Prize issue

July - September 2026

# التقدم العلمي

**Kuwait Prize 2025: Honouring Arab Minds Shaping the Future**

**KFAS Strengthens a Culture of Excellence and Knowledge For More Than Four Decades**

**From Mathematics to Computational Biology: Arab Achievements Shaping Global Science**

# AL-TAQADDUM AL-ILMI

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Kuwait Foundation for the Advancement of Sciences

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Stimulate and catalyse the advancement of STI for the benefit of society, research and enterprise in Kuwait.

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Kuwait Foundation for the Advancement of Sciences

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AL-TAQADDUM AL-ILMI

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## Editorial letter

# When Science Honors Excellence

With every cycle of scientific awards presented by the Kuwait Foundation for the Advancement of Sciences, a profound conviction is renewed: true investment in the future begins with people—with minds devoted to research and discovery, and with knowledge that transforms into meaningful impact on society, development, and human progress.

This year's honors, led by the Kuwait Prize and the Jaber Al-Ahmad Award for Young Researchers, reaffirm this enduring vision: connecting scientific excellence with service to humanity, while granting researchers and scholars the recognition they deserve for their intellectual and scientific achievements.

The laureates of the Kuwait Prize this year exemplified inspiring models of interdisciplinary and globally impactful research, with distinguished accomplishments spanning mathematics, environmental sciences, sociology, cultural criticism, and computational biology—fields that reflect the complexity of contemporary challenges and the growing need for innovative scientific solutions.

At the same time, the Jaber Al-Ahmad Award for Young Researchers stands as a national platform that celebrates promising Kuwaiti talent and supporting young researchers in their scientific journeys, driven by the conviction that building a knowledge-based economy begins with empowering national capabilities and fostering creativity and innovation.

Honoring scientific minds is not merely an act of individual recognition; it is a cultural and societal message affirming that scientific research remains one of the most essential drivers of progress and sustainability. Through these initiatives, the Kuwait Foundation for the Advancement of Sciences continues to nurture an environment that values knowledge, embraces researchers, encourages scientific dialogue, and inspires new generations to contribute to shaping the future.

In this issue, we highlight the journeys and achievements of the award winners in celebration of their valuable scientific contributions and in the belief that stories of scientific success will always inspire ambitious minds across the Arab world.

**Ameenah Farhan**
**Director General**

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## the Jaber Al-Ahmad Award for Young Researchers 2025



**As part of its ongoing commitment to supporting scientific research and advancing the role of young kuwaiti scientists**









# Kuwait Prize 2025

## Honoring Minds that Shape the Future

Reaffirming its status as one of the Arab world's most prestigious scientific awards, the Kuwait Foundation for the Advancement of Sciences announced the winners of the Kuwait Prize, which since its establishment in 1979 has continued to recognize Arab scientists and researchers for their outstanding scientific and intellectual contributions that have had made a global impact.

The winners were announced following approval by the Foundation's Board of Directors and Awards Council, based on the recommendations of specialized judging and selection committees, in line with the Foundation's commitment to fostering a culture of scientific excellence and supporting research and innovation across the Arab world.

The 44th edition honored a distinguished group of scholars whose achievements span in the field of mathematics, environmental sciences, sociology, cultural criticism, and computational biology, demonstrating the breadth of the Prize and its alignment with contemporary scientific developments.

In the field of Basic Sciences, under the topic of Mathematical Sciences, the Prize was awarded to Professor Jalal Shatah, Silver Professor of Mathematics at the Courant Institute of Mathematical Sciences at the New York University, in recognition of his pioneering contributions to partial differential equations, as well as his influential academic and leadership roles within the international scientific community.

In Applied Sciences, under the topic of Environmental Sciences, the Prize was jointly awarded to Professor Abdelhamid Sayari of the University of Ottawa and Professor Noureddine Ghaffour of King Abdullah University of Science and Technology, in recognition of their impactful environmental research. Professor Sayari's work focused on the design of porous materials and their applications in separation, purification, and greenhouse gas reduction, while Professor Ghaffour contributed innovative solutions to improve desalination efficiency, reduce energy consumption, and minimize environmental impact.

In the field of Economic and Social Sciences, under the topic of Sociology, the Prize was awarded to Professor Mohammad Bamyeh, Professor of Sociology at the University of Pittsburgh, in recognition of his distinguished contributions to the study of knowledge systems, globalization, religion, and social movements, as well as his influential academic publications that enriched global sociological discourse.

The Prize in Humanities, Arts, and Literature, under the topic of Literature and Art in the Arab World, was awarded to Professor Abdullah Al-Ghathami, one of the Arab world's leading literary and cultural critics. Through his extensive intellectual and academic contributions, he has played a major role in advancing Arab critical studies and localizing concepts of cultural criticism to the Arab context through a number of highly influential reference works.

In the field of Emerging Interdisciplinary Sciences, under the topic of Computational Biology and its Applications, the Prize was awarded to Professor Ahmed Khalil of Harvard University, in recognition of his pioneering contributions to synthetic biology, including the design of genetic circuits and the development of platforms and technologies with promising medical and research applications.

**For more than four decades, the Kuwait Prize has established itself as a distinguished scientific platform that celebrates Arab intellectual excellence**

This year's edition of the Prize reflects the continuing role of the Kuwait Foundation for the Advancement of Sciences in supporting Arab scientists and strengthening their presence on the global scientific stage by celebrating intellectual achievement and encouraging research that offers innovative solutions to human, environmental, and developmental challenges.

For more than four decades, the Kuwait Prize has established itself as a distinguished scientific platform that celebrates Arab intellectual excellence and contributes to building an environment that promotes innovation and knowledge production, in line with the Foundation's mission of investing in science and human potential for a more advanced and sustainable future.

# Professor Abdullah Al-Ghathami

## The Hidden Meanings in Our Words

As a teenager growing up in Unayzah, a city in the heart of Saudi Arabia, Professor Abdullah Al-Ghathami had a habit: He would tear off small pieces of paper, then write down the titles of books — not of books he had read, but of books he planned to write one day. Now that Professor Al-Ghathami has turned 80, those notes are long gone, lost to time and house moves. But he has more than fulfilled the dream they represented.

Today, Professor Al-Ghathami is one of Saudi Arabia's most celebrated writers and critics, the author of more than 35 books and the creator of an influential theory about the relationships between language, culture, and power. His theory, which he calls "Hidden Cultural Norms," argues that beneath the surface of everyday speech — in political slogans, poetry, and offhand remarks — lie buried beliefs that lay bare what a society truly thinks and feels, even when those beliefs go unspoken and unacknowledged.

For his body of work, Professor Al-Ghathami was awarded a 2025 Kuwait Prize for Literature and Arts in the Arab World.

His theory took shape gradually, beginning when he left Saudi Arabia in 1971 to pursue his doctorate at the University of Exeter in Britain. There, he learned English and immersed himself in the works of English philosophers and poets. This triggered something unexpected: when he returned to the Arabic books he had read as a child, he saw them differently. "Adding another language in your mind makes you see things you didn't see within your language," he said. "Like reading yourself in another mirror."

That new perspective led him to notice connections between Arabic literary theory — much of it centuries old — and the ideas of English thinkers who had independently arrived at remarkably similar conclusions.

