Department of Biotechnology

NPTEL/SWAYAM Courses for Honours Degree in Biotechnology

Admitted Batch: 2020)

S.no	Course Name	Duration	Credits	Click here to join the course
1	Introduction to mechanobiology	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc 21_bt31/preview
2	Introduction to Dynamical Models in Biology	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc 21_bt42/preview
3	Conservation Geography	12 Weeks	2	https://onlinecourses.nptel.ac.in/noc 21_bt44/preview
4	Wildlife Ecology	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_bt45/preview
5	Organic Chemistry in Biology and Drug Development	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_cy30/preview
6	Legal and Regulatory Issues in Biotechnology	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc 21_lw04/preview
7	Nanomaterials and their Properties	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_mm38/preview
8	Ecology and Environment	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc 21_ge16/preview
9	Bioreactors	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc 21_bt28/preview
10	Transport Phenomena in Biological Systems	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_bt40/preview

11	Technologies For Clean And Renewable Energy Production	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc 21_ch42/preview
12	Principles and Practices of Process Equipment and Plant Design	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_ch52/preview
13	Patent Law for Engineers and Scientists	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_hs71/preview
14	Biomicrofluidics	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc 21_bt24/preview
15	Biomedical nanotechnology	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc 21_bt30/preview
16	Introduction to Biomedical Imaging Systems	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_bt50/preview
17	Biomechanics of Joints and Orthopaedic Implants	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc 21_me130/preview
18	Neuroscience of Human Movements	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_ge17/preview
19	Current regulatory requirements for conducting clinical trials in India for investigational new drugs/new drug (Version 3.0)	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc 21_ge25/preview
20	Introduction to Proteogenomics	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_bt25/preview

21	Introduction to proteomics	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc 21_bt26/preview
22	Computer Aided Drug Design	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc 21_bt29/preview
23	Drug Delivery: Principles and Engineering	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc 21_bt37/preview
24	Functional Genomics	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc 21_bt39/preview
25	Maternal Infant Young Child Nutrition	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22bt01/preview
26	Optical Spectroscopy and Microscopy: Fundamentals of optical measurements and instrumentation	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22bt05/preview
27	Human Molecular Genetics	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc22bt07/preview
28	Demystifying The Brain	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc22bt14/preview
29	Medical Biomaterials	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22bt15/preview
30	Forests And Their Management	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22bt24/preview
31	Nanotechnology In Agriculture	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22bt25/preview
32	Bioelectrochemistry	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc22bt26/preview

33	Plant Developmental Biology	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc22bt27/preview
34	Conservation Economics	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22bt31/preview
35	Soft Nano Technology	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22ch11/preview
36	Understanding Design	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc22de01/preview
37	Design, Technology and Innovation	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22de05/preview
38	Emotional Intelligence	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22hs11/preview
39	Exploring Survey Data on Health Care	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22hs40/preview
40	Material and Energy Balances	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22bt04/preview
41	Bioreactor Design and Analysis	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22bt19/preview
42	Waste to Energy Conversion	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22ch05/preview
43	Physico-chemical processes for wastewater treatment	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22ch25/preview
44	Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems	12 weeks	3	https://onlinecourses.nptel.ac.in/noc22ch27/preview

45	Biomass Conversion and Biorefinery	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22ch28/preview
46	Environmental Quality Monitoring & Analysis	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22ch33/preview
47	Bio photonics	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22ee59/preview
48	Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22ge06/preview
49	Computational Systems Biology	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22bt03/preview
50	Interactomics: Basics & Applications	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc22bt11/preview
51	Data Analysis for Biologists	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22bt20/preview
52	Biointerface Engineering	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc22bt21/preview

Note: Those who have completed the courses in the previous semesters which are mentioned in the above list are not eligible to do the same in the present Semester.

Introduction to Mechanobiology

Duration: 8 weeks
Credits: 2
Prerequisites: B.Sc/B. Tech: Biotech/Biosciences/Bioengineering MSc/M.Tech: Biotech/ Biosciences/ Bioengineering

Course layout
Week 1
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

Week 2
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

Week 3
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

Week 4
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

Week 5
Lecture 21: Adhesion Independent Migration
Lecture 22: Adhesion Independent & Collective Cell Migration
Lecture 23: Collective Cell Migration
Lecture 24: Mechanobiology of Stem Cell Fate - I
Lecture 25: Mechanobiology of Stem Cell Fate - II

Week 6
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 & Hypertension

Week 7

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 & DNA damage

Week 8

Lecture 36: Techniques in Mechanobiology: Hydrogels
Lecture 37: Techniques in Mechanobiology: AFM
Lecture 38: Techniques in Mechanobiology: Traction Force Microscopy, Trypson Deadhesion & Laser Ablation
Lecture 39: Techniques in Mechanobiology: Microfabrication
Lecture 40: Techniques in Mechanobiology: FRE

Books and references

1.Introduction to Cell mechanics and Mechanobiology, Christopher. R. Jacobs (Garland Science)
2.Cellular and biomolecular mechanics and mechanobiology, Editors: Gefen, Amit (Springer)

Introduction to Dynamical Models in Biology

Duration: 4 weeks
Credits: 1
Prerequisites: Must have studied Mathematics at 10+2 level. Have studied graduate-level Biochemistry and Molecular Biology. Knowledge of Computer Programming will be helpful but not a necessity.

Course layout
Week 1:

1. L1: Introduction to mathematical modeling in biology
2. L2: How to start modeling?
3. L3: Basic concepts of modeling using ODEs: Modeling the spread of infectious disease
4. L4: Basic concepts of modeling using ODEs: Modeling population growth
5. L5: Numerical solution of ODE-based models - I
6. L6: Numerical solution of ODE-based models - II

Week 2:

1. L1: Simulating ODE-based models: Introduction to JSim
2. L2: Simulating ODE-based models: Examples of simulation in JSim
3. L3: Steady state and stability analysis: Understanding steady state
4. L4: Steady state and stability analysis: Stability of steady states
5. L5: Phase plane analysis - I
6. L6: Phase plane analysis - II

Week 3:

1. L1: Concepts of bifurcation
2. L2: Bifurcation in Biological systems
3. L3: Modeling molecular processes in cell
4. L4: Modeling molecular processes-I: Ligand-receptor binding
5. L5: Modeling molecular processes-II: Enzymatic reaction
6. L6: Modeling molecular processes-III: Transcription and translation

Week 4:

1. L1: Modeling a signal transduction circuit: Negative feedback
2. L2: Modeling a signal transduction circuit: Positive feedback
3. L3: Modeling a signal transduction circuit: Incoherent feedforward
4. L4: Modeling transcriptional circuits – I
5. L5: Modeling transcriptional circuits - II
6. L6: Online resources for mathematical modeling in biology

Books and references

1. Mathematical Modeling in Systems Biology: An Introduction, Brian P. Ingalls, MIT Press, 2013
2. Modeling the Dynamics of Life: Calculus and Probability for Life Scientists, Frederick R. Adler, Brooks/Cole, 2012
3. Biocalculus: Calculus for Life Sciences, James Stewart, Troy Day, Cengage Learning, 2015

Conservation Geography

Duration: 12 weeks
Credits: 2
Prerequisites: Nil

Course layout
Week 1: Introduction to Conservation Geography **Week**

2: The Earth

Week 3: Lithosphere and landforms

Week 4: Atmosphere

Week 5: Hydrosphere

Week 6: Physical Geography in the Indian context **Week**

7: Biosphere

Week 8: Conservation of biodiversity

Week 9: Human population and conservation

Week 10: Resources and conservation

Week 11: Economic Geography and conservation **Week 12:**

Special topics in Geography and conservation

Books and references
1. Modern Physical Geography, Strahler & Strahler 2.
General Climatology, Howard Critchfield
3. Principles of Geomorphology, William Thornbury 4. RS-
GIS with free software, Ankur Awadhiya
5. Earth's Climate: Past and Future, William F. Ruddiman

Wildlife Ecology

Duration: 12 weeks
Credits: 3
Prerequisites: Has cleared 10+2 with science

Course layout
Week 1: Introduction

Week 2: Ecological structure

Week 3: Ecological interactions

Week 4: Ecological energetics

Week 5: Population Ecology

Week 6: Community Ecology

Week 7: Distribution & abundance

Week 8: Management of threatened species

Week 9: Human Ecology

Week 10: Ecology of change

Week 11: Applied Ecology

Week 12: Revision

Books and references
Krebs, C. J. The experimental analysis of distribution and abundance. Ecology. New York: Harper and Row.2. Odum, E. P., & Barrett, G. W. Fundamentals of Ecology. Philadelphia: Saunders.3. Selected articles / papers as referred to in the lectures.

Organic Chemistry in Biology and Drug Development

Duration: 12 weeks
Credits: 3
Prerequisites: Basic Organic Chemistry

Course layout
Week 1: Introduction, Amino Acids, Peptides and proteins

Week 2: Peptides and proteins (contd.)

Week 3: Peptides and proteins (contd.)

