

# SCIENCE AND ISLAM

All over the world, no matter what the cultural or language differences, science is more or less guided by scientific principles. Except in Islamic countries, where it is guided by the Koran. This is the ultimate story about science and religion.

BY TODD PITOCK

**Cairo, Egypt:** “There is no conflict between Islam and science,” Zaghoul El-Naggar declares as we sit in the parlor of his villa in Maadi, an affluent suburb of Cairo. “Science is inquisition. It’s running after the unknown. Islam encourages seeking knowledge. It’s considered an act of worship.”

What people call the scientific method, he explains, is really the Islamic method: “All the wealth of knowledge in the world has actually emanated from Muslim civilization. The Prophet Muhammad said to seek knowledge from the cradle to the grave. The very first verse came down: ‘Read.’ You are required to try to know something about your creator through meditation, through analysis, experimentation, and observation.”

Author, newspaper columnist, and television personality El-Naggar is also a geologist whom many Egyptians, including a number of his fellow scientists, regard as a leading figure in their community. An expert in the somewhat exotic topic of biostratification—the layering of Earth’s crust caused by living organisms—El-Naggar is a member of the Geological Society of London and publishes papers that circulate internationally. But he is also an Islamic fundamentalist, a scientist who views the universe through the lens of the Koran.

Religion is a powerful force throughout the Arab world—but per-



We are not behind because of Islam. We are behind because of what the Americans and the British have done to us.

Modern Cairo is a crowded city of 20 million people.

haps nowhere more so than here. The common explanation is that the Egyptian people, rich and poor alike, turned to God after everything else failed: the mess of the government's socialist experiment in the 1960s; the downfall of Gamal Abdel Nasser's Arab nationalism; the military debacle of the 1967 war with Israel; poverty; inept government—the list goes on.

I witness firsthand the overlapping strands of history as I navigate the chaos of Cairo, a city crammed with 20 million people, a quarter of Egypt's population. In residential neighborhoods, beautiful old buildings crumble, and the people who live in them pile debris onto rooftops because there is no public service to take it away. Downtown, luxury hotels intermingle with casinos, minarets, and even a Pizza Hut. The American University in Cairo is a short distance from Tahrir Square, a wide traffic circle where bruised old vehicles brush pedestrians who make the perilous crossing. At all hours men smoke water pipes in city cafés; any woman in one of these *qawas* would almost certainly be a foreigner. Most Egyptian women wear a veil, and at the five designated times a day when the muezzins call, commanding the Muslims to pray, the men come, filling the city's mosques.

The Islamic world looms large in the history of science, and there were long periods when Cairo—in Arabic, El Qahira, meaning “the victorious”—was a leading star in the Arabic universe of learning. Islam is in many ways more tolerant of scientific study than is Christian fundamentalism. It does not, for example, argue that the world is only 6,000 years old. Cloning research that does not involve people is becoming more widely accepted. In recent times, though, knowledge in Egypt has waned. And who is accountable for the decline?

El-Naggar has no doubts. “We are not behind because of Islam,” he says. “We are behind because of what the Americans and the British have done to us.”

The evil West is a common refrain with El-Naggar, who, paradoxically, often appears in a suit and tie, although he is wearing a pale green *galabiyya* when we meet. He says that he grieves for Western colleagues who spend all their time studying their areas of specialization but neglect their souls; it sets his teeth on edge how the West has “legalized” homosexuality. “You are bringing man far below the level of animals,” he laments. “As a scientist, I see the danger coming from the West, not the East.”

He hands me three short volumes he has written about the relationship of science and Islam. These include *The Geological Concept of Mountains in the Holy Koran*, and *Treasures in the Sunnah, A Scientific Approach*, parts one and two, along with a translation of the Koran, whose title page he has signed, although his name does not appear as a translator.

In *Treasures in the Sunnah*, El-Naggar interprets holy verses: the hadiths, sayings of the Prophet, and the sunnah, or customs. There are scientific signs in more than one thousand verses of the Koran, according to El-Naggar, and in many sayings of the Prophet, although these signs often do not

speak in a direct scientific way. Instead, the verses give man's mind the room to work until it arrives at certain conclusions. A common device of Islamic science is to cite examples of how the Koran anticipated modern science, intuiting hard facts without modern equipment or technology. In *Treasures of the Sunnah*, El-Naggar quotes scripture: “and each of them (i.e., the moon and the sun) floats along in (its own) orbit.” “The Messenger of Allah,” El-Naggar writes, “talked about all these cosmic facts in such accurate scientific style at a period of time when people thought that Earth was flat and stationary. This is definitely one of the signs, which testifies to the truthfulness of the message of Muhammad.”

