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International Center for Chemical and Biological Sciences

KARACHI, PAKISTAN

ICCBS

EXCELLENCE IN SCIENCE

Profiles of Research Institutions in Developing Countries

PUBLISHED IN COLLABORATION WITH

COMSATS

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Published by TWAS, the academy of sciences for the developing world

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ISSN 2222-7385

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Design & Art Direction
Studio Link, Trieste (www.studio-link.it)

Printing
Prism Graphics, Islamabad 2011

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Foreword

For more than a decade, TWAS, the academy of sciences for the developing world, has developed, in collaboration with several other organizations and funding agencies – including the United Nations Development Programme's Special Unit for South-South Cooperation (UNDP-SSC), the Global Environment Facility (GEF), the Packard Foundation and the Science Initiative Group (SIG) – a large number of profiles of scientific institutions of excellence in the developing world. The profiles have been published as books (by Harvard University Press and Kluwer Academic Publishers), as articles (in *Environment Magazine*) and as news stories (in the *TWAS Newsletter*).

To date, more than 150 institutions have been examined. Each profile details how the institution has developed and how its research programmes are organized. Each explores the institution's strengths, probes its weaknesses – and, most importantly – describes how its experience can offer valuable lessons for other institutions seeking to build scientific capacity. With this volume, we warmly welcome a new partner in this effort – the Commission on Science and Technology for Sustainable Development in the South (COMSATS).

A major goal of this decade-long initiative has been to showcase the high level of scientific excellence taking place in the developing world and to illustrate how science is being put to work to address critical social needs in the South. In this way, we hope that our expanding series of 'best practices in the applications of science and technology' can

serve as a valuable blueprint for policy-makers and those involved in the administration and management of national policies and programmes.

The case study that follows – examining the broad-ranging research and training activities of the International Center for Chemical and Biological Sciences (ICBBS) in Karachi, Pakistan – is about one such successful scientific institution.

ICCBS is located in a region that once boasted the world's most eminent scientists and scientific institutions. History shows that scientists from the Islamic world first measured the circumference of the Earth, first mapped the constellations of the stars, and first laid out the basic tenants of the scientific method based on observation, measurement and verifiable proof. The golden age of Islamic science spanned more than 600 years from the 7th to the 13th centuries. But the region subsequently entered a period of decline from which it has never truly recovered.

Today, the level of scientific capacity in countries with predominantly Muslim populations lags far behind not only the level of scientific capacity in the developed world but also the level in many developing countries. For example, according to a 2009 report issued by the Organization of Islamic Cooperation (OIC), *Research and Scientific Development in OIC Countries*, OIC's 57 member states spend on average less than 0.4% of their gross domestic product on research and development, compared to a global average of 1.7%. Throughout the region, there are 402 researchers per one million population, compared to a global average of nearly 1,500. Not surprisingly, similar gaps exist for the number of articles published in peer-reviewed international scientific journals and the number of international patents awarded to technologists in the region.

Yet, there are bright spotlights of encouragement found in countries such as Turkey, Malaysia, Qatar and Iran, where investments in science and technology are rapidly rising, as well as among a growing number of scientific institutions, where scientific capacity and excellence is swiftly growing. Within a region of great diversity, voices of support for science and technology are becoming stronger and more influential in nearly every country.

The International Center for Chemical and Biological Sciences (ICCBS), which is being profiled in the pages that follow, is one of Pakistan's most eminent centres of excellence. Its reputation for scientific research and training extends far beyond the country's borders. Between 2000 and 2008, ICCBS rode the wave of national investment in science and technology to emerge as one of the most prominent research centres for chemistry and biology, not just in the region, but also throughout the developing world.

As Iqbal Choudhary, the director of the ICCBS, notes in the concluding paragraphs of the booklet: The centre's "focus has been on research and training, and that is where it will remain in the years ahead as we seek to create a pillar of scientific capacity-building and excellence in a country and a region where science can and must play a critical role for advancing social and economic well-being."

Daniel Schaffer
TWAS Public Information Officer
Trieste, Italy

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Introduction and Issues

Located in Pakistan's financial centre and largest city, Karachi University's International Center for Chemical and Biological Sciences (ICCBS) is one of the developing world's finest research and training centres in its field.

The large complex, which covers more than 40 hectares, is comprised of 10 research buildings that contain some of the region's most sophisticated laboratory equipment. The complex also includes a residential area with 50 houses, five apartment buildings and an international guesthouse.

ICCBS carries out research, training, product development and service delivery in the chemical, biological and biomedical sciences. The centre also provides diagnostic, analytical and clinical testing for a broad range of clients in both the public and private sectors.

Over the past 40 years, more than 600 students have earned doctorate and master's degrees at the centre. These degree-granting programmes have served as the focal points of ICCBS efforts to provide world-class training to young scientists coming primarily from developing countries, including those belonging to the Organization of Islamic Cooperation (OIC), an international network comprised of 57 Muslim countries.

ICCBS also conducts cutting-edge research for the discovery of clinically important enzymes and antioxidants, explores innovative methodologies for the synthesis of novel proteins, devises effective pharmacological evaluations of bioactive compounds, and seeks to identify new varieties of horticulture plants through applications of biotechnology.

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UNIVERSITY OF KARACHI

• *The University of Karachi was established in 1951, just four years after Pakistan gained independence. Today, with 1,000 faculty members and 25,000 students, it is not only Pakistan's largest university but also one of the country's best. In 2008, the University of Karachi was ranked among the top 300 universities in the world by the QS World University Rankings.*

The urban campus, located in the country's largest city, covers over more than 700 hectares. It is comprised of eight faculties that include the arts, law, medicine and science. It also supports 21 research institutes.

In addition to HEJRIC and PCMD, the university houses the Institute of Marine Sciences, the National Nematological Research Center, the Center for Molecular Genetics, the Institute of Clinical Psychology and the A.Q. Khan Institute of Biotechnology and Genetic Engineering.

The University of Karachi leads the country's institutions of higher education in research output as measured by the number of articles published in international peer-reviewed journals, the number of international patents filed and approved, and the number of academic conferences and workshops held.

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> *"Karachi University's International Center for Chemical and Biological Sciences is one of the developing world's finest research and training centres in its field."*

The centre employs 400 people, including more than 80 researchers with advanced degrees. In addition to their in-house teaching and research responsibilities, many researchers offer fee-based consultancy services to manufacturers and farmers in Pakistan.

ICCBS also oversees an on-going series of short-term, non-degree 'certificate' programmes in subject areas ranging from how to build energy-efficient greenhouses to the testing and analyses of indigenous and novel pharmaceuticals.

In addition, ICCBS directs international conferences, symposia and workshops for participants from Pakistan and abroad on topics ranging from natural products, molecular medicine, spectroscopy, nanotechnology and computational medicinal chemistry.

The ICCBS annual core budget totals USD5.5 million. A portion of the centre's overhead funds is derived from the Husein Ebrahim Jamal (HEJ) Foundation and the Dr. Panjwani Trust. ICCBS also receives USD2 million a year in development funds from the government of Pakistan. These funds are allocated through the country's federal Higher Education Commission (HEC).

Over the past five years, grant funds for research conducted by individual scientists have matched the core budget. In addition, the centre has attracted an additional USD1.5 million a year from abroad for joint research projects that are carried out in collaboration with other scientific institutions.

Atta-ur-Rahman – Pakistan's former minister of science and technology and chair of HEC – currently serves as ICCBS 'chief patron' providing strategic guidance for the centre's broad-ranging goals. Between 1990 and 2002, he was ICCBS director, guiding the centre through a period of unprecedented growth. The current director is Muhammad Iqbal Choudhary, who was Atta-ur-Rahman's student nearly 30 years ago. Pirzada Qasim Raza Siddiqui, vice-chancellor of Karachi University, heads the ICCBS executive board.



The centre enjoys a great deal of autonomy. Its day-to-day activities are largely managed by its director, Muhammad Iqbal Choudhary, who has established a framework of 'shared management' in which each faculty member is assigned responsibility for a specific set of administration tasks in addition to his or her teaching and research responsibilities.

ICCBS has twice won the Islamic Development Banks (IDB) Prize for Science and Technology, which includes a check for USD100,000. In 2004, IDB honoured ICCBS for its contributions to science-based development, especially in Pakistan. In 2010, IDB honoured HEJ Research Institute of Chemistry (HEJRIC), a constituent component of the ICCBS, for its contributions to the field of chemical sciences.

