Hepatic and Bone Tissue Development for Drug Metabolism and Tissue Engineering

Department of Biological Sciences and Bioengineering (BSBE),
Indian Institute of Technology Kanpur (IIT K), Kanpur - 208016, UP, INDIA

Overview

Human body is one of the most complex machinery, nonetheless fascinating. It comprises some of the most intricately designed systems, functioning in harmony. The immense complexity itself creates curiosity to study and decipher them. Since every system has natural life, body too undergoes wear and tear. Similarly, due to ageing, trauma or infection these systems may go out of order, or fail completely if not addressed accordingly. Therefore, there is earnest need to develop systems, drugs, therapies to cater to. With advancement in medicine, materials and manufacturing technologies today, we are in a position to develop entire organs or functional tissues which may replace or assist the non-functional original tissue/organ, enhancing overall quality and longevity of life. Pharmaceutical companies and researchers use human tissue or cells extracted from cadaveric donors during preclinical evaluation of drug molecules. Pre-clinical testing of a new candidate molecule is an important part of drug development process. Scientist prefer to use human tissue rather than animals/animal tissue, as the former can predict the side effects specific to humans, thereby increasing the safety and efficacy of the drug candidate to proceed for clinical trials. However, there is a huge demand in the market and the supply is limited. So, there is another need of establishment of an in-vitro functional human tissue and organ that can be used for various drug research purpose.

In bioengineering we employ biomaterials, cells, drugs, growth factor or a combination to generate biomimetic materials and systems. In addition to creating systems, products and therapies to replace, augment, sustain and support the biological tissue/organ in physicochemical or mechanical processes. The course aims to take a step forward to unravel the mysteries of this fascinating field.

This course is organized in two modules that can be taken together or independently. The topics in Module A will expose the participants to the entire gamut of advanced biomaterial technologies like properties of materials, polymers, drug delivery systems, physico-chemical characterization and evaluation, in-vitro cell culture, drug metabolism, high-throughput screening, with special emphasis to liver. In Module B, advanced topics such as medical physiology, bio-ceramics, composites, drug delivery systems, physico-chemical characterization, animal models, 3D cell and tissue culture systems, organoid development for functional evaluation will be studied with special emphasis towards bone. Additionally, evaluation techniques such as advance imaging, material performance evaluation, mechanical and rheological analysis, confocal imaging, micro-CT, microscopy and x-ray imaging will be discussed and demonstrated.

BSBE department at IIT Kanpur was established in year 2001. Since then department is involved in conducting cutting edge research and academic activities in areas ranging from core biology, biomaterials, biomedical research to frontier areas of bioengineering and computational biology. The department is equipped with some of the most advanced facilities for research in field of biology, biomaterials and bioengineering, capable of conducting research using in-vitro cell systems to advance in-vivo studies using animal models.

Course participants will learn these topics through lectures, hands-on experiments and demonstrations. Also, case studies and assignments will be shared to stimulate research motivation of participants.

Modules	**A: Biomaterials and technology for liver tissue development: April 1st – April 5th 2019** **B: Biomaterials and technology for bone tissue development: April 8th – April 12th 2019** **Number of participants for the course will be limited to Fifty.**
You Should Attend If…	▪ You are an engineer or research scientist interested in designing systems for medical diagnostics or medical devices and materials. ▪ You are medical student or physician interested to learn application of advanced biomaterials towards developing systems for regenerative therapies. ▪ You are a student or faculty from academic institution or researcher from industry interested in learning how to do research on advanced biomaterials, medical ceramics, polymers, drug delivery, medical physiology, animal models and evaluation systems, 3D cell and tissue culture, high-throughput screening. ▪ You are a student or faculty from academic institution or researcher from industry interested in learning advance imaging, material performance evaluation, bioanalysis, confocal, micro-CT, microscopy and x-ray imaging.
Fees	The participation fees for taking the course is as follows: **Participants from abroad:** US$ 350/- per module — Both modules: US$ 700/- **Participants from India:** **Academic institutions:** Students (Masters/PhD/Research fellows) Rs. 5000/- per module — Both modules: Rs. 8000/- **Public Organizations:** Faculty/Scientists/Staff Rs. 10000/- per module — Both modules: Rs. 20000/- **Private Industry/ Research Organizations:** Any of two modules: Rs. 15000/- — Both modules: Rs. 30000/- The above fee includes all instructional materials, computer use for tutorials and assignments, laboratory equipment/consumables usage charges, 24 h free internet facility and complementary tea/coffee and beverages. The participants will be provided with on-campus lodging and boarding on payment basis.
Last date of registration:	**20th March 2019**

