II, Plates I and II, pp. xix, xx. For the identification of anatomical structures I am indebted to Prof. J.-A. Baumann, Head, Dept. of Anatomy, University of Geneva.

7.14 I owe this striking photograph to Mr. Harry Miller, Madras, India, who was also the owner of this rare white cobra.

7.15 From R. Vira and L. Chandra 1965, end of fascicle 48 (text pp. 9–10). Courtesy of Prof. L. Chandra, International Academy of Indian Culture, New Delhi. I learned from Prof. Chandra that these mantras, written by the monk Zen-nin, bear no explanation in the original book. They are mantras simplified to the extreme, *bija-mantras* (*bija* = "seed"). Ordinary mantras may be a whole sentence or even a hymn; bija-mantras sum it up in a single, "nuclear" syllable. Typical is the mantra-syllable *om;* it is the traditional opening of most Sanskrit texts, somewhat like an invocation. Because its sound originates deep down in the throat, and terminates at the lips, it is thought to encompass all possible sounds: hence its symbolic value. (Information courtesy of Gopal Sukhu).

7.16 Granite figure, sixth century Pallava from Mahabalipuram. From a color slide kindly provided by Mr. Harry Miller.

7.18 From Coomaraswamy 1931 II Plate 25.1. Courtesy of the Indian Museum, Calcutta.

7.19 Courtesy of the Musée de l'Homme, Paris. Child of the *cheddoul* caste wearing heavy copper and silver earrings (Madras, Madurai). Cliché P. Monge, 1947.

7.20 From Merker 1910 p. 138 Fig. 47. Courtesy of D. Reimer Verlag (Andrews and Steiner), Berlin.

7.21 I had these fourteen ear-conditions drawn, to the best of my understanding, from Sushruta's descriptions, some of which are not clear. The fifteenth of Sushruta's list is the "ganda-karna" shown in Fig. 7.22.

7.22 Drawn after J. M. Converse, *Reconstructive Plastic Surgery,* 1968, Vol. III Fig. 28.52 ABC.

7.23 Drawn with the guide of the "bullock driver" illustration (Gnudi and Webster 1950 Fig. 47).

7.24 From Converse 1959 p. 339. Courtesy of Dr. J. M. Converse and of W. B. Saunders Co.

7.25 The drawing was made by combining Sushruta (SS II 159–160), who describes the superimposed pitchers and the use of "basket material" for making the pipe, and Charaka (ChS I 559–560), who says that the pipe should be made airtight with thick leaves. "Triple bend" and shape like an elephant trunk are specified in both sources. The diameter is anybody's guess: (1) Sushruta, no figure; (2) Charaka: circumference *or* caliber (sic) from 1/4 to 1/8 of a *Vyama* (width of outstretched arms!); (3) Mukhopadhyaya 1913 I p. 145 quotes Sushruta (?!) as specifying the "circumference of a common pea". . .

Illustrations

7.26 Prepared with the help of Prof. D. Ingalls and of Gopal Sukhu.

7.28 Lotus flower courtesy of Jean Mohr, Geneva. Knife drawn by Mr. P. Duvernay.

7.29 From Fergusson 1868 Plate XXXIII.

7.30 Courtesy of Dr. Jean-Pierre Lamelin. From the Sun Temple of Konarak (Orissa).

7.31 From Neal A. Weber, "Fungus-Growing Ants," Science, 5 Aug. 1966: *153,*

587–604, Fig. 12 (top right). Copyright 1966 by the American Association for the Advancement of Science. With permission of Science and Prof. N. A. Weber. As to the "6 mm. wounds" caused by *Atta*, I owe this information to Prof. Weber (Swarthmore College, Penn.), who also feels sure that *Atta*, the leaf-cutting ant, could not suture wounds. I tend to agree. The mystery is Beebe's reference to clamping by *Atta*. Beebe wrote a book about ants and was a personal friend of Wheeler, top authority on ants: how could he go so wrong?