"These were both days of enormous pride for the centre", says Choudhary. "Receiving the most prestigious prize that IDB gives to scientific institutions is a distinct honour. Receiving it twice in six years is unprecedented and truly rewarding."

Current Challenges

Pakistan gained its independence in 1947 following nearly a century of British rule. For more than 50 years following independence, science remained a low priority on the government's agenda as the newly created country struggled to meet the basic needs of its citizens and deal with continual political and religious strife.

However, beginning in 2000, with the support of president Pervez Musharraf, and spurred by initiatives conceived by Atta-ur-Rahman, Pakistan embarked upon an unprecedented effort to improve education and scientific and technological capacity. That effort continued through 2008 when Musharraf stepped down.

Progress during this decade of reform was impressive. For example, the number of scientific publications written by Pakistani scientists in international peer-reviewed journals

SALIMUZZAMAN SIDDIQUI

• ***Salimuzzaman Siddiqui*** *(1897–1994), a renowned natural products chemist, pioneered the isolation of unique chemical compounds from several medicinal plants, including* Azadirachta indica *(neem), which is used as a pesticide plant, and* Rauwolfia serpentina *(snakeroot), which provides for the treatment of heart disease and hypertension. Born in 1897 near Lucknow, then under British rule, Siddiqui earned his doctorate in organic chemistry from Frankfurt University in Germany in 1927. Upon graduation, he briefly worked as a researcher at the Indian Institute of Technology (ITT) in Bangalore, before joining the Ayurvedic and Unani Tibi Research Institute in Delhi in 1929.*

Following Pakistan's independence in 1947, Siddiqui remained in India as director of the Indian Council of Scientific and Industrial Research (CSIR), a post to which he had been appointed in 1940. In 1951, however, he heeded the call of Pakistan's first prime minister, Liaquat Ali Khan, to head the new country's Department of Research (subsequently renamed Pakistan Council of Scientific and Industrial Research or PCSIR).

At PCSIR, Siddiqui continued his work on the isolation of alkaloids from Rauwolfia, Ajmaline *and Serpajmaline, identifying molecules that could be used for new drugs to treat heart ailments and other diseases.* Ajmaline *was ultimately manufactured by drug companies in Germany and* Serpajmaline *by drug companies in Bangladesh.*

In recognition of his scientific achievements, Frankfurt University granted Siddiqui an honorary doctorate degree in 1958. The same year, the government of Pakistan gave him the prestigious Tamgha-e-Pakistan civil award. In 1960, he became the president of the Pan-Indian Ocean Science Association and, the following year, he was named a Fellow of the Royal Society (FRS). In 1962, the government presented him the Sitara-e-Imtiaz award for distinguished merit in the fields of science and medicine. Siddiqui remained the director and chairman of PCSIR until his retirement in 1966. In that year, the president of Pakistan awarded him the Pride of Performance Medal.

In 1967, Siddiqui was invited by the University of Karachi to establish a postgraduate institute of chemistry within the university's chemistry department. A generous donation from the Husein Jamal Foundation in 1976 led officials to rename the facility the Husein Ebrahim Jamal Research Institute of Chemistry (HEJRIC). Siddiqui remained at HEJRIC until 1990.

Over nearly a quarter century, Siddiqui played a central role in building HEJRIC into a distinguished centre of international excellence in the field of chemistry and natural products. The centre has since served as one more stellar accomplishment in a career marked by enormous success and impact.

increased 600% and the number of citations of articles written or co-written by Pakistani scientists footnoted in international peer-reviewed journals rose 1,000%. Thomson Reuters (formerly ISI) Web of Knowledge, identified three Pakistani universities – the University of Karachi, Quaid-i-Azam University and the National University of Science and Technology (NUST) – among the top 500 universities in its global ranking of institutions of higher education.

Critics of the government's reform efforts, however, contended that greater emphasis was placed on higher education than on primary and secondary education, and that the reforms may have been introduced too quickly for the measures to be fully integrated into the existing system of higher education – let alone within the larger society.

In 2008, as stated earlier, a new government assumed power in Pakistan. Soon after, the world's most severe financial crisis in more than a half century battered the economies of developed and developing countries alike.

Responding to the steep economic downturn and subsequent turmoil, the Pakistani parliament enacted substantial cuts to the government's overall budget and delayed or terminated a large number of initiatives that had been launched during the previous decade.

"Beginning in 2000, Pakistan embarked upon an unprecedented effort to improve education and scientific and technological capacity."

PUBLIC-PRIVATE PARTNERS

• ICCBS has successfully marketed its services and products to Pakistan's industrial sector. This effort has enabled the centre to achieve a degree of financial sustainability that is unique among Pakistan's research institutions.

While the need for university-industry linkages have long been discussed in Pakistan, ICCBS has thus far been among only a few research institution in the country to pursue this strategy aggressively. The centre currently has links with more than 350 industries across the country. In addition, many international organizations and firms, including local field offices of such international pharmaceutical firms as GSK, Merck, Pfizer and Eli Lilly, also use ICCBS services and products. The ICCBS Industrial Analytical Center (IAC) alone generates an annual income of USD350,000.

"When research is relevant to local demands and conditions," Choudhary says, "self-sustainability ensues. ICCBS", he adds, "is an excellent example of public-private collaboration that could serve as a model for other research institutions in Pakistan. The centre's experience shows that excellence in research and training can be achieved with limited resources, and, more importantly,

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Universities and research institutes were not exempt from the government's fiscal retrenchment. Then, in 2010, historic floods swept across the country, upending the lives of some 20 million people and causing an estimated USD43 billion in damages. The disaster added to Pakistan's woes and placed additional constraints on the country's finances, including its investments in science and technology.

ICCBS has not escaped these problems. Indeed the centre has been forced to confront an unprecedented budget crunch, requiring it to sharply curtail a number of its research and training activities.

that such worthy goals can be sustained even in times of political uncertainty and relentless resource constraints."

Over the years, ICCBS has acquired sophisticated modern instruments valued at more than USD70 million. In addition to state-of-the-art laboratory equipment, including more than ten superconducting spectrometers, ICCBS has acquired mass spectroscopic databases, an electronic dictionary of natural products and a comprehensive CD collection of chemical abstracts. ICCBS also has access to SciFinder Scholar, Chemical DataBase on-line and other large databases. The centre's library subscribes to more than 250 periodicals and journals and contains more than 7,000 books in the biological and chemical sciences.

A 12-MB broad-band radiowave caters to the communication needs of ICCBS researchers, providing access to online lectures delivered by eminent professors from around the world as well as full connectivity to the Pakistan Education & Research Network (PERN). The Latif Ebrahim Jamal National Science Information Center, a part of ICCBS, has access to more than 31,000 e-journals and 40,000 e-books.

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Nevertheless, ICCBS has weathered the economic storm better than most other scientific institutions in Pakistan, largely as a result of its ability to obtain external funding and to generate revenues through the commercialization of its services and products.

Atta-ur-Rahman believes that the quality of ICCBS research and training does not simply lie in its superb infrastructure but also in the superior work that the faculty and researchers do. To fulfill this goal, he maintains that ICCBS needs a skilled faculty that receives adequate compensation and rewards for its efforts. "Core funding for the faculty", he says, "can only be provided by the government."

The 2010 budget, which Pakistan's parliament approved in June, imposed a 50% reduction in the budget of the Ministry of Science and Technology compared to the previous year, leaving it with annual funding of USD19.2 million. The parliament also reduced the 2010 budget of the federal Higher Education Commission (HEJ) by 40%. HEC's budget now stands at USD17.5 million. Core funding for the ICCBS, which comes largely from both the HEC and the Ministry of Science and Technology, was pared from USD6 million to USD5.5 million.

The cutbacks have forced ICCBS not only to cancel new projects but also to dramatically curtail the scope of its existing activities.

"If substantial funds are not restored," Atta-ur-Rahman says, "the situation is likely to become even worse, placing the centre's hard-earned international reputation at risk."

Choudhary echoes Atta-ur-Rahman's concerns, noting that the centre's research and training efforts have stalled in the face of the government's deep budget cuts. He ominously adds that "decisions made over the next year or two are likely to determine whether ICCBS can maintain the level of excellence that it has achieved after decade of efforts."

"Financial stability and infrastructure development", Atta-ur-Rahman notes, "are critical elements in the success of any research institution. Such success requires a continual flow of funding at adequate levels commensurate with the scope of activities that are taking place now and in the near future."

