



QATAR BIOMEDICAL RESEARCH INSTITUTE CORE FACILITIES

QBRI
معهد قطر لبحوث الطب الحيوي
Qatar Biomedical Research Institute
جامعة حمد بن خليفة
HAMAD BIN KHALIFA UNIVERSITY



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Driving Forward Cutting-Edge
Research and Innovation



QATAR BIOMEDICAL RESEARCH INSTITUTE CORE FACILITIES

QBRI's core facilities provide a wide spectrum of innovative cutting-edge services and equipment. They are maintained by highly skilled and trained scientists and staff. QBRI's core facilities are located in the HBKU Research and Development Complex (RDC) and are closely integrated with QBRI's research teams in the same building. QBRI's core facilities aim to fulfill the organization's mission through three major operational lines (Fig.1).

These core facilities support QBRI's main biomedical research areas, such as diabetes, cancer, immunity, and neurological disorders. QBRI's core facilities are the backbone for fulfilling HBKU's leading role in training, education, and knowledge transfer for students and the scientific community in Qatar and beyond. QBRI's core facilities are actively embedded in a growing national and international collaborative environment, including academic, clinical, and industry partners.

To this aim, the infrastructure and services of QBRI's core facilities include collaborations with and providing services to local and international entities to increase efficiency, exchange knowledge, and avoid duplication of instrumentation and services. This setup is unique to the region and highlights QBRI's role as a major hub for education, innovation, research, and healthcare development in Qatar, the Middle East, and beyond.

