



Technical Workshops Series – 2016

## Three-Days Workshop on Membrane Separations – Theory and Techniques in Bioprocessing

- Organized by Biotechnology Industry Research and Assistance Council (BIRAC) and Venture Center -

<b>Learn</b>	The workshop will cover the fundamental principles and techniques used in experimental and process membrane separations in the area of bioprocess and product recovery.					
<b>Organized by</b>	<ul style="list-style-type: none"><li>• Biotechnology Industry Research and Assistance Council (BIRAC)</li><li>• Venture Center</li></ul>					
<b>For whom</b>	<ul style="list-style-type: none"><li>• Technical Scientists and Engineers from biotech, biopharma and food processing industries</li><li>• Scientists, researchers and engineers interested in membrane separation techniques</li></ul>					
<b>When</b>	<b>Thursday – Saturday   25 – 27 February 2016   Time: 0900-1730 hrs</b>					
<b>Where</b>	Board room, Venture Center, 100 NCL Innovation Park, Dr. Homi Bhabha Road, Pashan, Pune-411008					
<b>W/S Director</b>	Dr. Sanjay Nene (Founder Director- Innovation Biologicals; Ex-Head, Biochemical Engineering Unit, NCL)					
<b>Knowledge Partners</b>	<ul style="list-style-type: none"><li>• Polymer Science &amp; Engineering Division, CSIR-NCL</li><li>• Dept of Food Engineering, CSIR-CFTRI</li><li>• Innovation Biologicals</li></ul>					
<b>W/S Technical Coordinators</b>	<b>Dr Shilpi Gupta</b> Manager- Technical, BIRAC Phone: +91-11-2438-9600 Email: sgupta.birac@nic.in	<b>Dr Mugdha Lele</b> Manager – Social Innovations, Venture Center Phone: +91-20-2586-5877 Email: siip@venturecenter.co.in				
<b>Admin contact</b>	Ms. Lipika Biswas   Phone: +91-20-25865877   Email: <a href="mailto:eventsdesk@venturecenter.co.in">eventsdesk@venturecenter.co.in</a>					
<b>Cost</b>	<table border="1"><tr><td>BIRAC grantees/ Venture Center Incubatees</td><td>Rs. 5,000/-</td></tr><tr><td>Others – Industry, R&amp;D institutions etc</td><td>Rs. 10,000/-</td></tr></table> <p>Limited seats: <b>18</b> Register online at: <a href="http://goo.gl/forms/QUTzK3NxHw">http://goo.gl/forms/QUTzK3NxHw</a></p> <p>Note:-</p> <ul style="list-style-type: none"><li>• Fees paid is not refundable and non transferable under any circumstances.</li><li>• Organizers reserve the right to accept or refuse or delay registrations so to optimize the composition of the group and hence maximize learning for all participants.</li><li>• A few fellowships for partial fee waiver are available for deserving candidates who cannot afford the fees. Contact above mentioned contact person with a formal email request.</li></ul>		BIRAC grantees/ Venture Center Incubatees	Rs. 5,000/-	Others – Industry, R&D institutions etc	Rs. 10,000/-
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## Introduction

Membrane separations have become a crucial unit operation in the bioprocess industry. All Biotech, Biopharma and Food Processing industries use membrane separations in their downstream recovery of valuable products. There is a need for translation of basic knowledge on membrane separation, at a highly technical level, which is currently being done by companies supplying membranes. Often there is a bias in such technical seminars conducted by rival companies who are only interested in promoting their own products.

The technical teams, who will conduct this proposed workshop are well seasoned users of membranes who have done technical consultancies to industry and have advised industrial end-users in the selection of large membrane assemblies for a particular end use.

The object of this workshop is to introduce industry scientists and technology on basic theory and industrial practice for many of the membrane unit operations currently practiced in industry

The course is directed primarily to middle management technical scientist / engineers from industry that routinely use membrane processes in their downstream activities, so that they can improve on the productivity of their process and reduce manufacturing costs by selection and proper use of appropriate products.

