



Arabick Roots

Acknowledgements

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Unlocking human potential.



Curator:
Dr Rim Turkmani

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RichGallery dealers & agents in art



ENGLISH HERITAGE

Marc-Antoine Bourgeois

Ferdinand Albert Duke of Brunswick
and Lunenburg. Fellow.

Handwritten Arabic text, likely a signature or official statement.

Handwritten Arabic text, including the date 1726 and 1138.

Handwritten Arabic text, possibly a signature or official statement.

Handwritten Latin text, including names like Otto Christophorus Comenius and Philipus Comenius.

Handwritten Latin text, including names like Marc de la Roche and M. de la Roche.

Right: Signatures of Arab Fellows elected in the 17th and 18th centuries, in the Royal Society Charter Book.



10. Intra Constellatione Cassiopeiæ.					
1	Quæ præcipue Humeros		0	14	28 24 02
2	Quæ est in sinistro dextro		0	35	45 26 34
3	Quæ est in sinistro sinistro		0	12	35 22 24
4	Australior triam quæ sunt in brachio dextro		0	13	38 30 47
5	Borealis triam		0	33	16 22 30
6	Media triam		0	14	40 31 30
7	Australior triam quæ sunt in palmæ dextre		0	8	34 41 0
8	Media triam		0	9	38 41 49
9	Borealis triam		0	10	32 43 24
10	Quæ est in brachio sinistro		0	12	25 17 18
11	Quæ est in cubito sinistro		0	13	10 15 38
12	Australior triam supra Subligaculo sunt ad dext.		0	23	12 25 10
13	Media triam		0	47	38 29 30
14	Borealis triam		0	21	1 32 30
15	Quæ est supra pedem sinistram, & inter est Ansh AlAns		1	6	32 27 38
16	Quæ est supra pedem dextram		1	6	31 38 30
17	Quæ præcipue inclinat ad Astrum		1	4	33 31 0

Preface

No scientist works alone, and no scientist works without understanding and appreciating the work of those who have gone before. This was just as true at the beginning of English science in the seventeenth and eighteenth centuries as it is today. As Isaac Newton famously wrote, 'If I have seen further, it is by standing on the shoulders of giants'.

This exhibition uncovers some of Newton's 'giants'. The early Fellows of the Royal Society were keenly aware of the rich scholarly tradition of the Arab and Muslim world. They took every opportunity to read and discuss the works of the Arab and Persian astronomers, physicians and mathematicians whose names are still remembered by scholars today – Ulugh Beg, Ibn al-Haytham, Ibn Sina, and many others. They also valued the living knowledge shared by ambassadors from Morocco and the kingdom of Tripoli, and they welcomed three such men into the Fellowship. Science has no borders, and the Society today is still proud to elect leading scientists from all parts of the world, and to promote international scientific collaboration. Arab and Muslim nations are taking an increasing role in modern science, and the rest of the world will watch developments in these countries with interest.

The Royal Society is very grateful to our lead sponsor The Qatar Foundation, and also to the Foundation for Science, Technology and Civilisation and our exhibition design partners Cultural Innovations for supporting 'Arabick Roots'. We are pleased to acknowledge and thank Dr Rim Turkmani for her painstaking work as exhibition curator.

Dr Peter Collins
 Director
 Royal Society Centre for History of Science

Foreword

This exhibition tells a fascinating story. Many of the founding members of the Royal Society, such as Edmond Halley and Robert Boyle, are well-known figures in science. What is less well known is how aware they were of the importance of building on what had been achieved in science before them, and in particular the many scientific resources written in Arabic and Persian. This story also shows that these great figures were not in the least bit shy of crediting their Arab scientific predecessors. It is very fitting that the Royal Society, 350 years later, pays this gracious tribute to their roles.

This unique exhibition responds to a much needed effort to bridge cultures. Unfortunately, much of the respect and understanding the founders of the Royal Society had for their forebears has been lost and the celebration of scientists in our school books is often confined to those from the West. We tend to fast forward from the Greeks all the way to the Renaissance, neglecting the contributions of the Chinese, Indian and Arab cultures, to name but a few.

We owe future generations a balanced history in which all cultures and civilisations are recognised and cherished for their contributions to our present knowledge. In highlighting our shared scientific heritage, this exhibition goes a long way to promoting inter-cultural respect.

It is a great credit to this distinguished institution that, right from the outset, they were open to organising this exhibition honouring the finest traditions of their founders. The Royal Society willingly opened its archives and library to enable this research, the fruits of which you see here.

The Foundation for Science, Technology and Civilisation (FSTC) has been delighted to be involved in this venture that goes to the heart of its mission of 'using cultural roots of science to enhance social cohesion and to promote inter-cultural respect'. I congratulate the Royal Society for organising this landmark exhibition and I invite you to enjoy its content.

Emeritus Professor Salim Al-Hassani
Chairman
Foundation for Science, Technology and Civilisation (FSTC)
www.fstc.org.uk
www.1001inventions.com





The old ‘new philosophy’

The late historian of science Marie Boas Hall spent decades editing the correspondence of Henry Oldenburg, secretary of the Royal Society from 1663 to 1677. Struck by his frequent references to Muslim scholars and the need to translate their work, she wrote, “At first thought, it seems unlikely that the Fellows of the Royal Society founded by the ‘new philosophy’ in England in 1660 ‘for the promotion of natural knowledge’, self-confessedly forward looking modernists, should have concerned themselves with Islamic learning. That they did so throws further light upon the complexities of the scientific revolution.”

This interest of the ‘New Philosophers’ in learning that was eight centuries old might seem surprising. But it becomes less so if we consider the ground they shared with their classical Muslim counterparts, some of whom are acknowledged as pioneers of the scientific method.

Ibn al-Haytham (or Alhazen, 965–c.1040), for example, followed a rigorous research procedure. He started by stating the problem, explicitly supported by observations. He critically reviewed previous work, conducted verifiable experiments to test hypotheses, interpreted the data and formulated conclusions, often mathematically. Only then did he publish his findings. Most modern scientists would follow a similar path. No wonder the pioneers of the scientific revolution could look backwards without betraying their Baconian principles, which demanded complete independence from previous traditions.

Johannes Hevelius, the first foreign Fellow of the Royal Society, expressed the indebtedness of his generation of scientists to Ibn al-Haytham by putting him on the title page of his *Selenographia* (page 28). There he portrayed al-Haytham as one of the twin pillars of the scientific method, symbolising rational thinking: he stands on a plinth that bears an image of the brain and the Latin word *ratione* (reason).

And although it may come as a surprise that Robert Boyle, the founder of modern chemistry, often turned to the ancient practices of Muslim chemists like Jabir Ibn Hayyan (Geber) (pages 39-42), Boyle and Geber both championed the experimental approach to chemistry, despite the nine centuries between them. Geber made this clear when he wrote, “The first essential in chemistry is that you should perform practical work and conduct experiments, for he who performs not practical work nor makes experiments will never attain to the least degree of mastery. But you, O my son, do experiment so that you may acquire knowledge. Scientists delight not in abundance of material; they rejoice only in the excellence of their experimental methods.”

Seventeenth-century scientists knew that much essential Muslim knowledge had not yet reached the West. They recognized that the answers to many questions were to be found in Arabic and Persian sources, including masterpieces of Greek mathematics that survived as Arabic versions enriched with commentaries and solutions to equations (page 51). Most of the material that seventeenth-century scientists hoped to find in these manuscripts epitomised the new spirit of the Royal Society, with its emphasis on empirical data,

experimental methods and observations. It was not the theoretical models of Islamic astronomers that interested Edmond Halley and Edward Bernard; it was their remarkably accurate observations and observational methods (page 24). Boyle was not interested in knowing to which of the classical elements a substance like sal-ammoniac belonged. His focus was on its description and properties, where it could be found in nature, ways of extracting it and any health and other benefits it might offer (page 40). At a time when Islamic medicine was going out of fashion, an interest in Muslim physicians’ use of herbs and drugs, and their method of immunising people against smallpox, remained strong (page 54). The philosophical story of Hayy ibn Yaqzan had remarkable influence on the ‘New Philosophers’ five hundred years after it was written (page 48).

“...the seeker after the truth is not one who studies the writings of the ancients and, following his natural disposition, puts his trust in them, but rather the one who suspects his faith in them and questions what he gathers from them, the one who submits to argument and demonstration, and not to the sayings of a human being whose nature is fraught with all kinds of imperfection and deficiency. Thus the duty of the man who investigates the writings of scientists, if learning the truth is his goal, is to make himself an enemy of all that he reads, and, applying his mind to the core and margins of its content, attack it from every side. He should also suspect himself as he performs his critical examination of it, so that he may avoid falling into either prejudice or leniency.”

Ibn al Haytham, *Book of Optics* (11th century)

Arabick material in the collections of the Royal Society

Early Fellows of the Royal Society wanted to extend their experimentation and observation beyond their own space and time, even if this meant learning Arabic in order to decipher the flood of Arabic and Persian manuscripts sweeping into seventeenth-century England. Evidence of this interest is demonstrated in many parts of the Society’s archive and library; in this exhibition we present a small taste of it.

As well as classical Arabic books such as Ibn Sina’s *Canon of Medicine* (page 53) and al-Idrisi’s *Geography*, the Society’s collection includes books in Persian, three beautifully illustrated books by the Ottoman scholar Katip Çelebi (page 33) and even books in Syriac.

Two large collections of Arabic and Persian manuscripts formerly belonging to the Royal Society are now housed at the British Library, including manuscripts on astronomy, mathematics, and medicine as well as grammar, history and literature.



The Society also has a selection of books translated from Arabic, such as Ibn al-Haytham's *Book of Optics* (page 50). Some of these, including the star catalogue of Ulugh Beg, were translated by Fellows of the Royal Society (page 27) or at the request of the Society. Several of these works have hand written annotations in their margins.

Many references to oriental learning and oriental tongues appear in the correspondence of the Royal Society, with the names of scholars like Abu Al Fida of Hama (or Abulfeda) (1273-1131) or places like Aleppo appearing frequently (page 22). There is also evidence of interest in contemporary knowledge: letters were sent to the Levant and North Africa with long lists of enquiries such as 'what kind of learning they now excel in' and 'the way used for redeeming their ores into metals.' (pages 18-19).

There is further evidence in the *Philosophical Transactions of the Royal Society*. Papers were published about a wide spectrum of subjects, such as the observations of classical Muslim astronomers (page 24), the medical use of herbs in Aleppo (page 53), the method of inoculation against smallpox in Aleppo, and even the manner of hatching eggs in ovens in Cairo (page 57)! Fellows who lived or travelled in the Levant also wrote books, including the splendid *Natural History of Aleppo* by Alexander Russell (page 54) and the first detailed drawing of the eternal city of Palmyra (page 56).

Nearly forty Fellows from the seventeenth and eighteenth centuries were involved in this 'Arabick interest' in one way or another. Five were professors of Arabic, including Edmund Castell, who devoted his life to compiling an elaborate dictionary of oriental tongues (page 46) and who ordered his memorial stone to be engraved in Arabic, creating what is now England's oldest Arabic inscription. During the same period the Royal Society elected three Arab Fellows (page 14), one of whom, Cassem Aga, made a valuable contribution to smallpox immunisation (page 58).

Some Fellows used actual Arabic quotations in their work. John Wallis translated a proof of Euclid's fifth postulate by Al Tusī (1201–1274) and included it in his book *Opera Mathematica* (page 49). Richard Mead thought it essential to commission a fresh translation of the work of al-Razi (865–925) on smallpox and measles and he included the full text in his book on the subject (page 61).

Arabic and Oriental manuscripts in seventeenth-century England

All this scientific and literary activity needed Arabic. A renewed interest in the language had led to the establishment of chairs of Arabic in Cambridge and Oxford in the 1630s. Arabic was seen as a useful language not only for science but also for trade, diplomacy and religious affairs.

There is much evidence in the archives and correspondence of the Royal Society for the existence of active lines of communication between these Arabists at the universities and the new philosophers (page 20). Scholars realised that Latin medieval translation had corrupted much of the knowledge transferred during the Renaissance; they wanted to read the sources in the original. Writing to the Royal Society about his contribution to solving the Alhazen problem (page 51) after consulting the original Arabic *Book of Optics* of Ibn al-Haytham rather than the medieval Latin translation, Edward Bernard said "the prolixity of the book proceeds from the ignorance of the interpreter rather than the inelegance of the Arab."

Edmond Halley also expressed his desire for texts in their original language. In a paper on the observations of Muslim astronomer al-Battani (page 38) published in the *Philosophical Transactions* of the Royal Society of 1693 he wrote, "I would have wished to be able to obtain from one of the best equipped libraries of Europe an Arabic copy of al-Battani, so as to be able to confirm our emendations; and I would appeal to those who know the language, since, at least as regards the observations, there is not much, and it is not difficult to compare the manuscripts and then communicate with us."

Halley's wish was not granted. But had he laid his hands on such a manuscript he would no doubt have translated it himself. When he located the Arabic version of the work of the Greek mathematician Apollonius (c. 262 BC – c. 190 BC) he took on the painful task of learning Arabic at the age of 50, with very limited resources, in order to translate it into Latin. The result was two books published in 1706 and 1710 (page 38).

Arabick routes

Arabic and Persian books and manuscripts were at the heart of the seventeenth-century fascination with Arabic and Islamic science. Scarce in England, they were abundant in the Muslim world, and an active manuscript hunt was necessary to bring them to European libraries. Enhanced diplomatic and trade relations with the Ottoman Empire, culminating in the establishment of the Levant Company in 1580, provided excellent routes for these manuscripts to be sent back to England. The manuscript hunt was supported by influential figures including King Charles I and William Laud, Archbishop of Canterbury (page 18).

Laud was so keen on collecting and using these manuscripts that he spent his own money on the project, sponsoring travellers to collect them from cities including Constantinople and Aleppo. He also established the first English Chair of Arabic at Oxford University in 1636. Laud donated his huge collection of oriental manuscripts to the Bodleian Library, and the history of many of these manuscripts shows that they were actively used in research. Laud's collection had a librarian to match: Thomas Hyde, who later became the Laudian Professor of Arabic. Hyde communicated with scientists and philosophers at the Royal Society. He wrote to Boyle frequently, providing him with information from Arabic and Persian manuscripts and writing to Boyle that 'if for the future I meet with anything in oriental authors, that may illustrate natural knowledge, I shall be sure to take notice of it' (page 22).

