

ANNUAL REPORT

IN THE REVIEW



THE AGA KHAN UNIVERSITY
CENTRE FOR REGENERATIVE MEDICINE
AND STEM CELL RESEARCH

January - December 2024



DIRECTOR'S MESSAGE

“ The field of stem cell research and regenerative medicine holds great potential to revolutionize healthcare, offering new hope to patients, particularly in low- and middle-income countries like Pakistan, where affordable access to advanced care is crucial.
Professor Syed Ather Enam

I am proud to share an overview of the Aga Khan University's Centre for Regenerative Medicine and Stem Cell Research's (AKU-CRM) key accomplishments during the year 2024. The field of stem cell research and regenerative medicine holds great potential to revolutionize healthcare, offering new hope to patients, particularly in low- and middle-income countries like Pakistan, where affordable access to advanced care is crucial. Our researchers have remained steadfast in creating knowledge and driving innovation.

This year was significant in terms of our partnership with the University of California, San Francisco (UCSF), where we rekindled our partnership through my recent visit to UCSF in November. This visit was a cornerstone for our shared interest in pushing the boundaries of knowledge across borders and solidifying our existing ties.

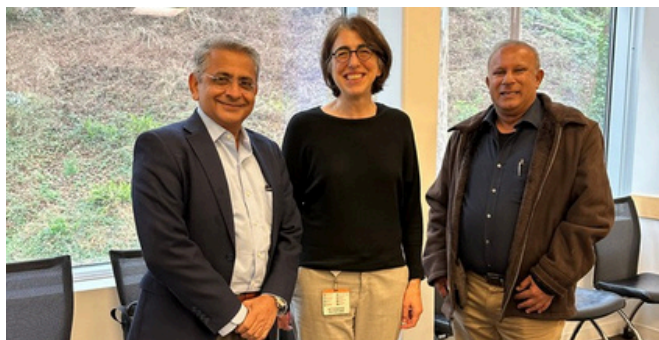
The year witnessed publications in renowned journals, along with faculty talks and presentations. We fostered knowledge exchange through mini-retreats, research meetings, and journal clubs. Young researchers were supported via student exchanges and training programs with collaborators. Our continuous endeavours to seamlessly engage with a broader network within AKU have led to new collaborative ties with the Centre of Oncological Research in Surgery (COORS) and Juma Research Laboratories (JRL).

We hope the forthcoming year will bring exciting breakthroughs, along with grants and funding to make CRM a self-sustainable centre.

With deep gratitude for our team's efforts,
Professor Ather Enam
Director, AKU-CRM

Rekindling Partnership with UCSF

CRM Director visits UCSF



Left (L) to Right (R): Prof. Ather Enam, Director of AKU-CRM, Prof. Tippi MacKenzie Director Eli and Edythe Broad Stem Cell Center, UCSF and Dr Azhar Hussain, Director of Research and Teaching Laboratories, MC



L to R: Prof. Ather Enam, Prof. Susan Fisher and Dr Azhar Hussain



L to R: Prof. Ather Enam, Prof. Arnold Kriegstein, and Dr Azhar Hussain

This year the Director of CRM and the Director of Research and Teaching Laboratories, Medical College (MC) visited our partner Eli and Edythe Broad Center for Regeneration Medicine and Stem Cell Research at UCSF. This visit aimed to reinforce the existing collaborative ties between the two universities and explore new avenues for academic and research partnerships. During this time at UCSF, they engaged in productive meetings with key faculty members and university leadership, where they discussed potential joint projects and research initiatives aligning with their shared interests. The discussions encompassed a range of topics, including collaborative research endeavors, prospective student exchange programs, and capacity building for early-career scientists. This visit has laid a solid foundation for future collaborations, further strengthening the relationship between AKU and UCSF.

New Material Transfer Agreements

New material transfer agreements (MTAs) are being formalized with prominent institutions including Gladstone Institutes, the University of Connecticut, and the University of Chicago, United States to foster collaborative ventures.

