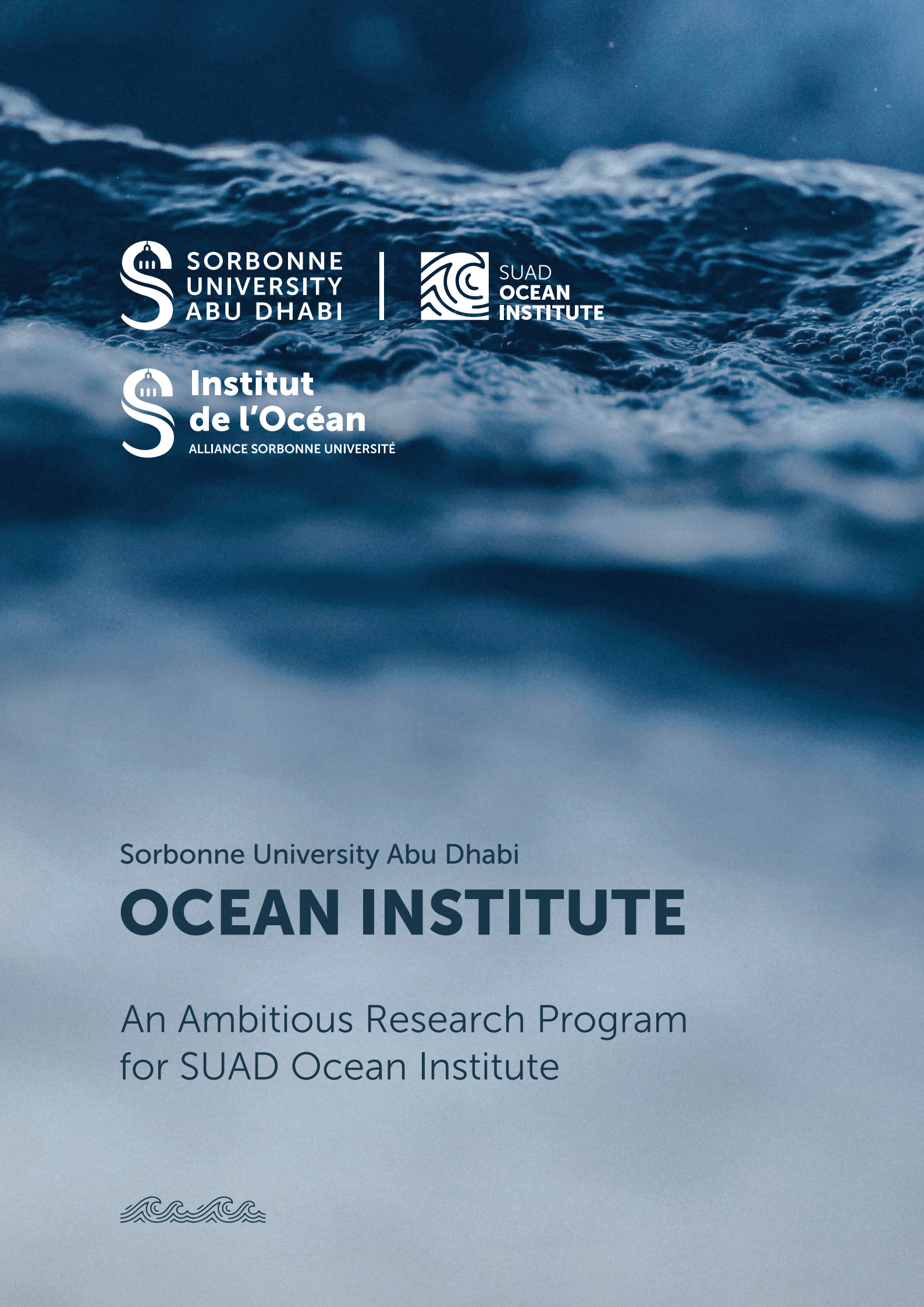


Sorbonne University Abu Dhabi

OCEAN INSTITUTE

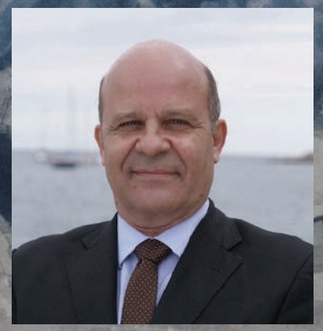
An Ambitious Research Program for SUAD Ocean Institute