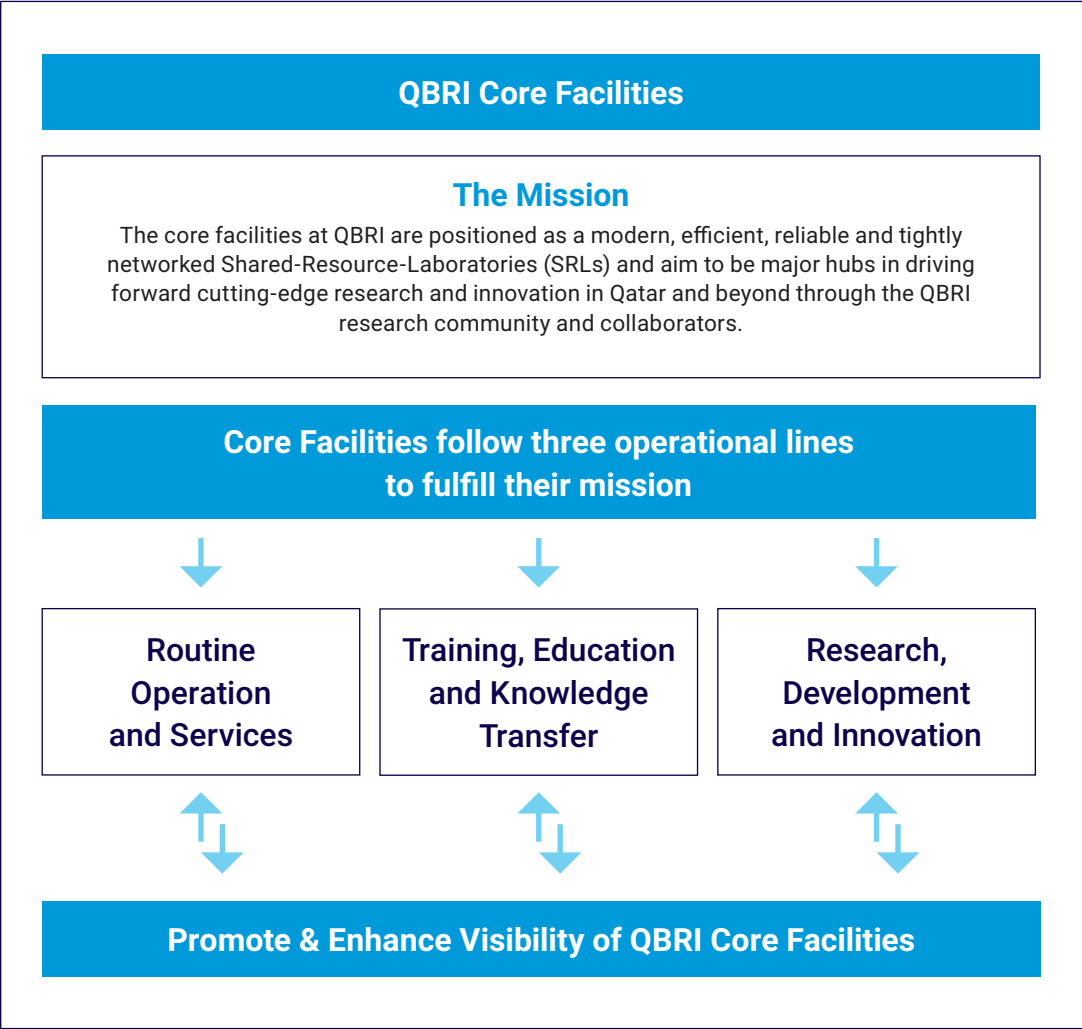


Fig. 1

A summary of equipment and services available at QBRI’s core facilities.

<div>01</div> <div>IMAGING AND FLOW CYTOMETRY CORE</div>		<div>02</div> <div>GENOMICS AND GENOME TECHNOLOGY CORE</div>	<div>03</div> <div>PROTEOMICS CORE</div>
<div>ADVANCED IMAGING AND HISTOPATHOLOGY</div> <div>Major Instruments:</div> <div>▶ Multiphoton</div> <div>▶ Confocal</div> <div>▶ Super Resolution</div> <div>▶ Wide Field Fluorescence</div> <div>▶ Microscopes</div> <div>Major Services:</div> <div>▶ Image Acquisition</div> <div>▶ Histology</div> <div>▶ Experimental Design</div> <div>▶ Data Management</div> <div>▶ Training</div>	<div>FLOW CYTOMETRY</div> <div>Major Instruments:</div> <div>▶ Flow Analyzer</div> <div>▶ Cell Sorter</div> <div>▶ Image Stream</div> <div>▶ CTC System</div> <div>Major Services:</div> <div>▶ Flow Analysis</div> <div>▶ Bulk Cell Sorting</div> <div>▶ Single Cell Sorting</div> <div>▶ Experimental Design</div> <div>▶ Data Analysis</div> <div>▶ Data Management</div> <div>▶ Training</div>	<div>Major Instruments:</div> <div>▶ Illumina HiSeq 4000, 2500 and Miseq</div> <div>▶ Capillary Sequencers</div> <div>▶ Illumina Iscan</div> <div>▶ Nanosttring System</div> <div>▶ QuantStudio 12K Flex</div> <div>Major Services:</div> <div>▶ Experimental Design</div> <div>▶ Whole Genome, Transcriptome, and Exome Sequencing</div> <div>▶ Targeted Gene</div> <div>▶ Genotyping Studies</div>	<div>Major Instruments:</div> <div>▶ BioMark HD Reader and BioMark IFC-HX Controller, Fluidigm</div> <div>▶ SureScan Microarray Scanner G4900D, Agilent</div> <div>▶ HD-X Analyzer, Quanterix</div> <div>Major Services:</div> <div>▶ Olink Technology</div> <div>▶ Sengenics Technology</div> <div>▶ Simoa Technology</div> <div>▶ Consultation and Study Design</div> <div>▶ Data Analysis</div> <div>▶ Data Management</div> <div>▶ Training</div>
<div>04</div> <div>BIOINFORMATICS CAPABILITIES</div>	<div>05</div> <div>STRUCTURAL BIOLOGY CORE</div>	<div>06</div> <div>STEM CELLS AND GENOME ENGINEERING CORE</div>	<div>07</div> <div>CLINICAL RESEARCH CORE</div>
<div>Major Instruments:</div> <div>▶ 472-core High performance cluster with 720 TB of InfiniBand-connected file storage</div> <div>▶ 20-core servers (10)</div> <div>Major services:</div> <div>▶ Whole Exome Sequencing Analysis</div> <div>▶ RNA Sequencing and Differential Expression Analysis</div>	<div>Major Instruments:</div> <div>▶ X-Ray System</div> <div>▶ ITC</div> <div>▶ Biacore (SPR)</div> <div>▶ CD</div> <div>▶ HPLC-MALS</div> <div>▶ NanoIR</div> <div>▶ Fermenter</div> <div>▶ Mosquito LCP</div> <div>Major Services:</div> <div>▶ Protein Production and Crystallization Protein Characterization</div> <div>▶ Structure Determination</div> <div>▶ Protein Interaction Analysis</div>	<div>Major Instruments:</div> <div>▶ Automated Cell Colony Picker</div> <div>▶ Tissue Culture Capabilities</div> <div>▶ 3D Cell Culture Expansion and Differentiation Platform</div> <div>▶ Amaxa 4D Electroporator</div> <div>Major Services:</div> <div>▶ Generation of hiPSCs</div> <div>▶ Karyotype and Pluripotency Characterization of hiPS and hESCs (hPSC)</div> <div>▶ Directed Differentiation of hPSCs to Beta Cells, Neurons, and Organoids</div> <div>▶ Genome Engineering of hPSCs by CRISPR/Cas9</div> <div>▶ Consulting and Training</div>	<div>Major Services:</div> <div>▶ Storing of Biospecimens in Secure Freezers</div> <div>▶ Dedication of Research Assistant for Short and Long Term Projects</div> <div>▶ Data Storage for Future Research</div>



