

"Search for knowledge  
from cradle to grave"

Islamic hadit

SCIENCE

IN AL-ANDALUS





# SCIENCE IN AL-ANDALUS

## 1. Introduction

From the 9th to the 14th century, all scientific disciplines experienced a formidable process of development and refinement in Muslim Spain (al-Andalus), partly inherited from the fundamental scientific legacy left by classic Antiquity, as much as from the Eastern world (China, India and Persia), and pre-Hellenic Egypt. Nevertheless, soon Andalusian scientific practices and research acquired a clearly Islamic identity, crucial in the subsequent evolution of scientific methods and ideas.

Throughout six centuries, from the House of Wisdom (Bayt al-Hikma) in Baghdad (9th century) - one of the most illustrious wisdom institutions in the Islamic world at that time- to the diverse seats of learning in Cordova, Denia, Toledo, Zaragoza or Granada, Islamic scientific knowledge laid the foundations for the European Renaissance with a marked Hispanic-Muslim approach.

Astronomy, medicine, alchemy, pharmacology, mathematics, hydraulics and thermo-dynamics, botany, agriculture and architecture, among other disciplines, radiated their influence from Muslim Spain, and contributed to the scientific progress in the rest of the Iberian Peninsula and Europe.

In this exhibition, based on rigorous historical research, the visitor is invited to enter deeply into the mindset responsible for the golden scientific era in medieval al-Andalus, fulfilling the Islamic hadith (axiom): "Search for knowledge from cradle to grave". Nevertheless, the scarcity of surviving images and written testimonies chronicling Andalusian times, forces the modern researcher to explore contextual similarities with other contemporaneous societies of the Islamic world and, essentially, to work on hypothesis.



## SCIENCE IN AL-ANDALUS

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Visitors will contemplate the Rich Hall of Madinat al-Zahra (Cordova) in the city-palace built by the Omeyan caliph Abderrahman the Third (10th century), as an exemplary materialization of political and social development achieved in muslim Spain. In this great ceremonial hall ambassadors and delegations from all over the world were received by the Caliph. The refinement of the architecture and the displays of mechanical water and mercury fixtures were the astonishment of courtiers and foreign diplomats.

Visitors also enter an astronomical observatory located in Cordova between the 9th and the 11th centuries, where intricate instruments recently invented or perfected back then (astrolabes, ecuator, azafeas) are exhibited, along with archaic clocks built with a series of peculiar mechanisms.

Afterwards, visitors get into an Alchemist's laboratory, where metals were sublimated, sharing space with a Pharmacy in which drugs were elaborated with rare exotic Oriental plants brought in from a nearby botanical garden. It is also to be seen how Abulcasis (10th century) crucially contributed to the development of surgery and other medical techniques, and visitors can marvel at the famous libraries of al-Andalus, veritable havens for erudition. Furthermore, the visitor can have a stroll outdoors and see a great mechanical wheel watering a rich orchard of exotic fruit trees (11th to 13th centuries).