But it was not only silk and manuscripts that were shipped back home through trade routes and diplomatic channels. There were also products like coffee, with its coffee-house culture. Two papers were published in the *Philosophical Transactions* about the coffee of the Arabs and how the tradition of drinking it in public houses was spreading in England, much to the annoyance of brewers. Coffee houses became an integral part of the intellectual life of the period: many of the Royal Society's earliest Fellows would have held their heated discussions there. New trees and plants also found their way back to England. Three of these trees, imported in 1640, are still alive in and around Oxford, giving the term 'Arabick roots' a literal meaning (page 55).



Our shared sky

Newly developed models of the skies required better observations to support them, and observing an astronomical body like the Moon over a short period was often not enough. Modern observations had to be compared with those made over centuries or even millennia to discover how the trajectory or obliquity of an object evolved over time. Making observations in places such as Alexandria and comparing them with those made there during the ancient Egyptian, Greek and Islamic periods was the only way that seventeenth-century astronomers could arrive at convincing answers to some of the questions of the day.

To make use of this ancient data, the exact coordinates of the places from which the observations had been made were essential. Without these reference points astronomers could make little sense of their observations (page 35). The books of Arab geographers like Abulfeda of Hama became important because they included these coordinates. Comparisons of old and new observations would sometimes pose new questions, such as those concerning the acceleration of the Moon (page 37) or the axial tilt of the Earth (page 24).

Arabic and Persian astronomical tables and star catalogues were also invaluable in research. In 1663 Hevelius wrote to the Royal Society enquiring about a copy of the famous fifteenth-century star catalogue of Ulugh Beg of Samarkand, which he had heard about from John Wallis, and asking for it to be translated. The Society met his request and a translation was made by Hyde, enriched by the addition of the Arab astronomer al-Tizini's sixteenth-century star catalogue. The finished product was sent to Hevelius, who used it to guide his mission of remapping the sky. Ulugh Beg had himself produced his catalogue by revising that of the tenth-century Muslim astronomer al-Sufi (page 30) (in whose observations Hevelius also showed interest). Al-Sufi in his turn had used the *Almagest* of Ptolemy of Alexandria for guidance in his observations, adding many stars not observed by Ptolemy to his new version. Tracing the roots of Ptolemy's constellations would take us even further back to ancient Egypt and Mesopotamia.

This truly multicultural history of our shared sky is demonstrated best in the commentary that Thomas Hyde wrote to his translation to some of Ulugh Beg's observations (page 26). To explain the context of the translation, and all the complexity in the names of stars and constellations, Hyde found himself having to use Latin, Arabic, Persian, Hebrew, Greek and Syriac, all in their original scripts and all on the same page.

Our shared Earth

As Europeans expanded their horizons in the sixteenth and seventeenth centuries they discovered another reason for paying attention to Arabic sources and the Arabic language. Many parts of the world new to Europeans had already been described by those who had travelled there before the Europeans – the Muslims. Books by Arab geographers such as Abulfeda became invaluable, containing as they did detailed descriptions of the geography, natural resources and people of countries unfamiliar to European travellers.

Abulfeda's book *A Sketch of the Countries (Taqwim al-Buldan)* (page 35) was much sought after in the seventeenth-century and often featured in the correspondence of the Royal Society. The French scientist and orientalist Jean de Thévenot wrote to the Society in 1671

about his struggle to translate Abulfeda, saying, "I should tell you sir that I found myself engaged in the translation of Abulfeda, which is an undertaking in which the difficulty of the language is the least [impediment]; the scarcity of Oriental historians and geographers up to the present has given me more trouble than anything else."

“ This we now call the Gothick manner of architecture, though the Goths were rather destroyers than builders; I think it should be with more reason be called the Saracen [Muslim] style; for those people [the Goths] wanted neither arts nor learning; and after we in the west had lost both, we borrowed again from them [Saracens], out of their Arabick books, what they with great diligence had translated from the Greeks.”

Christopher Wren, *Memorial to the Bishop of Rochester (1713)*

Arabick acknowledgment

Many scientists of the seventeenth and eighteenth centuries were happy to use Islamic resources for their scientific content while clearly understanding where the contributions of Arab and Muslim scholars fitted within the history of science. Roger Long demonstrated this brilliantly in his book *Astronomy* (page 25) in which he used the observations of Muslim astronomers like al-Fergani and al-Battani, and then devoted a chapter to 'Astronomy of the Arabians, Persians and Tartars'. This begins, "From the year 800, almost to the beginning of the fourteenth-century, Europe was plunged in darkness, and the most profound ignorance; but during this period several able men arose among the Arabians, and chiefly at Bagdad, which is very near the ancient Babylon; and some useful works were performed by them."

Long continued to demonstrate wide knowledge of the history of Arabic and Islamic science, citing many names such as Al Tusī and Thabit Ibn Qurra (836–901) and demonstrating that his knowledge also stretched to mathematics, "It is, undoubtedly, to the Arabians that we are indebted for the present form of trigonometry; for although Ptolemy rendered the theory of Menelaus much more simple, yet he worked by very laborious rules." Long, like many other scientists of the period, such as John Flamsteed and Christopher Wren, openly acknowledged the contribution of the Arabs and Muslims to science and philosophy, and demonstrated wide knowledge of this contribution.

The founders of modern science clearly recognised the importance of their Arabic heritage. We should recognise it too. Dialogue, not clash, between civilizations is at the heart of science and at the heart of the Royal Society.

Dr Rim Turkmani
Exhibition curator

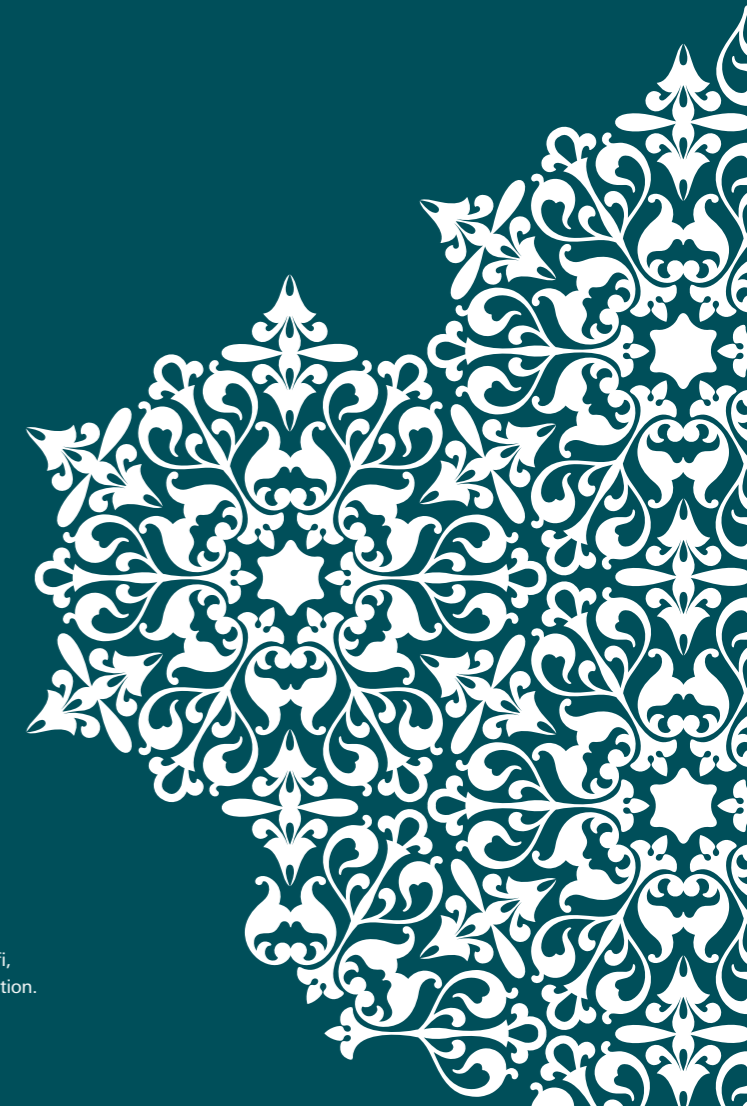


Arabick Roots

The Arabick roots of knowledge were significant at the founding period of the Royal Society. English philosophers showed continued appreciation for the classical science of the Arabic and Islamic worlds and interest in its living knowledge; they used both as sources for their research.

Arabick Roots uses the seventeenth-century spelling of Arabic that was seen as the key to unlock the treasure troves of knowledge coming from the East and that was often used to refer to languages that uses the Arabic type such as Arabic and Persian.

Left: Europe's oldest printed star map featuring Al-Sufi, one of the Arab astronomers highlighted in this exhibition.



The Arab Fellows of the Royal Society

The Royal Society elected three Arab Fellows in the seventeenth and early eighteenth centuries. All were prominent ambassadors who showed scientific curiosity, and they provided the Fellows with knowledge about popular medical practices and the ancient history of the region. They were Muhammad ibn Haddu and Mohammed Ben Ali Abgali of Morocco and Cassem Algiada Aga of Tripoli.



1.1 (Right)
Portrait of Muhammed Ibn Haddu
by Godfrey Kneller (1684)

Ibn Haddu was Moroccan Ambassador to London in 1682. His visit to the Society was recorded by Robert Hooke, and John Evelyn described him as “the fashion of the season, a handsome person, well featured and of a wise look, subtle and extremely civil.”

© English Heritage. The original portrait can be seen at Chiswick House (www.chgt.org.uk).

1.2 (Left)
Portrait of Mohammed Ben Ali Abgali
by Enoch Seeman (c. 1726)

Abgali was Moroccan Ambassador to London from 1725 to 1727.

On loan from RichGallery London.

1.3 (Above)
Royal Society Charter Book (1663)

Arab Fellows signed the Society’s Charter Book when they were elected. The first was Muhammad ibn Haddu the Moroccan Ambassador in 1682, the second was Mohammed Ben Ali Abgali the Moroccan Ambassador in 1726 and the third was Cassem Algiada Aga the Ambassador of Tripoli in 1728.



A new philosophy and the quest for Arabick knowledge

In seventeenth-century Europe, men began to study the world in a new way, using methods we now think of as scientific. At the same time, trade routes to Arab countries expanded, allowing a greater flow of information in both directions.



2.1 (Below)
Arabick routes

Map of the west and middle eastern worlds showing some major trade cities and knowledge centres.

2.1

A new philosophy

The Royal Society was founded in 1660 by a group of men who wanted to know more about the world. They were called the 'new philosophers', because they believed experiment and observation were better tools than abstract argument. They tested old theories and questioned old beliefs, showing that it was possible to delve deeper into the natural world using instruments such as the microscope and telescope. Chemists like Robert Boyle and astronomers like Edmond Halley made important discoveries that changed the way people understood the world.



Arabick routes

England's diplomatic and trade relations with the Ottoman Empire, boosted by the establishment of the Levant Company, enabled the exchange not only of goods but also of knowledge and manuscripts. Many aspiring Arabists learned Arabic while serving the Levant Company mission in Aleppo and acted as manuscript agents for sponsors such as William Laud, the Archbishop of Canterbury. Thousands of manuscripts were shipped back home along with fine horses, Damask silk, new varieties of trees and plants and even coffee-house culture.



2.4

2.2 (Above, right)
Charles I to the Levant Company (1634; reproduction)

Charles I asked the merchants of the Levant Company to send home a manuscript on every ship returning to England from the Levant.

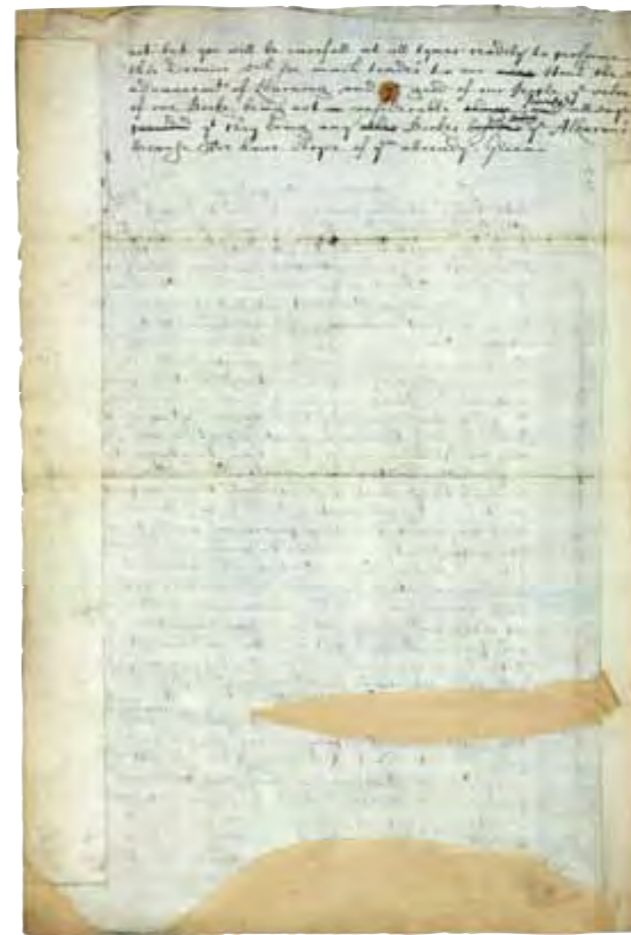
© The National Archives.

2.3 (Right)
Questions for Barbary (1669)

The Royal Society asked Henry Howard, English ambassador to Morocco, to bring back information about life and popular knowledge in North Africa.

2.4 (Above)
Damask Silk

The English merchants employed by the Levant Company imported many different goods from the Middle East, including fine silk.



