Integrated M.Sc./ M.Tech (Five/Six year) Biotechnology Syllabus

COURSE	TITLE	CREDITS
SEMESTER I		
IBT-101T	Fundamentals of Physics I	4
IBT-102T	Fundamentals of Chemistry I	4
IBT-103T	Mathematics and Statistics I	4
IBT-104T	Living World	2
IBT-105T	Microbial World	2
IBT-121P	Laboratory Exercises in Physics I	3
IBT-122P	Laboratory Exercises in Chemistry I	3
IBT-123P	Laboratory Exercises in Biology I	3

SEMESTER II		
COURSE	**TITLE**	**CREDITS**
IBT-201T	Fundamentals of Physics II	4
IBT-202T	Fundamentals of Chemistry II	4
IBT-108T +P	Introduction to Computers	2
IBT-206T	Biomolecules	2
IBT-207T	Mathematics and Statistics II	2
IBT 212T	Microbial growth and control	1
IBT-221P	Laboratory Exercises in Physics II	3
IBT-222P	Laboratory Exercises in Chemistry II	3
IBT-223P	Laboratory Exercises in Biology II	4

SEMESTER III

COURSE	TITLE	CREDITS
IBT-301T	Fundamentals of Electronics and Instrumentation	4
IBT-302T	Organic Chemistry: Stereochemistry and Reaction Mechanisms	2
IBT-303T	Spectroscopy of Bio-Organic Compounds	2
IBT- 306 T	Microbial, Plant and Animal Biodiversity	3
IBT-305T	Mathematical & Statistical Methods	2
IBT-208T +P	Introduction to Computational Laboratory	4
IBT-209T	Principles of Molecular Biology	2
IBT-321P	Laboratory Exercises in Physics III	2
IBT-322P	Laboratory Exercises in Chemistry III	2
IBT-323P	Laboratory Exercises in Molecular Biology & Microbial Biodiversity	2

SEMESTER IV

COURSE	TITLE	CREDITS
IBT-204T	English	2
IBT-401T	Modern Physics I	3
IBT-403T	Spectroscopy and Physical Organic Chemistry	2
IBT-405T	Techniques in Molecular Biology	2
IBT-205T	Cellular Basis of Structure and Function in Biology	2
IBT-304T	Microbial Genetics	2
IBT-307T	Biochemical and Biophysical Techniques	3
IBT106 T+P	Histochemistry and Cytochemistry	4

IBT-421P	Laboratory Techniques in Molecular Biology	3
IBT-328P	Laboratory Exercises in Cell Biology and Microbial Genetics	2
IBT-324P	Practical Applications in Biochemical and Biophysical Techniques	2

SEMESTER V

COURSE	TITLE	CREDITS
IBT-402T	Modern Physics II	2
IBT 308T	Introductory Enzymology	2
IBT-314T	Introduction to Developmental Biology	2
IBT 406T	Microbial Biotechnology I	2
IBT-404T	Genetics of Higher Organisms	2
IBT 107T	Seminars	1
IBT 325P	Laboratory Exercises in Enzymology	2
IBT 422P	Laboratory Exercises in Microbial Biotechnology	2
IBT 328 P	Laboratory Exercises in Developmental Biology	2
IBT 513T +P	Basic Separation Techniques in Biology	3
IBT 212 T+P	Project Work	2

Optional courses in Physics/Electronics/Biology/Biochemistry/Chemistry,

IBT511 T+P	Structure of Macromolecules & Energetics I	4
IBT 515T	Introduction to Nano-technology	4
IBT 516 T	Transport Properties of Biological membrane	2
IBT-413T	Internal motion in molecules and Statistical Thermodynamics	2
IBT-414T	Bio-physiology	3
IBT-415T	Light and Optics	3

SEMESTER VI

COURSE	TITLE	CREDITS
IBT 517 T	Heterocyclic Chemistry of Bioorganic Compounds	2
IBT 210T	Fundamentals of Immunology I	2
IBT 309T	Bioinformatics I	2
IBT 408 T	Microbial Biotechnology II	2
IBT 409 T	General Aspects of Plant Biotechnology	2
IBT 213 T	Seminars	2
IBT 326P	Lab Exercises in Bioinformatics	2
IBT 212 T+P	Project	4
IBT 224 P	Techniques in Immunology I	2
IBT 423P	Lab Exercises in Microbial Biotechnology II	2

Optional courses in Physics/Electronics/Biology/Biochemistry/Chemistry

IBT611T	Structure of Macromolecules & Energetics II	2
IBT612T	Interface of Biology & Chemistry: Interaction of Biomolecule	2
IBT 613T	Nanotechnology Principles	4

SEMESTER VII

COURSE	TITLE	CREDITS
IBT-407T	Metabolic Pathways	2
IBT 602T	Recent Developments in cell and molecular biology	4
IBT 310 T	Fundamentals of Immunology II	2
IBT 503T	Basic aspects of Plant tissue culture	2
IBT311T	Introduction to Animal cell culture	2
IBT214T	Basics in Virology	2

IBT312T	Seminars in Contemporary Biotechnology	2
IBT 411 T+P	Bioinformatics II	4
IBT621P	Lab Techniques in Cell and Molecular Biology	4
IBT521P	Basic techniques in Plant Tissue culture	1
IBT 225 P	Laboratory Exercises in Virology	2

Optional courses

IBT 514 T+P	Mathematical Modeling in Biology I	4

SEMESTER VIII

COURSE	**TITLE**	**CREDITS**
IBT 501T	Genomics	2
IBT 502T	Nucleic acid protein chemistry	2
IBT504T	Applications of Biotech in Environment	2
IBT 601T	Genetic Engineering	4
IBT603T	Enzyme Technology	2
IBT604T	Applications of Plant Tissue culture	2
IBT313T	Trends in Biotechnology (Review writing)	3
IBT623P	Laboratory Exercises in Plant Tissue culture	3
IBT624P	Laboratory Exercises Enzyme Technology	2
IBT 522P	Laboratory Exercises Environmental Biotechnology	2
IBT 622P	Laboratory Exercises in RDT	4

Optional Course

IBT 614 T+P	Mathematical Modeling in Biology II	4

SEMESTER IX

COURSE	**TITLE**	**CREDITS**
IBT- 605 T+P	Understanding Genomes	4
IBT-701 T	Fermentation Technology and Downstream Processing	4
IBT-702 T	Applications of Plant Biotechnology	2
IBT- 703T	Vaccines	2
IBT -801T	Biotechnology : Industry, Infrastructure and Human Resource Development	5

IBT-721 P	Laboratory Exercises in Fermentation Technology and Downstream Processing	4
IBT-722P	Laboratory Exercises in Plant Biotechnology Applications	1
IBT-723P	Project	5

Optional Courses (select any one)

IBT-704T	Molecular Medicine and Diagnostics	2
IBT-705T	Drug design and Targeting	2
IBT-706T	Natural Products and Medicinal Chemistry	2

SEMESTER X

COURSE	TITLE	**CREDITS**
IBT-723P	Project	25

M.Tech Programme 50 credits

SEMESTER XI and SEMESTER XII	**CREDITS**
Research proposal writing	5
Review writing	5
Management in Biotechnology	2
Research and Development	38

Semester I

IBT 101T Fundamentals of Physics I 4 credits

Vectors and Co-ordinate frames. Revision of basic vector concepts such as vectors in 3-D Cartesian co-ordinate systems and vector algebra. Concept of inertial frame and Newton's laws of motion and applications (friction, laws of friction, projectile motion and uniform circular motion), Work and Energy, Potential and Kinetic energy, conservation laws of momentum and energy, non-conservative forces. 20L

Rotational motion – rotational variables, kinetic energy of rotation, rotational inertia, torque, Newton's second law of angular motion, conservation of angular momentum. System of particles, center of mass, laws of motion, systems with variable mass such as one stage rocket, Rigid body, its Kinetic energy, torque equation, angular momentum conservation, precession of top (elementary). 20L

Law of gravitation, Kepler's laws, Oscillatory motion, Free harmonic oscillations, damped harmonic motion, forced oscillations and resonance, Concept of temperature and its measurement, heat and work, First law of thermodynamics, Second law of thermodynamics Carnot engine and cycle, isothermal and adiabatic processes, enthalpy and concept of entropy. 20L

References:

1. University Physics By F W Sears
2. Fundamentals of physics by Haliday, Resnick and Walke
3. Lecture series by Feynman.
4. Physics by Catnell and Johnson
5. Principles of Physics : H.C. Verma

IBT 102T Fundamentals of Chemistry I 4 credits

1. Atomic structure – concept of orbitals, aufbau principle, periodic trends in atomic properties, atomic spectra 20L

2. Molecules: PE diagram, diatomic molecules, valence bond theory, hybridization, VSEPR theory, linear combination of atomic orbitals, homo and heteronuclear molecules, bond orders, magnetic properties, polyatomic molecules 20L

3.Periodic table –groups and periods, s and p block elements, transition metals, d orbitals splitting in octahedral, tetrahedral and square planar environment – spectral and magnetic properties. 20L

References:

1. Physical Chemistry-A molecular approach by Mcquairee and Simon
2. Physical Chemistry by G M Barrow
3. Concise Inorganic Chemistry by J D Lee
4. Inorganic Chemistry by Shriven and Atkin

IBT 103T Mathematics & Statistics I 4 credits

Mathematics (30 L) 2 credits

Refreshing course on Sets & symbolic logic, Power functions & polynomials, integration & differentiation, periodic functions and conversion of different co-ordinate system.

Matrices and determinants: addition of matrices, multiplication of scalars, transpose of a matrix, system of linear equations, inverse of a matrix. Eigen values and eigen vectors.

Vector differential calculus: curves, arc length, tangent, curvature, velocity & deceleration, directional derivative, transformation of coordinate systems and vector components, divergence and curl of vector field.

Relations & Functions: Linear, periodic, logarithmic, exponential, Quadratic functions. Mapping & Cartesian product. Their application in Biology.

Partial differential equations: Introduction to partial derivatives & Ordinary Differential Equation of the first order.

Graphical representations: Linear scales, nonlinear scales, Semilogarithmic, triangular, nomography, pictoral presentations

Statistics (30L) 2 credits

Probability Theory, Probability Distributions. Sample mean, Sample variance, mean and variance of a distribution, random numbers, random sampling.

Probability Distributions: Applications of probability and standard distributions, estimation, standard error and confidence interval, t-tests, F-test, single tail & double tail.

Confidence intervals, acceptance of sampling, goodness of fit, pairs of measurements, fitting straight lines, curves, polynomials etc.

The scope of statistics in biological data analysis.

