

Lecture 1 - Introduction

Lecture 2 - Graphs and functions - I

Lecture 3 - Graphs and functions - II

Lecture 4 - Functions and derivatives

Lecture 5 - Calculation of derivatives

Lecture 6 - Differentiation and its application in Biology - I

Lecture 7 - Differentiation and its application in Biology - II

Lecture 8 - Differentiation and its application in Biology - III

Lecture 9 - Differentiation and its application in Biology - IV

Lecture 10 - Integration - I

Lecture 11 - Integration - II

Lecture 12 - Differential equations - I

Lecture 13 - Differential equations - II

Lecture 14 - Vectors - I

Lecture 15 - Vectors - II

Lecture 16 - Vectors - III

Lecture 17 - Nernst equation

Lecture 18 - Diffusion - I : Diffusion equation

Lecture 19 - Diffusion - II : Mean-square displacement

Lecture 20 - Diffusion - III : Einstein's relation

Lecture 21 - Statistics : Mean and variance

Lecture 22 - Statistics : Distribution function

Lecture 23 - Understanding Normal distribution

Lecture 24 - Fitting a function to experimental data

Lecture 25 - Size of a flexible protein: Simplest model

Lecture 26 - Uniform and Poisson distributions; Knudsen's analysis

Lecture 27 - Fourier Series - I

Lecture 28 - Fourier Series - II

Lecture 29 - Fourier transform

Lecture 30 - Master equation: Polymerization dynamics, Molecular motor motion

Lecture 31 - Evolution: Simplest model

[Lecture 32 - Tutorial - I](#)

[Lecture 33 - Tutorial - II](#)

[Lecture 34 - Temperature, Energy and Entropy](#)

[Lecture 35 - Partition function, Free energy](#)

[Lecture 36 - Bending fluctuations of DNA and spring-like proteins](#)

[Lecture 37 - Force-extension and looping of DNA](#)

[Lecture 38 - Thermodynamics of protein organization along DNA](#)

[Lecture 39 - Learning mathematics with the help of a computer](#)

NPTEL : Proteomics: Principles and Techniques (Biotechnology)

Co-ordinators : Prof. Sanjeeva Srivastava

[Lecture 1](#)

[Lecture 2](#)

[Lecture 3](#)

[Lecture 4](#)

[Lecture 5](#)

[Lecture 6](#)

[Lecture 7](#)

[Lecture 8](#)

[Lecture 9](#)

[Lecture 10](#)

[Lecture 11](#)

[Lecture 12](#)

[Lecture 13](#)

[Lecture 14](#)

[Lecture 15](#)

[Lecture 16](#)

[Lecture 17](#)

[Lecture 18](#)

[Lecture 19](#)

[Lecture 20](#)

[Lecture 21](#)

[Lecture 22](#)

[Lecture 23](#)

[Lecture 24](#)

[Lecture 25](#)

[Lecture 26](#)

[Lecture 27](#)

[Lecture 28](#)

[Lecture 29](#)

[Lecture 30](#)

[Lecture 31](#)

[Lecture 32](#)

[Lecture 33](#)

[Lecture 34](#)

[Lecture 35](#)

[Lecture 36](#)

[Lecture 37](#)

[Lecture 38](#)

[Lecture 39](#)

[Lecture 40](#)

[Lecture 0 - Proteins and Gel-Based Proteomics; Course Introduction](#)

[Lecture 1 - Introduction to amino acids](#)

[Lecture 2 - Introduction to proteins](#)

[Lecture 3 - Protein folding & misfolding](#)

[Lecture 4 - Protein purification techniques](#)

[Lecture 5 - Introduction to proteomics](#)

[Lecture 6 - Systems biology and proteomics](#)

[Lecture 7 - Sample preparation and pre-analytical factors](#)

[Lecture 8 - Sample preparation: Pre-analytical factors \(Continued...\)](#)

[Lecture 9 - Sample preparation: Protein extraction and quantification](#)

[Lecture 10 - One-dimensional electrophoresis](#)

[Lecture 11 - 2-DE: Rehydration, IEF & Equilibration](#)

[Lecture 12 - 2-DE: Second dimension, staining & destaining](#)

[Lecture 13 - 2-DE: Gel analysis](#)

[Lecture 14 - 2-DE: Applications](#)

[Lecture 15 - 2-DE: Applications \(Continued...\) & Challenges](#)

[Lecture 16 - 2D-DIGE: Basics](#)

[Lecture 17 - 2D-DIGE: Data analysis](#)

[Lecture 18 - 2D-DIGE: Applications](#)

[Lecture 19 - Protein identification using MALDI-TOF/TOF](#)

[Lecture 20 - Proteomics experiment data analysis & challenges](#)

[Lecture 0 - Introductory lecture](#)

[Lecture 1 - Introduction to proteomics](#)

[Lecture 2 - Proteomics and sample preparation](#)

[Lecture 3 - Bacterial protein extraction](#)

[Lecture 4 - In-gel digestion](#)

[Lecture 5 - Fundamentals of mass spectrometry](#)

[Lecture 6 - Chromatography technologies](#)

[Lecture 7 - Liquid chromatography](#)

[Lecture 8 - Mass spectrometry: Ionization sources](#)

[Lecture 9 - Mass spectrometry: Mass analyzers](#)

[Lecture 10 - MALDI sample preparation and analysis](#)

[Lecture 11 - Introduction to quantitative proteomics](#)

[Lecture 12 - Hybrid mass spectrometry configurations](#)

[Lecture 13 - SILAC: In Vivo labeling](#)

[Lecture 14 - iTRAQ: In Vitro labeling](#)

[Lecture 15 - TMT: In vitro labeling](#)

[Lecture 16 - Quantitative proteomics data analysis](#)

[Lecture 17 - Proteomics and Systems biology I](#)

[Lecture 18 - Proteomics & Systems biology II](#)

[Lecture 19 - Proteomics applications](#)

[Lecture 20 - Advances and challenges in proteomics](#)

Lecture 1 - Introduction to Interactomics

Lecture 2 - An overview of label-free technologies

Lecture 3 - An overview of surface plasmon resonance (SPR)

Lecture 4 - An overview of surface plasmon resonance imaging (SPRi)

Lecture 5 - Basics of SPR: Surface chemistry

Lecture 6 - Basics of SPR: Experimental design

Lecture 7 - Protein immobilization for protein-protein interaction studies

Lecture 8 - Protein-protein interaction study: Binding analysis

Lecture 9 - Protein-protein interaction study: Kinetic analysis

Lecture 10 - Protein-small molecule interaction study: Immobilization and binding analysis

Lecture 11 - Protein-small molecule interaction study: Kinetic analysis

Lecture 12 - SPR: Interactive Session - I

Lecture 13 - SPR: Interactive Session - II

Lecture 14 - An overview of ellipsometry and interferometry techniques

Lecture 15 - An introduction to BioLayer Interferometry (BLI) and its applications in protein research

Lecture 16 - Kinetic analysis of protein-protein interaction using BLI

Lecture 17 - Label-free quantification of proteins using BLI

Lecture 18 - Diffraction-based biosensors - I

Lecture 19 - Diffraction-based biosensors - II

Lecture 20 - Nanotechniques in proteomics - I

Lecture 21 - Nanotechniques in proteomics - II

Lecture 22 - High throughput platforms of interactomics: Protein arrays

Lecture 23 - Conventional label based detection techniques for Protein microarrays

Lecture 24 - Novel detection techniques for Protein microarrays

Lecture 25 - Recombinational cloning and its application for Protein microarrays

Lecture 26 - An introduction to Cell-free protein synthesis

Lecture 27 - Cell-free synthesis based protein microarrays: PISA and NAPPA

Lecture 28 - Cell-free synthesis based protein microarrays: MIST, DAPA and Halotag Arrays

Lecture 29 - Digging deeper into NAPPA: Basic Workflow

Lecture 30 - Digging deeper into NAPPA: Surface Chemistry, Printing and Assessment

Lecture 31 - Application of cell free expression protein microarrays in biomarker discovery

[Lecture 32 - Application of cell free expression protein microarrays in immunological studies](#)

[Lecture 33 - Basics of microarray image scanning](#)

[Lecture 34 - Software for Image scanning and data processing](#)

[Lecture 35 - Microarray Data Analysis - Part I](#)

[Lecture 36 - Microarray Data Analysis - Part II](#)

[Lecture 37 - Application of protein microarray in biomarker discovery - I](#)

[Lecture 38 - Application of protein microarray in biomarker discovery - II](#)

[Lecture 39 - Systems biology and networks](#)

[Lecture 40 - Challenges in proteomics](#)

Lecture 1 - Introduction to amino acids

Lecture 2 - Introduction to proteins

Lecture 3 - Protein folding and misfolding

Lecture 4 - Introduction to proteomics

Lecture 5 - Lab session – Protein-protein interaction using label-free biosensors

Lecture 6 - Sample preparation and pre-analytical factors

Lecture 7 - Sample preparation: Pre-analytical factors (Continued...)

Lecture 8 - Sample preparation: Protein extraction and quantification

Lecture 9 - One-dimensional electrophoresis

Lecture 10 - Introduction to 2-DE

Lecture 11 - 2-DE: Second dimension, staining and destaining

Lecture 12 - 2-DE: Gel analysis

Lecture 13 - 2-DE Applications

Lecture 14 - 2-DE Applications (Continued...) and Challenges

Lecture 15 - Lab session - Protein/peptide pre-fractionation using OFFGEL FRACTIONATOR and data analysis

Lecture 16 - 2D-DIGE: Basics

Lecture 17 - 2D-DIGE: Data analysis

Lecture 18 - 2D-DIGE: Applications

Lecture 19 - Systems biology and proteomics - I

Lecture 20 - Systems biology and proteomics - II

Lecture 21 - Fundamentals of mass spectrometry

Lecture 22 - Chromatography technologies

Lecture 23 - Liquid chromatography

Lecture 24 - Mass spectrometry: Ionization sources

Lecture 25 - Mass spectrometry: Mass analyzers

Lecture 26 - MALDI sample preparation and analysis

Lecture 27 - Hybrid mass spectrometry configurations

Lecture 28 - Lab session - Demonstration of Q-TOF MS technology

Lecture 29 - In-gel and in-solution digestion

Lecture 30 - Lab session - Sample preparation: tissue sample preservation technology

Lecture 31 - Introduction to quantitative proteomics

[Lecture 32 - SILAC: In vivo labeling](#)

[Lecture 33 - iTRAQ: In vitro labeling](#)

[Lecture 34 - TMT: In vitro labeling](#)

[Lecture 35 - Quantitative proteomics data analysis](#)

[Lecture 36 - Proteomics applications](#)

[Lecture 37 - Challenges in proteomics](#)

[Lecture 38 - OMICS and translational research](#)

[Lecture 39 - Lab session – Targeted proteomics using triple quadrupole mass spectrometry](#)

[Lecture 40 - Lab session – Targeted proteomics: multiple reaction monitoring](#)

- Lecture 1 - Introduction to the course
- Lecture 2 - Data representation and plotting
- Lecture 3 - Arithmetic mean
- Lecture 4 - Geometric mean
- Lecture 5 - Measure of Variability, Standard deviation
- Lecture 6 - SME, Z-Score, Box plot
- Lecture 7 - Moments, Skewness
- Lecture 8 - Kurtosis, R programming
- Lecture 9 - R programming
- Lecture 10 - Correlation
- Lecture 11 - Correlation and Regression - Part-I
- Lecture 12 - Correlation and Regression - Part-II
- Lecture 13 - Interpolation and extrapolation
- Lecture 14 - Nonlinear data fitting
- Lecture 15 - Concept of Probability: introduction and basics
- Lecture 16 - Counting principle, Permutations, and Combinations
- Lecture 17 - Conditional probability
- Lecture 18 - Conditional probability and Random variables
- Lecture 19 - Random variables, Probability mass function, and Probability density function
- Lecture 20 - Expectation, Variance and Covariance - Part-I
- Lecture 21 - Expectation, Variance and Covariance - Part-II
- Lecture 22 - Binomial random variables and Moment generating function
- Lecture 23 - Probability distribution: Poisson distribution and Uniform distribution Part-I
- Lecture 24 - Uniform distribution Part-II and Normal distribution Part-I
- Lecture 25 - Normal distribution Part-II and Exponential distribution
- Lecture 26 - Sampling distributions and Central limit theorem - Part-I
- Lecture 27 - Sampling distributions and Central limit theorem - Part-II
- Lecture 28 - Central limit theorem - Part-III and Sampling distributions of sample mean
- Lecture 29 - Central limit theorem - Part-IV and Confidence intervals
- Lecture 30 - Confidence intervals Part- II
- Lecture 31 - Test of Hypothesis - 1

[Lecture 32 - Test of Hypothesis - 2 \(1 tailed and 2 tailed Test of Hypothesis, p-value\)](#)

[Lecture 33 - Test of Hypothesis - 3 \(1 tailed and 2 tailed Test of Hypothesis, p-value\)](#)

[Lecture 34 - Test of Hypothesis - 4 \(Type -1 and Type -2 error\)](#)

[Lecture 35 - T-test](#)

[Lecture 36 - 1 tailed and 2 tailed T-distribution, Chi-square test](#)

[Lecture 37 - ANOVA - 1](#)

[Lecture 38 - ANOVA - 2](#)

[Lecture 39 - ANOVA - 3](#)

[Lecture 40 - ANOVA for linear regression, Block Design](#)

Lecture 1 - Need to Study Mechanobiology

Lecture 2 - Cell as a Tent, Individual Components

Lecture 3 - Cell-ECM Crosstalk

Lecture 4 - ECM Proteins: Collagen

Lecture 5 - Measuring Properties of Collagen Networks

Lecture 6 - Properties of Collagen Networks

Lecture 7 - Rheology

Lecture 8 - Rheology of Biopolymer Networks

Lecture 9 - Atomic Force Microscopy (AFM)

Lecture 10 - Design of Protein Constructs for AFM

Lecture 11 - Protein Unfolding using AFM

Lecture 12 - Protein Unfolding using AFM

Lecture 13 - Focal Adhesions: Focal Adhesion Proteins

Lecture 14 - Focal Adhesion Organization

Lecture 15 - Focal Adhesions: Role of Forces

Lecture 16 - Cytoskeleton: Actin

Lecture 17 - Force-velocity Relationships of Actin Networks

Lecture 18 - Mesenchymal Cell Migration

Lecture 19 - Actin Dynamics during Mesenchymal Migration

Lecture 20 - Actin Dynamics during Mesenchymal Migration

Lecture 21 - Adhesion Independent Migration

Lecture 22 - Adhesion Independent and Collective Cell Migration

Lecture 23 - Collective Cell Migration

Lecture 24 - Mechanobiology of Stem Cell Fate - I

Lecture 25 - Mechanobiology of Stem Cell Fate - II

Lecture 26 - Mechanobiology of Stem Cell Fate - III

Lecture 27 - Mechanobiology of Diseases: Cancer - I

Lecture 28 - Mechanobiology of Diseases: Cancer - II

Lecture 29 - Mechanobiology of Diseases: Cancer - III

Lecture 30 - Mechanobiology of Diseases: Atherosclerosis and Hypertension

Lecture 31 - Mechanobiology of Diseases: Muscular Dystrophy

[Lecture 32 - Nuclear Mechanotransduction: LINC complex](#)

[Lecture 33 - Nuclear Mechanotransduction: LINC Complex in Cell Migration](#)

[Lecture 34 - Nuclear Mechanotransduction: Gene Regulation](#)

[Lecture 35 - Mechanical Forces and DNA damage](#)

[Lecture 36 - Techniques in Mechanobiology: Hydrogels](#)

[Lecture 37 - Techniques in Mechanobiology: AFM](#)

[Lecture 38 - Techniques in Mechanobiology: Traction Force Microscopy, Trypson Deadhesion and Laser Ablation](#)

[Lecture 39 - Techniques in Mechanobiology: Microfabrication](#)

[Lecture 40 - Techniques in Mechanobiology: FRET](#)

Lecture 1 - Introduction

Lecture 2 - Graphs and Functions

Lecture 3 - Equations as Graphs

Lecture 4 - Graphs : Exponential and Periodic Functions

Lecture 5 - Graphs : Logarithmic and Other Functions

Lecture 6 - Images as 2D/3D Functions

Lecture 7 - Functions and its Derivatives

Lecture 8 - Computing Derivatives of Curves

Lecture 9 - Rules for Calculating Derivatives

Lecture 10 - Understanding Derivatives

Lecture 11 - Curvature and Second Derivative

Lecture 12 - Plotting Curves

Lecture 13 - Numerical Calculation of Derivatives

Lecture 14 - Function, Derivatives and Series Expansion

Lecture 15 - L'Hopital's Rule and Partial Derivatives

Lecture 16 - Integration

Lecture 17 - Integration : Rules

Lecture 18 - Integration : Graphical Understanding

Lecture 19 - Integration : More Examples

Lecture 20 - Integration : Product of Two Functions

Lecture 21 - Exponential Growth and Decay

Lecture 22 - Scalars and Vectors

Lecture 23 - Vectors : Position and Movement in 2D

Lecture 24 - Cell Symmetry : Use of Polar Coordinates

Lecture 25 - Gradient, Forces and Flows : Part I

Lecture 26 - Gradient, Forces and Flows : Part II

Lecture 27 - Understanding Diffusion

Lecture 28 - Diffusion Constant and Einstein Relation 1905

Lecture 29 - Diffusion Equation

Lecture 30 - Diffusion vs. Active Transport

Lecture 31 - Nernst Equation

[Lecture 32 - Fourier Series : Part I](#)

[Lecture 33 - Fourier Series : Part II](#)

[Lecture 34 - Fourier Transform](#)

[Lecture 35 - Introduction to Statistics](#)

[Lecture 36 - Mean, Standard deviation and Distribution](#)

[Lecture 37 - Frequency Distribution and Probability Distribution](#)

[Lecture 38 - Binomial Distribution](#)

[Lecture 39 - Normal Distribution](#)

[Lecture 40 - Hypothesis Testing and Mathematical Modeling](#)

Lecture 1 - Why biology for engineers - Part I

Lecture 2 - Why biology for engineers - Part II

Lecture 3 - Life processes and Cell

Lecture 4 - Cell and its properties

Lecture 5 - Clinician's Perspective - I

Lecture 6 - Nucleic Acid and Central Dogma

Lecture 7 - DNA Tools: Gene Cloning - I

Lecture 8 - DNA Tools: Gene Cloning - II

Lecture 9 - DNA Tools and Biotechnology - I

Lecture 10 - DNA Tools and Biotechnology - II

Lecture 11 - DNA Tools and Biotechnology - III

Lecture 12 - DNA Tools and Biotechnology - IV

Lecture 13 - DNA Tools and Biotechnology - V

Lecture 14 - DNA Tools and Biotechnology - VI

Lecture 15 - Clinician's Perspective - II

Lecture 16 - Genetics - I

Lecture 17 - Genetics - II

Lecture 18 - Genetics - III

Lecture 19 - Genetics - IV

Lecture 20 - Clinician's Perspective - III

Lecture 21 - Chromosomal basis of inheritance

Lecture 22 - Linkage, chromosomal disorders

Lecture 23 - Classical Genetics Experiments

Lecture 24 - Bacteria and Viruses

Lecture 25 - Clinician's Perspective - IV

Lecture 26 - Cell cycle dysregulation and Cancer

Lecture 27 - Developmental Biology

Lecture 28 - Principles and application of Animal Cloning

Lecture 29 - Evolution

Lecture 30 - Clinician's Perspective - V

Lecture 31 - Amino acids and proteins

[Lecture 32 - Proteins and Proteomics](#)

[Lecture 33 - Techniques to Study Protein and Proteome - I](#)

[Lecture 34 - Techniques to Study Protein and Proteome - II](#)

[Lecture 35 - Bioinformatics - I](#)

[Lecture 36 - Techniques to Study Protein and Proteome - III](#)

[Lecture 37 - Protein Interactions and Microarrays](#)

[Lecture 38 - Protein interactions and Systems biology](#)

[Lecture 39 - Bioinformatics - II](#)

[Lecture 40 - Ethics in Research and Publications](#)

Lecture 1 - Introduction to Interactomics and Protein Arrays

Lecture 2 - NAPPA Technology and Protein Arrays - I

Lecture 3 - NAPPA Technology and Protein Arrays - II

Lecture 4 - Biomarkers: Harnessing the immune system for early detection of disease - I

Lecture 5 - Biomarkers: Harnessing the immune system for early detection of disease - II

Lecture 6 - Biomarkers: Harnessing the immune system for early detection of disease - III

Lecture 7 - NAPPA and its applications in study of antibody immune response in disease and in drug Screening - I

Lecture 8 - NAPPA and its applications in study of antibody immune response in disease and in drug screening - II

Lecture 9 - NAPPA and its applications in study of antibody immune response in disease and in drug screening - III

Lecture 10 - Using functional proteomics to identify biomarkers and therapeutic targets - I

Lecture 11 - Using functional proteomics to identify biomarkers and therapeutic targets - II

Lecture 12 - Applications of protein microarrays in Malaria Research - I

Lecture 13 - Applications of protein microarrays in Malaria Research - II

Lecture 14 - Applications of protein microarrays in Cancer Research - I

Lecture 15 - Applications of protein microarrays in Cancer Research - II

Lecture 16 - Introduction to Bioprinting and Iris's Optical QC Benefits - I

Lecture 17 - Introduction to Bioprinting and Iris's Optical QC Benefits - II

Lecture 18 - Basics and Applications of Reverse Phase Protein Arrays - I

Lecture 19 - Basics and Applications of Reverse Phase Protein Arrays - II

Lecture 20 - Basics and Applications of Reverse Phase Protein Arrays - III

Lecture 21 - Antibody signatures defined by high-content peptide microarray analysis

Lecture 22 - An overview of label-free technologies - I

Lecture 23 - An overview of label-free technologies - II

Lecture 24 - Mass Spectrometry coupled Interactomics - I

Lecture 25 - Mass Spectrometry coupled Interactomics - II

Lecture 26 - Biomolecular interactions using Bio-Layer Interferometry (BLI) - I

Lecture 27 - Biomolecular interactions using Bio-Layer Interferometry (BLI) - II

Lecture 28 - Biomolecular interaction analytics using MicroScale Thermophoresis

Lecture 29 - Surface Plasmon Resonance- Principles and Assays - I

Lecture 30 - Surface Plasmon Resonance- Principles and Assays - II

Lecture 31 - Use of SPR in unravelling domain motif interactions of proteasomal assembly chaperones

[Lecture 32 - Next-Generation Sequencing Technology- Ion Torrent™](#)

[Lecture 33 - NGS Technology- Bioinformatics and data analysis - I](#)

[Lecture 34 - NGS Technology- Bioinformatics and data analysis - II](#)

[Lecture 35 - Next-Generation Sequencing Technology-MiSeq System](#)

[Lecture 36 - NGS target enrichment workflow for exomes, targeted panels and beyond](#)

[Lecture 37 - The Human Pathology Atlas: A Pathology Atlas of the Human Transcriptome - I](#)

[Lecture 38 - The Human Pathology Atlas: A Pathology Atlas of the Human Transcriptome - II](#)

[Lecture 39 - Conclusions and Overview - I \(Statistical analysis - I\)](#)

[Lecture 40 - Conclusions and overview - II \(Statistical analysis - II\)](#)

- Lecture 1 - Proteogenomics overview - I
- Lecture 2 - Proteogenomics overview - II
- Lecture 3 - Introduction to Genomics - Part I : Gene sequencing and mutations
- Lecture 4 - Introduction to Genomics - Part II : Sequence Alignment
- Lecture 5 - Introduction to Genomics - Part III : Transcriptome
- Lecture 6 - Perspectives in Proteogenomics - I
- Lecture 7 - Advancement in Cancer Genomics
- Lecture 8 - Introduction to Genomics - Part IV : Epigenome
- Lecture 9 - Introduction to Genomics - cBioPortal
- Lecture 10 - Genotype, Gene expression and Phenotype - I
- Lecture 11 - Genotype, Gene expression and Phenotype - II
- Lecture 12 - An overview of NGS technology
- Lecture 13 - NGS - Sequencing by synthesis - I
- Lecture 14 - NGS - Sequencing by synthesis - II
- Lecture 15 - Introduction to Proteomics
- Lecture 16 - Proteomics: Sample Prep and Protein Quantification
- Lecture 17 - Applications of Proteomics
- Lecture 18 - Introduction to MS-based Proteomics - I
- Lecture 19 - Introduction to MS-based Proteomics - II
- Lecture 20 - Applications of NGS - IonTorrent
- Lecture 21 - Genomic Analysis using Droplet PCR - I
- Lecture 22 - Introduction to MS-based Proteomics - I (Hands-on session)
- Lecture 23 - Introduction to MS-based Proteomics - II (Hands-on session)
- Lecture 24 - Data analysis : Normalization
- Lecture 25 - Data analysis : Batch Correction and Missing values
- Lecture 26 - Data analysis : Statistical Test
- Lecture 27 - Genomic Analysis using Droplet PCR - II
- Lecture 28 - Topics in Proteogenomics : Malaria case study
- Lecture 29 - Machine learning and Clustering
- Lecture 30 - Hypothesis testing
- Lecture 31 - ProTIGY - I

[Lecture 32 - ProTIGY - II](#)

[Lecture 33 - Proteomics Data Analysis](#)

[Lecture 34 - Proteomics Lab Demonstration - I](#)

[Lecture 35 - Proteomics Lab Demonstration - II](#)

[Lecture 36 - Workflow to Automated Data Processing](#)

[Lecture 37 - Introduction to Fire Cloud](#)

[Lecture 38 - FireCloud and Data Model](#)

[Lecture 39 - Bioinformatics solutions for Big Data Analysis - I](#)

[Lecture 40 - Bioinformatics solutions for Big Data Analysis - II](#)

[Lecture 41 - Introduction to Targeted Proteomics](#)

[Lecture 42 - Data analysis using Skyline](#)

[Lecture 43 - Large-scale data Science - I](#)

[Lecture 44 - Large-scale data Science - II](#)

[Lecture 45 - Large-scale data Science - III](#)

[Lecture 46 - DIA-SWATH Atlas - I](#)

[Lecture 47 - DIA-SWATH Atlas - II](#)

[Lecture 48 - Prediction Analysis](#)

[Lecture 49 - Pathway Enrichment and Network Analysis](#)

[Lecture 50 - Human Protein Atlas - I](#)

[Lecture 51 - Human Protein Atlas - II](#)

[Lecture 52 - Affinity based proteomics & HPA](#)

[Lecture 53 - Clinical Considerations for OMICS - I](#)

[Lecture 54 - Clinical Considerations for OMICS - II](#)

[Lecture 55 - Topics in Proteogenomics: Cancer case study](#)

[Lecture 56 - Integrative Genomics Viewer \(IGV\)](#)

[Lecture 57 - Introduction to Proteogenomics - I](#)

[Lecture 58 - Introduction to Proteogenomics - II](#)

[Lecture 59 - Sequence centric proteogenomics](#)

[Lecture 60 - Variant Analysis](#)

[Lecture 61 - Proteomics - Clinical Applications](#)

[Lecture 62 - Perspectives in Proteogenomics - II](#)

[Lecture 63 - Predictive Analysis - I](#)

[Lecture 64 - Predictive Analysis - II](#)

[Lecture 65 - Association/ Marker Selection](#)

[Lecture 66 - WebGestalt - I](#)

[Lecture 67 - WebGestalt - II](#)

[Lecture 68 - Perspectives in Proteogenomics - III](#)

[Lecture 69 - Network Analysis - I](#)

[Lecture 70 - Network Analysis - II](#)

[Lecture 71 - Mutations and Signaling - I](#)

[Lecture 72 - Mutations and Signaling - II](#)

[Lecture 73 - Pathway Enrichment - I](#)

[Lecture 74 - Perspectives in Proteogenomics - IV](#)

[Lecture 75 - Pathway Enrichment - II](#)

[Lecture 76 - Sequence - GSEA](#)

[Lecture 77 - Linked Omics - I](#)

[Lecture 78 - Linked Omics - II](#)

[Lecture 79 - Proteogenomics - Opportunities and Challenges](#)

[Lecture 80 - Perspectives in Proteogenomics - V](#)

Lecture 1 - Introduction to Proteomics

Lecture 2 - Introduction to Interactomics

Lecture 3 - High throughput platforms of interactomics: Protein arrays

Lecture 4 - Cell-free expression based protein microarrays

Lecture 5 - NAPPA: Recombinational Cloning, Basic workflow, Surface Chemistry, Printing and Assessment

Lecture 6 - NAPPA Technology and Protein Arrays - I

Lecture 7 - NAPPA Technology and Protein Arrays - II

Lecture 8 - Biomarkers: Harnessing the immune system for early detection of disease - I

Lecture 9 - Biomarkers: Harnessing the immune system for early detection of disease - II

Lecture 10 - Biomarkers: Harnessing the immune system for early detection of disease - III

Lecture 11 - NAPPA and its applications in study of antibody immune response in disease and in drug screening - I

Lecture 12 - NAPPA and its applications in study of antibody immune response in disease and in drug screening - II

Lecture 13 - NAPPA and its applications in study of antibody immune response in disease and in drug screening - III

Lecture 14 - Using functional proteomics to identify biomarkers and therapeutic targets - I

Lecture 15 - Using functional proteomics to identify biomarkers and therapeutic targets - II

Lecture 16 - Applications of protein microarrays in Malaria Research - I

Lecture 17 - Applications of protein microarrays in Malaria Research - II

Lecture 18 - Introduction to Bioprinting and IrisOptical QC Benefits - I

Lecture 19 - Introduction to Bioprinting and IrisOptical QC Benefits - II

Lecture 20 - Screening of autoantibody signatures in cancer patients: Lab demonstration

Lecture 21 - Basics of Image Scanning and data acquisition

Lecture 22 - Applications of protein arrays in identification of autoantibody signatures - I

Lecture 23 - Applications of protein arrays in identification of autoantibody signatures - II

Lecture 24 - Applications of protein microarrays in deciphering PTMs and biological networks

Lecture 25 - Basics and Applications of Reverse Phase Protein Arrays - I

Lecture 26 - Basics and Applications of Reverse Phase Protein Arrays - II

Lecture 27 - Basics and Applications of Reverse Phase Protein Arrays - III

Lecture 28 - An overview of label-free technologies

Lecture 29 - Surface Plasmon Resonance - Principles and Assays - I

Lecture 30 - Surface Plasmon Resonance - Principles and Assays - II

Lecture 31 - Basics of SPR: Surface chemistry

[Lecture 32 - Basics of SPR: Experimental design](#)

[Lecture 33 - Protein immobilization for protein-protein interaction studies](#)

[Lecture 34 - Protein-protein interaction study: Binding analysis](#)

[Lecture 35 - Protein-protein interaction study: Kinetic analysis](#)

[Lecture 36 - Use of SPR in unravelling domain motif interactions of proteasomal assembly chaperones](#)

[Lecture 37 - Protein-small molecule interaction study: Immobilization and binding analysis](#)

[Lecture 38 - Protein-small molecule interaction study: Kinetic analysis](#)

[Lecture 39 - An introduction to biolayer interferometry \(BLI\) and its applications in protein research](#)

[Lecture 40 - Biomolecular interactions using Bio-Layer Interferometry \(BLI\) - I](#)

[Lecture 41 - Biomolecular interactions using Bio-Layer Interferometry \(BLI\) - II](#)

[Lecture 42 - Lab session- An introduction to BioLayer Interferometry \(BLI\) and its applications in protein research](#)

[Lecture 43 - Applications of label-free technologies - II](#)

[Lecture 44 - Biomolecular interaction analytics using MicroScale Thermophoresis](#)

[Lecture 45 - Mass Spectrometry coupled Interactomics - I](#)

[Lecture 46 - Mass Spectrometry coupled Interactomics - II](#)

[Lecture 47 - Next-Generation Sequencing Technology - Ion Torrent](#)

[Lecture 48 - NGS Technology - Bioinformatics and data analysis - I](#)

[Lecture 49 - NGS Technology - Bioinformatics and data analysis - II](#)

[Lecture 50 - Next-Generation Sequencing Technology- Illumina](#)

[Lecture 51 - Agilent complete NGS target enrichment workflow for exomes, targeted panels and beyond](#)

[Lecture 52 - The Human Pathology Atlas: A Pathology Atlas of the Human Transcriptome - I](#)

[Lecture 53 - The Human Pathology Atlas: A Pathology Atlas of the Human Transcriptome - II](#)

[Lecture 54 - Statistical Analysis - I](#)

[Lecture 55 - Statistical Analysis - II](#)

[Lecture 56 - Secondary Data Analysis](#)

[Lecture 57 - Pathway Enrichment and Network Analysis](#)

[Lecture 58 - Data Repositories and Databases](#)

[Lecture 59 - Application of multi-omics approach for better understanding of cancers](#)

[Lecture 60 - Integrated Omics and Systems Biology- Conclusion](#)

Lecture 1 - NFHS 5 data

Lecture 2 - Evidences from the field

Lecture 3 - MIYCF framework

Lecture 4 - Capacity building

Lecture 5 - The story of urban and rural NGO and the story of Kailash

Lecture 6 - CNNS Nutrition data of children between 5-9 years of age

Lecture 7 - New Learnings - HST Pedagogy

Lecture 8 - Nutrients essential in children - Type 1 and Type 2 nutrients

Lecture 9 - Hidden hunger and types of malnutrition

Lecture 10 - Importance of Protein

Lecture 11 - Importance of Fat

Lecture 12 - Importance of Folate

Lecture 13 - Importance of Vitamin B12

Lecture 14 - Importance of Selenium

Lecture 15 - Importance of Calcium and Calcium rich recipes

Lecture 16 - Importance of Magnesium and Magnesium rich recipes

Lecture 17 - Importance of Potassium and Potassium rich recipes

Lecture 18 - Junk food and reasons for consumption of junk food

Lecture 19 - Importance of Insulin

Lecture 20 - Introduction to macronutrients

Lecture 21 - First 1,000 days LIVE session-Importance of first 1000 days spoken tutorial

Lecture 22 - Essential nutrition actions for pregnant women

Lecture 23 - Importance of Iron-Iron rich veg and non-veg recipes

Lecture 24 - Importance of Vitamin C and vitamin C rich recipes

Lecture 25 - Sulphur Live session-Importance of sulphur-Sulphur rich recipes

Lecture 26 - Science of breastfeeding

Lecture 27 - Golden hour-Importance of golden hour and Colostrum feeding Spoken Tutorial

Lecture 28 - Importance of breastfeeding-Comparsion of breatsmilk with other substitutes

Lecture 29 - Breast crawl during normal delivery and ceasarean delivery

Lecture 30 - Indian law to protect breastfeeding

Lecture 31 - Spoken tutorials on new born care and how to bathe a baby

[Lecture 32 - Spoken tutorials on KMC and KMC bag making](#)

[Lecture 33 - Mother's Preparation and Baby's Positioning](#)

[Lecture 34 - Holding the Breast and Latching the Baby to the Breast](#)

[Lecture 35 - Other Counselling Points](#)

[Lecture 36 - Health Spoken Tutorial on Cross Cradle Hold and Latching](#)

[Lecture 37 - Solutions to Problems faced while Feeding the Baby in Cross Cradle Hold](#)

[Lecture 38 - Live PDF of Positioning and Latching](#)

[Lecture 39 - Other breastfeeding holds - Football hold. Cradle hold](#)

[Lecture 40 - Sidelying Hold and Laid back Hold](#)

[Lecture 41 - Poor weight gain due to breastfeeding factors and other factors](#)

[Lecture 42 - Breastfeeding During Covid](#)

[Lecture 43 - Manual Expression and storage of Breastmilk and how to feed expressed breastmilk](#)

[Lecture 44 - Nipple conditions, complications of nipple shields. Breast conditions](#)

[Lecture 45 - Guidelines for complementary feeding. General guidelines](#)

[Lecture 46 - Personal Hygiene needed for handling baby food. Safe preparation and storage of baby food](#)

[Lecture 47 - Vegetarian and non-vegetarian recipes for 6-month-old babies. Powder recipes for babies](#)

[Lecture 48 - Vegetarian and non-vegetarian recipes for 7-month-old and 8 to 11-month-old babies](#)

[Lecture 49 - Issues faced during complementary feeding](#)

[Lecture 50 - Veg recipes for 12-18 month old babies-Non-veg recipes for 12-18 month old babies](#)

[Lecture 51 - Veg recipes for 19-24 month old children-Non-veg recipes for 19-24 month old children](#)

[Lecture 52 - Celebration recipes - Delicious recipes for kids parties](#)

[Lecture 53 - Vegetarian and Non vegetarian recipes for Adolescents. Pre pregnancy nutrition](#)

[Lecture 54 - Nutritious vegetarian and non-vegetarian recipes for pregnant women](#)

[Lecture 55 - Nutritious vegetarian and non-vegetarian recipes for lactating women](#)

[Lecture 56 - The WHO Multicentre Growth Reference Study \(1997-2003\)](#)

[Lecture 57 - Standard Normal Deviation. WHO Z Score Charts](#)

[Lecture 58 - Spoken tutorials on WHO weight-for-age and length-for-age percentile growth charts](#)

[Lecture 59 - Anthropometric Measurements](#)

[Lecture 60 - Cross Cradle Hold and 45 points - IEC chart - Part 1](#)

[Lecture 61 - Cross Cradle Hold and 45 points - IEC chart - Part 2. Breastfeeding assessment form](#)

[Lecture 62 - Nutrition Chart](#)

[Lecture 63 - Learning Action Protocol - Part 1](#)

[Lecture 64 - Learning Action Protocol - Part 2](#)

[Lecture 65 - Keypoints of Maternal, Infant and Young Child Nutrition](#)

DIGIMAT - The No.1 Learning Management Platform for Creative Learning

[illegible]

Lecture 29 - à^aàⁱà^oà^uà^eà^yà^äà^ö : à@à%à& à•à€ àààâàãàäàåàæàçàèàéàêàëàìàíàîàïàªà«à¬à®à¯à°à±à²à³à´àµà¶à·à¸à¹àºà»à¼à½à¾à¿àÀàÁàÂàÃàÄàÅàÆàÇàÈàÉàÊàËàÌàÍàÎàÏàÐàÑàÒàÓàÔàÕàÖà×àØàÙàÚàÛàÜàÝàÞàßàà

Lecture 30 - àçà¥ä, àçà°à³¼ ä²â¥‡äç•â¥àðšà° : àç, â¥àääà°- äç•â¥(äºâç•àçìàò¼äå°ä²¼ ä²”ä° äç—àçšâ¥àðšâ¥‡ äç•â¥(àç, â¥àääà°-
àç, â¥‡ ä²äç—ä³¼äè”ä³¼

Lecture 31 - àðà¥€àð,à°à³/4 à²à¥†àð•à¥àðšà° : àð...àð"à¥àð- àªà°à³/4àð®à°à¥àð¶ àð¬àð¿àð,àð|à¥

Lecture 32 - àòšàŸEàòŸàó% àò²àŸàŸà•àŸàòšàò : à•àŸàòàŸ%àò, à•àŸàòàŸ‡àò;àò² à,àŸàòŸàòà¿àòà¿à¿à”àò² àò²àŸ^àòšà¿à¿à,à—àò²àò² àò¹àŸàŸàò²àŸàòŸ à àŸàòà²àŸ(à•àò² àòŸàŸàò²àŸ,àòŸàŸ(àò²à¿à¿à²àò²

[illegible]

Lecture 34 - àçàç àç¼ à²à¥†àç•àçàç° : àç,à¥àçàçàçàçàç àç°àç àç—àç°à¥† àççà¥àçàç¼àç¼àçµ àç•à¥† àç²àç¼àç†àçµ àçµà¥àçàçàçàçàçàç

Lecture 35 - à^aà¹à²à³/₄ à²à[†]à[•]à[¥]à^sà[°]-à... : à à[¥]à[∞]à[∞]à^aà³/à[∞] à[•]à[†] à²à^j;à à«à[¥]à^Yà⁻à[¥]%à² à^aà[•]à^j;à¹/₄

Lecture 36 - àç•àŸ,àç,àç°àç¼ àç•àŸ‡àç•àŸàçšàç°-àç... : àçàç• àçççàç°àç« àç²àŸ‡àçŸ àç•àç° àç,àŸàçççàç°àç°àç¼àç° àç•àç°àç³⁄⁴àç°àŸ‡àç•àŸ€ àç°àç•àç¼àç¼

[illegible]

Lecture 38 - àðšà¥CEàð¥àð³/4 àð²à¥†àð•à¥àðšàð° : àð•à¥(àðuàð;àð; - 19 àð•à¥† àð†à¥CEàð°àð³/4àð° àð.à¥àððàð°àð°àð³/4àð°

Lecture 39 - à⁴à³/₄à•àðšàùà³/₄ à²à¥†àð•à¥àðšà°-à... : à¹à³/₄àð¥ àð à¥† àð à¥àððàð" àð•à³/₄ àð|à¥.àð§ àð"àð; àð•à³/₄àð²àð"àð³/₄

Lecture 40 - àðàð àð¼ à²à¥‡à²à¥à³à°-à... : àð,à¥à³à²à²à²à³⁄à² à²•à²à²⁄à³àà¥€ à²@à²⁄à²à²à², à²•à¥‡ à²à²¿à²à¥à²à² à²à¥€ à²,à¥à³à¥à;à³àà;

Lecture 41 - àòàáà²à³¼ à²à¥àðà¥àòàó-à... : 6 à,à¥‡ 24 à@à!à¥Càà¥‡ à•à¥‡ à@à¼à¼à¥àð“à, à•à¥‡ à²àöàò
à²à¥,àòàç •à†à¹à³¼àò à•à¥‡ à,àç,àç-àç,àç\$ à@à¥‡à, à¼à¼,à¼à¼¾-à”à; àòà¥àà¥‡àç

[illegible][illegible]

