IMET Strategic Plan 2023-2028

The Institute of Marine & Environmental Technology

IMET

Institute of Marine and Environmental Technology

University System of Maryland

UMBC

University of Maryland Center for Environmental Science

University of Maryland Baltimore

Institute of Marine and Environmental Technology | Strategic Plan 2023-2028

The Institute of Marine and Environmental Technology (IMET) is home to one of the largest groups of scientists in the world addressing marine and environmental research through molecular and technological approaches. IMET is a collaborative partnership of the University System of Maryland, capitalizing on the strengths of the University of Maryland Center for Environmental Science (UMCES), the University of Maryland Baltimore County (UMBC) and the University of Maryland, Baltimore (UMB), in a dedicated state-of-the-art research facility located at Baltimore's Inner Harbor. The scientists at IMET take innovative approaches to protect and restore coastal marine systems and their watersheds. We develop approaches for sustainable use of resources that provide benefits to society and human health. IMET applies advanced tools of biotechnology and molecular biology to the study of marine organisms and processes, with a strong emphasis on research excellence, inclusive education, broad public outreach and economic development. IMET is in a unique position to enhance its role as a world leader in marine and environmental biotechnology. IMET can do this by growing our faculty base, increasing research capabilities through effective collaborations, investing in state-of-the-art equipment and facilities. In this Strategic Plan, IMET's growth and program for the next five years are carefully charted to enhance IMET's scientific contributions to the environmental sustainability, economic and health goals of Maryland and the nation in the face of climate change and other anthropogenic impacts on the environment.

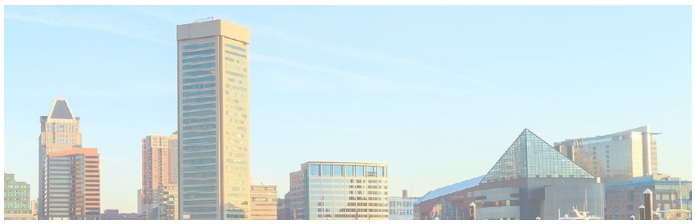
The Strategic Plan is the result of a coordinated effort of all IMET faculty members. With the help of IMET's Program Committee and Governing Council, we will implement this plan to maintain and enhance IMET's position as a world leading, state-of-the-art research institute in marine and environmental technology.

Mission

IMET's mission is to develop innovative approaches and foster collaborations to protect and restore coastal marine systems and their watersheds, sustainably and equitably use resources in ways to benefit human well-being, and to integrate research excellence with inclusive education, training, community outreach and economic development.

Vision

IMET will strive to be the leading research institute in marine and environmental technology through research, education, economic development and outreach. These efforts will be focused in three key areas: Sustainable Seafood Production; Environment, Animal & Human Health; and Energy, Water & the Environment.



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- Land-based, fully contained and precision aquaculture

- Reproduction, breeding, hatchery and trait enhancement technologies

- Disease prevention and control

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- Aquaculture microbiology and waste management

Environment, Animal & Human Health

- Host-pathogen interactions of established and emerging model systems

- Fish and shellfish models to understand development and health

- Composition and regulation of the microbiome in health and disease

- Development of extremophile-based technologies for environmental and human health

- Bioactive compounds with therapeutic potential

- Mechanisms of antibiotic resistance

- Natural and man-made environmental toxins

Energy, Water & the Environment

- Biodiversity and sustainable urban ecosystems

- Ecosystem restoration and responsible waste management

- Microbial processes in marine and estuarine ecosystems

- Conservation of water resources

- Energy for a carbon-neutral future

IMET has a culturally and socioeconomically diverse student body and a very strong track record of excellence in training graduate students. IMET scientists mentor high-school and undergraduate students from diverse backgrounds to encourage them to enter careers in environmental science. IMET provides a highly collaborative environment and established interdisciplinary collaborations to address challenging scientific questions. IMET occupies a unique position as a hub for communication and collaboration between three universities. Research from IMET's programs has also contributed to economic development through the creation of an intellectual property portfolio and the formation of nine startup companies.

In its first decade of existence, IMET has succeeded in developing a high functioning multidisciplinary program. To firmly maintain our position as an international leader in the field of Marine and Environmental Technology, we need to grow in faculty excellence, research impact, funding and graduate education. The present strategic/program development plan aims to achieve this goal.

IMET has developed a critical core of expertise in the area of photosynthetic algae and cyanobacteria. (Photo by: Cheryl Nemazie)

Scientists at IMET are working on raising commercially important fish in sustainable, recirculating aquaculture systems. (Photo by: Logan Bilbrough)

Sustainable Seafood Production

- Land-based, fully contained and precision aquaculture
- Reproduction, breeding, hatchery and trait enhancement technologies
- Disease prevention and control
- Sustainable feeds and value-added products
- Aquaculture microbiology and waste management

