جامعة نيويورك أبوظبي

NYU | ABU DHABI

CORE TECHNOLOGY PLATFORMS

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NYU Abu Dhabi is located at a new crossroads of the world; it is enriched by the intellectual vitality and research opportunities of a new world-class research institute, and benefits from an active connection to NYU New York and other NYU global sites. NYU Abu Dhabi provides the finest educational opportunities and supports innovative research programs that push forward the frontiers of knowledge, responding in powerful and interdisciplinary ways to vital local and global challenges. NYUAD advances NYU as a model University and contributes in multiple ways to the development of a sustainable, knowledge-based economy in Abu Dhabi.

NYU Abu Dhabi has dedicated significant resources to developing one of the premier science and engineering research laboratories in the region. An integral component of the laboratories is the Core Technology Platforms, which are shared facilities that support research activities across disciplines.

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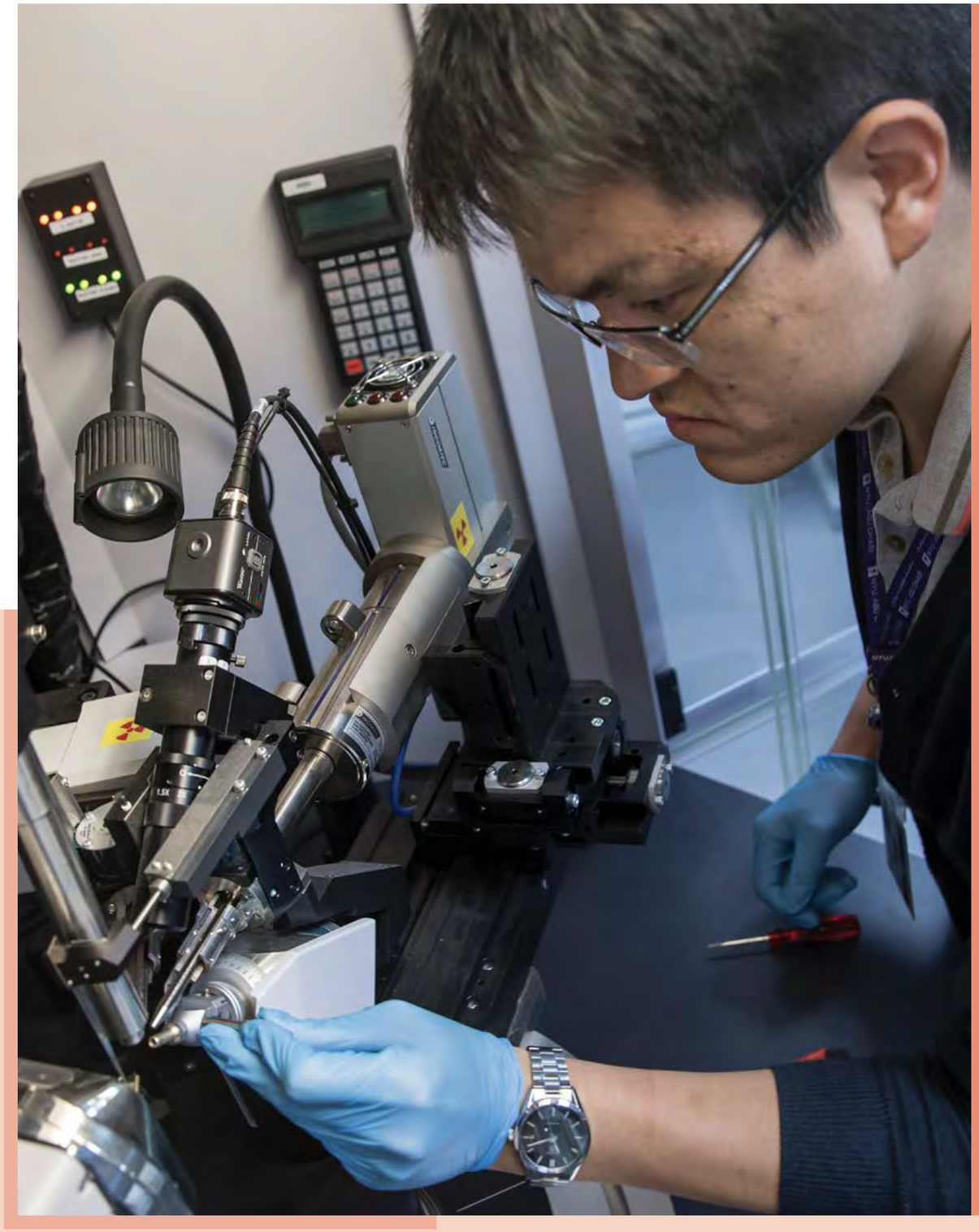
Each Core Technology Platform (CTP) consists of a suite of research-grade equipment and are defined by the type of research they facilitate. The CTPs will continue to evolve and develop as new technology is added and new areas of research are conducted at NYUAD.

Support is provided by a team of highly qualified specialists who maintain and upgrade the equipment, define standards for operational performance, and provide service across the CTPs.

CORES



ANALYTICAL AND MATERIALS CHARACTERIZATION

The Analytical and Materials Characterization Core Technology Platform supports scientific advancements and development of new technologies. This facility provides state-of- the-art instrumentation with major capabilities for fundamental studies of the surface, ultrastructure and interfacial properties of materials in the following major areas:

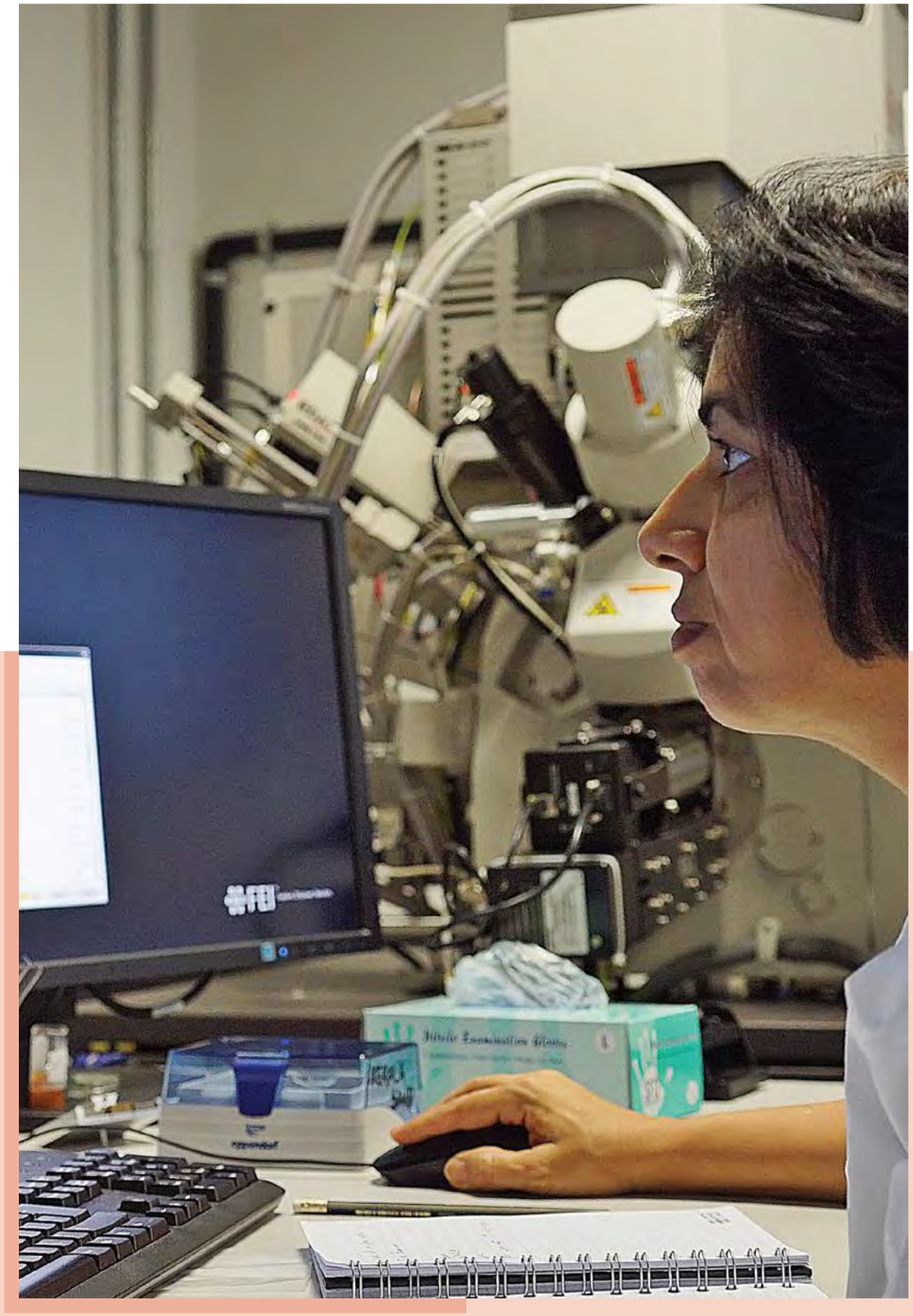
Materials Characterization

Characterization is used by researchers in the fields of chemistry, physics, biology, engineering, and archeology to study the properties of samples by morphology, mechanical, chemical and crystalline properties from macro to nanometer scale. The main techniques used in this area are optical microscopy, scanning electron microscopy, transmission electron microscopy, energy-dispersive x-ray spectroscopy, x-ray fluorescence, focused ion beam, atomic force microscopy, and mechanical testing.

Crystallography Characterization

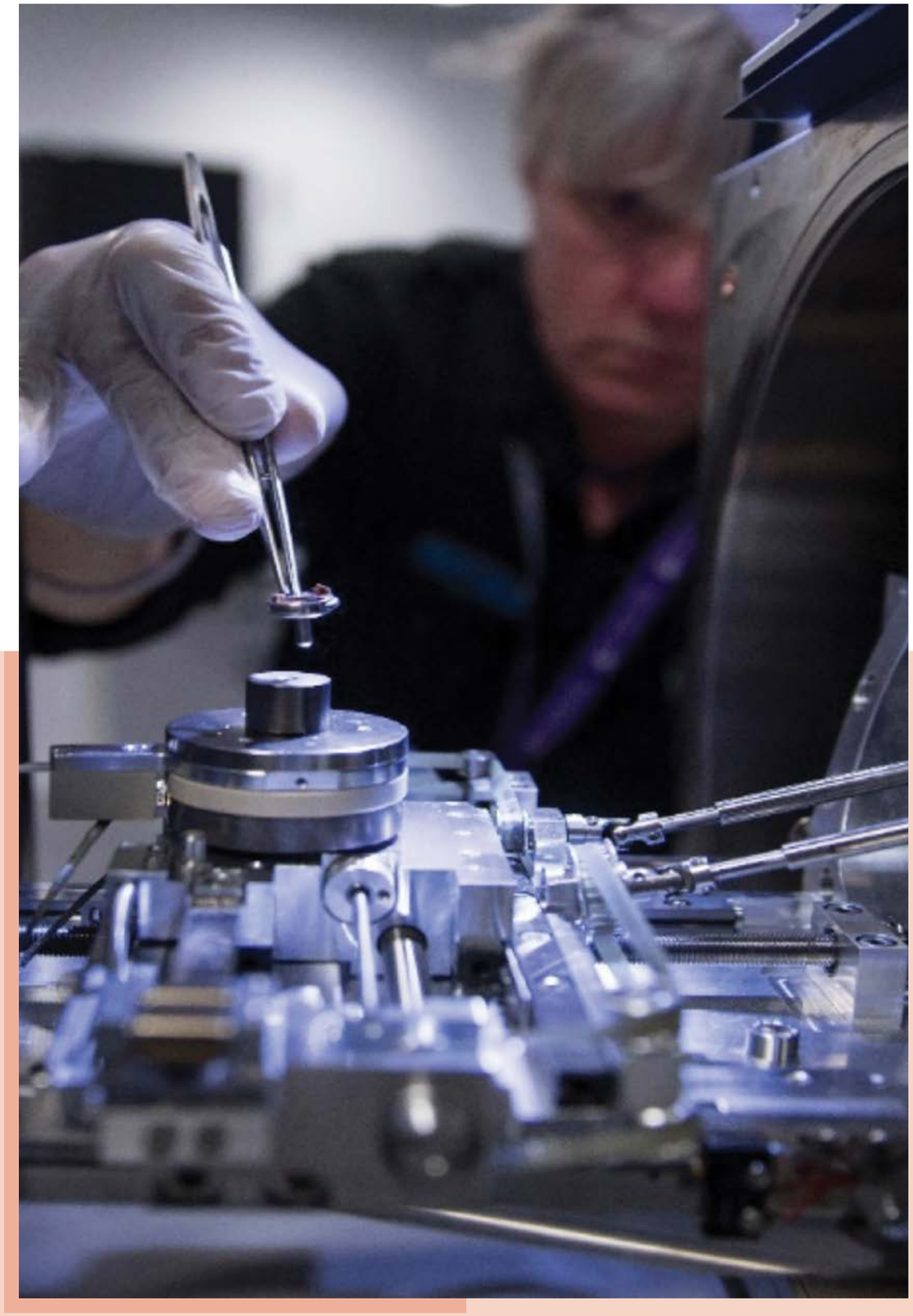
Powder and single crystal x-ray diffractometers are available for a wide range of structural characterization.

Recent research activities have included work on the structure of insect eyes, identification of diatoms on coral substrates, characterization of archeological debris, cross-sectional imaging of integrated circuits, mechanical properties of organic crystals, x-ray tomography of organic crystals, analysis of lithographically defined materials, structure of nanoscale scaffolds and Raman identification of several materials.



MAIN EQUIPMENT

- Transmission Electron Microscope (TEM) - Talos F200X -ThermoFisher
- Dual Beam Focused Ion Beam (FIB)-Scios - ThermoFisher
- FEG Scanning Electron Microscope-Quanta 450 - ThermoFisher
- Single Crystal X-Ray Diffraction System - ApexII - Bruker
- Powder X-Ray Diffraction System -Empyrean 3 - Malvern Panalytical
- Combined Imaging System -Alpha300 - Witec
- Atomic Force Microscope (AFM) -5500 - AgilentConfocal Raman AFM SNOM
- Microcalorimeter - TAM IV - TA Instruments
- High Pressure Freezer (HPF) - EM ICE - Leica
- Automatic Freeze Substitution(AFS) - EM AFS2 - Leica
- Surface Characterization Analyzer -3 Flex 3500 - Micromeritics
- Accelerated Solvent Extractor -Dionek
- Vitrobot and Cryo - Transfer -Vitrobot Mark IV - ThermoFisher
- Liquid Cell Holder - Poseidon-Protochips
- Cryoholder - Gatan 914



MAIN EQUIPMENT

- Thermal Conductivity Analyzer -Tci - Ctherm
- Simultaneous Thermal Analyzer(STA) - Q600 - TA Instruments
- Ultra and Cryo - Ultramicrotome (UC7 and FC7) - Leica
- AFM - Dimension Icon - Bruker
- Pyncometer - 1340 - Micromeritics
- X-Ray Fluorescence - NEX - CG -Rigaku
- Particle Analyzer - ZS - 90 Zetasizer-Malvern
- Particle Analyzer - PSA 1190 - Anton Paar
- Differential Scanning Calorimeter (DSC) - Q2000 - TA Instruments
- Critical Point Dryer - 300 - Leica
- Nanoindenter - G200 - Agilent
- Rotary Microtome - RM 2265 - Leica
- CHNS/O Elemental Analyzer -Vario - MICRO - Elementar
- Universal Testing System - 5965 -5kN - Instron

SPECTROMETRY & SPECTROSCOPY

The Spectrometry and Spectroscopy Core Technology Platform assists researchers in the following applications:

Chemical Discovery, Synthesis, and Characterization

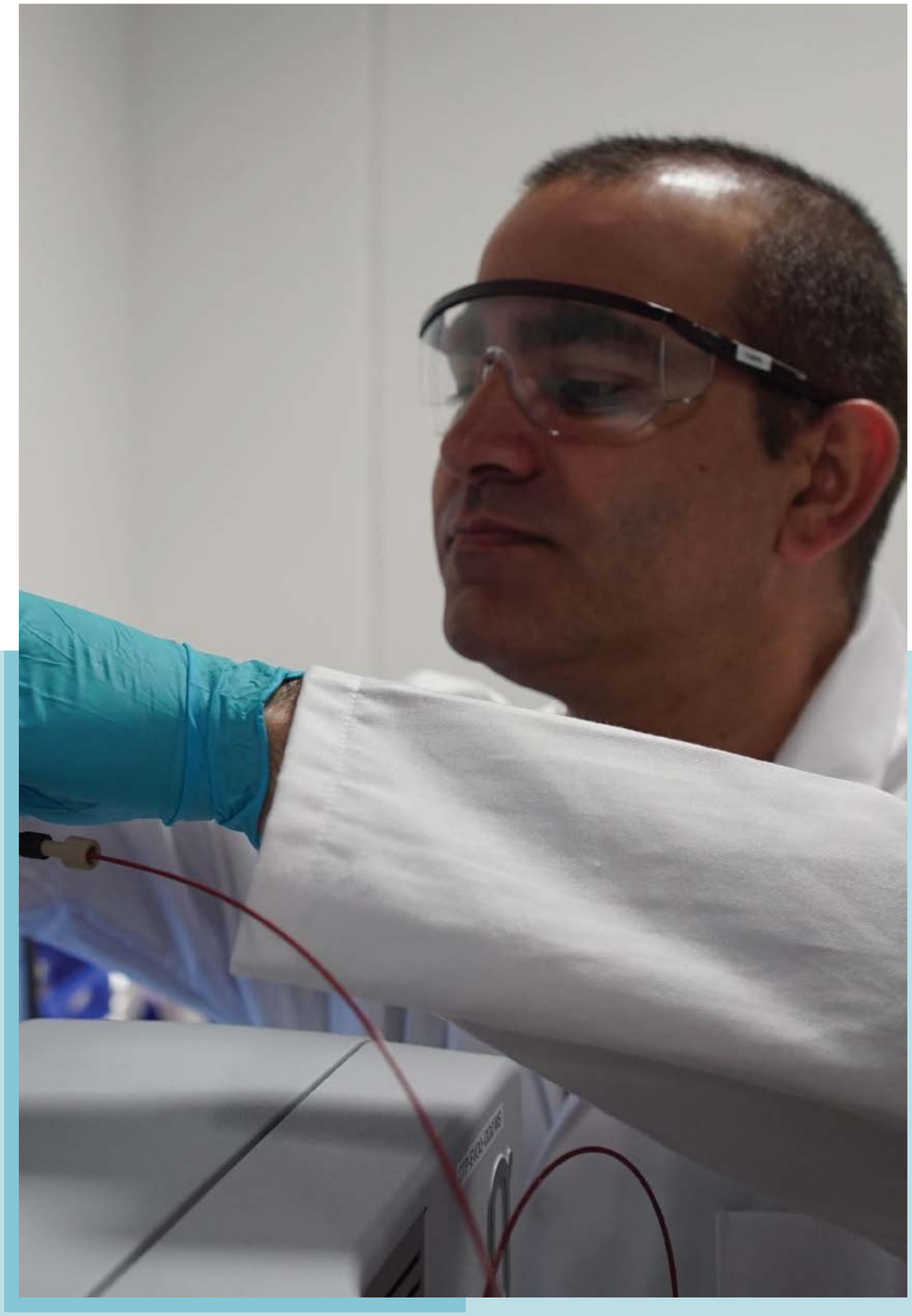
This facility maintains and operates a wide range of tools for separation and characterization of compounds which aids in the synthesis and discovery of chemical compounds.

Metabolomics

Metabolomics is a term used for the characterizing and understanding of all metabolites present in living organisms. The metabolome can help us understand biochemical processes, diseases, and biodiversity by using spectroscopic and spectrometric techniques to characterize and quantify complex biological mixtures.

