

1 From geography to gemstones, scholars developed exciting new ideas about the natural sciences during Muslim civilization.

2 Many areas of science, including geology, meteorology, botany, and zoology, are linked to ideas from a thousand years ago.

3 Scientists in Muslim civilization used observation and experimentation to explore and explain such natural phenomena as earthquakes and the formation of mountains.

4 The boundaries of the Muslim world gave scholars a wide range of geographical regions to study.

5 INFORMATION ABOUT MINERALS, PLANTS, AND ANIMALS WAS GATHERED FROM AS FAR AWAY AS THE MALAY ISLANDS.

6 Al-Hamdani, a 10th-century scholar, wrote three books about ways to look for gold, silver, and other minerals in Arabia.

7 The 11th-century scholar Ibn Sina's *The Book of Cure* presented his observations and theories about how the Earth works.

8 The Latin translation of Ibn Sina's book influenced the study of earth science in Europe for more than 300 years.

9 Al-Biruni, another 11th-century Muslim scholar, took the lead in studies about minerals.

Sand dunes of Erg Chebbi, in Morocco

10 Al-Biruni's works included a focus on diamonds, rubies, sapphires, and other gemstones.

11 Like other scientists in the medieval Muslim world, Al-Biruni built upon the work of scholars in earlier civilizations.

12 Al-Biruni classified gemstones by color, shape, and hardness.

13 "Hardness" is the ability of a mineral to scratch the surface of softer minerals.

14 Al-Biruni used crystal shape to help him decide whether a gemstone was a quartz or a diamond.

15 Today scientists and jewelers use similar techniques to identify gemstones.

16 Carnelian, a reddish brown gemstone, is prized by Muslims because the Prophet Muhammad is said to have worn a ring with this stone.

17 Carnelians are often engraved with verses from the Quran.

18 Al-Biruni studied India's Ganges River basin and accounts of other geologic formations from the Baltic Sea to Mozambique.

19 Al-Biruni could speak Greek, Sanskrit, and Syriac and wrote all of his books in Arabic and Persian.

20 BY FINDING FOSSILS OF OCEAN LIFE IN ROCKS HIGH ABOVE SEA LEVEL, AL-BIRUNI PROVED THE OCEAN HAD ONCE COVERED PARTS OF INDIA.

21 Al-Biruni's work became a key reference on precious stones.

22 By observing the moon's effects on the ocean, Al-Biruni figured out that tides changed based on the phases of the moon.

23 Al-Biruni discussed the possibility of the Earth being in motion without rejecting it.

24 Like other scholars of the time he believed the Earth was a sphere and discussed the possibility that it rotates on its axis.

25 Six hundred years later the Italian astronomer Galileo Galilei proved Al-Biruni was correct.

26 Al-Biruni also measured latitudes and longitudes and came up with the concept of antipodes, places that are directly opposite each other on the Earth's surface.

27 ONE OF THE EARLIEST EXPLANATIONS OF WHY THE SKY IS BLUE WAS WRITTEN IN THE 9TH CENTURY BY AL-KINDI.

28 Al-Kindi reasoned that the color midway between darkness and light was blue.

29 Al-Kindi was partly right. The sky is not really blue—that's just the way light acts on the atmosphere.

30 Since ancient times some people have believed that stars and planets had souls and minds.

31 Ibn Hazm, a 10th-century scholar from Córdoba, dared to say that "stars are celestial bodies with no mind or soul."

32 Ibn al-Haytham, another earth science innovator, searched for ways to control flooding along the Nile River. A thousand years later his idea became a reality when the powerful Aswan Dam was completed in present-day Egypt.

33 IBN AL-HAYTHAM'S EXPERIMENTS WITH RAYS OF LIGHT LED TO A DETAILED THEORY OF VISION.

34 His observations paved the way for others to figure out that rainbows are caused by a refraction of sunlight in raindrops.

35 Why does the moon seem to grow in size when it is low in the sky? Ibn al-Haytham said it was a visual trick played by the brain.

36 Later a scholar named Kamal al-Din al-Farisi experimented with glass jars full of water to find out how rainbows are made.

37 Scholars also studied the shape of the Earth, the amount of water versus land, and how rivers, seas, winds, and sea storms formed.

38 Like the ancient Greeks, geographers in Muslim civilization believed the world was round, not flat, and made detailed measurements of the globe.

