TECHNOLOGIES TO ADDRESS
Global Catastrophic Biological Risks

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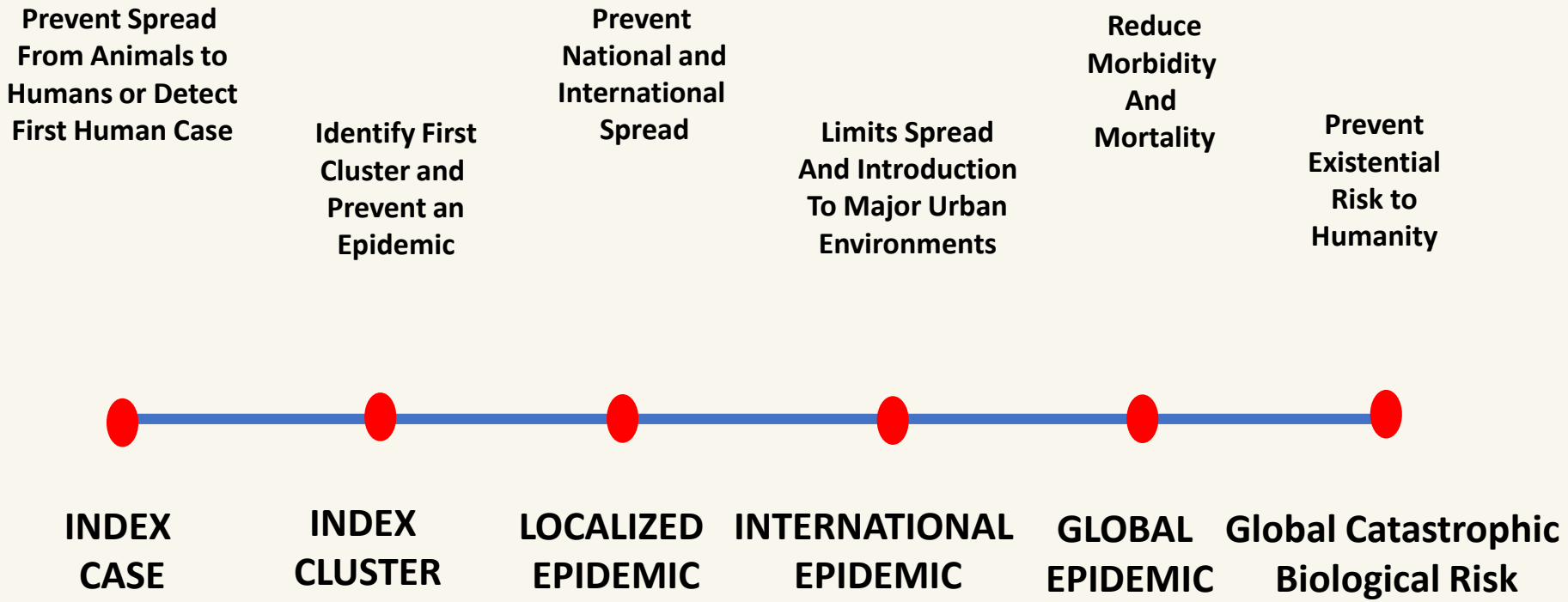
Global Catastrophic Biological Risks (GCBRs)

- Global Catastrophic Risks are a class of risks – naturally or technologically driven – that have potential to inflict serious damage to human wellbeing on a global scale
- GCBRs might include:
  - Naturally occurring severe pandemics
  - Deliberately created and released pathogens
  - Laboratory engineered and escaped pathogens

