

**NETAJI SUBHAS INSTITUTE OF TECHNOLOGY, SECTOR-3, DWARKA
NEW DELHI-110 045**

**Bachelor of Engineering in Biotechnology
(4-year Degree Course)**

SUGGESTED SCHEME AND THE COURSES OF READING

| 1 BT | TH | PR | VS | | |
|--------------|--------------------|---------------------------|-----------|-----------------------|-------------------------|
| | 5 | 4 | 0 | | |
| Paper | Course Code | Subject | | L-T-P | Credits and Type |
| TH 1 | BT 101 | Humanities | | 3-1-0 | 4 H |
| TH 2 | BT 102 | Mathematics I | | 3-1-0 | 4 H |
| TH 3 | BT 103 | Physics I | | 3-1-0 | 4 H |
| TH 4 | BT 104 | Chemistry | | 3-1-0 | 4 H |
| TH 5 | BT 105 | Manufacturing Processes | | 3-1-0 | 4 A |
| PR 1 | BT 106 | Engineering Drawing I Lab | | 0-0-3 | 3 A |
| PR 2 | BT 107 | Physics I Lab. | | 0-0-2 | 2 H |
| PR 3 | BT 108 | Chemistry Lab. | | 0-0-3 | 2 H |
| PR 4 | BT 109 | Workshop I | | 0-0-2 | 2 A |
| | | | | Total Credits: | 29 |

| 2 BT | TH | PR | VS | | |
|-------------|-----------|-------------------------------|-----------|-----------------------|-----------|
| | 5 | 4 | 0 | | |
| TH 1 | BT 111 | Introduction to Biotechnology | | 3-1-0 | 4 C |
| TH 2 | BT 112 | Physics II | | 3-1-0 | 4 H |
| TH 3 | BT 113 | Chemistry II | | 3-1-0 | 4 H |
| TH 4 | BT 114 | Mechanical Sciences | | 3-1-0 | 4 A |
| TH 5 | BT 115 | Engineering Mathematics | | 3-1-0 | 4 A |
| PR 1 | BT 116 | Introduction to Biotech Lab | | 0-0-3 | 2 C |
| PR 2 | BT 117 | Physics II Lab. | | 0-0-2 | 2 H |
| PR 3 | BT 118 | Chemistry II Lab. | | 0-0-3 | 2 H |
| PR 4 | BT 119 | Mechanical Sciences Lab. | | 0-0-2 | 2 A |
| | | | | Total Credits: | 28 |

| 3 BT | TH | PR | VS | | |
|-------------|-----------|--|-----------|-------|-----|
| | 5 | 4 | 0 | | |
| TH 1 | BT 201 | Cell Biology | | 3-1-0 | 4 C |
| TH 2 | BT 202 | Biochemistry | | 3-1-0 | 4 C |
| TH 3 | BT 203 | Microbiology | | 3-1-0 | 4 C |
| TH 4 | BT 204 | Basics of Computer Systems and Programming | | 3-1-0 | 4 C |
| TH 5 | BT 205 | Basic Electronics and Instrumentation | | 3-1-0 | 4 A |
| PR 1 | BT 206 | Cell Biology Lab. | | 0-0-3 | 2 C |
| PR 2 | BT 207 | Biochemistry and Microbiology Lab. | | 0-0-3 | 2 C |

| | | | | |
|------|--------|---|-----------|-----|
| PR 3 | BT 208 | Basics of Computer Systems and Programming Lab. | 0 – 0 – 2 | 2 C |
| PR 4 | BT 209 | Basic Electronics and Instrumentation Lab. | 0 – 0 – 2 | 2 A |