But observing their thinking from this dual vantage point also prompted Professor Al-Ghathami to develop his own ideas about how language and culture shape each other. "It's not in English, it's not in Arabic, it's my work," he said. "But based on these two."

His concept revolves around the idea that language often conceals as much as it reveals. Just as a poet uses a metaphor to place one meaning in the foreground while another lurks beneath — or just as a slip of the tongue can expose what lies beneath our conscious thoughts, as psychoanalysts since Freud have long argued — public speech is filled with unspoken assumptions that reflect the deeper values and anxieties of entire societies.

As an example Professor Al-Ghathami offered an incident from 2018 when a member of the British Parliament muttered "stupid woman" in the direction of then-Prime Minister Theresa May. The comment caused an uproar, with many Britons feeling that the words amounted to an attack on all women, not just the prime minister. But why, asked Al-Ghathami. To him, the reaction betrayed a cultural anxiety buried in British society — a collective feeling that women in positions of power are not truly accepted as equals. If the same words had been directed at a man, no one would have assumed the speaker meant all men were stupid, Professor Al-Ghathami explained: "This is what I call the hidden cultural norms."

The question of women and collective speech in particular has long preoccupied Professor Al-Ghatami. Five of his books trace how cultural discourse confined women to a separate, limited sphere, and how those ingrained patterns persisted even after women became educated and began contributing to public discourse themselves. He built out his concept of hidden cultural norms during a teaching career that took him first to King Abdulaziz University in Jeddah, where he helped establish the Arabic Language Department, and later to King Saud University in Riyadh. He was named Cultural Personality of the Year in 2022 at the 16th Sheikh Zayed Book Award, one of the Arab world's most prestigious literary prizes, which is presented annually in Abu Dhabi in conjunction with the Abu Dhabi International Book Fair.

Yet his critical ideas were not always received favourably. Although some critics attacked him, Professor Al-Ghadhami remained unfazed. Of his detractors, he remarked: 'I attributed their criticism to a lack of familiarity with the subject, and this, in turn, became a welcome opportunity to initiate a continuing dialogue.

Now 14 years retired from teaching, Professor Al-Ghathami has no intention of going quiet. "You don't retire from thinking. I wish I could," he said. He still writes an article every two weeks, applying his theory to current events and public figures and has authored a recent piece on U.S. President Donald Trump's speeches. "I keep connecting with the world. I keep watching what's happening."

Whether hidden cultural norms can ever truly change is a question he approaches with doubt. Such norms have been forming for centuries and do not dissolve easily, he noted. But that, he suggested, is not quite the point anyway. The goal is awareness — bringing what is hidden to the surface so it can be examined. "Like a doctor, when he discovers a virus, he must tell us about this virus and you have to deal with it," he said. "I cannot kill the virus. But I can tell people: this is the virus."

In Saudi Arabia, he sees encouraging signs. Since the reforms that began there in 2015, he believes his country has started confronting its hidden cultural norms with new openness. "We are facing them with courage," he said. "This is the greatest achievement."

**His theory, «Hidden Cultural Norms,» argues that beneath the surface of everyday speech lie buried beliefs that lay bare what a society truly thinks and feels**

# Professor Abdelhamid Sayari

## Capturing Carbon, One Molecule at a Time

Last year, the world released roughly 40 billion tons of carbon dioxide — the heat-trapping gas produced by burning coal, oil, or natural gas, and widely recognized as the leading driver of climate change. Since the start of the industrial age, humanity has emitted over 1.5 trillion tons of $CO_2$ into Earth's atmosphere.

In Ottawa, Canada, Professor Abdelhamid Sayari is working to recapture as much of that $CO_2$ as possible. At his laboratory at the University of Ottawa's Department of Chemistry and Biomolecular Sciences, the Tunisian-born chemist has pioneered carbon capture methods for more than two decades. "This is now a completely new industry," said Professor Sayari. "There are dozens and dozens of companies working on

$CO_2$ capture." For his work, the Kuwait Foundation for the Advancement of Sciences has awarded him a 2025 Prize in Environmental Sciences.

In a way, Professor Sayari started at the opposite end of this issue. As a young man, he recalled, he had "100% decided" to study physics. But in his first two years at university — where physics and chemistry students took classes together — he found the chemistry professors far more compelling and switched fields. He turned to porous materials: honeycomb-like solids full of microscopic holes, giving them an enormous internal surface area that made them ideal for accelerating chemical reactions, a process called catalysis. During a postdoctoral fellowship at the University of Pittsburgh in the early 1980s, Professor Sayari used those materials to coax gas mixtures to form liquid hydrocarbons — "making artificial oil," he said.

Then, in 1992, a research group at ExxonMobil published a paper describing a new family of porous materials — more ordered and uniform than any before. Professor Sayari jumped in immediately, spending the next several years learning to synthesize and manipulate these new substances. Before long, he and others in the field began asking what these materials could be used for. For Professor Sayari, the answer was $CO_2$ capture.

At the time, some techniques for capturing $CO_2$ already existed, but solely to purify valuable gases such as natural gas that commonly comes out of the ground mixed with carbon dioxide. The standard approach involved passing the gas mix through a liquid solution laced with chemicals called amines — compounds whose natural affinity for $CO_2$ makes them act almost like molecular flypaper. The $CO_2$ would stick to the amines and get pulled from the gas stream. To release it and reuse the solution, though, engineers had to heat the entire liquid volume — an undertaking that consumed vast amounts of energy. For companies purifying natural gas or hydrogen, the expense was worth it, Professor Sayari explained: those gases were valuable enough to justify the cost. But if the goal was simply to remove $CO_2$ for the climate's sake, the energy costs made the technology unworkable. Liquid amines also tended to break down over time, releasing noxious gases of their own.

Professor Sayari realized he could achieve the same result using porous solid materials. Instead of dissolving amines in water, he found ways to anchor them chemically to the surface of his "Honeycombs." The result was a far less energy-intensive method, said Professor Sayari, whose papers have been cited more than 30,000 times.

The process works in three stages. First, the solid material captures $CO_2$ from whatever gas flows through it, whether industrial exhaust or open air. Second, a burst of steam at about 100 degrees Celsius heats the material just enough to release the $CO_2$ as a pure gas. The steam and $CO_2$ can then be separated simply by cooling: the steam condenses into water, leaving behind pure carbon dioxide ready for storage underground or conversion into other products. Third, cooling the material to start the cycle again.

The key, Professor Sayari said, is choosing the right base material. "It has to immediately react, adsorb very quickly, release very quickly, and last very long." His carbon-capturing "Honeycombs" are made from substances like silica that form the basis of sand and glass.

The approach works so well that companies including Svante in Canada, Climeworks in Switzerland, Carbyon in the Netherlands, and several American firms have built carbon capture technologies around amine-containing solid adsorbents like those Professor Sayari pioneered. The materials can be deployed at the exhaust stacks of power plants and cement factories, among the largest point sources of carbon dioxide. They can also be used for direct air capture: pulling $CO_2$ from the open atmosphere, where it exists at far lower concentrations.

