

# LIVES IN THE ANCIENT WORLD

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# INTRODUCTION<sup>1</sup>

## Human history as cultural history

We need to reform our teaching of history so that the emphasis will be placed on the gradual growth of human culture and knowledge, a growth to which all nations and ethnic groups have contributed.

This book is part of a series on cultural history. Here is a list of the other books in the series that have, until now, been completed:

- Lives in the 18th Century
- Lives in the 19th Century
- Lives in Biology
- Lives of Some Great Novelists
- lives in Mathematics
- Lives in Exploration
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<sup>1</sup>This book makes some use of my previously-published book chapters, but much of the material is new.

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# Chapter 1

## THE MYCENAEAN CIVILIZATION

### 1.1 Mycenaean Greece

#### The Minoan and Mycenaean civilizations

Histories of the development of western civilization usually begin with the Greeks, but it is important to remember that the Greek culture was based on the much earlier civilizations of Mesopotamia and Egypt. The cultural achievements of these very early civilizations were transmitted to the Greeks in part through direct contact, and in part through the Minoan and Mycenaean civilizations.

The Minoan civilization on Crete is the civilization which is familiar to us through the legends of Theseus, the Minotaur and the Labyrinth, and the legend of Daedalus and Icarus. Apart from the Greek legends, whose truth was doubted, nothing was known about the Minoan civilization until 1900. In that year, the English archaeologist, Sir Arthur Evans, began to dig in a large mound at Knossos on Crete. What he uncovered was a palace of great beauty which, to his astonishment, seemed once to have boasted such conveniences as hot and cold running water and doors with metal locks and keys. Sir Arthur Evans considered this to represent the palace of the legendary King Minos.

The Minoan civilization seems to have been based not on agriculture, but on manufacture and on control of the Mediterranean sea trade. It flourished between 2,600 B.C. and 1,400 B.C.. In that year, the palace at Knossos was destroyed, and there is evidence of scattered looting. Other evidence shows that in about 1,400 B.C., a nearby island called Theria exploded in a volcanic eruption of tremendous violence; and probably this explosion, combined with an invasion of Mycenaeans, caused the end of the Minoan civilization. The palace at Knossos was inhabited later than 1,400 B.C., but the later people spoke Greek.

The Minoan civilization, as shown in the graceful works of art found at Knossos, seems to have been light-hearted and happy. The palace at Knossos was not fortified and was apparently protected by sea power. Women's dresses on ancient Crete looked a bit like the



Figure 1.1: A vase depicting a scene from the Trojan wars. Upper frieze: the marriage of Helen and Paris; sirens under the handles facing toward the front of the vessel. Lower frieze with animals: goats and panthers.

dressess which were popular in Europe during the 1900's, except that they left the breasts bare. Some of the wall paintings at Knossos show dances and bull-fights. In the bull-fights, the bull was not killed. The bull-fighter was an acrobat, often a girl, who seized the lowered horns of the charging bull and was tossed in a somersault over its back.

The Mycenaean civilization developed at Troy, Mycenae (the home of the legendary Agamemnon), and other sites around the Aegean Sea. It is the civilization familiar to us through the stories of Ulysses, Priam, Ajax, Agamemnon, Paris and Helen. Like the Minoan civilization, the Mycenaean culture was thought to be purely legendary until quite recent times. We now know that the Homeric epics have a basis in fact, and this surprising revelation is mainly due to the work of a brilliant businessman-turned-archaeologist named Heinrich Schliemann.

As a young (and poor) boy, Schliemann was inspired by reading Homer's Iliad, and he decided that when he grew up he would find the site of ancient Troy, which most people considered to be a figment of Homer's imagination. To do this, he first had to become very rich, a task which he accomplished during the first 45 years of his life.

At last he had accumulated a huge fortune, and he could follow the dream of his boyhood. Arriving in Greece, Schliemann put an advertisement into a newspaper describing himself and saying that he needed a wife. This was answered by a beautiful and intelligent Greek girl, whom he promptly married.

Aided by armies of excavators, his beautiful wife, his brilliant intellect and a copy of Homer, Schliemann actually succeeded in unearthing ancient Troy at a site in Asia Minor! At this site, he uncovered not one, but nine ancient cities, each built on the ruins of the last. He also found beneath the walls of Troy a treasure containing 8,750 pieces of gold



jewelry, which he considered to be King Priam's treasure. He went on to uncover many other remains of the Mycenaean civilization at sites around the Aegean.

Schliemann's discoveries show the Mycenaeans to have been both technically and artistically accomplished. They spoke an Indo-European language (a form of Greek), and they were thus linguistically related to the tribes which conquered Persia, India and Europe.

The Mycenaean civilization lasted until about 1,075 B.C.. Between that date and 850 B.C., the Greek-speaking peoples of the Aegean entered a dark age. Probably the civilized Mycenaeans were conquered by fresh waves of semi-primitive Greek-speaking tribes from the north.

It is known that the Greeks arrived in the Aegean region in three waves. The first to come were the Ionians. Next came the Achaeans, and finally the Dorians. Warfare between the Achaeans and the Ionians weakened both groups, and finally they both were conquered by the Dorians. This conquest by the semi-primitive Dorians was probably the event which brought the Mycenaean civilization to an end. At any rate, during the dark ages between 1,075 B.C. and 850 B.C., the art of writing was lost to the Greeks, and the level of artistic and cultural achievement deteriorated.

## **The Ionian Renaissance**

Beginning in about 850 B.C., there was a rebirth of Greek culture. This cultural renaissance began in Ionia on the west coast of present-day Turkey, where the Greeks were in close contact with the Babylonian civilization. Probably the Homeric epics were written in Miletus, a city on the coast of Asia Minor, in about 700 B.C.. The first three philosophers of the Greek world, Thales, Anaximander and Anaximenes, were also natives of Miletus.

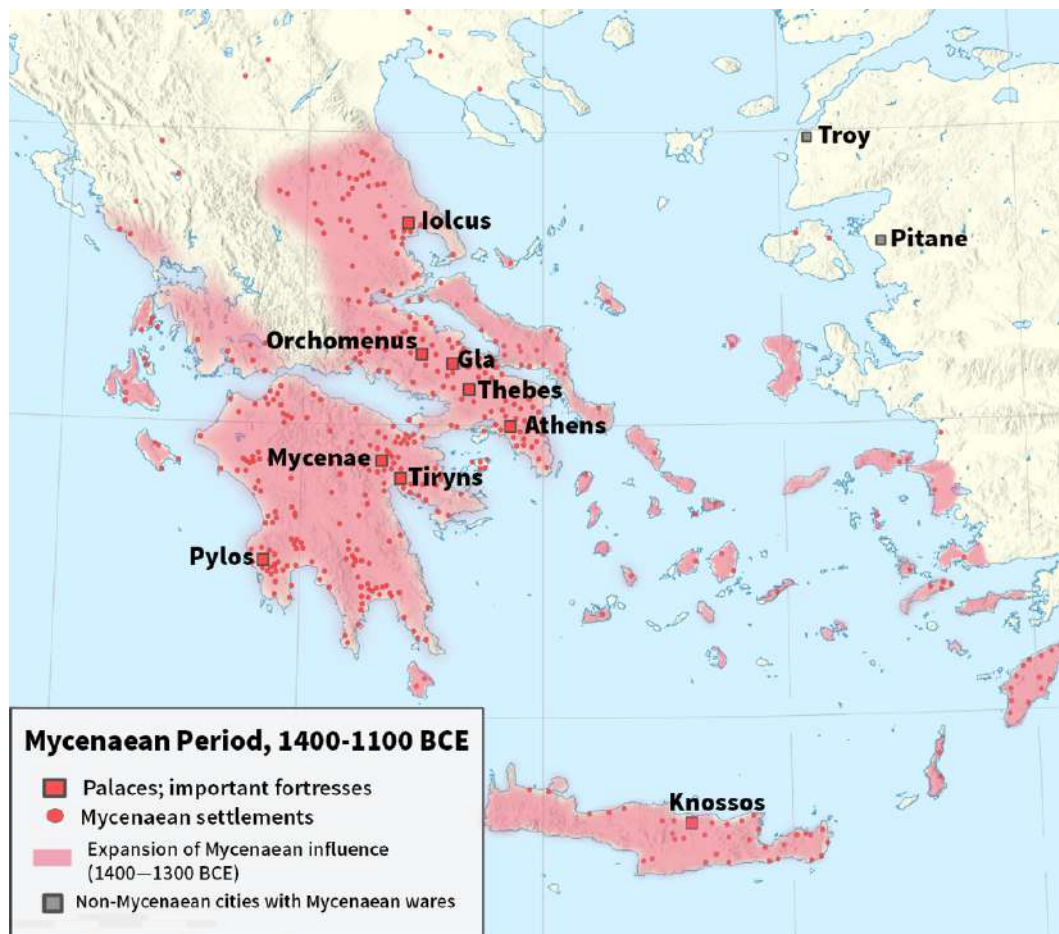


Figure 1.2: Map of Mycenaean Greece 1400-1200 BC: Palaces, main cities and other settlements.



Figure 1.3: Warrior wearing a boar's tusk helmet, from a Mycenaean chamber tomb in the Acropolis of Athens, 14th-13th century BC.





Figure 1.4: Death mask, known as the Mask of Agamemnon, Grave Circle A, Mycenae, 16th century BC, probably the most famous artifact of Mycenaean Greece.



Figure 1.5: Fresco depicting a female figure in the acropolis of Mycenae, 13th century BC.

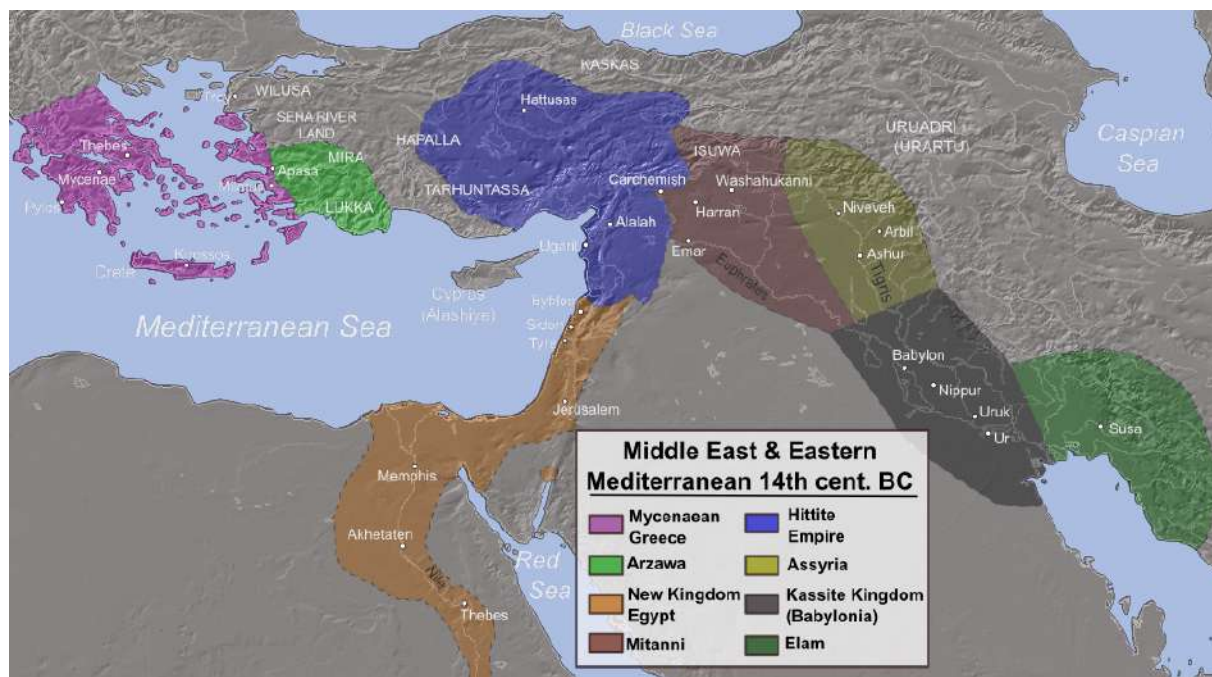


Figure 1.6: Eastern Mediterranean and the Middle East during the 14th century BC; Mycenaean Greece in purple.





Figure 1.7: Mycenaean palace amphora, found in the Argolid.



Figure 1.8: Mycenaean stirrup vase found in the acropolis of Ugarit, Eastern Mediterranean (1400-1300 BC).





Figure 1.9: Mycenaean gold earring, c. 1600 BC, Louvre Museum.



Figure 1.10: The Lady of Phylakopi; wheel-made pottery figurine of a goddess or priestess from the West Shrine in Phylakopi; late Helladic IIIA period, 14th century BC, Archaeological Museum of Milos.





Figure 1.11: Fresco of a Mycenaean woman.

## 1.2 Frescos from the palace at Knossos, Crete

The palace at Knossos on the island of Crete, discovered by Sir Arthur Evans, contains many beautiful examples of Minoan art. The frescos in the palace show a light-hearted and confident society.

### **Bullfighting**

Some of the frescos show bullfighting, but in these fights, the bull was not killed. Instead an acrobat, often a girl, seized the horns of the charging bull, and was tossed in a somersault over the bull's back. One is reminded of the Minotaur, which featured in legends about the Minoan culture

### **Woman's fashions**

The women's dresses shown in the frescos are remaniscient of the dresses that were popular in Europe in the 1890's, except that the breasts were left bare.

### **Dolphins**

One of the most beautiful frescos shows a school of dolphins. It reminds us of the close connection between the Minoan culture and the sea.

















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# Chapter 2

## THE ETRUSCAN CIVILIZATION

The Etruscan civilization dates from approximately 900 BC. It lasted until the 4th century BC, when Etruscans began to be assimilated into the Roman population.

### 2.1 Where the Etruscans lived

#### The Etruscan League

Figure 2.1 shows the extent of the territory in which the Etruscans lived. The twelve cities of the Etruscan League are shown in the figure. The city called Perusia corresponds to present-day Perugia.

#### Ethnic groups in Italy

Figure 2.1 shows the areas occupied by various ethnic groups in Italy during the 4th century BC. These groups included Celts, Etruscans, Umbrians, Romans, Samnites, Messapians, Apulians, Italiotes, Carthaginians, Greeks, and Sardinians.

#### Did the Etruscans come from the North?

The similarity between the Etruscan script and the Runic script used in ancient Scandinavia hints at the possibility that the Etruscans may have arrived in Italy from the north.



Figure 2.1: Extent of Etruscan civilization and the twelve Etruscan League cities..





Figure 2.2: Ethnic groups of Italy (as defined by today's borders) in 400 BC.



Figure 2.3: A former Etruscan walled town, Civita di Bagnoregio.

## 2.2 Perugia

Perugia was once an Etruscan city. At its center is a high hill, on which the University of Perugia now is situated. At the very top of the hill, there is a large open space, called the “Corso Vannucci”, where today’s university students go in the evening to eat ice cream and to enjoy the view. One can look across a valley and see the lights of another hill town, Assisi, the town of Saint Francis.

At one end of the “Corso Vannucci” there is an entrance to a staircase, leading down below the surface. After paying a small fee, one is allowed to descend below the surface, and there one can see some well preserved ruins of the old Etruscan city.

In the valley, halfway between Perugia and Assisi, are some Etruscan tombs, in which one can see examples of the Etruscan script. It has some similarity to the Runic script of Scandinavia. These Etruscan tombs also contain beautiful frescos, some of which depict winged figures similar to the angels of Christianity and other religions.



Figure 2.4: The Etruscan Arch in Perugia.

## **2.3 Etruscan art**

### **Casting statues in bronze**

The Etruscans were proficient at casting statues in bronze. Examples are shown in Figure 2.8 and Figure 2.9, as well as in Figure 2.11. There is evidence that the Etruscans exported their works of art to other countries in the Mediterranean region.

### **Etruscan frescos**

The frescos made by Etruscan artists show a light-hearted attitude towards life, and we can see in the fresco of dancers shown in Figure 2.12.

### **Sarcophagi in tombs**

Figures 2.6 and 2.7 show beautifully carved portraits on top of sarcophagi in Etruscan tombs.





Figure 2.5: Etruscan pendant from Bolsena, Italy, 700-650 BC. Louvre.



Figure 2.6: Sarcophagus of the Spouses, about 1st century BC, Volterra, Museo etrusco Guarnacci.



Figure 2.7: Painted terracotta Sarcophagus of Seianti Hanunia Tlesnasa, about 150-130 BC.





Figure 2.8: The Mars of Todi, an Etruscan bronze sculpture, about 400 BC.





Figure 2.9: The Capitoline Wolf, long considered an Etruscan bronze, feeding the twins Romulus and Remus.



Figure 2.10: Etruscan mother and child, 500-450 BC.





Figure 2.11: **Chimera of Arezzo.**



Figure 2.12: 5th century BC fresco of dancers and musicians, Tomb of the Leopards, Monterozzi necropolis, Tarquinia, Italy.



Figure 2.13: Terracotta head of a Man Wearing a Laurel-Wreath, 2nd century BC.



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# Chapter 3

## HOMER

### 3.1 The little that is known about Homer's life

Wikipedia states that “Homer is the legendary author of the Iliad and the Odyssey, two epic poems that are the central works of ancient Greek literature. The Iliad is set during the Trojan War, the ten-year siege of the city of Troy by a coalition of Greek kingdoms. It focuses on a quarrel between King Agamemnon and the warrior Achilles lasting a few weeks during the last year of the war. The Odyssey focuses on the ten-year journey home of Odysseus, king of Ithaca, after the fall of Troy. Many accounts of Homer's life circulated in classical antiquity, the most widespread being that he was a blind bard from Ionia, a region of central coastal Anatolia in present-day Turkey. Modern scholars consider these accounts legendary.

“The Homeric Question - concerning by whom, when, where and under what circumstances the Iliad and Odyssey were composed - continues to be debated. Broadly speaking, modern scholarly opinion falls into two groups. One holds that most of the Iliad and (according to some) the Odyssey are the works of a single poet of genius. The other considers the Homeric poems to be the result of a process of working and reworking by many contributors, and that ‘Homer’ is best seen as a label for an entire tradition.[4] It is generally accepted that the poems were composed at some point around the late eighth or early seventh century BC.”

### 3.2 The Iliad, late 8th or early 7th century BC

#### The Iliad: Invocation and Introduction

*Goddess, sing me the anger, of Achilles, Peleus' son, that fatal anger that brought countless sorrows on the Greeks, and sent many valiant souls of warriors down to Hades, leaving their bodies as spoil for dogs and carrion birds: for thus was the will of Zeus brought to*

*fulfilment. Sing of it from the moment when Agamemnon, Atreus' son, that king of men, parted in wrath from noble Achilles.*

*Which of the gods set these two to quarrel? Apollo, the son of Leto and Zeus, angered by the king, brought an evil plague on the army, so that the men were dying, for the son of Atreus had dishonoured Chryses the priest. He it was who came to the swift Achaean ships, to free his daughter, bringing a wealth of ransom, carrying a golden staff adorned with the ribbons of far-striking Apollo, and called out to the Achaeans, above all to the two leaders of armies, those sons of Atreus: 'Atreides, and all you bronze-greaved Achaeans, may the gods who live on Olympus grant you to sack Priam's city, and sail back home in safety; but take this ransom, and free my darling child; show reverence for Zeus's son, far-striking Apollo.'*

*Then the rest of the Achaeans shouted in agreement, that the priest should be respected, and the fine ransom taken; but this troubled the heart of Agamemnon, son of Atreus, and he dismissed the priest harshly, and dealt with him sternly: 'Old man, don't let me catch you loitering by the hollow ships today, and don't be back later, lest your staff and the god's ribbons fail to protect you. Her, I shall not free; old age will claim her first, far from her own country, in Argos, my home, where she can tend the loom, and share my bed. Away now; don't provoke me if you'd leave safely.'*

*So he spoke, and the old man, seized by fear, obeyed. Silently, he walked the shore of the echoing sea; and when he was quite alone, the old man prayed deeply to Lord Apollo, the son of bright-haired Leto: 'Hear me, Silver Bow, protector of Chryse and holy Cilla, high lord of Tenedos: if ever I built a shrine that pleased you, if ever I burned the fat thighs of a bull or goat for you, grant my wish: Smintheus, with your arrows make the Greeks pay for my tears.'*

*So he prayed, and Phoebus Apollo heard him. Down he came, in fury, from the heights of Olympus, with his bow and inlaid quiver at his back. The arrows rattled at his shoulder as the god descended like the night, in anger. He set down by the ships, and fired a shaft, with a fearful twang of his silver bow. First he attacked the mules, and the swift hounds, then loosed his vicious darts at the men; so the dense pyres for the dead burned endlessly.*

*For nine days the god's arrows fell on the army, and on the tenth Achilles, his heart stirred by the goddess, white-armed Hera, called them to the Place of Assembly, she pitying the Danaans, whose deaths she witnessed. And when they had assembled, and the gathering was complete, swift-footed Achilles rose and spoke: 'Son of Atreus, if war and plague alike are fated to defeat us Greeks, I think we shall be driven to head for home: if, that is, we can indeed escape death. But why not consult some priest, some prophet, some interpreter of dreams, since dreams too come from Zeus, one who can tell why Phoebus Apollo shows such anger to us, because of some broken vow perhaps, or some missed sacrifice; in hopes the god might accept succulent lambs or unmarked goats, and choose to avert our ruin.'*



Figure 3.1: **Homer.**

*He sat down again when he had spoken, and Calchas, son of Thestor, rose to his feet, he, peerless among augurs, who knew all things past, all things to come, and all things present, who, through the gift of prophecy granted him by Phoebus Apollo, had guided the Greek fleet to Ilium. He, with virtuous intent, spoke to the gathering, saying: ‘Achilles, god-beloved, you ask that I explain far-striking Apollo’s anger. Well, I will, but take thought, and swear to me you’ll be ready to defend me with strength and word; for I believe I’ll anger the man who rules the Argives in his might, whom all the Achaeans obey. For a king in his anger crushes a lesser man. Even if he swallows anger for a while, he will nurse resentment till he chooses to repay. Consider then, if you can keep me safe.’*

*Swift-footed Achilles spoke in reply: ‘Courage, and say out what truth you know, for by god-beloved Apollo to whom you pray, whose utterances you grant to the Danaans, none shall lay hand on you beside the hollow ships, no Danaan while I live and see the earth, not even if it’s Agamemnon you mean, who counts himself the best of the Achaeans.’*

*Then the peerless seer took heart, and spoke to them, saying: ‘Not for a broken vow, or a missed sacrifice, does he blame us, but because of that priest whom Agamemnon offended, refusing the ransom, refusing to free his daughter. That is why the god, the far-striker, makes us suffer, and will do so, and will not rid the Danaans of loathsome plague, until we return the bright-eyed girl to her father, without his recompense or ransom, and send a sacred offering to Chryse; then we might persuade him to relent.’*

### 3.3 The Odyssey

#### The return of Ulysses

translated by Samuel Butler

*Tell me, o muse, of that ingenious hero who travelled far and wide after he had sacked the famous town of Troy. Many cities did he visit, and many were the nations with whose manners and customs he was acquainted; moreover he suffered much by sea while trying to save his own life and bring his men safely home; but do what he might he could not save his men, for they perished through their own sheer folly in eating the cattle of the Sun-god Hyperion; so the god prevented them from ever reaching home. Tell me, too, about all these things, O daughter of Jove, from whatsoever source you may know them. So now all who escaped death in battle or by shipwreck had got safely home except Ulysses, and he, though he was longing to return to his wife and country, was detained by the goddess Calypso, who had got him into a large cave and wanted to marry him. But as years went by, there came a time when the gods settled that he should go back to Ithaca; even then, however, when he was among his own people, his troubles were not yet over; nevertheless all the gods had now begun to pity him except Neptune, who still persecuted him without ceasing and would not let him get home.*

*Now Neptune had gone off to the Ethiopians, who are at the world's end, and lie in two halves, the one looking West and the other East. He had gone there to accept a hecatomb of sheep and oxen, and was enjoying himself at his festival; but the other gods met in the house of Olympian Jove, and the sire of gods and men spoke first. At that moment he was thinking of Aegisthus, who had been killed by Agamemnon's son Orestes; so he said to the other gods:*

*"See now, how men lay blame upon us gods for what is after all nothing but their own folly. Look at Aegisthus; he must needs make love to Agamemnon's wife unrighteously and then kill Agamemnon, though he knew it would be the death of him; for I sent Mercury to warn him not to do either of these things, inasmuch as Orestes would be sure to take his revenge when he grew up and wanted to return home. Mercury told him this in all good will but he would not listen, and now he has paid for everything in full."*

*Then Minerva said, "Father, son of Saturn, King of kings, it served Aegisthus right, and so it would any one else who does as he did; but Aegisthus is neither here nor there; it is for Ulysses that my heart bleeds, when I think of his sufferings in that lonely sea-girt island, far away, poor man, from all his friends. It is an*

*island covered with forest, in the very middle of the sea, and a goddess lives there, daughter of the magician Atlas, who looks after the bottom of the ocean, and carries the great columns that keep heaven and earth asunder. This daughter of Atlas has got hold of poor unhappy Ulysses, and keeps trying by every kind of blandishment to make him forget his home, so that he is tired of life, and thinks of nothing but how he may once more see the smoke of his own chimneys. You, sir, take no heed of this, and yet when Ulysses was before Troy did he not propitiate you with many a burnt sacrifice? Why then should you keep on being so angry with him?"*

*And Jove said, "My child, what are you talking about? How can I forget Ulysses than whom there is no more capable man on earth, nor more liberal in his offerings to the immortal gods that live in heaven? Bear in mind, however, that Neptune is still furious with Ulysses for having blinded an eye of Polyphemus king of the Cyclopes. Polyphemus is son to Neptune by the nymph Thoosa, daughter to the sea-king Phorcys; therefore though he will not kill Ulysses outright, he torments him by preventing him from getting home. Still, let us lay our heads together and see how we can help him to return; Neptune will then be pacified, for if we are all of a mind he can hardly stand out against us."*

*And Minerva said, "Father, son of Saturn, King of kings, if, then, the gods now mean that Ulysses should get home, we should first send Mercury to the Ogygian island to tell Calypso that we have made up our minds and that he is to return. In the meantime I will go to Ithaca, to put heart into Ulysses' son Telemachus; I will embolden him to call the Achaeans in assembly, and speak out to the suitors of his mother Penelope, who persist in eating up any number of his sheep and oxen; I will also conduct him to Sparta and to Pylos, to see if he can hear anything about the return of his dear father- for this will make people speak well of him."*

*So saying she bound on her glittering golden sandals, imperishable, with which she can fly like the wind over land or sea; she grasped the redoubtable bronze-shod spear, so stout and sturdy and strong, wherewith she quells the ranks of heroes who have displeased her, and down she darted from the topmost summits of Olympus, whereon forthwith she was in Ithaca, at the gateway of Ulysses' house, disguised as a visitor, Mentis, chief of the Taphians, and she held a bronze spear in her hand. There she found the lordly suitors seated on hides of the oxen which they had killed and eaten, and playing draughts in front of the house. Men-servants and pages were bustling about to wait upon them, some mixing wine with water in the mixing-bowls, some cleaning down the tables with wet sponges and*

*laying them out again, and some cutting up great quantities of meat. Telemachus saw her long before any one else did. He was sitting moodily among the suitors thinking about his brave father, and how he would send them flying out of the house, if he were to come to his own again and be honoured as in days gone by. Thus brooding as he sat among them, he caught sight of Minerva and went straight to the gate, for he was vexed that a stranger should be kept waiting for admittance. He took her right hand in his own, and bade her give him her spear. "Welcome," said he, "to our house, and when you have partaken of food you shall tell us what you have come for."*

*He led the way as he spoke, and Minerva followed him. When they were within he took her spear and set it in the spear-stand against a strong bearing-post along with the many other spears of his unhappy father, and he conducted her to a richly decorated seat under which he threw a cloth of damask. There was a footstool also for her feet, and he set another seat near her for himself, away from the suitors, that she might not be annoyed while eating by their noise and insolence, and that he might ask her more freely about his father.*

*A maid servant then brought them water in a beautiful golden ewer and poured it into a silver basin for them to wash their hands, and she drew a clean table beside them. An upper servant brought them bread, and offered them many good things of what there was in the house, the carver fetched them plates of all manner of meats and set cups of gold by their side, and a man-servant brought them wine and poured it out for them.*