BUILDING SKILLS FOR TOMORROW'S INNOVATIONS



Workshop on gene-editing technologies

A three-day workshop in May this year provided participants with hands-on training in advanced gene editing techniques. Attendees learned to isolate and analyze blood-forming stem cells using magnetic sorting and cytogenetic methods.

The workshop covered the reprogramming of somatic cells into induced pluripotent stem cells (iPSCs) for diverse applications. Participants gained practical skills in designing and using CRISPR-Cas9 for precise gene editing, including synthesizing guide RNAs, preparing CRISPR-Cas9 ribonucleoproteins, and performing cell transfections. The workshop also focused on engineering exosomes to deliver CRISPR-Cas9 into cells and included sessions on exosome isolation, liposome fabrication, and viral transduction techniques for gene therapy.

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The workshop has come to be an excellent learning opportunity for me. All talks were comprehensive, and the speakers elaborated on the concepts. - Participant



Researchers in action, at AKU-CRM

FOSTERING COLLABORATIONS

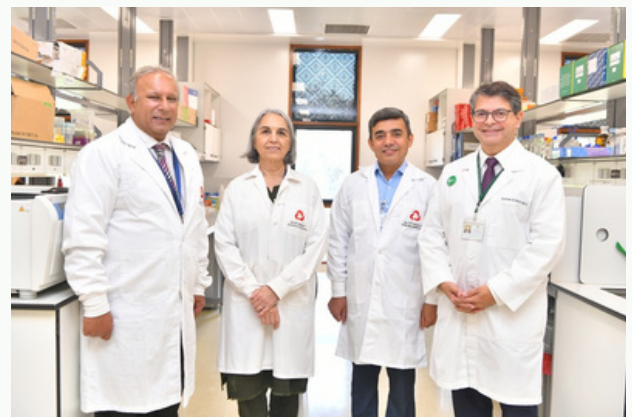
VISUAL RESTORATION

CRM has expanded its research portfolio, introducing a new thematic area: “visual restoration” in March this year. This project is being conducted in collaboration with AKU’s Department of Ophthalmology & Visual Sciences (OVS). The project is led by Dr Irfan Khan, Assistant Professor at CRM. Dr Khan will be working closely with Professor Karim F. Damji, Chair of OVS department and his team. “This project aims to develop photoreceptors and retinal ganglion cells from various stem cell sources, particularly human umbilical cord-derived mesenchymal stem cells, and iPSCs”, explains Dr Khan.

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This new collaboration opens up exciting opportunities for CRM to advance the development of innovative therapies for ocular diseases.

- Dr Irfan Khan



L to R: Dr Azhar Hussain, Professor Rumina Hassan, Dr Irfan Khan and Dr Karim F. Damji.



Cancer and Oncological Research

CRM researchers are working closely with entities like COORS and BBS to advance research in the critical areas of cancer research such as colorectal cancer, triple-negative breast cancer and brain tumors. Researchers are also harnessing the potential of 3D-Bioprinting for developing disease modeling for Glioblastoma. This will ultimately pave the way for new targeted treatment approaches and advance personalized medicine.



Cardiac Regeneration

This thematic area has been introduced with the collaboration of the Department of Biological and Biomedical Sciences (BBS). Dr Satwat Hashmi, Associate Professor and Vice Chair of BBS has a cross-appointment at CRM and will work along with CRM faculty on this project.



Novel Approach to Alzheimer's Treatment

Dr Fawad Ur Rehman is co-leading a study with the BBS department on stem cells derived exosome-based drug delivery for Alzheimer's disease. The research focuses on using allogeneic exosomes to deliver thymol to animal models. The team will isolate and characterize exosomes, load them with thymol, and evaluate their effects in animal models.



Potential International Collaborations

New collaborations are underway with SickKids, Toronto, Canada. Discussions have been held with Prof. Dr. Jim Dowling, a leading expert in gene therapies, focusing on potential researcher exchange programs. Additionally, SickKids Chair, Dr. Stephen Scherer, visited CRM in October to explore collaborative opportunities. CRM researchers are also actively participating in the International Society for Stem Cell Research (ISSCR), further strengthening their global engagement in cutting-edge science.



