BIOCHEMICAL ENGINEERING

UCL

Rapid Fermentation Process Design

14 October - 16 October 2024

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MBI Modular training for the bioprocess industries

MBI Training Programme

Rapid Fermentation Process Design

14 - 16 October 2024

Welcome to the UCL MBI Rapid Fermentation Process Design module.

This module focuses on the design and specification of bioreactors and the application of microscale techniques for rapid fermentation process development and scale-up. It is aimed at fermentation scientists in biotechnology SMEs who are involved in process transfer to manufacturers and also those in established fermentation development groups wishing to be kept up to date with the latest research in this area.

Particular emphasis is placed on the engineering principles of aeration and agitation systems and how good design can improve performance in stirred tank bioreactors. This knowledge is then taken further to develop scale-up strategies and consider how miniaturised bioreactors and other microscale devices can be used to accelerate fermentation process development and scale-up.

The underlying engineering principles are introduced through a series of lectures which are supported by case studies

Module Coverage:

- Engineering principles of fermentation
- Power consumption and mixing
- Oxygen mass transfer
- Strategies for scale-up and scale-down
- Miniaturised bioreactors and their role in fermentation process development
- Case Studies: Design and scale-up of a bioreactor

Related Modules:

- Principles of Fermentation Processes
- Design of Experiments for Bioprocess Optimisation
- Mammalian Cell Culture Hands-On (Resilience)
- Microbial Fermentation Hands-On (Resilience)

Qualifications:

An assessment is offered for those who wish to build up credits for qualifications and demonstrate their new skills. It is based on the content of the two fermentation modules (Principles of Fermentation Processes and Rapid Fermentation Process Design) and takes the form of a written examination on a date to be confirmed. Successful completion of the assessment will lead to the award of 30 credits that can be counted towards a UCL MSc Bioprocessing.

Module Leader

- Frank Baganz, UCL

Expert Speakers

- Gary Lye, UCL
- Nicolas Szita, UCL
- Tibor Anderlei, Kuhner Shaker
- Alison Rees-Manley, Sartorius
- Edward Milner, Fujifilm Diosynth Biotechnologies

MBI Training Agenda

Monday, 14 October 2024

10.45am
Registration

11.00am
Introduction to MBI Training Programme and Module
Frank Baganz, UCL and Olivia Festy, UCL

This session will cover the objectives of:
(i) Lectures
(ii) Case Studies

11.20am
Review of Fermentation Mass Balancing and Bioreactor Design
Frank Baganz,UCL

12.30pm
Lunch

1.30pm
Power Consumption in Gassed and Ungassed Bioreactors
Gary Lye, UCL

In order to establish the optimum operating conditions in a bioreactor it is essential to understand the underlying principles of bioreactor design. One essential feature is the power consumption. This lecture describes the fundamentals of power development in both gassed and ungassed systems. Correlations for the prediction of power requirements are also discussed.

2.30pm
Scale-up: Effects of Scale and Scale-Up Strategies
Frank Baganz, UCL

Scale-up has significant consequences on homogeneity. This lecture will look at the objectives of scale-up and the effects of scale on fermentation with focus on mixing and mass transfer. Different methods for scale up of fermentation processes will be introduced and examples of the techniques and their relative success will be presented.

3.30pm
Oxygen Mass Transfer in Bioreactors
Gary Lye, UCL

The provision of sufficient oxygen to micro-organisms within a bioreactor is frequently the limiting factor with respect to biomass growth and productivity. This lecture outlines the fundamental principles of oxygen mass transfer and describes the basic equations for bioreactor design and scale-up. The influence of bubble size and gas hold-up are also discussed.

4.30pm
Break

4.45pm
Case Study: Design of a Bioreactor
Frank Baganz, UCL and Gary Lye, UCL

Stage 1: Delegates will evaluate the growth characterisation for the organism as a basis for large scale design.

Stage 2: Here delegates will consider the mechanical design of the bioreactor for the chosen application.

6.15pm
Close

MBI Training Agenda

Tuesday, 15 October 2024

9.00am
Case Study: Design of a Bioreactor Cont.
Frank Baganz, UCL and Gary Lye, UCL

Stage 3: In this part of the study the oxygen requirement of the organism will be evaluated. Calculation of the operational oxygen consumption rate will conclude this section.

