Chaitanya Bharathi institute of Technology (A)
Department of Biotechnology
NPTEL/SWAYAM Courses for Honours Degree in Biotechnology
R20 Regulations

S.no	Course Name	Duration	Credits	Click here to join the course
1	Introduction to mechanobiology	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc21_bt31/preview
2	Introduction to Dynamical Models in Biology	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc21_bt42/preview
3	Conservation Geography	12 Weeks	2	https://onlinecourses.nptel.ac.in/noc21_bt44/preview
4	Wildlife Ecology	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_bt45/preview
5	Organic Chemistry in Biology and Drug Development	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_cy30/preview
6	Legal and Regulatory Issues in Biotechnology	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc21_lw04/preview
7	Nanomaterials and their Properties	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_mm38/preview
8	Ecology and Environment	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc21_ge16/preview
9	Bioreactors	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc21_bt28/preview
10	Transport Phenomena in Biological Systems	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_bt40/preview
11	Technologies For Clean And Renewable Energy Production	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc21_ch42/preview
12	Principles and Practices of Process Equipment and Plant Design	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_ch52/preview
13	Patent Law for Engineers and Scientists	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_hs71/preview
14	Biomicrofluidics	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc21_bt24/preview
15	Biomedical nanotechnology	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc21_bt30/preview
16	Introduction to Biomedical Imaging Systems	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_bt50/preview

17	Biomechanics of Joints and Orthopaedic Implants	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc21_me130/preview
18	Neuroscience of Human Movements	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_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/noc21_ge25/preview
20	Introduction to Proteogenomics	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_bt25/preview
21	Introduction to proteomics	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc21_bt26/preview
22	Computer Aided Drug Design	8 Weeks	2	https://onlinecourses.nptel.ac.in/noc21_bt29/preview
23	Drug Delivery: Principles and Engineering	12 Weeks	3	https://onlinecourses.nptel.ac.in/noc21_bt37/preview
24	Functional Genomics	4 Weeks	1	https://onlinecourses.nptel.ac.in/noc21_bt39/preview

Note:

1. Students can secure minimum 4 credits in each semester(It is not mandatory but just for the convenience of students so that they can secure 20 credits before seventh semester)

2. Students cannot choose the courses they have studied as part of the regular curriculum (160 credits).

3. In case, an elective match with the subjects given in the above list, student can choose such subject only when he/she has not opted that elective in regular curriculum

4. In case, NPTEL is not offering any course listed above, BoS chairman can suggest an alternative course being offered by NPTEL during that time

5. The list of courses will be updated time to time based on the courses announced by NPTEL and same will be informed to the students before deadline by the concerned faculty coordinators

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 (CEG -I)

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 (CEG -II)

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 (CEG -II)

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 (CEG -III)

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 (CEG -III)

Duration: 12 weeks

Credits: 3

Prerequisites: Engineering students from most core branch will be ready to take it in 6th-8th 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, 2nd Edition, CRC press

Biomechanics of Joints and Orthopaedic Implants (CEG -III)

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 (CEG -III)

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) (CEG -III)

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

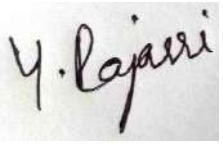
Course layout
Week 1: [2.5 hrs; 4 lectures]
Introduction to Functional Genomics:
Pre- and post-genomic era; major advancements in genomic approaches; epigenetics and metagenomics; forward versus reverse genetics

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.



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