Week 4: Proteins as biological catalyst, Concept of inhibition **Week**

5: Nucleic acids,

Week 6: Metabolism, Synthetic biology, Molecular Biology **Week**

7: Chemistry of cofactors/coenzymes

Week 8: Principle of drug design, Modern day drug discovery **Week**

9: Chemistry of diseases and Drug development

Week 10: Chemistry of diseases and Drug development (contd.) **Week 11**:

Proton pump inhibitors, Gene replacement and delivery **Week 12**:

Revision and Problem solving

Books and references
Biochemistry by Voet and Voet
Drug Design by R. Silverman
Medicinal Chemistry by G. L. Patrick

Legal and Regulatory Issues in Biotechnology

Duration: 4 weeks
Credits: 1
Prerequisites: Bachelor degree students Prerequisite: anyone who is interested to know the legal aspects of biotechnology industry

Course layout
Week-1: Regulation of Biotechnology Research

Week-2: Intellectual Property Rights and Life sciences (Agriculture, Pharma, Biotech) **Week-**

3: Biotech Product commercialization: Regulatory Approval Process **Week-4**: Understanding

technology transfer in biotech sector

Books and references

1. Bucknell Duncan (ed.), I *Pharmaceutical,Biotechnology and Chemical Inventions* (Oxford University Press, 2011).
2. Cook M.Trevor, *Pharmaceutical Biotechnology and the Law* (Lexis Nexis , 2d ed. 2009). 3. Cook M.Trevor,*The Protection Of Regulatory Data In Pharmaceutical And Other Sectors* (Sweet and Maxwell, 2000).
4. Hardcastel Rohan, *Law and The Human Body; Property Rights, Ownership and Control* (Hart Publishing, 2007).
5. Valverde J.L. (ed.), *Key Issues in Pharmaceutical Law* (IOS Press, Vol. 9 2009). 6. Drexl Josef, Nari Lee (ed.), *Pharmaceutical Innovation, Competition and Patent Law; A Trilateral Perspective* (Edward Elgar, 2013),
7. Verkey Elizabeth, *Law of Plant Varieties Protection, 30-32* (Eastern Book Company, 1st ed. 2007).
8. Herring Jonathan, *Medical Law & Ethics* (Oxford University Press, 5th Ed., 2014). 9. Ventose Eddy, *Medical Patent law- The Challenges of Medical Treatment* (Edward Elgar, 2011).
10. Krattiger Anatole, Mahoney T. Richard, et.al., II *Intellectual Property Management in Health and Agricultural Innovation; A handbook of best practices* (MIHR, Oxford Center for Innovation, 2007). 11. Emily Jackson, Medical Law, text, cases and Materials , (Oxford University Press, 4th ed. 2013)
12. Holy F Lynch, Effy Vayena and Urs Gasser, Big data, Health Law and Bioethics, Edited by I. G. Cohen, (Cambridge University Press, 2018)

Nanomaterials and their Properties

Duration: 12 weeks
Credits: 3
Prerequisites: Knowledge of thermodynamics and atomic structure

Course layout
Week 1: Introduction, Overview of nanostructures nanomaterials

Week 2: Multiscale hierarchical nanostructures

Week 3: Thermodynamics of Nanomaterials

Week 4: Thermodynamics of Nanomaterials

Week 5: Surfaces and interfaces in nanostructures

Week 6: Surfaces and interfaces in nanostructures

Week 7: Properties of nanomaterials

Week 8: Properties of nanomaterials

Week 9: Properties of nanomaterials

Week 10: Properties of nanomaterials

Week 11: Properties of nanomaterials

Week 12: Properties of nanomaterials

Books and references
1. M. F. Ashby, P.J. Ferreira, D.L. Schodek, Nanomaterials Nanotechnologies and Design, Butterworth-Heinemann
2. Dieter Vollath, Nanomaterials: An Introduction to Synthesis, Properties and Applications, Wiley-VCH

Ecology and Environment

Duration: 8 weeks
Credits: 2
Prerequisites: Nil

Course layout
Week 1: Dr. B.S. Murty -Introduction (1), Sustainability Definition / Goals, Climate Change (2), Case Studies (3) (Eg: Dams, Chemicals, e-waste, IOT, Landfill siting etc)

Week 2: Dr. Sudhir Chella Rajan-Sustainability and Economics (3), Sustainability and Ethics (3)

Week 3: Dr. Ligy Philip-(Water Quality/ Waste Management), Water Quality and Treatment (3), Waste Management and Treatment (3)

Week 4: Dr. B. S. Murty (Water Management/ Resources), Urban Drainage, Water Resource Management, Impact of Climate Change

Week 5: Dr. Srinivas Jayanti (Energy)-Energy Demand / Resources (1), Pollution from Energy generation (1), Energy and Climate Change (Global Warming) (1), Energy and Sustainability (1), Long Range and Short Range Solutions (1) (Global vs. India)

Week 6: Dr. R. Ravi Krishna-Risk Assessment Definition (1), Pollutant Pathways / Safety/ Exposure (1), Liability /Examples (1), Life Cycle Assessment (2), Environmental Management and LCA (1)

Week 7: Dr. Sudhir Chella Rajan-Urban Planning / Sprawl (1), Challenges in Urban Planning, Transport (1), Energy (Smart Grid) (1), Waste (1), Governance (1)

Week 8: Dr. Susy Varughese / Dr. Parag Ravindran-Ecology – definitions / Systems (1), Biodiversity (1), Examples of Historical Impact of economy on Ecology, Restoration / Ecological Engineering

Week 9: Dr. Ligy Philip / Dr. Ravi Krishna -Solid Waste Management, Hazardous Waste Management

Books and references
Wrap up Emphasis on Climate Change and Adaptation

Bioreactors

Duration: 4 weeks
Credits: 1
Prerequisites: Ability to appreciate simple mathematical analysis

Course layout
Week 1: Introduction

Week 2: Two important outcomes of a bioprocess: biomass (cells) and bio-products **Week 3:**

Common bioreactor operation modes, factors that affect bioreactor performance **Week 4:** The cell

view of a bioreactor

Books and references
Shuler, M.L. and Kargi, F. 2002. Bioprocess Engineering: Basic Concepts, Prentice Hall, Englewood Cliffs, NJ J. Bailey and D. Ollis, Biochemical Engineering Fundamentals; McGraw Hill, 1986. In addition, the students would be directed to specific sources during the course – they will become available during the course on the course page.

Transport Phenomena in Biological Systems

Duration: 12 weeks
Credits: 3
Prerequisites: Undergraduate engineering mathematics

Course layout
Week 1: Introduction; Mass conservation principle

Week 2: Mass flux

Week 3: Mass flux contd.; Review

Week 4: Momentum flux

Week 5: Momentum flux contd.

Week 6: Momentum flux contd.

Week 7: Momentum flux contd.; Review; Energy (heat) flux

Week 8: Energy (heat) flux contd; Review

Week 9: Charge flux; Review

Week 10: Fluxes under simultaneous, multiple driving forces

Week 11: Fluxes under simultaneous, multiple driving forces contd.

Week 12: Fluxes under simultaneous, multiple driving forces contd.; Review

Books and references
Textbook:
Suraishkumar GK. 2014. Continuum Analysis of Biological Systems: Conserved Quantities, Forces and Fluxes. Springer, Heidelberg (e-book available free through SpringerLink if your Institution has access to it).
References:
Truskey, GA, Yuan F, Katz DF. 2009. Transport Phenomena in Biological Systems. II ed. Prentice Hall, New Jersey.
Bird, RB, Stewart, WE, Lightfoot, EN. 2001. Transport Phenomena, II edition, John Wiley and Sons, New York.

Technologies For Clean And Renewable Energy Production

Duration: 8 weeks
Credits: 2
Prerequisites: Nil

Course layout
Week 1: Introduction, characterization of coal and conventional routes for energy production from coal

Week 2: Cleaner routes for energy production form coal

Week 3: Characterization of crude oil and conventional routes for crude oil utilization **Week**

4: Cleaner routes for energy production form petroleum crude

Week 5: Cleaner energy production from gaseous fuels

Week 6: Solar and wind energy production

Week 7: Production of hydro and geothermal energy

Week 8: Energy production from biomass and wastes and energy conservation

Books and references
1.Miller Bruce G., Coal Energy Systems, Elsevier Academic Press, Paris 2005 2..Twidel, J. and Tony W., Renewable Energy Resources, Second Edition, Taylor & Francis 2006
3.Kreith F., Goswami D.Y., Energy Management and Conservation, CRC Press 2008 4.Sukhatme S., J Nayak J., Solar Energy: Principles of thermal Collection and Storage, 3 rd Ed., Tata McGrow-Hill Pulishing Company Ltd. 2008
5.Mondal P and Dalai A., Sustainable utilization of natural resources, CRC Press 2017

Principles and Practices of Process Equipment and Plant Design

Duration: 12 weeks
Credits: 3
Prerequisites: Mass Transfer, Heat Transfer, Fluid Mechanics, Process instrumentation

Course layout
Week-1: Introduction to Plant Design (2); Introduction to Mass transfer Equipment (1); Phase Equilibrium (2)

Week-2: Distillation – Fractionation (4); Design Problem (1)

Week-3: Flash Distillation (1); Batch Distillation (3); Design Problem (1) **Week-**

4: Absorption (2); Adsorption (2); Design Problem (1)

Week-5: Liquid-Liquid Extraction - 3; Column Internals – 2 [Sieve (1), Valve (1)] **Week-6**: Column

Internals contd. - Bubble Cap (2); Packed column (1); Design Problem (2) **Week-7**: Heat Exchanger:

Introduction (1); Double Pipe HE (2); S&T HE (2) **Week-8**: S&T HE contd. (1); Design Problem (1+2);

Heat Exchanger Network (1) **Week-9**: Heat Exchanger Network (3); Design Problem (2)

Week-10: Plant hydraulics: Pumps (2) Compressors (2), Pipeline (1)

Week-11: Pressure Vessels (2); Design Problem (2); Process Utilities (1) **Week-**

12: Safety (2), Process Design Package (3)

Books and references
1. Process Equipment and Plant Design - Principles and Practices", Ray. Subhabrata and Das, Gargi; ISBN: 9780128148853; 1st Edn., May 2020, Elsevier Inc.
2. Smith BD. Design of equilibrium stage processes. McGraw-Hill Companies; 1963. 3. Sinnott, R.K. and Towler, G., 2013. Chemical Engineering Design, Chemical Engineering Design.
4. Shah RK, Sekulic DP. Fundamentals of heat exchanger design. John Wiley & Sons; 2003 Aug 11.
5. Lestina, T. and Serth, R.W., 2007. Process heat transfer: Principles, applications and rules of thumb., Elsevier Ltd.