*Then the suitors came in and took their places on the benches and seats. Forthwith men servants poured water over their hands, maids went round with the bread-baskets, pages filled the mixing-bowls with wine and water, and they laid their hands upon the good things that were before them. As soon as they had had enough to eat and drink they wanted music and dancing, which are the crowning embellishments of a banquet, so a servant brought a lyre to Phemius, whom they compelled perforce to sing to them. As soon as he touched his lyre and began to sing Telemachus spoke low to Minerva, with his head close to hers that no man might hear.*

*"I hope, sir," said he, "that you will not be offended with what I am going to say. Singing comes cheap to those who do not pay for it, and all this is done at the cost of one whose bones lie rotting in some wilderness or grinding to powder in the surf. If these men were to see my father come back to Ithaca they would pray for longer legs rather than a longer purse, for money would not serve them; but he, alas, has fallen on an ill fate, and even when people do sometimes say that he is coming, we no longer heed them; we shall never see him*

*again. And now, sir, tell me and tell me true, who you are and where you come from. Tell me of your town and parents, what manner of ship you came in, how your crew brought you to Ithaca, and of what nation they declared themselves to be- for you cannot have come by land. Tell me also truly, for I want to know, are you a stranger to this house, or have you been here in my father's time? In the old days we had many visitors for my father went about much himself."*

*And Minerva answered, "I will tell you truly and particularly all about it. I am Mentos, son of Anchialus, and I am King of the Taphians. I have come here with my ship and crew, on a voyage to men of a foreign tongue being bound for Temesa with a cargo of iron, and I shall bring back copper. As for my ship, it lies over yonder off the open country away from the town, in the harbour Rheithron under the wooded mountain Neritum. Our fathers were friends before us, as old Laertes will tell you, if you will go and ask him. They say, however, that he never comes to town now, and lives by himself in the country, faring hardly, with an old woman to look after him and get his dinner for him, when he comes in tired from pottering about his vineyard. They told me your father was at home again, and that was why I came, but it seems the gods are still keeping him back, for he is not dead yet not on the mainland. It is more likely he is on some sea-girt island in mid ocean, or a prisoner among savages who are detaining him against his will I am no prophet, and know very little about omens, but I speak as it is borne in upon me from heaven, and assure you that he will not be away much longer; for he is a man of such resource that even though he were in chains of iron he would find some means of getting home again. But tell me, and tell me true, can Ulysses really have such a fine looking fellow for a son? You are indeed wonderfully like him about the head and eyes, for we were close friends before he set sail for Troy where the flower of all the Argives went also. Since that time we have never either of us seen theother."*

*"My mother," answered Telemachus, tells me I am son to Ulysses, but it is a wise child that knows his own father. Would that I were son to one who had grown old upon his own estates, for, since you ask me, there is no more ill-starred man under heaven than he who they tell me is my father."*

*And Minerva said, "There is no fear of your race dying out yet, while Penelope has such a fine son as you are. But tell me, and tell me true, what is the meaning of all this feasting, and who are these people? What is it all about? Have you some banquet, or is there a wedding in the family- for no one seems to be bringing any provisions of his own? And the guests- how atrociously they are behaving; what riot they make over the whole house; it is enough to*

*disgust any respectable person who comes near them."*

*"Sir," said Telemachus, "as regards your question, so long as my father was here it was well with us and with the house, but the gods in their displeasure have willed it otherwise, and have hidden him away more closely than mortal man was ever yet hidden. I could have borne it better even though he were dead, if he had fallen with his men before Troy, or had died with friends around him when the days of his fighting were done; for then the Achaeans would have built a mound over his ashes, and I should myself have been heir to his renown; but now the storm-winds have spirited him away we know not wither; he is gone without leaving so much as a trace behind him, and I inherit nothing but dismay. Nor does the matter end simply with grief for the loss of my father; heaven has laid sorrows upon me of yet another kind; for the chiefs from all our islands, Dulichium, Same, and the woodland island of Zacynthus, as also all the principal men of Ithaca itself, are eating up my house under the pretext of paying their court to my mother, who will neither point blank say that she will not marry, nor yet bring matters to an end; so they are making havoc of my estate, and before long will do so also with myself."*

*"Is that so?" exclaimed Minerva, "then you do indeed want Ulysses home again. Give him his helmet, shield, and a couple lances, and if he is the man he was when I first knew him in our house, drinking and making merry, he would soon lay his hands about these rascally suitors, were he to stand once more upon his own threshold. He was then coming from Ephyra, where he had been to beg poison for his arrows from Ilus, son of Mermerus. Ilus feared the ever-living gods and would not give him any, but my father let him have some, for he was very fond of him. If Ulysses is the man he then was these suitors will have a short shrift and a sorry wedding."*

*"But there! It rests with heaven to determine whether he is to return, and take his revenge in his own house or no; I would, however, urge you to set about trying to get rid of these suitors at once. Take my advice, call the Achaean heroes in assembly to-morrow -lay your case before them, and call heaven to bear you witness. Bid the suitors take themselves off, each to his own place, and if your mother's mind is set on marrying again, let her go back to her father, who will find her a husband and provide her with all the marriage gifts that so dear a daughter may expect. As for yourself, let me prevail upon you to take the best ship you can get, with a crew of twenty men, and go in quest of your father who has so long been missing. Some one may tell you something, or (and people often hear things in this way) some heaven-sent message may direct you. First go to Pylos and ask*



*Nestor; thence go on to Sparta and visit Menelaus, for he got home last of all the Achaeans; if you hear that your father is alive and on his way home, you can put up with the waste these suitors will make for yet another twelve months. If on the other hand you hear of his death, come home at once, celebrate his funeral rites with all due pomp, build a barrow to his memory, and make your mother marry again. Then, having done all this, think it well over in your mind how, by fair means or foul, you may kill these suitors in your own house. You are too old to plead infancy any longer; have you not heard how people are singing Orestes' praises for having killed his father's murderer Aegisthus? You are a fine, smart looking fellow; show your mettle, then, and make yourself a name in story. Now, however, I must go back to my ship and to my crew, who will be impatient if I keep them waiting longer; think the matter over for yourself, and remember what I have said to you."*

*"Sir," answered Telemachus, "it has been very kind of you to talk to me in this way, as though I were your own son, and I will do all you tell me; I know you want to be getting on with your voyage, but stay a little longer till you have taken a bath and refreshed yourself. I will then give you a present, and you shall go on your way rejoicing; I will give you one of great beauty and value- a keepsake such as only dear friends give to one another."*

*Minerva answered, "Do not try to keep me, for I would be on my way at once. As for any present you may be disposed to make me, keep it till I come again, and I will take it home with me. You shall give me a very good one, and I will give you one of no less value in return."*

*With these words she flew away like a bird into the air, but she had given Telemachus courage, and had made him think more than ever about his father. He felt the change, wondered at it, and knew that the stranger had been a god, so he went straight to where the suitors were sitting.*

*Phemius was still singing, and his hearers sat rapt in silence as he told the sad tale of the return from Troy, and the ills Minerva had laid upon the Achaeans. Penelope, daughter of Icarius, heard his song from her room upstairs, and came down by the great staircase, not alone, but attended by two of her handmaids. When she reached the suitors she stood by one of the bearing posts that supported the roof of the cloisters with a staid maiden on either side of her. She held a veil, moreover, before her face, and was weeping bitterly.*

*"Phemius," she cried, "you know many another feat of gods and heroes, such as poets love to celebrate. Sing the suitors some one of these, and let them drink their wine in silence, but cease this sad*

*tale, for it breaks my sorrowful heart, and reminds me of my lost husband whom I mourn ever without ceasing, and whose name was great over all Hellas and middle Argos."*

*"Mother," answered Telemachus, "let the bard sing what he has a mind to; bards do not make the ills they sing of; it is Jove, not they, who makes them, and who sends weal or woe upon mankind according to his own good pleasure. This fellow means no harm by singing the ill-fated return of the Danaans, for people always applaud the latest songs most warmly. Make up your mind to it and bear it; Ulysses is not the only man who never came back from Troy, but many another went down as well as he. Go, then, within the house and busy yourself with your daily duties, your loom, your distaff, and the ordering of your servants; for speech is man's matter, and mine above all others- for it is I who am master here."*

*She went wondering back into the house, and laid her son's saying in her heart. Then, going upstairs with her handmaids into her room, she mourned her dear husband till Minerva shed sweet sleep over her eyes. But the suitors were clamorous throughout the covered cloisters, and prayed each one that he might be her bed fellow.*

*Then Telemachus spoke, "Shameless," he cried, "and insolent suitors, let us feast at our pleasure now, and let there be no brawling, for it is a rare thing to hear a man with such a divine voice as Phemius has; but in the morning meet me in full assembly that I may give you formal notice to depart, and feast at one another's houses, turn and turn about, at your own cost. If on the other hand you choose to persist in spunging upon one man, heaven help me, but Jove shall reckon with you in full, and when you fall in my father's house there shall be no man to avenge you."*

*The suitors bit their lips as they heard him, and marvelled at the boldness of his speech. Then, Antinous, son of Eupheithes, said, "The gods seem to have given you lessons in bluster and tall talking; may Jove never grant you to be chief in Ithaca as your father was before you."*

*Telemachus answered, "Antinous, do not chide with me, but, god willing, I will be chief too if I can. Is this the worst fate you can think of for me? It is no bad thing to be a chief, for it brings both riches and honour. Still, now that Ulysses is dead there are many great men in Ithaca both old and young, and some other may take the lead among them; nevertheless I will be chief in my own house, and will rule those whom Ulysses has won for me."*

*Then Eurymachus, son of Polybus, answered, "It rests with heaven to decide who shall be chief among us, but you shall be master in your own house and over your own possessions; no one while there is a man*

*in Ithaca shall do you violence nor rob you. And now, my good fellow, I want to know about this stranger. What country does he come from? Of what family is he, and where is his estate? Has he brought you news about the return of your father, or was he on business of his own? He seemed a well-to-do man, but he hurried off so suddenly that he was gone in a moment before we could get to know him."*

*"My father is dead and gone," answered Telemachus, "and even if some rumour reaches me I put no more faith in it now. My mother does indeed sometimes send for a soothsayer and question him, but I give his prophecyings no heed. As for the stranger, he was Mentès, son of Anchialus, chief of the Taphians, an old friend of my father's." But in his heart he knew that it had been the goddess.*

*The suitors then returned to their singing and dancing until the evening; but when night fell upon their pleasuring they went home to bed each in his own abode. Telemachus's room was high up in a tower that looked on to the outer court; hither, then, he hied, brooding and full of thought. A good old woman, Euryclea, daughter of Ops, the son of Pisenor, went before him with a couple of blazing torches.*

*Laertes had bought her with his own money when she was quite young; he gave the worth of twenty oxen for her, and shewed as much respect to her in his household as he did to his own wedded wife, but he did not take her to his bed for he feared his wife's resentment. She it was who now lighted Telemachus to his room, and she loved him better than any of the other women in the house did, for she had nursed him when he was a baby. He opened the door of his bed room and sat down upon the bed; as he took off his shirt he gave it to the good old woman, who folded it tidily up, and hung it for him over a peg by his bed side, after which she went out, pulled the door to by a silver catch, and drew the bolt home by means of the strap. But Telemachus as he lay covered with a woollen fleece kept thinking all night through of his intended voyage of the counsel that Minerva had given him.*

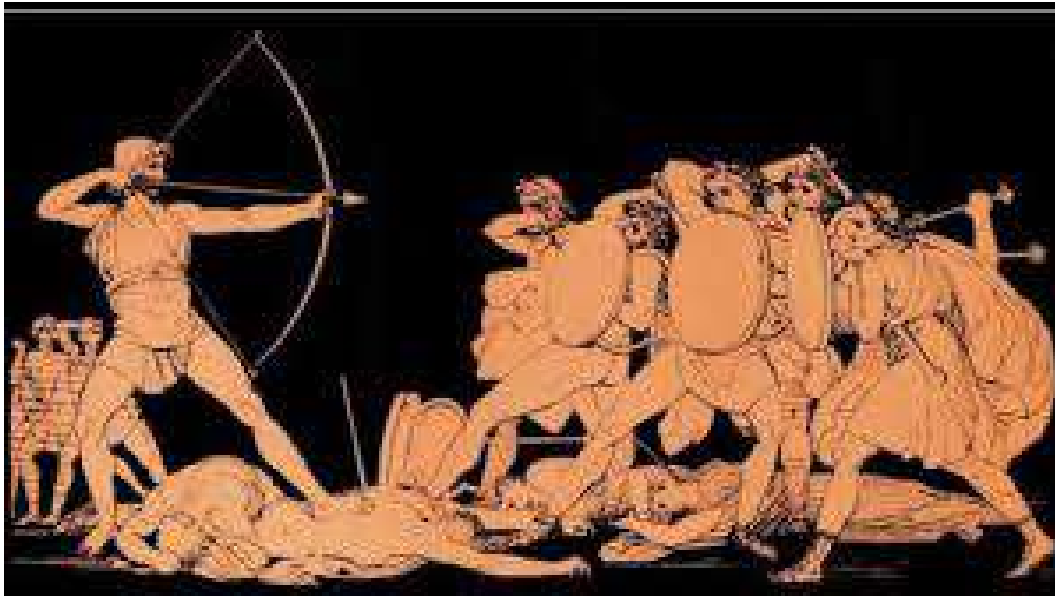


Figure 3.2: Ulysses returns to Ithica. He comes disguised as an old beggar, and is recognized only by his old nurse and his son, Telemachus. Ulysses then suddenly reveals his identity by easily stringing his very large bow, with which he directs arrows against the suitors who have been plotting to take over his kingdom.

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## Chapter 4

# ANCIENT GREEK POETRY AND DRAMA

### 4.1 The ethical message of Greek drama

In ancient Greece, drama was an essential part of ethical culture. Performances of the plays of great dramatists, such as Sophocles, Aeschylus and Euripides, allowed the public to debate questions of morality. A recurring theme was the punishment of *hubris* (excessive pride) by *nemesis* (the revenge of the gods). Hubris is arrogance in word, deed and thought. For example, hubris is having or maintaining stubbornly an attitude which goes against or ignores, say, the prophecies, counsel or pronouncements of the Delphic Oracle. The central meaning of hubris is doing deeds and thinking thoughts more than a mere mortal human should do and think, thereby showing impiety towards the gods.

Starting in approximately 500 B.C., drama flourished in the Greek city-states, especially in Athens, which was an important cultural center. The presentation of dramas was part of a festival dedicated to the god Dionysus. Masks were used by the actors, and by members of the chorus. The chorus commented on the action, and often pointed to the moral that could be drawn from it.

### 4.2 Sophocles, 497 BC - 406 BC

#### Power of Love

*O LOVE, thou art victor in fight: thou mak'st all things afraid;  
Thou coucest thee softly at night on the cheeks of a maid;  
Thou passest the bounds of the sea, and the folds of the fields;  
To thee the immortal, to thee the ephemeral yields;  
Thou maddenest them that possess thee; thou turnest astray  
The souls of the just, to oppress them, out of the way;  
Thou hast kindled amongst us pride, and the quarrel of kin;*

*Thou art lord, by the eyes of a bride, and the love-light therein;  
Thou sittest assessor with Right; her kingdom is thine,  
Who sports with invincible might, Aphrodite divine.*

### **Chorus from *Antigone***

#### *[Strophe 1]*

*Numberless are the world's wonders, but none  
More wonderful than man; the stormgray sea  
Yields to his prow, the huge crests bear him high;  
Earth, holy and inexhaustible, is graven  
With shining furrows where his plows have gone  
Year after year, the timeless labor of stallions.*

#### *[Antistrophe 1]*

*The lightboned birds and beasts that cling to cover,  
The lithe fish lighting their reaches of dim water,  
All are taken, tamed in the net of his mind;  
The lion on the hill, the wild horse windy-maned,  
Resign to him; and his blunt yoke has broken  
The sultry shoulders of the mountain bull.*

#### *[Strophe 2]*

*Words also, and thought as rapid as air,  
He fashions to his good use; statecraft is his,  
And his the skill that deflect the arrows of snow,  
The spears of winter rain: from every wind  
He has made himself secure - from all but one:  
In the late wind of death he cannot stand.*

#### *[Antistrophe 2]*

*O clear intelligence, force beyond all measure!  
O fate of man, working both good and evil!  
When the laws are kept, how proudly his city stands!  
When the laws are broken, what of his city then?  
Never may the anarchic man find rest at my hearth,  
Never be it said that my thoughts are his thoughts.*



## 4.3 Euripides, c.480 BC - c.406 BC

### Speech of the nurse from Media

*Would that the Argo had never winged its way to the land of Colchis through the dark-blue Symplegades! Would that the pine trees had never been felled in the glens of Mount Pelion and furnished oars for the hands of the heroes who at Pelias' command set forth in quest of the Golden Fleece! For then my lady Medea would not have sailed to the towers of Iolcus, her heart smitten with love for Jason, or persuaded the daughters of Pelias to kill their father and hence now be inhabiting this land of Corinth, jseparated from her loved ones and country. At first, to be sure, she had, even in Corinth, a good life with her husband and children, an exile loved by the citizens to whose land she had come, and lending to Jason himself all her support. This it is that most rescues life from trouble, when a woman is not at variance with her husband.*

*But now all is enmity, and love's bonds are diseased. For Jason, abandoning his own children and my mistress, is bedding down in a royal match, having married the daughter of Creon, ruler of this land. Poor Medea, finding herself thus cast aside, calls loudly on his oaths, invokes the mighty assurance of his sworn right hand, and calls the gods to witness the unjust return she is getting from Jason. She lies fasting, giving her body up to pain, wasting away in tears all the time ever since she learned that she was wronged by her husband, neither lifting her face nor taking her eyes from the ground. She is as deaf to the advice of her friends as a stone or a wave of the sea: she is silent unless perchance to turn her snow-white neck and weep to herself for her dear father and her country and her ancestral house. All these she abandoned when she came here with a man who has now cast her aside. The poor woman has learned at misfortune's hand what a good thing it is not to be cut off from one's native land.*

*She loathes the children and takes no joy in looking at them. And I am afraid that she will hatch some sinister plan. For she has a terrible temper and will not put up with bad treatment (I know her, and I fear she may thrust a whetted sword through her vitals, slipping quietly into the house where the bed is spread, or kill the royal family and the bride-groom and then win some greater calamity. For she is dangerous. I tell you, no man who clashes with her will find it easy to crow in victory.*

### ***The Trojan Women*, by Euripides**

An example of a Greek tragedy with ethical implications, *The Trojan Women* follows the fate of the women of Troy after all their husbands and sons had been slaughtered by the

conquering Greeks. The play makes it clear to the audience that the conquering Greeks were guilty of *hubris*.

## 4.4 Aristophanes, c.446 BC - c.386 BC

### ***Lysistrata*, by Aristophanes**

Although *The Trojan Women* protested against the atrocities and horrors of war, the play did not attack the institution of war itself. However, in *Lysistrata*, an comedy by Aristophanes first performed in Athens in 411 B.C., war as an institution is attacked. In the play, the women of all parts of Greece are persuaded to withhold sex from their husbands and lovers until the painfully long Peloponnesian Wars are ended. After much comic struggle, the men, of course, give in and agree to peace, since their overpowering desire for sex is greater than their addiction to fighting.

### **The opening scene from *Lysistrata***

*LYSISTRATA stands alone with the Propylaea at her back.*

*LYSISTRATA If they were trysting for a Bacchanal, A feast of Pan or Colias or Genetyllis, The tambourines would block the rowdy streets, But now there's not a woman to be seen Except - ah, yes - this neighbour of mine yonder.*

*Enter CALONICE.*

*Good day Calonice.*

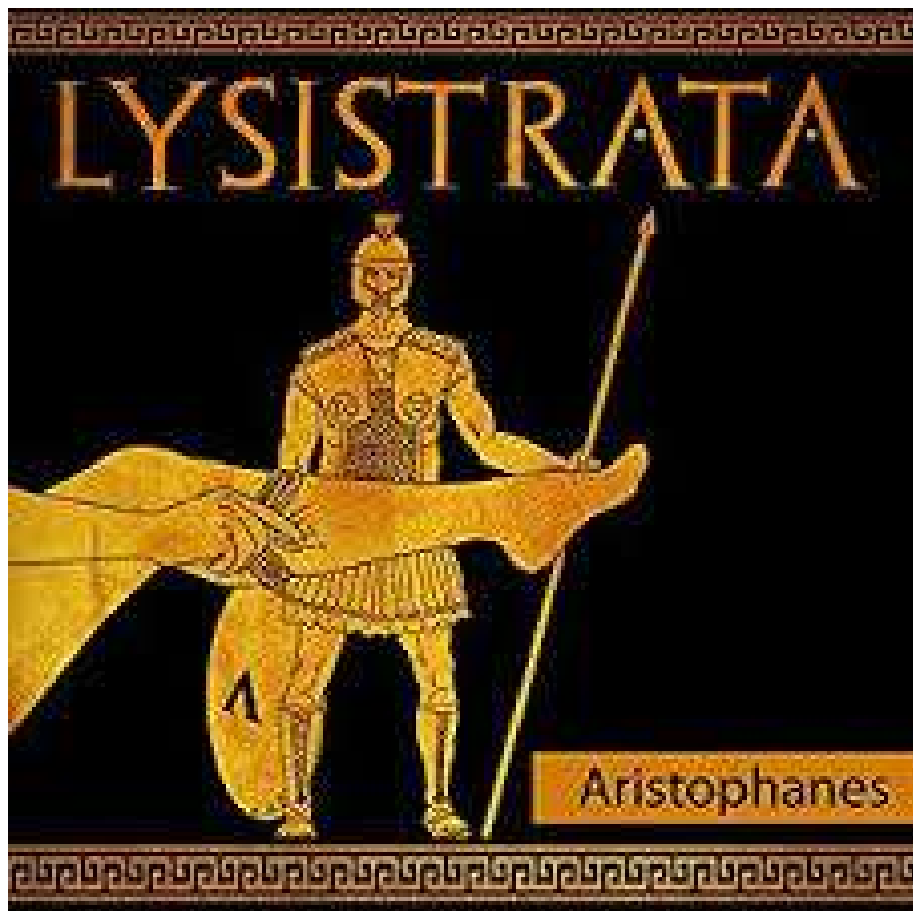
*CALONICE Good day Lysistrata. But what has vexed you so? Tell me, child. What are these black looks for? It doesn't suit you To knit your eyebrows up glumly like that.*

*LYSISTRATA Calonice, it's more than I can bear, I am hot all over with blushes for our sex. Men say we're slippery rogues -*

*CALONICE And aren't they right?*

*LYSISTRATA Yet summoned on the most tremendous business For deliberation, still they snuggle in bed.*

*CALONICE My dear, they'll come. It's hard for women, you know, To get away. There's so much to do; Husbands to be patted and put in good tempers: Servants to be poked out: children washed Or soothed with lullays or fed with mouthfuls of pap.*



*LYSISTRATA But I tell you, here's a far more weighty object.*

*CALONICE What is it all about, dear Lysistrata, That you've called the women hither in a troop? What kind of an object is it?*

*LYSISTRATA A tremendous thing!*

*CALONICE And long?*

*LYSISTRATA Indeed, it may be very lengthy.*

*CALONICE Then why aren't they here?*

*LYSISTRATA No man's connected with it; If that was the case, they'd soon come fluttering along. No, no. It concerns an object I've felt over And turned this way and that for sleepless nights.*

*CALONICE It must be fine to stand such long attention.*

*LYSISTRATA So fine it comes to this - Greece saved by Woman!*

## 4.5 Sappho, c.630 BC - c.570 BC

### Glittering-minded deathless Aphrodite

*Glittering-Minded deathless Aphrodite,  
I beg you, Zeus's daughter, weaver of snares,  
Don't shatter my heart with fierce  
Pain, goddess,  
But come now, if ever before  
You heard my voice, far off, and listened,  
And left your father's golden house,  
And came,  
Yoking your chariot. Lovely the swift Sparrows that brought you over black earth  
A whirring of wings through mid-air  
Down the sky.*

*They came. And you, sacred one,  
Smiling with deathless face, asking  
What now, while I suffer: why now*

*I cry out to you, again:  
What now I desire above all in my  
Mad heart. 'Whom now, shall I persuade  
To admit you again to her love,  
Sappho, who wrongs you now?*

*If she runs now she'll follow later,  
If she refuses gifts she'll give them.  
If she loves not, now, she'll soon  
Love against her will.'  
Come to me now, then, free me  
From aching care, and win me  
All my heart longs to win. You,  
Be my friend.*

### **Come With Me To Crete**

*Come to me here from Crete,  
To this holy temple, where  
Your lovely apple grove stands,  
And your altars that flicker  
With incense.*

*And below the apple branches, cold  
Clear water sounds, everything shadowed  
By roses, and sleep that falls from  
Bright shaking leaves.*

*And a pasture for horses blossoms  
With the flowers of spring, and breezes  
Are flowing here like honey:  
Come to me here,*

*Here, Cyprian, delicately taking  
Nectar in golden cups  
Mixed with a festive joy,  
And pour.*



Figure 4.1: **Sappho.**



# Chapter 5

## PYTHAGORAS

### 5.1 The Pythagorean brotherhood

Pythagoras, a student of Anaximander, first became famous as a leader and reformer of the Orphic religion. He was born on the island of Samos, near the Asian mainland, and like other early Ionian philosophers, he is said to have travelled extensively in Egypt and Mesopotamia. In 529 B.C., he left Samos for Croton, a large Greek colony in southern Italy. When he arrived in Croton, his reputation had preceded him, and a great crowd of people came out of the city to meet him. After Pythagoras had spoken to this crowd, six hundred of them left their homes to join the Pythagorean brotherhood without even saying goodbye to their families.

For a period of about twenty years, the Pythagoreans gained political power in Croton, and they also had political influence in the other Greek colonies of the western Mediterranean. However, when Pythagoras was an old man, the brotherhood which he founded fell from power, their temples at Croton were burned, and Pythagoras himself moved to Metapontion, another Greek city in southern Italy. Although it was never again politically influential, the Pythagorean brotherhood survived for more than a hundred years.

The Pythagorean brotherhood admitted women on equal terms, and all its members held their property in common. Even the scientific discoveries of the brotherhood were considered to have been made in common by all its members.

### 5.2 Pythagorean harmony

The Pythagoreans practiced medicine, and also a form of psychotherapy. According to Aristoxenus, a philosopher who studied under the Pythagoreans, “They used medicine to purge the body, and music to purge the soul”. Music was of great importance to the Pythagoreans, as it was also to the original followers of Dionysus and Orpheus.

Both in music and in medicine, the concept of harmony was very important. Here Pythagoras made a remarkable discovery which united music and mathematics. He discovered that the harmonics which are pleasing to the human ear can be produced by

dividing a lyre string into lengths which are expressible as simple ratios of whole numbers. For example, if we divide the string in half by clamping it at the center, (keeping the tension constant), the pitch of its note rises by an octave. If the length is reduced to  $2/3$  of the basic length, then the note is raised from the fundamental tone by the musical interval which we call a major fifth, and so on. The discovery that harmonious musical tones could be related by rational numbers<sup>1</sup> made the Pythagoreans think that rational numbers are the key to understanding nature, and this belief became a part of their religion.

Having discovered that musical harmonics are governed by mathematics, Pythagoras fitted this discovery into the framework of Orphism. According to the Orphic religion, the soul may be reincarnated in a succession of bodies. In a similar way (according to Pythagoras), the “soul” of the music is the mathematical structure of its harmony, and the “body” through which it is expressed is the gross physical instrument. Just as the soul can be reincarnated in many bodies, the mathematical idea of the music can be expressed through many particular instruments; and just as the soul is immortal, the idea of the music exists eternally, although the instruments through which it is expressed may decay.

In distinguishing very clearly between mathematical ideas and their physical expression, Pythagoras was building on the earlier work of Thales, who thought of geometry as dealing with dimensionless points and lines of perfect straightness, rather than with real physical objects. The teachings of Pythagoras and his followers served in turn as an inspiration for Plato’s idealistic philosophy.

Having found mathematical harmony in the world of sound, and having searched for it in astronomy, Pythagoras tried to find mathematical relationships in the visual world. Among other things, he discovered the five possible regular polyhedra. However, his greatest contribution to geometry is the famous Pythagorean theorem, which is considered to be the most important single theorem in the whole of mathematics.