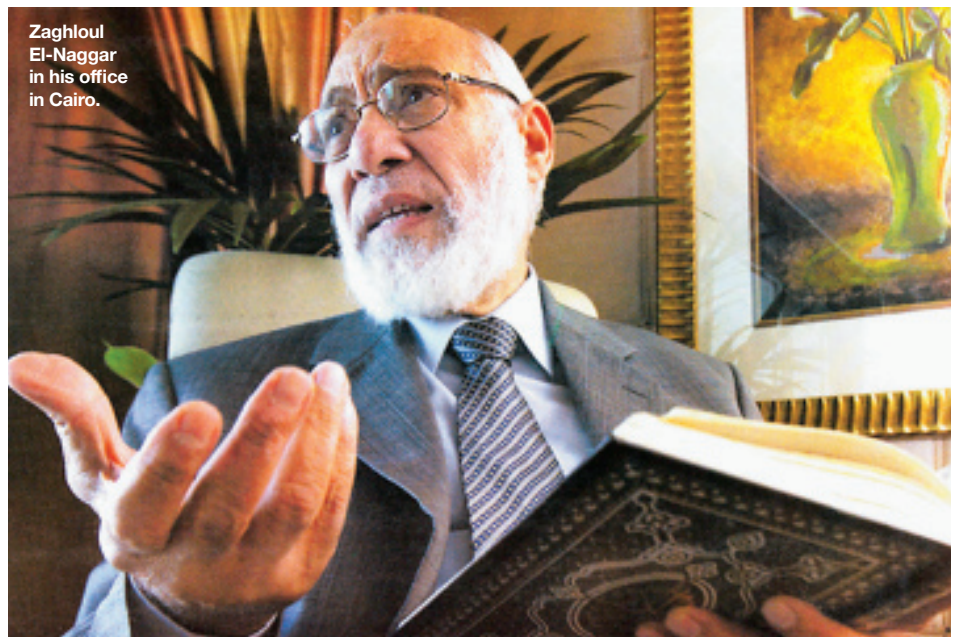
Elsewhere, he notes the Prophet's references to “the seven earths”; El-Naggar claims that geologists say that Earth's crust consists of seven zones. In another passage, the Prophet said that there were 360 joints in the body, and other Islamic researchers claim that medical science backs up the figure. Such knowledge, the thinking goes, could only have been given by God.

Critics are quick to point out that Islamic scientists tend to use each other as sources, creating an illusion that the work has been validated by research. The existence of 360 joints, in fact, is not accepted in medical communities; rather, the number varies from person to person, with an average of 307. These days most geologists divide Earth's crust into 15 major zones, or tectonic plates.

El-Naggar even sees moral meaning in the earthquake that triggered the 2005 tsunami and washed away nearly a quarter of a million lives. Plate tectonics and global warming be damned: God had expressed his wrath over the sins of the West. Why, then, had God punished Southeast Asia rather than Los Angeles or the coast of Florida? His answer: Because the lands that were hit had tolerated the immoral behavior of tourists.

**The influence and popularity of El-Naggar—as a frequent guest** on Arab satellite television, he reaches an audience of millions—does not sit well with Gamal Soltan, a political scientist at Al-Ahram Center for Political and Strategic Studies, a Cairo-based think tank.

“This tendency to use their knowledge of science to ‘prove’ that



Zaghoul El-Naggar in his office in Cairo.

## Nobody can just write what he thinks without proof. But we have real proof that the story of Adam as the first man is true.

the religious interpretations of life are correct is really corrupting,” he tells me. Soltan, who got his doctorate at the University of Northern Illinois, works in a small office that’s pungent with tobacco smoke; journals and newspapers lie stacked on his desk and floor. “Their methodology is bad,” he says. Soltan explains that Islamic scientists start with a conclusion (the Koran says the body has 360 joints) and then work toward proving that conclusion. To reach the necessary answer they will, in this instance, count things that some orthopedists might not call a joint. “They’re sure about everything, about how the universe was created, who created it, and they just need to control nature rather than interpret it,” Soltan adds. “But the driving force behind any scientific pursuit is that the truth is still out there.”

