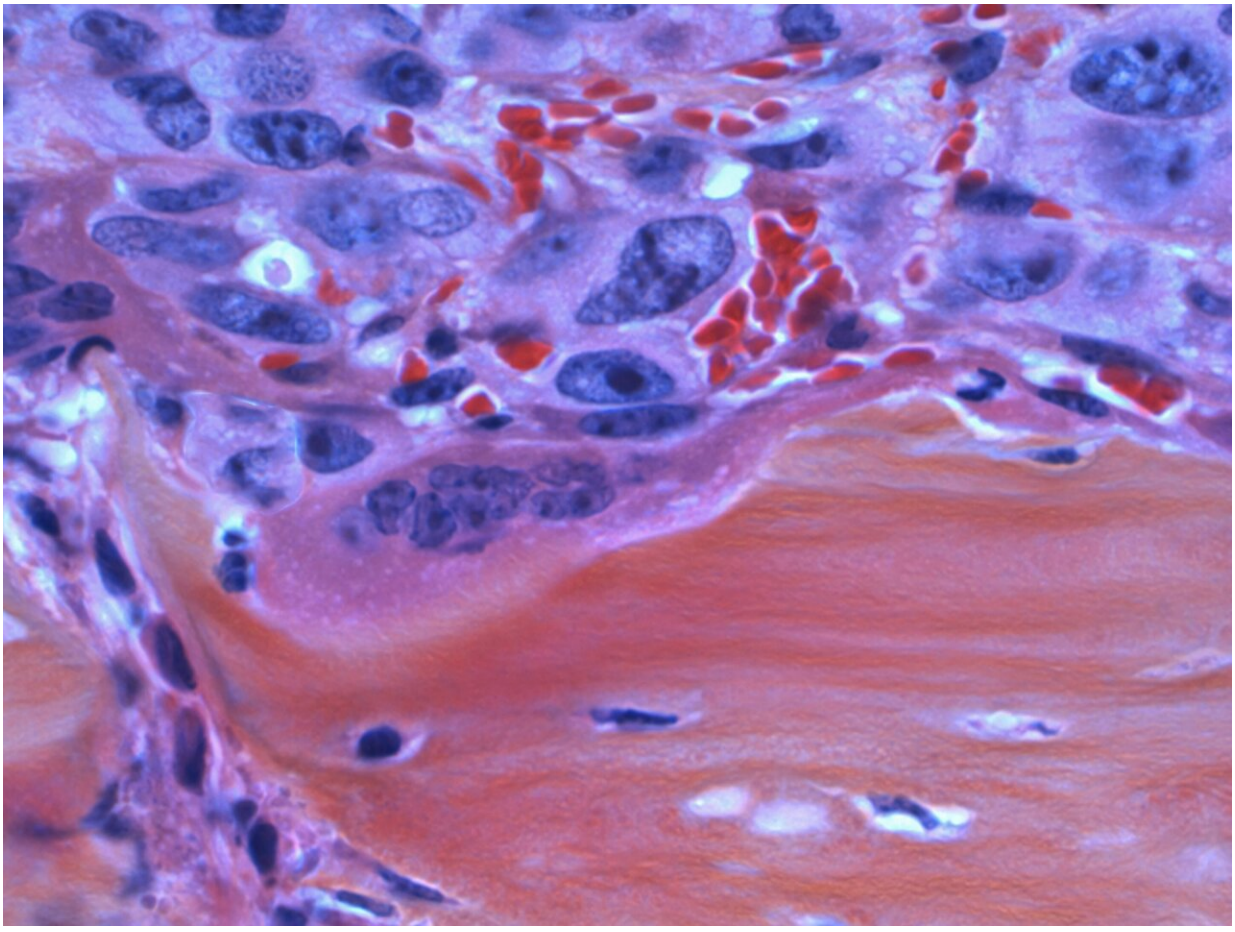
Bio-hybrid robotics need regulation and public debate, say researchers

July 22 2024



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Researchers are calling for regulation to guide the responsible and

ethical development of bio-hybrid robotics—a pioneering science which fuses artificial components with living tissue and cells.