The Mesopotamians and the Egyptians knew that for many special right triangles, the sum of the squares formed on the two shorter sides is equal to the square formed on the long side. For example, Egyptian surveyors used a triangle with sides of lengths 3, 4 and 5 units. They knew that between the two shorter sides, a right angle is formed, and that for this particular right triangle, the sum of the squares of the two shorter sides is equal to the square of the longer side. Pythagoras proved that this relationship holds for every right triangle.

In exploring the consequences of his great theorem, Pythagoras and his followers discovered that the square root of 2 is an irrational number. (In other words, it cannot be expressed as the ratio of two integers.) The discovery of irrationals upset them so much that they abandoned algebra. They concentrated entirely on geometry, and for the next two thousand years geometrical ideas dominated science and philosophy.

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<sup>1</sup>i-e. numbers that can be expressed as a ratio of two integers

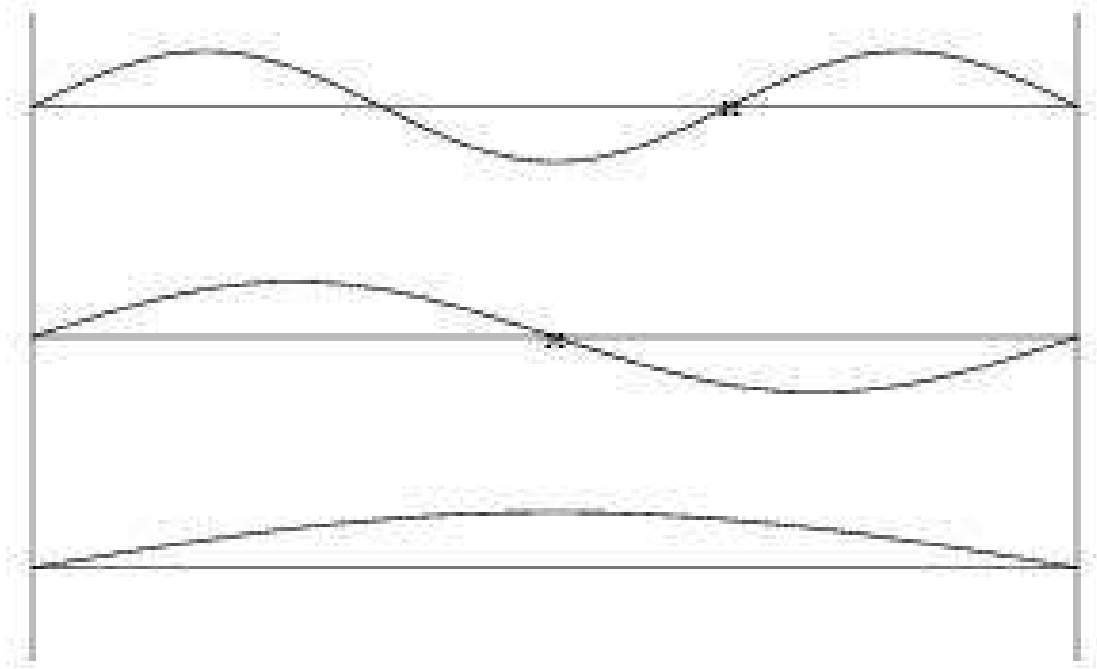


Figure 5.1: Pythagoras (569 B.C. - 475 B.C.) discovered that the musical harmonics that are pleasing to the human ear can be produced by clamping a lyre string of constant tension at points that are related by rational numbers. In the figure the octave and the major fifth above the octave correspond to the ratios  $1/2$  and  $1/3$ .

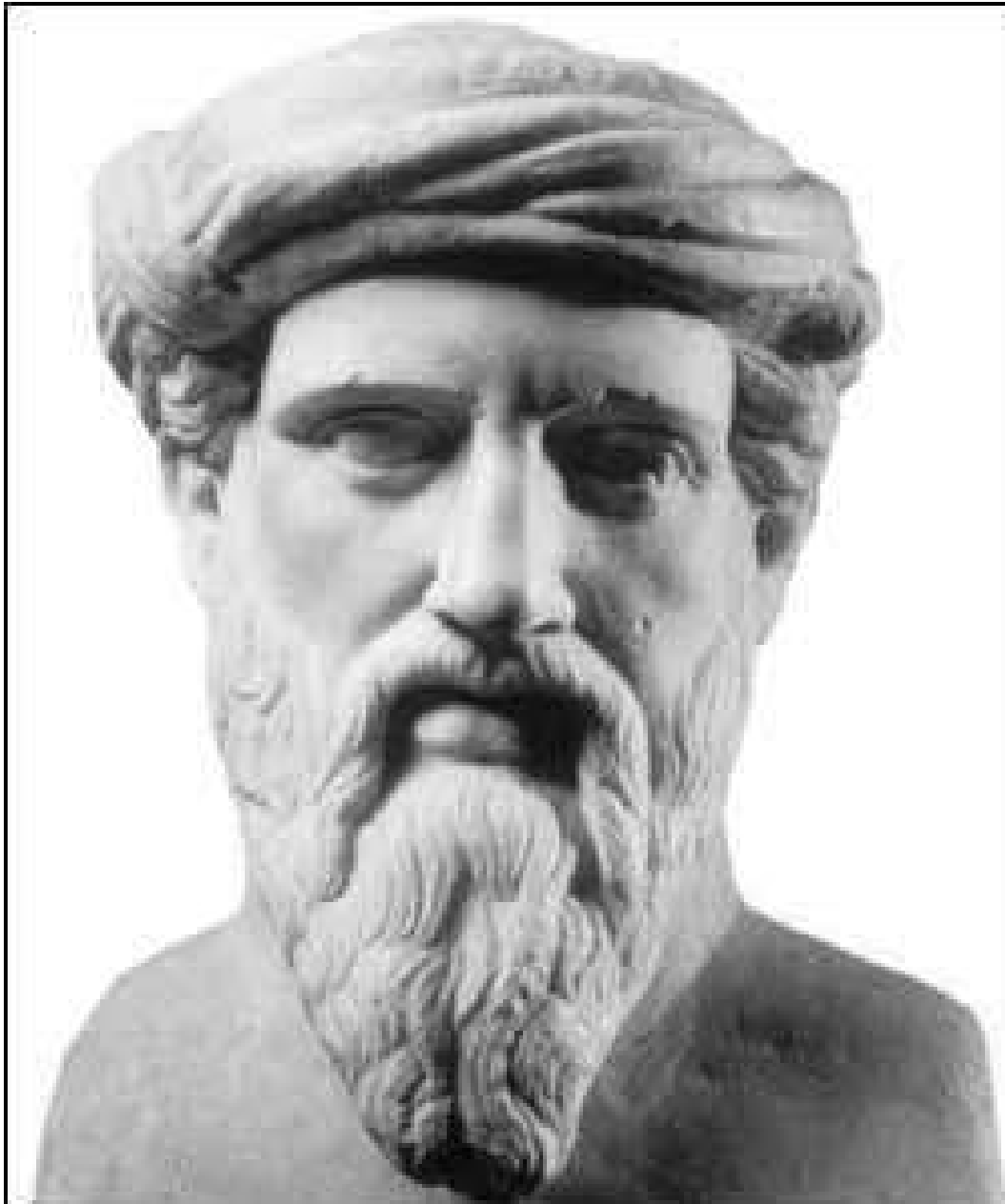


Figure 5.2: Pythagoras founded a brotherhood that lasted about a hundred years and greatly influenced the development of mathematics and science. The Pythagorean theorem, which he discovered, is considered to be the most important single theorem in mathematics.

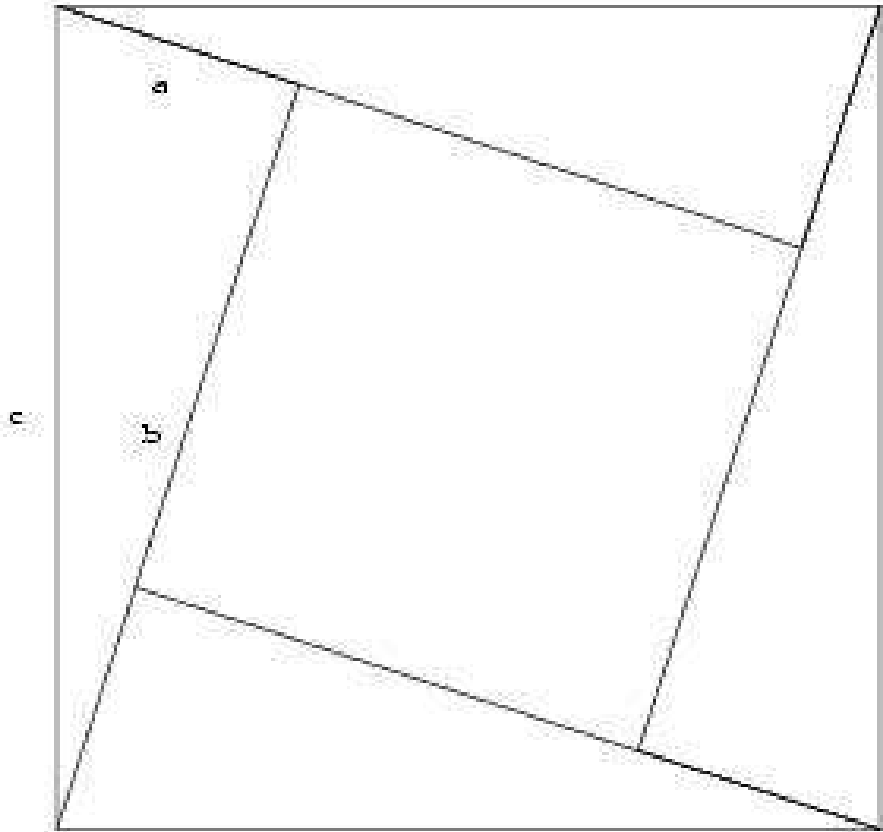


Figure 5.3: This figure can be used to prove the famous theorem of Pythagoras concerning squares constructed on the sides of a right triangle (i.e. a triangle where two of the sides are perpendicular to each other). It shows a right triangle whose sides, in order of increasing length, are  $a$ ,  $b$  and  $c$ . Four identical copies of this triangle, with total area  $2ab$ , are inscribed inside a square constructed on the long side.

### 5.3 Geometry as a part of religion

The classical Greek geometers, most of whom were Pythagoreans, discovered many geometrical theorems. They believed that the contemplation of eternal geometrical truths was a way of finding release from the suffering of human existence, and geometry was a part of their religion. There were certain rules that had to be followed in geometrical constructions: only a compass and a straight ruler could be used. The theorems of the geometers of classical Greece were collected and put into a logical order by Euclid, who lived in Alexandria, the capital city of Egypt founded by Alexander of Macedon.

#### Suggestions for further reading

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23. B L van der Waerden, *Die Arithmetik der Pythagoreer*, Math. Annalen 120 (1947-49), 127-153, 676-700.
24. L Zhmud, *Pythagoras as a Mathematician*, Historia Mathematica 16 (1989), 249-268.



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## Chapter 6

# SOCRATES, PLATO AND ARISTOTLE

### 6.1 The Sophists and Socrates

Since Athens was a democracy, the citizens often found themselves speaking at public meetings. Eloquence could be turned into influence, and the wealthy Athenians imported teachers to help them master the art of rhetoric. These teachers, called “Sophists” (literally “wisdomists”), besides teaching rhetoric, also taught a form of philosophy which denied the existence of absolute truth, absolute beauty and absolute justice. According to the Sophists, “man is the measure of all things”, all truths are relative, “beauty is in the eye of the beholder”, and justice is not divine or absolute but is a human institution.

Opposed to the Sophists was the philosopher Socrates, who believed passionately in the existence of the absolutes which the Sophists denied. According to Socrates, a beautiful object would be beautiful whether or not there were any humans to observe it. Socrates adopted from the Sophists a method of conducting arguments by asking questions which made people see for themselves the things which Socrates wanted them to see.

The Sophists talked about moral and political questions, rather than about the nature of the universe. Socrates was an opponent of the Sophists, but like them he also neglected the study of nature and concentrated on the moral and political problems of man, “the measure of all things”. The Sophists, together with Socrates and his pupil Plato, exerted a great influence in causing a split between moral philosophy and natural philosophy.

The beginning of the end of classical Greek civilization came in 431 B.C., when Athens, pushing her aggressive commercial policy to an extreme, began to expel Corinthian merchants from markets around the Aegean. Corinth reacted by persuading the Peloponnesian League to declare war on Athens. This was the beginning of a long war which ruined Greece.

Realizing that they could not resist the Spartan land forces, the Athenians abandoned the farmland outside their city, and took refuge inside the walls. The Athenians continued their prosperous foreign trade, and they fed their population with grain imported from

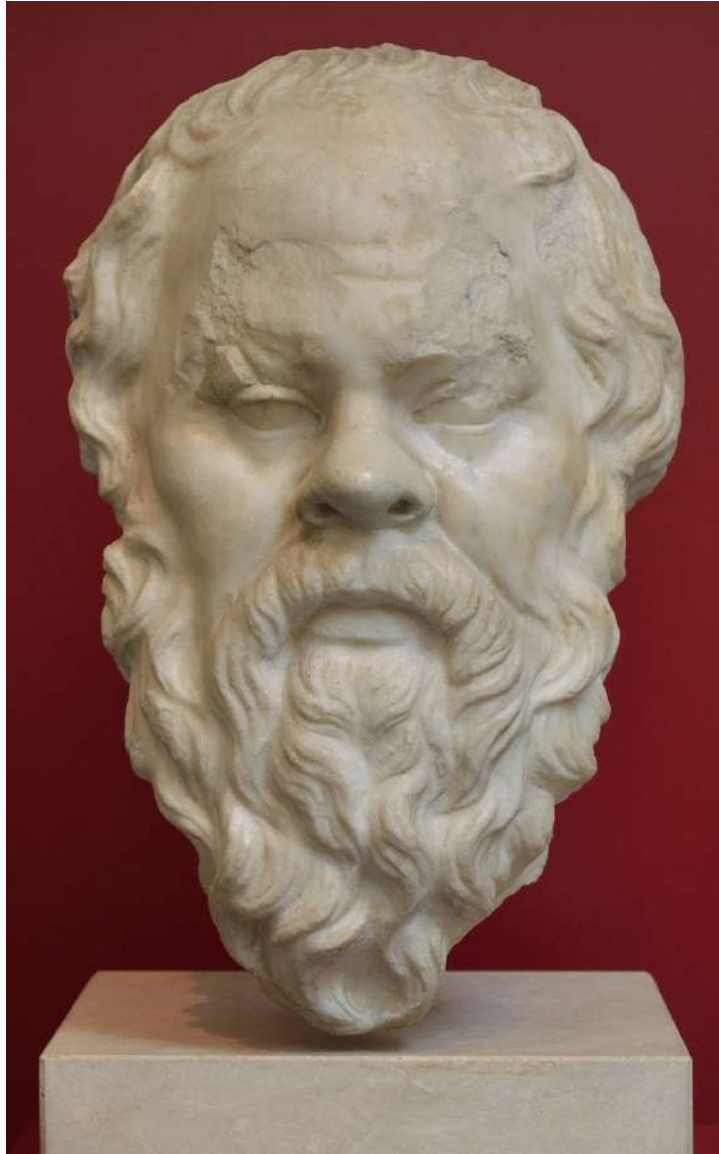


Figure 6.1: Head of Socrates in Palazzo Massimo alle Terme (Rome). Uploaded by Livoandronico2013, [CC BY-SA 4.0], Wikimedia Commons

the east. Ships bringing grain also brought the plague. A large part of the population of Athens died of the plague, including the city's great leader, Pericles. No leader of equal stature was found to replace him, and the democratic Athenian government degenerated into mob rule.

In 404 B.C., when the fleet of Athens was destroyed in a disastrous battle, the city surrendered to the Spartans. However, the Spartans remembered that without Athens, they would be unable to resist the Persian Empire. Therefore they did not destroy Athens totally, but were content to destroy the walls of Athens, reducing the city to the status of a satellite of Sparta.

Looking for scapegoats on whom to blame this disaster, the Athenian mobs seized Socrates (one of the few intellectuals who remained alive after the Peloponnesian War), and they condemned him to death for failing to believe in the gods of the city.

For a short period, Sparta dominated the Greek world; but soon war broke out again, and the political scene degenerated into a chaos of wars between the city states.

## 6.2 Plato and Aristotle

### Plato

Plato (427 B.C. - 317 B.C.) was an Athenian aristocrat, descended from the early kings of Athens. His real name was Aristocles, but he was called by his nickname, Platon (meaning "broad") because of his broad shoulders. After the death of Socrates, Plato left Athens, saying that the troubles of the city would never end until a philosopher became king. (He may have had himself in mind!) He travelled to Italy and studied under the Pythagoreans. In 387 he returned to Athens and founded a school, which was called the Academy because it stood on ground which had once belonged to a Greek named Academus.

Plato developed a philosophy which was based on the idealism of the Pythagoreans. In Pythagorean philosophy, a clear distinction was made between mathematical ideas and their physical expression. For example, geometry was considered to deal, not with real physical objects, but with idealized figures, constructed from lines of perfect straightness and infinite thinness. Plato developed and exaggerated the idealism of Pythagoras. In Plato's philosophy, the real world is corruptible and base, but the world of ideas is divine and eternal. A real table, for example, is an imperfect expression of the idea of a table. Therefore we ought to turn our eyes away from the real world and live in the world of ideas.

Plato's philosophy was just what the Athenians wanted! All around them, their world was crumbling. They gladly turned their backs on the unpleasantness of the real world, and accepted Plato's invitation to live in the world of ideas, where nothing decays and where the golden laws of mathematics rule eternally.

By all accounts, Plato was an excellent mathematician, and through his influence mathematics obtained a permanent place in education.





Figure 6.2: Plato and Aristotle by Raphael. According to Wikipedia, “The human soul in the works of Plato and Aristotle has a nature that is divided in a specifically human way. One part is specifically human and rational, being further divided into (1) a part which is rational on its own; and (2) a spirited part which can understand reason. Other parts of the soul are home to desires or passions similar to those found in animals.”

## Aristotle

Plato's favorite student was a young man from Macedon named Aristotle. Plato called him "the intelligence of the school". He was born in 381 B.C., the son of the court physician of the king of Macedon, and at the age of seventeen he went to Athens to study. He joined Plato's Academy and worked there for twenty years until Plato died. Aristotle then left the Academy, saying that he disapproved of the emphasis on mathematics and theory and the decline of natural science.

Aristotle traveled throughout the Greek world and married the sister of the ruler of one of the cities which he visited. In 312 B.C., Philip II, who had just become king of Macedon, sent for Aristotle and asked him to become the tutor of his fourteen-year-old son, Alexander. Aristotle accepted this post and continued in it for a number of years. During this period, the Macedonians, under Philip, conquered most of the Greek city-states. Philip then planned to lead a joint Macedonian and Greek force in an attack on the Persian Empire. However, in 336 B.C., before he could begin his invasion of Persia, he was murdered (probably by an agent of his wife, Olympia, who was jealous because Philip had taken a second wife). Alexander then succeeded to his father's throne, and, at the head of the Macedonian and Greek army, he invaded Persia.

Aristotle, no longer needed as a royal tutor, returned to Athens and founded a school of his own called the Lyceum. At the Lyceum he built up a collection of manuscripts which resembled the library of a modern university.

Aristotle was a very great organizer of knowledge, and his writings almost form a one-man encyclopedia. His best work was in biology, where he studied and classified more than five hundred animal species, many of which he also dissected. In Aristotle's classification of living things, he shows an awareness of the interrelatedness of species. This interrelatedness was later brought forward by Darwin as evidence for the theory of evolution. One cannot really say that Aristotle proposed a theory of evolution, but he was groping towards the idea. In his history of animals, he writes:

"Nature proceeds little by little from lifeless things to animal life, so that it is impossible to determine either the exact line of demarcation, or on which side of the line an intermediate form should lie. Thus, next after lifeless things in the upward scale comes the plant. Of plants, one will differ from another as to its apparent amount of vitality. In a word, the whole plant kingdom, whilst devoid of life as compared with the animal, is yet endowed with life as compared with other corporeal entities. Indeed, there is observed in plants a continuous scale of ascent towards the animal."

Aristotle's classification of living things, starting at the bottom of the scale and going upward, is as follows: Inanimate matter, lower plants and sponges, higher plants, jellyfish, zoophytes and ascidians, molluscs, insects, jointed shellfish, octopuses and squids, fish and reptiles, whales, land mammals and man. The acuteness of Aristotle's observation and analysis can be seen from the fact that he classified whales and dolphins as mammals (where they belong) rather than as fish (where they superficially seem to belong).

One of Aristotle's important biological studies was his embryological investigation of the developing chick. Ever since his time, the chick has been the classical object for em-

bryological studies. He also studied the four-chambered stomach of the ruminants and the detailed anatomy of the mammalian reproductive system. He used diagrams to illustrate complex anatomical relationships - an important innovation in teaching technique.

Aristotle's physics and astronomy were far less successful than his biology. In these fields, he did not contribute with his own observations. On the whole, he merely repeated the often-mistaken ideas of his teacher, Plato.

Besides writing on biology, physics and astronomy, Aristotle also discussed ethics, politics and literary criticism, and he made a great contribution to western thought by inventing a formal theory of logic. His writings on logic were made popular by St. Thomas Aquinas (1225-1274), and during the period between Aquinas and the Renaissance, Aristotle's logic dominated theology and philosophy. In fact, through his work on logic, Aristotle became so important to scholastic philosophy that his opinions on other subjects were accepted as absolute authority. Unfortunately, Aristotle's magnificent work in biology was forgotten, and it was his misguided writings on physics and astronomy which were influential. Thus, for the experimental scientists of the 16th and 17th centuries, Aristotle eventually became the symbol of wrongness, and many of their struggles and victories have to do with the overthrow of Aristotle's doctrines.

Even after it had lost every vestige of political power, Athens continued to be a university town, like Oxford or Cambridge. Plato's Academy continued to teach students for almost a thousand years. It was finally closed in 529 A.D. by the Emperor Justinian, who feared its influence as a stronghold of "pagan philosophy".

Aristotle's Lyceum continued for some time as an active institution, but it soon declined, because although Athens remained a center of moral philosophy, the center of scientific activity had shifted to Alexandria. The collection of manuscripts which Aristotle had built up at the Lyceum became the nucleus of the great library at Alexandria.

The books of Plato and Aristotle survived better than the books of other ancient philosophers, perhaps because Plato and Aristotle founded schools. Plato's authenticated dialogues form a book as long as the Bible, covering all fields of knowledge. Aristotle's lectures were collected into 150 volumes. (Of course, each individual volume was not as long as a modern printed book.) Of these, 50 have survived. Some of them were found in a pit in Asia Minor by soldiers of the Roman general Sulla in 80 A.D., and they were brought to Rome to be recopied.

Some of the works of Aristotle were lost in the West, but survived during the dark ages in Arabic translations. In the 12th and 13th centuries, these works were translated into Latin by European scholars who were in contact with the Arab civilization. Through these translations, Europe enthusiastically rediscovered Aristotle, and until the 17th century, he replaced Plato as *the* philosopher.

The influence of Plato and Aristotle was very great (perhaps greater than they deserved), because of their literary skill, because so many of their books survived, because of the schools which they founded, and because Plato and Aristotle wrote about all of knowledge and wrapped it up so neatly that they seemed to have said the last word.

## 6.3 Plato

Darkness was falling on the classical Greek world, but the light of civilization had not quite gone out. Socrates was dead, but Plato, the student of Socrates, kept his memory alive by writing dialogues in which Socrates appeared as a character.

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Aristotle's physics and astronomy were far less successful than his biology. In these fields, he did not contribute with his own observations. On the whole, he merely repeated the often-mistaken ideas of his teacher, Plato. In his book *On The Heavens*, Aristotle writes:

"As the ancients attributed heaven and the space above it to the gods, so our reasoning shows that it is incorruptable and uncreated and untouched by mortal troubles. No force is needed to keep the heaven moving, or to prevent it from moving in another manner. Nor need we suppose that its stability depends on its support by a certain giant, Atlas, as in the ancient fable; as though all bodies on high possessed gravity and an earthly nature. Not so has it been preserved for so long, nor yet, as Empedocles asserts, by whirling around faster than its natural motion downward."

Empedocles (490 B.C. - 430 B.C.) was a Pythagorean philosopher who studied, among other things, centrifugal forces. For example, he experimented with buckets of water which he whirled about his head, and he knew that the water does not run out. The passage which we have just quoted shows that Empedocles had suggested the correct explanation for the stability of the moon's orbit. The moon is constantly falling towards the earth, but at the same time it is moving rapidly in a direction perpendicular to the line connecting it with the earth. The combination of the two motions gives the moon's orbit its nearly-circular shape.

Empedocles had thus hit on the germ of the idea which Newton later developed into his great theory of universal gravitation and planetary motion. In the above passage, however, Aristotle rejects the hypothesis of Empedocles. He asserts instead that the heavens are essentially different from the earth, and not subject to the same laws.

Aristotle believed celestial bodies to be composed of a fifth element - ether. This, he thought, was why the heavens were not subject to the laws which apply to earthly matter. He thought that for earthly bodies, the natural motion was a straight line, but for celestial bodies the natural motion was circular because "one kind of motion is divine and immortal, having no end, but being in itself the end of other motions"; and motion in a circle is "perfect, having no beginning or end, nor ceasing in infinite time."

This doctrine, that the motion of celestial bodies must be uniform and circular, was a legacy from Plato. In fact, Plato had placed before his Academy the problem of reconciling the apparently irregular motion of the planets with the uniform circular motion which Plato believed they *had* to have. In a famous phrase, Plato said that the problem was to "save the appearances".

The problem of "saving the appearances" was solved in a certain approximation by Eudoxis, one of Plato's students. He imagined a system of concentric spheres, attached to one another by axes. In this picture, each sphere rotates uniformly about its own axis, but since the spheres are attached to each other in a complex way, the resulting motion duplicates the complex apparent motion of the planets.

Aristotle accepted the system of Eudoxis, and even added a few more spheres of his own to make the system more accurate. In making a distinction between the heavens and the

earth, Aristotle gave still another answer to the question of which things in the universe change and which are permanent: According to Aristotle, the region beneath the sphere of the moon is corrupt and changeable, but above that sphere, everything is eternal and divine. Change is bad, permanence is good - that is the emotional content of the teaching of Plato and Aristotle, the two great philosophers of the rapidly-decaying 4th century B.C. Greek civilization.

Besides writing on biology, physics and astronomy, Aristotle also discussed ethics, politics and literary criticism, and he made a great contribution to western thought by inventing a formal theory of logic. His writings on logic were made popular by St. Thomas Aquinas (1225-1274), and during the period between Aquinas and the Renaissance, Aristotle's logic dominated theology and philosophy. In fact, through his work on logic, Aristotle became so important to scholastic philosophy that his opinions on other subjects were accepted as absolute authority. Unfortunately, Aristotle's magnificent work in biology was forgotten, and it was his misguided writings on physics and astronomy which were influential. Thus, for the experimental scientists of the 16th and 17th centuries, Aristotle eventually became the symbol of wrongness, and many of their struggles and victories have to do with the overthrow of Aristotle's doctrines.

Even after it had lost every vestige of political power, Athens continued to be a university town, like Oxford or Cambridge. Plato's Academy continued to teach students for almost a thousand years. It was finally closed in 529 A.D. by the Emperor Justinian, who feared its influence as a stronghold of "pagan philosophy".

Aristotle's Lyceum continued for some time as an active institution, but it soon declined, because although Athens remained a center of moral philosophy, the center of scientific activity had shifted to Alexandria. The collection of manuscripts which Aristotle had built up at the Lyceum became the nucleus of the great library at Alexandria.

The books of Plato and Aristotle survived better than the books of other ancient philosophers, perhaps because Plato and Aristotle founded schools. Plato's authenticated dialogues form a book as long as the Bible, covering all fields of knowledge. Aristotle's lectures were collected into 150 volumes. (Of course, each individual volume was not as long as a modern printed book.) Of these, 50 have survived. Some of them were found in a pit in Asia Minor by soldiers of the Roman general Sulla in 80 A.D., and they were brought to Rome to be recopied.

Some of the works of Aristotle were lost in the West, but survived during the dark ages in Arabic translations. In the 12th and 13th centuries, these works were translated into Latin by European scholars who were in contact with the Arab civilization. Through these translations, Europe enthusiastically rediscovered Aristotle, and until the 17th century, he replaced Plato as *the* philosopher.