Objectives

The primary objectives of the course are as follows:

1) Introducing participants to biomaterials, tissue engineering, bone and liver physiology
2) Providing exposure to cell isolation and in-vitro hepatic and osteoblast cell culture
3) Describe the different possible in-vitro culture systems for hepatocytes/osteoblasts including two-dimensional (2D) and three-dimensional (3D) culture platforms
4) Elaborate the interaction of liver and bone physiology and in disease conditions
5) Application of hepatic cell culture and tissue engineering in in-vitro and in-vivo drug toxicity screening
6) Developing and characterizing biomaterials, composites and functional tissue in-vitro

The Faculty

Foreign Faculty:

Professor Andreas Nüssler received his PhD from University Paris, France. He has vast experience in industry and academia. He is head of clinical and basic research in the Deptartment of Traumatology, BG Clinic, University of Tübingen, Germany. His major scientific interests are in the development of 2D & 3D human liver cell culture models, AdMSCs-derived cells in aging as well as tissue regeneration and their use in in-vitro metabolism. During past 20 years, he was involved in the coordination of the BMBF funded networks HepatoSyS, Virtual Liver, and ESNATS for providing human liver cells. Furthermore, his group is partner of several industrial, national and international research consortia in the area of in-vitro metabolisms. Working at the Siegfried Weller Institute for Trauma Research in Germany, his research interest is in bone & liver molecular biology, cell biology, regenerative medicine, musculoskeletal disorders and biotechnology.

Webpage:

https://www.bgu-tuebingen.de/forschung/siegfried-weller-institut-fuer-unfallmedizinische-forschung/

Google Scholar:

https://scholar.google.com/citations?user=0t0P0B8AAAAJ&hl=en

Course Co-ordinator:

Professor Ashok Kumar received his PhD in Biotechnology jointly from Institute of Genomics and Integrative Biology, Delhi and Indian Institute of Technology Roorkee, India. He has long experiences in academic research and biotech industry. He has worked on various senior research and academic positions and fellowships in India and abroad. He is actively pursuing bioprocess and bioengineering research in India and is actively involved in collaborations with clinical research in Sweden and biomedical engineering research in Finland. He is currently Professor of Bioengineering at the Department of Biological Sciences and Bioengineering, Indian Institute of Technology Kanpur, India and is also associated with Center for Environmental Sciences and Engineering and Center for Nanosciences at IIT Kanpur. His current research interests are in the area of stem cell research, regenerative medicine, biomaterials, tissue engineering, bioprocess engineering and environmental biotechnology.

Webpage:

https://www.iitk.ac.in/bsbe/ashok-kumar

Google Scholar:

https://scholar.google.co.in/citations?user=eFMI9XQAAAAJ&hl=en

BSBE Host Faculty:

1. Prof. Dhirendra S. Katti
   https://www.iitk.ac.in/bsbe/dhirendra-s-katti
2. Prof. Jayandharan G. Rao
   https://www.iitk.ac.in/bsbe/jayandharan-g-rao
3. Prof. Santosh K. Misra
   https://www.iitk.ac.in/bsbe/santosh-misra

Course Co-ordinator

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http://www.gian.iitk.ac.in/xxxx