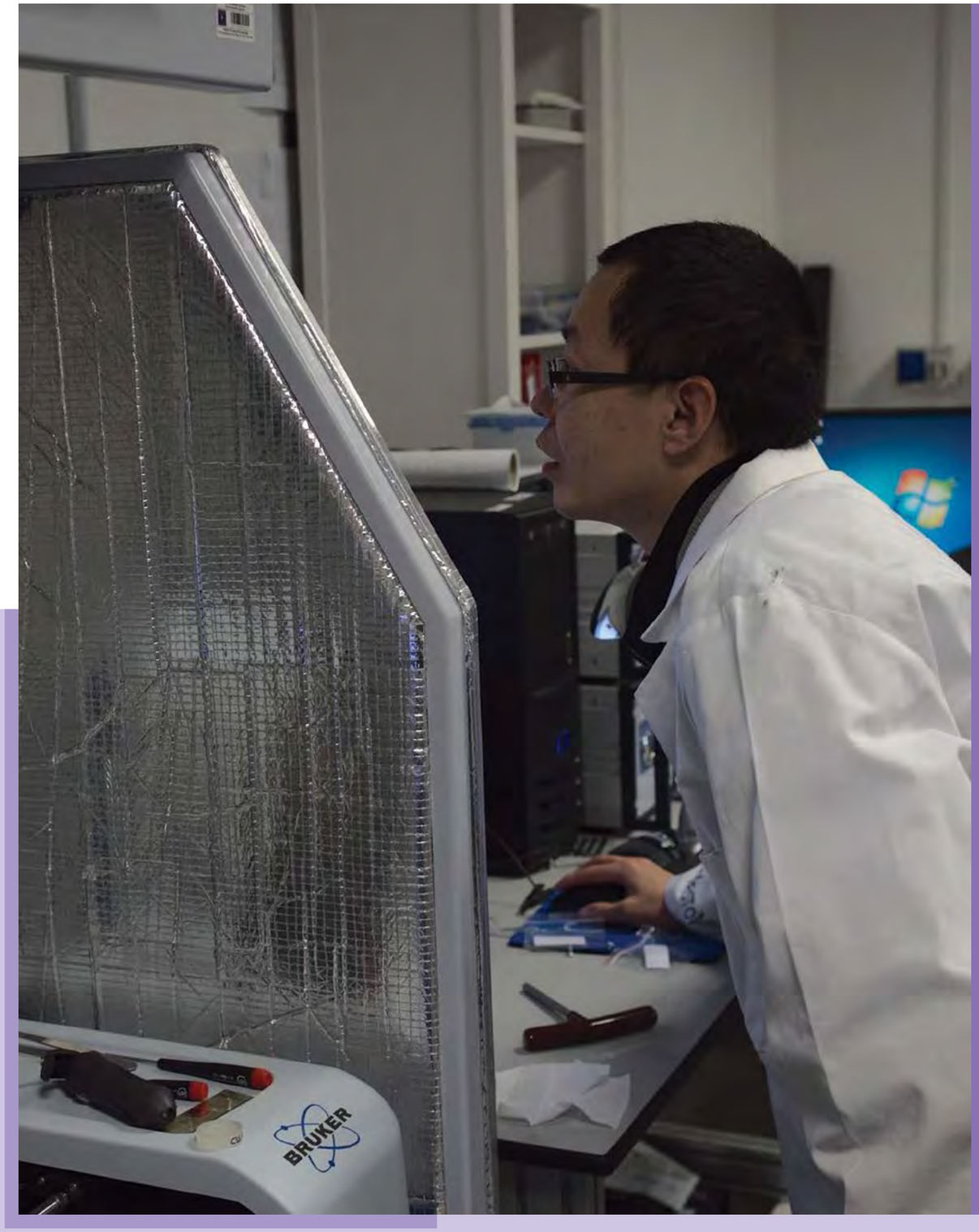
Protein Structure

As proteins are large molecules, the same spectroscopic techniques can be used to characterize and validate these compounds as smaller ones, only with additional time, care, and data handling.



MAIN EQUIPMENT

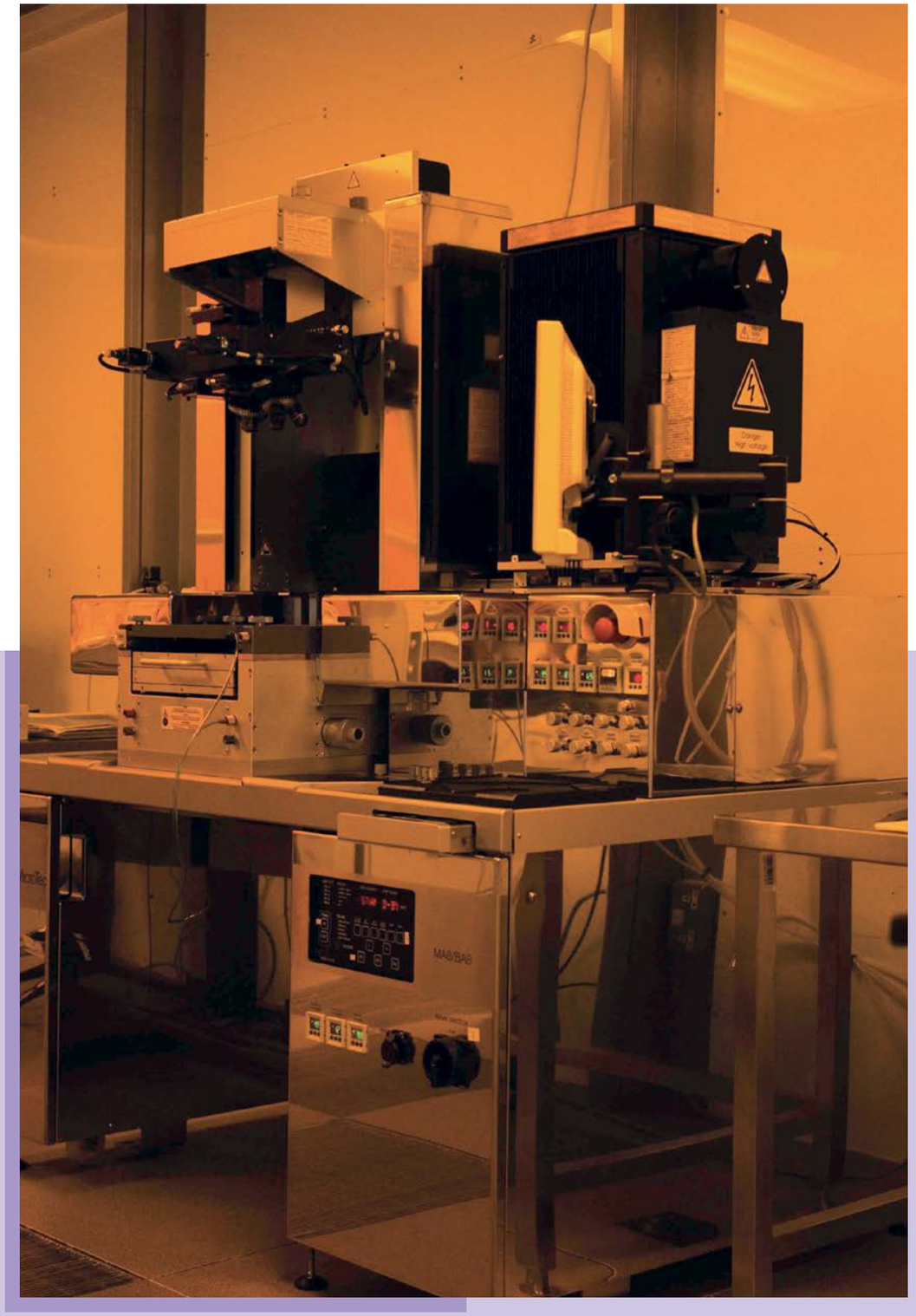
- Nuclear Magnetic Resonance (NMR) Spectrometer - 500 MHz - Bruker
- Nuclear Magnetic Resonance (NMR) Spectrometer - 600 MHz - Bruker
- Solid State Nuclear Magnetic Resonance(NMR) Spectrometer - 600 MHz w/Dynamic Nuclear Polarization (DNP) - Bruker
- Particle Size Analyzer - Zetasizer - Malvern
- Fourier Transform Ion Cyclotron Resonance Mass Spectrometer (FTICR - MS) - Solarix 7T – Bruker
- Liquid Chromatography Quadrupole Time -of-Flight Mass Spectrometer (Q - TOF LC/MS) - Impact 11 - Bruker
- Liquid Chromatography Triple Quadrupole Mass Spectrometer (QqQ LC/MS) - EVOQ - Bruker
- Liquid Chromatography Quadrupole Time-of-Flight Mass Spectrometer (Q - TOF LC/MS) - 6538 Agilent
- Hydrogen Deuterium Exchange (H/D - X PAL) - Leap
- Ion Chromatography - Metrohm
- Fluoromax 4 Emission Spectrometer – Horiba
- UV - Vis Spectrophotometer - Lamda 25 - Perkin Elmer
- UV - Vis Spectrophotometer - Cary 5000 - Agilent
- Fluorescence Spectrometer - LS 55 - Perkin Elmer
- Gas Chromatography Mass Spectrometer (GC - MS) - Clarus SQ8T - Perkin Elmer
- Ultra High Performance Liquid Chromatography (UHPLC) - System Base Vanquish-Thermo Scientific
- Easy - nLC 1200 Orbitrap Mass Spectrometer - Q - Exactive HF - Thermo Scientific
- Inductively Coupled Plasma Mass Spectrometer (ICP - MS) 7800 – Agilent
- Autoanalyzer 3HR - Seal Analytical



MICROFABRICATION

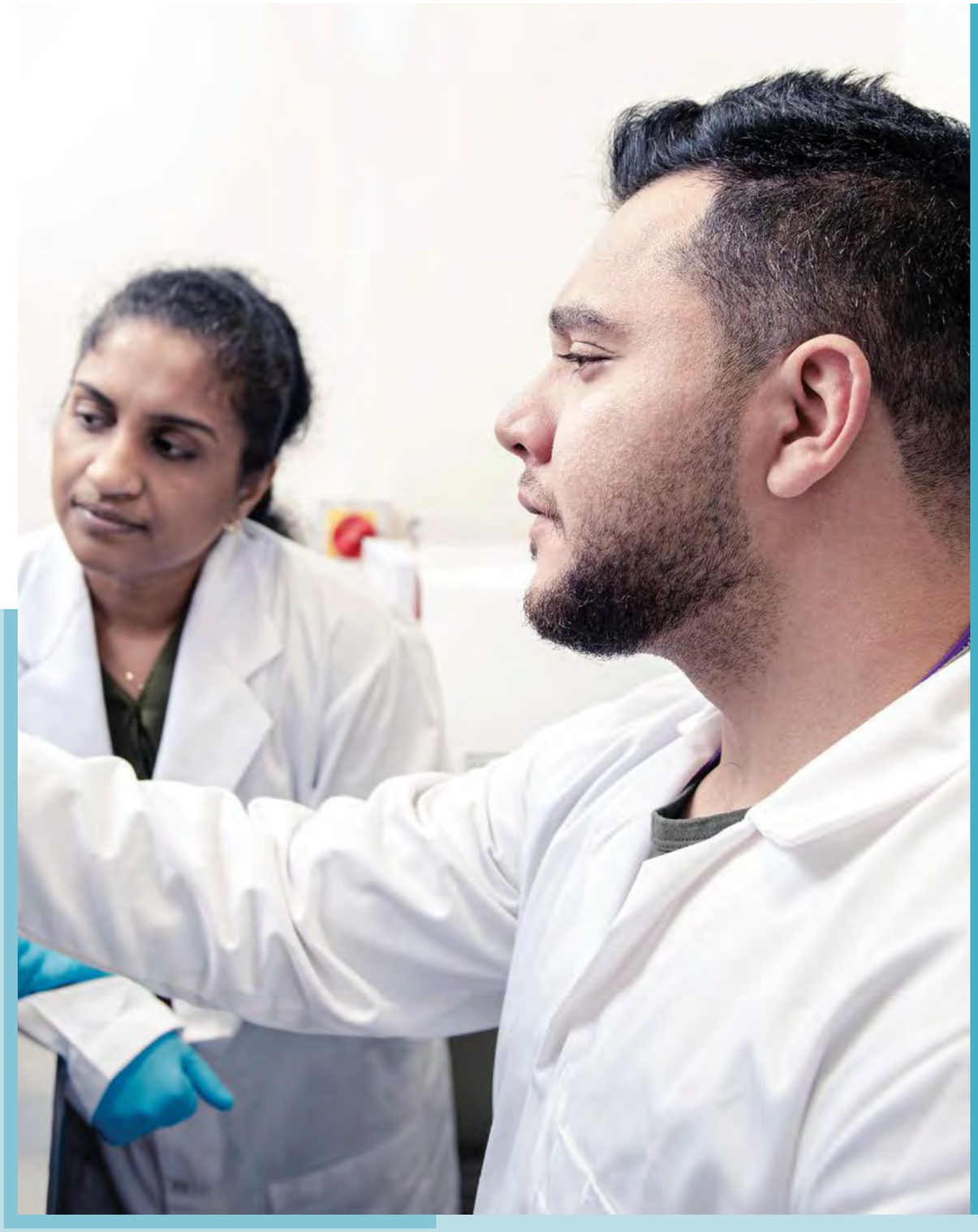
The Microfabrication Core Technology Platform is equipped with the equipment necessary to perform material deposition, lithography and etching for microfabrication process.

Researchers are utilizing this CTP, a class 1000 cleanroom, to build microfluidic platforms for high-throughput drug screening, develop ultrasensitive point-of-care diagnostic chips for early detection of cancer and other diseases, design chips to isolate fetal cells from maternal blood, and create portable platforms for monitoring the quality of water in the world.



MAIN EQUIPMENT

- Proline PVD E-BEAM EVAPORATOR/Sputtering System - Kurt Lesker
- Parylene Depositon System - Labcoter 2 - SCS
- Reactive Ion Etch System - Vision 320 - Advanced Vaccum
- Mask Aligner - MA8 - Suss
- DWL 66 + Mask Writer - Heidelberg Instruments
- 3D Printer - Nano - Nanoscribe
- Oxygen Plasma Processor - RF - Femtoscience
- BioPrinter - GIX 11 - Sonoplot
- Surface Profiler - Dektak XT - A - Bruker
- Spin Coater – Headway PWM32 – PS



MOLECULAR & CELL BIOLOGY

The Molecular and Cell Biology Core Technology Platform provides a broad range of instruments that aid scientists in performing research at the molecular, single cell, and tissue culture level. Research activities carried out at NYUAD in this core include:

Gene Cloning and Manipulation

Research in this field includes the cloning and subcloning of genes into a variety of different vectors; gene manipulation that alters specific domains, or simply changes fusion tags on proteins and mutagenesis which alters single amino acids.

Protein Expression and Purification

This includes an efficient E. coli expression system to express a variety of protein samples (including human proteins) with purity higher than 95%.

Biophysical and Biochemical Structural Characterization of Different Macromolecules

The research applications in this area include the characterization of the structure of Molecular Cell Biology different macromolecules and the determination of the thermal and chemical stability of biological macromolecules; the analysis of the energetics of binding different molecules to a biological sample; and screening for binding partners to the macromolecule using small molecule libraries as the first method in drug discovery and design.

Genomics at Single Cell Resolution

Single-cell genomics is a method used to analyze individual cells from a tissue sample. Classifying cell types is an important step in understanding functional states and cellular processes. Our integrative microfluidic based system enables several complementary genomic application including high throughput gene expression, genotyping, digital PCR, single cell expression profiling and sample preparation of single cell whole genome or targeted sequencing.

MAIN EQUIPMENT

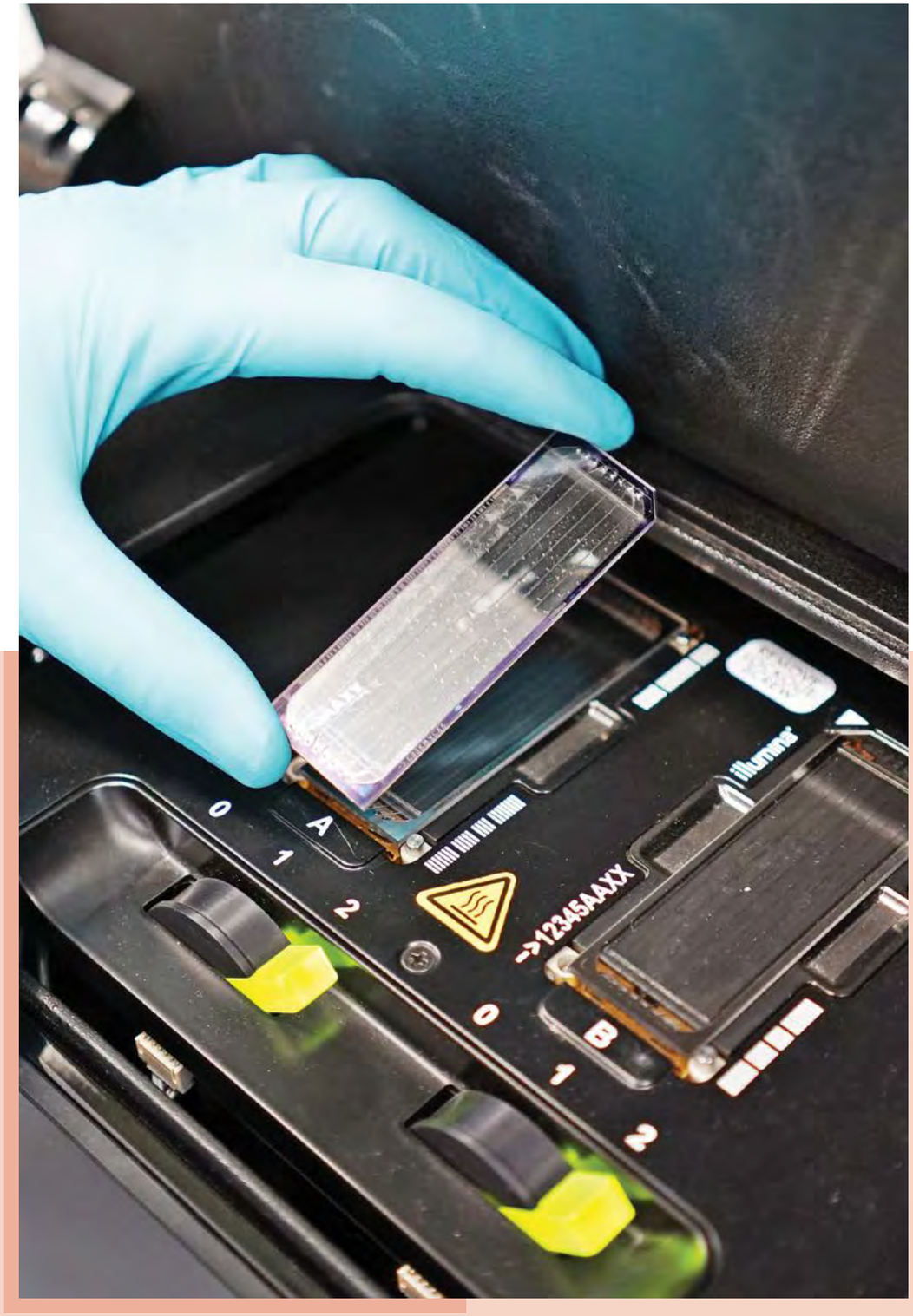
- Single Cell Analysis - Biomark HD and C1 System - Fluidigm
- Nano Differential Scanning Calorimeter - Nano DSC - TA Instruments
- Nano Isothermal Titration Calorimeter - Nano ITC - TA Instruments
- Microcalorimeter - TAM IV - TA Instruments
- High - Throughput Screening Platform - ThermoFisher
- Stopped - Flow Spectrometer - SX20 - Applied Photophysics
- Circular Dichroism Spectrometer - Chirascan Plus - Applied Photophysics
- Protein Purification System - Aktapure 25 M2 - GE Healthcare Life Sciences
- BSL2 Tissue Culture Facilities including:
  - CB160 Incubators
  - Nuaire Classic 11 Bscs
  - Countess II FL, Invitrogen
  - Evos FL Imaging Systems
  - Fluorescence Microscope
  - Nucleofector 4D, Lonza 25
  - UV - Crosslinker, UVP 24
- UV - VIS Spectrophotometer - 2700 - Shimadzu
- PCR - Multigene Optimax and Mastercycler Pro
- QPCR – MX3005P & StepOne QPCR With HRMA Software
- Protein Gel Electrophoresis and Western Blot - Mini Protean Tetra Cell and Trans - Blot Kits - Biorad
- ElastoSens Bio 2 (Rheometer) - Rheolution
- Flow Cytometer - Aria - BD Biosciences
- Flow Cytometer - Attune NxT - Invitrogen
- Microplate Reader - Synergy H1MF with Dual Reagent Dispenser and Gas Control - BIOTEK
- BSL2 Bacterial Culture and Molecular Biology Facility including:
  - Cytation 5 Spectrophotometer
  - Multiflo FX Liquid Handler
  - Biostack - Microplate Stackers
  - Colony Counters - Protocol 3
  - CB160 Incubators
  - Nuaire Classic 11 Bscs

SEQUENCING

The Sequencing facility enables researchers to rapidly collect large amounts of data on DNA and RNA sequences. Researchers are using this technology to sequence samples from humans, model organisms and nonmodel organisms in order to characterize their genomes (DNA), transcriptomes (RNA), and genetic diversity in populations (sequence variants). Other applications include investigating interactions between proteins and nucleic acids and analyzing samples collected from the environment.

This core is used by researchers to investigate how marine microbes interact with each other and how these interactions influence both our oceans and other important ecosystems in the oceans, such as coral reefs. Another research group seeks to reveal how neuronal cells from multiple anatomically distinct nuclei networked together in the basal brain in a mouse paradigm that manifests in sleep and circadian disturbance under social defeat depression.