The influence of Plato and Aristotle was very great (perhaps greater than they deserved), because of their literary skill, because so many of their books survived, because of the schools which they founded, and because Plato and Aristotle wrote about all of knowledge and wrapped it up so neatly that they seemed to have said the last word.

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# Chapter 7

## FOUNDERS OF RELIGIONS

### What is human nature?

What is human nature? Are we humans good or evil? To what extent is the character of a person produced by heredity, and to what extent by environment? Is competition more central to our existence than cooperation, or is it the other way around? How can a happy, peaceful and stable society be created? Are humans essentially the same as other animals, or are we fundamentally different? Should humans dominate and control nature, or should we be the custodians of nature? These questions are central to philosophy, and the opinions of some famous philosophers, religious leaders and scientists are given below.

### 7.1 Abrahamic religions

#### Some stories from the Bible

The Old Testament is the common heritage of the three Abrahamic religions, Christianity, Judaism and Islam. Some of the stories which it contains can be seen as attempts to explain the paradoxes of human emotional nature: Why are we born with emotions that drive us to commit the seven deadly sins? Why are pride, envy, wrath, gluttony, lust, sloth and greed so much a part of human nature? The story of Adam and Eve and the Garden of Eden attempts to answer this question, as do stories about the role of Satan in the world.

According to the biblical account, Adam and Eve ate apples from the Tree of Knowledge and were therefore expelled from the Garden of Eden. This story can be seen as containing elements of historical truth. Humans were originally hunter-gatherers. Populations were so sparse that gathering roots, berries and fruits from their environment gave them enough to eat. Occasionally they obtained additional protein from the meat of animals that they were able to kill. Then agriculture was invented. Populations rapidly became so dense that humans were no longer able to live simply by gathering fruit from the Garden of Eden. Expelled from the garden, they were henceforth forced to sweat for their daily bread.



Figure 7.1: **The garden of Eden.**

What about “original sin” and the role of the Devil in the world? In the Bible, the Devil, or Satan, appears as a fallen angel who tempts humans to commit sins, i.e to break the rules of their societies. The existence of Satan is the biblical explanation of the presence of evil in the world. An alternative explanation is given by the doctrine of “original sin”, which maintains that humans are born with a sinful nature. Like the story of the Garden of Eden, these biblical concepts may also chronicle true historical events in human evolution. A sinful human is sometimes described as “behaving like an animal”. In fact, what is regarded a sin in humans can be a necessary survival trait in an animal. It would be ridiculous to say “Thou shalt not steal” to a mouse or “Thou shalt not kill” to a tiger.

Our emotions have an extremely long evolutionary history. Both lust and rage are emotions that we share with many animals. However, with the rapid advance of human cultural evolution, our ancestors began to live together in progressively larger groups, and in these new societies, our inherited emotional nature was often inappropriate. What once was a survival trait became a sin which needed to be suppressed by morality and law. Today we live in a world that is entirely different from the one into which our species was born. We face the problems of the 21st century: exploding populations, vanishing resources, and the twin threats of catastrophic climate change and thermonuclear war. We face these severe problems with our poor cave-man’s brain, with an emotional nature that has not changed much since our ancestors lived in small tribes, competing for territory on the grasslands of Africa.



Figure 7.2: Satan.

## 7.2 Confucius

After the fall of Rome in the 5th century A.D., Europe became a culturally backward area. However, the great civilizations of Asia and the Middle East continued to flourish, and it was through contact with these civilizations that science was reborn in the west.

During the dark ages of Europe, a particularly high level of civilization existed in China. The art of working in bronze was developed in China during the Shang dynasty (1,500 B.C. - 1,100 B.C.) and it reached a high pitch of excellence in the Chou dynasty (1,100 B.C. - 250 B.C.). “ In the Chou period, many of the cultural characteristics which we recognize as particularly Chinese were developed. During this period, the Chinese evolved a code of behavior based on politeness and ethics. Much of this code of behavior is derived from the teachings of K’ung Fu-tzu (Confucius), a philosopher and government official who lived between 551 B.C. and 479 B.C.. In his writings about ethics and politics, K’ung Fu-tzu advocated respect for tradition and authority, and the effect of his teaching was to strengthen the conservative tendencies in Chinese civilization. He was not a religious leader, but a moral and political philosopher, like the philosophers of ancient Greece. He is traditionally given credit for the compilation of the Five Classics of Chinese Literature, which include books of history, philosophy and poetry, together with rules for religious ceremonies.

### Some sayings of Confucius

**By three methods we may learn wisdom: First, by reflection, which is noblest; Second, by imitation, which is easiest; and third by experience, which is the bitterest.**



Everything has beauty, but not everyone sees it.

Wheresoever you go, go with all your heart.

It does not matter how slowly you go as long as you do not stop.

Life is really simple, but we insist on making it complicated.

If you make a mistake and do not correct it, this is called a mistake.

The man who moves a mountain begins by carrying away small stones.

The funniest people are the saddest ones.

Before you embark on a journey of revenge, dig two graves.

To be wronged is nothing, unless you continue to remember it.

Respect yourself and others will respect you.

Silence is a true friend who never betrays.

You cannot open a book without learning something.

When you see a good person, think of becoming like her/him. When you see someone not so good, reflect on your own weak points.

Attack the evil that is within yourself, rather than attacking the evil that is in others.

The man who asks a question is a fool for a minute, the man who does not ask is a fool for life.

What the superior man seeks is in himself; what the small man seeks is in others.

I hear and I forget. I see and I remember. I do and I understand.

Music produces a kind of pleasure which human nature cannot do without.

The hardest thing of all is to find a black cat in a dark room, especially if there is no cat.

It is not the failure of others to appreciate your abilities that should trouble you, but rather your failure to appreciate theirs.

The man of wisdom is never of two minds; the man of benevolence never worries; the man of courage is never afraid.

The gem cannot be polished without friction, nor man perfected without trials.

Give a bowl of rice to a man and you will feed him for a day. Teach him how to grow his own rice and you will save his life.

Only the wisest and stupidest of men never change.

It is more shameful to distrust our friends than to be deceived by them.

Real knowledge is to know the extent of one's ignorance.

And remember, no matter where you go, there you are.

Hold faithfulness and sincerity as first principles.

If what one has to say is not better than silence, then one should keep silent.

Forget injuries, never forget kindnesses.

When it is obvious that the goals cannot be reached, don't adjust the goals, adjust the action steps.

Better a diamond with a flaw than a pebble without.

To put the world in order, we must first put the nation in order; to put the nation in order, we must first put the family in order; to put the family in order; we must first cultivate our personal life; we must first set our hearts right.

A lion chased me up a tree, and I greatly enjoyed the view from the top.

To be wealthy and honored in an unjust society is a disgrace.

In a country well governed, poverty is something to be ashamed of. In a country badly governed, wealth is something to be ashamed of.

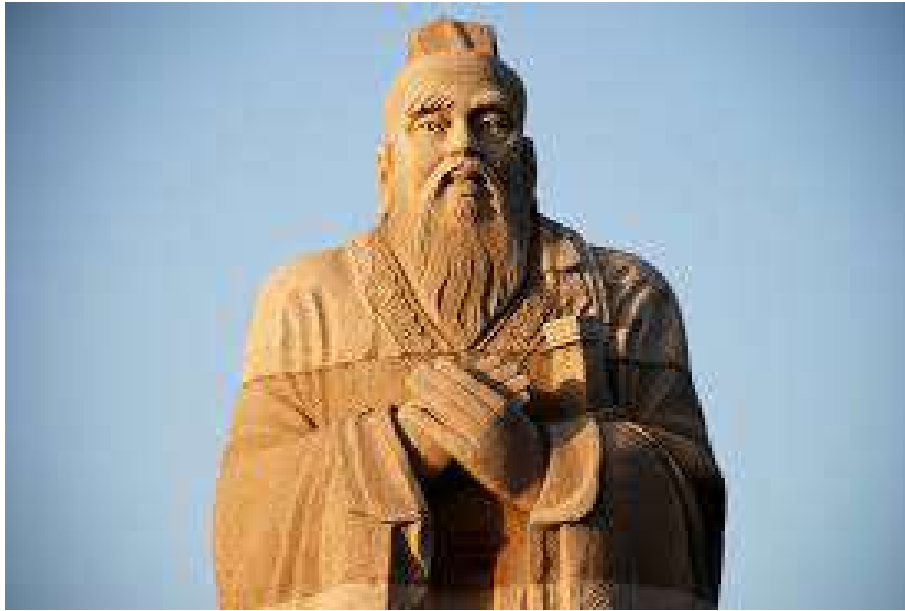


Figure 7.3: Confucius

If your plan is for one year plant rice. If your plan is for ten years plant trees.  
If your plan is for one hundred years educate children.

Don't do unto others what you don't want done unto you.

Education breeds confidence. Confidence breeds hope. Hope breeds peace.

To see what is right and not do it is the worst cowardice.

Time flows away like the water in the river.

The superior man thinks always of virtue; the common man thinks of comfort.

## 7.3 Gautama Buddha

Evidence of a very early river-valley civilization in India has been found at a site called Mohenjo-Daro. However, in about 2,500 B.C., this early civilization was destroyed by some great disaster, perhaps a series of floods; and for the next thousand years, little is known about the history of India. During this dark period between 2,500 B.C. and 1,500 B.C., India was invaded by the Indo-Aryans, who spoke Sanskrit, a language related to Greek. The Indo-Aryans partly drove out and partly enslaved the smaller and darker native Dravidians. However, there was much intermarriage between the groups, and to prevent

further intermarriage, the Indo-Aryans introduced a caste system sanctioned by religion.

According to Hindu religious belief, the soul of a person who has died is reborn in another body. If, throughout his life, the person has faithfully performed the duties of his caste, then his or her soul may be reborn into a higher caste. Finally, after existing as a Brahman, the soul may be so purified that it can be released from the cycle of death and rebirth.

In the 6th century B.C., Gautama Buddha founded a new religion in India. Gautama Buddha was convinced that all the troubles of humankind spring from attachment to earthly things. He felt that the only escape from sorrow is through the renunciation of earthly desires. He also urged his disciples to follow a high ethical code, the Eightfold Way. Among the sayings of Buddha are the following:

“Hatred does not cease by hatred at any time; hatred ceases by love.”

“Let a man overcome anger by love; let him overcome evil by good.”

“All men tremble at punishment. All men love life. Remember that you are like them, and do not cause slaughter.”

One of the early converts to Buddhism was the emperor Ashoka Maurya, who reigned in India between 273 B.C. and 232 B.C.. During one of his wars of conquest, Ashoka Maurya became so sickened by the slaughter that he resolved never again to use war as an instrument of policy. He became one of the most humane rulers in history, and he also did much to promote the spread of Buddhism throughout Asia.

Under the Mauryan dynasty (322 B.C. - 184 B.C.), the Gupta dynasty (320 B.C. - 500 A.D.) and also under the rajah Harsha (606 A.D. - 647 A.D.), India had periods of unity, peace and prosperity. At other times, the country was divided and upset by internal wars. The Gupta period especially is regarded as the golden age of India's classical past. During this period, India led the world in such fields as medicine and mathematics.

The Guptas established both universities and hospitals. According to the Chinese Buddhist pilgrim, Fa-Hsien, who visited India in 405 A.D., “The nobles and householders have founded hospitals within the city to which the poor of all countries, the destitute, crippled and diseased may go. They receive every kind of help without payment.”

Indian doctors were trained in cleansing wounds, in using ointments and in surgery. They also developed antidotes for poisons and for snakebite, and they knew some techniques for the prevention of disease through vaccination.

When they had completed their training, medical students in India took an oath, which resembled the Hippocratic oath: “Not for yourself, not for the fulfillment of any earthly desire or gain, but solely for the good of suffering humanity should you treat your patients.”

In Indian mathematics, algebra and trigonometry were especially highly developed. For example, the astronomer Brahmagupta (598 A.D. - 660 A.D.) applied algebraic methods to astronomical problems. The notation for zero and the decimal system were invented in India, probably during the 8th or 9th century A.D.. These mathematical techniques were later transmitted to Europe by the Arabs.

Many Indian techniques of manufacture were also transmitted to the west by the Arabs. Textile manufacture in particular was highly developed in India, and the Arabs, who were the middlemen in the trade with the west, learned to duplicate some of the most famous



Figure 7.4: **Gautama Buddha**

kinds of cloth. One kind of textile which they copied was called “quttan” by the Arabs, a word which in English has become “cotton”. Other Indian textiles included cashmere (Kashmir), chintz and calico (from Calcutta, which was once called Calicut). Muslin derives its name from Mosul, an Arab city where it was manufactured, while damask was made in Damascus.

Indian mining and metallurgy were also highly developed. The Europeans of the middle ages prized fine laminated steel from Damascus; but it was not in Damascus that the technique of making steel originated. The Arabs learned steelmaking from the Persians, and Persia learned it from India.

## The Noble Eightfold Path

1. **Right understanding.** *And what is right understanding? There are fruits, and results of good and bad actions. There is this world and the next world. There is mother and father. There are spontaneously reborn beings; there are contemplatives and Brahmins who faring rightly and practicing rightly, proclaim this world and the next after having directly known and realized it for themselves.’ This is the right view with effluents, siding with merit, resulting in acquisitions*
2. **Right resolve.** *And what is right resolve? Being resolved on renunciation, on freedom from ill will, on harmlessness: This is called right resolve.*
3. **Right speech.** *And what is right speech? Abstaining from lying, from divisive speech, from abusive speech, and from idle chatter: This is called right speech.*
4. **Right action.** *And what is right action? Abstaining from killing, abstaining from stealing, abstaining from sexual misconduct. This is called right action.*

5. **Right livelihood.** *And what is right livelihood? Not possessing more than is strictly necessary. Avoiding causing suffering to sentient beings by cheating them, or harming or killing them in any way.*
6. **Right effort.** *And what is right effort? Here the monk arouses his will, puts forth effort, generates energy, exerts his mind, and strives to prevent the arising of evil and unwholesome mental states that have not yet arisen. He arouses his will... and strives to eliminate evil and unwholesome mental states that have already arisen, to keep them free of delusion, to develop, increase, cultivate, and perfect them. This is called right effort.*
7. **Right mindfulness.** *And what is right mindfulness? Here the monk remains contemplating the body as body, resolute, aware and mindful, having put aside worldly desire and sadness; he remains contemplating feelings as feelings; he remains contemplating mental states as mental states; he remains contemplating mental objects as mental objects, resolute, aware and mindful, having put aside worldly desire and sadness; This is called right mindfulness.*
8. **Right concentration.** *And what is right concentration? [i] Here, the monk, detached from sense-desires, detached from unwholesome states, enters and remains in the first jhana (level of concentration, in which there is applied and sustained thinking, together with joy and pleasure born of detachment; [ii] And through the subsiding of applied and sustained thinking, with the gaining of inner stillness and oneness of mind, he enters and remains in the second jhana, which is without applied and sustained thinking, and in which there are joy and pleasure born of concentration; [iii] And through the fading of joy, he remains equanimous, mindful and aware, and he experiences in his body the pleasure of which the Noble Ones say: “equanimous, mindful and dwelling in pleasure”, and thus he enters and remains in the third jhana; [iv] And through the giving up of pleasure and pain, and through the previous disappearance of happiness and sadness, he enters and remains in the fourth jhana, which is without pleasure and pain, and in which there is pure equanimity and mindfulness. This is called right concentration.*

### Some of the sayings of Gautama Buddha

In the end, only three things matter: How much you loved, how gently you lived, and how gracefully you let go of things not meant for you.

Buddha was asked, “What have you gained from mediation?” He replied NOTHING! However let me tell you what i have lost: anger, anxiety, depression, insecurity, fear of old age and death.

When the student is ready, the teacher will appear.



The less you respond to negative people, the more peaceful your life will become.

Health is the greatest gift, contentment is the greatest wealth, A trusted friend is the best relative, liberated mind is the greatest bliss.

The thought manifests as the word: the word manifests as the deed: the deed develops into character. So watch the thought and its ways with care, and let it spring from love born out of concern for all beings.

Do not learn how to react learn how to respond.

If your compassion does not include yourself, It is incomplete.

Everything that has a beginning has an ending. Make your peace with that and all will be well.

If anything is worth doing, do it with all your heart.

Your worst enemy cannot harm you as much as your own unguarded thoughts.

The root of suffering is attachment.

Holding onto anger is like drinking poison and expecting the other person to die.

All that we are is the result of what we have thought.

Do not dwell in the past, do not dream of the future, concentrate the mind on the present moment.

What you think you become, what you feel, you attract. what you imagine, you create.

nothing can harm you as much as your own thoughts unguarded.

The trouble is you think you have time.

Your work is to discover your world and then with all your heart give yourself to it.

Believe nothing, no matter where you read it or who has said it, not even if i have said it. Unless it agrees with your own reason and your own common

sense.

On the long journey of human life, Faith is the best of companions.

To understand everything is to forgive everything.

No one saves us but ourselves. No one can and no one may. We ourselves must walk the past.

There is no path to happiness: Happiness is the path.

No matter how hard the past, you can always begin again.

If you want to fly, give up everything that weighs you down.

You only lose what you cling to.

When we meet real tragedy in life, we can react in two ways- Either by losing hope and falling into self-destructive habits or by using the challenge to find our inner strength.

Don't rush anything. When the time is right, it will happen.

The whole secret of existence is to have no fear.

Be kind to all creatures; this is the true religion.

Those who are free of resentful thoughts surely find peace.

It is during our darkest moments that we must focus to see the light

Quiet the mind, and the soul will speak.

Each morning we are born again. What we do today is what matters most.

A man who conquers himself is greater than one who conquers a thousand men in a battle.

All human unhappiness comes from not facing reality squarely, exactly as it is.

It is better to be hated for what you are than to be loved for what you are not.

He who does not understand your silence will probably not understand your words.

You will not be punished for your anger, you will be punished by your anger.

Whatever befalls you, walk on untouched, unattached.

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# Chapter 8

## HIPOCRATES AND GALEN

### 8.1 Medicine in ancient India

According to an article by Tejraj Aminabhavi in Asian Review<sup>1</sup>, “Among India’s many claims to fame is the ancient medical science known as Ayurveda (from the Sanskrit words ayur, or life, and veda, science). This is a healing method that relies on herbs as medicines for maintaining good health. The 5,000-year-old system of natural healing is originated in India’s ancient Vedic culture. It was suppressed during the years of foreign occupation, but its medical practices have been enjoying a resurgence both in its native land and throughout the world.

“Early Greek medicine embraced many concepts originally described in classical Ayurvedic texts dating back thousands of years. Traditional Tibetan and Chinese medicine also have roots in Ayurveda. Over time, Ayurveda has become the science of life, encompassing body, mind and spirit. This body of knowledge is believed to have been originally delivered by God to sages and seers, who were yogis renowned in their insight, intuition and keen observation of human behavior. They handed down their knowledge to their disciples. An important goal of Ayurveda is to identify the ideal state of balance of a person and offer solutions using diet, herbs, music, massage treatments and meditation to restore the body’s balance.

“The key concepts of Ayurvedic medicine are based on universal interconnections among people, their health, the universe, the body’s constitution and life forces that are often compared to the “humors” of the ancient Greek system. Using these concepts, Ayurvedic physicians prescribe individualized treatments that include herbs, diet and exercise along with lifestyle recommendations. The majority of the Indian population today uses Ayurvedic medicine, combined with conventional Western medicine, a practice popular all over South-east Asia as well.”

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<sup>1</sup><https://asia.nikkei.com/Business/Science/Ayurveda-the-ancient-Indian-medical-practice>

## 8.2 Mesopotamian medicine

In medicine, the Mesopotamians believed that disease was a punishment inflicted by the gods on men, both for their crimes and for their errors and omissions in the performance of religious duties. They believed that the cure for disease involved magical and religious treatment, and the diseased person was thought to be morally tainted. However, in spite of this background of superstition, Mesopotamian medicine also contained some practical remedies. For example, the prescription for urinary retention was as follows: “Crush poppy seeds in beer and make the patient drink it. Grind some myrrh, mix it with oil and blow it into his urethra with a tube of bronze. Give the patient anemone crushed in alpanu-beer.”

Until recently it was believed that the Mesopotamians had no idea of hygiene and preventive medicine. However, the following remarkable text was published recently. It is a letter, written by Zimri-Lim, King of Mari, who lived about 1780 B.C., to his wife Shibtu: “I have heard that Lady Nanname has been taken ill. She has many contacts with the people of the palace. She meets many ladies in her house. Now then, give severe orders that no one should drink in the cup where she drinks. No one should sit on the seat where she sits. No one should sleep in the bed where she sleeps. She should no longer meet many ladies in her house. This disease is contagious.”

### Mesopotamian treatments and prescriptions

The Encyclopedia of Ancient History states that: “Fees for services were on a sliding scale depending on one’s social status. A doctor presiding over the birth of a noble was paid more than for a common birth. Prescriptions were on this same sliding scale and, whereas a doctor might be paid in gold for mixing a prescription for a prince, the payment for doing the same for a common person might be a bowl of soup or a clay cup. There is no evidence, however, that doctors refused to treat the poor and the same prescriptions were given, with the same ingredients, without regard for a patient’s social status. Prescriptions were ground by the doctor, usually, in the presence of the patient, while some incantation was recited. A prescription from Babylon for an injury to the face reads: “If a man is sick with a blow on the cheek, pound together fir-turpentine, pine-turpentine, tamarisk, daisy, flour of Inninnu; mix in milk and beer in a small copper pan; spread on skin, bind on him, and he shall recover” (Te. Antiseptics were made from a mixture of alcohol, honey, and myrrh, and surgery was more advanced than in other regions of the time. Teall writes, “In the treatment of all wounds, there are three critical steps: washing, applying a plaster, and binding the wound”. The Mesopotamians recognized that washing a wound with clean water, and making sure the doctor’s hands were also clean, prevented infection and hastened healing. Hands and wounds were cleaned with a mixture of beer and hot water though, as Teall notes, “a liquid soap was already available”. Teall continues: “While some aspects of ancient Mesopotamian wound dressing are completely lacking as seen through the lens of modern biomedical practices... others were surprisingly advanced, such as the washing and the preparation of poultices for wounds”





Figure 8.1: **An ancient Egyptian doctor and patient.**

### 8.3 Medicine in ancient Egypt

The Wikipedia article on Ancient Egyptian Medicine mentions several papyrus texts dealing with surgery and treatments for disease: “The Edwin Smith Papyrus is a textbook on surgery and details anatomical observations and the ‘examination, diagnosis, treatment, and prognosis’ of numerous ailments. It was probably written around 1600 BC, but is regarded as a copy of several earlier texts. Medical information in it dates from as early as 3000 BC. It is thus viewed as a learning manual. Treatments consisted of ointments made from animal, vegetable or fruit substances or minerals. There is evidence of oral surgery being performed as early as the 4th Dynasty (2900-2750 BC).

“The Ebers papyrus c. 1550 BC includes 877 prescriptions (as categorized by a modern editor) for a variety of ailments and illnesses, some of them involving magical remedies, for Egyptian beliefs regarding magic and medicine were often intertwined. It also contains documentation revealing awareness of tumors, along with instructions on tumor removal.

“The Kahun Gynecological Papyrus treats women’s complaints, including problems with conception. Thirty four cases detailing diagnosis and treatment survive, some of them fragmentarily. Dating to 1800 BC, it is the oldest surviving medical text of any kind.”

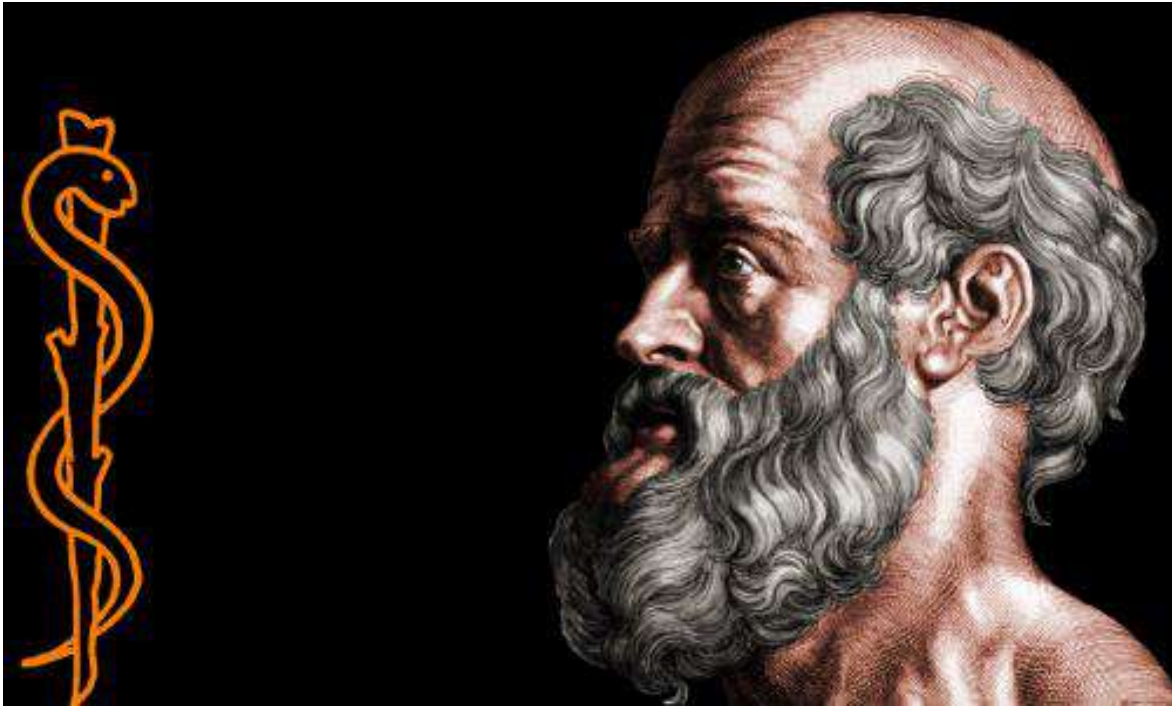


Figure 8.2: Hippocrates (460 BC - c, 370 BC) has been called “the father of modern medicine”.

## 8.4 Hippocrates

The physician Hippocrates was born in about 460 B.C. on the island of Kos. His family belonged to the nobility, and for several generations they had been outstanding physicians. Hippocrates married a noblewoman, and they had two sons and a daughter. Both sons became physicians, and the daughter married a physician.

According to tradition, Hippocrates visited Egypt during the early part of his life. There he studied medicine, especially the medical works of Imhotep. He is also said to have studied under Democritus. Returning to the island of Kos, he founded the most rational school of medicine of the ancient world. He had many students, among whom were his sons and his sons-in law. During the later part of his life, he also taught and practiced in Thrace and Athens.

The medical school founded by Hippocrates was famous for its rationality and for its high ethical standard. The medical ethics of Hippocrates live on today in the oath taken by physicians. The rationality of Hippocrates is evident in all the writings of his school. For example, a book on epilepsy, called *The Sacred Disease*, contains the following passage:

“As for this disease called divine, surely it has its nature and causes, as have other diseases. It arises, like them, from things which enter and leave the body... Such things are divine or not - as you will, for the distinction matters not, and there is no need to make

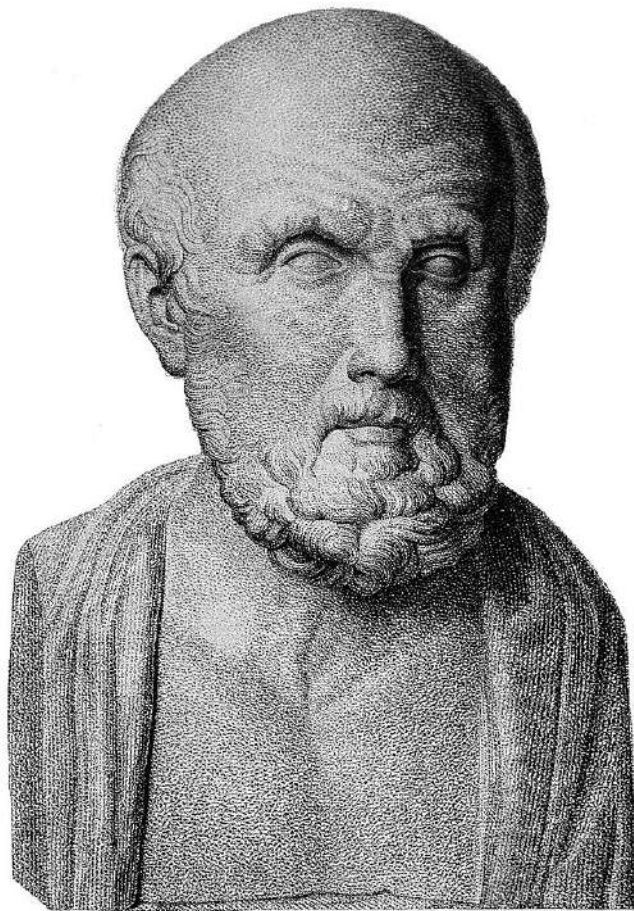


Figure 8.3: A statue of Hippocrates.