Total Credits: 28

4 BT TH PR VS
5 3 1

| | | | | |
|------|--------|---|-----------|-----|
| TH 1 | BT 211 | Molecular Biology | 3 – 1 – 0 | 4 C |
| TH 2 | BT 212 | Genetics | 3 – 1 – 0 | 4 C |
| TH 3 | BT 213 | Methods and Instrumentation in Biotechnology | 3 – 1 – 0 | 4 C |
| TH 4 | BT 214 | Statistics for Biology | 3 – 1 – 0 | 4 C |
| TH 5 | BT 215 | Data Structure and Algorithms | 3 – 1 – 0 | 4 C |
| PR 1 | BT 216 | Molecular Biology and Genetics Lab | 0 – 0 – 3 | 2 C |
| PR 2 | BT 217 | Methods and Instrumentation in Biotechnology Lab. | 0 – 0 – 3 | 2 C |
| PR 3 | BT 218 | Data Structure Lab. | 0 – 0 – 3 | 2 C |
| VS 1 | BT 219 | Project | 0 – 0 – 2 | 2 C |

Total Credits: 28

5 BT TH PR VS
5 4 1

| | | | | |
|------|--------|---------------------------------------|-----------|-----|
| TH 1 | BT 301 | Structural Biology | 3 – 1 – 0 | 4 C |
| TH 2 | BT 302 | Immunology and Immuno-technology | 3 – 1 – 0 | 4 C |
| TH 3 | BT 303 | Recombinant-DNA Technology I | 3 – 1 – 0 | 4 C |
| TH 4 | BT 304 | Database Management Systems | 3 – 1 – 0 | 4 C |
| TH 5 | BT 305 | Chemical Engineering principles | 3 – 1 – 0 | 4 A |
| PR 1 | BT 306 | Structural Biology Lab | 0 – 0 – 3 | 2 C |
| PR 2 | BT 307 | Immunology and Immuno-technology Lab. | 0 – 0 – 3 | 2 C |
| PR 3 | BT 308 | Recombinant -DNA Technology I Lab. | 0 – 0 – 3 | 2 C |
| PR 4 | BT 309 | Database Management Lab. | 0 – 0 – 3 | 2 C |
| VS 1 | BT 310 | Term Paper and Seminar | 0 – 0 – 2 | 2 C |

Total Credits: 30

6 BT TH PR VS
5 4 0

| | | | | |
|------|--------|--|-----------|-----|
| TH 1 | BT 311 | Recombinant DNA Technology II | 3 – 1 – 0 | 4 C |
| TH 2 | BT 312 | Enzymology and Enzyme Technology | 3 – 1 – 0 | 4 C |
| TH 3 | BT 313 | Plant and Animal Biotechnology | 3 – 1 – 0 | 4 C |
| TH 4 | BT 314 | Computational Biology I | 3 – 1 – 0 | 4 C |
| TH 5 | BT 315 | Fundamentals of Biochemical Engg. | 3 – 1 – 0 | 4 A |
| PR 1 | BT 316 | Recombinant - DNA Technology II Lab. | 0 – 0 – 3 | 2 C |
| PR 2 | BT 317 | Enzymology and Enzyme Technology Lab.. | 0 – 0 – 3 | 2 C |

| | | | | |
|-----------------------|--------|------------------------------------|-----------|-----------|
| PR 3 | BT 318 | Plant and Animal Biotechnology Lab | 0 – 0 – 3 | 2 C |
| PR 4 | BT 319 | Computational Biology I Lab. | 0 – 0 – 3 | 2 C |
| Total Credits: | | | | 28 |