Patent Law for Engineers and Scientists

Duration: 12 weeks
Credits: 3
Prerequisites: A background degree in Science or Technology is preferable. Students who enroll for this course may also benefit from the course "Patent Drafting for Beginners"

Course layout
Week 1: Introduction to the Indian Patent System Patent Laws as Concepts; Understanding the Patents Act, 1970; Understanding the Patents Rules, 2003; Preliminary Sections; Preliminary Rules; What's New in the Patents (Amendment) Rules, 2016; Easy way to read the Patents Act and Rules

Week 2: Patentability of Inventions Statutory Exceptions to Patentability; Novelty and Anticipation; Inventive Step; Capable of Industrial Application; Person Skilled in the Art

Week 3: Patent Specification Provisional and Complete Specifications; Structure of a Patent Specification—Title, Abstract, Description, Claims, etc.; Reading a Patent Specification—Fair basis, Enabling Disclosure, Definiteness, Priority; Introduction to Patent Drafting.

Week 4: Patent Prosecution: Patent Applications Patent Application—Who Can Apply, True and First Inventor, How to Make a Patent Application,What to include in a Patent Application, Types of Patent Applications, Patents of Addition, Dating of Application;

Week 5: Patent Prosecution: Publication and Examination - I Publication of Application; Request for Examination; Examination of Application—First Examination Report

Week 6: Patent Prosecution: Publication and Examination – II Expedited Examination of Application; Search for Anticipation—Procedure, wthdrawal of Application; Consideration of Report of Examiner

Week 7: Patent Prosecution: Powers of Controller Powers of Controller—Examination Stage, Consideration of report by examiner, Refuse or Amend Applications, Division of Applications, Dating of Application, Anticipation, Potential Infringement; Putting Applications in Order; Amendments during Prosecution

Week 8: Patent Prosecution: Opposition Pre-grant opposition; Post-grant opposition; Wrongful obtaining of invention; Mention of Inventor; Opposition in General.

Week 9: Patent Prosecution: Practice at the Patent Office- I Secrecy Provisions; Grant of Patents; Rights Conferred by Grant; Rights of Co-Owners; Term of Patent; Restoration of Lapsed Patents;

Week 10: Patent Office and Patent Prosecution, Surrender; Revocation—Grounds for Revocation; Register of Patents, Patent Office and its Establishment; Patent Agents; Use and Acquisition by Government; Penalties.

Week 11: Compulsory Licensing
Compulsory Licensing—Working of Patents, Grounds for Grant of Compulsory License, Revocation; Patent Licensing;

Week 12: Patent Enforcement, International Arrangements and Other Miscellaneous Provisions
Intellectual Property Appellate Board; Declaratory Suits, Infringement Suits;

International Application—Convention Application,
PCT Application, Application Designating India, Multiple Priorities; PCT Timeline; Fees—Application, In Relation to Grant of Patents; Timelines, Application, Examination, Publication etc.

Books and references

- Feroz Ali, The Law of Patents, LexisNexis
- Ronald D. Slusky, Invention Analysis and Claiming – A Patent Lawyer's Guide, Second Edition, American Bar Association, 2012.
- Feroz Ali, The Touchstone Effect – The Impact of Pre-grant Opposition on Patents, LexisNexis, 2009.

Biomicrofluidics

Duration: 4 weeks
Credits: 1
Prerequisites: Nil

Course layout

Week 1: Introduction to Biomicrofluidics
Engineers' guide to the cell
Fluidics in living systems and mechanobiology
Pressure driven flows

Week 2: Surface tension driven flows
Modulating surface tension
Lab on a CD
Introduction to Electrokinetics

Week 3: Microfluidic cell culture
On-chip cellular assay techniques
Microfluidics for understanding biology

Week 4: Organ-on-a-chip
Lab-on-a-chip for genetic analysis
Microfluidic technology for monoclonal antibody production

Books and references
Nil

Biomedical Nanotechnology

Duration: 4 weeks

Credits: 1

Prerequisites: Basic Knowledge in biology

Course layout

Week 1: Introduction to nano, Nano-biomimicry, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterisation of nanomaterials.

Week 2: DNA nanotechnology, Protein & glyco nanotechnology, Lipid nanotechnology, Bio nanomachines, Carbon nanotube and its bio-applications.

Week 3: Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering, Nano artificial cells, Nanotechnology in organ printing.

Week 4: Nanotechnology in point-of-care diagnostics, Nanopharmacology & drug targeting, Cellular uptake mechanisms of nanomaterials, In vitro methods to study antibacterial and anticancer properties of nanomaterials, Nanotoxicology.

Books and references

1. Malsch, N.H., “Biomedical Nanotechnology”, CRC Press. (2005).
2. Mirkin, C.A. and Niemeyer, C.M., “Nanobiotechnology II: More Concepts and Applications”, Wiley-VCH. (2007).
3. Kumar, C. S. S. R., Hormes, J. and Leuschner C., “Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact”, WILEY -VCH Verlag GmbH & Co. (2005).
4. Lamprecht, A., “Nanotherapeutics: Drug Delivery Concepts in Nanoscience”, Pan Stanford Publishing Pte. Ltd. (2009).
5. Jain, K.K., “The Handbook of Nanomedicine”, Humana press. (2008).

Introduction to Biomedical Imaging Systems

Duration: 12 weeks

Credits: 3

Prerequisites: Engineering students from most core branch will be ready to take it in 6^{th}- 8^{th} semester as they would have completed signals and systems and linear algebra.

Course layout

Week 1: Introduction, 2D- Signals Systems review, Image Quality metrics **Week 2**:

Introduction, 2D- Signals Systems review, Image Quality metrics **Week 3**:

Projection Radiography

Week 4: Projection Radiography

Week 5:X-ray CT

Week 6: Nuclear Medicine- PET/SPECT

Week 7: Nuclear Medicine- PET/SPECT

Week 8: Ultrasound Imaging

Week 9: Ultrasound Imaging

Week 10: MRI

Week 11: MRI

Week 12: MRI

Books and references

1. Medical Imaging Signals and Systems by J. L. Prince and J. M. Links, Pearson Prentice Hall, 2006, ISBN 0130653535.
2. Webb's Physics of Medical Imaging, 2^{nd} Edition, CRC press

Biomechanics of Joints and Orthopaedic Implants

Duration: 8 weeks

Credits: 2

Prerequisites: Engineering Mechanics, Solid Mechanics

Course layout

Week 1: Introduction Musculoskeletal system Bone, Muscle, Ligament, Tendon, Cartilage and Meniscus – structure and function Anatomy of Synovial Joints – Hip, Knee, Shoulder, Elbow

Week 2: Biomechanics of Human Joints: (a) Hip Joint; (b) Knee Joint; (c) Shoulder Joint; (d) Elbow Joint

Week 3: Biomechanics of Gait cycle Gait Analysis Measurement techniques 3-D Motion analysis system – markers, cameras and force platform Lower extremity – hip musculoskeletal forces

Week 4: Joint Kinematics Principle of Forward and Inverse Dynamics Calculations on joint forces and moments Calculations on muscle forces Model-based estimation of musculoskeletal forces during movements

Week 5: Concepts of Stresses and Strain Bone structure - Cancellous and Cortical Bone Mechanical Behaviour of Bone
Bone Adaptation and Viscoelasticity Bone Anisotropy.