## Workshop Outline

The workshop will cover the fundamental principles and techniques used in experimental and process membrane separations in the area of bioprocess and product recovery. The indicative areas are:

- Basic principles underlying membrane separation processes
  - a) Membrane structure, membrane materials, porous and non-porous membranes
  - b) Properties of polymers used in membrane manufacture
  - c) Ceramic membranes and their properties
  - d) Characterization of membranes: Techniques used in the laboratory and industry for membrane characterization: Clean water flux, Bubble point, forward flow test, mercury intrusion test, passage/ rejection of standard compounds, Tracer retention techniques, microbiological tracers
- Theory of Microfiltration, Ultrafiltration, Nanofiltration and Reverse Osmosis. Gas filtration/separation and pervaporation
  - a) Basic theory and equations used to predict performance of MF, UF, NF and RO
  - b) Dense membranes used in Gas filtration and pervaporation. Theory of membrane preparation with respect to membrane end use, illustrated by relevant applications
- Microfiltration Ultrafiltration, Nanofiltration, Gas filtration and pervaporation in Bioprocessing
  - a) Applications of Microfiltration membranes in Bioprocess (cell harvesting, clarification, sterile filtration of liquids and gas, liquid-liquid contactors, perfusion)
  - b) Application of Ultrafiltration in concentration of microbial metabolites, and diafiltration (proteins, biopolymers, enzymes, blood products, colours and pigments, dairy products, sweeteners)



- c) Applications of Nanofiltration and Reverse Osmosis in concentration of peptides, API's, antibiotics,
- d) Applications of membranes for gas filtration and pervaporation (sterilization of air, oxygen enrichment, recovery of absolute ethanol from rectified spirit)
  
- Application of Membranes in Food Processing and Beverages
  - a) Clarification and concentration of extracts, hydrolysates, fruit juice and sterile filtration (MF, UF, NF/RO)
  - b) Membrane Distillation, Osmotic Membrane Distillation and Forward Osmosis for treatment of fruit juices, recovery of aroma and other volatile products.
  - c) Integrated membrane processes for processing of food products
- Visit to an Industrial Membrane manufacturing facility

#### Workshop includes

- Workshop includes tea and lunch at Venture Center Innovation Cafeteria
- Course handout with slides. Other resources available via restricted website
- Access to restricted website with online compilation of resources for 1 month
- Lab demo sessions
- One-on-one interactions with the experts
- Certificate of participation issued by Venture Center
- Membership in mailing list to other workshops by Venture Center

**\*Please note, the participants will have to arrange for their own travel/local transport and accommodation.**

- For accommodation (standard and budgeted hotels) please visit: <http://www.venturecenter.co.in/puneguide/standard.php>
- For accommodation (deluxe and luxury hotels) please visit: <http://www.venturecenter.co.in/puneguide/deluxe.php>
- For local transport details visit: <http://www.venturecenter.co.in/puneguide/taxi.php>







