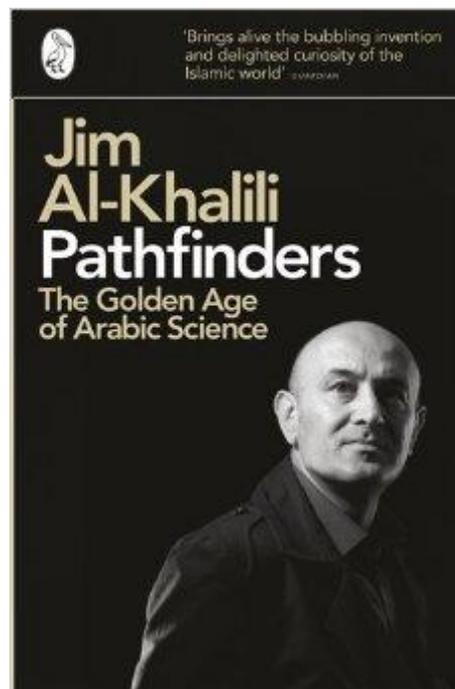**The Pathfinders**
Jim Al-Khalili
Book Review

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The Greek Science reached its pinnacle with the theories and of knowledge from the welt philosophers like Plato, Pythagoras and Socrates. After this the Europe skidded into what is now remembered as the "Dark Ages" as for nine centuries there was no great theologian or scientist produced by the European civilization. The Renaissance period began in the middle of the second millennium and great names like those of Galileo, Newton and Einstein surfaced. Subsequently, the Western narratives of scientific history jump directly from the Greek to the Renaissance times, skipping seven to nine centuries of the "Golden Period of the Arable Science" when advances In science were made at par with the two flanking periods of scientific Inquiry. In his book "Pathfinders", Jim Al-Khalili, a self-declared Iraqi-British atheist, unprecedentedly presents and assembles the leaps and discoveries made by the Arabic scientists of the fore-mentioned period. Personally, I agree with many of the points Al-Khalili raised in his book and that is what motivated me write a review of the book so that a wider audience interested in Arab Science history would become aware of this work. One of the most important point Al-Khalili raises in his book is the negation of the binary between 'Arabic' and 'Islamic'. He specially adds a chapter "A Note on the term Arabic Science" to explain that, opposed to the standard practice, the credit of the scientific discoveries goes to the civilization of the scientist rather than his/her religion. Therefore, the correct term to describe the scientific progress during the 8-15th century period is "Arabic Science". The book, "Pathfinders" is included in the syllabus of the Core course "What is a Number?" conducted at the New York University Abu Dhabi.

The following is a short description of different chapters in the book.

Chapter 1-3

In the very first chapter of the book Al-Khalili talks about Al-Mamun's dream in which he meets Aristotle and finds the inspiration to invest in learning and education. In the following chapters Al-Khalili narrates the story behind the rise of the Islamic empire to power during 8-9th century. In the third chapter he writes about the translation movement which lasted several centuries and shifted almost all the scientific knowledge from Greek to Arabic, making the latter the language of science.

Chapter 4-6

In these chapters Al-Khalili writes mainly about early scholars and the establishment of the House of Wisdom by Al-Mamun. About an early chemist Jabir ibn-Hayyan he writes that, "Many (of his) books are just one-page manuscripts, and there are gaps in the numbering of the catalogue. Of course, even a conservative estimate of five hundred books is the still a huge legacy for one man" (Al-Khalili 61).

Chapters 7-8

These chapters were mainly devoted towards mathematics and the greatest mathematician of the Arab world, Al-Khwarizmi. He passes comments about many controversies in the mathematical world such as the discovery of zero and deeply elaborates the contribution made by Al-Khwarizmi to algebra. He also writes about the achievements by Omar Khayyam, a not very widely known but equally competent mathematician.

Chapters 9-12

These four chapters have been individually devoted to four great Arabic scientists: Yaqub ibn Ishaq al-Kindi (The Philisopher), Muhammad ibn Zakariyā Rāzī (The Medic), Abū ʿAlī al-Ḥasan ibn al-Ḥasan ibn al-Haytham (The Physicist), Abū al-Rayhān Muhammad ibn Ahmad al-Bīrūnī and Abū ʿAlī al-Ḥusayn ibn ʿAbd Allāh ibn Al-Hasan ibn Ali ibn Sīnā (The Prince and the Pauper).

Chapters 13-16

These chapters mainly comment about the decline of the Arabic science and the transition to the European Renaissance. Al-Khalili quotes Abdus Salam at the start of the chapter 'Decline and Renaissance' stating that, "The history of science, like the history of all civilization, has gone through cycles". Al-Khalili closes the books by remarking that, "A scientific renaissance will not happen overnight and requires not only the political will but also an understanding of the meaning of both academic freedom and scientific method itself. But if the Islamic world managed it before, it can do so again" (Al-Khalili 251).

Overall Review

This seven-century streak of Arabic scientific research extending from the 8th to the 15th century AD began with a massive translation movement, which lasted two centuries and translated nearly all the previously acquired knowledge of the Greek philosophers into the Arabic language. Michael Hamilton Morgan in his book about the Muslim scientists, 'Lost History' writes that the caliph AI-Mamun once called his vizier expressed his desire to establish a great center of translation and learning in Baghdad. He told his vizier that, "I want to build a great center of

learning here in Baghdad to support free inquiry, philosophy science, astronomy and mathematics.

Send out emissaries to find for me all the greatest books held by the Byzantines and Persians... And bring me the best translators, to translate into Arabic all that has come before. I will call it the House of Wisdom" (Morgan 56). Thus, began the enlightening two centuries of the translation movement, ending at around the mid of the tenth century. This took over more than just a state affair and soon many of the masses got engaged in it, making translation a unique field in itself. Jim writes about it that, "Once it got going, it became a wider part of the quest for knowledge.