Researchers who don’t agree with Islamic thinking “avoid questions or research agendas” that could put them in opposition to authorities—thus steering clear of intellectual debate. In other words, if you are a scientist who is not an Islamic extremist, you simply direct your work toward what is useful. Scientists who contradict the Koran “would have to keep a low profile.” When pressed for examples, Soltan does not elaborate.

The emphasis on utility wasn’t always present here. The Napoleonic occupation from 1798 to 1801 brought French scientists to Egypt. The arrival of the Europeans alerted Egyptians to how far behind they’d fallen; that shock set in motion a long intellectual awakening. During the 150 years that followed, institutions for higher learning in Cairo gave the city an international reputation for prestigious institutions, and the exchange of scholars went in both directions, with Egyptians going west and Americans and Europeans coming here.

Then came the 1952 coup led by Gamal Abdel Nasser that toppled King Farouk I. Nasser was the first modern leader to position

himself as a spokesman for the whole Arab world. His brand of nationalism was meant to unify all Arab people, not just Egyptians, and it set them in opposition to America and Europe. “After Nasser, Arab nationalism raised suspicions about the West,” Soltan says.

In Soltan’s view, the twin forces of Islamization and government policy have inadvertently worked together to blunt scientific curiosity. “We are in a period of transition,” he says. “I think we are going to be in transition for a long time.”

People and the authorities are still grappling with religion’s place in Egyptian society, resulting in a situation similar to one in Europe during the time of Copernicus and Galileo, when scientific knowledge was considered threatening to the prevailing religious power structure. For now, the door on freedom of thought has nearly been shut. As Soltan points out, “Cairo University has not received Western professors since the 1950s, and because of the turmoil in the country, many professors who didn’t like the regime were excluded from the university.”

**I walk the campus of Cairo University prior to meeting Waheed Badawy, a chemistry professor who has taught there since 1967. His students, male and female, wander in and out during our talk; the women all wear head covers, highlighting the degree to which religion is particularly strong among the young. He wears a white lab coat, and there are religious verses posted on his laboratory walls and corkboard. Yet Badawy, who specialized in solar energy conversion while working for Siemens in Germany in the 1980s, does not consider himself an “Islamic scientist” like El-Naggar. He is a scientist who happens to be devout, one who sees science and religion as discrete pursuits.**

“Islam has no problems with science,” he says. “As long as what

## ISLAM’S SCIENTIFIC LEGACY

Citizens of the Arabic city of Samarqand (in modern-day Uzbekistan) obtained the Chinese secrets of papermaking in A.D. 751, when Chinese invaders were captured, held prisoner, and forced to build and operate a paper mill. Inspired by the Koran (“The scholar’s ink is more sacred than the blood of martyrs”), Samarqand became the papermaking capital of the Arabic world. Thousands of books were produced, and Greek, Chinese, and Hebrew texts were translated. Here began the centuries-long golden age of Islam, widely regarded as a time of rich scientific discovery.

Today Samarqand is an intellectual backwater, and Muslim nations are conspicuously underrepresented in science. The cause of this decline provokes fierce debate. What happened to Islam’s scientific tradition from the time of the caliphate?

Toby Huff, a sociologist at the University of Massachusetts at Dartmouth, argues that some of the decline is illusory. “It is an

exaggerated claim [to say that this era was] laying the foundation for modern science,” he says. Aside from progress in math and astronomy, what happened during the golden age was that “a whole lot of Greek philosophy and science was translated into Arabic and then passed on to the West.”

George Saliba, professor of Arabic and Islamic science at Columbia University, vehemently disagrees. “There is evidence of achievements of such sophistication that they were eventually used by Renaissance scientists,” he says. By some accounts the scientific method itself sprang from Islam’s golden age. Heuristics—the use of experimentation rather than philosophy to understand nature—may have originated with the 11th-century Islamic polymath Al-hazen, who conducted experiments on the diffraction of light 700 years before Newton picked up a prism. His treatise, *Kitab al-Manazir*, inspired Roger Bacon and Johannes Kepler centuries later. Other re-

searchers note that during Europe’s Dark Ages, Muslim physicians diagrammed the body’s structural, nervous, and circulatory systems, discovered pulmonary circulation, and pioneered surgical procedures like the tracheotomy.