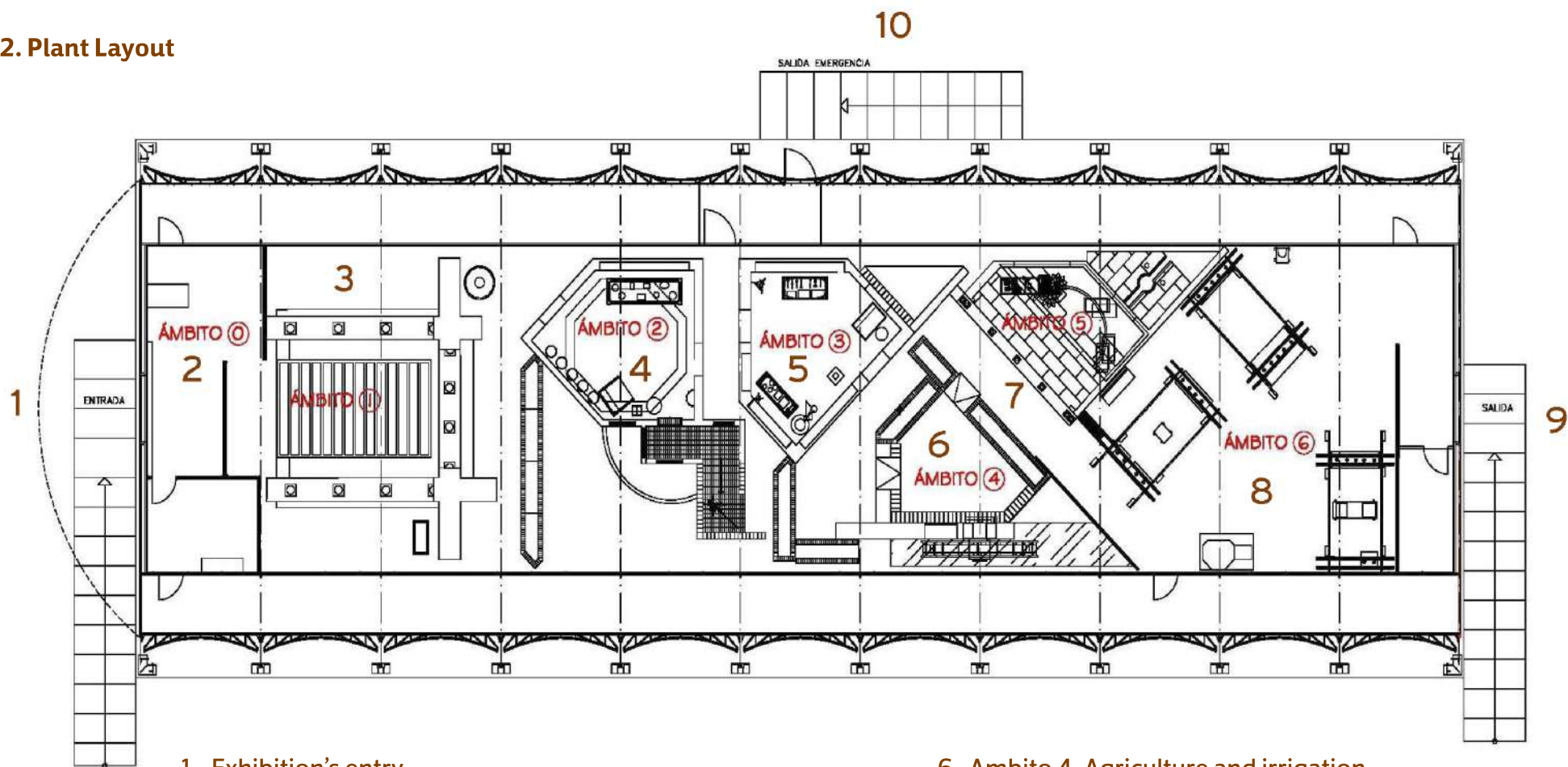
And finally, visitors are invited to walk into the Alhambra as it looked like while under construction in order to have a closer look at the work of those master builders and their technique with ceramic tiles (13th and 14th centuries).

The exhibition has been curated by Cherif Abderrahman Jah, President of the Islamic Culture Foundation.



# SCIENCE IN AL-ANDALUS

## 2. Plant Layout



1. Exhibition's entry
2. Ambito 0. Entrance Hall
3. Ambito 1. "Rich Hall" Madinat al-Zaharat
4. Ambito 2. Astronomical Observatory
5. Ambito 3. Library, Medical and laboratory Study of Alchemy

6. Ambito 4. Agriculture and irrigation
7. Ambito 5. Master builder's workshop
8. Ambito 6. Interactive elements
9. Exhibition's exit
10. Emergency exit

## 3. Rich Hall of Madinat al-Zahra.

It was in this room where the caliph Abderrahman the Third (10th century) received Muslim and Christian ambassadors, coming from the East and the Magreb, as well as from the rest of the Iberian Peninsula and Europe.

The Cordovan chronicler Ibn Hayyan described the magnificence of this famous hall and the court's grand protocol and pomp, detailing minutely the grandiosity of its architecture and its profuse and ornate decoration, as well as the startling effects produced by the combined mercury and water fountains and other mechanical devices in display.

All this, along with the spectacular mise en scene of the Caliph's domestic entourage, aimed at impressing courtiers and ambassadors, whilst unambiguously demonstrating the political, economic and social splendor of Muslim Spain at that time.



This is a mere archetypal synthesis of such a palatial greatness, where the imagination combines with the scarce historical and archeological data available today in order to recreate as accurately as possible the atmosphere of Caliphal Cordova during the Caliphal Omeya dynasty.



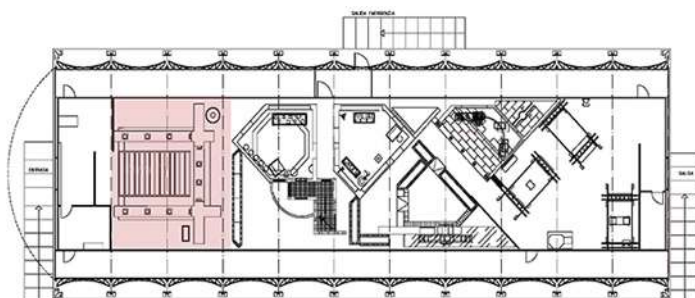
### Scenography

The "Rich Hall" of Madinat al-Zahra, has been played in scale. Inside this hall there are two water founts. One contains a liquid that simulates mercury. Another simulates a green marble fountain with 12 golden animals figures. There is also a model that reproduces the famous "hourglass of Gazelles".