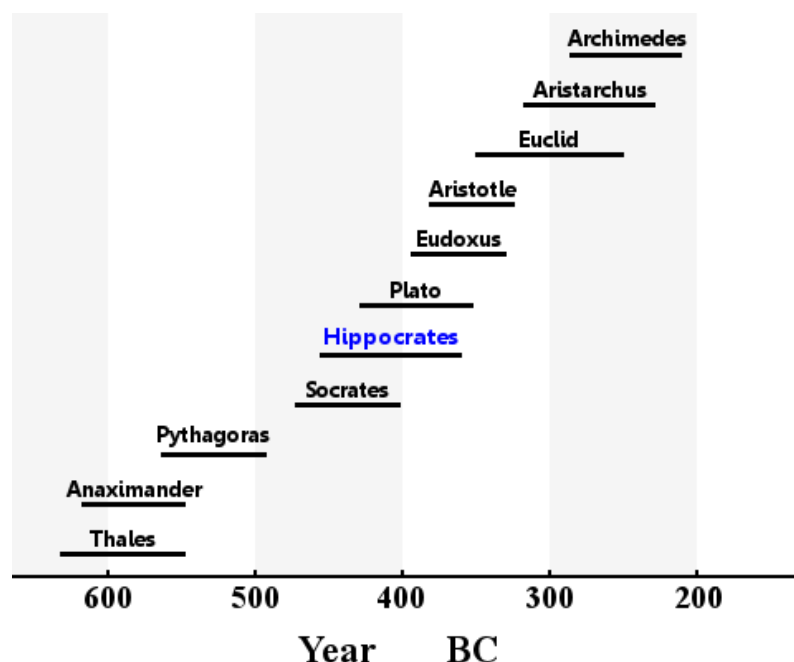


Figure 8.4: Lifetimes of some ancient philosophers and scientists.

such a division anywhere in nature; for all alike are divine, or all are natural. All have their antecedent causes, which can be found by those who seek them.”

More than fifty books of Hippocrates’ school were collected in Alexandria in the 3rd century B.C.. All of them were attributed by the Alexandrians to Hippocrates himself, but undoubtedly many of the books were written by his students. The physicians of the school of Hippocrates believed that cleanliness and rest are important for a sick or wounded patient, and that the physician should interfere as little as possible with the natural healing processes of the body. The books of the school contain much careful observation of disease. Hippocrates and his school resisted the temptation to theorize without a basis of carefully observed facts, just as they also resisted the temptation to introduce supernatural causes into medicine.

Hippocrates is said to have died in his hundredth year. According to tradition, he was humane, observant, learned, orderly and calm, with a grave and thoughtful attitude, a complete mastery of his own passions and a profound sympathy for the sufferings of his patients. We feel his influence today, both as one of the great founders of rational medicine, and as a pioneer of observation and inductive reasoning in science.

## 8.5 Galen

Aelius Galenus or Claudius Galenus (129 AD - c. 200 AD), whose name is commonly Anglicized as Galen, was born in Pergamon, in present-day Turkey. Pergamon was then a Greek city-state and a great cultural center, whose library rivaled the Great Library

of Alexandria. Because the Ptolemaic dynasty of pharaohs had forbidden the export of papyrus from Egypt, Pergamon developed a way of treating animal skins so that they could be used as written documents. The term of these skins *charta pergamena*, is the root of the English word “parchment”.

Galen’s father was a wealthy and highly cultured architect and builder. He originally gave his son an education in philosophy to prepare him for a career in politics. However, when Galen was 16, his father had a dream in which Asclepius, the Greek god of medicine, commanded him to make his son study medicine instead of philosophy. As the result of his father’s dream, Galen continued to be given the best education available, but in a different field.

In AD 149. Galen’s beloved father died, and he inherited a very large fortune. Now financially independent, Galen was able to follow the advice that Hippocrates had given to young physicians. Hippocrates advised them to travel widely and to study medical practice in many countries. Galen studied first in Smyrna under Pelops, then in Corinth, and finally in Alexandria, where he absorbed the knowledge of anatomy and physiology handed down by the 3rd century BC physicians, Herophilus and Erasistratus, and the 1st century AD anatomist, Marinus.

In AD 157. after nine years of medical studies in foreign countries, Galen returned to Pergamon, where he spent three years as the surgeon of gladiators. He performed these duties so skillfully the death rate of wounded gladiators dropped to a small fraction of what it had been.

## **The physician of Emperor Marcus Aurelius**

In AD 161. Galen traveled to Rome, where he practiced medicine so successfully that he aroused the jealousy of local Roman physicians. Finally, fearing that he might be these jealous rivals, Galen returned to Pergamon. However, the Roman Emperor, Marcus Aurelius, had heard of his great skill as a physician, and commanded him to return to Rome. Galen then became the personal physician of Emperor Marcus Aurelius.

## **20 scribes, 400 books!**

Since Galen was independently very wealthy, he could afford to employ scribes to take down his thoughts. He is said to have employed 20 of them! Whether or not this is an exaggeration, Galen certainly produces a huge volume of writing. an estimated 400 books, on philosophy and medicine, amounting to ten million words.

## **A few things that Galen said or wrote**

**My father taught me to despise the opinion and esteem of others and to seek only the truth . . . He insisted further that the primary end of personal possessions is to relieve hunger, thirst, and nakedness, and if more than sufficient remains it should be transmitted into good works.**

Nature does nothing without a purpose. The physician is Nature's assistant.

### A few more quotations from Galen

Employment is Nature's physician, and is essential to human happiness.

Confidence and hope do more good than physic.

It is impossible for anyone to find the correct function of a part unless he is perfectly acquainted with the action of the whole instrument

When I tell them this, and add that all voluntary movement is produced by muscles controlled by nerves coming from the brain, they call me a "teller of marvelous tales" . . . No one has ever been able to withstand me when I have demonstrated the muscles of respiration and voice. The muscles move certain organs, but they themselves require, in order to be moved, certain nerves from the brain, and if you intercept one of these with a ligature, immediately the muscle in which the nerve is inserted and the organ moved are rendered motionless.

After my twenty-eighth year from birth, having persuaded myself that there is a certain art of hygiene, I followed its precepts for my subsequent life, so I was no longer sick with any disease except an occasional fever.

To me it seems that those who through ambition or zeal have chosen some form of life so involved in affairs of business that they can have little leisure for the care of their bodies, are also willing slaves to hard masters. So that for these it is impossible to prescribe absolutely perfect care of the body. But whoever is completely free, both by fortune and by choice, for him it is possible to suggest how he may enjoy the most health, suffer the least sickness, and grow old most comfortably.



Figure 8.5: A statue of the Greek god of healing, Asclepius. Although Galen believed Asclepius came to his aid, he also came to believe there was only one God. This made the later Christian and Muslim worlds much more receptive to his work.





Figure 8.6: Roman surgical instruments.



Figure 8.7: Galen dissecting a monkey, as imagined by Veloso Salgado in 1906



Figure 8.8: An 18th century portrait of Galen by Paul Busch

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# Chapter 9

## THE ATOMISTS

### 9.1 Leucippus, Democritus and the concept of atoms

#### What is permanent, and what changes?

In the 5th century B.C. there was a great deal of discussion among the Greek philosophers about whether there is anything permanent in the universe. Heraclitus (540 B.C. - 475 B.C.) maintained that *everything* is in a state of flux. Parmenides (540 B.C. - c. 470 B.C.) maintained that on the contrary *nothing* changes - that all change is illusory. Leucippus (490 B.C. - c. 420 B.C.) and his student Democritus (470 B.C. - c. 380 B.C.), by a lucky chance, hit on what a modern scientist would regard as very nearly the correct answer.

According to Democritus, if we cut an apple in half, and then cut the half into parts, and keep on in this way for long enough, we will eventually come down to pieces which cannot be further subdivided. Democritus called these ultimate building blocks of matter “atoms”, which means “indivisible”. He visualized the spaces between the atoms as being empty, and he thought that when a knife cuts an apple, the sharp edge of the blade fits into the empty spaces between the atoms and forces them apart.

Democritus believed that each atom is unchanged in the processes which we observe with our senses, where matter seems to change its form. However, he believed that the atoms are in a state of constant motion, and that they can combine with each other in various ways, thus producing the physical and chemical changes which we observe in nature. In other words, each atom is in itself eternal, but the way in which the atoms combine with each other is in a state of constant flux because of the motion of the atoms.

This is very nearly the same answer which we would give today to the question of which things in the universe are permanent and which change. Of course, the objects which we call “atoms” *can* be further subdivided, but if Democritus were living today he would say that we have merely made the mistake of calling the wrong things “atoms”. We should really apply the word to fundamental particles such as quarks, which cannot be further subdivided.

In discussing which things in the universe are permanent and which change, we would also add, from our modern point of view, that the fundamental laws of the universe are

permanent. In following these unchanging laws, matter and energy constantly alter their configuration, but the basic laws of nature remain invariant. For example, the configuration of the planets changes constantly, but these constant changes are governed by Newton's laws of motion, which are eternal.

## Parmenides' challenge

The Stanford Encyclopedia of Philosophy describes the doctrines of the atomists as follows:

Ancient sources describe atomism as one of a number of attempts by early Greek natural philosophers to respond to the challenge offered by Parmenides. Despite occasional challenges, this is how its motivation is generally interpreted by scholars today. Parmenides had argued that it is impossible for there to be change without something coming from nothing. Since the idea that something could come from nothing was generally agreed to be impossible, Parmenides argued that change is merely illusory. In response, Leucippus and Democritus, along with other Presocratic pluralists such as Empedocles and Anaxagoras, developed systems that made change possible by showing that it does not require that something should come to be from nothing. These responses to Parmenides suppose that there are multiple unchanging material principles, which persist and merely rearrange themselves to form the changing world of appearances. In the atomist version, these unchanging material principles are indivisible particles, the atoms: the atomists are often thought to have taken the idea that there is a lower limit to divisibility to answer Zeno's paradoxes about the impossibility of traversing infinitely divisible magnitudes. Reconstructions offered by Wardy (1988) and Sedley (2008) argue, instead, that atomism was developed as a response to Parmenidean arguments.

The atomists held that there are two fundamentally different kinds of realities composing the natural world, atoms and void. Atoms, from the Greek adjective *atomos* or *atomon*, 'indivisible,' are infinite in number and various in size and shape, and perfectly solid, with no internal gaps. They move about in an infinite void, repelling one another when they collide or combining into clusters by means of tiny hooks and barbs on their surfaces, which become entangled. Other than changing place, they are unchangeable, ungenerated and indestructible. All changes in the visible objects of the world of appearance are brought about by relocations of these atoms: in Aristotelian terms, the atomists reduce all change to change of place. Macroscopic objects in the world that we experience are really clusters of these atoms; changes in the objects we see - qualitative changes or growth, say - are caused by rearrangements or additions to the atoms composing them. While the atoms are eternal, the objects compounded out of them are not. Clusters of atoms moving in the infinite void come to form *kosmoi* or worlds as a result of a circular motion that gathers atoms up into a whirl, creating clusters within it; these *kosmoi*



are impermanent. Our world and the species within it have arisen from the collision of atoms moving about in such a whirl, and will likewise disintegrate in time.

## 9.2 Opposition from Plato and Aristotle

Of the various ancient philosophers, Democritus is the one who comes closest to our modern viewpoint. However, the ideas of Democritus were too advanced for his contemporaries. Although Democritus was not actually thrown into prison for his beliefs, they aroused considerable hostility. According to Diogenes Laertius, Plato dislike the ideas of Democritus so much that he wished that all of his books could be burned. (Plato had his wish! None of the seventy-two books of Democritus has survived.) Aristotle also argued against atomism, and because of the enormous authority which was attached to Aristotle's opinions, atomism almost disappeared from western thought until the time of John Dalton (1766 - 1844).

## 9.3 Epicurus and Lucretius

That the ideas of Democritus did not disappear entirely was due to the influence of Epicurus (341 B.C. - 270 B.C.), who made mechanism and atomism the cornerstones of his philosophy. The Roman poet Lucretius (95 B.C. - 55 B.C.) expounded the philosophy of Epicurus in a long poem called *De Natura Rerum* (On the Nature of Things). During the middle ages, this poem disappeared completely, but in 1417, a single surviving manuscript was discovered. The poem was then published, using Gutenberg's newly-invented printing press, and it became extremely popular. Thus, the idea of atoms was not entirely lost, and after being revived by John Dalton, it became one of the cornerstones of modern science.



Figure 9.1: A painting depicting Democritus. He was sometimes called “the laughing philosopher” because of his belief in a cheerful attitude towards life.



Figure 9.2: An English translation of *De Natura Rerum*.

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# Chapter 10

## ALEXANDER OF MACEDON

### 10.1 Alexander of Macedon

How much influence did Aristotle have on his pupil, Alexander of Macedon? We know that in 327 B.C. Alexander, (who was showing symptoms of megalomania), executed Aristotle's nephew, Callisthenes; so Aristotle's influence cannot have been very complete. On the other hand, we can think of Alexander driving his reluctant army beyond the Caspian Sea to Parthia, beyond Parthia to Bactria, beyond Bactria to the great wall of the Himalayas, and from there south to the Indus, where he turned back only because of the rebellion of his homesick officers. This attempt to reach the uttermost limits of the world seems to have been motivated as much by a lust for knowledge as by a lust for power.

Alexander was not a Greek, but nevertheless he regarded himself as an apostle of Greek culture. As the Athenian orator, Isocrates, remarked, "The word 'Greek' is not so much a term of birth as of mentality, and is applied to a common culture rather than to a common descent."

Although he was cruel and wildly temperamental, Alexander could also display an almost hypnotic charm, and this charm was a large factor in his success. He tried to please the people of the countries through which he passed by adopting some of their customs. He married two barbarian princesses, and, to the dismay of his Macedonian officers, he also adopted the crown and robes of a Persian monarch.

Wherever Alexander went, he founded Greek-style cities, many of which were named Alexandria. In Babylon, In 323 B.C., after a drunken orgy, Alexander caught a fever and died at the age of 33. His loosely-constructed empire immediately fell to pieces. The three largest pieces were seized by three of his generals. The Persian Empire went to Seleucis, and became known as the Seleucid Empire. Antigonus became king of Macedon and protector of the Greek city-states. A third general, Ptolemy, took Egypt.

Although Alexander's dream of a politically united world collapsed immediately after his death, his tour through almost the entire known world had the effect of blending the

ancient cultures of Greece, Persia, India and Egypt, and producing a world culture. The era associated with this culture is usually called the Hellenistic Era (323 B.C. - 146 B.C.). Although the Hellenistic culture was a mixture of all the great cultures of the ancient world, it had a decidedly Greek flavor, and during this period the language of educated people throughout the known world was Greek.

## 10.2 Alexandria

Nowhere was the cosmopolitan character of the Hellenistic Era more apparent than at Alexandria in Egypt. No city in history has ever boasted a greater variety of people. Ideally located at the crossroads of world trading routes, Alexandria became the capital of the world - not the political capital, but the cultural and intellectual capital.

Miletus in its prime had a population of 25,000; Athens in the age of Pericles had about 100,000 people; but Alexandria was the first city in history to reach a population of over a million!

Strangers arriving in Alexandria were impressed by the marvels of the city - machines which sprinkled holy water automatically when a five-drachma coin was inserted, water-driven organs, guns powered by compressed air, and even moving statues, powered by water or steam!

For scholars, the chief marvels of Alexandria were the great library and the Museum established by Ptolemy I. Credit for making Alexandria the intellectual capital of the world must go to Ptolemy I and his successors (all of whom were named Ptolemy except the last of the line, the famous queen, Cleopatra). Realizing the importance of the schools which had been founded by Pythagoras, Plato and Aristotle, Ptolemy I established a school at Alexandria. This school was called the Museum, because it was dedicated to the muses.

Near to the Museum, Ptolemy built a great library for the preservation of important manuscripts. The collection of manuscripts which Aristotle had built up at the Lyceum in Athens became the nucleus of this great library. The library at Alexandria was open to the general public, and at its height it was said to contain 750,000 volumes. Besides preserving important manuscripts, the library became a center for copying and distributing books.

The material which the Alexandrian scribes used for making books was papyrus, which was relatively inexpensive. The Ptolemys were anxious that Egypt should keep its near-monopoly on book production, and they refused to permit the export of papyrus. Pergamum, a rival Hellenistic city in Asia Minor, also boasted a library, second in size only to the great library at Alexandria. The scribes at Pergamum, unable to obtain papyrus from Egypt, tried to improve the preparation of the skins traditionally used for writing in Asia. The resulting material was called *membranum pergamenum*, and in English, this name has become "parchment".



Figure 10.1: An image of Alexander.





Figure 10.2: Alexander on horseback.



Figure 10.3: Another image of Alexander.



Figure 10.4: Alexander's empire was very large, but it fell apart quickly after his early death..

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# Chapter 11

## EUCLID

### 11.1 Alexandria

Alexander of Macedon's brief conquest of the entire known world had the effect of blending the ancient cultures of Greece, Persia, India and Egypt, and producing a world culture. The era associated with this culture is usually called the Hellenistic Era (323 B.C. - 146 B.C.). Although the Hellenistic culture was a mixture of all the great cultures of the ancient world, it had a decidedly Greek flavor, and during this period the language of educated people throughout the known world was Greek.

Nowhere was the cosmopolitan character of the Hellenistic Era more apparent than at Alexandria in Egypt. No city in history has ever boasted a greater variety of people. Ideally located at the crossroads of world trading routes, Alexandria became the capital of the world - not the political capital, but the cultural and intellectual capital.

Miletus in its prime had a population of 25,000; Athens in the age of Pericles had about 100,000 people; but Alexandria was the first city in history to reach a population of over a million!

Strangers arriving in Alexandria were impressed by the marvels of the city - machines which sprinkled holy water automatically when a five-drachma coin was inserted, water-driven organs, guns powered by compressed air, and even moving statues, powered by water or steam!

### 11.2 The Museum and the Great Library of Alexandria

For scholars, the chief marvels of Alexandria were the great library and the Museum established by Ptolemy I. Credit for making Alexandria the intellectual capital of the world must go to Ptolemy I and his successors (all of whom were named Ptolemy except the last of the line, the famous queen, Cleopatra). Realizing the importance of the schools which had been founded by Pythagoras, Plato and Aristotle, Ptolemy I established a school

at Alexandria. This school was called the Museum, because it was dedicated to the muses.

Near to the Museum, Ptolemy built a great library for the preservation of important manuscripts. The collection of manuscripts which Aristotle had built up at the Lyceum in Athens became the nucleus of this great library. The library at Alexandria was open to the general public, and at its height it was said to contain 750,000 volumes. Besides preserving important manuscripts, the library became a center for copying and distributing books.

The material which the Alexandrian scribes used for making books was papyrus, which was relatively inexpensive. The Ptolemys were anxious that Egypt should keep its near-monopoly on book production, and they refused to permit the export of papyrus. Pergamum, a rival Hellenistic city in Asia Minor, also boasted a library, second in size only to the great library at Alexandria. The scribes at Pergamum, unable to obtain papyrus from Egypt, tried to improve the preparation of the skins traditionally used for writing in Asia. The resulting material was called *membranum pergamenum*, and in English, this name has become “parchment”.

### 11.3 Euclid is called to the Museum

One of the first scholars to be called to the newly-established Museum was Euclid. He was born in 325 B.C. and was probably educated at Plato’s Academy in Athens. While in Alexandria, Euclid wrote the most successful text-book of all time, the *Elements of Geometry*. The theorems in this splendid book were not, for the most part, originated by Euclid. They were the work of many generations of classical Greek geometers. Euclid’s contribution was to take the theorems of the classical period and to arrange them in an order which is so logical and elegant that it almost defies improvement. One of Euclid’s great merits is that he reduces the number of axioms to a minimum, and he does not conceal the dubiousness of certain axioms.

Euclid’s axiom concerning parallel lines has an interesting history: This axiom states that “Through a given point not on a given line, one and only one line can be drawn parallel to a given line”. At first, mathematicians doubted that it was necessary to have such an axiom. They suspected that it could be proved by means of Euclid’s other more simple axioms. After much thought, however, they decided that the axiom is indeed one of the necessary foundations of classical geometry. They then began to wonder whether there could be another kind of geometry where the postulate concerning parallels is discarded. These ideas were developed in the 18th and 19th centuries by Lobachevsky, Bolyai, Gauss and Riemann, and in the 20th century by Levi-Civita. In 1915, the mathematical theory of non-Euclidean geometry finally became the basis for Einstein’s general theory of relativity.

Besides classical geometry, Euclid’s book also contains some topics in number theory. For example, he discusses irrational numbers, and he proves that the number of primes is infinite. He also discusses geometrical optics.

Euclid’s *Elements* has gone through more than 1,000 editions since the invention of printing - more than any other book, with the exception of the Bible. Its influence has been immense. For more than two thousand years, Euclid’s *Elements of Geometry* has



Figure 11.1: Euclid, detail from “The School of Athens”, a painting by Raphael. It is not proven that this is Euclid. Some references point this person out as Archimedes.



Figure 11.2: One of the oldest surviving fragments of Euclid’s Elements, found at Oxyrhynchus and dated to circa AD 100 (P. Oxy. 29). The diagram accompanies Book II, Proposition 5.

served as a model for rational thought.



## 11.4 The eight books of Euclid's *Elements*

Here are the titles of the eight books of Euclid's *Elements of Geometry*:<sup>1</sup>

1. Book I, On basic plane geometry
2. Book II, On geometric algebra
3. Book III, On circles and angles
4. Book IV, On construction of regular polygons
5. Book V, On Eudoxes' of abstract theory of ratio proportions, abstract algebra
6. Book VI, On similar figures and geometric proportions
7. Book VII, On basic number theory
8. Book VIII, On continuous proportions (geometric progressions) in number theory

## 11.5 Euclid's Book I, *On basic plane geometry*

### Definitions

1. A point is that which has no part.
2. A line is breadthless length.
3. The ends of a line are points.
4. A straight line is a line which lies evenly with the points on itself.
5. A surface is that which has length and breadth only.
6. The edges of a surface are lines.
7. A plane surface is a surface which lies evenly with the straight lines on itself.
8. A plane angle is the inclination to one another of two lines in a plane which meet one another and do not lie in a straight line.
9. And when the lines containing the angle are straight, the angle is called rectilinear.

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<sup>1</sup><https://mathcs.clarku.edu/~djoyce/elements/trip.html>

10. When a straight line standing on a straight line makes the adjacent angles equal to one another, each of the equal angles is right, and the straight line standing on the other is called a perpendicular to that on which it stands.
11. An obtuse angle is an angle greater than a right angle.
12. An acute angle is an angle less than a right angle.
13. A boundary is that which is an extremity of anything.
14. A figure is that which is contained by any boundary or boundaries.
15. A circle is a plane figure contained by one line such that all the straight lines falling upon it from one point among those lying within the figure equal one another.
16. And the point is called the center of the circle.
17. A diameter of the circle is any straight line drawn through the center and terminated in both directions by the circumference of the circle, and such a straight line also bisects the circle.
18. A semicircle is the figure contained by the diameter and the circumference cut off by it. And the center of the semicircle is the same as that of the circle.
19. Rectilinear figures are those which are contained by straight lines, trilateral figures being those contained by three, quadrilateral those contained by four, and multilateral those contained by more than four straight lines.
20. Of trilateral figures, an equilateral triangle is that which has its three sides equal, an isosceles triangle that which has two of its sides alone equal, and a scalene triangle that which has its three sides unequal.
21. Further, of trilateral figures, a right-angled triangle is that which has a right angle, an obtuse-angled triangle that which has an obtuse angle, and an acute-angled triangle that which has its three angles acute.
22. Of quadrilateral figures, a square is that which is both equilateral and right-angled; an oblong that which is right-angled but not equilateral; a rhombus that which is equilateral but not right-angled; and a rhomboid that which has its opposite sides and angles equal to one another but is neither equilateral nor right-angled. And let quadrilaterals other than these be called trapezia.

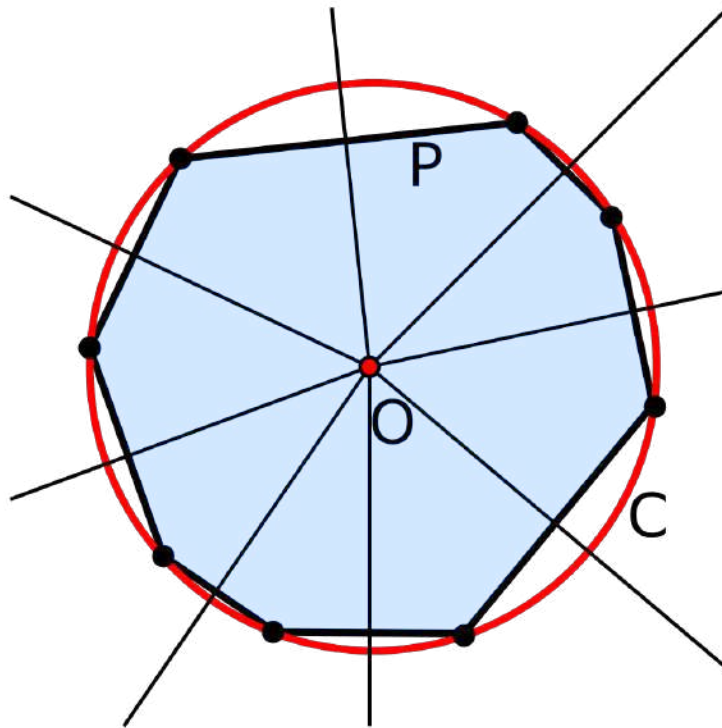


Figure 11.3: Circumscribed circle,  $C$ , and circumcenter,  $O$ , of a cyclic polygon,  $P$ .

23. Parallel straight lines are straight lines which, being in the same plane and being produced indefinitely in both directions, do not meet one another in either direction.

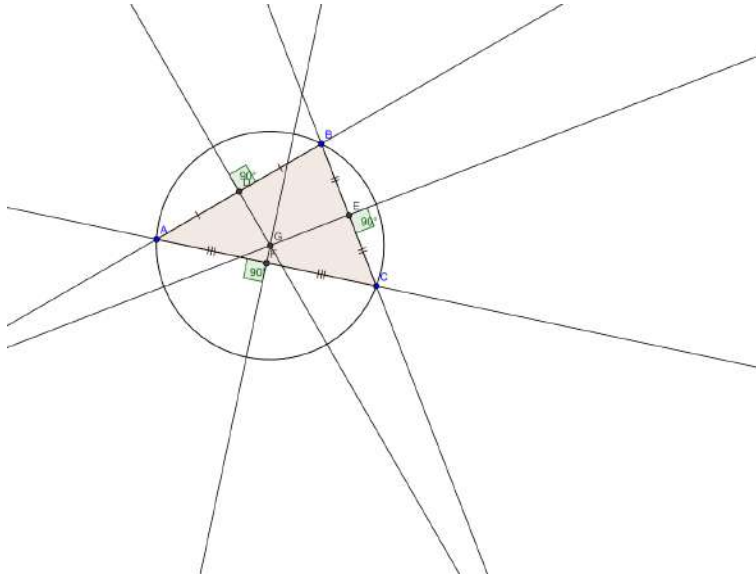


Figure 11.4: **Construction of the circumcircle and the circumcenter.**

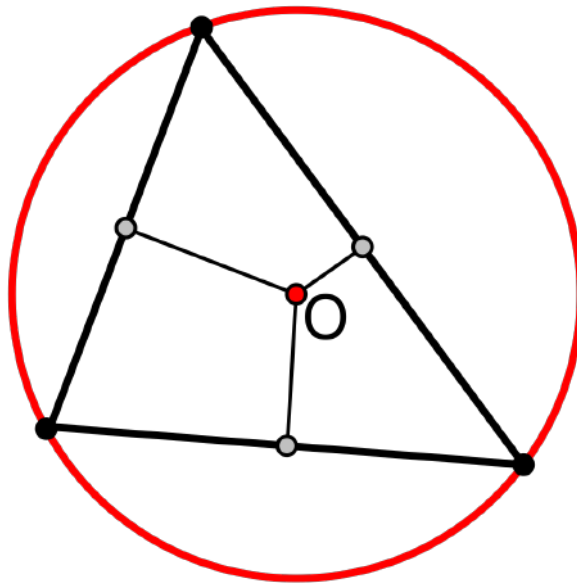


Figure 11.5: **The circumcenter of an acute triangle is inside the triangle.**

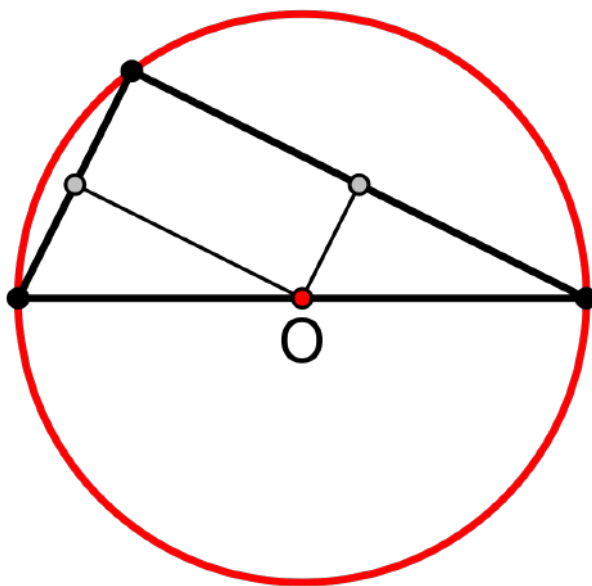


Figure 11.6: The circumcenter of a right triangle is at the midpoint of the hypotenuse.