7.32 Originals in Doflein 1905 Figs. 3, 4 (redrawn in Wheeler 1910 Figs. 122, 123). With permission from G. Thieme Verlag, Leipzig, and of Columbia University Press.

7.33 See 7.32

7.34 Photographed in Mayidi, ancient Belgian Congo. *Anomma wilverthi* (Emery) is *Dorylus wilverthi* Em. Even very small workers, 33 mm long, brace themselves in this "cataleptic" sentinel attitude. Data and photograph courtesy of Prof. A. Raignier, S. J., Heverlee, Belgium. *Eciton* and *Dorylus* are the most important genera in the subfamily Dorylinae, one of eight in the family Formicidae. *Eciton* is typical of American tropics, *Dorylus* of the African; they are called army ants, soldier ants, driver ants, etc.

7.35 Photographed in my laboratory, with a specimen kindly provided by Dr. W. Wittmer, Naturhistorisches Museum, Basel, Switzerland (*Scarites buparius* Forst.; *pyracmon* is a synonym). With permission, Naturhistorisches Museum, Basel.

7.36 From "The Social Behavior of Army Ants" by Howard R. Topoff.

The unnumbered drawing at the end of the chapter is another Mantra from the same group as those of Fig. 7.15. With kind permission from Prof. L. Chandra.

Ch. 8 title page: the Roman coin shows a ship approaching the lighthouse of Alexandria. Second century A.D. Courtesy Mr. R. A. Gardner, British Museum, London.

8.1 Based on the 1866 map reproduced by Bernand 1966 pp. 364–365.

8.2 Rephotographed from Sudhoff 1909 Plate III (number P. 3983 at bottom retouched off). The word *trauma* identified and redrawn with the help of Prof. Jean Rudhardt, University of Geneva. With permission from J. A. Barth Verlag, Leipzig.

8.3 From the Flinders Petrie Papyri, Plate XIII (Mahaffy 1893), with permission from The Royal Irish Academy. For other papyri with *iatrikón* see Mahaffy and Smyly 1905.

8.4 From Commandino edition of Heron, No. 44 and No. 33; and from Aleotti edition, No. 67.

8.5 From Eco and Zorzoli 1963 p. 59, with permission of Dr. U. Eco and of Casa Editrice V. Bompiani, Milan.

8.6 From Aleotti edition of Heron, No. 37.

8.7 From Commandino edition of Heron, No. 21.

8.8 From Thiersch 1909 p. 90 Fig. 71, with permission of B. G. Teubner Verlag, Stuttgart.

8.10 From Aleotti edition of Heron, No. 27.

8.11 From Drachmann 1967 Fig. 8 (letters added). Courtesy of Prof. A. G. Drachmann and of Artemis Verlag, Zürich.

8.13 From Aleotti edition of Heron, No. 57.

8.14 From Heron, *De machinis Bellicis*. Rephotographed from Eco and Zorzoli 1963 p. 83, with permission of Dr. U. Eco and of Casa Editrice V. Bompiani, Milan.

Unnumbered drawing at end of chapter: bronze coin struck at Alexandria, showing the lighthouse (144–145 A.D.). Courtesy of American Numismatic Society, N.Y.

Ch. 9 title page: the Latin words emphasize the importance of military medicine in Rome. They represent the beginning of a marble inscription found in Via Nomentana, Rome (Briau 1866 p. 25), and read: *Tiberius Claudius Iulianus, clinical*

physician to the fourth infantry battalion ("cohors IIII"). The modern-sounding word *clinicus* had a somewhat different connotation: it probably meant "in charge of lying patients" (from the Greek *klíno*, "I lie") i.e. bedridden patients hospitalized in the wards, as opposed to ambulatory cases (see Davies 1969 p. 87).