Whether carbon capture can make a meaningful dent in the climate problem, however, will come down to a factor beyond the science: scale. The amount of $CO_2$ humanity releases into the atmosphere every year — those 40 billion tons — dwarfs anything else the world produces. To put it in perspective: The most widely intentionally manufactured

**The key, is choosing the right base material. His carbon-capturing "Honeycombs" are made from substances like silica that form the basis of sand and glass**

**For now, he focuses on making his CO2 -capturing materials as durable as possible and to keep every unit operating for two years, running through 1 million capture-and-release cycles without significant loss of performance**

chemical on Earth is sulfuric acid, a compound used in everything from making fertilizers to processing metals, refining fuels, and producing batteries — which is why factories worldwide churn out hundreds of millions of tons every year. Yet that entire global output pales against the carbon dioxide humanity pumps into the atmosphere, said Professor Sayari: "Every year we release an amount of $CO_2$ equivalent to 150 years of production of sulfuric acid." Recapturing a meaningful fraction of that would likely require thousands of installations worldwide. “To make a real impact, it has to be developed on a very, very large scale,” said Professor Sayari.

For now, he focuses on making his $CO_2$ -capturing materials as durable as possible. The goal is to keep every unit operating for two years, running through 1 million capture-and-release cycles without significant loss of performance. He is also applying similar materials to remove heavy metals from wastewater and pollutants from air — work that accounts for roughly 20% of his research. Professor Sayari is hopeful that carbon capture will make a difference, particularly if paired with deeper cuts in coal and oil burning. He sees momentum building in Europe, Asia, and Canada, even as policy uncertainty has slowed progress elsewhere. "I think we are moving there," he said.

# Professor Noreddine Ghaffour

## Solutions for The World's Freshwater Problem

When Professor Noreddine Ghaffour started working in water desalination, freshwater shortages were a concern in only a handful of regions: the Gulf states, parts of North Africa, and a few other arid zones where scarcity was a fact of life. By now, though, water scarcity has spread to places where no one thought it would ever occur, said Professor Ghaffour. "Even in the North." In Europe, for example, both the United Kingdom and the Netherlands now operate desalination plants.

Unfortunately, today more regions around the world are running out of fresh water. Although water covers roughly 70 percent of Earth's surface, only about 3 percent is fresh, and less than 1 percent of that is easily accessible. Climate change, population growth, and rising consumption are all shrinking available supplies. A 2026 report by the United Nations show that three-quarters of the world's population now live in countries classified as water-insecure, with around four billion people

**Professor Ghaffour and his team recently have developed an ultrathin polymer film that can desalinate water at nearly ambient temperature and pressure, using low-grade thermal energy that can be readily brought from waste heat, solar panels or other renewable sources**

suffering severe water scarcity for at least one month each year.

Fortunately, dedicated researchers are finding new ways to produce fresh water. Professor Ghaffour, who has been a professor since 2010 at King Abdullah University of Science and Technology (KAUST) in Saudi Arabia, runs hundreds of experiments a year in pursuit of better, cheaper, and more flexible approaches to turning unusable water into a water that people can drink, grow food with, or put to industrial use. His work earned him a 2025 Kuwait Prize in Environmental Sciences.

Typically, desalinated freshwater is produced from seawater or brackish water. Two methods have long dominated the field. Reverse osmosis, which forces seawater through a very fine membrane under high pressure, leaving the salt behind, and thermal desalination, which heats seawater until it evaporates, then collects the condensed vapor as fresh water.

For a long time, both approaches came with significant drawbacks. The most significant being an excessive energy consumption. Reverse osmosis requires large amounts of electricity to maintain the pressure required to push freshwater through the membranes while thermal processes demand substantial heat. Moreover, both methods produce brine — a concentrated salty byproduct that has long been thought to harm marine ecosystems if returned to the sea without treatment.

However, newer advances, including some from Professor Ghaffour's and his team, have gone a long way toward addressing these challenges. For example, they have recently developed a membrane — an ultrathin polymer film — that can desalinate water at nearly ambient temperature and pressure, using low-grade thermal energy that can be readily brought from waste heat, solar panels or other renewable sources.

The membrane, which is currently being tested at pilot scale, could enable smaller, decentralized desalination plants. Not only could such plants bring clean water to rural communities that are too remote for conventional desalination, but their smaller scale would ease other challenges, too. "If you have smaller volumes of brine, you can treat it more easily," Professor Ghaffour said.

Additionally, brine may prove less of a threat than once feared. In Australia, which built a fleet of coastal desalination plants during the severe drought of the 2000s, brine became a flashpoint for environmentalists. Nevertheless, divers and researchers have found that long-running plants still have fish around their outfalls, suggesting impacts may be less severe than had been assumed, Professor Ghaffour noted. By now, some experts even see the abundance of minerals in brine as an opportunity rather than a liability. "Brine mining is a hot topic," said Professor Ghaffour.

Some of the approaches Professor Ghaffour is pursuing appear almost counterintuitive. For example: desalinating water only partially. In arid regions, a lot of desalinated water goes to agriculture, but standard desalination strips this water of virtually all dissolved ions — including minerals that are beneficial to plants. Farmers then must add those nutrients back as fertilizer. Professor Ghaffour's team is developing processes that can be tuned to a specific crop, removing only what the plant cannot handle — sodium and chloride, typically — while leaving behind the calcium and magnesium that it needs. Partial desalination will make agriculture water cheaper, said Professor Ghaffour, "because the less you remove the better."

The breadth of his work reflects his wide technical background. He trained originally as a mechanical engineer, then moved into

Properly treated wastewater can serve many purposes in industry and agriculture, reducing the need for desalination without tapping new sources

membrane separation technology during his master's degree and doctoral research at the University of Montpellier in France, and later encountered desalination through an industry project on treating wastewater from oil wells. That grounding in thermodynamics, fluid mechanics, and materials science allows him to approach problems from angles a more specialized researcher might miss. In one collaboration, for example, his team developed a system that captures fresh water from the frost that forms on refrigeration units — recovering a water source while improving the unit's energy efficiency. In 2024, Saudi Arabia granted him citizenship for his contributions to desalination — a rare honor.

He is confident that technology can help ensure the world has the fresh water it needs even as water stress spreads. However, desalination should not be the first resort, he cautioned: Many water crises stemmed from poor management rather than scarcity — not capturing enough rainwater, for example. "We should not go for desalination if we have other, cheaper solutions," he said.

We should also learn to reuse water better, Professor Ghaffour added. Properly treated wastewater can serve many purposes in industry and agriculture, reducing the need for desalination without tapping new sources. While some countries already reuse up to 80 percent of their water, many others are not even close.

"Every drop of water is important," Professor Ghaffour said.

# Professor Ahmad Khalil

## Rewriting the Code of Life

As a boy growing up in New Jersey, Professor Ahmad 'Mo' Khalil dreamed of rockets. He wanted to work in propulsion, in engineering for space. Accordingly, when it came to study, he picked mechanical engineering and chemistry as his subjects at Stanford University, then earned a PhD in mechanical engineering from MIT in Boston. But while he pursued that dream, his father fell ill with cardiovascular disease and underwent surgery. “This opened my eyes to problems in biomedicine and bioengineering,” said Professor Khalil, “and got me thinking about how, as an engineer, I might be able to create interesting new solutions.”

He pivoted to a new path that led him to one of science’s most extraordinary new disciplines. Today, Professor Khalil is the Hok Lam and Kathleen Kam Wong Professor of Bioengineering, and Professor of Molecular and Cellular Biology at Harvard University, where he runs a laboratory devoted to synthetic biology: the fundamental science and application of reprogramming living cells. His work earned him a 2025 Kuwait Prize.

