

On the horizon in biomedical engineering



It is an exciting time for biomedical engineering, with advances rapidly reshaping the forefront of translational research and medicine. Here we highlight some areas and technologies that we are particularly excited about for the coming years.

As we highlighted in our recent end-of-year Editorial¹, 2025 saw advances in biomedical engineering across a wide range of disciplines. In this piece, we look forward and share our thoughts on areas, tools and technologies that have captured our attention and that we think represent important spaces where engineering will have a great impact on human health.

Immuno-oncology is a field with tremendous momentum, and we are excited, as ever, to witness the coming advances in chimeric antigen receptor (CAR) therapies. Researchers working in immunotherapy are already focused on developing tools that improve the performance of CAR T cell therapy in solid tumours, and while we are quite selective with these papers, we continue to seek translatable breakthroughs to address this major challenge. In addition, we are paying close attention to approaches enabling in vivo CAR T cell engineering that bypass expensive and time-consuming ex vivo manufacturing steps as well as methods that expand the repertoire of immune cell types and types of antigen that can be used in CAR therapy. Furthermore, as CAR T cell therapies become commonplace in the clinic, their side effects in humans come to the fore. We are actively seeking the next generation of cellular immunotherapies that not only prioritize efficacy but also improve their safety. We are also looking forward to seeing applications of cellular immunotherapies beyond cancer, with promising treatments for allergies and autoimmune diseases.

A study in the *New England Journal of Medicine*² caught our attention last year, because it showed that radiation from medical imaging was associated with haematological cancers in adolescents. We think that biomedical engineers are uniquely suited to develop imaging technology to allow necessary monitoring while mitigating negative impacts.

We hope to see progress in hardware and instrument design alongside machine learning methods for improving image generation, translation and analysis to enable high-quality imaging at lower radiation doses.

We are closely following methods for automated imaging that combine the strengths of machine learning for real-time image analysis and instrument control with improved technology that can lead to robust, expert-level diagnostic imaging in diverse contexts, contributing to democratization of crucial biomedical imaging. Further innovation in this space is poised to feed into improved automated surgery, another area we are watching closely as the tools begin to move from the bench to the clinic.

Machine learning and artificial intelligence have shown their potential in medicine, and we are actively seeking innovative work in this space. The year 2025 was one of ‘foundation models’ for radiology and digital pathology, and while we are still excited for these technologies, our greater overarching interest lies in methods that are truly robust, trustworthy and accurate enough to be used in the clinic. While there is much to be excited about, issues such as data drift, poor performance on unseen data, lack of interpretability, lack of generalizability and more still plague methods and limit their clinical utility. As such, we hope to shine a light on where the field stands and what still needs to be accomplished to prioritize technology that not only pushes the performance limits but also offers explainable guidance to clinicians for productive integration into diagnostic workflows.

A number of achievements in xenotransplantation were seen in 2025. A study in *Nature*³ showed that a kidney from a genetically engineered pig could be used to support long-term life-sustaining renal functions in a human. Another landmark study published in *Nature Medicine*⁴ showed that a genetically modified porcine heart could be used to sustain life in a human for 40 days. Although there are challenging issues to face, including organ size mismatch, immune compatibility and rejection, incompatibilities related to the genomic disparities between pigs and humans, and ethical concerns regarding the use of animals for developing organs for

humans, we consider such studies breakthrough achievements in meeting the dire need for life-sustaining organs. We hope to see the next generation of tools and technologies to improve organ and tissue transplantation as well as studies showing their efficacy in humans published in our pages.

Ida Tin, the entrepreneur who coined the term ‘FemTech’ and founder of the app Clue for the monitoring of menstruation cycles, just [announced](#) that the proposal of the grant challenge for continuous hormone monitoring is going forward. We are excited about how this will shift and expand the development of biosensors from decoding biomarkers of diabetes and stress (glucose, lactate and so on) to continuously monitoring hormones from blood, interstitial fluid and possibly sweat, providing useful information regarding women’s health.

We would be extremely excited to see in vitro models of human endometrium that accurately recapitulate the complex processes of cyclic remodelling, decidualization and menstruation. Such model systems would be invaluable for characterizing the molecular drivers of endometrial pathophysiology such as endometriosis and adenomyosis while providing physiologically relevant systems for the identification and validation of novel therapeutic targets. More broadly, we want to explicitly stress the journal’s interest in technologies and biomedical advances for women’s health.