In al-Andalus were built hourglasses (water clocks) and automats, from the ninth century. Hourglasses created by Azarquiel in Toledo were famously, along the Tajo river, in the eleventh century. Recorded the passing of the hours and the phases of the moon during the first 14 days of the month, the containers were filled with water at a constant speed, also emptied steadily in fourteen seconds.

### Objects

Two water central founts, the "hour glass of Gazelles" and Caliphate pottery.



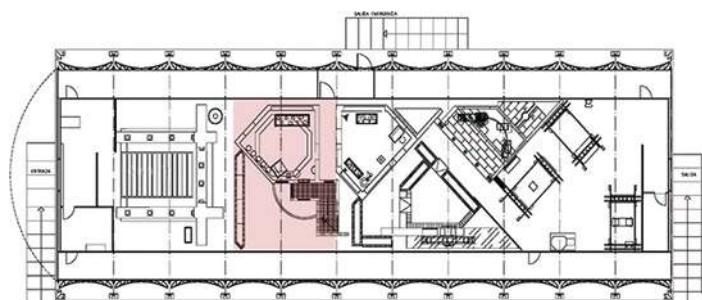


## 4. Astronomical Observatory

This place represents an astronomer's observatory, of the sort contemporary chroniclers described as existing in Cordova back in the Middle Ages. In this place all previous astronomical knowledge compiled in the Islamic world between the 9th and the 11th centuries was put to use, as were a wide range of newly invented apparatuses designed to calculate the position of the stars and planets. Also, these mechanical instruments helped to establish the precise location of the diverse cities of the Islamic empire, like Cordova or Toledo, and, most essentially, the direction towards Mecca, spiritual center of all Muslims.

In this observatory, a master astronomer like Maslama of Madrid (10th century), would lecture from his lectern a numerous group of students on the use of the astrolabe to determine the position and movement of the stars, or how to use the compass to make the same measurements according to any latitude, or how to calculate the exact position of the moon and planets aided by the equator. Besides

these instruments, time could be measured with candle-operated clocks and water clocks called clepsydras, both of which served the essential purpose of accurately scheduling daily prayers and the end of the Ramadan. From the roof



### Scenography

This area plays an observatory of stars, according to the descriptions of the time. It is circular and has an elevated stage, plus an opening roof for observation.

At the bottom there is a work table with astronomical equipment, in the grounds is a bow window Caliphate, showing on the horizon at sunset, Córdoba.

### Objects

Stellar observation tube. Desk to take notes. Plane astrolabe. Universal blade - Azafea. Water clocks attached to the wall or free.

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## 5. Library, medical and laboratory study of alchemy

This space reproduces the ambience in which different sciences were developed in al-Andalus between the 10th and the 13th centuries.

An alchemist would try and obtain the mythical philosopher's stone in his laboratory, deploying all sort of experimental techniques to achieve the transmutación of metals. Through the same distillation methods, he would also elaborate perfumes and magical potions.

Medicine had great importance in al-Andalus, producing expert surgeons like Abu l-Qasim (Abulcasis), born in the 10th century, who designed manifold medical and surgical instruments. There were entire family dynasties of prestigious doctors, like the Ibn Zuhr (Avenzoar), or the Ibn Rusd (Averroes), experts in the treatment of ailments through experimental methods and direct patient observation.

The Pharmacy, always located near a Botanical Garden so that exotic and curative plants might be permanently available and fresh, would generally be within the Palace enclosure, where expert botanists elaborated medicines and unguents, many of which they were donated free of charge to the poor and those in dire need. The pharmacology of al-Andalus was inherited from the Greeks, benefiting from the knowledge contained in Dioscorides' canonical treatise, the Medical Compendium.



Libraries in al-Andalus were abundant and well equipped, like the famous library of the Cordovan caliph al-Hakam II (10th century), which contained more than four hundred thousand volumes. They were places for learning and exchanging information, where many women, experts in Arabic calligraphy worked as copiers.