References:

1. Biostsistics:: A foundation for analysis in Health Science. 7 th Edition Wayne Daniel
2. Fundamental and University Mathematics by Colin McGregor
3. Statistical methods in Biology by Norman Bailey
4. Biostatistics by Striecke
5. Mathematical models in biology by Allama
6. Engineering Mathematics- M-1, M-2, M-3
7.Advanced Engineering Mathematics : Kreyzig
8.Introduction to Mathematics for Life Scientists by Edward Batschalet, Springer
9. Mathematics for the Biological Sciences by J.C. Acharya and R. Lardner, Prentice Hall

IBT 104T Living World 2 credits

Origin of life: primordial soup, bioelements, biomolecules, importance of water, Cell as the unit of life, development of cell theory, cell types: prokaryotes vs. eukaryotes; from single cell to multi-cellular organism 5L

Cell and cell organelles- ultra structure of animal and plant cells 15L

Concepts of multicellualrity, cell- cell interactions in plants and animals, tissue level, organ level organization in plants and animals 10L

References:

The world cell by Wayne M. Becker Author.
Molecular cell biology by Harvey Lodish Author
Human molecular genetics by Tom Strachan Author
Essential cell biology second edition by Bruce Alberts Author
Essential Developmental Biology Second Edition by J M W Slack

IBT 105T Microbial World 2 credits

Introduction to the microbial world	2L
History and scope of microbiology	2L
Microbial diversity	2L
Morphological features of microbes	6L
Cultivation of microbes (media and techniques)	6L
Archaeabacteria	2L
Virus and bacteriophages	2L
Fungi	1L
Useful and harmful activities of bacteria	7L

References:

1.Black, J.G. (2005) Microbiology Principles and Explorations 6th edition John Wiley and Sons Inc.
2.Deacon, J. (2007) Fungal Biology. Blackwell Publishing.
3.Flint S.J., Racaniello,V.R., Enquist L.W., Skalka, A.M., Krug, R.M. (2000) Virology Molecular Biology, Pathogenesis and Control. ASM Press.
4.Pelczar M.J.Jr. Chan E.C.S., Kreig (2006) Microbiology 5 th edition Tata McGraw Hill.
5.Perry, J.J., Staley, J.T., Lory, S., (2002) Microbial life Sinauer Associates Publishers.
6.Schaechter, M., Ingraham J.L., Neidhardt, F. (2006) Microbe ASM press
7.Madigan, M.T., Martinc J.M., Parker, J.Brock Biology of Microorganisms

IBT 121 P Laboratory Exercises in Physics I 3 credits

Moment of inertia of flywheel
Moment of inertia of disc – torsional pendulum
Log decrement in air and water
'g' by resonance pendulum
Determination of frequency of A.C
Viscosity of liquid by continous flow
Velocity of sound by resonance tube
Thermal conductivity – Lee's method
Surface tension – Jaeger's method (temperature variation)

Surface tension – Capillary rise method (concentration variation)
'γ' by bending – metal and wood
'γ' and 'η' by flat spring spiral

IBT 122 P Laboratory Exercises in Chemistry I 3 credits

Determine stability constant of ferrisalicylate complex by colorimetric measurements
Investigate the conductrimetric titration of oxalic acid with standard NaOH solution
Determine the concentration of KCI solution by titrating it with standard $AgNO_3$ conductometrically.
Investigate basic hydrolysis of ethyl acetate by conductivity measurements.
Determine simultaneously dichromate and permangnate ions in the given acid solution by colorimetric measurements
Determine the concentration of KCI solution by titrating it with standard $AgNO_3$ conductometrically
Study the hydrolysis of an ester in presence of hydrochloric acid
To determine the hydrolysis constant of aniline hydrochloride by pH measurements.
Determine redox potential of Fe^{2+} / Fe^{3+} systems by titrating it with standard $K_2Cr_2O_7$ solution.
Determine the viscosity of a given liquid by Oswald's viscometer.
12. Techniques like recrystallization, distillation, sublimation, TLC

IBT 123 P Laboratory Exercises in Biology I 3 credits

Introduction to microscopy and stains
Use of heamocytometer and cell count
Plant cell types
Plant cell organelleles
Memebrane permeability
Osmosis
Pinoocytosis
Concept of sterility
Preparation of media
Gram staining and morphology of bacteria
Staining techniques in bacteria

Semester II

IBT 201T Fundamentals of Physics II 4 credits

Fluids at rest, pressures within fluids, upthrust, Archimedes' principle, Surface phenomena. Fluid dynamics, streamlines,Bernoulli's equation and its applications. Viscosity, Reynold's number, Turbulence.

Revision of electrostatics, Applications of Gauss law for various symmetric situation, electric potential equipotential surfaces, dipole, potential calculation in simple cases. Ohmś Law, Biot-Savart Law, Ampere's law and its applications, Lorentz force, cyclotron motion, magnetic force on a current carrying wire, Torque on a current.

Faradays law of induction, Lenz's law, induction and induced electric field, Alternating current induction (self and mutual), L-R, C-R and L-C-R circuits, resonance energy stored in inductance and capacitance.

Maxwell's modification of Ampere's law, displacement current, qualitative discussion of traveling electromagnetic waves, energy transport, Poynting vector, radiation pressure and polarization.

References:

1. University Physics By F W Sears
2. Fundamentals of physics by Haliday, Resnick and Walke
3. Lecture series by Feynman.
4. Physics by Catnell and Johnson
5. Principles of Physics : H.C. Verma

IBT 202T Fundamentals of Chemistry II 4credits

1. Kinetics- order and molecularity of a reaction, differential and integrated rate equations, rate equations for reversible, parallel and consecutive reactions, steady state approximation, rate determining step and reaction mechanisms from SSA, temperature dependence of reaction rates, collision theory-basics of absolute reaction rate theory, Eyring equation, thermodynamic aspects, reactions in solutions, enzyme catalysis, auto catalysis 15 L

2. Adsorption, chemisorption, adsorption isotherms 4L

3. Thermodynamics – second law of thermodynamics, entropy, spontaneous change, free energy, enthalpy, adiabatic demagnetization, reactions at equilibrium, interpretation of equilibrium constants, acid and bases, solubility equilibria, biological activity, thermodynamics of ATP 15 L

4. Electrochemistry – electrochemical cells, half cell reactions, reduction potentials, the electrochemical series, thermodynamic functions from cell potential measurements, liquid junction potentials, Debye Huckel Theory, over voltage 12 L

5. Classification of organic compounds: nomenclature structural and constitutional isomers, functional group chemistry (alcohols, aldehydes, ketones, esters, amines, amides etc.) 14 L

References:

1. Physical Chemistry by P W Atkins
2. Physical Chemistry by Venullapalli
3 Physical Chemistry for life sciences and biosciences by R Chang
4. Organic Chemistry by R T Morrison and R N Boyd (2006)
5. Organic Chemistry by P Y Bruice (2006)

IBT 203 T+P Introduction to Computer Science 2 credits

Theory

Introduction
History and generation of computers
Structure of a computer
Computer operation: keyboard, mouse, screen, printer, and other I/O devices
Operating systems: introduction e.g., Linux, Windows
System handling, system commands and utilities
File formats and directory structure
Data organization on a computer
Glossary of important terms

Practicals

Hands-On experience and regular usage: Tutorials (Typing, Windows 98/XP, Internet, Unix (LINUX), etc), applications and utilities of Windows 98/XP, Browsers (I.E., Netscape), surfing the Internet, Search Engines, using E-Mail/Web mail, ftp

Basic Unix commands

Searching/Surfing on the WWW

Word Processing (Microsoft Word): Creating, Saving & Opening a document, Editing, Inserting, Deleting, Formatting, Moving & Copying Text, Find & Replace, Spell Checker & Grammar Checker (Thesaurus), Document Enhancement (Borders, Shading, Header, Footer), Printing document (Page layout, Margins), Introduction to the use of Wizards & Templates, Working with Graphics (Word Art), Working with Tables & Charts, Inserting Files (Pictures, Databases, Spreadsheets)

Spreadsheet Applications (Microsoft Excel): Worksheet Basics (Entering information in a worksheet, Saving & Opening a worksheet, Editing, Copying & Moving data, Inserting, Deleting & Moving Columns & Rows, Clearing Cells & Formatting cells), Working with workbooks, Working with formulae and functions, Printing worksheets, An introduction

to the use of advanced spreadsheet concepts, Database Management (Sorting records, Finding records, Adding & Deleting records, Filtering records in a worksheet), Working with Macros, Creating and using multiple worksheets

Database Applications (Microsoft Access): Fields, Records, Files, Organization of Files, Access Modes; Database, Relational Database; Primary and Secondary Key, Working with databases & tables, Creating a Database, Appending, Updating Records Querying, Reports, Forms and sub forms, Sorting, Filters, An introduction to use of Macros, Modules, Wizards with database applications

Creation of Computer Presentations with graphics (Microsoft Power Point): Creation of slides, Rapid Presentation design using wizards, Inserting graphs & charts Action buttons, Transitions, Build and Animation effects

Introduction to Multi-Media Tools & Devices

References:

1. Introduction to Computers by A. Leon and M. Leon, Vikas Publishing House.
2. Fundamentals of Computers by Rajaraman V., PHI.
3. Computers Today by Sanders D. H., McGraw Hill.
4. Computer Architecture and Organizations by J. P. Hayes, Mc Graw Hill.
5. Modern Digital Electronics by R. P. Jain, Tata Mc Graw Hill.
6. Computer Network by Andrew S. Tanenbaum, PHI.
7. Inter Networking With TCP/IP: Principles, Protocol And Architecture by D.E. CornerVol1,

IBT 212T	**Growth and control of microbes**	**1C**
Characteristics of bacterial growth		2L
Methods of measurement of growth		4L
Population growth, growth curves, diauxic growth		2L
Continuous cultures		2L
Control of microbial growth		5L

Reference :

1. Black, J.G. (2005) Microbiology Principles and Explorations 6th edition John Wiley and Sons Inc.
2.Pelczar M.J.Jr. Chan E.C.S., Kreig (2006) Microbiology 5 th edition Tata McGraw Hill.
3.Perry, J.J., Staley, J.T., Lory, S., (2002) Microbial life Sinauer Associates Publishers.
4.Schaechter, M., Ingraham J.L., Neidhardt, F. (2006) Microbe. ASM press
5.Madigan, M.T., Martinc J.M., Parker, J.Brock Biology of Microorganisms (Pearson prentice Hall)

IBT 206 T **Biomolecules** **2credits**

1.	Introduction /overview	2L
2.	Water and Intermolecular Forces	2L
3.	Thermodynamics in Biochemistry	2L
4.	pH, acids bases and Buffers	3L
5.	Amino Acids	2L
6.	Peptide Bonds and Introduction to Proteins and Ramchandran plot	3L
7.	Sugars and Polysaccharides	2L
8	Glycoproteins and Proteoglycans	1L
9	Lipids	2L
10	Membranes	2L
11	Membrane Proteins	1L
12	Nucleosides and Nucleotides	1L
13	Primary Structure of Nucleic Acids	5L
14	Vitamins, Coenzymes and other small molecules	2L

Reference

1. Garrett & Grisham, Biochemistry, Saunders Publishing,
2. Voet and Voet. Biochemistry, second edition, Prentice-Hall,
3. Lehninger, Nelson and Cox. Principles of Biochemistry
4. Zubay. Biochemistry
5. Mathews, van Holde and Ahern. Biochemistry
6. Stryer, Biochemistry

IBT 207 T **Mathematics and Statistics II** **2 Credits**

Mathematics (15L) **1 credit**

Line integrals - evaluation, double integrals, surfaces, surface integrals, triple integrals, Stoke's theorem. Complex number and analysis.

Statistics (15L) **1 credit**

Frequency distributions and associated statistical measures.

Statistical design of experiments for clinical and laboratory data; random allocation, methods of allocation without random numbers. Volunteered bias. Cross over designs. Selection and distribution of experimental unit.

Testing of hypotheses: Correlation and Regression. Analysis of Variance & covariance.

Problem oriented approach to illustrate application of Statistical methods and computer aided inference.