To Saliba, the lack of scientific progress in the modern Islamic world is a political and economic issue, not a religious one. “Muslim countries are part of the underdeveloped world. Whether people are Muslim, Hindu, or Confucian, they have all been suffering from this rat race, trying to catch up with what is produced in the first world.”

But Huff thinks the Islamic belief that God is in complete control of nature is an important impediment. As Muslim culture became more conservative over the centuries, he says, science began to shut down: “To argue that something happens because of naturalistic forces and not because of God was considered heresy.”

Susan Kruglinski

you do does not harm people, it is permitted. You can study what you want, you can say what you want.”

What about, say, evolutionary biology or Darwinism? I ask. (Evolution is taught in Egyptian schools, although it is banned in Saudi Arabia and Sudan.) “If you are asking if Adam came from a monkey, no,” Badawy responds. “Man did not come from a monkey. If I am religious, if I agree with Islam, then I have to respect all of the ideas of Islam. And one of these ideas is the creation of the human from Adam and Eve. If I am a scientist, I have to believe that.”

But from the point of view of a scientist, is it not just a story? I ask. He tells me that if I were writing an article saying that Adam and Eve is a big lie, it will not be accepted until I can prove it.

“Nobody can just write what he thinks without proof. But we have real proof that the story of Adam as the first man is true.”

“What proof?”

He looks at me with disbelief: “It’s written in the Koran.”

**Tunis, Tunisia: After the hazy congestion of Cairo, the briny sea breeze and open spaces of Tunis are liberating.** Anchored on the Mediterranean coast, Tunisia’s capital is rimmed by mountainous suburbs with palm trees and gardens trellised with bougainvillea. The town where I am staying is Sidi Bou Said. It has a kind of high-rent antiquity that feels like Italy or the south of France. Indeed, just 80 miles from Sicily, Tunis is physically closer—and culturally closer, too, many people say—to Mediterranean Europe than it is to much of the rest of the Arab world. “They’re not really Arabs,” my Egyptian translator says en route to the airport. “They’re French.” He does not mean it as a compliment.

“We have succeeded in keeping extremism and that mentality out of our schools and institutions,” says a government official who asks not to be named. “We are an island of 10 million people in a sea of Islamists. The extremists want to remove the buffer between religion and everything else, including science. There has to be a buffer between religion and science.”

Tunisia, a former French protectorate that became independent in 1956, shares with its Arab neighbors a poor human rights record and a president whose family has been charged with corruption. Freedom House, a nonprofit monitoring group, ranks it 179 out of 195 countries for press freedom. In March, a dissident was sentenced to three and a half years in prison (after already serving two years while awaiting trial) for decrying the lack of freedom. Yet, unlike the Egyptians who complain openly about their lack of freedom, the Tunisians I encounter tend to put things in a more optimistic light. One reason for the allegiance to their government is a widely held belief that the alternative to their president, Ben Ali, would be Islamic extremists. Another reason many support the government: It has been more effective than those of most Arab countries at delivering basic services, including education and health care.

Although officially Muslim, Tunisia maintains the closest thing there is in the Arab world to separation of mosque and state. In public sector jobs, beards and veils are banned. On the street, you see young women with their hair covered, but it is not unusual to see the same women wearing tight jeans, making the veil as much fashion accessory as religious garment. School textbooks lack information on different religions and religious beliefs. “Islamic science” is not a university subject here, as it is in Egypt; “Islamology,” which looks

## AT WAR WITH SCIENCE IN IRAN

**Iran’s contentious nuclear program underscores a larger issue in the Muslim world: Money is flowing to arms development while basic science often goes starving.** In recent years, nations of the Organization of the Islamic Conference spent 0.34 percent of their gross domestic product on research and development, compared with a global average of 2.36 percent. At the same time, Oman, Kuwait, Syria, Jordan, Saudi Arabia, and Yemen each devoted more than 7 percent of their GDP to weapons. And the Iranian program has its neighbors ready to jump on the nuclear bandwagon. “In all of the 62 years of the nuclear age, there has been exactly one nuclear plant constructed in the Middle East, and that’s the one in Iran. Suddenly in the last six months, 10 Muslim countries have expressed interest in developing nuclear power,” says nonproliferation expert Joe Cirincione of the Center for American Progress.

The related U.S. embargo against Iran has led some scientific societies to bar Iranian researchers. This March, the American Chemical Society announced that it was rescinding the memberships of 36 Iranian scientists, claiming that their participation in the society violated federal law. “Chemists all around the world communicate through the ACS. Restricting that will prevent Iranian scientists from participating in that exchange,” says Ali Banijamali, codirector of the Iranian Chemists’ Association.