At the heart of synthetic biology is a bold idea: introduce new genetic instructions into a living cell and get it to perform useful tasks or ones that it would never do on its own. Make yeast produce a cancer-fighting antibody, for example. Or engineer a patient’s immune cells to hunt down tumours. It’s a challenging undertaking: a cell “is a constantly evolving and highly dynamic bag of chemical reactions,” Professor Khalil said. Billions of years of evolution have shaped it, and it does not always cooperate with new instructions. The tools that allow scientists to try to program cells at all have been decades in the making. Starting in the 1970s, scientists learned to manipulate DNA; later, improved sequencing technologies enabled them to read the genetic code of virtually every living organism on Earth. “That gave us the catalogue,” said Professor Khalil. Now, his lab and others are using genes found across nature to design new combinations — what Professor Khalil calls genetic circuits — to make cells behave in new and useful ways.

Once the biology bug had bitten Professor Khalil, he did his doctoral work in a lab that engineered viruses to build physical materials such as electrodes. To do this, the researchers exploited the fact that a virus's outer protein coat can bind to specific metals and minerals, allowing vast numbers of them to self-assemble in solution into living scaffolds around which useful materials grow. Professor Khalil then did his postdoctoral work with Jim Collins at Boston

University, one of the founders of the synthetic biology field, before joining BU's faculty for 12 years. He moved to Harvard in 2025.

Today, his lab has three main research areas. The first involves yeast — the same organism responsible for beer, bread, and wine. Professor Khalil's team inserts genetic circuits into yeast, turning it into a discovery machine. Say researchers want to find a molecule that binds to a specific protein on the surface of a cell. They insert genetic instructions that prompt yeast cells to produce a variety of molecules. If any of them bind to the target protein, the genetic instructions can trigger the yeast cell to produce a fluorescent substance, making it glow. Because yeast reproduces quickly and can be grown by the billions, researchers can simultaneously screen an enormous number of candidate molecules, then simply collect the glowing cells and study what they made. Professor Khalil and his team are using this approach to find antibodies for cancer treatments. He co-founded a company called Eira Bio, based in San Francisco, that aims to develop such antibody-based therapies.

Professor Khalil's second area of research also targets cancer, but through cellular immunotherapy, specifically CAR-T cell therapy. The concept works like this: doctors take immune cells from a cancer patient's own blood, genetically modify them outside the body to carry a new receptor — a kind of microscopic antenna on the cell's surface that recognizes and grabs onto cancer cells — and then return them to the patient's bloodstream. Once inside the patient, the redesigned cells seek out and attack tumours. The approach "has shown some really remarkable results in certain types of cancers," said Professor Khalil. But CAR-T therapy does not yet work for all cancers, and reintroducing the modified cells can provoke dangerous immune reactions. Professor Khalil's lab is developing genetic circuits to make the engineered immune cells more effective and safer. He is also looking beyond T cells to other immune system components — including macrophages and NK cells — hoping to deploy a broader arsenal of cells against cancer.

The third and newest focus area is plants. By 2050, Earth's population is projected to hit 10 billion, and farmers may need to at least double their output to keep everybody fed. Meanwhile, climate change is destabilizing agriculture systems worldwide. "I believe that bringing new ideas and new technologies to plants is going to be very important," said Professor Khalil. His team is working to accelerate the development of plant varieties that are, for example, more tolerant of drought. "How do we take what took thousands or even millions or billions of years of evolution and shorten that to get to these interesting plant varietals?" he asked.

Professor Khalil, who grew up Palestinian-Jordanian and whose family moved frequently in the Middle East before settling in the United States, feels proud to represent Arab researchers and to receive the Kuwait Prize. "It's a wonderful thing to recognize Kuwaiti and Arab scientists around the world," he said of the award. He is quick to credit his team. "This is the result of many years of amazing work of lab members past and present," he said. "I am lucky to be able to work with them."

In the future, Professor Khalil expects artificial intelligence to play an ever-greater role in synthetic biology. High-throughput automated experiments are generating richer biological datasets than ever before — and modern AI models are finding patterns in that complexity that can be used to engineer cells in smarter ways. "That's only really happened in the last three, four years," said Professor Khalil. "It's opening up an interesting direction for how you might begin to engineer that complexity."

**Say researchers want to find a molecule that binds to a specific protein on the surface of a cell. They insert genetic instructions that prompt yeast cells to produce a variety of molecules**

**Professor Khalil expects artificial intelligence to play an ever-greater role in synthetic biology**

# Professor Jalal Shatah

## The Order Inside the Chaos

When Professor Jalal Shatah was in first grade, a worried teacher pulled his mother aside at a parent-teacher conference. She had taught all four of Professor Shatah's siblings and feared that Jalal — the youngest — would not match the others academically. In particular, the teacher felt, Jalal would not be good at math.

"My mother was upset," Professor Shatah said.

He recalled the story with a twinkle in his eyes, sitting in his office at the Courant Institute of Mathematical Sciences at New York University. The Courant is widely regarded as one of the world's top mathematics centers, and Professor Shatah has worked there for more than four decades as a leading authority on wave turbulence and nonlinear partial differential equations — advanced mathematical formulas used to describe how complex waves and motions evolve over space and time. His foundational contributions to mathematics earned him a 2025 Kuwait Prize.

The passion for mathematics gripped Professor Shatah about two years after that parent-teacher conference. In third grade, he realized the subject always had exactly one right answer. Other subjects at school often felt subjective to him — open to interpretation, endlessly arguable. Mathematics was not. "I love ordering things, I don't like uncertainty," Professor Shatah said. To the young Jalal, math's precision felt like solid ground.

After high school, he wanted to study mathematics, but his family pushed him toward a more practical field with steadier job prospects. It was the mid-1970s, during the Middle East oil boom, and Professor Shatah applied for a spot in engineering at the American University of Beirut.

Then the civil war broke out, and he fled. He found himself a refugee in the United States, studying electrical engineering at the University of Texas at Austin. "But math kept pulling me in," he recalled. "I could not stand not doing math." He added a second major to his studies. "Engineering to satisfy the family and math to satisfy myself," he said. To save money, he finished both degrees in just three years.

A scholarship took him to Brown University in Providence, Rhode Island, where he earned a master's degree in applied mathematics in 1981 and a doctorate in 1983. Then came a postdoctoral position at the Courant Institute in New York City, an institution with almost mythological appeal for Professor Shatah. It was founded by Richard Courant, a German Jewish mathematician who trained under David Hilbert in Göttingen — one of history's great centers of mathematical thought — before fleeing Nazi Germany and rebuilding that tradition in New York. "It was my dream to come here," Professor Shatah said. The first time he walked through the doors, he declared: "I'm not leaving this place for the rest of my life." That was 43 years ago. Over those years, he rose through the faculty ranks, served as chair of the mathematics department and as deputy director of the institute, and in 2019 earned the Silver Chair in Mathematics, one of New York University's highest academic honors.