In a paper published in *Proceedings of the National Academy of Sciences*, titled "Ethics and responsibility in bio-hybrid robotics research," a multidisciplinary team from the University of Southampton and universities in the US and Spain set out the unique ethical issues this technology presents and the need for proper governance.

Combining living materials and organisms with synthetic robotic components might sound like something out of science fiction, but this emerging field is advancing rapidly.

Bio-hybrid robots using living muscles can crawl, swim, grip, pump, and sense their surroundings. Sensors made from sensory cells or insect antennae have improved chemical sensing. Living neurons have even been used to control mobile robots.

Dr. Rafael Mestre from the University of Southampton, who specializes in emergent technologies and is co-lead author of the paper, said, "The challenges in overseeing bio-hybrid robotics are not dissimilar to those encountered in the regulation of biomedical devices, stem cells and other disruptive technologies.

"But unlike purely mechanical or digital technologies, bio-hybrid robots blend biological and synthetic components in unprecedented ways. This presents unique possible benefits but also potential dangers."

Research publications relating to bio-hybrid robotics have increased continuously over the last decade. But the authors found that of the more than 1,500 publications on the subject at the time, only five considered its ethical implications in depth.

The paper's authors identified three areas where bio-hybrid robotics present unique ethical issues: Interactivity—how bio-robots interact with humans and the environment, Integrability—how and whether humans might assimilate bio-robots (such as bio-robotic organs or limbs), and Moral status.

In a series of thought experiments, they describe how a bio-robot for cleaning our oceans could disrupt the food chain, how a bio-hybrid robotic arm might exacerbate inequalities, and how increasing sophisticated bio-hybrid assistants could raise questions about sentience and moral value.

"Bio-hybrid robots create unique ethical dilemmas," says Aníbal M. Astobiza, an ethicist from the University of the Basque Country in Spain and co-lead author of the paper. "The living tissue used in their fabrication, potential for sentience, distinct environmental impact, unusual moral status, and capacity for biological evolution or adaptation create unique ethical dilemmas that extend beyond those of wholly artificial or biological technologies."

The paper is the first from the Biohybrid Futures project led by Dr. Rafael Mestre, in collaboration with the Rebooting Democracy project. Biohybrid Futures is setting out to develop a framework for the responsible research, application, and governance of bio-hybrid robotics.

The paper proposes several requirements for such a framework, including risk assessments, consideration of social implications, and increasing public awareness and understanding.

Dr. Matt Ryan, a political scientist from the University of Southampton and a co-author on the paper, said, "If debates around embryonic stem cells, human cloning or artificial intelligence have taught us something, it is that humans rarely agree on the correct resolution of the moral

dilemmas of emergent technologies.

"Compared to related technologies such as embryonic stem cells or artificial intelligence, bio-hybrid robotics has developed relatively unattended by the media, the public and policymakers, but it is no less significant. We want the public to be included in this conversation to ensure a democratic approach to the development and ethical evaluation of this technology."

In addition to the need for a governance framework, the authors set out actions that the research community can take now to guide their research.

"Taking these steps should not be seen as prescriptive in any way, but as an opportunity to share responsibility, taking a heavy weight away from the researcher's shoulders," says Dr. Victoria Webster-Wood, a biomechanical engineer from Carnegie Mellon University in the US and co-author on the paper.

"Research in bio-hybrid robotics has evolved in various directions. We need to align our efforts to fully unlock its potential."

More information: Mestre, Rafael et al, Ethics and responsibility in biohybrid robotics research, *Proceedings of the National Academy of Sciences* (2024). DOI: 10.1073/pnas.2310458121.
doi.org/10.1073/pnas.2310458121

Provided by University of Southampton

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