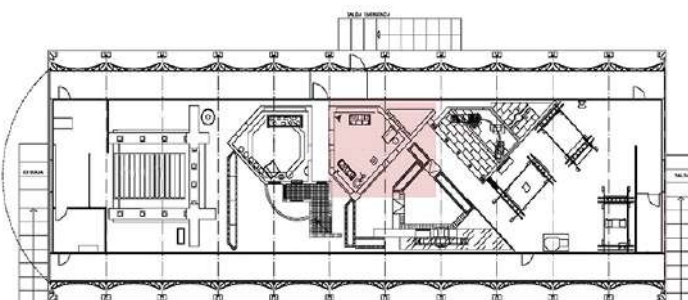
### Scenography

Recreation of a library full of books with medical and optical studies. There is a small representation of a pinhole camera and a small section of chemistry lab with a small pharmacy of the era.

In the library there is a window where we can see, in the daylight, a botanical garden, which supplies plants to produce medicines. There is a gate giving access to this botanical garden.

### Objects

Medical instruments, books, shelves, sets of lenses, alembics for alchemical



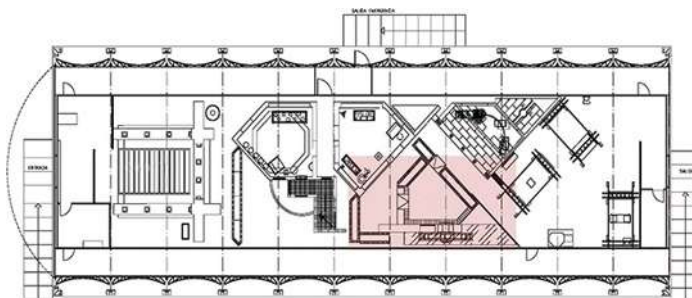


## 6. Agriculture and Irrigation.

Medieval agriculture experienced a tremendous advancement in Andalusian territories from the 10th to the 14th centuries. The introduction of new species imported from the East (aromatic herbs, spices, fruits etc), and the deployment of new intensive farming methods, caused this period to be known as "the Green Revolution". Thus for the first time species like citrons, bananas, mulberry trees, new varieties of pomegranates and dates, among other fruit trees, were imported into the Iberian Peninsula, as were also vegetables and fruits like eggplant, spinach, and watermelon, or condiments like saffron. Andalusians perfected grafting techniques with peculiar practices like the insertion of a rosier in a blackberry bush. Andalusian horticulturists truly considered agriculture a true science, and an art, therefore perpetuating all their acquired knowledge in diverse treatises on agronomy, some of which have been preserved to this day.



Land irrigation systems in al-Andalus were the necessary complement to this huge agricultural expansion. Fully aware of previous techniques of irrigation developed in ancient Mesopotamia and Syria, Muslims who arrived in the Peninsula knew very well how to reactivate and increase the existing the Roman canalization networks and hydraulic systems, already much deteriorated by centuries of neglect. With new drains, canals and sprinklers in place, water previously extracted from rivers and wells was then distributed to the different estates, backed up in waterwheels and stored in ponds by means of great fluvial chain pumps and small mills powered by animal traction. Some of these great Arab chain pumps have been preserved, like those in Ñora and Alcantarilla (Murcia), Albolafia (Cordova), or the one in Camarasa (Lleida).



### Scenography

The scenery simulates an open space with skyline. Accessed from the medical library as an exit toward the open field. A path helps us to walk and contemplate a chain dump (na'ura) of up 3 metres of diameter, on his wheel the water from a river is being collecting. In the background the sky in the morning, and the other side of the canal: lemon, pomegranate, almond blossoms and palm trees on the horizon (landscape of al-Andalus).

### Objects

Examples of different crops introduced by the Arabs in the Iberian Peninsula at the time of al-Andalus. Examples of grafts, as roses in apple, almonds and grapes. A Power Noria, 3m diameter, with arcades.



## 7. The Master builder's workshop. A room of the Alhambra under construction.

Building techniques in al-Andalus achieved great perfection and refinement. They received Eastern influences, mainly from Mesopotamia and Syria, although also retained a marked Greek and Roman ascendancy.

Soon Andalusian master builders learned how to work with mosaics and the Musivaria style of decoration, which can be appreciated in Greek tiles covering the mihrab of the Great Mosque of Cordova (10th century). This technique was the antecedent of the art of the ceramic tile, of which they were true masters.



Andalusian master builders applied to socles and walls their great knowledge of geometry, with intricately creative designs of great virtuosity.

To this infinitely geometrical decorative landscape, saturated with cosmic symbolism and allusions to nature through ornamental lattice-shaped vegetal motifs (called "atauriques"), they added spectacular three-dimensional effects through clever use of water and light which projected forms and shadows on the spheric and prismatic plaster and wood alveoli carved on the vaults).

Example of this ornamental ability can be seen in this recreation of a room from the Patio of the Lions of the Alhambra (Granada, 14th century).

