MB212 January 2:0

Electron microscopy and 3D image processing for Life sciences

Instructor

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Department: Molecular Biophysics Unit

Course Time: 10-11 AM

Lecture venue: MBU seminar hall (Annex building)

Detailed Course Page: http://mbu.iisc.ac.in/courses.htm

Announcements

4-5 Practical classes. Due limited resources (electron microscope, image processing workstations) more than 4-5 practical classes are not possible.

Brief description of the course

This course is offered for Ph.D. students, undergraduates, Master's degree students, and postdoctoral fellow.

Prerequisites

Basic Physics and Mathematics background will help to understand the course.

Syllabus

1. Objectives and basic principles of different types of microscopes.

2. Different types of electron microscopes and their applications.

3. Basic introduction to electron microscopy physics and optics.

4. Principles of image formation, Fourier analysis, Contrast Transfer Function and point spread function. 5. Advanced sample preparation, imaging, data collection techniques of bio-molecules by negative staining and cryo-electron microscopy.

6. Theoretical, computational and practical aspects of various advanced 3D image processing techniques.

7. Cryo-EM map interpretation and data analysis, validation, molecular docking (use of Chimera, VMD) and

application of Molecular Dynamics Flexible Fitting (MDFF).

Course outcomes

Cryo-electron microscopy and the image processing is an emerging technology.

This course will clear the idea about image formation, Fourier analysis, Contrast Transfer Function, Point Spread Function and Electromagnetic applications in biology and medicine. Also, this course will help to understand the common line methods, particle symmetry, Projection Theorem, K-means clustering algorithm. Researchers (Ph.D. student and postdoctoral researchers) will learn how to handle the electron microscope, what is the basic principle and how we can use this instrument for our research purposes. They will also learn the data processing, data collection, data analysis, model building and molecular docking.

Grading policy

50% for mid-term and 50% for final

Assignments

Assignments are there after finishing every chapter.

Resources

Books and references:

1. John J. Bozzola and Lonnie D. Russell (1992). Electron Microscopy (Jones & Bartlett Publishers).
2. Ray F. Egerton (2005). Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM (Springer).
3. Elaine Evelyn Hunter and Malcolm Silver (1993). Practical Electron Microscopy: A Beginner's Illustrated Guide (Cambridge University).
4. John Kuo (2007). Electron Microscopy: Methods and Protocols (Methods in Molecular Biology) (Humana).

5. Earl J. Kirkland (2014). Advanced Computing in Electron Microscopy (Springer).
6. Gabor T. Herman and Joachim Frank (2014). Computational Methods for Three-Dimensional Microscopy Reconstruction (Birkh user Basel).
7. Joachim Frank (2006). Electron Tomography, (New York, Springer).
8. Joachim Frank (2006). Three-Dimensional Electron Microscopy of Macromolecular Assemblies (New York, Oxford U. Press).