01 IMAGING AND FLOW CYTOMETRY CORE

Imaging

The mission of the QBRI Imaging Core is to provide researchers with efficient, reliable, and innovative imaging solutions at the highest standards of instrumentation, accuracy, quality control, and professional expertise. This is achieved by providing access to state-of-the-art equipment and the expertise of highly skilled professionals in microscopy and imaging. The core is equipped with the most advanced and automated digital microscopy and live-cell imaging instrumentation. These technologies allow investigators to conduct a wide range of imaging research experiments that help answer important biomedical questions related to their fields of study. The core also provides training and easy access to researchers, as well as services that range from routine microscopy to cutting-edge live-animal multi-photon microscopy. The core's expertise and services provide support in the planning and evaluation of histopathology experiments, tissue processing and sectioning, cryopreservation, histological staining methods, and laser caption microdissection microscopy.

The following resources and services are offered: Optical Microscopy and Digital Imaging Equipment

- ▶ Nikon A1+ MultiPhoton microscope
- ▶ Zeiss LSM 780 confocal microscope inclusive of incubation chamber
- ▶ Leica GSD super resolution microscope
- ▶ Zeiss Primo Star upright microscope
- ▶ Zeiss Axio Imager Z2 upright + camera fully automated fluorescence microscope
- ▶ Olympus Inverted microscope IX73 and IX83
- ▶ Zeiss Axio Imager A2 Microscope
- ▶ Several Olympus microscopes and Phase Contrast microscopes (Upright and Inverted)

Services – Optical Microscopy and Digital Imaging

- ▶ State-of-the-art microscopes for a wide variety of imaging research experiments
- ▶ Cutting-edge bright-field, dark-field and fluorescence imaging
- ▶ Standard, confocal and multi-photon microscopy applications
- ▶ Automated digital microscopy
- ▶ Advanced high-end live-cell imaging
- ▶ Image processing and analysis tools
- ▶ Training and education in microscopy and imaging
- ▶ Enhanced level of imaging research
- ▶ Support with data analysis and presentation
- ▶ Data management and storage

Histopathology Equipment

- ▶ Digital whole slide scanner, Leica Aperio® AT2 Turbo
- ▶ High quality digital slide scanner, Leica Aperio CS2
- ▶ Automated upright microscope, Leica DM4000B
- ▶ Semi-motorized rotary microtome, Leica RM2245
- ▶ Cryostat, Leica Biosystems CM3050 S
- ▶ Bright Instrument 8000 Sledge (Sliding Microtome)
- ▶ Leica rotary microtome RM2125
- ▶ Leica ASP6025 Automated Tissue Processor
- ▶ Leica EG1150 modular tissue embedding center
- ▶ Leica Biosystems ST5020 Multistainer
- ▶ CryoViz robotic sectioning and imaging system
- ▶ Dako Omnis automated staining System GI100
- ▶ Dako Coverslipper

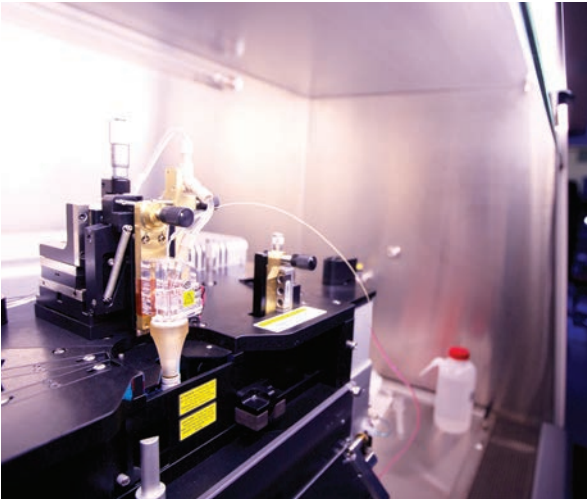
Services – Histopathology

- ▶ Tissue processing, embedding and sectioning
- ▶ Cryopreservation and cryosectioning (Leica Cryostat and Microtome systems)
- ▶ Different histological staining methods, such as H&E and special stains
- ▶ Immunohistochemical and immunofluorescence techniques
- ▶ Laser Capture Microdissection microscopy (Leica)
- ▶ Expert advice in the planning and evaluation of histopathology experiments