## Workshop Outline


Time (hrs)	Topic and Contents	Venue	Faculty
<b>DAY 1</b>			
0900-0930	Registration	Exhibition area	
0930-1000	Welcome to Venture Center Introduction to BIRAC Introduction to the workshop	Board room	Mugdha Lele Shilpi Gupta Sanjay Nene
1000-1145	Membrane structure, membrane materials, porous and non-porous membranes Properties of polymers used in membrane manufacture	Board room	Ulhas Kharul
1145-1200	Tea/coffee and biscuits	Exhibition area	
1200-1330	Ceramic membranes: Structure, preparation and their properties. Ceramic modules (hollow fiber and monoliths)	Board room	Sushumna Shukla, Sanjay Nene
1330-1400	Lunch	Exhibition area	
1400-1530	<b>Lab demo session</b> <b>Group 1:</b> Preparation of flat sheet membrane and their clean water flux, passage/ rejection of standard compounds, microbiological tracers Preparation of hollow fiber membranes, their potting	NCL	Ulhas Kharul
1400-1530	<b>Lab demo session</b> <b>Group 2:</b> Performance of ceramic HF and monolith modules for MF and UF applications in Biotechnology	Innovation Biologicals Lab	Sushumna Shukla, Sanjay Nene
1530-1600	Tea/coffee and biscuits	Exhibition area	
1600-1730	<b>Lab demo session</b> <b>Group 1:</b> Performance of ceramic HF and monolith modules for MF and UF applications in Biotechnology	Innovation Biologicals Lab	Sushumna Shukla, Sanjay Nene
1600-1730	<b>Lab demo session</b> <b>Group 2:</b> Preparation of flat sheet membrane and their clean water flux, passage/ rejection of standard compounds, microbiological tracers Preparation of hollow fiber membranes, their potting	NCL	Ulhas Kharul
<b>DAY 2</b>			
0900-1100	Theory of Microfiltration, Ultrafiltration, Nanofiltration and Reverse Osmosis	Board room	Sanjay Nene
1100-1115	Tea/coffee and biscuits	Exhibition area	
1115-1300	Application of Membranes in Food Processing and Beverages Clarification and concentration of extracts, hydrolysates, fruit juice and sterile filtration (MF, UF, NF/RO) Membrane Distillation, Osmotic Membrane Distillation and Forward Osmosis for treatment of fruit juices, recovery of aroma and other volatile products. Integrated membrane processes for processing of food products	Board Room	KSMS Raghavarao
1300-1400	Lunch	Exhibition area	
1400-1600	<b>Lab demo session</b> <b>Group 1:</b> Membrane Distillation, Osmotic Membrane Distillation and Forward Osmosis for treatment of fruit juices, recovery of aroma and other volatile products. Membrane distillation for continuous removal of volatile fermentation product with recycle. Hybrid process for low temperature concentration of liquid foods and natural colours	Lab L6, 400 NIP	KSMS Raghavarao
1400-1600	<b>Lab demo session</b> <b>Group 2:</b> MF of fermentation broth, UF for concentration of enzyme, NF for concentration of API and removal of solvents. Detailed protocol formulation and analysis of data	Innovation Biologicals Lab	Sanjay Nene
1600-1630	Tea/coffee and biscuits	Exhibition area	
1630-1830	<b>Lab demo session</b> <b>Group 1:</b> MF of fermentation broth, UF for concentration of enzyme, NF for concentration of API and removal of solvents. Detailed protocol formulation and analysis of data	Innovation Biologicals Lab	Sanjay Nene
1630-1830	<b>Lab demo session</b> <b>Group 2:</b> Membrane Distillation, Osmotic Membrane Distillation and Forward Osmosis for treatment of fruit juices, recovery of aroma and other volatile products. Membrane distillation for continuous removal of volatile fermentation product with recycle. Hybrid process for low temperature concentration of liquid foods and natural colours	Lab L6, 400 NIP	KSMS Raghavarao










DAY 3			
0900-1030	Case studies and calculations for MF and UF and fruit juice concentration	Board room	Sanjay Nene, KSMS Raghavarao
1030-1045	Tea/coffee and biscuits	Exhibition area	
1045-1300	Visit to Membrane manufacturing facility (UniqFlux)	Industry visit	Sanjay Nene
1300-1400	Lunch	Exhibition area	
1400-1600	Analysis of Experimental Data.( Presentation by both group of participants) Question/answer session and Feed Back from participants	Board room	Sanjay Nene, Ulhas Kharul, Sushumna Shukla, KSMS Raghavarao
1600-1630	Feedback and Valedictory	Board room	V. Premnath
1630-1700	Tea/coffee and biscuits	Exhibition area	