During his electrical engineering studies, Professor Shatah had become familiar with electromagnetic waves and, through them, Fourier analysis — the mathematical technique for decomposing complex signals into their component frequencies. He found it captivating. When he turned to mathematics as a discipline, he kept studying waves across different fields, including plasma physics and fluid dynamics. A central focus has been to understand how waves interact when they don't simply add up neatly but push and pull on one another — canceling each other out or reinforcing each other, the way a push at just the right moment sends a child on a swing soaring, while a poorly timed push barely moves them. Mathematicians call these moments of perfect timing resonances, and understanding how they arise and how they shape waves over time, is, Professor Shatah said, "probably the thing I am best known for in my work." Although his contributions to nonlinear wave theory range considerably wider, from questions of when waves remain stable, to whether equations describing them can be solved cleanly, to the geometry of surface waves. Ocean waves, in particular, have drawn much of his attention in recent years. To most people, the ocean looks like pure disorder, with waves churning and crossing in every direction. Professor Shatah sees something entirely different. "It's very funny because many people think, oh, you work in turbulence and chaotic behavior. This is uncertainty. No, no, no," he said. "I look at these waves and I say: the waves are not interacting randomly. They are interacting because of arithmetic."

This strand of his work connects directly to pressing questions in climate science. In the ocean, internal waves — slow-moving formations that can be hundreds of kilometers long and travel through the ocean's depths — play a crucial role in mixing water masses. They also carry trillions of watts of energy across vast distances, shaping how the ocean distributes heat around the planet. But no climate model can yet directly capture these processes. One of Professor Shatah's goals has been to explain how the statistical patterns observed in the ocean emerge from the underlying wave dynamics.

He is awed by how mathematics can build bridges across cultures and centuries. At some point, he looked up what he called his

**He rose through the faculty ranks, served as Chair of the mathematics department, Deputy director of the institute, and in 2019 earned the Silver Chair in Mathematics; one of New York University's highest academic honors**

**A central focus has been to understand how waves interact when they don't simply add up neatly but push and pull on one another**

"mathematical genealogy" — the chains of teachers and students stretching back across the centuries that link his work to scholars of the distant past. "The fact that I can relate what I'm doing right now to things that have been going on for 5,000 years — this continuity is, for me, an amazing feeling. I'm connected to Bukhari, I'm connected to Ibn Yunus," he said, naming Islamic mathematicians who studied harmonics nearly 1,000 years ago. That the Kuwait Prize comes from the region he grew up in, and from the same part of the world as the mathematicians in his own genealogy, makes the recognition especially resonant. "After 900 years or so, to be coming back full circle," he said, "it is very meaningful to me."

As for the first-grade teacher who was so worried about him? Professor Shatah said she became one of his biggest fans.

# Professor Mohammed Bamyeh

## Why the Arab World Needs Its Own Social Science

Since growing up Palestinian in Lebanon, Professor Mohammed Bamyeh has lived in 18 cities across four continents, including in two civil wars and two revolutions. Early on, he realized that the standard explanations for social turmoil didn't satisfy him — they were often too pat, too simple. So Professor Bamyeh became a sociologist. He considered sociology to be "the one science" for analyzing the complexities of reality. "For me, it was the broadest social science," said Professor Bamyeh, now one of the leading scholars of the Arab world. "Within it, you can analyze political developments, economic developments, cultural transformations."

By now, Professor Bamyeh has written major books on globalization, the origins of Islam, anarchism, and the Arab uprisings, drawing on anthropology, political science, history, literature, and even cinema. He has served as president of the Arab Council for the Social Sciences. And he remains convinced that sociology — done right — is an urgent practical necessity, especially in a region where the problems it could address are both entrenched and profound. Sociology helps people understand their reality at a more informed level and make better decisions about how they live and how they want to live, Professor Bamyeh says.

Currently a professor at the University of Pittsburgh in the United States, Professor Bamyeh has watched societies fracture during the Arab uprisings of 2011, then struggle to rebuild. Revolutions, he has concluded, are fundamentally communicative events. They begin when people from different classes, age groups, and regions learn to talk to each other. The opening phase succeeds when this coalition manages to express a broad social consensus — something approaching 75% of the population, by Professor Bamyeh's reckoning.

But problems usually follow. "It is easy to have consensus about what you are against," he said, "but not really about what you want to replace it with." Once the initial goal — removing a head of regime — is accomplished, the groups that made up the movement often turn on each other, and the revolt can collapse into civil war, as happened in several countries after the Arab spring. Sociology, Professor Bamyeh believes, can help societies learn from such failures. "It is this distance between what we expect, what we hope to accomplish, and our incapacity to get there — this is where sociology comes in. Why it didn't work, and how you can do it better."

The uprisings during the Arab spring grew out of the region's underlying problems — unaccountable governance, extreme inequality, and an inability to achieve the integration its shared language and history would seem to allow — all of which remain unresolved today, Professor Bamyeh notes. Yet although social science is, by his estimation, among the tools best suited to address these issues, they remain largely underused. In much of the Arab world, social science is rarely

**«If it is social,...it has to live in society as well»**

consulted, he says — and sometimes not even funded or taught.

He has spent much of the last decade studying the state of the social sciences in the Arab world, first as lead author of a landmark 2015 report for the Arab Council for the Social Sciences, and now completing a fifth report. The picture that has emerged from these reports is one of uneven development and persistent blind spots. While North African countries like Morocco and Tunisia have relatively established social science traditions and more academic freedom, countries like Iraq and Egypt have seen strong traditions disrupted by wars, sanctions, or government repression. In parts of the Gulf, universities have long functioned as prestige objects rather than sources of knowledge.

The neglect extends beyond sociology. "For example, we are told that Arab societies are conservative and traditional — that is propaganda, but that is what we are told," said Professor Bamyeh. "But the science that actually studies traditions, mainly anthropology, is the least represented social science in Arab universities." History programs are also underrepresented — something he finds curious, given how often Arab societies hear that their history defines them.

Three things, Professor Bamyeh argues, are necessary for social science to take root: a regionally integrated scholarly community that allows researchers in one country to engage with peers across the region; institutional continuity, so that scholars stay long enough in one place to build traditions and train students; and a strong civil society that uses and produces social science outside university walls. "If it is social," he said, "it has to live in society as well."

Rating systems, which many countries have adopted with the stated goal of improving institutions of higher learning, he finds counterproductive at best. Comparing a university in Benghazi to Harvard is meaningless, Professor Bamyeh argues — the only useful measure is the role a university plays in its own environment. Instead, rankings teach administrators the wrong habits, pulling their attention away from what works toward a number that may have little to do with their institution's real value. "I really wish that we just get rid of this ranking obsession," he said, arguing that it only serves to reestablish global hierarchies. "That is the colonial mentality that we have been living with all our life."

When social science is sidelined, it leaves a vacuum that other forces rush to fill, Professor Bamyeh warns. "The interpretation of our culture or history is left over to extremist groups or to serve narrow politicized interests, "So the marginalization of social sciences exposes society to dangerous trends."

But Professor Bamyeh also sees reasons for hope, mostly among the young. In recent years, he has received far more invitations to speak at youth forums, reading circles, and debate clubs — most of which did not exist before the 2011 uprisings. "There is a thirst for knowledge," he said, and a dawning understanding that going into the street and protesting isn't enough.

Whether more revolutions are coming, he isn't sure. But something, he believes, is shifting. "The last thing revolutions change is the political system," he said. "The first thing they change is the culture. People, especially the young, begin to ask new questions."