SCIENTIFIC PUBLICATIONS



Hydrophobic iron oxide nanoparticles

CRM researchers (Dr Afsar Mian: PI) along with researchers from Norway and Italy, published a study in the Journal of Colloid And Interface Science. The study sheds light on creating safer and more effective magnetic nanoparticles for biomedical use by showing how different conditions affect their size, stability, and coating for better medical applications. (Bandyopadhyay S. et al., Hydrophobic iron oxide nanoparticles: Controlled synthesis and phase transfer via flash nanoprecipitation. *Journal of Colloid and Interface Science* 678 (2025) 873–885.)



New Drug Delivery System Shows Promise for Treating Inflammation and Pain

Dr Irfan Khan in collaboration with the University of Karachi, published research in the Journal of Drug Delivery Science and Technology. The study introduces a new drug delivery system using tiny particles that safely release methylprednisolone, a medication for inflammation and pain management. This system shows promise for treating conditions like back pain and disc problems. (Arif, A., et al. (2024). Nanoscale lipid-methylprednisolone conjugates: Effective anti-inflammatory, antioxidant, and analgesic agents. *Journal of Drug Delivery Science and Technology*, 101(Part B), 106251. <https://doi.org/10.1016/j.jddst.2024.106251>)



Advancing understanding of neurodevelopmental challenges

Dr Ambrin Fatima, in collaboration with researchers from Norway, has identified a rare genetic link to a condition characterized by muscle weakness, developmental delays, and intellectual disabilities. The case study, published in the journal Rare, examines three siblings affected by the disorder. (Ibrahim, R., et al. (2024). A novel homozygous frameshift variant in SPTBN4 causes axonal neuropathy with intellectual disability in a consanguineous family. *Rare*, 2, 100037. <https://doi.org/10.1016/j.rare.2024.100037>)



The Promise of Blood Pharming

Dr Hammad Hassan and Dr Sheerien Rajput, published a review article in the journal Frontiers in Hematology that sheds light on the progress and obstacles in developing lab-grown red blood cells in laboratory settings. (Hassan, H., & Rajput, S. (2024). Blood pharming: Exploring the progress and hurdles in producing in-vitro red blood cells for therapeutic applications. *Frontiers in Hematology*, 3. <https://doi.org/10.3389/frhem.2024.1373408>)



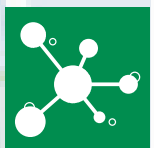
Improving treatments for degenerative diseases

Dr Irfan along with researchers from the University of Karachi, published a study in the Cell Biochemistry and Function Journal which sheds light on repairing damaged tissues. In this study, the researchers focused on a process that activates a molecule called Rap1 GTPase in two types of cells: mesenchymal stem cells (MSCs) and heart muscle cells (cardiomyocytes). The study found that by activating Rap1, the cells are better able to stick together and survive which can supplement the healing process in patients. (Khan, I., et al., (2024). Pharmacological activation of mesenchymal stem cells increases gene expression pattern of cell adhesion molecules and fusion with neonatal cardiomyocytes. *Cell Biochemistry and Function*, 42(5).)



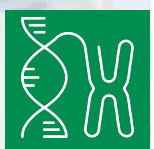
Optimizing Expansion of Stem Cells for Enhanced Cellular Transplantation

In a study, published in the World Journal of Stem Cells in collaboration with the University of Karachi, Dr Irfan Khan published a novel protocol to expand mesenchymal stem cells (MSCs) derived from human umbilical cord tissue, overcoming limitations in stem cell therapy. The method efficiently increases MSC numbers, ensuring high-quality cells for transplantation. (Rajput, S. N., et al., (2024). Expansion of human umbilical cord derived mesenchymal stem cells in regenerative medicine. World Journal of Stem Cells, 16(4), 410-433.)