### Speakers and Lecture Faculty (in alphabetical order of last names)

 <p>Shilpi Gupta</p>	<p>Shilpi is Senior Manager-Technical (Discovery and Product Development) at Biotechnology Industry Research Assistance Council (BIRAC). She is responsible for evaluation, management and due-diligence of affordable products in the area of industrial biotechnology, bioenergy, green technology and sanitation. She is also responsible for identifying the priority areas of research and looking for ways in which the research innovation can be developed in these areas. Besides this, she is managing the BIRAC-DBT-BMGF Grand Challenges India Funding opportunity on “Re-invent the Toilet Challenge – India” and “Biotechnology Industry Partnership Programme”. She has done her Post doctoral Research at the Dublin Institute of Technology, Ireland, Doctorate in Biochemical Engineering and Biotechnology from IIT Delhi and Masters in Biotechnology.</p>
 <p>Ulhas Kharul</p>	<p>Ulhas is Sr. Principal Scientist in Polymer Science and Engineering Division of National Chemical Laboratory, Pune. His areas of research include structure-permeation property relation in polymeric membranes. His group explores proton exchange membranes for fuel cell, MOF-polymer composite membranes for gas separation, development of PIL based CO<sub>2</sub> selective membranes, membrane reactor, hollow fibre membranes for water purification and O<sub>2</sub>/N<sub>2</sub> enrichment of air and acid separation using chemodialysis. He is a recipient of VASVIK award towards his contribution in Membrane Science and Technology.</p>
 <p>Mugdha Lele</p>	<p>Mugdha is currently Manager – Social Innovations at Venture Center, Pune. She has completed her M.Sc and Ph.D from School of Health Sciences, University of Pune and has teaching experience in a State Government medical university. Her research work is related to epidemiological profiling and development of molecular diagnostics for Genetic disorders. At Venture Center, she is responsible for driving the Social Innovations related activities. She also provides technical support in conducting life sciences workshops and is also responsible for providing technical mentoring for few incubatees at Venture Center.</p>
 <p>Sanjay Nene</p>	<p>Sanjay was working with the National Chemical Laboratory, Pune, and held the position of Head, Biochemical Engineering Unit. He completed his M Sc. (Applied Microbiology) from Heriot-Watt University, Edinburgh, M.Tech (Biochemical Engineering) from IIT, Delhi and Ph.D (Chemical Engineering) from Mumbai University. Earlier he has worked as a Research Associate at Hindustan Antibiotics Ltd. Pimpri, Pune in their fermentation Pilot Plant, where he worked on scale up and development of antibiotic products. He has also worked as a Technical Consultant for Millipore Intertech Inc identifying applications in the area of Biotechnology, Pharmaceuticals and Chemical Industry. Recently he has founded his own startup company, Innovation Biologicals, which is incubated at Venture Center and is involved in proof-of principle work for fermentation and downstream processing in biotechnology. He is also Vice President R&amp;D at Nilsan Nishotech Systems Pvt Ltd, involved in development of good R&amp;D facilities for industrial membrane and chromatographic applications.</p>
 <p>KSMS Raghavarao</p>	<p>Raghavarao is Chief Scientist at Dept of Food Engineering at Central Food Technological Research Institute (CFTRI), Mysore. He holds Ph.D. (Chemical Engg) from Institute of Chemical Technology, Mumbai and B.Tech. from Andhra University, Visakhapatnam. The core activity of his group revolves around Process Engineering, Scale-up, Design and Development of Food Processing Machinery, with an emphasis on product development.</p>
 <p>Sushumna Shukla</p>	<p>Sushumna is currently a consultant in membrane engineering. She has been Erasmus Mundus Fellow at University of Montpellier, France working on membrane distillation with inorganic hollow fiber membranes. Earlier she has also worked as Erasmus Mundus Fellow at University of Leuven, Belgium, working on surface modification of hollow fiber membranes and application in pervaporation. She has been awarded a multiple doctoral degree by University of Montpellier (France), KU Leuven (Belgium) and University of Twente (The Netherlands) on Montpellier – European Institute of Membranes. Sushumna was the first PhD student, successfully completing the programme Erasmus Mundus Doctorate In Membrane Engineering – EUDIME.</p>