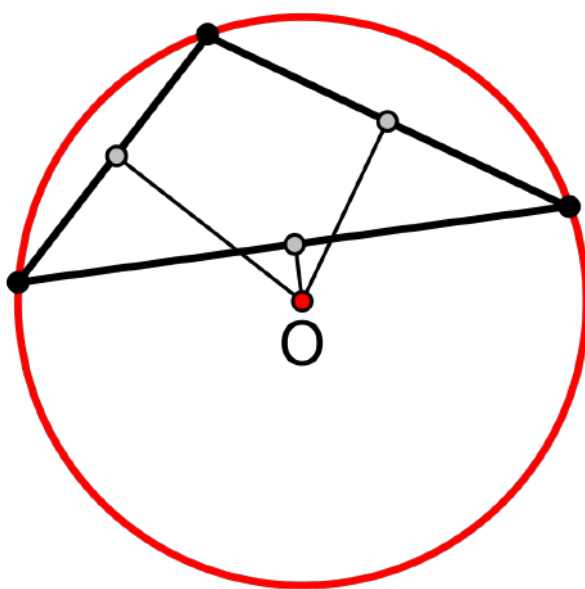


Figure 11.7: The circumcenter of an obtuse triangle is outside the triangle.

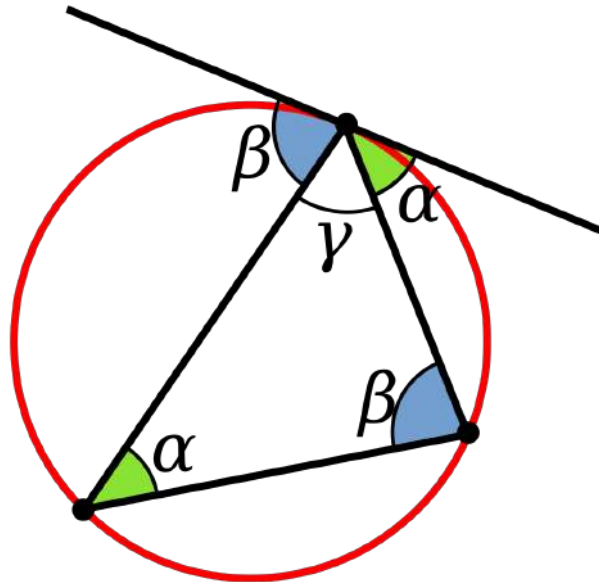


Figure 11.8: A diagram of the angles in a circumcircle of a triangle, showing the alternate angle theorem.

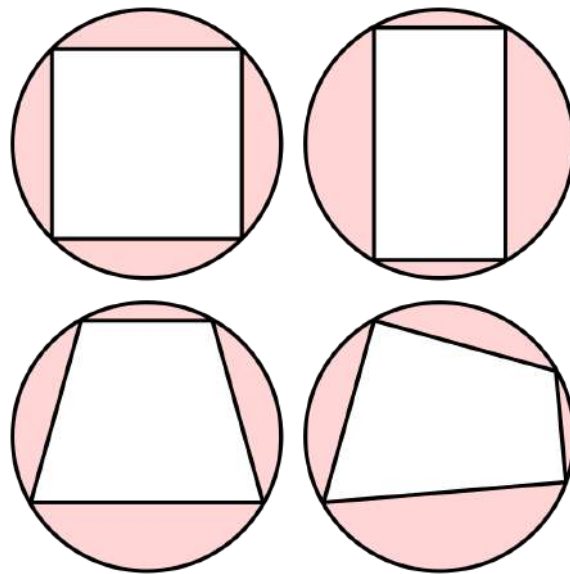


Figure 11.9: Cyclic quadrilaterals.

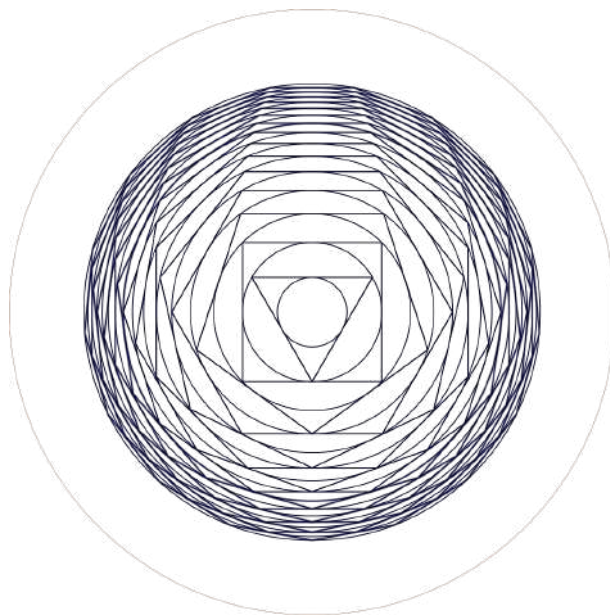


Figure 11.10: A sequence of circumscribed polygons and circles.

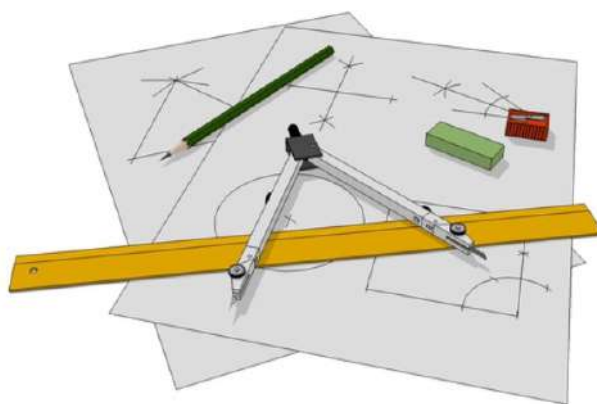


Figure 11.11: Straightedge and compass, the only tools that classical geometers were allowed to use.

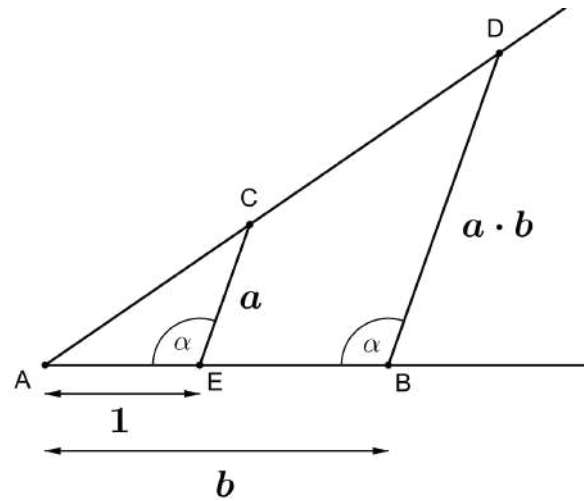


Figure 11.12: The intercept theorem.

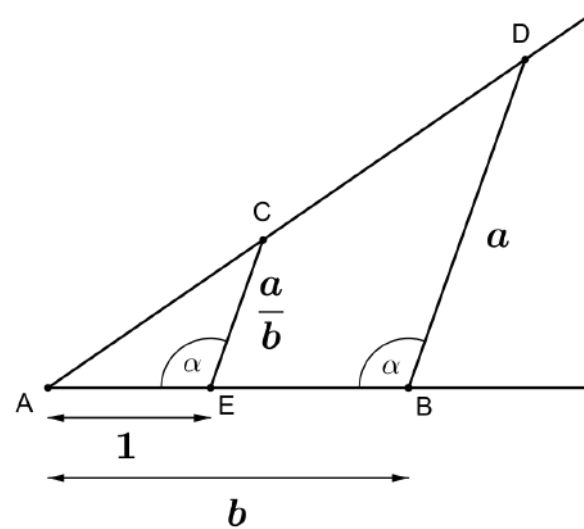
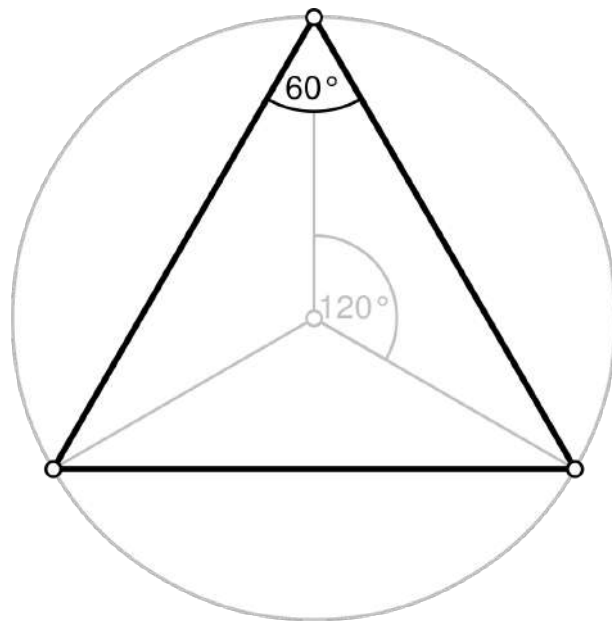
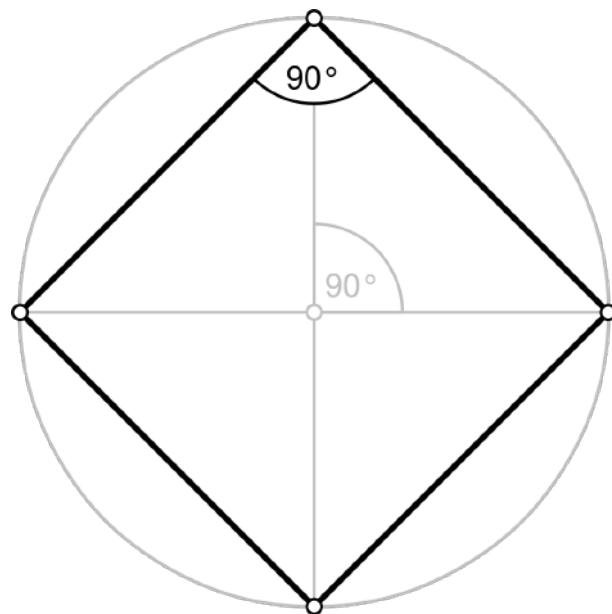


Figure 11.13: Another form of the intercept theorem.



Figure 11.14: **Equilateral triangle with angles.**Figure 11.15: **Square with angles.**

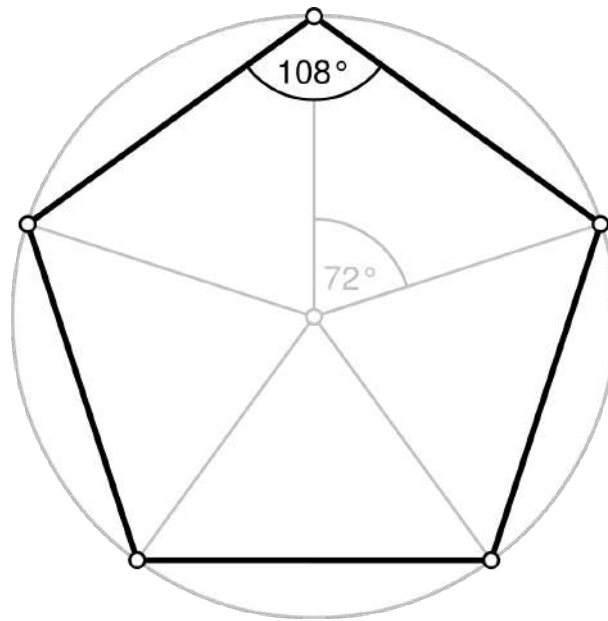


Figure 11.16: **Regular pentagon with angles.**

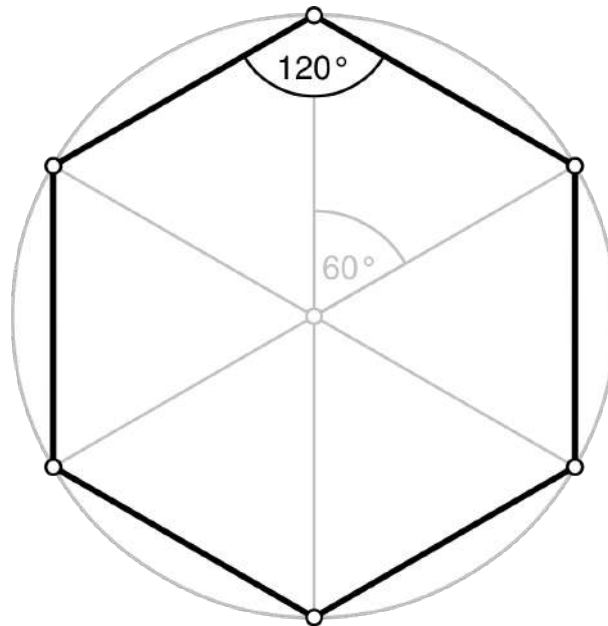


Figure 11.17: **Regular hexagon with angles.**

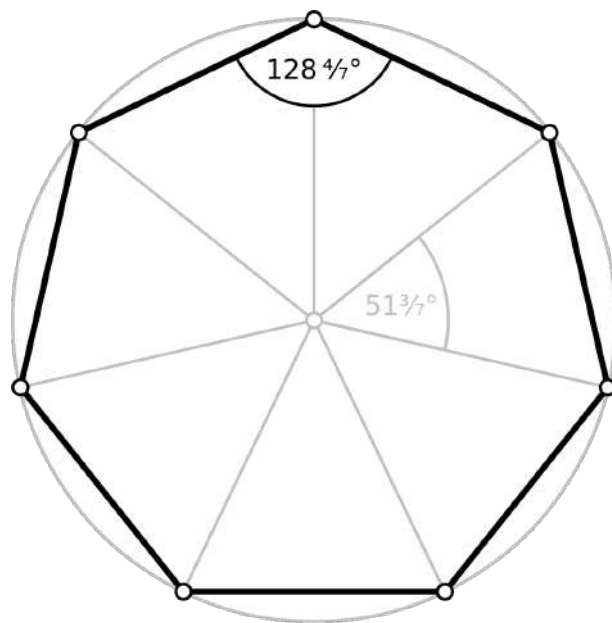


Figure 11.18: Regular heptagon with angles.

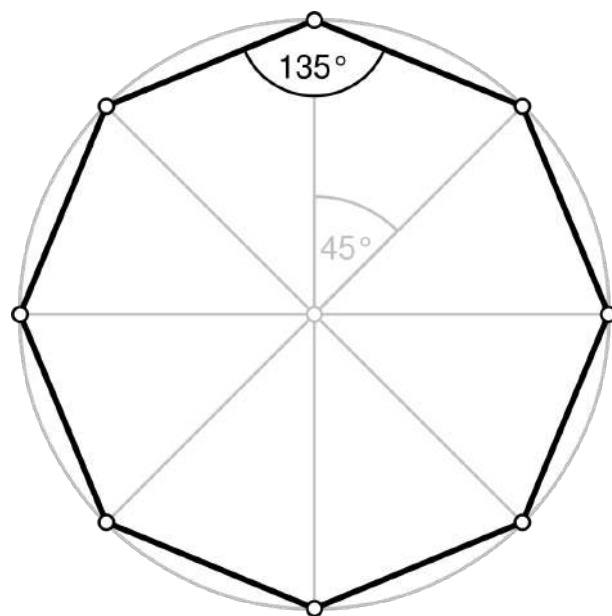


Figure 11.19: Regular octagon with angles.

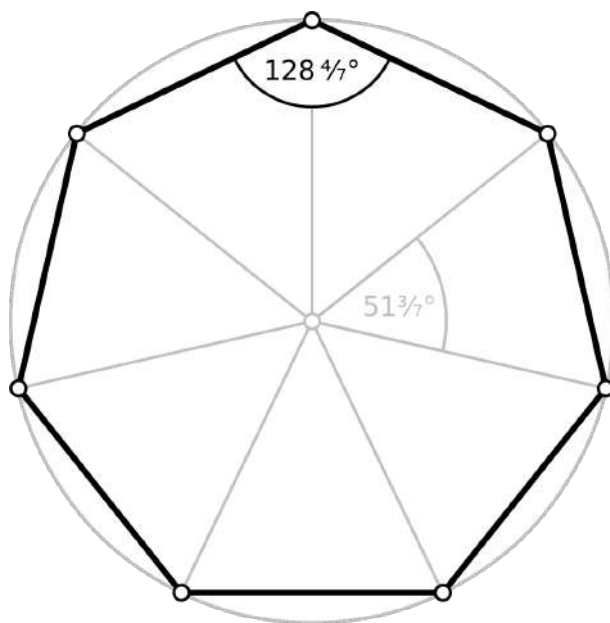


Figure 11.20: **Regular nonagon with angles.**

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## Chapter 12

# ERATOSTHENES AND ARISTARCHUS

### 12.1 Eratosthenes

Eratosthenes (276 B.C. - 196 B.C.), the director of the library at Alexandria, was probably the most cultured man of the Hellenistic Era. His interests and abilities were universal. He was an excellent historian, in fact the first historian who ever attempted to set up an accurate chronology of events. He was also a literary critic, and he wrote a treatise on Greek comedy. He made many contributions to mathematics, including a study of prime numbers and a method for generating primes called the “sieve of Eratosthenes”.

As a geographer, Eratosthenes made a map of the world which, at that time, was the most accurate that had ever been made. The positions of various places on Eratosthenes’ map were calculated from astronomical observations. The latitude was calculated by measuring the angle of the polar star above the horizon, while the longitude probably was calculated from the apparent local time of lunar eclipses.

As an astronomer, Eratosthenes made an extremely accurate measurement of the angle between the axis of the earth and the plane of the sun’s apparent motion; and he also prepared a map of the sky which included the positions of 675 stars.

Eratosthenes’ greatest achievement however, was an astonishingly precise measurement of the radius of the earth. The value which he gave for the radius was within 50 miles of what we now consider to be the correct value! To make this remarkable measurement, Eratosthenes of course assumed that the earth is spherical, and he also assumed that the sun is so far away from the earth that rays of light from the sun, falling on the earth, are almost parallel. He knew that directly south of Alexandria there was a city called Seyne, where at noon on a midsummer day, the sun stands straight overhead. Given these facts, all he had to do to find the radius of the earth was to measure the distance between Alexandria and Seyne. Then, at noon on a midsummer day, he measured the angle which the sun makes with the vertical at Alexandria. From these two values, he calculated the circumference of the earth to be a little over 25,000 miles. This was so much larger than the

size of the known world that Eratosthenes concluded (correctly) that most of the earth's surface must be covered with water; and he stated that "If it were not for the vast extent of the Atlantic, one might sail from Spain to India along the same parallel."

## 12.2 Aristarchus

The Hellenistic astronomers not only measured the size of the earth - they also measured the sizes of the sun and the moon, and their distances from the earth. Among the astronomers who worked on this problem was Aristarchus (c. 320 B.C. - c. 250 B.C.). Like Pythagoras, he was born on the island of Samos, and he may have studied in Athens under Strato. However, he was soon drawn to Alexandria, where the most exciting scientific work of the time was being done.

Aristarchus calculated the size of the moon by noticing the shape of the shadow of the earth thrown on the face of the moon during a solar eclipse. From the shape of the earth's shadow, he concluded that the diameter of the moon is about a third the diameter of the earth. (This is approximately correct).

From the diameter of the moon and the angle between its opposite edges when it is seen from the earth, Aristarchus could calculate the distance of the moon from the earth. Next he compared the distance from the earth to the moon with the distance from the earth to the sun. To do this, he waited for a moment when the moon was exactly half-illuminated. Then the earth, moon and sun formed a right triangle, with the moon at the corner corresponding to the right angle. Aristarchus, standing on the earth, could measure the angle between the moon and the sun. He already knew the distance from the earth to the moon, so now he knew two angles and one side of the right triangle. This was enough to allow him to calculate the other sides, one of which was the sun-earth distance. His value for this distance was not very accurate, because small errors in measuring the angles were magnified in the calculation.

Aristarchus concluded that the sun is about twenty times as distant from the earth as the moon, whereas in fact it is about four hundred times as distant. Still, even the underestimated distance which Aristarchus found convinced him that the sun is enormous! He calculated that the sun has about seven times the diameter of the earth, and three hundred and fifty times the earth's volume. Actually, the sun's diameter is more than a hundred times the diameter of the earth, and its volume exceeds the earth's volume by a factor of more than a million!

Even his underestimated value for the size of the sun was enough to convince Aristarchus that the sun does not move around the earth. It seemed ridiculous to him to imagine the enormous sun circulating in an orbit around the tiny earth. Therefore he proposed a model of the solar system in which the earth and all the planets move in orbits around the sun, which remains motionless at the center; and he proposed the idea that the earth spins about its axis once every day.

Although it was the tremendous size of the sun which suggested this model to Aristarchus, he soon realized that the heliocentric model had many calculational advantages: For ex-



ample, it made the occasional retrograde motion of certain planets much easier to explain. Unfortunately, he did not work out detailed table for predicting the positions of the planets. If he had done so, the advantages of the heliocentric model would have been so obvious that it might have been universally adopted almost two thousand years before the time of Copernicus, and the history of science might have been very different.

Aristarchus was completely right, but being right does not always lead to popularity. His views were not accepted by the majority of astronomers, and he was accused of impiety by the philosopher Cleanthes, who urged the authorities to make Aristarchus suffer for his heresy. Fortunately, the age was tolerant and enlightened, and Aristarchus was never brought to trial.

The model of the solar system on which the Hellenistic astronomers finally agreed was not that of Aristarchus but an alternative (and inferior) model developed by Hipparchus (c. 190 B.C. - c. 120 B.C.). Hipparchus made many great contributions to astronomy and mathematics. For example, he was the first person to calculate and publish tables of trigonometric functions. He also invented many instruments for accurate naked-eye observations. He discovered the “precession of equinoxes”, introduced a classification of stars according to their apparent brightness, and made a star-map which far outclassed the earlier star-map of Eratosthenes. Finally, he introduced a model of the solar system which allowed fairly accurate calculation of the future positions of the planets, the sun and the moon.

In English, we use the phrase “wheels within wheels” to describe something excessively complicated. This phrase is derived from the model of the solar system introduced by Hipparchus! In his system, each planet has a large wheel which revolves with uniform speed about the earth (or in some cases, about a point near to the earth). Into this large wheel was set a smaller wheel, called the “epicycle”, which also revolved with uniform speed. A point on the smaller wheel was then supposed to duplicate the motion of the planet. In some cases, the model of Hipparchus needed still more “wheels within wheels” to duplicate the planet’s motion.. The velocities and sizes of the wheels were chosen in such a way as to “save the appearances”.

The model of Hipparchus was popularized by the famous Egyptian astronomer, Claudius Ptolemy (c. 75 A.D. - c. 135 A.D.), in a book which dominated astronomy up to the time of Copernicus. Ptolemy’s book was referred to by its admirers as *Megale Mathematike Syntaxis* (The Great Mathematical Composition). During the dark ages which followed the fall of Rome, Ptolemy’s book was preserved and translated into Arabic by the civilized Moslems, and its name was shortened to *Almagest* (The Greatest). It held the field until, in the 15th century, the brilliant heliocentric model of Aristarchus was rescued from oblivion by Copernicus.



Figure 12.1: A map of the known world by Eratosthenes, surrounded by spheres on which moved the sun, moon and stars.



Figure 12.2: A statue of Aristarchus. In the background we see his sun-centered picture of planetary motion.

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# Chapter 13

## ARCHIMEDES

### 13.1 Hieron's crown

Archimedes was the greatest mathematician of the Hellenistic Era. In fact, together with Newton and Gauss, he is considered to be one of the greatest mathematicians of all time.

Archimedes was born in Syracuse in Sicily in 287 B.C.. He was the son of an astronomer, and he was also a close relative of Hieron II, the king of Syracuse. Like most scientists of his time, Archimedes was educated at the Museum in Alexandria, but unlike most, he did not stay in Alexandria. He returned to Syracuse, probably because of his kinship with Hieron II. Being a wealthy aristocrat, Archimedes had no need for the patronage of the Ptolemys.

Many stories are told about Archimedes: For example, he is supposed to have been so absent-minded that he often could not remember whether he had eaten. Another (perhaps apocryphal) story has to do with the discovery of “Archimedes Principle” in hydrostatics. According to the story, Hieron had purchased a golden crown of complex shape, and he had begun to suspect that the goldsmith had cheated him by mixing silver with gold. Since Hieron knew that his bright relative, Archimedes, was an expert in calculating the volumes of complex shapes, he took the crown to Archimedes and asked him to determine whether it was made of pure gold (by calculating its specific gravity). However, the crown was too irregularly shaped, and even Archimedes could not calculate its volume.

While he was sitting in his bath worrying about this problem, Archimedes reflected on the fact that his body seemed less heavy when it was in the water. Suddenly, in a flash of intuition, he saw that the amount by which his weight was reduced was equal to the weight of the displaced water. He leaped out of his bath shouting “*Eureka! Eureka!*” (“I’ve found it!”) and ran stark naked through the streets of Syracuse to the palace of Hieron to tell him of the discovery.

