Advancing Gas Fermentation Technologies: A multi-disciplinary challenge

Summary of workshop findings

Gas fermentation technologies have the potential to revolutionise sustainable bioproduction by enabling carbon capture and utilisation (CCU), but key research issues and implementation challenges need to be addressed. In the field of microbiology, these include: improved understanding of systems biology; exploration of a wider range of species (i.e. non-model organisms) and of mixed cultures; and development of associated tools for genetic characterisation and manipulation. Better insights on how microbial metabolism and spatial and community structures are influenced by the engineering envelope will open new opportunities for process development and optimisation.

Enhanced understanding of gas-liquid transfer processes and the hydrodynamic behaviour of complex multi-phase fermentation liquors is fundamental to effective system design. New multi-scale modelling approaches that integrate biokinetics, thermo- and hydrodynamics will be needed to support these advances. Scale-up is a particularly critical area, due to the significance of scale effects for mixing and mass transfer, and thus for microbial performance. Easier access to scale-up facilities is essential to progress the development of cost-effective bioreactor designs.

Feedstock, process and product selection are vital links in the chain to widespread technology implementation. Open discussions supported by techno-economic and whole-life sustainability assessments are needed to determine which bioprocesses and products to focus on. Consideration must be given to the impact of gas quality, purification requirements, and intermittent patterns of renewable energy production. Product recovery methods and integration with upstream, downstream and sidestream processes all have key roles to play. Modelling, including AI and machine learning, can aid in both design and operational decisions.

Two-stage processes, where gases are converted by chemical catalysis into soluble feedstocks (e.g. formate, methanol), also merit attention as they eliminate some difficulties associated with gaseous substrates. Tackling the R&D issues identified above will additionally benefit such processes, as well as a broader range of industrial biotechnologies.

Implementing gas fermentation technologies requires multi-disciplinary perspectives. Better understanding and communication across specialisms is vital to create a new generation capable of rapidly advancing this field. Talent acquisition and retention can be facilitated through interdisciplinary work and training opportunities. Cross-remit funding and support for industrial engagement are crucial for effective technology progression.

Addressing these key R&D issues will unlock the full potential of gas fermentation technologies and allow them to contribute to meeting national and international net-zero and sustainability targets.

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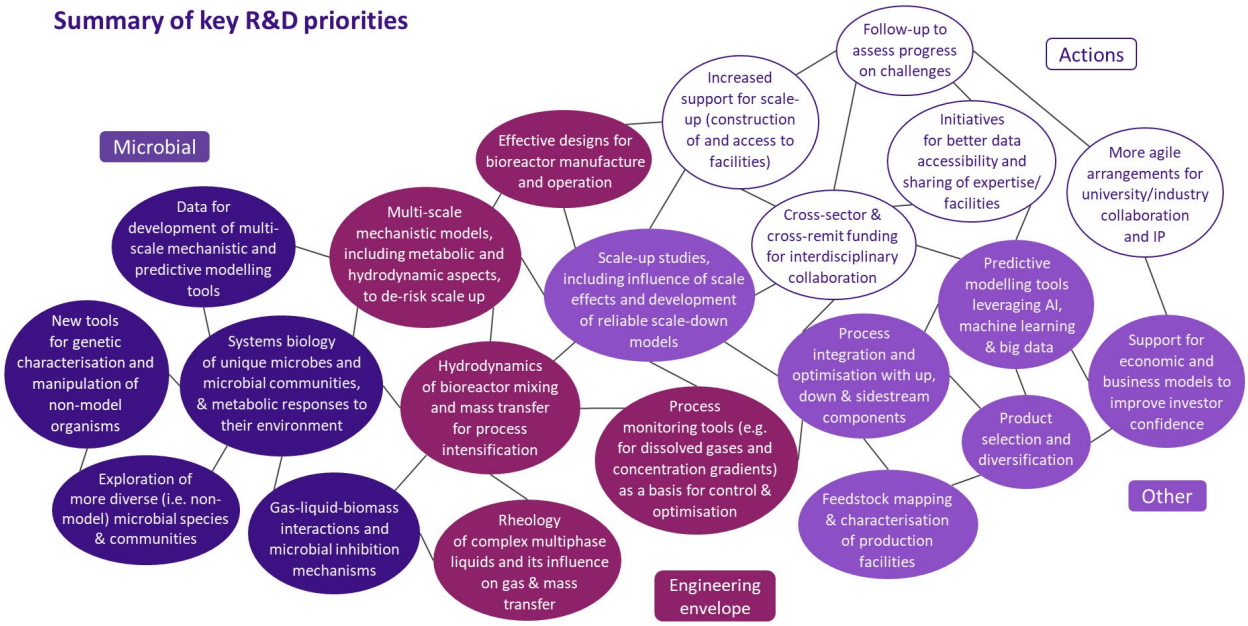

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