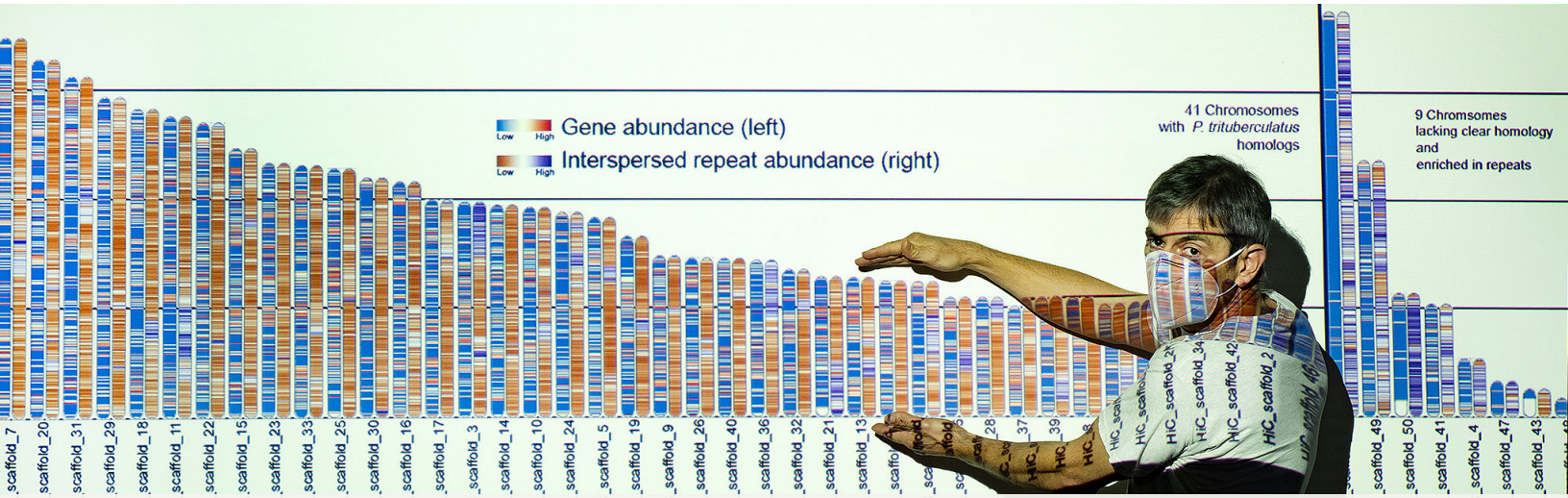
Aquaculture is the fastest growing sector of agriculture globally and in the US. Half of all seafood consumed currently comes from aquaculture. Aquaculture must increase production three-fold in the next 20 years to fill the growing gap between the increasing demand for and declining supply of fishery products. IMET's research will help the aquaculture industry attain this goal while employing approaches that are efficient, cost-effective and environmentally responsible. The IMET Sustainable Aquaculture program focuses on key research areas that address the main biological and technological challenges that aquaculture is now facing. Our Aquaculture Research Center (ARC) provides unique capabilities for research on land-based, fully contained, precision aquaculture systems, focusing on improvement of water conservation by recycling, solid waste conversion to energy and aquaculture system engineering.

IMET studies aquaculture in sustainable recirculating systems. (Photo by: Logan Bilbrough)

The aim is to provide biosecure seafood that is environmentally sustainable and economically viable.

A prerequisite to the introduction of any new aquaculture species is closing its life cycle in captivity, i.e. producing fertilized eggs and viable juveniles on a year-round basis. The IMET faculty has critical expertise in the molecular and endocrine basis of reproduction, development and growth. This positions us to continue our leadership role in understanding the mechanisms responsible for these processes and in developing technologies to enable reliable spawning, larval rearing and year-round seed production. The most promising strategy to ensure genetic containment in aquaculture is to generate reproductively sterile fish. This alleviates the threat of farmed fish breeding with wild stocks, preventing propagation in the wild of genetically-engineered and non-native species. Our innovative research on understanding the molecular and hormonal basis of sex determination and differentiation, germ-cell and gamete development in both the zebrafish model and commercially important aquaculture species adds to fundamental knowledge and is directly applicable in aquaculture.

Our algal production and live feed capabilities support an integrated broodstock/breeding/hatchery program ready for transfer to the industry. Fish health is critical to the



Researchers at IMET sequenced and assemled the entire blue crab genome. (Photo by: David Harp, Chesapeake Bay Journal)

aquaculture industry for both stock enhancement and commercial farming. The development of improved adjuvants and delivery systems will enable vaccines to become even more targeted, specific, and allow for faster responses to emerging diseases. Using synthetic biology, we can tailor efficient vaccines for specific pathogens whose complete genomes are known and in the future create disease resistant hosts via RNA-guided “gene drives”.

Feed costs comprise up to 50% of the cost of raising fish to harvest. Current aquaculuture feeds use ingredients extracted from wild fishery stocks. IMET is using molecular approaches to aid development of healthy and sustainable plant, insect and algal-based feeds as an alternative to conventional fish-based feeds, to reduce reliance on a limited fishery resource while continuing to support the increasing consumption of fish around the world.

IMET faculty engineer microbial communities to improve water quality in recirculating aquaculture systems, control the development of microbial infections and address the challenge of off-flavor during high-density production. We assess microbiomes of production systems and cultured fish to determine how to control aquaculture microbiota by use of probiotics.

IMET Faculty

UMB-IMET: Helen Dooley, Jim Du, Gerardo Vasta

UMBC-IMET: Harold Schreier, Keiko Saito, Kevin Sowers, Vikram Vakharia, Ten-Tsao Wong, Nilli Zmora, Yonathan Zohar

UMBC-UMB-IMET: Allison Tracy

UMCES-IMET: Sook Chung, Allen Place, Eric Schott, Yantao Li

Collaborating Faculty at Partner Institutions

UMB: Martin Flajnik, Jacques Ravel (Microbiology and Immunology, School of Medicine); Margaret McCarthy (Physiology, School of Medicine)

UMBC: Bill LaCourse (Chemistry & Biochemistry); Rachel Brewster & Tamra Mendelson (Biological Sciences)

UMCES: Louis Plough, Matthew Gray (HPL); Dave Secor, Tom Miller (CBL)

UMCP: Reggie Harrell (Department of Environmental Science and Technology, Agricultural and Natural Sciences)

Strengths and Challenges

ARC provides unique, outstanding resources for research in recirculating and sustainable aquaculture. ARC allows us to seamlessly alternate between different species and projects, depending on the research and funding opportunities. There are cohesive and synergistic interactions among the majority of IMET faculty in interdisciplinary, complementary research areas specifically addressing key challenges in current aquaculture production and sustainability. These include closing the life cycle of commercially important fish (including exciting work on spawning and larval rearing of blue-fin tuna), overcoming disease, formulating environmentally responsible plant, insect and algal-based feeds and developing technologies and production systems to prevent genetic and chemical interactions between aquaculture and the environment. Discussions on commercialization of our recirculating aquaculture technology are far advanced and key system components have been successfully commercialized. IMET researchers have strong links and funded collaborations with the aquaculture industry which is seeking innovative solutions. The projected rapid growth of aquaculture in the US and globally provides IMET a unique opportunity to advance its national and international leadership in this field over the next five years.