An Ambitious Research Program for SUAD Ocean Institute

The Sorbonne University Abu Dhabi Ocean Institute aims to develop research and education within three avenues

- **The holistic monitoring of the UAE coastal areas**
- **The Development and Dissemination of Ocean Science: from scientific research to community engagement**
- **The creation of the world's first Biofoundry dedicated to marine algae**

Director of the Ocean Institute



Admiral Christophe Prazuck

Admiral (2S) Christophe Prazuck is the current Director of the Ocean Institute at Sorbonne University Alliance in Paris. He was Chief of the French Navy from 2016 to 2020, from 2012 to 2016 Vice-admiral and HR director for the French navy and Rear-admiral chief of the French naval special forces in Lorient from 2010 to 2012. Admiral Christophe Prazuck has a Ph.D. in physical oceanography from the NPGS in Monterey (USA).

MONITORING UAE COASTAL AREAS WITH A HOLISTIC APPROACH AND INNOVATIVE STATE-OF-THE-ART TECHNICS

The livelihoods of more than 3 billion people depend on marine coastal ecosystems, but pressures driven by human activities and climate change increasingly threaten the sustainability and resilience of these tightly interdependent socio-economic and environmental ecosystems. Long- term observation of coastal environments, biodiversity and associated socio-economic uses is critical for understanding the functioning and dynamics of such socio-ecosystems, risk management, and for evaluating the relevance of public policies. Despite significant progress in observation efforts over recent decades, particularly for physico-chemical and biogeochemical variables, sectorial fragmentation has precluded the development of the systemic-thinking and holistic analysis that is essential to fully understand the complexity of coastal socio-ecosystems.

At Sorbonne University, in addition to traditional approaches, new techniques, and capabilities such as environmental genomics and in situ imaging, as well as the crowd-sourcing potential of social media, are breaking new ground and leading to the implementation of more agile and innovative "augmented observatories".

The roll-out of this more socially responsive and integrative approach will lead to development of new indicators to track and understand the healthy functioning and change trajectories of coastal ecosystems and will greatly facilitate the implementation of eco - responsible sustainable development initiatives designed to address major environmental issues.

In the field of ocean science research, the key-goal of the SUAD Ocean Institute is to develop systems-thinking based targeted strategies for multi-scale and multidisciplinary observation of coastal socio-ecosystems. **Work will focus first on environmentally sensitive areas, such as vulnerable maritime frontage (Fujairah, Dubai, Abu Dhabi), marine protected areas and mangroves which will act as demonstrators and use cases.**

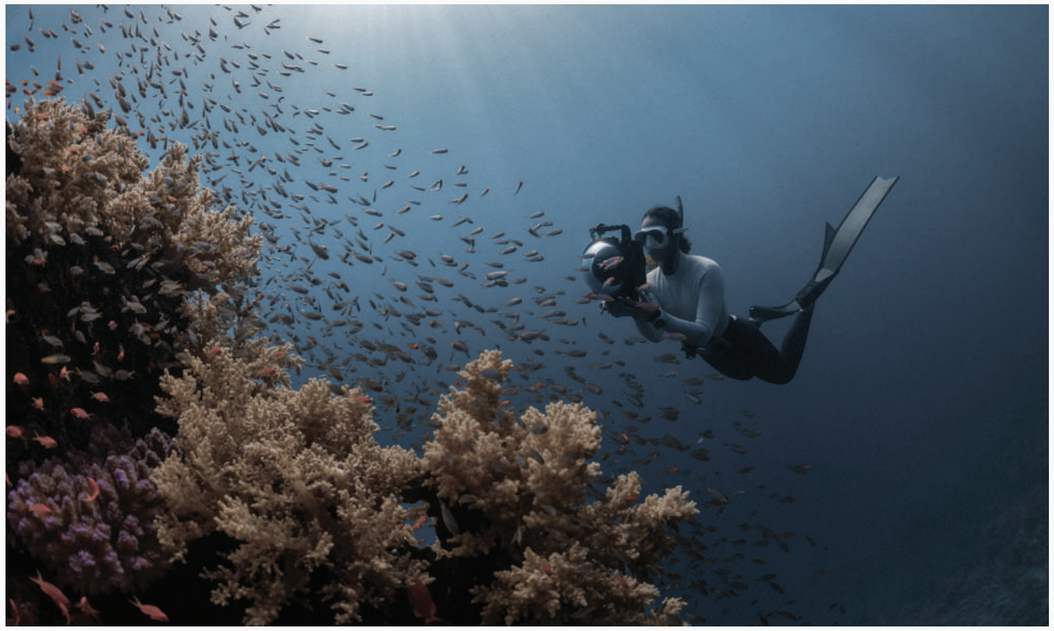
This holistic approach will bring together scientific experts from distinct fields such as oceanography, ecology, economics, and social sciences, along with public and private sector stakeholders, decision-makers, to identify priorities and ensure a broader uptake of the solutions produced. The development and deployment of data-intensive approaches for observing biodiversity and societal uses will produce a massive quantity of new and heterogeneous data.