2.2



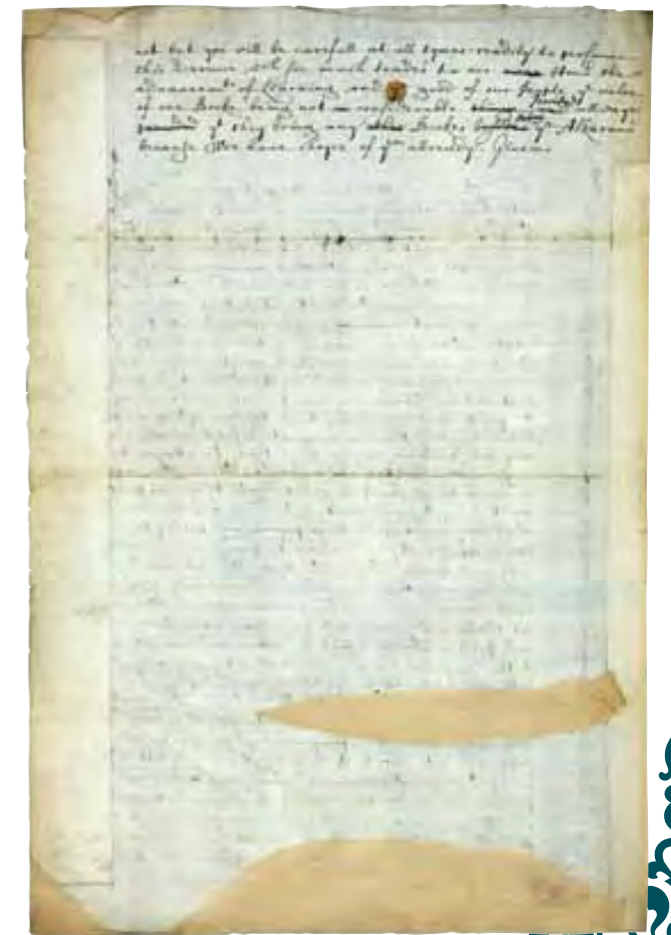
2.5

2.5 (Above)
The firman (decree) of Sultan Murad III
(Constantinople, 1587)

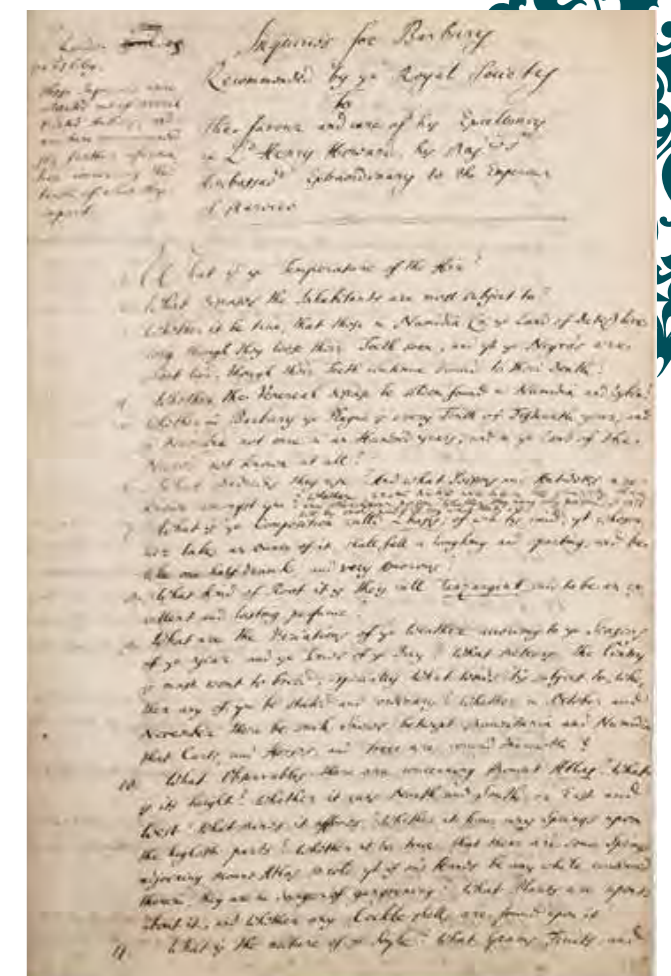
This decree, published on the final page of the Arabic edition of Euclid's *Elements*, gave European merchants the right to buy and sell Arabic printed books.

2.6 (Not pictured)
Oldenburg to English Consul at Aleppo (1666)

The Royal Society sent questions to the English merchants in Ispahan, ranging from "the present studies of ye Persians" to "How they unhusk their rice?"



2.3



2.3



The circle of philosophers and orientalists

Several Fellows of the Royal Society were part of a lively circle of philosophers and orientalists corresponding frequently on valuable knowledge in Arabic and Persian manuscripts. In some cases the orientalist and the philosopher were one and the same.



Robert Boyle FRS
(1627-1691)



Britain's most famous chemist, he learned the 'oriental tongues' to study the Bible and read oriental scholars.

Edward Bernard FRS
(1638-1697)



Bernard was a mathematician and an orientalist. The Savilian Professor of Astronomy at Oxford, he was particularly interested in translating ancient mathematical works and planned a 14-volume edition of ancient mathematicians. He used Arabic observations heavily in his astronomical research.

John Wallis FRS
(1616-1703)



A renowned mathematician, he was a founding Fellow of the Royal Society and a very active member. He translated from Arabic and often quoted Arabic mathematicians in his lectures. He included Nasir Eddin Al Tusi's five-page proof to Euclid's fifth postulate in his book, *Opera Mathematica*.

Edward Pococke
(1604-1691)



The first Laudian professor of Arabic at Oxford University, sponsored by the Archbishop of Canterbury, William Laud. He lived in Aleppo for many years where he learnt Arabic and collected manuscripts for Laud. He realised that the old medieval translations of Arabic philosophy were probably corrupt.

Portrait © National Portrait Gallery, London

Thomas Hyde
(1636-1703)



Professor of Arabic at Oxford University, he searched the oriental manuscripts of the Bodleian library for useful knowledge that he communicated to philosophers. He translated Ulugh Beg's star catalogue.

Henry Oldenburg FRS
(1617-1677)



The first secretary of the Royal Society, he was very aware of the importance of Arabic learning. He was one of the most active members of the circle of philosophers and orientalists, and he was often the hub of its correspondence.

Edmund Castell FRS
(1606-1685)



The professor of Arabic at Cambridge, he delivered his inaugural lecture on the use of Avicenna's medical work and later published it. He devoted 18 years to compiling an extensive dictionary of seven oriental languages including Arabic and Persian.

Edmond Halley FRS
(1656-1742)



A leading astronomer, he was keen to use historical observations for the benefit of the new astronomy. He researched the observations of al-Battani and learned Arabic in order to translate the Arabic editions of Greek mathematicians.

John Greaves
(1602-1652)



Greaves was both astronomer and orientalist. The Savilian Professor of Astronomy at Oxford, he travelled twice to the Levant where he collected manuscripts and observed with local astronomers. He translated Arabic and Persian books and wrote a book on Persian grammar.

Portrait © National Portrait Gallery, London



3.3

3.1 (Not pictured)
Letter from John Wallis to Henry Oldenburg (1667)

Responding to Oldenburg's query about "those skilled in Arabick" at Oxford, Wallis named Pococke, Clarck, Hyde, Huntington, Bernard, Marsh, Smith and Greaves.

3.2 (Not pictured)
The works of Robert Boyle edited by Thomas Birch (1744)

Hyde periodically sent Boyle extracts out of the oriental manuscripts at the Bodleian. Here he also asks for Boyle's support to "obtain more considerable books of such kind of learning".

3.3 (Above)
Letter from Wallis to Oldenburg for Johannes Hevelius (1668)

Wallis promised to translate Arabic and Persian astronomical tables with help from Pococke and Hyde 'because I find the Persian tables to be praised by the publisher of Tycho's observations'.

3.4 (Not pictured)
Letter from Wallis to Oldenburg (1671)

Wallis referred to Edmund Pococke's letter on coffee and tea, and informed Oldenburg on the whereabouts of the manuscripts of Abulfeda, the celebrated Syrian geographer.

Arabist astronomers

Several seventeenth-century astronomers made the effort to learn Arabic and Persian to have access to observations that would help them settle topical astronomical debates. This included the first five Savilian professors of Astronomy at Oxford. Some, like John Greaves, travelled to the Arab world where they made observations, learned Arabic and collected manuscripts.



4.1

4.1 (Above)
Persian/Latin edition of Ulugh Beg's star catalogue (1648)

Translated and introduced by the first and the second Savilian professors of Astronomy, John Bainbridge and John Greaves. They both mastered Arabic and Persian.

4.2 (Not pictured)
Islamic astrolabe (1849)

This astrolabe was commissioned for Sir Henry Elliott, an English historian who worked for the East India Company. It has Elliott's name engraved on it in Arabic letters.

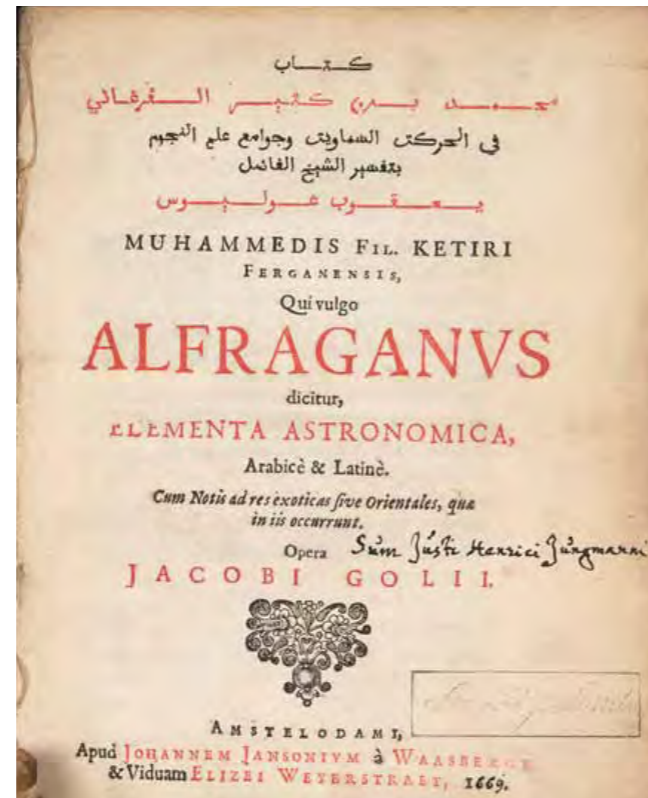
4.3 (Not pictured)
Letter from John Collins to Edward Bernard (1670)

Collins urged Bernard to find important observations from Arabic manuscripts because "without such the middle motion [of the Sun and the Moon] cannot be certainly determined."



Analysing the Earth's axial tilt

Establishing the precise axial tilt of the Earth (also called the obliquity of the ecliptic) and whether it has changed over the years is important for many astronomical and calendrical calculations. To do this Edward Bernard, Fellow of the Royal Society and Savilian Professor of Astronomy, dug deep into a wealth of Arabic materials and discovered valuable measurements of this tilt that did not match the contemporary value. He initially interpreted this as observational error but others like Pierre-Simon Laplace confirmed what some Arab astronomers thought 800 years earlier – the tilt changed periodically.



4.6

4.4 (Above right)
Letter from Edward Bernard to John Flamsteed on the Earth's axial tilt, printed in *Philosophical Transactions* (1684)

Bernard concluded the tilt is constant and attributed the disagreement between Arabic and contemporary values to observational errors.

4.5 (Not pictured)
John Flamsteed, *Historiae Coelestis Britannicae* (1725)

Flamsteed used the Arabic observations of the axial tilt provided by Bernard and agreed with him on his conclusion of a constant tilt.

4.6 (Above)
Al-Farghani, *Elements of Astronomy* (Latin translation, 1669)

Al-Farghani's work was among many Arabic resources used by Bernard. The book was first translated into Latin in the 12th century and was very influential during the Renaissance.



4.4

4.7

4.7 (Right)
Roger Long, *Astronomy* (1742)

Long used twelve of the Arabic values of the axial tilt provided by Bernard, but contrary to them he accepted that there had been a slow decrease over the centuries.

4.8 (Not pictured)
Pierre-Simon Laplace, *Traité de Mécanique Céleste* (1808)

Laplace found that the axial tilt changes periodically, as proposed by Ibn Thabit (circa. 900), due to perturbations to the Earth's orbit caused by other planets.



Our shared sky

The sky has always unified people across history and geography. Theories explaining stars and planets change, but observations always remain independently valuable. The new astronomy of the seventeenth-century needed Arabic and ancient observations to support its theories, especially when detecting movements of celestial bodies, which needed centuries and even millennia of observations.



Johannes Hevelius FRS

1611-1687

Johannes Hevelius was a renowned Polish astronomer and in 1664 was elected the first foreign Fellow of the Royal Society. He had great respect for Arab and Muslim scholars; he cited them and depicted them often in his books. As he set himself up to re-map the sky he focussed his attention on the well-known fifteenth-century star catalogue of Ulugh Beg. Hevelius wrote to the Royal Society asking them to find and translate the catalogue. The Society appointed John Wallis to oversee the translation that was later sent to Hevelius.



Ulugh Beg

1394-1449

Ulugh Beg was a Timurid ruler, astronomer and mathematician. He lived in Samarkand, which he turned into an intellectual centre that attracted many scholars to its Madrasa and observatory. He achieved remarkably accurate observations by building an enormous sextant in his observatory, parts of which still survive. He compiled his observations in a highly celebrated star catalogue in which he built upon the star atlas of al-Sufi and used al-Sufi's observations of the stars too far south to be observed from Samarkand.



5.1 (Left and above) Thomas Hyde, Latin translation of star catalogues by Ulugh Beg and Mohammed Tizin (1665)

The Royal Society supported Hyde in completing this translation after it was requested by some of the Fellows. It was printed in Oxford using Arabic type provided by Archbishop Laud.



5.2

5.3



5.2 (Left)
Johannes Hevelius, *Selenographia* (1647)

Ibn al-Haytham (here Alhasen) sharing with Galileo the honour of holding up the title page of *Selenographia*. Both al-Battani and Ibn al-Haytham are cited in the book.