Week 6: Biomechanics of Joint Replacement – Hip, Knee, Shoulder, Spine Cemented and Cementless fixation Failure mechanisms of implants Implant Design Considerations

Week 7: Biomechanical modelling techniques and analysis Finite Element Analysis of bone and implant Bone Remodelling – formulation, algorithm, simulation Experimental validation of numerical models

Week 8: Bone Fracture Healing Tissue Differentiation Mechanoregulatory principle Mechanobiology based simulation of bone ingrowth around implants – acetabular and femoral components

Books and references

(1) "Basic Biomechanics of the Musculoskeletal System" by Margareta Nordin and Victor H. Frankel
(2) "Biomechanics and Motor Control of Human Movement" by David A. Winter (3)
“Orthopaedic Biomechanics” by D.L. Bartel, D.T. Davy and T.M. Keaveny

Neuroscience of Human Movements

Duration: 12 weeks

Credits: 3

Prerequisites: Motivation & open-mindedness is the only pre-requisite

Course layout

Week 1: Introduction, Membrane Physiology, Nernst Equation, GHK Equation, Action potential

Week 2: Neuromuscular Junction, Skeletal Muscles

Week 3: Skeletal muscles, Motor Units

Week 4: Receptors, Muscle Spindles, Golgi Tendon Organs, Spinal control Week 5:

Monosynaptic, Oligosynaptic & Polysynaptic reflexes

Week 6: Preprogrammed reactions, Spinal control, Overview of motor control system, Primary Motor cortex – Part 1

Week 7: Primary Motor cortex – Part 2, Lesions, Brain Machine interfaces **Week 8**:

Primary Motor Cortex – Part 3, Role of Cerebellum in movement control **Week 9**: Role of

Cerebellum in movement control

Week 10: Parietal & Pre-motor cortex

Week 11: Role of Basal Ganglia in movement control

Week 12: Role of Basal Ganglia in movement control

Books and references

1. Kandel & Schwartz, Principles of Neural Science, 2012, McGraw-Hill.

Current regulatory requirements for conducting clinical trials in India for investigational new drugs/new drug (Version 3.0)

Duration: 8 weeks

Credits: 2

Prerequisites: There is no pre-requisite to undertake this course. It is suitable for personnel with scientific/medical background (BSc/MSc/PhD/B Pharm/M Pharm/BAMS/BHMS/BDS/MDS/MBBS/MD/DM). Personnel working in the area of drug development/clinical trials/research may benefit from this course.

Course layout

Week 1: Lecture 0: Course overview
Lecture 1: Overview of Indian drug regulatory system
Lecture 2: Overview of drugs & cosmetics Act and Rules thereunder
Lecture 3: Overview of New Drug and Clinical Trials Rules Rules, 2019

Week 2: Lecture 4: Pre-clinical data requirements
Lecture 5: Rules governing clinical trials
Lecture 6A: Phases of clinical trial, forms, and fees
Lecture 6B: Regulatory pathway and data requirements for NDCT, 2019

Week 3: Lecture 7: BA/BE study and study centres: Legal provisions
Lecture 8: Guidelines to conduct BA/BE studies
Lecture 9: Ethics Committee registration and re-registration

Week 4: Lecture 10: Ethical considerations
Lecture 11: Good Clinical Practice
Lecture 12A: Requirements for import/manufacture of new drug/IND for conducting clinical trials in India
Lecture 12B: Requirements for import/manufacture of new drug/IND for sale/distribution and unapproved new drug for patients

Week 5: Lecture 13: Important issues
Lecture 14: Special concerns
Lecture 15: Clinical trial related guidelines (NDCT Rules)

Week 6: Lecture 16: Content of proposed clinical trial protocol
Lecture 17: Content of a clinical trial report
Lecture 18: Post marketing assessment and clinical trial compensation

Week 7: Lecture 19: Common observations during submission of CT/BA/BE protocol Lecture 20: Common observations during CT/BA/BE centre inspections Lecture 21: Drug development process: Overview

Week 8: Lecture 22: Salient feature of NDCT 2019 (What's new in NDCT?) Lecture 23A: Online submission (SUGAM)
Lecture 23B: Online submission (CTRI)
Lecture 24: Tables given in NDCT 2019 and its content

Books and references

1. Drugs & Cosmetics Act, 1940 and Rules thereunder 1945, New Drugs and Clinical Trial Rules, 2019, Related Guidance documents available at CDSCO website.

Introduction to Proteogenomics

Duration: 12 weeks
Credits: 3
Prerequisites: Nil

Course layout

Week 1: Proteogenomics overview- Part I, Proteogenomics overview- Part II, Introduction to Genomics- Part I: Gene sequencing and mutations Introduction to Genomics-Part II: Sequence alignment, Introduction to Genomics-Part III: Transcriptome, SL1: Advancement in Cancer Genomics, SL2: Advancement in Cancer Genomics

Week 2: Introduction to Genomics IV: Epigenome, Introduction to Genomics: cBioPortal, Genotype, Gene expression & Phenotype - Part I, Genotype, Gene expression & Phenotype Part II, An overview of NGS technology, SH1: NGS-Sequencing by synthesis, SH2: NGS Sequencing by synthesis

Week 3: Introduction to Proteomics, Proteomics: Sample Prep & Protein Quantification, Proteomics: Sample Prep & Protein Quantification (Hands-on), Introduction to MS-based Proteomics- Part I, Introduction to MS-based Proteomics- Part II, SL 3: Applications of NGS – Ion Torrent, SL4: Applications of NGS – Ion Torrent

Week 4: Introduction to MS-based Proteomics- Part I (Hands-on), Introduction to MS-based Proteomics- Part II (Hands-on), Data analysis: Normalization, Data analysis: Batch Correction and Missing values, Data analysis: Statistical Tests, SH3: NGS- Ion Torrent, SH4: NGS- Ion Torrent

Week 5: Machine learning and Clustering, Hypothesis testing, ProTIGY- Part I, ProTIGY- Part II, Proteogenomics approach to unravel proteoforms, SL5: Genomic Analysis using Droplet PCR, SL6: Genomic Analysis using Droplet PCR

Week 6: Workflow to Automated Data Processing, Introduction to Fire Cloud, Fire Cloud and Data Model, Bioinformatics solutions for 'Big Data' Analysis- Part I, Bioinformatics solutions for 'Big Data' Analysis-Part II, SH5: Genomic Analysis using Droplet PCR, SH6: Genomic Analysis using Droplet PCR

Week 7: Data Science infrastructure management- Part I, Data Science infrastructure management- Part II, Data Science infrastructure management- Part III, DIA-SWATH Atlas Part I, DIA-SWATH Atlas- Part II, SL7: Introduction to Targeted Proteomics, SH7: Data Analysis using Skyline

Week 8: Human Protein Atlas-Part I Clinical, Human Protein Atlas-Part II, Affinity based proteomics & HPA, Clinical Considerations for OMICS-Part I, Considerations for OMICS- Part II, SL8: Proteomics: PTMs, SL9: Clinical Proteomics

Week 9: Introduction to Proteogenomics-Part I, Introduction to Proteogenomics-Part II, Sequence centric proteogenomics, Gene Variant Analysis, Proteomics in Clinical studies, SH8: ProTIGY

Week 10: Supervised Machine learning- Predictive Analysis Part I, Supervised Machine learning- Predictive Analysis Part II, Supervised Machine learning- Marker Selection, Gene Set Analysis using WebGestalt- Part I, Gene Set Analysis using WebGestalt- Part II, SH9: Supervised Machine Learning

Week 11: Biological Network Analysis- Part I, Biological Network Analysis- Part II, Mutation and Signaling - Part I, Mutation and Signaling- Part II, Pathway Enrichment, SH10: Pathway Enrichment and Network Analysis

Week 12: Gene Set Enrichment Analysis (GSEA), Pathway enrichment: GSEA, Linked Omics, Linked Omics (Hands-on), Proteogenomics Conclusions, SL10: Topics in Proteogenomics Malaria and Cancer case study

Books and references

Proteomics: A Cold Spring Harbor Laboratory Course Manual, A.J. Link and J. LaBaer, Cold Spring Harbor Laboratory Press, 2009. Selected papers from scientific journals

Introduction to proteomics

Duration: 8 weeks
Credits: 2
Prerequisites: The target audiences of this course are required to have a basic introduction to biology.

Course layout
Week 1: Basics of Proteins and Proteomics
Lecture 1: Introduction to amino acids
Lecture 2: Introduction to Proteins
Lecture 3: Protein folding & misfolding
Lecture 4: Introduction to Proteomics
Lecture 5: Lab session – Protein-protein interaction using label-free biosensors

Week 2: Gel-based proteomics
Lecture 6: Sample preparation and pre-analytical factors
Lecture 7: Sample preparation: pre-analytical factors (contd.)
Lecture 8: Sample preparation: Protein extraction and quantification
Lecture 9: One-dimensional electrophoresis
Lecture 10: Introduction to 2-DE

Week 3: Two-dimensional gel electrophoresis (2-DE)
Lecture 11: 2-DE: Second dimension, staining & destaining
Lecture 12: 2-DE: Gel analysis
Lecture 13: 2-DE Applications
Lecture 14: 2-DE Applications (contd.) & Challenges
Lecture 15: Lab session - Protein/peptide pre-fractionation using OFFGEL FRACTIONATOR & data analysis

Week 4: Difference in gel electrophoresis (DIGE) & Systems Biology
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

Week 5: Basics of mass spectrometry
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

Week 6: Basics of mass spectrometry and sample preparation
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 & in-solution digestion
Lecture 30: Lab session - Sample preparation: tissue sample preservation technology

Week 7: Quantitative proteomics
Lecture 31: Introduction to quantitative proteomics
Lecture 32: SILAC: In vivo labelling
Lecture 33: iTRAQ: In vitro labelling
Lecture 34: TMT: In vitro labelling
Lecture 35: Quantitative proteomics data analysis

Week 8: Advancement in Proteomics
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

Books and references
Nil

Computer Aided Drug Design

Duration: 8 weeks
Credits: 2
Prerequisites: Prior knowledge of biochemistry, bioinformatics

Course layout
Week 1: Introduction to drug discovery

Week 2: Structure and property

Week 3: ADME-rules

Week 4: Force field/MM/QM

Week 5: Boundary conditions/Conformation

Week 6: QSAR/Pharmacophore

Week 7: Enzymes/proteins structures/docking

Week 8: PK/PD

Books and references
1. Voit E (2012) A First Course in Systems Biology. Garland Science, 1/e. ISBN 0815344678 2. Klipp E (2009) Systems biology: a textbook. Wiley-VCH, 1/e. ISBN 9783527318742 3. Newman MEJ (2011) Networks: an introduction. Oxford Univ. Press. ISBN 9780199206650