Lecture 44 - àðšàŸĈàŸàŸà³⁄₄ à²àŸ‡àò•àŸàòšàòš-à... : 7 à@à¹àŸĈàò•àŸ‡ àò•àŸ‡ àò-àòšàŸàòšàŸ(àò, àò•àŸ‡ àò²àòòàò àòªà³⁄₄àà¹àò³⁄₄àò¹àò³⁄₄àò¹àŸĈ àà-àò³⁄₄àà²àò³⁄₄ àà-àò³⁄₄àà²àò³⁄₄àò¹àŸ‡ àò•àŸ‡ àòàààòàŸĈàò•àŸ‡

[illegible][illegible]

Lecture 47 - à¶à¥,à¶,à¶òà¶¼ à¶à¥†à¶•à¥à¶à¶ : 12 à¶,à¥† 18 à¶@à¶à¥Cà¶à¥† à¶•à¥† à¶-à¶sä¥à¶sä¥(à¶, à¶•à¥† à¶òà¶_à¶
à¶¶à¶¾à¶•à¶¾à¶à¶à¶¾à¶à¥C à¶-à¶¾à¶òà¶¼ à¶-à¶à¶¾à¶à¶à¥† à¶•à¥† à¶à¶à¶à¥Cà¶à¥†|

Lecture 48 - àààÀCàò, àà²à³¼ àà²À†àò·àYàòSàò : 19 àò, À†‡ 24 àò@à¹ÀYCaò·À†‡ àò·À†‡ àò-àòSàYàòSàY(àò, àò·À†‡ àò²àò²àò àò¹àò³¼àò·àò¹àò³¼àò¹ÀYCaò-àò³¼àò¹àò³¼ àò-àò²àò³¼àò¹À† àò·À†‡ àòàòàòÀYCaò·àY†

[illegible][illegible]

[illegible][illegible][illegible]

Lecture 54 - àð|àŸ,àð,àðòàð% àð²àŸ†àð·àŸàððàð° : àð@àð³/4àð²àð· àð,àð³/4àð@àð³/4àð²àŸàð² àðµàððàððàð²àð²| àð;àð-àŸàð²àŸàð²àŸ,àðàððàð²“ àðceàŸ†àð; àð àŸàð·àŸ(àð² àððàð³/4àð²àŸàðŸ

[illegible]

Lecture 56 - àðšà¥œàð¥à³¼ à²à¥†àð•à¥àðšà° : àðàð,àð¥à¥à°à¥«à²à¥«àð®à¥†àðÿà¥à°àð;àð• àð®à³¼à²à

Lecture 57 - àªà¹à²à³⁴ à²à¥‡à¤•à¥à¤šà° : à¤,à¥à¤¤à¤“àªà³⁴à¤” à¤•à¥‡ à²à¤¤à¤ à¥à¥« àªà°à³⁴à¤@à¤à¥à¤¶ à¤-à¤¤à¤,à¤|à¥-à¤à³⁴⁵à¤—]

[illegible]

Lecture 59 - àààààààà àà°àà³⁄₄ à²à¹à¹àà•à¹ààšàà° : ààªà¹(àà·àà£ ààšàà³⁄₄àà°à¹ààŸ

Lecture 60 - àðšàŸEàðŸàð³/₄ àð²àŸŸàð•àŸàðšàð° : àð²àð°àŸàð"àð/àð,àð— àðàð•àŸàð¶àð" àð⁴àŸàð°àŸ(àðŸàŸ(àð•àŸ%àð² - àðàð³/₄àð— 1

Lecture 61 - à^aà^o/à^o,à^osà^oµà^o% à^oà^o¥†:à^o•à^o¥à^osà^o: à^oà^oà^oà^o¥à^oà^oà^oà^o— à^oà^o•à^o¥à^oà^oà^o à^oà^o¥à^oà^oà^o¥(à^oYà^o(à^o•à^o¥%à^o- à^oà^o/à^o

—2

Lecture 62 - àðàð àð³/à ò²à¥¥¥àð•à¥àòsàò : àò@àò³/4àòòà¥f, àò¶àò¿àò¶à¥ àò''àò° àò-àò³/4àò² àòªà¥(àò-àò£ àò•à¥¥¥ àòªà¥àò°àò®à¥àò-àò-àò¿;àð,àò'à¥

Lecture 1 - Introduction and Scope to Enzyme Science and Engineering

Lecture 2 - Characteristic Features of Enzymes

Lecture 3 - Enzymes as Biocatalysts

Lecture 4 - Enzymatic Catalysis

Lecture 5 - Specificity of Enzyme Action

Lecture 6 - Kinetics of Enzyme Catalyzed Reactions

Lecture 7 - Kinetics of Enzyme Catalyzed Reactions

Lecture 8 - Deviation from Hyperbolic Enzyme Kinetics

Lecture 9 - Role of Effector Molecules in Enzyme Kinetics

Lecture 10 - Reversible Inhibition

Lecture 11 - Effect of PH and Temperature on Enzyme

Lecture 12 - Kinetics of Bi substrate Enzyme

Lecture 13 - Kinetics of Bi substrate Enzyme

Lecture 14 - Immobilized Enzymes - I

Lecture 15 - Immobilized Enzymes - II

Lecture 16 - Immobilized Enzymes - III

Lecture 17 - Immobilization of Enzymes by Entrapment

Lecture 18 - Effect of Immobilization

Lecture 19 - Reactors for Enzyme Catalyzed Reactions

Lecture 20 - Idealized Enzyme Reactor Performance

Lecture 21 - Idealized Enzyme Reactor Performance

Lecture 22 - Kinetic Parameters for IME Systems

Lecture 23 - Steady State Analysis of Mass Transfer

Lecture 24 - Steady State Analysis of Mass Transfer

Lecture 25 - Non Ideal Flow in Continuous Immobilized Enzyme

Lecture 26 - Applications of Immobilized Enzymes in Process

Lecture 27 - Analytical Applications

Lecture 28 - Enzyme Technology Challenges

[Lecture 1 - Mathematical modeling in Biology](#)

[Lecture 2 - How to Start Modeling](#)

[Lecture 3 - Modeling the spread of infectious disease](#)

[Lecture 4 - Modeling population growth](#)

[Lecture 5 - Numerical solution of ODE-1](#)

[Lecture 6 - Numerical solution of ODE-2](#)

[Lecture 7 - Simulating ODE-based models: Introduction to JSim](#)

[Lecture 8 - Simulating ODE-based models: Examples of simulation in JSim](#)

[Lecture 9 - Steady state and stability analysis: Understanding Steady State](#)

[Lecture 10 - Steady state and stability analysis: Stability of Steady States](#)

[Lecture 11 - Phase Plane Analysis - I](#)

[Lecture 12 - Phase Plane Analysis - II](#)

[Lecture 13 - Concepts of Bifurcation:Introduction](#)

[Lecture 14 - Concepts of Bifurcation:Bifurcation in Biological Systems](#)

[Lecture 15 - Modeling Molecular Processes in Cell: Introduction](#)

[Lecture 16 - Modeling Molecular Processes in Cell: Receptor-Ligand Interaction](#)

[Lecture 17 - Modeling Molecular Processes in Cell: Enzymatic Processes](#)

[Lecture 18 - Modeling Molecular Processes in Cell: Transcription and Translation](#)

[Lecture 19 - Modeling Cell Signaling: Negative Feedback Motif](#)

[Lecture 20 - Modeling Cell Signaling: Positive Feedback Motif](#)

[Lecture 21 - Modeling Cell Signaling: Incoherent Feedforward Motif](#)

[Lecture 22 - Modeling Transcriptional Circuits-1](#)

[Lecture 23 - Modeling Transcriptional Circuits-2](#)

[Lecture 24 - Online Resources for Mathematical Modeling in Biology](#)

[Lecture 1 - Cellular Structure - Part I](#)

[Lecture 2 - Cellular Structure - Part II](#)

[Lecture 3 - Cellular Structure - Part III](#)

[Lecture 4 - Metabolic Reactions in Biological System](#)

[Lecture 5 - Growth Media For Different Expression System](#)

[Lecture 6 - Microbial Growth Kinetics](#)

[Lecture 7 - Isolation of a Gene Fragment - Part I](#)

[Lecture 8 - Isolation of a Gene Fragment - Part II](#)

[Lecture 9 - Isolation of a Gene Fragment - Part III](#)

[Lecture 10 - Polymerase Chain Reaction](#)

[Lecture 11 - Molecular Tools for Cloning](#)

[Lecture 12 - Cloning Vectors - I](#)

[Lecture 13 - Cloning Vectors - II](#)

[Lecture 14 - DNA Delivery In Host - Part I](#)

[Lecture 15 - DNA Delivery In Host - Part II](#)

[Lecture 16 - Screening of Recombinant Clones](#)

[Lecture 17 - Protein Production in Host - Part 1](#)

[Lecture 18 - Protein Production in Host - Part 2](#)

[Lecture 19 - Protein Production in Host - Part 3](#)

[Lecture 20 - Product Recovery from Host Cells](#)

[Lecture 21 - Basics of Chromatography - Part 1](#)

[Lecture 22 - Basics of Chromatography - Part 2](#)

[Lecture 23 - Ion-exchange Chromatography](#)

[Lecture 24 - Hydrophobic Interaction Chromatography](#)

[Lecture 25 - Gel Filtration chromatography - Part 1](#)

[Lecture 26 - Gel Filtration chromatography - Part 2](#)

[Lecture 27 - Affinity Chromatography - Part 1](#)

[Lecture 28 - Affinity Chromatography - Part 2](#)

[Lecture 29 - Affinity Chromatography - Part 3](#)

[Lecture 30 - Affinity Chromatography - Part 4](#)

[Lecture 31 - Electrophoresis - Part 1](#)

[Lecture 32 - Electrophoresis - Part 2](#)

[Lecture 33 - Electrophoresis - Part 3](#)

[Lecture 34 - Protein Sequencing](#)

[Lecture 35 - Spectroscopy - Part I](#)

[Lecture 36 - Spectroscopy - Part II](#)

[Lecture 37 - Biotechnology Applications - Part 1](#)

[Lecture 38 - Biotechnology Applications - Part 2](#)

[Lecture 39 - Biotechnology Applications - Part 3](#)

[Lecture 40 - Summary and Conclusions - Part 1](#)

[Lecture 41 - Summary and Conclusions - Part 2](#)

Lecture 1 - Good Lab Practices - Part 1

Lecture 2 - Good Lab Practices - Part 2

Lecture 3 - Operation of Laboratory Instruments - Part 1

Lecture 4 - Operation of Laboratory Instruments - Part 2

Lecture 5 - Operation of Laboratory Instruments - Part 3

Lecture 6 - Solution and Buffer Preparation

Lecture 7 - Basics of Electrophoresis - Part 1

Lecture 8 - Basics of Electrophoresis - Part 2

Lecture 9 - Horizontal Gel Electrophoresis

Lecture 10 - Different Variants of Gel Electrophoresis

Lecture 11 - Scientific Questions - Part 1

Lecture 12 - Scientific Questions - Part 2

Lecture 13 - Scientific Questions - Part 3

Lecture 14 - Scientific Questions - Part 4

Lecture 15 - Basics of Chromatography - Part 1

Lecture 16 - Basics of Chromatography - Part 2

Lecture 17 - Ion-Exchange Chromatography - Part 1

Lecture 18 - Ion-Exchange Chromatography - Part 2

Lecture 19 - Hydrophobic Interaction Chromatography

Lecture 20 - Gel Filtration Chromatography - Part 1

Lecture 21 - Gel Filtration Chromatography - Part 2

Lecture 22 - Gel Filtration Chromatography - Part 3

Lecture 23 - Affinity Chromatography - Part 1

Lecture 24 - Affinity Chromatography - Part 2

Lecture 25 - Affinity Chromatography - Part 3

Lecture 26 - Affinity Chromatography - Part 4

Lecture 27 - Antibody Generation

Lecture 28 - Antibody-Antigen Interaction - Part 1

Lecture 29 - Immunoassay

Lecture 30 - Antibody-Antigen Interaction - Part 2

Lecture 31 - Antibody-Antigen Interaction - Part 3

[Lecture 32 - Cell Culture Medium](#)

[Lecture 33 - Cell Fractionation](#)

[Lecture 34 - Microscopy - Part 1](#)

[Lecture 35 - Microscopy - Part 2](#)

[Lecture 36 - Cell Biology Experiments](#)

[Lecture 37 - Flow Cytometry](#)

[Lecture 38 - Polymerase Chain Reaction - Part 1](#)

[Lecture 39 - Polymerase Chain Reaction - Part 2](#)

[Lecture 40 - Polymerase Chain Reaction - Part 3](#)

[Lecture 41 - Polymerase Chain Reaction - Part 4](#)

[Lecture 42 - Sequencing Techniques](#)

[Lecture 43 - Blotting Techniques - Part 1](#)

[Lecture 44 - Blotting Techniques - Part 2](#)

[Lecture 45 - Designing Experiments](#)

Lecture 1 - Intermolecular Forces

Lecture 2 - Classification of Intermolecular Forces

Lecture 3 - Thermodynamics Aspects of Intermolecular Forces

Lecture 4 - Surface Tension and Energy

Lecture 5 - Wettability

Lecture 6 - Adhesion and Cohesion

Lecture 7 - Methods for Surface Tension Measurement

Lecture 8 - Methods for Contact Angle Measurement

Lecture 9 - Determination of Surface Tension of Solids

Lecture 10 - Protein Adsorption

Lecture 11 - Characterization of Protein Adsorption

Lecture 12 - Kinetics of Protein Adsorption

Lecture 13 - Aggregation of Proteins

Lecture 14 - Kinetics of Protein Aggregation

Lecture 15 - Effect of Surfaces on the Aggregation of Protein

Lecture 16 - Host Responses to Biomaterials

Lecture 17 - Cell Adhesion

Lecture 18 - Biocompatibility of Biomaterials

Lecture 19 - Surface Modification

Lecture 20 - Surface Modification Techniques

Lecture 21 - Coating of Calcium Phosphates on Ti-6Al-4V

Lecture 22 - Surface Characterization

Lecture 23 - Self-Assembled Monolayers

Lecture 24 - Effect of SAMs on Biointerfacial Interactions

Lecture 1 - Introduction to Living Organisms

Lecture 2 - Classification of Living Organisms - Part 1

Lecture 3 - Classification of Living Organisms - Part 2

Lecture 4 - Classification of Living Organisms - Part 3

Lecture 5 - Classification of Living Organisms - Part 4

Lecture 6 - Origin of Life - Part 1

Lecture 7 - Origin of Life - Part 2

Lecture 8 - Evolution - Part 1

Lecture 9 - Evolution - Part 2

Lecture 10 - Evolution - Part 3

Lecture 11 - Basics of Cells - Part 1

Lecture 12 - Basics of Cells - Part 2

Lecture 13 - Basics of Cells - Part 3

Lecture 14 - Cell Division and regulation

Lecture 15 - Nucleic acids

Lecture 16 - Carbohydrates - Part 1

Lecture 17 - Carbohydrates - Part 2

Lecture 18 - Carbohydrates - Part 3

Lecture 19 - Lipids

Lecture 20 - Proteins - Part 1

Lecture 21 - Proteins - Part 2

Lecture 22 - Proteins - Part 3

Lecture 23 - Proteins - Part 4

Lecture 24 - Central Dogma of Life

Lecture 25 - Replication

Lecture 26 - Polymerase chain reaction

Lecture 27 - Transcription - Part 1

Lecture 28 - Transcription - Part 2

Lecture 29 - Translation - Part 1

Lecture 30 - Translation - Part 2

Lecture 31 - Immune system - Part 1

[Lecture 32 - Immune system - Part 2](#)

[Lecture 33 - Phagocytosis](#)

[Lecture 34 - Cell Death and Apoptosis](#)

[Lecture 35 - Vesicular Transport](#)

[Lecture 36 - Digestion - Part 1](#)

[Lecture 37 - Digestion - Part 2](#)

[Lecture 38 - Digestion - Part 3](#)

[Lecture 39 - Circulatory System - Part 1](#)

[Lecture 40 - Circulatory System - Part 2](#)

[Lecture 41 - Muscular System - Part 1](#)

[Lecture 42 - Muscular System - Part 2](#)

[Lecture 43 - Nervous System - Part 1](#)

[Lecture 44 - Nervous System - Part 2](#)

[Lecture 45 - Nervous System - Part 3](#)

[Lecture 46 - Homeostasis - Part 1](#)

[Lecture 47 - Homeostasis - Part 2](#)

[Lecture 48 - Homeostasis - Part 3](#)

[Lecture 49 - Summary and Conclusions - Part 1](#)

[Lecture 50 - Summary and Conclusions - Part 2](#)

Lecture 1 - Rules of probability

Lecture 2 - Discrete probability distribution

Lecture 3 - Continuous probability distribution

Lecture 4 - Moments: mean and variance

Lecture 5 - Moments: variance and covariance

Lecture 6 - Bayes theorem and likelihood

Lecture 7 - Concept of statistical tests

Lecture 8 - Vector and vector operations

Lecture 9 - Matrix and matrix operations

Lecture 10 - Determinant and Inverse of a matrix

Lecture 11 - Eigenvalue and eigenvector

Lecture 12 - Linear system of equations

Lecture 13 - Singular value decomposition

Lecture 14 - Getting ready with R

Lecture 15 - Algebraic and logical operations in R

Lecture 16 - Reading and writing data

Lecture 17 - Statistics using R - descriptive statistics

Lecture 18 - Statistics using R - t-test and ANOVA

Lecture 19 - Linear algebra using R

Lecture 20 - Scatter plot, Line plot and Bar plot

Lecture 21 - Histogram and Box plot

Lecture 22 - Heatmap and Volcano plot

Lecture 23 - Network visualization

Lecture 24 - Data visualization using ggplot2 - I

Lecture 25 - Data visualization using ggplot2 - II

Lecture 26 - Correlations

Lecture 27 - Linear regression - I

Lecture 28 - Linear regression - II

Lecture 29 - Linear regression using R

Lecture 30 - Multiple linear regression

Lecture 31 - Multiple linear regression using R

[Lecture 32 - Nonlinear regression](#)

[Lecture 33 - Nonlinear regression using R](#)

[Lecture 34 - Clustering and classification](#)

[Lecture 35 - Logistic regression](#)

[Lecture 36 - Logistic regression using R](#)

[Lecture 37 - Distance measures for clustering](#)

[Lecture 38 - k-means clustering](#)

[Lecture 39 - k-means clustering using R](#)

[Lecture 40 - Hierarchical clustering](#)

[Lecture 41 - Hierarchical clustering using R](#)

[Lecture 42 - Decision tree classifier](#)

[Lecture 43 - Support vector machines](#)

[Lecture 44 - Higher-dimensional data in biology](#)

[Lecture 45 - Principle component analysis](#)

[Lecture 46 - Principle component analysis using R](#)

[Lecture 47 - t-SNE](#)

[Lecture 48 - t-SNE using R](#)

[Lecture 49 - Diffusion maps](#)

Lecture 1 - Introduction: Genes and Genome Organization

Lecture 2 - History and Basics of Genetic Engineering

Lecture 3 - Advantages and Limitations of Genetic Engineering

Lecture 4 - Breakage of Genomic DNA

Lecture 5 - Repair of Genomic DNA

Lecture 6 - Homologous and non homologous recombination

Lecture 7 - Site specific recombination

Lecture 8 - Targeted genetic modification - I

Lecture 9 - Targeted genetic modification - II

Lecture 10 - Basics of Zinc Finger Nucleases

Lecture 11 - Design of Zinc Finger Nucleases for genome editing

Lecture 12 - Applications of Zinc Finger Nucleases - Part A

Lecture 13 - Applications of Zinc Finger Nucleases - Part B

Lecture 14 - Basics of TALEN - Part A

Lecture 15 - Basics of TALEN - Part B

Lecture 16 - Design of TALEN for genome editing - Part A

Lecture 17 - Design of TALEN for genome editing - Part B

Lecture 18 - Application of TALEN - Part A

Lecture 19 - Application of TALEN - Part B

Lecture 20 - CRISPR system in bacteria - Part A

Lecture 21 - CRISPR system in bacteria - Part B

Lecture 22 - CRISPR/Cas9 in Genome Editing - Part A

Lecture 23 - CRISPR/Cas9 in Genome Editing - Part B

Lecture 24 - Applications of CRISPR/Cas9 - Part A

Lecture 25 - Applications of CRISPR/Cas9 - Part B

Lecture 26 - Computational Resources for CRISPR / Cas - Part A

Lecture 27 - Computational Resources for CRISPR / Cas - Part B

Lecture 28 - Human cell engineering in diseases : Thalassemia - Part A

Lecture 29 - Human cell engineering in diseases : Thalassemia - Part B

Lecture 30 - Human cell engineering in diseases : Severe combined immunodeficiency (SCID) - Part A

Lecture 31 - Human cell engineering in diseases : Severe combined immunodeficiency (SCID) - Part B

[Lecture 32 - Human cell engineering in diseases : Hemophilia - Part A](#)

[Lecture 33 - Human cell engineering in diseases : Hemophilia - Part B](#)

[Lecture 34 - Animal models - Part A](#)

[Lecture 35 - Animal models - Part B](#)

[Lecture 36 - iPSc models - Part A](#)

[Lecture 37 - iPSc models - Part B](#)

[Lecture 38 - Cancer disease models - Part A](#)

[Lecture 39 - Cancer disease models - Part B](#)

[Lecture 40 - Engineered immune cells for Cancer therapy \(I\) - Part A](#)

[Lecture 41 - Engineered immune cells for Cancer therapy \(I\) - Part B](#)

[Lecture 42 - Engineered immune cells for Cancer therapy \(II\) - Part A](#)

[Lecture 43 - Engineered immune cells for Cancer therapy \(II\) - Part B](#)

[Lecture 44 - History and Basics - Part A](#)

[Lecture 45 - History and Basics - Part B](#)

[Lecture 46 - Genome editing and personalized therapy](#)

[Lecture 47 - Bioethics and Biosafety - Part A](#)

[Lecture 48 - Bioethics and Biosafety - Part B](#)

[Lecture 49 - Regulatory issues in Genome Editing](#)

Lecture 1 - Introduction to Enzymes

Lecture 2 - Basics of Enzyme

Lecture 3 - Enzyme Classification - Part I

Lecture 4 - Enzyme Classification - Part II

Lecture 5 - Enzyme Nomenclature

Lecture 6 - Primary Structure of Enzyme

Lecture 7 - Determination of Primary Structure

Lecture 8 - Secondary Structure of Protein

Lecture 9 - Tertiary Structure of Enzyme - Part I

Lecture 10 - Tertiary Structure of Enzyme - Part II

Lecture 11 - Molecular Modelling of Enzyme Structure - Part II

Lecture 12 - Identification of Enzyme Gene - Part II

Lecture 13 - Identification of Enzyme Gene - Part II

Lecture 14 - Polymerase Chain Reaction

Lecture 15 - Enzymes in Molecular Cloning

Lecture 16 - Cloning of Enzyme Coding Gene

Lecture 17 - DNA Delivery in host - Part I

Lecture 18 - DNA Delivery in host - Part II

Lecture 19 - Screening of Recombinant Clones

Lecture 20 - Over-expression of Enzyme in host - Part I

Lecture 21 - Over-expression of Enzyme in host - Part II

Lecture 22 - Over-expression of Enzyme in host - Part III

Lecture 23 - Host Cell Disruption Methods

Lecture 24 - Basics of Chromatography

Lecture 25 - Chromatography - Part I

Lecture 26 - Chromatography - Part II

Lecture 27 - Chromatography - Part III

Lecture 28 - Carbohydrate Metabolism

Lecture 29 - Lipid Metabolism

Lecture 30 - Amino acid Metabolism and Detoxification

Lecture 31 - Enzyme-Substrate Interactions - Part I - Chromatographic Methods

[Lecture 32 - Enzyme-Substrate Interactions - Part II - Spectroscopic Methods](#)

[Lecture 33 - Enzyme-Substrate Interactions - Part III - ITC](#)

[Lecture 34 - Enzyme-Substrate Interactions - Part IV - SPR](#)

[Lecture 35 - Enzyme Assay System - Part I](#)

[Lecture 36 - Enzyme Assay System - Part II](#)

[Lecture 37 - Enzyme Assay System - Part III](#)

[Lecture 38 - Enzyme Kinetics](#)

[Lecture 39 - Inhibitor Designing - Part I - Traditional Approach](#)

[Lecture 40 - Inhibitor Designing - Part II - Modern Approach](#)

[Lecture 41 - Inhibitor Designing - Part III - Computational Approach](#)

[Lecture 42 - Enzyme Inhibition - Part I](#)

[Lecture 43 - Enzyme Inhibition - Part II](#)

[Lecture 44 - Application of Enzyme - Part I - Food Industry](#)

[Lecture 45 - Application of Enzyme - Part II - Medical Field](#)

[Lecture 46 - Enzyme in Drug Discovery](#)

[Lecture 47 - Enzymes in Environmental Field](#)

Lecture 1 - Cellular Structure (Prokaryotic cells)

Lecture 2 - Cellular Structure (Eukaryotic cells)

Lecture 3 - Cellular Structure (Eukaryotic cells)

Lecture 4 - Cell Fractionation - Part 1

Lecture 5 - Cell Fractionation - Part 2

Lecture 6 - Cellular Metabolism - Part 1

Lecture 7 - Cellular Metabolism - Part 2

Lecture 8 - Cell Cycle and Control - Part 1

Lecture 9 - Cell Cycle and Control - Part 2

Lecture 10 - Program Cell Death

Lecture 11 - Biomolecules - Part 1 : DNA

Lecture 12 - Biomolecules - Part 2 : DNA Sequencing

Lecture 13 - Biomolecules - Part 2 : RNA

Lecture 14 - Amino acids

Lecture 15 - Protein

Lecture 16 - Enzymes

Lecture 17 - Genetic Material - Part 1

Lecture 18 - Genetic Material - Part 2

Lecture 19 - Genetic Material - Part 3

Lecture 20 - Central Dogma of Molecular Biology

Lecture 21 - Replication - Part 1 : Prokaryotic System

Lecture 22 - Replication - Part 2 : Prokaryotic System

Lecture 23 - Replication - Part 2 : Eukaryotic System

Lecture 24 - Mutagenesis and repair Mechanism

Lecture 25 - Transcription in Prokaryotic system

Lecture 26 - Transcription in Eukaryotic System

Lecture 27 - Post Transcriptional modifications

Lecture 28 - Gene Control Mechanism - Part 1

Lecture 29 - Gene Control Mechanism - Part 2

Lecture 30 - Translation in Prokaryotic system

Lecture 31 - Translation in Eukaryotic System

[Lecture 32 - Post Translational modifications](#)

[Lecture 33 - Southern Blotting](#)

[Lecture 34 - Northern Blotting](#)

[Lecture 35 - Western Blotting - Part 1](#)

[Lecture 36 - Western Blotting - Part 2](#)

[Lecture 37 - Polymerase Chain Reaction - Part 1](#)

[Lecture 38 - Polymerase Chain Reaction - Part 2](#)

[Lecture 39 - Real-Time PCR](#)

[Lecture 40 - Cloning - Part 1](#)

[Lecture 41 - Cloning - Part 2](#)

[Lecture 42 - Cloning Vectors](#)

[Lecture 43 - DNA Delivery - Part 1](#)

[Lecture 44 - DNA Delivery - Part 2](#)

[Lecture 45 - Screening of Recombinant Clones](#)

[Lecture 46 - Protein Over-expression](#)

[Lecture 47 - Genome Editing - Part 1](#)

[Lecture 48 - Genome Editing - Part 2](#)

[Lecture 49 - Applications of Molecular Biology - Part 1](#)

[Lecture 50 - Applications of Molecular Biology - Part 2](#)

[Lecture 51 - Applications of Molecular Biology - Part 3](#)

[Lecture 52 - Applications of Molecular Biology - Part 4](#)

Lecture 1 - Introduction and principles of microbial biotechnology

Lecture 2 - Classification and taxonomy of microbes A

Lecture 3 - Classification and taxonomy of microbes B

Lecture 4 - Techniques for microbial Classification and Identification

Lecture 5 - Structure, life cycle and classification of viruses

Lecture 6 - Structure and life cycle of representative groups of prokaryotic microbes

Lecture 7 - Structure of cyanobacteria and archaea

Lecture 8 - Diversity and Structure of selected eukaryotic microorganisms

Lecture 9 - Life cycle of representative groups of microbes

Lecture 10 - Basic Physiology of Microorganisms

Lecture 11 - Physiology of Extremophiles and adaptation-energy storage, temperature, pH and pressure

Lecture 12 - Physiology of Extremophiles and adaptation-halophiles, xerophiles, radiophiles and metallaphiles

Lecture 13 - Genome structure, transcription, genetic code, translation

Lecture 14 - Regulation of gene expression

Lecture 15 - Microbial growth kinetics

Lecture 16 - Control methods: Physical methods

Lecture 17 - Control methods: Chemical methods

Lecture 18 - Control methods: Biological methods

Lecture 19 - Microorganisms in industry

Lecture 20 - Microorganisms in pharmaceutical industry

Lecture 21 - Microbial Enzymes of Industrial Importance

Lecture 22 - Engineered Microbial Consortia for Industry

Lecture 23 - Microbes in Agriculture

Lecture 24 - Microbial Biocontrol

Lecture 25 - Biopesticides and Integrated Pest Management

Lecture 26 - Microbial ecology, biogeochemical cycles

Lecture 27 - Microbial waste treatment methods

Lecture 28 - Microbial Bioremediation

Lecture 29 - Fermented Food - Foundations and Principles

Lecture 30 - Health Benefits, Risks and Advances in Food Fermentation

Lecture 31 - Fermented Beverages: Microbial Processes and Biotechnological Innovations

[Lecture 32 - Industrial Fermentation and Health Aspects of Fermented Beverages](#)

[Lecture 33 - Single Cell Protein production](#)

[Lecture 34 - Production of biopharmaceuticals \(Enzymes, antibodies and therapeutic proteins\) using rDNA technology](#)

[Lecture 35 - Production of vaccines](#)

[Lecture 36 - Production of Biofuel using microbes](#)

[Lecture 37 - Microbial fuel Cells \(MFCs\) and microbial electrolysis cells \(MECs\)](#)

[Lecture 38 - Introduction to IPR, biotechnology patents, app. process, legal and ethical considerations](#)

[Lecture 39 - Patenting in microbial biotechnology, commercialization and future of microbial patenting](#)

Lecture 1 - Origin of Life - Part 1

Lecture 2 - Origin of Life - Part 2

Lecture 3 - Basics of Evolution

Lecture 4 - Theories of Evolution - Part 1

Lecture 5 - Theories of Evolution - Part 2

Lecture 6 - Prokaryotic Cells

Lecture 7 - Eukaryotic Cells - Part 1

Lecture 8 - Eukaryotic Cells - Part 2

Lecture 9 - Cell Growth and regulation

Lecture 10 - Cell Growth Medium

Lecture 11 - Cell Growth Monitoring

Lecture 12 - Cell Cycle

Lecture 13 - Mitosis and Meiosis

Lecture 14 - Apoptosis and Autophagy

Lecture 15 - Transport in Prokaryotic Cells

Lecture 16 - Transport in Eukaryotic Cells - Part 1

Lecture 17 - Transport in Eukaryotic Cells - Part 2

Lecture 18 - Cellular Communication - Part 1

Lecture 19 - Cellular Communication - Part 2

Lecture 20 - Cellular Communication - Part 3

Lecture 21 - Genetic Material in Organism

Lecture 22 - Organization of Genome - Part 1

Lecture 23 - Organization of Genome - Part 2

Lecture 24 - Genome Damage and Repair Mechanism

Lecture 25 - Law of Inheritance - Part 1

Lecture 26 - Law of Inheritance - Part 2

Lecture 27 - Epigenetics

Lecture 28 - Genetic Recombination

Lecture 29 - Transgenic Organisms

Lecture 30 - Gene Regulation in Organism

Lecture 31 - Structure of DNA - Part 1

[Lecture 32 - Structure of DNA - Part 2](#)

[Lecture 33 - Structure of RNA](#)

[Lecture 34 - Central Dogma of Molecular Biology](#)

[Lecture 35 - Replication - Part 1](#)

[Lecture 36 - Replication - Part 2](#)

[Lecture 37 - Replication - Part 3](#)

[Lecture 38 - Transcription - Part 1](#)

[Lecture 39 - Transcription - Part 2](#)

[Lecture 40 - Translation](#)

[Lecture 41 - Components of Immune System](#)

[Lecture 42 - Antibody](#)

[Lecture 43 - Vaccines](#)

[Lecture 44 - Gene Therapy](#)

[Lecture 45 - Cell Factory: Concept and Application](#)

[Lecture 46 - Summary and Conclusion](#)

Lecture 1 - Overview of Fermentation Process

Lecture 2 - Strain Isolation and Process Flow

Lecture 3 - Metabolic Pathways

Lecture 4 - Cell Nutrients

Lecture 5 - Industrial Important Products

Lecture 6 - Material and mass balance

Lecture 7 - Stoichiometry of cell growth and product formation

Lecture 8 - Stoichiometry of cell growth and product formation

Lecture 9 - Stoichiometry of product formation

Lecture 10 - Metabolic energetics

Lecture 11 - Energy balance

Lecture 12 - Basic of Enzyme catalysis

Lecture 13 - Michaelis Menten Equation

Lecture 14 - Evaluation of kinetic Parameters

Lecture 15 - Enzyme Inhibition - 1

Lecture 16 - Enzyme Inhibition - 2

Lecture 17 - Immobilization of Enzymes

Lecture 18 - External Mass Transfer

Lecture 19 - Internal Mass Transfer

Lecture 20 - Simultaneous External and Internal mass Transfer

Lecture 21 - Application of Immobilized Enzyme

Lecture 22 - Microbial Growth Kinetics

Lecture 23 - Monod Equation

Lecture 24 - Transient Growth Kinetics - 1

Lecture 25 - Transient Growth Kinetics - 2

Lecture 26 - Primary and Secondary Metabolites

Lecture 27 - Structured kinetic model for product formation

Lecture 28 - Structured kinetic model - II

Lecture 29 - Product formation kinetics - I

Lecture 30 - Product formation kinetics - II

Lecture 31 - Ideal reactor operation - Batch fermentation

[Lecture 32 - Ideal reactor operation - fed batch and continuous with free cells](#)

[Lecture 33 - Ideal reactor operation - CSTR](#)

[Lecture 34 - Special Bioreactors](#)

[Lecture 35 - Mass transfer and diffusion related theories](#)

[Lecture 36 - Oxygen transfer from bubble to cell](#)

[Lecture 37 - Measurement of mass transfer coefficient](#)

[Lecture 38 - Role of Agitation](#)

[Lecture 39 - Heat transfer in bioprocessing](#)

[Lecture 40 - Cell death kinetics](#)

[Lecture 41 - Batch and continuous sterilization](#)

[Lecture 42 - Heat transfer equipment](#)

[Lecture 43 - Scale up](#)

[Lecture 44 - Sensors for Bioreactor](#)

[Lecture 45 - Measurement of Process Parameter](#)

[Lecture 46 - Process Control System](#)

[Lecture 47 - Process Dynamic](#)

[Lecture 48 - Process Controller](#)

[Lecture 49 - Importance of downstream processing](#)

[Lecture 50 - Centrifugation, filtration, sedimentation](#)

[Lecture 51 - Cell separation and disruption](#)

[Lecture 52 - Extraction and chromatography](#)

[Lecture 53 - Adsorption](#)

[Lecture 54 - Membrane separation](#)

[Lecture 55 - Drying](#)

[Lecture 56 - Introduction to bioprocess economics](#)

NPTEL : Animal Physiology (Biotechnology)

Co-ordinators : Prof. Mainak Das

[Lecture 1 - Animal Physiology](#)

[Lecture 2 - Animal Physiology](#)

[Lecture 3 - Animal Physiology](#)

[Lecture 4 - Animal Physiology](#)

[Lecture 5 - Animal Physiology](#)

[Lecture 6 - Animal Physiology](#)

[Lecture 7 - Animal Physiology](#)

[Lecture 8 - Animal Physiology](#)

[Lecture 9 - Animal Physiology](#)

[Lecture 10 - Animal Physiology](#)

[Lecture 11 - Animal Physiology](#)

[Lecture 12 - Animal Physiology](#)

[Lecture 13 - Animal Physiology](#)

[Lecture 14 - Animal Physiology](#)

[Lecture 15 - Animal Physiology](#)

[Lecture 16 - Animal Physiology](#)

[Lecture 17 - Animal Physiology](#)

[Lecture 18 - Animal Physiology](#)

[Lecture 19 - Animal Physiology](#)

[Lecture 20 - Animal Physiology](#)

[Lecture 21 - Animal Physiology](#)

[Lecture 22 - Animal Physiology](#)

[Lecture 23 - Animal Physiology](#)

[Lecture 24 - Animal Physiology](#)

[Lecture 25 - Animal Physiology](#)

[Lecture 26 - Animal Physiology](#)

[Lecture 27 - Animal Physiology](#)

[Lecture 28 - Animal Physiology](#)

[Lecture 29 - Animal Physiology](#)

[Lecture 30 - Animal Physiology](#)

[Lecture 31 - Animal Physiology](#)

[Lecture 32 - Animal Physiology](#)

[Lecture 33 - Animal Physiology](#)

[Lecture 34 - Animal Physiology](#)

[Lecture 35 - Animal Physiology](#)

[Lecture 36 - Animal Physiology](#)

[Lecture 37 - Animal Physiology](#)

[Lecture 38 - Animal Physiology](#)

[Lecture 39 - Animal Physiology](#)

[Lecture 40 - Animal Physiology](#)

NPTEL : Bio electricity (Biotechnology)

Co-ordinators : Prof. Mainak Das

[Lecture 1 - Bio electricity](#)

[Lecture 2 - Bio electricity](#)

[Lecture 3 - Bio electricity](#)

[Lecture 4 - Bio electricity](#)

[Lecture 5 - Bio electricity](#)

[Lecture 6 - Bio electricity](#)

[Lecture 7 - Bio electricity](#)

[Lecture 8 - Bio electricity](#)

[Lecture 9 - Bio electricity](#)

[Lecture 10 - Bio electricity](#)

[Lecture 11 - Bio electricity](#)

[Lecture 12 - Bio electricity](#)

[Lecture 13 - Bio electricity](#)

[Lecture 14 - Bio electricity](#)

[Lecture 15 - Bio electricity](#)

[Lecture 16 - Bio electricity](#)

[Lecture 17 - Bio electricity](#)

[Lecture 18 - Bio electricity](#)

[Lecture 19 - Bio electricity](#)

[Lecture 20 - Bio electricity](#)

[Lecture 21 - Bio electricity](#)

[Lecture 22 - Bio electricity](#)

[Lecture 23 - Bio electricity](#)

[Lecture 24 - Bio electricity](#)

[Lecture 25 - Bio electricity](#)

[Lecture 26 - Bio electricity](#)

[Lecture 27 - Bio electricity](#)

[Lecture 28 - Bio electricity](#)

[Lecture 29 - Bio electricity](#)

[Lecture 30 - Bio electricity](#)

[Lecture 31 - Bio electricity](#)

[Lecture 32 - Bio electricity](#)

[Lecture 33 - Bio electricity](#)

[Lecture 34 - Bio electricity](#)

[Lecture 35 - Bio electricity](#)

[Lecture 36 - Bio electricity](#)

[Lecture 37 - Bio electricity](#)

[Lecture 38 - Bio electricity](#)

[Lecture 39 - Bio electricity](#)

[Lecture 40 - Bio electricity](#)

[Lecture 1 - Fundamentals of central dogma, Part 1](#)

[Lecture 2 - Fundamentals of central dogma, Part 2](#)

[Lecture 3 - Fundamentals of central dogma, Part 3](#)

[Lecture 4 - Chromosome Structure and Function](#)

[Lecture 5 - Pedigree Analysis](#)

[Lecture 6 - Complications in Mendelian Pedigree Patterns](#)

[Lecture 7 - DNA Cloning and Hybridization Techniques - Part 1](#)

[Lecture 8 - DNA Cloning and Hybridization Techniques - Part 2](#)

[Lecture 9 - Practice Session 1: Problems Related to Pedigree Analysis](#)

[Lecture 10 - Practice Session 2: Restriction Fragment Length Polymorphism and its Applications in Pedigree Analysis](#)

[Lecture 11 - Mutations and instability of human DNA \(Part 1\)](#)

[Lecture 12 - Mutations and instability of human DNA \(Part 2\)](#)

[Lecture 13 - Animal Models for Human Diseases](#)

[Lecture 14 - Positional cloning of genes for monogenic disorders](#)

[Lecture 15 - Human Genome Project and HapMap project](#)

[Lecture 1 - Introduction to Functional Genomics](#)

[Lecture 2 - The Genomics Era](#)

[Lecture 3 - Epigenetics](#)

[Lecture 4 - Forward Genetics vs Reverse Genetics](#)

[Lecture 5 - Genome Editing Approaches - Part 1](#)

[Lecture 6 - Genome Editing Approaches - Part 2](#)

[Lecture 7 - Transcriptomics - Part 1](#)

[Lecture 8 - Transcriptomics - Part 2](#)

[Lecture 9 - Genome Sequence Databases](#)

[Lecture 10 - DNA Sequencing Methods - Part 1](#)

[Lecture 11 - DNA Sequencing Methods - Part 2](#)

[Lecture 12 - Applications of Next-Generation Sequencing \(NGS\)](#)

[Lecture 13 - Tutorial - Session 1](#)

[Lecture 14 - Tutorial - Session 2](#)

[Lecture 15 - Genomic Insight into Evolution](#)

[Lecture 16 - Genome sequence: Different Questions, Different Comparisons](#)

[Lecture 17 - Outcome of Comparative Genomics](#)

[Lecture 18 - Laboratory - Session 1](#)

[Lecture 19 - Laboratory - Session 2](#)

Lecture 1 - Introduction

Lecture 2 - Oil Economy of the World

Lecture 3 - Unit of Energy and Introduction of Bioenergy

Lecture 4 - How Biomass Formed on the Earth

Lecture 5 - Road Map of Bioenergy

Lecture 6 - Basic Biomass Technology (Resources and Production)