10.30am
High throughput process development
Gary Lye, UCL, Frank Baganz, UCL

This tutorial will introduce the concept and methods of HTP process development and it will cover:

- Microwell plates and miniaturised bioreactors
- The engineering bases for predictive scale up using microscale data
- Tour of Automation lab
- Demonstration of Tecan robot – microwell processing techniques

12.00pm
Scale-Up from Shake Flasks to Stirred Bioreactors
Tibor Anderlei, Kuhner Shaker

Based on a problem scenario we will discuss how to achieve reproducible data, optimise screening conditions to find the real production strain and make a more secure scale up to stirred bioreactors.

1.00pm
Lunch

2.00pm
Bioreactor Mixing
Gary Lye, UCL

Since micro-organisms or other cells require the provision of nutrients and most importantly oxygen, mixing is vital to ensure that all cells are exposed to a homogenous environment. This lecture addresses how to characterise the mixing of a bioreactor and how different operational parameters affect the mixing.

2.50pm
Bioreactor Scale-Down: Strategies and Devices
Frank Baganz, UCL

In scale down the principle is to establish the conditions the micro-organism meets at the production scale. This lecture demonstrates the ways in which these conditions might be simulated in laboratory experiments. Furthermore the application of miniaturised bioreactors and microscale processing techniques to speed up fermentation process development will be introduced.

3.40pm
Break

4.00pm
Microfluidic Bioreactors
Nicolas Szita, UCL

This presentation will cover:
• Microfluidics Fundamentals
• Microfluidic Bioreactor Design and Applications

5.00pm
Case Study: Design of a Bioreactor Cont.
Frank Baganz, UCL and Gary Lye, UCL

Stage 4: In this part of the study delegates will evaluate the oxygen transfer capability of the vessel to be utilised and calculate the minimum dissolved oxygen tension attained to establish if the proposed fermentation is feasible in the allocated vessel.

Stage 5: Having undertaken the design of a bioreactor delegates will consider how the design can be achieved more quickly and the process designed more robustly using the emerging microscale processing methods.

6.30pm
Close

7.00pm
Dinner

MBI TRAINING AGENDA

Wednesday, 16 October 2024

9.30am
Case Study: Predictive Scale-Up Based on Microscale Experiments
Frank Baganz, UCL and Gary Lye, UCL

In this session the delegates will carry out a scale-up from a miniature stirred tank bioreactor to a pilot scale stirred vessel using 1) constant kLa or 2) constant P/V.

11.00am
Break

11.15am
Ambr® 15 and Ambr® 250 bioreactor systems for automated high throughput screening and process development studies across mammalian cell culture and microbial applications
Alison Rees-Manley, Sartorius

Key challenges in biopharmaceutical culture processes include how to explore sufficient cell lines or microbial strains at the screening stage with confidence in scalable results, and how to increase capacity and reduce timelines for process optimization studies with bioreactor bottlenecks. Good decisions at the screening stage require bioreactor relevant conditions to be applied as early as possible, while rapid, powerful optimization studies can be delivered through a design of experiments (DOE). The restrictive capacity limitations and FTE requirements of traditional bioreactor systems in these areas have now been overcome through industry-wide adoption of these highly productive, cost-effective, automated single use bioreactor platforms. An introduction to system design and a range of industry data highlights the capability of these experimental platforms to transform productivity and timelines in a wide range of culture processes.

12.30pm
Lunch

1.30pm
Rapid Fermentation Process Development - Industrial Perspective
Edward Milner, Fujifilm Diosynth Biotechnologies

This lecture will provide an overview of fermentation process development in the biomanufacturing industry. It will cover issues of scale-up, technology transfer and process validation.

2.30pm
Panel Discussion | Miniaturised Bioreactor Systems

This panel discussion will focus on the use of microfluidic bioreactors, shaken microwell-based systems and miniature stirred tank bioreactors as screening tools and scale-down models to accelerate bioprocess development. We will discuss the potential and limitations of different miniaturised bioreactor systems that have been covered in this module.

Panel Members:
- Frank Baganz, UCL
- Nicolas Szita, UCL
- Edward Milner, Fujifilm Diosynth Technologies
- Alison Rees-Manley, Sartorius

3.30pm
Close

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