The story of Hieron’s crown illustrates the difference between the Hellenistic period and the classical period. In the classical period, geometry was a branch of religion and philosophy. For aesthetic reasons, the tools which a classical geometer was allowed to use were restricted to a compass and a straight-edge. Within these restrictions, many problems

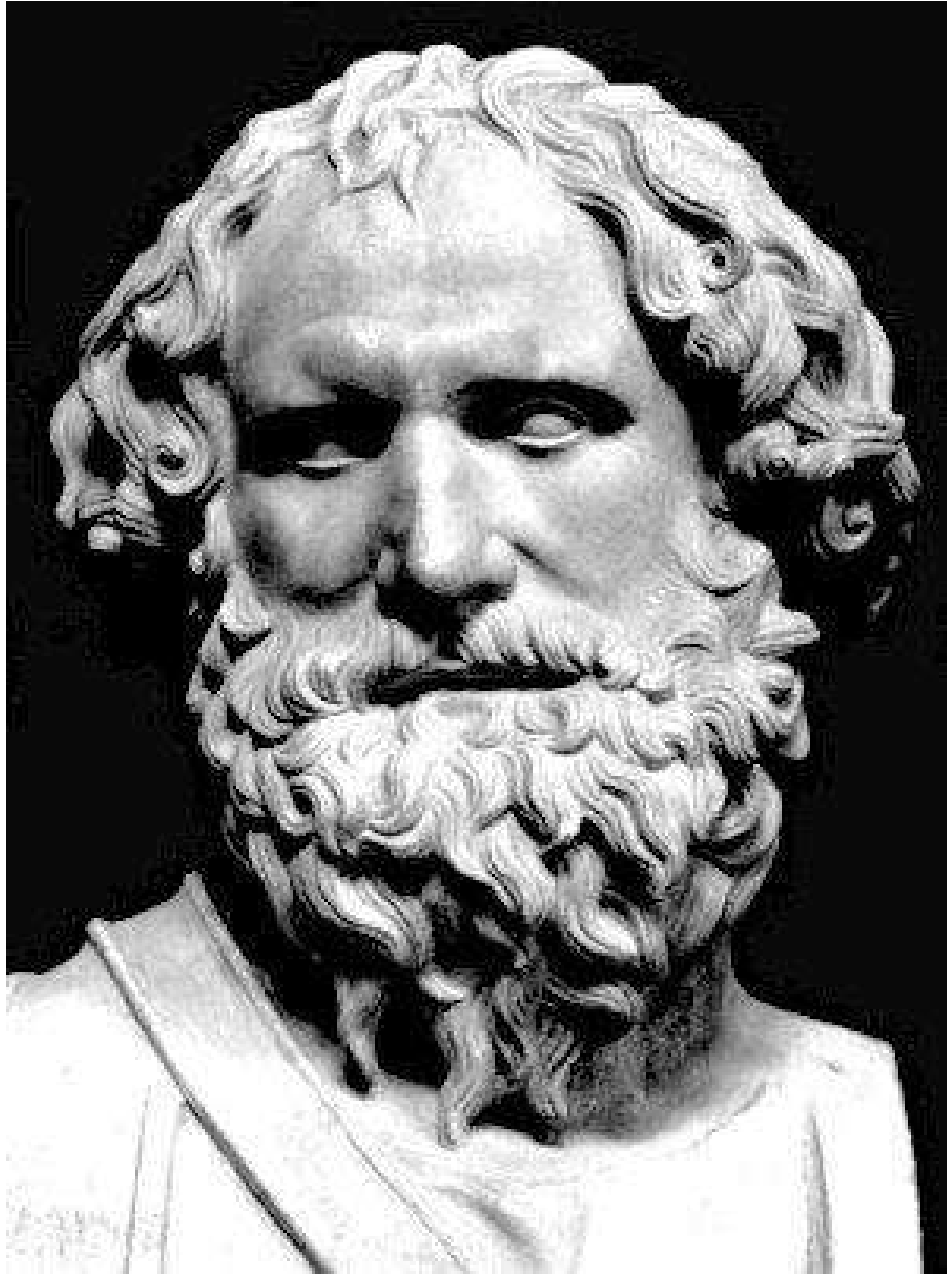


Figure 13.1: **A statue of Archimedes (287 BC - 212 BC.** He invented both differential and integral calculus almost two milenia before Newton, but he was unable to teach his methods to his contemporaries.

are insoluble. For example, within the restrictions of classical geometry, it is impossible to solve the problem of trisecting an angle. In the story of Hieron's crown, Archimedes breaks free from the classical restrictions and shows himself willing to use every conceivable means to achieve his purpose.

One is reminded of Alexander of Macedon who, when confronted with the Gordian Knot, is supposed to have drawn his sword and cut the knot in two! In a book *On Method*, which he sent to his friend Eratosthenes, Archimedes even confesses to cutting out figures from paper and weighing them as a means of obtaining intuition about areas and centers of gravity. Of course, having done this, he then derived the areas and centers of gravity by more rigorous methods.

## 13.2 Invention of differential and integral calculus

One of Archimedes' great contributions to mathematics was his development of methods for finding the areas of plane figures bounded by curves, as well as methods for finding the areas and volumes of solid figures bounded by curved surfaces. To do this, he employed the "doctrine of limits". For example, to find the area of a circle, he began by inscribing a square inside the circle. The area of the square was a first approximation to the area of the circle. Next, he inscribed a regular octagon and calculated its area, which was a closer approximation to the area of the circle. This was followed by a figure with 16 sides, and then 32 sides, and so on. Each increase in the number of sides brought him closer to the true area of the circle.

Archimedes also circumscribed polygons about the circle, and thus he obtained an upper limit for the area, as well as a lower limit. The true area was trapped between the two limits. In this way, Archimedes showed that the value of pi lies between  $223/71$  and  $220/70$ .

Sometimes Archimedes' use of the doctrine of limits led to exact results. For example, he was able to show that the ratio between the volume of a sphere inscribed in a cylinder to the volume of the cylinder is  $2/3$ , and that the area of the sphere is  $2/3$  the area of the cylinder. He was so pleased with this result that he asked that a sphere and a cylinder be engraved on his tomb, together with the ratio,  $2/3$ .

Another problem which Archimedes was able to solve exactly was the problem of calculating the area of a plane figure bounded by a parabola. In his book *On method*, Archimedes says that it was his habit to begin working on a problem by thinking of a plane figure as being composed of a very large number of narrow strips, or, in the case of a solid, he thought of it as being built up from a very large number of slices. This is exactly the approach which is used in integral calculus.

Archimedes must really be credited with the invention of both differential and integral calculus. He used what amounts to integral calculus to find the volumes and areas not only of spheres, cylinders and cones, but also of spherical segments, spheroids, hyperboloids and paraboloids of revolution; and his method for constructing tangents anticipates differential calculus.

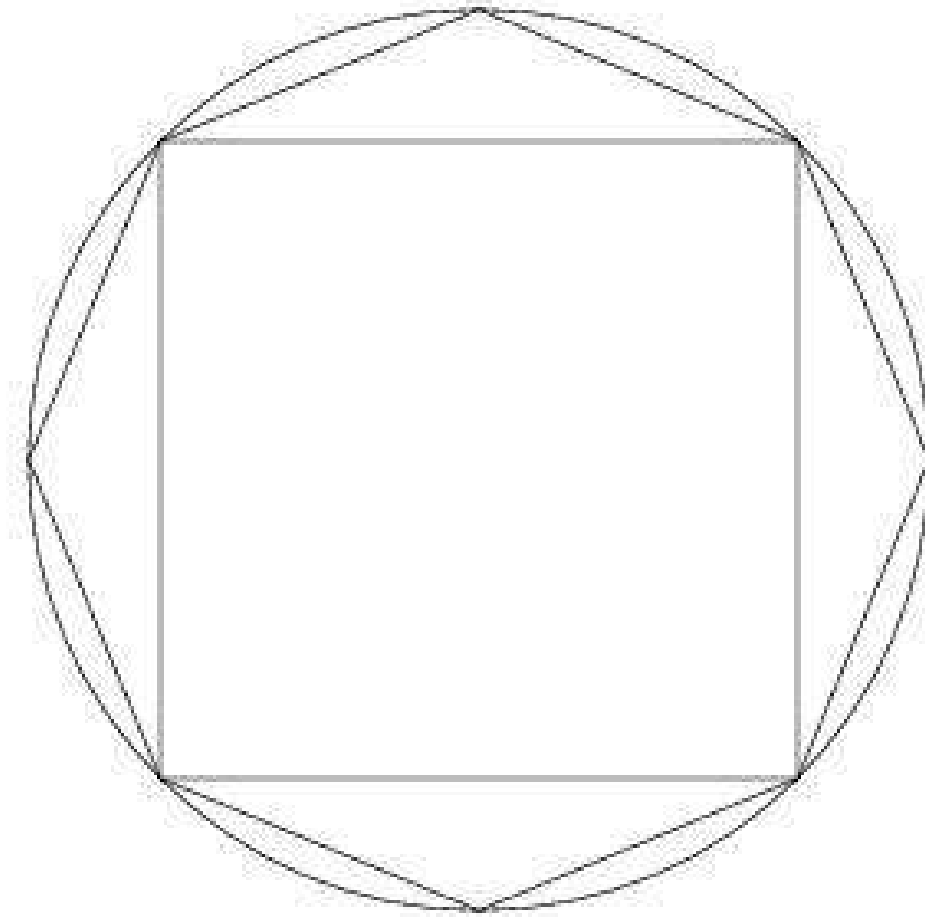


Figure 13.2: This figure illustrates one of the ways in which Archimedes used his doctrine of limits to calculate the area of a circle. He first inscribed a square within the circle, then an octagon, then a figure with 16 sides, and so on. As the number of sides became very large, the area of these figures (which he could calculate) approached the true area of the circle.



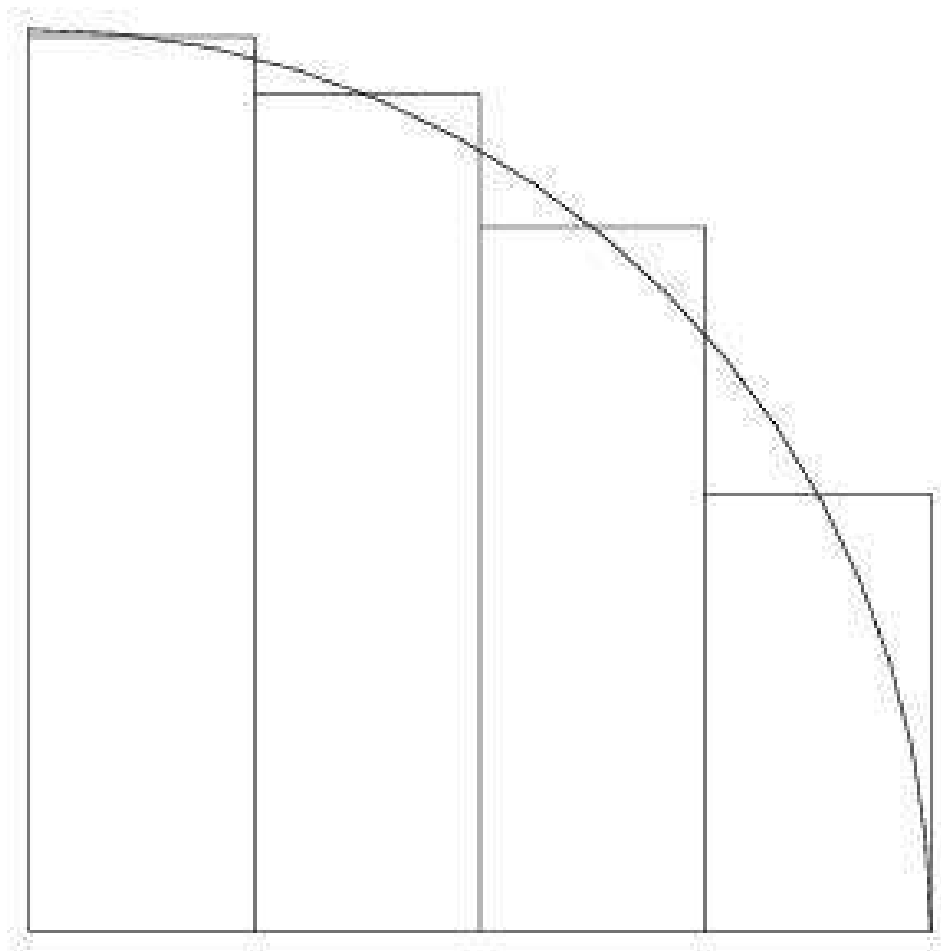


Figure 13.3: Here we see another way in which Archimedes used his doctrine of limits. He could calculate the areas of figures bounded by curves by dividing up these areas into a large number of narrow strips. As the number of strips became very large, their total area approached the true area of the figure.

Unfortunately, Archimedes was unable to transmit his invention of the calculus to the other mathematicians of his time. The difficulty was that there was not yet any such thing as algebraic geometry. The Pythagoreans had never recovered from the shock of discovering irrational numbers, and they had therefore abandoned algebra in favor of geometry. The union of algebra and geometry, and the development of a calculus which even non-geniuses could use, had to wait for Descartes, Fermat, Newton and Leibniz.

### 13.3 Statics and hydrostatics

Archimedes was the father of statics (as well as of hydrostatics). He calculated the centers of gravity of many kinds of figures, and he made a systematic, quantitative study of the properties of levers. He is supposed to have said: “Give me a place to stand on, and I can move the world!” This brings us to another of the stories about Archimedes: According to the story, Hieron was a bit sceptical, and he challenged Archimedes to prove his statement by moving something rather enormous, although not necessarily as large as the world. Archimedes good-humoredly accepted the challenge, hooked up a system of pulleys to a fully-loaded ship in the harbor, seated himself comfortably, and without excessive effort he singlehandedly pulled the ship out of the water and onto the shore.

Archimedes had a very compact notation for expressing large numbers. Essentially his system was the same as our own exponential notation, and it allowed him to handle very large numbers with great ease. In a curious little book called *The Sand Reckoner*, he used this notation to calculate the number of grains of sand which would be needed to fill the universe. (Of course, he had to make a crude guess about the size of the universe.) Archimedes wrote this little book to clarify the distinction between things which are very large but finite and things which are infinite. He wanted to show that nothing finite - not even the number of grains of sand needed to fill the universe - is too large to be measured and expressed in numbers. *The Sand Reckoner* is important as an historical document, because in it Archimedes incidentally mentions the revolutionary heliocentric model of Aristarchus, which does not occur in the one surviving book by Aristarchus himself.

In addition to his mathematical genius, Archimedes showed a superb mechanical intuition, similar to that of Leonardo da Vinci. Among his inventions are a planetarium and an elegant pump in the form of a helical tube. This type of pump is called the “screw of Archimedes”, and it is still in use in Egypt. The helix is held at an angle to the surface of the water, with its lower end half-immersed. When the helical tube is rotated about its long axis, the water is forced to flow uphill!

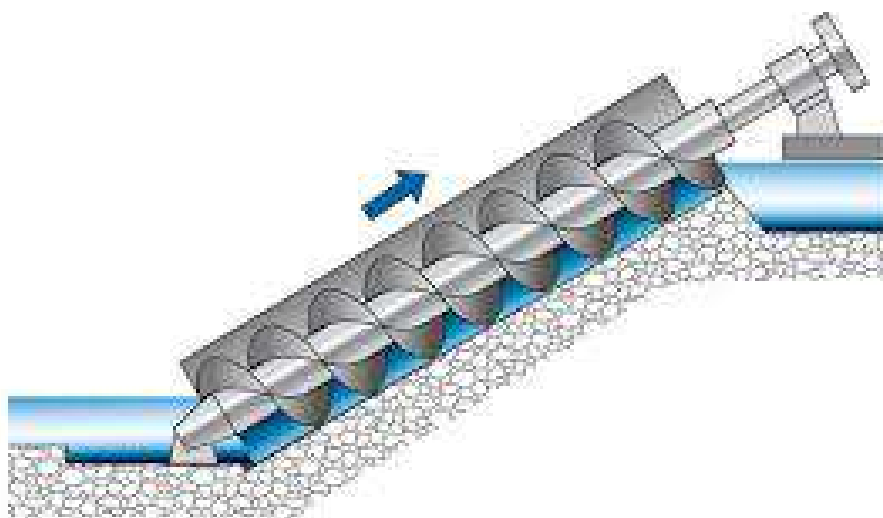


Figure 13.4: Archimedes' screw, the helical pump which he invented, is still in use today.

## 13.4 Don't disturb my circles!

His humanity and his towering intellect brought Archimedes universal respect, both during his own lifetime and ever since. However, he was not allowed to live out his life in peace; and the story of his death is both dramatic and symbolic:

In c. 212 B.C., Syracuse was attacked by a Roman fleet. The city would have fallen quickly if Archimedes had not put his mind to work to think of ways to defend his countrymen. He devised systems of mirrors which focused the sun's rays on the attacking ships and set them on fire, and cranes which plucked the ships from the water and overturned them.

In the end, the Romans hardly dared to approach the walls of Syracuse. However, after several years of siege, the city fell to a surprise attack. Roman soldiers rushed through the streets, looting, burning and killing. One of them found Archimedes seated calmly in front of diagrams sketched in the sand, working on a mathematical problem. When the soldier ordered him to come along, the great mathematician is supposed to have looked up from his work and replied: "Don't disturb my circles." The soldier immediately killed him.

The death of Archimedes and the destruction of the Hellenistic civilization illustrate the fragility of civilization. It was only a short step from Archimedes to Galileo and Newton; only a short step from Eratosthenes to Columbus, from Aristarchus to Copernicus, from Aristotle to Darwin or from Hippocrates to Pasteur. These steps in the cultural evolution of mankind had to wait nearly two thousand years, because the brilliant Hellenistic civilization was destroyed, and Europe was plunged back into the dark ages.



Figure 13.5: Machines used by Archimedes to defend Syracuse against the Roman attack.



Figure 13.6: "The death of Archimedes", a painting by Thomas DeGeorge.



Figure 13.7: The Great Library of Alexandria was partially burned during an attack by Julius Caesar in 48 BC. Much of the library survived, but during the Roman period which followed, it declined through neglect. With the destruction of the advanced Hellenistic civilization, much knowledge was lost. Had it survived, the history of human culture and science would have been very different.

## Suggestions for further reading

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3. Rorres, Chris. *The Golden Crown: Galileo's Balance*. Drexel University. Archived from the original on 24 February 2009.
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6. Carroll, Bradley W. *The Sand Reckoner*. Weber State University. Archived from the original on 13 August 2007.
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# Chapter 14

## POETS OF ANCIENT ROME

### 14.1 Lucretius, c.90 BC - c.55 BC

In the 5th century B.C. there was a great deal of discussion among the Greek philosophers about whether there is anything permanent in the universe. Heraclitus (540 B.C. - 475 B.C.) maintained that *everything* is in a state of flux. Parmenides (540 B.C. - c. 470 B.C.) maintained that on the contrary *nothing* changes - that all change is illusory. Leucippus (490 B.C. - c. 420 B.C.) and his student Democritus (470 B.C. - c. 380 B.C.), by a lucky chance, hit on what a modern scientist would regard as very nearly the correct answer.

According to Democritus, if we cut an apple in half, and then cut the half into parts, and keep on in this way for long enough, we will eventually come down to pieces which cannot be further subdivided. Democritus called these ultimate building blocks of matter “atoms”, which means “indivisible”. He visualized the spaces between the atoms as being empty, and he thought that when a knife cuts an apple, the sharp edge of the blade fits into the empty spaces between the atoms and forces them apart.

That the ideas of Democritus did not disappear entirely was due to the influence of Epicurus (341 B.C. - 270 B.C.), who made mechanism and atomism the cornerstones of his philosophy. The Roman poet Lucretius (95 B.C. - 55 B.C.) expounded the philosophy of Epicurus in a long poem called *De Natura Rerum* (On the Nature of Things). During the middle ages, this poem disappeared completely, but in 1417, a single surviving manuscript was discovered. The poem was then published, using Gutenberg’s newly-invented printing press, and it became extremely popular. Thus, the idea of atoms was not entirely lost, and after being revived by John Dalton, it became one of the cornerstones of modern science.

#### On the Nature of Things, Prologue

*Mother of Rome, delight of Gods and men,  
Dear Venus that beneath the gliding stars  
Makest to teem the many-voyaged main*

*And fruitful lands- for all of living things  
Through thee alone are evermore conceived,  
Through thee are risen to visit the great sun-  
Before thee, Goddess, and thy coming on,  
Flee stormy wind and massy cloud away,  
For thee the daedal Earth bears scented flowers,  
For thee waters of the unweared deep  
Smile, and the hollows of the serene sky  
Glow with diffused radiance for thee!  
For soon as comes the springtime face of day,  
And procreant gales blow from the West unbarred,  
First fowls of air, smit to the heart by thee,  
Foretoken thy approach, O thou Divine,  
And leap the wild herds round the happy fields  
Or swim the bounding torrents. Thus amain,  
Seized with the spell, all creatures follow thee  
Whithersoever thou walkest forth to lead,  
And thence through seas and mountains and swift streams,  
Through leafy homes of birds and greening plains,  
Kindling the lure of love in every breast,  
Thou bringest the eternal generations forth,  
Kind after kind. And since 'tis thou alone  
Guidest the Cosmos, and without thee naught  
Is risen to reach the shining shores of light,  
Nor aught of joyful or of lovely born,  
Thee do I crave co-partner in that verse  
Which I presume on Nature to compose  
For Memmius mine, whom thou hast willed to be  
Peerless in every grace at every hour-  
Wherefore indeed, Divine one, give my words  
Immortal charm. Lull to a timely rest  
O'er sea and land the savage works of war,  
For thou alone hast power with public peace  
To aid mortality; since he who rules  
The savage works of battle, puissant Mars,  
How often to thy bosom flings his strength  
O'er-mastered by the eternal wound of love-  
And there, with eyes and full throat backward thrown,  
Gazing, my Goddess, open-mouthed at thee,  
Pastures on love his greedy sight, his breath  
Hanging upon thy lips. Him thus reclined  
Fill with thy holy body, round, above!  
Pour from those lips soft syllables to win*



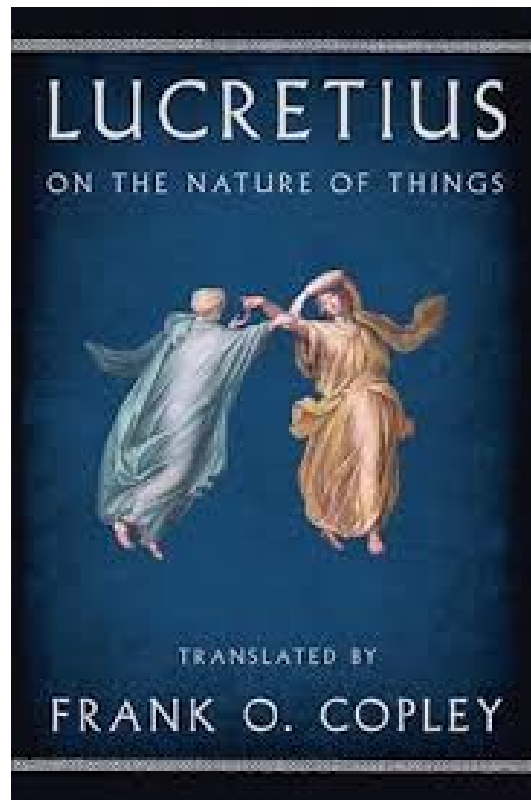


Figure 14.1: Lucretius, *On the Nature of Things*.

*Peace for the Romans, glorious Lady, peace!  
 For in a season troublous to the state  
 Neither may I attend this task of mine  
 With thought untroubled, nor mid such events  
 The illustrious scion of the Memmian house  
 Neglect the civic cause.*

## 14.2 Ovid, 43 BC - c.17 AD

### Love and War

translated from the Latin by Jon Corelis

*Lovers all are soldiers, and Cupid has his campaigns:  
 I tell you, Atticus, lovers all are soldiers.  
 Youth is fit for war, and also fit for Venus.  
 Imagine an aged soldier, an elderly lover!  
 A general looks for spirit in his brave soldiery;*

*a pretty girl wants spirit in her companions.  
Both stay up all night long, and each sleeps on the ground;  
one guards his mistress's doorway, one his general's.  
The soldier's lot requires far journeys; send his girl,  
the zealous lover will follow her anywhere.  
He'll cross the glowering mountains, the rivers swollen with storm;  
he'll tread a pathway through the heaped-up snows;  
and never whine of raging Eurys when he sets sail  
or wait for stars propitious for his voyage.  
Who but lovers and soldiers endure the chill of night,  
and blizzards interspersed with driving rain?  
The soldier reconnoiters among the dangerous foe;  
the lover spies to learn his rival's plans.  
Soldiers besiege strong cities; lovers, a harsh girl's home;  
one storms town gates, the other storms house doors.  
It's clever strategy to raid a sleeping foe  
and slay an unarmed host by force of arms.  
(That's how the troops of Thracian Rhesus met their doom,  
and you, O captive steeds, forsook your master.)  
Well, lovers take advantage of husbands when they sleep,  
launching surprise attacks while the enemy snores.  
To slip through bands of guards and watchful sentinels  
is always the soldier's mission - and the lover's.  
Mars wavers; Venus flutters: the conquered rise again,  
and those you'd think could never fall, lie low.  
So those who like to say that love is indolent  
should stop: Love is the soul of enterprise.  
Sad Achilles burns for Briseis, his lost darling:  
Trojans, smash the Greeks' power while you may!  
From Andromache's embrace Hector went to war;  
his own wife set the helmet on his head;  
and High King Agamemnon, looking on Priam's child,  
was stunned (they say) by the Maenad's flowing hair.  
And Mars himself was trapped in The Artificer's bonds:  
no tale was more notorious in heaven.  
I too was once an idler, born for careless ease;  
my shady couch had made my spirit soft.  
But care for a lovely girl aroused me from my sloth  
and bid me to enlist in her campaign.  
So now you see me forceful, in combat all night long.  
If you want a life of action, fall in love.*

**On Fidelity**

translated from the Latin by Jon Corelis

*I don't ask you to be faithful - you're beautiful, after all -  
but just that I be spared the pain of knowing.  
I make no stringent demands that you should really be chaste,  
but only that you try to cover up.  
If a girl can claim to be pure, it's the same as being pure:  
it's only admitted vice that makes for scandal.  
What madness, to confess by day what's wrapped in night,  
and what you've done in secret, openly tell!  
The hooker, about to bed some Roman off the street  
still locks her door first, keeping out the crowd:  
will you yourself then make your sins notorious,  
accusing and prosecuting your own crime?  
Be wise, and learn at least to imitate chaste girls,  
and let me believe you're good, though you are not.  
Do what you do, but simply deny you ever did:  
there's nothing wrong with public modesty.  
There is a proper place for looseness: fill it up  
with all voluptuousness, and banish shame;  
but when you're done there, then put off all playfulness  
and leave your indiscretions in your bed.  
There, don't be ashamed to lay your gown aside  
and press your thigh against a pressing thigh;  
there take and give deep kisses with your crimson lips;  
let love contrive a thousand ways of passion;  
there let delighted words and moans come ceaselessly,  
and make the mattress quiver with playful motion.  
But put on with your clothes a face that's all discretion,  
and let Shame disavow your shocking deeds.  
Trick everyone, trick me: leave me in ignorance;  
let me enjoy the life of a happy fool.  
Why must I see so often notes received - and sent?  
Why must I see two imprints on your bed,  
or your hair disarrayed much more than sleep could do?  
Why must I notice love bites on your neck?  
You all but flaunt your indiscretions in my face.  
Think of me, if not of your reputation.  
I lose my mind, I die, when you confess you've sinned;  
I break out in cold sweat from hand to foot;  
I love you then, and hate you - in vain, since I must love you;  
I wish then I were dead - and you were too!*

*I won't investigate or check whatever you try  
to hide: I will be thankful to be deceived.  
But even if I catch you in the very act  
and look on your disgrace with my own eyes,  
deny that I have seen what I have clearly seen,  
and my eyes will agree with what you claim.  
You'll win an easy prize from a man who wants to lose,  
only remember to say, 'I didn't do it.'  
Since you can gain your victory with one short phrase,  
win on account of your judge, if not your case.*

### 14.3 Virgil, 70 BC - 19 AD

#### Alexis

*The shepherd Corydon with love was fired  
For fair Alexis, his own master's joy:  
No room for hope had he, yet, none the less,  
The thick-leaved shadowy-soaring beech-tree grove  
Still would he haunt, and there alone, as thus,  
To woods and hills pour forth his artless strains.  
'Cruel Alexis, heed you naught my songs?  
Have you no pity? you'll drive me to my death.  
Now even the cattle court the cooling shade  
And the green lizard hides him in the thorn:  
Now for tired mowers, with the fierce heat spent,  
Pounds Thestilis her mess of savoury herbs,  
Wild thyme and garlic. I, with none beside,  
Save hoarse cicadas shrilling through the brake,  
Still track your footprints 'neath the broiling sun.  
Better have borne the petulant proud disdain  
Of Amaryllis, or Menalcas wooed,  
Albeit he was so dark, and you so fair!  
Trust not too much to colour, beauteous boy;  
White privets fall, dark hyacinths are culled.  
You scorn me, Alexis, who or what I am  
Care not to ask- how rich in flocks, or how  
In snow-white milk abounding: yet for me  
Roam on Sicilian hills a thousand lambs;  
Summer or winter, still my milk-pails brim.*