Drug Delivery: Principles and Engineering

Duration: 12 weeks
Credits: 3
Prerequisites: A course in biochemistry, molecular biology, anatomy is recommended

Course layout
Week 1: Pharmacokinetics: Bioavailability, Elimination, Therapeutic index **Week**

2: Prodrugs, Controlled release

Week 3: Polymers: Synthesis, properties, characterization, crystallinity and amorphousness

Week 4: Biopolymers: Natural and Synthetic, biocompatibility, Biodegradation, commonly used biopolymers

Week 5: Polymer-Drug conjugates, PEGylation

Week 6: Diffusion controlled systems, Ficks laws, Reservoir systems, non-erodible matrix systems, Bio-erodible systems

Week 7: Hydrogels: Physical or chemical, pore-size calculation, in-situ crosslinking **Week**

8: Nano and Micro-particles: Dendrimers, Liposomes, Micelles

Week 9: Metal and polymeric particles, effect of particle shape, charge and elasticity **Week 10**:

Protein Adsorption and tissue engineering, Drug delivery in tissue engineering

Week 11: Implant associated infections, Route specific delivery: Oral, Subcutaneous, Intramuscular, transdermal, inhalation, intravenous

Week 12: Vaccines, Cancer vaccines, Cell and gene delivery, Smart responsive drug delivery, Targeted drug delivery, Nanotoxicology and market translation

Books and references
1.Drug Delivery: Engineering Principles for Drug Therapy, W. Mark Saltzman, Oxford University Press, 2001
2.Drug Delivery: Fundamentals and Applications, Anya M. Hillery and Kinam Park, 2nd Edition, CRC Press, 2016

Functional Genomics

Duration: 4 weeks
Credits: 1
Prerequisites: Basic level of understanding in cell and molecular biology is expected

Course layout
Week 1: [2.5 hrs; 4 lectures]
Introduction to Functional Genomics:
Pre- and post-genomic era; major advancements in genomic approaches; epigenetics and metagenomics; forward versus reverse genetics

Week 2: [2.5 hrs; 4 lectures]
Genome Analyses - Part 1
Genome editing approaches and their applications; gene expression analyses and applications

Week 3: [3 hrs: 4 lectures and 2 tutorial sessions]
Genome Analyses - Part 2
Methods for DNA/RNA sequencing, sequence analysis and their applications

Week 4: [2.5 hrs: 3 lectures and 2 laboratory sessions]
Comparative Genomics
Genomic insight into evolution; power of comparative genomic analysis

Books and references
Mostly publically available literature. Will be shared with the participants during the launch of the course.

Maternal Infant Young Child Nutrition

Course Duration; 12 Weeks
Credits: 3

Week 1: Maternal Infant Young Child Nutrition - Introduction

Week 2: Science of nutrition

Week 3: Types of malnutrition and hidden hunger

Week 4: Importance of first 1,000 days

Week 5: Science of Breastfeeding

Week 6: Cross cradle hold and 45 points of breastfeeding counselling.

Week 7: Other breastfeeding holds

Week 8: Manual expression, storage and feeding of the expressed breastmilk. Nipple/Breast conditions

Week 9: New born care and Kangaroo mother care

Week 10: Complementary feeding

Week 11: Maternal Nutrition-pre-pregnancy pregnancy-lactating mothers Adolescent Nutrition

Week 12: Assessment of anthropometric measurement and growth charts - Percentile & Z Score

Books and references

WHO Growth Charts

Optical Spectroscopy and Microscopy: Fundamentals of optical measurements and instrumentation

Course Duration:12 weeks
Credits:3

Week 1: Essential Quantum Mechanics: Uncertainty Principle, Probabilistic nature of measurement, postulates of qmech, Stern Gerlach equivalent in light, Photon picture (PMT response), Linear Vector Space.

Week 2: Time dependent perturbation theory, Fermi Golden Rule, Transition probability in light matter interaction, Beer Lambert relation, Einstein's phenomenological treatment, A and B coefficients, Spontaneous emission, Origins of fluorescence

Week 3: Nature of Fluorescence, Emission spectrum, Absorption spectrum, Anisotropy, Life time, FRET

Week 4: Second quantization, creation and annihilation operators, Fock states, light matter interaction in Feynman diagrams

Week 5: Spontaneous emission origin, Stimulated Emission origin dependence through Fock states

Week **6**: Laser emission, two state, three state and four state laser systems

Week 7: Real world lasers, Characteristics of laser emission, threshold behavior, Laser gain equation, CW operation, Pulsed lasers, Switching, mode locking, Saturable absorber

Week 8: Laser induced fluorescence, optical components (lenses, mirrors, gratings, prisms) and their working principles, Interference filters, dichroic filters, efficiency calculations for SNR improvement, aligning an optical equipment.

Week 9: Intro to optical hardware, common opto-mechanical assemblies, setting up a simple laser-based spectrometer using gratings in lab, calibration and acquisition of fluorescein spectra.

Week 10: Principles of photo detection, QE, Dynamic range shot noise, photodetectors – PMTs, photodiodes, photo resistors, understanding common metrics and specs. Detection electronics – preamps, A2Ds

Week 11: Area detectors, CCDs, emCCDs, sCMOS, comparison, read noise, speed and other sensor characteristics. Theory of Image formations – widefield microscopy, bright field, phase contrast, DIC and fluorescence microscopy

Week 12: Scanning system: Principles of scanning system, Gaussian light progation and focusing, optical resolution, definition in xy and z. Measurement and characterization in lab. Scanning as time averaged focus, optical hinges, imaging of hinges, Confocal microscope.

Books and references

1. Optical Spectroscopy (Demtroder), Quantum Electronics – Yariv, Building Scientific Apparatus – WJ Moore.

Human Molecular Genetics

Course Duration: 4 Weeks

Credits: 1

Week 1: Fundamentals of central dogma (DNA, RNA and proteins; mutations), Chromosome structure and function (organization; structure- function relationship; chromosome abnormalities).

Week 2: Genes in pedigree (Mendelian pedigree patterns, complications to pedigree patterns), DNA cloning and hybridization techniques (vector-based cloning; nuclei acid hybridizations; PCR-based DNA analyses)

Week 3: Mutation and instability of human DNA (mutation and polymorphism; pathogenic mutations, repeat expansions), Molecular pathology (types of mutations; animal models for human disease)

Week 4: Identifying human disease genes (functional cloning versus positional cloning; mutation screening), Complex diseases; The Human Genome and HapMap projects

BOOKS AND REFERENCES

Human Molecular Genetics 4 Tom Strachan, Andrew P. Read Garland Science/Taylor & Francis Group, 2011

Demystifying The Brain

Course Duration: 4 weeks

Credits: 1

Week 1: History of neuroscience, Brain through evolution

Week 2: Neurons and neural signaling Networks that learn

Week 3: Organization of the nervous system Maps in the brain

Week 4: Memories and holograms, Emotions in the brain, Theories of Consciousness

BOOKS AND REFERENCES

1. Demystifying the brain, ebook on NPTEL.

2. Valentino Braitenberg, Vehicles.

3. VS Ramachandran, Phantoms in the Brain.Joseph LeDoux, Emotional Brain

Medical Biomaterials

Course Duration: 8 weeks
Credits: 2

Week 1: Introduction to
Biomaterials Background history
History
Properties (Mechanical and Physico chemical) Properties (Mechanical and Physico-chemical)

Week 2: Mechanical properties
Mechanical properties
Resorbability,
biodegradation
Resorbability,
biodegradation Biofilm

Week 3: Biofilm
Biofil
m
Material characterization - Analytical instruments Analytical instruments

Week 4: Analytical
instruments Analytical
instruments
Biological responses, compatibility, cytotoxicity Proteins, Tissue and blood
Response
Cell-biomaterial interaction

Week 5: Animal trials (in
vivo) Animal trials
Metals-types, classifications,
applications
Metals - properties

Week 6: Metals - properties
Metals
Polymers-types, classifications,
applications
Polymers

Week 7: Blends/composites
Biopolymer
s Hydrogels
Preparation of different morphologies (with experiments) Surface modifications (with experiments)

Week 8: Ceramics
Drug delivery systems/encapsulation
Biomaterials for
cardiovascular/pulmonary/ophthalmological

applications Biomaterials for urinary/dental/skin applications Sterilization of implants, device failures, unique issues, conclusion

Books and references NIL

Forests and Their Management

Course Duration: 12 weeks
Credits: 3

Week 1: Introduction

Week 2: Basics of silviculture

Week 3: Forest soils

Week 4: Forest mensuration

Week 5: Forest surveying

Week 6: Forest protection

Week 7: Silvicultural management - I

Week 8: Silvicultural management - II

Week 9: Logging and yield

Week 10: Silvicultural practices

Week 11: Newer trends in forestry

Week 12: Revision

Books and references

1. Principles and practices of Silviculture by S. S. Bist

2. Forest soils by Wilde

Nanotechnology in Agriculture

Course Duration: 8 weeks

Credits: 2

Week 1: History of agriculture and the role of chemicals in modern agriculture

Week 2: Overview of nanotechnology

Week 3: Application of nanotechnology in modern day agriculture practices I **Week 4:** Application of nanotechnology in modern day agriculture practices II **Week 5**: Application of nanotechnologies in animal production

Week 6: Nanotechnology and shelf life of agricultural and food products

Week 7: Nanotechnologies for water quality and availability

Week 8: Green nanotechnology and the role of good governance and policies for effective nanotechnology development**.**

Books and references

- E-Reference materials will be provided during the course

Bioelectrochemistry

Course Duration: 4 weeks

Credits: 1

Week 1: Fundamentals of electrochemistry with special references to bioelectrochemistry

Week 2: Electrodes & potentiometry

Week 3: Redox titrations

Week 4: Electro-analytical techniques

Books and references

1.Quantitative chemical analysis by Daniel C Harris

2.D. Bioelectrochemistry: Fundamentals, Applications and Recent Developments Richard C. Alkire (Editor), Dieter M. Kolb (Editor), Jacek Laskowski (Editor), Phil N. Ross (Series Editor).

