HELMHOLTZ Biomedical Engineering EMBO

WHITE PAPER

Bridging the **Translation Gap:** Bioengineering in Europe

Strengthening Europe's bioengineering capacities for accelerated innovation, improved translation and future competitiveness in the life sciences.

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PREAMBLE

Bioengineering is a strategic pillar of biomedical advances and economic competitiveness. Realising its full public value for **Europe** requires coordinated action. This whitepaper crystallizes the main results from a March 2026 Bioengineering Policy Workshop organised by EMBO and the Helmholtz Association. Addressing decision makers across the political, policy, academic, industry, funding, investment and philanthropy communities, it proposes a **European Bioengineering Agenda**. Europe must act with greater ambition and coherence to leverage the full potential of bioengineering, sustainably accelerating the **translation of its scientific excellence** into societal benefit, industrial capacity, and long-term public good.

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Disclaimer: all workshop participants have agreed to be acknowledged as contributors to the discussion. This does however not imply any endorsement of the resulting policy recommendations by their institutions, organizations, or employers.

EXECUTIVE SUMMARY

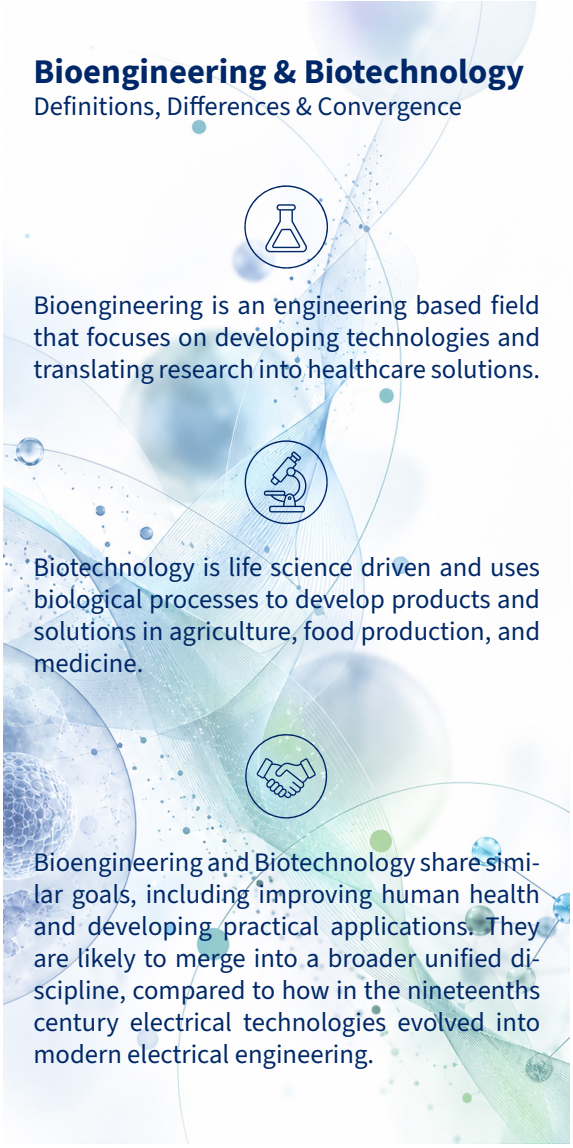
Europe is globally recognized for its outstanding research, engineering legacy in the natural sciences, disruptive invention and continuous innovation. Yet Europe does not efficiently translate its scientific excellence into biological and scalable medical solutions. Gaps in bioengineering education have prevented Europe from building the critical mass of expertise needed to sustain a strong bioengineering ecosystem, from dedicated research funding instruments and expert review panels to integrated translation infrastructures capable of advancing discoveries toward clinical and commercial impact. Against the backdrop of accelerating global biotech innovation and a health economy projected to reach multi-trillion-euro scale, this white paper issues an **urgent call to action** to European stakeholders to close these gaps and convert Europe's scientific strength into technological, clinical and economic leadership.