Flow Cytometry

The mission of the QBRI Flow Cytometry Core is to offer researchers efficient, reliable, and innovative flow cytometry and cell sorting solutions at the highest standards of instrumentation, quality control, biosafety, and productivity. This is achieved by providing access to state-of-the-art instruments and professional flow cytometry and cell sorting services supported by highly motivated staff with extensive skills and expertise in flow cytometry. In addition, the Flow Cytometry Core provides support and guidance regarding flow cytometry education, operation of instruments, software workflows, and biosafety to fulfil its mission to create a productive, collaborative, and highly innovative environment for research and development.



The following resources and services are currently offered:

Equipment

- ▶ BD Accuri C6 flow cytometer (2 lasers, 6 detectors)
- ▶ BC Gallios flow cytometer (3 lasers, 12 detectors)
- ▶ BD LSR Fortessa X-20 SORP flow cytometer (5 lasers, 20 detectors)
- ▶ Amnis Image Stream MKII imaging flow cytometer (2 lasers, 6 detectors)
- ▶ CellSee CTC Single Cell Analysis System
- ▶ 2 x BD FACSAria SORP cell sorter (5 lasers, 18 detectors)
- ▶ BD FACSJazz cell sorter (3 lasers, 8 detectors, in BSL-2 cabinet)
- ▶ Flow cytometry software analysis (BD FACSDiva, FlowJo, BD Software, ModFit LT, etc.)

Services

- ▶ Advice on sample preparation (reagent selection, protocol design & optimization)
- ▶ Advice and support on multicolor panel design (negative controls, compensation setup, and multicolor panels)
- ▶ Multicolor sample acquisition and analysis
- ▶ Single cell analysis and sorting applications
- ▶ Aseptic cell sorting and biosafety advice
- ▶ Surface phenotyping and intracellular staining
- ▶ Apoptosis, cell cycle analysis, and proliferation
- ▶ Flow cytometry training and education of researchers and students
- ▶ Support with data analysis and presentation
- ▶ Data management and storage



02 GENOMICS AND GENOME TECHNOLOGY CORE

The Genomics Core at QBRI actively supports research by providing advanced research technologies and services to the research community at HBKU and QBRI, and their collaborators from academia and the industry. The Genomics Core facility houses various state-of-the-art technological platforms to sequence nucleic acids by next-generation sequencing (NGS) as well as capillary sequencing methods and different array platforms. Applications include sequencing of different nucleic acid templates, high throughput genotyping, epigenome analysis, gene expression analysis, single-cell technologies, NanoString technologies, and digital PCR methods.

The following resources and services are offered: **Next Generation Sequencing**

- ▶ Illumina HiSeq 4000 and 2500 platforms (high throughput sequencing for whole exome sequencing, and RNA sequencing “total RNAseq, mRNAseq, miRNAseq”)
- ▶ Illumina MiSeq (for smaller genome, amplicon sequencing and targeted sequencing)

Genetic Analyzers

- ▶ ABI 3500xL Dx (24-capillary electrophoresis)
- ▶ ABI 3730XL (96-capillary electrophoresis)

Targeted Gene Expression Analysis

- ▶ NanoString Technologies (targeted gene expression for up to 800 targets “mRNA expression, long non coding lncRNA expression, Leukemia fusion gene analysis and miRNA expression)
- ▶ QuantStudio 12K Plus for qPCR and Digital PCR and Gene Expression Panels studies

Single Cell Genomics

- ▶ Bio-Rad ddSEQ System and NGS platform (single cell RNA sequencing)

DNA methylation analysis

- ▶ Illumina HiSeq 4000 platform (Methylated DNA immunoprecipitation sequencing “MeDIP-Seq”, whole-genome bisulfite sequencing and amplicon methyl-seq or target enrichment)
- ▶ Illumina iScan array scanner (methylation profiling microarray of over 850,000 methylation sites)