In light of the major new funding being attracted by our aquaculture research, expanded capabilities for ARC are necessary, with an immediate need for more efficient space use, followed by additional ARC space to meet the growth of the research projects. The ground -floor area, under the tent, could be an ideal space to provide ARC with expanded space to support collaborative activities including workforce development, and outreach.

Future Directions:

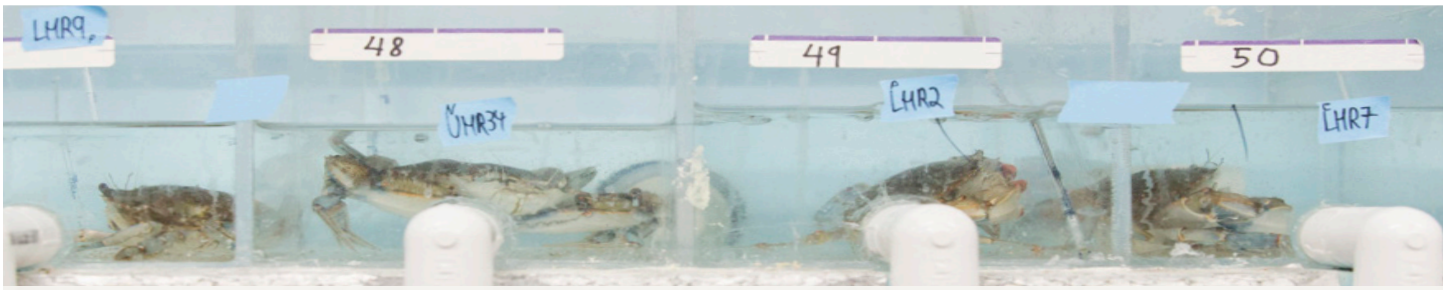
The aquaculture industry is increasingly driven towards environmental sustainability, further increasing the importance of our programs. There is a trend towards growing diversification of species, and the need for closing life cycles of new aquaculture species, genetically containing farmed species and developing alternative feeds, providing opportunities for current and future IMET faculty. Salmon aquaculture is a high priority in the U.S. because this is the most desirable finfish for US consumers and this species is a major component of the growing US deficit for seafood importation. Research using the tools of genetic engineering, gene silencing and gene editing enables new understanding and control of reproduction, development, disease resistance and growth. This drives our faculty to meet industry needs by enhancing traits in aquaculture species such as developmental success, growth rate, environmental tolerance and disease resistance.

Priorities for faculty recruitment:
Recruitment of two faculty members is a high priority. One of these faculty members will work to accelerate research on trait enhancement technologies and disease prevention; solid genomics and immunology background is preferred. The other faculty member will facilitate development of precision aquaculture that uses control-engineering principles and concepts to provide data-driven aquaculture production. A researcher focused on engineering/AI approaches is favored.

To support the aquaculture industry, workforce development is an emerging focus for IMET. We have initiated a course and certification program to fulfill the objective proposed in the USDA SAS[2] (Sustainable Aquaculture Systems Supporting Atlantic Salmon) proposal. A research faculty member is needed to run the courses and programs, with assistance from the ARC staff.

Funding Opportunities:

In the past five years, significant funding was received from USDA, NOAA, and private companies. A high priority is to extend the USDA SAS[2] grant to the next funding cycle (2026-2031) and secure other NOAA and USDA grants. The results obtained from these projects will bolster grants for basic research on fish reproduction, genomics, immunology, and microbiology. Our successful research program also promotes interaction with many leading industry players, which can lead to more collaborations and contract research grants with these partners. IMET will also explore collaborations with foundation and philanthropic organizations interested in preserving ocean biodiversity and in food security and marine-based proteins to feed the world.



IMET is leading research on diseases of the ecologically and economically important Chesapeake blue crab. (Photo by: Cheryl Nemazie)

Environment, Animal & Human Health

- Host-pathogen interactions of established & emerging model systems
- Fish and shellfish models to understand development and health
- Composition and regulation of the microbiome in health and disease
- Development of extremophile-based technologies for environmental and human health
- Bioactive compounds with therapeutic potential
- Mechanisms of antibiotic resistance
- Natural and man-made environmental toxins

IMET is a leader in research of protozoan, bacterial, and viral diseases of economically and ecologically important marine and estuarine species, including Chesapeake Bay species such as the blue crab and the eastern oyster. Research spans innate immune recognition mediated by protein-carbohydrate interactions and acquired immunity in model and non-model systems, including in sharks. An important area for application of this research is in vaccine development, including gene-based vaccine antigens and archaea-derived vaccine delivery technology.

IMET contributes to human health through work in established and emerging model systems for the study of human infectious disease, including SARS-CoV-2, influenza A, pneumococcal pneumonia, and sepsis, and the role of *Helicobacter pylori* in gastric inflammation and cancer. Research in aquatic and microbial model systems contributes to understanding of vertebrate musculoskeletal development, eye lens development and retinal regeneration and the glycobiology of neoplastic transformation and progression.

Human and environmental health is maintained by the balance of microbes that live within and around us. IMET uses state-of-the-art methods to characterize and understand the microbiome. Research on drug discovery at IMET aims to find beneficial products from microbes associated with marine invertebrates and high value lipids and secondary products from algae. The growing challenge of antibiotic resistance is being addressed by IMET research aimed at understanding the fundamental biological principles that lead to *Staphylococcus aureus* infection. Novel lectins are explored as reagents for histochemistry, analytical and preparative glycoprotein studies, cell separation, and other applications.