SUAD Ocean Institute will include an in-depth strategic reflection on how best to structure, make accessible, and maintain new and existing data in-line with the FAIR principles. This conceptual design phase is essential to guarantee the optimal exploitation of multi-scale and multi-source marine data and will serve as a basis for selecting new thematic and integrated indicators. The routine use of interoperable, data- intensive approaches will enable the introduction of new artificial intelligence tools and machine learning capabilities in this field.

All UAE national institutions involved in the observation of coastal socio-ecosystems (Ministry of Climate Change and The Environment Agency-Abu Dhabi, Fisheries, other UAE universities involved in ocean science) could be associated to the project. It will actively strengthen relations between these scientific communities and national and European research infrastructures (ILICO, EMBRC). Through integrative and interdisciplinary research, it will propose innovative and sustainable solutions along with co-designed regulatory frameworks supporting the operational implementation of augmented observatories by 2030, capable of analyzing and predicting socio-ecosystem trajectories in the face of environmental change.

This research project led by SUAD would be an innovative and leading project meeting the highest scientific standards. It is designed on the example of FUTUREOBS, an ambitious French research program including most of the French marine research organisms and led by Sorbonne University.

- It will provide to the UAE decision makers a state-of-the-art assessment of the health and evolution of the coastal approaches of the UAE.
- It will feed impact studies of any project aiming at modifying a coastal area.
- It will detect pollutions, invasive species and evaluate their impact.
- It will help the fisheries administration to drive a sustainable exploitation of living marine resources.
- It will strongly support UAE efforts to preserve and develop mangroves.
- It will be a very valuable tool to promote scientific diplomacy and cooperation with the neighboring countries.
- It will participate to Emiratization efforts by hiring operators, engineers and other professionals.
- It will be a remarkable and inspiring example for the international science community.
- It will be the large foundation on which different curricula will be plugged and attract young students of the UAE to become marine biologist, bio-data analysts, AI imaging engineers, marine protected areas managers, genomics experts and synthetic biologists.



THE DEVELOPMENT AND DISSEMINATION OF OCEAN SCIENCE: FROM SCIENTIFIC RESEARCH TO COMMUNITY ENGAGEMENT

The SUAD Ocean Institute will create, in cooperation with Sorbonne University and Sorbonne University Abu Dhabi, and other international partners to be chosen, educational programmes to **train professionals capable of answering the challenges and developments of Ocean science.** Two types of programmes can be developed. On the one hand, Standard academic education with bachelors and masters degree programme.

On the other hand, executive life-long training can be developed to propel careers of professionals in the field. The development of these programmes will enable the Ocean Institute to become a comprehensive centre for Ocean Science, from student research to research and innovation. It is thought of as a high-level all-inclusive centre nurturing the knowledge economy of the UAE, in the UAE and abroad.

SUAD's Ocean Institute will also pursue an active policy of scientific outreach to the Emirati public and residents of the Emirates at large, to introduce them to the wonders of the marine world and raise their awareness of the challenges of protecting the oceans in the spirit of UN Sustainable Development Goal 14. This policy will be supported by external partners who welcome the community, such as the National Aquarium, Seaworld, public and private schools, museums and other institutions interested in developing awareness about Ocean.

Examples of University & Executive Education Programmes

<u>Bachelor in Marine Science</u>

Certificates in:

- Dugong Watching & Monitoring
- Rangers training for Mangroves Monitoring
- Scientific Diving

7 INITIAL PROJECTS SPEARHEADED BY LEADING EXPERTS

- Marine environment monitoring, sensors, and data banking.