Opportunities for Intervention Severe Pandemics



Categories of Applicable Technologies

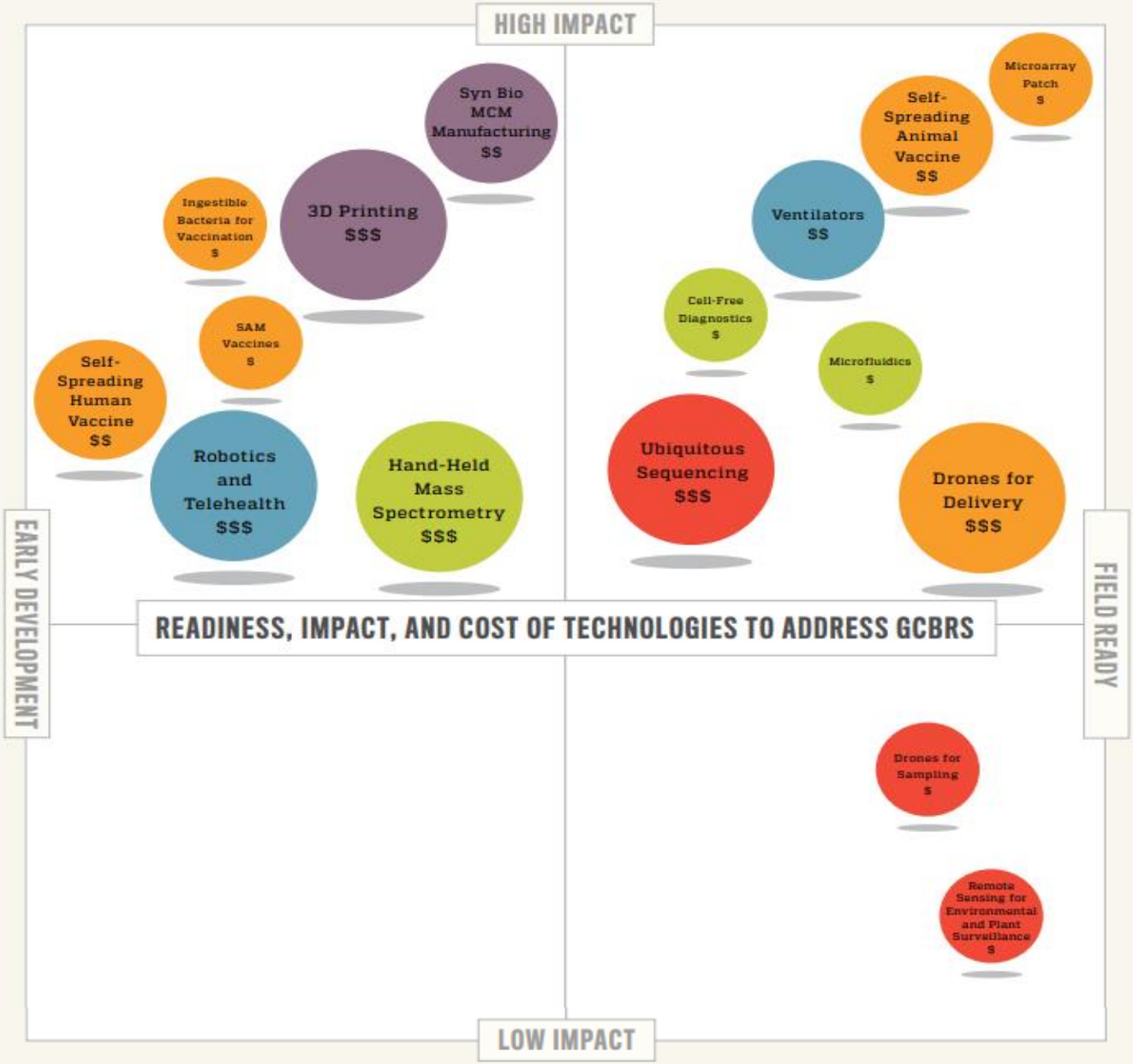
- Technologies can be applied at each of these inflection points in a number of ways to reduce biological risk, including through:
- Better detection, surveillance and characterization of a GCB event such that action can be taken to quickly prevent or quickly quell a biological event
- Increased response speed and global response reach in both resource-rich and low-resource-settings to mitigate the impacts of an unfolding event

Project Approach

- Structured exploration of **extant and emerging technologies** with the potential to radically alter the trajectory of severe infectious disease events with catastrophic potential
- **Goals**:
  - ID areas of need for tech solutions to address pandemic and GCBRs;
  - ID technologies that have significant potential to reduce GCBRs; and
  - Provide context for those technologies
- **Uses:** results should be used to guide further detailed analyses

