Science & Technology: Trends, Limits, Futures, and Transitions

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General Philosophical Points

- Interdisciplinary research is a huge opportunity and win-win for participants - with or without DARPA, it is the wave of the future.
- Need to consider short-term (teaming) and long-term (education).
- Need to be sensitive to cultural differences (vocabulary, background, approach to problems).

Broad Tools at the Interfaces...

- Moving gene arrays and other diagnostics into real-time (fast results -> within therapeutic windows + building intuition).
- Fast gene *expression* arrays (mRNA).
- Rapid analytical tools for determining molecular identity and structure in physiologic settings (e.g., proteomics, glycomics & lipomics technologies).

Biologically Inspired Algorithms

- Self-evolving design methods (for this to be effective, need autonomous self-evaluation metrics).
- Self-repair & fault-tolerance design philosophies.
- Harnessing biological (e.g., ecosystem) network, feedback, sensor fusion, control, and communications concepts.
- Autonomous navigation & decision making.

Models & Standards

- Reference *normal* cells for major organ systems.
- Model of minimal systems & processes for cellular function, with capability to selectively add functionality.
- Computational cell pathway models coupled to automated experimental systems -> self-checking and self-expanding models.

Engineered Biologicals

- Technologies to harvest local ecological resources to minimize logistical support requirements.
- Genetically enhanced plants, animals, and humans.
- Advanced (designed/bioinspired) molecular sensors for molecules of critical interest such as cytokines.

Killer Apps

- True predictive molecule design (build from "cassette" combinations through truly random designs).
- Virtual cell -> human -> clinical trials.
- Self-repairing and adaptive surfaces/systems (biological or abiotic).
- Massively parallel, *goal-directed* molecular synthesis instrumentation.

Technology Limiters

- Complexity and the lack of frameworks & algorithms for dealing with it.
- Limits to miniaturization leading to the need for biological, failure-tolerant designs.
- Lack of molecular detector sensitivity and selectivity.
- Dependence on immortalized cell lines.
- Need to use biological molecules in real-world settings (e.g., no LB films!).
- High cost of testing pharmaceuticals.
- Maintaining pace of basic understanding.

Thanks to the enthusiastic participants in this session.