  Eric Thiébaut

- Operational monitoring of blooms of toxic algae or jellyfish near desalination plants or the Emirati nuclear reactor. The impact of brine discharges.

  Eric Thiébaut

- Mangroves, conservation, monitoring, carbon cycle, ranger training.

  Tarik Meziane

- Industrial ports, acoustics, and genomics. Monitoring anthropic pressure, measuring, and tracking the stress gradient from industrial ports to marine protected areas.

  Jean-Luc Jung

- Monitoring fishery resources using genomic techniques.

  Jean Luc Jung

- Dugongs and marine mammals, species, and individual monitoring. Creation of a virtuous whale-watching activity contributing to the scientific monitoring of populations.

  Olivier Adam

- Implementation of autonomous sensors to monitor Gulf waters and their discharge into the Gulf of Oman and the Arabian Sea.

  Hervé Claustre

- Professor of marine biology at Sorbonne University
- Director of the « Marine Station » of the Universe Science Observatory (Observatoire des sciences de l'univers "Stations marines") at Sorbonne University

Eric Thiébaut

- Professor of aquatic ecology at the French National Museum of Natural History
- Director of the Research Unit BOREA
- Curator of the museum collection Annelids

Tarik Meziane

- Professor of marine biology at the French National Museum of Natural History
- Director of the Dinard Marine Station (France)

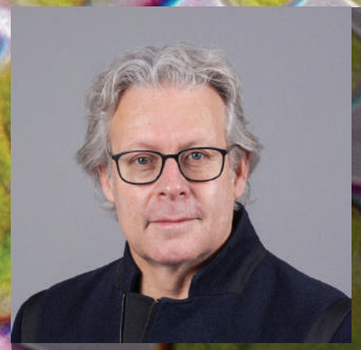
Jean Luc Jung

- Professor at Sorbonne University
- Specialist of Cetaceans sounds and acoustics (bio acoustician)

Olivier Adam

- Research Director at CNRS
- Researcher at the Villefranche-sur-mer Oceanography laboratory & specialist in underwater robotics

Hervé Claustre



PROF GUILLAUME FIQUET

- Vice President for International Relations, and Territorial and Socio-Economic Partnerships, Sorbonne Université.
- CNRS research director

SUAD BIOFOUNDRY: PIONEERING SUSTAINABLE BIOTECHNOLOGICAL INNOVATION

The SUAD Biofoundry initiative represents a strategic investment in the burgeoning field of synthetic biology, aligning with Abu Dhabi's vision for economic diversification and sustainable development. This state-of-the-art facility will harness the untapped potential of marine microalgae, setting a new standard for innovation and sustainable solutions in critical areas such as medicine, nutrition, energy, and materials. It will position Abu Dhabi as a leader in the fourth industrial revolution[1], which is based on the convergence of bioengineering, exact sciences, and computer science, and sets the stage for a transformative era in lifestyle, work, and interactions. Driven by environmental imperatives, this evolution promises to integrate "made with biology" practices into every facet of life, including medicine, food, and new material creation, within the next 10 to 20 years. Just as the digital revolution has massively entered our daily lives, today's and tomorrow's biotechnologies will play a pivotal role in our society.

A McKinsey report[2] underscores the profound impact of biological innovation, projecting that up to 60% of physical inputs in the global economy could be biologically produced. This paradigm shift, estimated to generate an economic impact of $2 trillion to $4 trillion annually by 2040, promises advancements in human health, agriculture, consumer products, and materials, while offering solutions to climate change and sustainability challenges. The report also noted the rise of platform-based business models in the bioeconomy, enabling scalable experimentation and learning. These applications are not merely theoretical; they represent a tangible evolution in production methods, with microalgae at the forefront as a sustainable resource.

Over the past two decades, bioengineering has evolved from its early stages in synthetic biology to a robust scientific domain, now integral to sectors like chemical synthesis, green materials, health, food, and energy[3]. Advances in DNA manipulation and data analysis have led to the creation of platforms for synthesizing bacterial genomes[4] and eukaryotic chromosomes[5], and designing and testing logic circuits in bacteria and yeasts[6]. The applications of living organisms-based production are broad, encompassing carbon fixation, biofuel production[7] and the creation of medical molecules to innovative uses of DNA for data storage[8]. Healthcare, innovations like CAR-T technology and therapeutic bacteria are prime examples of biologically based medical solutions[9].