Iranian scientists face plenty of internal challenges as well. In April 2006, a leading Iranian sociologist, Ramin Jahanbegloo, was jailed for “contacts with foreigners.” He was released four months later, but only after researchers around the world petitioned Iranian authorities. Hadi Ghaemi, Human Rights Watch’s analyst for Iran, says the imprisonment “had an absolutely chilling effect on academic freedom” among Iranian researchers. The restrictive environment has pushed some scholars—including Jahanbegloo—to leave the country. “We’ve had a number of prominent intellectuals in many fields going into self-exile because they’ve lost their academic positions. They can’t publish, and they can’t lecture,” Ghaemi says. “There is a tremendous brain drain in the natural sciences and technical fields.” **Jennifer Barone**



critically at Islamic extremism, is.

In contrast to the situation in Egypt, where even the most Western-oriented scientist I talked to at some point or other declares himself to be “a good Muslim,” in Tunisia the personal religious views of scientists I meet hardly seem relevant. Even so, I am reminded how science, like politics, tends to be local, addressing immediate problems using materials at hand. Sami Sayadi, director of the bioprocesses lab at the Biotechnology Center of Sfax, Tunisia’s second-largest city, spent more than a decade figuring out how to turn the waste of olives pressed for oil into clean, renewable energy. Olives have been a major export here since the heyday of Carthage and remain an icon for Arabs everywhere, making Sayadi’s achievement sound almost like modern-day alchemy.

Sayadi’s thinking is the kind of pragmatism the Tunisian government wants, and in recent years it has come to see science and technology as important tools of national advancement. There were 139 laboratories across different disciplines in 2005, compared with 55 in 1999. The government is actively promoting this growth.

Ninety minutes south of Tunis is the Borj-Cedria Science and Technology Park, a campus that will eventually combine an educational facility, an industrial and R&D center, and a business incubator. The park’s completion is still years away, however, and although some buildings and labs are in place, geologists, physicists, and other scientists laboring here work with equipment that in the West wouldn’t pass muster in many high schools. They pursue projects for the love of science.

The situation may soon change. In its hunger for patents and profits, the Tunisian government is giving out four-year contracts to labs whose work has industrial applications. Senior researchers



Sami Sayadi studies alternative energy in his lab in Sfax, Tunisia.

at Borj-Cedria currently make about \$1,100 a month (a livable but modest wage here), but the new program would give anyone who earns a patent a 50 percent stake in royalties.

Still, Tunisia’s support of science has clear limits: Projects whose aim is solely to advance knowledge get no support. “Everyone would like to do [basic] research,” says Taieb Hadhri, Minister of Scientific Research, Technology, and Competency Development, who has held the cabinet-level post since the department was created in 2004. “I’m a mathematician by training, and I would also like to do [basic] research. But that will have to come later. We have more pressing needs now.”

And the push toward advancement here is not entirely free from the pull of tradition, as I learn when I visit Habiba Bouhamed Chabouni, a medical geneticist who splits her time between research and teaching at the Medical Faculty of the University of Tunis and seeing patients at the Charles Nicolle Hospital, also in the capital. In 2006, she won a L’Oréal-UNESCO Women in Science Award, a

## THE SELF-CENSORSHIP OF SCIENCE

**Physicist Taner Edis of Truman State University** in Kirksville, Missouri, grew up in Turkey and attended Boğaziçi University in Istanbul before moving to the U.S. He is the author of four books on science and faith, including *An Illusion of Harmony: Science and Religion in Islam* (Prometheus, 2007).

**Do scientists in the Muslim world feel pressured to accommodate religious beliefs into their work?**

Overtly, rarely. Compare it more to a journalistic environment where people learn how to self-censor because the work environment is such that you know it doesn’t pay to offend the boss.

**Some Islamic scholars argue that Islam’s emphasis on reading, learning, and inquiry promotes science. Does it?**

Is anyone going to claim that they don’t promote learning and inquiry? In practice, until recently Muslim societies have been

like any other preindustrial society, regardless of religion. The vast majority have been illiterate, and the kind of scholarship that found official support was very narrow religious scholarship.