As part of its ongoing commitment to supporting scientific research and advancing the role of young scientists

# KFAS has announced the winners of the Jaber Al-Ahmad Award for Young Researchers 2025

**Jaber Al-Ahmad Award for Young Researchers established in 1988 and remains a leading national platform for celebrating promising scientific talent**

As part of its ongoing commitment to supporting scientific research and advancing the role of young scientists, the Kuwait Foundation for the Advancement of Sciences (KFAS) has announced the winners of the 36th edition (2025) of the Jaber Al-Ahmad Award for Young Researchers. This prestigious award is considered one of the leading national initiatives dedicated to recognizing outstanding Kuwaiti researchers and encouraging innovation and knowledge production.

The award is presented annually to Kuwaiti PhD (or its equivalent) holders in recognition of their distinguished contributions to their respective fields, underscoring the vital role of scientific research in promoting sustainable development and building a knowledge-based economy.

This year's edition covered six major scientific fields, reflecting the diversity and significance of research efforts in serving society.

In the field of engineering sciences, the award was granted to Dr. Yousef Saad Al-Qaheem, a researcher at the Petroleum Research Center of the Kuwait Institute for Scientific Research, in recognition of his contributions to developing applied engineering solutions that support the oil and gas sectors, enhancing operational efficiency and addressing technical challenges in this critical industry.

In the field of natural sciences and mathematics, the award was granted to Professor Dr. Yousef Abdullah Al-Khazi, in recognition of his pioneering research in mathematics, as well as his contributions to advancing the educational process, demonstrating the integration of academic research with educational practice.

In the field of social sciences and humanities, the award was granted to Dr. Aisha Ahmed Al-Azmi for her research contributions that help develop educational policies and improve the efficiency of educational systems—an area of growing importance amid the challenges facing modern education.

In the field of biological sciences, the award was granted to Prof. Hussein Mehdi Behbehani for his outstanding scientific contributions and advanced research, which contributed to expanding scientific knowledge and deepening understanding in the biological sciences.

Through this award, KFAS reaffirms its strong commitment to supporting Kuwaiti researchers and fostering an enabling environment for continued scientific excellence, ultimately contributing to societal progress and prosperity.

It is worth noting that the Jaber Al-Ahmad Award for Young Researchers was established in 1988 on the initiative of the late Amir Sheikh Jaber Al-Ahmad Al-Jaber Al-Sabah. The award aims of recognizing young Kuwaiti scientists and encouraging excellence and innovation.

It remains a leading national platform for celebrating promising scientific talent.

Most people get math all wrong. “The most common misconception is that mathematics is essentially about calculation — that being good at mathematics means being fast with numbers,” said Yousuf Al-Khezi, a full professor of mathematics at the Public Authority for Applied Education and Training (PAAET)- College of Basic Education (CBE). “In reality, professional mathematics has very little to do with arithmetic.”

What mathematicians actually spend most of their time doing, Al-Khezi explained, is constructing arguments, identifying patterns, and figuring out why things are true. “Doing mathematics is much closer to artistic or philosophical thinking than most people would expect,” he said.

This may sound abstract, yet mathematics touches all of us. Mathematical insights shape how engineers design safer bridges, how doctors reconstruct images from MRI scans, how search engines rank results, and how banks secure transactions. Disease outbreaks are modeled with mathematics. So are traffic flows, weather systems, and the algorithms behind artificial intelligence. “Mathematics research matters because it builds the framework behind better decisions, better technologies, and deeper understanding of the world,” said Al-Khezi.

# Professor Yousuf Al-Khezi

## Studying the Beautifully Simple Structures Underneath Complexity

His own love for the field developed, driven by a teacher who presented mathematics as a way of thinking rather than a set of formulas. Al-Khezi began to admire mathematics' inner logic and consistency, marvelling how each step in a proof inevitably led to a conclusion. He realized that different areas of math, like algebra and geometry, are deeply connected — like different views of the same landscape. "I'm fascinated by the idea that complex systems often hide beautifully simple structures underneath — whether that's symmetry in geometry or patterns in number theory. There's something deeply satisfying about uncovering an elegant principle that was always there, just not immediately visible," he said.

After earning his undergraduate degree at Kuwait University, Al-Khezi pursued a Master's degree at Bowling Green State University in Ohio - USA and then a doctorate at the University of Texas at Arlington - USA, where he specialized in algebra. He returned to Kuwait in 2015 and has been on the mathematics faculty at PAAET – College of Basic Education ever since, now also serving as Chair of both the Mathematics and Science Departments at the College of Basic Education. He received a 2025 Jaber Al-Ahmad Prize for Young Researchers in Natural and Mathematical Sciences.

Much of his research focuses on three closely linked areas of pure mathematics: commutative algebra, homological algebra, and tensor products.

For all their abstraction, these fields sit at the heart of technologies that many people encounter every day. Algebraic structures studied in commutative algebra underlie the encryption systems that secure online banking and private messages. Homological ideas power techniques that detect hidden patterns — loops and voids — in large, messy data sets, a method now used in fields from cancer research to materials science. And tensor structures are woven into the inner workings of the AI models that

**Mathematical insights shape how engineers design safer bridges, how doctors reconstruct images from MRI scans, how search engines rank results, and how banks secure transactions**

have become part of daily life, from voice assistants to image recognition.

Al-Khezi's more recent work has extended into so-called fractional partial differential equations — advanced mathematical tools used to model fluid flow, heat transfer, and wave propagation. He has also conducted research on encryption and digital signatures, and on image inpainting: the mathematical process by which damaged or incomplete images are repaired.

For Al-Khezi, the gap between mathematics' abstract nature and its real-life applications is one of the field's greatest charms. "Mathematics doesn't set out to be useful," he said, "and yet it almost always becomes useful, often in ways that weren't anticipated when the theory was first developed." It's something he finds deeply motivating.

He also loves how creative the discipline is. Mathematics was widely perceived as cold and mechanical, he said: follow the rules, arrive at the answer. But in practice, intuition played a central role, especially in research. "Before you can write a rigorous proof, you usually need a feeling for why something should be true," said Al-Khezi. "Two mathematicians can solve the same problem through completely different approaches and both be correct, which I find genuinely exciting."

It is a deeply social undertaking, he stressed. "Ideas develop through conversation, seminars, and collaboration, often across very different subfields. Some of the most interesting progress happens at the boundaries between areas that weren't previously connected."

As Al-Khezi noted, much of the field remains to be explored: "Mathematics is not a finished subject. There are fundamental questions that remain completely open, some of which have resisted the efforts of the best mathematical minds for centuries. The subject is very much alive."

# Dr. Ayeshah Ahmed Alazmi

## Kuwait's Teachers, Ready to Lead

When rockets started falling within range of Kuwait at the start of the Iran war in February 2026, the government made an urgent decision: children would no longer go to school in person. Overnight, the country's entire public education system moved online – just as it had years earlier during the COVID-19 pandemic.

What happened next didn't surprise Ayeshah Ahmed Alazmi, an associate professor of educational administration at Kuwait University. The teachers, she said, rose to the occasion. They began organizing informal training sessions and devising new ways to reach their students. They were improvising and thriving, much as they had during the pandemic, when Alazmi watched teachers seize "the leader's opportunity."

Alazmi studies educational leadership, law, and policy — work that has earned her a 2025 Jaber Al-Ahmad Prize for Young Researchers — but she also draws on a more direct source of knowledge: her own years in the classroom. Education runs in her family – her mother was a school principal – and after earning a B.A. in Education from Kuwait University, Alazmi spent six years teaching high school biology and chemistry before pursuing a master's degree in education administration.