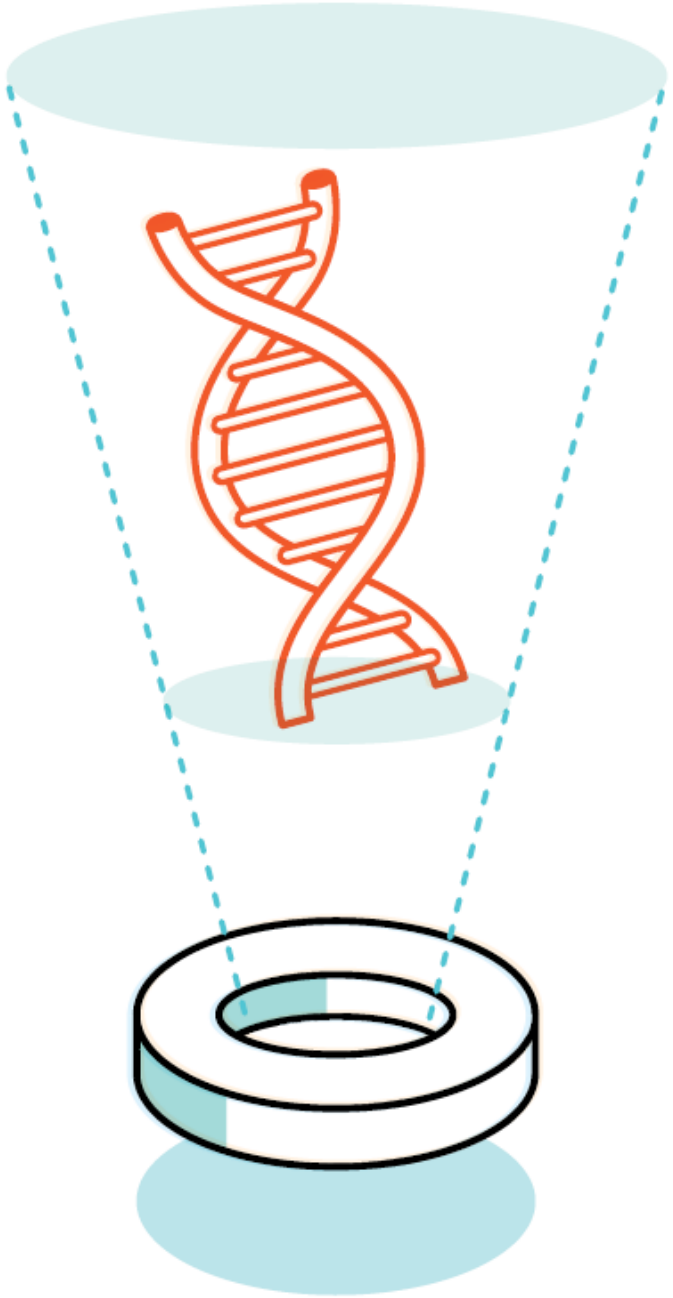
Technology Evaluation Process

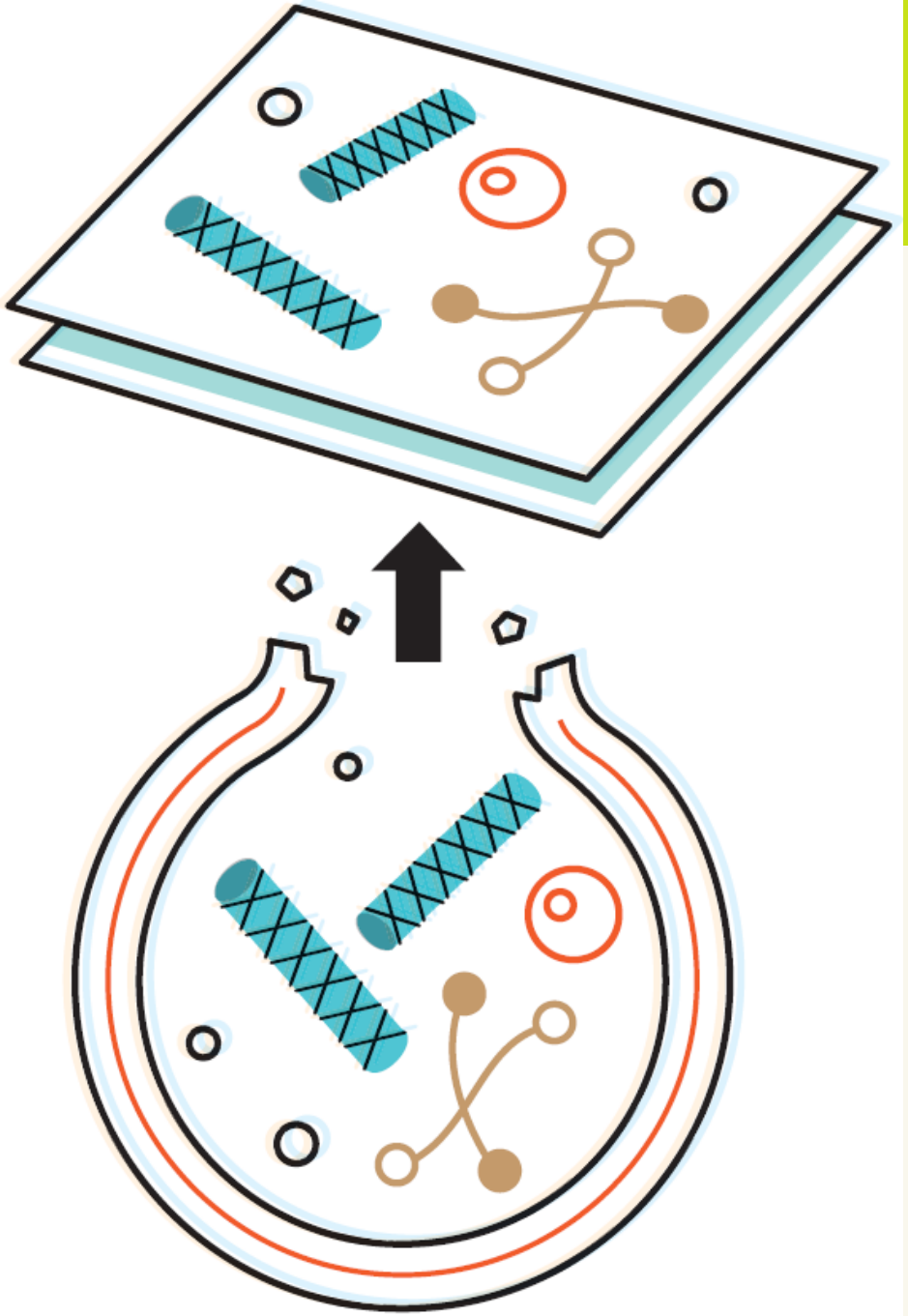
- Our Questions:
  - What is the technology?
  - What problem does it solve?
  - How do we do it now?
  - What does success look like?


HIGH IMPACT
Syn Bio MCM Manufacturing $$
3D Printing $$$
Ingestible Bacteria for Vaccination $
SAM Vaccines $
Self-Spreading Human Vaccine $$
Robotics and Telehealth $$$
Hand-Held Mass Spectrometry $$$
Microarray Patch $
Self-Spreading Animal Vaccine $$
Ventilators $$
Cell-Free Diagnostics $
Microfluidics $
Ubiquitous Sequencing $$$
Drones for Delivery $$$
EARLY DEVELOPMENT
READINESS, IMPACT, AND COST OF TECHNOLOGIES TO ADDRESS GCBRS
FIELD READY
Drones for Sampling $
Remote Sensing for Environmental and Plant Surveillance $
LOW IMPACT

Ubiquitous Genomic Sequencing and Sensing

- What is the technology?
  - Rapid, accurate, affordable, and fieldable nucleotide sequencing for detection of pathogens in human and environmental samples – nanopore sequencing
- What problem does it solve?
  - Sequencing can be used to detect novel or unexpected pathogens, whereas other molecular diagnostics like PCR only test for known pathogens
- How do we do it now?
  - Prior to nanopore, sequencing was centralized and laboratory-based
- What does success look like?
  - Ubiquitous sequencing will allow for the near real-time characterization of pathogen biology, including determinations of virulence, transmissibility, sensitivity or resistance to medicines or vaccines.