5.4 (Not pictured)
Letter from Oldenburg to Hevelius (1668)

Oldenburg promised to send Hevelius the coordinates of fixed stars according to 'the tables of the celebrated Al-Sufi', and the Arabic copy of Ptolemy's *Almagest*, all prepared by Wallis.

5.3 (Above)
Johannes Hevelius, *Firmamentum Sobiescianum sive Uranographia* (1687)

Hevelius produced this atlas of constellations after years of observations. He used the observations of al-Sufi, Ulugh Beg and Tizini as guidance but also identified many new stars.

5.5 (Not pictured)
Letter from Henry Oldenburg to Hevelius (1664)

Oldenburg told Hevelius that in response to his request "the Royal Society has decided that the whole of Ulugh Beg's astronomical manuscript should be translated from Persian into Latin."

Star by star

Hevelius used the star catalogue of Ulugh Beg to re-map the sky, and Ulugh Beg used that of the tenth-century astronomer al-Sufi. Al-Sufi used the *Almagest* of Ptolemy of Alexandria to produce his catalogue. The roots of Greek star catalogues go back to ancient Egypt and Babylon. This has been always the way we mapped our sky, star by star.



5.6 (Above left)
The constellation Andromeda, depicted in Johannes Hevelius's *Firmamentum Sobiescianum sive Uranographia* (1687)



5.7 (Above right)
The constellation Andromeda, depicted in a copy of al-Sufi's star atlas (10th century)

Bodleian Library, University of Oxford, MS Marsh 144, p. 167.

Re-mapping the Earth and the sky

The seventeenth-century quest to re-map the Earth and the sky called for another quest – to find and translate the observations and measurements made previously by Muslim astronomers and geographers. Fellows of the Royal Society played an important part in this project.



5.10



5.11

5.8 (Not pictured)
Islamic celestial globe (18th/19th century)

The silver inlaid points surrounded by circles indicate more than a thousand different stars outlined in the form of 48 constellations.

On loan from the Science Museum, London.

5.9 (Bottom right)
Reflecting telescope made by Isaac Newton (1671)

Newton built his first reflecting telescope in 1668; this is his second model. It consists of two tubes, one sliding inside the other to focus the mirrors.

5.10(Left)
Islamic planisphere astrolabe, Maghrib (18th century)

Astrolabes were used throughout the Islamic Golden age to map the sky and the Earth. Abulfeda used such an instrument to determine the coordinates of cities and other places.

On loan from the Science Museum, London.

5.11 (Above)
Islamic horary quadrant

Horary quadrants were primarily used to tell the time from the altitude of the Sun. They were particularly useful for determining the Muslim prayer times.

On loan from the Science Museum, London.



5.12

5.12 (Above)
Katip Çelebi, *Jihannuma* (1732)

This book, the title of which can be translated as *Displaying the World*, is among the first in the Muslim world to use translated European resources. It was printed in Constantinople on the press of Ibrahim Müteferrika who petitioned the Sultan to fund a press with Arabic type.



5.9

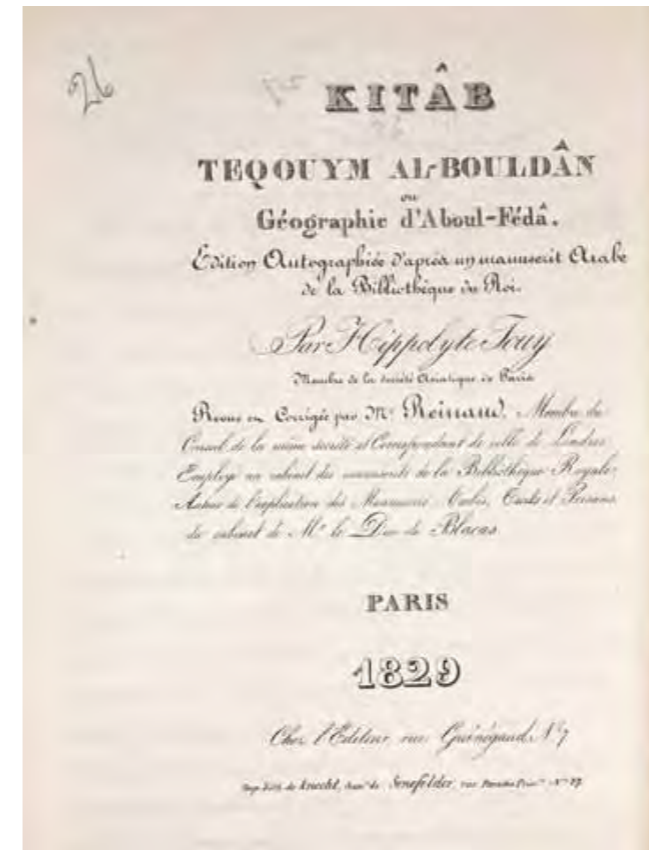


5.13

5.13 (Above)
Brass cabinet (19th century replica of 14th century original)

Brass, silver damascened and engraved cabinet with an Arabic inscription commemorating 'the scientist king', possibly referring to Abulfeda, the 14th century geographer and king of Hama, Syria.

On loan from the Science Museum, London.



5.15

5.15 (Above)
Abulfeda, *Taqwim al-Buldân* (1892)
(Title in English, *A Sketch of the Countries*)

From the 14th century original by Abulfeda, the ruler of Hama. The book described towns and cities and also gave their longitude, latitude and climate.

5.14 (Not pictured)
Letter from Henry Justel to Oldenburg (1667)

The secretary of Louis XIV reports "Mr. Thevenot has translated Abulfeda from Arabic into Latin. He has revised it with a gentleman from Marseilles who understands that language perfectly".



Edmond Halley FRS

1656-1742

Halley (below) used Arabic observations, and learnt Arabic himself in order to translate two books from that language. He admired the tenth-century astronomer al-Battani for being a keen and very precise observer and the first to dare to criticize Ptolemy. Halley spotted unlikely observations in the Latin translations of al-Battani's work, but he was confident that these were only translation errors. He wrote that he wished he could lay his hands on the original Arabic text "so as to be able to confirm our emendations".



Right: Hevelius making observations with a telescope, from *Selenographia* (1647)

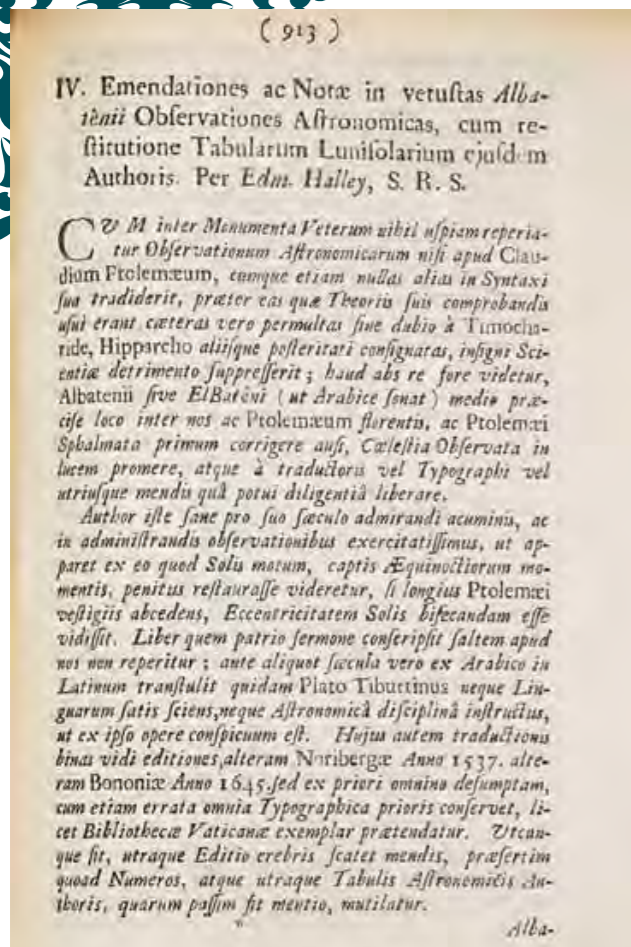


Acceleration of the Moon

Halley began the research that led to the establishment of the secular acceleration of the Moon, a possible increase in the Moon's mean rate of motion relative to the stars. Halley started by using al-Battani's observations of the eclipses at al-Raqqa (in modern Syria) and comparing them to ancient and modern observations. The debate was followed up by other astronomers, including Richard Dunthorne, Long and Laplace. All used al-Battani's observations and those of other Babylonian, Greek and Muslim astronomers in addressing this question, which was finally settled in 1853.

From astrolabes to telescopes

Astrolabes and quadrants gradually gave way to the newly-invented telescope, but this was not a swift change. Telescopes offered a closer look at stars, but mapping the coordinates of these stars remained the task of the traditional quadrant. Hevelius (left) was reluctant to use the telescope and claimed he could do as well with his quadrant and alidade (Arabic for ruler), a claim that was verified by Halley when he visited Hevelius. Eventually Hevelius fitted his telescope with a quadrant to get the best of both worlds.



5.16

5.16 (Above)
Letter on al-Battani's observations by Edmond Halley from *Philosophical Transactions* (1693)

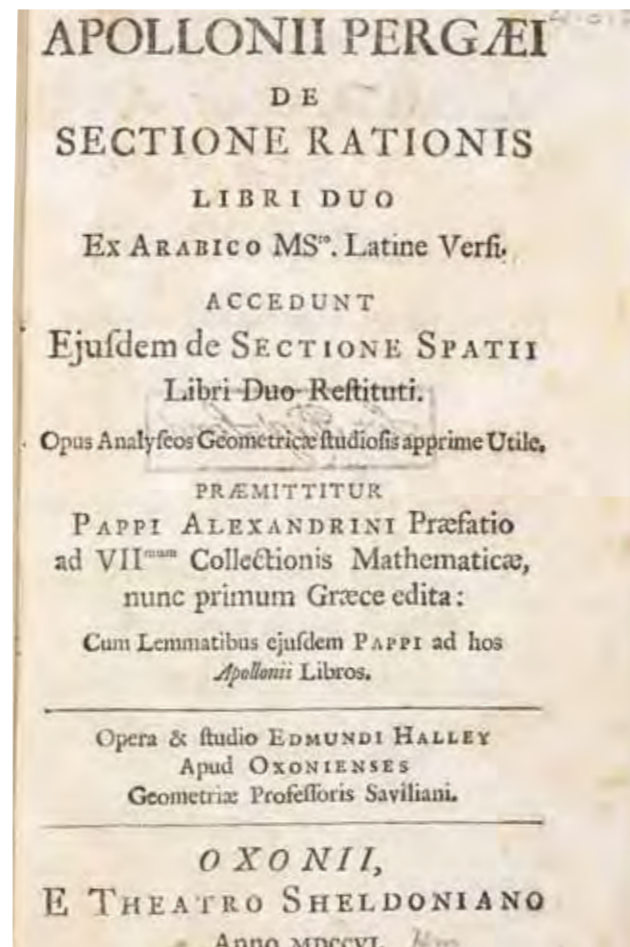
Using al-Battani's observations Halley started the debate on the acceleration of the Moon. Halley noted in this paper that al-Battani was the first to dare to correct Ptolemy.

5.17 (Not pictured)
Letter from Richard Dunthorne concerning the Moon's motion from *Philosophical Transactions* (1747)

In his quest to investigate the acceleration of the Moon Dunthorne used the observations of al-Battani and Ibn Yunus as well as those made in Babylon and Alexandria.

5.18 (Not pictured)
Concerning the ancient city of Palmyra by Edmond Halley from *Philosophical Transactions* (1695)

Halley appealed to travellers "to observe... the Phases of the Moon's Eclipse at Bagdad, Aleppo and Alexandria, thereby to determine their longitude". He said that in doing this, travellers "could not do the Science of Astronomy a greater service".



5.19

5.19 (Above)
Edmond Halley, *Apollonii Pergæi de Sectione Rationis* (1706)

The original Greek of Apollonius is lost, but Halley translated this volume from Arabic into Latin. He learned Arabic at the Bodleian Library in Oxford, with support from Edward Bernard.

5.20 (Not pictured)
European astrolabe (1650)

This astrolabe with a compass was made by Anthony Sneewins. During the 17th century the use of astrolabes declined after the invention of the telescope and pendulum clock.

On loan from the Science Museum, London.

5.21 (Not pictured)
Boxwood Gunter quadrant (17th century)

Edmond Gunter (1581-1626) was Professor of Astronomy at Gresham College. He invented a new design for the quadrant that was very easy to use for determining time.

On loan from the Science Museum, London.

Robert Boyle FRS

1627-1691

Boyle (below) was England's most famous chemist in the seventeenth-century. He was initially motivated to study oriental languages like Arabic and Syriac because of their biblical significance. Later he became more interested in the natural philosophy found in texts written in these languages, and his circle of orientalist friends helped him to find useful information in the increasing number of Arabic and Persian manuscripts that were arriving in England.



Boyle's interest in Arabick science

Arab chemists influenced Boyle's understanding of chemical processes and his natural philosophy. His main source of such knowledge was his friend the orientalist Thomas Hyde. As a librarian at the Bodleian in Oxford, Hyde had access to a treasure of Arabic and Persian manuscripts and periodically sent Boyle extracts from them including recipes out of a book "as thick as one's thumb" by al-Iraqi, a thirteenth-century Muslim chemist. Boyle also asked Pococke to translate for him the tables of longitude and latitude compiled by the Syrian geographer Abulfeda.



6.1

6.1 (Above)
Notes written by Thomas Hyde to Boyle (c.1667)

Here Hyde displays a wide knowledge of Arabic resources, providing Boyle with information about sal ammoniac, amber and petrification, and citing six Muslim scholars: Ibn al-Bitar, Ibn al-Talmiz, Ulugh Beg, Nassir Eddin, Al Gaphiti and Said Ibn Ali.



6.1



6.2

6.2 (Bottom right)
Printed table of oriental languages, including Arabic (17th century)

Found among the papers of Robert Boyle, this may be a specimen of Edmund Castell's *Lexicon*.