While doing so, a mentor and inspire—Professor Abdulmuhsen Ayedh Al-Qahtani — encouraged her to pursue a doctoral program in the United States focused on a field that barely existed in the Middle East at the time: educational law. Alazmi enrolled at Virginia Tech under David Alexander, among the world's leading authorities on the subject. "My degree was the first Ph.D. in the Middle East related to school law," Alazmi said.

She came home to a system in need of new thinking. Kuwait spent roughly 10 to 12% of its national income on education — a share that exceeded that in many other nations, said Alazmi. Yet Kuwaiti students have long underperformed their peers in other Gulf states in subjects like math and science, and many struggle with reading comprehension even in the upper grades.

Multiple reforms have been tried and abandoned. In recent years, growing numbers of Kuwaiti parents have turned to private schools instead. Twenty years ago, only about 10% of Kuwaiti children attended private schools, Alazmi noted. Today that figure had Increased. The main draw, she said, was language: private schools teach primarily in English, and parents want their children to emerge fluent. Alazmi has children in both systems for that very reason. Her older kids, who were with her in the USA, returned to Kuwait struggling with Arabic. They now attend private institutions, while her younger children are in public school.

Beyond language, private schools also shine in what Alazmi sees as Kuwait's public schools' one central weakness: an almost exclusive reliance on exams that reward rote memorization over understanding. As a result, experts have found, students who may sail through primary and high school with strong grades may still struggle when they reach university, having never developed the comprehension, analytical, and independent reasoning skills that higher education demands.

In private schools, a student's grades are built largely from projects, assignments, and presentations — work that requires sustained thinking and self-expression. "Only 20%, or sometimes 30%, of their grade depends on tests," Alazmi said.

That exam culture is an outgrowth of the very structure Alazmi studied during her pioneering doctorate: Kuwait's education law concentrates authority at the top, with the Ministry of Education controlling curricula, teacher evaluation, and school budgets, leaving principals with limited room to maneuver and teachers with even less. "We have very little space to control our system within the school," Alazmi said.

She is convinced that giving teachers more say over how they run their classrooms would significantly strengthen Kuwait's public schools. "Teachers are the main core of education," she said. "Building their leadership skills will affect the entire system."

Paradoxically, the Iran war and its threat of rocket fire have already brought teachers some of the freedoms Alazmi believes are needed. Released from the confines of their physical classrooms – and some of the rules that came with them – Kuwaiti teachers began to experiment with pedagogy. Many built more collaborative learning environments. Some started making videos; others leaned into AI tools or invented songs to help students absorb language lessons.

Alazmi watched the effects at home, where her children were learning to build presentations, create digital content and use online


platforms — none of it part of the standard curriculum. "Our kids now learn more skills than before," she said. “What's happening now and what happened during COVID-19 gives us signs that our teachers are capable of being very good leaders.”

Alazmi is now optimistic about the future of public education in Kuwait. For most of her career, the system has seemed unstable — Kuwait's education ministry changed hands six times in a single decade, each new minister arriving with a fresh vision, then departing before it could take root. There were stretches, she recalled, when “we used to change our minister every six months.”

Now it feels different. The country has a new president and, with him, a Minister of Education whom Alazmi described as clear-eyed and serious and who has laid out a concrete agenda: modernizing curricula, introducing competency-based learning, and strengthening school leadership. These are central pillars of Kuwait’s Vision 2035, the country's long-term development roadmap, which has set improving education quality as one of its core goals.

Recently, the Minister of Education has invited Alazmi to discuss her work. She has come away feeling heard. "My research is taken and discussed," she said. She sees good decisions being made, and it inspires her: "I will work harder for my country Kuwait."

**Modernizing curricula, Introducing competency-based learning, and Strengthening school leadership, are central pillars of Kuwait’s Vision 2035**

# Dr. Yousef Alqaheem

## The Membranes Cleaning Kuwait's Gas

Kuwait's oil and gas wealth traces back roughly 100 to 150 million years ago, to when the region lay beneath a warm, shallow sea teeming with marine life. As organisms died and sank, their remains accumulated in thick layers on the seafloor. Over millions of years, heat and pressure cooked that organic matter into fossil fuels. The process preserved a kind of chemical memory of the ancient ocean above. Because those waters, like modern seawater, contained abundant dissolved sulfates and the conditions on the seafloor helped to preserve them, the oil and gas that formed ended up rich in sulfur compounds.

Today, Kuwait holds a little over 100 billion barrels of proven oil reserves — around 6% of the global total — placing it among the world's top reserve holders, alongside Venezuela, Saudi Arabia, Iran, Iraq, the UAE and Canada. And while the natural gas that rises alongside crude oil was once often burned off at the wellhead, it is now increasingly recognized as a valuable resource in its own right. Properly treated and processed, it can fuel power plants and heating systems, be sold commercially, or be fed back into industrial processes.

But the legacy of the prehistoric ocean creates complications for Kuwait's gas. In addition to the sulfur compound it contains, called hydrogen sulfide, it also holds notable amounts of carbon dioxide. Both of these gases are acidic — they react with water to form corrosive acids — creating what engineers call sour gas. Left


untreated, these impurities corrode pipelines. Being toxic, hydrogen sulfide also poses hazards for workers and can pollute the air.

Yousef Alqaheem, a research scientist at the Kuwait Institute for Scientific Research (KISR), has spent more than a decade developing a solution to this challenge. His focus is on polymer membranes: thin, flexible sheets of engineered material that act as molecular filters. "It lets some gases pass through and rejects others," he said. By selecting the right membrane material and configuring it correctly, engineers can strip out hydrogen sulfide and carbon dioxide from natural gas while letting its useful parts — mainly methane and other light hydrocarbons that we use for heat and power — pass through. For his research, Alqaheem received a 2025 Jaber Al-Ahmad Prize.

His path to this work began with a love of chemistry that emerged in high school and carried him through a bachelor's, master's, and doctoral degree — all in chemical engineering. He joined KISR in 2010, and the institute encouraged him to pursue his PhD at Newcastle University in the United Kingdom, focusing on gas separation using membranes. Back in Kuwait, he built up a laboratory at KISR to further refine this technology and run process simulations. Membrane units that he tested are now operating in Kuwaiti refineries, pulling

**The natural gas that rises alongside crude oil was once often burned off at the wellhead, it is now increasingly recognized as a valuable resource in its own right**

hydrogen from gas flows. In the future, Alqaheem hopes to push the technology further upstream — to the wellhead and the moment gas first emerges from the ground.

His membranes are designed to replace — or supplement — the conventional treatment processes that Kuwait's gas-gathering centers rely on. Today, gas-gathering centers typically treat sour gas through amine scrubbing, a chemical process in which the gas is washed with a solvent that absorbs hydrogen sulfide and carbon dioxide. Additionally, the gas is passed through a dehydrator, which contains chemicals that latch onto water molecules — much like a molecular sponge — thereby stripping moisture from the gas before it can form corrosive acids in pipelines.

These processes are energy-intensive, require large installations, and generate liquid and solid toxic waste streams that must be carefully managed and disposed of. They also take considerable time and capital to set up.

The membranes, by contrast, are compact and can be integrated into an existing facility easily. The membranes themselves require little maintenance and operate without chemical solvents. This means they produce no toxic liquid or solid waste. The technology "is environmentally-friendly, there is no harm coming from the membrane," Alqaheem said.