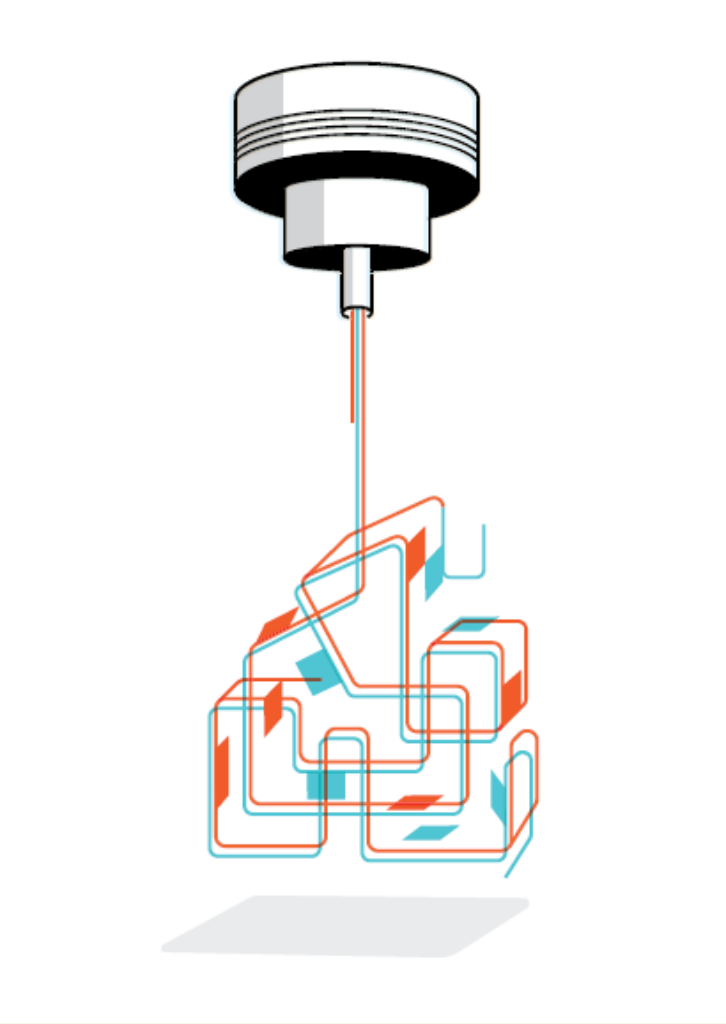


Cell-Free Diagnostics

- What is the technology?
  - Cell-free diagnostics take bioengineered cellular machinery from lysed cells, freeze dries these components, and uses them for diagnosis
- What problem does it solve?
  - It provides cheap, accurate, and portable diagnostics
- How do we do it now?
  - Diagnostics like polymerase chain reaction (PCR) require laboratories and expensive equipment
- What does success look like?
  - Cell-free diagnostics could be rapidly manufactured and distributed widely