For the first time in the UAE, the Public Health Research Center at NYUAD in collaboration with investigators from the leading universities and hospitals in the UAE are establishing the first national cohort study, the UAE Health Future Study. The UAE has some of the highest rates of obesity, diabetes and heart disease in the world and this study seeks to understand the reasons behind this, which is something never previously studied in the UAE or the region before. The sequencing facility at NYUAD will be used to sequence human and oral bacterial samples that are collected as part of the UAE Health Future Study. This research will provide a greater understanding of how human genes and the oral microbiome affect the health of the people of the UAE.



MAIN EQUIPMENT

- Next Generation Sequencer (NGS) - NovaSeq 6000 - Illumina
- Next Generation Sequencer (NGS) - NextSeq 550 - Illumina
- Next Generation Sequencer (NGS) - MiSeq - Illumina
- Sanger Sequencer - SeqStudio Genetic Analyzer - Applied Biosystems
- Focused Ultrasonicator - E220 - Covaris
- Automated Electrophoresis - 2100 Bioanalyzer-Agilent
- Real Time PCR-StepOnePlus-Applied Biosystems

HIGH-THROUGHPUT SCREENING

The High-Throughput Screening (HTS) Core Technology Platform is a laboratory automation system which allows researchers to rapidly automate chemical and biological processes.

This platform is optimized to carry out most of the steps involved in high throughput screening of small molecule or genomic (e.g., RNAi, CRISPR) libraries. These steps include mixing reagents with cells or whole organisms, sample incubation in controlled environments, and highcontent imaging at multiple levels of magnification in both brightfield and multichannel fluorescence modes.

The HTS system is capable of performing a variety of processes such as liquid handling, imaging, incubation, labeling, shaking, sealing and can be adaptable to any new process required by adding a new equipment and integrating it with the rest of the automated system.

The users of this platform are currently focusing on screening large libraries of chemical and biological reagents for bioactive compound discovery, toxicity studies, and cell biology research.

MAIN EQUIPMENT

The HTS platform was commissioned by the NYUAD Center for Genomics & Systems Biology - Chemical and Functional Genomics Lab.

An articulated robotic arm integrates diverse modules:

- Liquid Handling Stations - Bravo Agilent, Multiflo FX Biotek, Multidrop Combi - ThermoFisher
- Barcode Labeler and Readers
- Plate Sealing - ALPS 3000
- Robotic Arm – F5 - FANUC
- Automated Incubators – Cytomat 24, Cytomat 6001 – ThermoFisher
- Microplate Reader for Fluorescence, Luminescence and Absorbance Readings – Spectramax i3 - Molecular Devices
- Automated Microscopes for collecting Brightfield and Fluorescence High Resolution Images from Multiwell Plates - CX7 Cellinsight and CX5 Cellinsight ThermoFisher

The experimental logic flow is controlled by a centralized scheduling software, enabling a nearly operator free environment for performing multiday screens.

LIGHT MICROSCOPY

The Light Microscopy Core Technology Platform provides access to several state-of-the-art microscopes and aids in the following research activities:

Confocal and Super-Resolution Imaging

The microscopy facility applications include molecular motor transport studies, 3D neuronal network imaging and nanoparticle testing and cell screening. The facility also can perform imaging of fluorescently labelled samples like drosophila brains, mouse brain sections and cultured cells.

Widefield Microscopy

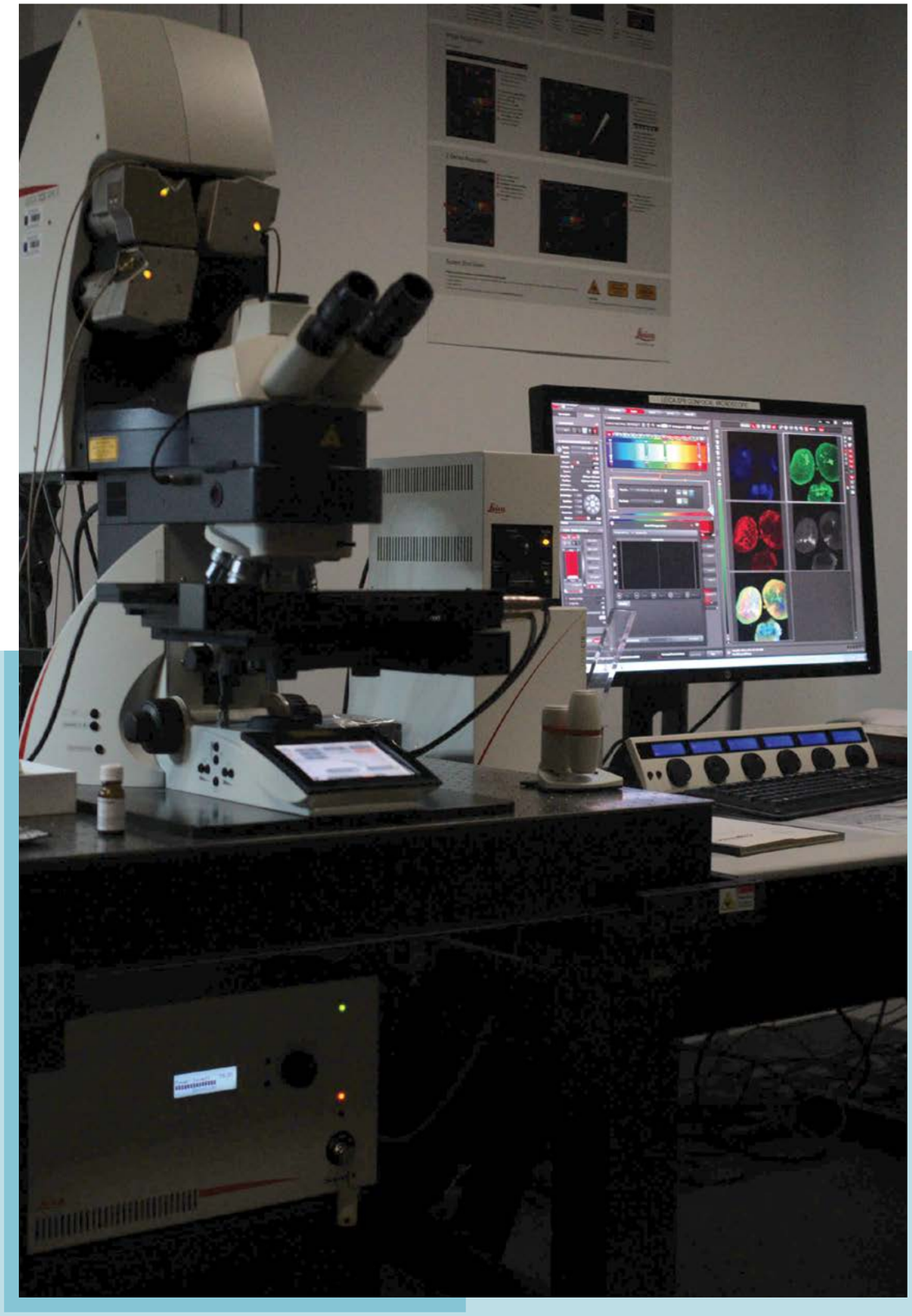
Various imaging techniques are used in widefield microscopy which include epifluorescence, phase contract, and differential contrast microscopy. These are used in the core facility in various projects such as cell growth and proliferation regulation studies, actin reprogramming and C. elegans embryogenesis.

Sample Preparation

The facility supports researchers in experimental design and suggests different labelling techniques and microscopes setups for the various applications.

Data Analysis

Various software programs are available for the post processing of the images on a processing workstation.



MAIN EQUIPMENT

- Confocal Laser Scanning Microscope (LSM) - SP8 – Leica
- Super-Resolution Microscope (SRM) - STED 3X - Leica
- Widefield Microscope - DMI6000 - Leica
- Stereo Microscope - M205 - Leica
- Two - Photon - Confocal Microscope (2P - LOSM) - FV1000 - Olympus
- Metallurgical Microscope - LVdia - Nikon
- Holographic Microscope - 3D Cell Explorer - Nanolive

BRAIN IMAGING

The Brain Imaging Core Technology Platform performs cutting edge, noninvasive examination of the brain's structural features and functional activation, and its relation to human behavior, language, and working memory, which is observed via magnetic resonance imaging (MRI) technology.

This CTP is staffed with an imaging physicist and a certified MRI technologist, and is equipped with a state-of-the-art 3T Siemens MAGNETOM Prisma MRI scanner. The latest pulse sequences such as simultaneous multislice (SMS) for BOLD and diffusion sequences provide unparalleled capability of acquiring high spatial and temporal resolution images with adequate signal-to- noise ratio in shorter scan times. Several RF coils are available with the Prisma such as 20, 32 and 64 Channels head "TIM" RF receiver in addition to the RF body coils.

In addition, this CTP is equipped with a magnetoencephalography (MEG) system managed by Neuroscience of Language Lab (Nellab) which houses a noninvasive imaging technology that allows researchers to investigate how the brain gives rise to various aspects of cognition.

MAIN EQUIPMENT

Magnetic Resonance Imaging (MRI) 3 Tesla Human Scanner - Magnetom Prisma - Siemens Healthineers including supporting equipment:

- Functional Stimulus Equipment for Visual, Auditory, and Response Recordings - Vpixx Technologies
- Infrared Eye Tracking during Functional Examinations - Eyelink - SR Research (MRI Compatible)

Magnetoencephalography (MEG) - 208 Channel KIT MEG System including supporting equipment

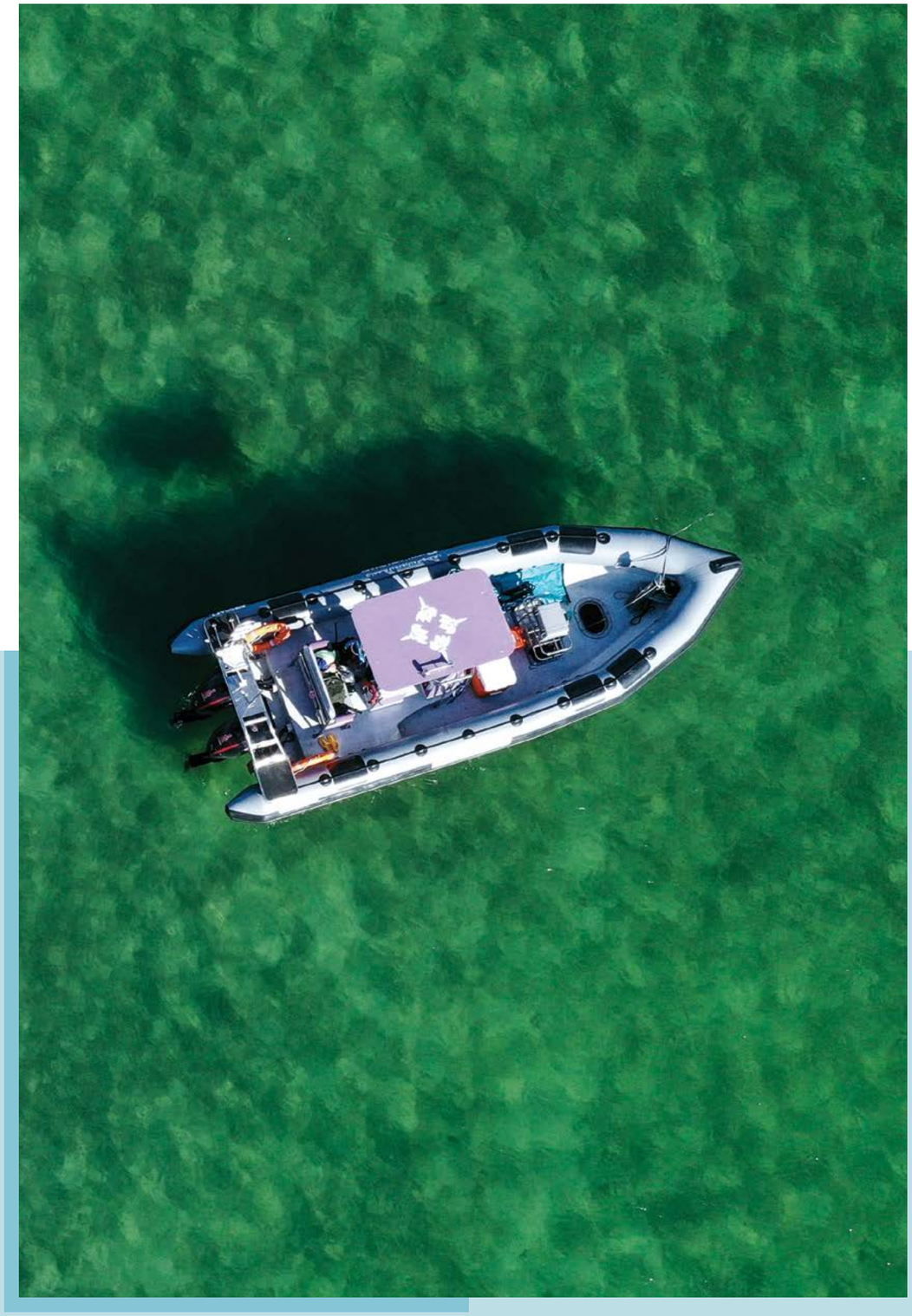
- Electroenceohalography - 32/64 - Channel Brain Products Eeg System (MEG Compatible)
- Fast SCAN Laser Scanner

MARINE BIOLOGY

The Marine Biology Core Technology Platform provides the necessary tools to allow researchers to use the Arabian Gulf and the Gulf of Oman as natural laboratories. Among the many research activities, scientists at NYUAD are seeking to examine how coral communities in these extreme environments respond to and recover from mass bleaching events and how variation in environmental conditions affect biogeographic patterns of community structure of corals, fish, and other reef biota in the region.

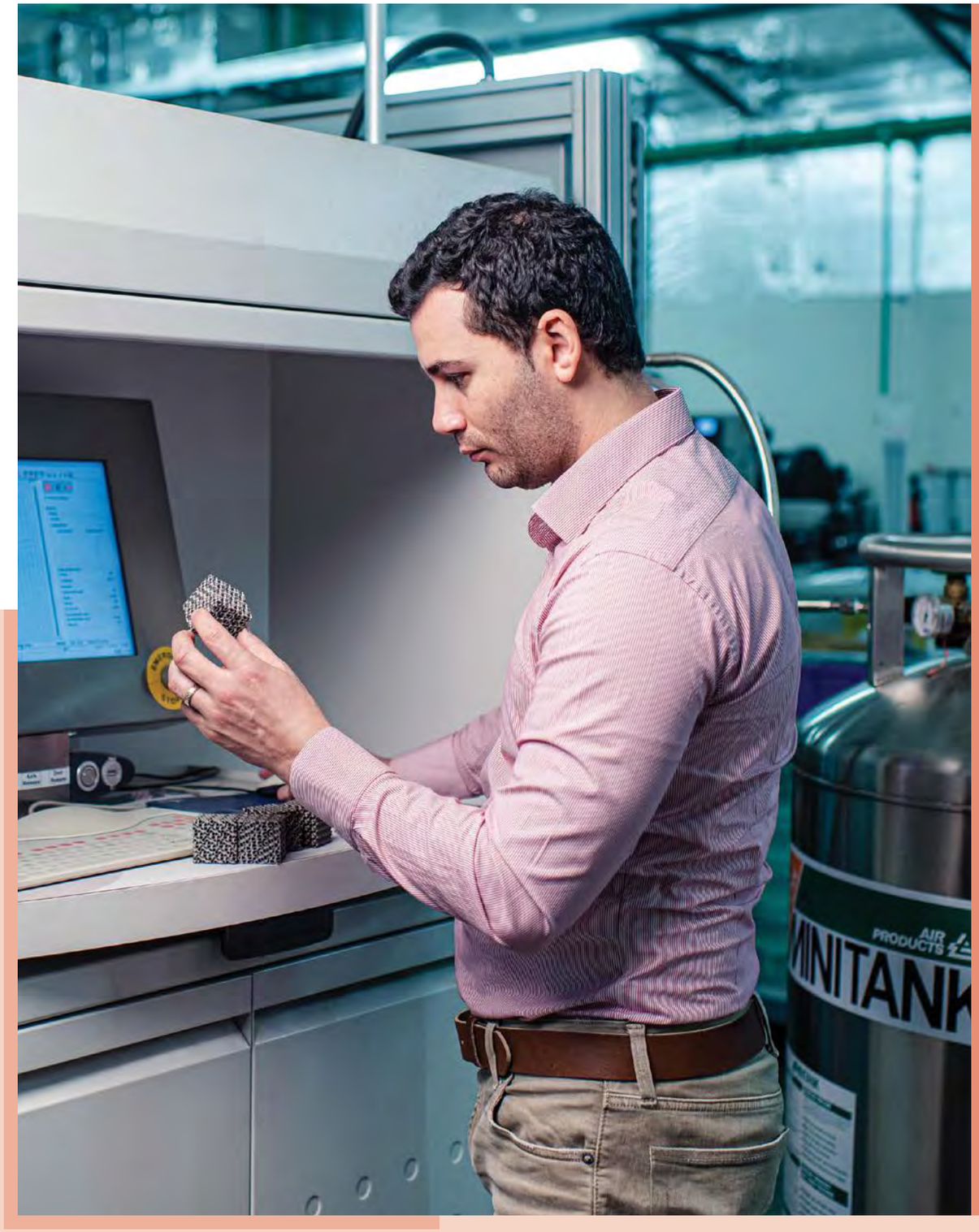
Another group of scientists are monitoring and collecting samples from coral colonies around the Emirate of Abu Dhabi to understand coral disease. They are also collecting net plankton samples for isolation of marine phytoplankton from the Arabian Gulf exploring mangrove sediments in order to isolate novel marine bacteria with potential for biomedical drugs.

The Marine Biology facility is equipped with the latest technology and tools to conduct research in this field.



MAIN EQUIPMENT

- Thuraya Boat - 8m – Ribcraft
- NYUAD Boat - 10m - Arabiancraft
- SCUBA diving equipment
  - BCD'so
  - Regulatorso
  - Dive Cylinderso
  - Exposure suits
- Mini Verticus III Breathing Air Compressor-Bauer
- 12m Boat trailer for NYUAD
- 10m Boat trailer for Thuraya
- Dodge Ram 4x4 Field Truck



ADVANCED MANUFACTURING & ELECTRONICS

The Advanced Manufacturing and Electronics Core Technology Platform supports research in the following areas:

- Mechanical design
- Manufacturing custom made parts
- Design and manufacturing printed circuit boards (PCB)
- Reverse Engineering
- Design and manufacture custom made equipment or modify existing equipment

All activities are performed using state-of-the-art software and manufacturing equipment operated by specialized trained personnel using cutting edge techniques. Depending on the nature of the project, a single machine or combination of these machines are used. The facility can produce parts accurate to the micro scale.

MAIN EQUIPMENT

- SLS 3D Metal Printer - M270 - EOS
- SLS 3D Metal Printer - M280 - EOS
- SLS 3D Polymer Printer - P110 - EOS
- FDM 3D Printer - Dimensions SST 120es - Stratasys
- FDM 3D Printer - F370 - Stratasys
- Polyjet 3D Printer - J750 - Stratasys
- CT Scanner - X5000 - Northstar Imaging
- CNC turning Center - DS 30Y - HAAS
- CNC Milling Machine - VF 2TR - HAAS
- Circuit Board Plotter - ProtoMat S63 - LPKF
- Through-Hole Plating System- Contac RS - LPKF
- Water Jet Machining - 55100 - OMAX
- CNC Milling Machine - PRSstandard - Shopbot
- Wire EDM- AgieCharmilles CUT 30P - GF Machining
- Variety of manual machines

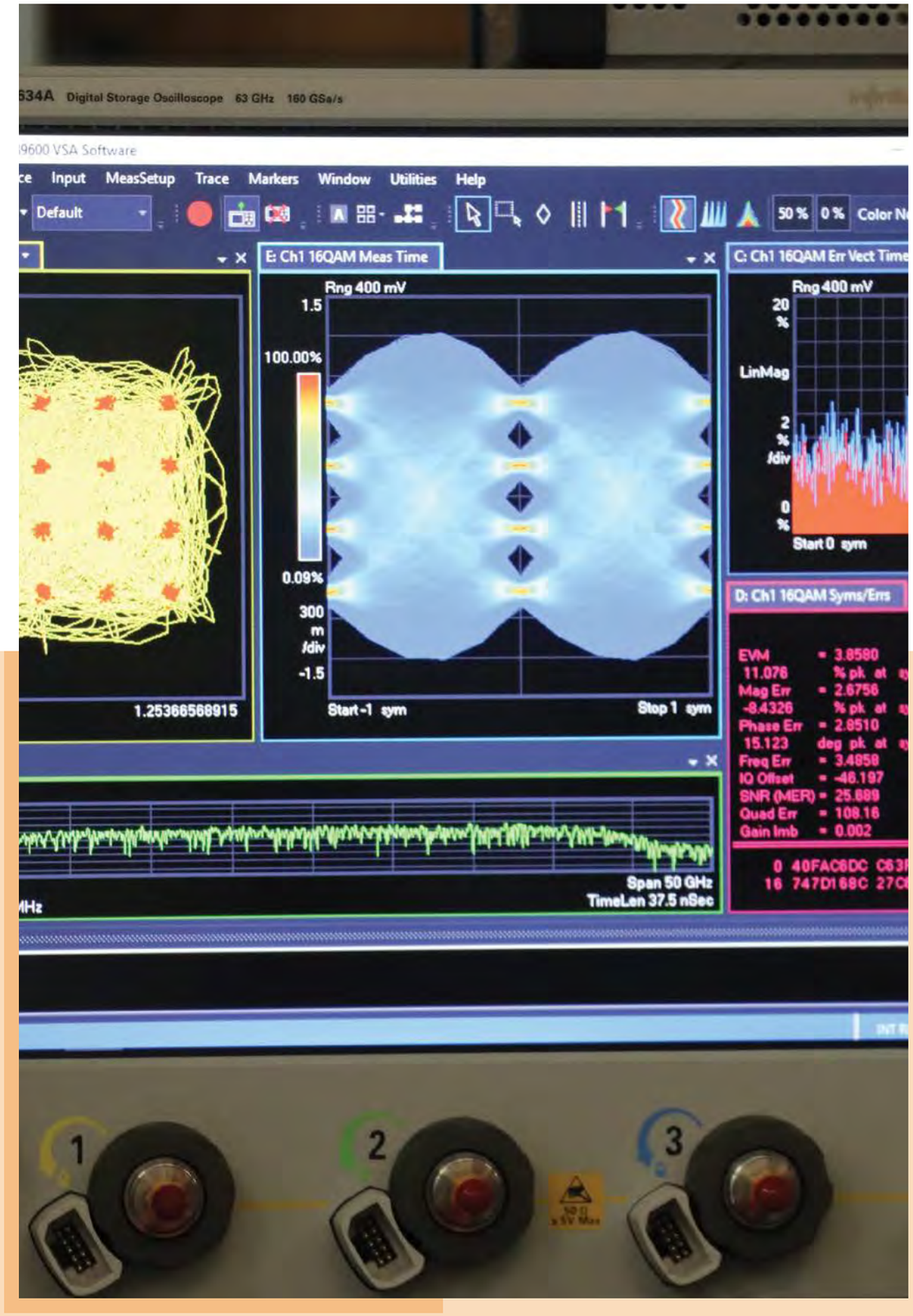
PHOTONICS

The Photonics Core Technology Platform is an advanced facility that has been exclusively established to address the current and future research activities in the field of telecommunications.