Atta-ur-Rahman and Choudhary cite other challenges as well. For example, terrorist threats deter foreign researchers from coming to Pakistan and have required the centre to send its researchers and students to other countries for specialized training. At the same time, trade regulations marked by high tariffs have not only increased the cost of imported chemicals but have also caused lengthy delays in the delivery of products that are essential for conducting experiments. A 20% depreciation in the value of Pakistan's currency, which has taken place over the past three years, has raised the cost of purchases and placed additional strains on the centre's depleted budget.

ATTA-UR-RAHMAN

• ***Atta-ur-Rahman**, who served as Pakistan's Minister of Science and Technology from 2000 to 2002 and chairman of the federal Higher Education Commission from 2002 to 2008, is widely credited for dramatically reforming the country's science, technology and higher education sectors. He has also gained an international reputation as a leading organic chemist. His research interests lie in the synthesis of natural products, the chemistry of bioactive secondary metabolites, the search for new enzyme inhibitors and applications of stem cells for therapeutic purposes.*

Atta-ur-Rahman joined HEJRIC in 1969, after earning a PhD at Kings College, Cambridge the previous year. He was appointed the institute's co-director in 1977, sharing oversight for HEJRIC with its founding director Salimuzzaman Siddiqui. In 1990, Atta-ur-Rahman was named director of HEJRIC, a post he held until 2008 when he was made the Center's "chief patron". Throughout his tenure as co-director and director, Atta-ur-Rahman secured external funding not only for state-of-the-art equipment, but also for a number of major research projects that have transformed the institute into an international centre of excellence in natural product chemistry.

Atta-ur-Rahman has authored more than 900 scientific articles in international journals, holds 18 patents and has written and collaborated on more than 100 books. He is on the editorial board of many European science journals, including Natural Product Research *in the UK and* Current Medicinal Chemistry *and* Current Pharmaceutical Design *in The Netherlands. He has received the highest civil award from the government of Austria for the unprecedented progress that was made during his tenure as the Commissioner of Higher Education, as well as many distinguished national awards, including Nishan-e-Imtiaz, Hilal-e-Imtiaz, Sitara-e-Imtiaz and Tamgha-e-Imtiaz. He has been awarded honorary doctorate degrees from many universities, including Cambridge University. He is a member of a number of science academies, including the Korean Academy of Sciences, the Islamic World Academy of Sciences, TWAS and the Royal Society in the UK. He is a UNESCO Science Laureate and a recipient of the ISESCO Chemistry Award, the ECO Prize given by the government of Azerbaijan, the TWAS Award in Chemical Sciences and the TWAS Regional Prize. He is an honorary life fellow of Kings College, Cambridge University, and has served three mandates as the elected president of the Pakistan Academy of Sciences.*

"For all of these reasons," Choudhary says, "we have issued urgent appeals for the government to reconsider its budget cutbacks."

Meanwhile, social unrest and growing incidences of violence, combined with a sharp economic downturn and limited career opportunities, have led to an increasing number of bright young Pakistani scientists to pursue their careers in other countries, where they enjoy higher compensation, better job prospects and greater security.

"To keep our most highly educated and best trained youth at home, we must be able to offer them benefits and opportunities that are comparable to what they can receive in other countries. We do not currently have the resources to do that", Choudhary says.

"If the government fails to adequately support its scientists and scientific institutions, the progress that has been achieved during the past decade could be undone", Choudhary warns.

"ICCBS", he adds, "has been able to recruit a talented and an experienced faculty. It has attracted excellent students that compare favourably to the best students enrolled in institutions in both developing and developed countries. It has built adequate research facilities. It is widely viewed as an institution of accomplishment and acclaim. And it has shown that it has the capacity to help boost the national economy and raise the scientific profile both within Pakistan and abroad."

However, Choudhary laments that none of these worthy contributions to the country's well-being will continue to be realized unless the "government continues to acknowledge the centre's value and supports its efforts."

Structural Framework

ICCBS research takes place within largely independent research units, each of which has its own faculty and facilities. Overall, the institute is divided into two major branches:

- HEJ Research Institute of Chemistry (HEJRIC), which is comprised of five centres: Third World Center Laboratory; Latif Ebrahim Jamal National Science Information Center (LEJNSIC); Pakistan Biotechnology Information Center (PABIC); Industrial Analytical Center (IAC); and Plant Tissue Culture and Biotechnology Division.
- Dr Panjwani Center for Molecular Medicine and Drug Research (PCMD), which includes the Center for Bioequivalence Studies and Bioassay Research (CBSBR) and a group of diagnostics centres.

MUHAMMAD IQBAL CHOUDHARY

• ***Muhammad Iqbal Choudhary***, *ICCBS current director, is recognized internationally for his contributions to natural products and bio-organic chemistry. The Higher Education Commission has named him a Distinguished National Professor of Chemistry. Choudhary's current research interests include the study of new enzyme inhibitors, antioxidant and anti-angiogenic agents, and anti-parasitic compounds. He has written and edited 30 books and published nearly 700 articles and book chapters in international science journals. In addition, he holds 12 international patents and is on the the editorial board of 5 international science journals.*

Choudhary earned DSc and a PhD degrees in organic chemistry from Karachi University. He has served as visiting faculty in many universities, including Cornell University, Purdue University, Pennsylvania State University and the Scripps Institution of Oceanography in the United States. He joined HEJRIC in 1988 and was appointed director of ICCBS in 2008.

Choudhary is a member and fellow of many prestigious societies, including the American Chemical Society, the International Union of Pure and Applied Chemistry, the Islamic World Academy of Sciences, the Royal Society of Chemistry and TWAS. He has received several national and international honours, such as the Hilal-e-Imtiaz, Sitara-e-Imtiaz and Tamgha-e-Imtiaz awards, the Pakistan Academy of Sciences Gold Medal and the TWAS Young Scientist Prize. He was also selected as the recipient of the first Khwarizmi International Award and the ECO Prize given by the governments of Iran and Azerbaijan respectively. He has been appointed a member of executive committee of the National Commission for Science and Technology chaired by the Prime Minister of Pakistan.

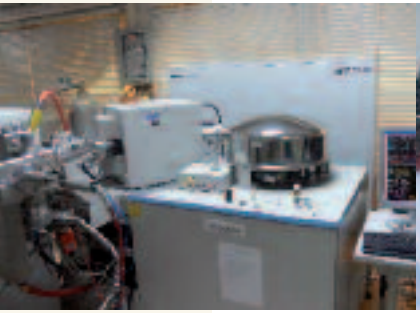
HEJ Research Institute of Chemistry

In 1967, Karachi University's Department of Chemistry established a postgraduate institute of chemistry. Salimuzzaman Siddiqui, who led this effort, became the institute's founding director. Atta-ur-Rahman joined the institute in 1969 after earning a doctorate degree from Kings College, Cambridge, in the UK.

In 1990, Atta-ur-Rahman was named the director, succeeding his mentor Siddiqui. Atta-ur-Rahman would lead the institute for nearly two decades, handing over the reigns to his former student and long-time colleague Muhammad Iqbal Choudhary in 2008.

ICCBS has enjoyed remarkably stable leadership throughout its history, marked by just three changes in the directorship, which has been held by a succession of people who have worked together for a long time.

In 1976, Latif Ebrahim Jamal, a wealthy Pakistani industrialist and philanthropist, donated USD500,000 to the institute on behalf of the HEJ Foundation. At the time, this represented the largest private donation in Pakistan's history. The institute, in turn, was named after Husein Ebrahim Jamal, the elder brother of Latif Ebrahim Jamal.



Today, the HEJ Research Institute of Chemistry (HEJRIC) oversees Pakistan's largest doctoral programme in a single field of interest. The main areas of student training and research include natural product, protein and synthetic organic chemistry; computational medicinal chemistry; pharmacology; and plant biotechnology. Specific areas of research relate largely to pharmacological studies of novel natural products and protein chemistry. To ensure that international standards are met, doctoral degrees are awarded to students only upon the recommendation of two eminent scientists from abroad who are part of a larger team that reviews and approves their doctoral dissertations.

INDUSTRIAL ANALYTICAL CENTER (IAC)

• In response to growing demand from both consumers and industries, in 2003 HEJRIC established a world-class Industrial Analytical Center (IAC). The initiative was partly supported by Pakistan's Ministry of Science and Technology and subsequently by the federal Higher Education Commission.