Human health can be impacted by algal toxins in positive and negative ways. The genes, biosynthesis and mechanisms of action of algal toxins are being studied and these toxins may have beneficial uses as drugs. Development of cost bio-assays and *in-situ* methods to reduce cyanobacteria blooms can help reduce the negative health impacts of harmful algal blooms. Tracking, understanding and remediating PCBs and other man-made toxins in the environment is an area where IMET research is poised to make important commericial advances.

IMET researchers explore innate immune recognition and acquired immunity in model and non-model systems, including in sharks. (Photo by: Cheryl Nemazie)

IMET Faculty

UMB-IMET: Shiladitya DasSarma, Helen Dooley, Jim Du, Frank Robb, Gerardo Vasta

UMCES-IMET: Tsvetan Bachvaroff, Rosemary Jagus, Russell Hill, Allen Place, Eric Schott

UMB-UMCES-IMET: Som Chatterjee

UMBC-UMB-IMET: Allison Tracy

UMCES-UMBC-IMET: Yantao Li

UMBC-IMET: Harold Schreier, Vikram Vakharia

Collaborating Faculty at Partner Institutions

UMB: Thomas Blanchard (Pediatrics, School of Medicine), Alan Cross (Medicine, School of Medicine), Shengyun Fang (Physiology, School of Medicine), Martin Flajnik (Microbiology & Immunology, School of Medicine), Matthew Frieman (Microbiology & Immunology, School of Medicine), Simeon Goldblum (Medicine, School of Medicine), Margaret McCarthy (Pharmacology, School of Medicine), Eric Sundberg (Medicine, School of Medicine)

UMBC: Lee Blaney (Civil and Environmental Engineering), Rachel Brewster (Biological Sciences), Tom Cronin (Biological Sciences), William LaCourse (Chemistry & Biochemistry)

UMCES: Louis Plough (HPL); Tom Miller, David Secor (CBL), Ryan Woodland (CBL)

Additional regional and USM collaborators: National Aquarium, Morgan State University, Coppin State University, University of Maryland Eastern Shore, Smithsonian Environmental Research Center, Johns Hopkins University.

Strengths and Challenges

IMET has a critical mass of faculty working on diverse host-pathogen systems. Our research spans diverse approaches to immunity, including the study of innate and acquired immunity, glycoimmunology, and vaccine development. The high functioning recirculating marine aquaculture system provides unique capabilities. We use diverse model systems and have the ability to create models from novel organisms.

IMET has strong collaborations to meet its need for aquatic pathogen challenge facilities. Interactions between IMET and partners should be increased from our already strong foundation. The challenging trends in support of research funding at the federal and state level require extra effort to obtain these funds and are an incentive for further diversification of IMET's funding base, including more funding from industry and philanthropic support.

Future Directions

The potential for gene editing technology to enable genetic manipulation of non-model systems provides great scientific opportunities. Climate change and increasing anthropogenic inputs to the environment will increase the already high level of harmful algae blooms and and infectious diseases.

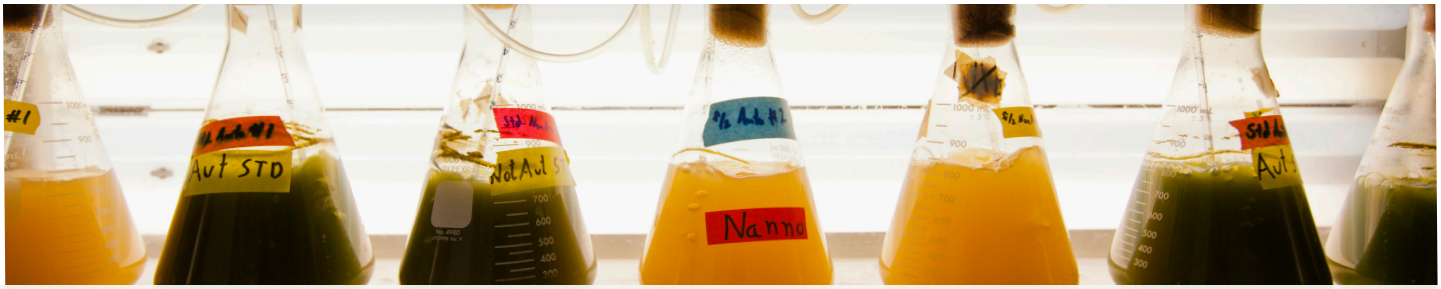
There is great potential in developing a program to understand the epigenetic effects of environment, diet, etc. on health of organisms and even ecosystems.

Funding Opportunities

The two massive infrastructure bills have environmental concern/sustainability as a high priority. Environmental monitoring and climate change will provide IMET with opportunities in the coming five years. State and federal funding agencies are anticipated to provide growing funding opportunities.

Priorities for faculty recruitment:
Dr. Allison Tracy was recruited to IMET in 2022 and will establish research in the area of shellfish pathogens.

IMET researchers are exploring the possibility of using the filtration abilities of shellfish to remove pollutants from urban estuaries. (Photo by: Cheryl Nemazie)



Algae are being explored as promising producers of biofuel. (Photo by: Cheryl Nemazie)

Energy, Water & the Environment

- Biodiversity and sustainable urban ecosystems
- Ecosystem restoration and responsible waste management
- Microbial processes in marine and estuarine ecosystems
- Conservation of water resources
- Energy for a carbon-neutral future

Research at IMET on energy, water and the environment includes renewable energy and biofuels, climate change and nutrient cycling, ecosystem restoration, and sustainable waste management. Microalgae and cyanobacteria, along with their symbiotic bacteria, are being investigated as producers of lipids and hydrocarbons at molecular and systems level to develop innovative bioenergy processes and for sequestering carbon dioxide into inert material such as calcite that can be used for building materials. Consortia of bacteria and archaea that degrade biomass to biogas are also being studied and developed for efficient conversion of organic waste solids to energy with specific application in the aquaculture industry.