*I sing as erst Amphion of Circe sang,  
What time he went to call his cattle home  
On Attic Aracynthus. Nor am I  
So ill to look on: lately on the beach  
I saw myself, when winds had stilled the sea,  
And, if that mirror lie not, would not fear  
Daphnis to challenge, though yourself were judge.  
Ah! were you but content with me to dwell.  
Some lowly cot in the rough fields our home,  
Shoot down the stags, or with green osier-wand  
Round up the straggling flock! There you with me  
In silvan strains will learn to rival Pan.  
Pan first with wax taught reed with reed to join;  
For sheep alike and shepherd Pan hath care.  
Nor with the reed's edge fear you to make rough  
Your dainty lip; such arts as these to learn  
What did Amyntas do?- what did he not?  
A pipe have I, of hemlock-stalks compact  
In lessening lengths, Damoetas' dying-gift:  
'Mine once,' quoth he, 'now yours, as heir to own.'  
Foolish Amyntas heard and envied me.  
Ay, and two fawns, I risked my neck to find  
In a steep glen, with coats white-dappled still,  
From a sheep's udders suckled twice a day-  
These still I keep for you; which Thestylis  
Implores me oft to let her lead away;  
And she shall have them, since my gifts you spurn.  
Come hither, beauteous boy; for you the Nymphs  
Bring baskets, see, with lilies brimmed; for you,  
Plucking pale violets and poppy-heads,  
Now the fair Naiad, of narcissus flower  
And fragrant fennel, doth one posy twine-  
With cassia then, and other scented herbs,  
Blends them, and sets the tender hyacinth off  
With yellow marigold. I too will pick  
Quinces all silvered-o'er with hoary down,  
Chestnuts, which Amaryllis wont to love,  
And waxen plums withal: this fruit no less  
Shall have its meed of honour; and I will pluck  
You too, ye laurels, and you, ye myrtles, near,  
For so your sweets ye mingle. Corydon,  
You are a boor, nor heeds a whit your gifts  
Alexis; no, nor would Iollas yield,*

*Should gifts decide the day. Alack! alack!  
What misery have I brought upon my head!-  
Loosed on the flowers Siroces to my bane,  
And the wild boar upon my crystal springs!  
Whom do you fly, infatuate? gods ere now,  
And Dardan Paris, have made the woods their home.  
Let Pallas keep the towers her hand hath built,  
Us before all things let the woods delight.  
The grim-eyed lioness pursues the wolf,  
The wolf the she-goat, the she-goat herself  
In wanton sport the flowering cytisus,  
And Corydon Alexis, each led on  
By their own longing. See, the ox comes home  
With plough up-tilted, and the shadows grow  
To twice their length with the departing sun,  
Yet me love burns, for who can limit love?  
Ah! Corydon, Corydon, what hath crazed your wit?  
Your vine half-pruned hangs on the leafy elm;  
Why haste you not to weave what need requires  
Of pliant rush or osier? Scorned by this,  
Elsewhere some new Alexis you will find.'  
For fair Alexis, his own master's joy:  
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 Why haste you not to weave what need requires  
 Of pliant rush or osier? Scorned by this,  
 Elsewhere some new Alexis you will find.'*

## 14.4 Juvenal, late 1st century AD - early 2nd century AD

### SATIRE I: *Difficile est Saturam non Scribere*

*What? Am I to be a listener only all my days? Am I never to get my word in - I that have been so often bored by the Theseid of the ranting Cordus? Shall this one have spouted to me his comedies, and that one his love ditties, and I be unavenged? Shall I have no revenge on one who has taken up the whole day with an interminable Telephus, or with an Orestes, which, after filling the margin at the top of the roll and the back as well, hasn't even yet come to an end? No one knows his own house so well as I know the groves of Mars, and the cave of Vulcan near the cliffs of Aeolus. What the winds are brewing; whose souls Aeacus has on the rack; from what country another worthy is carrying off that stolen golden fleece; how big are the ash trees which Monychus tosses about; these are the themes with which Fronto's plane trees and marble halls are for ever ringing until the pillars quiver and quake under the continual recitations; such is the kind of stuff you may*



*look for from every poet, greatest or least. Well, I too have slipped my hand from under the cane; I too have counselled Sulla to retire from public life and sleep his fill; it is a foolish clemency when you jostle against poets at every corner, to spare paper that will be wasted anyhow. But if you can give me time, and will listen quietly to reason, I will tell you why I prefer to run in the same course over which the great nursling of Aurunea drove his steeds.*

*When a soft eunuch takes to matrimony, and Maevia, with spear in hand and breasts exposed, to pig-sticking; when a fellow under whose razor my stiff youthful beard used to grate[9] challenges, with his single wealth, the whole nobility; when a gutter-snipe of the Nile like Crispinus - a slave-born denizen of Canopus - hitches a Tyrian cloak on to his shoulder, whilst on his sweating finger he airs a summer ring of gold, unable to endure the weight of a heavier gem - it is hard not to write satire. For who can be so tolerant of this monstrous city, who so iron of soul, as to contain himself when the brand-new litter of lawyer Matho comes along, filled with his huge self; after him one who has informed against his noble patron and will soon sweep away the remnant of our nobility already gnawed to the bone - one whom Massa dreads, whom Carus propitiates by a bribe, and to whom Thymele was sent as envoy by the terrified Latinus; when you are thrust on one side by men who earn legacies by nightly performances, and are raised to heaven by that now royal road to high preferment - the favours of an aged and wealthy woman? Each of the lovers will have his share; Proculcius a twelfth part, Gillo eleven parts, each in proportion to the magnitude of his services. Let each take the price of his own blood, and turn as pale as a man who has trodden upon a snake bare-footed, or of one who awaits his turn to orate before the altar at Lugdunum.*

*Why tell how my heart burns hot with rage when I see the people hustled by a mob of retainers attending on one who has defrauded and debauched his ward, or on another who has been condemned by a futile verdict - for what matters infamy if the cash be kept? The exiled Marius[15] carouses from the eighth hour of the day and revels in the wrath of Heaven, while you, poor Province, win your cause and weep!*

*Must I not deem these things worthy of the Venusian's[16] lamp? Must I not have my fling at them? Should I do better to tell tales about Hercules, or Diomedes, or the bellowing in the Labyrinth, or about the flying carpenter[17] and the lad[18] who splashed into the sea; and that in an age when the compliant husband, if his wife may not lawfully inherit, takes money from her paramour, being well trained to keep his eyes upon the ceiling, or to snore with wakeful nose over his cups; an age when one who has squandered his family fortunes upon horse flesh thinks it right and proper to look for the command of a cohort? See him dashing at break-neck speed, like a very Automedon, along the Flaminian way, holding the reins himself, while he shows himself off to his great-coated mistress!*

*Would you not like to fill up a whole note-book at the street crossings when you see a forger borne along upon the necks of six porters, and exposed to view on this side and on that in his almost naked litter, and reminding you of the lounging Maecenas; one who by help*

*of a scrap of paper and a moistened seal has converted himself into a fine and wealthy gentleman?*

*Then up comes a lordly dame who, when her husband wants a drink, mixes toad's blood with his old Calenian, and improving upon Lucusta herself, teaches her artless neighbours to brave the talk of the town and carry forth to burial the blackened corpses of their husbands. If you want to be anybody nowadays, you must dare some crime that merits narrow Gyara or a gaol; honesty is praised and starves: It is to their crimes that men owe their pleasure-grounds and high commands, their fine tables and old silver goblets with goats standing out in relief. Who can get sleep for thinking of a money-loving daughter-in-law seduced, of brides that have lost their virtue, or of adulterers not out of their 'teens? Though nature say me nay, indignation will prompt my verse, of whatever kind it be - such verse as I can write, or Cluvienus!*

*From the day when the rain-clouds lifted up the waters, and Deucalion climbed that mountain in his ship to seek an oracle - that day when stones grew soft and warm with life, and Pyrrha showed maidens in nature's garb to men - all the doings of mankind, their vows, their fears, their angers and their pleasures, their joys and goings to and fro, shall form the motley subject of my page. For when was Vice more rampant? When did the maw of Avarice gape wider? When was gambling so reckless? Men come not now with purses to the hazard of the gaming table, but with a treasure-chest beside them. What battles will you there see waged with a steward for armour-bearer! Is it a simple form of madness to lose a hundred thousand sesterces, and not have a shirt to give to a shivering slave? Which of our grandfathers built such numbers of villas, or dined by himself off seven courses? Look now at the meagre dole set down upon the threshold for a toga-clad mob to scramble for! The patron first peers into your face, fearing that you may be claiming under someone else's name; once recognised, you will get your share. He then bids the crier call up the Trojan-blooded nobles - for they too besiege the door as well as we: "The Praetor first," says he, "and after him the Tribune." "But I was here first," says a freedman who stops the way; "why should I be afraid, or hesitate to keep my place? Though born on the Euphrates - a fact which the little windows in my ears would testify though I myself denied it - yet I am the owner of five shops which bring me in four hundred thousand sesterces. What better thing does the Broad Purple bestow if a Corvinus herds sheep for daily wage in the Laurentian country, while I possess more property than either a Pallas or a Licinus?"[28] So let the Tribunes await their turn; let money carry the day; let the sacred office give way to one who came but yesterday with whitened feet into our city. For no deity is held in such reverence amongst us as Wealth; though as yet, O baneful money, thou hast no temple of thine own; not yet have we reared altars to Money in like manner as we worship Peace and Honour, Victory and Virtue. or that Concord that twitters when we salute her nest.*

*If then the great officers of state reckon up at the end of the year how much the dole brings in, how much it adds to their income, what shall we dependants do who, out of the self-same dole, have to find ourselves in coats and shoes, in the bread and fire of our homes? A*

*mob of litters comes in quest of the hundred farthings; here is a husband going the round, followed by a sickly or pregnant wife; another, by a clever and well-known trick, claims for a wife that is not there, pointing, in her stead, to a closed and empty chair; "My Galla's in there," says he; "let us off quick, will you not?" "Galla, put out your head!" "Don't disturb her, she's asleep!"*

*The day itself is marked out by a fine round of business. First comes the dole; then the courts, and Apollo learned in the law, and those triumphal statues among which some Egyptian Arabarch or other has dared to set up his titles; against whose statue more than one kind of nuisance may be committed! Wearied and hopeless, the old clients leave the door, though the last hope that a man relinquishes is that of a dinner; the poor wretches must buy their cabbage and their fuel. Meanwhile their lordly patron will be devouring the choicest products of wood and sea, lying alone upon an empty couch; for at a single one of their fine large and antique tables they devour whole fortunes. Ere long no parasites, will be left! Who can bear to see luxury so mean? What a huge gullet to have a whole boar - an animal created for conviviality - served up to it! But you will soon pay for it, my friend, when you take off your clothes, and with distended stomach carry your peacock into the bath undigested! Hence a sudden death, and an intestate old age; the new and merry tale runs the round of every dinner-table, and the corpse is carried forth to burial amid the cheers of enraged friends!*

*To these ways of ours Posterity will have nothing to add; our grandchildren will do the same things, and desire the same things, that we do. All vice is at its acme; up with your sails and shake out every stitch of canvas! Here perhaps you will say, "Where find the talent to match the theme? Where find that freedom of our forefathers to write whatever the burning soul desired? 'What man is there that I dare not name? What matters it whether Mucius forgives my words or no?'" But just describe Tigellinus[36] and you will blaze amid those faggots in which men, with their throats tightly gripped, stand and burn and smoke, and you[37] trace a broad furrow through the middle of the arena.*

*What? Is a man who has administered aconite to half a dozen uncles to ride by and look down upon me from his swaying cushions? "Yes; and when he comes near you, put your finger to your lip; he who but says the word, 'That's the man!' will be counted an informer. You may set Aeneas and the brave Rutulian a-fighting with an easy mind; it will hurt no one's feelings to hear how Achilles was slain, or how Hylas was searched for when he tumbled after his pitcher. But when Lucilius roars and rages as if with sword in hand, the hearer, whose soul was cold with crime, grows red; he sweats with the secret consciousness of sin. Hence wrath and tears. So turn these things over in your mind before the trumpet sounds; the helmet once donned, it is too late to repent you of the battle." Then I will try what I may say of those worthies whose ashes lie under the Flaminian and Latin roads.*

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# Chapter 15

## PAINTING IN ANCIENT ROME

### 15.1 Pompeii

Pompeii was a flourishing Roman town of about 15,000 people at the foot of Mount Vesuvius on the bay of Naples. Its prosperity was due to the rich agricultural soil, made fertile by minerals in ash from volcano. However, in October of November of the year 79 AD, tragedy struck the town. Vesuvius erupted and a pyroclastic flow engulfed the town. Its citizens had no time to flee, and were killed instantly by the heat. Pliny the Younger described the tragic event in a letter to a friend. His uncle, Pliny the Elder had died attempting to rescue people from nearby towns.

The eruption of Vesuvius in 79 AD did not completely cover the tops of Pompeii's buildings, so robbers knew where to dig to find valuables, such as marble statues, and there is evidence of looting. Nevertheless, after a few centuries, the location and the name of the town were forgotten.

In 1592, workers digging an underground channel to divert the River Sarno uncovered ancient walls covered with paintings and inscriptions, but nothing came of this discovery and the existence of the ancient town was again forgotten, until rediscovered two centuries later.

A systematic excavation of Pompeii was conducted during the period when the French occupied Naples. The land on which the town lies was expropriated by the government, and 700 workers were employed to clear away the volcanic ash.

Because Pompeii was deeply buried in volcanic ash, everything in the town, including frescos on the walls of villas, have been perfectly preserved. The town offers us a glimpse of what life was like at that time, and today it is a UNESCO World Heritage Site. However, now that the ash has been cleared away, dampness is threatening to destroy the frescos. Excessive tourism is also a danger, and is now being restricted. Many of the artifacts from Pompeii can be seen today at a museum in the city of Naples.

### 15.2 Frescos and portraits



Figure 15.1: *Fresco from the Villa of the Mysteries, Pompeii, 80 BC.*





Figure 15.2: *Meniad in a Silk Dress*, Pompeii, first century AD.



Figure 15.3: *Heracles and Omphale*, Roman fresco Pompeian Fourth Style, 45-79 AD, National Archaeological Museum of Naples, Italy.



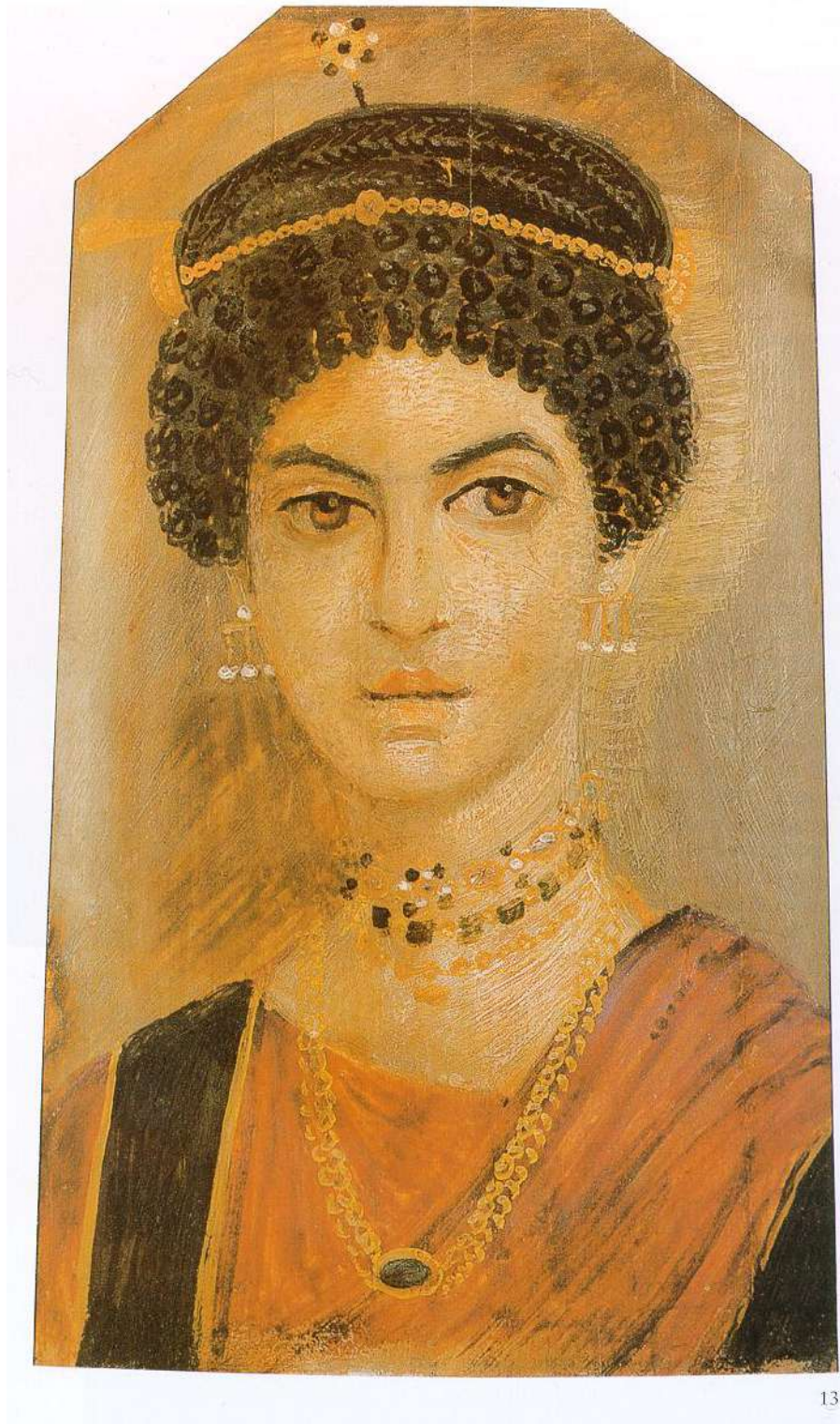


Figure 15.4: *Fayum mummy portrait of a woman from Roman Egypt with a ringlet hairstyle*, mummy portrait, tempera on wood, Royal Museum of Scotland.

## 15.3 Roman mosaics

Wikipedia states that

“A Roman mosaic is a mosaic made during the Roman period, throughout the Roman Republic and later Empire. Mosaics were used in a variety of private and public buildings, on both floors and walls, though they competed with cheaper frescos for the latter. They were highly influenced by earlier and contemporary Hellenistic Greek mosaics, and often included famous figures from history and mythology, such as Alexander the Great in the Alexander Mosaic.

“A large proportion of the surviving examples of wall mosaics come from Italian sites such as Pompeii and Herculaneum. Otherwise, floor mosaics are far more likely to have survived, with many coming from the fringes of the Roman Empire. The Bardo National Museum in Tunis has an especially large collection from large villas in modern Tunisia...

“The earliest mosaics of Roman Pompeii, dated to the Pompeian First Style of wall painting in the late 2nd and early 1st centuries BC, were clearly derived from the Hellenistic Greek model. However, they contained far more figured scenes on average, less abstract design, the absence of lead strips, as well as an almost complete lack of complex, three-dimensional scenes utilizing polychromy until the Pompeian Second Style of wall painting (80-20 BC).

“The mosaics in the Villa Romana del Casale (c. 300 AD) from Roman Sicily perhaps represent the hallmark of mosaic art in the Late Imperial period. The mosaic decoration of the local palace complex culminates in the gallery, which contains a scene of animal hunting and fighting covering an area of 3,200 square feet.

“Roman mosaics are constructed from geometrical blocks called tesserae, placed together to create the shapes of figures, motifs and patterns. Materials for tesserae were obtained from local sources of natural stone, with the additions of cut brick, tile and pottery creating coloured shades of, predominantly, blue, black, red, white and yellow. Polychrome patterns were most common, but monochrome examples are known. Marble and glass were occasionally used as tesserae, as were small pebbles, and precious metals like gold.

“Mosaic decoration was not just confined to floors but featured on walls and vaults as well. Traces of guidelines have been found beneath some mosaics, either scored into or painted onto the mortar bedding. The design might also be pegged out in string, or mounted in a wooden frame.”





Figure 15.5: A Roman mosaic inscribed with the Latin phrase *cave canem* (“beware of the dog”), from the House of the Tragic Poet in Pompeii, Italy, 2nd century BC.



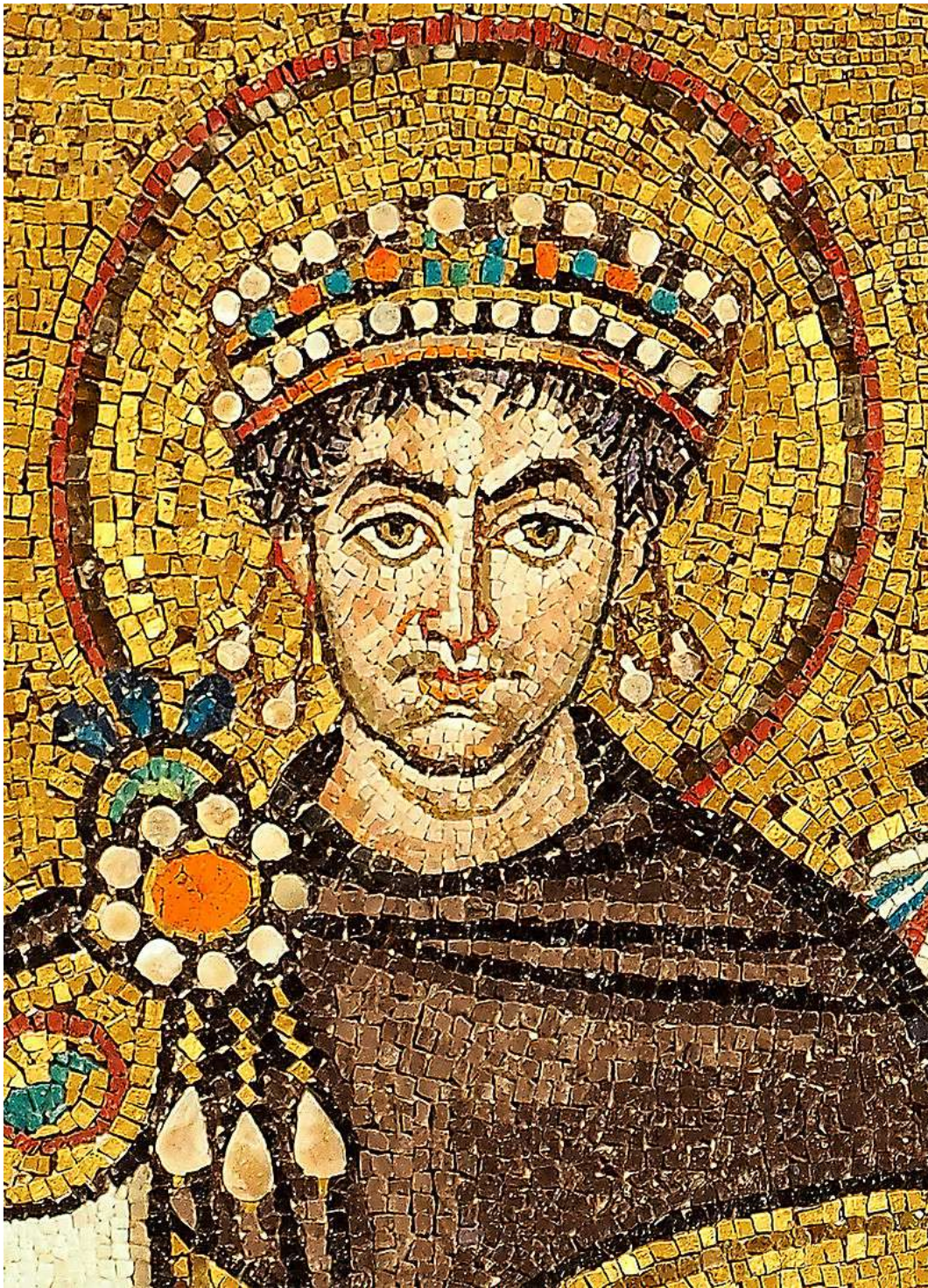


Figure 15.6: Mosaic of Eastern Roman emperor Justinian I, 6th century.





Figure 15.7: Neptune driving his chariot.





Figure 15.8: Ulysses during his journey.



Figure 15.9: The Centaur mosaic (2nd-century), found at Hadrian's Villa in Tivoli, Italy. Altes Museum, Berlin.





Figure 15.10: Comedy Mask.





Figure 15.11: Antioch Mosaic.





Figure 15.12: Epiphany of Dionysus mosaic, from the Villa of Dionysus (2nd century AD) in Dion, Greece. Now in the Archeological Museum of Dion.





Figure 15.13: A Roman mosaic depicting the wedding of Dionysos and Ariadne, with Silenus and a satyr, 2nd century AD, Tunis, Tunisia.





Figure 15.14: A mosaic showing Medusa and representational figures of the four seasons, from Palencia, Spain, made between 167 and 200 AD.



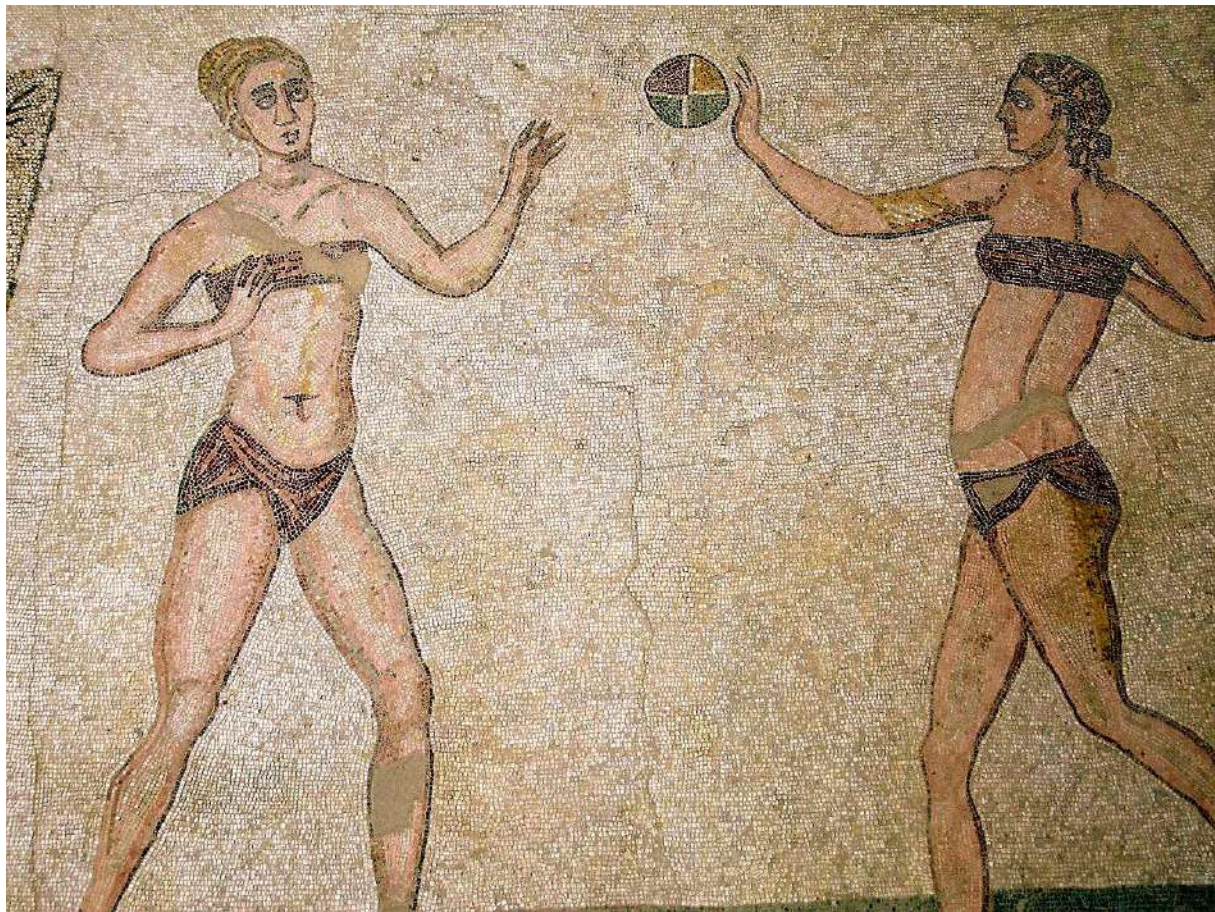


Figure 15.15: Mosaic of female athletes playing ball at the Villa Romana del Casale of Piazza Armerina, 4th century AD.





Figure 15.16: Triumph of Poseidon and Amphitrite showing the couple in procession, detail of a mosaic from Cirta, Roman Africa, 315/325 AD, Louvre.



Figure 15.17: Paleochristian mosaic from Santa Pudenziana in Rome, about 410 AD.





Figure 15.18: A mosaic from the Roman era Poseidon Villa in Zeugma, Com-magene (now in the Zeugma Mosaic Museum) depicting Achilles on Skyros disguised as a woman and Odysseus tricking him into revealing himself.





Figure 15.19: Mosaic of Orpheus from Caralis, modern Cagliari (Italy), now in Archeological Museum of Turin.



Figure 15.20: Mosaic of Amazon warrior engaged in combat with a hippeus, 4th century AD, Louvre.

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