Titania–Graphene Oxide Nanocomposite

In a study, led by Dr Afsar Mian, researchers from CRM and the University of Engineering and Information Technology Rahim Yar Khan published a paper in the journal ACS Publications. The paper explores how nanotechnology can improve leukemia treatment by delivering cancer drugs more precisely, reducing side effects, and enhancing the effectiveness of the potential treatments. (Batool M. et al., Titania–Graphene Oxide Nanocomposite-Based Philadelphia-Positive Leukemia Therapy. ACS Appl. Bio Mater. 2024, 7, 7, 4352–4365.)



Genomic insights for geneomic diseases

Dr Ambrin Fatima along with researchers from Switzerland, published a study in the journal BMC Genomics that helps uncover the genetic causes of a rare hormone condition called congenital hypogonadotropic hypogonadism in Pakistani families using advanced DNA testing methods. (Zouaghi, Y., et al., (2024). Genome sequencing reveals novel causative structural and single nucleotide variants in Pakistani families with congenital hypogonadotropic hypogonadism. BMC Genomics, 25, 787.



New Tool to Study DNA

Dr Irfan Hussain, along with researchers from Quaid-i Azam University, Islamabad published a paper in the journal FEBS Letters. In this study, the researchers have developed a new computer-based approach for studying enhancers, specific DNA sequences that control the activity of genes in our body. The new tool will serve to complement traditional techniques for studying DNA. (Shireen, H., et al., (2024). Predicting genome-wide tissue-specific enhancers via combinatorial transcription factor genomic occupancy analysis. FEBS Letters.)



Insights into brain development

Dr Ambrin Fatima and researchers from Norway and Belgium conducted a study in which they identified a novel gene Dmrta2 in a Pakistani family with a rare neurodevelopmental disorder. This gene plays an important role in shaping the brain and helps control brain structure by interacting with specific proteins. This study is available as a preprint. (Shen, X., et al., (2024). Evidence that Dmrta2 acts as a transcriptional repressor of Pax6 in murine cortical progenitors and identification of a mutation crucial for DNA recognition associated with microcephaly in humans. bioRxiv.)



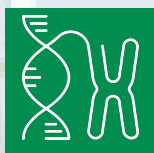
In search of cost-effective methods

In a study, led by Dr Irfan Hussain, CRM researchers introduced a new affordable technique to purify DNA. The researchers compared the effectiveness of this new less costly method with the commercial kits which showed it equally efficient. The new technique, currently published as a preprint. (Fatima, S., et al.,(2024). A rapid, cost-effective method for high-yield DNA purification from PCR products and agarose gels. bioRxiv.)



Effective anti-inflammatory, antioxidant, and analgesic agents

Dr Irfan Khan in collaboration with researchers from the University of Karachi, published a study in the Journal of Drug Delivery Science and Technology that aimed to develop a stable lipid-drug nanoparticles of methylprednisolone, demonstrating potent anti-inflammatory, antioxidant, and pain-relieving effects in cell and animal models. (Arif, A., et al (2024). Nanoscale lipid-methylprednisolone conjugates: Effective anti-inflammatory, antioxidant, and analgesic agents. Journal of Drug Delivery Science and Technology, 101(Part B), 106251.)



Stem cells for Wound Healing

Dr Irfan Khan in collaboration with researchers from the University of Karachi published a study, in the Journal of Drug Delivery Science and Technology that shows Nanoscale Lipid-Diclofenac Conjugates (NLDCs) can accelerate wound healing, reduce pain, and improve tissue regeneration by targeting inflammation and enhancing repair proteins, offering a promising solution for faster, effective recovery to the patients. (Hussain, S. et al. (2024). Enhanced wound healing effects of nanoscale lipid-diclofenac conjugates. Journal of Drug Delivery Science and Technology, 101(Part A), 106223.)



STEM CELL AWARENESS DAY

Every second Wednesday in October marks the Stem Cell Awareness Day. This day is dedicated to raising awareness about the important role of stem cell research in modern medicine. It offers a valuable opportunity to educate the public about the science behind stem cells, their transformative potential in healthcare, and the ethical considerations that accompany their use. This year, in celebration of the occasion, we launched a new page on our website with messages from our leadership and faculty. To raise awareness about stem cells, we also ran a social media campaign on our LinkedIn page with infographics and informational videos.