Arabic	Hebrew	Chaldean	Persian	Turkish	Armenian	Malabar	Indic	Sinica	Japanica	Cosmopolitana
א	א	ܐ	ا	آ	Ա	അ	अ	ア	A	Α
ב	ב	ܒ	ب	ب	Բ	ബ	ब	バ	B	Β
ג	ג	ܓ	ب	پ	Գ	ഗ	ग	ガ	G	Γ
ד	ד	ܕ	د	د	Դ	ദ	द	ダ	D	Δ
ה	ה	ܗ	ه	ه	Կ	ഹ	ह	ハ	H	Η
ו	ו	ܘ	و	و	Վ	വ	व	ヴァ	V	Θ
ז	ז	ܙ	ز	ز	Զ	ജ	ज	ジャ	J	Ι
ח	ח	ܚ	ح	ح	Ժ	ജ	ज	ジャ	J	Κ
ט	ט	ܛ	ط	ط	Թ	ത	त	タ	T	Λ
י	י	ܝ	ي	ي	Ի	ഇ	इ	イ	I	Μ
כ	כ	ܚ	ك	ك	Կ	ക	क	カ	K	Ν
ל	ל	ܠ	ل	ل	Լ	ല	ल	ラ	L	Ξ
מ	מ	ܡ	م	م	Մ	മ	म	マ	M	Ο
נ	נ	ܢ	ن	ن	Ն	ന	न	ナ	N	Π
ס	ס	ܣ	س	س	Տ	ശ	श	シャ	S	Ρ
ע	ע	ܥ	س	س	Տ	ശ	श	シャ	S	Σ
פ	פ	ܦ	ف	ف	Փ	ഫ	फ	ファ	F	Τ
ק	ק	ܩ	ق	ق	Ք	ഖ	ख	खा	X	Υ
ר	ר	ܪ	ر	ر	Ր	ര	र	ラ	R	Φ
ש	ש	ܫ	ش	ش	Տ	ശ	श	シャ	S	Χ
ת	ת	ܛ	ط	ط	Թ	ത	त	タ	T	Ψ
י	י	ܝ	ي	ي	Ի	ഇ	इ	イ	I	Ω
כ	כ	ܚ	ك	ك	Կ	ക	क	カ	K	Α
ל	ל	ܠ	ل	ل	Լ	ല	ल	ラ	L	Β
מ	מ	ܡ	م	م	Մ	മ	म	マ	M	Γ
נ	נ	ܢ	ن	ن	Ն	ന	न	ナ	N	Δ
ס	ס	ܣ	س	س	Տ	ശ	श	シャ	S	Ε
ע	ע	ܥ	س	س	Տ	ശ	श	シャ	S	Ζ
פ	פ	ܦ	ف	ف	Փ	ഫ	फ	ファ	F	Θ
ק	ק	ܩ	ق	ق	Ք	ഖ	ख	खा	X	Ι
ר	ר	ܪ	ر	ر	Ր	ര	र	ラ	R	Κ
ש	ש	ܫ	ش	ش	Տ	ശ	श	シャ	S	Λ
ת	ת	ܛ	ط	ط	Թ	ത	त	タ	T	Μ
י	י	ܝ	ي	ي	Ի	ഇ	इ	イ	I	Ν
כ	כ	ܚ	ك	ك	Կ	ക	क	カ	K	Ξ
ל	ל	ܠ	ل	ل	Լ	ല	ल	ラ	L	Ο
מ	מ	ܡ	م	م	Մ	മ	म	マ	M	Π
נ	נ	ܢ	ن	ن	Ն	ന	न	ナ	N	Ρ
ס	ס	ܣ	س	س	Տ	ശ	श	シャ	S	Σ
ע	ע	ܥ	س	س	Տ	ശ	श	シャ	S	Τ
פ	פ	ܦ	ف	ف	Փ	ഫ	फ	ファ	F	Υ
ק	ק	ܩ	ق	ق	Ք	ഖ	ख	खा	X	Φ
ר	ר	ܪ	ر	ر	Ր	ര	र	ラ	R	Χ
ש	ש	ܫ	ش	ش	Տ	ശ	श	シャ	S	Ψ
ת	ת	ܛ	ط	ط	Թ	ത	त	タ	T	Ω

Jabir Ibn Hayyan (Geber)

721-815

This legendary polymath excelled in any fields but it is his achievements in chemistry that made him famous in medieval Europe. The name 'Geber' was used by an anonymous European writer in the thirteenth-century as a pen-name for his book on alchemy. Geber believed in experimentation, "The first essential in chemistry is that thou shouldst perform practical work and conduct experiments, for he who performs not practical work nor makes experiments will never attain to the least degree of mastery". For such experiments he is credited with developing many items of chemical laboratory equipment.

Alembic

An alembic is a type of flask used for distillation and sublimation – the process where liquids are separated and purified. Alembics became essential pieces of apparatus used by early chemists and alchemists. Muslim chemists used this process to make essential oils and perfumes and other chemicals.

Like most alchemical terminology, the word 'alembic' originates from the Arabic: al-inbeeq, meaning 'that which refines'. Geber (Jabir Ibn Hayyan) is renowned for developing the alembic in the eighth-century.



6.3

6.3 (Above)
The world's oldest alembic (10th-12th century)

This Islamic glass apparatus, an alembic used for distillation, is reputed to be among the oldest to survive in the world.

On loan from the Science Museum, London.

6.4 (Not pictured)
Islamic chemistry glassware (7th-13th century)

Examples of Islamic glassware, used for chemistry and other purposes. The collection includes a rare 7th century phial.

On loan from the Science Museum, London.



6.5

6.5 (Not pictured)
European alembic (19th century)

Hand-moulded green glass alembic. Alembics were refined slightly over the years, but the essential design remained the same.

On loan from the Science Museum, London.

6.6 (Not pictured)
The Works of Geber, the Most Famous Arabian Prince and Philosopher (1686)

The real Geber was an alchemist in the court of Harun al-Rashid, but the Pseudo-Geber was himself also given royal pedigree. Newton had four different copies of this book in his library.



6.7 (Above)
Avicenna and Geber, *Artis Chemicae Principes* (1572)

This Latin book claims to offer the best out of the chemistry of Avicenna (Ibn Sina) and Geber (Jabir Ibn Hayyan).

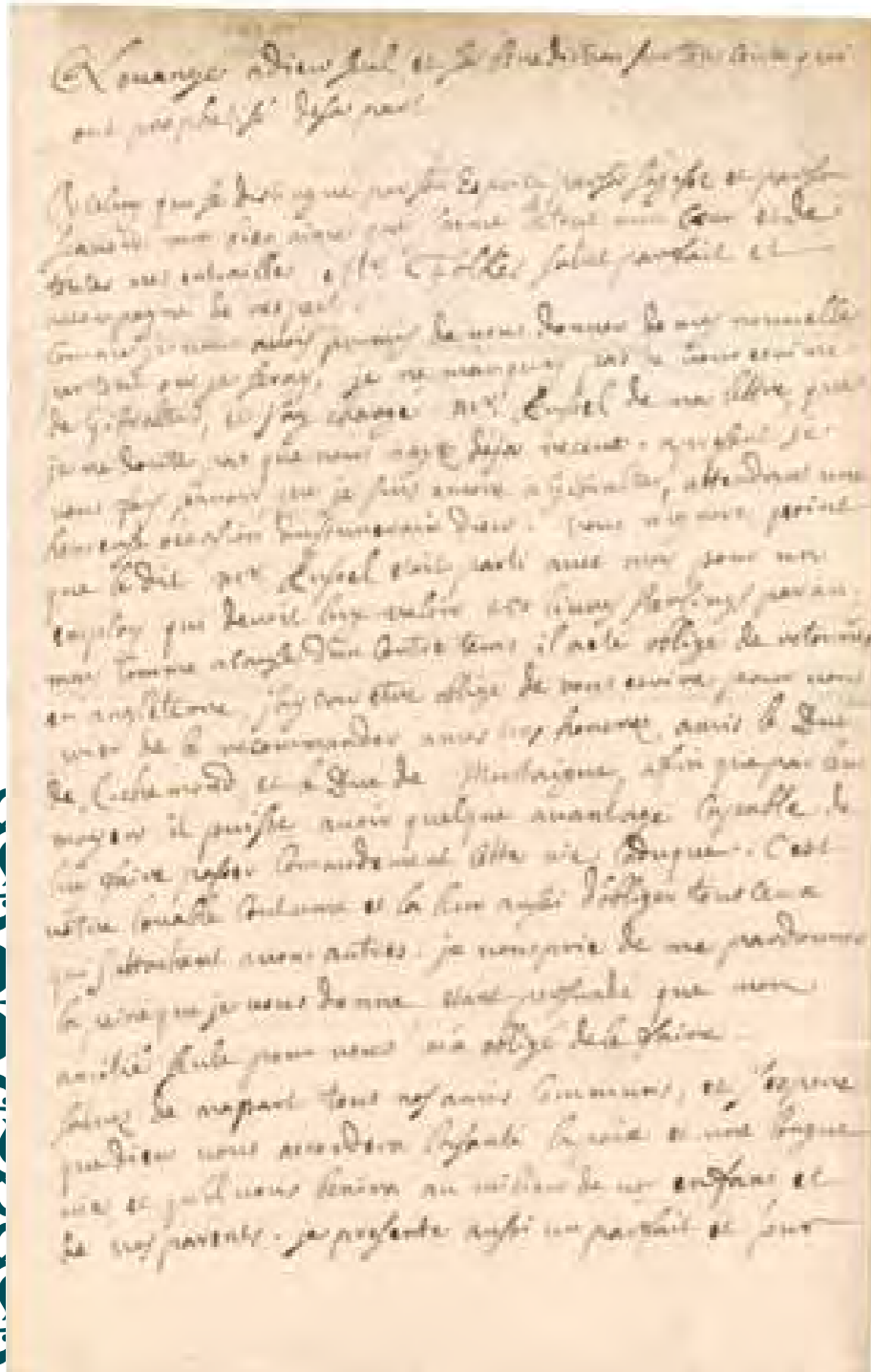
6.8 (Not pictured)
Drawing of alembics (late 17th century)

These drawings, found among Boyle's papers, describe the use of alembics in different settings for chemical laboratory experiments.



Arabick language and philosophy

Some of the early Royal Society Fellows were also leading Arabists. They were not only interested in what Arabic sources could tell them about science – they also wanted to bring literary and philosophical works to western audiences. Several Arabic grammars and dictionaries were published in this period and were read and used by Fellows.



Mohammed Abgali wrote to the Society before and after he was elected a Fellow in 1726. His letter to Martin Folkes (right) was translated for the Fellows (left).



Handwritten Arabic text, likely a translation of the letter to Martin Folkes, mentioning the author's election as a Fellow of the Royal Society in 1726.

Arabick in seventeenth-century England

Arabic studies in England had been promoted by Archbishop Laud, who founded an Arabic professorship at Oxford in 1636. English people studied eastern languages for a variety of reasons: to enable merchants to communicate with traders from the Arab world; to read early Biblical texts; and to learn about Arabic literature and culture. Edmond Halley was so keen to read mathematical works in Arabic that he 'deciphered' the language as though it were a code, using only a few pages of translated text as a guide.



8.1 (Left)
Engraving of Edmund Castell by William Faithorne (1669)

Castell worked on the polyglot Bible, and published a dictionary of seven oriental languages.

8.2 (Above)
Letter from Edward Pococke to Robert Boyle (1660)

Pococke asked Boyle to use his influence to encourage merchants in Aleppo to send back Arabic books.



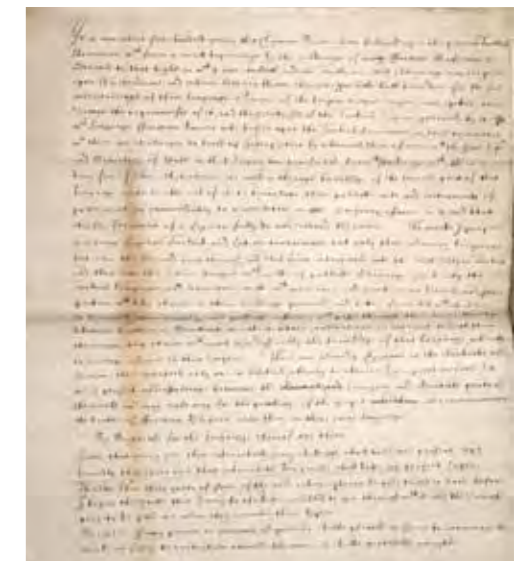
8.2

LIBER PRIMVS.		
8	D	Dal د د
9	D blafon	Dhal ذ ذ
10	R	Re ر ر
11	Z	Ze ز ز
12	S	Sin س س
13	S, li. Gall.	Sin ش ش
14	S	Sad ص ص
15	D	Dad ض ض
16	T	Ta ط ط
17	D	Da ظ ظ
18	y thraam.	Ain ع ع
19	G Zetuum.	Gain ج ج
20	F	Fe ف ف
21	K	Kaf ك ك
22	C	Kef ق ق
23	L	Lam ل ل
24	M	Mim م م
25	N	Nun ن ن
26	W German.	Waw و و
27	H	He ه ه
28	I Confon.	Ie ي ي

8.4

RVDIMENTORVM ARABICORVM LIBER PRIMVS. De Elementis Linguae Arabicae.			
Ceterum Arabica dextra finitram verius: & prima linguae sua Elementa habent Consonas & Vocales.			
Consonarum Tabella haec est:			
Quo.	Potrihu.	Nomen.	Figura.
1	Alif	Elif	ا ا ا ا
2	B	Be	ب ب ب ب
3	T	Te	ت ت ت ت
4	T blafon.	Thife	ث ث ث ث
5	G Zetuum.	Gjin	ج ج ج ج
6	Hl	Hla	ح ح ح ح
7	Ch	Cha	خ خ خ خ

8.4



8.5



8.6

8.3 (Not pictured)
Edmund Castell, *Lexicon Heptaglotton* (1669)

Castell's dictionary of seven oriental languages (Hebrew, Samaritan, Chaldee, Syriac, Arabic, Ethiopian, and Persian) took twelve years and was a commercial disaster.