The instruments in this core work in synergy to perform advanced characterizations necessary to test research theories, and for the evaluation and certification (IEEE Standards) of optical and electronic telecommunication devices that operate at very high bit rates. The latest research on data telecommunication channels use a combination of optical and electrical components to offer data rates of 400 Gigabits/sec. The combination of instruments is essential in the field of telecommunication. Individually, the same instruments can be utilized for research in physics, chemistry, engineering, computer science and much more.

Some of the measurements that can be conducted in this core are as follows:

- Bit error rate testing
- Coherent detection
- Vector signal analysis
- S-Parameters evaluation
- Insertion loss (IL) / Polarization dependent loss (PDL)
- Spectral measurements
- Polarization analysis
- Swept-wavelength measurement
- Frequency domain / Time domain response
- Various modulation formats analysis
- Fast spectral measurements
- Signal integrity
- Small signal and large signal analysis



MAIN EQUIPMENT

- Tunable Laser Source - 81606A - 113 - Keysight
- Tunable Laser Source - 81606A - 216 - Keysight
- Optical Multiport Power Meter - N7744A - Keysight
- High Power Optical Head - 81626B - Keysight
- Dual Optical Power Sensor - 81635A - Keysight
- Variable Optical Attenuator - 81577A - Keysight
- Benchtop Polarization Synthesizer - N7786B - Keysight
- Optical Switch Module - 81595B 1x4 - Keysight
- Return Loss Module - 81610A - keysight
- Lightwave Component Analyzer - N4373D - Keysight
- Infiniium Oscilloscope - 63 GHzDSAZ634A - Keysight
- Arbitrary Waveform Generator - M8196A 92 GSa/s - Keysight
- High-performance BERT - M 8040A 64 Gbaud - Keysight
- Two-Channel Variable Optical Attenuator-N7762A - Keysight
- Photonic Application Suite - N7700A - Keysight
- Infiniium DCA - X Wide-Bandwidth Oscilloscope - 86100D - Keysight
- USB Thermocouple Power Sensor - U8487A 10 MHz – 50 GHz - Keysight
- Signal Analyzer, Multi - touch, 2 Hz to 50 GHz - N9030B PXA - Keysight
- Optical/Electrical Clock Recovery - N1078A - Keysight

KINESIS

The Kinesis Core Technology Platform is a space for exploration and experimentation related to motion. The laboratory is divided into two main zones:

The Arena and the Workspace.

Arena

The Arena is the dedicated area for motion experimentation. The Arena is a 17m x 6.4m x 8m space constructed from adaptable truss structures with surrounding nets for safety and can be reconfigured accordingly.

The lighting system is controllable for colors and intensity, and removable protective mattresses cover the ground area. The Arena is equipped with a local position tracking system, 2 kW sound system, a projection system and a high-speed ethernet and wireless network.

Workspace

The Workspace houses workstations for eight scientists with a high-speed local network and controllable lighting system. The Workspace is also a home to a high-performance GPU unit and a safe charging station for LiPo batteries.

The Kinesis Core Technology Platform supports research in the following areas:

Biomechanical

Gait Analysis & Rehabilitation Posture, Balance and Motor Control Athletics (Sports Performance, Movement Evaluation,) Animal Biomechanics and Science Psychology and Neurology Research

Engineering

Robotics (UAV, Industrial Robots, Robots' Localization, Movement Analysis, Trajectory Generation) Product Design and Evaluation (Car Production Industry, Aerospace, etc.) Virtual Reality, Immersive Reality, and Augmented Reality (Subject Localization, Gesture Recognition) Aerodynamics Research Control Systems, Artificial Intelligence and Machine Learning (Artificial Neural Networks, Deep Learning, Deep Reinforcement Learning, etc.)

Entertainment

Video Games Development (Character Animation, Object Animation, Effects Generation) Film production (Character Animation, Object Movement and Animation), Computer-Generated Imagery (CGI) Sound and Motion Application and Research (Music Performance and Pedagogy, Neuroscience, Music Psychology Research)

MAIN EQUIPMENT

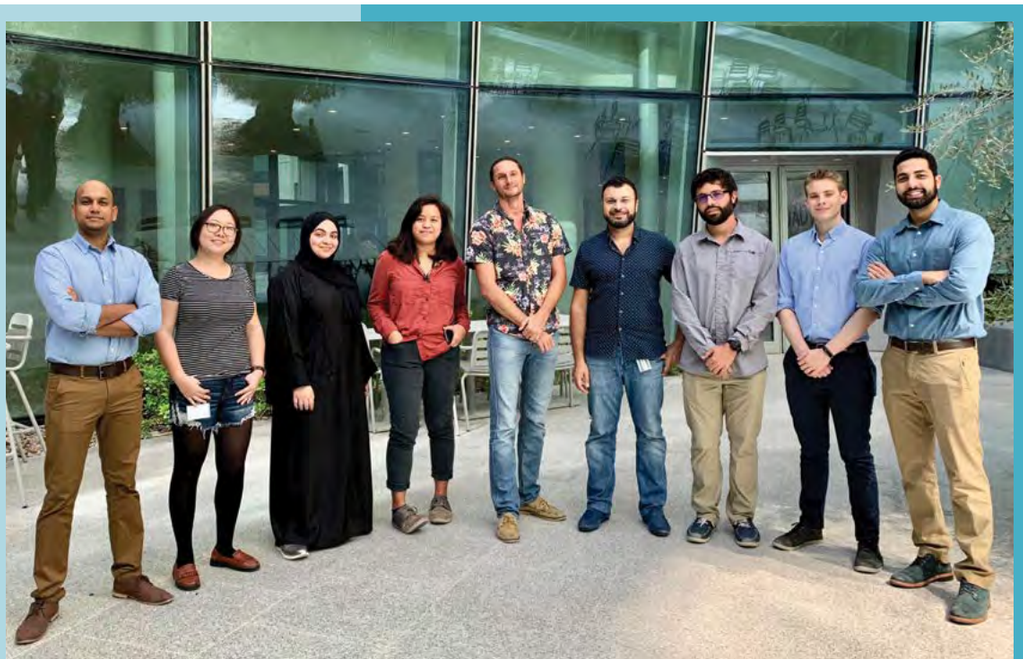
- Virtual Reality (VR) Equipment
- Unmanned Aerial Vehicle (Drones)
- Motion Capture System - V16 Cameras - Vicon
- Robotic Arm - LBR iiwa 14 R820 - KUKA
- Linear and Rotary Stages - Aerotech

The Core Technology Platforms Operations' specialists have been fortunate to support and contribute to the groundbreaking research and efforts of the NYUAD Faculty. Recent research has addressed issues of local, regional and global significance such as self-healing and shape memory crystals, gene cloning and manipulation, rates of bio-erosion of the coral reefs, and many more.

This research has potential life-changing impacts for humanity. It helps us in **Restoring Our Environments**, ways of **Understanding How We Think**, **Improving Our Health**, and **Increasing Efficiency In Our Lives**.

RECENT INNOVATIVE RESEARCH

RESTORING OUR ENVIRONMENT



"Interactions between phytoplankton and other oceanic species are the most important inter-species interaction on Earth."

CHARTING THE SYMBIOTIC INTERACTIONS BETWEEN PHYTOPLANKTON, THEIR MICROBIOME AND CORALS

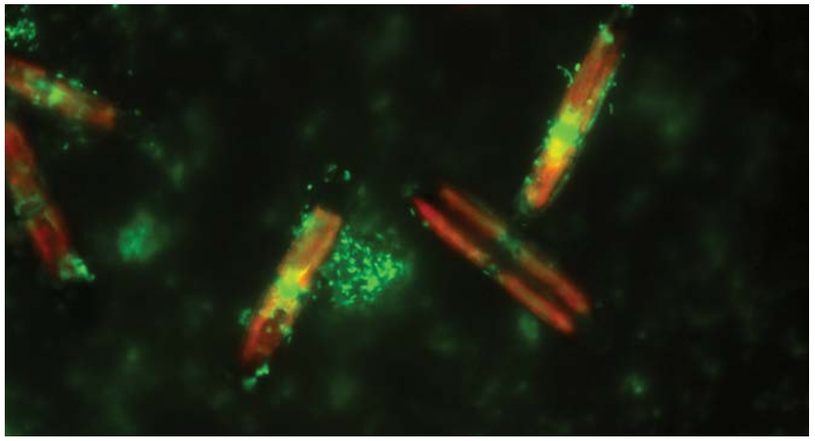
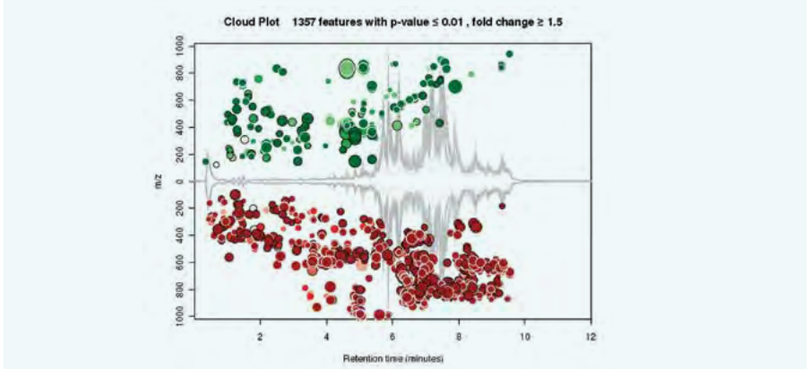


FIGURE: Epifluorescent micrograph of the phytoplankton Nitzschia longissima with its microbiome.

FIGURE: LC-MS cloud plot spectrum of comparison between healthy and diseased parts of one colony.



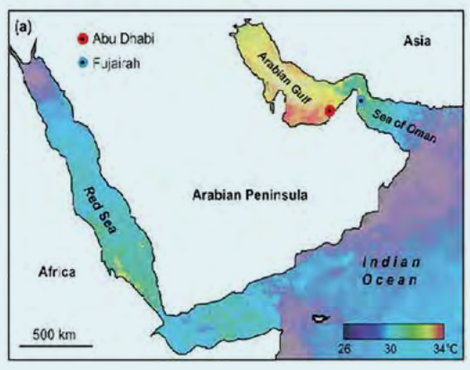
The Marine Microbial Ecology Lab, headed by Assistant Professor of Biology Shady Amin, studies interspecies interactions in our oceans with a particular focus on the Arabian Gulf. Interactions between phytoplankton and other oceanic species are the most important interspecies interaction on Earth. Phytoplankton are unicellular single-celled, photosynthetic microbes that are responsible for ~50% of all oxygen on Earth, form the base of the marine food web and remove a significant fraction of carbon dioxide generated from fossil fuels from our atmosphere. Their interactions with bacteria have major implications to productivity in our oceans that influence fish populations, the gaseous makeup of our atmosphere, cloud nucleation and the widespread phenomenon of harmful algal blooms (HABs). Their symbiotic interactions with corals form coral reefs throughout the world and foster a significant proportion of fish populations.

Employing genomics and metabolomics, Amin's lab is studying how these drifting phytoplankton cells form and maintain healthy microbiomes in a dilute aquatic environment. Using microfluids, single-cell genomics, microscopy and mass spectrometry facilities at CTP, the group is discovering that cell attachment and infochemical molecules are instrumental in maintaining a stable microbiome.

They are also studying how the breakdown of symbiosis between corals and specific phytoplankton species (Symbiodinium) occurs. They recently reported the discovery of a unique environment that surrounds coral colonies termed the 'holosphere' where specific microbes and molecules play an important role in promoting a healthy coral. Corals suffering from disease have an altered holosphere that lacks many metabolites present in healthy corals.

"The findings of this study provide evidence that genetic adaptation... enabled corals to cope with extreme temperatures in the Gulf."

CORAL ADAPTATION TO EXTREME TEMPERATURES IN THE ARABIAN GULF



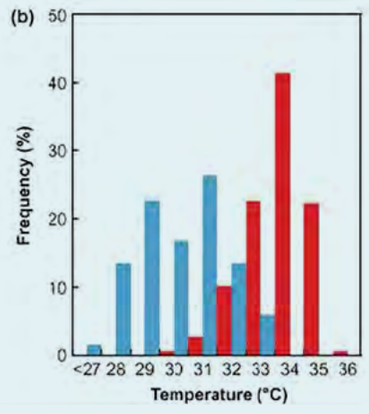
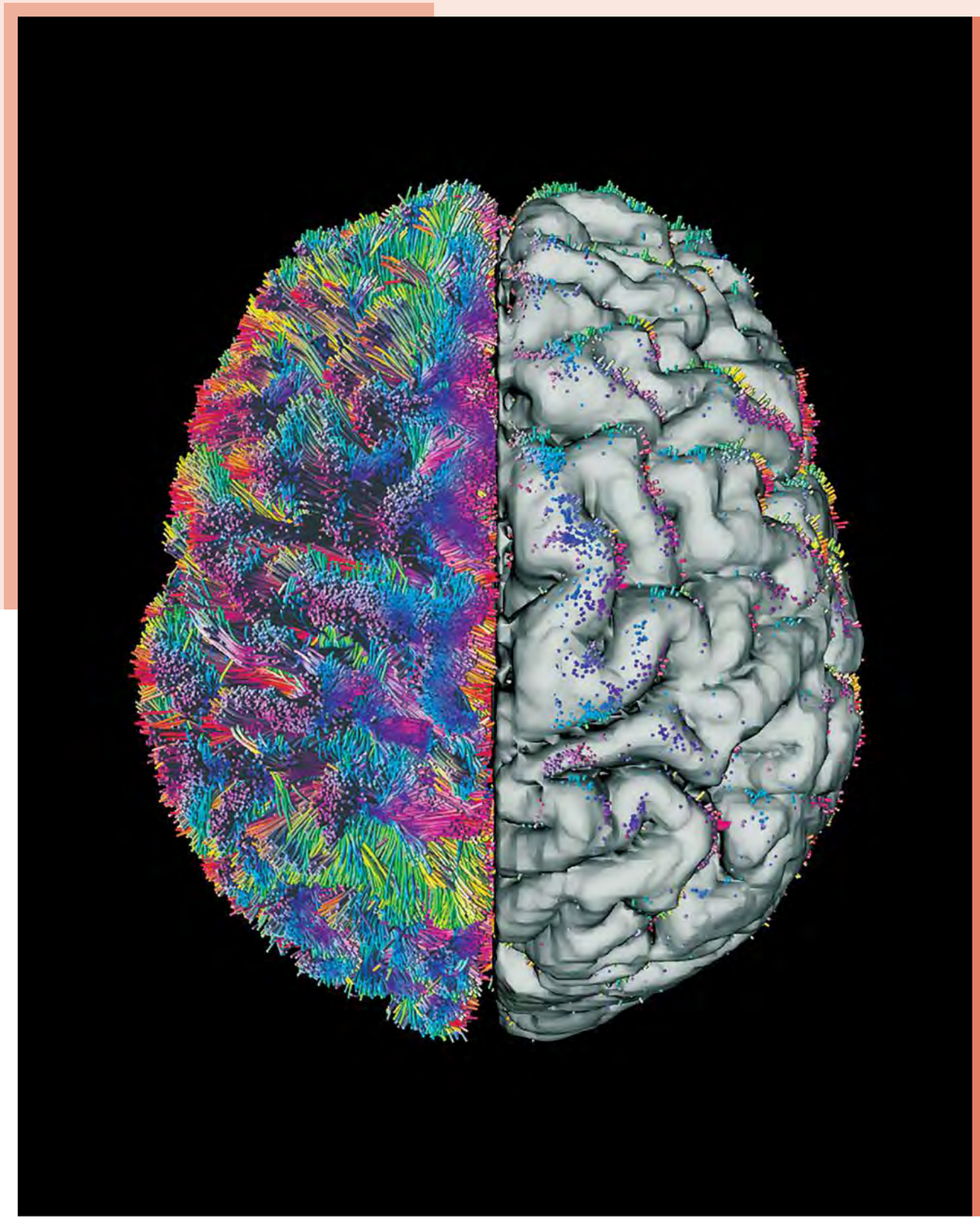


FIGURE: the sites used for sample collection and (right) the temperature range.

The Marine Biology Lab at NYU Abu Dhabi headed by John Burt, Associate Professor of Biology, uses the Arabian Gulf as a natural laboratory to study coral reef ecology in extreme environments and to understand how these may serve as a model for the possible impacts of future climate change on reefs elsewhere.

The labs current research seeks to examine how coral communities in these extreme environments respond to and recover from mass bleaching events, and how variation in environmental conditions affect biogeographic patterns of community structure of corals, fish, and other reef biotas in the region. For this, the lab is studying the corals adaptation to warming by characterizing the contribution of both animal host and symbiotic algae to thermal tolerance in corals that have already experienced considerable warming on par with end-of-century projections for most coral reefs.

The findings of this study provide evidence that genetic adaptation of both host and Symbiodinium has enabled corals to cope with extreme temperatures in the Gulf. Thus, the persistence of coral populations under continued warming will likely be determined by evolutionary rates in both, rather than single, symbiotic partners.



UNDERSTANDING HOW WE THINK

"...seeks to answer questions about how the brain mediates the most critical aspects of our communication system, and which properties of the mind/brain accomplish the seemingly effortless processing of language."

HOW OUR BRAINS ACCOMPLISH LANGUAGE PROCESSING

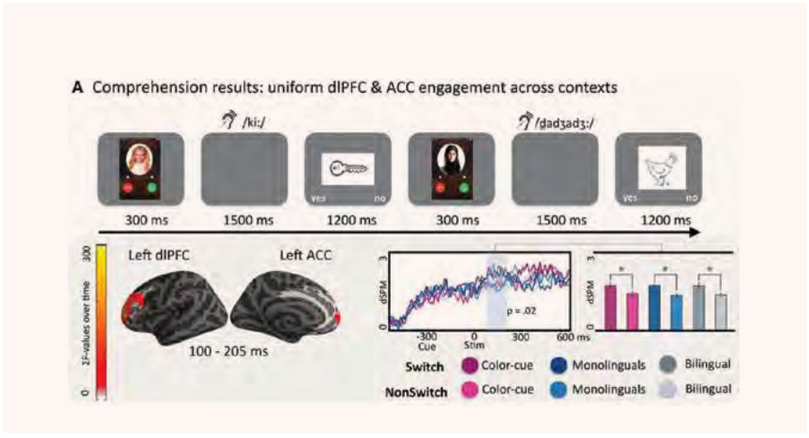


FIGURE: Brain basis of language switching in the Arabic-English bilingual. Commonly observed prefrontal effects of switching are only observed during somewhat artificial laboratory tasks (A) and not when the switches occur within a fully natural conversation (B) This suggests that, contrary to much prior literature, language switching is in fact not an effortful process for fluent bilinguals.