The proposed **European Bioengineering Agenda** outlines transformative measures to accelerate Europe's bioengineering and biomedical engineering education and institutional capacity, including European Flagship Bioengineering Institutes. It calls for the implementation of novel, integrated and transfer-oriented structures; dedicated bioengineering funding mechanisms; and the harmonisation of innovation-fostering regulation. These key pillars, alongside more effective European collaboration across *Lighthouse Innovation Clusters*, will drive sustainable innovation and translation cycles, turning Europe's outstanding discoveries more efficiently into market applications, **securing Europe's technological sovereignty and resilience and safeguarding future economic prosperity**.

BACKGROUND

Technology underpins societal and economic growth. Technological inventions typically draw upon multiple scientific domains, with engineering serving as a key discipline that transforms discovery and knowledge into efficient products and solutions. Despite its engineering legacy, Europe is lagging behind in creating a robust *bioengineering education and research ecosystem* in the life- and health sciences. Key indicators reveal that the growing gap in Europe's bioengineering capacity, for example, in education and investments in institutions and infrastructures, reduce Europe's ability to develop the biomedical technologies of the future, undermining Europe's competitiveness in the global life sciences innovation landscape.

As an illustration, the US currently accounts for roughly 60% of the global biotech value, followed by Europe with 12%, and China with 11%. Irrespective of its sizeable economy and nominal GDP, Europe today employs significantly less top academic talent, produces fewer patent-relevant biomedical publications and issues fewer PCT patents, compared to both the USA and China. Europe's clinical trial activity dropped by 50% in the last decade, and Europe's biotech ventures secured in 2023 only half of the investments attracted by Chinese firms. Such stagnation, compared to China's massive strategic investments in bioengineering and biotechnology, indicates a tremendous powershift in one of the most rapidly growing technology sectors with a predicted health economy and biotech market value of $9-12 trillion by 2035. China already outcompeted Europe and overtook the US in patent-relevant publications in 2017 and in clinical trial activity by 2024. Furthermore, China hosts today 18 of the top 30 globally leading bioengineering departments, with no European institution ranking among them (Shanghai Ranking, 2025).



ANALYSIS AND CHALLENGES

The core challenge for Europe is structural rather than scientific. Europe has strong biology, medicine and engineering communities, but bioengineering (also encompassing biomedical engineering or engineering for biology and medicine) remains institutionally marginal. Bioengineering is not consistently recognized as a strategic discipline in higher education, funding systems, or policy design, limiting Europe's ability to generate and scale biomedical technologies with the same strength and effectiveness achieved in other engineering sectors.

The gap in bioengineering education and talent formation is vastly overlooked and the full potential to accelerate transfer is not recognized. Compared to North America and China, Europe has relatively few stand-alone bioengineering faculties and very limited tracks to train bioengineers specialising in biomedical research and translation. European classification systems (ISCED-F 2013) do not track bioengineering as a distinctive engineering discipline, and only an estimated 1.5% of Europe's ~2.8M engineering students become exposed to biomedical engineering problems. Europe hence misses entire generations of bioengineers, and produces graduates lacking deep knowledge of human biology or medicine, rooted in the fact that bioengineering is typically taught only a specialization over traditional engineering degrees.