On loan from the Science Museum Library

8.4 (Above)
Thomas Erpenius, *Rudimenta Linguae Arabicae* (1638)

Erpenius was professor of Arabic at Leiden and was the first to publish a detailed Arabic grammar for European readers.

8.5 (Above)
Proposal for printing a Turkish lexicon (c. 1670)

Probably prepared by William Seaman, author of a Turkish translation of the New Testament, published in 1666 at Robert Boyle's expense.

8.6 (Above)
The Grammar Book of al-Ajrumiyah

Originally written in the 14th century by Ibn Ajroom Al Sanhaji of Fez, this popular Arabic grammar book is part of the collection of the Royal Society library.

The self-taught philosopher

In 1671 Edward Pococke junior published a translation of the Arabic work *Hayy Ibn Yaqzan* by Ibn Tufail. The short novel describes the story of Hayy, a boy raised by animals on a desert island, who comes to an understanding of the world entirely through his own reasoning. The book caused an immediate stir in the western world. It was reviewed in the *Philosophical Transactions*, Robert Boyle wrote a similar story in English, and the ideas influenced John Locke, one of England's most important philosophers.



8.9

8.7 (Not pictured)
Review of *Philosophus Autodidactus*,
in *Philosophical Transactions* (1671)

The reviewer called it, "a very ingenious piece... elegant in the original".

8.8 (Not pictured)
John Locke, *An Essay Concerning Human Understanding*
(1690; this edition 1721)

Locke's concept of the unformed mind as a 'tabula rasa' was influenced by the story of Hayy Ibn Yaqzan.

8.9 (Above)
Robert Boyle, a fragment of *The Aspiring Naturalist*

Boyle seems to have written part of a philosophical romance based on the Hayy Ibn Yaqzan story.



8.10 (Not pictured)
John Wallis, *Opera Mathematica* (1665)

Wallis translated from Arabic and often quoted Arabic mathematicians in his lectures. In this book he included Nasir Eddin Al Tusi's five-page proof to Euclid's fifth postulate.

Arabick mathematics

Some mathematicians, including John Wallis, learned Arabic in order to translate the works of Greek mathematicians that only survived in Arabic. But these Arabic books were more than just translations: they were commentaries full of queries and solutions. Edmond Halley translated two Arabic mathematics books. John Pell translated the Greek geometer Apollonius from an Arabic manuscript after a heated debate with the Arabist Hugo Grotius, who asked Pell to leave the fame of translating such a work to him and went to great lengths to prevent Pell publishing his translation.

Left: Portrait of John Wallis by Gerard Soest, in the collection of the Royal Society.

Alhazen and his problem

The tenth-century polymath Ibn al-Haytham, known in the west as Alhazen, was known as 'The Physicist' and 'Ptolemy the Second' in Europe. He is recognized as a pioneer of scientific method for his development of an experimental method to verify hypotheses. He left behind the notorious Alhazen problem (only solved in 1997): "Given a light source and a spherical mirror, find the point on the mirror where the light will be reflected to the eye of an observer."



8.11

8.11 (Above)
Ibn al-Haytham, *Book of Optics* (Latin translation, 1572)

Ibn al-Haytham's *Book of Optics* is now a thousand years old. It revolutionized optics and had a great impact on science in Europe, being cited by Roger Bacon and Johannes Kepler, among others.

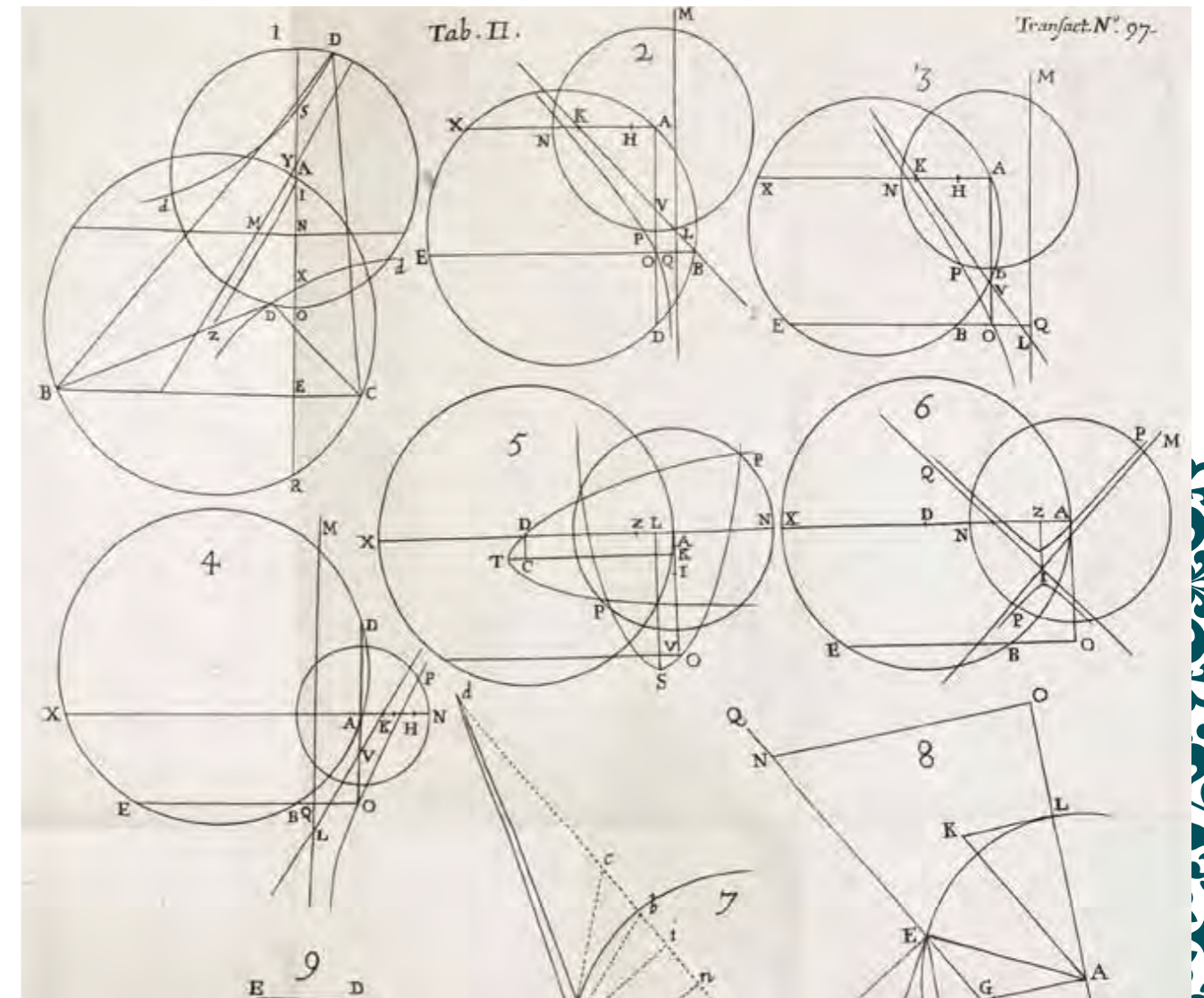
8.12 (Section pictured above)
Letter about the Alhazen problem
from *Philosophical Transactions* (1673)

The French mathematician René de Sluse and the Dutch astronomer Christiaan Huygens wrote to Oldenburg their "second thoughts on the problem of Alhazen".

8.13 (Not pictured)
Wooden cupboard with tortoise-shell and mother-of-pearl inlay

This Islamic cupboard has many drawers and may have been used to store medicinal preparations.

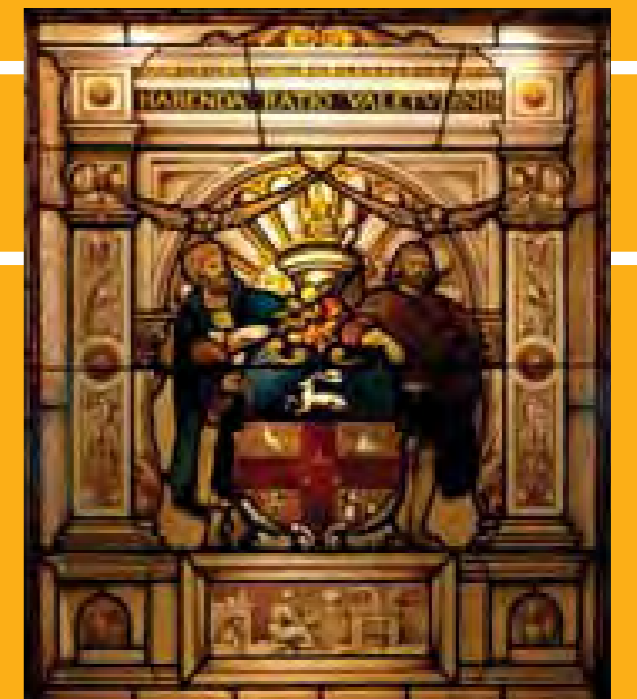
On loan from the Science Museum, London.



8.12

Islamic Pharmacy

The coat of arms of the Royal Pharmaceutical Society of London, depicted on a stained glass window. The figures are Ibn Sina (Avicenna) and Galen. Reproduced by permission of the Royal Pharmaceutical Society of London.



Arabick medicine

Some of the most influential writers from the Arab world were physicians. Their writings on medicine, disease, and how to live a healthy lifestyle were studied in European universities into the seventeenth-century. They commented on Greek and Roman authors, and added their own theories and observations.



9.1



9.2

9.1 (Illustrations left)
The Maintenance of Health, Ibn Butlan (11th century)

Ibn Butlan was an 11th century physician who originally practised in Baghdad. His book discussed hygiene, diet and exercise and emphasized the importance of a balanced lifestyle.

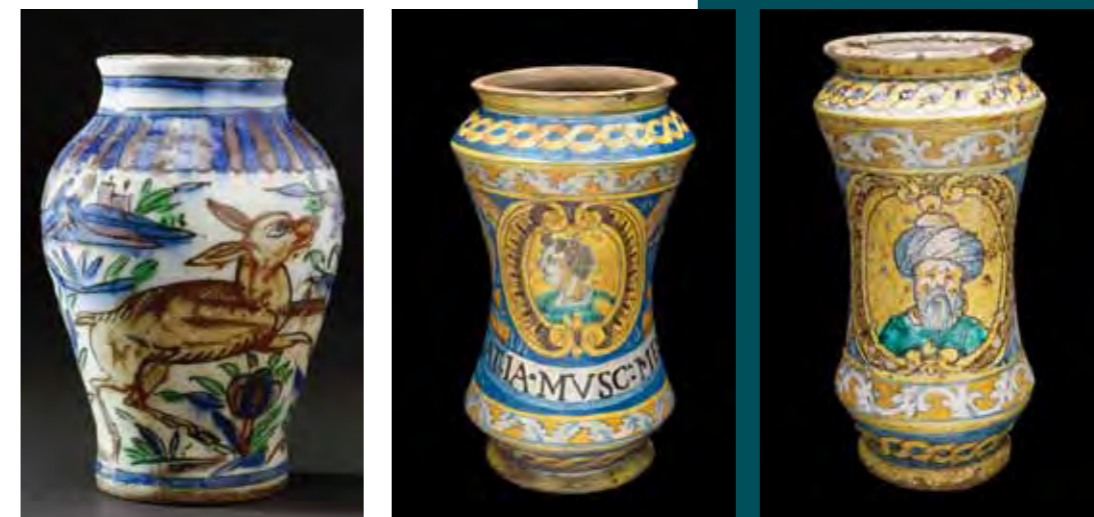
9.2 (Above)
Ibn Sina (Avicenna), The Canon of Medicine (1593)

The first printed Arabic edition of *The Canon of Medicine*. The work was completed in 1025 by Ibn Sina, a Persian physician and philosopher whose works were widely studied in the west. Printed at the Medici Press in Rome.

9.3 (Below)
Earthenware flasks and jars

Jars like these were widely used to hold medicinal preparations and ingredients in apothecaries' shops.

On loan from the Science Museum, London.



9.3

Arabick roots, literally

Importing medical plants and herbs from the Arabic world goes back to the twelfth-century, but the foundation of the Levant Company gave it a new impetus. Merchants, diplomats and clergymen sent back bulbs and plants, with descriptions of how they were grown and used. Doctors who practiced in the Levant benefited from the long-established tradition of Islamic pharmacy and sent back dried specimens of medical herbs with descriptions and drawings.

The Russell brothers and *The Natural History of Aleppo*

Alexander Russell, and his brother Patrick, were Scottish physicians who travelled to Aleppo in the eighteenth-century as official doctors for the Levant Company. When Alexander returned to England he wrote a popular and very detailed book about Aleppo, which included information about local flora and fauna, social customs, and diseases prevalent at the time (particularly the plague). Patrick sent his brother information about smallpox inoculation in Aleppo.



9.5

9.5 (Above and right)
Alexander Russell, *The Natural History of Aleppo* (1756)

Russell's book described local flora and fauna, customs, and medicines in detail.

9.6 (Left)
Smallpox inoculation in Arabic countries (1768)

Patrick Russell wrote to his brother Alexander describing the Arabic custom of inoculating children against smallpox with a needle.

9.7 (Not pictured)
Specimens of medicinal products

Western apothecaries bought plants and other products used in traditional Indian and Chinese medicine from Arabic traders in Aleppo and elsewhere.

9.8 (Not pictured)
Description of three substances mentioned by Arabian physicians (1766)

John Channing, a London apothecary, wrote to the Royal Society about medicinal specimens sent to him from Aleppo, including wormwood and tabasheer, a drug made from bamboo.