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We are building a team of pioneering researchers and fostering solid collaborations with leading clinicians across AKU and renowned scientists worldwide. These partnerships ensure that our work remains clinically relevant and focuses on developing innovative, cell-based treatments for once-incurable diseases, including complex conditions like cancer, neurological diseases, blood disorders, heart disorders, and vision impairments.

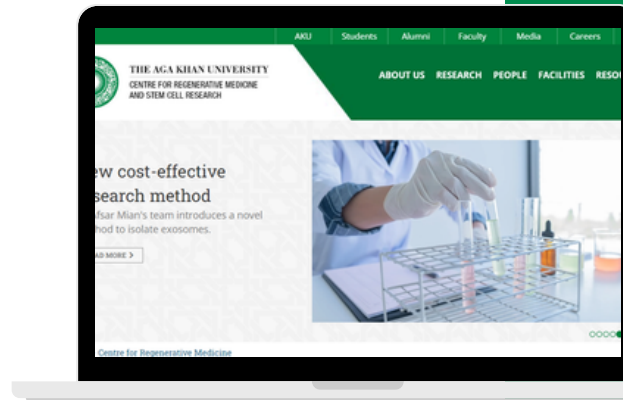
Professor Syed Ather Enam, Director CRM



PUBLIC ENGAGEMENT

Public engagement via digital platforms is one of our integral public outreach approaches. Our efforts have yielded significant results, particularly on LinkedIn and our official website. This growth indicates a strong and engaged professional network and a broader public interest in our content and research.

A highlight of this year's outreach efforts was the launch of our "Did You Know?" campaign on our LinkedIn page. This initiative aims to enhance public understanding of various diseases and their treatment approaches. By breaking down complex scientific concepts into layman content, we're bridging the gap between scientific research and public knowledge.



6.3 K

Subscribers on LinkedIn

132 K

Impressions on LinkedIn
in past 365 days

23 K

Views on Website
in past 365 days



INSPIRING FUTURE SCIENTISTS

14



“As a volunteer at AKU CRM, I have gained hands-on experience in stem cell research and nanotechnology, building on my Biotechnology background. The center’s innovative environment and mentorship have truly enhanced my skills and deepened my passion for regenerative medicine.”

Seema Inayat



08 INTERNS

Volunteers and students joining CRM gain firsthand experience in our cutting-edge work, bridging the gap between scientific innovation and community understanding, while inspiring the next generation of researchers and advocates for regenerative medicine.

