Imperial College London

Institute for Molecular Science and Engineering

Briefing Note – summary of Briefing Paper No 1 April 2017

Molecular science and engineering

Read the full paper: http://hdl.handle.net/10044/1/53609

Headlines

- Global society currently faces many pressing challenges, including clean and affordable water for all, growing antimicrobial resistance, and anthropogenic climate change.
- To solve these grand challenges, research practices need to change radically. A convergent approach involves industry, policy and government communities, as well as the general public, at the early stages of research.
- Molecular science and engineering is a powerful transdisciplinary approach to solving grand challenges. It links innovation at the molecular and biological scale to engineering a final product within a complex world. Final function and end-use requirements are an integral part of molecular-scale scientific research.
- The Institute for Molecular Science and Engineering (IMSE) was founded in 2015 at Imperial College London to advance integrated transdisciplinary research, transform education and enable effective translation of research to industry.
- IMSE works to overcome organisational barriers in academic institutions, personal motivational issues for researchers, poor communication between traditionally separated disciplines and between academia, industry and government, as well as a scarcity of collaboration-ready science and engineering graduates.

Examples of molecular science and engineering in action

- Mitigation of the 'hole' in the ozone layer after international scientific, engineering, industrial and political communities took action to phase out the use of chloroflurocarbons (CFCs) in 1987 but only after a decade of strife.
- The decades-long development time of organic light emitting diodes (OLEDs) from first discovery in 1963 to their current ubiquity in television screens, computer monitors and mobile phone screens, once they became serious alternatives for solid-state lighting applications (inorganic LEDs).

The convergence revolution

Convergence is "the integration of knowledge, tools, and ways of thinking from life and health sciences, physical, mathematical, and computational sciences, engineering disciplines and beyond" to create mission-driven frameworks that can be used to address many of the world's most pressing problems.

In more traditional interdisciplinary research, individual specialists come together from separate 'silos' to share skills as and when necessary. In convergence-style projects, multidisciplinary collaboration is embedded from the very start into a network of mutually beneficial partnerships. This approach has been gaining ground since the early 2010s, first in the US, in both academia and industry, and subsequently in the UK (Nurse review, creation of UKRI, GCRF).

Imperial College London

Institute for Molecular Science and Engineering

Barriers to successful molecular science and engineering research

- Rigid funding and administrative systems in the traditional structures of academic institutions can block flexible exchange of knowledge between disciplines.
- Conventional university hiring and promotion procedures do not normally reward transdisciplinary scientists and engineers, particularly in the early stages of their careers. Department rankings (e.g., Times Higher, US News, QS) largely ignore multidisciplinarity.
- Scientists and engineers in the convergence landscape need to be conversant and knowledgeable over a broad range of disciplines, as well as having a strong grounding in their individual subjects. A change in workforce training is required.
- New organisational support is required to generate and maintain greater between academia, industry, government and other groups (e.g., charitable foundations).
- Peer-review of translational, applied and transdisciplinary research proposals requires a wider pool of expertise, and potentially a different set of review criteria, than historically used.

The Institute for Molecular Science and Engineering

Imperial College London founded the Institute for Molecular Science and Engineering (IMSE) in 2015. IMSE is hosted at a world-class university with an existing culture of collaboration, multidisciplinarity and grand challenge goals. The College already harbours a critical mass of researchers in molecular science and engineering and a wide range of the world-leading technologies necessary to conduct research in this field. We are also able to draw on Imperial's long tradition of effectively translating innovative research into economic and societal benefits. IMSE has three guiding pillars:

Pillar 1: Advancing integrated transdisciplinary research

Any Imperial engineer, scientist, medic and business researcher whose work and interests align with the Institute's mission can become an IMSE affiliate. Affiliates meet, communicate and collaborate with other researchers from across college, help develop the Institute's agenda and define the grand challenges we address. Community-building is central to the success and sustainability of IMSE. IMSE also catalyses bottom-up investigator-led research by supporting a set of 'seed-funded' research projects to foster new cross-faculty collaborations.

Pillar 2: Transforming education

IMSE runs a unique science and engineering Master's of Research (MRes) course. This one-year course equips graduates to work across the molecular science/engineering interface. The course includes a six-month research project with an industrial partner. Graduates can help to break down the academia/industry innovation barrier.

Pillar 3: Enabling effective research translation

IMSE enables effective commercialisation and translation of research into practice, via a range of events and research projects in collaboration with industrial partners. IMSE's flexible, multistep workshop–research initiative model is an iterative process to consult internal and external stakeholders to identify a grand challenge topic.

Imperial College London

Institute for Molecular Science and Engineering

The College's core capabilities can provide unique contributions and guide ongoing activities in the following grand challenges identified in molecular science and engineering:

- novel manufacturing processes to bring new chemistries to fruition
- molecular engineering of 'smart' interfaces
- development of engineered composites and tissues
- design of novel formulations
- molecular engineering to address energy challenges
- carbon utilisation
- molecular engineering solutions for antimicrobial resistance.

Contact us

Professor Claire S. Adjiman, Director of the Sargent Centre for Process Systems Engineering

Professor Nicholas Harrison, co-Director of IMSE

Further information and contact: imse@imperial.ac.uk