Laboratory Services

- ▶ Advice on experimental design and sample preparation
- ▶ Quality control of nucleic acid materials by LabChip and Bioanalyzer
- ▶ Different types of sequencing library preparation and data generation by high-throughput sequencing methods
- ▶ Quantitative PCR for differential gene expression analysis
- ▶ Helping researchers with the generation of preliminary data for grant applications
- ▶ Data management and storage

03 PROTEOMICS CORE

The Proteomics Core provides services and supports investigators at QBRI, HBKU colleges, and other institutions in Qatar and abroad with the aim of addressing and solving protein-based challenges related to their research projects. This core operates a cutting-edge technological platform, offering users access to high throughput, affinity-based proteomics assays such as Olink, Sengenics, and Simoa. In addition to analytical capabilities, the core also offers additional services, including technological consultation, study design, custom panel selection, experimental design optimization, and biostatistical analysis.

Equipment

- ▶ Fluidigm Biomark HD: Used for proximity extension assays (known as Olink technology)
- ▶ SureScan detection system: Used for Sengenics proteomics technology
- ▶ HD-X analyzer, Quanterix (measurements of proteins at the femtomolar scale)

The following resources and services are offered:

OLINK technology: Protein Biomarker Discovery

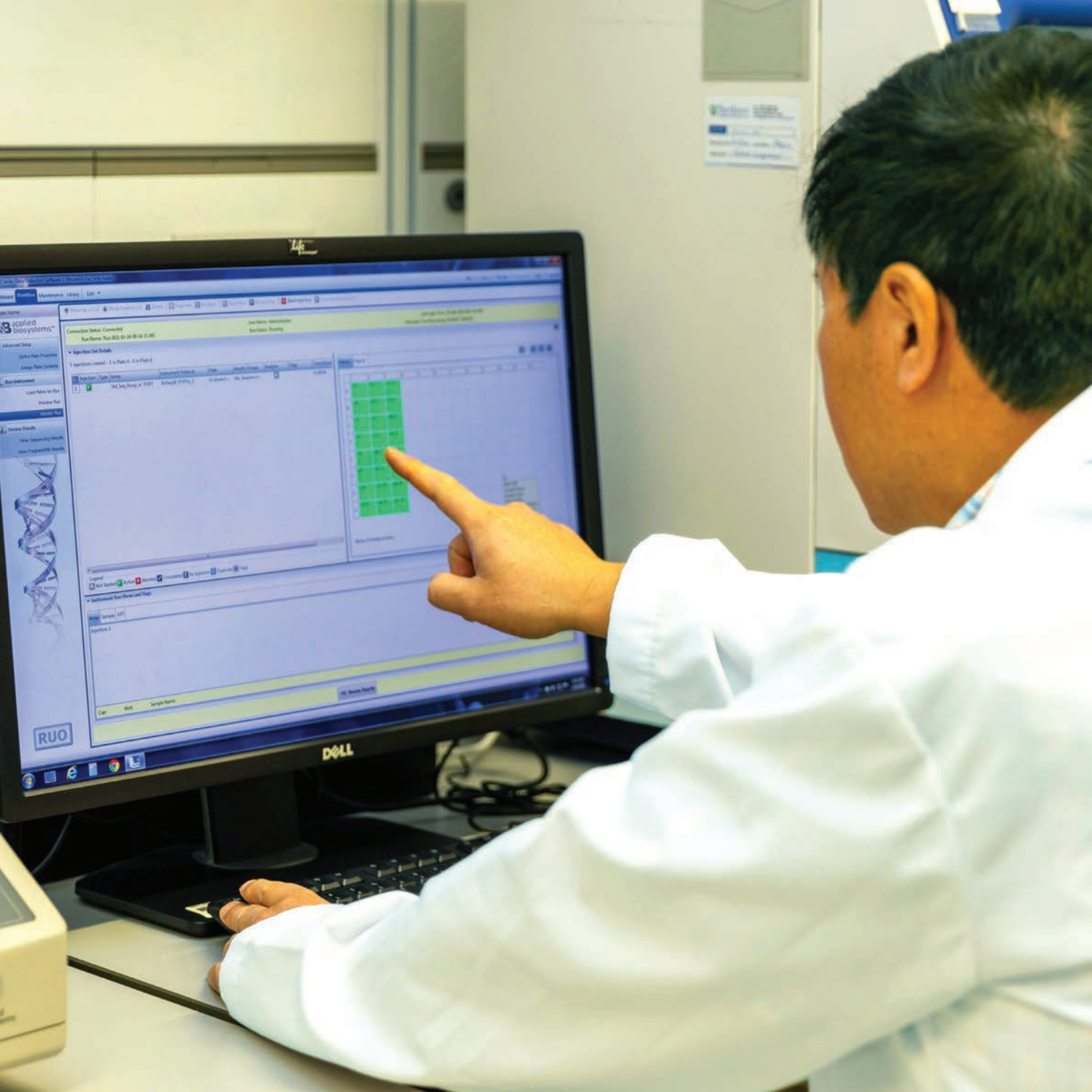
Olink technology provides high-multiplex immunoassays using a Proximity Extension Assay (PEA) technology capable of measuring 92 biomarker proteins across 88 samples simultaneously using only 1 µl of plasma, serum, saliva, or CSF. Olink services offer 13 different panels, targeting a total of 1200 established and/or exploratory human biomarkers panels: cardio-metabolic, cardiovascular, metabolism, inflammation, immune response, neurology and neuro-exploratory, oncology, organ damage, and cell regulation/development. Each panel is focused on a disease or key biological process.