Genomic and metagenomic studies of marine and estuarine microbes at IMET contribute to understanding of microbial biodiversity and roles of microbes in biogeochemical cycles, including the critically important cycling of carbon in the deep ocean. Modeling of microbial metabolic fluxes contributes to understanding of processes driving climate change.

IMET researchers are conducting research in microbial bioremediation to develop novel technologies for sustainable, *in-situ* treatment of organic pollutants such as PCBs in sediments and soils. IMET researchers are developing mitigation strategies and approaches to lessen the impact of harmful algae and nutrient pollution. IMET scientists study complex symbioses between bacteria and microalgae or animals, with implications for biofuel production and global health.

Research on extremophiles at IMET seeks to understand the origin, evolution, distribution, and future of life in the Universe, specifically the potential for life to adapt to different environments, and the implications for life elsewhere. Our understanding of the adaptive mechanisms of extremophiles is opening up a large area for development of high and low temperature enzymes for manufacturing and bioenergy production.

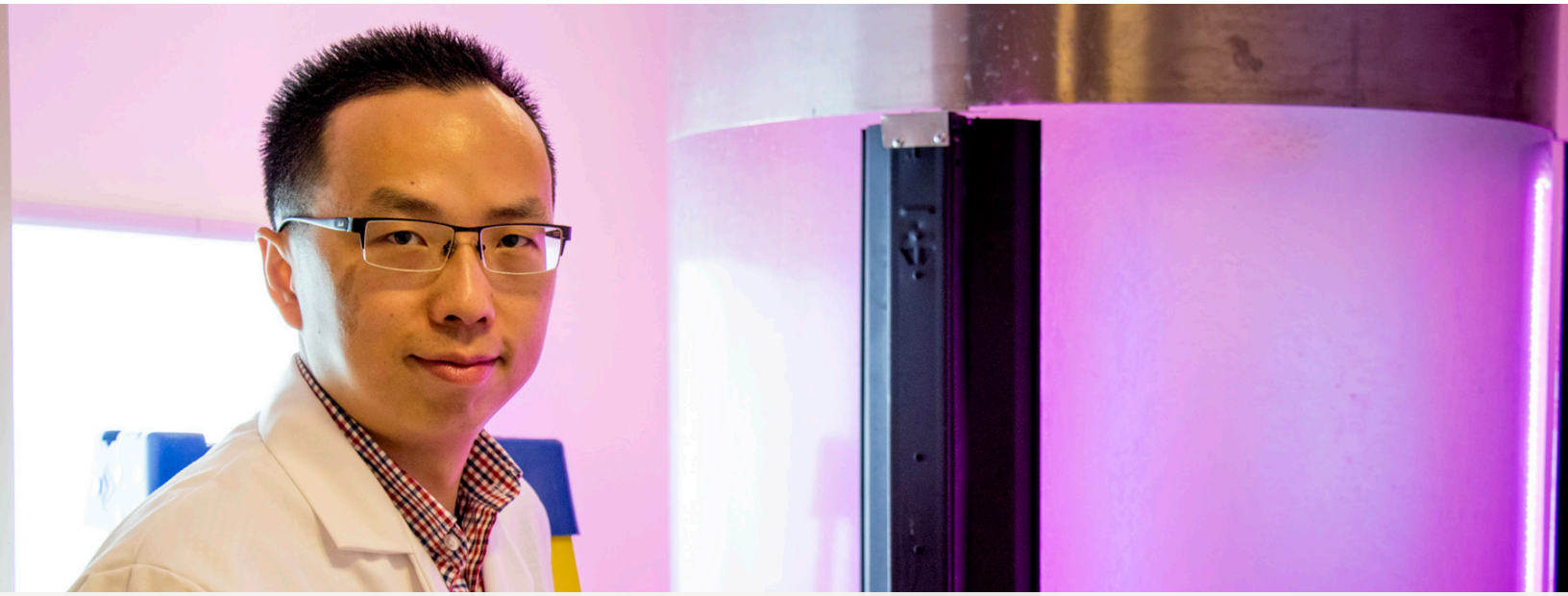
IMET Faculty

UMB-IMET: Shiladitya DasSarma, Frank Robb

UMBC-IMET: Harold Schreier, Kevin Sowers

UMCES-IMET: Feng Chen, Russell Hill, Allen Place, Eric Schott

UMCES-UMBC-IMET: Yantao Li



Researchers at IMET are exploring new ways to remove excess carbon dioxide from the atmosphere. (Photo by: Cheryl Nemazie)

Collaborating Faculty at Partner Institutions

UMB: Ilia Baskakov (Anatomy and Neurobiology, School of Medicine), C.S. Raman (Pharmaceutical Sciences, School of Pharmacy), Jacques Ravel, (Institute for Genome Sciences)

UMBC: Jeffrey Gardner (Biological Sciences), Stephen Miller (Biological Sciences), Lee Blaney (Civil and Environmental Engineering), Upal Ghosh (Civil and Environmental Engineering)

UMCES: Michael Gonsior, Ryan Woodland, Lora Harris (CBL)

Strengths and Challenges

IMET has developed a critical core of expertise in the areas of photosynthetic algae and cyanobacteria, lipid chemistry, and biomass conversion that is only beginning to leverage this strength for funding and potential applications in both the private and public sectors. More collaboration is needed to position IMET for competitive funding in larger multi-investigator projects from both federal agencies and the private sector.