By the mid-ninth century it had evolved into a new tradition of scientific and philosophical scholarship that further fuelled the demand for more translations, both in quantity and quality (AI-Khalili 136). The reason why the translation movement slowly came to an end in the mid-tenth century was that by the time nearly all the Greek and prior knowledge had been translated into and improved upon in the Arabic language. From this point onwards the Arabic scientists independently took the progress of science ahead.

Talking about the House of Wisdom, it was the direct result of Al-Mamun's desire to make a great learning hub out of Baghdad. The caliph even used to demand books as a ransom amount for the war captives (Morgan 56). Established In the mid-eighth century, the House of Wisdom soon became the world's most important learning center and remained so till the next couple of centuries, only to be rivaled by the great knowledge centers of the medieval time such as Damascus, Cordoba, and Cairo.

One of the earliest great Arab scientist was a chemist, Jabir lbn Hayyan (721- 815), He laid foundations for many chemical processes such as distillation and sublimation and is also credited with the introduction of the Arabic word 'AI-Kali' from which we derive the modern day chemical term. Historical facts narrate more than 3000 works in chemistry during the 8th century have been credited to this scientist, a fact with which many modern-day science historians do not agree with and thus it still remains a cause of science history controversy, better called as the 'Jabir Problem'(AI-Khalili 58). Many French historians credit the man with fewer than a thousand works and provide their evidence that many of the works attributed to Jabir were actually accomplished after his death. Al-Khalili remarks about him that, "Of course even a conservative estimate of five hundred books is still a huge legacy for one man'(Al-Khalili 61). One of his most Important books was Kitab al-Rahma al-Kabir (The Great Book of Mercy) ·

Coming towards Mathematics Al-Khalili devotes a few pages to resolve one of the greatest problems/mysteries in the history of the subject: Who invented the Zero? He states that the Initial concept of the zero was neither from the Hindus or the Arabs as normally claimed or argued. He states that, "It would be correct in an answer to the question 'who first invented the symbol for zero?' to say: the Babylonians"(AI-Khalili 105). However, He attests to the fact that it were the Hindus who first came up with the idea and the application of the zero, in the following page of the book. In the later part of the chapter 'Numbers' he compares the contributions made by the Hindus and the Arabs to the modem numbering system. After enlisting several Hindu mathematicians, including the Brahamagupta, and Arabic counterparts like Al'Samawal, Al-

Khalili concludes by stating that it were the Hindus who first brought the base-ten numeral system and the concept of zero and that the Arabic improvements over the Hindu system were the use of fractions and decimals. Hence the present system is properly referred as the Hindu-Arabic system.

Proceeding from this, Al-Khalili starts to discuss the achievements of one of the greatest mathematicians of all times, Al-Khawarizmi. Al-Khawarizml's greatest work can be referred to as his book on mathematics, al-kitan al-mukhtasar first hisab al-jabrwal-muqabala (The Compendium on Calculation by Restoration and Balancing). After enlisting several of the achievements of this mathematics AI-Khalili quickly states him at his right position in the history of the subject by debarring him from the title of being the Father of Algebra, as it is claimed by many historians of science he writes that, "We should be careful not to credit Al-Khawarizmi with inventing a discipline just because the name we use for it today originated from the title of his book" (Al-Khalili 112), However, Al-Khalili does agree that Khawarizmi added so significantly to the subject that he made it possible for it to exist as a separate discipline. For Instance, it was him who pioneered the system for solving the cubic equations, though that use of negative coefficients was introduced later on (Al-Khalili 122).

Onward from this follows the period of one of the greatest physicists of the medieval time, lbn AI-Haytham. The greatest of his work has been he book Kitab al-manazir of the Book on Optics, which came in 7 volumes, and according to Al-Khalili It ranks side-by-side Newton's Principia Mathematica In the scope and magnitude of scientific inquiry. This book essentially covers the

physics behind vision and discovers several properties of light and its nature. Other achievements by Haytham include his debunking of the abortive Greek theory that the human eye emits rays that enable vision. a problem, which great minds like Plato, Galen and Hunayn lbn Ishaq failed to solve He also credited with providing the solution for the ancient Greek Moon illusion (Al-Khalili 161). Al-Khalili personally praises the achievements by this physicist by stating that, "A man alter my own heart: a physicist; in fact, the greatest physicists since Archimedes and the like of whom would not be seen until Isaac Newton seven hundred years later. And acknowledging someone as being the greatest physicist in the span of nearly two thousand years is not done lightly" (Al-Khalili 153).

One point worth noting about the book by Al-Khalili is that the author has remained unbiased throughout his account of the Greek, Arab, Hindu and then finally the Renaissance scientists. This characteristic has been noted and praised by other famous reviews of the book. For Instance, the Times higher Education (UK) notes that, "Al-Khalili has made a conscious effort not to be unduly biased towards the scholars of Islam and there by downplay the activities of the earlier societies, such as Greece (he mostly succeeds)". Here It is worth noting that in his book Al-Khalili has stated Pythagoras to be the 'first great mathematician in history though he recognizes that the bases for Ms advancement were more religious and scientific science, For example, in his book 'History of Mathematics', David Burton employs thirteen chapters to account for the development of the subject, out of which the Arab mathematicians like Al-Khawarizmi and AI-Kindi do not find even one complete sub-section in one of the thirteen chapters. This might explain why it was essential for Jim Al-Khalili to take up the task of recounting the achievements by the Arab and Persian scientists.

References:

Pathfinders by Jim Al - Khalili

Lost History by Michael Morgan

History of Mathematlcs by David Burton