9.1 Courtesy of Prof. Zdenek Vogel and of Urania-Verlag, Leipzig. From Vogel 1963 Fig. 164.

9.2 From Hall 1971 p. 68 No. 46.

9.3 Found by my daughter Corinne on the beach of Gay Head, Mass., where the fossils date from the Miocene (12–20 million years old).

9.4 Specimen kindly provided by Prof. A. Imbesi, Director, Istituto di Farmacognosia, Università di Messina, Italy.

9.5 From Hartner 1941 p. 217, with permission of the China-Institut, J. W. Goethe-Universität, Frankfurt am Main.

9.7 From Gunther 1934 p. 439, with kind permission of A. E. Gunther.

9.8 Stele at the Museum of Palestrina, with permission of the Soprintendenza alle Antichità del Lazio, Rome.

9.9 The bas-relief was found "South of the Acropolis, on the site of the Asklepieion, in the defense wall of Turkish times . . . It decorated a base that carried an ex-voto to Asklepios." Photograph and data courtesy of B. Kallipolitis, Director, National Museum, Athens.

9.10 From Vulpes 1847 Plate VII; text pp. 74–81.

9.11 From the Museo Nazionale, Naples, with permission of Prof. A. de Franciscis, Soprintendenza alle Antichità, Naples.

9.12 For the first draft of this drawing I had the stick of "swan collyrium" stamped with "the likeness of a swan," as suggested by an explanatory note in CDM/LB II 196. I then found that the swanness was only in the color; Galen explains that these collyria "are called by physicians *libiana* or *swans* because of their white color." Note the astonishing appearance of the Arabic *lubán*, "white" (*De compos. medicam.*/K XII 707–708; see also *Paulus Aegineta*/Adams III 549, 550). The swan-collyrium or *cygnarium* was meant especially for the eyes: surely its name and color had something to do with "whiteness" being good for "clear vision." There is a Greek inscription about a blind soldier to whom the God ordered a collyrium made with the blood of a white swan (I.G. XIV 966). Only tablet-shaped collyria have been found (duly stamped with the physician's seal).

9.13 From Vulpes 1847 Plate IV; text p. 39 ff.

9.14 From Frölich 1880, also reproduced by Haberling 1912.

9.15 Drawn after Meyer-Steineg 1912 Plate II No. 3 and pp. 26–27.

9.16 Courtesy of Dr. D. Baatz, Saalburgmuseum, to whom I owe the following data. The instrument was found in 1890 and not labeled until 1900; shortly thereafter someone (probably a physician) gave it the present interpretation. Also published by Davies 1970 p. 92 (Museum Inv. No. P 5603).

9.17 With permission of Max Parrish Publisher, London (Fig. 15.6 in *Roman Silchester* by G. Boon; also in Liversidge 1968 p. 342 Fig. 131 f). For similar Pompeian specimen see Vulpes 1847 Plate V Fig. 4.

9.18 From Vulpes 1847 Plate IV; text p. 39 ff.

Illustrations

9.19 Photograph (reversed) and text from the posthumous English edition of 1678 p. 304 (the original is from 1564).

9.20 Photograph courtesy of Dr. M.-A. Dollfus, retouched. The forceps is now at the Cabinet des Médailles, Paris. According to Dr. Dollfus, other such forceps have been found (Dollfus 1965 Figs. 4, 5).

9.21 From Blinkenberg 1926; (a) Crete (p. 40), (b) Arcadia, age uncertain (p. 41), (c) Mycenaean (p. 48), (d) Mycenaean (p. 44). Sizes not given for all; (c) is about ½ of natural size. With permission from Det Kongelige Danske Videnskabernes Selskab, Copenhagen.

9.22 From Goffres 1858 Plate 77 Fig. 8; text p. 534.

9.23 From Paré 1564 p. 214.

9.24 From Vulpes 1847 Plate V; text pp. 49–54.

9.25 Bas-relief at the Museo Nazionale, Naples. Descriptions also in Winckelmann 1767 I p. 163 Fig. 122; Jeanselme 1921. With permission from Prof. A. de Franciscis, Soprintendenza alle Antichità, Naples.