The Neuroscience of Language Lab (NeLLab) lead by Liina Pylkkänen, Professor of Linguistics and Psychology, and Alec Marantz, Professor of Linguistics and Psychology, explores how natural language is implemented in the brain. This research is conducted at sister facilities in New York and Abu Dhabi.

In collaboration with several local entities, including the United Arab Emirates University (UAEU), the NeLLab seeks to answer questions about how the brain mediates the most critical aspects of our communication system, and which properties of the mind/brain accomplish the seemingly effortless processing of language, ranging from the analysis of speech sounds to the construction of meaning.

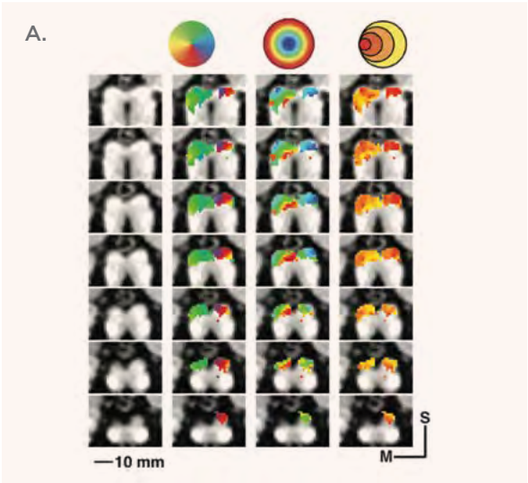
The research uses advanced magnetoencephalography (MEG), a cutting-edge, non-invasive technology that is supplemented by EEG and MRI. For example, a recent study published in the Journal of Neuroscience (Figure) shows how in the Arabic-English bilingual brain, language switching engages prefrontal executive control mechanisms when listening to switches within a classic laboratory task but not when listening to switches within a natural conversation, recorded on the NYU Abu Dhabi campus (kindly scan QR code).

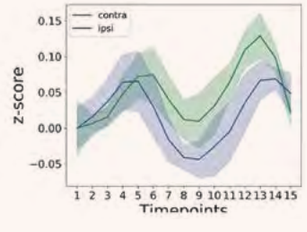
While our extant neurobiological understanding of language is heavily based on English, the mission of the NeLLaB is to branch out to the rich language diversity of the UAE to reveal a more comprehensive neural basis of language.

(Scan for article in National)

"This work has the potential to update existing models of cognition as well as inform clinical work on disorders related to the superior colliculus such as attention deficit/ hyperactivity disorder (ADHD) and spatial neglect."

BRAIN IMAGING FOR BETTER UNDERSTANDING OF WORKING MEMORY





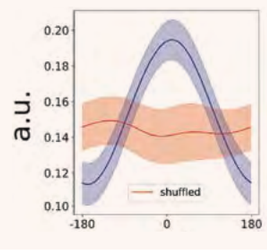


FIGURE: Working memory in the human superior colliculus. (A) Retinotopic maps in the superior colliculus demonstrate a spatial organization that can be revealed with functional MRI. (B) Functional MRI signal measured from retinotopically organized superior colliculus when the memory location was in the contralateral vs. ipsilateral visual field. Higher signal during the memory delay for contralateral memory locations suggests that memory information is stored in the superior colliculus.(C) Tuning for memory location in superior colliculus. Population activity was tuned to the remembered location, suggesting that the superior colliculus helps to generate and maintain memory representations for spatial position.

Kartik Sreenivasan, Assistant Professor of Psychology, aims to understand the neuro-biological mechanisms that support the ability to form and carry out goals. This work focuses on the dynamic and flexible neural coding of short-term memory representations as well as the networks involved in keeping memory representations robust to interference.

To study these phenomena, the lab employs a multimodal approach that includes methods such as functional magnetic resonance imaging (fMRI), human electrophysiology, and transcranial magnetic stimulation (TMS). One area the Sreenivasan Lab studies is the role of subcortical nuclei in cognition. Recently, they examined the contributions that the superior colliculus - a brain region that is largely implicated in eye movements - makes to human working memory.

In this study, research subjects remembered a location in space over a blank delay. Functional MRI data collected from the superior colliculus during the memory delay was used to predict where subjects were remembering. This suggests that the superior colliculus contains goal-related memory information and may make important contributions to cognition. This work has the potential to update existing models of cognition as well as inform clinical work on disorders related to the superior colliculus such as attention deficit/ hyperactivity disorder (ADHD) and spatial neglect.

"... the high-level visual cortex is also involved in categorization or transformation of visual inputs into different concepts such as animals and objects, which has implications on modifying current understanding of visual object recognition."

HOW WE MAKE SENSE OF WHAT WE SEE

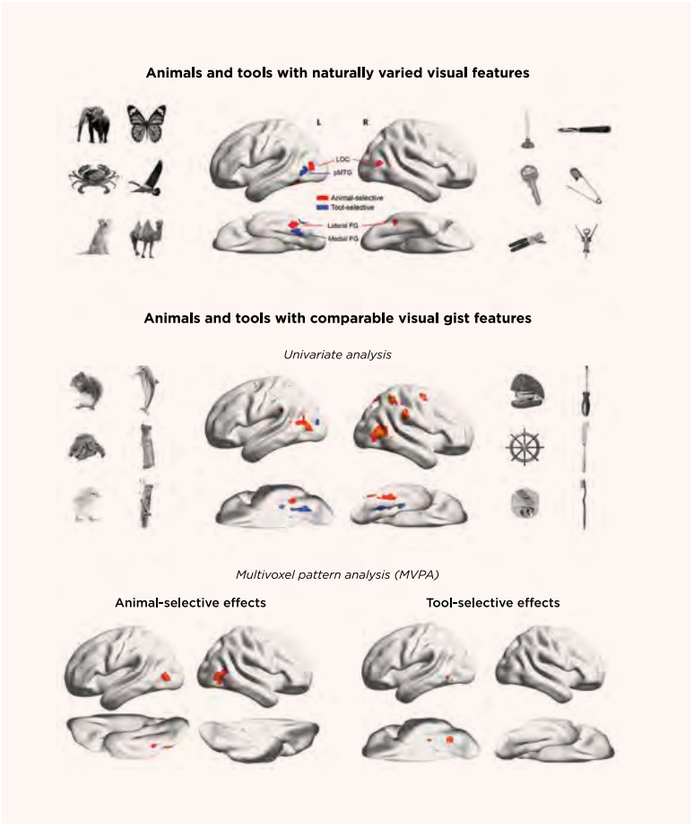
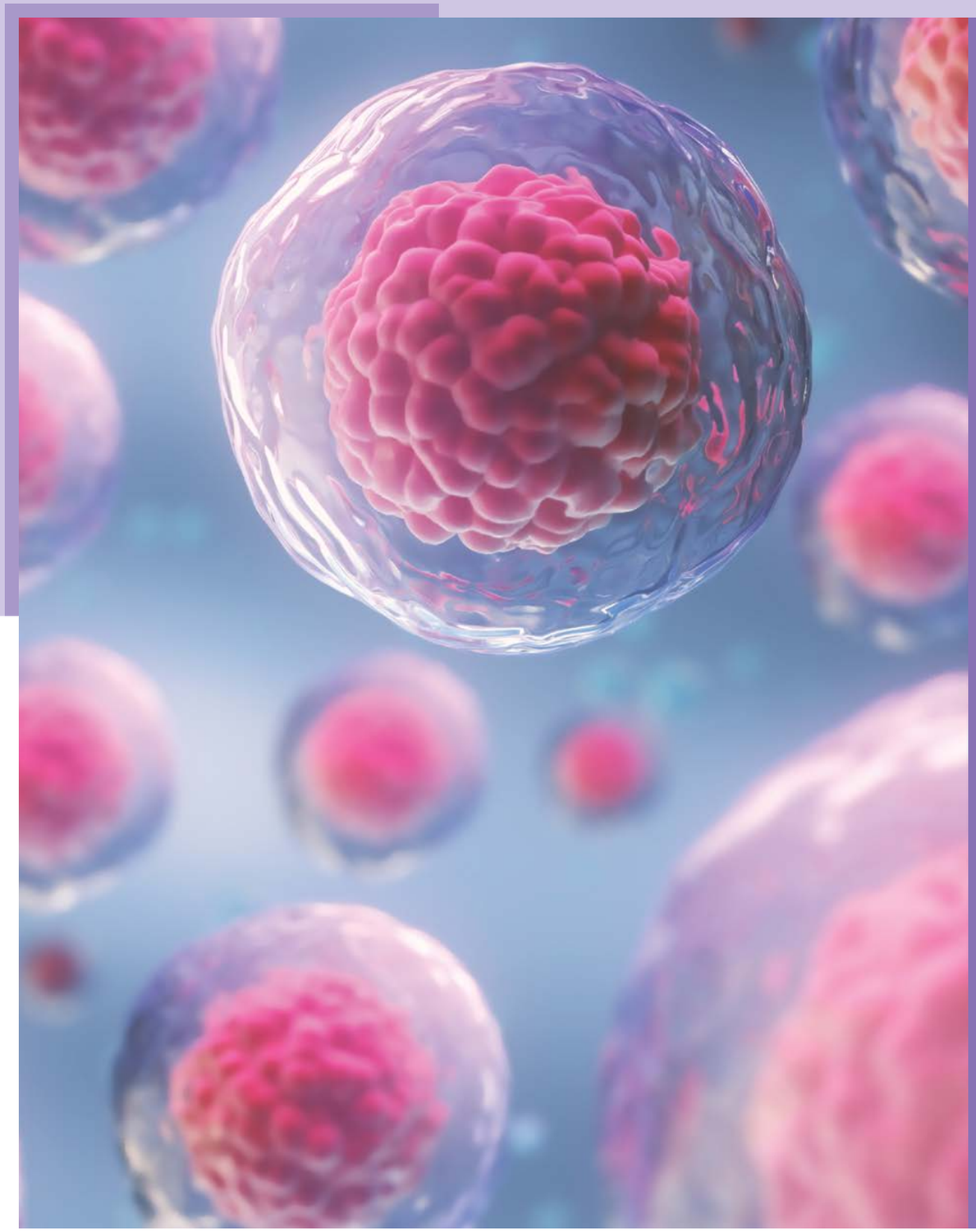


FIGURE: Differential brain activations for common categories in the visual cortex. Sample images of animals and tools with naturally varied visual features (top panel) and comparable image statistics (bottom panel). Whole-brain univariate analyses illustrated here revealed highly similar neural responses between the two sets of images of varied vs. comparable visual features for animals vs. tools: stronger activations for animals than tools were observed in bilateral lateral occipital complex (LOC) and bilateral lateral fusiform gyri (FG), whereas stronger activations for tools than animals were observed in the left posterior middle temporal gyrus (pMTG) and left fusiform gyrus (FG). These results suggest that in addition to the processing of visual features, these brain regions are also involved in categorization or transformation of visual inputs into different concepts such as animals and objects.

Animals and tools are not only different concepts, but items in the two categories also look very different. To explore how visual and conceptual information of animate and inanimate categories are represented in the human brain, a recent study conducted in the lab of Olivia Cheung, Assistant Professor of Psychology, controlled for image statistics between the images of animals and tools presented in the MRI scanner - See He, C., & Cheung, O.S. (2019). Using univariate and multivoxel pattern analysis, the results reveal that the occipitotemporal cortex, which has been thought to be primarily engaged in visual processing, shows selective sensitivity for animals and tools with comparable image statistics.

This novel finding suggests that in addition to the processing of visual features, the high-level visual cortex is also involved in categorization or transformation of visual inputs into different concepts such as animals and objects, which has implications on modifying current understanding of visual object recognition.

Using multivoxel pattern analysis (MVPA), it was further confirmed that for different common categories such as animals and tools, highly similar neural response patterns among different animals, or among different tools, were observed in the animal-selective and tool-selective regions mentioned above, respectively.



IMPROVING OUR HEALTH

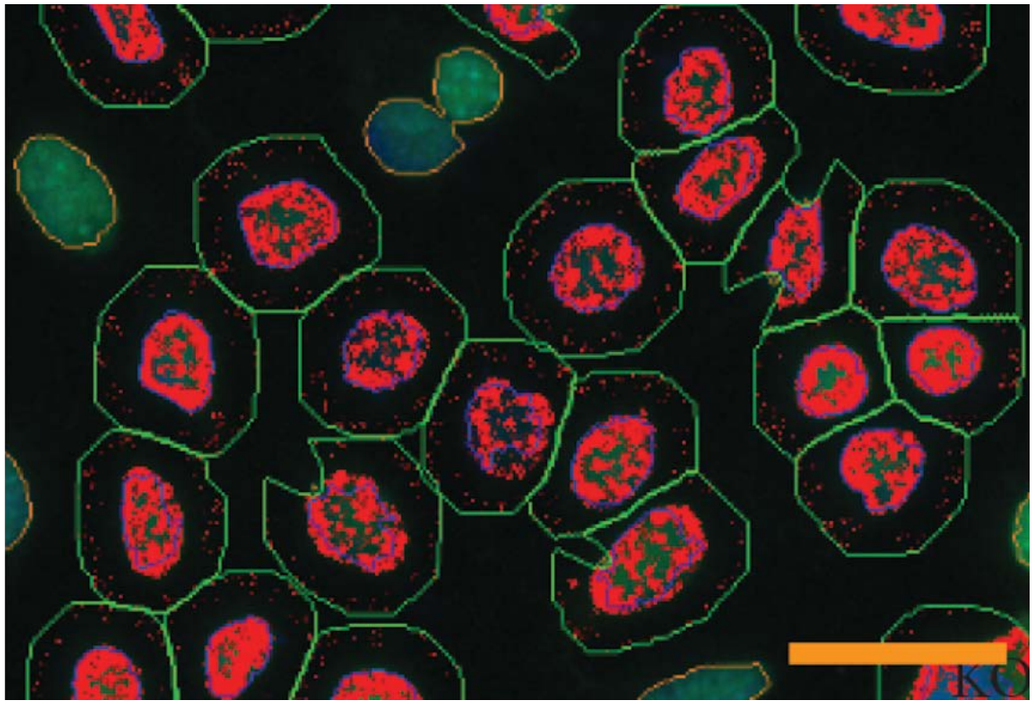


FIGURE: Quantitative analysis of chromatin. Cells were scanned using a high content phenotypic profiling screening platform for quantitative analysis of potential abnormalities in the chromatin visualized using a specific antibody (Red). Scale bar: 25 ×m (Xie et al., 2017).

"The findings of the research may impact global transcription as well as the establishment of cellular identity."

GENE REGULATION

The lab of Piergiorgio Percipalle, Associate Professor of Biology, studies the molecular mechanisms underlying gene regulation and genome organization in development and differentiation, and how they are deregulated in disease. Recently, the lab discovered that cytoskeletal proteins such as actin and myosin play an important role in gene expression regulation by participating in chromatin structure, function and dynamics, in transcription and in assembly of ribonucleoprotein complexes. Seeing the prominent role that these cytoskeletal proteins play in nuclear function, the lab is currently investigating their role in genome organization. The findings of the research may impact global transcription as well as the establishment of cellular identity.

Using the genomics and bioinformatics pipeline and a platform for high content phenotypic profiling, the lab studied the potential of global alterations in transcription that reflect observed changes in the chromatin.

The results of the project identified a novel paradigm to explain how cellular identity is acquired and the lab is now developing reprograming protocols to better understand the process and the main players involved in differentiation when cells acquire a specific identity.

"Intracellular transport is indispensable for the proper functioning of the cell."

INTERCELLULAR TRANSPORT REGULATION

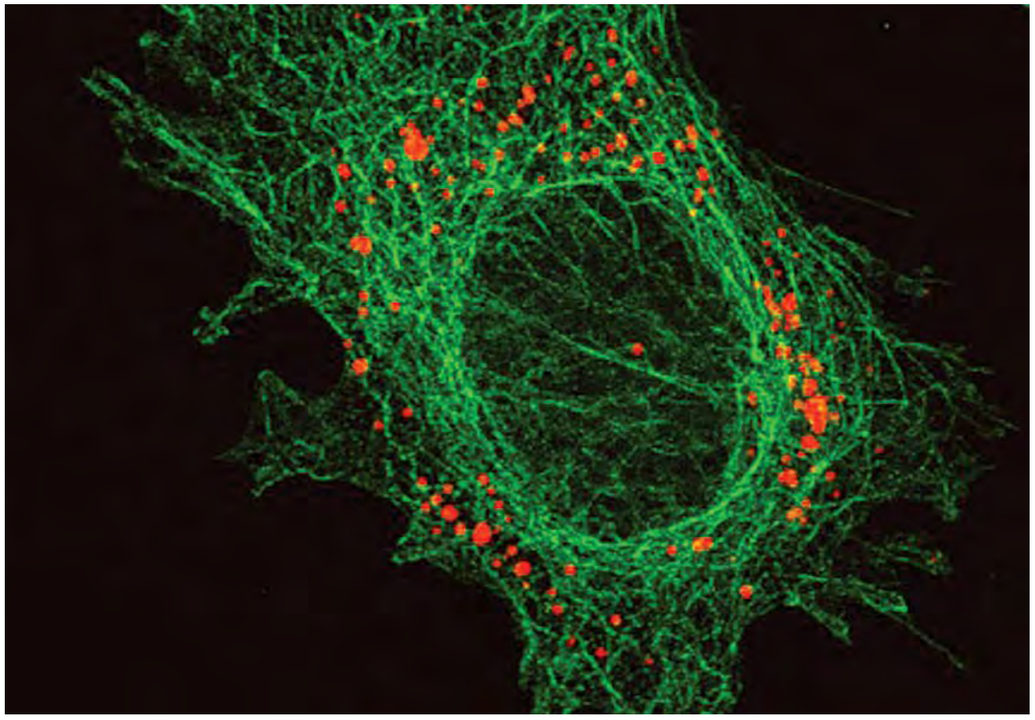


FIGURE: A confocal microscopy image showing microtubules (green) and lipid droplets (red) allowing us to determine cargo distribution and dynamics in mouse embryonic fibroblasts under various conditions. (Image is 80 microns across)

George Shubeita, Assistant professor of Physics, research focus is on understanding the organization of living cells at various length and time scales. A major contributor to cell organization is intracellular transport by molecular motor proteins which is indispensable for the proper functioning of the cell. Transport relies on the cell's cytoskeletal filaments that act as roads for the associated molecular motors, which deliver various cargoes to where they are needed at the time they are needed. Defects in motor protein function or its regulation have been found in many degenerative disease models such as Alzheimer's and Huntington's diseases, and amyotrophic lateral sclerosis (ALS). Therefore, a thorough understanding of intracellular transport is required to understand those diseases.

One ongoing study in George Shubeita's laboratory uses GSK3 knockout Mouse Embryonic Fibroblasts as a model system to tease out the details of how GSK3 regulates transport along the microtubule filaments. GSK3 is of relevance given that it appears to be a major player in Alzheimer's disease, other neurological and neuropsychiatric disorders, and normal neuronal development and plasticity.

Preliminary results using advanced confocal microscopy show that GSK3 depletion causes distorted distribution of different cargoes, including mitochondria and lipid droplets. GSK3, being a kinase, alters proteins' function through phosphorylation. Its downstream targets can be the motors, motor adaptors and cofactors, the cytoskeletal roads, Microtubules Associated proteins (MAPs) that bind to the roads, or a combination of these. Shubeita's lab are investigating a combination of proteomic, biochemical, biophysical and super-resolution cell imaging approaches to tease out the mechanism of transport regulation by GSK3. This requires the use of advanced technological resources housed in the core technology platforms at NYUAD.

"...enhancing the regenerative potential to treat liver diseases."

ZEBRAFISH AS MODEL SYSTEM TO UNDERSTAND HUMAN LIVER DEVELOPMENT AND DISEASE

FIGURE: Precancerous zebrafish hepatoctyes stained with markers of DNA (blue), markers of nuclear structure (red) an oncogene (UHRF1- green).

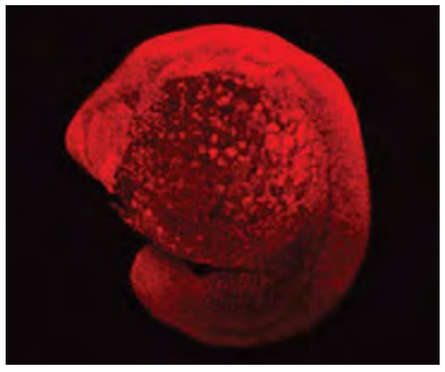


FIGURE: Zebrafish embryo (18 hours post fertilization) stained with an antibody against the histone variant h2afza.