Lecture 7 - Basics of Mechanism of Light Reaction

Lecture 8 - Exploration of Photosynthesis Process

Lecture 9 - In Photosynthesis Oxygen Comes from Water Molecule

Lecture 10 - Hill Reaction

Lecture 11 - Electron Transport Process in Light Reaction

Lecture 12 - How Carbon dioxide converted in Carbohydrate

Lecture 13 - From Carbon dioxide to two Molecules of 3 - Phospho Glycerate by RUBISCO

Lecture 14 - RUBISCO enzyme

Lecture 15 - Photo respiration and Calvin Cycle

Lecture 16 - Efficiency Calculation of Photosynthesis Process

Lecture 17 - C3 and C4 Plant Structure and Photosynthesis Process

Lecture 18 - Biomass production System and their Categorization

Lecture 19 - Important Parameters for Selecting Biomass Crops

Lecture 20 - Factors Determining the Conversion Process - I

Lecture 21 - Factors Determining the Conversion Process - II

Lecture 22 - Factors Determining the Conversion Process - III

Lecture 23 - Conversion Technology

Lecture 24 - Conversion Process- (Combustion Process)

Lecture 25 - Pyrolysis Process

Lecture 26 - Classification of Pyrolysis

Lecture 27 - Bio Oil - (Solution for Thermal Instability and Corrosivity)

Lecture 28 - Spark Ignition Engine

Lecture 29 - Compression Ignition Engine

Lecture 30 - Carbonization - Graphene like material

Lecture 31 - Introduction of Gasification

[Lecture 32 - Thermo Chemical Process of Gasification](#)

[Lecture 33 - Feed Stock Treatment of Gasification](#)

[Lecture 34 - Feed Stock Property](#)

[Lecture 35 - Gasification Types - Up Drift Gasifier](#)

[Lecture 36 - Down drift and Cross Flow Gasifier](#)

[Lecture 37 - Operation and Performance of Fixed Bed Gasifier](#)

[Lecture 38 - Fluidized Bed Gasification](#)

[Lecture 39 - Operation and Performance of Fluidized Bed Gasifier](#)

[Lecture 40 - Biological Root of Gasification and Summary of Course](#)

Lecture 1 - An Introduction to Anatomy and Physiology

Lecture 2 - Organization of living system

Lecture 3 - Homeostasis and system integration

Lecture 4 - Positive feedback loop in homeostasis

Lecture 5 - Chemical basis of organization of the body

Lecture 6 - Integumentary System - I

Lecture 7 - Integumentary system - II

Lecture 8 - Integumentary System - III

Lecture 9 - Bone and Cartilage - I

Lecture 10 - Bone and Cartilage - II

Lecture 11 - Introduction of muscle

Lecture 12 - Skeletal muscle formation

Lecture 13 - Anatomy of skeletal muscle

Lecture 14 - Contraction in muscle

Lecture 15 - Function of actin and myosin

Lecture 16 - Length tension relationship of skeletal muscle

Lecture 17 - Excitation contraction coupling with nervous system

Lecture 18 - Stretch reflex phenomena

Lecture 19 - Nervous system anatomy and signaling

Lecture 20 - Structure and circuit of neurons

Lecture 21 - Origin of biological cell

Lecture 22 - Excitability in cell

Lecture 23 - Ion transportation in the cell

Lecture 24 - Signal propagation in neurons

Lecture 25 - Neurotransmitter and action potential

Lecture 26 - Spatial temporal summation of signal in mesh neurons

Lecture 27 - Anatomy of Hippo-campus

Lecture 28 - Epilepsy and memory

Lecture 29 - Long term potentiation

Lecture 30 - Long term depression

Lecture 31 - Alzheimers disease

[Lecture 32 - Parkinsons disease](#)

[Lecture 33 - Amyotrophic lateral sclerosis](#)

[Lecture 34 - Spinal cord injury](#)

[Lecture 35 - Glial cells](#)

[Lecture 36 - Stretch reflex arc circuit - I](#)

[Lecture 37 - Stretch reflex arc circuit - II](#)

[Lecture 38 - Neuro muscular junction](#)

[Lecture 39 - Hearing system](#)

[Lecture 40 - Olfaction system](#)

[Lecture 41 - Anatomy of eye](#)

[Lecture 42 - Eye lens and cataract](#)

[Lecture 43 - Structure of Retina](#)

[Lecture 44 - Image formation and processing in eyes](#)

[Lecture 45 - Mechanism of photo processing by rods](#)

[Lecture 46 - Structure and Function of Heart - I](#)

[Lecture 47 - Structure and Function of Heart - II](#)

[Lecture 48 - Conduction circuit of heart](#)

[Lecture 49 - Contractile system and Conducting system](#)

[Lecture 50 - EKG and Comparison of action potential between pace make cell and work cell](#)

[Lecture 51 - Respiratory Physiology](#)

[Lecture 52 - Anatomy and physiology of Blood vessels - I](#)

[Lecture 53 - Anatomy and Physiology of Blood vessels - II](#)

[Lecture 54 - Anatomy and physiology of blood vessels - III](#)

[Lecture 55 - Anatomy and physiology of blood vessels - IV](#)

[Lecture 56 - Endocrine system - I](#)

[Lecture 57 - Digestive system and Endocrine system - II](#)

[Lecture 58 - Blood](#)

[Lecture 59 - Kidney and immune system](#)

[Lecture 60 - Reproductive system](#)

Lecture 1 - Introduction of Cell Culture Technology

Lecture 2 - Philosophy and complexity in cell culture

Lecture 3 - To grow the cell outside the body

Lecture 4 - Cell cycle concept

Lecture 5 - Dividing cells

Lecture 6 - Biology of cell culture

Lecture 7 - Layout(s) and design(s) of cell culture facility

Lecture 8 - Precautions during designing the lab layout - I

Lecture 9 - Precautions during designing the lab layout - II

Lecture 10 - Precautions during designing the lab layout - III

Lecture 11 - State of the art facility in cell culture lab - I

Lecture 12 - State of the art facility in cell culture lab - II

Lecture 13 - Specialized facility in cell culture lab

Lecture 14 - Interaction of cell and glass/polycarbonate surface - I

Lecture 15 - Interaction of cell and glass/polycarbonate surface - II

Lecture 16 - Poly D lysine deposition

Lecture 17 - Surface chemical analysis

Lecture 18 - Cell growth process

Lecture 19 - Cell surface interface

Lecture 20 - Cell culture substrate patterning

Lecture 21 - Introduction of define system

Lecture 22 - Mechanical dissociation of hippocampal tissue

Lecture 23 - Rules for mechanical dissociation of tissue

Lecture 24 - Drug molecule testing

Lecture 25 - Adult hippocampal neuron dissociation

Lecture 26 - Cell separation and In vitro myelination cell culture mode - I

Lecture 27 - Cell separation and In vitro myelination cell culture mode - II

Lecture 28 - Cell separation and In vitro myelination cell culture mode - III

Lecture 29 - Cell Separation and In vitro myelination cell culture mode - IV

Lecture 30 - Cell separation and in vitro myelination cell culture mode - V

Lecture 31 - Fluorescent assisted cell sorting

[Lecture 32 - Condition for regenerated cells](#)

[Lecture 33 - Introduction of skeletal muscle cell culture](#)

[Lecture 34 - Skeletal muscle cell culture](#)

[Lecture 35 - Cardiac muscle cell culture](#)

[Lecture 36 - Advance cell culture modules - I](#)

[Lecture 37 - Advance cell culture modules - II](#)

[Lecture 38 - Advance cell culture modules - III](#)

[Lecture 39 - Advance cell culture modules - IV](#)

[Lecture 40 - Advance cell culture modules - V](#)

Lecture 1 - Introduction

Lecture 2 - Recap of formulae: area and volume

Lecture 3 - Recap of trigonometry

Lecture 4 - Measurement of central tendency and dispersion

Lecture 5 - Graphical presentation of data

Lecture 6 - Shape of a tree: Form and Taper

Lecture 7 - Metzgers theory

Lecture 8 - Form factor and form quotients

Lecture 9 - Taper equations

Lecture 10 - Making the cuts

Lecture 11 - Cross-section of a tree

Lecture 12 - Where to measure the diameter

Lecture 13 - Callipers - Usages and Issues

Lecture 14 - Tape: Usage and issue

Lecture 15 - Measurement of bark and growth rings

Lecture 16 - Tree height: Direct and indirect measurements

Lecture 17 - Method of similar triangles: Shadow and sticks

Lecture 18 - Distance measurements: foot, tape and rangefinder

Lecture 19 - Angular measurement

Lecture 20 - LIDAR

Lecture 21 - Canopy attributes - Part I

Lecture 22 - Canopy attributes - Part II

Lecture 23 - Canopy attributes - Part III

Lecture 24 - Canopy cover and closure

Lecture 25 - Photogrammetry

Lecture 26 - Basal area of a tree and stand

Lecture 27 - Stand basal area, crop diameter and crop age

Lecture 28 - Point sampling - I

Lecture 29 - Point sampling - II

Lecture 30 - Number density and sample calculations

Lecture 31 - Volume: Direct calculations through sections

[Lecture 32 - The Quarter - girth formula](#)

[Lecture 33 - Volume computations in the field](#)

[Lecture 34 - Volume Table](#)

[Lecture 35 - Forest Sampling](#)

[Lecture 36 - Density and mass measurement](#)

[Lecture 37 - Normalized difference vegetation Index \(NDVI\)](#)

[Lecture 38 - Site quality](#)

[Lecture 39 - Recap - I](#)

[Lecture 40 - Recap - II](#)

Lecture 1 - Introduction to the topic

Lecture 2 - Where do research ideas come from?

Lecture 3 - Inductive vs Deductive Reasoning

Lecture 4 - Scientific Hypothesis

Lecture 5 - Scientific Hypothesis (Continued...)

Lecture 6 - Testing the Hypothesis

Lecture 7 - Introduction to Scientific Writing

Lecture 8 - Writing an Abstract

Lecture 9 - Title for a Research Paper

Lecture 10 - Title and Keywords

Lecture 11 - Mileposts for the Article Writing

Lecture 12 - Writing the Methods Section

Lecture 13 - Writing the Results Section

Lecture 14 - Writing Results Section (Continued...)

Lecture 15 - How to Prepare Figures

Lecture 16 - How to Prepare Schematics

Lecture 17 - How to write Introduction and Discussion Sections

Lecture 18 - Finalizing the Manuscript and Ethics in Research

Lecture 19 - Writing a Research Proposal and Preparing for a Presentation

Lecture 20 - Tutorial Session : Oral communication

[Lecture 1 - Basic Concepts - I](#)

[Lecture 2 - Basic Concepts - II](#)

[Lecture 3 - Key Terms](#)

[Lecture 4 - Galvanic Cells - I](#)

[Lecture 5 - Galvanic Cells - II](#)

[Lecture 6 - Salt Bridge](#)

[Lecture 7 - Standard Potentials - I](#)

[Lecture 8 - Standard Potentials - II](#)

[Lecture 9 - Standard Potentials - III](#)

[Lecture 10 - Nernst Equation](#)

[Lecture 11 - Relationship between Standard electrode potential \(\$E^\circ\$ \) and Equilibrium constant \(K\)](#)

[Lecture 12 - Cell as chemical probe and Biochemist's formal potential](#)

[Lecture 13 - Concept of Concentration Cell - I](#)

[Lecture 14 - Concept of Concentration Cell - II](#)

[Lecture 15 - Bio-electrochemistry of excitable cells \(nerve cells\)](#)

[Lecture 16 - Types of electrodes](#)

[Lecture 17 - Critical care profile and metal electrode](#)

[Lecture 18 - pH measurement: Ion selective electrode](#)

[Lecture 19 - Redox indicators amperometry: glucose, oxygen sensors](#)

[Lecture 20 - Redox proteins, Metalloproteins and Cyclic Voltammetry](#)

[Lecture 1 - Bioenergetics of Life Processes: An Overview](#)

[Lecture 2 - Bioenergetics: Origin of life](#)

[Lecture 3 - Iron-Sulfur world](#)

[Lecture 4 - Evolution of complex cellular membranes](#)

[Lecture 5 - Charge transfer across membrane: Key terms](#)

[Lecture 6 - Biological order and energy - I](#)

[Lecture 7 - Biological order and energy - II](#)

[Lecture 8 - Biological order and energy - III](#)

[Lecture 9 - Summary of thermodynamical parameters - I](#)

[Lecture 10 - Summary of thermodynamical parameters - II](#)

[Lecture 11 - Photosynthesis - I](#)

[Lecture 12 - Photosynthesis - II](#)

[Lecture 13 - Photosynthesis - III](#)

[Lecture 14 - Photosynthesis - IV](#)

[Lecture 15 - Photosynthesis - V](#)

[Lecture 16 - Photosynthesis - VI](#)

[Lecture 17 - Photosynthesis - VII](#)

[Lecture 18 - Photosynthesis - VIII](#)

[Lecture 19 - ATP Synthesis](#)

[Lecture 20 - Mitochondria and Chemiosmotic hypothesis](#)

Lecture 1 - Preliminaries

Lecture 2 - A closer look at Biodiversity

Lecture 3 - Economics Valuation of Biodiversity

Lecture 4 - Threats to Biodiversity

Lecture 5 - Preliminaries

Lecture 6 - Basics of Sampling

Lecture 7 - Distance Sampling - I

Lecture 8 - Distance Sampling - II

Lecture 9 - Radio-telemetry

Lecture 10 - Behavioural monitoring

Lecture 11 - What is a habitat

Lecture 12 - Habitat degradation, loss, fragmentation and displacement

Lecture 13 - Reserve selection and design

Lecture 14 - Habitat management and improvement

Lecture 15 - Some terminologies

Lecture 16 - Some common wildlife diseases

Lecture 17 - Principles of disease management

Lecture 18 - Preliminaries

Lecture 19 - Mechanical capture

Lecture 20 - Chemical capture

Lecture 21 - Capture myopathy

Lecture 22 - Care of immobilised animal

Lecture 23 - Legal aspects of capture and restraint

Lecture 24 - Other topics in capture and restraint

Lecture 25 - Preliminaries and introduction to genetics

Lecture 26 - Population genetics

Lecture 27 - Chromosomal and genetic disorders, inbreeding

Lecture 28 - Population viability analysis

Lecture 29 - Reintroductions and outbreeding

Lecture 30 - Fundamentals

Lecture 31 - Zoos and their management

[Lecture 32 - Botanical gardens](#)

[Lecture 33 - Other aspects: cryopreservation, seed banks, etc.](#)

[Lecture 34 - Impacts of climate change](#)

[Lecture 35 - Plastics and biodiversity](#)

[Lecture 36 - Oil spills](#)

[Lecture 37 - Crisis and learnings: The Sariska case-study](#)

[Lecture 38 - Revision - I](#)

[Lecture 39 - Revision - II](#)

[Lecture 40 - Revision - III](#)

Lecture 1 - Introduction

Lecture 2 - What is Nanotechnology

Lecture 3 - An outline

Lecture 4 - Agriculture: Natural versus Modern

Lecture 5 - Modern Agriculture: controlled or out of control

Lecture 6 - A Restart:Utilising Our Discoveries

Lecture 7 - Classifying nanomaterials Based on Shape and Geometry

Lecture 8 - Classifying Nanomaterials Based on Chemical Nature

Lecture 9 - Physical Approaches to Nanomaterial Synthesis

Lecture 10 - Biological and Chemical Approaches to Nanomaterial Synthesis

Lecture 11 - Detailed Physical Techniques - I

Lecture 12 - Detailed Physical Techniques - II

Lecture 13 - Detailed Chemical Techniques

Lecture 14 - Detailed Biological Techniques

Lecture 15 - Basic Characterisation Techniques of Nanomaterials

Lecture 16 - Characterisation techniques for physical and chemical surface properties of a material

Lecture 17 - Nanomaterials in Agriculture

Lecture 18 - Iron pyrite and seed pre-treatment

Lecture 19 - nano-Pyrite and its lab trial with chickpea

Lecture 20 - nano-Pyrite field trial with spinach and its mechanistic details

Lecture 21 - Mechanistic details of the action of Pyrite nano-particle

Lecture 22 - Application of Pyrite nano-particle in different crops

Lecture 23 - Application of different nano-particles in Agriculture - I

Lecture 24 - Benefits of nanoparticles in Agriculture

Lecture 25 - Nanotechnology in animal production

Lecture 26 - Antioxidant nanomaterial in animal production - I

Lecture 27 - Antioxidant nanomaterial in animal production - II

Lecture 28 - Antioxidant nanomaterial in animal production - III

Lecture 29 - Antioxidant nanomaterial in skeletal muscle development - I

Lecture 30 - Antioxidant nanomaterial in skeletal muscle development - II

Lecture 31 - Skeletal muscle development and nanomaterial intervention

[Lecture 32 - Fabrication of nano-micro devices to study force generation in muscles](#)

[Lecture 33 - Summarising role of nanomaterials in animal production](#)

[Lecture 34 - Nanomaterials in food processing and preservation - I](#)

[Lecture 35 - Nanomaterials in food processing and preservation - II](#)

[Lecture 36 - Multifunctionality of nanomaterial: water purification, waste disposal, and energy](#)

[Lecture 37 - Futuristic multifunctional, sustainable and green nanomaterial](#)

[Lecture 38 - Case study of Titanium dioxide - I](#)

[Lecture 39 - Case study of Titanium dioxide - II](#)

[Lecture 40 - The future: evolving nano world](#)

Lecture 1 - Introduction to the course

Lecture 2 - A historical overview of Ecology

Lecture 3 - Ecology and Evolution

Lecture 4 - The levels of organisation

Lecture 5 - Species abundance and composition: Biodiversity

Lecture 6 - Biodiversity - II

Lecture 7 - Positive Interactions

Lecture 8 - Negative Interactions

Lecture 9 - Study of Behaviour and Behavioral Ecology

Lecture 10 - Food chains, Food webs and trophic levels

Lecture 11 - Primary Production

Lecture 12 - Nutrient Cycles

Lecture 13 - Population parameters and demographic techniques

Lecture 14 - Population growth and regulation

Lecture 15 - Population studies and applications

Lecture 16 - Community nature and parameters

Lecture 17 - Community changes and ecological succession

Lecture 18 - Community organisation

Lecture 19 - Biogeography: Analysis of geographic distributions

Lecture 20 - Why are things where they are?

Lecture 21 - Some push and pull factors in greater detail

Lecture 22 - Threats to species

Lecture 23 - In-situ conservation

Lecture 24 - Ex-situ conservation

Lecture 25 - Introduction and impacts

Lecture 26 - Human population growth and food requirements

Lecture 27 - Sustainable development

Lecture 28 - Oil spills

Lecture 29 - Plastic and biodiversity

Lecture 30 - Impacts of climate change

Lecture 31 - Optimum yield problem

[Lecture 32 - Biological control](#)

[Lecture 33 - Ecotoxicology and pollution management, Restoration ecology](#)

[Lecture 34 - Revision](#)

[Lecture 35 - Revision](#)

[Lecture 36 - Revision](#)

Lecture 1 - What is a forest ?

Lecture 2 - Classification of forests

Lecture 3 - Value of forests

Lecture 4 - What is Silviculture ?

Lecture 5 - Plant Growth Factors

Lecture 6 - Ecological Succession

Lecture 7 - Soil and Soil Profile

Lecture 8 - Major Soil Types

Lecture 9 - Nutrient Cycles

Lecture 10 - Tree Form

Lecture 11 - Measurement of Tree attributes - I

Lecture 12 - Measurement of Tree attributes - II

Lecture 13 - Classical Tools

Lecture 14 - Photogrammetry

Lecture 15 - LiDAR

Lecture 16 - Kinds of Threats

Lecture 17 - Forest Fire

Lecture 18 - Forest Law

Lecture 19 - Regeneration

Lecture 20 - Silvicultural Systems

Lecture 21 - Clear Felling System

Lecture 22 - Shelterwood System - I

Lecture 23 - Shelterwood System - II

Lecture 24 - Selection System and Irregular Shelterwood System

Lecture 25 - Logging and Processing

Lecture 26 - Growing Stock and Increment

Lecture 27 - Yield and Sustained Yield

Lecture 28 - Seed Collection and Treatment

Lecture 29 - Nursery Techniques

Lecture 30 - Planting and Tending

Lecture 31 - NTFP

[Lecture 32 - Social Forestry and Tribal Welfare](#)

[Lecture 33 - Conservation of Wild Animals](#)

[Lecture 34 - Revision - Part 1](#)

[Lecture 35 - Revision - Part 2](#)

[Lecture 36 - Revision - Part 3](#)

Lecture 1 - Introduction to the Course, Making Decisions - I

Lecture 2 - Making Decisions - II and Interactions - I

Lecture 3 - Interactions-II and Working of the Economy

Lecture 4 - Conservation in the Anthropocene

Lecture 5 - Human population growth and food requirements

Lecture 6 - Unsustainable development

Lecture 7 - Climate change

Lecture 8 - Plastics

Lecture 9 - Oil spills and mining

Lecture 10 - Push and pull factors: Localisation of species

Lecture 11 - Threats to species

Lecture 12 - Developmental Hazards and Ecotoxicology

Lecture 13 - Need to understand controls

Lecture 14 - Thinking as an Economist

Lecture 15 - Interdependence and gains from trade

Lecture 16 - Demand and supply

Lecture 17 - Elasticity

Lecture 18 - Government policy

Lecture 19 - Surplus and market efficiency

Lecture 20 - Market Efficiency and Cost of Taxation

Lecture 21 - International Trade

Lecture 22 - Externalities

Lecture 23 - Public goods and common resources

Lecture 24 - The design of the tax system

Lecture 25 - The Costs of Production

Lecture 26 - Competition

Lecture 27 - Monopoly

Lecture 28 - Markets for factors of production

Lecture 29 - Earnings and discrimination

Lecture 30 - Income inequality and poverty

Lecture 31 - Consumer choice

[Lecture 32 - Asymmetric information, Politics and Behavioural Economics](#)

[Lecture 33 - Valuation of natural resources](#)

[Lecture 34 - Economics of Protected Areas](#)

[Lecture 35 - Economics of Environmental Disasters - 1](#)

[Lecture 36 - Economics of Environmental Disasters - 2](#)

Lecture 1 - The need for conservation

Lecture 2 - Geography and conservation

Lecture 3 - Biogeography

Lecture 4 - Origin and evolution of the earth

Lecture 5 - Structure of the earth

Lecture 6 - Features of the earth

Lecture 7 - Rocks and minerals

Lecture 8 - Geomorphology and processes

Lecture 9 - Evolution of landforms

Lecture 10 - Structure and composition

Lecture 11 - Atmospheric circulation and weather

Lecture 12 - Climate and climate change

Lecture 13 - Structure and composition

Lecture 14 - Oceans and water movement

Lecture 15 - Hydrological cycle

Lecture 16 - Structure and physiography of India

Lecture 17 - Climate and habitats of India

Lecture 18 - Drainage systems

Lecture 19 - Soil

Lecture 20 - Life on Earth

Lecture 21 - Biodiversity

Lecture 22 - Threats to species

Lecture 23 - Ex-situ and in-situ conservation

Lecture 24 - Benefits from conservation

Lecture 25 - Population and population growth - I

Lecture 26 - Population and population growth - II

Lecture 27 - Human development and sustainable development

Lecture 28 - Resources and Conservation

Lecture 29 - Water Resources

Lecture 30 - Mineral and Energy Resources

Lecture 31 - Economic Geography and Conservation

[Lecture 32 - Trade](#)

[Lecture 33 - Settlements](#)

[Lecture 34 - Special Topics in Geography and Conservation](#)

[Lecture 35 - Disasters](#)

[Lecture 36 - Valuation of Natural Resources](#)

[Lecture 1 - L1 Module 1](#)

[Lecture 2 - L1 Module 2](#)

[Lecture 3 - L1 Module 3](#)

[Lecture 4 - L1 Module 4](#)

[Lecture 5 - L1 Module 5](#)

[Lecture 6 - L1 Module 6](#)

[Lecture 7 - L1 Module 7](#)

[Lecture 8 - L1 Module 8](#)

[Lecture 9 - L1 Module 9](#)

[Lecture 10 - L2 Module 1](#)

[Lecture 11 - L2 Module 2](#)

[Lecture 12 - L2 Module 3](#)

[Lecture 13 - L2 Module 4](#)

[Lecture 14 - L2 Module 5](#)

[Lecture 15 - L2 Module 6](#)

[Lecture 16 - L2 Module 7](#)

[Lecture 17 - L2 Module 8](#)

[Lecture 18 - L2 Module 9](#)

[Lecture 19 - L3 Module 1](#)

[Lecture 20 - L3 Module 2](#)

[Lecture 21 - L3 Module 3](#)

[Lecture 22 - L3 Module 4](#)

[Lecture 23 - L3 Module 5](#)

[Lecture 24 - L4 Module 1](#)

[Lecture 25 - L4 Module 2](#)

[Lecture 26 - L4 Module 3](#)

[Lecture 27 - L4 Module 4](#)

[Lecture 28 - L4 Module 5](#)

[Lecture 29 - L5 Module 1](#)

[Lecture 30 - L5 Module 2](#)

[Lecture 31 - L5 Module 3](#)

[Lecture 32 - L5 Module 4](#)

[Lecture 33 - L5 Module 5](#)

[Lecture 34 - L5 Module 6](#)

Lecture 1 - Introduction to Biosecurity and Course Overview

Lecture 2 - Allelopathic Interferences and Case Study

Lecture 3 - U.N.W.H.I.M.A.A.I

Lecture 4 - Livestock Biosecurity and its Preventive Measures

Lecture 5 - Bioterrorist Agents and Modes of Attack

Lecture 6 - History of Bioterrorism : Black Death

Lecture 7 - Bioweapons Used in Warfare and Biological Weapon and Toxin Convention (BWC)

Lecture 8 - Ebola and Marburg Virology in context to Biosensor Development

Lecture 9 - Bacillus Anthrax Bacteriology in context to Biosensor Development

Lecture 10 - Anthrax Types and Preventive Measures

Lecture 11 - Unraveling the Ingenious Bacillus Anthracis Attack and Case Study for Anthrax Sensor

Lecture 12 - Components for Designing Biosensors

Lecture 13 - Principle of Quartz Crystal Microbalance (QCM)

Lecture 14 - Sauerbrey Equation and QCM-D

Lecture 15 - Principle, Setup and Applications of E-QCM-D

Lecture 16 - Use of AFM Tool for Sensing - Part 1

Lecture 17 - AFM for Bio-sensing - Part 2

Lecture 18 - AFM and Recap Raman and IR Spectroscopy

Lecture 19 - Applications of Raman

Lecture 20 - AFM Cum Electrochemistry Workstation

Lecture 21 - Monoclonal Antibody

Lecture 22 - Monoclonal Antibody Production

Lecture 23 - MAB Production Via Hybridomas

Lecture 24 - Recognition Elements scFvs

Lecture 25 - SPR : Surface Plasmon Resonance

Lecture 26 - Design and Fabrication of Lateral-Flow Immunoassays

Lecture 27 - Sandwich (Non-Competitive) Assays

Lecture 28 - Botulism Toxin

Lecture 29 - Botox Therapy

Lecture 30 - Developing Biosensor for Botulinum Toxin

Lecture 31 - Story of Insulin

[Lecture 32 - Setting the Stage for the Discovery of Insulin](#)

[Lecture 33 - Insulin Controversy](#)

[Lecture 34 - Insulin Chemistry](#)

[Lecture 35 - Insulin as Weapon of Murder](#)

[Lecture 36 - Electrochemical Biosensors](#)

[Lecture 37 - Electrode System in the Glucose Sensor](#)

[Lecture 38 - World of Electrochemical Biosensors](#)

[Lecture 39 - Glucose Sensor - Part 1](#)

[Lecture 40 - Glucose Sensor - Part 2](#)

[Lecture 41 - Non Enzymatic Glucose Sensor - Part 1](#)

[Lecture 42 - Non Enzymatic Glucose Sensor - Part 2](#)

[Lecture 43 - Summarizing Glucose Sensing - Part 1](#)

[Lecture 44 - Summarizing Glucose Sensing - Part 2](#)

[Lecture 45 - Summarizing Glucose Sensing - Part 3](#)

[Lecture 46 - Far-Infrared Spectroscopy](#)

[Lecture 47 - Metabolic Heat Conformation](#)

[Lecture 48 - Electromagnetic Sensing](#)

[Lecture 49 - World of Biohybrid Biosensors](#)

[Lecture 50 - Whole Cell Biosensor](#)

[Lecture 51 - Action Potential - Part 1](#)

[Lecture 52 - Action Potential - Part 2](#)

[Lecture 53 - Action Potential - Part 3](#)

[Lecture 54 - Action Potential - Part 4](#)

[Lecture 55 - Action Potential - Part 5](#)

[Lecture 56 - Cell Based Biosensors - Part 1](#)

[Lecture 57 - Cell Based Biosensors - Part 2](#)

[Lecture 58 - Cell Based Biosensors - Part 3](#)

[Lecture 59 - Cell Based Biosensors - Part 4](#)

[Lecture 60 - Cell Based Biosensors - Part 5](#)

NPTEL : BioChemistry I (Biotechnology)

Co-ordinators : Prof. S. Dasgupta

[Lecture 1 - Amino Acids - I](#)

[Lecture 2 - Amino Acids - II](#)

[Lecture 3 - Protein Structure - I](#)

[Lecture 4 - Protein structure - II](#)

[Lecture 5 - Protein Structure - III](#)

[Lecture 6 - Protein Structure - IV](#)

[Lecture 7 - Enzymes - I](#)

[Lecture 8 - Enzymes - II](#)

[Lecture 9 - Enzymes - III](#)

[Lecture 10 - Enzymes Mechanisms - I](#)

[Lecture 11 - Enzymes Mechanisms - II](#)

[Lecture 12 - Myoglobin and Hemoglobin](#)

[Lecture 13 - Lipids and Membranes - I](#)

[Lecture 14 - Lipids and Membranes - II](#)

[Lecture 15 - Membrane Transport](#)

[Lecture 16 - Carbohydrates - I](#)

[Lecture 17 - Carbohydrates - II](#)

[Lecture 18 - Vitamins and Coenzymes - I](#)

[Lecture 19 - Vitamins and Coenzymes - II](#)

[Lecture 20 - Nucleic Acids - I](#)

[Lecture 21 - Nucleic Acids - II](#)

[Lecture 22 - Nucleic Acids - III](#)

[Lecture 23 - Bioenergetics - I](#)

[Lecture 24 - Bioenergetics - II](#)

[Lecture 25 - Metabolism - I](#)

[Lecture 26 - Metabolism - II](#)

[Lecture 27 - Metabolism - III](#)

[Lecture 28 - Overview of the Course](#)

[Lecture 1 - Industrial Biotechnology](#)

[Lecture 2 - Development of industrial strain](#)

[Lecture 3 - Medium characteristics and biochemical pathways](#)

[Lecture 4 - Chemical reaction kinetics](#)

[Lecture 5 - Chemical reaction analysis \(Continued...\)](#)

[Lecture 6 - Different types of reactors](#)

[Lecture 7 - Reactor analysis](#)

[Lecture 8 - Reactor analysis \(Continued...\)](#)

[Lecture 9 - Stoichiometry of bioprocesses](#)

[Lecture 10 - Stoichiometry of bioprocesses \(Continued...\)](#)

[Lecture 11 - Enzymatic reaction Kinetics](#)

[Lecture 12 - Enzymatic reaction Kinetics \(Continued...\)](#)

[Lecture 13 - Enzymatic reaction Kinetics \(Continued...\)](#)

[Lecture 14 - Immobilization techniques](#)

[Lecture 15 - Immobilization techniques \(Continued...\)](#)

[Lecture 16 - Life cycle of the microbial cell, Microbial growth kinetics, product formation and substrate degradation](#)

[Lecture 17 - Life cycle of the microbial cell, Microbial growth kinetics, product formation and substrate degradation \(Continued...\)](#)

[Lecture 18 - Life cycle of the microbial cell, Microbial growth kinetics, product formation and substrate degradation \(Continued...\)](#)

[Lecture 19 - Overview of the fermenter](#)

[Lecture 20 - Flow diagrams and pumps and valves used in fermentation industries](#)

[Lecture 21 - Upstream processing: Air sterilizer](#)

[Lecture 22 - Upstream processing: Medium sterilizer](#)

[Lecture 23 - Upstream processing: Medium sterilizer \(Continued...\)](#)

[Lecture 24 - Downstream processing: solid-liquid separators](#)

[Lecture 25 - Downstream processing: evaporator, crystallizer](#)

[Lecture 26 - Downstream processing: liquid-liquid extraction, distillation, chromatography](#)

[Lecture 27 - Ethanol fermentation](#)

[Lecture 28 - Ethanol fermentation \(Continued...\)](#)

[Lecture 29 - Brewing industry](#)

[Lecture 30 - Brewing industry \(Continued...\)](#)

[Lecture 31 - Wine industry](#)

[Lecture 32 - Vinegar production](#)

[Lecture 33 - Citric acid production](#)

[Lecture 34 - Citric acid production \(Continued...\)](#)

[Lecture 35 - Citric acid production \(Continued...\)](#)

[Lecture 36 - Lactic acid production](#)

[Lecture 37 - Lactic acid production \(Continued...\)](#)

[Lecture 38 - Glutamic acid production](#)

[Lecture 39 - Penicillin production](#)

[Lecture 40 - Penicillin production \(Continued...\)](#)

[Lecture 41 - Cephalosporin production](#)

[Lecture 42 - Streptomycin production](#)

[Lecture 43 - Baker's yeast fermentation](#)

[Lecture 44 - Baker's yeast fermentation \(Continued...\)](#)

[Lecture 45 - Fodder yeast production](#)

[Lecture 46 - Spirulina production](#)

[Lecture 47 - Alpha amylase production](#)

[Lecture 48 - High fructose corn syrup production](#)

[Lecture 49 - Metal leaching](#)

[Lecture 50 - Cheese production](#)

[Lecture 51 - Cheese production \(Continued...\)](#)

[Lecture 52 - Biodiesel production](#)

[Lecture 53 - Butanol production](#)

[Lecture 54 - Biofertilizer](#)

[Lecture 55 - Aerobic effluent treatment process](#)

[Lecture 56 - Aerobic effluent treatment process \(Continued...\)](#)

[Lecture 57 - Anaerobic effluent treatment process: Biomethanation process](#)

[Lecture 58 - Anaerobic effluent treatment process: Biomethanation process \(Continued...\)](#)

[Lecture 59 - 10 m³ Pilot Plant operation for Biohydrogen production](#)

[Lecture 60 - Summary and conclusion](#)

Lecture 1 - Introduction

Lecture 2 - Microbiology - I

Lecture 3 - Microbiology - II

Lecture 4 - Fundamentals of Biochemistry

Lecture 5 - Bioproducts and their market values

Lecture 6 - Stoichiometry of Biochemical Processes - I

Lecture 7 - Stoichiometry of Biochemical Processes - II

Lecture 8 - Stoichiometry of Biochemical Processes - III

Lecture 9 - Reaction Thermodynamics - I

Lecture 10 - Reaction Thermodynamics - II

Lecture 11 - Kinetics of homogeneous chemical reactions - I

Lecture 12 - Kinetics of homogeneous chemical reactions - II

Lecture 13 - Kinetics of homogeneous chemical reactions - III

Lecture 14 - Kinetics of homogeneous chemical reactions - IV

Lecture 15 - Kinetics of homogeneous chemical reactions - V

Lecture 16 - Different types of reactors

Lecture 17 - Reactor analysis - I

Lecture 18 - Reactor analysis - II

Lecture 19 - Reactor analysis - III

Lecture 20 - Reactor analysis - IV

Lecture 21 - Kinetics of enzyme catalyzed reactions using free enzymes - I

Lecture 22 - Kinetics of enzyme catalyzed reactions using free enzymes - II

Lecture 23 - Kinetics of enzyme catalyzed reactions using free enzymes - III

Lecture 24 - Kinetics of enzyme catalyzed reactions using free enzymes - IV

Lecture 25 - Kinetics of enzyme catalyzed reactions using free enzymes - V

Lecture 26 - Kinetics of enzyme catalyzed reactions using free enzymes - VI

Lecture 27 - Immobilization of Enzymes - I

Lecture 28 - Immobilization of Enzymes - II

Lecture 29 - Kinetics of enzyme catalyzed reactions using immobilized enzymes - I

Lecture 30 - Kinetics of enzyme catalyzed reactions using immobilized enzymes - II

Lecture 31 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - I

[Lecture 32 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - II](#)

[Lecture 33 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - III](#)

[Lecture 34 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - IV](#)

[Lecture 35 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - V](#)

[Lecture 36 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - VI](#)

[Lecture 37 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - VII](#)

[Lecture 38 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - VIII](#)

[Lecture 39 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - IX](#)

[Lecture 40 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - X](#)

[Lecture 41 - Kinetics of substrate utilization, product formation and biomass production of microbial cells - XI](#)

[Lecture 42 - Design and analysis of activated sludge process - I](#)

[Lecture 43 - Design and analysis of activated sludge process - II](#)

[Lecture 44 - Design and analysis of anaerobic digestion process](#)

[Lecture 45 - Scale up of Bioreactor - I](#)

[Lecture 46 - Scale up of Bioreactor - II](#)

[Lecture 47 - Transport Phenomenon in Bioprocess - I](#)

[Lecture 48 - Transport Phenomenon in Bioprocess - II](#)

[Lecture 49 - Transport Phenomenon in Bioprocess - III](#)

[Lecture 50 - Transport Phenomenon in Bioprocess - IV](#)

[Lecture 51 - Air sterilization - I](#)

[Lecture 52 - Air sterilization - II](#)

[Lecture 53 - Medium sterilization - I](#)

[Lecture 54 - Medium sterilization - II](#)

[Lecture 55 - Operation of industrial fermenter and material analysis](#)

[Lecture 56 - Process control of the biochemical processes](#)

[Lecture 57 - Downstream processing - I](#)

[Lecture 58 - Downstream processing - II](#)

[Lecture 59 - Economic analysis of the biochemical processes](#)

[Lecture 60 - Summary and Conclusion](#)

[Lecture 1 - Introduction to Biomicrofluidics](#)

[Lecture 2 - Introduction to Biomicrofluidics \(Continued...\)](#)

[Lecture 3 - Engineers' guide to the cell](#)

[Lecture 4 - Fluidics in living systems and mechanobiology](#)

[Lecture 5 - Pressure Driven Flows](#)

[Lecture 6 - Surface tension driven flows](#)

[Lecture 7 - Modulating surface tension](#)

[Lecture 8 - Lab on a CD](#)

[Lecture 9 - Introduction to Electrokinetics - Part I](#)

[Lecture 10 - Introduction to Electrokinetics - Part II](#)

[Lecture 11 - Microfluidic cell culture - Part I](#)

[Lecture 12 - Microfluidic cell culture - Part II](#)

[Lecture 13 - On-chip cellular assay techniques - Part I](#)

[Lecture 14 - On-chip cellular assay techniques - Part II](#)

[Lecture 15 - Microfluidics for understanding biology](#)

[Lecture 16 - Organ-on-a-chip](#)

[Lecture 17 - Lab-on-a-chip for genetic analysis](#)

[Lecture 18 - Microfluidic technology for monoclonal antibody production](#)

[Lecture 19 - Microfluidics for Healthcare](#)

[Lecture 20 - Microfluidics for Healthcare](#)

[Lecture 1 - Basic Concepts in Immunology](#)

[Lecture 2 - Basic Concepts in Immunology \(Continued...\)](#)

[Lecture 3 - Basic Concepts in Immunology \(Continued...\)](#)

[Lecture 4 - Basic Concepts in Immunology \(Continued...\)](#)

[Lecture 5 - Basic Concepts in Immunology \(Continued...\)](#)

[Lecture 6 - Innate Immunity](#)

[Lecture 7 - Inflammatory Response](#)

[Lecture 8 - Adaptive Immunity](#)

[Lecture 9 - Adaptive Immunity \(Humoral\)](#)

[Lecture 10 - Effector Mechanisms](#)

[Lecture 11 - Structure of antibody](#)

[Lecture 12 - Structure of antibody and T-Cell Receptors](#)

[Lecture 13 - Generation of diversity \(GOD\) of lymphocyte antigen receptors \(Continued...\)](#)

[Lecture 14 - Generation of diversity \(GOD\) of lymphocyte antigen receptors \(Continued...\)](#)

[Lecture 15 - Generation of diversity \(GOD\) of lymphocyte antigen receptors \(Continued...\)](#)

[Lecture 16 - Generation of diversity \(GOD\) of lymphocyte antigen receptors \(Continued...\)](#)

[Lecture 17 - Structural variation in immunoglobulin constant regions and isotype switching](#)

[Lecture 18 - Structural variation in immunoglobulin constant regions and isotype switching \(Continued...\)](#)

[Lecture 19 - Antigen recognition by T cell : major histocompatibility complex](#)

[Lecture 20 - Antigen recognition by T cell : major histocompatibility complex \(Continued...\)](#)

[Lecture 21 - Antigen Recognition by T cell : Major Histocompatibility Complex \(Continued...\)](#)

[Lecture 22 - Antigen Recognition by T cell : Major Histocompatibility Complex \(Continued...\)](#)

[Lecture 23 - The Generation of \$\hat{I}^\pm\$: \$\hat{I}^2\$ T - Cell receptor ligands](#)

[Lecture 24 - The Generation of \$\hat{I}^\pm\$: \$\hat{I}^2\$ T - Cell receptor ligands \(Continued...\)](#)

[Lecture 25 - Summary of Immune system](#)

[Lecture 26 - Tools and Techniques](#)

[Lecture 27 - Tools and Techniques \(Continued...\)](#)

[Lecture 28 - Tools and Techniques \(Continued...\)](#)

[Lecture 29 - Tools and Techniques \(Continued...\)](#)

[Lecture 30 - Flow Cytometry](#)