References:

1. Biostsistics:: A foundation for analysis in Health Science. 7 th Edition Wayne Daniel
2. Statistical methods in Biology by Norman Bailey
3. Biostatistics by Striecke
4. Mathematical models in biology by Allama
5.Engineering Mathematics- M-1, M-2, M-3
6. Advanced Engineering Mathematics : Kreyzig
7. Fundamental and University Mathematics by Colin McGregor
8.Introduction to Mathematics for Life Scientists by Edward Batschalet, Springer
9. Mathematics for the Biological Sciences by J.C. Acharya and R. Lardner, Prentice Hall

IBT 221 P Laboratory Exercises in Physics II 3 credits

Temperature coefficient of resistance
LR circuit – determination of power factor
Characteristics of solar cell
Verification of Kirchoff's laws
Characteristics of semiconductor diode
Study of multimeter
Hystersis
CR circuit – Determination of time constant
Characteristics of photo cell
LCR circuit – Study of resonance
Diode as rectifier
Characteristics of transistor

IBT 222 P Laboratory Exercises in Chemistry II 3credits

1.Standardization of NaOH
Potentiometery
pH metery - I
pH metery - II
Kinetics
Colorimetery
Phase rule
Conductometery
Preparation of 2,4 Dinitrophenylhydrazine derivative of carbonyl compounds
Preparation of acetyl derivative
Column Chromatography

IBT 223 P Laboratory Exercises in Biology II 4 credits

Measurement of pH
Estimation of carbohydrates
Estimation of proteins
Molar extinction coefficient of molecules
Extraction and estimation of lipids
Direct microscopic counts
Total viable counts
Tubidimetric measurement of growth
Methods of isolation of bacteria and fungi
Control of microbial growth
Determination of MIC (plate method)

Semester III

301T – Fundamentals of Electronics and Instrumentation 3 credits

Electronics

1. What is signal? Characteristics of electrical signal. Input output relations, simple electronic devices such as resistor, capacitor, inductor, bias voltage. Simple circuits used for amplifications, power supplies and wave shaping circuits, concept of amplification, input/output impedance, impedance

matching, bandwidth, selection, fidelity, types of amplifiers, OP-Amp and its characteristics, simple applications (adder, subtracter, integrator, differentiator), filters.

2. Digital electronics, number systems, binary codes, Boolean algebra, arithmetic operations, logic functions, combinational and sequential logic, different OR, AND, NOR, NAND, EXOR gates, flip flops and registers.

Instrumentation

1. Sensing elements: electrodes and transducers. Electrode-electrolyte interface, stability of electrode potentials, circuit models, external and internal electrodes, pH, pO_2 and pCO_2 electrodes. Transducer, definition, types, displacement velocity, acceleration, pressure, temperature vibration, ultrasound etc., calibration, sensitivity and resolution.

2. Interfacing A to D converters, amplification, storage and analysis methods and principles. Signals, periodic, aperiodic, principles of imaging techniques and applications.

References:

1. Digital Electronics by R.K.Jain

IBT 302T Organic Chemistry:Stereochemistry and Reaction Mechanisms 2credits

1. Stereochemistry of organic compounds 12L

Conformational, constitutional isomers, stereoisomers, isomers with one chirality centre, more than one chirality centre, separation of stereoisomers

2. Reaction mechanisms in organic chemistry- substitution and elimination reactions
S_N1, S_N2, S_Ni, E1, E2, E1cb reactions 18 L

References:

Stereochemistry of organic compounds by E L Eliel and S H Wilen (2005)
Organic Chemistry by R T Morrison and R N Boyd (2006)
Organic Chemistryby byJ Clayden, N Greaves, S Warren, P Wothers, First edition
Advanced Organic Chemistry, Wiley Publication
Organic Chemistry, Solomon
Spectrometric Identification of Organic Compounds : Silverstein
Intoduction to Spectroscopy : Pavia and Lampman

IBT 303T Spectroscopy of Bio-organic Compounds 2 credits

Structure elucidation of organic molecules
Ultraviolet-visible spectroscopy, solvent effects, Woodward rules
Infra-red spectroscopy, infrared absorption bands, shapes of absorption bands and intensity of absorption bands.
Mass spectrometry, mass spectrum, fragmentation patterns, isotopes in mass spectrometry

References:

Spectrometric Identification of Organic compounds by R M Silverstein and F X Webster, Sixth edition (2002), Wiley

Introduction to Spectroscopy by D Pavia, G Lampman, G Kriz, Second edition (1996), Saunders Golden Sunburst Series

Organic Chemistry by R V Hoffman (1997), Oxford University Press

Spectroscopy, by I Fleming

Organic Structure Analysis by P Crews, J Rodriguez, M Jaspars, (1998), Oxford University Press

IBT 306 T Microbial, Plant & Animal Biodiversity 3credits

1. Criteria of taxonomy :
   Kingdoms, Binomial, Hierarchies Morphological, Biochemical and Molecular Criteria 6L

2. Microbial ecosystems and effect of environmental factors 2L
   Microbiology of specific environments 3L
   Plant microbe interactions 3L
   Animal microbe interactions 3L
   Specialized groups of microbes 4L
3. Plant kingdom
   Major groups, Ecosystems & niche, Environmental pressures, adaptation and association. Evoluationary trends and global distribution Anthropological, and natural impact. 10L
4. Animal kingdom
   Major groups, Zoogeographical distribution and environmental adaptation, Manmade and natural factors; Inter and Intra – specific relationships, inter relationships between Microbes, Plants and Animal is a vis – ecosystem. 8L
5. Concept of conservation. 5L

References:

Madigan, M.T., Martinc J.M., Parker, J.Brock Biology of Microorganisms

A textbook of Algae by Sambamurth

A textbook of Bryophytes,Pteridophytes, Gymnosperms and Paelobotany by Sambamurth

IBT 305T Mathematical & Statistical Methods 2 credits

Mathematics:

Exactness and integrating factors, variation of parameters. Ordinary linear differential equations of n-th order, solution of homogeneous and non-homogeneous equations, operator method, method of undetermined coefficients and variation of parameters.

Eigen vectors systems of linear differential equations.

Sequence of series, power series methods for linear ordinary differential equations.

Laplace transform and its applications, Fourier series and Fourier transform and their applications.

Partial differential equations: models in chemical kinetics and physiology.

Introduction to solution techniques such as variable separation, product method and Laplace Transform method.

Statistics :

.Frequency distributions and associated statistical measures

Multivariate analysis. Multiple linear regressions, Factor analysis. Partial Least Square, Principle Component analysis

3. Cluster Analysis (a) Nearest neighbour search (b)Search using stem numbers (c)Search using text signatures

Reference:

Applied Multivariate analysis by Wicherman & Johnson.
Biostsistics:: A foundation for analysis in Health Science. 7 th Edition Wayne Daniel
Fundamental and University Mathematics by Colin McGregor
Statistical methods in Biology by Norman Bailey
Biostatistics by Striecke
Mathematical models in biology by Allama
Introduction to Mathematics for Life Scientists by Edward Batschalet, Springer
Mathematics for the Biological Sciences by J.C. Acharya and R. Lardner, Prentice Hall

IBT 208T +P – Introduction to Computational Laboratory (T+P) 4 credits

Algorithms & Flow Chart

Logic of programming, Introduction to Complexity , Structure of Flowchart with biological applications.

Various Searching , Sorting & Classification techniques.

Programming in C (Theory)

C Fundamentals: Data types, Operators and expressions, Hierarchy of operators, C instructions

Control statements: Decision (*if*, *if-else*) and loop (*while*, *do-while*, *for*) controls, branching (*switch*, *break* and *continue*).

Functions: Passing arguments to a function, function declaration, prototypes, call by value, pointers and call by reference, recursion.

Arrays: Initializations, passing arrays to functions, multidimensional arrays, pointers and arrays.

Strings: Standard library string functions, pointers and strings.

Input/Output in C: Types of I/O, Console I/O, Disk I/O, formatted & unformatted I/O functions

Structures: Defining, accessing structure elements, array of structures, structures and pointers, passing structures to a function.

Some additional features of C: Command line arguments, C preprocessor, macros, enumerations, user defined datatypes (*typedef*), typecasting, memory allocation (*malloc*, *calloc*)

Data structures: linked lists, binary trees , stacks and Queues.

3. Programming in C (Practical)

Concepts on flowcharting, algorithm development, pseudo codes etc.

Laboratory assignments based on the following topics in 'C programming'

Data types, operators and expressions, Hierarchy of operators, control statements including decision (if, if-else), loops (while, do-while, for), branching (switch, break, continue), functions, arrays (1D, 2D- all matrix operations including inverse of a matrix), strings, file handling, data structures etc.

Extract a protein or nucleic acid sequence from any of the databank files (GenBankentry, Swiss-Prot, EMBL entry etc.)

Inter-converting the sequence from one databank format to the other. Determining the base composition in a nucleic acid sequence and amino acid composition in a protein sequence.

e Generating the complimentary sequence of a DNA sequence

f Calculation of probability and distribution analysis.

g. Count the number of Open Reading frames (ORF's) in a DNA sequence.

h. Calculate the codon usage in a nucleic acid sequence.

References:

The C programming language by Kerighan & Richie, PHI Publication.

2.. Schaum's outline of programming with C by Byron Gottorfried.

Programming in ansi 'C' by E. Balaguruswamy, Tata McGraw Hill.

Let Us C by Kanetkar, BPB Publications.

Algorithms in bioinformatics by Guigo R. Ed. & Gusfield D., Ed.: Berlin. Springer-Verlag

IBT 209 T Principles of Molecular Biology 2 credits

1 DNA as genetic material (5L)

2 Historical experiments leading to fundamental concepts in molecular biology (10L)

3 Central dogma (10L)

4 Transcription – discuss RNA polymerase (5L)
(Should be taught at basic level)

Reference Books:

1. Genes VIII : Benjamin Lewin
2. Molecular Biology of Gene: Watson et al.
3. Cell & Molecular Biology: Lodish et al.

IBT 321 P Laboratory Exercises in Physics III 2 credits

Experiments related to course IBT 301T

IBT 322 P Laboratory Exercises in Chemistry III 2 credits

To determine transference numbers of H^+ ions in HCl by moving boundary method.

To determine the mean activity coefficient of HCl in aqueous solution of different concentrations.

Phase diagram of a two-component system.

To verify Debye, Huckel and Onsagars limiting law.

Interpretation of the PMR /CMR spectrum: structure elucidation.

Assigning different vibrations in the infrared spectrum of a given molecule.

Photometric titration of copper (II) and EDTA.

Determination of magnetic moment of a paramagnetic metal ion in a complex.

To study the adsorption of acetic acid on activated charcoal.

To determine the pH (in the range 4.5 to 5.9)of a given solution by spectrophotometry.

IBT 323P Laboratory Exercises in Molecular Biology & Microbial Biodiversity 2credits

1.	Isolation of Bacterial, animal, plant and plasmid DNA	4
2	Agarose gel electrophoresis of DNA	1
3.	Isolation and characterization of photosynthetic microbes	1
4.	Isolation of microbes from aquatic and terrestrial environments	2
5.	Isolation of marine microbes	1
6.	Biochemical characterization	1

Semester IV

IBT 106 T+P Histochemistry and Cytochemistry 4 credits

Theory

Fundamentals of histology: tissue structure structures and their organization
Fixatives Types and choice
Sample preparation
Stains: Methods tools and techniques for tissue staining
Principles of histochemical reactions
Staining and visualization of a) carbohydrates b) proteins c) lipids d) Nucleic acids

Practicals

1. Tissue fixation, Processing and sectioning
2. Staining and permanent preparation
3. Detection of carbohydrates/ Lipids/ mucopolysaccharides/nucleic acids /proteins
4. Immunohistochemistry techniques
4. *In situ* detection of nucleic acid homology

References:

IBT 204 T English 2 credits

1. Language as a communication tool, relationships among reading, writing, hearing and speaking.
2. Organization of English language: sentence structure, vocabulary, word formation, basic grammar, Syntax, context, paragraphs, paraphrase, précis
3. Spoken English: pronunciation, diphthong, accent, clarity, speed, punctuation, simplicity and syntax
4. Common errors in written and spoken presentation; tautology, double negatives and double positives, sequence, tenses
5. Outline of scientific paper – planning of parts
6. Title, Introduction and Summary/abstract
7. Materials and methods – importance of measurements, reproducibility, statistics, confidence
8. Results: Text, data presentation, methodology: Tables, graphs, histograms, photographic plates, legends.
9. Discussion: Logical presentation and critical analysis of ideas and data, conclusions
10. Citations: How to find references from journals, books etc
11. Reading an English text: Recognize important facts, deciphering the pictorials