IAC houses state-of-the-art analytical instrumentation capable of meeting the requirements of industrial clients. Equipment at IAC includes centrifuges, spectrophotometers, a sonicator, ion and gas chromatography, and an ICP spectrometre, which has been used for a wide variety of research and commercial activities, including testing for the effectiveness of pharmaceuticals and the risks posed by food contamination. The spectrometre is also used to analyse industrial solvents and textile chemicals for commerical applications.

In today's competitive global market, Pakistan's industries depend on quality control to ensure that the raw materials they use and the products that they manufacture meet the standards and expectations of increasingly quality-conscious companies and consumers. A growing number of companies have turned to IAC's services both to verify the authenticity of the raw materials they use and analyse

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"The institute's analytical, spectroscopic and computational equipment is on par with that found in other institutions across the world", says Choudhary. "We have recently placed increasing emphasis on training students in fields that are economically relevant – for example, genetic engineering, plant biotechnology, and textile and food chemistry. And we are investing additional resources in such frontier disciplines as supramolecular chemistry, proteomics and metabolomics that we believe will offer better career opportunities for our graduates."

To advance these efforts even further, as well as to generate much needed revenue,

and demonstrate the quality of their end products. Meeting the needs of customers and enabling Pakistani industries to be competitive in the global marketplace are IAC's two main objectives.

IAC currently offers a wide range of professional, analytical, training and consultancy services. The services draw on a comprehensive database outlining the molecular makeup of food commodities and agricultural products, as well as chemical profiles for such industrial materials as polymers, dyes and solvents. The centre uses this data to conduct tests on pharmaceutical and herbal products, with a special focus on assessing pharmaceutical raw materials.

IAC also undertakes microbiological and toxicological studies, provides in-depth analyses of petroleum products, and engages in physical and chemical assessments of a full of range of materials. To fulfill these tasks, IAC relies on the services of analysts and researchers with expertise in chemical analysis, microbiological testing, food analysis and pharmaceutical material testing. Most of IAC's research staff hold PhD or master's degrees and have extensive hands-on experience gained through training abroad and through their work with the Center.

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the institute's Industrial Analytical Center (IAC) offers fee-based services to Pakistani industrialists and farmers. Such work includes the testing of food, pharmaceutical products and industrial chemicals, and analyses of pesticide residues.

ICCBS has been designated a World Health Organization's (WHO) Center for Pesticide Analysis for the Eastern Mediterranean Region. It is also a member of the International Union for Conservation of Nature (IUCN), the World Association of Industrial and Technological Research Organizations (WAITRO), and the Commission on Science and Technology for Sustainable Development in the South (COMSATS).

The centre has a well-equipped pharmacology section, animal houses, a plant biotechnology facility and a pilot plant building. Several new laboratories have been built to facilitate research in enzyme inhibition, tissue culture and plant micropropagation. In addition, anti-tumour, radio-labelling and tropical research laboratories have also been established in collaboration with the National Cancer Institute and Abbott Laboratories in the USA. The IAC, launched in 2003, has helped to raise the profile of ICCBS in the private sector, and the Third World Center Laboratory, inaugurated in 2005, has expanded the institute's ability to collaborate with scientists from other developing countries.

While the majority of the faculty and students come from Pakistan, the institute's reputation for excellence has also attracted researchers from around the world and particularly from other Muslim countries. For example, scientists from Bangladesh, Cameroon, Egypt, Germany, Iran, Kazakhstan, Malaysia, Myanmar, Nigeria, Sudan, Thailand, Turkey and Uzbekistan have participated in ICCBS activities. In addition, more than 75 institutions, both from Pakistan and abroad, have benefitted from ICCBS bioassay facilities. To date, over 20 Pakistani universities have accessed the institute's spectroscopic and analytical facilities and some 350 industries have utilized ICCBS consultancy services.

"ICCBS has enjoyed remarkably stable leadership throughout its history."

INDUSTRIAL ANALYTICAL CENTER (IAC)

• ***Latif Ebrahim Jamal*** *(1925-2004), chairman of the Husein Ebrahim Jamal Foundation, was a leading Pakistani industrialist. He generously gifted a substantial portion of his personal wealth to launch a number of educational, research, health and social service organizations that continue to benefit the people of Pakistan. In 1976, he donated USD500,000 to the University of Karachi for the establishment of HEJRIC. The support – a reflection of his deep commitment to building scientific and technological capacity in Pakistan for the purposes of spurring economic developmen – was given in memory of his brother, Husein Ebrahim Jamal, for whom the Center is named.*

• ***Nadira Panjwani****, founder and managing trustee of the Dr. Muhammad Hussain Panjwani Trust (named in honour of her father), is a leading Pakistani philanthropist. In 2002, the Trust provided funds to the University of Karachi to launch PCMD. The Center sponsors research and training initiatives in molecular medicine, paying particular attention to diseases that are prevalent Pakistan, including cancer, diabetes, hepatitis, leshmaniasis and malaria. Panjwani served as Minister for Women Development and Population Planning in 2007-2008, and was the founding director of the Pakistan Human Development Fund, which promotes rural development in Pakistan.*

• ***Wolfgang Voelter****, professor of chemistry at the University of Tübingen, Germany, played a key role in the early stages of the development of HEJRIC by securing a series of large grants from the German government in the 1970s. The funds enabled HEJRIC to buy valuable equipment and establish a framework for collaboration between scientists at the Center and colleagues in other countries. Voelter has received numerous awards, including honours from the American Chemical Society, the Royal Society of Chemistry and TWAS, for both his research and his contributions to promoting scientific collaboration and capacity-building in the developing world, and particularly in Pakistan.*

HEJRIC's Latif Ebrahim Jamal National Science Information Center

The Latif Ebrahim Jamal National Science Information Center (LEJNSIC), which operates under HEJRIC, owes its existence to the generosity of Latif Ebrahim Jamal, chairperson of the HEJ Foundation, who bequeathed funding for the centre in the final year of his life.

The centre was officially launched in 2006, three years after Latif Ebrahim Jamal's death. It became the first institution in Pakistan to obtain high-speed internet access to major research and industrial scientific databases. Today, the centre enjoys state-of-the-art ICT facilities and access to more than 31,000 e-journals and 40,000 e-books.

LEJNSIC serves as a scientific information hub for faculty and students at HEJRIC and other research facilities operating under the ICCBS. In addition, it provides access to the most up-to-date scientific literature to researchers throughout Pakistan on a 'cost-plus' basis that is both affordable for the users and generates welcome revenue for the centre. A digital library, currently under construction, will store electronic information that will be made accessible to universities and research centres across the country via local area networks.

LEJNSIC is also in the process of building an industrial informatics facility to support Pakistan's major industries. Its state-of-the-art virtual education programme has helped to raise research and teaching standards in Pakistan by making available real-time interactive lectures by eminent scientists from around the world to universities across the country.

KEY PERSONNEL

VIQAR UDDIN AHMAD

• ***Viqar Uddin Ahmad****, who joined HEJRIC as a researcher in 1976 and currently serves as professor of chemistry, holds DSc and PhD degrees in organic chemistry from Karachi University. His research interests include isolation and structure elucidation of new natural products. He has published eight books and more than 400 articles. Ahmad has received Pakistan's Hilal-e-Imtiaz and Sitara-e-Imtiaz civil awards for his research and teaching. In 2006, he was named a Distinguished National Professor by the Higher Education Commission of Pakistan. He is also a recipient of the Iranian government's Khwarizmi International Award and has served as vice-president of the Pakistan Academy of Sciences and president of Pakistan's Chemical Society.*

In addition, LEJNSIC hosts the newly created Pakistan Biotechnology Information Center (PABIC). PABIC, which functions under the administrative umbrella of the non-profit International Service for the Acquisition of Agri-Biotech Applications (ISAAA) and Pakistan's National Commission on Biotechnology, is designed to support multidisciplinary research and raise public awareness and appreciation for biotechnology in Pakistan. It also oversees training workshops for journalists, operates internship programmes for students and researchers, and organizes biotechnology-related events in Pakistan for researchers and the public.

HEJRIC's Plant Tissue Culture and Biotechnology Division

The ICCBS Plant Tissue Culture and Biotechnology Division, located at the HEJRIC, provides advanced services in the micro-propagation of plants, mass multiplication of elite plant varieties, and for-fee production of client-specific plant varieties. The division was established as part of the ICCBS Plant Biotechnology Initiative, which was launched in 1998. It now cultivates exotic varieties of orchids and other cut flowers. It has also introduced disease-free horticulture varieties, including banana, pineapple and date palm, which have since been brought to market.