**Are current political changes in Islamic countries helping or hindering scientific progress?**

Developments favoring conservative Muslim revival movements and Islamist politics invite friction with scientific institutions. In the longer term, what will happen is less clear. Islamists tend to be very technology positive, so they may divert significant funds to applied science. Another possible scenario is fundamentalist failure, if Islamist rule leads to a backlash that gives science more freedom to operate.

**Are certain areas of research especially difficult to work in?**

Evolutionary biology often risks public disap-

proval, as does archaeological or historical inquiry that might touch on religious origins.

**What is it like for scientists in these fields to secure funding?**

Everyone has difficulty getting funding. The major difficulty for scientists working in the Muslim world is that Muslim countries are typically poor, and basic science (as opposed to applied science) is never a high priority.

**How is extremism affecting science?**

Depends on what you mean by “extremism.” If it’s the bomb-throwing variety, it’s pretty irrelevant. Any effect they have is indirect—promoting institutional instability and so forth. More important is moderate Islamist politics, which has a much broader democratic base. That in my judgment has a mild depressant effect on science, since it tends to favor populist culture-war themes in its mass politics.

\$100,000 prize given to five women, each representing one of the continents, for her work analyzing and preventing hereditary disorders. When she greets me in her office, she is wearing a white lab coat. Test tubes clink as they spin in a centrifuge to separate strands of a patient's DNA that Chaabouni will examine later.

Chaabouni recalls the early days of her career, in the mid-1970s, when she saw children afflicted with disfiguring diseases. "It was very sad," she says. "I met families with two, three, four affected siblings. I wanted to do something about it, to know how to prevent it." There was no facility for genetic research at that time, and for two decades, she lobbied government officials hard for it. "We wanted better conditions and facilities. They also saw we were publishing in international [peer-reviewed] journals. I think the policymakers finally



Left: The Great Mosque dominates the town of Kairouan, Tunisia. Right: Tunisian medical geneticist Habiba Bouhamed Chaabouni, who has championed government support for genetics.

understood the value of developing research."

The Tunisian medical-genetics community, which includes about 100 doctors and technicians, now publishes more than any other Arab country. "We looked on PubMed, and we're ahead of Egypt," Chaabouni says, beaming. "Not by a lot, but remember, we're one-tenth the size."

Over the last 30 years, Chaabouni has also seen how people who once resisted her message have begun listening. Once, genetic counseling or even coming in for certain treatments almost amounted to a social taboo; now, it is becoming more accepted, and things that were once simply ignored or not spoken of—such as autism in children, which is being identified more commonly—are more often out in the open.

For all that, Chaabouni still sees how her advice sometimes clashes with her patients' beliefs. Like many Arab and Muslim countries, Tunisia has a high incidence of congenital diseases, including adrenal and blood disorders, that Chaabouni has traced to consanguinity.

"It's a custom here, and in the rest of the Arab world, to marry cousins, even first cousins," she tells me, though the practice is becoming less common. "Of course, that means they share a lot of genes from common sets of grandparents."

In other fields, pure research does not get support; in medical genetics, even practically applicable knowledge can spark conflicts

with Islamic culture. "Taking a blood sample to study abnormalities is not a problem," Chaabouni says. "That's just investigation. The problem is when you take the results of research into the clinic and try to give genetic counseling to patients. Then you have people who won't accept the idea that they have to stop having children or that they shouldn't marry their cousin."

Today prenatal screening and genetic testing is more widely accepted, and when it's necessary to save the mother's life, doctors terminate pregnancies. Islamic law permits abortion in cases of medical necessity (where the mother's life is in jeopardy) until 120 days in utero, at which point it regards the fetus as "ensouled" and abortion becomes homicide. For Chaabouni, the challenge is mainly one of communication. "They look for arguments why you may be wrong," she says. "They go to other doctors. In the end, they usually follow our advice, but it's hard because you're giving them bad news that may also go against what they believe."

Mohammed Haddad, an Islamology specialist at the Université de la Manouba in Tunis, points out the many little assaults that can turn people's minds against scientific advances. For example, a sheikh recently declared that he'd found a cure for AIDS—spelled out in the Koran. "He was from Yemen, but they reach us by satellite, and it's all a big business," Haddad says. "People listen, and it's a problem. In this situation, many will die."