In his modeling and economic assessment, Alqaheem found that membranes can be profitable for the refinery by recycling hydrogen


from the hydrotreatment unit instead of producing a fresh hydrogen stream. The membrane payback period was only 4 months, and for this reason, the membrane unit has already been installed in Kuwait.

Despite the benefits the membrane provides, there are still some challenges. Because they are made from polymer materials — essentially plastic — they cannot withstand temperatures above roughly 80 degrees Celsius. They also struggle under very high pressure (>175 bar). In some settings, that means that the gas stream must be pre-cooled and/or relieved before it reaches the membrane, said Alqaheem. But his team is working on a patent to push those thresholds higher.

With their molecular filtering abilities, the membranes could even help reverse climate change. Kuwait has pledged to achieve zero carbon emissions by 2050, while aiming to raise oil production capacity to around 4 million barrels per day by the mid-2030s and also significantly increase gas output by 2040. Conventional methods alone could not achieve Kuwait's 2050 zero-emissions goal, Alqaheem said. "We have to implement new technologies."

He has been pushing to adapt his membrane to capture $CO_2$, the gas that drives much of the climate change. Technologically, capturing $CO_2$ with membranes is already possible. But the costs remain prohibitive, he acknowledged. "That is one challenge we want to overcome."

His team is now experimenting with sustainable alternatives for producing the membranes. Instead of creating them from petroleum-derived polymers — the current standard — Alqaheem is, for example, considering coconut shells and sugarcanes, which can be ground into powder and then heated to make the membranes. These bio-carbon membranes offer better separation performance and a longer lifespan, therefore reducing operating cost.

If it works, the ancient chemistry that loaded Kuwait's petroleum with sulfur may ultimately be countered by a membrane made from a plant that thrives in the same tropical heat that once warmed Kuwait's prehistoric sea. But the technology needs to become cost-effective, Alqaheem knows. Otherwise, the industry won't advance.

**By selecting the right membrane material and configuring it correctly, engineers can strip out hydrogen sulfide and carbon dioxide from natural gas while letting its useful parts**

# Professor Hussain Bahbahani

## Reading the Genome of the Desert's Defining Animal

No one can pinpoint exactly when dromedary camels arrived on the Arabian Peninsula, but these humped animals undoubtedly dramatically shaped the civilizations that took root there. The ancient Arab writer al-Jahiz is said to have called the camel "the complete animal" of the desert — almost miraculously suited to a landscape that defeats other large creatures. While humans begin to falter after losing five percent of their body weight to dehydration, a camel can go up to a month without drinking, shed more than a quarter of its body weight in fluids, and then rehydrate by consuming up to 110 liters of water in 10 minutes.

It can also let its body temperature climb from 34 to over 40 degrees Celsius, which reduces its sweating, since a hotter body requires less evaporative cooling. Able to live on sparse, spiny vegetation, camels can carry loads of several hundred pounds across terrain where wheeled vehicles founder — making settlement possible and trade routes viable long before a single road was built.

But how did camels acquire the ability to concentrate their urine down to such a level that it becomes three times saltier than seawater? How do genes govern the fat stored in their iconic hump, or establish the two rows of lashes that protect their eyes from the sand that desert winds kick up? These are the questions driving the work of Prof. Hussain Bahbahani, a geneticist and professor at Kuwait University, who studies population genomics in livestock — a field that compares DNA across large groups of animals to reveal how evolution has shaped their genetic code. For his research, he received a 2025 Jaber Al-Ahmad Prize.

Like many Kuwaitis today, Prof. Bahbahani has little personal connection with camels beyond the occasional desert camping trip in winter, when the weather turns cool enough to venture out and camels roam visibly across the open terrain. Unsurprisingly, then, he came to study this animal by a roundabout path.

As a doctoral student at the University of Nottingham in the United Kingdom, Prof. Bahbahani studied how African cattle populations had genetically adapted to their local environments. After graduating, a close collaborator, Prof. Faisal Almathen of King Faisal University in Saudi Arabia, urged Prof. Bahbahani to turn his bioinformatic expertise toward a new subject. “Let’s study something that all the Arabian Gulf countries will get the benefit of,” Prof. Bahbahani recalled Prof. Almathen suggesting. “The symbol of our countries. That is the camel, of course.”

Although trucks and airplanes have now long since replaced camels as the primary means of transport across the Arabian Peninsula, they are still widely kept – for racing but also for their milk, meat, and hides. Camel milk was now even used to produce chocolate, Prof. Bahbahani noted.

Their role as livestock made it imperative to decode their genes, he argued: “To have food security, you need to better understand your domestic species,” he said.

With collaborators, Prof. Bahbahani set out to conduct the first whole-genome analysis of dromedary populations across the Arabian Peninsula. He quickly ran into an obstacle. "Camel owners usually don't like people touching their camels with needles," he learned. To obtain the blood samples he needed, he enlisted veterinarians, whose presence the owners were more willing to accept. Eventually, he and his team assembled samples from 12 distinct camel populations across Kuwait, Saudi Arabia, and Oman.

By sequencing and comparing the full genomes of these dromedaries, Prof. Bahbahani established that the Arabian camels fall into four broad genetic groups that correspond to different parts of the Peninsula, though with considerable intermingling. The pattern seems to fit with the Peninsula’s long history of caravan trade and the movement of animals during religious pilgrimages. The team also identified regions where evolution has acted most forcefully: sections of DNA that show signs of positive selection, likely because they conferred a survival advantage.

Among them were regions containing genes related to kidney function and, by extension, water conservation. The team also found genes associated with, for example, fertility (which can be a challenge for many species

**Prof. Bahbahani›s research has identified genes linked to cartilage development and muscle strength that show signs of positive selection**

**Prof. Bahbahani would like to see camel owners follow the lead of many cattle and sheep farmers by running formal breeding programs guided by DNA profiles to predict which animals will be the best producers of milk and meat, or the fastest racers**

under heat stress), immunity, eyesight, and neurological pathways related to brain development, which may help underpin dromedaries' famous spatial memory when navigating vast and featureless deserts.

"These are interesting biological pathways that may relate to the camel's adaptation to its environment," Prof. Bahbahani said.

Recently, he has turned his attention to a particular subset of camels: those bred for racing. Although camel racing is deeply embedded in Gulf culture and carries considerable prize money, breeders have so far relied mainly on a camel's appearance and its race history – rather than its genetics – when deciding which animals to mate.

Genomics, Prof. Bahbahani believes, could offer a more reliable guide. His research has identified genes linked to cartilage development and muscle strength that show signs of positive selection. In other words: These traits may well relate to running performance, though more research is needed to confirm the connection.

Scientific interest in camels is growing, Prof. Bahbahani noted. Researchers across the Gulf are now studying these animals from multiple angles, from how their bodies function and are built to the chemistry of their milk. Yet whole-genome analysis remained more limited, said Prof. Bahbahani: For that, "we need scientists with good training in bioinformatic tools. This is the missing part."

He would like to see camel owners follow the lead of many cattle and sheep farmers by running formal breeding programs guided by DNA profiles to predict which animals will be the best producers of milk and meat, or the fastest racers. A country cannot rely on imported or exotic livestock alone, he argued. "You don't know what will happen. One day you are able to import these animals, but another day you may not. So you need to raise an indigenous population adapted to your local environment."