In terms of the application of molecular techniques to address key questions in marine and environmental microbiology, IMET is amongst the top two or three centers worldwide. The closest competing institutes are the SARS Institute in Bergen, Norway, the Woods Hole Oceanographic Institute, the Scripps Institute of Oceanography, and the Monterey Bay Aquarium Research Institute. IMET must maintain a commitment to state-of-the-art facilities for molecular biology, omics (including genomics, transcriptomics, proteomics, metabolomics, and fluxomics), bioinformatics, and genome engineering tools. In order to join the front rank of omics-driven research, we need to increase our commitment to infrastructure to enable IMET to carry out stand-alone omics projects and establish strong relationships with the Institute for Genome Sciences at UMB and other collaborators.

IMET is a world leader in the development of sustainable bioremediation technologies for soils and sediments. Our primary focus has been on developing the first *in-situ* microbe-based treatment of polychlorinated biphenyls, which is being field tested and commercialized through a startup company. Basic research on this treatment approach will continue with the goal of expanding it to emerging environmental pollutants. To ensure continuous success of this program it is critical to maintain state-of-the-art instrumentation for analyses of environmental pollutants and continue to maintain collaborations with environmental engineers and chemists to develop real-world solutions both in the lab and the field.

Future Directions

Changes in the field likely to influence the program: The field of alternative energy, which includes production of biofuels, will continue to be driven by the need to reduce effects on climate by fossil fuels due to emission of greenhouse gas (GHG) pollutants, and national security as it relates to fluctuating energy costs due to natural and political events, finite resource depletion and dependence on unstable foreign suppliers. DOD and DOE will continue to promote production of biofuels, including biodiesel and aviation fuel and the transportation industry will continue to drive research in production of biofuel precursors and gasoline. Rising concern over the environmental and monetary costs of natural gas has generated renewed interest in biogas for heating and generation of electricity, and for bioconversion to liquid fuels. Conversion of non-food feedstocks such as agricultural plant waste, grasses and wood will continue to be funded. The advent of high-throughput analysis and the use of genomic data to examine adaptive responses and biodiversity will lead to greatly increased ability to explore microbial diversity and understand marine processes. A critical mass of expertise exists at IMET, addressing the molecular biology and ecology of extremophiles. IMET has unique facilities for research with extremophiles with capabilities found at few institutions in the world. With the current multi-institutional structure of IMET that has the potential to further broaden our expertise in extremophiles, attempts will be made to identify funding opportunities for a large program grant.

Through bold and innovatiove collaborations, IMET will extend the impact of our fundamental and laboratory-scale research on biofuels and carbon sequestration to achieve large-scale impact. This will require extensive engagement with engineers and collaboration with UMCP School of Engneering is essential in this regard. IMET already collaborates with start-up companies in Maryland and will expand collaborations to include medium and large enterprises.

Funding Opportunities

The DOE will continue to be a strong source of funding for research on energy and carbon sequestration over the next five years. IMET has a strong track record of funding from NASA to conduct research on archaea as models for adaptation to extreme environments and IMET is well placed for continued funding in this area. The ambitious objectives of the State of Maryland for reducing greenhouse gas emissions specified in the Climate Solutions Now Act of 2022 will require major research investments by the Maryland Department of the Environment and other state agencies, presenting opportunities for IMET.

In response to the current large-scale expansion of aquaculture in the U.S. we anticipate continued funding opportunities from NOAA and USDA to support research on aquaculture waste treatment. We also anticipate funding opportunities from DOD and the NIEHS Superfund Program for development of approaches to treat persistent organic pollutants such as PCBs and PFAS.

Priorities for faculty recruitment: Faculty member with expertise in environmental bioengineering working in the areas of water/environmental sustainability. Faculty member working on photosynthetic micro or macroalgae for carbon sequestration and biomass conversion.

Scientists at IMET explore microbial processes in marine and estuarine systems.

Harbor Launch at IMET Incubator provides wet lab and office space for companies solving problems in the fields of human and environmental health.

Innovation & Entrepreneurship in Marine & Environmental Technology

IMET currently leads three programs in entrepreneurship: 1) the Ratcliffe Environmental Entrepreneurs Fellowship (REEF) Program, 2) the Harbor Launch at IMET Business Incubator and 3) the IMET Entrepreneur in Residence Program. The **REEF Program**, supported by Ratcliffe Foundation helps young scientists explore the potential business applications of their research, and cultivate the leadership and business skills necessary to bring research into commercial markets. The program includes fellowships for select students as well as short courses over four weekends each semester that cover basic business principles including: marketing, market research and customer discovery, intellectual property, funding and financing, communication, and leadership and other factors that foster entrepreneurship. The program remains popular among IMET and UMCES graduate students, and is reflected in their professional advancement beyond IMET.

Harbor Launch at IMET Incubator serves as a business launch pad for young companies developing products and services having a positive impact on the environment and human health. The incubator provides wet lab and office space, meeting space, and easy access to IMET's Core Research services. Mentoring is led by IMET's Assistant Director who co-serves as Director of Harbor Launch. The inclusion of small science and technology businesses at IMET contributes to the innovative and entrepreneurial culture at the Institute. Harbor Launch at IMET also provides an avenue for IMET to contribute to economic development in the City and the State.

The **IMET Entrepreneur in Residence Program** builds on a well-established practice. Entrepreneur in Residence (EIR) programs originated from venture capital firms needing very experienced entrepreneurs in a particular area of interest. These EIRs gave insights into new market trends, business climate, business landscape, industry networks and the future direction of the market. The IMET EIRs provides mentoring and advice to tenant companies at Harbor Launch. These include helping tenants refine their business plan, giving advice on sources of funding for early stage companies, and making introductions to people and institutions that will aid in propelling the startup companies toward success.

Strengths and Challenges

IMET has developed an essential core of an entrepreneurial ecosystem containing both startup companies and stable, growth-focused companies operating in proximity to university faculty. In addition to proximity, Harbor Launch at IMET actively maintains networks with the entrepreneurial programs and ecosystems within the University, and around the state to further company commercialization efforts. As with IMET itself, partnership has been a cornerstone of economic development efforts at IMET IMET has many research interests centered on nutrition and human health, including sustainable aquaculture, lipids and nutrients sourced from algae, and water quality management.

