APPROVED

PHAR S8008: Biopharmaceutical Processing (Downstream)

Module Details

Module Code:	PHAR S8008
Full Title:	Biopharmaceutical Processing (Downstream) APPROVED
Valid From::	Semester 1 - 2013/14 (September 2013)
Language of Instruction:	
Duration:	1 Semester
Credits::	7.5
Module Owner::	annamarie rogers
Departments:	Unknown
Module Description:	The aim of this module is to provide students with an in-depth knowledge of the downstream processing of biopharmaceuticals (both theoretical and practical topics pertaining to the isolation/purification and manufacture of biopharmaceuticals).

Module Learning Outcome	
On successful completion of this module the learner will be able to:	
#	**Module Learning Outcome Description**
MLO1	Distinguish processes for initial biopharmaceutical recovery on the basis of whether the product is intracellular or extracellular.
MLO2	Compare and contrast large scale chromatography techniques for the recovery, purification and concentration of biopharmaceuticals.
MLO3	Compare and contrast filtration systems for recovery, concentration and risk reduction of biopharmaceuticals.
MLO4	Evaluate both theoretical and practical aspects of finished product characterisation and have a working knowledge of all associated analytical techniques.
MLO5	Discuss and convey the validation requirements of regulatory authorities relating to biopharmaceutical processing.

Pre-requisite learning
Module Recommendations *This is prior learning (or a practical skill) that is strongly recommended before enrolment in this module. You may enrol in this module if you have not acquired the recommended learning but you will have considerable difficulty in passing (i.e. achieving the learning outcomes of) the module. While the prior learning is expressed as named DkIT module(s) it also allows for learning (in another module or modules) which is equivalent to the learning specified in the named module(s).*
No recommendations listed

Module Indicative Content
Initial Biopharmaceutical Recovery Extracellular biopharmaceutical product recovery - preparative centrifugation (Disk-Stack, Tubular Bowl, Basket centrifuge) or MicroFiltration (Normal Filtration versus Tangenital Flow Filtration; Operation Mode -Batch or Continuous). Intracellular Biopharmaceutical Recovery- Cell disruption (Physicomechanical - Homogenisation, Bead Mill, Rotor-Stator Mill or Chemical - lysozyme, detergents) followed by centrifugation or filtration.
Chromatographic Purification Selection of a purification regime. Range of available chromatographic systems (Ion-Exchange, Gel Filtration, Affinity Chromatography) at laboratory and industrial levels. Design, operation and maintenance of process-scale chromatography systems. Extraction and precipitation of biopharmaceutical product.
Filtration and membrane processes Normal versus Tangenital Flow Filtration. Micro, Ultra and Nanofiltration techniques and applications. Membrane module types (Stirred Cell, Flat Sheet Tangential Flow (TF) Module, Spiral Wound, Tubular and Hollow Fibre Membrane Modules. Use of ultrafiltration and nanofiltration for minimisation of destructive influences during downstream processing - removal of virus particles. Other membrane processes -Dialysis, Reverse Osmosis.
QC functions in downstream processing In-process and final product testing. Detection and determination of yield, purity and biological activity. Detection and quantification of excipients and all other expected components. Physical characterisation of final product and detection of product impurities. Approaches to contaminant removal.
Experimental Work: The following list is designed to serve as an illustration of possible practical exercises which would illustrate key concepts and techniques. Many of the practical situations are applicable to a range of biopharmaceutical products and so have a broad spectrum of merit. • Fractionation and homogenisation of rabbit liver tissue for isolation of macromolecules using differential centrifugation and sedimentation. Investigation of isolated marcomolecular (mitochondria) activity using specific enzyme assays (lactate dehydrogenase assay) and protein assays. • Separation of proteins from sheep blood using gel filtration chromatography. • Extraction and purification via ion exchange chromatography, activity assay and agarose electrophoresis of a selected enzyme e.g. restriction enzyme ECO R1. • Extraction of Concanavalin A, a carbohydrate-binding lectin protein, from jack bean meal using enzymatic disruption, purification via affinity chromatography. Biological activity determination of the isolated protein using an immunoblot enzyme assay. Assessment of protein purity using SDS-PAGE electrophoresis.

Module Assessment

Assessment Breakdown	%
Course Work	50.00%
Final Examination	50.00%

Module Special Regulation

Assessments

Full Time On Campus

Course Work

Assessment Type	Practical/Skills Evaluation	**% of Total Mark**	30
Marks Out Of	0	**Pass Mark**	0
Timing	Every Week	**Learning Outcome**	1,2,3,4
Duration in minutes	0		

Assessment Description
Students will be required to submit regular typed laboratory reports. Marks for reports will be based on a student's ability to record preliminary data, calculate derivatives from these, display data, comment on their meaning in the context of the actual experiment and associated theory, and discuss limitations to the experiment and results obtained. Reports will be maintained according to document control under GMP.