In particular, the division is working on propagating bananas free from the bunchy top virus (BTV), a pathogen that poses a grave risk to bananas worldwide and that results in millions of dollars in economic losses each year. The plant tissue culture and biotechnology division oversees the only Pakistani laboratory that supplies micro-propagated banana plants to farmers across the country.

Under contracts arranged with Pakistani farmers, the division also mass produces elite varieties of such economically important plant species as cherries, tomatoes and pineapples. The initiative enables farmers to grow and sell these species year-round. It has also successfully produced crops that have proven difficult and costly to propagate in Pakistan through conventional cultivation methods but that nevertheless elicit strong consumer demand. These crops include bananas and orchids.

All told, the division's tissue-culture laboratories are capable of producing half a million plants per year. Ten 'growth rooms', which are equipped with 'fan and pad' systems, strictly control temperature and humidity levels during cultivation. Four 'inoculation rooms' avoid cross-pollination of new plant varieties.

"HEJRIC's analytical, spectroscopic and computational equipment is on par with that found in other institutions across the world."

BINA S. SIDDIQUI

• ***Bina S. Siddiqui*** *holds a DSc and a PhD in organic chemistry from Karachi University. Her research interests include phytochemical and synthetic studies that seek to obtain new 'molecular' leads for potential medicinal agents and botanical pesticides. She has more than 260 publications in leading international journals and nine patents to her credit. She is a recipient of the Khwarizmi, Tamgha-e-Imtiaz award and Sitara-e-Imtiaz awards, and has been named a Distinguished National Professor by the federal Higher Education Commission.*

The half-hectare cultivation area is currently being expanded to 2.5 hectares. The goal is to provide additional space for increasing the number and size of *in-situ* demonstration projects. The species that are grown have largely been developed in ICCBS tissue-culture laboratories. More than 100 varieties of ornamental, horticultural, medicinal and aromatic plants can currently be mass-produced on demand. The five-fold expansion of the cultivation area is intended to ease and expand the 'translational' research process from laboratory experimentation to field demonstrations to the market place – and thus generate additional revenues for the ICCBS.

Successful production of virus-free banana plants and sixteen varieties of orchids have been cultivated at pilot scale. On an experimental scale, the division has begun to use hydroponics to grow, for example, cherry tomatoes.

Among the division's major achievements are the first-time micropropagation of pineapples in Pakistan, and the development of protocols for *in-vitro* propagation of several exotic plants, including *Croton*, African violet, *Ixora*, ferns, date palms and *Anthurium*.

At a commercial level, the division offers 16 varieties of orchids, 20 varieties of *Croton*, three varieties of *Anthurium*, two varieties of pineapples, six varieties of *Ixora*, four varieties of date palms and 12 varieties of bananas. Its product lines also include high-value ornamental and medicinal plants such as *Dracaena*, fern, African violet, *Furcraea* and *Aloe vera*. In addition, the division cultivates kiwis and *Kalanchoe tomentosa* that have broad commercial value.

INSTITUTIONAL MILESTONES

• *The creation of the **Dr Panjwani Center for Molecular Medicine and Drug Research (PCMD)**, launched in 2002 with a generous donation from Nadira Panjwani that she bestowed in honour of her father, marked an important milestone in the evolution of the ICCBS.*

PCMD focuses on the use of diagnostic tools and affordable treatments for addressing Pakistan's most prominent diseases. The centre's expertise lies in molecular biology and genetics and computational methodologies.

*Another milestone in the evolution of ICCBS was the establishment of the **Latif Ebrahim Jamal National Science Information Center (LEJNSIC)**. The centre unites large databases across several institutions to facilitate researcher access to digital information. These institutions include the Pakistan Biotechnology Information Center (PABIC), the Asia Pacific Traditional Medicine Network (APTMNET) and the Science Teachers Forum (STF).*

LEJNSIC is equipped with a high-speed internet connection that supplies intranet connectivity to major universities in Pakistan through PERN (Pakistan Educational Research Network). PERN's e-library system gives Pakistan's universities access to more than 23,000 full-text journals and 40,000 online books. PERN also provides a platform for the transmission of live lectures and videoconferencing. A large bank of computer terminals can accommodate 400 users. The ICT infrastructure also includes off-line databases, a campus-wide Wi-Fi-network and a PABX (private automated branch exchange) system that manages the sharing of lines between telephones and other communication devices.

SNAPSHOT

Atta-ur-Rahman and Choudhary both believe that the division could generate substantially more income from the sale of its products and services in Pakistan and abroad. For example, they note that agricultural economists project that annual global sales of ornamental cut flowers worldwide could reach USD7 billion. For bananas, global sales could reach USD5.8 billion and for cherries USD1.5 billion.

"ICCBS has excellent export potential for its horticultural and floricultural products," says Choudhary, "especially in the Middle East and Central Asia, where the market is small but rapidly growing." This potential, however, remains largely untapped. To date, sales of division products and services have been confined almost exclusively to local markets, and even there the level of income-generating activity remains low.

The first 'compound molecular bank' in Pakistan was established at ICCBS in 2007. The bank is designed to systematically collect and organize the wealth of natural and synthetic compounds isolated or synthesized at PCMD.

More specifically, the activities of the bank largely consist of receiving compounds replete with detailed biological and structural information. This information, in turn, is grouped into various categories depending on their source and structural types, and then arranged for various types of biological screenings. The data is managed in computer-readable form for ready reference and use.

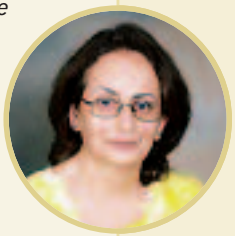
The goal is to build a comprehensive library of molecular diversity that can be utilized by researchers and commercial organizations in Pakistan and neighbouring countries. The database is also intended to serve as a platform for international scientific collaboration and as the basis of revenue-generating research and development initiatives designed to expand the market for the plant resources of Pakistan and countries throughout the region.



KEY PERSONNEL

AHSANA DAR FAROOQ

• ***Ahsana Dar Farooq**, professor of pharmacology at ICCBS, earned a doctorate degree in pharmacology from the University of Cambridge, UK. Her research interests include the evaluation of synthetic compounds, natural products as well as herbal preparations for depression and other neurological disorders, cancer and inflammation. She has authored more than 40 articles and serves as a coordinator for ICCBS international collaborations.*



Research Forward

The HEJ Research Institute of Chemistry is mandated to train high-quality researchers in a variety of fields in the chemical and biochemical sciences. In addition to conducting basic research, scientists at HEJRIC have often worked on 'applied' projects that have led to the commercialization of products and services that include:

- **Neem-based pesticides:** A range of neem-based pesticides developed at the HEJRIC have been produced at a pilot plant with a capacity of 200 litres per day. These products are now marketed in domestic and international markets.
- **Phytopesticides:** Field trials for two new botanical insecticides, based on *Annona* and *Acorus*, have been completed. Large-scale production trials are under way. The goal is to produce bio-pesticides for organic farming in Pakistan.
- **Virus-free banana species:** HEJRIC's plant biotechnology unit has created several varieties of virus- and disease-free bananas that are being commercially marketed in Sindh and other banana-growing provinces in Pakistan.
- **Analytical services:** The Industrial Analytical Center relies on analytical and spectrometric facilities at ICCBS to provide a range of small-scale products and services currently being utilized by more than 350 private firms in Pakistan. Clients include Abbott Laboratories, Pakistan State Oil (PSO) and the Worldwide Fund for Nature (WWF). The initiative currently generates USD350,000 in annual revenues.

Dr Panjwani Center for Molecular Medicine and Drug Research

Like the HEJ Research Institute of Chemistry, the Dr Panjwani Center for Molecular Medicine and Drug Research (PCMD), established in 2002, operates under the administrative umbrella of ICCBS.

Scientists at the PCMD work closely with their counterparts at the HEJ Research Institute of Chemistry. PCMD is named after Dr. Mohammad Husein Panjwani, a philanthropist and founder of the Panjwani Charitable Trust, who died in 1992. The trust – with Panjwani's daughter Nadira serving as chairperson – has been the centre's primary source of capital funding. It has also remained a primary source of PCMD's operational funding through an endowment fund that was created by the trust for that purpose.

PCMD concentrates its efforts on training master and doctoral degree students, primarily in the fields of biomedical research and molecular medicine. Research activities focus largely on tracking diseases, especially diseases prevalent in Pakistan – tropical diseases, cancer, diabetes, hypertension and depression. The aim is to assemble a comprehensive database of prominent diseases in Pakistan and to conduct comprehensive laboratory and clinical research to explore new, more effective methods of diagnosis, treatment and prevention.