References

1 Barrass,R.(1978): Scientists Must Write. Chapman and Hall. London.
2 Day, RA(1995) : How to Write and Publish aScientific Paper. Edn. 4. Cambridge University Press, Cambridge.
3 Farr,AD(1985): Sciences Writing for Beginners, Blackwell Scientific, Oxford 4
4. Gibaldi, J and WS Achtert (1988): MLA Handbook for Writers of Research Papers. Edn.3. Affiliated East-West Press, New Delhi.
5 Goodman, NW and MB Edwards (1997) : Medical Writing: a Prescription for Clarity. Edn.2. Cambridge University Prees,Cambridge.
6 Hailman, JP and KB Strier (1997) : Planning, Proposing and Presenting Scienc Effectively. Cambridge University Prees, Cambridge.
7. International Committee of Medical Journal Editors (1993): Uniform Requirements for Manuscripts Submitted to Biomedical Journals. J. Am. Med. Assoc. 269 : 2282-2286
8. McMillan, VE (1997) : Writing Papers in the Biological Sciences. Edn. 2 W.H. Freeman and Co. New York
9. O'Connor, M and FP Woodford (1975) : Writing Scientific Papers in English. Associated Scientific Publishers, Amsterdam.
10.Tufte, ER (1983) : The Visual Display of Quantitative Information. GraphicsPress, Cheshire, CT.
11.University of Chicago Press (1993) : The Chicago Manual of Style. N. 14. Univ. of Chicago Press, IL

IBT 205T Cellular Basis of Structure and Function in Biology 2 credits

Transport –simple diffusion, facilitated diffusion, active transport, exocytosis and endocytosis, nuclear transport, osmosis and imbibition in plants	5L
Cytoskeleton and motility and extracellular matrix in plants and animals	5L
Signal transduction- electrical signals, messengers and receptors	5L
Plants forms and functions	5L
Mitosis, meiosis in plants and animals	5L
Basics genetics of animals and plants	5L

Reference :

The world cell by Wayne M. Becker Author.
Molecular cell biology by Harvey Lodish Author
Human molecular genetics by Tom Strachan Author
Essential cell biology second edition by Bruce Alberts Author
Essential Developmental Biology Second Edition by J M W Slack

IBT 401T – Modern Physics I 3 credits

Classical Statistical Physics

Temperature, measurement of temperature, Boltzmann distribution, statistical measurement, ensemble, diffusion, master equation of diffusion, statistical equilibrium, definition of statistical entropy, concept of entropy as applied to biological systems, relation with the information process and spontaneous reactions.

Nuclear Physics

Structure of Nucleus, Binding energy curves of various elements, fission, fusion, effects of nuclear radiation, optical, microwave radiation, absorption, penetration, energy density, biological half life, interaction of radiation with living matter, isotopes used in biology and medicines.

References:

IBT 304T Microbial Genetics 2credits

Historical overview: Classical genetics	3
Bacterial chromosome	2
Genetic exchanges in bacteria conjugation, transformation Transduction, transfection.	8
Chromosome mapping	2
Bacterial gene function and regulation operons	5
Bacteriphages structure genomes life cycles, use of bacteriophages in genetic studies (Lambda, T4, MS2 , M13, P1)	10

References:

1. Birge,E.A. (2006) Bacterial and Bacteriophage Genetics. 5th Edition. Sriger Publications
2. Dale, J.W., Park, S.F. (2005) Molecular Genetics of Bacteria 4th Edition Wiley and Sons Inc
3. Freifelder, D. (2005). Moleular Biology. 2nd Edition. Narosa Pub. House
4. Synder,L., Champness W. (1997) Molecular Genetics of Bacteria. ASM Press.
5. Turn, N., Trempy, J. (2006) Fundamental Bacterial Genetics. Blackwell Publishers

IBT 307 T Biochemical & Biophysical Techniques 3credits

1. Principles & Applications of uv-vis, .fluorescence, CD, ORD, NMR, ESR, Dynamic Light Scattering 5L
2. Microscopy Techniques 15L
3. Electrochemical cell, pH and electrodes 3L
4. Labelling techniques 4L
5. .Separation Techniques 10L
   - Homogenizatiom
   - Membrane filtration, and dialysis.
   - Centrifugation
   - Electrophoresis
   - Viscosity
5. Chromatography techniques, Ion exchange, gel filtration, Adsorption chromatography, HPLC and GC 8L

Reference

1.Bioanalytical Chemistry (Susan R. Mikkelsen and Eduardo Cortón, Wiley-Interscience, 2004; ISBN 0-471-54447-7

2. Biophysical Chemistry Friedfielder

IBT 403T Spectroscopy and Physical Organic Chemistry 2credits

1. Nuclear Magnetic Resonance, PMR, FT-NMR, chemical shift, position of signals, splitting of signals, diamagnetic anisotropy, CMR spectra, structure elucidation 20L

2. Physical Organic Chemistry –The Hammett ρσ relationship, elucidation of reaction mechanisms, applications to aliphatic systems, thermodynamic aspects of the Hammett equation. 10L

Reference

1. Spectrometric Identification of Organic compounds by R M Silverstein and F X Webster, Sixth edition (2002)
2. Introduction to Spectroscopy by D Pavia, G Lampman, G Kriz, Second edition (1996)
3. A guidebook to mechanism in Organic Chemistry by Peter Sykes, Sixth edition (2006)
4. Organic Chemistry by J Clayden, N Greaves, S Warren, P Wothers, First edition (2001)
5. Organic Chemistry by P Y Bruice (2006), Pearson education

IBT 405 T Techniques in Molecular Biology 2 credits

1. Nucleic Acids Isolation and Characterization
   Principles of various techniques
   Choice of method for extraction
   Variations of conditions and effect on quality & quantity
   Purity criteria & characterization
   (Phage, bacterial, animal & plant systems) 6L
2. Gene expression analysis
   Genetic Complementation, Protein Expression, RNA detection (Southern, Northern, Western blottings) 7L
3. In situ characterization of DNA/RNA/Proteins
   Hybridisations
   b) Immunological techniques 6L
4. General strategy of gene cloning and applications 6L
5. DNA sequencing techniques 4L
   (should be broad based)

Reference Books:

Genes VIII : Benjamin Lewin
Molecular Biology of Gene: Watson et al.
Cell & Molecular Biology: Lodish et al.

IBT 324 P – Practical Applications of Biochemical & Biophysical Techniques 2C

1 Homogenization
2. Centrifugation
3. Column chromatography
4. Microscopy
5. Thin Layer Chromatography
6. Dialysis / Membrane filtration

IBT 328P Laboratory Exercises in Cell Biology and Microbial Genetics 2 credits

Bacteriophage titration 1
Uv mutagenesis 1
Bacterial transformation 1
Diauxic growth curve 1
Bacterial conjugation
Study of animal cells
Mitosis
Meiosis
Differential WBC count

IBT 421 P Laboratory Techniques in Molecular Biology 3Credits

1. Isolation of plasmid DNA 2 P
   Miniprep.
   Large scale
2. Cleaning of DNA 1P
3. Isolation of nuclei 1P
4. Chromatin organization by micrococcal nuclease & Agarose gel electrophoresis 2P
5. Restriction endonuclease digestion & restriction mapping 1P
6. Extraction of DNA from Agarose gels 1P
7. Isolation of bacterial RNA
8 Spectroscopic and colorimetric analysis of nucleotides, RNA & DNA (2P)

Semester V

IBT 402T – Modern Physics II 2 credits

Solid State Physics

Types of solids, crystals structures, conductivity, diffusion, types of bonding, role of electrons in binding, electronic structure of solids, x-ray diffraction, introduction to the diffraction techniques as applied to the structure determination of the biological molecules.

Quantum Physics
Photons, quantization, diffraction of particle, photoelectric effect, Compton scattering, dual nature of light, Bohr atom, failure of classical mechanics on basis of experiments, introduction to Schroedinger's equation, 1-D simple harmonic oscillator, bound states, scattering states, concept of wave function, shapes of orbitals, hydrogen atom (Note: This introduction to be given using simple motivational hand waving arguments. Skip algebra as much as possible)

IBT 308T Introduction to Enzymology 2 credits

I ENZYMES AS CATALYSTS
A. Overview--proteins as catalysts (historical background)
B. Enzyme characteristics and properties
C. Enzyme nomenclature/classification
D. Enzyme Purification and Assay

II. ENZYME KINETICS
A. Kinetics of single substrate reactions
B. Enzyme inhibition
C. Multi-substrate reactions

III. MECHANISM OF ENZYME CATALYSIS
A. Reaction Mechanisms and Catalysis
B. Active Site studies
C. Specific enzymes Case examples of enzymes

IV. ENZYME REGULATION
A. Partial Proteolysis
B. Phosphorylation, adenylylation, disulphide reduction
C. Allosteric regulation

Reference

1.Alan Fersht *Structure and Mechanism in Protein Science*, 2nd ed. W.H. Freeman & Co.
2.Nicolas Price & Lewis Stevens *Fundamentals of Enymology*, 2nd edition, Oxford Univ. Press, New York, NY.
3.Trevor Palmer *Understanding Enzymes*, Second Edition, J. Wiley & Sons, New York.
4. Donald Voet & Judith Voet *Biochemistry*, J. Wiley & Sons, New York
5. Geoffrey Zubay (1993) *Biochemistry*, 3rd edition, Wm. C. Brown, Oxford
6. Berg, Tymoczo and Stryer, *Biochemist*

IBT-314T Introduction to Developmental Biology 2 credits

Introduction: Developmental phenomena
Oogenesis and spermatogenesis
Fertilization and cleavage
Early development and axis formation s
Ectoderm, mesoderm and endoderm development and derivatives
Development of neural crest and nervous system
Cell interactions, cell death and signaling pathways during development
Cell adhesion in development and the extracellular matrix
Regulation of gene expression
Epigenetics in development
Imprinting and primordial germ cells
Sex determination and sex reversal.

IBT 406T Microbial Biotechnology I 2 credit

Food Microbiology (microbes associated with food, spoilage preservation food poisoning, food infection)	10
Foods made by microbial activity (cheese making, Oriental food products, pickles, mushroom cultivation, Single cell proteins)	10

Algal Biotechnology 5
Polysaccharides, biopalstics 5

Reference

1. Jay, J.M. (2000)Modern Food Microbiology. Sixth Edition. Aspen Publishers, Inc., Gaithersburg, Maryland.
2. Doyle, M.P., Beuchat L.R., Montville, T.J. (2001) Food Microbiology. Fundamentals and Frontiers, ASM Press, Washington, DC.
3. Ray. B. (2001) Fundamental Food Microbiology. Second Edition. CRC Press

IBT 404 T Genetics of higher organisms 2 credits

1. Animal genetics:

   a. Historical overview: Mendel's laws, definition of terms, mutations, genes, alleles, multiple alleles, polymorphism, linkage groups, dominant and recessive lethal alleles, conditional mutants etc. 5L

   b. Gene linkage: recombination, mapping of genes, *Drosophila* as model system. 5L

   c. Population genetics: Hardy-Weinberg law, genes in population, mutation and selection as a means of variation. 5L