Plant Developmental Biology

Course Duration: 4 weeks

Credits: 1

Week 1: Introduction: Life cycle of an angiosperm plant, Plant growth and development, Embryonic and post-embryonic development, Characteristics of plant development

Week 2: Molecular Genetics of Plant Development: Generation and characterization of developmental mutants, studying temporal and spatial expression pattern of developmental regulators, Functional genomics, Genetic manipulation of plant for studying development

Week 3: Root development: Organization and maintenance of root apical meristem, radial patterning during vascular development, Root branching; lateral root development

Week 4: Shoot development: Organization and maintenance of shoot apical meristem, Organogenesis and organ polarity, Floral transition, Floral organ patterning and determinacy, Cell-to-cell communication during development.

Books and references

1. Leyser, O. and Day, S. Mechanisms in plant development. John Wiley & Sons. 2009. 2. Howell, S.H. Molecular genetics of plant development. Cambridge University Press. 1998. 3. Taiz, L. and Zeiger, E. Plant Physiology. Sinauer Associates. 2010 5th Eds. 4. Raven, P.H. Evert, R.F. and Eichhorn, S.E. Biology of plants. Macmillan. 2005 8th Eds.

Conservation Economics

Course Duration: 12 weeks

Credits: 3

Week 1 What is Economics?

Week 2 What is Conservation?

Week 3 Modern impacts necessitating conservation

Week 4 Threats to wildlife

Week 5 How can Economics help?

Week 6 Markets: Places where Economics works

Week 7 Markets, welfare and conservation

Week 8 Public sector and conservation

Week 9 Industrial organization and conservation

Week 10 Labour market economics and conservation

Week 11 Practical issues in Economics and Conservation

Week 12 Case Studies

Books and references

1.Economics, Krugman and Wells

2.Economics, Hubbard & O'Brien

3.Principles of Economics, N. Gregory Mankiw

4.Basic Economics, Thomas Sowell

Soft Nano Technology

Course Duration: 8 weeks

Credits: 2

Week 1: Introduction to Patterning of Thin Films

Application of Nano Patterned Films and Surfaces

Basic Concepts of Wetting: Cassie and Wenzel Regimes

Basic Concepts of Surface Tension

Week 2: Different Nano Fabrication Regimes including self-assembly

Micelle formation

Introduction to Photo Lithography

Week 3: Discussion on Photo Lithography: Photo Resists

Spin Coating

Exposure

Development

Week 4: Nano Imprint Lithography

Week 5: Soft Lithography: Introduction

Different Techniques

Week 6: Soft Lithography Techniques

Week 7: Basic Concepts of Atomic Force Microscopy

Week 8: Different Imaging Modes of Atomic Force Microscopy

Books and references

1. Alternative Lithography", C. M. Sotomayor Torres (Ed.), Kluwer Academic Press, 2003. 2. Creating Micro and Nano Patterns on Polymeric Materials", A del Campo and E. Arzt (Ed), Wiley, 2011.

3. "Micro Fluidics and Micro Scale Transport Process", Suman Chakraborty (Ed), CRC Press, 2013

Understanding Design

Course Duration: 4 weeks

Credits: 1

Week 1:

Module 1- An Introduction to Design,

Module 2- Users and Context

Week 2:

Module 3-Design and Society,

Module 4 - Design and Sustainability

Week 3:

Module 5 - Design and Industry,

Module 6 - Design and collaboration

Week 4:

Module 7 - Innovation by Design

Books and references

Ansell, C & Torfing J (eds) (2014). Public Innovation through Collaboration and Design. London and New York: Routledge.

Antonelli, Paola (2005). Humble Masterpieces: everyday marvels of Design. Harper Collins Publishers.

Baxter, Mike (1995). Product Design. London Glasgow New York: Chapman & Hall. Brown, Dan M (2013). Designing Together. New Riders.

Doordan, Dennis (ed) (2000). Design History: An Anthology. Cambridge, London: MIT Press. Heskett, John (2002). Design: a very short introduction. Oxford University Press.

Geist, Valerius (1978). Life Strategies, Human Evolution, Environmental Design: towards a biological theory of health. New York, Heidelberg, Berlin: Springer-Verag

Lawson, Brian (2006). How Designer's Think: The design process demystified. Routledge.

Highmore, Ben (ed) (1975). The Design Culture Reader. London and New York: Routledge. Kepes, Gyorgy (ed) (1966). The Man-Made Object. Studio Vista London. Norman, Don (2013). The Design of Everyday Things. Hachette UK.

Papanek, Victor J (1984). Design for the Real World: Human Ecology and Social Change. Academy Chicago.

Essi Salonen Designing Collaboration Link

Gupta, Anil K, Grassroots Innovation: Minds On The Margin Are Not Marginal Minds

Link Brown Tim, Change by Design: How Design Thinking Transforms Organizations

and Inspires Innovation Link D'Source, IDC, IITBombay: http://www.dsource.in/

Design, Technology and Innovation

Course Duration: 8 weeks

Credits: 2

Week 1: i. Jaipur Foot - A classic innovation by Prof. B. K.

Chakravarthy

ii.User Centered Helmet Design by Prof. B. K.

Chakravarthy

Week 2: Challenges of Reaching a Million Users by Prof. Chetan Solanki and Prof

Jayendran V **Week 3:** i. Technology to Solution by Prof. Ramesh Singh

ii. Collaborative Excellence by Prof. B. Ravi & Prof. B. K.

Chakravarthy **Week 4:** Collaborative Innovation Methods by Prof B. K.

Chakravarthy

Week 5: Learnings from Grassroot Innovation by Prof. Anil Gupta

Week 6: Systemic Approach to Biomed Innovations by Prof. B. Ravi

Week 7: Research to Innovation by Prof. Amaresh Chakrabarti

Week 8 : Smartcane for the Blind- A Success Story by Prof. P. V. Madhusudhan Rao

Books and references

Nil

Emotional Intelligence

Course Duration: 8 weeks

Credits: 2

Week 1: Introduction to emotion, intelligence & wisdom

Week 2: Concept, theory, measurement and applications of intelligence

Week 3: Emotional intelligence: concept, theory and measurements

Week 4: Correlates of emotional intelligence

Week 5: Emotional intelligence, culture, schooling and happiness

Week 6: For enhancing emotional intelligence EQ mapping

Week 7: Managing stress, suicide prevention, through emotional intelligence, spirituality and meditation

Week 8: Application of emotional intelligence at family, school and workplace

Books and references

NIL

Exploring Survey Data on Health Care

Course Duration: 8 weeks

Credits: 2

Week 1: Introduction to Health Care Data

Week 2: Preparation for Field Survey on Health Care

Week 3: Testing of Sample Data

Week 4: Handling of Data Software

Week 5: Survey Data using STATA

Week 6: Analysis of Data

Week 7: Panel Survey Data

Week 8: Policy Evaluation of Health Care

Books and references

1.William H Greene: Econometric Analysis, Pearson 8th Edn.

2.Freedman & Pisani & Purves: Statistics 4th Edn

3.Cameron & Trivedi: Micro econometrics using STATA, Revised Edn.

4.Damodar Gujarati, Econometrics: By example, 2nd edition

5.Wooldridge: Econometric Analysis of Cross-section and Panel Data, MIT Press

6.Consoli, S; Recupero, D; Petkovic, M (2019), Data Science for Healthcare: Methodologies and applications

7.Drummond, M; Sculpher, M; Torrance, G (2005), Methods for the Economic Evaluation of Health Care Programmes

Other Readings during lecture ppts.