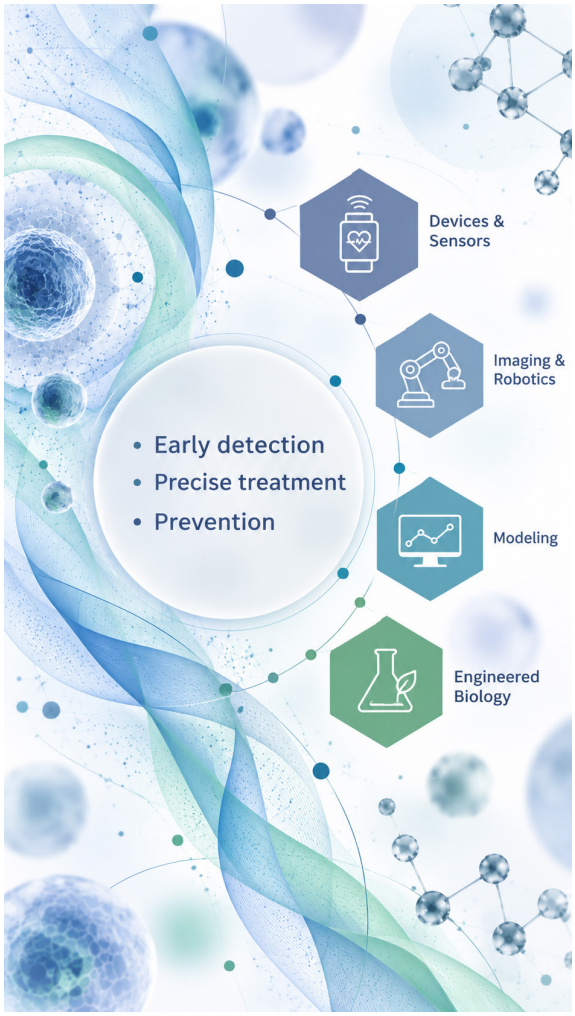
EU-level funding bodies often lack expert bioengineering panels and funding calls. In the absence of strong bioengineering academic expertise and institutional capacity, highly interdisciplinary and transfer-oriented proposals need to be assessed by experts from neighboring disciplines, who too often underestimate the societal and economic impact of newly emerging technologies. This extends to many granting agencies, foundations or funding bodies, significantly hampering Europe's capability to capture the full value of product- and solutions-development, scale-up and commercialization that would naturally arise from its bioengineering discoveries and innovations.

Europe's significant venture capital (VC) investment gap also ties to limited bioengineering education. Europe has very few bioengineering-specialist investors because bioengineering education at large is barely existent. Naturally, generalist biotech VCs tend not to have the expertise to assess bioengineering-oriented cases. Therefore, European VCs decide more conservatively than US or Chinese VCs, which deal more comfortably with bioengineering and techbio innovations, including AI-driven applications.

European innovations often struggle with overregulation or national asymmetries. The EU Medical Device Regulation (MDR), In Vitro Diagnostic Regulation (IVDR) and the European Medicines Agency's (EMA) approval processes disproportionately harm academic entrepreneurs and early-stage startups. While large companies easily absorb compliance costs and enter European markets regardless, startups rationally prioritise US or Asian markets for reasons of capital efficiency. Therefore European bioengineering innovations are more often commercialised outside Europe, significantly reducing economic value and job opportunities also in production and product refinments.

Additional barriers include insufficient concentration of innovation-support functions such as prototyping, intellectual property, clinical validation, venture building, access to risk capital and support in navigating regulatory complexity. Translation-oriented initiatives, like the **Wyss Institute** at Harvard, **Google X** - Alphabet's Moonshot Factory, Roche's **Institute for Human Biology**, the NovoNordisk Foundation supported **BioInnovation Institute**, the National University of Singapore's **Mechanobiology Institute** and others, have streamlined biomedical innovation pipelines around core bioengineering concepts for ideation, refinement and rapid commercialization. Despite distinct purposes and business models, their institutionalized support is closely aligned to accelerate invention, product- and company building, representing best-in-class blueprints for future European innovation-translation pipelines.

The economic implications are significant. Ecosystems with formalized bioengineering education and transfer systems - through integrated department- and faculty structures, closely collaborating hospitals, biotech incubators and startup networks – consistently produce breakthrough medical technologies such as novel imaging methods, biosensors and organ-on-chip platforms, tissue engineering capabilities, life-support systems, neuroprosthetics or robotic surgery. In many cases, Europe contributed foundational discoveries without capturing the full downstream commercial value. As a brief reminder, DNA- and protein sequencing, in-vitro fertilization, the monoclonal antibody technology, Magnetic Resonance Imaging, Computed Tomography, balloon catheters, robotic surgery, mRNA-based vaccines and CRISPR engineering have, at least in part, been invented in Europe, with often anglo-saxon bioengineers and companies turning them into profitable solutions, that created substantial value for economies outside Europe.



