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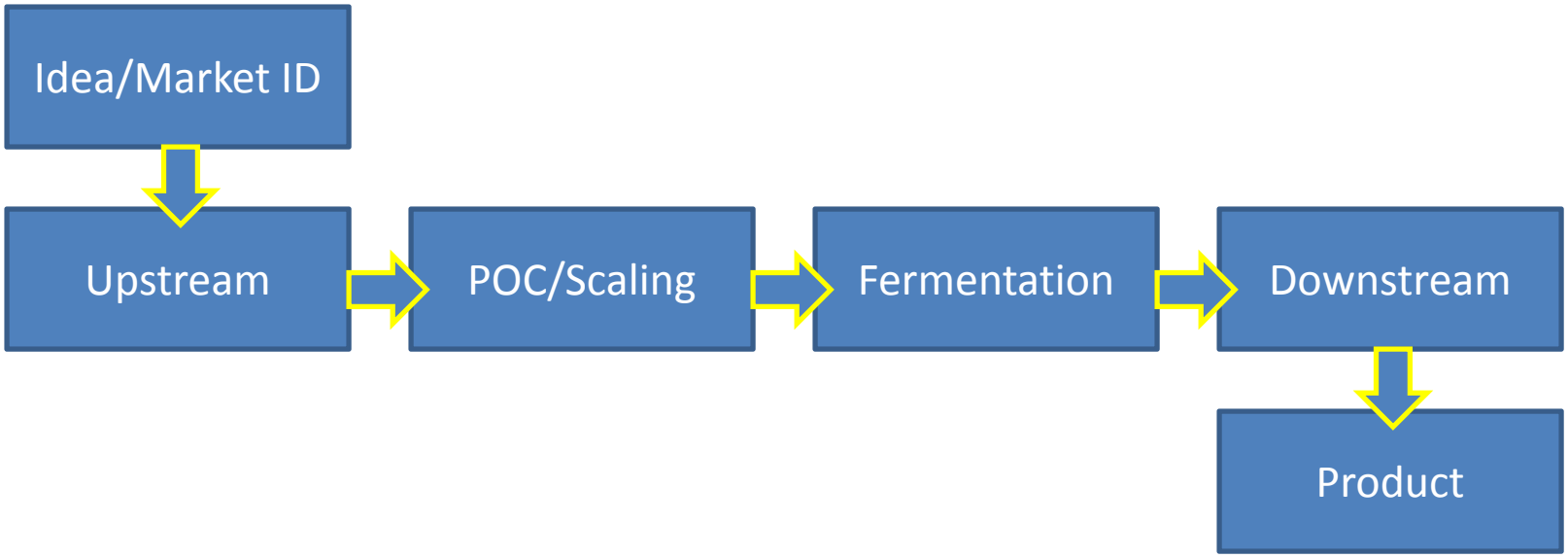
Industrial Fermentative Processes

- Broad Term Encompassing Many Industrial Processes;
  - Food
  - Liquid Fuels
  - Pharma
  - Active Biomolecules
  - Beer & Wine



- Key Driving Forces:
  - Profit (ROI)
  - Government Regulation/Subsidies

Stages of Industrial Process Detail

Upstream

- Identification of target/goal
- Identify appropriate organisms for the system
- Genetics
  - Identification of GOIs
  - Host choice
  - Engineering – Promoter choice, codon optimization, vector design, secretion signals, tags, markers, etc.
- Screening, assay development
- Development/adaptation
  - Re-engineer? Pathway associations, extra copies, "helper" proteins, intermediaries/transport, etc.

POC/Scaling

- Shake flasks, performance evaluation
- Proceed or return to upstream development?
- Bioreactors
  - Controlled parameters - %DO, pH, Temp, Agit., GFR, redox, cell mass, etc.
  - Scaling Evaluation
    - Profitable w/ regard to projected product value? **- Constant Concern –**
    - Infrastructure does not scale linearly

Stages of Industrial Fermentative Processes

Fermentation

- Plant design/engineering implementation
    - Handling
    - Operational issues
    - Regulatory
- Product dependent but typically very large scales
- Re-optimization

Downstream

- Bulk Separation
    - Filtration, TFF
    - Centrifugation
- Purification/Concentration
    - MWCO filtration
    - IEX, SEC, Affinity
    - Precipitation
    - Lyophilization

- Recovery
- Quantification

Potential NASA Applications

1. Cycling of resources through multiple types of bioreactors or culture chambers where the output from one is utilized as feedstock or nutrient supplement in successive reactors.
   - MELiSSA
   - Requires elemental analysis of effluents to determine proper control valving, metering and mass balancing, ideally near real-time
   - In a base situation, this would probably require an array of support reactors at smaller scales. These could be used as seed reactors for individual chambers in the system in the event of a collapse of a culture or contamination issues
     - Needs to be re-seeded very quickly to prevent a negative cascade through the system
     - A cryo-bank of all the cultures used in the system as backups
2. Another use for this multiple reactor plan would be an on-demand production of various products, as mentioned earlier. These could include lubricants, medicine, nutrition supplements for personnel, etc.
   - Versatility and redundancy
   - Large cryo-bank of many potential products required.