

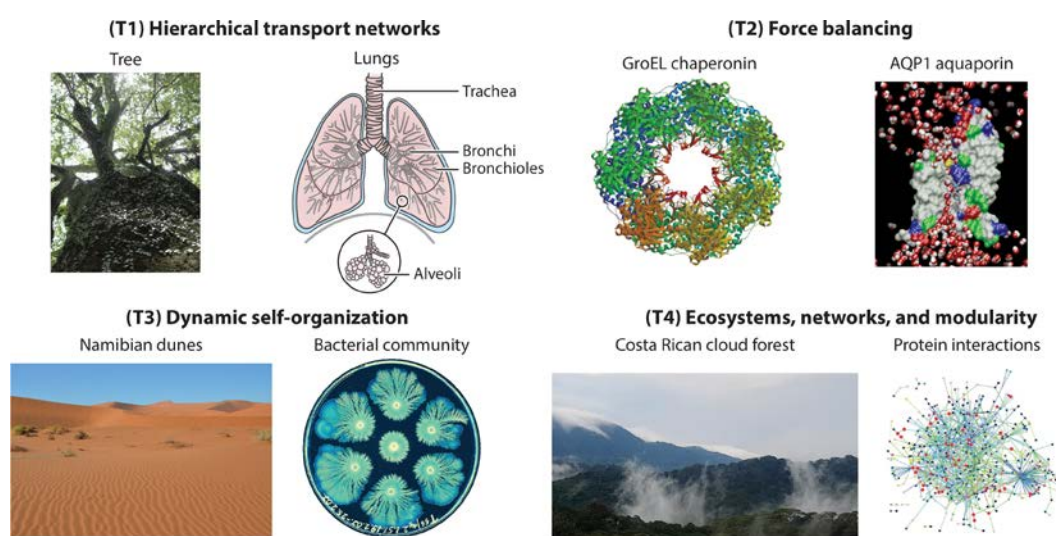
A nature-inspired chemical engineering (NICE) approach to accelerate the energy and environmental transition

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Tackling Grand Challenges in energy and sustainable manufacturing, framed by the UN Sustainable Development Goals (SDGs), but also economic requirements, requires step-changes through transformative approaches and interdisciplinary thinking, beyond incremental variations on traditional designs. We turn to nature for inspiration, because nature provides us with examples of solutions, perfected over the eons, to challenges that mirror those we encounter in technology, such as scalability, efficiency, and resilience. However, such solutions from nature cannot be copied: the fundamental mechanisms underpinning properties of interest need to be understood, before adopting and adapting them to the different context of industrial applications. This can be achieved via a systematic, nature-inspired solution (NIS) methodology, developed and applied at UCL's Centre for Nature-Inspired Engineering (CNIE), to accelerate innovation and sustainable development. Theory and computational tools are essential to aid the development and optimisation of nature-inspired designs, which are prototyped, experimentally validated, and iterated upon. Incorporating dynamics and holistic, systems thinking from inception is also instrumental, emulating nature's emergent systems properties.

This approach will be illustrated with examples related to chemical engineering (NICE) in areas relevant to process intensification and supporting the energy and environmental transition required for sustainable development. Discussed examples will include the design of multiphase reactors and hierarchically structured catalysts, electrochemical devices, and membrane separations. The broader applicability of NICE and the versatile NIS methodology will be touched upon as well, with applications in biomedical and healthcare engineering, as well as materials for space technology and the built environment.



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Figure 1 : Ubiquitous fundamental mechanisms in nature, underpinning NICE applications

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