Program Details

WEEK ONE

Module A	Biomaterials and technology for liver tissue development
Day-1 **Monday** **April 1st 2019**	**Lecture 1**: 9:30 to 10:30 AM ***Role of the liver in metabolism*** **Lecture 2**: 10:45 to 11:45 AM ***Application of biomaterials in liver: An overview*** **Lab 1:** 2:00 to 5:00 PM **(Hands-on)** ***3D matrix synthesis by cryogelation technology of hepatic cell culture***
Day-2 **Tuesday** **April 2nd 2019**	**Lecture 3**: 9:30 to 10:30 AM ***Hepatocyte-like cells: An overview*** **Lecture 4**: 10:45 to 11:45 AM ***Biomaterials for soft tissue engineering with specific application for liver*** **Lab 2:** 2:00 to 5:00 PM **(Demonstration)** ***Techniques for physico-chemical characterization of the developed 3D matrix, Mechanical testing, Rheology, Porosimetry***
Day-3 **Wednesday** **April 3rd 2019**	**Lecture 5**: 9:30 to 10:30 AM ***Liver cell isolation: An overview*** **Lecture 6**: 10:45 to 11:45 AM ***Development of Bioartificial Liver system/device*** **Lab 3:** 2:00 to 5:00 PM **(Hands-on/Demonstration)** ***Handling of mammalian cells on developed 3D matrix. 3D Cell culture, 3D printing and histological evaluation of animal tissue*** **Extra event:** Visit to animal housing facility
Day-4 **Thursday** **April 4th 2019**	**Lecture 7**: 9:30 to 10:30 AM ***Culture of liver cells 2D versus 3D systems*** **Lecture 8**: 10:45 to 11:45 AM ***Development of Ectopic Liver in Mice model*** **Lab 4:** 2:00 to 5:00 PM **(Demonstration)** ***Biological characterization of the developed 3D matrix, Imaging (X-ray, Micro-CT)***
Day-5 **Friday** **April 5th 2019**	**Lecture 9**: 9:30 to 10:30 AM ***Use of liver cells to study specific disease*** **Lecture 10**: 10:45 to 11:45 AM ***Development of in vitro drug screening model*** **Lab 5:** 2:00 to 5:00 PM **(Demonstration)** ***Characterization of the developed 3D matrix, Imaging (Optical, SEM and Confocal)***

Program Details

WEEK TWO

Module B	Biomaterials and technology for bone tissue development
Day-8 **Monday** **April 8th 2019**	**Lecture 11**: 9:30 to 10:30 AM ***Bone in the body - role and physiology*** **Lecture 12**: 10:45 to 11:45 AM ***Biomaterial for hard tissue with specific application for bone*** **Lab 6:** 2:00 to 5:00 PM **(Hands-on)** ***3D matrix synthesis for bone tissue engineering and injectable ceramic bone cements***
Day-9 **Tuesday** **April 9th 2019**	**Lecture 13**: 9:30 to 10:30 AM ***Liver-bone interaction: An overview*** **Lecture 14**: 10:45 to 11:45 AM ***Cryogels for osteochondral tissue engineering*** **Lab 7:** 2:00 to 5:00 PM **(Demonstration)** ***Techniques for physico-chemical characterization of the developed 3D matrix, Mechanical testing, Rheology, Porosimetry***
Day-10 **Wednesday** **April 10th 2019**	**Lecture 15**: 9:30 to 10:30 AM ***Diabetes-bone interaction: An overview*** **Lecture 16**: 10:45 to 11:45 AM ***Injectable bone cements*** **Lab 8:** 2:00 to 5:00 PM (**Hands-on/Demonstration)** ***Handling of mammalian cells on developed 3D matrix. 3D Cell culture, 3D printing and histological evaluation of animal tissue*** (**Extra event:** Visit to animal housing facility)
Day-11 **Thursday** **April 11th 2019**	**Lecture 17**: 9:30 to 10:30 AM ***Knitted implant for nucleus replacement*** **Lecture 18**: 10:45 to 11:45 AM ***Multi-layer cranial implants: An overview*** **Lab 9:** 2:00 to 5:00 PM **(Demonstration)** ***Biological characterization of the developed 3D matrix, Imaging (X-ray, Micro-CT)***
Day-12 **Friday** **April 12th 2019**	**Lecture 19**: 9:30 to 10:30 AM ***New devices in our clinics: sole, magnesium alloy screw, low electric field exposure*** **Lecture 20**: 10:45 to 11:45 AM ***Polymers, composites and metallic biomaterials for application in bone*** **Lab 10:** 2:00 to 5:00 PM **(Demonstration)** ***Biological characterization of the developed 3D matrix, Imaging (Optical, SEM and Confocal)***