2. Plant genetics:

   a.Nuclear genome: Genes in nuclei, chloroplast and mitochondria, classes of DNA in nuclear genome 1L
   b.Polyploidy: Introduction to euploids and anuploids and their cytogenetic behavior. 1L
   c. The inheritance of nuclear genes: qualitative v/s quantitative traits. Inheritance of simple traits and genes. 1L
   d. Phenotypic and molecular markers, linkage mapping and karyotypic evolution. 2L
   e Chlorplast genome: Breeding system, chloroplast genome organization, inheritance of chloroplast genes. 1L
   f. Mitochondria: mitochondrial genome organization, cytoplasmic male sterility. 1L
   g. Transposable elements: Discovery of maize trasnposable elements 1L
   h. Tissue specific expression of plants genes, seed storage proteins : seed storage proteins , Zein proteins of maize, legumins and vicilins/canvicilins in pea, regulatory sequences controlling legumin biosynthesis in pea. 1L

   i. Regeneration: protoplast formation, cybrids, Tissue culture-somatic cell hybrids. 1L
   j. Effect of light on plant development: Criteria for identifying a phytochrome controlled response, phytochrome proteins, phytomorphic mutants in *Arabidopsis,* control of gene expression by light 1L
   k. Flowering: sexual reproduction in higher plants, genes involved in regulation of flower development in *Arabidopsis* and *Antirrhium,* homeostasis of flower development, temporal regulation of gene expression during flower development 1L
   l. Breeding systems 1L
   m. Genetic systems of families and taxonomy 2L

Reference:

IBT 325P Laboratory Exercises in Enzymology 2 credits

1. Measuring time course of an enzyme
2. Effect of varying enzyme concentration
3. Estimation of K_m and V_{max} for an enzyme
4. Effect of temperature on enzyme activity
5. Effect of pH on enzyme activity
6. Effect of metal ions on enzyme activity
7. Enzyme inhibition
8. Temperature stability of enzymes
9. pH stability of enzymes

IBT-328P Laboratory Exercises in Developmental Biology 2 credits

1. Preparation of culture media, autoclaving and sterilization 1P
2. Gross anatomy of chick and frog embryo 2P
3. Filter paper ring method for *in vitro* culturing and harvesting of chick Embryo 2P
4. Regeneration in *Hydra/Planaria* 1P
5. Cell death in limbs formation 1P
6. Cleavage patterns during development 1P
7. Mounting of chick embryo and preparation of permanent mounts 2P

IBT 422P Laboratory Exercises in Microbial Biotechnology 2 credits

1. Isolation and characterization 2
2. (morphological, and biochemical) of
3. Lactic acid bacteria (LAB)
4. Isolation and characterization of microbes
5. from grains 2
6. Isolation of dextran form *Leuconostoc* 1
7. Fermentation of fruit juices 1
8. Thermal Death rate 1
9. Thermal Death time 1
10. Determination of most probable number of coliforms 2

IBT 513 T + P Basic Separation Techniques in Biology 3 credits

1. Paper chromatography
2. Column chromatography
3. Cell organelle separation
4. Electrophoresis
5. Ultrafiltration

IBT 107 T Seminars 1 credit

IBT 212 T+P Project 2 credits

Optional courses in Physics/Electronics/Biology/BioChemistry, Chemistry

IBT 511 T +P Structure of Macromolecules & Energetics I 4 credits

Pre-requirements:
Physicochemical principles underlying the structure and function of bio-molecules (DNA, RNA, Proteins, Carbohydrates)

Objective:
The students should be able to understand and work on the following topics:
Various levels of structural organizations in bio-molecules
Representation of the 2D and 3D structures: coordinate systems & modeling
Bioinformatics approaches for structure analysis and structure predictions
Conformations & analysis of macromolecules.

Detail :
Internal and external co-ordinate system
Generation of co-ordinates of biopolymers in Cartesian and cylindrical polar co-ordinate System.
Anatomy of Proteins
Ramachandran plot
Secondary structures
Motifs
Domains
Tertiary and quaternary structures
Fold recognition
Methods for Comparison of 3D structures
Anatomy of DNA: A, B, Z DNA, DNA bending etc.
RNA structure
Structure of Ribosome
Analysis of Structural data banks - Protein Data Bank, Cambridge small molecular crystal structure data bank
Calculation of conformational energy for bio-macromolecules
Developing the energy functions & Force fields
Charge calculation methods

References
"Conformations of Biopolymers", Vol. 2. Edited by G.N.Ramachandran.
Ramachandran,G.N. and Sasisekharan,V. (1968) Conformation of polypeptides and proteins. *Adv. Prot. Chem.*, 23,283.
Creighton, T. E. Ed.: Protein Structure: A Practical Approach. 1989.
Creighton, T.E.: Proteins: Structure And Molecular Properties. Second Edition. New York. W. H. Freeman and Company, 1993.
Creighton.: Protein Folding, 1992.
JA McCammon & S.Hervey :Molecular Dynamics of Protein & Nucleic acids. 1989
Sternberg, M.J.E.: Protein structure prediction: a practical approach, 1996
Pain, R.G.: Mechanisms of protein folding, 1994
Leach.A.R: Molecular modelling: principles and applications

IBT 515T Introduction to Nanotechnology 4 Credits

Need of quantum mechanics, dual nature of light, heisenberg's uncertainity principle, schrodinger's equation in one and three dimension, particle in a one dimensional box, density of states for particle in a box, density of stats for a 1-D quantum wire, tunneling.

Revision of crystal structures, quasicrystals, bonding in solids, electronic structure of solids

Physical methods for synthesis of nanomaterials: mechanical methods, vapour deposition, cluster beam deposition, laser vapourization, laser pyrolysis, sputter deposition, chemical vapour deposition, electric arc deposition, ion implantation, molecular beam epitaxy

Chemical methods for synthesis of Nanomaterials: colloids and colloids in solutions, colloids in vacuum, colloids in medium, synthesis of colloids, growth of nanoparticles, synthesis of metal nanoparticles, synthesis of semicinductor nanoparticles, langmuir-blodgett method, microemulsions, sol-gel method

Biological synthesis of Nanomaterials: synthesis using microorganisms, synthesis using plant extracts, synthesis using proteins and DNA templates

Review of axioms of quantum mechanics, states and the bra / ket notation, rudiments of quantum theory of the process of measurement, relationship between quantum and classical concepts, WKB approximation, time evolution: Heisenberg, Schrödinger and interaction picture, fluctuations, correlations and eigen-functions, harmonic oscillator, angular momentum and three dimensional wave equation, orbital and spin angular momentum, exclusion principle.

IBT 516 T Transport properties of Biological membrane 2 credits

Chemical potential, definition, factors contributing to chemical potential, Nernst-Planck equation, Fick's law, osmotic pressure for water and impermeant solute separated by a semi-permeable membrane, reflection coefficient, Donnan equilibrium, Goldmann equation, assumptions, active transport, membrane equivalent circuit using flux equation.

IBT-413T Internal motion in molecules 2 credits

Regions of electromagnetic spectrum, spectral line width-line intensity
Microwave-infrared-electronic spectroscopy. Fine structure associated with the spectra.
Dissociation energies from the spectra.

References

Molecular Spectroscopy by C M Banwell
Molecular Spectroscopy by G M Barrow

IBT 414T Bio-physiology 3 credits

The passive and active electrical properties of excitable cells. Cellular biopotentials and currents, techniques for recording them. Resting membrane potential, action potential,: origins; models and theories of explanation. Hodgkin-Huxley model of action potential membrane ionic pumps and exchange processes. Physiological and clinical significance. Electrophysiology of neuroeffector transmission. Prejunctional and postjunctional electrical events. Transmission processes in skeletal, smooth and cardiac muscle and synapses. Time courses of transmitter activated postjunctional membrane potentials and currents. Electrophysiology of membrane ionic channels and neurotransmitter receptors. Modification of bioelectric activity using drugs.

IBT 415T **Light and Optics** **3 credits**

Light – nature and propagation, plane waves, spherical waves, reflection, refraction, interference, diffraction, dispersion, polarization, polarization by reflection and scattering. photoelectric effect.

Optics – Plane mirrors, spherical mirrors, refraction at spherical surfaces, thin lenses, thick lenses and lens combinations, simple magnifiers. Principles of microscopes, viz., Electron, phase contrast, fluoresence and confocal , telescopes, cameras. Birefringence, scattering, fourier optics.

Eye and Vision – human eye, mechanism of color vision, mechanisms of seeing.

Laboratory Courses in Physics / Electronics /Biology /Biochemistry
2 credits each **2 X 2 = 4**

SEMESTER VI

IBT 210T **Fundamentals of Immunology I** **2 credits**

Overview of immunology	3L
Cell and organs of immune system	4L
Generation of B cells and T cells response	5L
Antibodies structure and function	2L
Organization and expression of immunoglobin gene	3L
Antigen and antibody interaction principles and application	5L
Major histocompatibility complex	3L
Antigen processing and presentation	3L
T cell receptor	2L

Reference

Janes Kuby; Immunology, W. H. Freeman and Company New York
I.M. Roit; Essential Immunology, Blackwell Scientific Publication
W. E. Paul; Fundamental Immunology, Raven Press

IBT 309T **Bioinformatics** **2 credits**

- Overview of Bioinformatics (1L)

Nature of biological data (2L)

- Major Bioinformatics Resources (1L)
- Literature databases (searching & downloading) (1L)
- Introduction & overview of Biological databases (1L)
- Nucleic Acid sequence databases (3L)
  - GenBank
  - EMBL
  - DDBJ
- Protein sequence databases (3L)
  - PIR-PSD
  - SwissProt
  - TrEMBL/GenPept
- Database searches: I (2L)
  - Text-based searching
  - Simple and advanced forms
  - Manipulation of displays

o Entrez/SRS- query engines
 Computational molecular biology & genetics (2L)
o Overview
o Exploring EMBOSS series
o Exploring OMIM
 Database searches: II
Sequence comparisons & alignment concepts . 6L)
o Fundamentals of sequence-based searching
Scoring Matrices
o Introduction to BLAST series
o Introduction to FASTA
Pairwise Sequence Alignments (6L)
o Global Alignments - Needleman Wunsch Algorithm
oLocal Alignments - Smith Waterman Algorithm
 Structure databases (2L)
o PDB
o NDB
Visualisation & other utilities

Reference:

BAXEVANIS, A.D. & OUELLETTE, B,F.F.: Bioinformatics: a practical guide to the analysis of genes and proteins. 2nd Ed.. 2002. John Wiley & Sons, Inc. Publications, New York.

BAXEVANIS, A.D., DAVISON, D.B., PAGE, R.D.M. & PETSKO, G.A.: Current protocols in bioinformatics. 2004. John Wiley & Sons, Inc. Publications, New York.

ORENGO, C., JONES, D. & THORNTON, J.: Bioinformatics: genes, proteins and computers. 2003. Bios Scientific Publishers, Ltd. Oxford.