**Amman, Jordan: "The Koran says, 'Read,' but it does not even say 'Read the Koran.' Just 'Read,'"** says Prince El

Hassan bin Talal, who greets me at the Royal Scientific Society, Jordan's largest research institution—one that he helped establish in 1970. Hassan was heir to the throne until his brother, King Hussein, bypassed him in favor of Abdullah, Hussein's own son. The 60-year-old prince, who speaks classical Arabic and Oxford English and has studied biblical Hebrew, can tick off a whole list of things that are wrong with Jordan, from Western governments and non-governmental organizations that come proposing solutions without having identified the causes of problems, to a culture that does not value reading. He is bookish himself; during our 40-minute-plus interview, he refers to Kierkegaard, Karen Armstrong's *A History of God*, and *What Price Tolerance*, a 1939 book by his wife's relative Syud Hossain.

He is also candid, calling suicide bombers "social rejects" and questioning the validity of those who would take the Muslim world back to the times of the Prophet Muhammad. "Are we talking Islam or *Islamism*?" he asks, pointing out the difference between the religion and those extremists who use the religion to advance their own agendas. "The danger [posed by Islamists] is not only to Christians but also to Islam itself. The real problem is not the Arab-Israel issue but the rise of Islamism."

Science, rather than religion, is the way to ensure a country's future, Prince Hassan believes, and he has made supporting scientific achievement a personal mission for almost 40 years. He envisions

projects that would promote regional partnerships, including with Israel—an idea that, despite official peace between the countries, remains controversial.

He notes that some important science initiatives are under way. One of the Royal Scientific Society's pursuits is the Trans-Mediterranean Renewable Energy Cooperation, or TREC, a multinational effort that would use wind, water, geothermal, and solar resources to provide renewable energy from Oman to Iceland. If successful, the endeavor would take decades to be realized. Like Moses standing on Mount Nebo (in fact, the site of the Exodus story lies just about 20 minutes outside Amman), the 60-year-old Hassan knows that he is not likely to see this technological promised land himself.

"Vision," he says, "is not an individual thing. It's a collaboration."

**"The biggest disaster in the region, I am sorry to say, is the loss of brainpower,"** admits Hassan. The emigration of trained academics plagues the entire Arab world, and half of those students who graduate from foreign universities never return to the Arab states. "A large percentage of [America's] NASA staff are of Middle Eastern origin," Hassan notes.

In some ways, the brain drain in Jordan is more obvious than in Egypt because resources here are stretched to the breaking point. Conservative estimates put the number of Iraqi refugees living in Jordan at 700,000—an enormous burden considering that Jordan has just 6 million citizens. To put that figure in perspective, imagine the United States adding 35 million people in a period of four years.

The population influx has triggered inflation, soaring rents and property prices, and urban sprawl. Like Egypt, Tunisia, and Syria (and like Israel, for that matter), Jordan lacks significant natural resources; the country has little oil or fresh water. In fact, since most of the water from the Jordan River's tributaries has been diverted and no longer flows to the Dead Sea, even the Dead Sea is dying. There are plans for resuscitating it, but they will require a delicate process of regional cooperation, including the Israelis and the Palestinians, and most likely Western aid.

Jordan also lacks financial resources, unlike the oil-rich Gulf states that can afford to treat knowledge and expertise as an accessible commodity, able to be imported as needed. Furthermore, the perception of danger—terrorists bombed three hotels in Amman in 2005, and Al Qaeda has admitted to killing an American diplomat—has all but shut the valve on Jordanian tourism and the considerable revenue it used to bring.

Jordan, the quip goes, is caught between Iraq and a hard place. For now, it embodies many of the issues that the Arab Human Development Report blamed for the region's intellectual malaise, among them lack of freedom and dysfunctional, authoritarian governments whose security services have too much say; the triumph of who-you-know advancement over merit-based promotion; and poor communication between researchers within the region. Educational opportunities are limited, especially for girls and women.



Jordanian prince El Hassan bin Talal, brother of King Hussein.

All of this means that if you are a talented scientist, there is a good chance you'll leave.

"Science needs stability, democracy, freedom of expression," says Senator Adnan Badran, who has a Ph.D. in molecular biology from Michigan State University, as we drink Turkish coffee at his office. "You must have an environment that's conducive to free thinking, to inquiry. If you don't, you'll never be able to release the mind's potential. It's a very bleak story, a very disappointing story, about the state of science and technology in the Arab region."