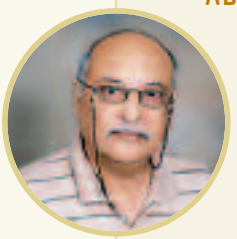
PCMD has been instrumental in introducing novel laboratory techniques in Pakistan. For example, the patch clamp technique – developed in the United States in the 1980s to enhance the study of the electrical properties of ion channels in cells – was first made available in Pakistan at PCMD in 2007. It provides a state-of-the-art tool for researchers not available in any other laboratory in the country.

PCMD also manages the Animal House Facility (AHF). The facility, which shelters animals used for experimental research, operates under strict guidelines that meet international ethical standards. The newly renovated two-storey structure occupies more than 900 square metres. The ground floor houses guinea pigs, rats, mice and rabbits. The first floor contains state-of-the-art laboratories for pharmacological and pre-clinical research.

Construction is currently under way for a large centralized state-of-the-art animal research centre that, in addition to surgical theatres and investigator procedural rooms, will include an autoclave for the sterilization of equipment and supplies as well as post-operative rooms for animal care and recuperation.

PCMD also oversees the Center for Bioequivalence Studies and Bioassay Research (CBSBR). Established in 2006, CBSBR is the first research facility in Pakistan designed to evaluate the safety and efficacy of generic pharmaceutical products and services. In 2007, the federal Higher Education Commission granted CBSBR USD4 million in seed money. The funding arrangement calls on CBSBR to attract sufficient levels of external funding over the next few years to become a self-sustaining institute dedicated to biomedical and pharmaceutical research.

ABDUL MALIK



• ***Abdul Malik**, who earned a doctorate degree from the University of Karachi, focuses his research on bioassay-directed isolation related to bioactive natural products. He has acquired two patents and published more than 270 research articles in international journals. He has been honoured with Pakistan's Sitara-e-Imtiaz award.*

Center for Bioequivalence Studies and Bioassay Research (CBSBR)

PCMD's Center for Bioequivalence Studies and Bioassay Research (CBSBR) conducts clinical trials and statistical and pharmacokinetic analyses of bodily fluids for the purposes of detecting the bioequivalence, bioavailability and pharmacokinetics of generic medicines. The goal is to make safe and effective generic drugs available at an affordable price.

The centre also examines and renders nonbinding, but nevertheless influential, opinions about ethical and regulatory issues concerning biotechnology for representatives of government, private companies, universities and nongovernmental organizations. It does this through the Pakistan Biotechnology Information Center (PABIC), an organization that also operates under the administrative umbrella of ICCBS. In addition to botanists, ecologists, pharmacologists and biochemists, the CBSBR research team consists of business people, doctors and pharmacists, IT personnel, statisticians and quality assurance experts.

As stated earlier, the patch clamp technique, first developed in the 1980s, was introduced to Pakistan at PCMD in 2007. A mainstay for researchers at the CBSBR, it allows precise measurements of small-scale ionic currents within cells. In this way, researchers can investigate the role that ion channels play in the physiological function of tissues. The technique is used to analyse the effects of drugs in combating such diseases as epilepsy and diabetes by revealing the mechanism through which the disease affects tissue. The knowledge that is acquired could play a critical role in the design of new, more targeted drugs.

YOUNG SCIENTISTS

• ***Syed Ghulam Musharraf***, *assistant professor at PCMD, uses mass spectroscopy to aid in the search of biosignatures in lung, oral and breast cancer. He also conducts research on algal oil to determine its potential use in biodiesel production.*

• ***Sonia Siddiqui***, *assistant professor at PCMD, investigates the role that extracellular matrix proteins play in retinal neurite outgrowth in embryos and new borns. She also supervises ICCBS's Biobank and Patch-Clamp facility.*

• ***Zaheer-ul-Haq Qasmi***, *assistant professor at PCMD, conducts molecular computer simulations of biological systems, especially to identify potential molecules for drug development. He is also pursues the design of new bioactive molecules.*

• ***M. Raza Shah***, *assistant professor at HEJRIC, synthesizes interlocked molecules with unique topologies and develops artificial ion channels based on the principles of synthetic supramolecular chemistry.*

• ***Hina Siddiqui***, *HEJRIC research officer, seeks to discover antioxidant compounds from natural and synthetic sources. She explores new methodologies for drug development with a focus on synthesizing anti-malarial trioxane compounds.*

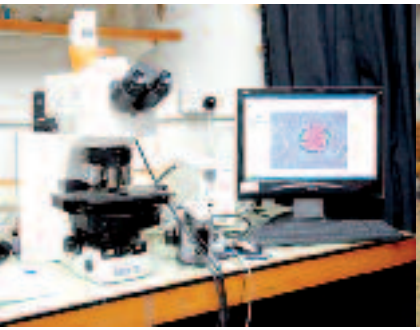
• ***Huma Rasheed***, *assistant professor at PCMD, pursues research on cancer genomics and therapeutics. She is particularly interested in uncovering genetic factors responsible for multi-drug resistance to chemotherapy.*

> *"ICCBS has excellent export potential for its horticultural and floricultural products, especially in the Middle East and Central Asia."*

- ***Muhammad Shaiq Ali**, professor of chemistry at HEJRIC, conducts research on issues related to marine and terrestrial natural product chemistry and the biotransformation of organic molecules.*
- ***Farzana Shaheen**, assistant professor at HEJRIC, concentrates her research on solid phase combinatorial synthesis and the isolation and structural characterization of bioactive natural products from medicinal plants.*
- ***Sammer Yousef**, assistant professor at HEJRIC, uses single-crystal X-ray diffraction to determine the structural markers of organic molecules. She has discovered a novel class of organoflourine secondary metabolites from natural sources.*
- ***Jamshed Hashim**, assistant professor at HEJRIC, has extensive experience using a variety of microwave instruments. He draws on his skill to synthesize organic compounds.*
- ***Abdul Hameed**, assistant professor at HEJRIC, concentrates his research on developing and utilizing innovative methodologies for synthesizing biologically active natural products with unique structures.*
- ***Asmat Salim**, assistant professor at PCMD, is involved in the study of differentiation mechanisms of stem cells derived from bone marrow for in vitro and in vivo laboratory studies in micro cardiac environments.*
- ***Talat Makhmoor**, assistant professor at PCMD, focuses her research on cellular immunology related to the regulation of immune responses. She hopes to discover catalysts for enhanced peptide loading to activate T-cells to combat cancer.*
- ***Atia-tul-Wahab**, assistant professor at PCMD, concentrates her research on structural and synthetic biology and organic chemistry. She is currently leading efforts to establish the first structural biology laboratory in Pakistan to be located at PCMD.*

Clinical trials at CBSBR, focusing on bioequivalence and bioavailability of generic drugs, have been conducted in collaboration with consultants from the World Health Organization (WHO), Pakistan's Ministry of Health, and the Pharmaceutical Research Center of Jordan.

Bioanalytical laboratory investigations for drug molecules and drug metabolites in body fluids take place through the application of high performance liquid chromatography (HPLC). These investigations have concentrated on gas chromatograph-mass spectrometry (GS-MS) and liquid chromatography-tandem mass spectrometry (LC-MS/MS) used to diagnose a wide range of diseases found in plants and animals.



Diagnostic Laboratory and Clinical Research

PCMD's well-equipped clinical laboratory conducts advanced diagnostic laboratory tests largely unavailable at other laboratories in Pakistan. The overall goal of the laboratory is to provide high quality reliable diagnostic services to both researchers and the community at an affordable cost. The services include molecular diagnostic services and tests that are not readily available in other laboratories in Pakistan. PCMD also promotes the development of diagnostic skills by organizing medical technology and technical training programmes. The laboratory, which is staffed by highly skilled technologists, researchers, consultants and support personnel, houses state-of-the-art automated analysers for diagnostics and research.

KEY PERSONNEL

KHALID M. KHAN

• ***Khalid M. Khan****, professor of organic chemistry at HEJRIC, holds a PhD in organic chemistry from Karachi University. Recognized in Pakistan as a pioneer in microwave-based synthetic chemistry, his current research interests include organic, natural product and medicinal chemistry. With more than 250 research publications to his credit, Khan has received many honours, including the Tamgha-e-Imtiaz and Sitara-e-Imtiaz awards and the Gold Medal given by the Chemical Society of Pakistan.*

New Frontiers

By focusing on diverse, yet interrelated fields, ICCBS encourages inter-disciplinary research with the potential for commerical applications. In fact, the centre performs a critical role in transferring research in Pakistan from the laboratory to the marketplace through, for example, studies and investigations into natural product and protein chemistry, computational medicinal chemistry and plant biotechnology.