[Lecture 31 - Development of T Lymphocytes](#)

[Lecture 32 - Development of T Lymphocytes \(Continued...\)](#)

[Lecture 33 - Development of T Lymphocytes \(Continued...\)](#)

[Lecture 34 - T Cell Mediated Immunity](#)

[Lecture 35 - T Cell Mediated Immunity \(Continued...\)](#)

[Lecture 36 - B-Cell Maturation - I](#)

[Lecture 37 - B-Cell Maturation - II](#)

[Lecture 38 - B-Cell Activation](#)

[Lecture 39 - B-Cell Activation and Differentiation](#)

[Lecture 40 - Effector T - Cells](#)

[Lecture 41 - Complement System Overview](#)

[Lecture 42 - Complement System Overview \(Continued...\)](#)

[Lecture 43 - Complement Biological Consequences](#)

[Lecture 44 - Complement Biological Consequences \(Continued...\)](#)

[Lecture 45 - Cytokines : Introduction](#)

[Lecture 46 - Cytokines : Introduction \(Continued...\)](#)

[Lecture 47 - Cytokines in Innate and Adaptive Immunity](#)

[Lecture 48 - Interferons](#)

[Lecture 49 - Hypersensitivity](#)

[Lecture 50 - Hypersensitivity \(Continued...\)](#)

[Lecture 51 - Autoimmunity](#)

[Lecture 52 - Autoimmunity \(Continued...\)](#)

[Lecture 53 - Autoimmunity \(Continued...\)](#)

[Lecture 54 - Transplantation or Graft vs. Host Reaction](#)

[Lecture 55 - Transplantation or Graft vs. Host Reaction \(Continued...\)](#)

[Lecture 56 - Active and Passive Immunity and Vaccination](#)

[Lecture 57 - Active and Passive Immunity and Vaccination \(Continued...\)](#)

[Lecture 58 - Active and Passive Immunity and Vaccination \(Continued...\)](#)

[Lecture 59 - Monoclonal Antibody](#)

[Lecture 60 - Monoclonal Antibody \(Continued...\)](#)

Lecture 1 - Introduction to Metabolic Engineering

Lecture 2 - Essence of Metabolic Engineering - Part A

Lecture 3 - Essence of Metabolic Engineering - Part B

Lecture 4 - Essence of Metabolic Engineering - Part C

Lecture 5 - Essence of Metabolic Engineering - Part D

Lecture 6 - Review of Cellular Metabolism - Part A

Lecture 7 - Review of Cellular Metabolism - Part B

Lecture 8 - Review of Cellular Metabolism - Part C

Lecture 9 - Review of Cellular Metabolism - Part D

Lecture 10 - Review of Cellular Metabolism - Part E

Lecture 11 - Review of Cellular Metabolism - Part F

Lecture 12 - Introduction to Metabolic Networks

Lecture 13 - Introduction to Systems Biology

Lecture 14 - Regulatory Networks

Lecture 15 - Reconstruction of Metabolic Networks

Lecture 16 - The Stoichiometric Matrix: Representing Reconstructed Network Mathematically

Lecture 17 - Flux Balance Analysis (FBA)

Lecture 18 - Flux Variability Analysis (FVA) and Flux Coupling (FC)

Lecture 19 - Dynamic Flux Balance Analysis (DFBA) and Gene Deletion Algorithms

Lecture 20 - Optimization in MATLAB

Lecture 21 - Robustness Analysis and Phenotypic Phase Planes

Lecture 22 - Flux Sampling, Optknock and Optstrain

Lecture 23 - Extreme Pathways and Elementary modes

Lecture 24 - ^{13}C Metabolic Flux Analysis (^{13}C MFA)

Lecture 25 - ^{13}C Metabolic Flux Analysis (^{13}C MFA)

Lecture 26 - Advancement in ^{13}C Metabolic Flux Analysis

Lecture 27 - E.coli core metabolic Network Optimization in MATLAB

Lecture 28 - Application of Metabolic Flux Analysis

Lecture 29 - CRISPR-Cas system and its application in metabolic engineering - Part I

Lecture 30 - CRISPR-Cas system and its application in metabolic engineering - Part II

Lecture 31 - CRISPR-Cas system and its application in metabolic engineering - Part III

[Lecture 32 - CRISPR-Cas system and its application in metabolic engineering - Part IV](#)

[Lecture 33 - Examples of pathway manipulations by metabolic engineering - Biofuels](#)

[Lecture 34 - Metabolic engineering for biofuel production - Part A](#)

[Lecture 35 - Metabolic engineering for biofuel production - Part B](#)

[Lecture 36 - Metabolic engineering for biofuel production - Part C](#)

[Lecture 37 - Applications of metabolic engineering in amino acids production](#)

Lecture 1 - Acids, Bases and Salts - Part I

Lecture 2 - Acids, Bases and Salts - Part II

Lecture 3 - Acids, Bases and Salts - Part III

Lecture 4 - Acids, Bases and Salts - Part IV

Lecture 5 - Acids, Bases and Salts - Part V

Lecture 6 - Chemical Equilibrium - I

Lecture 7 - Chemical Equilibrium - II

Lecture 8 - Chemical Equilibrium - III

Lecture 9 - Chemical Equilibrium - IV

Lecture 10 - Chemical Equilibrium - V

Lecture 11 - Chemical Kinetics - I

Lecture 12 - Chemical Kinetics - II

Lecture 13 - Chemical Kinetics - III

Lecture 14 - Chemical Kinetics - IV

Lecture 15 - Chemical Kinetics - V

Lecture 16 - Chemical Kinetics - Reaction Mechanism - Part A

Lecture 17 - Chemical Kinetics - Reaction Mechanism - Part B

Lecture 18 - Chemical Kinetics - Catalysis - Part A

Lecture 19 - Chemical Kinetics - Catalysis - Part B

Lecture 20 - Chemical Kinetics - Catalysis - Part C

Lecture 21 - Nitrogen chemistry - Part A

Lecture 22 - Nitrogen chemistry - Part B

Lecture 23 - Chlorine chemistry and disinfection - Part A

Lecture 24 - Chlorine chemistry and disinfection - Part B

Lecture 25 - Chlorine chemistry and disinfection - Part C

Lecture 26 - Radioactivity - Part A

Lecture 27 - Radioactivity - Part B

Lecture 28 - Radioactivity - Part C

Lecture 29 - Radioactivity - Part D

Lecture 30 - Radioactivity - Part E

Lecture 31 - Introduction - I

[Lecture 32 - Introduction - II](#)

[Lecture 33 - Overview of microbial life - I](#)

[Lecture 34 - Overview of microbial life - II](#)

[Lecture 35 - Overview of microbial life - III](#)

[Lecture 36 - Cell chemistry - I](#)

[Lecture 37 - Cell chemistry - II](#)

[Lecture 38 - Cell Biology - I](#)

[Lecture 39 - Cell Biology - II](#)

[Lecture 40 - Cell Biology - III](#)

[Lecture 41 - Cell Biology - IV](#)

[Lecture 42 - Microscopy - I](#)

[Lecture 43 - Microscopy - II](#)

[Lecture 44 - Microbial Metabolism - I](#)

[Lecture 45 - Microbial Metabolism - II](#)

[Lecture 46 - Microbial Metabolism - III](#)

[Lecture 47 - Xenobiotics - I](#)

[Lecture 48 - Xenobiotics - II](#)

[Lecture 49 - Microbial Growth - I](#)

[Lecture 50 - Microbial Growth - II](#)

[Lecture 51 - Microbial Growth - III](#)

[Lecture 52 - Microbial Growth and Control - I](#)

[Lecture 53 - Microbial Growth and Control - II](#)

[Lecture 54 - Pathogens and diseases - I](#)

[Lecture 55 - Pathogens and diseases - II](#)

[Lecture 56 - Metabolic Diversity - I](#)

[Lecture 57 - Metabolic Diversity - II](#)

[Lecture 58 - Metabolic Diversity - III](#)

[Lecture 59 - Metabolic Diversity - IV](#)

[Lecture 60 - Metabolic Diversity - V](#)

[Lecture 61 - Metabolic Diversity - VI](#)

[Lecture 62 - Biogeochemical cycles - I](#)

[Lecture 63 - Biogeochemical cycles - II](#)

NPTEL : NOC:Environmental Biotechnology (Biotechnology)

Co-ordinators : Prof. Pinaki Sar

Lecture 1 - Introduction of Environmental Biotechnology, Scope and applications of the subject

Lecture 2 - Introduction of Environmental Biotechnology, Scope and applications of the subject

Lecture 3 - Ecosystem : Basic concepts of structure and function

Lecture 4 - Ecosystem : Basic concepts of structure and function (Continued...)

Lecture 5 - Microbial Ecology

Lecture 6 - Microbial Ecology (Continued...)

Lecture 7 - Microbial Ecosystems and Biogeochemical Cycling

Lecture 8 - Biogeochemical Cycles

Lecture 9 - Microbial ecology and environmental biotechnology - Part A

Lecture 10 - Microbial ecology and environmental biotechnology - Part B

Lecture 11 - Microbial ecology and environmental biotechnology - Part B (Continued...)

Lecture 12 - Microbial ecology and environmental biotechnology - Part B (Continued...)

Lecture 13 - Microbial ecology and environmental biotechnology - Part C

Lecture 14 - Microbial ecology and environmental biotechnology - Part C (Continued...)

Lecture 15 - Microbial ecology and environmental biotechnology - Part C (Continued...)

Lecture 16 - Microbial Ecology and Environmental Biotechnology - Part C (Continued...)

Lecture 17 - Microbiology of Environmental Engineering System

Lecture 18 - Microbiology of Environmental Engineering System

Lecture 19 - Microbiology of Environmental Engineering System

Lecture 20 - Microbiology of Environmental Engineering System (Continued...)

Lecture 21 - Physiological Ecology and Resource Exploitation by Microorganisms

Lecture 22 - Physiological ecology and Resource Exploitation by Microorganisms (Continued...)

Lecture 23 - Physiological ecology and Resource Exploitation by Microorganisms (Continued...)

Lecture 24 - Physiological ecology and Resource Exploitation by Microorganisms (Continued...)

Lecture 25 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology

Lecture 26 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 27 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 28 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 29 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 30 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

Lecture 31 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology (Continued...)

[Lecture 32 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology \(Continued...\)](#)

[Lecture 33 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology \(Continued...\)](#)

[Lecture 34 - Methods in Microbial Ecology with Relevance to Environmental Biotechnology \(Continued...\)](#)

[Lecture 35 - Bioremediation](#)

[Lecture 36 - Bioremediation \(Continued...\)](#)

[Lecture 37 - Bioremediation \(Continued...\)](#)

[Lecture 38 - Bioremediation \(Continued...\)](#)

[Lecture 39 - Biodegradation](#)

[Lecture 40 - Biodegradation](#)

[Lecture 41 - Biodegradation \(Continued...\)](#)

[Lecture 42 - Microbial Interactions with Heavy Metals and Metalloids](#)

[Lecture 43 - Microbial Interactions with Heavy Metals and Metalloids - Bioremediation](#)

[Lecture 44 - Biohydrometallurgy](#)

[Lecture 45 - Enhanced biological phosphorus removal process \(EBPR\)](#)

[Lecture 46 - Biological nitrogen removal](#)

[Lecture 47 - Microbially Enhanced Oil Recovery \(MEOR\)](#)

[Lecture 48 - Emerging Pollutants](#)

[Lecture 49 - Carbon capture, Carbon Sequestration and Utilization](#)

[Lecture 50 - Bioenergy and Environmental Biotechnology](#)

[Lecture 51 - Bioremediation case studies](#)

[Lecture 52 - Bioremediation case studies \(Continued...\)](#)

[Lecture 1 - Amino Acids - I](#)

[Lecture 2 - Amino Acids - II](#)

[Lecture 3 - Amino Acids - III](#)

[Lecture 4 - The Peptide Bond](#)

[Lecture 5 - Discussion Class](#)

[Lecture 6 - Primary Structure](#)

[Lecture 7 - Secondary Structure](#)

[Lecture 8 - Tertiary and Quaternary Structure](#)

[Lecture 9 - Protein Interactions](#)

[Lecture 10 - Discussion Class](#)

[Lecture 11 - Protein folding and structure](#)

[Lecture 12 - Thermodynamics of Protein Folding](#)

[Lecture 13 - Protein Structure Methods](#)

[Lecture 14 - Protein Denaturation](#)

[Lecture 15 - Discussion Class](#)

[Lecture 16 - Protein Isolation Methods](#)

[Lecture 17 - Protein Purification](#)

[Lecture 18 - Biophysical Methods - I](#)

[Lecture 19 - Biophysical Methods - II](#)

[Lecture 20 - Biophysical Methods - III](#)

[Lecture 21 - Types of Protein ligand interactions](#)

[Lecture 22 - Kinetics and Thermodynamics of protein-ligand binding](#)

[Lecture 23 - Experimental methods in protein ligand interactions](#)

[Lecture 24 - Protein ligand docking](#)

[Lecture 25 - Discussion class](#)

[Lecture 26 - Enzymes I - Classification](#)

[Lecture 27 - Enzymes - II](#)

[Lecture 28 - Enzyme Mechanisms - I](#)

[Lecture 29 - Enzyme Mechanisms - II](#)

[Lecture 30 - Enzyme mechanisms - III](#)

[Lecture 31 - Enzyme Kinetics - I](#)

[Lecture 32 - Enzyme Kinetics - II](#)

[Lecture 33 - Enzyme Inhibition - I](#)

[Lecture 34 - Enzyme Inhibition - II](#)

[Lecture 35 - Discussion class](#)

[Lecture 36 - Motor Proteins - I](#)

[Lecture 37 - Motor Proteins - II](#)

[Lecture 38 - Metalloproteins - I](#)

[Lecture 39 - Metalloproteins - II](#)

[Lecture 40 - Myoglobin and Hemoglobin](#)

[Lecture 41 - Membrane Proteins - I](#)

[Lecture 42 - Membrane proteins - II](#)

[Lecture 43 - Membrane Transport - I](#)

[Lecture 44 - Membrane Transport - II](#)

[Lecture 45 - Electron Transport Chain](#)

[Lecture 46 - Protein Carbohydrate Interactions - I](#)

[Lecture 47 - Protein Carbohydrate Interactions - II](#)

[Lecture 48 - Protein Nucleic Acid Interactions - I](#)

[Lecture 49 - Protein Nucleic Acid Interactions - II](#)

[Lecture 50 - Protein Nucleic Acid Interactions - III](#)

[Lecture 51 - Protein Protein Interactions - I](#)

[Lecture 52 - Protein Protein Interactions - II](#)

[Lecture 53 - Protein Peptide Interactions](#)

[Lecture 54 - Chaperone proteins](#)

[Lecture 55 - Protein Nanoparticle Interactions](#)

[Lecture 56 - Oxidative stress in Proteins](#)

[Lecture 57 - Enzyme action and Proteolytic cleavage](#)

[Lecture 58 - Intrinsically disordered proteins](#)

[Lecture 59 - Viral proteins](#)

[Lecture 60 - Overview of Course](#)

[Lecture 1 - Introduction - 1](#)

[Lecture 2 - Introduction - 2](#)

[Lecture 3 - Signals and Systems Overview](#)

[Lecture 4 - Important Signals](#)

[Lecture 5 - System](#)

[Lecture 6 - LSI Systems](#)

[Lecture 7 - Image Quality](#)

[Lecture 8 - Local Contrast](#)

[Lecture 9 - Blurring and Noise](#)

[Lecture 10 - Physics of Radiography](#)

[Lecture 11 - Types of Ionizing Radiations](#)

[Lecture 12 - EM Radiation](#)

[Lecture 13 - Attenuation Models](#)

[Lecture 14 - Radiation Dosimetry](#)

[Lecture 15 - PR_Instrument](#)

[Lecture 16 - PR_Instru_CA](#)

[Lecture 17 - PR_Image_formation](#)

[Lecture 18 - Imaging Equation_updated](#)

[Lecture 19 - Film screen_Optical Density](#)

[Lecture 20 - PR_Image Quality](#)

[Lecture 21 - CT_Intsru](#)

[Lecture 22 - CT_Instru_finish](#)

[Lecture 23 - CT Back projection](#)

[Lecture 24 - CT_BP_finish](#)

[Lecture 25 - Fan beam_IQ](#)

[Lecture 26 - CT_IQ_Artifact](#)

[Lecture 27 - Nuclear Med_Phys](#)

[Lecture 28 - Nuclear_Med_Radiotracers](#)

[Lecture 29 - Planar_Scintigraphy_Instru](#)

[Lecture 30 - Planar_Scintigraphy_Im and IQ](#)

[Lecture 31 - Spect_Pet](#)

[Lecture 32 - Ultrasound_Intro_Phys](#)

[Lecture 33 - Ultrasound Phys_Interactions](#)

[Lecture 34 - US doppler and Instrumentation](#)

[Lecture 35 - US_Beampattern](#)

[Lecture 36 - Approximations](#)

[Lecture 37 - US_Imaging Equation_modes](#)

[Lecture 38 - Parameters of interest](#)

[Lecture 39 - Beam Steering : Phased Array](#)

[Lecture 40 - MRI_Intro_S1-S9](#)

[Lecture 41 - MRI_Phys_S10-S16](#)

[Lecture 42 - MRI_Phys_S17-S20](#)

[Lecture 43 - MRI_Phys_S21-S28](#)

[Lecture 44 - MRI_Phys_S29-S39](#)

[Lecture 45 - MRI_Phys_S40-S44](#)

[Lecture 46 - MRI_Phys_S45_S52](#)

[Lecture 47 - MRI_Instru_S1_S16](#)

[Lecture 48 - MRI_Instru_s17_s26](#)

[Lecture 49 - MRI_slice sel_S27_S41](#)

[Lecture 50 - MRI_Freq_Encode_S42_S60](#)

[Lecture 51 - MRI_DAQ_S61_S69](#)

[Lecture 52 - MRI_RECON_S70_S82](#)

[Lecture 53 - MRI_IQ_S83_S96](#)

[Lecture 1 - Introduction](#)

[Lecture 2 - Next Generation Sequencing Technologies - 454 Sequencing](#)

[Lecture 3 - Illumina Sequencing By Synthesis \(SBS\)](#)

[Lecture 4 - Single Molecule Real Time \(SMRT\) Sequencing](#)

[Lecture 5 - Ion Torrent and Nanopore Sequencing](#)

[Lecture 6 - Sequencing Coverage, Quality Score and Experiment Design](#)

[Lecture 7 - Data Formats](#)

[Lecture 8 - Data Formats \(Continued...\)](#)

[Lecture 9 - Data Quality](#)

[Lecture 10 - Data QC and Trimming](#)

[Lecture 11 - Hands-on: Setting up the system](#)

[Lecture 12 - Basic Shell Commands](#)

[Lecture 13 - Data Download and Exploration](#)

[Lecture 14 - Hands-on 1 - Data exploration and QC](#)

[Lecture 15 - Hands-on 1 - Data QC and Trimming](#)

[Lecture 16 - Read Mapping](#)

[Lecture 17 - Mapping Algorithms](#)

[Lecture 18 - Suffix tree-based mapping algorithm](#)

[Lecture 19 - Burrows-Wheeler Transform \(BWT\)](#)

[Lecture 20 - Read Mapping with BWT](#)

[Lecture 21 - Bowtie2 tool](#)

[Lecture 22 - Mapping reads with Bowtie2](#)

[Lecture 23 - Bowtie2 output](#)

[Lecture 24 - SAM and BAM format](#)

[Lecture 25 - SAM format: Alignment section](#)

[Lecture 26 - Variant Calling](#)

[Lecture 27 - Calling SNP/SNVs and Indels](#)

[Lecture 28 - Hands-on analysis : Variant Calling](#)

[Lecture 29 - VCF Files](#)

[Lecture 30 - Variant Annotation](#)

[Lecture 31 - Analysis of CNVs and SVs](#)

[Lecture 32 - Introduction to RNA sequencing](#)

[Lecture 33 - RNA-seq data processing pipeline](#)

[Lecture 34 - Transcriptome Assembly and Quantification](#)

[Lecture 35 - Transcript Abundance Quantification](#)

[Lecture 36 - Biases in RNA-seq experiments](#)

[Lecture 37 - Data Normalization Methods](#)

[Lecture 38 - Data Normalization Methods \(Continued...\)](#)

[Lecture 39 - Differential Gene Expression \(DGE\) Analysis](#)

[Lecture 40 - DGE analysis results and visualizations](#)

[Lecture 41 - Multiple hypothesis testing correction](#)

[Lecture 42 - FDR correction and interpretation of DGE analysis results](#)

[Lecture 43 - Functional Enrichment Analysis](#)

[Lecture 44 - RNA-seq data analysis - Hands-on 2](#)

[Lecture 45 - Hands-on 2: Setting up the system](#)

[Lecture 46 - Hands-on 2: Preliminary Data Analysis](#)

[Lecture 47 - Sample Specific Bias Correction](#)

[Lecture 48 - Differential Gene Expression Analysis I](#)

[Lecture 49 - DGE Analysis with spike-ins](#)

[Lecture 50 - DGE Analysis Results and Functional Enrichment Analysis](#)

[Lecture 51 - Genome Assembly](#)

[Lecture 52 - Shortest Common Superstring \(SCS\) assembly](#)

[Lecture 53 - Overlap-Layout-Consensus \(OLC\) approach](#)

[Lecture 54 - de Bruijn Graph \(DBG\) based assembly](#)

[Lecture 55 - Assembly and Quality Control](#)

[Lecture 56 - Applications of NGS in Epigenomics](#)

[Lecture 57 - Detecting DNA Methylations](#)

[Lecture 58 - Genome-wide Transcription Factor\(TF\) Binding Sites](#)

[Lecture 59 - Chromatin Accessibility](#)

[Lecture 60 - Genome Organization in 3D](#)

Lecture 1 - Neuron Structure

Lecture 2 - Networks of Neurons and Synapses

Lecture 3 - Basic Structures in the Brain

Lecture 4 - Systems of neural processing

Lecture 5 - Methods of Recording Neural Activity

Lecture 6 - Membrane Potential and All or None Spike

Lecture 7 - Patch Clamp Measurements

Lecture 8 - Ion channels

Lecture 9 - Current injection: Synapses

Lecture 10 - Single Neuron Activity

Lecture 11 - Point and compartmental models of neurons

Lecture 12 - Hodgkin Huxley Equations - I

Lecture 13 - Hodgkin Huxley Equations - II

Lecture 14 - Reducing the HHE and Moris-Lecar Equations (MLE)

Lecture 15 - Properties of MLE

Lecture 16 - Phase Plane Analysis - I

Lecture 17 - Phase Plane Analysis - II

Lecture 18 - Phase Plane Analysis - III

Lecture 19 - Analysing HHE with Phase Plane Analysis - I

Lecture 20 - Analysing HHE with Phase Plane Analysis - II

Lecture 21 - Random variables and random process

Lecture 22 - Spike train statistics and response measure

Lecture 23 - Receptive fields and models of receptive fields

Lecture 24 - Stimulus to Response mapping (Coding) - I

Lecture 25 - Stimulus to Response mapping (Coding) - II

Lecture 26 - Stimulus to Response Mapping (Coding) - III

Lecture 27 - Response to Stimulus Mapping (Decoding)

Lecture 28 - Basics of Information Theory - I

Lecture 29 - Basics of Information Theory - II

Lecture 30 - Maximally Informative Dimensions

Lecture 31 - Intro to Discrimination based methods

[Lecture 32 - Kullback Leibler Distance](#)

[Lecture 33 - Measuring Spike Train Distances - I](#)

[Lecture 34 - Measuring Spike Train Distances - II](#)

[Lecture 35 - Signal and Noise Correlations](#)

[Lecture 36 - Statistical Methods in Discrimination](#)

[Lecture 37 - Single Cell Decoding - I: Two Alternative Forced Choice task in Monkeys](#)

[Lecture 38 - Single Cell Decoding - II: Using ROC Curves for discrimination](#)

[Lecture 39 - Single Cell Encoding - I: Operant Conditioning Task in Ferrets](#)

[Lecture 40 - Single Cell Encoding - II: Learning in avoidance and approach methods in Ferrets](#)

[Lecture 41 - Plasticity - Synaptic Transmission and Synaptic Strength](#)

[Lecture 42 - Ways of modification of Synaptic Strength](#)

[Lecture 43 - Type of Plasticity](#)

[Lecture 44 - Short Term Plasticity - I](#)

[Lecture 45 - Short Term Plasticity - II](#)

[Lecture 46 - Long Term Plasticity](#)

[Lecture 47 - Spike Time Dependent Plasticity](#)

[Lecture 48 - Hebbian Plasticity](#)

[Lecture 49 - BCM Rule](#)

[Lecture 50 - Synaptic Normalization](#)

[Lecture 51 - Adaptation](#)

[Lecture 52 - Models of Short Term Plasticity](#)

[Lecture 53 - Attention - I](#)

[Lecture 54 - Attention - II](#)

[Lecture 55 - Developmental Cicuits](#)

[Lecture 56 - Optimal Coding in Visual System](#)

[Lecture 57 - Optimal Coding in Auditory System](#)

[Lecture 58 - Optimal Coding of Deviant Stimuli in Development](#)

[Lecture 59 - Spike Timing Dependent Plasticity - a theoretical Perspective](#)

[Lecture 60 - Important Problems in Neuroscience](#)

NPTEL : NOC:Electrophysiology of Heart (Biotechnology)

Co-ordinators : Dr. Arijita Banerjee

Lecture 1 - Ionic basis of membrane potential

Lecture 2 - Physiology of voltage gated channels

Lecture 3 - Physiology of voltage gated channels

Lecture 4 - Cardiac muscle physiology

Lecture 5 - Action potential of cardiac muscle - 1

Lecture 6 - Action potential of cardiac muscle - 2

Lecture 7 - Conducting system of heart

Lecture 8 - ECG-Physiological basis

Lecture 9 - ECG-Normal, Technical aspects

Lecture 10 - ECG Interpretation

Lecture 11 - Abnormal ECG - 1

Lecture 12 - Abnormal ECG - 2

Lecture 13 - ECG and Myocardial Infarction

Lecture 14 - Heart rate and Blood pressure - Baroreflex pathway

Lecture 15 - ECG and Hypertension

Lecture 16 - Autonomic regulation of heart

Lecture 17 - Heart rate variability (HRV)

Lecture 18 - Heart rate variability-interpretation and clinical uses, Blood pressure variability

Lecture 19 - Autonomic Function Tests - 1

Lecture 20 - Autonomic Function Tests - 2

Lecture 1 - Pharmacognosy and Medicinal Plants

Lecture 2 - Plant Specialized Metabolites: Waste Products or Ecochemicals?

Lecture 3 - Evolution of Specialized Metabolism from Primary Metabolism

Lecture 4 - Production of specialized metabolites through cell and organ culture

Lecture 5 - Eliciting specialized metabolism in culture

Lecture 6 - Analysis of Specialized Metabolites - Tools and Techniques

Lecture 7 - Metabolic phytochemistry-based approaches for studying plant specialized metabolism

Lecture 8 - Metabolic engineering strategies in plants

Lecture 9 - Plant genetic transformation (through natural genetic engineer)

Lecture 10 - Design of vectors for Agrobacterium-mediated gene transfer; Transformed and co-

Lecture 11 - Introduction to alkaloids

Lecture 12 - Biosynthesis of tropane alkaloids

Lecture 13 - Engineering tropane alkaloid pathways in plants - I

Lecture 14 - Engineering tropane alkaloid pathways in plants - II : Engineering tropane alkaloid pathway

Lecture 15 - Isoquinoline alkaloids - Biosynthesis and tissue localization

Lecture 16 - Isoquinoline alkaloids - Late steps of biosynthetic pathway and tissue localization

Lecture 17 - Benzyloquinoline alkaloids - Induced top1 mutant and natural T mutantEngineering

Lecture 18 - Benzyloquinoline alkaloids - Metabolic pathway engineering

Lecture 19 - RNAi-mediated replacement of morphine with nornarcotic alkaloid reticuline in opium

Lecture 20 - Isoquinoline alkaloids - biosynthesis and tissue localization

Lecture 21 - Indole alkaloids - Early steps of biosynthesis

Lecture 22 - Indole alkaloids - Metabolic engineering of early steps of indole alkaloid pathway

Lecture 23 - Indole alkaloids - Environmental factors regulating indole alkaloid biosynthesis

Lecture 24 - Indole alkaloids - Role of elicitors in modulating alkaloids accumulation

Lecture 25 - Indole alkaloids - Late steps of indole alkaloid biosynthesis

Lecture 26 - Indole alkaloids - Regulatory roles of transcription factors in light-induced

Lecture 27 - Engineering indole alkaloid pathways in Catharanthus roseus hairy root cultures

Lecture 28 - Missing enzymes of vindoline biosynthetic pathway

Lecture 29 - Monoterpene indole alkaloid pathway cell and tissue localization

Lecture 30 - Model for biosynthesis and secretion of monoterpenoid indole alkaloids involving

Lecture 31 - Metabolic reprogramming of periwinkle plant culture

[Lecture 32 - Engineered yeast brews precursors of anticancer drug vinblastine](#)

[Lecture 33 - Recent discovery of strychnine biosynthetic pathway](#)

[Lecture 34 - Indole alkaloid biosynthesis - a final overview](#)

[Lecture 35 - Recent discovery of colchicine biosynthetic pathway](#)

[Lecture 36 - Biosynthesis of terpenoids - an outline](#)

[Lecture 37 - Diversity of monoterpenoids](#)

[Lecture 38 - Biosynthesis of monoterpenoids](#)

[Lecture 39 - Diversity of sesquiterpenes, diterpenes, triterpenes and polyterpenes](#)

[Lecture 40 - Oleoresins and polyterpenes - an outline](#)

[Lecture 41 - Monoterpenoids as components of floral scent volatiles: Metabolic engineering of](#)

[Lecture 42 - Biosynthesis of carotenoids and carotenoid cleavage products](#)

[Lecture 43 - Metabolic engineering of carotenoid pathway](#)

[Lecture 44 - Metabolic engineering of carotenoid pathway: Golden Rice Story](#)

[Lecture 45 - Menthol story: Biosynthesis and pathway manipulation - I](#)

[Lecture 46 - Menthol story: Biosynthesis and pathway manipulation - II](#)

[Lecture 47 - Artemisinin, hyperforin and taxol - three promising candidates for biotechnological](#)

[Lecture 48 - Phenolics: Origin via shikimate pathway](#)

[Lecture 49 - Phenolics: Phenylpropanoids, benzenoids, coumarins, tannins](#)

[Lecture 50 - Phenolics: Monolignols, lignins and lignans](#)

[Lecture 51 - Phenolics: Metabolic engineering of monolignol pathways](#)

[Lecture 52 - Phenolics: Biosynthesis of lignans and podophyllotoxin; Caffeic acid esters](#)

[Lecture 53 - Phenolics: Flavonoids, Flavones, Isoflavonoids, Proanthocyanidins](#)

[Lecture 54 - Phenolics: Biosynthesis of anthocyanins; Metabolic pathway engineering for enhance](#)

[Lecture 55 - Phenolics: Metabolic engineering of anthocyanin pathways in flowers](#)

[Lecture 56 - Phenolics: Alcohol acetyl transferses and volatile phenolics](#)

[Lecture 57 - Phenolics: Biosynthesis of volatile benzenoids](#)

[Lecture 58 - Phenolics: Biosynthesis of vanillin in plants](#)

[Lecture 59 - Phenolics: Metabolic engineering for vanillin](#)

[Lecture 60 - Phenolics: Biosynthesis of shikonin](#)

[Lecture 61 - Phenolics: Metabolic engineering of shikonin pathway](#)

[Lecture 62 - Molecular Pharming: Transplastomic plants](#)

[Lecture 63 - Molecular Pharming: production of human somatotropin in tobacco](#)

Lecture 1 - Fundamentals of a Living System

Lecture 2 - Discovery of Genetic Material

Lecture 3 - Chemical and Physical Properties of Nucleic Acids

Lecture 4 - Introduction to DNA Replication

Lecture 5 - Mechanistic Overview of DNA Replication

Lecture 6 - Gene expression and The Central Dogma of Molecular Biology

Lecture 7 - Transcription: Involved Machineries and Processes

Lecture 8 - Translation: Decoding the message of an mRNA

Lecture 9 - Time-space correlation and fidelity of transcription and translation

Lecture 10 - Regulation of gene expression

Lecture 11 - Amino acids, hierarchy of protein structure

Lecture 12 - Protein folding, Folding funnel, Anfinsen's experiment

Lecture 13 - Protein-ligand interactions

Lecture 14 - Allosteric regulation of proteins, e.g. haemoglobin

Lecture 15 - Membrane proteins

Lecture 16 - Introduction to enzymes

Lecture 17 - Theory of enzyme catalysis

Lecture 18 - Specificity of enzymes, e.g. Chymotrypsin

Lecture 19 - Enzyme inhibition. Types and mechanism of inhibitors. Design of inhibitors

Lecture 20 - Engineered enzymes and their applications

Lecture 21 - Introduction to cells

Lecture 22 - Visualizing cells

Lecture 23 - Cell division cycle

Lecture 24 - Stem Cells

Lecture 25 - Cancer

Lecture 26 - Overview of the development of multicellular organization

Lecture 27 - Pattern formation and growth

Lecture 28 - Cell division, cell death and tissue homeostasis

Lecture 29 - Cell Junctions and extracellular matrix

Lecture 30 - Introduction to Neuron and the action potential

Lecture 31 - Vitamins and introduction to bioenergetics

[Lecture 32 - Glycolysis, Gluconeogenesis and PPP](#)

[Lecture 33 - Citric Acid Cycle and Oxidative Phosphorylation](#)

[Lecture 34 - Photosynthesis](#)

[Lecture 35 - Photosynthetic carbohydrate synthesis](#)

[Lecture 36 - Evolution of life on earth](#)

[Lecture 37 - Protein evolution](#)

[Lecture 38 - Mechanisms of evolution](#)

[Lecture 39 - Evolution of eye](#)

[Lecture 40 - Model organisms](#)

[Lecture 41 - Introduction to microbial world and infectious diseases](#)

[Lecture 42 - Cell organization and unique features of bacteria](#)

[Lecture 43 - Understanding viruses - The smallest enemy](#)

[Lecture 44 - Pathogenicity and infection](#)

[Lecture 45 - Antibacterial and Antiviral Drugs](#)

[Lecture 46 - Introduction to the immune system](#)

[Lecture 47 - Innate immunity: the first lines of defense](#)

[Lecture 48 - Adaptive immune response](#)

[Lecture 49 - Antibody - structure, function and diversity](#)

[Lecture 50 - Vaccines and immunotherapy](#)

[Lecture 51 - Visualizing and analyzing nucleic acids: Gel electrophoresis and PCR](#)

[Lecture 52 - Visualizing and analyzing nucleic acids: DNA Sequencing](#)

[Lecture 53 - Overview of genetic engineering and its impact on society](#)

[Lecture 54 - Genetic engineering: Methods and applications](#)

[Lecture 55 - Cloning and Gene manipulation](#)

[Lecture 56 - Characterization methods](#)

[Lecture 57 - Chromatographic methods](#)

[Lecture 58 - Protein - ligand interactions](#)

[Lecture 59 - Immunoassay techniques](#)

[Lecture 60 - Landmark experiments in biology](#)

Lecture 1 - Introduction

Lecture 2 - Setting up R

Lecture 3 - Basic functions in R

Lecture 4 - Basic data structures in R

Lecture 5 - Data structures and File I/O

Lecture 6 - Basic statistical tests with R

Lecture 7 - Correlation Analysis

Lecture 8 - Analysis of Variance (ANOVA)

Lecture 9 - Basic data visualization techniques

Lecture 10 - Data visualization

Lecture 11 - Visualization with vioplot and ggplot2

Lecture 12 - R packages for plotting and data organization

Lecture 13 - Data transformation in R

Lecture 14 - Bioconductor packages

Lecture 15 - Flow cytometry data analysis in R/Bioconductor

Lecture 16 - Gene expression analysis and co-expression network

Lecture 17 - WGCNA package and Data Download

Lecture 18 - WGCNA hands-on: Data preprocessing

Lecture 19 - WGCNA hands-on: Soft-threshold

Lecture 20 - WGCNA: Module gene expression

Lecture 21 - Introduction to ChIP-seq

Lecture 22 - ChIP-seq data analysis

Lecture 23 - ChIP-seq data analysis: Peak calling

Lecture 24 - Peak calling and Visualization

Lecture 25 - ChIP-seq data analysis: bigWig/bw files

Lecture 26 - Regression models on Biological data

Lecture 27 - Predictive models with linear regression

Lecture 28 - Multicollinearity

Lecture 29 - Lasso regression

Lecture 30 - Non-linear regression

Lecture 31 - Dimensionality reduction

[Lecture 32 - Principal Component Analysis \(PCA\)](#)

[Lecture 33 - PCA analysis hands-on](#)

[Lecture 34 - PCA analysis using "PCAtools"](#)

[Lecture 35 - UMAP analysis](#)

[Lecture 36 - Classification of biological samples](#)

[Lecture 37 - Penalized and Stepwise Logistic regression](#)

[Lecture 38 - Decision trees](#)

[Lecture 39 - Classification and Regression trees](#)

[Lecture 40 - Random Forests](#)

Lecture 1 - Introduction

Lecture 2 - Mass balance, Heat Balance, flow sheet

Lecture 3 - Costing

Lecture 4 - Costing (continued), Physical and chemical principles in Downstream

Lecture 5 - Problems in Mass balance, flow sheet

Lecture 6 - Cell Breakage

Lecture 7 - Cell breakage (Continued...)

Lecture 8 - Solid Liquid Separation

Lecture 9 - Solid Liquid Separation (Continued...)

Lecture 10 - Solid Liquid separation-problems

Lecture 11 - Pre-treatment and Filters

Lecture 12 - Adsorption

Lecture 13 - Adsorption

Lecture 14 - Adsorption

Lecture 15 - Adsorption

Lecture 16 - Liquid-Liquid Extraction

Lecture 17 - Liquid-Liquid Extraction

Lecture 18 - Liquid-Liquid Extraction

Lecture 19 - Liquid liquid extraction

Lecture 20 - Reversed micellar and aqueous two phase extraction

Lecture 21 - Membranes

Lecture 22 - Membranes

Lecture 23 - Membranes

Lecture 24 - Membranes

Lecture 25 - Precipitation

Lecture 26 - Chromatography

Lecture 27 - Chromatography

Lecture 28 - Chromatography

Lecture 29 - Chromatography

Lecture 30 - Chromatography

Lecture 31 - Chromatography

[Lecture 32 - Chromatography](#)

[Lecture 33 - Crystallisation](#)

[Lecture 34 - Drying](#)

[Lecture 35 - Drying and distillation](#)

[Lecture 36 - Future trends](#)

NPTEL : Thermodynamics (Biotechnology)

Co-ordinators : Prof. G.K. Suraishkumar

Lecture 1 - Introduction and Review

Lecture 2 - Need for Analysis Additional Thermodynamic Functions State and Path Variables

Lecture 3 - Equations for a Closed system Chemical Potential Concept Gibbs-Duhem Equation

Lecture 4 - Maxwell's relations

Lecture 5 - Inter-Relationships between Thermodynamic Variables

Lecture 6 - Some Useful Mathematical Manipulations

Lecture 7 - Thermodynamic Relations for a Closed System with 1 mole of a pure Substances

Lecture 8 - Maximum Work, Lost Work Review of Closed Systems

Lecture 9 - Open Systems

Lecture 10 - Equations of State - Virial Equations

Lecture 11 - Equations of State - Cubic Equations

Lecture 12 - Volume Estimation

Lecture 13 - Volume Estimation (Continued...) Generalized correlations

Lecture 14 - Generalized correlations (Continued...) Residual Properties

Lecture 15 - Residual Properties (Continued...)

Lecture 16 - Generalized Correlations and Residual Properties

Lecture 17 - Fugacity Coefficient Estimation

Lecture 18 - Review of Module 3

Lecture 19 - Learning Aspects Chemical Potential Formulations

Lecture 20 - Lewis and Randall rule partial Molar Properties

Lecture 21 - Partial Molar Property Estimation from Mixing Experiments

Lecture 22 - Partial Molar Property Estimation (Continued...) Excess Property

Lecture 23 - Activity Coefficient from Excess Property

Lecture 24 - Activity Coefficient from Excess Property (Continued...)

Lecture 25 - Activity Coefficient from Excess Property (Continued...) Models for Activity Coefficient in Binary Systems

Lecture 26 - Models for Activity Coefficient in Binary Systems (Continued...)