| | | | | | | |
|-----------------------|-----------|--|-----------|-----------|--|--|
| 7 | BT | TH | PR | VS | | |
| | | 5 | 4 | 1 | | |
| TH 1 | BT 401 | Computational Biology II | 3 – 1 – 0 | 4 C | | |
| TH 2 | BT 402 | Bioprocess Technology | 3 – 1 – 0 | 4 A | | |
| TH 3 | BT 403 | Downstream Processing | 3 – 1 – 0 | 4 A | | |
| TH 4 | BT 404 | Elective I | 3 – 1 – 0 | 4 C | | |
| TH 5 | BT 405 | Management, Accounting and Cost Control | 3 – 1 – 0 | 4 C | | |
| PR 1 | BT 406 | Computational Biology II Lab. | 0 – 0 – 3 | 2 C | | |
| PR 2 | BT 407 | Bioprocess Technology Lab. | 0 – 0 – 3 | 2 A | | |
| PR 3 | BT 408 | Downstream Processing Lab. | 0 – 0 – 3 | 2 A | | |
| PR 4 | BT 409 | Practical Training (after 6 th Sem) | 0 – 0 – 4 | 4 M | | |
| VS 1 | BT 410 | Seminar (International Economic Environment / IPR) | 0 – 0 – 2 | 1 C | | |
| Total Credits: | | | | 31 | | |

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|-----------------------|-----------|---|-----------|--------------------|--|--|
| 8 | BT | TH | PR | VS | | |
| | | 4 | 3 | 0 | | |
| TH 1 | BT 411 | Genomics and Proteomics | 3 – 1 – 0 | 4 C | | |
| TH 2 | BT 412 | Elective II | 3 – 1 – 0 | 4 C | | |
| TH 3 | BT 413 | Project Management | 3 – 1 – 0 | 4 C | | |
| TH 4 | BT 414 | Principles of Management and Entrepreneurship Development | 3 – 1 – 0 | 4 C | | |
| PR 1 | BT 415 | Genomics and Proteomics Lab. | 0 – 0 – 3 | 2 C | | |
| PR 2 | BT 416 | Major Project | 0 – 0 – 8 | 8 M | | |
| PR 3 | BT 417 | Practical Training / Project | 0 – 0 – 4 | 4 M | | |
| Total Credits: | | | | 30 | | |
| TOTAL | | | | 232 Credits | | |

Paper IV - BT 404 Elective I : Any one of the following -

1. Thermodynamics of Biological systems
2. Pharmaceutical Chemistry
3. Biological Imaging and Computer Graphics
4. Current topics in Biotechnology I
5. Bioelectronics
6. Environmental Biotechnology

Paper II BT 412 Elective II : Any one of the following -

1. Drug Design and Development
2. Bioprocess Plant Design
3. Drug Delivery systems
4. Current topics in Biotechnology II
5. Artificial Neural Networks
6. Biosensors and Biomedical sensors and transducers

All the courses in the first semester represent the common course component for all B.E. degree programs at Delhi University

B.E. (Bio-technology): I Year: I Semester

Examination Theory

L T P

Paper I BT 101 Humanities (English)

3 1 0

(Same as COE 101, EE 101 and IC 101)

(A) **Text :** Essay, Short Stories and One Act Plays : Editor, R.K. Kaushik and S.C. Bhatia, Published by Oxford University Press.

The following chapters are prescribed for study.

Essays :

1. Nehru the Democrat by M. Chalapathi Rao
2. Bores by E.V. Lucas
3. Freedom by G.B. Shaw
4. What I require from Life by J.B.S. Haldane
5. Student Mobs by J.B. Priestley

Short Stories:

6. The Fortune-Teller by K. Capek
7. Grief by A. Chekov
8. The Doll's House by K. Mansfield

One Act Plays:

9. A Marriage Proposal by A. Chekov
10. The Boy Comes Home by A.A. Milne

(B) ENGLISH LANGUAGE PRACTICE

Applied Grammar:

Common Errors, Use of words, Synonymous and Antonyms, Formation of words- Prefixes and Suffixes.

Presentation of Technical Information:

Technical description of (i) Simple objects, tools and appliances (ii) Processes and Operations (iii) Scientific principles.

Composition:

Comprehension, Dialogues - conversational and colloquial idiom.

Spoken English:

Practice in self-expression talks, Lecture and speeches.