Sengenics technology: Auto-antibody Biomarker Discovery

Sengenics technology is based on the detection and identification of novel auto-antibodies in plasma or serum using KREX protein array technology. Protein arrays made with the KREX technology are characterized by correct folded proteins that ensure high specificity, reproductivity, and sensitivity. Sengenics services offers 3 different panels and also the possibility of making custom panels. The main panel that is used in the core laboratory is the Immunome Discovery Array, which contains up to 1600 human proteins including kinases, signaling molecules, cytokines, interleukins, chemokines, and cancer antigens. Autoantibody binding is detected and quantified using a Cy3-labelled anti-human IgG and Cy5-labelled anti-human IgM polyclonal antibodies. Signals are recorded using a microarray scanner at 10µm resolution. The output from the microarray scanner (a raw .tiff image file) is extracted using GenePix Pro 7 software and analyzed using Sengenics data processing pipeline.

SIMOA Technology

The HD-X Analyzer from Quanterix is a fully automated digital immunoassay instrument capable of analyzing samples using the proprietary single-molecule array (Simoa) technology and delivering ultra-sensitive measurements of the targeted proteins over a wide dynamic range and with low CV's. Simoa detects thousands of single protein molecules simultaneously on a variety of different matrices (Serum, plasma, SCF, urine, and cell extract) at femtomolar (fg/ml) concentrations, offering a 1000-fold improvement in sensitivity.