Lecture 27 - Review of Module 4

Lecture 28 - Criteria for Phase Equilibrium Phase Rule for Non-reacting Biosystems

Lecture 29 - Clausius - Clayperon Equation

Lecture 30 - Clausius - Clayperon Equation (Continued...) vapour-Liquid Equilibrium

Lecture 31 - Vapour-Liquid Equilibrium (Continued...) Estimation of Fugacity coefficient from Equilibrium P-V-T Data

[Lecture 32 - Liquid/Liquid and Solid/Liquid Equilibria](#)

[Lecture 33 - Review of Module 5](#)

[Lecture 34 - Criteria for Bio-reaction Equilibria](#)

[Lecture 35 - Phase rule for Reacting Biosystems Equilibrium constants](#)

[Lecture 36 - Effect of Temperature and Pressure on the Equilibrium constants](#)

[Lecture 37 - Reaction in Liquid or Solid Phases](#)

[Lecture 38 - Free energy Changes for some Bioreactions](#)

[Lecture 39 - Electrolytes](#)

[Lecture 40 - Course Review](#)

[Lecture 1 - Introduction](#)

[Lecture 2 - Mass balance, Heat Balance, Flow sheet](#)

[Lecture 3 - Costing](#)

[Lecture 4 - Cell Breakage](#)

[Lecture 5 - Solid Liquid Separation](#)

[Lecture 6 - Pre-treatment and Filters/centrifuge](#)

[Lecture 7 - Liquid-Liquid Extraction](#)

[Lecture 8 - Liquid-Liquid extraction \(Continued...\)](#)

[Lecture 9 - Adsorption](#)

[Lecture 10 - Reversed micellar and aqueous two phase extraction](#)

[Lecture 11 - Membranes](#)

[Lecture 12 - Membranes \(Continued...\)](#)

[Lecture 13 - Product stabilization, Drying, Lyophilisation](#)

[Lecture 14 - Precipitation and crystallization](#)

[Lecture 15 - Electrophoresis / SDS PAGE](#)

[Lecture 16 - Chromatography](#)

[Lecture 17 - Chromatography \(Continued...1\)](#)

[Lecture 18 - Chromatography \(Continued...2\)](#)

[Lecture 19 - Chromatography \(Continued...3\)](#)

[Lecture 20 - Future trends, Other downstream operations/Summary of the course](#)

Lecture 1 - Introduction

Lecture 2 - Experimental Design Strategy

Lecture 3 - Data types : Binomial distribution

Lecture 4 - Poisson Distribution

Lecture 5 - Normal Distribution

Lecture 6 - Standardized Normal Distribution / t-distribution

Lecture 7 - t-distribution/confidence interval

Lecture 8 - Statistical tests

Lecture 9 - t-Test

Lecture 10 - t-Tests

Lecture 11 - t-test

Lecture 12 - F-tests

Lecture 13 - F-tests

Lecture 14 - ANOVA

Lecture 15 - ANOVA

Lecture 16 - Anova

Lecture 17 - Anova

Lecture 18 - Anova

Lecture 19 - Anova

Lecture 20 - Anova

Lecture 21 - Normality test / Odds ratio

Lecture 22 - Chi square distribution

Lecture 23 - Chi square distribution / test

Lecture 24 - Chi square test

Lecture 25 - Chi square test and Weibull Distribution

Lecture 26 - Weibull Distribution

Lecture 27 - Weibull distribution.

Lecture 28 - Non-parametric test

Lecture 29 - Non parametric test/homogeneity of variance / beta distribution

Lecture 30 - Exponential / hypergeometric distributions

Lecture 31 - Hypergeometric / Log normal distribution

[Lecture 32 - Design of experiments \(DOE\) - Introduction](#)

[Lecture 33 - Factorial Design](#)

[Lecture 34 - Full factorial design](#)

[Lecture 35 - Fractional factorial design](#)

[Lecture 36 - Other designs](#)

[Lecture 37 - Second order designs](#)

[Lecture 38 - Second order design](#)

[Lecture 39 - Regression analysis](#)

[Lecture 40 - Control charts](#)

Lecture 1 - Introduction

Lecture 2 - Sterilization

Lecture 3 - Solution to PP 1.1

Lecture 4 - Some important concepts

Lecture 5 - Enzyme bioreactors, enzyme kinetics

Lecture 6 - Solution to PP 2.1

Lecture 7 - Inhibited enzyme kinetics

Lecture 8 - Solution to PP 2.2

Lecture 9 - Measurement principles and methods

Lecture 10 - Batch growth kinetics

Lecture 11 - Solution to PP 3.1

Lecture 12 - Bioreactor analysis: chemostat and fed-batch

Lecture 13 - Solution to PP 3.2

Lecture 14 - Bioreactor environment parameters

Lecture 15 - Bioreactor env. par. (DO)

Lecture 16 - Solution to PP 4.1

Lecture 17 - Shear stress, scale-up, scale-down

Lecture 18 - Cell view: stoichiometry; degree of reductance

Lecture 19 - Solution to PP 5.1

Lecture 20 - Culture status, metabolic flux analysis

Lecture 21 - Course summary

Lecture 1 - Introduction to Biomaterials

Lecture 2 - Background history

Lecture 3 - History

Lecture 4 - Properties - Mechanical and Physico-chemical

Lecture 5 - Properties - Mechanical and Physico-chemical

Lecture 6 - Mechanical properties

Lecture 7 - Mechanical Properties (Continued...)

Lecture 8 - Resorbability, biodegradation

Lecture 9 - Resorbability, biodegradation (Continued...)

Lecture 10 - Biofilm

Lecture 11 - Biofilm (Continued...)

Lecture 12 - Biofilm (Continued...)

Lecture 13 - Biofilm (Continued...)

Lecture 14 - Material characterization - Analytical instruments

Lecture 15 - Analytical instruments

Lecture 16 - Analytical instruments (Continued...)

Lecture 17 - Analytical instruments (Continued...)

Lecture 18 - Biological responses, compatibility, cytotoxicity

Lecture 19 - Biological Responses

Lecture 20 - Cell-biomaterial interaction

Lecture 21 - Animal trials (in vivo)

Lecture 22 - Animal trials

Lecture 23 - Metals-types, classifications, applications

Lecture 24 - Metals - properties

Lecture 25 - Metals - properties (Continued...)

Lecture 26 - Metals - properties (Continued...)

Lecture 27 - Metals

Lecture 28 - Polymers-types, classifications, applications

Lecture 29 - Polymers

Lecture 30 - Polymers (Continued...)

Lecture 31 - Polymer blends

[Lecture 32 - Natural biopolymers](#)

[Lecture 33 - Natural biopolymers - \(Continued...\)](#)

[Lecture 34 - Biopolymers- proteins / hydrogels](#)

[Lecture 35 - Hydrogels](#)

[Lecture 36 - Experiments](#)

[Lecture 37 - surface modification-Demonstration](#)

[Lecture 38 - Ceramics](#)

[Lecture 39 - Cardiovascular and ocular biomaterials](#)

[Lecture 40 - Sterilisation/Device failure](#)

[Lecture 1 - Concepts and importance of Bioinformatics](#)

[Lecture 2 - Complexities in biological systems](#)

[Lecture 3 - DNA sequence analysis](#)

[Lecture 4 - Sequence based parameters](#)

[Lecture 5 - Database](#)

[Lecture 6 - Database categories](#)

[Lecture 7 - Protein structure and function - I](#)

[Lecture 8 - Protein structure and function - II](#)

[Lecture 9 - Protein sequence databases - I](#)

[Lecture 10 - Protein sequence databases - II](#)

[Lecture 11 - Pairwise alignment - I](#)

[Lecture 12 - Pairwise alignment - II](#)

[Lecture 13 - Uniprot Demo](#)

[Lecture 14 - Sequence alignment - I](#)

[Lecture 15 - Sequence alignment - II](#)

[Lecture 16 - Sequence alignment: Online resources - I](#)

[Lecture 17 - Sequence alignment: Online resources - II](#)

[Lecture 18 - Conservation score - I](#)

[Lecture 19 - Conservation score - II](#)

[Lecture 20 - Blast Demo](#)

[Lecture 21 - Phylogenetic trees - I](#)

[Lecture 22 - Phylogenetic trees - II](#)

[Lecture 23 - Protein sequence analysis - I](#)

[Lecture 24 - Protein sequence analysis - II](#)

[Lecture 25 - Hydrophobicity profiles](#)

[Lecture 26 - Patterns and PSSM profiles](#)

[Lecture 27 - Construction of Non-redundant datasets - I](#)

[Lecture 28 - Non-redundant datasets - II](#)

[Lecture 29 - Protein secondary structure](#)

[Lecture 30 - Secondary structure prediction - I](#)

[Lecture 31 - Secondary structure prediction - II](#)

[Lecture 32 - Secondary structure prediction - III](#)

[Lecture 33 - Protein tertiary structure - I](#)

[Lecture 34 - Protein tertiary structure - II](#)

[Lecture 35 - Protein structure analysis - I](#)

[Lecture 36 - Protein structure analysis - II](#)

[Lecture 37 - Protein structure analysis - III](#)

[Lecture 38 - Demo: PDB or Pymol or PDBParam](#)

[Lecture 39 - Protein structure analysis - IV](#)

[Lecture 40 - Protein structure prediction - I](#)

[Lecture 41 - Protein structure prediction - II](#)

[Lecture 42 - Protein stability - I](#)

[Lecture 43 - Protein stability - II](#)

[Lecture 44 - Demo: Homology Modelling](#)

[Lecture 45 - Stabilizing residues](#)

[Lecture 46 - Thermodynamic database](#)

[Lecture 47 - Stability of proteins upon mutations - I](#)

[Lecture 48 - Stability of proteins upon mutations - II](#)

[Lecture 49 - Demo: ProTherm](#)

[Lecture 50 - Protein folding rate - I](#)

[Lecture 51 - Protein folding rate - II](#)

[Lecture 52 - Protein interactions - I](#)

[Lecture 53 - Protein interactions - II](#)

[Lecture 54 - Computer aided drug design - I](#)

[Lecture 55 - Computer aided drug design - II](#)

[Lecture 56 - Virtual screening - I](#)

[Lecture 57 - Virtual screening - II](#)

[Lecture 58 - QSAR - I](#)

[Lecture 59 - QSAR - II](#)

[Lecture 60 - Demo: Autodock](#)

[Lecture 61 - awk programming - I](#)

[Lecture 62 - awk programming - II](#)

[Lecture 63 - Development of algorithms - I](#)

[Lecture 64 - Development of algorithms - II](#)

[Lecture 65 - Applications of bioinformatics - I](#)

[Lecture 66 - Applications of bioinformatics - II](#)

[Lecture 67 - Overview - I](#)

[Lecture 68 - Overview - II](#)

[Lecture 69 - Demo: Weka](#)

NPTEL : NOC:Demystifying the Brain (Biotechnology)

Co-ordinators : Dr. V Srinivasa Chakravarthy

- Lecture 1 - The Whole and Its Parts: A History of Ideas about Brain
- Lecture 2 - Understanding Brain's Shape - Segment 1 - Brain size and intelligence
- Lecture 3 - Understanding Brain's Shape - Segment 2 - Save Wire Principle
- Lecture 4 - Understanding Brain's Shape - Segment 3 - Brain Evolution
- Lecture 5 - Neurons and Neural Signaling: Outline
- Lecture 6 - Neural Signalling : Molecular and Cellular Basis
- Lecture 7 - Networks that Learn - Segment 1
- Lecture 8 - Multilayer Perceptrons Applications in Psychology and Neuroscience
- Lecture 9 - Organization of the Central Nervous System-Segment 1 - Cortex
- Lecture 10 - Organization of the Central Nervous System-Segment 2 - Subcortical Structures
- Lecture 11 - Maps in the Brain - Segment 1
- Lecture 12 - Maps in the Brain - Segment 2
- Lecture 13 - Emotions in the Brain - Segment 1
- Lecture 14 - Emotions in the Brain - Segment 2
- Lecture 15 - Memories and Holograms - Segment 1
- Lecture 16 - Memories and Holograms - Segment 2
- Lecture 17 - Consciousness - Segment 1
- Lecture 18 - Consciousness - Segment 2

[Lecture 1 - Introduction](#)

[Lecture 2 - Introduction to Modelling](#)

[Lecture 3 - Introduction to Modelling](#)

[Lecture 4 - Fundamentals of Mathematical Modelling](#)

[Lecture 5 - Fundamentals of Mathematical Modelling](#)

[Lecture 6 - Fundamentals of Mathematical Modelling](#)

[Lecture 7 - Some Example Models](#)

[Lecture 8 - Representation of Biological Networks](#)

[Lecture 9 - Lab: MATLAB Basics](#)

[Lecture 10 - Lab: MATLAB Basics](#)

[Lecture 11 - Lab: MATLAB Basics](#)

[Lecture 12 - Lab: MATLAB Basics](#)

[Lecture 13 - Introduction to Networks](#)

[Lecture 14 - Introduction to Networks](#)

[Lecture 15 - Introduction to Network Biology](#)

[Lecture 16 - Introduction to Network Biology](#)

[Lecture 17 - Introduction to Network Biology](#)

[Lecture 18 - Network Biology](#)

[Lecture 19 - Network Models](#)

[Lecture 20 - Network Models](#)

[Lecture 21 - Biological Networks](#)

[Lecture 22 - Network Perturbations](#)

[Lecture 23 - Community Detection](#)

[Lecture 24 - Network Motifs](#)

[Lecture 25 - Lab: Cytoscape](#)

[Lecture 26 - Lab: Cytoscape](#)

[Lecture 27 - Lab: Network Biology](#)

[Lecture 28 - Network Biology: Recap](#)

[Lecture 29 - Lab: Network Models and Perturbations](#)

[Lecture 30 - Lab: Network Models and Perturbations](#)

[Lecture 31 - Reconstruction of Gene Regulatory Networks](#)

[Lecture 32 - Reconstruction of Protein Networks](#)

[Lecture 33 - Reconstruction of Signalling Networks](#)

[Lecture 34 - Reconstruction of Signalling Networks](#)

[Lecture 35 - Introduction to Dynamic Modelling](#)

[Lecture 36 - Introduction to Dynamic Modelling](#)

[Lecture 37 - Introduction to Dynamic Modelling](#)

[Lecture 38 - Lab: Solving ODEs in MATLAB](#)

[Lecture 39 - Lab: Example Biological Model](#)

[Lecture 40 - Parameter Estimation](#)

[Lecture 41 - Parameter Estimation](#)

[Lecture 42 - Parameter Estimation](#)

[Lecture 43 - Methods for Parameter Estimation](#)

[Lecture 44 - Direct Search Methods](#)

[Lecture 45 - Genetic Algorithms](#)

[Lecture 46 - Genetic Algorithms](#)

[Lecture 47 - Other Evolutionary Algorithms](#)

[Lecture 48 - PyGMO](#)

[Lecture 49 - Dynamic Modelling Recap](#)

[Lecture 50 - Lab: Parameter Estimation](#)

[Lecture 51 - Guest Lecture: Modelling in Drug Development](#)

[Lecture 52 - Guest Lecture: Modelling in Drug Development](#)

[Lecture 53 - Guest Lecture: Quantitative Systems Pharmacology](#)

[Lecture 54 - Guest Lecture: Quantitative Systems Pharmacology](#)

[Lecture 55 - Guest Lecture: Quantitative Systems Pharmacology](#)

[Lecture 56 - Constraint-based Modelling of Metabolic Networks](#)

[Lecture 57 - Flux Balance Analysis](#)

[Lecture 58 - Flux Balance Analysis](#)

[Lecture 59 - Flux Balance Analysis](#)

[Lecture 60 - Other Constraint-Based Approaches](#)

[Lecture 61 - Other Constraint-Based Approaches](#)

[Lecture 62 - Lab: FBA using MATLAB](#)

[Lecture 63 - Perturbations to Metabolic Networks: Deletions](#)

[Lecture 64 - Lab: COBRA Toolbox](#)

[Lecture 65 - Understanding FBA](#)

[Lecture 66 - Understanding FBA](#)

[Lecture 67 - Perturbations to Metabolic Networks: Over-expression](#)

[Lecture 68 - Perturbations to Metabolic Networks: Synthetic Lethals](#)

[Lecture 69 - Perturbations to Metabolic Networks: Synthetic Lethals](#)

[Lecture 70 - Constraint-based Modelling of Metabolic Networks](#)

[Lecture 71 - Lab: Gene Deletions](#)

[Lecture 72 - Integrating Regulatory Information into Constraint-Based Models](#)

[Lecture 73 - Elementary Modes](#)

[Lecture 74 - Elementary Modes](#)

[Lecture 75 - Constraint-based Modelling of Metabolic Networks: Applications](#)

[Lecture 76 - Constraint-based Modelling of Metabolic Networks: Applications](#)

[Lecture 77 - Constraint-based Modelling of Metabolic Networks: Applications](#)

[Lecture 78 - Lab: Gene Deletions](#)

[Lecture 79 - Constraint-based Modelling of Metabolic Networks: Recap](#)

[Lecture 80 - Constraint-based Modelling of Metabolic Networks: Recap](#)

[Lecture 81 - Constraint-based Modelling of Metabolic Networks: Recap](#)

[Lecture 82 - \$^{13}\text{C}\$ -Metabolic Flux Analysis using Mass Spectrometry](#)

[Lecture 83 - \$^{13}\text{C}\$ -Metabolic Flux Analysis using Mass Spectrometry](#)

[Lecture 84 - \$^{13}\text{C}\$ -Metabolic Flux Analysis using Mass Spectrometry](#)

[Lecture 85 - Lab: \$^{13}\text{C}\$ -Metabolic Flux Analysis using Mass Spectrometry](#)

[Lecture 86 - Modelling Gene Regulatory Networks](#)

[Lecture 87 - Modelling Gene Regulatory Networks](#)

[Lecture 88 - Modelling Gene Regulatory Networks](#)

[Lecture 89 - Lab: Modelling Gene Regulatory Networks](#)

[Lecture 90 - Lab: Modelling Gene Regulatory Networks](#)

[Lecture 91 - Computational Modelling of Host-Pathogen Interactions](#)

[Lecture 92 - Computational Modelling of Host-Pathogen Interactions](#)

[Lecture 93 - Robustness in Biological Systems](#)

[Lecture 94 - Robustness in Biological Systems: Mechanisms](#)

[Lecture 95 - Robustness in Biological Systems: Organising Principles](#)

[Lecture 96 - Robustness in Biological Systems: Trade-offs](#)

[Lecture 97 - Robustness and Evolvability](#)

[Lecture 98 - robustness and Evolvability](#)

[Lecture 99 - Introduction to Synthetic Biology](#)

[Lecture 100 - Advanced Topics](#)

[Lecture 101 - Advanced Topics](#)

[Lecture 102 - Advanced Topics](#)

[Lecture 103 - Course Recap](#)

Lecture 1 - Fundamentals of Engineering Calculations

Lecture 2 - Process Parameters and Variables

Lecture 3 - Fundamentals of Material Balances

Lecture 4 - Material Balance Calculations for Single Units Without Reactions - Part 1

Lecture 5 - Material Balance Calculations for Single Units Without Reactions - Part 2

Lecture 6 - Material Balance Calculations for Single Units Without Reactions - Part 3

Lecture 7 - Material Balance Calculations for Single Units Without Reactions - Part 4

Lecture 8 - Material Balance Calculations for Multiple Units Without Reactions - Part 1

Lecture 9 - Material Balance Calculations for Multiple Units Without Reactions - Part 2

Lecture 10 - Fundamentals of Reactive Processes

Lecture 11 - Material Balance Calculations For Single Units With A Single Reaction

Lecture 12 - Material Balance Calculations for Single Units with A Single Reaction (Continued...)

Lecture 13 - Material Balance Calculations for Single Units with Multiple Reactions - Part 1

Lecture 14 - Material Balance Calculations for Single Units with Multiple Reactions - Part 2

Lecture 15 - Material Balance Calculations for Single Units with Multiple Reactions - Part 3

Lecture 16 - Material Balance Calculations for Multiple Units with Reactions - Part 1

Lecture 17 - Material Balance Calculations for Multiple Units with Reactions - Part 2

Lecture 18 - Material Balances on Reactive Processes - Tutorials

Lecture 19 - Combustion Reactions: An Introduction

Lecture 20 - Material Balances for Combustion Reactions

Lecture 21 - Biochemical Reactions: Enzyme Kinetics

Lecture 22 - Biochemical Reactions: Cell Growth

Lecture 23 - Recycle Without Reactions

Lecture 24 - Recycle with Reactions

Lecture 25 - Recycle: Tutorials

Lecture 26 - Bypass

Lecture 27 - Purge

Lecture 28 - Material Balance: A Review - Part 1

Lecture 29 - Material Balance: A Review - Part 2

Lecture 30 - Material Balance: A Review - Part 3

Lecture 31 - The Unreasonable Effectiveness of Material Balance

[Lecture 32 - Constraint-based modelling](#)

[Lecture 33 - Flux balance analysis - Part 1](#)

[Lecture 34 - Flux balance analysis - Part 2](#)

[Lecture 35 - Energy Balance Terminologies and Concepts](#)

[Lecture 36 - Introduction to Energy Balances - Part 1](#)

[Lecture 37 - Introduction to Energy Balances - Part 2](#)

[Lecture 38 - Introduction to Energy Balances: Tutorials](#)

[Lecture 39 - Mechanical Energy Balances](#)

[Lecture 40 - Mechanical Energy Balances: Tutorials](#)

[Lecture 41 - Energy Balance Objectives and Procedures](#)

[Lecture 42 - Introduction to Nonreactive Processes Without Phase Change](#)

[Lecture 43 - Energy Balances on Single-Phase Nonreactive Processes](#)

[Lecture 44 - Energy Balances on Single-Phase Nonreactive Processes: Tutorials](#)

[Lecture 45 - Fundamentals of Nonreactive Phase Change Processes](#)

[Lecture 46 - Estimating Latent Heats](#)

[Lecture 47 - Energy Balances on Nonreactive Processes With Phase Change](#)

[Lecture 48 - Energy Balances on Nonreactive Processes With Phase Change: Tutorials - 1](#)

[Lecture 49 - Energy Balances on Nonreactive Processes With Phase Change: Tutorials - 2](#)

[Lecture 50 - Psychrometric Charts](#)

[Lecture 51 - Energy Balances Using Psychrometric Charts](#)

[Lecture 52 - Mixing and Solution](#)

[Lecture 53 - Mixing and Solution: Tutorials - 1](#)

[Lecture 54 - Mixing and Solution: Tutorials - 2](#)

[Lecture 55 - Fundamentals for Energy Balances on Reactive Processes - Part 1](#)

[Lecture 56 - Fundamentals for Energy Balances on Reactive Processes - Part 1 and Part 2](#)

[Lecture 57 - Fundamentals for Energy Balances on Reactive Processes - Tutorials](#)

[Lecture 58 - Energy Balances on Reactive Processes - Part 1](#)

[Lecture 59 - Energy Balances on Reactive Processes - Part 2](#)

[Lecture 60 - Energy Balances on Reactive Processes - Part 3](#)

[Lecture 61 - Energy Balances on Reactive Processes - Part 4](#)

[Lecture 62 - Energy Balances on Reactive Processes - Part 5](#)

[Lecture 63 - Energy Balances on Reactive Processes - Part 6](#)

[Lecture 64 - Energy Balances: A Review - Part 1](#)

[Lecture 65 - Energy Balances: A Review - Part 2](#)

[Lecture 66 - Energy Balances: A Review - Part 3](#)

[Lecture 67 - Energy Balances: A Review - Part 4](#)

[Lecture 68 - Unsteady State Material Balances](#)

[Lecture 69 - Unsteady State Energy Balances](#)

Lecture 1 - Introduction

Lecture 2 - Drug Discovery - Issues

Lecture 3 - Target and Lead Identification

Lecture 4 - Drug And Data bases

Lecture 5 - Drug Properties

Lecture 6 - Drug - Properties / SMILES

Lecture 7 - Drug Solubility

Lecture 8 - Drug Solubility / permeability

Lecture 9 - ADME

Lecture 10 - Drug - ADME

Lecture 11 - Drug - ADME

Lecture 12 - Drug - BBB

Lecture 13 - Pgp efflux/Drug Likeness

Lecture 14 - Drug Likeness

Lecture 15 - Molecular Modelling

Lecture 16 - Molecular Mechanics / Force Field

Lecture 17 - Molecular Mechanics / Force Field

Lecture 18 - Molecular Mechanics / Force Field

Lecture 19 - Molecular Mechanics / Force Field

Lecture 20 - ODES and Numerical methods

Lecture 21 - ODES and Numerical methods

Lecture 22 - Conformational Search / MD

Lecture 23 - Quantum Mechanics

Lecture 24 - Quantum Mechanics

Lecture 25 - Quantitative Struture Activity Relationship (QSAR)

Lecture 26 - Quantitative Struture Activity Relationship (QSAR)

Lecture 27 - Quantitative Struture Activity Relationship (QSAR)

Lecture 28 - Quantitative Struture Activity Relationship (QSAR)

Lecture 29 - Quantitative Struture Activity Relationship (QSAR)

Lecture 30 - Quantitative Struture Activity Relationship (QSAR)

Lecture 31 - 3D QSAR

[Lecture 32 - Pharmacophore modelling](#)

[Lecture 33 - Target based drug design](#)

[Lecture 34 - Target based drug design](#)

[Lecture 35 - Target based drug design](#)

[Lecture 36 - Target based drug design](#)

[Lecture 37 - Docking](#)

[Lecture 38 - Docking](#)

[Lecture 39 - Pharmacokinetics / pharmacodynamics](#)

[Lecture 40 - Pharmacokinetics / pharmacodynamics](#)

- Lecture 1 - Introduction to plant cell technology
- Lecture 2 - History of plant cell and tissue culture
- Lecture 3 - Anatomy of plant cells
- Lecture 4 - Plant tissues and functions
- Lecture 5 - Photosynthesis and Photorespiration
- Lecture 6 - In-vitro culture initiation
- Lecture 7 - Nutritional requirements of plant cells
- Lecture 8 - Organogenesis and Regeneration
- Lecture 9 - Somaclonal variation and Micropropagation
- Lecture 10 - Somatic embryogenesis and Protoplast culture
- Lecture 11 - Synthetic seeds, Cryopreservation and Freezing methods
- Lecture 12 - Secondary metabolism in plant cells - Part 1
- Lecture 13 - Secondary metabolism in plant cells - Part 2
- Lecture 14 - Secondary metabolism in plant cells - Part 3
- Lecture 15 - Secondary metabolism in plant cells - Part 4
- Lecture 16 - Optimization strategies - Part 1
- Lecture 17 - Optimization strategies - Part 2
- Lecture 18 - Optimization strategies - Part 3
- Lecture 19 - Optimization strategies - Part 4
- Lecture 20 - Biotransformation in plant cultures
- Lecture 21 - Immobilization of plant cells
- Lecture 22 - Genetic transformations in plant cells - Part 1
- Lecture 23 - Genetic transformations in plant cells - Part 2
- Lecture 24 - Genetic transformations in plant cells - Part 3
- Lecture 25 - Plant Cell Bioreactors - Part 1
- Lecture 26 - Plant Cell Bioreactors - Part 2
- Lecture 27 - Bioreactors for Hairy Root cultures
- Lecture 28 - Case study - Part 1
- Lecture 29 - Case study - Part 2

[Lecture 1 - Introduction to Tissue Engineering - Part 1](#)

[Lecture 2 - Introduction to Tissue Engineering - Part 2](#)

[Lecture 3 - Introduction to Tissue Engineering - Part 3](#)

[Lecture 4 - Scaffolds: Extracellular Matrix](#)

[Lecture 5 - Scaffolds: Natural Polymers](#)

[Lecture 6 - Scaffolds: Synthetic Polymers](#)

[Lecture 7 - Hydrogels - Part 1](#)

[Lecture 8 - Hydrogels - Part 2](#)

[Lecture 9 - Bioceramics](#)

[Lecture 10 - Scaffold fabrication strategies](#)

[Lecture 11 - Self Assembly](#)

[Lecture 12 - 3D Bioprinting](#)

[Lecture 13 - Material Characterization - Part 1](#)

[Lecture 14 - Material Characterization - Part 2](#)

[Lecture 15 - Material Characterization - Part 3](#)

[Lecture 16 - Cell Source](#)

[Lecture 17 - Cell Isolation - Part 1](#)

[Lecture 18 - Cell Isolation - Part 2](#)

[Lecture 19 - Tissue Dynamics](#)

[Lecture 20 - Cell Differentiation](#)

[Lecture 21 - Cell Adhesion](#)

[Lecture 22 - Cell Migration](#)

[Lecture 23 - Signaling and biomolecule delivery in Tissue Engineering](#)

[Lecture 24 - Bioreactors in Tissue Engineering](#)

[Lecture 25 - Challenges in Tissue Engineering](#)

[Lecture 26 - Host integration and immune responses - Part 1](#)

[Lecture 27 - Host integration and immune responses - Part 2](#)

[Lecture 28 - Bioethics of Tissue Engineering - Part 1](#)

[Lecture 29 - Bioethics of Tissue Engineering - Part 2](#)

[Lecture 30 - Skin Tissue Engineering - Part 1](#)

[Lecture 31 - Skin Tissue Engineering - Part 2](#)

[Lecture 32 - Bone Tissue Engineering - Part 1](#)

[Lecture 33 - Bone Tissue Engineering - Part 2](#)

[Lecture 34 - Bone Tissue Engineering - Part 3](#)

[Lecture 35 - Vascular Tissue Engineering](#)

[Lecture 36 - Corneal Tissue Engineering - Part 1](#)

[Lecture 37 - Corneal Tissue Engineering - Part 2](#)

Lecture 1 - Introduction and review

Lecture 2 - Review (Continued...)

Lecture 3 - Need for analysis

Lecture 4 - Additional Thermodynamic Functions

Lecture 5 - State and Path Variables

Lecture 6 - Equations for a Closed System

Lecture 7 - Chemical Potential

Lecture 8 - Gibbs Duhem equation

Lecture 9 - Maxwell's relations

Lecture 10 - Inter-relationships between thermodynamic variables (Continued...)

Lecture 11 - Some useful mathematical manipulations

Lecture 12 - Thermodynamic relations for a closed system with 1 mole of pure substance

Lecture 13 - Maximum work

Lecture 14 - Open systems

Lecture 15 - Equations of state - Virial equations

Lecture 16 - Equations of state - Cubic equations

Lecture 17 - Volume estimation

Lecture 18 - Volume estimation (Continued...)

Lecture 19 - Generalized correlations

Lecture 20 - Generalized correlations (Continued...)

Lecture 21 - Residual properties

Lecture 22 - Residual properties (Continued...)

Lecture 23 - Generalized correlations and residual properties

Lecture 24 - Fugacity coefficient estimation

Lecture 25 - Review of module 3

Lecture 26 - Learning aspects

Lecture 27 - Chemical potential formulations

Lecture 28 - Lewis and Randall rule

Lecture 29 - Partial molar properties

Lecture 30 - Partial molar property estimation from mixing experiments

Lecture 31 - Partial molar property estimation (Continued...)

[Lecture 32 - Activity coefficient from excess property](#)

[Lecture 33 - Activity coefficient from excess property \(Continued...\)](#)

[Lecture 34 - Models for activity coefficient in a binary system](#)

[Lecture 35 - Models for activity coefficient for a binary system \(Continued...\)](#)

[Lecture 36 - Review of module 4](#)

[Lecture 37 - Criteria for phase equilibrium](#)

[Lecture 38 - Phase rule for non-reacting systems](#)

[Lecture 39 - Clausius Clayperon equation](#)

[Lecture 40 - Clausius Clayperon equation \(Continued...\)](#)

[Lecture 41 - Vapour liquid equilibrium](#)

[Lecture 42 - Vapour liquid equilibrium \(Continued...\)](#)

[Lecture 43 - Estimation of fugacity coefficient from P-V-T data at equilibrium](#)

[Lecture 44 - Liquid-liquid and solid-liquid equilibria](#)

[Lecture 45 - Review of module 5](#)

[Lecture 46 - Criteria for bioreaction equilibria](#)

[Lecture 47 - Phase rule for reacting biosystems](#)

[Lecture 48 - Equilibrium constants](#)

[Lecture 49 - Effect of temperature on the equilibrium constants](#)

[Lecture 50 - Reaction in liquid or solid phases](#)

[Lecture 51 - Free energy changes for some bioreactions](#)

[Lecture 52 - Electrolytes](#)

[Lecture 53 - Review of the classical thermodynamics part](#)

[Lecture 54 - Introduction to Statistical thermodynamics](#)

[Lecture 55 - Concepts of macro and microstates](#)

[Lecture 56 - Thermodynamic probability](#)

[Lecture 57 - Boltzmann distribution law](#)

[Lecture 58 - Defining \$\hat{I}^2\$ in Boltzmann distribution law](#)

[Lecture 59 - Relationship between partition function and thermodynamic quantities](#)

[Lecture 60 - Partition function of mono atomic gases](#)

[Lecture 61 - Entropy in terms of probablity](#)

[Lecture 62 - Gibbs paradox](#)

[Lecture 63 - Thermodynamic probability for distinguishable particles](#)

[Lecture 64 - Thermodynamic probability for indistinguishable particles](#)

[Lecture 65 - Sackur - Tetrode equation](#)

[Lecture 66 - Partition function and Helmholtz and Gibbs free energy](#)

[Lecture 67 - Ensemble approach](#)

[Lecture 68 - Ensemble average, time average, Ergodic hypothesis](#)

[Lecture 69 - Partition function for classical systems](#)

[Lecture 70 - Pair potentials for atomic systems](#)

[Lecture 71 - Potential for molecular systems](#)

[Lecture 72 - Computer code for LJ potential](#)

[Lecture 73 - Introduction to computer simulations](#)

[Lecture 74 - Computer simulations of macromolecules](#)

[Lecture 75 - MD simulation examples](#)

[Lecture 76 - Link between theory and experiments](#)

[Lecture 77 - MD protocol](#)

[Lecture 78 - Computer simulation tricks](#)

[Lecture 79 - Understanding force fields](#)

[Lecture 80 - Idea of Z-matrix](#)

[Lecture 81 - Basics of MD simulations](#)

[Lecture 82 - Integration algorithms](#)

[Lecture 83 - Calculation of Columbic force](#)

[Lecture 84 - Calculation of LJ force](#)

[Lecture 85 - Monte Carlo simulations](#)

[Lecture 86 - Analysis of MD trajectory](#)

[Lecture 87 - Case study \(water\)](#)

[Lecture 1 - Introduction](#)

[Lecture 2 - Mass Conservation](#)

[Lecture 3 - Mass Conservation for a Macroscopic System](#)

[Lecture 4 - Mass Conservation for a Microscopic System](#)

[Lecture 5 - Useful Derivatives](#)

[Lecture 6 - Equation of Continuity](#)

[Lecture 7 - Mass Flux](#)

[Lecture 8 - Mass and Molar Fluxes](#)

[Lecture 9 - Shell Balance Approach](#)

[Lecture 10 - Continuity Equation Approach](#)

[Lecture 11 - Steady-state Diffusion](#)

[Lecture 12 - Steady-state Diffusion across Tubular Walls](#)

[Lecture 13 - Steady-state Radial Diffusion](#)

[Lecture 14 - Steady-state Diffusion with Reaction](#)

[Lecture 15 - Unsteady-state Diffusion](#)

[Lecture 16 - Unsteady-state Diffusion \(Continued...\)](#)

[Lecture 17 - Pseudo Steady State Approximation \(Continued...\)](#)

[Lecture 18 - Pseudo Steady State Approximation \(Continued...\)](#)

[Lecture 19 - Review of Mass Flux](#)

[Lecture 20 - Momentum Flux - Introduction](#)

[Lecture 21 - Rheology](#)

[Lecture 22 - Fluid Flow types](#)

[Lecture 23 - Shell Momentum Balances](#)

[Lecture 24 - Shell Momentum Balances \(Continued...\)](#)

[Lecture 25 - Equation of Motion](#)

[Lecture 26 - Equation of Motion \(Continued...\)](#)

[Lecture 27 - Application of Equation of Motion to Flow Over an Inclined Plane](#)

[Lecture 28 - Laminar Flow through a Pipe](#)

[Lecture 29 - Laminar Flow through a Pipe \(Continued...\)](#)

[Lecture 30 - Capillary Flow](#)

[Lecture 31 - Couette Flow](#)

[Lecture 32 - Non-dimensional Analysis](#)

[Lecture 33 - Unsteady State Flow](#)

[Lecture 34 - Unsteady State Flow \(Continued...\)](#)

[Lecture 35 - Pulsatile Flow](#)

[Lecture 36 - Turbulent Flow](#)

[Lecture 37 - Macroscopic Aspects: The Engineering Bernoulli Equation](#)

[Lecture 38 - Friction Factor for Flow through a Straight Horizontal Pipe](#)

[Lecture 39 - Application of the Engineering Bernoulli Equation to a Piping Network](#)

[Lecture 40 - Stenosis in an Artery](#)

[Lecture 41 - Friction Factor for Relative Motion between a Solid and a Liquid](#)

[Lecture 42 - Friction Factor for Packed Beds](#)

[Lecture 43 - Review of Momentum Flux](#)

[Lecture 44 - Review of Momentum Flux \(Continued...\)](#)

[Lecture 45 - Thermal Energy Flux](#)

[Lecture 46 - Equation of Energy](#)

[Lecture 47 - Temperature Profile in a Tissue](#)

[Lecture 48 - Unsteady-state Heat Conduction](#)

[Lecture 49 - Review of Heat Flux](#)

[Lecture 50 - Charge Flux](#)

[Lecture 51 - Charge Flux - Some Fundamentals](#)

[Lecture 52 - Charge Flux - Some More Fundamentals](#)

[Lecture 53 - Getting Useful Relationships through Maxwell's Equations](#)

[Lecture 54 - Charges/Ions in Solution](#)

[Lecture 55 - Charge Flux: Review](#)

[Lecture 56 - Fluxes Under Simultaneous, Multiple Driving Forces](#)

[Lecture 57 - Simultaneous Concentration Gradient and Electrical Potential Gradient](#)

[Lecture 58 - Mobility of Ions Across a Membrane](#)

[Lecture 59 - Electrical Circuit Representation of a Membrane](#)

[Lecture 60 - Action Potential and Axial Current](#)

[Lecture 61 - Electrophoresis](#)

[Lecture 62 - Simultaneous Concentration Gradient and Velocity Gradient](#)

[Lecture 63 - Simultaneous Concentration Gradient and Velocity Gradient - Bioreactor K_{La}](#)

[Lecture 64 - Gas-Liquid Interphase Transport](#)

- [Lecture 65 - Gas-Liquid Interphase Transport \(Continued...\)](#)
- [Lecture 66 - Bioreactor \$K_L a\$ Estimation](#)
- [Lecture 67 - Liquid Phase Oxygen-Supply Strategy](#)
- [Lecture 68 - LPOS and Its Mechanism](#)
- [Lecture 69 - LPOS for Mold Cultivations](#)
- [Lecture 70 - LPOS Optimization and Costs](#)
- [Lecture 71 - Couette Flow Cultivations](#)
- [Lecture 72 - Pseudo-Steady State Approximation Applied to Bio-oil Production](#)
- [Lecture 73 - Pseudo-Steady State Approximation Applied to Cancer Treatment](#)
- [Lecture 74 - Kinetics of a Process with an Enzyme Immobilized on a Non-porous Slab](#)
- [Lecture 75 - Simultaneous Temperature Gradient and Velocity Gradient](#)
- [Lecture 76 - Design of Heat Exchangers](#)
- [Lecture 77 - Design of Heat Exchangers \(Continued...\)](#)
- [Lecture 78 - Course Review - Part 1](#)
- [Lecture 79 - Course Review - Part 2](#)
- [Lecture 80 - Course Review - Part 3](#)
- [Lecture 81 - Course Review - Part 4](#)

Lecture 1 - Introduction

Lecture 2 - Life cycles and evolution of developmental patterns

Lecture 3 - Experimental embryology

Lecture 4 - Differential gene expression - Part 1

Lecture 5 - Differential gene expression - Part 2

Lecture 6 - Differential gene expression - Part 3

Lecture 7 - Differential gene expression - Part 4

Lecture 8 - Genetic basis - Part 1

Lecture 9 - Genetic basis - Part 2

Lecture 10 - Genetic basis - Part 3

Lecture 11 - Genetic basis - Part 4

Lecture 12 - Genetic basis - Part 5

Lecture 13 - Cell-cell communication - Part 1

Lecture 14 - Cell-cell communication - Part 2

Lecture 15 - Cell-cell communication - Part 3

Lecture 16 - Cell-cell communication - Part 4

Lecture 17 - Genetics of axis formation in Drosophila - Part 1

Lecture 18 - Genetics of axis formation in Drosophila - Part 2

Lecture 19 - Genetics of axis formation in Drosophila - Part 3

Lecture 20 - Genetics of axis formation in Drosophila - Part 4

Lecture 21 - Plant Development - Part 1

Lecture 22 - Plant Development - Part 2

Lecture 23 - Plant Development - Part 3

Lecture 24 - Early Mammalian Development - Part 1

Lecture 25 - Early Mammalian Development - Part 2

Lecture 26 - Evolutionary Developmental Biology - Part 1

Lecture 27 - Evolutionary Developmental Biology - Part 2

Lecture 28 - Evolutionary Developmental Biology - Part 3

[Lecture 1 - Introduction to the course - Part 1](#)

[Lecture 2 - Introduction to the course - Part 2](#)

[Lecture 3 - Design of Batch Bioreactors - Part 1](#)

[Lecture 4 - Design of Batch Bioreactors - Part 2](#)

[Lecture 5 - Design of Batch Bioreactors - Part 3](#)

[Lecture 6 - Design of Batch Bioreactors - Part 4](#)

[Lecture 7 - Design of Batch Bioreactors - Practice problems](#)

[Lecture 8 - Design of Fed Batch bioreactors - Part 1](#)

[Lecture 9 - Design of Fed Batch bioreactors - Part 2](#)

[Lecture 10 - Design of Fed Batch bioreactors - Practice problems - Part 1](#)

[Lecture 11 - Design of Fed Batch bioreactors - Practice Problems - Part 2](#)

[Lecture 12 - Design of Fed Batch bioreactors - Practice Problems - Part 3](#)

[Lecture 13 - Design of Continuous Bioreactors - Part 1](#)

[Lecture 14 - Design of Continuous Bioreactors - Part 2](#)

[Lecture 15 - Design of Continuous Bioreactors - Part 3](#)

[Lecture 16 - Design of Continuous bioreactors - Practice Problems - Part 1](#)

[Lecture 17 - Design of Continuous bioreactors - Practice Problems - Part 1](#)

[Lecture 18 - Design of Continuous bioreactors - Practice Problems - Part 2](#)

[Lecture 19 - Mass Transfer in Bioreactors - Part 1](#)

[Lecture 20 - Mass Transfer in Bioreactors - Part 2](#)

[Lecture 21 - Mass Transfer in Bioreactors - Part 3](#)

[Lecture 22 - Rheology of fluids](#)

[Lecture 23 - Mass Transfer in Bioreactors - Practice Problems](#)

[Lecture 24 - Heterogeneous reactions in Bioreactors - Part 1](#)

[Lecture 25 - Heterogeneous reactions in Bioreactors - Part 2](#)