IMET's REEF Program helps young scientists explore the potential business applications of their research.

Future Directions

Changes in the field likely to influence the program:
As climate and environment accelerate their importance in driving the priorities of innovation and technology development, Harbor Launch at IMET is ready to support young businesses in the region that are focused on environmental sciences, as well as health and life sciences. IMET will continue to strengthen its position as a collaborative partner in applied research thereby contributing to the support of economic development in the state of Maryland and beyond.

Funding Opportunities

Harbor Launch at IMET is financially self-sustaining, having reached this milestone shortly after its creation in 2016. Over the next 5 years, IMET will continue to support the incubator, and seek engagement and collaborative opportunities to help commercialize technologies, as well as research and advance new ideas.

IMET Personnel

Lamba, Nina (IMET Assistant Director; Harbor Launch Director, UMCES-IMET)

Collie, Betsy (Harbor Launch Manager, UMCES – IMET)

IMET's location in Baltimore's Inner Harbor provides many opportunities for connecting with the local community.

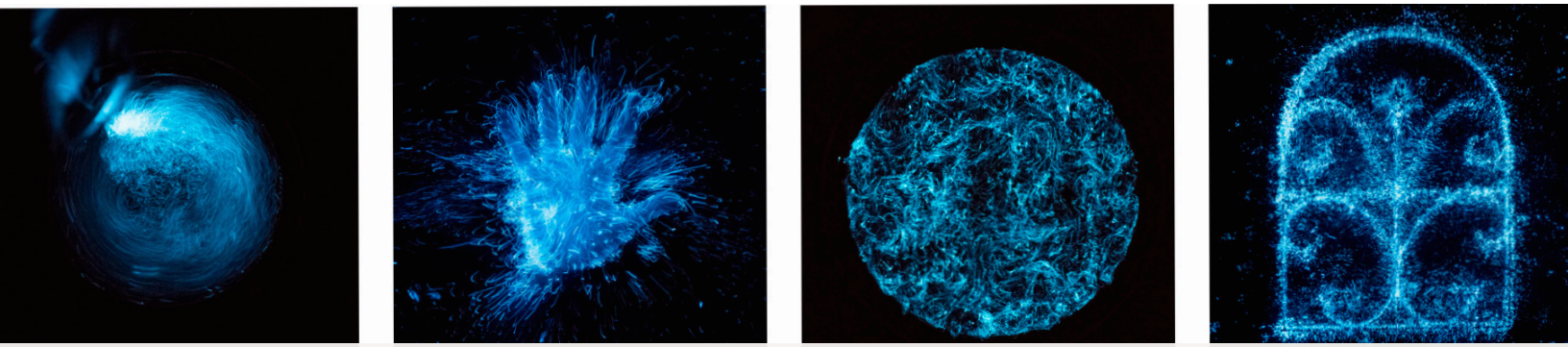
Diversity, Equity and Inclusion at IMET

IMET is committed to a workplace in which all of us feel respected, supported and valued for who we are. IMET strives for student, staff and faculty diversity that mirrors our diverse community in Maryland, believing that this diversity contributes to our excellence and helps us achieve our mission. Our research includes a focus on equitably using resources in ways to benefit human well-being.

IMET's Diversity, Equity and Inclusion Taskforce serves as a conduit to IMET of the DEI initiatives at our partner universities, and solicits input from across the IMET community. Some of the important issues being addressed by the Taskforce are work-life balance, orientation for personnel, search committees and hiring processes, and equitable and efficient access to all IMET resources.

With the support of NOAA's **Living Marine Resources Cooperative Science Center (LMRCSC),** IMET contributes to diversity, equity, and inclusion in the field of marine science. Through UMCES's partnership with the LMRCSC, IMET receives funding to help support graduate students from underserved communities with an interest in marine science. The NOAA LMRCSC is a partnership of six institutions that trains graduate students from underrepresented communities in marine science for careers in research, management and public policy that support the sustainable harvest and conservation of our nation's living marine resources. In 2021, the University of Maryland Eastern Shore received an additional five years of funding for this program, enabling IMET to continue in this partnership.

IMET receives NOAA funding through the Living Marine Resources Cooperative Science Center to train students from underrepresented communities in marine science.



What is the Shape of Water? By Lisa Moren with Tsvetan Bachvaroff, 2019.

IMET Outreach

IMET has many links with our local community and aims to enhance inclusive excellence over the next five years. IMET holds an Open Day and typically hosts at least three public lecture events each year. We aim to host an average of 50 high school and undergraduate interns per year, including at least 20 p.a. from communities where students typically do not have access to scientists as role models. IMET will host at least 50 visiting groups of local and state leaders, international visitors and prospective donors over the next five years. We aim also to have a major role in organization of one scientific conference per year.

Every summer IMET faculty welcome undergraduate interns into their laboratories through the **IMET Summer Undergraduate Internship Program**. This internship is designed to provide marine/environmental science laboratory experience to sudents from educational backgrounds with limited access to research opportunites or students from underserved communities with an interest in marine science. In the summer of 2023, IMET will begin the 22nd year of the IMET Summer Undergraduate Internship Program. This program has provided internships for over 250 undergraduate students. Several of these students have returned to IMET for graduate studies.

IMET also works with local artists through the **CIRCA Artist-In-Residence Program**. This program is a collaboration with UMBC's Center for Innovation, Research, and Creativity in the Arts. Each year one faculty member from UMBC's College of Arts, Humanities, and Social Services is selected to work with IMET faculty on a project of their own design. This program has created many unique and informative tools for engaging the general public in IMET's research and vision for the future.

IMET's Summer Internship Program has been providing undergraduate students with research internships for more than 20 years.

IMET Faculty

The faculty at IMET is highly collaborative and the research programs of individual faculty members typically involve more than one focus area. Primary research interests for each faculty member are described below.