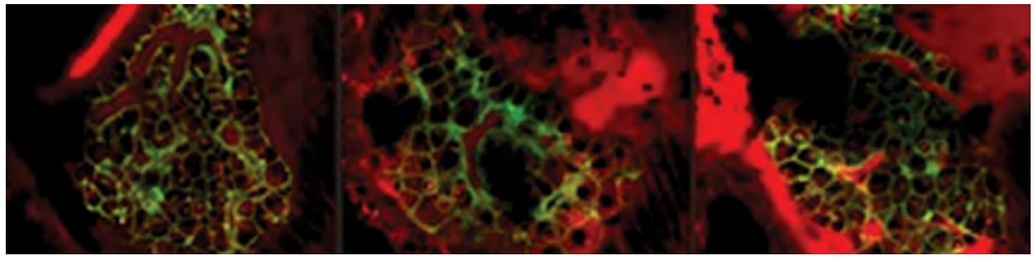


FIGURE: Lipid accumulation in liver during ER stress

Liver, the largest organ in the human body, performs a range of physiological functions, including energy homeostasis, drug metabolism, serum protein secretion and bile production. Despite the remarkable regenerative capacity compared to most other organs, liver failure is among the leading causes of death worldwide as it is not always able to undergo efficient repair. Kirsten Sadler Edepli, Associate Professor of Biology, research focus is to not only understand the mechanisms that give rise to metabolic liver disease but also to identify how widespread changes to the epigenome promote liver development. To investigate this, she uses Zebrafish as a model system since their liver looks and functions similar to that in humans.

One of her research projects funded both internally (NYUAD Start up Fund) and externally (National Institute of Health (NIH) and Abu Dhabi Education Council) aims to investigate how stress in the endoplasmic reticulum (ER) causes fatty liver disease. This alarming widespread disease can be caused by obesity, toxins including alcohol, type II diabetes, and other factors and can result in cirrhosis and death. The project, in its early stage, has already identified key players in ER stress. They showed that ER stress is accompanied to bring changes in ER structure that are mechanistically related to fatty liver disease.

The project demonstrated for the first time that the epigenetic regulator UHRF1 is essential for liver development and regeneration. In addition, it also revealed that the overexpression of UHRF1 causes liver cancer. This indicates that further understanding of how the mechanism behind this works, would ultimately advance the long term goal of enhancing the regenerative potential to treat liver diseases.

The state-of-the-art equipment available at CTP and their highly qualified staff played an instrumental role in the success of this project. "The lab has made dramatic advances in their research through imaging the live cells under stress. They have identified structures no one has been able to see and their next steps are to figure out how these morphological changes relate to disease outcome".

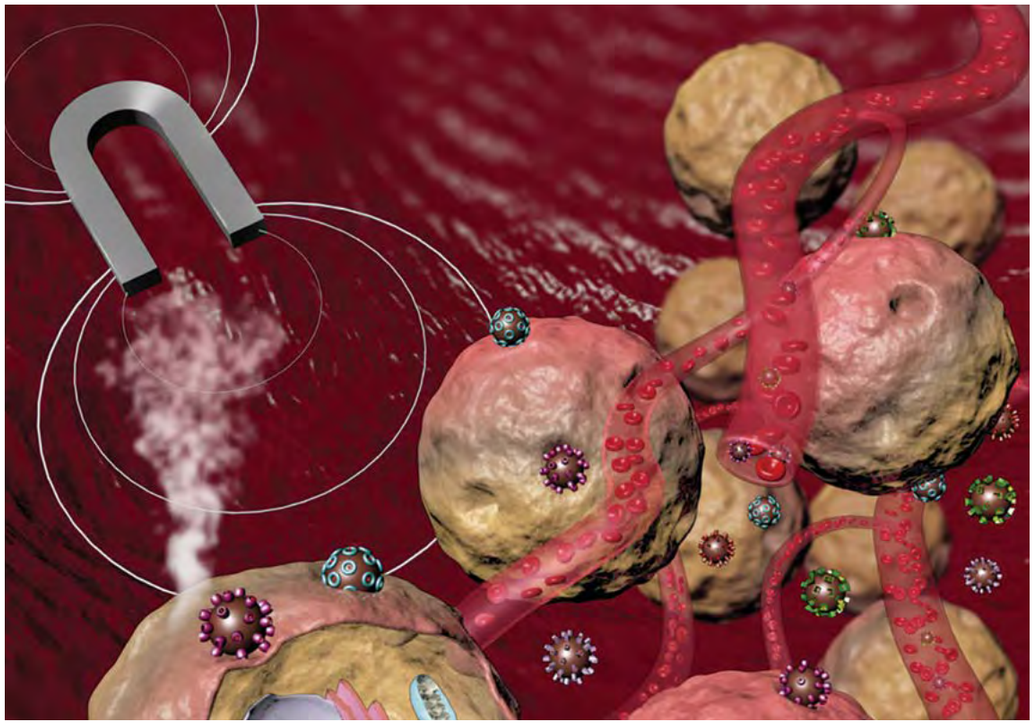


FIGURE: Representation of nanoparticles delivering drugs and inducing hyperthermia into cancer cells.

"...aims in the development of theranostic platforms that can be loaded with chemotherapeutics to provide targeted and sustained delivery to tumor cells."

DIRECT CHEMOTHERAPEUTIC DELIVERY TO TUMOR CELLS

Ali Trabolsi, Associate professor of chemistry, research aims in the development of theranostic platforms that can be loaded with chemotherapeutics to provide targeted and sustained delivery to tumor cells. It will serve to control the timing as well as the location of cargo delivery that will eventually result in optimizing the drug's efficiency.

The lab has developed different kinds of organic and inorganic materials (polymer, gold, silver, iron oxide...) and it is primordial to assess their biological effects, especially on cancer cells. For this purpose, the lab synthesizes the materials and assesses their biological effects on different models of cancer and non-cancer cell lines. State-of-the-art instrumentation at NYUAD is used to determine the toxicity of these materials, a hallmark of any material success as chemotherapeutics.

"...understanding the fundamental factors that govern the formation of molecular knots and their application development as nano- molecular machine in the direction of biology and material science."

MOLECULAR KNOTS

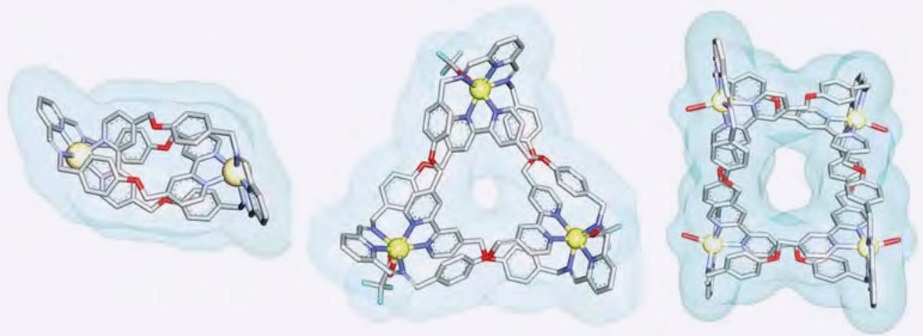


FIGURE: X-ray crystal structures of self-assembled [2]catenane (top), trefoil knot (middle) and Solomon link (below)

Historically, synthetic chemists have been fascinated by molecular links and curious to discover easy and efficient ways to prepare them– often simply because the molecules are structurally complex and beautiful, but also for potential applications in materials science or biology. For example, molecular knots have been observed in nature in the form of DNA, RNA and proteins, and synthetic versions of these structures may have diagnostic or therapeutic value. Preparation of molecular links is often considerably most challenging, and insights into their mechanisms of formation, and their potential applications have thus far been uncommon. Ali Trabolsi's lab is working to explore the application of molecular knots in-terms of catalysis and biology focusing on the synthesis of different topological metal organic structures, understanding the fundamental factors that govern the formation of molecular knots and their application development as nano-molecular machine in the direction of biology and material science.

Three of the x-ray crystal structures of molecular knots shown in the diagrams were thoroughly characterized using the advanced technology (NMR, HR-ESIMS and SCXRD) available at Core Technology Platforms in NYUAD.

"The characterization of HK2 can be used for the design and development of new inhibitors as anticancer therapeutics."

CANCER METABOLISM FOR THE DISCOVERY OF EFFECTIVE ANTICANCER THERAPEUTICS

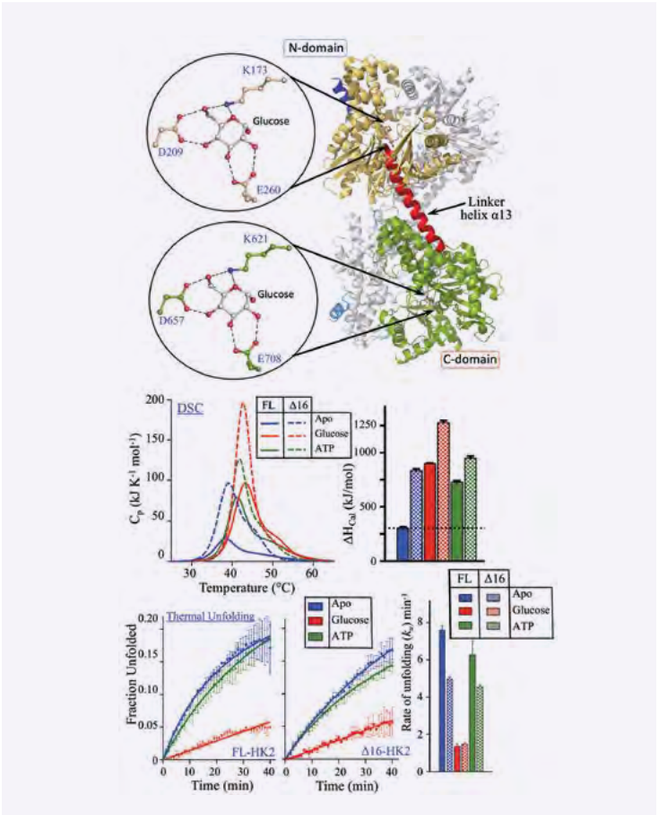


FIGURE: The Crystal Structure of Human HK2 show a homodimer with monomers colored in white and gold. The mitochondrial binding peptide (MBP) is colored blue at beginning of the N-terminus and the linker helix-α13 (red) is between the N- and C-halves. Helix-α13 is a long 8 turn helix that protrudes out of the active site of the N-half. Insets: the glucose binding pockets in the N- and C-halves.

DSC (differential scanning calorimetry) of HK2. The DSC thermograms of full-length (FL; solid bars) and mutant lacking the MBP (Δ16; dotted bars) variants of the WT HK2 in the absence (blue) and presence of 5 mM glucose (red) or 5 mM ATP (green). Thermal unfolding of HK2 at 37 °C. Time dependence of CD scans on the thermal kinetic stability of HK2 variants in the absence and presence of 5 mM Glucose or 1 mM ATP at 37 °C. Ellipticity readings at 222 nM were normalized to fraction unfolded protein. Thermal unfolding rates (ku) were calculated from the slope of the lines and values are shown in the bar plot.

Despite extensive research efforts and the major advances seen in the field, cancer remains a significant clinical challenge for scientists worldwide with nearly 8 million cancer deaths every year. Chemotherapy, the most common treatment for cancer, is not effective in many cases and has shown severe side effects. To overcome many of these obstacles, the researcher is desperately trying to develop new and innovative anticancer therapeutics. The metabolic alteration of cancer cells is a result of over expression of specific metabolic enzymes that is important to maintain the metastasic state. Human hexokinase 2 (HK2), one of four human isozymes, is suggested to be upregulated in aggressive cancers. The inhibition of HK2 has shown to slow tumor progression and metastasis, making HK2 a novel target for anticancer therapy.

Structural Biology and Biophysical Chemistry lab headed by Wael Rabeh, Assistant Professor of Chemistry, research aims to fully characterize the four human hexokinases in particular HK2. HK2, a major player in cancer, supplies energy and building blocks to the highly proliferating cancer cells. In addition, its most important role is to bind to mitochondria that results to inhibit apoptosis. Cancer cells resist apoptosis as a result of this binding, where malignant cells resist apoptosis under hypoxic conditions at low oxygen level and extracellular acidosis. Recently, the lab characterized the biochemical and structural roles of HK2 in translocation to mitochondria. HK2 (~102 kDa) is a homodimer with α/β fold similar to other hexokinases. It contains two domains that are structurally similar to the single domain HK4 (52 kDa), also known as glucokinase. The structural folds of the N- and C-domains are identical to conserved glucose and G6P binding pockets. HK2 binds to the outer mitochondrial membrane through an α-helix (Figure, blue) at the N-terminus that is unique to HK 1 and 2. In addition, a long nine-turn α-helix (red) extends out of the active site of the N-domain (gold) and links it to the C-domain (green). The characterization of HK2 can be used for the design and development of new inhibitors as anticancer therapeutics.

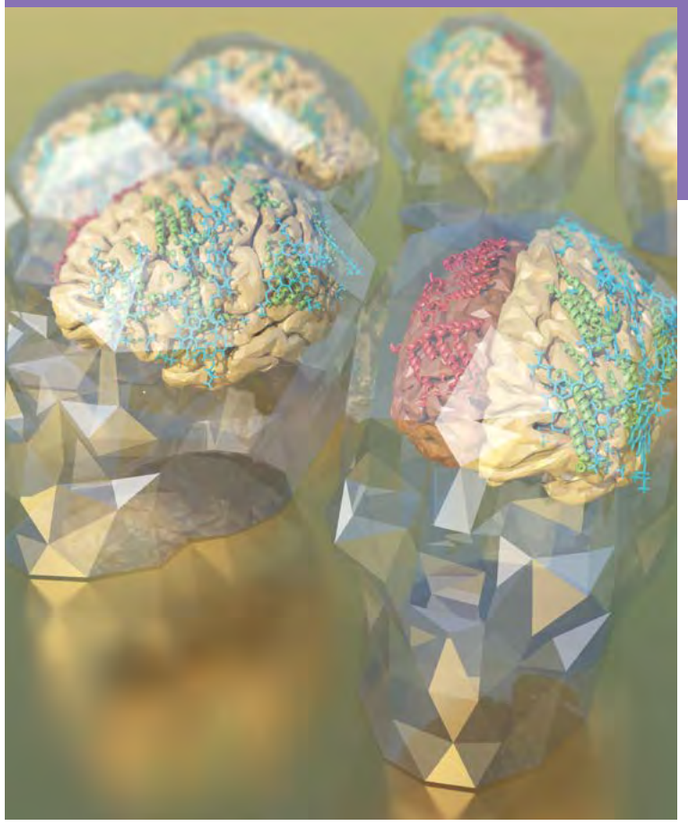


FIGURE: Proposed model of pHK-PAS action. Coupling a penetration accelerating sequence (PAS) to the VDAC-binding domain of HKII (pHK) enhances the peptide's cellular uptake by both endocytosis and energy-independent mechanisms. pHK- PAS accumulates at the mitochondrial membrane, where it binds to VDAC, displacing endogenous full-length HKII in the process.

Disruption of the HKII–VDAC interaction leads to mitochondrial dysfunction, depletion of intracellular ATP levels, release of cytochrome c and, finally, apoptosis.

Figure is designed by Khulood Alawadi

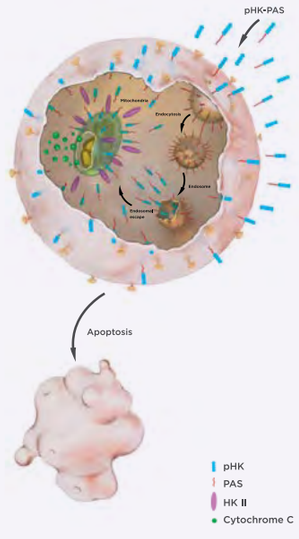


FIGURE: An oligoquinoline-based foldamer is identified as a potent antagonist of Aβ fibrillation, a process associated with the onset and the progression of Alzheimer's disease. The oligoquinoline foldamer retains its antagonist activity toward Aβ-mediated neurotoxicity in cellular milieu, which is unprecedented for Aβ inhibitors. This work is part of an ongoing collaboration with the Hamilton lab (NYU Chemistry).

Figure is designed by Khulood Alawadi

" ...results demonstrate the potential of the pHK-PAS CPP as a novel cancer therapeutic strategy."

NOVEL THERAPEUTICS FOR AMYLOID DISEASES AND CANCER

Several degenerative diseases are characterized by self-assembly of proteins or peptides into aggregates termed amyloid, which share several physicochemical features: a fibrillar morphology, a predominantly β-sheet secondary structure, insolubility in common solvents and detergents, and protease resistance. These so-called amyloid diseases include Alzheimer's disease, Huntington's disease, Parkinson's disease, prion diseases (Creutzfeldt-Jakob disease in humans and 'mad cow disease' in cattle), and type II diabetes. It has become generally accepted that the fibers themselves are not the toxic state; rather, it is the process of amyloid formation and in particular the formation of soluble intermediate states that represent the origin of toxicity.

Current efforts in the Magzoub lab are focused on identifying the toxic species, sub-cellular target and mechanism of cytotoxicity of amyloid beta (Aβ or Abeta; Alzheimer's disease) and the prion protein (PrP; prion diseases). Understanding the molecular basis for cellular dysfunction in Alzheimer's and prion diseases will facilitate design of more effective inhibitors and development of strategies for the targeted delivery of these inhibitors.

The Magzoub lab is also interested in developing tumor-specific therapeutics. These include small molecules, peptides and proteins. An example is their recently published peptide derived from the mitochondrial membrane-binding N-terminal domain of hexokinase II (HKII). Overexpression of mitochondria-bound HKII in cancer cells plays a paramount role in their metabolic reprogramming and protects them against apoptosis, thereby facilitating their growth and proliferation. The HKII-derived peptide, pHK-PAS, is readily taken up by cancer cells where it effectively disrupts the mitochondria-HKII association, leading to mitochondrial dysfunction and finally apoptosis. Significantly, pHK-PAS treatment of non-cancerous cells results in substantially lower cytotoxicity. Their results demonstrate the potential of pHK-PAS CPP as a novel cancer therapeutic strategy.

"This study will help in designing or identifying inhibitors that block the Par-4-Fbxo45 interaction, to reactivate the Par-4 function as a promising cancer therapeutic strategy."

SELECTIVE DESTRUCTION OF CANCER CELLS

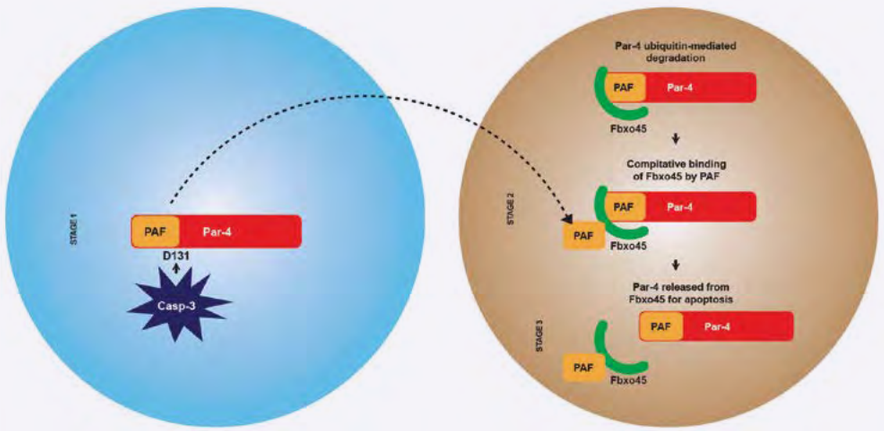


FIGURE: Mechanism of PAF-mediated inhibition of Par-4 degradation

Sehamuddin Hussain Galadari, Professor of Biology, investigates proteins that can selectively induce programmed cell death, known as apoptosis, in carcinoma cells. His lab studies the powerful tumor suppressor protein, prostate apoptosis response-4 (Par-4) that induces apoptosis selectively in cancer cells, while leaving the normal cells unaffected. During the process of apoptosis, Par-4 is known to be cleaved into two fragments - while one of these fragments is known to accumulate in the nucleus leading to increased apoptotic activity, no focus has been given to date on understanding the mechanism of action of the second fragment of Par-4 (PAF).

Very recently, a novel tumor suppressor mechanism mediated by PAF has been identified, involving PAF competitively binding with and inhibiting the ubiquitin ligase Fbxo45, which is primarily responsible for Par-4 degradation. Competitive inhibition of Fbxo45 by PAF disrupts the Fbxo45-Par-4 interaction and rescues Par-4 from degradation, making it available for apoptosis induction (Figure). Interestingly, PAF was found to be sufficient to induce tumor growth inhibition in immunocompromised mice injected with Lewis lung carcinoma cells. Based on this observation, the laboratory of Professor Galadari aims to characterize PAF as an inhibitor of the Par-4-Fbxo45 interaction, and is working on developing a high throughput screen in search of small molecules that inhibit the Par-4-Fbxo45 interaction. This study will help in designing or identifying inhibitors that block the Par-4-Fbxo45 interaction, to reactivate the Par-4 function as a promising cancer therapeutic strategy.

"Bt toxins will provide a safe alternative to chemical anthelmintics for increasing agricultural productivity and thus promote global food security."