For Advanced / Additional Reading:

1. Ingvar Eidhammer, Inge Jonassen, William R. Taylor: Protein Bioinformatics. 2003 John Wiley And Sons Ltd (UK)
2. HIGGINS, D. & TAYLOR, W.: Bioinformatics : sequence, structure, and databank. 2000. Oxford University Press, Oxford, UK.
3. David Mount: Bioinformatics : sequence and genome analysis. 2004.. Cold Spring Harbor Laboratory Press, New York

IBT 408T **Microbial Biotechnology II** **2 credits**

Microbes as biocontrol agents (Baculoviruses, entomopathogenic fungi, *Bacillus thurinigiensis Bacillus sphaericus Bacillus popilae*, Microbe derived inhibitors	6
Biology of nitrogen fixation, preparation of different Types of inoculants (nitrogen fixers phosphate solubilizers, plant growth promoting rhizobacteria, PGPR, composting	8
Introduction to the use of microbes in environmental Applications, Bioremediation, bioaugemntation, Bioemulsifiers, biosurfactants, MEOR, Leaching of ores	12
Microbial fuels (Methane, Hydrogen)	4

Reference:

1. Subba Rao, N. S. (1999) Soil Microbiology Science Pub Inc
2. Kosaric, N. (1993) Biosurfactants Marcel Dekker Inc

IBT 409T General Aspects of Plant Biotechnology 2 Credits

Unit I – Growth and Development
Plant Hormones - Types, structures, biosynthesis & metabolism (3 L)
Mineral Nutrition - Effect of soil pH on mineral availability, uptake & assimilation of minerals, their physiological role. (2L)
Vegetative Growth –
Seed to seedling (Hormonal & light control of seedling growth, gene expression during seedling development) (1 L)
Seedling to adult vegetative plant body (Organization of shoot & root apex, cell fate & tissue differentiation in meristems, growth & development of roots, stems & leaves, development of vascular tissues) (2 L)
Vernalization & Photoperiodism - Relevance in crop productivity (2 L)
Flowering – Transition from vegetative to flowering stage, molecular basis of determination & differentiation of floral organs, homeotic mutants (2L)
Embryo and Seed Development, Dormancy & Germination – Molecular Aspects (2 L)

Unit II – Metabolic Pathways in Plants ***(4 Lectures)***
Shikimic Acid
Mevalonic Acid
Acetyl CoA
TCA

Unit III – Applications
Biopesticides – Insecticides, Rodenticides & Pesticides – Biological Sources, Collection, Characters & Constituents. Biocontrol Methods, Engineered Biocontrol Methods.
(2 Lectures)
Biofertilizers & Vermiculture (1 Lecture)
Phytoremediation (2 Lectures)
Medicinal Plants & Nutraceuticals (3 Lectures)
Floriculture (3 Lectures)
Biofuels (1 Lecture)
Single Cell Proteins (1 Lecture)

Reference:

Biochemistry and molecular biology of plants by uchannan, Wilhelm and Russell
Plant Biochemistry by Hans Walter Heldt

IBT 517 T Heterocyclic Chemistry of Bioorganic Compounds 2 credits

5-membered heterocycles: Furan, Pyrrole and Thiophene
Condensed 5-membered heterocycles- Indoles, Benzofurans and benzothiophene
Pyridine, Quinoline and isoquinoline
Pyrimidines and Purines

Refeence:

Heterocyclic Chemistry by J A Joule and G F Smith
Essentials of Organic Chemistry by P M Dewick, 2006

IBT 213 T Seminars 2 credits

IBT 212 T+P Project 4 credits

IBT 326P Lab exercises in Bioinformatics 2 credits

Major Bioinformatics Resources (2P)

- Literature databases (searching & downloading) (2P)

Nucleic Acid sequence databases (3P)

- GenBank
- EMBL
- DDBJ

- Protein sequence databases (3P)

- PIR-PSD
- SwissProt
- TrEMBL/GenPept

Database searches: I (3P)

- Text-based searching
- Simple and advanced forms
- Manipulation of displays
- Entrez/SRS- query engines

Computational molecular biology & genetics (4P)

- Overview
- Exploring EMBOSS series
  - Exploring OMIM

- Database searches: II

Sequence comparisons & alignment . 8P)
NW , SW,BLAST & FASTA

- Structure databases (5P)

- PDB
- NDB

Visualisation & other utilities

IBT 224 P Techniques in Immunology 2 credits

Raising antibodies 1P
Routes of immunization 1P
Purification and characterization of immunoglobin 3P
Ouchterlony double diffusion 1P
Immunoelectrophoresis 1P
Conjugation of antibodies 2P
Development of dot blot 1P

IBT XXXP Laboratory Exercises in Microbial Biotechnology II 2 credits

Studies on *Bacillus thurinigiensis*	2
Isolation and characterization of Nitrogen fixers	2
Isolation and characterization of Phosphate solubilizers	1
Preparation of inoculants	1
Enrichment culture for hydrocarbon degradation	2
Production and characterization of emulsifiers by microbes	2

Optional courses in Physics/Electronics/Biology/BioChemistry, Chemistry

IBT 611T- Structure of Macromolecules & Energetics II 2 credits

Structure of Macromolecules & Energetics II
Pre-requirements:
Structure of Macromolecules & Energetics I

Molecular optimization techniques like , Newton Rahpson, Conjugate Gradient, Genetic algorithms, Simulated annealing etc. Applied to Biomolecules.

Methods to predict three dimensional structures of nucleic acids, rRNA, tRNA.
Molecular Mechanics & Molecular Dynamics of Oligopeptides, Proteins, Nucleotides and small Molecules
Mechanics and dynamics of & Monte Carlo Methods bio-macromolecules
Conformational Searches
Simulation of molecular mechanics and dynamics
Simulations of Free Energy changes
Electrostatics of Biomolecules

References

"Conformations of Biopolymers", Vol. 2. Edited by G.N.Ramachandran.
Ramachandran,G.N. and Sasisekharan,V. (1968) Conformation of polypeptides and proteins. *Adv. Prot. Chem.*, 23,283.
Creighton, T. E. Ed.: Protein Structure: A Practical Approach. 1989.
Creighton, T.E.: Proteins: Structure And Molecular Properties. Second Edition. New York. W. H. Freeman and Company, 1993.
Creighton,T.: Protein Folding, 1992.
JA McCammon & S.Hervey :Molecular Dynamics of Protein & Nucleic acids. 1989
Sternberg, M.J.E.: Protein structure prediction: a practical approach, 1996
Pain, R.G.: Mechanisms of protein folding, 1994
Leach.A.R: Molecular modelling: principles and applications

IBT 612T Interface of Biology & Chemistry: Interaction of Biomolecule 2 credits

Objective: Structure-function correlations in the context of protein ligand interactions & protein protein/nucleic acid/carbohydrate interactions.

Characterization of Forces acting in Biology
Water & its role in biological interactions
Receptor based molecular interactions
Ligand based Interactions
Protein & small Molecules

Docking and Scoring
Molecular interactions of
Protein – Protein
Protein – DNA
Protein – carbohydrate

IBT 613 T Nanotechnology Principles 4 Credits

Techniques for analysis of nanomaterials, introduction to microscopes, optical microscopes, confocal microscopes, electron microscopes, transmissionelectron microscopes, scanning probe microscopes, scanning tunneling microscope, atomic force microscope, scanning near field optical microscope, x-ray diffraction, atomic scattering factor, bragg's law of diffraction, crystal structure factor, diffraction from nanoparticles,optical absorption spectrometer, UV-Vis-NIR spectrometer, infra red spectrometers, dispersive infra red spectrometer, fourier transform infra red spectrometer, luminescence, X-ray and Ultra-Violet photoelectron spectroscopies, auger electron spectroscopy, magnetic measurements.

Mechanical properties of nanomaterials, structural properties of nanomaterials, melting of nanomaterials, electrical conductivity, optical properties of metal and semiconductor nanomaterials, luminescence, magnetic properties, types of magnetic materials, magnetic multilayers.

Introduction to Nanolithography, lithography using photons, lithography using paticle beams, scnaning probe lithography, soft lithography.

Special Nanomaterials, carbon nanotubes, types of carbon nanotubes, synthesis, growth mechanism, electronic structure, porous silicon, synthesis of porous silicon, properties of porous silicon, aerogels, type of aerogels, properties of aerogels, zeolites, synthesis of zeolites, properties of zeolites, ordered porous materials using micelles as templates, self assembled nanomaterials, self assemblyin inorganic materials, self assembly using organic molecules, self assembly using biological templates, core shell particles

Application of nanomaterials in electronics, industry, biotechnology and medicine, space and defense.

IBT625P- Practicals corresponding to 611T and 612T 3 credits

SEMESTER VII

IBT 214T Basics in Virology 2 credits

1 .Introduction History and principles of virology, virus taxonomy, introduction to replication strategies 5L
2. Virus structure and morphology, animal and plant viruses 5L
3. Life cycles of viruses 15L
4. Infrastructure: Principles of bio-safety, containment facilities, maintenance and handling of laboratory animals and requirements of virological laboratory 5 L

Reference:

IBT 310 T Fundamentals of Immunology II 2 credits

T cells maturation, activation and differentiation	5L
B cell generation, activation and differentiation	5L
Cytokines	3L
Complement system	3L
Cell mediated effector function	3L
Leukocyte migration and inflammation	3L
Hypersensitive reactions	3L
Immune response to infectious diseases	5L

Reference:

Janes Kuby; Immunology, W. H. Freeman and Company New York
I.M. Roit; Essential Immunology, Blackwell Scientific Publication
W. E. Paul; Fundamental Immunology, Raven Press

IBT 311T+P Introduction to Animal cell culture 4 credits

Nutrition in tissue culture - Balanced salt solution, synthetic media, sera, dissociation media, antibiotics, growth factors and substrates	2L
Concept of sterilization and aseptic technique, Sources of contamination in tissue culture and their its prevention	2L
Cryopreservation of cell	2L
Types of cells in tissue culture- epithelial cells, fibroblast, Mass culture of cells for production	2L
Classification: anchorage dependant and independent, stem cells, fastidious cell culture, kerotinocytes, malanocytes and nerve cells	2L
Primary culture, diploid culture and established cell lines and characterization	2L
Specialized cell culture : for biomedical application, hepatocytes, islets, skin cells, vascular endothelial cells	2L
Primary culture, diploid culture and established cell line and characterization	2L
Cell growth curve, viability, MTT assays	2L
FACS, confocal , immunoflourescence, thymidine uptake cytotoxicity	2L
Cell fusion	2L
Types of stem cells and their use in tissue engineering	2L
Tumerogenesis , angiogenesis metastatis in *in vivo* and *in vitro* studies	
Application of organ culture in virology and toxicology	2L
Cytogenetics studies, chromosome preparation and banding techniques	2L
Principles of cell separation and purification of cells and their products	2L

Practicals

Sterilization 1P
Media preparation 1P
Primary culture of chick embryo fibroblast 1P
Chick Heart- fibroblast culture 1P
Organ culture of chick trachea 1P
Shell less chick embryo culture 1P
Secondary culture 1P
Cytogenetic techniques 1P
Maintenance of cell line 1P
Cryopreservation 1P

Reference

Culture of Animal Cells: A Manual of Basic Technique by R. Ian Freshney
General Techniques of Cell Culture Handbooks in Practical Animal Cell Biology by Maureen A
Journal articles and reviews

IBT 407 T Metabolic Pathways 2credits

1. Metabolism overview
2. Glycolysis
3. Fermentation, regulation of glycolysis, and the pentose phosphate pathway
4 Pyruvate oxidation and the citric acid cycle
5 Oxidative phosphorylation and Electron transfers in biology
6 ATP and phosphoryl group transfers
7 Gluconeogenesis, Glycogen metabolism and Anaplerotic reactions
8 Photosynthesis, photophosphorylation and transpiration
9 Fatty acid oxidation
10 Fatty acid,lipid / phospholipid and sterol synthesis
11 Aminoacid metabolism
12 Nitrogen metabolism .heme metabolism and urea cycle
13 Nucleotide synthesis and degradation
14 Diseases of Protein and Nucleic Acid Breakdown
15 Integration of central metabolic pathways

Reference::

Garrett & Grisham, Biochemistry, Saunders Publishing,
. Voet and Voet. Biochemistry, second edition, Prentice-Hall,
Lehninger, Nelson and Cox. Principles of Biochemistry
Zubay. Biochemistry
Mathews, van Holde and Ahern. Biochemistry
Stryer, Biochemistry

IBT 411 T + P Bioinformatics II (2T+2P)

Objectives:

- To understand and explore the sequence comparison tools for nucleotide and protein sequences
- To interpret the results of sequence alignments (Pairwise - local and global alignments as well as multiple sequence alignments)
- To understand the processing of macromolecular sequences using sequence comparison tools and how the derived data can be generated
- To understand and explore the derived databases and their applications to biological systems
- To explore various computational tools for analysis of biomolecular sequences

Syllabus

- Revision - Sequence alignment concepts 1
- Multiple Sequence Alignments
  - Overview 1
  - Clustal-W method 2 + 3P
  - Applications of MSA 1 + 3P

Molecular Phylogeny 6+ 4P
Introduction to phylogeny
Clustering techniques
Hierarchial & non-hierarchial
Bootstrpping
Interpretation of phylogentetic trees

- Derived Data and Derived Databases

- Concept of derived data 2
- Types of derived data - consensus, patterns, motifs, blocks 2 + 3P
- Derived databases: PROSITE, BLOCKS, PRINTS, Pfam 2 + 3P
- Exploring various databases at InterPro 2 (P)
- Derived Databases: SCOP, CATH, DALI 4 + 4(P)
- Analysis of Macromolecular sequences
- Applications of various tools for protein sequence 6+4 (P)

analysis available at ExPASy such as

- Prediction of various secondary & tertiary structure of proteins
- Hydropathy profiles
- Post-translational modifications
- Signal peptides

- Basic Concepts and tools for Prediction of B- and T-cell epitopes 3 + 4(P)

References

BAXEVANIS, A.D. & OUELLETTE, B,F.F.: Bioinformatics: a practical guide to the analysis of genes and proteins. 2nd Ed.. 2002. John Wiley & Sons, Inc. Publications, New York.