9.26 Cod. Vatic. Lat. 5951, p. 41 verso. Courtesy of Biblioteca Apostolica Vaticana, Vatican City (codex described by Sabbadini 1900 p. 302).

9.27 See 9.26

9.28 Map based on Wheeler 1955. Amphorae: data in Wheeler 1946.

9.29 The ivory was found in a box with various bronze implements and glassware. A letter of the Indian *kharosthi* alphabet is carved beneath the base (see Maiuri 1938 Plate XLII). Courtesy of Le Arti, S.n.c., Milan.

9.30 From Simpson 1854. The writing on the first pot means "Lycium of Heracleus"; a physician of Tarentum by that name was actually named by Celsus and Galen (Simpson 1854 p. 415). This would date the pot (at the latest) from the first years A.D.; however, the name was a common one.

9.31 For advice concerning the cataract operation I am indebted to Dr. Jaqueline Starobinski, Geneva.

9.32 Drawing based on W. G. Spencer's illustration in CDM/LB III facing p. 362, and on comments by Daremberg 1847.

9.34 Sources on Roman military hospitals (the following list, with Davies 1970d, is a key to almost all the literature available). *In Germany and Austria* (general): Haberling 1909, Schultze 1934, Jetter 1966, von Petrikovits 1970, Baatz 1970. *Bonna* (Bonn): von Petrikovits 1960. *Haltern:* Stieren 1928, 1930. *Künzing:* Schönberger 1969, Schönberger and Herrman 1971. *Novaesium:* Nissen and others 1904; Waterman 1970. *Oberstimm:* publ. in local paper, Ingolstädter Heimatblätter, 34 Jahrg., No. 11, 1971, 37–40, and in Bayerische Vorgesichtsblätter 1972: 37, 31–37 (ref. courtesy of Prof. R. W. Davies). *Saalburg:* Baatz 1970(a, b). *Vindobona* (Vienna): Neumann 1950, 1965. *Carnuntum:* see Schultze 1934 (no new data since then, pers. comm. from Museum Carnuntinum). *Jugoslavia: Lotschitz,* Lorger 1919. *In Great Britain* (general): see Collingwood and Richmond 1969 pp. 15–59. *Benwell:* Simpson and Richmond 1941. *Corbridge:* Richmond and Gillam 1952, Arch. Aeliana *117* 1968. *Fendoch:* Richmond and McIntyre 1939. *Hod Hill:* Richmond 1968 p. 85. *Housesteads:* Bosanquet 1940. *Inchtuthil:* Richmond and St. Joseph 1957, 1961. *Pen Llystyn:* Hogg 1968. *Switzerland: Baden,* Anon. 1900? (perhaps not a *military* hospital). *Vindonissa:* Simonett 1937, Fellmann 1958. *Holland, Valkenburg:* Glasbergen 1966. *Hungary, Aquincum* (Budapest): Szilágyi 1956 (evidence indirect). *Israel, Masada:* Schulten 1933. *Africa, Lambaesis:* Cagnat 1909, 1913; *Alexandria:* only from literary evidence.

9.35 From Baatz 1970(b) p. 24. Courtesy of Dr. D. Baatz, Saalburg Museum.

9.36 All from Schultze 1934 (slightly retouched). Vetera I: Plate IV Fig. 2; Vetera II: Plate I; Novaesium: Plate IV Fig. 3; Lotschitz: Plate V. Courtesy of the Rheinisches Landesmuseum, Bonn.

9.37 From J. of Roman Studies 1961: *51,* 158. With kind permission of Lady Richmond and of the J. of Roman Studies.

9.38 From J. of Roman Studies 1956: *46,* 199. With kind permission of Lady Richmond and of the J. of Roman Studies.

9.39 For this scheme I am much indebted to my friend Jacques Vicari of Geneva, architect, archeologist, and expert on hospital buildings.

