STRATEGIC INNOVATION AND COMMERCIALIZATION: SUPPORTING IP AND TECH TRANSFER TO ADVANCE U.S. RESEARCH COMPETITIVENESS

GOVERNMENT-UNIVERSITY-INDUSTRY RESEARCH ROUNDTABLE

FEBRUARY 7-8, 2023

SUPPLY CHAIN RISKS IN PHARMA

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PHARMACEUTICAL SUPPLY CHAINS

Small Molecules:

- **Generally made by Chemical Synthesis.**
- **Mostly Solid Oral Forms.**
- **Most Essential Medicines.**
- **Many consider chemistry (API) a commodity**
- **Made all around the world. Mostly China and India**

Large Molecules:

- **MABs and Biologics, including Vaccines.**
- **Mostly parenteral.**
- **Majority made in the West**
- **Lots of proprietary technology**

Pharmaceutical Supply Chain Agility Challenges

Highly regulated industry

- Process enhancements and location changes take many years from inception to global approval.
- Pressure to go from centralized production to distributed, fractured system. Scaleable?
- High barriers to innovation, particularly in SM: Hardly any SOD new excipients in a long time. Tendency to stay with proven, known approaches. Continuous SOD manufacturing proven and established, but very slow adoption.
- Data, Sensors and Models allow for real time quality awareness and even real time release, but regulations still seek “black box” approaches to validation, and use procedural rather than engineering controls. The use of models is limited and the use of a systems approach (like aerospace and automoyive) is generally unknown.

Scientific Culture:

- By and large the Manufacturing Process is based on empirical science. Improvements, tech transfer and scaleup are uncertain.
- Lack of quantitative, data and predictive model-based approach, even when the science is there.
- Sometimes follow fads, e.g., flow chemistry

Pharmaceutical Supply Chain Security Challenges

Small Molecules:

- **Supply chain is very long: petroleum products are transformed into thousands of organic molecule building blocks, which are then converted into starting materials, which are used to make the Active Pharmaceutical Ingredient, which is then formulated into a product, then packaged, then distributed.**
- **Most building blocks come from China, even when the API is made in India or other locations.**
- **There are NO manufacturers of Solid Oral Dose equipment in the United States. China now makes most types.**

Large Molecules:

- **The Industry uses many proprietary (and single sourced) materials, such as bioreactor feed formulas, single use bioreactor bags, tubing, chromatography resins. Switching to a different source requires empirical validation (e.g., leachables and extractables). There is no standardization of materials or physical configurations**
- **Many quality assays are lab based (cannot be done online) and can take days or weeks to provide results.**

Standardization:

- **There are no equipment standards regarding interchangeability. For example, units for continuous OSD from different vendors do not fit other vendor's lines. Software is proprietary, bespoke, and monolythic rather than modular.**
- **Physical and software standards to enable plug – and – play or hot swap of equipment modules is just emerging**