In partnership with institutes and firms in both the public and private sectors**,** ICCBS has recently engaged in projects designed to develop new products and services for the marketplace. The focus has been on providing science-based knowledge and expertise to help facilitate this effort. Such efforts have included development of bio-pesticides and industrial enzymes.

"ICCBS offers expertise ranging from the development and validation of appropriate methodologies, to comprehensive surveys of the scientific literature, to a review of patents", Choudhary says. "Our goal is to become a primary reference point both in Pakistan and throughout the region for industrial analytical services in the biological and chemical sciences."

Envisioning a Better Future

"We plan to grow the ICCBS into a world-class multidisciplinary centre capable of catering to the needs of researchers from all developing countries", says Choudhary. "We envision creating several additional components to the centre, including a biotechnology park, a food science institute, a nano-chemistry laboratory and a tropical disease research laboratory. If we can secure the necessary financial backing for these projects, we are confident that within ten years all of them will become a reality."

Atta-ur-Rahman concurs with Choudhary's guarded optimism, adding that ICCBS also aspires "to build a world-class centre of genomics, a molecular medicine research institute and an advanced research centre for industrial biotechnology."

In addition, ICCBS aims to increase its capabilities to cultivate indigenous exotic flowers, fruit and medicinal plants at a larger scale, largely by applying biotechnology, and to sell these plants to farmers, manufacturers and consumers both within Pakistan and abroad. In addition to constructing larger greenhouse facilities, ICCBS hopes to build a state-of-the-art tissue culture laboratory staffed by researchers skilled, for example, in biotransformation, genetic engineering and DNA fingerprinting.

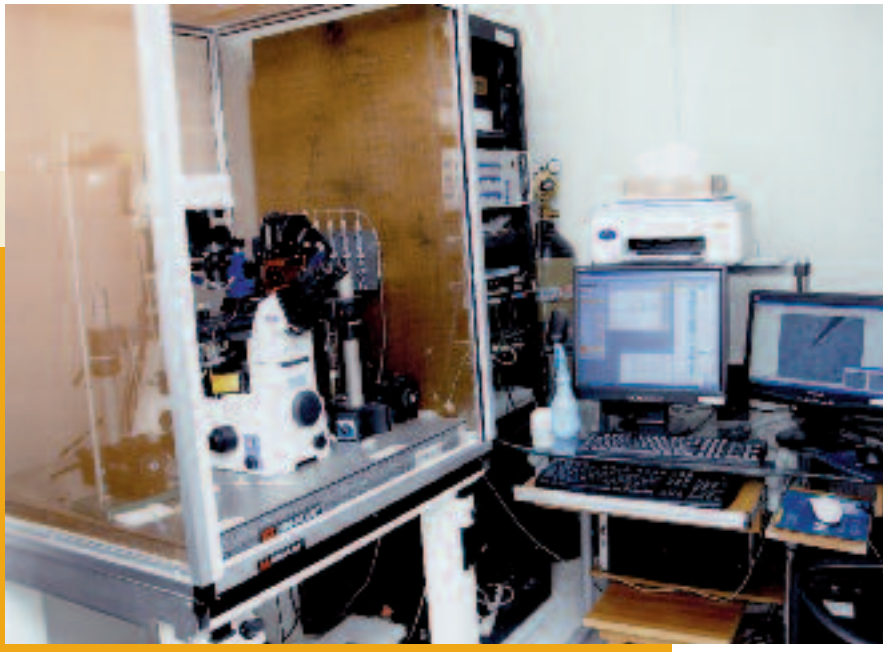
A project designed to extract essential oils from aromatic plants and flowers with novel technologies is underway. Both edible and non-edible oils have been extracted by a 'supercritical fluid extraction' process that separates components by relying on carbon dioxide and water as solvents. Oils, refined according to international standards, are being produced for export.

A hydroponics production system designed for cut flowers such as *Piper betle* and *Anthurium* is also being built. Hydroponics – the soil-less growing of suspended plants nourished by mineral nutrient solutions – denies the presence of soil-borne parasites. This, in turn, facilitates the production of high-quality disease-free plants.

Crisis and Hope

The recent financial crisis, accompanied by drastic budget cuts, has cast a shadow over ICCBS's efforts to grow into a world-class multi-disciplinary facility. A number of projects have already been delayed or thwarted, including the creation of a long-planned nano-chemistry centre. Additional retrenchment is likely unless the funds are restored and the financing is stabilized.

Despite the current woes, ICCBS management remains hopeful. "Science", Choudhary says, "is one of the strongest pillars of economic growth that any country can build. While the government has taken emergency measures to reduce expenditures in the face of a steep economic downturn, over the long term it will have to invest in science





and education if it hopes to achieve greater economic security and prosperity for its citizens."

Atta-ur-Rahman echoes similar thoughts. "Looking back," he says, "ICCBS has never existed in tranquil times. There have always been competing demands on Pakistan's resources and there have always been crises that required immediate attention. However, through all of these challenges, the centre has seemed to find a way to sustain its activities and expand its realms of excellence."

"We can only hope that the past is prelude for the ICCBS: that the centre's excellent track record and positive impact on Pakistani society will not go unnoticed and unappreciated, and that money will be found to allow ICCBS to grow and prosper in the years ahead."

> *"Science is one of the strongest pillars of economic growth that any country can build."*

Standing Tall

While many scientific institutions in Pakistan strive for excellence under difficult circumstances, few can match the level of success that ICCBS has achieved. What factors account for the success of the centre and, more importantly, what can other research institutions in Pakistan and other developing countries learn from its experience?

The most important lesson may also be the simplest: the primary sources driving success do not lie in exotic, unattainable principles, but are instead due to aspects of institutional behaviour and practice that one finds in most successful research institutions – whether they are located in rich or poor countries. Indeed, the factors that have driven success at ICCBS apply not just to scientific institutions, but to all institutions in all fields of endeavour. The bottom line is this: excellence may be the ultimate goal, but that goal remains unattainable unless you strive for excellence every day, even in the face of long odds. In this sense, excellence is a daily process as much as a destination.

Thus another important lesson learned from the experience of ICCBS is that the level of excellence that is achieved depends largely, but not solely, on an institution's own performance. Other factors, including the scope of government support, the level and reliability of core funding, the degree of political stability, and the receptivity of the public and the marketplace to the products and services that an institution produces, are all key factors in the level of success that is attained. Yet, influencing many of these factors may be beyond the reach of an institution's capacity or influence. As a result, institutions like ICCBS need to focus largely on those factors that they can shape and control on their own – and then hope for the best.

The truth is that the outcome of the current budget crisis will likely be determined by circumstances that are beyond the centre's control. Given the current forces at work in Pakistan, doing excellent work and making the best case for the work that is being done is the best – and only – defence.

Nevertheless, there are a number of institutional principles and practices that ICCBS has pursued that have seemingly placed it in a position to succeed despite the difficulties and uncertainties that it faces. These principles and practices include:

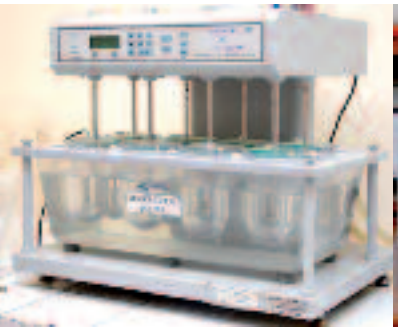
- **Merit matters:** ICCBS faculty is selected through an open, transparent and competitive process that is the hallmark of all research institutes of excellence.
- **Legacies endure:** HEJRIC's founder Salimuzzaman Siddiqui created a foundation of excellence that has since been strengthened by the noteworthy efforts of Atta-ur-Rahman and now Muhammad Iqbal Choudhary. Where an institution starts may not determine where it ends up. But nurturing a strong sense of purpose from the beginning, based on principles and practices that help to foster excellence during an institution's early years, is critical for success, especially if an institution is subsequently led by individuals dedicated to achieving the same ideals.
- **Bureaucracies stifle:** With varying degrees of success, ICCBS continually works to free itself from the burdens of bureaucracy. The centre not only independently designs but also oversees the implementation of its research agenda, and it shoulders full responsibility for the quality of the products and services it provides, especially in terms of its training and research programmes.
- **Maintain autonomy:** Many research institutions in Pakistan have been compromised and even dismantled by political interference and meddling. Although ICCBS is an integral part of Karachi University, it has achieved a degree of financial autonomy and it

manages its funds and hires its staff independently. The internal accountability mechanisms implemented at ICCBS are strictly enforced to guarantee transparency.