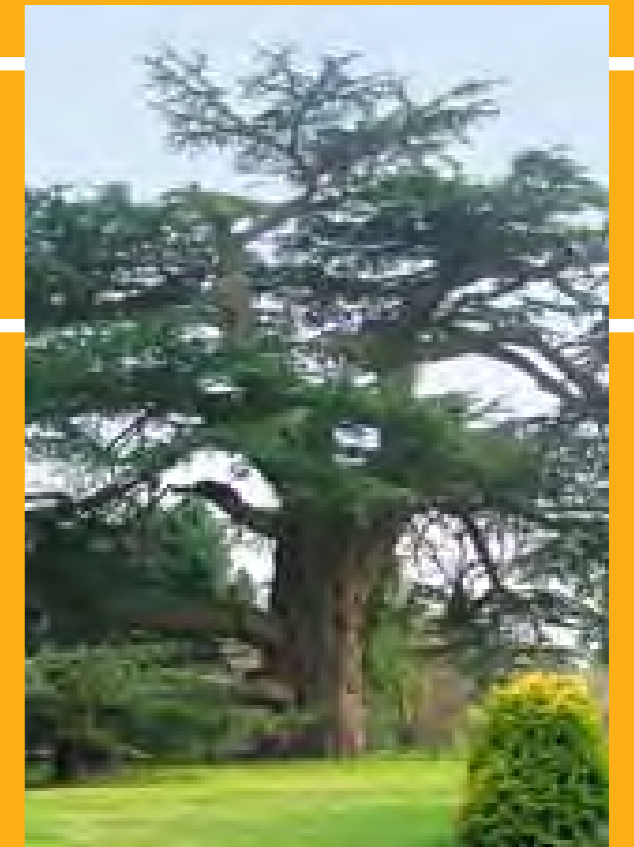


9.5

England's oldest cedar tree

Travellers to the Levant, delighted with the richness and diversity of its plants and trees, wanted to bring the splendour back home. Today, a long list of flowers that enrich English gardens and trees that line the streets of England have their roots back in the 'Arabick' world. Astonishingly, three of the trees brought back from Syria and planted in and around Oxford in 1640 by Edward Pococke are still alive. They are England's oldest cedar, plane and fig trees.

Right: Cedar of Lebanon at Childrey
© The Tree Council www.treecouncil.org.uk



[140]

Received April 20, 1768.

XX. An Account of Inoculation in Arabia, in a Letter from Dr. Patrick Russell, Physician, at Aleppo, to Alexander Russell, M. D. F. R. S. preceded by a Letter from Dr. Al. Russell, to the Earl of Morton. P. R. S.

My Lord,

Read May 31 1768. THE inclosed account of inoculation in the East, I have just received from my brother at Aleppo, and though nothing farther seems wanting in this country to remove prejudices against that practice, yet I thought its being made public might be of some use to other European nations, where such prejudices still prevail; and as a matter of curiosity, would not be unacceptable to the Royal Society. I have therefore taken the liberty to trouble your Lordship with it for that purpose.

Just before my leaving Aleppo, I did hear that it was practised amongst some of the Bedouins there, and went by the name of buying the small pox; but being then much engaged with other business, it quite escaped my memory, and indeed my information was so slight, that I did not think it right to mention it in my Natural History of Aleppo.

I shall

A View of the Ruines of Palmyra alias Tadmor, taken on the Southern Side



my self, and this Society, till my self be dead for their
 edification, or some more able Member in the same
 place, if not sooner, shall be pleas'd to give us.

In Extract of the Journals of two severall
 Voyages of the English Merchants of Aleppo
 to Tadmor, anciently call'd Palmyra.
 By Timothy Leary, and Thomas Fryer.

Our Merchants of this Worthy Factory being
 generally men of more than Ordinary Vertue
 and Education have not been wanting (as the
 intervals of their Leisure from their gainfull
 traffick would permit) to make Voyages of Curiosity
 to visit the celebrated Remains of Antiquity in those
 parts, where by the once flourishing State of the
 World under the Roman Empire, is abundantly witness'd.
 And being inform'd by the Natives that the Ruines
 of the City of Tadmor were more considerable than
 any they had yet seen, they were tempted to enterprize
 this hazardous and painfull Voyage over the Desert,
 but having seen by the perjury of the Arabs & suppos-
 ed of their defects in their first attempt, they were
 oblig'd to defer their Curiosity, till they could better
 provide for their security, whereof being assur'd from
 the confidence some of them had in a young Man King
 of the Arabs they adventur'd again in the Year 1695,
 and had full Liberty to visit, observe, & describe what
 they pleas'd.

9.7

(923) Num. 197.

PHILOSOPHICAL TRANSACTIONS.

Esq. 10. for the Months of January and February, 1677.

The Contents.

The manner of Hatching Chicken at Cairo; observed by Mr. John Graves, and communicated by Sr. George Ent. A Relation concerning Barnacles; by Sr. Robert Moray. A Description of the Island Hiwa; communicated also by Sr. Robert Moray. Some Observations of a Camelion; made by Dr. Jonathan Goddard. An Account of the Iron Works in the Forest of Dean; communicated by Henry Pouch, Esquire. A Relation of the making of Cervis; by Sr. Phillipario Verriani. An Account of Two Books: I. The true Intellectual System of the Universe. The First Part; by R. Cudworth, Ll. D. II. The Six Voyages of John Baptista Tavernier, published in English.

The manner of Hatching Chicken at Cairo, observed by Mr. John Graves, sometime Professor of Astronomy at Oxford; and communicated by Sr. George Ent. late President of the College of Physicians, London.

They begin in the middle of January to heat the Ovens; spending every Morning an hundred Kintars (or 20 hundred pound weight) of Camels, or of Buffals Dung; and the like proportion at Night, till the middle of February. About which time the Ovens are so hot, that the camel will scarce to lay his hand upon the Walls.

After this, they put the Eggs into the Ovens to hatch the Chicken; which they continue successively till the end of May.

9.8

9.7 (Left and top)
 Description of the ruined city Palmyra in Syria (1695)

English merchants based in Aleppo sent this description of Palmyra to the Royal Society. They were particularly interested in the ancient inscriptions and carvings.

9.8 (Above)
 The manner of hatching chickens at Cairo (1678)

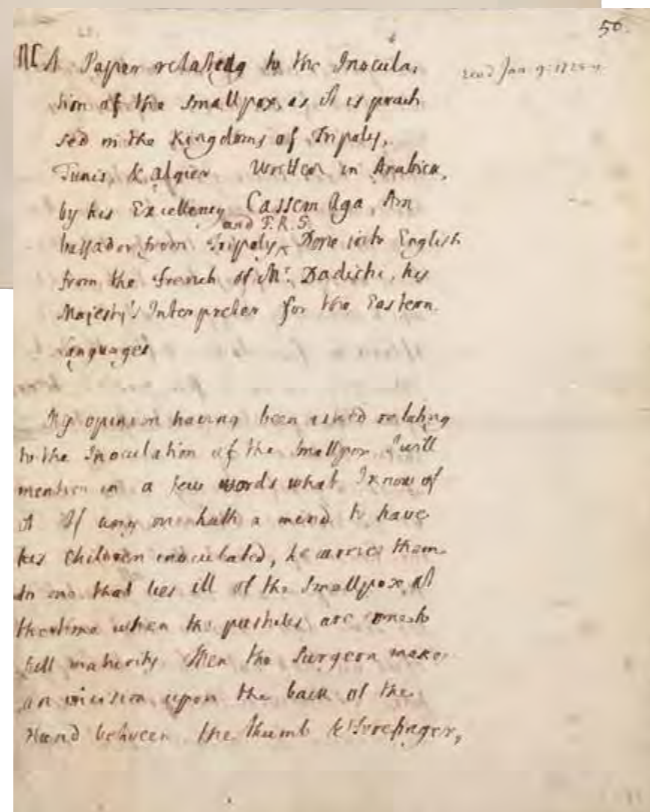
John Greaves described the Egyptians' use of large ovens to hatch several thousand eggs at a time.

Fight against smallpox

In the eighteenth-century a smallpox epidemic hit London. Little was known about the disease in England, so Fellows of the Royal Society turned to the Muslim physician al-Razi to learn about the disease. They also investigated methods of inoculation, an immunisation practice that was common in the Muslim world, where healthy people were given a mild dose of the virus from an infected person.



10.1



From inoculation to vaccination

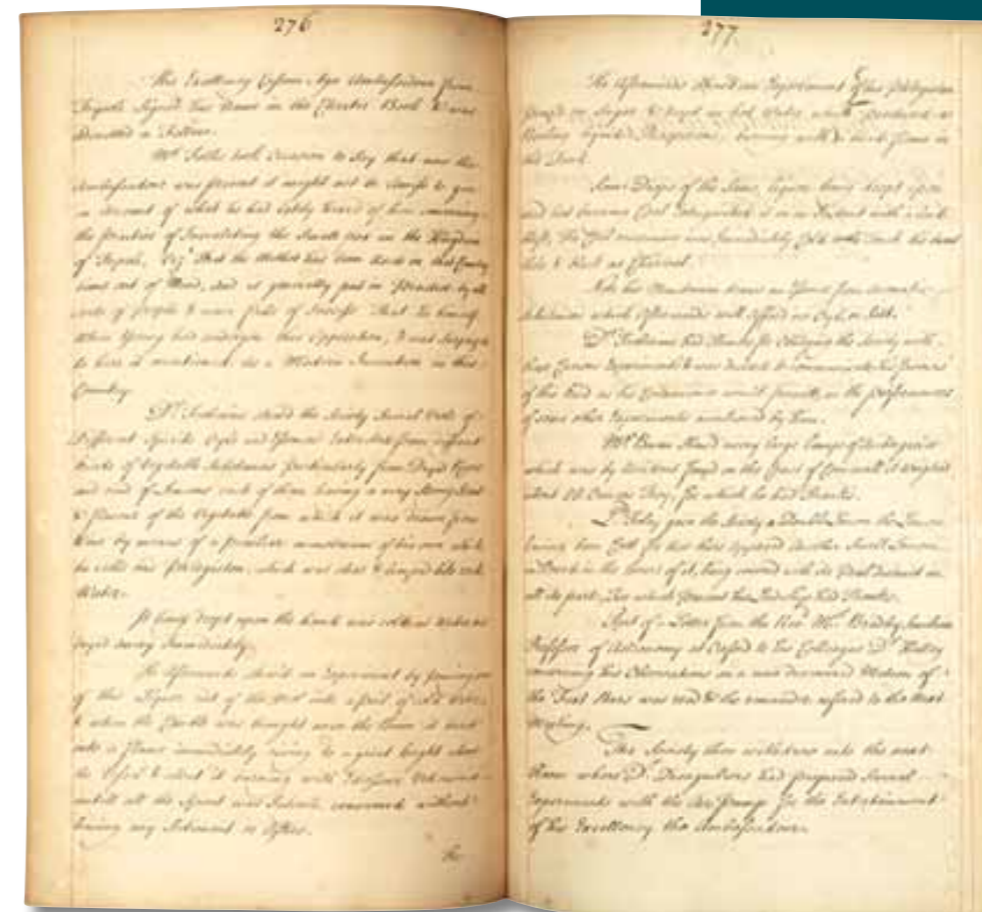
Doctors working in the Ottoman Empire as physicians to the British Embassy in Constantinople or the English Factory in Aleppo were among the first to write letters home about inoculation. English people were still cautious about the practice because of its recent introduction in Europe. The account of Cassem Aga, the Ambassador of Tripoli, provided valuable reassurance about the long safety record of the practice in Muslim countries. In 1796 Edward Jenner replaced the smallpox virus with cowpox, achieving a method of vaccination that eventually led to the eradication of the virus.

10.1 (Left)
Cassem Aga, on smallpox inoculation
(translated from Arabic, 1729)

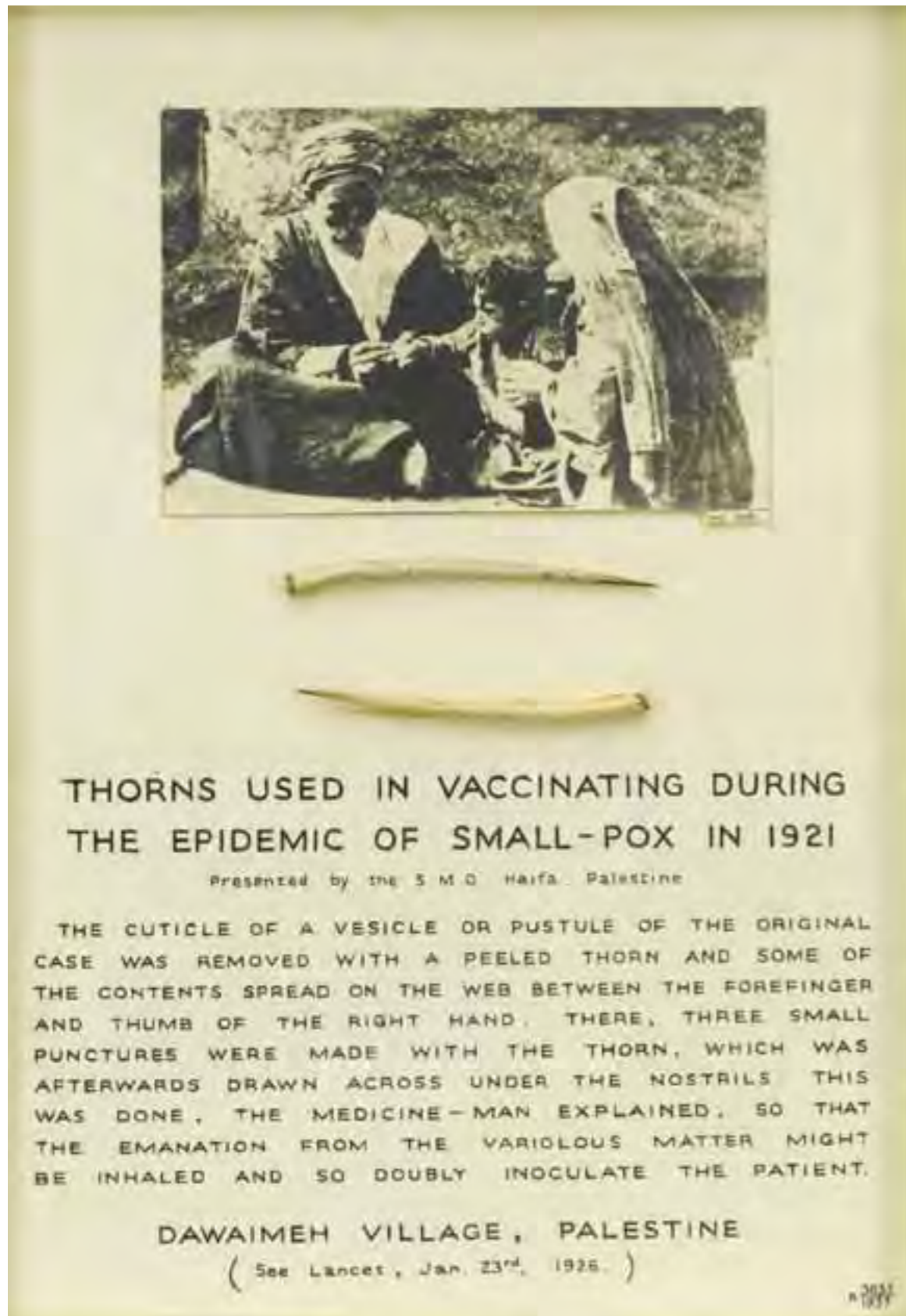
Cassem Aga provided a first hand account of inoculation and its safety record in 'Tripoly, Tunis and Algier', noting it was practised by both townsmen 'and wild Arabs' (meaning nomadic tribesmen).