39 Scientists now know that the Earth is slightly pear-shaped.

40 Beginning in the 9th century, people in Muslim civilization made very accurate measurements of the Earth, building on the ancient Greek astronomer Ptolemy's findings.

41 NINTH-CENTURY CALIPH AL-MA'MUN HIRED A GROUP OF MUSLIM ASTRONOMERS TO MEASURE THE DISTANCE AROUND THE EARTH.

42 They measured the distance around the Earth to be 25,012 miles (40,253 km). The current measurement is 24,897 miles (40,068 km) at the Equator.

43 Two centuries later Al-Biruni used an equation to calculate the Earth's circumference that "didn't require walking in deserts."

44 In the early 9th century, mathematician, scientist, and astronomer Al-Battani improved existing values for the length of the year and of the seasons that are very close to today's.

45 Observing the seasons led Muslim scholars to study and calculate the tilt of the Earth on its axis.

46 In the late 10th century, mathematician and astronomer Al-Khujandi built a huge observatory to observe the sun.

47 Al-Khujandi calculated the tilt of the Earth's axis relative to the sun and made a list of latitudes and longitudes of major cities.

48 MUSLIM SCIENTISTS STUDIED WEATHER PATTERNS ON LAND AND AT SEA AND WROTE BOOKS ON METEOROLOGY THAT WERE MUST-READS FOR SAILORS.

49 Ahmed ibn Majid, a great Muslim navigator, learned about currents and the monsoons that helped carry vessels to India.

50 Ninth-century Muslim inventor 'Abbas ibn Firnas invented a weather simulation room in which hidden mechanisms created thunder and lightning.

51 Farmers in Muslim lands followed the *Calendar of Córdoba*, an almanac of weather, planting, and harvesting times.

52 MUSLIM SCHOLARS ALSO EXPANDED THE STUDY OF ANIMALS, CALLED ZOOLOGY, DURING THE 9TH AND 10TH CENTURIES.

53 The most famous Muslim writer on animals was the Iraqi Al-Jahiz, who recognized the influence of environment on animals.

54 Al-Jahiz sometimes rented the contents of entire bookshops so he could read all of the books.

55 Though he wrote poetry and fiction, he mixed in scientific observations about things like camouflage and mimicry.

56 Al-Jahiz also investigated animal behavior and communication, especially among insects.

57 Al-Asmai, an Iraqi scholar, was likely the first Muslim scientist to contribute to zoology, botany, and animal husbandry.

58 Al-Asmai's expertise was in breeding horses and camels.

59 Merino wool, most likely from Morocco, resulted from centuries of careful sheep breeding.

60 Today Merino wool is popular among cyclists, hikers, runners, and other outdoor lovers.

61 The concept of pedigree—tracing the ancestry of an animal, especially the horse—originated in Muslim Spain and is used throughout the world today for all kinds of animals.

62 Arabians, which were originally bred as war horses and for their endurance in the desert, are now one of the world's most popular breeds of riding horses.

63 THE MUSLIM WORLD ALSO MADE SIGNIFICANT ADVANCES IN BIOLOGY, ESPECIALLY IN BOTANY—THE STUDY OF PLANTS.

64 A thousand years ago gardens in Muslim civilization were like scientific field laboratories tended by scholars who took detailed notes about the plants they grew.

65 Migrants to the Muslim world, homesick for their native lands, brought fruit trees, like date and pomegranate, then learned how to grow them in the new climate.

66 Some of the greatest botanists of medieval times came from Muslim civilization.

67 Ibn Bassal, a botanist in Toledo, Spain, came up with a way of classifying ten types of soil and explained which ones were best for raising which crops.

68 Al-Ghafiqi, a physician and botanist from Córdoba, Spain, made herbal medicines from plants he collected in Spain and Africa.

69 Ibn al-Baytar, another botanist of the Muslim world, collected plants and herbs from Spain to Syria.

70 He wrote a book outlining the medical uses for 3,000 plants.

71 Ibn Al-Awwam, a 12th-century scholar from Seville, in Muslim Spain, described in great detail how to grow 585 plants and 50 fruit trees.

72 His book also listed ways to fertilize plants and keep them safe from diseases.

73 The knowledge of plants that botanists in Muslim civilization collected and developed led to the cultivation of many useful, beautiful, and nutritious plants.

74 These plants improved the lives of people in other parts of the world, and they enriched gardens throughout Europe.

75 When Europeans colonized the New World, they brought with them many of the plants discovered, studied, and grown in the Muslim world.