Assessment Type	Written Report	**% of Total Mark**	20
Marks Out Of	0	**Pass Mark**	0
Timing	Week 26	**Learning Outcome**	2,3,4,5
Duration in minutes	0		

Assessment Description
Students will produce a report and numerically evaluate set tasks following a 1 day specialised workshop in the National Institute for Bioprocessing Research and Training (NIBRT) in UCD. During the workshop, students will perform and evaluate 2 different areas of large-scale downstream processing eg large scale chromatography, ultrafiltration. Students will be assessed on their understanding of the prescribed techniques including a comparison of of processes from laboratory to industrial scale.

No Project

No Practical

Final Examination

Assessment Type	Formal Exam	**% of Total Mark**	50
Marks Out Of	0	**Pass Mark**	0
Timing	End-of-Semester	**Learning Outcome**	1,2,3,4,5
Duration in minutes	0		

Assessment Description
End-of-Semester Final Examination

Reassessment Requirement

A repeat examination
Reassessment of this module will consist of a repeat examination. It is possible that there will also be a requirement to be reassessed in a coursework element.

Module Workload

Workload: Full Time On Campus					
Workload Type	*Contact Type*	*Workload Description*	*Frequency*	*Average Weekly Learner Workload*	*Hours*
Lecture	Contact	No Description	Every Week	2.00	2
Practical	Contact	No Description	Every Week	3.00	3
Tutorial	Contact	No Description	Every Week	1.00	1
Directed Reading	Non Contact	No Description	Every Week	3.00	3
Independent Study	Non Contact	No Description	Every Week	3.00	3
				Total Weekly Learner Workload	12.00
				Total Weekly Contact Hours	6.00

This module has no Part Time On Campus workload.

Module Resources

Recommended Book Resources

Walls and Loughran. (2011), Protein Chromatography "Methods and Protocols", 2011, Humana Press, [ISBN: 9781607619123].

Michael Gromiha. (2010), Protein Bioinformatics (from sequence to function), Academic Press, [ISBN: 9788131222973].

Walsh, G.. (2007), Pharmaceutical biotechnology: Concepts and applications, J. Wiley and Sons, [ISBN: 9780470012444].

Ghosh. (2006), Principles of Bioseparations Engineering, World Scientific Publishing, [ISBN: 9812568921].

Various. (2004), ISPE baseline guide for biotechnology, ISPE.

Petsko, G.A. and Ringe, D.. (2004), Protein structure and function, Blackwell Press.

Walsh, G.. (2003), Biopharmaceuticals: Biochemistry and biotechnology., J. Wiley and Sons.

Nash, R.A. and Wachter, A.H.. (2003), Pharmaceutical process validation, 2nd. Marcel Dekker.

Roe, S.. (2001), Protein purification techniques : A practical approach, Oxford University Press.

Reinhard Renneberg. Biotechnology for Beginners, Academic Press, [ISBN: 9783827418470].

Clark and Pazdernik. Biotechnology, Academic Cell, [ISBN: 9780123850638].

Recommended Article/Paper Resources

Bangaru Balasundaram, Sue Harrison and Daniel G. Bracewell. (2009), Advances in product release strategies, Trends in Biotechnology, 27, p.477-485.

Hage et al.. (2009), Characterisation of drug protein interactions - Affinity Chromatography, J Sep Sci, 31, p.835 - 853.

Wen-Chien Lee and Kelvin H. Lee. (2004), Analytical Biochemistry, Applications of affinity chromatography in proteomics, 324, p.1-10.

Other Resources

Website, British pharmacopoeia,
http://www.pharmacopoeia.co.uk

Website, European Directorate or the Quality of Medicines and Healthcare,,
http://www.edqm.eu

Website, European Medicines Agency,
http://www.emea.ie

Website, FDA/Center for Drug Evaluation and Research,
http://www.fda.gov/CDER

Website, Irish Medical Board,
http://www.imb.ie

Website, National Centre for Biotechnology Information,
http://www.ncbi.nlm.nih.gov

Website, United States pharmacopoeia,,
http://www.usp.org

Website, U.S. Food and Drug Administration,
http://www.fda.gov

Link, Library Catalogue,
http://tinyurl.com/po8cced

Link, Library Catalogue,
http://tinyurl.com/kbph5pr