 <p>Premnath Venugopalan</p>	<p>Premnath is Founding Director of Venture Center and Head, NCL Innovations. He holds a B.Tech from the Indian Institute of Technology - Bombay and a Ph.D. from the Massachusetts Institute of Technology, USA. He has also been a Chevening Technology Enterprise Fellow with the Centre for Scientific Enterprises, London Business School and Cambridge University, UK. He brings with him considerable experience in technology development and commercialization, working with start-up companies (in Cambridge-UK and India) and engaging with large corporations on research and consulting projects as project leader.</p>
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Lab Faculty (in alphabetical order of last names)	
 <p>Mugdha Bapat</p>	<p>Mugdha is post-graduate in Bioinformatics from University of Mumbai. She is currently working with Innovation Biological. Earlier she has worked as project assistant in CSIR-NCL, Pune.</p>
 <p>Harshal Chaudhari</p>	<p>Harshal is pursuing his Ph.D. in Membrane Science and Technology at CSIR-NCL, Pune. His area of research is preparation and characterization of indigenous, low cost membranes for the HT-Fuel cell application. He is also involved in preparation of hollow fiber membranes for acid separation using Chemodialysis as a process. He has experience in making solvent resistance flat sheet ultra-filtration membranes for the various separation applications.</p>
<p>Ranjit Chaudhari</p>	<p>Ranjit is currently working as Senior Research Fellow at CSIR-NCL, Pune on his doctoral project in Chemical Sciences. His research is focused on use of micro-dispensing techniques for manufacturing composite polymer membranes for gas separations. He has done his graduation in Chemical Engineering from University of Pune and Post-graduation in Biochemical Engineering from School of Chemical Engineering, University of Birmingham, UK.</p>
 <p>Ketaki Dhavle</p>	<p>Ketaki is post-graduate in Microbiology from University of Pune. She is currently working with Innovation Biologicals. Earlier she has worked as project assistant in CSIR-NCL, Pune.</p>
 <p>Hrishikesh A</p>	<p>Hrishikesh is currently Senior Research Fellow at the Department of Food Engineering, CSIR-CFTRI, Mysore, pursuing his doctoral studies on "Department of Food Engineering, CSIR-CFTRI, Mysore, pursuing his doctoral studies on "Ionic Liquid Based Aqueous Two Phase Extraction for Downstream Processing of Phycocyanin". He is an engineering graduate in biotechnology.</p>
 <p>V V Jogdand</p>	<p>Jogdand has retired as Senior Principal Scientist from NCL-CSIR, Pune. He is post-graduate in Chemistry. Currently he is working with Innovation Biologicals. He has few publications and 7 US patents to his credit.</p>
 <p>Rohit Kulkarni</p>	<p>Rohit is currently working as Project fellow at CSIR-National Chemical Laboratory, Pune. He holds bachelor's degree in chemical Eng. He is working on development of Hollow Fiber (HF) membranes for water and gas separation applications. He has been also involved in up scaling of membrane and HF-module preparation.</p>
 <p>Rochak Mittal</p>	<p>Rochak is currently Junior Research Fellow at Department of Food Engineering, CSIR-CFTRI, Mysore, pursuing his doctoral studies on "Downstream processing of Phycocerythrin from macro-algae (<i>Gelidium pusillum</i>)". He has completed BTech in Biotechnology and MTech in Industrial Biotechnology.</p>



About the Organizers	
	<p>Biotechnology Industry Research &amp; Assistance Council is a new industry-academia interface and implements its mandate through a wide range of impact initiatives, be it providing access to risk capital through targeted funding, technology transfer, IP management and handholding schemes that help bring innovation excellence to the biotech firms and make them globally competitive. For more information about BIRAC: <a href="http://www.birac.nic.in">www.birac.nic.in</a></p>
	<p>Entrepreneurship Development Center (Venture Center) – a CSIR initiative – is a Section 25 company hosted by the National Chemical Laboratory, Pune. Venture Center strives to nucleate and nurture technology and knowledge-based enterprises by leveraging the scientific and engineering competencies of the institutions in the Pune region in India. The Venture Center is a technology business incubator supported by the Department of Science &amp; Technology's National Science &amp; Technology Entrepreneurship Development Board (DST-NSTEDB). Venture Center's focuses on technology enterprises offering products and services exploiting scientific expertise in the areas of materials, chemicals and biological sciences &amp; engineering. For more information, visit <a href="http://www.venturecenter.co.in/">http://www.venturecenter.co.in/</a></p>

Knowledge Partners	
<p><b>Polymer Science and Engineering Division, CSIR-NCL</b></p>	<p>The National Chemical Laboratory (NCL), Pune is a constituent laboratory of the CSIR. It is focused on R&amp;D in the fields of chemical, materials and biological sciences and engineering. NCL has a strong track record of working with the industry.</p> <p>The Polymer Science and Engineering Division of NCL is the largest integrated polymer science and engineering division in India with a history of fundamental research, industrial projects and consulting activities. More info: <a href="http://www.ncl-india.org/">http://www.ncl-india.org/</a></p>
<p><b>Dept of Food Engineering, CSIR-CFTRI</b></p>	<p>CSIR – Central Food Technological Research Institute(CFTRI), Mysore (A constituent laboratory of Council of Scientific and Industrial Research, New Delhi) came into existence during 1950 with the great vision of its founders, and a network of inspiring as well as dedicated scientists who had a fascination to pursue in-depth research and development in the areas of food science and technology. More info: <a href="http://www.cftri.com/">http://www.cftri.com/</a></p>
<p><b>Innovation Biologicals</b></p>	<p>Innovation Biologicals Pvt Ltd is a biotechnology start-up company based out of the Bioincubator at Venture Center that is focusing on biologicals and bioprocess engineering. The company has been founded by Dr S Kapre, Dr PA Ranjekar and Dr S Nene.</p>