Bachvaroff, Tsvetan (Associate Research Professor, UMCES-IMET): dinoflagellate evolution with focus on the parasitic dinoflagellates; large scale sequencing and phylogenetic methods to describe evolutionary histories.

Chatterjee, Som (Assistant Professor, UMB-UMCES-IMET): Understanding of the fundamental biological principles that lead to *Staphylococcus aureus* infections; mechanisms of antibiotic resistance in *S. aureus*.

Chen, Feng (Professor, UMCES-IMET): Marine microbial ecology; microbial oceanography and biogeography; microbial diversity, genomics, and functional genomics; phage-host interactions; clean green biotechnology.

Chung, Sook (Professor, UMCES-IMET): Neuroendocrine regulation on crustacean physiology of molting, growth, reproduction, sex differentiation and stress responses.

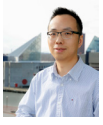
DasSarma Shiladitya (Professor, UMB-IMET): Post-genomics and biotechnology of salt-loving, radiation tolerant, and cold-adapted extremophiles; production of virus-like vaccine nanoparticles and therapeutic proteins.

Dooley, Helen (Assistant Professor, UMB-IMET): Comparative immunologist focused on cartilaginous fish, with an interest in the development of new technologies/therapies to understand, diagnose, and treat human and animal disease.

Du, Shaojun "Jim" (Professor, UMB-IMET): Comparative immunologist focused on cartilaginous fish, with an interest in the development of new technologies/therapies to understand, diagnose, and treat human and animal disease.

Hill, Russell (Professor, UMCES-IMET): Symbiosis between bacteria and marine invertebrates, especially sponges; marine actinomycete ecology and molecular biology: microbiology of marine natural products; microalgae and biofuels; marine biotechnology.

Jagus, Rosemary (Professor, UMCES-IMET): Translational control of gene expression; regulation of gene activity during early development; host defense against virus infection and viral countermeasures; role of protein synthesis in lactation.



Li, Yantao (Associate Professor, UMCES-UMBC-IMET): Microalgal molecular biology and lipid biochemistry; metabolic engineering for biofuels and bioproducts; microalgal biotechnology and environmental bioremediation.

Place, Allen (Professor, UMCES-IMET): Elucidation of the molecular mechanisms that permit organisms to adapt to unique diets, environments, and interactions (symbiosis); molecular basis of sex determination.

Robb, Frank (Professor, UMB-IMET): Mechanisms of heat tolerance in hyperthermophiles; heat shock proteins, including their use to improve high-temperature industrial or biomedical processes.

Saito, Keiko (Assistant Research Professor, UMBC-IMET): Aquatic microbial ecology and aquacultural microbiology; anaerobic ammonium-oxidizing bacteria (anammox) and ammonia-oxidizing archaea (AOA) for waste treatment in marine recirculating aquaculture systems (RAS).

Schott, Eric (Associate Research Professor, UMCES-IMET): Discovery, characterization and quantification of estuarine pathogens; aquaculture health; health and biodiversity of urban waters. Communication with fishing and urban community stakeholders.

Schreier, Harold (Associate Professor, UMBC-IMET): Microbial diversity and physiology of marine recirculating aquaculture biofilter systems; molecular genetics of probiotic bacteria and the use of *Bacillus* spore display technology for aquaculture applications.

Sowers, Kevin (Professor, UMBC-IMET): Biology of methanogenic Archaea; anaerobic conversion of organic wastes to biomethane; microbial reductive dehalogenation of organochlorines, *in-situ* treatment of persistent organic pollutants in sediment and soil.

Tracy Allison (Assistant Professor, UMBC-UMB-IMET): Ecology and evolution of infectious marine diseases; the microbiome in health and disease; habitat-forming species; spatial ecology; global change; shellfish fisheries, aquaculture, and restoration

Vakharia, Vikram (Professor, UMBC-IMET): Viral pathogenesis of fish rhabdoviruses; development of novel vaccines for economically important fish pathogens.

Vasta, Gerardo (Professor, UMB-IMET): Molecular, biochemical, structural, and functional aspects of protein-carbohydrate interactions relevant to immunity and early development.

Wong, Ten-Tsao (Associate Professor, UMBC-IMET): Molecular, cellular and applied aspects of fish germ cell biology and reproductive physiology.

Zmora, Nilli (Associate Research Professor, UMBC-IMET): Mechanisms that drive, direct and regulate puberty and ovulation in fish; neuropeptides; hormonal treatment through DNA platforms to manipulate puberty in late maturing fish.

Zohar, Yonathan (Professor; UMBC-IMET): Basic and applied aspects of fish reproductive physiology and molecular endocrinology; broodstock management and hatchery technologies; aquaculture and fisheries biotechnology; environmentally sustainable recirculating marine aquaculture.

IMET is governed by the IMET Governing Council, pictured here with IMET Executive Director Russell T. Hill, PhD (bottom left). The IMET Governing Council comprises the University System of Maryland Chancellor Jay A. Perman, MD (top right); Peter Goodwin, PhD (President UMCES; top left); Valerie Sheares Ashby, PhD (President UMBC; bottom center); and Bruce E. Jarrell, MD, FACS (President UMB; bottom right).

IMET

Institute of Marine and Environmental Technology

The Institute of Marine & Environmental Technology (IMET) has a culturally and socioeconomically diverse student body and a very strong track record of training a diverse student body. IMET provides a highly collaborative environment and establishes interdisciplinary collaborations to address challenging scientific questions. IMET occupies a unique position as the hub for communication and collaboration between three universities. IMET has succeeded in developing a high functioning multidisciplinary program.

In our second five years of existence, IMET has firmly established our position as an international leader in the field of marine and environmental technology. IMET is growing in faculty, research funding and graduate education. The present strategic/program development plan charts the course in achieving our goals.

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