[Lecture 26 - Heterogeneous reactions in Bioreactors - Part 3](#)

[Lecture 27 - Heterogeneous reactions in Bioreactors - Practice Problems](#)

[Lecture 28 - Heat Transfer Operations in Bioreactors - Part 1](#)

[Lecture 29 - Heat Transfer Operations in Bioreactors - Part 2](#)

[Lecture 30 - Heat Transfer Operations in Bioreactors - Part 3](#)

[Lecture 31 - Heat Transfer Operations in Bioreactors - Part 4](#)

[Lecture 32 - Heat Transfer Operations in Bioreactors - Practice Problems](#)

[Lecture 33 - Scale up of Bioreactors - Part 1](#)

[Lecture 34 - Scale up of Bioreactors - Part 2](#)

[Lecture 35 - Scale up of Bioreactors - Part 3](#)

[Lecture 36 - Scale up of Bioreactors - Part 4](#)

[Lecture 37 - Scale up of Bioreactors - Practice Problems](#)

[Lecture 38 - Non-ideal reactors: design and analysis - Part 1](#)

[Lecture 39 - Non-ideal reactors: design and analysis - Part 2](#)

[Lecture 40 - Non-ideal reactors: design and analysis - Practice Problems](#)

Lecture 1 - Introduction to Biomolecules - Part 1

Lecture 2 - Introduction to Biomolecules - Part 2

Lecture 3 - Stereochemistry and Properties of Water - Part 1

Lecture 4 - Properties of Water - Part 2 and Introduction to Proteins

Lecture 5 - Characteristics of Proteins and Chromatography techniques

Lecture 6 - Electrophoresis of Proteins and Protein Sequencing

Lecture 7 - Synthesis of Polypeptides and Enzymes - Part 1

Lecture 8 - Enzymes - Part 2

Lecture 9 - Enzymes - Part 3

Lecture 10 - Enzymes - Part 4

Lecture 11 - Enzymes - Part 5 and Carbohydrates - Part 1

Lecture 12 - Carbohydrates - Part 2 and Lipids - Part 1

Lecture 13 - Lipids - Part 2

Lecture 14 - Lipids - Part 3 and Introduction to Metabolism - Part 1

Lecture 15 - Introduction to metabolism - Part 2

Lecture 16 - Bioenergetics - Part 1

Lecture 17 - Bioenergetics - Part 2

Lecture 18 - Glycolysis - Part 1

Lecture 19 - Glycolysis - Part 2

Lecture 20 - Citric Acid Cycle - Part 1

Lecture 21 - Citric Acid Cycle - Part 2

Lecture 22 - Oxidative Phosphorylation - Part 1

Lecture 23 - Oxidative Phosphorylation - Part 2

Lecture 24 - Photosynthesis and Carbon assimilation - Part 1

Lecture 25 - Photosynthesis and Carbon Assimilation - Part 2

Lecture 26 - Photosynthesis and Carbon assimilation - Part 3

Lecture 27 - Nitrogen Metabolism

Lecture 28 - Catabolism of Amino acids

Lecture 29 - Urea cycle and Fatty acid catabolism - Part 1

Lecture 30 - Fatty acid catabolism - Part 2

Lecture 31 - Fatty Acid Biosynthesis

[Lecture 32 - Cholestrol Biosynthesis and Lipid transport - Part 1](#)

[Lecture 33 - Cholestrol Biosynthesis and Lipid transport - Part 2](#)

[Lecture 34 - Hormonal Regulation and Integration of Mammalian Metabolism](#)

[Lecture 1 - Introduction - Part 1](#)

[Lecture 2 - Introduction - Part 2](#)

[Lecture 3 - Introduction - Part 3](#)

[Lecture 4 - Solids vs Fluids](#)

[Lecture 5 - Viscosity](#)

[Lecture 6 - Measuring Viscosity](#)

[Lecture 7 - Tutorial - Part 1](#)

[Lecture 8 - Tutorial - Part 2](#)

[Lecture 9 - Tutorial - Part 3](#)

[Lecture 10 - Macromolecular Nature and Hydrophobicity, Structure of Ice, Pauling-Bernal-Fowler Model of Water](#)

[Lecture 11 - Entropy and Probability of Water Conformations, Boltzmann Law of Entropy](#)

[Lecture 12 - Reynolds Number](#)

[Lecture 13 - Tutorial - Part 1](#)

[Lecture 14 - Tutorial - Part 2](#)

[Lecture 15 - Tutorial - Part 3](#)

[Lecture 16 - Hagen-Poiseuille Equation](#)

[Lecture 17 - Tutorial - Part 4](#)

[Lecture 18 - Sedimentation and Centrifugation - Part 1](#)

[Lecture 19 - Sedimentation and Centrifugation - Part 2](#)

[Lecture 20 - Blood Centrifugation](#)

[Lecture 21 - Review: Paperfuge for Hematology](#)

[Lecture 22 - Biology by Numbers](#)

[Lecture 23 - Biology by Numbers: Bomb Yield Solved](#)

[Lecture 24 - Order of Magnitude Estimates and Approximations](#)

[Lecture 25 - Physical Basis of Life](#)

[Lecture 26 - Approximating Cellular and Molecular Size Scales](#)

[Lecture 27 - Quantifying DNA and Chromatin](#)

[Lecture 28 - Protein Abundance and Spacing](#)

[Lecture 29 - Model Gene](#)

[Lecture 30 - Cell-Biology by Numbers](#)

[Lecture 31 - Experimental Techniques to Quantify Cells](#)

[Lecture 32 - Time-Scales in Cells](#)

[Lecture 33 - Energy Scale](#)

[Lecture 34 - Energy and Thermodynamics of Life - Part 1](#)

[Lecture 35 - Energy and Thermodynamics of Life - Part 2](#)

[Lecture 36 - Energy and Life- Osmotic Engine](#)

[Lecture 37 - Energy and Life- Interconversion of Energy](#)

[Lecture 38 - Random Walk Statistics, Stoke-Einstein - Part 1](#)

[Lecture 39 - Random Walk Statistics, Stoke-Einstein - Part 2](#)

[Lecture 40 - Demonstration of Diffusion of Micron Sized Particles](#)

[Lecture 41 - Macromolecular Crowding - Part 1](#)

[Lecture 42 - Macromolecular Crowding - Part 2](#)

[Lecture 43 - Cytoskeleton](#)

[Lecture 44 - Beam Theory Applied to Biopolymer](#)

[Lecture 45 - Understanding Chromosomes as Statistical Polymers - Part 1](#)

[Lecture 46 - Understanding Chromosomes as Statistical Polymers - Part 2](#)

[Lecture 47 - Brownian Ratchets and Molecular Motors](#)

[Lecture 48 - Polymerization Dynamics - Part 1](#)

[Lecture 49 - Polymerization Dynamics - Part 2](#)

[Lecture 50 - Polymerization Dynamics - Part 3](#)

[Lecture 51 - Python Programming - Part 1](#)

[Lecture 52 - Python Programming - Part 2](#)

[Lecture 53 - Python Programming - Part 3](#)

[Lecture 54 - Introduction to Membrane Mechanics](#)

[Lecture 55 - Membrane Deformation](#)

[Lecture 56 - Developmental Pattern Formation](#)

[Lecture 57 - Turing Model](#)

[Lecture 58 - Phyllotaxis - Part 1](#)

[Lecture 59 - Phyllotaxis - Part 2](#)

[Lecture 60 - Phyllotaxis - Part 3](#)

Lecture 1 - Medical Image Analysis - Introduction

Lecture 2 - X-ray imaging

Lecture 3 - MRI Physics

Lecture 4 - Magnetic Resonance Image Acquisition

Lecture 5 - Ultrasound Imaging

Lecture 6 - Radionuclide Imaging

Lecture 7 - Basic Image Processing Methods

Lecture 8 - Contrast Enhancement

Lecture 9 - Histogram Equalization

Lecture 10 - Edge Enhancement - Laplacian

Lecture 11 - Noise Reduction

Lecture 12 - Diffusion Filtering

Lecture 13 - Bayesian Image Restoration

Lecture 14 - Registration Introduction

Lecture 15 - Framework

Lecture 16 - Image Coordinates

Lecture 17 - Transforms

Lecture 18 - Metrics

Lecture 19 - NonRigid Registration

Lecture 20 - Demons part - 1

Lecture 21 - Demons part - 2

Lecture 22 - FFDBSplines

Lecture 23 - Endoscopy - Where are we with AI ?

Lecture 24 - Computer vision and DL in the operating room

Lecture 25 - ML in intraoperative tissue identification

Lecture 26 - Basic Image Processing Techniques Using MATLAB

Lecture 27 - Image Registration Using Matlab

Lecture 28 - Basic Image Processing Techniques Using Python

Lecture 29 - Calculus of variations

Lecture 30 - Snakes - Active Contour Models

Lecture 31 - Level Sets, Geodesic Active Contours, Mumford-Shah Functional, Chan-Vese

[Lecture 32 - Mumford-Shah Functional, Chan-Vese](#)

[Lecture 33 - Segmentation Models Demo \[Snakes \(Active Contours \) Chan-Vese segmentation, Geodesic active Contour\]](#)

[Lecture 34 - Active Shape Models](#)

[Lecture 35 - Snake tutorial](#)

[Lecture 36 - Level Set Method](#)

[Lecture 37 - Chan Vese Segmentation](#)

[Lecture 38 - Neural Networks Introduction](#)

[Lecture 39 - Linear Regression](#)

[Lecture 40 - Gradient Descent Formulation](#)

[Lecture 41 - Linear Regression Demo](#)

[Lecture 42 - Feed forward neural Networks](#)

[Lecture 43 - Example with XOR](#)

[Lecture 44 - Introduction to CNNs](#)

[Lecture 45 - Max Pooling](#)

[Lecture 46 - Applications of Cnns](#)

[Lecture 47 - CNN Training](#)

[Lecture 48 - Semantic Segmentation](#)

[Lecture 49 - Classification Demo in Pytorch](#)

[Lecture 50 - Generative Models](#)

[Lecture 51 - GAN Final Demo](#)

Lecture 1 - Introduction to Organ Printing course and Content Discussion

Lecture 2 - Introduction to 3D Bioprinting

Lecture 3 - Introduction to Inkjet 3D Bioprinting

Lecture 4 - Introduction to Inkjet 3D Bioprinting (Continued...)

Lecture 5 - Introduction to Extrusion Bioprinting

Lecture 6 - Introduction to Extrusion 3D Bioprinting (Continued...)

Lecture 7 - Introduction to Laser-assisted Bioprinting

Lecture 8 - Comparison of Different Bioprinting Techniques - Part 1

Lecture 9 - Comparison of Different Bioprinting Techniques - Part 2

Lecture 10 - 3D Bioprinting in Support Bath

Lecture 11 - Introduction to Bioinks

Lecture 12 - Important material requirement for Bioink development

Lecture 13 - Crosslinking of Hydrogels for Bioprinting

Lecture 14 - Single-Material and Multimaterial Bioink Systems

Lecture 15 - Printability for Extrusion Bioprinting

Lecture 16 - What is required and how to print an organ?

Lecture 17 - Level of complexity in Tissues/Organs for Bioprinting

Lecture 18 - Design approaches in Bioprinting

Lecture 19 - Bioprinting of Vasculature

Lecture 20 - Direct printing of vasculature

Lecture 21 - Indirect printing of vasculature

Lecture 22 - Design of Cornea Tissue-Specific Bioink and 3D Bioprinting of Cornea

Lecture 23 - Design of Cornea Tissue-Specific Bioink and 3D Bioprinting of Cornea (Continued...)

Lecture 24 - Bioprinting of Heart

Lecture 25 - Bioprinting of Liver

Lecture 26 - Bioprinting of Kidney

Lecture 27 - Bioprinting of Lung

Lecture 28 - 4D Bioprinting - Part 1

Lecture 29 - 4D Bioprinting - Part 2

Lecture 30 - 4D Bioprinting - Part 3

Lecture 31 - In Situ Bioprinting

[Lecture 32 - In Situ Bioprinting \(Continued...\)](#)

[Lecture 33 - Medical Modeling for Organ Printing](#)

[Lecture 34 - Medical Modeling for Organ Printing \(Continued...\)](#)

[Lecture 35 - Next Step in Bioprinting](#)

[Lecture 36 - Next Step in Bioprinting \(Continued...\)](#)

[Lecture 37 - Ethical Issues related to Organ Printing](#)

[Lecture 1 - An Overview of Central Dogma of Molecular Biology - Part 1](#)

[Lecture 2 - An Overview of Central Dogma of Molecular Biology - Part 2](#)

[Lecture 3 - Central Dogma : The DNA Structure - Part 1](#)

[Lecture 4 - Central Dogma : The DNA Structure - Part 2](#)

[Lecture 5 - Central Dogma : The DNA Structure - Part 3](#)

[Lecture 6 - Central Dogma : Replication of DNA - Part 1](#)

[Lecture 7 - Central Dogma : Replication of DNA - Part 2](#)

[Lecture 8 - Central Dogma : Transcription - Part 1](#)

[Lecture 9 - Central Dogma : Transcription - Part 2](#)

[Lecture 10 - Central Dogma : Transcription - Part 3](#)

[Lecture 11 - Central Dogma : Translation - Part 1](#)

[Lecture 12 - Central Dogma : Translation - Part 2](#)

[Lecture 13 - Central Dogma : Translation - Part 3](#)

[Lecture 14 - Protein Structure, Folding and Function - Part 1](#)

[Lecture 15 - Protein Structure, Folding and Function - Part 2](#)

[Lecture 16 - Secondary Structure of Proteins: Ramachandran Plot - Part 1](#)

[Lecture 17 - Secondary Structure of Proteins: Ramachandran Plot - Part 2](#)

[Lecture 18 - Protein Structure, Folding and Function - Part 3](#)

[Lecture 19 - Protein Structure, Folding and Function - Part 4](#)

[Lecture 20 - Protein Structure, Folding and Function - Part 5](#)

[Lecture 21 - Protein Structure, Folding and Function - Part 6](#)

[Lecture 22 - Enzymes, Carbohydrates and Lipids](#)

[Lecture 23 - Introduction to Genetics - Part 1](#)

[Lecture 24 - Introduction to Genetics - Part 2](#)

[Lecture 25 - Introduction to Genetics - Part 3](#)

[Lecture 26 - Mendelian and Non-Mendelian Genetics - Part 1](#)

[Lecture 27 - Mendelian and Non-Mendelian Genetics - Part 2](#)

[Lecture 28 - Mendelian and Non-Mendelian Genetics - Part 3](#)

[Lecture 29 - Introduction to Microscopy - Part 1](#)

[Lecture 30 - Introduction to Microscopy - Part 2](#)

[Lecture 31 - Introduction to Microscopy - Part 3](#)

[Lecture 32 - Biology of Cells - Part 1](#)

[Lecture 33 - Biology of Cells - Part 2](#)

[Lecture 34 - Complexity and Compartmentalization in Cells - Part 1](#)

[Lecture 35 - Complexity and Compartmentalization in Cells - Part 2](#)

[Lecture 36 - Endosymbiont Theory](#)

[Lecture 37 - Structure of the Cell: Cell Wall and Cell Membrane](#)

[Lecture 38 - Structure of the Cell: Discussion Session](#)

[Lecture 39 - Plasma Membrane: The Boundaries of Life](#)

[Lecture 40 - Plasma Membrane: Discussion Session](#)

[Lecture 41 - Introduction to Cytoskeleton - Part 1](#)

[Lecture 42 - Cytoskeleton: Discussion Session 1](#)

[Lecture 43 - Introduction to Cytoskeleton - Part 2](#)

[Lecture 44 - Cytoskeleton: Discussion Session 2](#)

[Lecture 45 - Motor Proteins in Cell](#)

[Lecture 46 - Motor Proteins in Cell: Discussion Session](#)

[Lecture 47 - Discussion on Directionality of Motor Protein](#)

[Lecture 48 - Endomembrane System of Cells - Part 1](#)

[Lecture 49 - Endomembrane System of Cells: Discussion Session 1](#)

[Lecture 50 - Endomembrane System of Cells - Part 2](#)

[Lecture 51 - Endomembrane System of Cells: Discussion Session 2](#)

[Lecture 52 - Endomembrane System of Cells - Part 3](#)

[Lecture 53 - Endomembrane System of Cells: Discussion Session 3](#)

[Lecture 54 - Endomembrane System of Cells - Part 4](#)

[Lecture 55 - Endomembrane System of Cells: Discussion Session 4](#)

[Lecture 56 - Cell Division](#)

[Lecture 57 - Cell Division: Discussion session](#)

[Lecture 58 - Discussion Session on Organization and Function of a Cell](#)

Lecture 1 - Introduction to RNA Biology and RNA World - The Beginning

Lecture 2 - Introduction to RNA Biology and RNA World - Evidences

Lecture 3 - Introduction to RNA Biology and RNA World - Origin of Monomers

Lecture 4 - Introduction to RNA Biology and RNA World - Shift to DNA

Lecture 5 - Introduction to RNA Biology and RNA World - RNA Self Replication

Lecture 6 - Introduction to RNA Biology and RNA World - Origin of RNA Enzymes

Lecture 7 - RNA as Enzymes: The Ribozymes

Lecture 8 - RNA as Enzymes: Structure and Functions

Lecture 9 - RNA as Enzymes: The Present and Future

Lecture 10 - RNA Transcription: The Central Dogma

Lecture 11 - RNA Transcription: Initial Steps

Lecture 12 - RNA Transcription: Different Stages

Lecture 13 - RNA Transcription: Termination and RNA Modification

Lecture 14 - RNA Transcription: Different Polymerases

Lecture 15 - RNA Processing and Life Cycle: RNA Maturation and RNPs

Lecture 16 - RNA Processing and Life Cycle: RNA Splicing

Lecture 17 - RNA Processing and Life Cycle: Post Transcriptional Processing

Lecture 18 - Alternative RNA Processing and Editing: Alternative Splicing

Lecture 19 - Alternative RNA Processing and Editing: Implications of Introns

Lecture 20 - Alternative RNA Processing and Editing: Splicing and Pathology

Lecture 21 - Alternative RNA Processing and Editing: RNA Editing in Detail

Lecture 22 - Alternative RNA Processing and Editing: Relevance of RNA Editing

Lecture 23 - Alternative RNA Processing and Editing: Relevance in Immunology

Lecture 24 - RNA Splicing, Export and Stability: Relevance of Introns

Lecture 25 - RNA Splicing, Export and Stability: Introns in RNA Splicing

Lecture 26 - RNA Splicing, Export and Stability: Different Spliceosomes

Lecture 27 - RNA Splicing, Export and Stability: SMN Complex

Lecture 28 - snRNA, rRNA, miRNA, siRNA Processing, Export and Function: Introns and Link to Splicing

Lecture 29 - snRNA, rRNA, miRNA, siRNA Processing, Export and Function: RNA Helicases

Lecture 30 - snRNA, rRNA, miRNA, siRNA Processing, Export and Function: Nucleo Cytoplasmic Transport

Lecture 31 - snRNA, rRNA, miRNA, siRNA Processing, Export and Function: Nucleoporins and miRNAs

[Lecture 32 - snRNA, rRNA, miRNA, siRNA Processing, Export and Function: RNA Export Mechanisms](#)

[Lecture 33 - snRNA, rRNA, miRNA, siRNA Processing, Export and Function: RNA Quality Control](#)

[Lecture 34 - Mechanisms of RNA Decay and Non Coding RNAs: Decay Pathways](#)

[Lecture 35 - Mechanisms of RNA Decay and Non Coding RNAs: The Exosomes](#)

[Lecture 36 - Mechanisms of RNA Decay and Non Coding RNAs: mRNA Surveillance](#)

[Lecture 37 - Mechanisms of RNA Decay and Non Coding RNAs: Mechanisms of RNA Decay](#)

[Lecture 38 - Mechanisms of RNA Decay and Non Coding RNAs: Autoregulation of RNAs](#)

[Lecture 39 - Mechanisms of RNA Decay and Non Coding RNAs: Introduction to Non-Coding RNAs](#)

[Lecture 40 - Dosage Compensation and X-Inactivation: SRP and Different Modes of Compensation](#)

[Lecture 41 - Dosage Compensation and X-Inactivation: Dosage Compensation of X](#)

[Lecture 42 - Dosage Compensation and X-Inactivation: Omprinted vs Random X Inactivation](#)

[Lecture 43 - Dosage Compensation and X-Inactivation: Molecular Basis of X-Inactivation](#)

[Lecture 44 - Dosage Compensation and X-Inactivation: ES Cells and X-Inactivation](#)

[Lecture 45 - Dosage Compensation, Xist and ncRNA in Imprinting: The Roles of YY1](#)

[Lecture 46 - Dosage Compensation, Xist and ncRNA in Imprinting: shRNAs and Gene Expression](#)

[Lecture 47 - Dosage Compensation, Xist and ncRNA in Imprinting: Mechanism of RNAi in Action](#)

[Lecture 48 - Dosage Compensation, Xist and ncRNA in Imprinting: Genomic Imprinting in Action](#)

[Lecture 49 - Dosage Compensation, Xist and ncRNA in Imprinting: Different ncRNAs and their Roles](#)

[Lecture 50 - Dosage Compensation, Xist and ncRNA in Imprinting: lncRNA-Induced Cancer](#)

[Lecture 51 - Dosage Compensation, Xist and ncRNA in Imprinting: Xist and Cancer](#)

[Lecture 52 - Telomere, Telomerase and Impact on Genomes: The Importance of Telomeres](#)

[Lecture 53 - Telomere, Telomerase and Impact on Genomes: Telomerase and Aging](#)

[Lecture 54 - Telomere, Telomerase and Impact on Genomes: Telomere Length as Marker of Aging](#)

[Lecture 55 - Telomere, Telomerase and Impact on Genomes: Telomeres and Cancer](#)

[Lecture 56 - Telomere, Telomerase and Impact on Genomes: Cell Cycle Arrest](#)

[Lecture 57 - Telomere, Telomerase and Impact on Genomes: Maintenance and Manipulation of Telomeres](#)

[Lecture 58 - Epitranscriptome and Protein Synthesis: Important RNA Modifications](#)

[Lecture 59 - Epitranscriptome and Protein Synthesis: Readers, Writes and Erasers](#)

[Lecture 60 - Epitranscriptome and Protein Synthesis: Biological Implications of RNA Modifications](#)

[Lecture 61 - Epitranscriptome and Protein Synthesis: Roles of RNAs in Translation](#)

[Lecture 62 - Epitranscriptome and Protein Synthesis: Mechanism of Translation](#)

Lecture 1 - Introduction to forces - Resolving forces, principle of transmissibility

Lecture 2 - Statics FBD and EOE

Lecture 3 - Example problems on FBD and EOE

Lecture 4 - Joints in human body

Lecture 5 - Machines and mechanical advantage

Lecture 6 - Levers and types of levers

Lecture 7 - Insertion point and torque

Lecture 8 - Practice problem - 1

Lecture 9 - Practice problem - 2

Lecture 10 - Key terminologies

Lecture 11 - Anatomical planes and axis

Lecture 12 - Sagittal plane movements

Lecture 13 - Coronal plane movements

Lecture 14 - Transverse plane movements

Lecture 15 - Muscles - Muscle fascicles

Lecture 16 - Muscle fibers- Pennation angle

Lecture 17 - More on pennation angle

Lecture 18 - Excitation contraction coupling

Lecture 19 - Sliding filament theory

Lecture 20 - Force length relationship

Lecture 21 - Shoulder joints and muscles

Lecture 22 - Shoulder problem - 1

Lecture 23 - Shoulder problem - 2

Lecture 24 - Elbow theory

Lecture 25 - Elbow problem - 1

Lecture 26 - Elbow problem - 2

Lecture 27 - Elbow problem - 3

Lecture 28 - Wrist theory

Lecture 29 - Finger theory

Lecture 30 - Finger muscles

Lecture 31 - Spine anatomy and movements

[Lecture 32 - Spine muscles](#)

[Lecture 33 - Spine problem](#)

[Lecture 34 - Hip anatomy and movements](#)

[Lecture 35 - Hip muscles](#)

[Lecture 36 - Hip problem](#)

[Lecture 37 - Knee anatomy and movements](#)

[Lecture 38 - Knee muscles](#)

[Lecture 39 - Knee problem](#)

[Lecture 40 - Ankle anatomy and movements](#)

[Lecture 41 - Ankle muscles](#)

[Lecture 42 - Ankle problem](#)

[Lecture 43 - Grasping- reaching- chains](#)

[Lecture 44 - D.O.F mobility, open/closed chain](#)

[Lecture 45 - Forward kinematics and workspace](#)

[Lecture 46 - 2R inverse kinematics](#)

[Lecture 47 - 3R kinematics forward and inverse](#)

[Lecture 48 - D-H parameters](#)

[Lecture 49 - Velocity and jacobian](#)

[Lecture 50 - 3R velocity](#)

[Lecture 51 - Tissues and types of tissues](#)

[Lecture 52 - Bone microstructure and cells](#)

[Lecture 53 - Properties of bones](#)

[Lecture 54 - Wolffs Law and Hookean behavior](#)

[Lecture 55 - Elastic properties and stress strain relations](#)

[Lecture 56 - Stress strain curve and mechanical properties of biological materials](#)

[Lecture 57 - Bending of Bones](#)

[Lecture 58 - Viscoelastic modelling](#)

[Lecture 59 - Maxwell Model](#)

[Lecture 60 - Voight Model](#)

[Lecture 61 - Kelvin model](#)

[Lecture 62 - Viscoelasticity in bones](#)

[Lecture 63 - Tissues and its constituents](#)

[Lecture 64 - Cartilages, ligaments and tendons](#)

[Lecture 65 - Stress strain relations in tendons](#)

[Lecture 66 - Tendon forces and factors affecting tendon property](#)

[Lecture 67 - Gliding resistance, tendon wrapping and friction forces](#)

[Lecture 68 - Enslaving - Intertendinous force transfer and motor units](#)

[Lecture 69 - Introduction to enslavement](#)

[Lecture 70 - Enslaving effects in finger force production - 1](#)

[Lecture 71 - Enslaving effects in finger force production - 2](#)

[Lecture 72 - Wrist posture and finger interdependence - 1](#)

[Lecture 73 - Wrist posture and finger interdependence - 2](#)

[Lecture 74 - Wrist posture and finger interdependence - 3](#)

[Lecture 75 - Measurement of orientation in 3D space - Devices](#)

[Lecture 76 - Rotation matrices in 2D and 3D](#)

[Lecture 77 - Animating using rotation matrices- Matlab Examples](#)

[Lecture 78 - Composite rotation matrix and relative orientations](#)

[Lecture 79 - Complex numbers and quaternions](#)

[Lecture 80 - Singularity, Gimbal Lock, Advantages and disadvantages of parameterization methods](#)

[Lecture 81 - Single finger kinematics measurement using IMU's](#)

[Lecture 82 - IMU based Full hand kinematics measurement system \(HKMS\)](#)

[Lecture 83 - Demonstration of the Hand Kinematics Measurement System \(HKMS\)](#)

[Lecture 84 - Introduction to Gait and running](#)

NPTEL : Introduction to Synthetic Biology (Biotechnology)

Co-ordinators : Prof. Karthik Raman

[Lecture 1 - Introduction to Synthetic Biology - Day 1 Part 1](#)

[Lecture 2 - Introduction to Synthetic Biology - Day 1 Part 2](#)

[Lecture 3 - Introduction to Synthetic Biology - Day 1 Part 3](#)

[Lecture 4 - Introduction to Synthetic Biology - Day 1 Part 4](#)

[Lecture 5 - Introduction to Synthetic Biology - Day 2 Part 1](#)

[Lecture 6 - Introduction to Synthetic Biology - Day 2 Part 2](#)

[Lecture 7 - Introduction to Synthetic Biology - Day 2 Part 3](#)

[Lecture 8 - Introduction to Synthetic Biology - Day 2 Part 4](#)

[Lecture 9 - Introduction to Synthetic Biology - Day 3 Part 1](#)

[Lecture 10 - Introduction to Synthetic Biology - Day 3 Part 2](#)

[Lecture 11 - Introduction to Synthetic Biology - Day 3 Part 3](#)

[Lecture 12 - Introduction to Synthetic Biology - Day 3 Part 4](#)

[Lecture 13 - Introduction to Synthetic Biology - Day 4 Part 1](#)

[Lecture 14 - Introduction to Synthetic Biology - Day 4 Part 2](#)

[Lecture 15 - Introduction to Synthetic Biology - Day 4 Part 3](#)

[Lecture 16 - Introduction to Synthetic Biology - Day 5 Part 1](#)

[Lecture 17 - Introduction to Synthetic Biology - Day 5 Part 2](#)

[Lecture 18 - Introduction to Synthetic Biology - Day 5 Part 3](#)

[Lecture 19 - Introduction to Synthetic Biology - Day 5 Part 4](#)

[Lecture 20 - Introduction to Synthetic Biology - Day 6 Part 1](#)

[Lecture 21 - Introduction to Synthetic Biology - Day 6 Part 2](#)

[Lecture 22 - Introduction to Synthetic Biology - Day 6 Part 3](#)

[Lecture 23 - Introduction to Synthetic Biology - Day 7 Part 1](#)

[Lecture 24 - Introduction to Synthetic Biology - Day 7 Part 2](#)

[Lecture 25 - Introduction to Synthetic Biology - Day 7 Part 3](#)

[Lecture 26 - Introduction to Synthetic Biology - Day 8 Part 1](#)

[Lecture 27 - Introduction to Synthetic Biology - Day 8 Part 2](#)

[Lecture 28 - Introduction to Synthetic Biology - Day 9 Part 1](#)

[Lecture 29 - Introduction to Synthetic Biology - Day 9 Part 2](#)

[Lecture 30 - Introduction to Synthetic Biology - Day 9 Part 3](#)

[Lecture 31 - Introduction to Synthetic Biology - Day 10 Part 1](#)

[Lecture 32 - Introduction to Synthetic Biology - Day 10 Part 2](#)

[Lecture 33 - Introduction to Synthetic Biology - Day 10 Part 3](#)

Lecture 1 - Introduction to Different OMICS Approaches and their Applications

Lecture 2 - Genetic Information in Prokaryotic

Lecture 3 - Databases and Web Resources to Store and Access the Biological Data

Lecture 4 - First and Second Generation Sequencing Technologies

Lecture 5 - Long Read Sequencing and Linked Read Sequencing - Part 1

Lecture 6 - Long Read Sequencing and Linked Read Sequencing - Part 2

Lecture 7 - Sequence Formats and Databases for Genomic Analysis

Lecture 8 - Introduction to Linux

Lecture 9 - File Handling and Remote Connectivity in Linux

Lecture 10 - Running Linux Commands and Installation of Genomic Packages

Lecture 11 - Introduction to R and Applications in Genomic Analysis

Lecture 12 - Publicly Available Tools and Need for Workstations for Genomic Analysis

Lecture 13 - Overview of Genomic and Transcriptomic Analysis

Lecture 14 - Genomic and Transcriptomic Analysis of an Organism with Case Studies

Lecture 15 - How to Collect and Confirm Sample of the Species to be Sequenced and Transcriptome Sequencing Approaches

Lecture 16 - Estimating the Amount of Sequencing Coverage for a Genome and Hybrid Sequencing Approaches

Lecture 17 - Types of Reads, Quality Filtering, Estimating the Genome Complexity and Heterozygosity

Lecture 18 - Genome Assembly and its Completion Status, Assembly Algorithms

Lecture 19 - Commonly Used Assembly Tools

Lecture 20 - Linked-Read Sequencing and Processing

Lecture 21 - Long Reads Analysis and Assembly Workflow

Lecture 22 - De novo Assembly Using Genomic and Transcriptomic Reads

Lecture 23 - Merging Assemblies to Create Hybrid Assembly and Determining the Quality of Assembly

Lecture 24 - Chromosomal Level Assembly and Case Studies

Lecture 25 - Identification and Annotation of Repeats in Genomes

Lecture 26 - De novo Transcriptome Assembly and Making the Coding Gene Set

Lecture 27 - Prediction of tRNA, rRNA and miRNA in a Genome

Lecture 28 - Functional Annotation and Identification of Metabolic Pathways in a Genome

Lecture 29 - Comprehensive Functional Annotation of Predicted Genes in a Genome

Lecture 30 - Functional Annotation of Predicted Genes by Alternate Methods

Lecture 31 - Methods and Steps to Perform the Evolutionary Analysis of a Genome

[Lecture 32 - Methods for Taxonomic Classification and Phylogeny Econstruction and Analysis](#)

[Lecture 33 - Epigenetics, ChIp-seq, Transcriptome and Microarrays for Regulation of Expression](#)

[Lecture 34 - Single Cell Genomics, 10X Chromium Linked-reads and Illumina Sequencing, Single Cell Gene Expression](#)

[Lecture 35 - Application of Multiomics Approaches in Human Health and Diseases Such as Cancer, Diabetes, etc.](#)

[Lecture 36 - Prokaryotic Genome Sequencing and Assembly Approaches](#)

[Lecture 37 - Gene Prediction Approaches and Common Methods for Bacterial Gene Prediction](#)

[Lecture 38 - Common Methods for Annotation of a Bacterial Genome, t-RNA, rRNA, Operon Prediction and Annotation](#)

[Lecture 39 - Phylogenetic Analysis of Bacterial Genomes](#)

[Lecture 40 - Metabolic and Comparative Analysis](#)

[Lecture 41 - Microbiome and Metagenome, Human, Organismal and Environmental Microbiomes](#)

[Lecture 42 - Sequencing and Assembly of Metagenomes, Gene Prediction, Annotation, MAGs - Part 1](#)

[Lecture 43 - Sequencing and Assembly of Metagenomes, Gene Prediction, Annotation, MAGs - Part 2](#)

[Lecture 44 - Taxonomic Analysis Using Amplicon Sequence Variants, Statistical Analysis](#)

Lecture 1 - Introduction to Homeostasis

Lecture 2 - Mechanisms of Homeostasis - Part 1

Lecture 3 - Mechanisms of Homeostasis - Part 2

Lecture 4 - Physiology of muscle - Part 1

Lecture 5 - Physiology of muscle - Part 2

Lecture 6 - Molecular Mechanism of muscle contractility - Part 1

Lecture 7 - Molecular Mechanism of muscle contractility - Part 2

Lecture 8 - How does the heart muscle work? - Part 1

Lecture 9 - How does the heart muscle work? - Part 2

Lecture 10 - Cardiac system : From stimuli to rhythmic muscle contraction - Part 1

Lecture 11 - Cardiac system : From stimuli to rhythmic muscle contraction - Part 2

Lecture 12 - Cardiac system : From stimuli to rhythmic muscle contraction - Part 3

Lecture 13 - Cardiac system : From stimuli to rhythmic muscle contraction - Part 4

Lecture 14 - Rhythmicity of heart beat - Part 1

Lecture 15 - Rhythmicity of heart beat - Part 2

Lecture 16 - Hemodynamics

Lecture 17 - Hemodynamics and Regulation - Part 1

Lecture 18 - Hemodynamics and Regulation - Part 2

Lecture 19 - Hemodynamics and Regulation - Part 3

Lecture 20 - Hemodynamics and Regulation - Part 4

Lecture 21 - Hemodynamics and Regulation - Part 5

Lecture 22 - Hemodynamics and Regulation - Part 6

Lecture 23 - Lymphatic system

Lecture 24 - Excretory system : Kidney - Part 1

Lecture 25 - Excretory system : Kidney - Part 2

Lecture 26 - Excretory system : Kidney - Part 3

Lecture 27 - Kidney and RBC production

Lecture 28 - Excretory system : Nephron - Part 1

Lecture 29 - Excretory system : Nephron - Part 2

Lecture 30 - Excretory system : Nephron - Part 2.1

Lecture 31 - Excretory system : Nephron - Part 3

[Lecture 32 - Excretory system : Regulation of Osmolarity and counter-current mechanism - Part 1](#)

[Lecture 33 - Excretory system : Regulation of Osmolarity and counter-current mechanism - Part 2](#)

[Lecture 34 - Excretory system : Regulation of Osmolarity and counter-current mechanism - Part 3](#)

[Lecture 35 - Physiology and Introduction of Respiration - Part 1](#)

[Lecture 36 - Physiology and Introduction of Respiration - Part 2](#)

[Lecture 37 - Respiration - Part 1](#)

[Lecture 38 - Respiration - Part 2](#)

[Lecture 39 - Respiration - Part 3](#)

[Lecture 40 - Respiration - Part 4](#)

[Lecture 41 - Physiology of smooth muscles and digestive system - Part 1](#)

[Lecture 42 - Physiology of smooth muscles and digestive system - Part 2](#)

[Lecture 43 - Physiology of smooth muscles and digestive system - Part 3](#)

[Lecture 44 - Physiology of smooth muscles and digestive system - Part 4](#)

[Lecture 45 - Secretory functions of alimentary tract - Part 1](#)

[Lecture 46 - Secretory functions of alimentary tract - Part 2](#)

[Lecture 47 - Secretory functions of alimentary tract and Pancreas - Part 1](#)

[Lecture 48 - Secretory functions of alimentary tract and Pancreas - Part 2](#)

[Lecture 49 - Secretory functions of Pancreas and liver](#)

[Lecture 50 - Secretory functions of Liver and Gallbladder](#)

[Lecture 51 - Introduction to Endocrine system](#)

[Lecture 52 - Pituitary gland and growth hormone secretion - Part 1](#)

[Lecture 53 - Pituitary gland and growth hormone secretion - Part 2](#)

[Lecture 54 - Thyroid gland - Part 1](#)

[Lecture 55 - Thyroid gland - Part 2](#)

[Lecture 56 - Hormones of adrenal cortex - Part 1](#)

[Lecture 57 - Hormones of adrenal cortex - Part 2](#)

[Lecture 58 - Physiology of Glucocorticoids - Part 1](#)

[Lecture 59 - Physiology of Glucocorticoids - Part 2](#)

[Lecture 60 - Course Summary](#)

[Lecture 1 - What is Biology ?](#)

[Lecture 2 - Pillars of Biology](#)

[Lecture 3 - Biology and the City](#)

[Lecture 4 - The Process of Science](#)

[Lecture 5 - A Tale of Forgotten Scientists - Part I](#)

[Lecture 6 - A Tale of Forgotten Scientists - Part II](#)

[Lecture 7 - Numbers and Scales in Biology - Part I](#)

[Lecture 8 - Numbers and Scales in Biology - Part II](#)

[Lecture 9 - Experimentation vs Theory_Discussion](#)

[Lecture 10 - How to Find Reliable Information ?](#)

[Lecture 11 - How to Read a Scientific Article ?](#)

[Lecture 12 - Biomolecules - Part I](#)

[Lecture 13 - Biomolecules - Part II](#)

[Lecture 14 - Central Dogma](#)

[Lecture 15 - Gene Regulation](#)

[Lecture 16 - Non-Coding RNA](#)

[Lecture 17 - Introduction to Cells](#)

[Lecture 18 - Our Favourite Cells - Part I](#)

[Lecture 19 - Our Favourite Cells - Part II](#)

[Lecture 20 - Cell Cycle](#)

[Lecture 21 - Cell Cycle Control](#)

[Lecture 22 - Cancer Biology \(Guest Lecture\) - Dr. Ramray Bhat \(IISc\)](#)

[Lecture 23 - Discussion on Cancer Biology - Dr. Ramray Bhat \(IISc\) and Dr. Divya Uma \(Azim Premji University\)](#)

[Lecture 24 - Genetics - I](#)

[Lecture 25 - Genetics - II](#)

[Lecture 26 - Genetics - III](#)

[Lecture 27 - Gene Mutations and Genetic Disorders \(Guest Lecture\) Dr. Antara Das, Azim Premji University](#)

[Lecture 28 - Studying Human Genetic Disorders using Transgenic Animals - Research talk \(Guest Lecture\)](#)

[Lecture 29 - Bead Microscopy \(Guest Lecture\) Dr. Procheta Mallik \(ISPF and ThinkTac\)](#)

[Lecture 30 - Molecular Biology Techniques](#)

[Lecture 31 - Bacterial DNA Isolation and PCR - Hands-on \(Guest Lecture\) Dr. Beena DB \(Azim Premji University\)](#)

[Lecture 32 - BT Cotton - Part 1 \(Case study\)](#)

[Lecture 33 - Molecular Biology Techniques - BT Cotton - Part 2 \(Case study\)](#)

[Lecture 34 - Introduction to Evolution](#)

[Lecture 35 - Evidences of Evolution](#)

[Lecture 36 - Mechanism of Evolution](#)

[Lecture 37 - Misconceptions about Evolution - Discussion](#)

[Lecture 38 - Human Evolution](#)

[Lecture 39 - Species, Speciation and Biodiversity - I](#)

[Lecture 40 - Species, Speciation and Biodiversity - II](#)

[Lecture 41 - Measuring Biodiversity \(Tutorial\)](#)

[Lecture 42 - Speciation](#)

[Lecture 43 - Speciation \(Case studies\)](#)

[Lecture 44 - Introduction to Ecological Interactions - Part 1](#)

[Lecture 45 - Ecological Interactions - Part 2](#)

[Lecture 46 - Ecological Interactions - Part 3](#)

[Lecture 47 - Mutualism - Figs \(Case Study\)](#)

[Lecture 48 - Seed Dispersal \(Case study\)](#)

[Lecture 49 - Introduction to Public Health \(Guest Lecture\) Dr.Abha Rao \(Public Health Foundation of India\)](#)

[Lecture 50 - Public Health in India \(Guest Lecture\) Dr. Abha Rao \(Public Health Foundation of India\)](#)

[Lecture 51 - Discussion on Public Health - Dr. Abha Rao \(PHFI\) and Mr. Pratush Brahma \(University of Florida\)](#)

[Lecture 52 - Public Health - Rotavirus \(Case study\)](#)

[Lecture 53 - Public Health - Malaria \(Case study\) - Part 1](#)

[Lecture 54 - Public Health - Malaria \(Case study\) - Part 2](#)