BAXEVANIS, A.D., DAVISON, D.B., PAGE, R.D.M. & PETSKO, G.A.: Current protocols in bioinformatics. 2004. John Wiley & Sons, Inc. Publications, New York.

ORENGO, C., JONES, D. & THORNTON, J.: Bioinformatics: genes, proteins and computers. 2003. Bios Scientific Publishers, Ltd. Oxford.

For Advanced / Additional Reading:

Ingvar Eidhammer, Inge Jonassen, William R. Taylor: Protein Bioinformatics. 2003 John Wiley And Sons Ltd (UK)

HIGGINS, D. & TAYLOR, W.: Bioinformatics : sequence, structure, and databank. 2000. Oxford University Press, Oxford, UK.

David Mount: Bioinformatics : sequence and genome analysis. 2004.. Cold Spring Harbor Laboratory Press, New York

IBT 503T Basic aspects of Plant tissue culture 2 credits

Introduction & Historical Overview of Plant Tissue Culture 1 L
Nutritional Media: Obligatory & Optional Constituents 2 L
Plant Growth Regulators with special reference to Plant Tissue Culture Systems3
Incubation Systems: Light & Dark, Static & Agitated 1 L
Totipotency, Growth & Cytodifferentiation of Cultured Plant Tissues 3L
Callus & Suspension Culture Systems 2 L
Organogenesis: Direct & Indirect- Basic aspects 3 L
Somatic Embryogenesis – Basic aspects 3 L
Isolation & Culture of Protoplasts 2 L
Production of Secondary Metabolites *in vitro* 3 L
Biosynthesis, Functions, Associations with Specific Structures
Culture Systems: Differentiated, Undifferentiated
Detection
Germplasm Conservation 2 L
In vitro Variations 2 L
Somaclonal & Gametoclonal Variation
Spontaneous & Genetic Variations
Genetic & Epigenetic Variations

13.Problems in Plant Tissue Culture: Contamination, Phenolics, Recalcitrance, Seasonal Variations in Response 3 L

References:

Biotechnology: Theory and techniques of Plant Biotechnology, Animal cell culture and Immunobiotechnology vols 1 and 2 by Jack K Chirikjian

Plant Biotechnology and its applications in Plant tissue cultureby Ashwani Kumar and Shikha Roy

IBT 602T Recent Development in Cell and Molecular Biology 4 credits

1 Cell Cycle	5L
2 Apoptosis	5L
3 Cancer Cell Biology	5L
4 Protein Targeting	5L
5 Diseases related to Cell Function	5L
6 Chromatin architecture	5L
7 DNA/ RNA binding proteins and their functions	5L
8 Recent advances in Transcription and Translation	10L
9 Regulation of gene expression	10L
10 Recombination and repair	5L

Reference Books:

Genes VIII : Benjamin Lewin
Molecular Biology of Gene: Watson et al.
Cell & Molecular Biology: Lodish et al.
From Genes to Genomes: Concepts and Applications of DNA Technology by Jeremy W. Dale
Journal articles and reviews

IBT 312T Seminars in Contemporary Biotechnology 2 credits

IBT 621P Laboratory Techniques in Cell and Molecular Biology 4 credits

1 PCR and PCR product analysis
2 DNA sequencing and extrapolation of sequencing data
3 MTT assay 3P
4 Assays for apoptosis
5 cell proliferation assay

IBT 521P Basic techniques in Plant Tissue culture 1 credit

Aseptic Techniques, Laminar Flow Hood, Surface Sterilization, Inoculations

2. Induction & Maintenance of Callus & Cell Suspension Cultures, Growth Characterization

Organogenesis: Direct

Organogenesis: Indirect

IBT XXXP Laboratory Exercises in Virology 2 credits

Practicals related to IBT 214T

Optional Course

IBT 514T+P – Mathematical Modeling in Biology I 4 credits

Course Description:
This course is aimed as an introduction to the interdisciplinary field of computational and mathematical modeling in Biology. The aim of the course is to model and analyze problems from population genetics. The course will involve modeling single populations with separate generations and multi-population models where generations may not be separate.

Course Objectives:
Understanding how biological phenomena can be described with models.
Applying and discerning how mathematical models are useful is addressing specific biological processes.
Use computational methods to implement models of biological phenomena and analyze them.

Course Prerequisites:
Knowledge of elementary mathematics, ability to solve quadratic equations, familiarity with integrations and differentiation of functions, complex numbers, linear recurrence relations and linear differential equations, familiarity with any programming language C, C++, Fortran, Fortran 90
Grade B+ or better in Physics, Mathematics and Statistics courses or permission of instructor.
Course Syllabus:
Modeling Single Populations with difference equations (Generations Separate), Malthusian model, Non-linear models, analyzing non-linear models. Computational part involves an introduction to Scientific Computing, Properties of floating point arithmetic, numerical differentiation and integration. Applying the computational techniques to model specific problems in population regulation.
Linear Models of Structured Populations, Leslie model and Usher model.
Computational techniques involve numerical methods for matrix algebra. Applications of these techniques to the models studied.
Multi-population Models (Generations not separate), Predator-Prey models, Linearization and Stability, Positive and
Negative interactions, computational techniques related with these models and their applications.
Modeling Genetics of families.

SEMESTER VIII

IBT 501T Genomics and Proteomics 2+1(P) credits

Strategies of whole genome sequencing & shot-gun approach	6
chromosome walking, cloning, contig etc.	6
Contigs and Genome Assembly	4 + 5 (P)
Introduction to proteomics	1
Proteomics Technologies:	
Protein Arrays, Protein Chips and their application	2
2D Gel Electrophoresis and its application	2
Mass Spectrometry and Protein Identification	2
Role of Bioinformatics in Proteomics	
Proteomics Databases	2+4 (P)
Protein-Protein Interactions: Concepts and Databases	2+2 (P)

Proteomics Analysis Tools at ExPaSy 4 (P)
Applications of Proteomics in Life Sciences 3

References:

Gibson G. and Muse S. V. A Primer of Genome Science, Second Edition Sinauer Associates, Inc. Sunderland, MA

Igor Jurisica, Dennis Wigle. Knowledge Discovery in Proteomics. 2006. Chapman & Hall / CRC

Pennington SR (Ed), Dunn M. J. (Ed) Proteomics: from protein sequence to function. 2002 Viva Books Pvt. Ltd.

Srivastava Sudhir (Ed). Informatics in Proteomics 2005 Taylor & Francis Group / CRC

For Advanced / Additional Reading:

Akay M. (Ed) Genomics and Proteomics Engineering in Medicine and Biology 2007 Wiley-Interscience John Wiley & sons, Inc. Publication, USA.

IBT 502T Nucleic acid and protein chemistry 2 credits

Nucleic acid chemistry **15L**

1 DNA and RNA structure
regular and irregular and dynamic structures
2 Chemical Synthesis of oligodeoxyribonucleotides
Esters and anhydrides of Oxy phosphorus acids
Preparation of monomers, protecting and deprotecting groups
Diester triester and and H-phosphonate chemistry
Solid-phase organic synthesis - phosphramidate chemistry
Synthesis of oligoribonucleotides
Synthesis of modified oligonuleotides and their applications
3. Sequencing methods
4. Biosynthesis of nucleic acids
Biosynthesis of purine and pyrimidines nucleotides (De novo and salvage pathways)
Drug inhibition of biosynthesis
Polymerization
Applications of synthetic oligonucleotides
Molecular biology, diagnostics and medicine
Antisense and anti gene therapy

Protein chemistry ***15L***

1. Background information : Amino acids, peptide bonds,primary and secondary structures (1 L).

2. Protein folding structure and function: Determination of primary structure.-Techniques, interpretation including post translational modification of proteins(viz. glycosylation, N-terminal , modification, hydroxylation & modified amino acids) (2 L).
Determination of secondary structure- UV, CD and fluorescence (2 L).
Determination of quaternary structure - X-ray (2 L.)
Functional proteins - Hemoglobin and some well characterised enzymes / lectins / peptide hormons (4 L).

3. Solid phase synthesis of peptides and their biological applications (2L)

4.Chemical modifications (2L)

References

Introduction to Protein Structure (Garland Press, Second Edition), by Carl Branden and John Tooze.
Introduction to protein structure by Thomas Creighton
DNA structure and function by R. Sinden
Nucleic Acids: Structures, Properties, and Functions (University Science Books) edited by Victor Bloomfield, Donald Crothers, and Ignacio Tinoco

IBT 504T Applications of Biotechnology in the Environment 2 credits

Status and Scope of Biotechnology in Environmental protection. 1

Biological Processes for Industrial and domestic effluent 9
Treatment, Aerobic Biological Treatment,
Anaerobic Biological Treatment.
Role of biotechnology in water purification systems 2

Metal microbe interactions: Heavy Metal Pollution 8
and impact on environment, Microbial Systems
for Heavy Metal Accumulation, Biosorption,
molecular mechanisms of heavy metal tolerance, role of
Microbes in synthesis of nanoparticles

Biotechnology for Hazardous Waste Management 5
Persistent organic pollutants, Xenobiotics, Biological
Detoxification of PAH

Biotechniques for Air Pollution Control. 2
Solid Waste Management 3

References:

Biotechnology: Theory and techniques of Plant Biotechnology, Animal cell culture and Immunobiotechnology vols 1 and 2 by Jack K Chirikjian
Plant Biotechnology and its applications in Plant tissue cultureby Ashwani Kumar and Shikha Roy

IBT 601T Genetic Engineering 4 credits

Types of vectors, gene therapy 5L
Gene expression in prokaryotic and lower and higher eukaryotic system 8L
3 Trangenic plants and animals, Knock out mice 10L
4 Phage display and genetically engineered antibodies 5L
5 Isolation and application of recombinant proteins 7L
6 PCR technology and its applications 5L
7. Development of microarray, analysis of microarray and use of Bioinformatics packages 8L
8. Construction of genomic and cDNA library ,methods of sequencing 7L
9 Site directed mutagenesis 5L

Reference Books:

Genes VIII : Benjamin Lewin
Molecular Biology of Gene: Watson et al.
Cell & Molecular Biology: Lodish et al.
An Introduction to Genetic Engineering By Desmond S. T. Nicholl
Principles of Gene Manipulation and Genomics by Sandy Primrose
Gene and Genome Technology: Principles and Applications of Recombinant DNA and Genomics by Sandy Primrose

IBT 603T Enzyme Technology 2 credits

1. Fundamentals of enzyme kinetics 3L
2. Enzyme preparation and use 3L

The preparation of immobilised enzymes – rationale , choice of matrix, methods of immobilization 5L

4. Large scale enzyme production 3L
5. Immobilised enzymes : kinetics and their uses 5L

Whole cell immobilization

Enzyme stabilization: use of additives 2L

Application of enzymes in industry, analytical purpose and medical therapy. – case studies 5L

9 Biphasic systems 2L

10. Future prospects for enzyme technology 2L

Reference;

