

DARPA Launches Biological Technologies Office

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A new DARPA technology office will merge biology, engineering and computer science to harness the power of natural systems for national security.

"Biology is nature's ultimate innovator, and any agency that hangs its hat on innovation would be foolish not to look to this master of networked complexity for inspiration and solutions." – DARPA Director Arati Prabhakar, [Testimony to Subcommittee on Intelligence, Emerging Threats and Capabilities](#) [1], U.S. House of Representatives, March 26, 2014

Technology, like biology, constantly evolves. It is DARPA's mission to stay ahead of the shifting technology curve by making critical, early investments in areas that cut across fields of research and enable revolutionary new capabilities for U.S. national security. Now DARPA is poised to give unprecedented prominence to a field of research that can no longer be considered peripheral to technology's evolving nature. Starting April 1, 2104, biology takes its place among the core sciences that represent the future of defense technology.

DARPA has created a new division, the [Biological Technologies Office](#) [2] (BTO), to explore the increasingly dynamic intersection of biology and the physical sciences. Its goals are to harness the power of biological systems by applying the rigorous tools of engineering and related disciplines, and to design next-generation technologies that are inspired by insights gained from the life sciences. BTO's programs will operate across a wide range of spatial and temporal scales — from individual cells to humans and other organisms and the communities in which they operate, and from the time it takes for a nerve to fire to the time it may take a new virus to spread around the world one sneeze at a time. All told, BTO will explore the intricate and highly adapted mechanisms of natural processes and demonstrate how they can be applied to the mission of national defense.

BTO expands on the instrumental work undertaken by DARPA's [Defense Sciences](#) [3] (DSO) and [Microsystems Technology](#) [4] (MTO) Offices. Recent progress in such diverse disciplines as neuroscience, sensor design, microsystems, computer science, and other longstanding areas of DARPA investment has begun to converge, revealing newly emergent potential ready to be realized.

"The Biological Technologies Office will advance and expand on a number of earlier DARPA programs that made preliminary inroads into the bio-technological frontier," said [Geoff Ling](#) [5], named by DARPA Director Arati Prabhakar to be the first director of BTO. "We've been developing the technological building blocks, we've been analyzing our results, and now we're saying publicly to the research and development community, 'We are ready to start turning the resulting knowledge into practical tools and capabilities.'"

The initial BTO portfolio includes programs transferred from DSO and MTO, but will also include new opportunities, beginning with the recently announced [Hand Proprioception & Touch Interfaces \(HAPTIX\)](#) [6] program that expands on the work of DARPA's [Revolutionizing Prosthetics](#) [7] and [Reliable Neural-Interface Technology](#) [8] programs. In keeping with DARPA tradition, future programs will be created from ideas brought to the agency by program managers and through conversations with the research community.

"Before BTO, DARPA had a handful of biologists, neuroscientists, engineers, and the like, interested in synthesizing their work but distributed across different offices," Ling said. "Now we're under one roof, so to speak, and looking to attract a new community of scholars, who will bring a host of new ideas at the intersection of traditional and emerging disciplines."

Three research focus areas reflect the scale and scope of BTO's mission.

Restore and Maintain Warfighter Abilities: Because military readiness depends on the health and wellbeing of service members, a critical focus is on cultivating new discoveries that help maintain peak warfighter abilities and restoring those abilities as quickly and fully as possible when they are degraded — including through the development of advanced prosthetics and neural interfaces. BTO will seek to develop new techniques and therapeutic strategies for addressing current and emerging threats, but its work will extend beyond medical applications to include exploration of complex biological issues that can affect a warfighter's ability to operate and interact in the biological and physical world.

DARPA's Systems-Based Neurotechnology for Emerging Therapies (SUBNETS) program is an example of work to restore lost function. It pursues advanced therapies to reduce the burden and severity of neuropsychological illness in afflicted troops and veterans.

The Autonomous Diagnostics to Enable Prevention and Therapeutics (ADEPT) program, which seeks novel ways to identify and protect against infectious disease, is an example of work to mitigate or neutralize biological threats.

Harness Biological Systems: The highly evolved functional and synthetic capabilities of biological systems can be harnessed to develop new products and systems in support of national security with advantages over what even the most advanced conventional chemistry and manufacturing technologies can achieve. BTO seeks to establish a fundamental understanding of natural processes and

the underlying design rules that govern the behavior of biological systems, and apply that knowledge to forward-engineer new systems and products with novel functionality.

DARPA's Living Foundries program, for example, is focused in part on creating a biologically based manufacturing platform to provide rapid, scalable access to new materials with novel properties that can enable a new generation of mechanical, electrical, and optical products.

The Chronicle of Lineage Indicative of Origins (CLIO) program, meanwhile, aims to make biological engineering safer by establishing enduring control elements that protect against intentionally harmful genetic engineering, prevent illegal acquisition or misuse of proprietary strains, provide novel forensic tools to assist in the investigation of biological incidents, and allow responsible investigators to document compliance with safe biological manipulation practices.

Apply Biological Complexity at Scale: Biological systems operate over an enormous range of spatial, physical, and temporal scales. Some organisms thrive as individual cells but most depend on dynamic interactions with other species; humans, for example, are colonized by communities of foreign cells that greatly outnumber their own and have potentially significant but still largely mysterious impacts on metabolism, psychological state, performance, and health. A better understanding of the interactions between mammalian and non-mammalian species and micro- and macro-organisms could foster new approaches to enhancing mental and physical health in routine and threatening situations. Similarly, disease vectors migrate around the globe slowly and stealthily at times, and at other times in devastating waves of breathtaking speed — reflecting poorly understood dynamics that can undermine national security. And because they are so difficult to parse from larger biological and ecological phenomena, population-level effects of relevance to agriculture and food security remain largely unplumbed. BTO is looking into pursuing new insights derived from biological complexity and living-system dynamics with the goal of developing applications to enhance global-scale stability and human wellbeing.

The Biochronicity program studies the role of time in biological functions. By looking for temporal instructions, or “clock signatures,” in biological organisms, the program aims to make it possible to manage the effects of time on human physiology.

Because BTO programs push the leading edge of science, they will sometimes be society's first encounter with the ethical, legal, or social dilemmas that can be raised by new biological technologies. For that reason, DARPA periodically convenes scholars with expertise in these issues to discuss relevant ethical, legal, and social issues.

http://www.darpa.mil/Our_Work/BTO/ [2]

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