Material and Energy Balances

Course Duration: 12 weeks

Credits: 3

Week 1: Introduction; Units and dimensions; Basic terminologies

Week 2: Fundamentals of Material Balances; Material Balances for Single Units Without Reactions

Week 3: Material Balances for Multiple Units Without Reactions; Material Balances for Reactive Processes

Week 4: Material Balances for Reactive Processes; Combustion Reactions

Week 5: Material Balances for Systems with Recycle, Bypass, and Purge

Week 6: Energy Balance Terminologies; Introduction to Energy Balances

Week 7: Mechanical Energy Balances; Objectives and Procedures for Energy Balances **Week 8**: Energy Balances on Nonreactive Processes without Phase Change

Week 9: Energy Balances on Nonreactive Processes with Phase Change

Week 10: Mixing and Solutions; Fundamentals for Energy Balances on Reactive Processes **Week 11**: Energy Balances on Reactive Processes

Week 12: Material and Energy Balances for Unsteady State Processes

Books and references

David M. Hummable and James B. Riggs, Basic Principles and Calculations in Chemical Engineering, 7th Edition, Publisher: Prentice Hall India

Richard M. Felder and Ronald W. Rousseau, Elementary Principles of Chemical Processes, 3rd edition, Publisher: John Wiley & Sons

Pauline Doran, Bioprocess Engineering Principles, 2nd Edition, Publisher: Academic Press Ann Saterbak, Ka-Yiu San, Larry V. McIntire, Bioengineering Fundamentals, Publisher: Pearson

Bioreactor Design and Analysis

Course Duration: 8 weeks

Credits: 2

Week 1: Introduction to the course

Week 2: Design of batch bioreactors

Week 3: Design of fed-batch bioreactors

Week 4: Design of continuous mode of bioreactors

Week 5: Mass transfer in bioreactors, Rheology of fermentation broths, Heterogeneous reactions in bioprocesses

Week 6: Heterogeneous reactions in bioprocesses (contd.), Heat transfer in bioreactors

Week 7: Heat transfer in bioreactors (contd.) Scale-up of bioreactors: criteria for scale-up, scale-up parameters

Week 8: Scale-up of bioreactors (contd.), non-ideal reactors: design and analysis

Books and references

1. Michael L. Shuler and Fikret Kargi, Bioprocess Engineering: Basic Concepts, Prentice Hall, 1992 2. James M. Lee, Biochemical Engineering, Prentice Hall, 1992

3. Pauline Doran, Bioprocess Engineering Principles, 2nd Edition, Academic Press 2012 4. James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill 1986. 5. S. Liu, Bioprocess Engineering: Kinetics, Biosystems, Sustainability, and Reactor Design, Elsevier, 2016

6. Octave Levenspiel, Chemical Reaction Engineering, Wiley 2016.

Waste to Energy Conversion

Course Duration: 8 weeks

Credits: 2

Week 1 - Introduction, characterization of wastes.

Week 2 - Energy production form wastes through incineration, energy production through gasification of wastes.

Week 3 - Energy production through pyrolysis and gasification of wastes, syngas utilization.

Week 4 - Densification of solids, efficiency improvement of power plant and energy production from waste plastics.

Week 5 - Energy production from waste plastics, gas cleanup.

Week 6 - Energy production from organic wastes through anaerobic digestion and fermentation, introduction to microbial fuel cells.

Week 7 - Energy production from wastes through fermentation and transesterification.

Week 8 - Cultivation of algal biomass from wastewater and energy production from algae. **Books and references**

Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", Elsevier Store.

Young G.C., "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons. Harker, J.H. and Backhusrt, J.R., "Fuel and Energy", Academic Press Inc. EL-Halwagi, M.M., "Biogas Technology- Transfer and Diffusion", Elsevier Applied Science. Hall, D.O. and Overeed, R.P.," Biomass - Renewable Energy", John Willy and Sons. Mondal, P. and Dalai, A.K. eds., 2017. Sustainable Utilization of Natural Resources. CRC Press.

Physico-chemical processes for wastewater treatment

Course Duration: 12 weeks

Credits: 3

Week 1: Introduction to Water Pollution and Control

Week 2: Pre-treatment & Physical treatment: Flow equalization & Aeration **Week 3:** Pre-treatment & Physical treatment: Coagulation and Flocculation **Week 4**: Setting and Sedimentation & Settling Chamber Design

Week 5: Filtration & Filtration System Design

Week 6: Wastewater treatment by Adsorption & Ion Exchange

Week 7: Wastewater treatment by Membrane Based Technologies

Week 8: Advanced Oxidation Processes: Introduction

Week 9: Advanced Oxidation Processes: Fenton and catalytic treatment

Week 10: Advanced Oxidation Processes: Photo-induced processes

Week 11: Advanced Oxidation Processes: Sono- and Electro-chemical Treatment

Week 12: Case studies on wastewater treatment in various process, chemical and allied industries

Books and references

1.Weber, W.J., “Physico-chemical Processes”, Wiley Interscience, 1983.

2.Eckenfelder W.W., “Industrial Water Pollution Control”, 2nd Ed., McGraw Hill, 1999.

3.Tchobanoglous G., Burton F.L., Stensel H.D., “Metcalf and Eddy Inc.- Waste Water Engineering Treatment and Reuse”, Tata McGraw-Hill, 2017

4.Arceivala S.J. and Asolekar S.R., “Wastewater Treatment for Pollution Control and Reuse”, 3rd Ed., Tata McGraw Hill, 2007.

5.Sincero A.P. and Sincero G.A., “Environmental Engineering – A Design Approach”, Prentice Hall, 1996.

6.R.L.Droste, “Theory and Practice of Water and Wastewater Treatment”, John Wiley, 1997. 7.S. Vigneswaran and C. Visvanathan, “Water Treatment Processes: Simple Options”, CRC Press, 1995.

Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems

Course Duration: 12 weeks

Credits: 3

Week 1: Solar Energy: Basics and Concepts

Week 2: Non-Concentrating Solar Collectors

Week 3: Non-Concentrating Solar Collectors: Practice Problems

Week 4: Concentrating Solar Collectors

Week 5: Storage Systems

Week 6: Biomass types and characterization

Week 7: Biochemical conversion processes

Week 8: Biochemical conversion processes (Contd.)

Week 9: Bioconversion of substrates into alcohol and thermo-chemical conversion of biomass **Week 10:** Bioconversion of substrates into alcohol and thermo-chemical conversion of biomass (Contd.)

Week 11: Wind Energy: Basics: Turbine terms, types and theories

Week 12: Characteristics and Power Generation from Wind Energy

Books and references

(i) Sukhatme S. P., Nayak J. K., Solar Energy: Principles of thermal Collection and Storage, 3 rd Ed., Tata McGraw-Hill Education Pvt. Ltd 2008.

(ii) Twidell, J. and Tony W., Renewable Energy Resources, 2 nd Edition, Taylor & Francis 2006. (iii) Khan B. H., Non-Conventional Energy Resources, 2 nd Edition, Tata McGraw-Hill Education Pvt. Ltd. 2009.

(iv) Prabir Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier, 2013.

Biomass Conversion and Biorefinery

Course Duration: 12 weeks
Credits: 3

Week 1: Introduction: World energy scenario, consumption pattern, fossil fuel depletion and environmental issues

Week 2: Biomass: Availability and abundance, photosynthesis, composition and energy potential, virgin biomass production and selection, waste biomass (municipal, industrial, agricultural and forestry) availability, abundance and potential, biomass as energy resources: dedicated energy crops, annual crops (maize, sorghum sugar beet, hemp), perennial herbaceous crops (sugarcane, switchgrass, miscanthus), short rotation woody crops (poplar, willow), oil crops and their biorefinery potential, microalgae as feedstock for biofuels and biochemical, enhancing biomass properties for biofuels, challenges in conversion

Week 3: Biorefinery: Basic concept, types of biorefineries, biorefinery feedstocks and properties, economics

Week 4: Biomass Pretreatment: Barriers in lignocellulosic biomass conversion, pretreatment technologies such as acid, alkali, autohydrolysis, hybrid methods, role of pretreatment in the biorefinery concept

Week 5: Physical and Thermal Conversion Processes: Types, fundamentals, equipment's and applications; thermal conversion products, commercial success stories

Week 6: Microbial Conversion Process: Types, fundamentals, equipment's and applications,
products, commercial success stories

Week 7: Biodiesel: Diesel from vegetable oils, microalgae and syngas; transesterification; FT process, catalysts; biodiesel purification, fuel properties

Week 8: Biooil and Biochar: Factors affecting biooil, biochar production, fuel properties, biooil upgradation

Week 9: Bioethanol and Biobutanol: Corn ethanol, lignocellulosic ethanol, microorganisms for fermentation, current industrial ethanol production technology, cellulases and their role in hydrolysis, concepts of SSF and CBP, advanced fermentation technologies, ABE fermentation pathway and kinetics, product recovery technologies

Week 10: Hydrogen, Methane and Methanol: Biohydrogen generation, metabolic basics, feedstocks, dark fermentation by strict anaerobes, facultative anaerobes, thermophilic microorganisms, integration of biohydrogen with fuel cell; fundamentals of biogas technology, fermenter designs, biogas purification, methanol production and utilization

Week 11: Organic Commodity Chemicals from Biomass: Biomass as feedstock for synthetic organic chemicals, lactic acid, polylactic acid, succinic acid, propionic acid, acetic acid, butyric acid, 1,3-propanediol, 2,3-butanedioil, PHA

Week 12: Integrated Biorefinery: Concept, corn/soybean/sugarcane biorefinery, lignocellulosic biorefinery, aquaculture and algal biorefinery, waste biorefinery, hybrid chemical and biological conversion processes, techno- economic evaluation, life-cycle assessment

Books and references

1. Donald L. Klass, Biomass for Renewable Energy, Fuels, and Chemicals, Academic Press, Elsevier, 2006.
2. Prabir Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier,

2013. 3. A.A. Vertes, N. Qureshi, H.P. Blaschek, H. Yukawa (Eds.), Biomass to Biofuels: Strategies for Global Industries, Wiley, 2010.
4. S. Yang, H.A. El-Enshasy, N. Thongchul (Eds.), Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals and Polymers, Wiley, 2013.
5. Shang-Tian Yang (Ed.), Bioprocessing for Value Added Products from Renewable Resources, Elsevier, 2007.