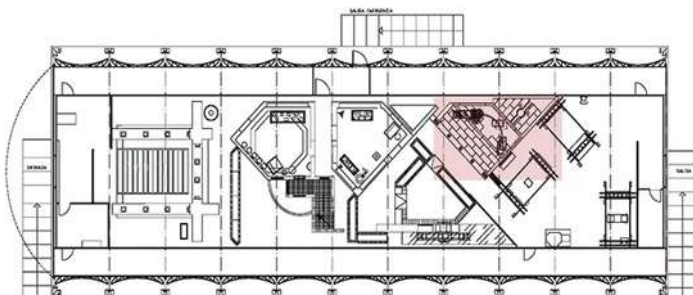


### Scenography

reproduction of a workshop of a master builder who is building the Alhambra in Granada (time of Muhammad V, s. XIV), for example, the Patio de los Leones, which is seen from the windows of the workshop.

### Objects

Fragments of tiles of various colors and shapes. Fragments of decorated stalactite (mocarabes). Sheets to support the geometric design and calculation. Construction plans. Leaves with the calculations of constructions. Blown glass pieces. Tools for blowing technique.



## 8. Scenary with Information about the exhibition

The exhibition concludes with an area designed to offer visitors information on science and technology through interactive elements of al-Andalus, scientific views, models, graphics and audio.

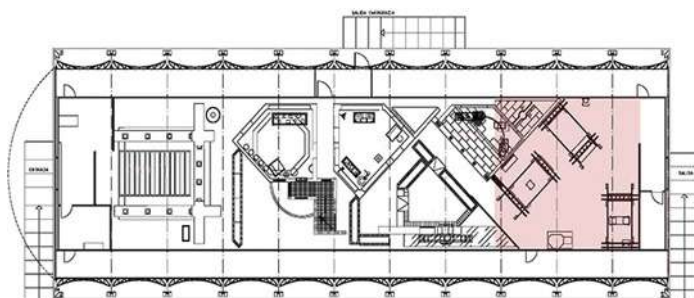


In this space, the pedagogical explanation of the content observed in previous environments is developed. Thus, there are different views, with models, panels, photographs and interactive multimedia. In addition to panels according to the outline expository texts.

Numerous astronomical instruments (astrolabes, armillary spheres, etc) are represented. There is the possibility of use a nocturlabe. You can see videos with a multimedia presentation on geometry and decoration with mucarnas. There are panels with celestial maps, where the stars indicate that if today they have Arabic names it is because that have been discovered by Muslim astronomers.



There are models showing irrigation, with water mills of the era. A series of ethnographic tools used in the development of agriculture are also presented. There are panels in which the technical details of the grafts are explained. Is possible to look a map with the network of botanical gardens that existed at the era of al-Andalus.





## 9. Requirements and needs for installation.

### 9.1. Surface and height required for installation.

The exhibition Room is estimated at least **400 / 500 m<sup>2</sup>**, of area. Also needs a height of at least **4,30 meters**. Depending on its size, will be necessary to develop a draft adaptation to the new space, taking into account also that exhibition has the entry and the exit in opposite directions.

Normally the exhibition is installed into a big tent (XXX). The tent is divided into three parts: **the platform** on which the tent is installed; **the access ramps** (there are three, one for the main entrance, one for the main exit and the other for emergency exit), and **the tent** itself. The tent's dimensions are:

- Built area: 735 m<sup>2</sup>
- Usable area: 440 m<sup>2</sup>
- Height interior box: 4,30 m

### 9.2. Electrical power needed.

The electrical estimated consumption for the installation is **100 kw**. Of these, 70 kw are for the tent and the rest (30 kw) for the exhibition.

### 9.3. Transportation. Storage

For transport, twelve trailers are needed. These are distributed as follows:

- Platform: 2 trailers
- Tent: 4 trailers
- Exhibition: 6 trailers.

During the stay of the exhibition, 2 trailers are needed to save the packing materials and parts.

### 9.4. Assembly and disassembly times.

In general, the time required for assembly and disassembly, is distributed as follows:

- Assembly:
  - Travel to destination
  - Platform: 2 days
  - Tent: 8 days
  - Exhibition: 9 days
  - Return
  
- Disassembly:
  - Travel to destination
  - Platform: 2 days
  - Tent: 4 days
  - Exhibition: 6 days
  - Return

### 9.5. Printing equipment.

The Islamic Culture Foundation carries out specifically branding for the itinerancies. It consists of a poster, flyers and invitations to the opening, all of them with the names and logos of local sponsors.

A catalogue and a book for teachers used for school visits are also published.

Number of words (Spanish): 8170 words