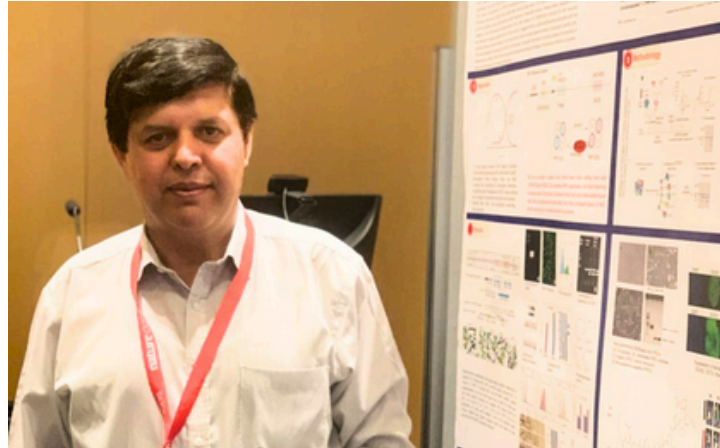
FOSTERING SCHOLARLY DIALOGUE & COLLABORATION



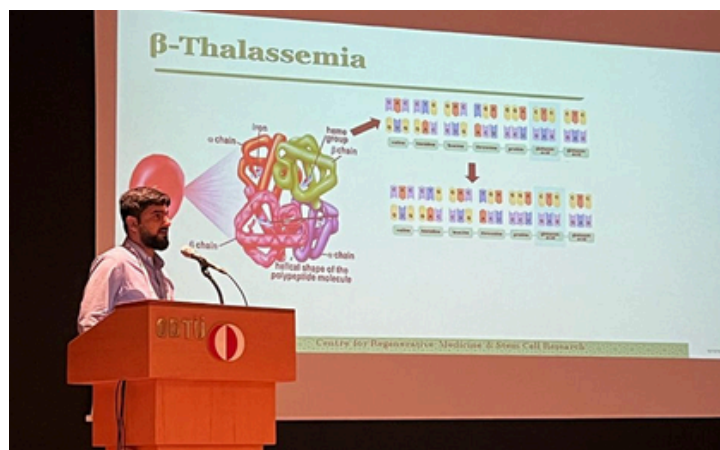
Journal and research meetings are integral to the academic and research environment at AKU-CRM. These forums provide a platform for our faculty and researchers to engage in critical discussions, share knowledge, and stay abreast of the latest developments in stem cell research and regenerative medicine.

In 2024, CRM organized 32 journal club sessions (JC) and research meetings, fostering discussions on scientific advancements. JC meetings have also received AKU's Continuing Medical Education (CME) accreditation, enhancing their value for participants.

FACULTY TALKS



Dr Afsar Mian presented his research at the Nature Conference, in Toronto, Canada, and at notable institutions such as NUST, Islamabad, and the University of Lahore. His presentations highlighted key research advancements in hematopoietic stem cells, the development of induced pluripotent stem cells (iPSCs) from thalassemic patients, and innovative gene editing techniques aimed at producing functional hemoglobin, offering promising insights into the treatment of blood disorders.



Dr Fawad ur Rehman presented his research at the First Conference of the Turkish Society for Extracellular Vesicles held in September in Ankara, Turkey. His presentation focused on the potential of stem cell-derived exosomes as a promising vehicle for delivering CRISPR-Cas9, aiming to make this gene-editing technology "druggable" for the correction of beta-thalassemia.

WELCOMING OUR NEW DIRECTOR

Dr Syed Ather Enam assumed his role as the new Director of CRM, effective September 1, 2024. Dr Enam has previously served as the Chair of the Department of Surgery at Aga Khan University (AKU). Currently, he serves as a Professor of Neurosurgery and is also the Scientific Director of the Centre of Oncological Research in Surgery (COORS), Juma Research Laboratories.



Left (L) to Right (R): Dr Irfan Khan, Dr Irfan Hussain, Dr Fawad Ur Rehman, Dr Ambrin Fatima, Prof. Ather Enam, Dr Sheerien Rajput, Dr Afsar Mian, and Dr Hammad Hassan

In his new role as Director of CRM, Dr. Enam will focus on advancing regenerative medicine and stem cell research across AKU campuses and will endeavor to strengthen our partnership with the University of California San Francisco (UCSF). He will leverage his efforts to foster collaboration among national/ international scientists and stakeholders, translate research into innovative therapies and diagnostic methods, and ensure compliance with the highest ethical and scientific standards.



APPOINTMENTS



DR SYED ATHER ENAM
Professor and Director CRM



DR AZHAR HUSSAIN
Director Laboratories, MC



YASMEEN MUGHAL
Manager, CRM

FACULTY PROMOTIONS



DR AFSAR MIAN
Associate Professor

NEW TEAM ADDITIONS



DR IRFAN KHAN
Assistant Professor



DR RABBIA MUNEER
Post-doctoral Fellow



MANAL FAROOQ
*Research Associate
(Core Laboratory)*



AAFIA SHAHID
Research Associate



SIDRAH SHAMS
Associate



SEEMA INAYAT
Senior Research Assistant



Established in 2016, the Centre for Regenerative Medicine and Stem Cell Research at AKU aims to design novel therapies for major diseases by developing a deeper understanding of disease processes through functional basic science research. We have a small, passionate team of researchers working with our international collaborators at the University of California, San Francisco and other universities on exciting research programs. Most of these programmes are in their exploratory phase. For more information, visit our website.



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