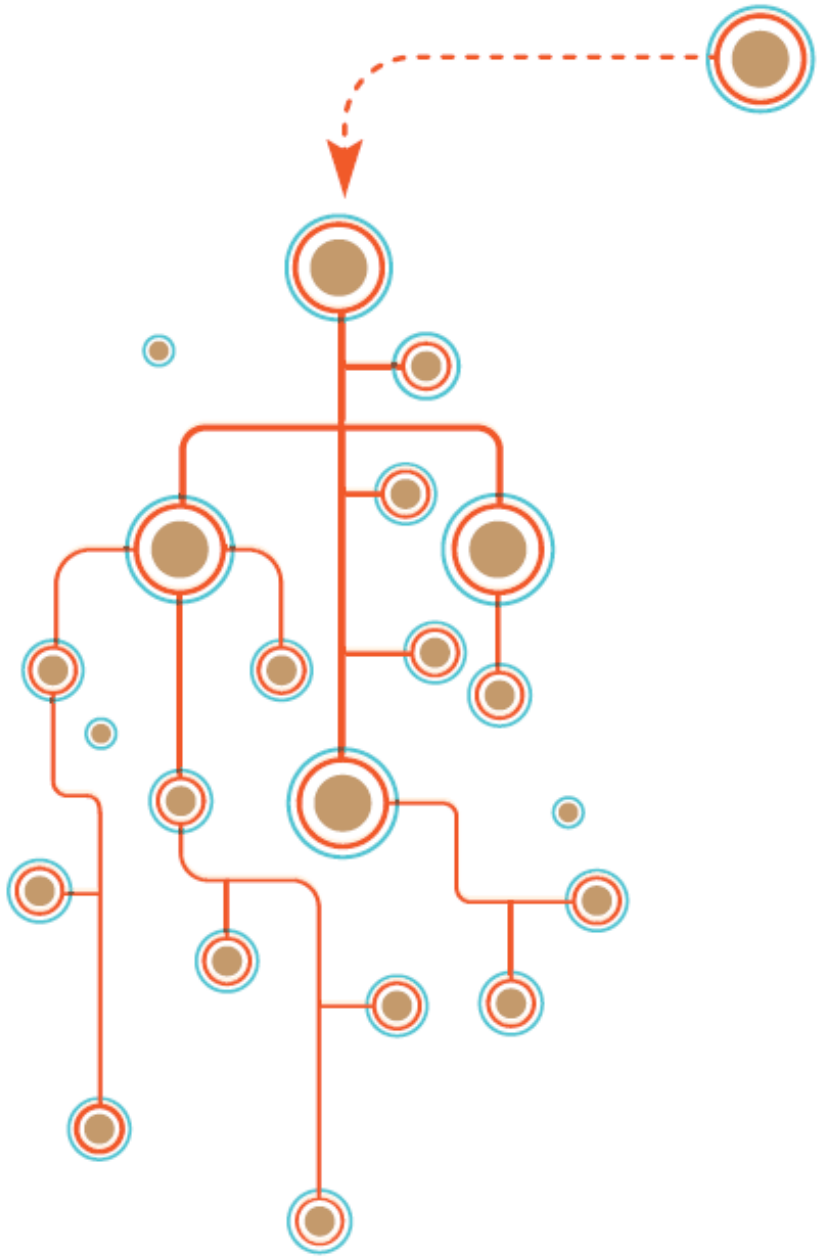
3D Printing of Chemicals and Biologics

- What is the technology?
  - 3D printing (additive manufacturing) of drugs and vaccines
- What problem does it solve?
  - Even when a drug or vaccine is developed in time to respond to a pandemic, getting access to them will be difficult in many parts of the world. 3D printers could be used in doctors' offices, pharmacies, and even at home
- How do we do it now?
  - Most MCM manufacturing occurs at centralized sites and on dedicated platforms
- What does success look like?
  - 3D printing could allow for greater and earlier access to medical countermeasures developed in response to or identified in a GCB event



Synthetic Vaccinology: Self-Amplifying mRNA Vaccines

- What is the technology?
  - SAM vaccines use the genome of a modified RNA virus to introduce an antigen of interest and replicate in the body
- What problem does it solve?
  - Safer and easier to deliver than other nucleic acid vaccines
  - Reduces dose needed, and induces a broader immune response than other vaccines
- How do we do it now?
  - Viral vectors hampered by immune response and have risk of reversion to wild type
  - Large amounts of antigen and sometimes multiple doses and difficulty manufacturing
- What does success look like?
  - Fast, dose-sparing technology could mean a vaccine that is available rapidly and can protect many more people



Conclusions

- Technologies – while not a panacea – will be a critical part of the response to severe pandemics and GCBR's.
- Horizon scanning is a useful exercise to identify new technologies and use cases
- Scalable technology solutions will be needed if we're going to protect the health of 8 billion + individuals.
- Fortunately, with a few exceptions, most of the technologies that we think could make a difference either already exist, or are linear projections of the state of the art.

Call to Action

- Innovative thinking and a certain amount of risk taking will be required if humanity faces a major pandemic
- Routine and ongoing technology horizon scanning is needed to identify risks and benefits
- Dedicated thought and resources are needed to integrate technologies into practice in preparation for the next pandemic
- The next step is to do further analysis on use cases and viability of the highlighted technologies

Thank You!

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