He blames a tradition that began with the Ottomans in the 1500s: lowering educational standards and promoting dogma. "We were open. Islam was open, a strong belief with dialogue. It was tolerant, mixing with other civilizations. Then we shifted to being dogmatic. Once you're dogmatic, you are boxed in," he says. "If you step outside the box, you're marginalized—and then you're out. So you go west."

That's what Badran did, spending 20 years in France and the United States, where he earned four patents doing research for the United Fruit Company. His work, which focused on retarding ripeness in bananas, has had huge economic impact—billions of dollars, potentially, because it allows the company to ship its crops around the world without spoiling.

Even so, Badran returned home to Jordan, where he took up academic positions, including the presidency of Philadelphia University in Amman. In 1987, he was made the first secretary general of Jordan's Higher Council for Science and Technology and was later appointed to the senate by the king of Jordan, Abdullah II. Then early in 2005, the king appointed Badran prime minister, the first scientist to hold that position. The king, who was educated at Royal Military Academy Sandhurst and at Oxford in the United Kingdom, and also attended Georgetown University in Washington, D.C., appreciated Badran's position on the need for Arab glasnost.

"I wanted to destroy every vested interest, to get rid of cronyism, to build accountability and transparency by freeing the press," Badran says. The circumstances of Badran's term were difficult, however. "He was an excellent academic and scientist," a journalist tells me, "but an ineffective politician."

Any chance for Badran to advance his agenda went up with the smoke in November 2005 when suicide bombers targeted the three Amman hotels. As the government shifted its focus from internal reform to security, Badran was a casualty of change. The prime minister here serves at the discretion of the king—and also, many people say, by tacit approval of Jordan’s security services. In less than a year, Badran was ousted (his thinking was considered to be too idealistic for that time) and returned to his seat in the senate.

**After leaving Badran, I get a primer on Jordan’s most dynamic and hopeful scientific collaboration.** I speak with physicist Hamed Tarawneh at his cramped, dingy temporary office at UNESCO’s headquarters in Amman. Tarawneh, a tall, broad-shouldered chain-smoker with a disarming smile, left years ago to get his Ph.D. in

## Islam was open, a strong belief with dialogue. It was tolerant. Then we shifted to being dogmatic.

Sweden and returned to Jordan just a few months prior to our meeting. He is in the process of assembling a staff of engineers and technicians for SESAME (Synchrotron-light for Experimental Science and Applications in the Middle East), an international laboratory organized around a machine that has wide applications in physics, biology, medicine, and archaeology. Only a handful of these versatile light generators exist, and this is the first in the Muslim world.

Jordan was selected as the site for SESAME after King Abdullah II donated land and ponied up \$10 million for the facility that would house the synchrotron. The project is modeled on CERN, the Swiss high-energy physics lab formed after World War II to restore Europe’s tradition of scientific learning. When SESAME becomes fully operational in 2009—the facility at Al-Balqa Applied University near Amman should be complete this June—researchers will rotate

through doing their work in weeks-long sessions. Like its European model, SESAME was conceived in part to motivate the region’s best and brightest to stay, or even to return from abroad; the laboratory should also create excitement and opportunity that will attract young students to science.

Tarawneh hopes SESAME will become a knowledge hub for the member states that pay annual dues, a group that now includes Bahrain, Egypt, Pakistan, Turkey, the Palestinian Authority—and Israel, the one country in the region that has a knowledge-based society but has been excluded from almost every other endeavor. “We are scientists,” Tarawneh says. “We don’t care about politics. So now we have a chance to discuss science here and work for the greater good of knowledge. It’s a very good start. It’s a cosmopolitan environment, which is what we’ve been lacking. Now we’ll all know each other as scientists, as people.”

I ask about the legions of scientists who have left Jordan, who regard it as a lost cause.

“Would I earn more if I went to Berkeley?” Tarawneh asks. “Yes, of course. But I am from here. I am an Arab. I am a Muslim. This is where I want to be. And why can’t we build something here that’s ours? In five years, others will see it’s useful, and it will become a world effort and create a culture of scientific inquiry here. Science is the way to break barriers. It’s about development and advancing people’s interests.”

Tarawneh’s enthusiasm makes SESAME’s success seem inevitable, but the king’s support and the international character of the project make it seem like much more than an individual triumph. It is precisely the kind of regional partnership that people like Prince Hassan say is the real road map to peace and prosperity in the Islamic world. As both machine and metaphor, a high-powered generator that shines light on scientific inquiry may be the answer to everyone’s prayers. ■



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