04 BIOINFORMATICS CAPABILITIES

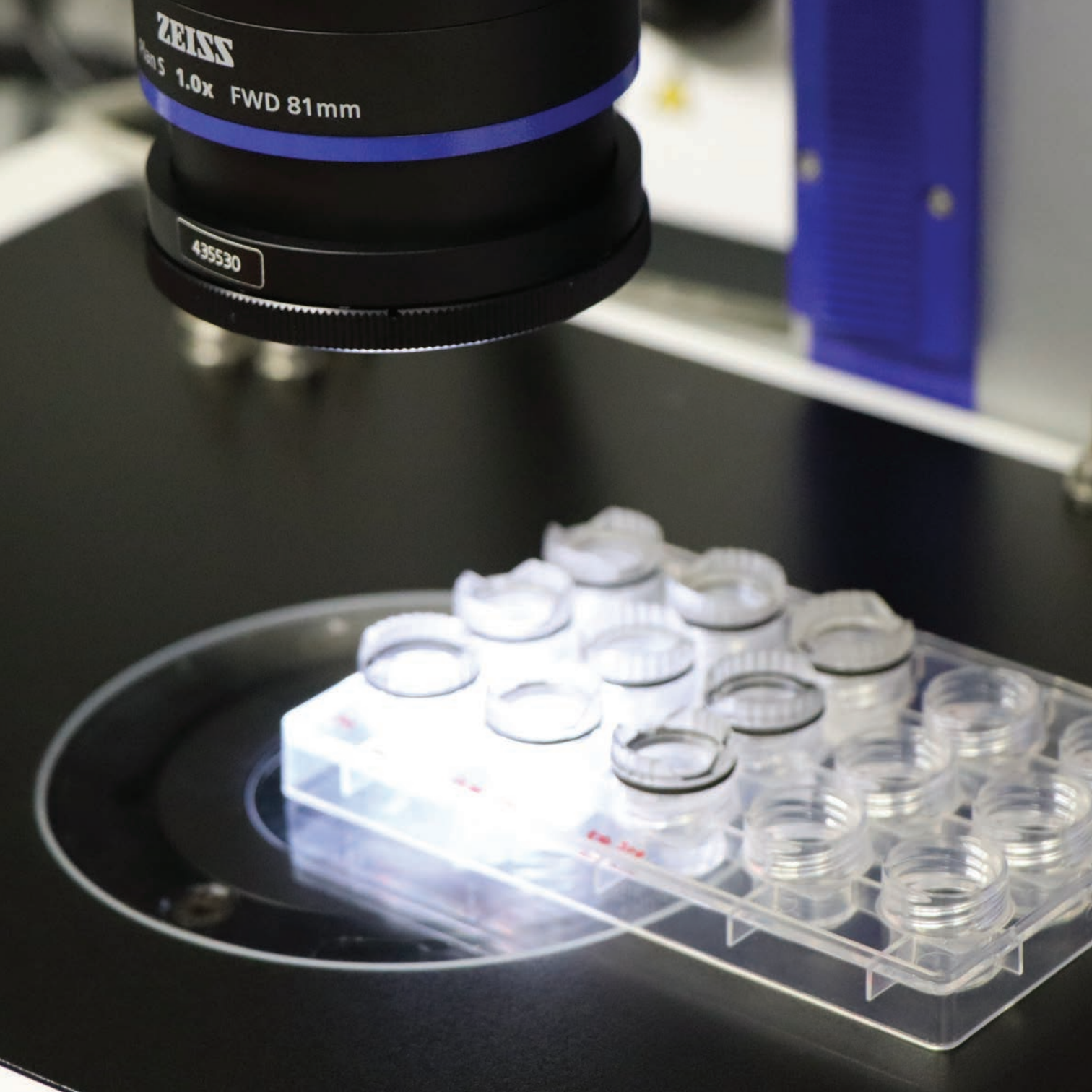
QBRI's Bioinformatics Capabilities provide support for data analysis and interpretation, as well as developing software and pipelines for analyzing next-generation data sets from DNA and RNA based experiments. These capabilities contribute to a wide range of research projects and collaborate closely with the Genomics and Proteomics Cores to provide high quality informatics support to all users. The QBRI HPC enables the rapid computational analysis of large data sets across a wide range of informatics tasks. In line with the computational needs of QBRI, HPC is primarily used for the analysis of whole-exome sequencing for variant analysis, RNA sequencing for differential expression analysis, ChIP-Seq analysis, MeDIP analysis, and protein analysis.

Equipment

- ▶ HPC: 472-core High-Performance Cluster, made up of
 - ▶ 10 36-core compute nodes with 256GB of memory
 - ▶ Two 56-core compute nodes with 1TB of memory
 - ▶ 720 TB of InfiniBand-connected file storages
- ▶ 10 Individual 20-core servers with 128GB of memory to carry out pipeline development and testing
- ▶ 400TB of Network Storage

The following resources and services are offered:

- ▶ Whole Exome Sequencing analysis
- ▶ RNA Sequencing and Differential Expression analysis
- ▶ Single-Cell Sequencing analysis
- ▶ Custom pipeline development
- ▶ Bioinformatics training



05 STRUCTURAL BIOLOGY CORE

The Structural Biology Core is currently the only advanced, comprehensive protein laboratory in Qatar, and is unique to the region. This advanced core provides full biochemical and biophysical characterization, including protein-protein and protein-nucleic acid interactions. In addition, X-ray crystallography and other structural tools are available to afford atomic-level descriptions of systems. The core supports protein biophysics and structural biology. The nature and complexity of protein research requires highly sophisticated technologies and advanced equipment. The needs of protein studies are quite diverse, including studies of single proteins, protein complexes, and interactions among groups of proteins, which may relate to structure, function, or biology. This core is committed to facilitate these needs within QBRI and Qatar. The Protein Biophysics unit houses a Mosquito LCP crystallization robot, which can carry out both membrane and non-membrane protein crystallizations. X-ray crystallography is supported by the latest generation microfocus source with high intensity, as well as a robust and sensitive CPAD detector. The unit also has a cryostream with an air compressor. This equipment facilitates the rapid screening of macromolecular crystals, as well as data collection for structure determination. In addition, several nitrogen dewars are housed for the storage and transport of crystals to synchrotron facilities. Support staff maintains all crystallographic software. QBRI's Structural Biology Core is well established and highly functional. Research collaborative initiatives with various stakeholders are ongoing, including with QBRI's diabetes and neurological disorders teams.