[Lecture 55 - Biology and Climate Change - Part 1](#)

[Lecture 56 - Biology and Climate Change - Part 2](#)

[Lecture 57 - Biology and Climate Change - Part 3](#)

[Lecture 58 - Biodiversity Conservation \(Guest Lecture\) Dr. Krishnapriya Tamma \(Azim Premji University\)](#)

[Lecture 59 - Discussion on Biology and Society](#)

[Lecture 60 - Discussion on Art and Science](#)

[Lecture 61 - Biology and Society - Case study on Stray Dogs](#)

[Lecture 62 - Nature Relatedness](#)

[Lecture 63 - Course Wrap-Up](#)

[Lecture 1 - History of Neuroscience - Introduction - Part 1](#)

[Lecture 2 - History of Neuroscience - Introduction - Part 2](#)

[Lecture 3 - Factors that produce discoveries](#)

[Lecture 4 - Importance of the 1950s in Neuroscience](#)

[Lecture 5 - Advances in Molecular Biology \(Genes to DNA\)](#)

[Lecture 6 - Discovery of the structure of the DNA](#)

[Lecture 7 - How DNA works](#)

[Lecture 8 - Molecular biology of the human brain](#)

[Lecture 9 - Signaling molecule: The First growth Factor](#)

[Lecture 10 - Nerve Growth Factor](#)

[Lecture 11 - Organizing the Connections](#)

[Lecture 12 - Axonal Transport](#)

[Lecture 13 - Signaling molecules: The First Neurotransmitter in the brain](#)

[Lecture 14 - The concept of Lock and Key](#)

[Lecture 15 - The Soup vs Sparks Debate](#)

[Lecture 16 - Intracellular Electrode, Neurotransmitter in the Brain, Dales Law](#)

[Lecture 17 - Early evidence of Acetylcholine and Glutamate](#)

[Lecture 18 - Early evidence of GABA and Serotonin](#)

[Lecture 19 - Catecholamine and Hormones](#)

[Lecture 20 - Second messengers and Hormones](#)

[Lecture 21 - Pheromones](#)

[Lecture 22 - Revolution in Cytology](#)

[Lecture 23 - Synapse and the 'Neuronism vs Reticularism' debate](#)

[Lecture 24 - Contributions by Rene Couteaux and George Koelle](#)

[Lecture 25 - Chemical Synapse](#)

[Lecture 26 - Synapse and the Neuromuscular Junction](#)

[Lecture 27 - The Electrical Synapse and Myelin](#)

[Lecture 28 - Physiology: The Action Potential - Part 1](#)

[Lecture 29 - Recording nerve impulses and single action potentials](#)

[Lecture 30 - Recording from nerve and plant cells](#)

[Lecture 31 - Recording Local circuits, Hodgkin and Huxely contributions - Part 1](#)

[Lecture 32 - Hodgkin and Huxely model - Part 2 and Kenneth Cole Contributions](#)

[Lecture 33 - GHK equation and HH action potentials](#)

[Lecture 34 - First Electrophysiological Evidence for Synaptic Transmission](#)

[Lecture 35 - Bernard Katz](#)

[Lecture 36 - End-Plate Potential and Synaptic Quanta](#)

[Lecture 37 - Eccles and Spinal motor neuron](#)

[Lecture 38 - Invertebrate simple systems: Aplysia](#)

[Lecture 39 - Other studies of sensory responses](#)

[Lecture 40 - Legacy of Golgi and Ramo`n y Cajal](#)

[Lecture 41 - Dynamic polarization of Neuron](#)

[Lecture 42 - Modern Research](#)

[Lecture 43 - Synaptic Integration and Action Potential Initiation](#)

[Lecture 44 - Active properties of dendrites](#)

[Lecture 45 - Dendritic dominance](#)

[Lecture 46 - Dendritic spines](#)

[Lecture 47 - Rethinking the concept of Neuron Doctrine](#)

[Lecture 48 - Muscle spindles](#)

[Lecture 49 - Spinal cord pathways](#)

[Lecture 50 - Retinal Processing](#)

[Lecture 51 - Keffler Hartline](#)

[Lecture 52 - Stephen Kuffler and Horace Barlow](#)

[Lecture 53 - Expansion of the Reflex concept](#)

[Lecture 54 - Central Pattern generators](#)

[Lecture 55 - The cortical column](#)

[Lecture 56 - Vernon Mountcastle](#)

[Lecture 57 - Central Visual Processing](#)

[Lecture 58 - Central Visual Processing and Feature Detectors](#)

[Lecture 59 - Intracellular recordings from the brain - Part 1](#)

[Lecture 60 - Intracellular recordings from the brain - Part 2](#)

[Lecture 61 - Two motor systems](#)

[Lecture 62 - Auditory cortex and The pattern theory of olfaction](#)

[Lecture 63 - Arousal and Reticular activating system](#)

[Lecture 64 - Sleep and Rapid Eye Movements](#)

[Lecture 65 - Operant Conditioning by brain stimulation](#)

[Lecture 66 - Hypothalamus and Feeding Behavior](#)

[Lecture 67 - Brain as a gland](#)

[Lecture 68 - Hypothalamic-Neurohypophyseal System](#)

[Lecture 69 - Hypothalamic-Adenohypophyseal System](#)

[Lecture 70 - Founding Modern Neuroanatomy](#)

[Lecture 71 - Psychology and Ethology](#)

[Lecture 72 - Karl Lashley](#)

[Lecture 73 - Donald Hebb](#)

[Lecture 74 - Limbic system-Limbic Lobe and Papez Circuit](#)

[Lecture 75 - Limbic system-Kluver-Bucy Syndrome](#)

[Lecture 76 - The Limbic system and Amygdala](#)

[Lecture 77 - The Hippocampus and Patient H.M](#)

[Lecture 78 - Brenda Milner](#)

[Lecture 79 - Neurology: Foundations of Brain Imaging](#)

[Lecture 80 - The Neurological unit of the Boston City Hospital](#)

[Lecture 81 - Derek Denny-Brown, Raymond Adams and C. Miller Fisher](#)

[Lecture 82 - Montreal Neurological Institute](#)

[Lecture 83 - Cerebral Circulation](#)

[Lecture 84 - Spreading depression of Leo and Migraine](#)

[Lecture 85 - The Eradication of Polio](#)

[Lecture 86 - Origin of Neurosurgery](#)

[Lecture 87 - Harvey Cushing](#)

[Lecture 88 - Pituitary Surgery](#)

[Lecture 89 - Stereotaxy](#)

[Lecture 90 - Epilepsy](#)

[Lecture 91 - Psychosurgery](#)

[Lecture 92 - Antipsychotic Drugs](#)

[Lecture 93 - Reserpine](#)

[Lecture 94 - Monoamine Oxidase Inhibitors](#)

[Lecture 95 - Lithium](#)

[Lecture 96 - Benzodiazepines](#)

[Lecture 97 - Stress](#)

Lecture 98 - Theoretical Neuroscience: Brain as computer and Computer as Brain

Lecture 99 - John Atanasoff

Lecture 100 - John von Newmann

Lecture 101 - Game and Information theory

Lecture 102 - Cybernetics and Artificial Intelligence

Lecture 103 - Towards Networks of Realistic Neurons: von Newman's Last word

Lecture 104 - Santiago Ramon y Cajal, 'The Peasant Genius'

Lecture 105 - 'Cajal- a giant wakes up'

Lecture 106 - Cajal's modifications to the Golgi method and studies of embryos and various systems

Lecture 107 - Law of dynamic polarization, support from others studies

Lecture 108 - Santiago Ramon y Cajal - Career turning point and Palm Sunday years

Lecture 109 - Cajal's trailblazing discoveries that earned him the Nobel Prize

Lecture 110 - 'Enduring Legacy of Cajal'

Lecture 111 - Robert Barany - Early life and prior work done by other scientists

Lecture 112 - Robert Barany - The serendipitous discovery of the caloric test

Lecture 113 - Robert Barany - Vestibular System and connection to Cerebellum

Lecture 114 - Robert Barany - Modern Applications of Barany's work - Space medicine and Astronaut training

Lecture 115 - Robert Barany - Summary of Contributions

Lecture 116 - Charles Sherrington Personal Background

Lecture 117 - Charles Sherrington - quiet mind expt, Neuroplasticity, animal locomotion studies

Lecture 118 - Charles Sherrington - Reciprocal innervation, Pain and Emotion, Mind and Body

Lecture 119 - Charles Sherrington's Magnum Opus - The integrative action of the nervous system

Lecture 120 - Charles Sherrington - Insights into life and work by Molnar and Brown

Lecture 121 - Charles Sherrington - Summary of contributions

Lecture 122 - Edgar Adrian, Keith Lucas and Novel instruments used in Neurophysiology

Lecture 123 - Edgar Adrian - Early life, All or none principle in neurons, Key findings with Keith Lucas

Lecture 124 - Edgar Adrian - Work with Alexander Forbes, Gasser and Erlanger (St. Louis connection)

Lecture 125 - Edgar Adrian - 'Failed experiment', Perseverance in science

Lecture 126 - Edgar Adrian - Recording from single sensory and motor neurons

Lecture 127 - Edgar Adrian - Nobel Prize, Admin work, Legacy

Lecture 128 - Edgar Adrian - Adventures with EEG

Lecture 129 - Edgar Adrian - Mapping cerebellar cortex, Cerebral cortex, Brain and Behavior, Olfaction

Lecture 130 - Hodgkin and Huxley - Biographical background, Scientific backdrop and state of Neurophysiology

- [Lecture 131 - Hodgkin and Huxley - Meeting of great minds and Challenges faced - Part 1](#)
- [Lecture 132 - Hodgkin and Huxley - Meeting of great minds and Challenges faced - Part 2](#)
- [Lecture 133 - Bernard Katz - personal background, scientific backdrop, soup vs spark debate](#)
- [Lecture 134 - Bernard Katz - Quantal nature of synaptic transmission, Vesicle hypothesis, foundational work](#)
- [Lecture 135 - Bernard Katz - del Castillo model of receptor activation, role of calcium in synapses, sodium](#)
- [Lecture 136 - Bernard Katz Paper: The fine structure of neuromuscular junction of the frog](#)
- [Lecture 137 - Roger Sperry - Personal Background, Split brain patients, Hemispheric specialization](#)
- [Lecture 138 - Roger Sperry: Split Brain patients and Dichotomous consciousness](#)
- [Lecture 139 - Roger Sperry: Unified consciousness and Behavioural differences in split brain patients,](#)
- [Lecture 140 - Roger Sperry, Gazzaniga's Interpreter theory, Impact on Psychology and Neuroscience, Nobel Prize](#)
- [Lecture 141 - Roger Sperry's Chemoaffinity hypothesis paper](#)
- [Lecture 142 - Roger Sperry paper 'Mentalism: Yes, Dualism:No'](#)
- [Lecture 143 - Jens Christian Skou Part 1 : The Story of Jens Christian Skou's life in science](#)
- [Lecture 144 - Jens Christian Skou: Sodium Potassium pump overview and Nobel Prize](#)
- [Lecture 145 - Jens Christian Skou: Paper - 'The Influence of Some Cations on an Adenosine Triphosphate](#)
- [Lecture 146 - Arvid Carlsson - Personal Background, Education and Early Career, Pivot, Nobel prize contributions](#)
- [Lecture 147 - Arvid Carlsson - History of L Dopa](#)
- [Lecture 148 - Arvid Carlsson - Antipsychotics, Dopamine hypothesis, Serotonin and SSRIs, Omeprazole](#)
- [Lecture 149 - Eric Kandel - Early life and nobel prize winning work](#)
- [Lecture 150 - Eric Kandel - Synaptic Plasticity](#)
- [Lecture 151 - Eric Kandel - Aplysia work, Short and long term memory and mechanisms](#)
- [Lecture 152 - Paul Greengard - The Phosphorylation Paradigm](#)
- [Lecture 153 - David Hubel and Torsten Wiesel - early life, education and collaboration](#)
- [Lecture 154 - Hubel and Wiesel - Effect of early visual deprivation on cortical function](#)
- [Lecture 155 - Hubel and Wiesel - Effect of visual misalignment on binocular integration](#)
- [Lecture 156 - Hubel and Wiesel - Limited capacity for recovery following early visual deprivation](#)

Lecture 1 - Introduction to Genomics - 1

Lecture 2 - Introduction to Genomics - 2

Lecture 3 - Advent of NGS

Lecture 4 - Genome Assembly: Few Concepts and Terminology

Lecture 5 - Genome Assembly Approaches

Lecture 6 - Pyrosequencing

Lecture 7 - Reversible Chain Termination Based Sequencing

Lecture 8 - Ph Sequencing

Lecture 9 - Sequencing by Ligation (Solid)

Lecture 10 - Sequencing by Ligation (Complete Genomics)

Lecture 11 - Other Short-Read Sequencing Technologies - Part 1

Lecture 12 - Other Short-Read Sequencing Technologies - Part 2

Lecture 13 - Long-Read Sequencing

Lecture 14 - Single Molecule Long-Read Sequencing

Lecture 15 - The Omics Data Avalanche

Lecture 16 - Evolutionary Biology and Genomics

Lecture 17 - Ancient Genomics

Lecture 18 - Whole-Genome Duplication

Lecture 19 - Tests of Selection

Lecture 20 - Genomics in Experimental Evolution

Lecture 21 - Making Sense of Genomic Sequences

Lecture 22 - Transcriptomics: New Tools Leading to Deeper Insights

Lecture 23 - Single Cell Transcriptomics and Beyond

Lecture 24 - Proteomics: A Brief Introduction

Lecture 25 - Protein Quantification

Lecture 26 - Introduction to Linux for Omics

Lecture 27 - The Linux Command Line Interface

Lecture 28 - Using the CLI-1: NCBI Datasets

Lecture 29 - Using the CLI-2: Short Read Archive Toolkit

Lecture 30 - UCSC and IGV genome browsers

Lecture 31 - Mega Omics Projects

[Lecture 32 - Genotype-Tissue Expression \(GTEx\)](#)

[Lecture 33 - Encyclopedia of DNA Element \(ENCODE\)](#)

[Lecture 34 - The Cancer Genome Atlas \(TCGA\)](#)

[Lecture 35 - Eukaryotic Genome Sequencing Consortia](#)

[Lecture 36 - The Postomics Era](#)

[Lecture 37 - RNA-Seq Differential Expression Analysis](#)

[Lecture 38 - Gene Loss and its Consequences](#)

[Lecture 39 - Establishing Gene loss: Few Examples](#)

[Lecture 40 - Course Summary](#)

[Lecture 1 - Statistics - Motivation](#)

[Lecture 2 - Statistics - Introduction](#)

[Lecture 3 - Statistics: Definition and Terminology - Part I](#)

[Lecture 4 - Statistics: Definition and Terminology - Part II](#)

[Lecture 5 - Data: Primary vs Secondary](#)

[Lecture 6 - Data: Quantitative vs Qualitative](#)

[Lecture 7 - Data: Presentation](#)

[Lecture 8 - Data: Static vs Dynamic](#)

[Lecture 9 - Data: Box Plot and Spyder Graphs](#)

[Lecture 10 - Data: Summarising Data](#)

[Lecture 11 - Probability: Event and Sample space](#)

[Lecture 12 - Probability: Mutually exclusive and Independent Events](#)

[Lecture 13 - Probability: Random Variables](#)

[Lecture 14 - Probability: Expectation of Random Variable](#)

[Lecture 15 - Probability: Variance of Random Variable](#)

[Lecture 16 - Probability Distribution: Binomial, Poisson, Bernoulli](#)

[Lecture 17 - Probability Distribution: Normal Distribution](#)

[Lecture 18 - Central Limit Theorem: Statement](#)

[Lecture 19 - Central Limit Theorem: Illustration](#)

[Lecture 20 - Confidence Interval](#)

[Lecture 21 - Determining Sample Size](#)

[Lecture 22 - Hypothesis Test: Introduction](#)

[Lecture 23 - Hypothesis Test: Example](#)

[Lecture 24 - Hypothesis: P value](#)

[Lecture 25 - Hypothesis: Type 2 error](#)

[Lecture 26 - Hypothesis: Chi square Distribution - Part 1](#)

[Lecture 27 - Hypothesis: Chi square Distribution - Part 2](#)

[Lecture 28 - Hypothesis: Probability Plots](#)

[Lecture 29 - Hypothesis: Contingency Table Test](#)

[Lecture 30 - Multivariate Hypothesis: Two Sample Test](#)

[Lecture 31 - Multivariate Hypothesis: Paired T test](#)

[Lecture 32 - Multivariate Hypothesis: Paired vs Unpaired Testing](#)

[Lecture 33 - Multivariate Hypothesis: Two population variances](#)

[Lecture 34 - Multivariate Hypothesis: Multiple Random Variables - Part 1](#)

[Lecture 35 - Multivariate Hypothesis: Multiple Random Variables - Part 2](#)

[Lecture 36 - Multivariate Hypothesis: Covariance and Correlation](#)

[Lecture 37 - One Way ANOVA: Motivation and Assumptions](#)

[Lecture 38 - One Way ANOVA: Fixed and Random effects Model](#)

[Lecture 39 - One Way ANOVA: Derivation and Confidence Interval](#)

[Lecture 40 - One Way ANOVA: Confidence Interval](#)

[Lecture 41 - One Way ANOVA: Unbalanced Experiment and Residuals](#)

[Lecture 42 - One Way ANOVA: Interpretation of Results](#)

[Lecture 43 - Statistical Modeling: Introduction](#)

[Lecture 44 - Statistical Modeling: Linear Regression Derivation](#)

[Lecture 45 - Statistical Modeling: Linear Regression - Assumption and Residuals](#)

[Lecture 46 - Statistical Modeling: Multi Linear Regression](#)

[Lecture 47 - Statistical Modeling: Logistic Regression](#)

[Lecture 48 - Statistical Modeling: Cross Entropy Loss](#)

[Lecture 49 - Statistical Modeling: Gradient Descent](#)

[Lecture 50 - Statistical Modeling: One Way Anova via Linear Regression](#)

[Lecture 51 - Design Of Experiments: Randomised Complete Block Design - Part 1](#)

[Lecture 52 - Design Of Experiments: Randomised Complete Block Design - Part 2](#)

[Lecture 53 - RCBD: Math Formulation and Derivation](#)

[Lecture 54 - RCBD: Necessity and Application](#)

[Lecture 55 - Latin Square: Introduction](#)

[Lecture 56 - Latin Square: Math and Formulation](#)

[Lecture 57 - Graeco - Latin Square](#)

[Lecture 58 - Interaction Among Variables](#)

[Lecture 59 - Two-Way ANOVA: Introduction - Part 1](#)

[Lecture 60 - Two-Way ANOVA: Introduction - Part 2](#)

[Lecture 61 - Two-Way ANOVA: Math and Formulation](#)

[Lecture 62 - Factorial Design: \$2^2\$ Experiments](#)

[Lecture 63 - Factorial Design: \$2^k\$ Experiments - Part 1](#)

[Lecture 64 - Factorial Design: \$2^k\$ Experiments - Part 2](#)

[Lecture 65 - Factorial Design: Blocking](#)

[Lecture 66 - Introduction to Python Programming for Biomedical Engineers](#)

Lecture 1 - Introduction to Fluorescence Microscopy

Lecture 2 - Introduction to Optics

Lecture 3 - Design of a fluorescence microscope

Lecture 4 - Fluorescent proteins, organic dyes, and protein labelling strategies

Lecture 5 - LIVE Demonstration of the fluorescence microscope, its design and components

Lecture 6 - 6D imaging, live cell imaging, time lapse imaging

Lecture 7 - Quantifying protein dynamics using FRAP, FLIP, FRET

Lecture 8 - LIVE Demonstration for 6D imaging of live cells on a Leica DMI8 inverted fluorescence microscope

Lecture 9 - Types of Illumination Epi, TIRF, HILO, light sheet, two photon

Lecture 10 - Confocal microscopy

Lecture 11 - LIVE Demonstration of the Nikon N-SPARC confocal microscope

Lecture 12 - Super-Resolution Microscopy (SIM, STED, STORM/PALM)

Lecture 13 - Nanomaterials for fluorescence imaging

Lecture 14 - Immunofluorescence IF and Immunohistochemistry IHC

Lecture 15 - Fluorescence In Situ Hybridization FISH, RNA FISH

Lecture 16 - LIVE Demonstration for immunofluorescence procedure

Lecture 17 - Digital images and camera technologies for microscopy

Lecture 18 - CCD, EMCCD, sCMOS Camera

Lecture 19 - LIVE Demonstration for digital images and adjustments

Lecture 20 - Basic operations of ImageJ/FIJI, montage preparation

Lecture 21 - Image filtering and object segmentation

Lecture 22 - Macros, intensity measurement, scale bar, time stamp, colocalization

Lecture 23 - LIVE Demonstration of ImageJ/Fiji based image processing

Lecture 24 - Single molecule imaging and tracking

Lecture 25 - Optical tweezers and traction force microscopy

Lecture 26 - LIVE Demonstration for single-molecule imaging under HILO illumination

Lecture 27 - Spatial transcriptomics and proteomics RNAscope, MERFISH, CODEX

Lecture 28 - High content imaging

Lecture 29 - Designing a fluorescence microscopy experiment

NPTEL : Cancer Biology (Biotechnology)

Co-ordinators : Prof. Karunakaran

Lecture 1 - Molecular Basis of Cancer

Lecture 2 - Hallmarks of cancer

Lecture 3 - Theories of Carcinogenesis

Lecture 4 - Genes associated with cancer Oncogenes

Lecture 5 - Genes associated with cancer Tumor suppressor genes

Lecture 6 - Signal transduction - Part 1

Lecture 7 - Signal transduction - Part 2

Lecture 8 - Aberrations in signaling in cancer

Lecture 9 - Wnt and cytokine signaling in cancer

Lecture 10 - Apoptotic signaling

Lecture 11 - Pro and antiapoptotic factors in cancer

Lecture 12 - NF κ B Signaling in cancer

Lecture 13 - Cervical Cancer

Lecture 14 - Cancer Therapy

Lecture 15 - Molecularly targeted therapies for cancer - Part 1

Lecture 16 - Molecularly targeted therapies for cancer - Part 2

Lecture 17 - Epigenetics and cancer - Part 1

Lecture 18 - Epigenetics and cancer - Part 2

Lecture 19 - Role of microRNAs in cancer - Part 1

Lecture 20 - Role of microRNAs in cancer - Part 2

Lecture 21 - Tumor immunology - Part 1

Lecture 22 - Tumor immunology - Part 2

Lecture 23 - Immune checkpoint inhibitors in cancer therapy

Lecture 24 - Hypoxia and cancer

Lecture 25 - DNA repair mechanisms and cancer - Part 1

Lecture 26 - DNA repair mechanisms and cancer - Part 2

Lecture 27 - Metastasis and epithelial mesenchymal transition

Lecture 28 - Cancer cell metabolism

Lecture 1 - Course Introduction

Lecture 2 - Reactive Species Introduction - 1

Lecture 3 - RS types; Oxygen in the Earth's Atmosphere

Lecture 4 - Oxygen, antioxidants and RS homeostasis

Lecture 5 - Review on initial concepts; A suitable framework for analysis

Lecture 6 - A suitable framework for analysis (Continued...)

Lecture 7 - Analysis of RS reactions - Thermodynamics

Lecture 8 - Analysis of RS reactions - Thermodynamics

Lecture 9 - Analysis of RS reactions - Kinetics

Lecture 10 - RS initiation reactions - Practical scenarios

Lecture 11 - RS propagation reactions

Lecture 12 - RS reactions - propagation, termination

Lecture 13 - RS reactions rate constants

Lecture 14 - RS measurement introduction

Lecture 15 - RS measurement - fluorescence

Lecture 16 - RS measurement - fluorescence (Continued...)

Lecture 17 - RS measurement - fluorescence (Continued...), chemiluminiscence

Lecture 18 - RS book first view; EPR spectroscopy; Game 1

Lecture 19 - EPR spectroscopy basics

Lecture 20 - EPR spectroscopy (Continued...)

Lecture 21 - Biomarkers and review

Lecture 22 - RS in cell signaling - Introduction

Lecture 23 - RS in cell signaling - Bacterial systems

Lecture 24 - RS in cell signaling - Mammalian systems and systemic effects

Lecture 25 - Game class - 2

Lecture 26 - RS in liquid phase oxygen supply (LPOS)

Lecture 27 - RS in LPOS (Continued...)

Lecture 28 - RS in LPOS discussion (Continued...)

Lecture 29 - RS induction in bioreactor inocula for improved productivity

Lecture 30 - General discussion; RS and other stresses

Lecture 31 - RS and other stresses (Continued...)

[Lecture 32 - RS rhythms in microalgae](#)

[Lecture 33 - RS in nano-bio-systems](#)

[Lecture 34 - RS in cancer treatment and management](#)

[Lecture 35 - Game class - 3](#)

[Lecture 36 - RS module](#)

[Lecture 37 - RS module discussion](#)

[Lecture 38 - Course review - Part 1](#)

[Lecture 39 - Course review - Part 2](#)

[Lecture 40 - Student presentation - Sujithra](#)

[Lecture 41 - Student presentation - Manisha](#)

[Lecture 42 - Student presentation - Vikash](#)

[Lecture 43 - Student presentation - Jayashree](#)

[Lecture 44 - Student presentation - Lakshmanan](#)

[Lecture 45 - Student presentation - Swati](#)

[Lecture 46 - Student presentation - Ankita](#)

[Lecture 47 - Student presentation - Ragavi](#)

[Lecture 48 - Student presentation - Abhas, and concluding remarks](#)

Lecture 1 - Basics of Regeneration: Basics and Types

Lecture 2 - Regeneration, Wound Healing and Scar Formation in Different Regenerative Capacity

Lecture 3 - Regeneration: In Normal Life and Implications

Lecture 4 - Tissue Regeneration: Mammalian Context

Lecture 5 - Liver Regeneration: Signaling Events

Lecture 6 - Liver Regeneration: Mechanistic Insights

Lecture 7 - Regeneration: lessons from animal model Hydra

Lecture 8 - Mechanisms of regeneration in Hydra

Lecture 9 - Asexual Reproduction - Fragmentation. Morphallaxis, Epimorphosis, lessons from Hydra

Lecture 10 - Mechanisms of regeneration in Planaria

Lecture 11 - Planaria regeneration-polarity and gradient in regeneration

Lecture 12 - Planaria regeneration: Neoblasts and organ formation and Species type and environment

Lecture 13 - Position control genes and regeneration - Part A

Lecture 14 - Position control genes and regeneration - Part B

Lecture 15 - Progenitor targeting and ectopic organs

Lecture 16 - Tissue dedifferentiation, cellular reprogramming into blastema Cellular types in regeneration. Neural crest cells in vertebrates

Lecture 17 - Totipotency, pluripotency, multipotency and unipotency, in regeneration context

Lecture 18 - Adult stem cells: Natural and induced and their roles in regeneration-zebrafish

Lecture 19 - Common cellular events during regeneration, embryonic development, and cancer

Lecture 20 - Epithelial to mesenchymal transition (EMT) and mesenchymal to epithelial transition (MET) in regeneration

Lecture 21 - Organ regeneration: Basics with examples

Lecture 22 - Zebrafish fin regeneration-in a brief

Lecture 23 - Zebrafish heart regeneration-in a brief

Lecture 24 - Zebrafish retina regeneration-in a brief

Lecture 25 - Spinal cord and brain regeneration-Conclusive mechanisms of regeneration

Lecture 26 - Cellular, Molecular and Genetic factors involved in retina regeneration

Lecture 27 - Detailed mechanisms of fin regeneration

Lecture 28 - Retina regeneration-importance of Shh signaling Roles of epigenetic factors and their involvement in regeneration

Lecture 29 - Importance of regeneration associated gene induction events-Transcription activators and repressors

Lecture 30 - Roles of different cellular signaling in regeneration: Examples- Wnt signaling

Lecture 31 - Different cellular signaling during regeneration-Overview

[Lecture 32 - Different cellular signaling during regeneration. Examples- Jak-STAT and Fgf signaling](#)

[Lecture 33 - Different cellular signaling during regeneration-Egf, and Hippo signaling](#)

[Lecture 34 - Roles of Delta-Notch signaling during regeneration](#)

[Lecture 35 - Tgf-beta signaling during regeneration](#)

[Lecture 36 - Organ regeneration: An overview](#)

[Lecture 37 - Accessory limb model of regeneration: lessons from Axolotl and newt](#)

[Lecture 38 - Nerve-dependent regeneration-Axolotl and Newt](#)

[Lecture 39 - Roles of Histone deacetylases in regeneration of vertebrates like fishes and amphibians](#)

[Lecture 40 - Dynamics of immune system in organ regeneration](#)

[Lecture 41 - Extracellular matrix and its roles in tissue regeneration](#)

[Lecture 42 - Induced pluripotency and roles of iPFs during tissue Hox genes and homeotic transformation](#)

[Lecture 43 - Animal cloning: implications in regeneration](#)

[Lecture 44 - Embryonic stem cells, cord blood stem cells and adult stem cells](#)

[Lecture 45 - Ethics of stem cell research in regeneration studies, regenerative medicine and biotechnology](#)

[Lecture 46 - Tissue engineering-Why and how?](#)

[Lecture 47 - History of tissue engineering](#)

[Lecture 48 - Different steps in tissue engineering](#)

[Lecture 49 - Different aspects of organ culture](#)

[Lecture 50 - Major challenges in tissue engineering in practice](#)

[Lecture 51 - Tissue 3D printing and organ culture](#)

[Lecture 52 - Importance of scaffolds in tissue engineering](#)

[Lecture 53 - Stem cells for tissue engineering-Use of CRISPR-Cas9 for genome targeting](#)

[Lecture 54 - Types of adult stem cells and trans-differentiation for tissue engineering](#)

[Lecture 55 - Influence of niches and scaffolds on stem cells: An organ culture perspective](#)

[Lecture 56 - The basics of regeneration put into practice in vitro](#)

[Lecture 57 - Adhesion, migration and aggregation of stem cells](#)

[Lecture 58 - Artificial, liver, kidney and urinary bladder for transplantation in patients](#)

[Lecture 59 - Limbal stem cells and artificial cornea](#)

[Lecture 60 - Xenotransplantation vs organ culture in practice](#)

[Lecture 61 - Future implications of regeneration in mammals](#)

[Lecture 62 - Future implications of Organ culture in patient care](#)

Lecture 1 - Introduction To Measurements - Sensors and Transducers

Lecture 2 - Examples and Characteristics of Sensors and Transducers

Lecture 3 - Generalized measurement system - Characteristics of Measurement system - Part 1

Lecture 4 - Generalized measurement system - Characteristics of Measurement system - Part 2

Lecture 5 - Generalized measurement system - Characteristics of Measurement system - Part 3

Lecture 6 - Overview of amplifiers and signal processing techniques

Lecture 7 - Overview of Signal Processing Techniques - Filtering methods

Lecture 8 - Introduction to basic biomedical sensor types and their principles

Lecture 9 - Biomedical Sensor - Resistive sensor - Part 1

Lecture 10 - Biomedical Sensor - Resistive sensor - Part 2

Lecture 11 - Biomedical Sensor - Capacitive sensor - Part 1

Lecture 12 - Biomedical Sensor - Capacitive sensor - Part 2

Lecture 13 - Biomedical Sensor - Inductive sensor

Lecture 14 - Biomedical Sensor - Piezoelectric sensor - Part 1

Lecture 15 - Biomedical Sensor - Piezoelectric sensor - Part 2

Lecture 16 - Biomedical Sensor - Electrochemical sensor

Lecture 17 - Biomedical Sensor - Optical sensor

Lecture 18 - Biomedical Sensor - Hall Effect sensor

Lecture 19 - Introduction to Measurement of Pressure

Lecture 20 - Measurement of Blood Pressure - Direct method - Part 1

Lecture 21 - Measurement of Blood Pressure - Direct method - Part 2

Lecture 22 - Measurement of Blood Pressure - Direct method - Part 3

Lecture 23 - Measurement of Blood Pressure - Direct method - Part 4

Lecture 24 - Measurement of Blood Pressure - Direct method - Part 5

Lecture 25 - Measurement of Blood Pressure - Indirect method - Part 1

Lecture 26 - Measurement of Blood Pressure - Indirect method - Part 2

Lecture 27 - Measurement of Body Temperature - Part 1

Lecture 28 - Measurement of Body Temperature - Part 2

Lecture 29 - Measurement of Body Temperature - Part 3

Lecture 30 - Introduction to flow and volume measurement

Lecture 31 - Blood Flow Measurement - Ultrasonic method - Part 1

[Lecture 32 - Blood Flow Measurement - Ultrasonic method - Part 2](#)

[Lecture 33 - Blood Flow Measurement - Ultrasonic method - Part 3](#)

[Lecture 34 - Blood Flow Measurement - Ultrasonic method - Part 4](#)

[Lecture 35 - Blood Flow Measurement - Ultrasonic method - Part 5](#)

[Lecture 36 - Blood Flow Measurement - Thermal method](#)

[Lecture 37 - Introduction to respiratory system and measurements - Part 1](#)

[Lecture 38 - Introduction to respiratory system and measurements - Part 2](#)

[Lecture 39 - Respiratory Volume Measurement - Part 1](#)

[Lecture 40 - Respiratory Volume Measurement - Part 2](#)

[Lecture 41 - Introduction to Cardiac Output Measurement](#)

[Lecture 42 - Cardiac Output Measurement Techniques](#)

[Lecture 43 - Origin of Biopotential - Part 1](#)

[Lecture 44 - Origin of Biopotential - Part 2](#)

[Lecture 45 - Introduction to Biopotential electrode - Part 1](#)

[Lecture 46 - Introduction to Biopotential electrode - Part 2](#)

[Lecture 47 - Introduction to Biopotential electrode - Part 3](#)

[Lecture 48 - Introduction to Biopotential electrode - Part 4](#)

[Lecture 49 - Introduction to Biopotential electrode - Part 5](#)

[Lecture 50 - Types of Biopotential Electrode - Micro Electrodes](#)

[Lecture 51 - Practical Hints and Recording issue in using Electrodes](#)

[Lecture 52 - Types of Biopotential Electrode - Body-Surface Recording Electrodes](#)

[Lecture 53 - Types of Biopotential Electrode - Internal Electrode](#)

[Lecture 54 - Types of Biopotential Electrode - Electrode Array](#)

[Lecture 55 - Summary of electrode theory](#)

[Lecture 56 - Introduction to Bioelectricity](#)

[Lecture 57 - Types of Biosignals - ECG - Part 1](#)

[Lecture 58 - Types of Biosignals - ECG - Part 2](#)

[Lecture 59 - Types of Biosignals - ECG - Part 3](#)

[Lecture 60 - Types of Biosignals - ECG - Part 4](#)

[Lecture 61 - Types of Biosignals - ECG - Part 5](#)

[Lecture 62 - Introduction to Nervous System](#)

[Lecture 63 - Types of Biosignal - EEG - Part 1](#)

[Lecture 64 - Types of Biosignal - EEG - Part 2](#)

[Lecture 65 - Types of Biosignal - EEG - Part 3](#)

[Lecture 66 - Types of Biosignal - EEG - Part 4](#)

[Lecture 67 - Types of Biosignal - EEG - Part 5](#)

[Lecture 68 - Types of Biosignal - EMG - Part 1](#)

[Lecture 69 - Types of Biosignal - EMG - Part 2](#)

[Lecture 70 - Types of Biosignal - EMG - Part 3](#)

[Lecture 71 - Types of Biosignal - EMG - Part 4](#)

[Lecture 72 - Types of Biosignal - EMG - Part 5](#)

[Lecture 73 - Comparison of ECG vs EEG vs EMG](#)

[Lecture 74 - Introduction to Physiology of Eye](#)

[Lecture 75 - Types of Biosignal - ERG](#)

[Lecture 76 - Types of Biosignal - EOG](#)

[Lecture 77 - Biofeedback Instrumentation](#)

[Lecture 78 - Types of Biosignal - PCG](#)

[Lecture 79 - Digital Stethoscope](#)

[Lecture 80 - Review of basic respiratory physiology](#)

[Lecture 81 - Introduction to Ventilator](#)

[Lecture 82 - Classification of Ventilator](#)

[Lecture 83 - Operation of Ventilator](#)

[Lecture 84 - Control Scheme for Ventilator](#)

[Lecture 85 - Breathing Sequences in Ventilator](#)

[Lecture 86 - Modes of Ventilation](#)

[Lecture 87 - Maneuvers during Ventilation](#)

[Lecture 88 - High Frequency Ventilation](#)

[Lecture 89 - Circuitry of Ventilator](#)

[Lecture 90 - Introduction to Human Heart](#)

[Lecture 91 - Cardiac Pacemaker](#)

[Lecture 92 - External Pacemaker](#)

[Lecture 93 - Implantable Pacemaker - Part 1](#)

[Lecture 94 - Implantable Pacemaker - Part 2](#)

[Lecture 95 - Leads and Electrodes for Pacemakers](#)

[Lecture 96 - Introduction to Cardiac Fibrillation](#)

[Lecture 97 - Introduction to Defibrillator](#)

[Lecture 98 - Defibrillators: Control Variables, Waveforms, and Electrode Placement](#)

[Lecture 99 - External Defibrillator- Part 1](#)

[Lecture 100 - External Defibrillator- Part 2](#)

[Lecture 101 - External Defibrillator- Part 3](#)

[Lecture 102 - Implantable Defibrillator - Part 1](#)

[Lecture 103 - Implantable Defibrillator - Part 2](#)

[Lecture 104 - Introduction to Cardioverter](#)

[Lecture 105 - Fundamental Physiology of the Renal system](#)

[Lecture 106 - Introduction to Dialysis](#)

[Lecture 107 - Hemodialysis](#)

[Lecture 108 - Dialysis - Dialyzing membrane, fluid and types of Dialyzer](#)

[Lecture 109 - Hemodialysis Machine](#)

[Lecture 110 - Physiology and disorders of oxygen transport](#)

[Lecture 111 - Pulse oximeter](#)

Lecture 1 - Human Physiology

Lecture 2 - Human Anatomy

Lecture 3 - Introduction to Cells, Structure and Functions of Cell

Lecture 4 - Ion and Molecular Transport - I

Lecture 5 - Ion and Molecular Transport - II

Lecture 6 - Homeostasis and Diseases caused due to Malfunction of Cell Organelles

Lecture 7 - Introduction to Hematology, Blood Components and Function

Lecture 8 - Hemostasis

Lecture 9 - Anticoagulation and Blood related diseases

Lecture 10 - Blood grouping and Transfusion

Lecture 11 - Lymph and Lymphatic Circulation

Lecture 12 - Immune Mechanism of Blood and Lymph

Lecture 13 - Anatomy of Heart, Heart Diseases and Electrical Activities

Lecture 14 - Cardiac and Peripheral Circulation

Lecture 15 - Blood Vessels and Capillary

Lecture 16 - Anatomical Parts of Lungs and Function

Lecture 17 - Mechanism of Respiration, Gas Transport

Lecture 18 - Gas Transport and Lung Volume Capacities

Lecture 19 - Carbon Monoxide Poisoning, Oximeter and Lung Diseases

Lecture 20 - Structure and Functions of Endocrine Glands

Lecture 21 - Glucose Homeostasis, Type I and Type II Diabetes

Lecture 22 - Cell Therapy for Diabetes and Artificial Pancreas

Lecture 23 - Blood Glucose Measurement, Therapies for Diabetes

Lecture 24 - Thyroid Synthesis and Functions

Lecture 25 - Disease of the Endocrine Gland

Lecture 26 - Digestive System Anomy and Function

Lecture 27 - Digestion and Absorption of Carbohydrate

Lecture 28 - Digestion and Absorptio of Proteins

Lecture 29 - Digestion and Absorption of Lipids

Lecture 30 - Digestive Disorder

Lecture 31 - Bones

[Lecture 32 - Joints and Other Connective Tissues](#)

[Lecture 33 - Different Types of Muscles](#)

[Lecture 34 - Neuromuscular Transmission](#)

[Lecture 35 - Disease Related to Skeletal system](#)

[Lecture 36 - Introduction of Excretory System](#)

[Lecture 37 - Glomerular Filtration](#)

[Lecture 38 - Proximal Convoluted Tubule](#)

[Lecture 39 - Loop of Henles and Other Parts of Nephron](#)

[Lecture 40 - Renal Control of Blood Pressure and Renal Disorder](#)

[Lecture 41 - Male Reproductive Organs](#)

[Lecture 42 - Spermatogenesis](#)

[Lecture 43 - Female Reproductive Organs](#)

[Lecture 44 - Ovarian Cycle - 1](#)

[Lecture 45 - Ovarian Cycle - 2](#)

[Lecture 46 - Menstrual Cycle and Hormonal Regulation](#)

[Lecture 47 - Fertilization and Pregnancy](#)

[Lecture 48 - Contraceptive and IVF](#)

[Lecture 49 - Male Reproductive Health and Disease](#)

[Lecture 50 - Female Reproductive Health and Disease](#)

[Lecture 51 - Introduction to Nervous System](#)

[Lecture 52 - Brain Structure and Function](#)

[Lecture 53 - Structure and Functions of Spinal Cords, Cranial and Spinal Nerves](#)

[Lecture 54 - Neuron and Nerve Structure and Function](#)

[Lecture 55 - Nerve Injury and Repair](#)

[Lecture 56 - Neurotransmission - 1](#)

[Lecture 57 - Neurotransmission - 2](#)

[Lecture 58 - Glial Cells and Blood Brain Barrier](#)

[Lecture 59 - Introduction to Various Sensory Organs and Their Function](#)

[Lecture 60 - Neurological Disorders](#)

Lecture 1 - Introduction to the Subject and Course Plan

Lecture 2 - Introduction to Microbial World

Lecture 3 - Basic of Microbial Metabolism

Lecture 4 - Importance of Microbes

Lecture 5 - Microbial Products

Lecture 6 - Cell Constituents and Growth

Lecture 7 - Microbial Growth

Lecture 8 - Microbial Growth Quantification

Lecture 9 - Aerobic vs Anaerobic Cultivation Methods

Lecture 10 - Numerical Practice

Lecture 11 - Microbial Growth Model

Lecture 12 - Microbial Growth Model and Parameters Estimation - Part 1

Lecture 13 - Microbial Growth Model and Parameters Estimation - Part 2

Lecture 14 - Yield and Maintenance Coefficients

Lecture 15 - Tutorial

Lecture 16 - Plant Cell Culture - Part I

Lecture 17 - Plant Cell Culture - Part II

Lecture 18 - Animal Cells

Lecture 19 - Animal Cell Culture

Lecture 20 - Numerical Practice

Lecture 21 - Animal Cells and Cell Lines

Lecture 22 - Cell Sorting Method - Part I

Lecture 23 - Cell Sorting Method - Part II

Lecture 24 - Methods of Transfection

Lecture 25 - Numerical Practice

Lecture 26 - Introductory Immunology

Lecture 27 - Immune Cells and Responses

Lecture 28 - Isolation of Immune Cells

Lecture 29 - Advanced Characterization of Immune Cells

Lecture 30 - Numerical Practice

Lecture 31 - Principles of Force, Motion and Energy in Biological Systems

[Lecture 32 - Static and Dynamic Analysis of Biological Systems](#)

[Lecture 33 - Biomechanics of Bacterial Systems](#)

[Lecture 34 - Case Study on Human Motion Biomechanics](#)

[Lecture 35 - Numerical Practice on Applications of Biomechanics](#)

[Lecture 36 - Introduction to Fluid Mechanics](#)

[Lecture 37 - Advanced Fluid Mechanics in Biological Systems](#)

[Lecture 38 - Case Study Blood Flow Through the Cardiovascular System](#)

[Lecture 39 - Case Study Flow in the Lungs](#)

[Lecture 40 - Numerical on Biological Fluid Mechanics](#)

[Lecture 41 - Sterilization in Bioprocesses](#)

[Lecture 42 - Sterilization Charts](#)

[Lecture 43 - Practical Issues in Sterilization](#)

[Lecture 44 - Kinetics of Thermal Sterilization](#)

[Lecture 45 - Numerical Practice](#)

[Lecture 46 - Bioreactor Configurations and Operating Considerations](#)

[Lecture 47 - Chemostat with Recycle](#)

[Lecture 48 - Multiple Chemostat, Fed batch and Perfusion Systems](#)

[Lecture 49 - Gaden and Deindoefer Classification of Product Formation](#)

[Lecture 50 - Numerical on Chemostat with Recycle and Fed Batch Operation](#)

[Lecture 51 - Oxygen Uptake in Cell Cultures](#)

[Lecture 52 - Oxygen Transfer Rate OTR vs Oxygen Uptake Rate OUR](#)

[Lecture 53 - DO Effect](#)

[Lecture 54 - Oxygen Supply and Transfer](#)

[Lecture 55 - Numerical](#)

[Lecture 56 - Mass Transfer Fundamentals](#)

[Lecture 57 - Rheology of Biological Fluids](#)

[Lecture 58 - Biological Wastewater Treatment Case Study](#)

[Lecture 59 - Case Study Related to Hematopoiesis i Bioreactor Systems](#)

[Lecture 60 - Numerical on Mass Transfer Coefficient, Rheologic Properties of Fluids and Anaerobic Digestion](#)

Lecture 1 - Introduction to the Living World and two major questions

Lecture 2 - History of Evolutionary Thought (Pre-Darwin)

Lecture 3 - Making of Darwinism (External Video)

Lecture 4 - Darwinism

Lecture 5 - Beyond Darwinism: Modern Synthesis_EES

Lecture 6 - Tying it all up_Back to the two questions

Lecture 7 - Evidence for evolution 1: Change and Speciation

Lecture 8 - Evidence for evolution 2: Descent with modification - Part 1

Lecture 9 - Evidence for evolution 3: Descent with modification - Part 2

Lecture 10 - Evidence for evolution 4: Objections to evolution

Lecture 11 - Classifying variation

Lecture 12 - Revising Mendel and introducing population genetics

Lecture 13 - From family to the population

Lecture 14 - Solving simple Hardy-Weinberg problems

Lecture 15 - Generating variation

Lecture 16 - Features of Mutations - Part 1

Lecture 17 - Features of Mutations - Part 2

Lecture 18 - Non-genetic Inheritance

Lecture 19 - Introduction to Selection

Lecture 20 - Dynamics of Selection 1: Numerical Simulations

Lecture 21 - Dynamics of Selection 2: Analytical

Lecture 22 - Features of selection: Insights from theory

Lecture 23 - Examples of selection

Lecture 24 - Features of selection: Insights from experiments

Lecture 25 - Finite population: Numerical Simulations

Lecture 26 - Genetic drift: examples and features

Lecture 27 - Effective population size and evolution of mutation rates

Lecture 28 - Non-random mating and inbreeding

Lecture 29 - Migration: Numerical simulations and analysis

Lecture 30 - Migration: Interactions and examples

Lecture 31 - Introduction to Aging

[Lecture 32 - Mechanistic Theories of Aging](#)

[Lecture 33 - Evolutionary Theories of Aging - Part 1](#)

[Lecture 34 - Evolutionary Theories of Aging - Part 2](#)

[Lecture 35 - Why sex?](#)

[Lecture 36 - Benefits of sex](#)

[Lecture 37 - Sexual Selection - Part 1](#)

[Lecture 38 - Sexual Selection - Part 2](#)

[Lecture 39 - Kin Selection and Hamilton's Rule](#)

[Lecture 40 - Evolutionary Conflicts](#)

[Lecture 41 - What is a species?](#)

[Lecture 42 - What are the isolation mechanisms?](#)

[Lecture 43 - Evolution of reproductive isolation](#)

[Lecture 44 - How new genes are born](#)

[Lecture 45 - Coping with changing environments](#)

[Lecture 46 - Evolutionary patterns in the genome](#)

[Lecture 47 - Origin of Life - Part 1](#)

[Lecture 48 - Origin of Life - Part 2](#)

[Lecture 49 - Human Evolution](#)

[Lecture 50 - Applications of Evolution - Part 1](#)

[Lecture 51 - Applications of Evolution - Part 2](#)

Lecture 1 - What is Signaling ?