9.40 Courtesy of Dr. K.-H. Knörzer (Knörzer 1963; *Hyoscyamus niger* p. 313; *Centaurium umbellatum Gilib.* pp. 32, 312). With permission from Gebr. Mann Verlag, Berlin.

9.41 See 9.40

9.42 From an amphora in Basel, Switzerland (Schefold 1967 p. 39). With kind permission from Holle Bildarchiv, Baden-Baden, Germany.

9.43 Courtesy of The Mansell Collection, London.

9.44 For advice on these derivations I am indebted to Prof. G. Devoto, University of Florence, and to Prof. G. B. Pellegrini, University of Padova. See Ernout-Meillet 1939 p. 599 ff. and Benveniste 1945.

Ch. 10 title page: the 22 volumes of Galen's works in the Kühn edition of 1821–1833.

10.1 From the front page of the Venetian edition of Galen published *apud Iuntas*, 1609 (7 vols.).

10.2 From Figuier 1866 opp. p. 378. Dr. J. Walsh, who discusses this painting in detail, suggests that Galen probably worked at a better operating table—and not with a *toga* (Walsh 1926 p. 180).

10.3 From the Museo Nazionale, Naples. With permission from Prof. A. de Franciscis, Soprintendenza alle Antichità, Naples.

10.4 From a color slide kindly provided by Nell C. Juliand for Time-Life Books. Published in Hadas 1965, pp. 50–51 (Great Ages of Man, *Imperial Rome*, photo by Pierre Belzeaux © Time Inc.). With kind permission from Issa Salem El Assouad, Directeur-Délégué des Recherches Archéologiques, Tripoli, R. A. U. The mosaic is at the Musée des Antiquités, Tripoli.

10.5 For details the artist, Mr. Axel Ernst, used documents from the Fossa Sanguinis of Neuss (Wortmann 1971) and the original description of Prudentius (Hymn. X, 1006–1050).

10.8 Ape hand, from Singer and Underwood, *A Short History of Medicine* (1962 p. 63 Fig. 25), courtesy of the Clarendon Press, Oxford. Snake Skeleton, courtesy of V. Aellen, Director, Museum of Natural History, Geneva.

10.9 From Buffon, *Histoire Naturelle*, Paris, Impr. Royale, 1766, Tome XIV, Plate VII.

10.10 From Livon, C., *Manuel de vivisection*, Paris, J.-P. Baillière, 1882. Livon has taken these illustrations from works of Claude Bernard.

10.11 Adapted from Daremberg 1854 I p. 505.

10.12 From *Oeuvres d'Oribase*, Bussemaker and Daremberg 1862 Vol. 4 p. 692.

10.13 For help in preparing this drawing I am indebted to Prof. J.-A. Baumann, Head, Dept. of Anatomy, University of Geneva.

10.14 Courtesy of C. K. Divakaran, Dean, Gujarat Ayurved University, Dhanvantari Mandir, Jamnagar, India.

10.15 Recipe from the 1676 edition of M. Charas, *Pharmacopée Royale Galénique*, Paris (p. 277). Composition and drawing by Miss Judith D. Love of the Rhode Island School of Design.

10.16 From NEED I p. 205.

10.17 Courtesy of Dr. F. E. Ducommun, Nyon, Switzerland.

10.18 Redrawn after Schöner 1964. With permission from F. Steiner Verlag, Wiesbaden, Germany.

10.20 Map based on Hazard 1952 (maps 9, 11).

Page 423: Temple of Poseidon, Cape Sounion, Greece, courtesy Lise Piguet.

COLOR PLATES

3.1 Courtesy of the New York Academy of Medicine.

3.2 Courtesy of the Trustees, British Museum, London. Papyrus of Ani (14th sheet).

Illustrations

3.3 Malachite from Lukuni (Siberia). Courtesy of Prof. M. Vuagnat, Institut des Sciences de la Terre, University of Geneva.