POLICY RECOMMENDATIONS

Europe possesses many essential foundations for a **bioengineering transformation**. It is home to world-class discovery science, distinct innovation ecosystems, and a life sciences sector that contributes approximately €1.5 trillion to the EU economy. Most recent EC and EU policies promote start-ups and scale-ups in key technologies, including biotechnology and AI. With its open society, social security and healthcare systems, largely accessible education, a heritage of innovation and a culture of academic–industry collaboration, Europe has the capacity to **attract global talent** to enable rapid and transformative innovation.

Building on such strengths, this white paper proposes the adoption of a targeted **European Bioengineering Agenda** that prioritises engineering for biology and medicine as a strategic capability for competitiveness, resilience, and public health. The main priorities of the agenda are:

- **make bioengineering a strategic EU priority**, that advances the life- and health sciences, creates societal and economic impact and acts as a catalyst from discovery through to economically sustainable healthcare solutions.

- establish **bioengineering as an academic and professional discipline** and ensure its **representation in funding bodies, review committees and political decision boards** that determine future strategies for the life sciences and the health technology sector.

- **attract international bioengineering talent at scale and create incentives for talent retention**. Europe will only benefit from talent attraction and increased bioengineering education in flourishing innovation ecosystems. Competitive employee stock option taxation (ESOP), allowing startups to compensate bioengineers with equity that offsets lower base salaries, and other instruments are also needed for talent retention.

- **build institutional capacity**, in a way that could include European Bioengineering Flagship Institutes (or a network of such institutes across member states), similar to the European Molecular Biology Laboratory (EMBL) model, for a robust and sustainable bioengineering education framework.

- **enhance funding instruments** - such as the European Research Council (ERC), the European Innovation Council (EIC) and complementary mechanisms - into a pipeline that prioritises scientific excellence for the generation of new paradigms in bioengineering innovation and the acceleration of translation.

- **strengthen Europe's leading innovation hubs** through cluster-based approaches and incentives that closely connect universities, hospitals, start-ups, investors, and regulators beyond their regional ecosystems and national borders; reduce barriers in data access, clinical validation and commercialization, and create tax incentives for investors.

- **implement internationally validated support mechanisms** that can streamline translational mechanisms, data access with standardized consent and unified frameworks, while optimizing the MDR and other regulations for early-stage technologies and including bioengineering in the Important Projects of Common European Interest (IPCEI) priorities.

CONCLUSION

Europe has yet to implement a consistent and scaled bioengineering education framework and shape and scale effective translation environments for the life and health sciences. Overcoming the long neglected gap in educating a sizeable talent pool and workforce with a distinguished solution focus, entrepreneurial mindset and risk-taking culture will more rapidly and sustainably turn Europe's excellent biomedical discoveries into new health solutions and market-ready ventures.

Establishing substantial and transformative bioengineering education and infrastructure capacity across Europe, together with seamlessly connected transfer mechanisms, will strongly synergize with Europe's already initiated start-up and scale-up policies and significantly contribute to Europe's technological competitiveness, societal health and economic prosperity in a sustainable manner.

Credit: EMBO

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Impressum

EMBO is an organization of more than 2,200 leading researchers that promotes excellence in the life sciences in Europe and beyond. The major goals of the organization are to support talented researchers at all stages of their careers, stimulate the exchange of scientific information, and help build a research environment where scientists can achieve their best work.

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The Biomedical Engineering Initiative of the Helmholtz Association
Biomedical Engineering is one of the Helmholtz Association's – Germany's largest research organization – campaigns that address emerging topics across programmes, institutions, and fields. It promotes biomedical engineering as an efficient driver of new health technologies and supports collaborative networks among research institutions, universities, clinics, industry, and other stakeholders and partners.

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