Lecture 2 - Why do we need signaling ?

Lecture 3 - Types of Cell Signaling

Lecture 4 - Signals: Nature and Composition

Lecture 5 - Consequences of Signaling in context of Signal

Lecture 6 - Types of Receptors and their functioning

Lecture 7 - Modes of regulation on signaling (Receptors, Signals, and Effectors)

Lecture 8 - G-proteins, and Kinase activity regulation in Signaling

Lecture 9 - Phosphorylation-dependent regulation in Signaling

Lecture 10 - Kinase activity assessment, Types of Kinases, and Signaling system of Microbial world

Lecture 11 - Signaling by Two-component System

Lecture 12 - Canonical and Hybrid Two-component system in Bacteria Life style changes

Lecture 13 - The two-component system coordinates various microbial responses

Lecture 14 - The two-component system coordinates sporulation and quorum sensing responses

Lecture 15 - The two-component Signaling in plants

Lecture 16 - The Cytokinin Signaling, TCS and plant development

Lecture 17 - The two-component Signaling in Ethylene, photomorphogenic, and diurnal responses

Lecture 18 - Receptor Serine-Threonine Kinase Signaling

Lecture 19 - Different modes of RLK Signaling in plants

Lecture 20 - Receptor-Like Kinase (RLK) Signaling shaping plants

Lecture 21 - Signaling in animal world: Receptor Serine/Threonine kinase pathway

Lecture 22 - Receptor Serine/Threonine kinase pathways and Bone morphogenesis

Lecture 23 - Activin and AMH signaling through receptor Serine/Threonine kinase pathway

Lecture 24 - Receptor Tyrosine Kinases (RTK)

Lecture 25 - Activation of Receptor Tyrosine Kinases and their recognition

Lecture 26 - JAK-STAT pathway and Phosphoinositides-dependent Receptor Tyrosine Kinase Signaling

Lecture 27 - Phosphoinositides-dependent Signaling downstream of RTK activation

Lecture 28 - Contact-mediated bidirectional Receptor Tyrosine Kinase Signaling

Lecture 29 - Contact-mediated Eph-Ephrin Signaling shapes tissue organization

Lecture 30 - Contact-mediated Signaling by Notch-Delta combination

Lecture 31 - Integrin Signaling for cell motility, movement, and growth

[Lecture 32 - G-protein coupled receptor \(GPCR\): the basics and uniqueness](#)

[Lecture 33 - G-protein coupled receptor mediated signaling pathways - I](#)

[Lecture 34 - G-protein coupled receptor mediated signaling pathways - II](#)

[Lecture 35 - G-protein coupled receptor mediated signaling pathways - III](#)

[Lecture 36 - Regulation of Signaling at receptor level](#)

[Lecture 37 - Signaling by Channel-type receptors](#)

[Lecture 38 - Water Channels and nuclear/cytosolic receptors](#)

[Lecture 39 - Nuclear receptors with TF activity, and signaling co-receptors](#)

[Lecture 40 - A Snapshot and brief summary of the Cell Signaling](#)

Lecture 1 - Basic concepts in microscopy - 1

Lecture 2 - Basic concepts in microscopy - 2

Lecture 3 - Dark-field and phase contrast microscopy

Lecture 4 - Differential interference contrast and polarization

Lecture 5 - Fluorescence and confocal microscopy

Lecture 6 - Transmission electron microscopy

Lecture 7 - Transmission electron microscopy cont. and scanning electron microscopy

Lecture 8 - Basic concepts - 1

Lecture 9 - Basic concepts - 2

Lecture 10 - GM counting and Scintillation counting

Lecture 11 - Scintillation counting continued

Lecture 12 - Autoradiography and RIA

Lecture 13 - Safety aspects and applications

Lecture 14 - Introduction and Basic concepts in chromatography - 1

Lecture 15 - Basic concepts in chromatography - 2

Lecture 16 - Low-pressure liquid chromatography (LPLC) and high performance liquid chromatography (HPLC)

Lecture 17 - Ion-exchange chromatography

Lecture 18 - Gel-filtration chromatography

Lecture 19 - Affinity chromatography

Lecture 20 - Gas-liquid chromatography

Lecture 21 - Basic concepts in electrophoresis

Lecture 22 - Horizontal and vertical gel electrophoresis

Lecture 23 - Native gel electrophoresis and SDS-PAGE

Lecture 24 - Isoelectric focusing (IEF), 2-D gel electrophoresis and protein detection methods

Lecture 25 - Electrophoresis of nucleic acids

Lecture 26 - Immunoelectrophoresis and capillary electrophoresis

Lecture 27 - Introduction and Basic Concepts - 1

Lecture 28 - Basic concepts - 2

Lecture 29 - Types of centrifuges and analytical ultracentrifugation method

Lecture 30 - Separation methods in preparative ultracentrifuges

Lecture 31 - Types of rotors

[Lecture 32 - Types of rotors cont. and care of rotors](#)

[Lecture 33 - Introduction and basic concepts](#)

[Lecture 34 - UV-Visible spectroscopy](#)

[Lecture 35 - Infrared and fluorescence spectroscopy](#)

[Lecture 36 - Circular dichroism \(CD\) spectroscopy](#)

[Lecture 37 - Nuclear magnetic resonance \(NMR\) spectroscopy and X-ray crystallography](#)

[Lecture 38 - Atomic spectroscopy and mass spectrometry](#)

[Lecture 39 - Polymerase chain reaction\(PCR\)](#)

[Lecture 40 - DNA sequencing methods](#)

[Lecture 41 - Enzyme linked immunosorbent assay \(ELISA\)](#)

[Lecture 1 - Introduction to Nano](#)

[Lecture 2 - Nano-Biomimicry](#)

[Lecture 3 - Synthesis of nanomaterials by Physical and Chemical Methods](#)

[Lecture 4 - Synthesis of nanomaterials by Biological Methods](#)

[Lecture 5 - Characterisation of Nanomaterials](#)

[Lecture 6 - DNA Nanotechnology](#)

[Lecture 7 - Protein and Glyco Nanotechnology](#)

[Lecture 8 - Lipid Nanotechnology](#)

[Lecture 9 - Bio-Nanomachines](#)

[Lecture 10 - Carbon nanotubes and Its Bio-Applications](#)

[Lecture 11 - Nanomaterials for Cancer Diagnosis](#)

[Lecture 12 - Nanomaterials for Cancer therapy](#)

[Lecture 13 - Nanotechnology in Tissue Engineering](#)

[Lecture 14 - Nano artificial cells](#)

[Lecture 15 - Nanotechnology in Organ Printing](#)

[Lecture 16 - Nanotechnology in Point-of-Care Diagnostics](#)

[Lecture 17 - Nano-Pharmacology and Drug Targeting](#)

[Lecture 18 - Cellular uptake mechanisms of nanomaterials](#)

[Lecture 19 - In vitro Methods to study antibacterial and anticancer properties of nanomaterials](#)

[Lecture 20 - Nanotoxicology](#)

- Lecture 1 - Life Cycle of an Angiosperm
- Lecture 2 - Characteristics of Plant Growth and Development - I
- Lecture 3 - Characteristics of Plant Growth and Development - II
- Lecture 4 - Molecular Genetics of Plant Development - I
- Lecture 5 - Molecular Genetics of Plant Development - II
- Lecture 6 - Molecular Genetics of Plant Development - III
- Lecture 7 - Molecular Genetics of Plant Development - IV
- Lecture 8 - Molecular Genetics of Plant Development (Continued...) - I
- Lecture 9 - Molecular Genetics of Plant Development (Continued...) - II
- Lecture 10 - Molecular Genetics of Plant Development (Continued...) - III
- Lecture 11 - Root Development
- Lecture 12 - Root Development (Continued...)
- Lecture 13 - Root Development (Vascular Development)
- Lecture 14 - Root Branching: Lateral Root Development
- Lecture 15 - Shoot Development: SAM Maintenance
- Lecture 16 - Shoot Development: Organogenesis
- Lecture 17 - Shoot Development: Leaf Development
- Lecture 18 - Shoot Development: Flowering
- Lecture 19 - Cell-Cell Communication During Plant Development
- Lecture 20 - Techniques Used in Lab

Lecture 1 - Introduction: Why to Study Structural Biology

Lecture 2 - Introduction to Biological Macromolecules

Lecture 3 - Introduction: Decoding Biological Macromolecules

Lecture 4 - Introduction: Genome Sequencing

Lecture 5 - Introduction: Post Genomic Era

Lecture 6 - Amino acids and their properties

Lecture 7 - Protein: Protein Chemistry, Chirality, Peptide bond and Levels of protein structures

Lecture 8 - Protein: Dihedral angles, Peptide bond and Ramachandran Plot

Lecture 9 - Protein: Super Secondary Structures, Motif, Domains, Non-covalent interactions

Lecture 10 - Protein: Folding of Protein, Thermodynamics and Kinetics of protein folding, Characterization of Proteins

Lecture 11 - Introduction to Structural Biology Techniques - Part I

Lecture 12 - Introduction to Structural Biology Techniques - Part II

Lecture 13 - X-ray Crystallography: Crystallization - Part I

Lecture 14 - X-ray Crystallography: Crystallization - Part II

Lecture 15 - X-ray Crystallography: Crystal Mounting

Lecture 16 - X-ray Crystallography: Production of X-ray and its properties

Lecture 17 - X-ray Crystallography: Journey to 3D land

Lecture 18 - X-ray Crystallography: Crystal Symmetry

Lecture 19 - X-ray Crystallography: Instrumentation in X-ray Crystallography

Lecture 20 - X-ray Crystallography: Data collection and processing

Lecture 21 - X-ray Crystallography: Data Analysis - Part I

Lecture 22 - X-ray Crystallography: Data Analysis - Part II

Lecture 23 - X-ray Crystallography: Phase Problem - Part I

Lecture 24 - X-ray Crystallography: Phase Problem - Part II

Lecture 25 - X-ray Crystallography: Refinement and Structure deposition to PDB

Lecture 26 - Introduction to Spectroscopy and NMR

Lecture 27 - Basic Principles of NMR and Instrumentation

Lecture 28 - NMR Sample Preparation and Chemical Shift related concepts

Lecture 29 - Factors effecting NMR Spectra (1D and 2D)

Lecture 30 - 2D and 3D NMR Spectroscopy focusing on protein structure

Lecture 31 - Introduction to Spectroscopy

[Lecture 32 - UV-Vis and CD spectroscopy](#)

[Lecture 33 - Fluorescence Spectroscopy and Green Fluorescence Protein \(GFP\)](#)

[Lecture 34 - Infrared and Raman Spectroscopy for protein](#)

[Lecture 35 - Raman Spectroscopy, Raman Microscopy and Raman Crystallography for studying protein](#)

[Lecture 36 - Introduction to Microscopy](#)

[Lecture 37 - Functioning details of Cryo Electron Microscopy \(Cryo EM\)](#)

[Lecture 38 - Cryo Electron Microscopy: Data Collection and Analysis](#)

[Lecture 39 - A concise story of advancement Cryo-EM](#)

[Lecture 40 - Protein Data Bank](#)

[Lecture 41 - History of Molecular Visualizations of Biological Macromolecules](#)

[Lecture 42 - Description of structure related files \(.pdb, .mmCIF, .mtz, etc.\)](#)

[Lecture 43 - Demonstration of COOT](#)

[Lecture 44 - 3D visualization using Pymol](#)

[Lecture 45 - Demonstration of Pymol](#)

[Lecture 46 - Why we need MD Simulation](#)

[Lecture 47 - Molecular Dynamic Simulation Process - Part I](#)

[Lecture 48 - Molecular Dynamic Simulation Process - Part II](#)

[Lecture 49 - Molecular Dynamic Simulation Process - Part III](#)

[Lecture 50 - Application of Molecular Dynamic Simulation](#)

[Lecture 51 - What, How and Which of Protein Engineering](#)

[Lecture 52 - How to make logical Protein Engineering: Process of Rational design](#)

[Lecture 53 - Success story of Rational Protein designing: Focusing on De Novo Process](#)

[Lecture 54 - Designing Protein by mimicking nature: Process of Directed Evolution](#)

[Lecture 55 - Achievement, Challenges, and Future direction in the field of Protein Engineering](#)

[Lecture 56 - Introduction to Structure Based Drug Discovery \(SBDD\)](#)

[Lecture 57 - Rational Drug Discovery](#)

[Lecture 58 - Docking Based Virtual Screening: Progress, Challenges and Future perspective](#)

[Lecture 59 - What makes a small molecule an ideal drug: Developing in silico ADMETox Model](#)

[Lecture 60 - Structure Based Drug Discovery: Case study and Conclusion](#)

[Lecture 1 - Synthesis of Nanomaterials Using Ball Milling](#)

[Lecture 2 - Synthesis Of Gold Nanoparticles](#)

[Lecture 3 - Biological Synthesis of Nanomaterials](#)

[Lecture 4 - Synthesis Of Carbon Dots](#)

[Lecture 5 - Synthesis Of Polymeric Nanoparticles](#)

[Lecture 6 - UV-Visible and Fluorescence Spectroscopy](#)

[Lecture 7 - Dynamic Light Scattering and Zeta Potential Analysis](#)

[Lecture 8 - Fourier Transform Infrared Spectroscopy](#)

[Lecture 9 - X-Ray Diffraction](#)

[Lecture 10 - Electron Microscopy](#)

[Lecture 11 - Atomic Force Microscopy](#)

[Lecture 12 - Electrochemical Nano-Biosensor](#)

[Lecture 13 - Fabrication of Nanofibers Using Electrospinning](#)

[Lecture 14 - Synthesis of Hydrogel and Nanogel](#)

[Lecture 15 - In vitro 3D Cell Culture](#)

[Lecture 16 - 3D Bioprinting](#)

[Lecture 17 - In vitro Methods to Study Antibacterial Properties of Nanomaterials](#)

[Lecture 18 - In vitro Cytotoxicity Analysis](#)

[Lecture 19 - In vitro Methods to Study the Apoptotic Potential of Nanomaterials](#)

[Lecture 20 - In vitro Hemocompatibility Test](#)

[Lecture 21 - In vivo Toxicity Studies Using Zebrafish Embryo](#)

Lecture 1 - Introduction to Learning and Memory - I : Historical perspective

Lecture 2 - Introduction to Learning and Memory - II : Classification

Lecture 3 - Associative Learning I : Rules of Associative learning

Lecture 4 - Associative learning II : Garcia and Koelling's Experiment, Kamin's Blocking Experiment

Lecture 5 - Introduction to the Rescorla Wagner Model

Lecture 6 - Application of Rescorla Wagner Model - I

Lecture 7 - Application of Rescorla Wagner Model - II

Lecture 8 - Application of Rescorla Wagner Model - III

Lecture 9 - Application of Rescorla Wagner Model - IV

Lecture 10 - Limitations of Rescorla Wagner Model

Lecture 11 - Introduction of Reinforcement Learning - I : Thorndike's view, Tolman's views, Skinner Box

Lecture 12 - Introduction of Reinforcement Learning - II : Classification, Thorndike's view, Tolman's views, Skinner Box (Continued...)

Lecture 13 - Introduction of Reinforcement Learning - III : Understanding scheduling of reinforcers in operant conditioning

Lecture 14 - Sign Tracking vs Goal Oriented/Tracking; Linking complex behaviors to simple molecules

Lecture 15 - Sign Tracking vs Goal Oriented; Learning Linking complex behaviors to simple molecules - II

Lecture 16 - Memory in Molecular Terms - I : Protein synthesis in memory consolidation

Lecture 17 - Memory in Molecular Terms - II : Long term potentiation

Lecture 18 - Memory in Molecular Terms - III : Properties of a memory molecule

Lecture 19 - Memory in Molecular Terms - IV : Remote memory and its characteristics

Lecture 20 - Memory in Molecular Terms - V : Selective labelling of memory encoding neurons and their manipulation

Lecture 1 - Drug Delivery Introduction and Pharmacokinetics

Lecture 2 - Pharmacokinetics (Continued...)

Lecture 3 - Pro-drugs and Polymers Introduction

Lecture 4 - Polymers - Synthesis

Lecture 5 - Polymers - Properties

Lecture 6 - Biomedical Polymers

Lecture 7 - Biodegradable Polymers and Polymer Drug Conjugates - I

Lecture 8 - Polymer Drug Conjugates - II

Lecture 9 - Research Paper Discussion and Diffusion Controlled Systems

Lecture 10 - Controlled Release: Reservoir System - I

Lecture 11 - Controlled Release: Reservoir Systems and Non-erodible Systems

Lecture 12 - Controlled Release: Non-erodible Systems and Erodible systems

Lecture 13 - Math Exercise

Lecture 14 - Hydrogels - I

Lecture 15 - Hydrogels - II

Lecture 16 - Hydrogels - III

Lecture 17 - Hydrogels - IV

Lecture 18 - Nano and Micro-particles - I

Lecture 19 - Nano and Micro-particles - II

Lecture 20 - Nano and Micro-particles - III

Lecture 21 - Nano and Micro-particles - IV

Lecture 22 - Nano and Micro-particles - V

Lecture 23 - Nano and Micro-particles - VI

Lecture 24 - Nano and Micro-particles - VII

Lecture 25 - Protein Adsorption - I

Lecture 26 - Protein Adsorption - II

Lecture 27 - Protein Adsorption - III

Lecture 28 - Tissue Engineering - I

Lecture 29 - Tissue Engineering - II

Lecture 30 - Tissue Engineering - III

Lecture 31 - Drug Delivery in Tissue Engineering - I

[Lecture 32 - Drug Delivery in Tissue Engineering - II](#)

[Lecture 33 - Implant Associated Infections - I](#)

[Lecture 34 - Implant Associated Infections - II](#)

[Lecture 35 - Route Specific Delivery: Oral Route - I](#)

[Lecture 36 - Route Specific Delivery: Oral Route - II](#)

[Lecture 37 - Route Specific Delivery: Oral and Subcutaneous Route](#)

[Lecture 38 - Route Specific Delivery: Intramuscular, Transdermal - I](#)

[Lecture 39 - Route Specific Delivery: Transdermal - II](#)

[Lecture 40 - Route Specific Delivery: Transdermal and Inhalation Route](#)

[Lecture 41 - Route Specific Delivery: Inhalation - II, Buccal and Rectal Administration](#)

[Lecture 42 - Research Paper Discussion: Dry Powder Particle Delivery](#)

[Lecture 43 - Route Specific Delivery: Intra-articular and Intravenous Administration](#)

[Lecture 44 - Intravenous Administration: Approved Nanocarriers and Immune System](#)

[Lecture 45 - Immune System - II](#)

[Lecture 46 - Complement System and Blood Clotting](#)

[Lecture 47 - Blood Clotting and Hemocompatibility of Materials; Adaptive Immune Response](#)

[Lecture 48 - Adaptive Immune Response and Vaccine](#)

[Lecture 49 - Vaccines](#)

[Lecture 50 - Vaccines and Immuno-isolated Cell Therapy](#)

[Lecture 51 - Immuno-isolated Cell Therapy](#)

[Lecture 52 - Immuno-isolated Cell and Gene Therapy](#)

[Lecture 53 - Gene Delivery: Vectors](#)

[Lecture 54 - Gene Delivery: Polymers](#)

[Lecture 55 - Genes as Vaccines](#)

[Lecture 56 - Vaccines: Gene Delivery and Other Variants](#)

[Lecture 57 - Cancer Vaccines](#)

[Lecture 58 - Cancer Vaccine: Immunotherapy](#)

[Lecture 59 - Responsive Delivery Systems - I](#)

[Lecture 60 - Responsive Delivery Systems - II](#)

[Lecture 61 - Targeted Drug Delivery System](#)

[Lecture 62 - Targeted Drug Delivery System: Research Paper Discussion](#)

[Lecture 63 - Nanotoxicology and Translation Pathways](#)

Lecture 1 - Introduction

Lecture 2 - Substrate

Lecture 3 - Substrate (Continued...)

Lecture 4 - Introduction to cleanroom

Lecture 5 - Contamination and surface cleaning

Lecture 6 - Advanced cleaning techniques

Lecture 7 - Defects

Lecture 8 - Diffusion

Lecture 9 - Diffusion - Advanced Concepts

Lecture 10 - Ion Implantation

Lecture 11 - Ion Implantation (Continued...)

Lecture 12 - Native Films

Lecture 13 - Native Films: Advanced Concepts

Lecture 14 - Native Films: Defects at Si/SiO₂ interface

Lecture 15 - Methods and Some Definitions

Lecture 16 - Chemical Vapor Deposition: Basics

Lecture 17 - Chemical Vapor Deposition: Precursor Transport

Lecture 18 - Chemical Vapor Deposition: Types of CVD Equipment

Lecture 19 - Chemical Vapor Deposition: Nucleation and Growth

Lecture 20 - Chemical Vapor Deposition: Other Details

Lecture 21 - Atomic Layer Deposition

Lecture 22 - Atomic Layer Deposition (Continued...)

Lecture 23 - Physical Vapor Deposition: Basics

Lecture 24 - Physical Vapor Deposition: Evaporation

Lecture 25 - Physical Vapor Deposition: Sputtering

Lecture 26 - Metallization: Contact resistance

Lecture 27 - Metallization: Electromigration and Epilogue

Lecture 28 - Pattern Transfer Basics

Lecture 29 - Optical lithography basics: resist process - 1

Lecture 30 - Optical lithography basics: resist process - 2

Lecture 31 - Optical Lithography: Contact and Proximity printing

[Lecture 32 - Optical Lithography: Stepper and Scanner](#)

[Lecture 33 - Projection Lithography: Image formation basics](#)

[Lecture 34 - Projection Lithography: Image formation in photoresist](#)

[Lecture 35 - Optical lithography: Surface Reflection](#)

[Lecture 36 - Optical Lithography: Mask Technology](#)

[Lecture 37 - Lithography process technology glossary](#)

[Lecture 38 - Optical Lithography: Resolution enhancement](#)

[Lecture 39 - Electron beam lithography: Basics](#)

[Lecture 40 - Electron beam lithography: Resist process](#)

[Lecture 41 - Emerging lithography techniques](#)

[Lecture 42 - Etching Figures of Merit](#)

[Lecture 43 - Wet etching Basics](#)

[Lecture 44 - Wet Etching Recipes](#)

[Lecture 45 - Wet Etching Recipes](#)

[Lecture 46 - Dry etch: Plasma Basics](#)

[Lecture 47 - Dry etch: Plasma etching basics](#)

[Lecture 48 - Dry etch: Plasma tool configuration](#)

[Lecture 49 - Dry etch: Etch mechanism](#)

[Lecture 50 - Dry etch: Etch chemistry](#)

[Lecture 51 - Chemical Mechanical Polishing \(CMP\): Basics](#)

[Lecture 52 - Chemical Mechanical Polishing \(CMP\): Tool and process](#)

[Lecture 53 - Design for Manufacturability - 1](#)

[Lecture 54 - Design for Manufacturability - 2](#)

[Lecture 55 - Design for Manufacturability: Case study](#)

[Lecture 56 - Process integration](#)

[Lecture 57 - PV integration](#)

[Lecture 58 - CMOS integration](#)

[Lecture 59 - Lab demo: Silicon Nitride cantilever fabrication - 1](#)

[Lecture 60 - Lab demo: Silicon Nitride cantilever fabrication - 2](#)

[Lecture 61 - CMOS process for photonics application](#)

Lecture 1 - Optical Focus and Localisation of Light

Lecture 2 - Relating Photon's Momentum to Spot Size

Lecture 3 - Shortest Pulse of Light: How fast can we shutter the light?

Lecture 4 - Behaviour of light through polarizers: Introduction

Lecture 5 - Nature of Light: Introduction to Photo Multiplier Tubes

Lecture 6 - Revisiting Polarisation Through Ket Vectors

Lecture 7 - Light through Polarisers: Detailed Description - I

Lecture 8 - Light through Polarisers: Detailed Description - II

Lecture 9 - Time Dependent Perturbation Theory (TDPT): Overview

Lecture 10 - TDPT in Steps-1: Unperturbed and Perturbed Hamiltonian

Lecture 11 - TDPT in Steps-2: Introducing the switch and first approximation

Lecture 12 - TDPT in Steps-3: Finding the co-efficients

Lecture 13 - Fermi's Golden Rule

Lecture 14 - Beer Lambert's Law from TDPT

Lecture 15 - Einstein's Phenomenology

Lecture 16 - Einstein's Coefficients, Fluorescence and Lifetime

Lecture 17 - Fock States and Photonic Treatment of Light

Lecture 18 - Operators in Fock State Space

Lecture 19 - Light Matter Interaction and Rudimentary Feynman Diagrams

Lecture 20 - Emergence of Spontaneous and Stimulated Emission Processes

Lecture 21

Lecture 22

Lecture 23

Lecture 24

Lecture 25

Lecture 26 - Introduction to LASER

Lecture 27 - LASER population dynamics

Lecture 28 - LASER population dynamics - Part- 2

Lecture 29 - Real world LASER and characteristics of LASER emission

Lecture 30 - Temporal and Spatial Coherence

[Lecture 31 - Transverse and Longitudinal modes of LASER](#)

[Lecture 32 - Pulsed LASER](#)

[Lecture 33 - Q-switching in detail](#)

[Lecture 34 - Q-switching in detail - Part 2](#)

[Lecture 35 - Basics of mode locking](#)

[Lecture 36 - Basics of mode locking - Part 2](#)

[Lecture 37 - Pulse compression](#)

[Lecture 38 - Real world system \(Mode lock Part-2\)](#)

[Lecture 39 - TEM mode](#)

[Lecture 40 - Alignment basics](#)

[Lecture 41 - Non-Linear Optics](#)

[Lecture 42 - Confocal Detection](#)

[Lecture 43 - Interference Filters](#)

[Lecture 44 - Laser Scanning System - 1](#)

[Lecture 45 - Laser Scanning System - 2](#)

[Lecture 46 - Alignment of Moving Beams](#)

[Lecture 47 - Decoding an Objective Lens - 1](#)

[Lecture 48 - Decoding an Objective Lens - 2](#)

[Lecture 49 - Designing Lens Systems](#)

[Lecture 50 - Astigmatism and Field Curvature](#)

[Lecture 51 - Intro to Lab Session](#)

[Lecture 52 - Optics in LAB: Aligning light through an optical fiber - 1](#)

[Lecture 53 - Optics in Lab: Telescope](#)

[Lecture 54 - Kinematic Mounts](#)

[Lecture 55 - Alignment with out iris](#)

[Lecture 56 - Fluorescence Spectrometer - 1](#)

[Lecture 57 - Fluorescence Spectrometer - 2](#)

[Lecture 58 - Ti:Sapphire Laser and Two Photon Fluorescence](#)

Lecture 1 - Introduction to Cell Biology, Cell components, organization and processes - Part I

Lecture 2 - Introduction to Cell Biology, Cell components, organization and processes - Part II

Lecture 3 - DNA: The genetic material - Part I

Lecture 4 - DNA: The genetic material - Part II

Lecture 5 - Regulation of the cell cycle - Part I

Lecture 6 - Regulation of the cell cycle - Part II

Lecture 7 - Checkpoints: The DNA damage and DNA replication checkpoints

Lecture 8 - The Ubiquitin Proteasome system

Lecture 9 - S-phase: Regulation of entry into S-phase and DNA Replication

Lecture 10 - DNA replication - Part I

Lecture 11 - DNA Replication - Part II

Lecture 12 - DNA Replication - Part III

Lecture 13 - DNA Replication - Part IV

Lecture 14 - Mitosis - Part I

Lecture 15 - Cytokinesis

Lecture 16 - Aging and Senescence

Lecture 17 - Apoptosis - Part I

Lecture 18 - Apoptosis - Part II

Lecture 19 - Meiosis - Part I

Lecture 20 - Meiosis - Part II

Lecture 21 - Nuclear organization

Lecture 22 - SMC proteins and chromosome organization - Real-Time imaging of DNA loop-extrusion by SMC complexes

Lecture 23 - The cohesin complex and its functions - The mysterious biological function of chromosome loops

Lecture 24 - Chromatin organization

Lecture 25 - SMC proteins and chromosome organization - Introduction

Lecture 26 - Meiosis - Part III

Lecture 27 - Mitosis - Part II

Lecture 28 - Cell diversity and properties of specialized cells-Budding yeast as a model system

Lecture 29 - The Plant Cell

Lecture 30 - Stem cells - Part I Intro-SL

Lecture 31 - Stem cells - Part II

[Lecture 32 - Nerve cells](#)

[Lecture 33 - The Cancer Cell](#)

Lecture 1 - Course Introduction - I

Lecture 2 - Course Introduction - II

Lecture 3 - Neuro anatomy for Neurosurgery

Lecture 4 - Neural Implant Fabrication: PVD - I

Lecture 5 - Neural Implant Fabrication: PVD - II

Lecture 6 - Rodent Neuroanatomy

Lecture 7 - Basics of BCI and Signal Processing

Lecture 8 - Neural Implant Fabrication: Sputtering and CVD

Lecture 9 - Principles of Stereotactic Rodent MicroNeurosurgery

Lecture 10 - Neural Signal Processing: Demonstrations

Lecture 11 - Neural Implant Fabrication: Photolithography - I

Lecture 12 - Neural Implant Fabrication: Photolithography - II

Lecture 13 - Craniotomy and Stereotactic Implantation Surgeries

Lecture 14 - Lithography Numericals

Lecture 15 - IDE Patterning

Lecture 16 - Etching

Lecture 17 - Introduction to Cleanroom and Gowning

Lecture 18 - E-Beam Evaporation Demonstration

Lecture 19 - Craniotomy and Cranial Window Surgeries

Lecture 20 - Flexible MEA: Introduction and Process Flow

Lecture 21 - Flexible MEA: EIB, Characterization and Analyses

Lecture 22 - Stereotactic Implantation Surgeries

Lecture 23 - Sputtering Demonstration

Lecture 24 - 3D Printing - Part I

Lecture 25 - Bioresorbable Microelectrode Array-based System

Lecture 26 - Fundamentals of Spinal Neuroanatomy

Lecture 27 - 3D Printing - Part II

Lecture 28 - Neural Implant - Microneedle

Lecture 29 - Spinal Cord Structure, and Circuits

Lecture 30 - Surgical Steps in Spinal Surgeries

Lecture 31 - 3D Printing - Part III

[Lecture 32 - 3D Printing - Demonstration](#)

[Lecture 33 - Wet Etching Demonstration](#)

[Lecture 34 - Neural Implants for Parkinson's Disease](#)

[Lecture 35 - Spinal micro neuro Surgery](#)

[Lecture 36 - Anesthesia in Rodents](#)

[Lecture 37 - Physiological Monitoring in Rodents](#)

[Lecture 38 - Lithography Demonstration](#)

[Lecture 39 - Electronic System Development for Neural Engineering - I](#)

[Lecture 40 - Anesthesia Administration Equipments and Vital Monitoring](#)

[Lecture 41 - Standard Safety Practices](#)

[Lecture 42 - Euthanasia](#)

[Lecture 43 - Euthanasia in Rodents](#)

[Lecture 44 - Electronic System Development for Neural Engineering - II](#)

[Lecture 45 - Rodent Brain and Spinal Cord Harvest](#)

[Lecture 46 - Rodent Behavioural Setups](#)

[Lecture 47 - Study Plan for Behavioural Setups: Stroke Model](#)

[Lecture 48 - PCB Design Demonstration for Neural Systems](#)

[Lecture 49 - Electronic Systems for Brain Stimulation - I](#)

[Lecture 50 - Behavioural Tasks in Rodent Models - I](#)

[Lecture 51 - Behavioural Tasks in Rodent Models - II](#)

[Lecture 52 - Behavioural Setup for Rodents: Parkinsonism Model - I](#)

[Lecture 53 - Behavioural Setup for Rodents: Parkinsonism Model - II](#)

[Lecture 54 - Electronic Systems for Brain Stimulation - II](#)

[Lecture 55 - Course Concluding Remarks](#)

NPTEL : NOC:Fundamentals of Cryo-Electron Microscopy (Cryo-EM) and 3D Image Processing in Structural Biology (Biotechnology)

Co-ordinators : Prof. Somnath Dutta

Lecture 1 - Introduction of the microscope

Lecture 2 - Image formation by glass lenses and its role in wavelength

Lecture 3 - Different components of electron microscope (EM)

Lecture 4 - Electron specimen interaction

Lecture 5 - Elements of TEM: electron gun - I

Lecture 6 - Elements of TEM: electron gun - II

Lecture 7 - Comparison between the various types of electron gun

Lecture 8 - Elements of TEM: electromagnetic lens (EM) - I

Lecture 9 - Trajectory of electrons in EM lens

Lecture 10 - Elements of TEM: electromagnetic lens (EM) - II

Lecture 11 - Image Formation by EM Lenses: Understanding Ray Diagrams

Lecture 12 - Aberrations and Focusing in Cryo-EM imaging

Lecture 13 - Understanding Chromatic, Spherical Aberrations, and Astigmatism in Cryo-EM

Lecture 14 - Aberrations and Practical Imaging in Cryo-EM

Lecture 15 - Electron Dose Control and Beam Optimization in Cryo-EM

Lecture 16 - Introduction to TEM Holders and Grids in Cryo-EM

Lecture 17 - Overfocused and Underfocused Images

Lecture 18 - Elements of TEM: Pumps in EM System

Lecture 19 - Elements of TEM: Detectors in EM System

Lecture 20 - Imaging and Effect of Thermal Drift

Lecture 21 - Wave and its properties

Lecture 22 - Addition/superposition of waves - I

Lecture 23 - Addition/superposition of waves - II

Lecture 24 - Decomposition of complex waves

Lecture 25 - Wave and their transformation

Lecture 26 - Complex 2D Images and Its Diffraction Pattern

Lecture 27 - Sample Preparation and Determination for TEM

Lecture 28 - Biological Sample Purification - I

Lecture 29 - Biological Sample Purification - II

Lecture 30 - Different Sample Preparation Techniques for TEM Imaging and Different Types of Grids used for Imaging

- Lecture 31 - TEM Grids: Types, Handling and Surface Coatings
- Lecture 32 - Carbon Coaters, Glow Discharge and Grid Surface Treatment
- Lecture 33 - Negative Staining in TEM: Stains, Grid Preparation and Protocols
- Lecture 34 - Carbon Sandwich and Metal Shadowing Techniques in TEM
- Lecture 35 - Staining Quality in TEM: Thick, Thin and Positive Staining
- Lecture 36 - Negative Staining - Imaging Quality and Artifacts
- Lecture 37 - Negative Staining - Particle Distribution and Contrast
- Lecture 38 - Applications of Negative Staining in Structural Biology
- Lecture 39 - Negative Staining for Complexes and Interactions
- Lecture 40 - Ultramicrotomy and Sectioning for Biological Molecules
- Lecture 41 - Cryo-EM Grid Preparation and Vitrification
- Lecture 42 - Grid Types and Sample Distribution in Cryo-EM
- Lecture 43 - Blotting Parameters and Ice Conditions
- Lecture 44 - Motion Correction and Defocus in Cryo-EM
- Lecture 45 - Microscope Alignment and Imaging Limitations
- Lecture 46 - CTF Estimation and Defocus in Cryo-EM
- Lecture 47 - Phase Flip and Motion Correction
- Lecture 48 - High Pressure and Rapid Freezing Methods
- Lecture 49 - Cryo-Ultra Microtomy and FIB-SEM
- Lecture 50 - Graphene Oxide Grids in Cryo-EM
- Lecture 51 - Motion Correction and 2D Classification Basics
- Lecture 52 - Concepts and Methods in 2D/3D Classification
- Lecture 53 - 3D Reconstruction and Resolution Assessment
- Lecture 54 - Practical: TEM Setup and Negative Staining
- Lecture 55 - Practical: Cryo-EM Plunge Freezing
- Lecture 56 - Practical: Cryo-EM Grid Clipping
- Lecture 57 - Practical: Grid Loading and Imaging Software