- **Put people first:** Only 30% of the budget goes to salaries; 70% is spent on research. The figures are reversed for many research institutions in Pakistan. Faculty, moreover, receive on-going training in management and administration to help ensure that the funds are spent both efficiently and effectively.
- **Respect technical know-how:** Successful research institutions depend not only on the quality of their research staff but also on the quality of their technical staff. Indeed, for institutions engaged in laboratory research, the quality of their technical staff is crucial. ICCBS technical staff is well trained and highly qualified. Technicians receive continual on-the-job training. The maintenance of equipment presents huge challenges for research institutions in Pakistan. Chronic breakdowns and disruptions are often the rule, not the exception. This is not the case at ICCBS where a skilled staff keeps the equipment running.
- **Earn confidence:** Thanks in large measure to its accomplishments, ICCBS has gained credibility both within Pakistan and abroad. The foundations and individuals, most notably the Punjwani Charitable Trust and the LEJ Foundation, which helped to launch the centre continue to support its research activities. The confidence displayed in the centre by early benefactors has served as a valuable and consistent source for funding over the decades and is testimony to the ability of ICCBS to sustain high levels of excellence.
- **Measure output:** Research output, measured in terms of research articles and their impact factors in peer-reviewed international journals, has helped ICCBS gain visibility in the global scientific community. So too has the large number of ICCBS graduates who now work in universities, research centres and private industry in Pakistan and abroad. ICCBS graduates deserve a great deal of credit for having helped to transform Pakistan's pharmaceutical industry into a profitable domestic industry with strong potential for future growth. Medicines previously imported from abroad are now produced in Pakistan thanks, in part, to research done at ICCBS. Such visible impacts, which positively affect the lives of all Pakistanis, have enhanced the reputation of ICCBS and largely account for why the centre is held in such high esteem throughout the country and region.

- **Sustain standards:** "Achieving excellence is not as difficult as maintaining it", says Choudhary wryly. Every five years, ICCBS has outside experts conduct an external review of the Center's performance. Such detailed evaluations serve to identify gaps and weaknesses in the system so that they can be rectified in the future. The audits have helped accelerate reforms at ICCBS and have played an important role in building its credibility and international reputation.
- **Be present**: ICCBS has forged numerous international collaborations with scientific institutions in both developed and developing countries. The centre has signed memorandums of understanding with universities and research institutes in nearly 30 countries. Collaborative activities, for example, take place with scientists from the University of Rhode Island and Mississippi University in the United States, Tübingen University and University of Hamburg in Germany, and the University of Rennes in France.

ICCBS, moreover, seeks to forge both North-South and South-South collaborations. For example, it has an agreement with Sultan Qaboos University in Oman to promote bilateral scientific cooperation and academic exchange in the agriculture sciences. ICCBS also has a joint initiative with the Centre for Science and Technology of the Non-aligned and Other Developing Countries (NAM S&T Centre), headquartered in Delhi, India, to provide opportunities to researchers in developing countries to work in ICCBS laboratories. And it has a similar arrangement with TWAS that provides fellowship opportunities to young scientists from developing countries seeking to pursue postgraduate and postdoctoral research in the chemical and biological sciences at ICCBS.



In addition, ICCBS and the Commission on Science and Technology for Sustainable Development in the South (COMSATS) have signed a memorandum of understanding with ICCBS to make education, training and research opportunities available to young faculty members and technicians in COMSATS member states. Likewise, the OIC Standing Committee on Scientific and Technological Cooperation (COMSTECH) has named ICCBS its primary research centre for the biological and chemical sciences, opening up the centre's facilities to researchers and technicians from the 57 OIC member countries.

Through such programmes, hundreds of scientists visit the centre each year to conduct collaborative research.

"Our focus has been on research and training, and that is where it will remain in the years ahead as we seek to create a pillar of scientific capacity-building and excellence in a country and region where science can and must play a critical role for advancing social and economic well-being", says a determined Choudhary.

"No one can predict the future. But the present lies before us, providing both immediate opportunities and challenges. We at ICCBS will take advantage of whatever the present provides to build an ever-stronger institution capable of serving the larger purpose of helping to build a more economically secure and peaceful country."

Acknowledgements

The authors of this booklet, Ameen Amjad Khan and Daniel Schaffer, would like to thank the staff at the International Center for Chemical and Biological Sciences (ICCBS) for their invaluable assistance. This publication would not have been possible without their generous help and patience. We extend a special thanks to Atta-ur-Rahman and Iqbal Choudhary for taking the time from their busy schedules to offer their insights and thoughts about ICCBS, and to Syed Ghulam Musharraf for accompanying Ameen during his visit to various facilities at the Center. In addition, we very much appreciate the careful reading and insightful comments of Imtinan Elahi Qureshi, executive director of COMSATS, and his enthusiasm in partnering with us on this initiative. Finally, we would also like to extend our gratitude to Tasia Asakawa, Gisela Isten and Cristina Serra, members of the TWAS public information office, for their skilful administrative and editorial help.

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COMSATS

The **Commission on Science and Technology for Sustainable Development in the South (COMSATS)** is an intergovernmental organization based in Islamabad, Pakistan. Founded in 1994, it seeks to achieve sustainable development in developing countries through the use of science and technology (S&T). COMSATS is comprised of 21 member countries in three continents. It has an international network of 17 S&T institutions. The executive director is Imtinan Elahi Qureshi.

COMSATS' mission is to foster sustainable socio-economic development in the South by building capacities in – and by making judicious use of – science and technology. To advance its objectives, COMSATS fosters South-South and North-South collaboration and exchange in science. Its broad objectives include:

- Sensitizing the countries in the South to the centrality of S&T in the development process, the importance of allocating adequate resources for research and development, and the value derived from integrating S&T into national and regional development plans.
- Supporting the creation of a network of international S&T centres for sustainable development in the South.
- Developing programmes and initiatives among major scientific organizations to promote S&T in the South.

For additional information, see **www.comsats.org**.

INNOVATIVE EXPERIENCES IN SCIENCE AND TECHNOLOGY SERIES

For the past decade, TWAS – in collaboration with several other organizations and funding agencies, including the UNDP's Special Unit for South-South Cooperation (UNDP-SSC), the Global Environmental Facility (GEF) and the Packard Foundation – has published a series of profiles focusing on scientific institutions of excellence in the developing world. The case study on the International Center for Chemical and Biological Sciences (ICCBS), which is presented here, is the first with our new partner, the Commission on Science and Technology for Sustainable Development (COMSATS). All case studies can be browsed online at www.twas.org. For print copies, contact info@twas.org.

TWAS

TWAS, the academy of sciences for the developing world, is an autonomous international organization that promotes scientific capacity and excellence in the South. Founded in 1983 by a group of eminent scientists under the leadership of the late Nobel Laureate Abdus Salam, TWAS was officially launched in Trieste, Italy, in 1985, by the secretary-general of the United Nations.

TWAS has nearly 1,000 members from 90 countries, over 85% of whom live and work in developing countries. A Council of 13 members is responsible for supervising the Academy affairs. TWAS is assisted in the administration and coordination of programmes by a secretariat headed by an executive director. The secretariat is located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. UNESCO is responsible for the administration of TWAS funds and staff. The Italian government provides a major portion of TWAS funding. The executive director is Romain Murenzi.

The main objectives of TWAS are to:

- Recognize, support and promote excellence in scientific research in the South;
- Provide promising scientists in the South with research facilities necessary for the advancement of their work;
- Facilitate contacts between individual scientists and institutions in the South;
- Encourage South-North cooperation between individuals and centres of scholarship.

To achieve these objectives, TWAS is involved in various activities and collaborates with a number of organizations, especially UNESCO and ICTP.

For additional information, see **www.twas.org**.

EXCELLENCE IN SCIENCE

This series of booklets – published by TWAS, the academy of sciences for the developing world – highlights successful scientific institutions in the South and explains how their research has both been sustained over a number of years and how it is helping their host nations achieve sustainable economic development.

ISSN 2222-7385

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