These advancements rely on the four fundamental pillars of bioengineering: Design, Build, Test, and Learn. Techniques like rapid gene synthesis and assembly, CRISPR and TALEN-based editing, next-generation sequencing, and high-throughput systems, are pivotal in creating and evaluating novel biological objects. Machine learning, plasmid sharing platforms, and computer-aided design tools further enhance this optimization cycle. The central idea is to use and modify living organisms to innovate and surpass the limits of traditional engineering.

To this end, it is imperative to invest in building a high-throughput bioengineering infrastructure, known as a Biofoundry, for providing students, researchers, and companies with cutting-edge synthetic biology technologies. **Among the world's 30 biofoundries, Sorbonne University's unique green biofoundry stands out as the first to construct and characterize microalgae at high throughput.** These microorganisms, central to ecological balance and sustainable production methods, can be cultivated on various scales. SU Biofoundry excels in algal synthetic biology and carbon fixation[10,11,12] and has also demonstrated expertise on the integration of AI with synthetic biology[13,14], de novo design of peptides and nucleic acids[15,16], chromosome biology[17,18] or drug discovery[19,20,21].

The SUAD Ocean Institute aims to create the first biofoundry in the world dedicated to marine microalgae. This unique infrastructure will implement high-throughput DBTL (Design, Build, Test, Learn) cycles, relying on state-of-the-art robotic instruments driven by an agile, open-source software solution, enhanced by artificial intelligence. It will not only assemble strains of bacteria and yeast but also microalgae. These photosynthetic microorganisms represent a major challenge in the ecological transition of our production methods as they could allow for the production of energy and organic molecules through a sustainable process dependent on the fixation of atmospheric CO2 and sunlight, without competing with agriculture.

Microalgae are at the forefront of industrial biotechnology, offering sustainable and innovative applications across various sectors. In the field of health, they are already being utilized for the production of therapeutic proteins and vaccines, offering a new frontier in medical treatments. In the energy sector, microalgae-derived biofuels such as biodiesel and bioethanol represent renewable alternatives to fossil fuels, while their role in carbon capture is pivotal in combating climate change. The cosmetics industry benefits from microalgae's natural antioxidants and pigments for skin care products. Additionally, microalgae's rapid growth rates and ability to utilize non-arable land make them a promising resource in the food and feed industry, providing nutrient-rich options without the drawbacks of conventional agriculture. These established industrial applications demonstrate microalgae's versatile and growing role in supporting a sustainable future.

The Focus of SUAD biofoundry on marine microalgae takes advantage on the unique assets of the United Arab Emirates (sunlight, heat, land space and sea water) and of the world leading expertise of Sorbonne University on microalgae synthetic biology. SUAD biofoundry will enable the generation of strains capable of producing therapeutics, biofuels, bioplastics, and industrially relevant carbon molecules (alcohols, alkanes, lipids, sugars, pigments, terpenes, etc.). This green biofoundry will be the first in the world capable of constructing and characterizing marine microalgae.

To harness bioeconomy's potential, it is imperative to master not only the science but also the scaling of these innovations to industrial levels, navigating the complex biocapability landscape and incorporating them into business models. **Sorbonne University's partnerships with local and international companies are pivotal in developing high-capacity infrastructures for microalgae industrial exploitation.**

SUAD Biofoundry will serve as a center of excellence, promoting impactful academic and industrial projects. It will educate public and private professionals in automated bioengineering technologies and concepts, providing access to state-of-the-art technologies, to accelerate fundamental research, applied and translational research, industrial development, and innovation across various fields, shaping the bioengineering sector and the emergence of a novel green industry.

This initiative is set to drive economic and scientific growth, fostering international collaborations and funding, and propelling Abu Dhabi to the forefront of global innovation in green biotechnologies and industries. It will be a driver for innovation through startup creation, as well as industrial R&D programs. Its role in pioneering interdisciplinary research (e.g., biomimicry, gene therapies, urban agriculture or data storage on DNA) is crucial to ensure the technological and conceptual foundations that will enable the green biotechnologies and industries of tomorrow.

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Jubail Mangrove Park in Abu Dhabi
Le parc de la mangrove de Jubail à Abu Dhabi

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