Environmental Quality Monitoring & Analysis

Course Duration: 12 weeks

Credits: 3

Week 1: Introduction; Definition of Environment; Link between source/environment/receptor; Exposure; Health effects; Toxicology; Defining the need for fate and transport.

Week 2: Chemicals of concern; relevant properties for environmental fate and transport; Definition of Equilibrium – partition constants, solubility, vapor pressure, henry's constant, Koc, Kow etc. Equilibrium partitioning of chemicals between different phases of the environment.

Week 3: Parameters for environmental water/ air / soil / sediment – screening parameters, priority air pollutants – definitions of PM

Week 4: Monitoring of environmental parameters – screening parameters – BOD, COD, TOC, TDS; Environmental sampling – definition and synthesis of a monitoring/sampling/analysis method. Quality Assurance and quality control (QA/QC).

Week 5: Methods for sampling/processing/analysis of organic and inorganic constituents in air/water/soil/sediment.

Week 6: Introduction to environmental transport – BOX Models and the application to multimedia transport of pollutants

Week 7: Atmospheric Dispersion – Gaussian Dispersion model

Week 8: Fundamentals of mass transport – definition of intraphase and inter-phase chemical flux;

interphase mass transport, diffusion coefficient and convenction mass transfer coefficients. **Week 9**: Chemical Exchange between air-water

Week 10: Chemical Exchange between sediment-water

Week 11: Chemical exchange between soil-air

Week 12: Overall transport model and scenarios

Books and references

Environmental Chemodynamics - Louis J Thibodeaux, 2nd Edition, Wiley

Interscience Environmental Engineering – Peavy, Rowe and Tchobanoglous,

McGraw-Hill. Additional References:

1. Atmospheric Chemistry and Physics – Seinfeld and Pandis.

Bio photonics

Course Duration: 12 weeks

Credits: 3

Week 1: Introduction of Biophotonics

Week 2: Fundamentals of Light and Matter

Week 3: Basics of Biology

Week 4: Basics of light-matter interactions in molecules, cells and tissues

Week 5: LASERs for Biophotonics

Week 6: Bioimaging: Principles and Applications

Week 7: Optical Biosensors

Week 8: Light Activated Therapy: Photo Thermal and Photo Dynamic

Therapy **Week 9**: Tissue Engineering with Light

Week 10: Optical Tweezers, Scissors and Traps

Week 11: Nanotechnology for Biophotonics: Nano Bio Photonics

Week 12: Optogenetics & Neurophotonics

Introduction to Environmental Engineering and Science – Fundamental and Sustainability Concepts

Course Duration: 12 weeks

Credits: 3

Week 1: Sustainability Concepts – Innovations and Challenges

Week 2: Environmental Measurements from Different Disciplines

Week 3: Ecology, Population & Environmental Chemistry

Week 4: Physical Process in Environment

Week 5: Environmental Biological Concepts

Week 6: Environmental Risk Assessments with Concepts of EIA

and LCA **Week 7**: Water – Quantity and Quality

Week 8: Water Treatment Basics

Week 9: Basics of Wastewater Collection, Treatment & Resource

Recovery **Week 10**: Basics of Solid Waste, Soil and Noise

Pollution

Week 11: Basics of Air Pollution Issues – Global and Local

Week 12: Case Studies and Course Wrap-up

Books and references

1. Introduction to Environmental Engineering and Science by Gilbert M Masters and Wendell P Ela, Paperback: 696 pages, Publisher: Pearson Education India; 3rd edition, ISBN-10:9332549761, ISBN-13: 978-9332549760

2. Environmental Engineering, by Howard Peavy, Donald Rowe, and George Tchobanoglous, Paperback: 736 pages, Publisher: McGraw Hill Education; ISBN-10: 9351340260,ISBN-13: 978- 9351340263

Computational Systems Biology

Course Duration: 12 weeks

Credits: 3

Week 1: Introduction to Mathematical Modelling

Week 2: Introduction to Static Networks

Week 3: Network Biology and Applications

Week 4: Reconstruction of Biological Networks

Week 5: Dynamic Modelling of Biological Systems: Introduction, Solving ODEs & Parameter Estimation

Week 6: Evolutionary Algorithms, Guest Lectures on Modelling in Drug Development **Week 7:** Constraint-based approaches to Modelling Metabolic Networks

Week 8: Perturbations to Metabolic Networks

Week 9: Elementary Modes, Applications of Constraint-based Modelling

Week 10: Constraint-based Modelling Recap, 13C Metabolic Flux Analysis

Week 11: Modelling Regulation, Host-pathogen interactions, Robustness of Biological Systems **Week 12**: Advanced topics: Robustness and Evolvability, Introduction to Synthetic Biology, Perspectives & Challenges

Books and references

Raman K (2021) An Introduction to Computational Systems Biology: Systems-Level Modelling of Cellular Networks. 1/e ISBN 9781138597327 (Chapman and Hall/CRC)

Voit E (2012) A First Course in Systems Biology. Garland Science, 1/e. ISBN 081534467 Klipp E (2009) Systems biology: a textbook. Wiley-VCH, 1/e. ISBN 9783527318742 Newman MEJ (2011) Networks: an introduction. Oxford Univ. Press. ISBN 9780199206650

Interactomics: Basics & Applications

Course Duration: 12 weeks
Credits: 3
Week 1- Interactomics: Basics and Applications
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
Week 2- Interactomics: Basics and Applications
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
Week 3- Interactomics: Basics and Applications
Lecture11: NAPPA & its applications in study of antibody immune response in disease & in drug screening-I
Lecture12: NAPPA & its applications in study of antibody immune response in disease & in drug screening-II
Lecture13: NAPPA & its applications in study of antibody immune response in disease & 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
Week 4- Interactomics: Basics and Applications
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 Iris™ Optical QC Benefits-I
Lecture 19: Introduction to Bioprinting and Iris™ Optical QC Benefits-II
Lecture 20: Screening of autoantibody signatures in cancer patients: Lab demonstration
Week 5- Interactomics: Basics and Applications
Lecture-21: Basics of Image Scanning and data acquisition
Lecture-22: Applications of protein arrays in the identification of autoantibody signatures-I Lecture-23: Applications of protein arrays in the 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
Week 6- Interactomics: Basics and Applications
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: An overview of label-free technologies
Lecture-30: Surface Plasmon Resonance- Principles and Assays-II
Week 7- Interactomics: Basics and Applications

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
Week 8- Interactomics: Basics and Applications
Lecture-36: Use of SPR in unravelling domain motif interactions of proteasomal assembly chaperones
Lecture-37: Protein-small molecule interaction study: Immobilization & 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
Week 9- Interactomics: Basics and Applications
Lecture 41: Biomolecular interactions using Bio-Layer Interferometry (BLI)-II Lecture 42: Lab session- An introduction to Bio-Layer 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
Week 10- Interactomics: Basics and Applications
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
Week 11- Interactomics: Basics and Applications
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
Week 12- Interactomics: Basics and Applications
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

Books and references

Proteomics: A Cold Spring Harbor Laboratory Course Manual, A.J. Link and J. LaBaer, Cold Spring Harbor Laboratory Press, 2009.
Selected papers from scientific journals

Instructor bio

Data Analysis for Biologists

Course Duration: 8 weeks

Credits: 2

Week 1: Basic concepts of probability and statistics

Week 2: Basic concepts of linear algebra

Week 3: Basics of R

Week 4: Data visualization

Week 5: Correlation and regression

Week 6: Clustering and classification, Correlation and regression

Week 7: Clustering and classification

Week 8: Analysis of higher-dimensional data

Books and references

Reading materials, links for online resources, Excel files and R codes will be provided by the instructor and will be adequate enough for this course.

Reference books:

1.Whitlock, Michael C.; Schluter, Dolph. The Analysis of Biological Data (2nd edition). Freeman, W. H. & Company, 2014.

2.Yang, Zheng R.; Machine Learning Approaches to Bioinformatics. World Scientific, 2010. 3.Moses, Alan; Statistical Modeling and Machine Learning for Molecular Biology. Chapman and Hall/CRC, 2016.

4.Hartvigsen, Gregg. A Primer in Biological Data Analysis and Visualization Using R, (1st Edition). Columbia University Press, 2014.

5.Stewart, James; Day, Troy; Biocalculus: Calculus for Life Sciences. Cengage Learning, 2015 6.James, Gareth, etal. An introduction to statistical learning with application in R. Vol. 112. New York: springer, 2013.

First edition can be downloaded from the website https://www.statlearning.com/

Biointerface Engineering

Course Duration: 8 weeks

Credits: 2

Week 1: Intermolecular Forces

Week 2: Adhesion and Wetting phenomena

Week 3: Characterization of interfaces

Week 4: Protein-surface interactions

Week 5: Protein Aggregation

Week 6: Cell-surface interactions

Week 7: Surface modification and characterization

Week 8: Surface modification and characterization

BOOKS AND REFERENCES

• J. N. Israelachvili, Intermolecular and Surface Forces, 3rd edition, Academic Press, 2011. • Willem Norde, Colloids and Interfaces in Life Sciences and Bio nanotechnology, 2nd edition, CRC Press, 2011.

• W. Adamson, and A. P. Gast, Physical Chemistry of Surfaces, John Wiley, New York, 1997.

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