Our long-standing enthusiasm for in vitro modelling of tissues and diseases continues, and we are excited to see reconstitution of the immune system occupy an increasingly large space. Achieving physiologically relevant immune function will refine our mechanistic understanding of healthy and diseased tissues and improve our ability to assess the efficacy and safety of developed treatments for pathological states in vivo.

Neuroengineering is another fast-moving field. With the identification of precise biomarkers, closed-loop technologies are showing incredible effectiveness in various therapeutic contexts, from vagus nerve stimulation to recover from spinal cord injury⁵ to gastrointestinal neuromodulation to induce satiety⁶. Paired with models that lengthen the unsupervised recalibration of

neuroengineered interfaces⁷, we look forward to seeing implantable and wearable technologies addressing drug-resistant mental health conditions, improving mobility and performance of everyday tasks in people with motor impairments, and discovering unknown connections between the brain and gut.

Gene therapies have reached the clinic and are offering treatments and even cures for diverse human diseases. We are interested in all aspects of improved gene therapies, from enzymatic tools for improved gene or base editing to therapeutic applications of such tools for treating specific diseases. For both gene therapy and nanomedicine more broadly, we hope to see continued development of tools with reduced immunogenicity and reactogenicity. For example, antibodies targeting polyethylene glycol (PEG) have been shown to interfere with the efficacy of lipid nanoparticles used in SARS-CoV-2 vaccines. Approaches to address PEG-related immunity include replacing PEG with alternatives such as zwitterionic polymers⁸ or PEGs with brush architecture⁹. These strategies aim to improve the safety and reliability of nanoparticle-based delivery systems.

Finally, a piece of this kind would not be complete without us expressing how gratifying it has been to see the clinical success of vaccines of all types, from those protecting populations against infectious diseases, to those helping cure cancers that were previously considered a death sentence. We were also excited to see a study¹⁰ showing that

mRNA-based SARS-CoV-2 vaccines can do both – preventing infectious disease and enhancing anti-cancer immune responses. We actively seek studies developing vaccines against novel targets, introducing improved adjuvants, and improving safety and efficacy. Furthermore, we are keeping a close eye on inverse vaccines, which show promise for treating currently intractable autoimmune diseases.

Speaking more broadly than the areas discussed above, we are hoping to publish more at the interface between biomedical engineering and mental health and global health, as these areas have been under-represented in the journal despite our long-held editorial enthusiasm for these topics and their importance. We welcome researchers to discuss their work with us and learn what we expect from these papers in hopes that we can champion these topics and broaden our impact in these fields.

Beyond the specific topics we have on our radar, we at *Nature Biomedical Engineering* are more committed than ever to an overarching goal of shortening or bridging the divide between the bench and the bedside. Too often we see extremely promising approaches or technologies both published and perished, destined to be cited only in literature reviews for what might have been and never coming close to improving the human condition. As such, we are interested in research, review and opinion pieces that can serve to help connect researchers and clinicians, address major

bottlenecks in clinical adoption and promote the push of promising technologies all the way to the end of the pipeline.

Biomedical engineering is an exceptionally broad field, and this collection of exciting topics is far from an exhaustive list of all the areas of high interest to our editorial team. One of the greatest parts of being an editor is that despite having read thousands of papers and having a good sense of what might come next, we still get submissions that surprise and delight us – many of which transform the state of the art. We believe that researchers working in the biomedical engineering space are uniquely poised to identify and solve ongoing challenges to understand, diagnose and treat diseases and are anxious to see what the field develops next. We hope we have shared our enthusiasm as we look forward to many advances to come and to working together in this new year.

Published online: 22 January 2026

References

1. *Nat. Biomed. Eng.* **9**, 2013–2014 (2025).
2. Smith-Bindman, R. et al. *N. Engl. J. Med.* **393**, 1269–1278 (2025).
3. Montgomery, R. A. et al. *Nature* <https://doi.org/10.1038/s41586-025-09847-6> (2025).
4. Griffith, B. P. et al. *Nat. Med.* **31**, 589–598 (2025).
5. Kligard, M. P. et al. *Nature* **643**, 1030–1036 (2025).
6. Srinivasan, S. et al. *Nat. Commun.* **16**, 7374 (2025).
7. Wilson, G. H. et al. *Nat. Biomed. Eng.* <https://doi.org/10.1038/s41551-025-01536-z> (2025).
8. Luozhong, S. et al. *Nat. Mater.* **24**, 1852–1861 (2025).
9. Xiao, Y. et al. *Nat. Mater.* **24**, 1840–1851 (2025).
10. Grippin, A. J. et al. *Nature* **647**, 488–497 (2025).