Enzyme Technology Chaplin Cambridge, Univ Press
Immobilized Enzymes, Chibata

IBT 604T Applications of Plant Tissue Culture 2 credits

Micropropagation: Theory & Commercial Applications 5 L
- Multiplication of Specific Elite Genotypes
- Multiplication of Rare & Endangered spp.
- Multiplication of Horticultural Crops (Banana)
- Multiplication of Floricultural Crops (Chrysanthemum, Orchids)
- Cereals & Pulses (Rice, Chickpea)

2. Use of Organogenesis & Embryogenesis for Commercial Utilization 2L
3. Commercial Production of Plant Secondary Metabolites 5 L
   - Increase in production by use of suitable media supplements (Elicitors, Growth Factors, Stress Factors, Precursors, Antimetabolites, Defense Proteins etc.)
   - Modification of Environmental Parameters
   - Immobilized Cell
   - Applications & Limitations
   - Case Studies

Protoplast Culture & Somatic / Parasexual Hybridization for Overcoming Incomapatibility Barriers – Somatic Hybrids, Cybrids 3 L

Transgenic Plants
- Single Gene Transfer to Plant Cells: Concepts 3 L
- Methods of Gene Transfer: Direct & Indirect 4 L
- Stabilities & Instabilities in Transgene Expression 1 L
- Present Status of Transgenic Plants 1 L

Case Studies: Insect & Herbicide Resistance, Vit. A / Golden Rice, Nutritious potato, Technical Enzymes etc. 6 L
Organelle Transformation
Gene silencing

References:

IBT313T Trends in Biotechnology (review writing) 3 credits

IBP 623P Practical Applications of Plant Tissue Culture 3credits

Micropropagation
Protoplast Isolation & Culture
Agrobacterium spp. Transformation of Plant Cells

IBP 624P Laboratory Exercises in Enzyme Technology 2 credits

Practicals related to 603T

IBT XXXP Laboratory Exercises in Environmental Biotechnology 2 credits

Isolation and characterization of heavy metal resistant microbes	1
Plate assays for determination of MIC of heavy metals	1
Bioaccumulation of heavy metals	1
Biosorption of heavy metals	1
Isolation and characterization of microbes degrading xenobiotics	2
Isolation and characterization of microbes degrading PAH	2
Synthesis of nanoparticles using microbes	2

IBT 622P Recombinant DNA Technology 4 credits

1 Preparation of probe, gel electrophoresis and blotting, Hybridization
2 Construction of recombinant molecule using simple plasmid vector include isolation of plasmid, preparation of vector, preparation of donor DNA ligation, transformation, identification of recombinant, restriction analysis, conformation by Southern
3 Isolation of total DNA and RNA from tissue culture plants, RNA gel, Northern blot
4 Cell culture (CHO, COS), Transfection with GFP vector, selection of clone
5 Expression in bacterial syste

Optional Courses

614T+P Mathematical Modeling in Biology II 4 credits

Modeling stochastic processes – Introduction to Monte-Carlo Technique, Ising model. Markov chains, deterministic models, stochastic models, modeling of simple epidemic in continuous time, interacting groups, homogeneous populations, stratified populations

IBT 811T - Optional courses in Biotechnology 2

IBT821P- Practicals corresponding to 811T 2

SEMESTER IX

IBT 605 T+P Understanding Genomes 4 credits

Introduction to post genomic bioinformatics	2
Comparative Genomics : methods, applications in Virus , Microbial and parasites	6 +12P
Structural Genomics	6+ 4P
Functional Genomics	6 + 8P
Metabolomics	4 + 2P
Case studies: Structural genomics Initiatives	4P
Impact on Biology	6

References:

Gibson G. and Muse S. V. A Primer of Genome Science, Second Edition Sinauer Associates, Inc. Sunderland, MA

SENSEN, C.W.: Essentials of genomics and bioinformatics. 2002.. Wiley-VCH, Weinheim

BAXEVANIS, A.D. & OUELLETTE, B,F.F.: Bioinformatics: a practical guide to the analysis of genes and proteins. 2nd Ed.. 2002. John Wiley & Sons, Inc. Publications, New York.

BAXEVANIS, A.D., DAVISON, D.B., PAGE, R.D.M. & PETSKO, G.A.: Current protocols in bioinformatics. 2004. John Wiley & Sons, Inc. Publications, New York.

For Advanced / Additional Reading:

KOLCHANOV, N. (ED.) & HOFESTAEDT, R. (ED.): Bioinformatics of Genome Regulation And Structure.. Part I and II . Kluwer Academic Publishers, Boston.

David Mount: Bioinformatics : sequence and genome analysis. 2004.. Cold Spring Harbor Laboratory Press, New York

Akay M. (Ed) Genomics and Proteomics Engineering in Medicine and Biology 2007 Wiley-Interscience John Wiley & sons, Inc. Publication, USA.

IBT 701T Fermentation Tech1nology and Downstream Processing 4 credits

Fermentation Technology

Process calculations and stoichiometry.	3
Metabolic engineering	2
Transport in reactors (oxygen, substrates, heat, (material balance)	7
Bioreactor design	
Types of reactors, sterilization Utilities: steam air water	7
Solid-state fermentation	2
Biotransformations	2
Instrumentation and control (probes of different types)	2
Specific industrial process applications in plant systems	7
(Suspension callus and hairy root cultures)	
.ii) Specific industrial processes involving microbes	4
Specific industrial process applications in animal systems	

Background, need, current products, cell lines.	1
Production strategy, Production platform	1
Vector design	1
Cell line development	2
Media development	2
Bioreactor design (animal cell culture specific)	1
Downstream formulation packaging	1

Downstream processing

Removal of insolubles: Centrifugation, sedimentation Flocculation, electro-precipitation, gravity settling (grinding, homogenization, leaching if required)	2
Product isolation: distillation, solvent extraction, Adsorption, ultra filtration, membrane separation, precipitation.	8
Product purification: chromatography, (fractional) Crystallization, recrystallization, desiccation, spray drying, product formulation	5

References:

Bioseparations: Downstream Processing for Biotechnology by Paul A. Belter (Author), E. L. Cussler , Wei-Shou Hu

Principles of Fermentation Technology by P F Stanbury, A Whitaker, S Hall

Fermentation and Enzyme Technology by Wang W

Fermentation Microbiology and Biotechnology, Second Edition by E. M. T. El-Mansi, C. F. A. Bryce, Arnold L. Demain, A.R. Allman

IBT 702T Applications of Plant Biotechnology in Agriculture 2 credit

Homozygous Plant Production through Ovule, Anther & Pollen Culture	2 L
Embryo Rescue & Embryo Culture	2 L
Endosperm Culture & Production of Seedless Plants	2 L
Apomixis & Experimental Polyembryony	2 L
AFLP – Variety Identification & Fingerprinting	2 L
Molecular Farming	2 L
Marker Assisted Technology	2 L
Use of Bioreactors in Plant Production & Scale-up –	3 L
Basic Aspects of Application-case studies	5L
Metabolic Engineering	5 L
Biotic & Abiotic Stress	
Secondary Metabolites	
Edible Vaccines and PHBV	
Diagnostic Kits & Virus Indexing	3 L

IBT 703T **Vaccines** **2 credits**

History of Vaccine Development	2L
Definition of Vaccine	2L
Evolution of Vaccines	3L
Process development for vaccines	3L
Manufacturing of vaccines	3L
Various aspects of vaccines, process development and manufacturing	3L
Clinical development of vaccines	3L
Clinical end-point : Evolution of vaccines	3L
General specifications and pharmaceuticals release criteria for the existing vaccines	3L
Cold chain management of vaccines	3L
Current vaccine research	3L

Reference :

1 Vaccines, 4th Edition by Stanley A. Plotkin, Elsevier publication
2 Vaccines and Immunotherapy by Stanley J. Cryz Elsevier science publishing co.
3 Journal articles and reviews

IBT 721P - Laboratory Exercises in Fermentation Technology and Downstream Processing **4**

Practicals corresponding to IBT 701T

IBT 722P - Laboratory Exercises in Plant Biotechnology Applications **1**

Practicals corresponding to IBT 702T

IBT 723 P - Project **6**

Optional Courses (any one)

IBT 704T **Molecular Medicine and Diagnostics** **2 credits**

1 Human Health and Diseases	8L
2 Human Diseases – morbidity, mortality, impact on social development	8L
Mechanism of disease development, Genetic susceptibility, Identification of targets for diagnosis and therapy	8L
a Acquired diseases , b Cardiovascular diseases ,c Neurological diseases, d Hematology , e Cancer	
4 Epidemiology of disorders	6L

Reference books:

1.Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine by Andrew J.T. George (Editor), Catherine E. Urch (Editor) Publisher: Humana Press; edition (August 15, 2000) ISBN-10: 0896037983
2. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) by Jochen Decker, U. Reischl Amazon Sales Rank: #287831 in Books
3. Human Molecular Genetics by T. Strachan, Andrew Read Amazon Sales Rank:
4. Principles of Biostatistics by Marcello Pagano , Kimberlee Gauvreau
5. Essentials of Epidemiology in Public Health, Second Edition by Ann Aschengrau , George R., III Seage
6. Designing Clinical Research: An Epidemiologic Approach, by Stephen B. Hulley, Steven R. Cummings
7. Journal articles and reviews

IBT 705 T Drug design and Targeting 2 credits

Objective : To understand the basic concepts which determines the design and discovery of drugs. To learn the Bioorganic, medicinal and physico-chemical principles behind the rational designing and mechanism of drugs. Mostly computer based approaches will be described which will have the followings:
Structure activity relationship with bioactive compounds
Key features of molecular interactions
ADMET properties and possible prodrug strategy

1. Introduction to rational drug design & its history 2L
Methods and applications: Molecular mechanics, QM/MM, Structure and conformation of small molecules, overlay and identification of active conformer, molecular properties, descriptors. 8L
3 Molecular interactions : Protein –drug, protein-protein, protein-DNA etc .4L
4. QSAR methods : Bioactivity and ADMET relationship using search for descriptors, linear regression, PCA 4L
5. Virtual screening : Structure based designing and ligand based designing 4L
6. Targeting methods for drug delivery 4L
7 Case studies : Disease based approaches , Principles of Target identification to compound synthesis . 4L

IBT 706 T Natural Product and Medicinal Chemistry 2 credits

Natural Products 1 credit

1. Introductory bio-organic chemistry: enzymatic transformations, co-factors, examples from carbohydrate chemistry.
2. Isoprenoids, Terpenes and Flavonoids: biosynthetic origins of the group, survey of classes, electron-deficient rearrangements, chemical synthesis, steroids
3. Alkaloids: shikimate pathway to aromatic amino acids, pyridoxyl phosphate mediated transformations in alkaloid biosynthesis,

Medicinal Chemistry 1 credit

Drug processing in mammals
The molecular basis of drug action
The multiphore conceptualization of drugs
Messenger and non-messenger target systems

References:

1. G.A. Poulton and C. Spino, "Natural Products Chemistry", available as a Chemistry 433 Course Pack in the Bookstore.
2. J. Mann, "Chemical Aspects of Biosynthesis", Oxford Science, 1994, QP517 B57M36 and P.M. Dewick, "Medicinal Natural Products: a Biosynthetic Approach, 1997,
3. Introduction to Natural Products, 2004 by Albert T. Sneden
4. Medicinal Chemistry by Graham Pat

SEMESTER X

IBT 801T Biotechnology: Industry, Infrastructure and Human Resource Development 5 credits

With respect to Animal ,Plant and Microbial Systems the following topics

Labortory infrastructure development
Bioethics
IPR
GMP/GLP
Regulatory Practices
HRD
QC/QA

IBT723P Project 20credits

SEMESTER XI and SEMESTER XII

M.Tech Programme 50 credits

	CREDITS
Research proposal writing	5
Review writing	5
Management in Biotechnology	2
Research and Development	38