CHEMICAL GENOMICS SCREENS TO UNDERSTAND EMBRYONIC DEVELOPMENT AND DISEASE

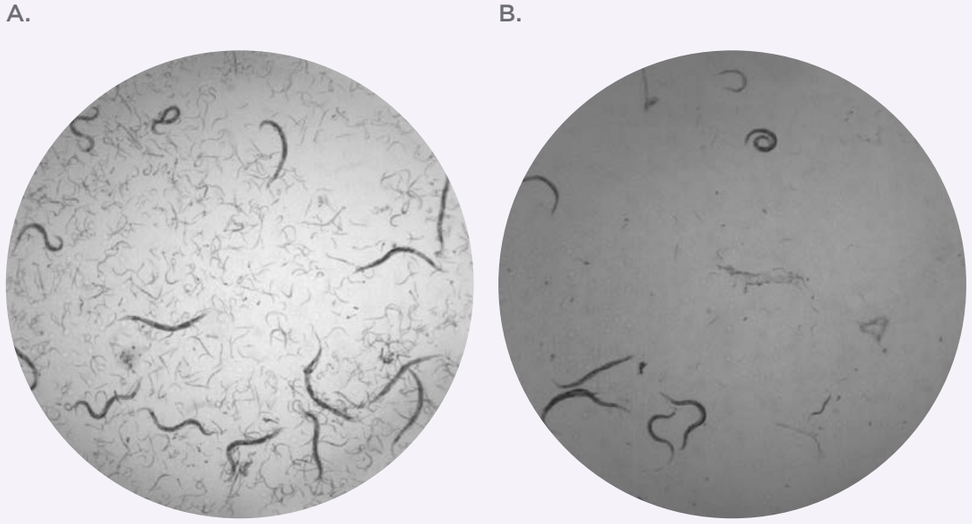


FIGURE: Control (A) and treated (B) C.elegans worms showing sterility phenotype after treatment with new potential anthelmintic.

The Chemical Genomics Lab led by Kristin Gunsalus and co-led by Fabio Piano focuses on the discovery and characterization of biologically active molecules and their modes of action.

The discovery of new potential disease therapeutics (e.g. anti-cancer) and broad-spectrum anthelmintics (to target parasitic worms, which affect 24% of humans, crops, and livestock) remains a challenge. The chemical Genomics Team designed workflows on the high-throughput screening (HTS) platform for chemical and functional genomic screening in both mammalian cells and whole organisms (e.g. microbes, worms and zebrafish).

The team has discovered several novel anthelmintic compounds from screens of small molecule and natural product libraries using the free-living nematode models C. elegans and the distantly related P. pacificus. They have also identified new Bacillus thuringiensis (Bt) crystal toxin proteins, which are safe to humans and show species-specific toxicity against insects and nematodes. Virulence factors from strains with efficacy against Meloidigyne, a plant parasitic nematode that constitutes a serious threat to a range of important crops, are being characterized by DNA sequencing and functional genomic assays to elucidate their mechanisms of action. Bt toxins will provide a safe alternative to chemical anthelmintics for increasing agricultural productivity and thus promote global food security.

High-Content Screening (HCS) of human cell lines with fluorescence microsopy has emerged as a promising tool for the discovery and characterization of bioactive chemical compounds. The Chemical Genomics team is using a panel of genetically encoded and reagent-based markers of subcellular compartments and pathways

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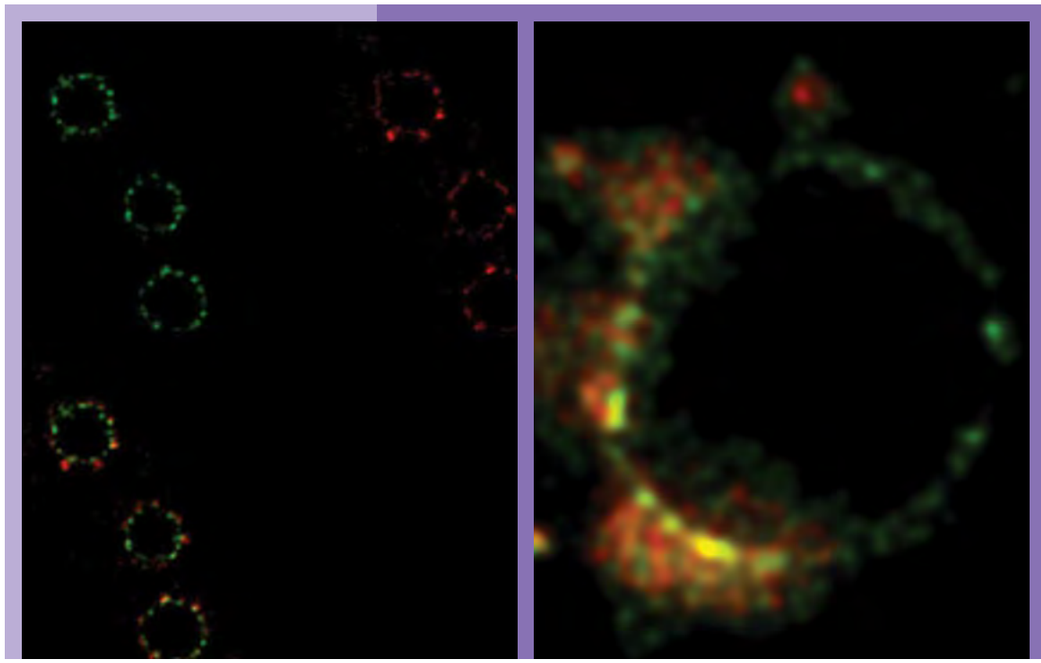


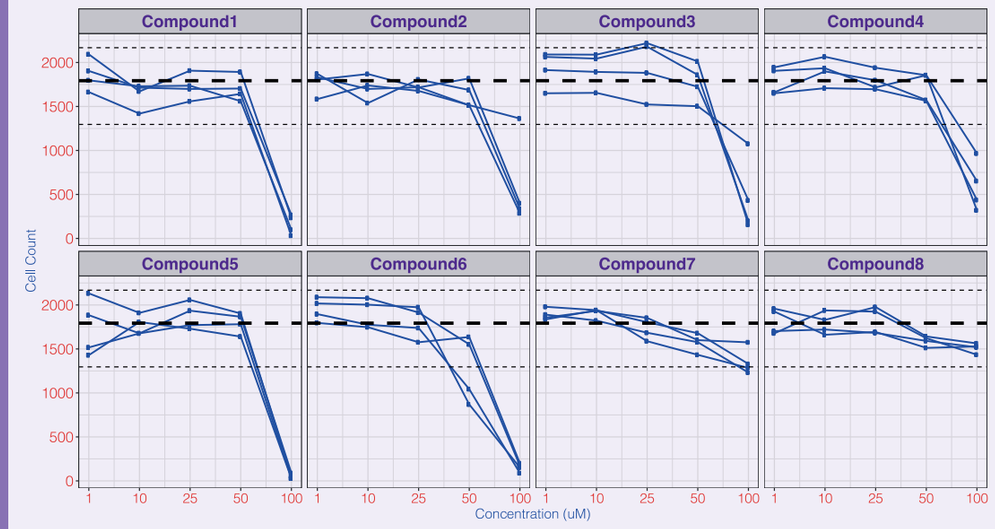


FIGURE:High-resolution images and time lapse movies show a dynamic localization pattern of germline protein structures on a sub-micron scale.

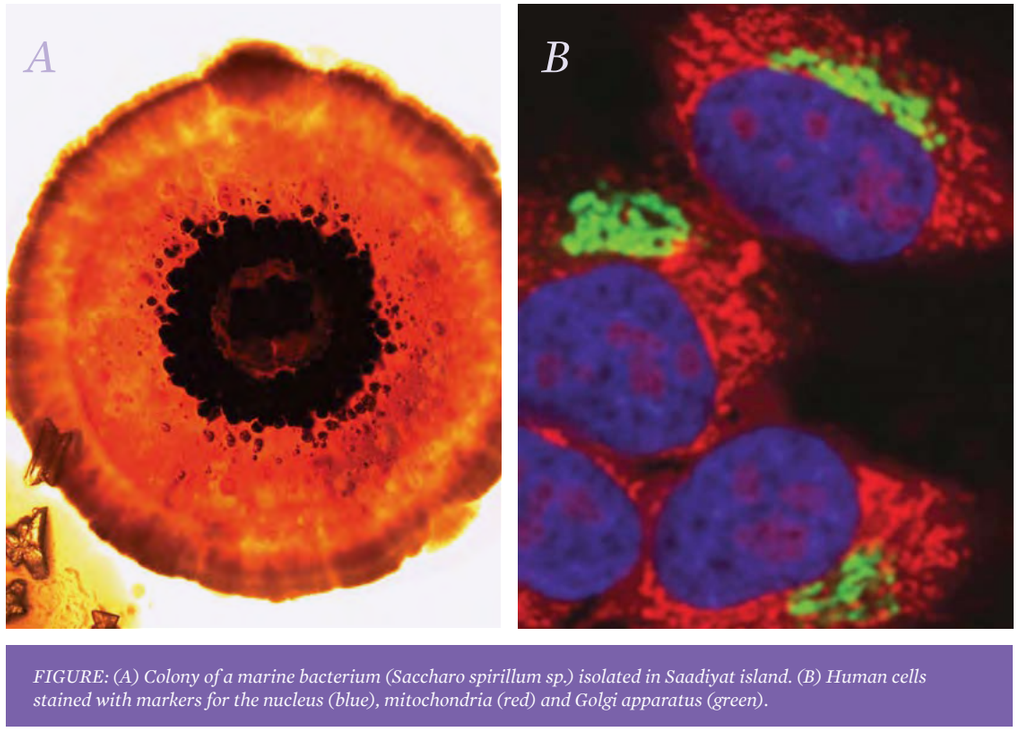


FIGURE: (A) Colony of a marine bacterium (Saccharo spirillum sp.) isolated in Saadiyat island. (B) Human cells stained with markers for the nucleus (blue), mitochondria (red) and Golgi apparatus (green).

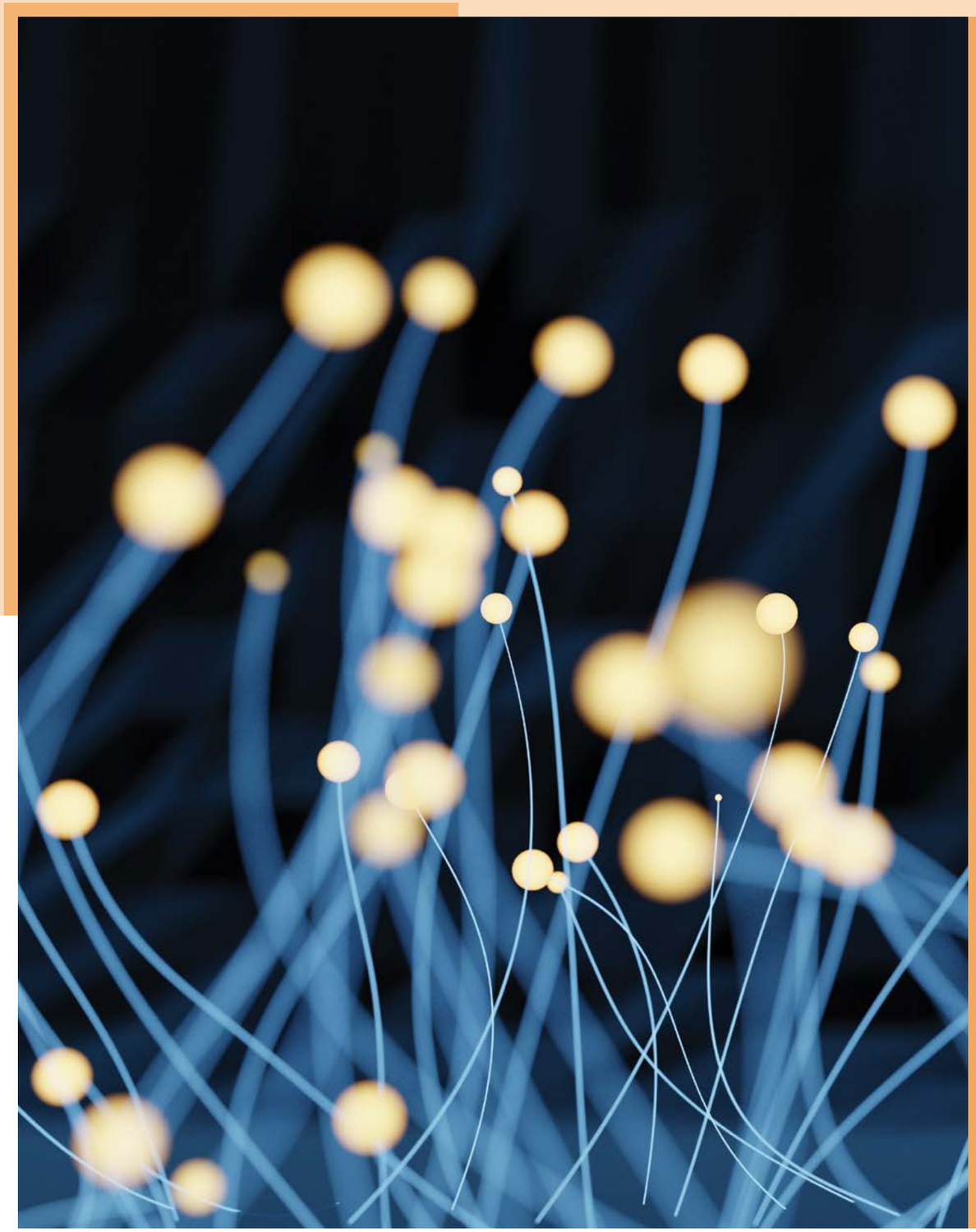
that reveal organelles, cytoskeleton, plasma membrane, cell cycle progression, stress responses, and cell death. HCS reveals changes in cellular morphology and function that provide information about mode of action, multi-level toxicity, and structure-activity relationships of test compounds. A major focus of this project is the isolation and characterization of novel bioactive molecules from marine organisms in the Arabian Gulf, a largely untapped, uncharted resource that holds significant potential for new bioactive molecules. The team is currently characterizing several promising candidates from microbial strains isolated from different habitats of the Gulf.

Another focus of the Chemical Genomics Lab is understanding the genetic mechanisms in early embryonic development.

Cells contain a variety of “membraneless organelles” (e.g. stress granules in mammals, P granules in C. elegans) harboring both proteins and RNAs. These enigmatic structures assemble different types of molecular machinery in response to a range of stimuli and play crucial and fascinating roles in development and disease.

In C. elegans embryos, cytoplasmic P granules segregate to specialized “immortal” cells that will become the germline, where they play important roles in mRNA surveillance and germline stem cell maintenance. However, their specific mode of assembly and functions remain to be elucidated. Confocal microscopy of novel P granule components using the Leica TSC SP8 platform coupled with Hyvolution software is revealing surprising new data about P granule structure and dynamics.

Using CRISPR alleles generated in the lab, genetic enhancer and suppressor screens were performed in the HTS platform to identify genetic modifiers of mutant phenotypes that may provide further insights into the function and regulation of P granules and their mammalian counterparts.



INCREASING EFFICIENCY IN OUR LIVES

"The possible application of this research could be artificial muscle, actuators for soft robotics and organic fuse."

FASCINATING PHASE-CHANGE PHENOMENA THAT MAKE CRYSTALS JUMP AND POP

Panče Naumov, Associate professor of chemistry, is working on smart materials with exotic properties, some of which are applicable to efficient and controllable energy transduction of light and heat into work. Examples of the most recent discoveries include self-healing and shape-memory crystals, organic martensites and mechanically deformable crystals. The research involving mechanistic studies and application of salient crystals, a new class of molecular crystalline solids that can rapidly transduce energy into mechanical motion and work at a millisecond time-scale, has received much international acclaim.

The crystals with motion were undergoing a rapid, self-perpetuated solid-state phase transformation. The phenomena is triggered by a temperature change that causes a molecular change leading to internal strain building up in the crystal lattice. Eventually the crystal undergoes a transition to an energetically more favorable phase. When one molecule switches from one crystal phase to another, it triggers the same change in a neighboring molecule – at the rate of over one billion molecules per second. The mechanical energy is released very fast and motion is observed as a consequence. The possible application of this research could be artificial muscle, actuators for soft robotics and organic fuse.

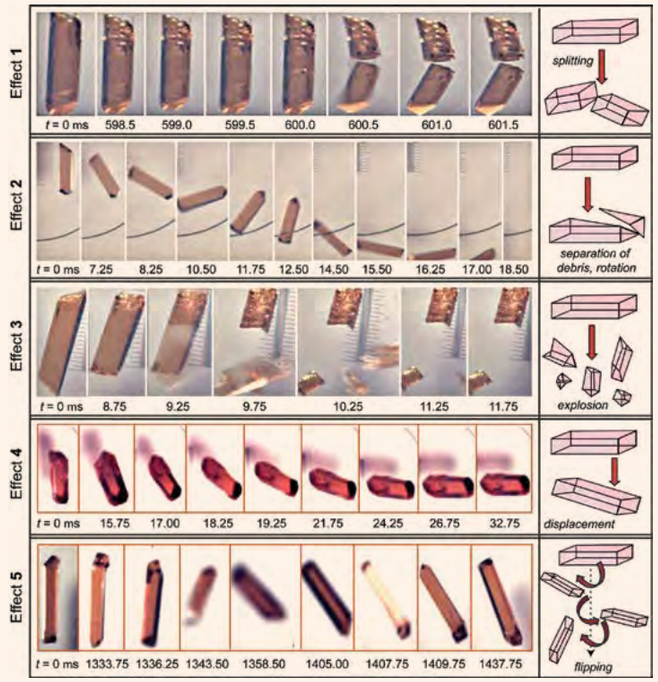


FIGURE: crystals undergoing with splitting, separation, explosion, displacement and flipping effects.

"...thriving to design and prepare the scaling inhibitors that may result in enhanced efficiency and reduced losses during cleaning operation"

FIGHTING SCALE TO REDUCE LOSSES IN ABU DHABI OIL RESERVOIRS

Deposited Asphaltene on carbon steel

Cleaned carbon steel sensor

FIGURE: Stainless steel sensor after deposition af asphaltenes and after application of a chemical for removal of the deposit. These images show a complete removal of the deposit, which could potentially act as a nucleus for formation of larger amounts of scale on the wellbore wall and cause clogging.

Scale, the most serious oil field problem, is a collection of deposits that cake perforations, production tubing, casing, pumps, valves, and downhole completion equipment resulting in the loss of millions of dollar every year. Researchers at NYU Abu Dhabi are thriving to design and prepare the scaling inhibitors that may result in enhanced efficiency and reduced losses during cleaning operation.

To address the scaling problem, Panče Naumov, Associate professor of chemistry, in a research work sponsored by Abu Dhabi National Oil Company (ADNOC) and Abu Dhabi Educational Council (ADEC) aims to design and prepare efficient inhibitors for organic scale deposition in Abu Dhabi oil reservoirs.

A similar project, funded by ADNOC, initiated by the same lab focuses on the 3D structure of the asphaltene deposits on different substrates as well as the synthetic development of chemical inhibitors.

In order to achieve the above goals, the lab has been deploying the following high-end instruments in the CTP Labs: NMR spectrometer, High-resolution mass spectrometer (FT-ICR-MS), IR, UV-VIS spectrophotometer, fluorescence spectrometer and atomic force microscopy.

"....following the roadmap for on-chip interconnects, the lab aims to demonstrate efficient designs that can speed up the silicon photonics link to 400 Gbit/s as a line rate."

NOVEL OPTOELECTRONICS IN NEXT-GENERATION OPTICAL COMMUNICATION

Room Temperature Phase Transformation of Ge-on-Si Films using Controlled Low Load Nano-indentation

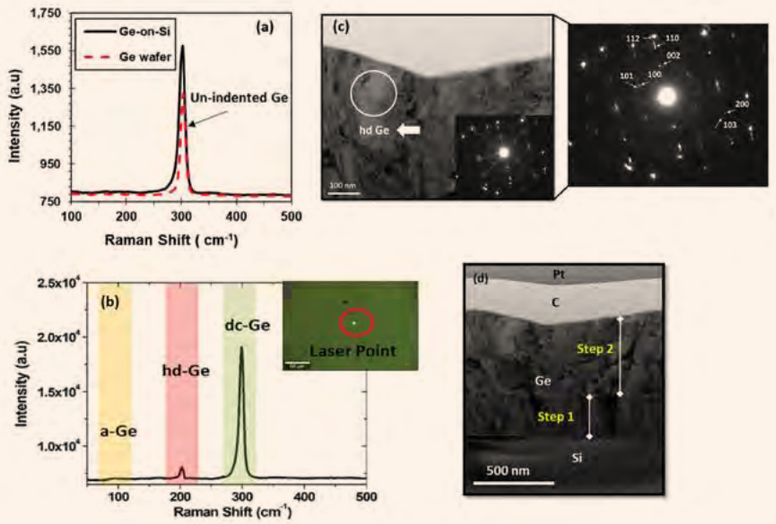


FIGURE: Micro-Raman spectra and bright field XTEM micrographs. (a) Raman spectrum of un-indented film and Ge wafer. (b) Raman spectrum of indented Ge film. (c) XTEM image of indentation impression carried out in depth control mode for indentation depth of 150 nm at room temperature. The selected area diffraction pattern (SADP) are collected in three region (right-center-left) beneath the indent, the SADP shown represents the region in the circle and its indexing (d) low magnification TEM image showing the entire indent region.