The following resources and services are offered:

Equipment

- ▶ Shaker/Incubator (Innova 44R)
- ▶ Fermenter (BioFlow 115)
- ▶ Ultracentrifuge (Beckman)
- ▶ FPLC (AktaXpress)
- ▶ TyphoonScanner (FLA 9500)
- ▶ Sonicator (Qsonica)
- ▶ CD (Applied Photophysics)
- ▶ ITC (Microcal AutoITC-200)
- ▶ Crystallization Robots (Mosquito LCP)
- ▶ X-ray Diffractometer (Bruker D8 Venture with Cobra Cooling system)
- ▶ NanoIR (Anasys/Bruker)

Bimolecular and Macromolecular Analysis

- ▶ Mosquito LCP for crystallization screening (TTP Labtech)
- ▶ D8 VENTURE X-ray Diffractometer for 3-D structure determination (Bruker)
- ▶ Circular Dichroism (CD Spectrometer)
- ▶ Isothermal Titration Calorimetry (ITC) from GE Healthcare Lifesciences



06 STEM CELLS AND GENOME ENGINEERING CORE

Human pluripotent stem cells (hPSCs) that include induced pluripotent stem cells (iPSCs) and embryonic stem cells (ESCs) provide an excellent platform for studying human development, disease progression modeling, drug screens, and cell-based therapies. The main objective of the Stem Cells and Genome Engineering Core is to facilitate the development of basic and translational stem cell research by providing scientific expertise, iPSCs derivation, directed differentiations, and genome engineering services to researchers. The facility is fully equipped with standard and state-of-the-art cell culture, cell biology, and molecular biology equipment. The Stem Cells and Genome Engineering Core is currently working with QBRI's neurological disorders and diabetes research teams, as well as with the Harvard Stem Cell Institute for generating and engineering iPSCs and their directed differentiation into cortical neurons, brain organoids, and pancreatic beta cells.

The following resources and services are offered:

Equipment

- ▶ Fully equipped cell culture facilities
- ▶ Quarantine tissue culture room
- ▶ Automated cell colony picker
- ▶ 3D cell culture expansion and differentiation platforms
- ▶ Amaxa 4D and Neon Electroporators

Services

- ▶ Consultation and project design
- ▶ Generation of human induced pluripotent stem cells (iPSCs)
- ▶ Karyotypic and pluripotency characterization of human iPSC and embryonic stem cells (ESCs)
- ▶ Genome engineering services to create isogenic human pluripotent stem cell (ESCs and iPSCs) lines
- ▶ Gene knockout/in via CRISPR/Cas9, TALENs, Recombinases, and transposases
- ▶ 3D adoption and directed differentiation of ESCs and iPSCs in a small-scale bioreactor setting
- ▶ Directed differentiation of ESCs and iPSCs into cortical neurons, organoids, and pancreatic beta cells
- ▶ Training and thesis supervision for students using ESCs and iPSCs in research projects



07 CLINICAL RESEARCH CORE

In line with QBRI's vision to improve and transform healthcare through innovation in prevention, diagnosis, and treatment of diseases, the investigators at QBRI are involved in clinical and translational research projects in collaboration with local, regional, and international clinicians and hospitals. The main mission of the Clinical Research Core (CRC) is to provide standard operating procedures and resources to collect different bio-specimens to support QBRI's researchers in order to advance and promote clinical and translational research activities at QBRI.

The following resources and services are offered:

Equipment

- ▶ BL2 biosafety cabinets
- ▶ Freezers (-80, -150 and -20°C) with backup freezers
- ▶ Fridges (4°C)
- ▶ Brooks BioStore™ IIIv -80°C automated storage system
- ▶ Refrigerated centrifuges
- ▶ Labeling system (BRADY)
- ▶ Barcode reading system

Services and Resources

- ▶ Standard operating procedures for collecting different biospecimens: blood, saliva, and urine, etc.
- ▶ Processing biospecimens
- ▶ Labeling biospecimens
- ▶ Storing biospecimens in secure freezers
- ▶ Training research assistants
- ▶ Research assistants for short and long-term projects
- ▶ Consumables for biospecimens processing and storage
- ▶ Streamlining data and/or biospecimens transfer
- ▶ Data storage for future research

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