10.2 (Below)
Royal Society Journal Book, vol. 14 (1729)

The minutes of the meeting at which Cassem Aga signed the Charter Book and was admitted as a Fellow.



10.2



10.4

10.3 (Not pictured)
Smallpox vaccination kit (19th century)

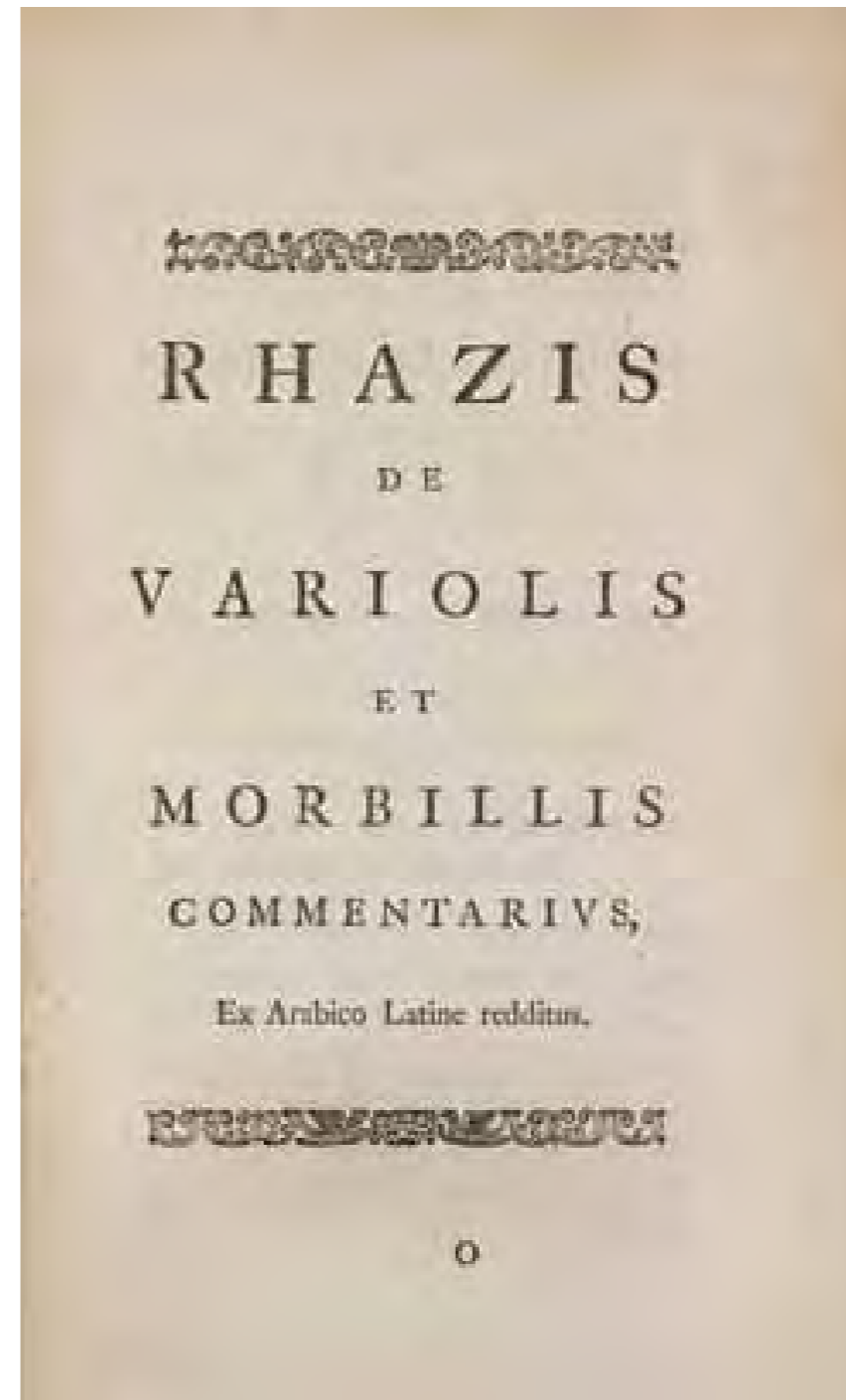
The kit contains a steel and ivory lancet, a glass tube and a roll of bandage.

On loan from the Science Museum, London.

10.4 (Above)
Inoculation in Palestine (20th century)

This picture shows a traditional method of smallpox immunisation being performed in Palestine, using sharp thorns instead of needles.

On loan from the Science Museum, London.



10.5

10.5 (Above)
Richard Mead, *De Variolis et Morbillis* (1747)

While preparing his work on the smallpox and measles, Mead commissioned a Latin translation of al-Razi's important treatise on the subject so he could include it in his book.

10.6 (Not pictured)
Richard Mead, *A Discourse on the Plague* (1744)

Mead was a high-profile London physician who worked on the prevention of transmissible diseases and also helped to establish the practice of smallpox inoculation.

10.7 (Not pictured)
Silver medal (c. 1805)

This medal commemorates a smallpox vaccination programme in Prussia. Similar coins and medals were issued throughout Europe.

On loan from the Science Museum, London.

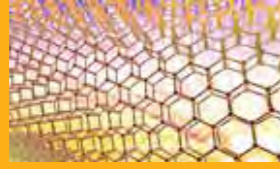




Turkey

The Turkish Government increased its spending on R&D by well over 500% in the years between 1995 and 2007. The number of researchers has increased by 43% and four times as many scientific papers were published in 2008 as in 1996.

Above: Istanbul University © Sadik Gülec.



Iran

As part of a comprehensive plan for science, Iran is aiming to become one of the world's top 15 countries in nanotechnology. The Iran Nanotechnology Laboratory Network (INLN) was established in 2004 and covers 40 laboratories in 12 cities.



Pakistan

Pakistan established over fifty new universities between 2002 and 2008, and the numbers of student enrolments tripled from 135,000 to 365,000 in the same period.

Above: DJ Science College, Karachi



Bangladesh

In Bangladesh researchers have developed a new approach to remove arsenic from drinking water, and whilst not written up in the scientific literature, this research has improved the quality of life in three municipalities.

Above: Dhaka, Bangladesh



Nigeria

Nigeria has been one of the most active among Africa's OIC Nations. A US\$5 billion investment in its Petroleum Technology Development Fund has resulted in the establishment of specialized colleges and a national laboratory dedicated to petroleum-based studies.

Above: Offshore oil platforms.



Egypt

In Egypt, the new Library of Alexandria is an example of a world-class teaching and research institution that has developed independently of the university system—it reports directly to parliament.

Above: Library of Alexandria.



Saudia Arabia

King Abdullah University of Science and Technology (KAUST) opened in September 2009. With an endowment of around US\$20 billion, this exclusively postgraduate university is attracting faculty and postgraduate students from across the world.



Qatar

The jewel in Qatar's scientific crown is Education City. It occupies a 2,500 acre campus on the edge of Doha where six top US universities, including Carnegie Mellon, Weill Cornell and Texas A&M, have opened international campuses.

Above: Weill Cornell Medical College campus, Education City © John Samples.



Abu Dhabi, UAE

Masdar is Abu Dhabi's attempt to create the world's first fully sustainable city and innovation hub. It will eventually house 50,000 people and 1,500 businesses focused on renewable energy and sustainable technologies.

Above: Artist's impression of Masdar City.



Dubai, UAE

Dubai's TechnoPark is being built on 21 million square meters of land, and will house 60,000 permanent residents and employ over 133,000 people. The park aims to function as a hub that enables research partners to access the resources of academic and research institutions and international associations worldwide.

Above: Technosphere designed for Dubai's TechnoPark by James Law Cybertecture International.



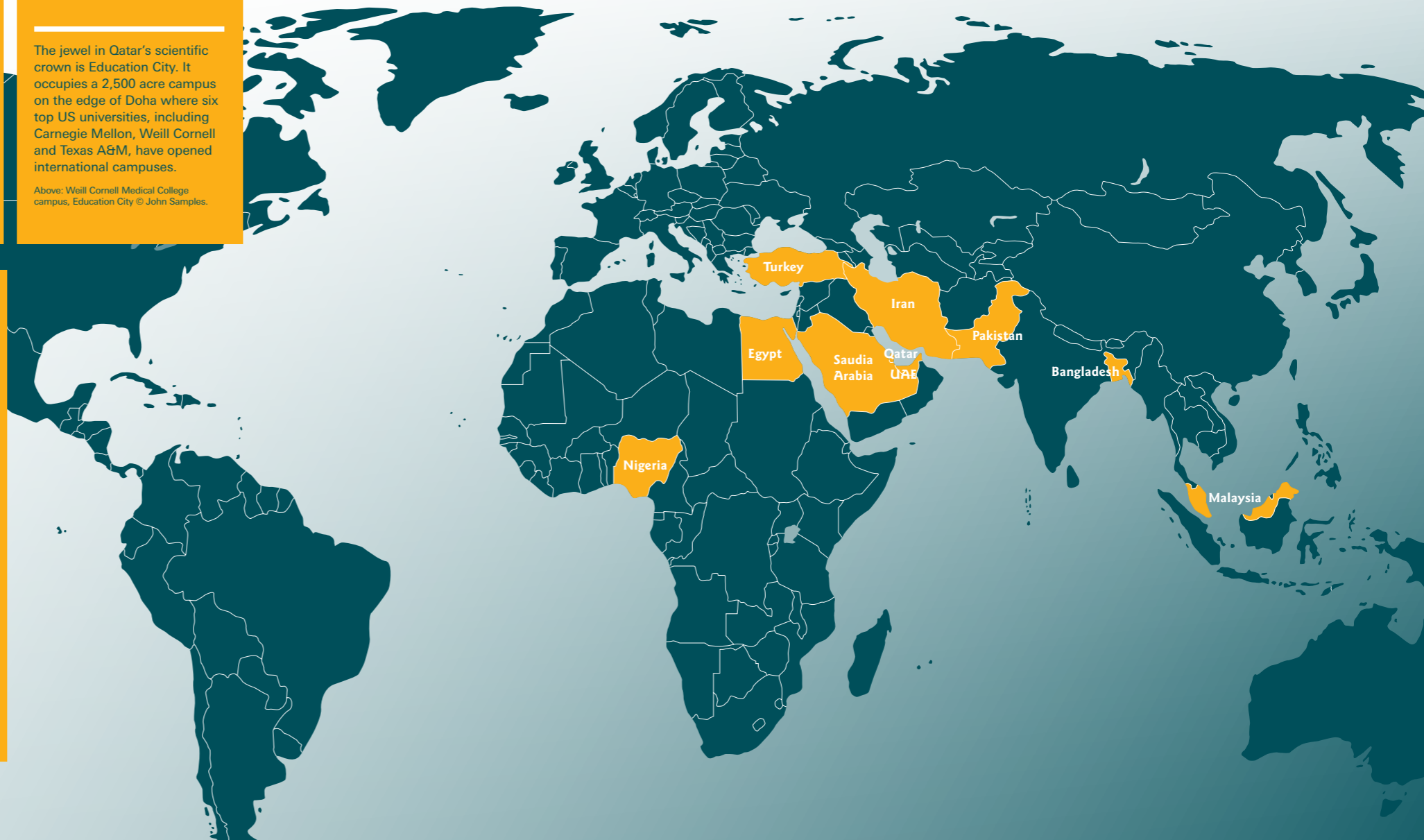
Malaysia

In Asia, Malaysia is amongst the more sophisticated champions of science and technology, and now leads the OIC in the number of patent applications being submitted.

Above: The Petronas Towers, Malaysia

Developments in science and innovation in the Islamic world

The Atlas of Islamic World Science and Innovation is a three-year project focussing on contemporary science and innovation in countries with large Muslim populations in the Middle East, Africa and Asia. Looking in detail at economically and geographically diverse countries, including Qatar, Egypt, Jordan, Malaysia and Pakistan, the project explores recent advances in science, technology and innovation and reviews the opportunities for, and barriers to, faster and further progress. Studies of these and other countries are being launched over the next 18 months, mapping key trends and highlighting signs of renewed ambition and investment in education, science and innovation.



الإسم المفرد وجمع التفسير والفعل
المضارع الذي لم يتصل باخرة شيء **وأما**
الألف فتكون علامة للنصب في
الاسماء الستة نحو رأيت أخاك
وأباك وما أشبه ذلك **وأما الكسرة**
فتكون علامة للنصب في التثنية
والجمع **وأما حذف النون** فتكون
علامة للنصب في الأفعال التي رفعها
بيئات النون **واللخض** ثلاثة علامات
الكسرة والياء والفتحة **فأما الكسرة**
فتكون علامة للخض في ثلاثة
مواضع في الإسم المفرد المنصرف وجمع
التفسير المنصرف وجمع المؤنث السالم
وأما

إذا دخل عليه ناصب

في جمع المؤنث السالم
فتكون علامة للنصب في



Left: Page from the *The Grammar Book of al-Ajrumiyah* originally written in the 14th century by Ibn Ajroom Al Sanhaji of Fez.



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excellence in science

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