Mahmoud Rasras, Associate Professor of Electrical and Computer Engineering, research focuses on developing novel optoelectronics components to address bandwidth limitations in next-generation optical communication links. His group actively works on silicon photonics, plasmonics and new emerging CMOS compatible materials for on-chip optical interconnect. Applications related to cybersecurity and optical sensors for health care and environmental monitoring are also investigated. These sensors are robust against electromagnetic interference and can be easily deployed at relatively low-cost.

In the last decade, Silicon photonics (SiPh) has emerged as an ideal platform for optical data communication, signal processing, and sensing applications. The general expectation is that it will become an integral part of the mainstream semiconductor electronics technology. This has been driven by the demand for large communication bandwidths exceeding terabits per second. The Photonics Research Lab (PRL) is working to develop a diverse set of key integrated photonics functions on this platform. The aim is to provide a baseline flow that can be used to construct monolithic photonic systems fully compliant with the industry standards. Additionally, following the roadmap for on-chip interconnects, the lab aims to demonstrate efficient designs that can speed up the silicon photonics link to 400 Gbit/s as a line rate. Towards this goal, the PRL has recently demonstrated high performance plasmonic and GaAs photodetectors integrated on a thin germanium buffer layer on silicon.

"The newly developed types of cement with controlled physical and chemical characteristics will cause a drastic reduction in the carbon footprint of the construction industry."

NOVEL CEMENTS FOR GREEN INFRASTRUCTURE

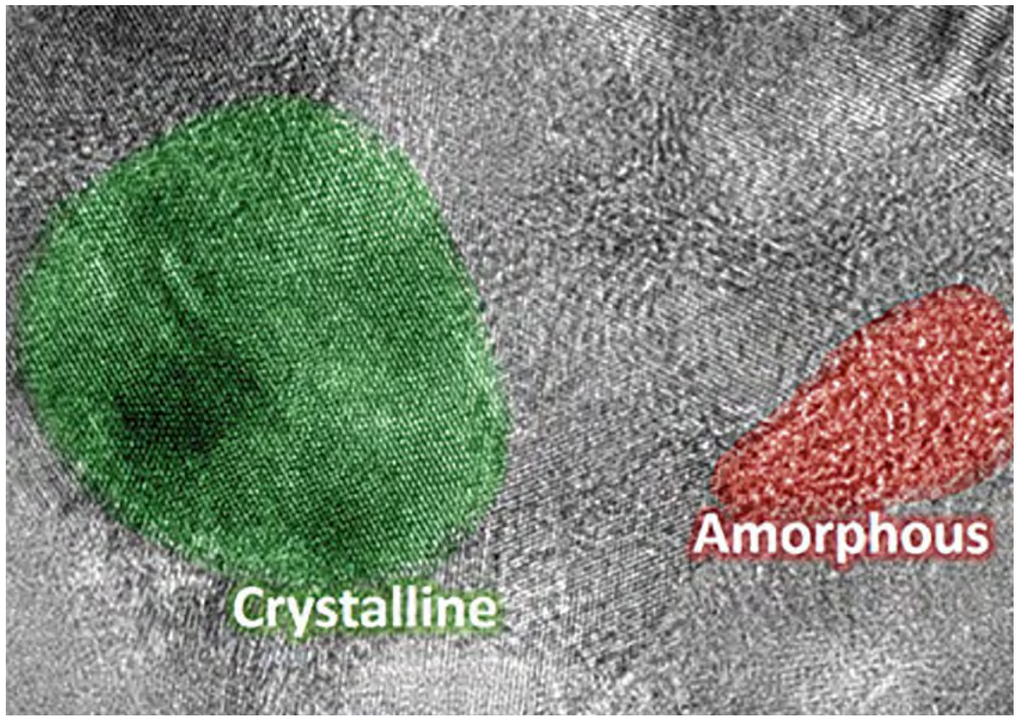


FIGURE: Reactive magnesium oxide cement (RMC) with co-existing crystalline (highly ordered atoms) and amorphous (highly disordered atoms) domains.

The Advanced Materials and Building Efficiency Research Laboratory (AMBER Lab), headed by Dr. Kemal Celik, Assistant Professor of Civil and Urban Engineering, is focusing on the development of novel types of cement that can play a positive role towards environmental protection.

The recently explored reactive magnesium oxide cement (RMC) is one of the candidates that has substantially reduced carbon dioxide emissions during the production as well as the operational phase. This unique ability arises from its high reactivity that is primarily governed by its microstructure, which comprises of both the crystalline (highly ordered atoms) as well as the amorphous (highly disordered atoms) domains. The researchers at the AMBER Lab utilize state-of-the-art Transmission Electron Microscope (TEM) installed within the Core Technology Platforms (CTP) to unveil the microstructure of the RMC with the atomic- scale resolution.

Also, the other facilities installed at the CTP, such as the x-ray diffractometer and the surface area analyzer, provide useful complementary information about the chemical and physical characteristics of the RMC and similar types of cement that hold substantial promise for a greener and sustainable infrastructure.

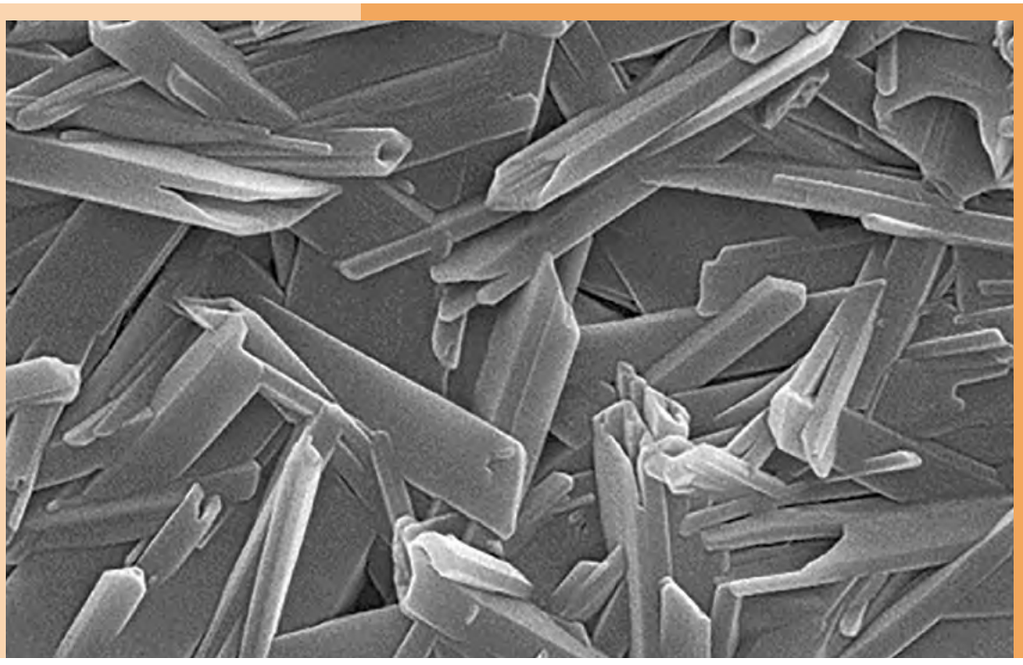


FIGURE: Needle- like nesquehonite predominantly formed in samples exposed to scCO2

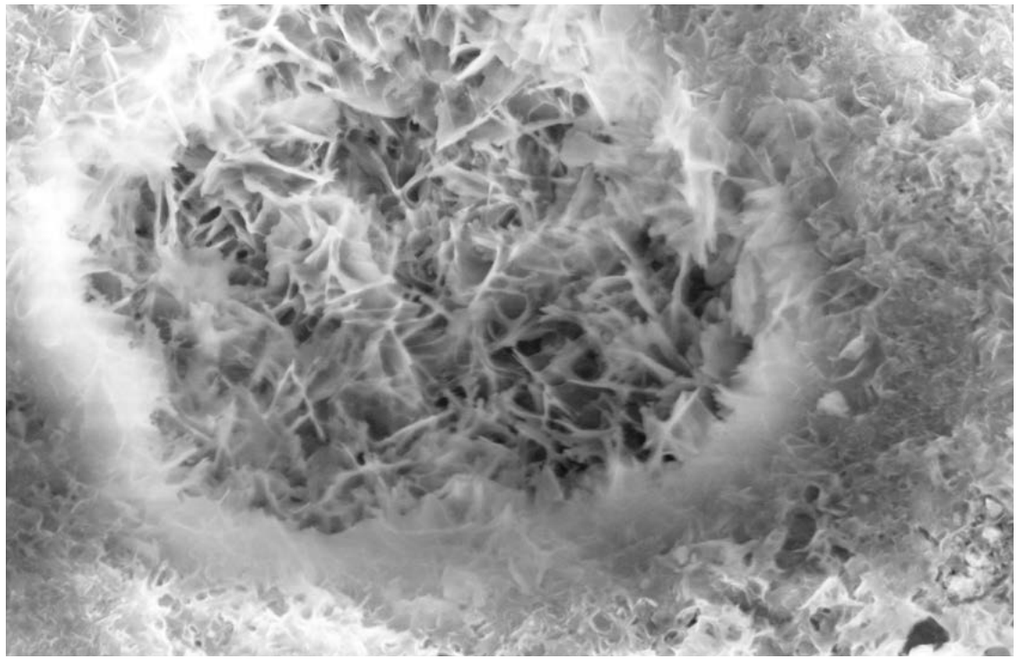


FIGURE: Rosette-like hydromagnesite/dypingite flakes observed in samples exposed to accelerated carbonation

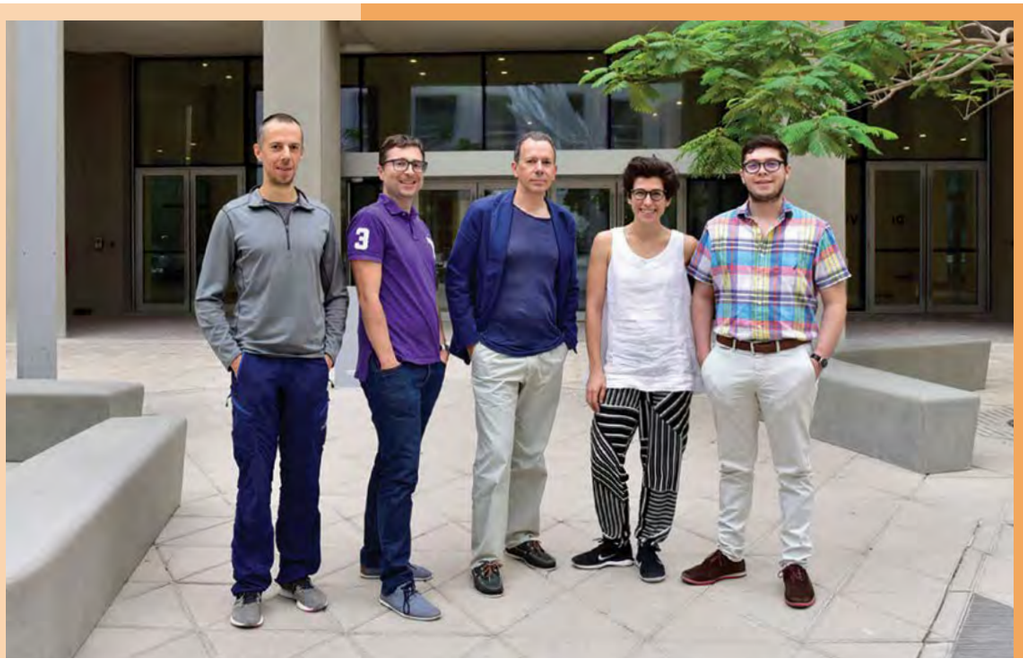
"A mature strength development of RMC-based composites could be attained within hours under supercritical CO_2 carbonation condition as compared to a time scale of days under a concentrated CO_2 environment."

ACCELERATED CARBONATION OF REACTIVE MAGNESIUM OXIDE CEMENT (RMC) COMPOSITES

Another related research lead by Dr. Kemal Celik highlights that one of the significant shortcomings of the reactive magnesium oxide cement (RMC) is its slow carbonation and the resulting poor strength development under the natural environment.

The reactivity could be enhanced by morphological modification through grinding. Meanwhile, it is known that any solvent in a supercritical state possesses a transport property intermediate between a gas and a liquid and hence exhibits a high diffusivity, low viscosity, and low surface tension. Thus, supercritical CO_2 ($scCO_2$) was used to accelerate the carbonation of RMC composites, and it was found that the $scCO_2$ enabled extremely fast carbonation and strength development with mature mechanical properties achievable within hours of the exposure.

Carbonation and the subsequent formation of carbonation products with nesquehonite as the dominant phase led to a refinement of the capillary porosity and a reduction in the specific surface area based on the N_2 adsorption test. TGA results show that the CO_2 sequestration factor was also increased by a factor of 3, thus paving the way for more sustainable construction materials of the future.



"...applying techniques from particle and nuclear physics to enrich our knowledge of objects that are considered important for preserving and understanding cultural heritage."

CUSTOM X-RAY INSTRUMENTATION FOR HERITAGE SCIENCE

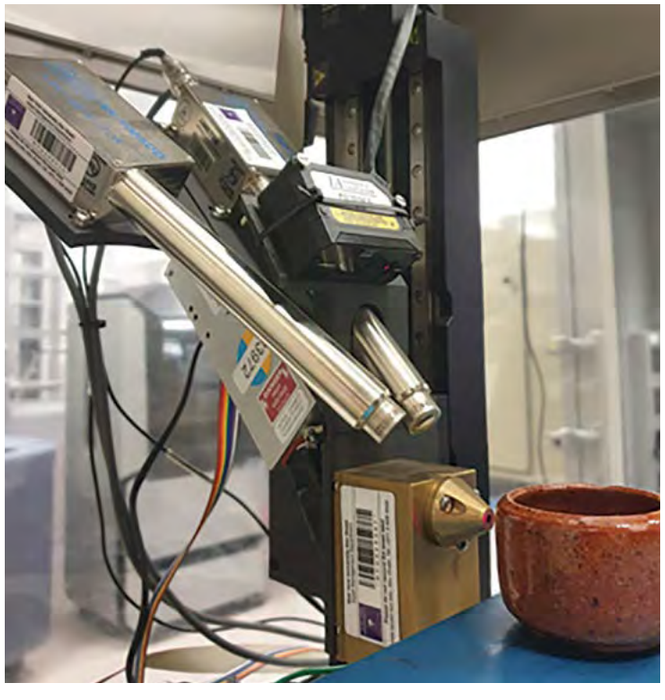


FIGURE: Frontend of the X-ray fluorescence scanner during data acquisition of a lacquered ceramic. The X-ray tube, the two radiation detectors, and the laser telemeter can be seen.

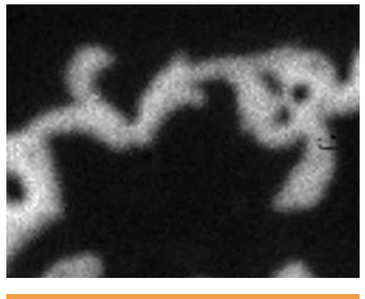


FIGURE: On the above and below, XRF image of the Cu Kα spectral line for the surface shown above it; the spatial distribution of this line matches that of the blue pigment on the surface, and it hints at its likely composition.

The NYUAD astroparticle physics laboratory, led by Prof. Francesco Arneodo, uses their expertise with radiation detectors and spectroscopy methods, and their awareness of the need for portable, non-invasive investigative methods in cultural heritage science, to invest in developing custom instrumentation suitable for the research of art and heritage materials. In particular, this enterprise started with the collaborative development of a portable X-ray fluorescence spectrometer geared towards portability and in-situ investigation.

X-ray fluorescence is a phenomenon whereby an element emits secondary X-ray photons, with characteristic energies relating to the atomic number Z of the element itself, as a response to being irradiated with a primary beam of X-rays. The technique is usually employed to investigate the elementary composition of an object's surface.

In collaboration with their colleagues from the INFN-LABEC laboratory in Florence, Italy, they developed an XRF spectrometer with imaging capabilities. Three motorized stages move the measuring head before the sample, scanning a user-defined, rectangular area of the sample's surface. The instrument acquires an XRF spectrum for every pixel of the surface (typically 1 mm^2), allowing it to create a digital map of the object which contains the information on the chemical elements composing its surface. An example can be seen in the figure, where a standard picture of a ceramic tile is shown alongside its digital map obtained through XRF, where only the energy line of copper has been isolated from the spectra of each pixel. The image shows clearly that the light blue. The image shows clearly that the light blue of the flower has been obtained with a copper based pigment.

".....Robots operating alongside humans and Unmanned Aerial Vehicles (UAVs-Drones).

ROBOTICS LABORATORY (IN COLLABORATION WITH CTP'S KINESIS LAB)

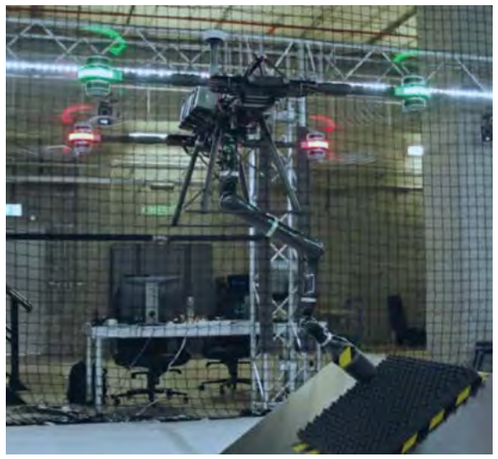


FIGURE: Aerial manipulator interacting with the environment

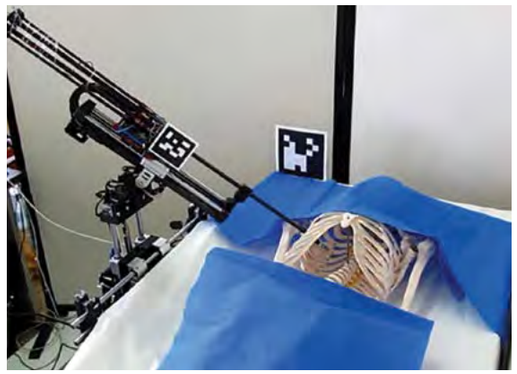


FIGURE: Surgical robot with snake-like end-effector

The Robotics Lab of Professor Anthony Tzes is envisioning robots operating alongside humans. The task is challenging owing to the need for control algorithms on autonomous operation that can simultaneously guarantee operational safety. Thus, the members of the lab are developing and applying algorithms in the areas of Unmanned Aerial Vehicles (UAVs-drones), surgical robotics and Mobile Ground Vehicles in an attempt to satisfy the aforementioned need. The Robotics lab utilizes the motion capture system of the CTP's Kinesis lab thus tracking objects in a volume (15m x 6m x 8m (LxWxH)).

In the area of UAVs, drones carrying robot manipulators have been designed to inspect the infrastructure of the new Abu Dhabi Airport (ADA). Furthermore, these aerial robots can interact with the environment by exerting forces from their end-effector. Hence, these are utilized for detecting microcracks, cleaning, grinding and other contact-wise maintenance tasks. These drones are equipped with high accuracy GPS-RTK sensors, laser scanners, stereoscopic and spherical cameras and other force transducers. These drones can also operate as a team to geofence the area around ADA by throwing a net to an evading drone from an attached aerial gun. Visual servoing algorithms relying on deep learning and fiducial markers are used to for collaborative control tasks.

Ground vehicles carrying large manipulators equipped with dexterous hands are used for synergistic alongside humans control.

These robots can be further equipped with snake-like medical tools for minimal invasive surgical procedures. These lightweight robotic probes are driven by smart memory alloy tendons and are capable of aiding physicians become more efficient and accurate. Owing to modular design, haptic feedback integration, positioning precision and sophisticated control algorithms the robots reduce tremor compensation, post-operative stay and cutting/suturing misalignments in varying surgical scenarios.

MEET THE CTP OPERATIONS TEAM

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A MESSAGE FROM THE EXECUTIVE DIRECTOR

During NYU Abu Dhabi's formative years, major laboratory equipment requested by the researchers was prioritized and acquired to support a multi-disciplinary research environment. Specialized facilities were established and categorized according to their operational techniques and located in key central labs. This resulted in the formation of the Core Technology Platforms (CTP).

The first series of cores consisted of Spectroscopy, Spectrometry, and Materials Characterization equipment. As faculty increased and research needs grew, the cores expanded along with them. Currently, we operate 12 core technology platforms. With a team of highly qualified scientists, specialists, engineers, and technicians, CTP operations support more than 350 researchers and host more than 500 pieces of capital equipment across the campus. We are proud to support and provide state-of- the-art technology for our researchers and students.

I personally feel extremely fortunate and honored to have been with NYU Abu Dhabi from the beginning to witness how ideas are transformed into reality in this dynamic environment. This would not have been possible without the tremendous support and guidance from faculty and leadership. We have come a long way and look forward to continued growth.

DR. REZA ROWSHAN

Executive Director, Core Technology Platforms Operations

جامعة نيويورك أبوظبي

NYU | ABU DHABI

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