3.4 Chrysocolla from Israel.

3.5 From Desroches-Noblecourt, *Toutankhamon*, Paris, Hachette (1963 p. 6). Courtesy of Prof. S. Curto, Museo Egizio, Turin, Italy.

3.6 Experiment by Dr. D. Kekessy, Institute of Hygiene, University of Geneva.

3.7 The honey from Paestum was generously provided by Prof. Mario Napoli, Soprintendenza alle Antichità, Salerno, Italy. It is now being chemically analyzed. Provisional study shows that the mass probably includes the whole hive, i.e. wax and honey. (The surface melting was caused by floodlights).

3.8 This scheme of the Egyptian vascular system is drawn according to the

longest of the three vessel lists (forty-six vessels, Eb 854 to 854-o, GMÄ IV-1/1–3; plus gloss Eb 855-c, ibid., p. 5, which mentions the "receiver vessel"). Breasted gives fifty vessels (Sm 110) rather than forty-six for the following reason: in the Ebers papyrus, after the "ear vessels" are mentioned (Eb 854 f), the text says "two vessels to his right shoulder, two to his left"; Breasted takes these as four additional vessels, but Grapow reads the text as if it meant "two [of the ear vessels mentioned previously] are to the right side, two to the left." None of the forty-seven *metw*, receiver included, is identifiable with any actual blood vessel. One paragraph states that "there are *metw* in [man] to every part of the body" (Eb 854a, GMÄ IV-1/1), but curiously none goes to the kidneys. The kidneys seem to have been entirely neglected by Egyptian medicine; no name for them is known. Detail of heart copied from a hieroglyph painted on a coffin dating 1878–1842 B.C., Boston Museum of Fine Arts, No. 20.1822-27/21.962. For checking the layout of this scheme, especially the *whdw* detail, I am much indebted to Dr. R. O. Steuer.

4.1 My interpretation. References in text.

4.2 See 4.1

4.3 Quotations supporting the ten sketches may be found as follows (see also LTT X, index). (1) Washing or soaking with wine: *Use of Liquids*/LTT VI 127 #4, 129 #5; *On Wounds* #1/A II 794 = LTT VI 401; warm wine: *Mochlicon* #33/A II 674 = LTT IV 375 (on open fractures); vinegar: *On Wounds*/A II 809 #17 = LTT VI 433 #27. (2) No dressing: *On Wounds* #1/A II 794 = LTT VI 401; *Wounds in the Head* #13/A I 457 = LTT III 231; *On Joints* #40/A II 602 = LTT IV 173. (3) Suture: see note 4.136. (4) Dry powders: *On Wounds*/A II 802 #7 = LTT VI 417 #13. (5) Wine on bandage: see note 4.60. (6) Sponge, leaves: *On Wounds*/A II 796 #1 = LTT VI 405 #2. (7) Wool: *On Wounds*/A II 808 #14 = LTT VI 429 #24; *On Fractures* #29/A II 537 = LTT III 517; etc. (8) Plaster directly on wound: *On Wounds*/A II 803 #8 = LTT VI 419 #15. (9) Plaster above linen pad: *On Wounds*/A II 799 #4 = LTT VI 411 #11. (10) Plaster around the wound: *On Wounds* #1/A II 795 = LTT VI 403; A II 798 #3 = LTT VI 409 #10; *On the Physician*/LTT IX 419 #15.

7.1 From Yazdānī, *Adjantâ*, 1954 Plate XXIII. Reproduced with permission of the New York Graphic Society and of UNESCO (Division of Cultural Development, Paris).

7.2 Major workers of *Eciton burchelli* (Westwood) kindly provided by the late Dr. T. C. Schneirla, American Museum of Natural History. Photographed in my laboratory with the assistance of Dr. I. Joris.

9.1 See note 9.77.

9.2 Codex "Urbinate" No. 1367, p. 1, verso. Courtesy of Biblioteca Apostolica Vaticana, Vatican City (see Sabbadini 1900 p. 306).

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