Reading materials

1. Essay, Short Stories and One Act Plays by R.K. Kaushik and S.C. Bhatia. Publisher : Oxford University Press.

B.E. (Bio-technology): I Year: I Semester

Examination Theory

L T P

Paper II BT 102 Mathematics I

3 1 0

(Same as COE 102, and IC 102)

Algebra: Partial fraction, Hyperbolic and inverse hyperbolic functions, De-Moivre's term, infinite series and their convergence (Comparison and Ratio tests), Alternating

series theorem and its applications; Relations between circular and hyperbolic functions; Positive term infinite series and their convergence (Comparison and Ratio tests), Alternating series.

Differential Calculus: Derivatives of hyperbolic functions; successive differentiation and Leibnitz's theorem. Taylor's and Maclaurin's series, Maxima and minima of functions of one variable; curvature and radius of curvature, points of inflexion.

Integral Calculus: Integration by partial fractions : Integration of forms $I, I/R$ where $R=ax^2 + bx + C$; Properties of definite Integrals. Reduction formulae, Application of integration to areas, lengths of area, surface and volume of solids of revolutions, Trapezoidal and Simpson's rules.

Reading materials

1. Advanced Engineering Mathematics by E. Kreyszig. Publisher : John Wiley and Sons Inc.
2. Differential Calculus by G.B. Thomas and R.L. Finney. Publisher : Addison-Wesley Publishing.

B.E. (Bio-technology): I Year: I Semester

Examination Theory

L T P

Paper III BT 103 Physics I

3 1 0

(Same as COE 103, EE 103 and IC 103)

Relativity: Absolute and inertial frames of reference, Newtonian (Galilean) relativity Galilean transformation, Michelson Morely experiment and its implications, Lorentz Transformation, Einstein's law of addition of velocities, Mass variation with velocity, concept of energy and momentum as four vector, Einstein's mass-energy relation.

Inverse Square Law of Forces: Fundamental interactions, Electro-magnetic and gravitational interactions. Force and potentials, Control Forces.

Invariance And Symmetry Principles: Invariance of a Physical quantity, laws of conservation of momentum, energy and charge, concept of symmetry and its implications.

Wave Oscillations: Free, damped and forced oscillatory motions, Resonant vibrations with applications, sharpness of resonance quality factor. Formation of waves in strings rods and air, acoustic waves, acoustic impedance, transmission through partitions, ultrasonic and its applications.

Interference of Light: Wave theory of light, superposition principle, Double lit experiment, Bi-prism and Newton's rings Theory of interference in thin films, interference filters, Michelson's interferometer.

Diffraction of Light: Fresnel and Fraunhofer class of diffraction, diffraction at straight edge cornices spiral, Fraunhofer diffraction at a slit and its extension for number of slits, Diffraction gratings, Resolving power of optical instrument, telescope, prism and grating.

Polarization of Light: Elementary aspects of electromagnetism, theory of light, polarization, reflection and transmission, Brewster law, polarization due to pile of plates and Double refraction, Elliptically and circularly polarized light, Nicol prism, quarter and half-wave plate.

Polarimeters : Half shade and Pi-quartz.

Optical Instrument: Cardinal points of a co-axial lens system, Defects in the images, spherical and chromatic aberration, Nodal slide assembly, Eye pieces.

Reading materials

1. College Practical Physics by D.R. Khanna and H.R. Gulati. Publisher : R. Chand and Company.
2. Elements of Properties of Matter by D.S. Mathur. Publisher : S. Chand and Company.
3. Fundamentals of Optics by D.R. Khanna and H.R. Gulati. Publisher : R. Chand and Company.
4. Fundamentals of Optics by D.R. Khanna and H.R. Gulati. Publisher : R. Chand and Company.
5. Introduction to Special Relativity by R. Resnick. Publisher : John Wiley and Sons Inc.
6. Physics by R. Resnick and D. Halliday. Publisher : John Wiley and Sons Inc.
7. Waves and Oscillation by B.L. Subrahmanyam. Publisher : Vikas Publishing House.

B.E. (Bio-technology): I Year: I Semester

Examination Theory

L T P

Paper IV BT 104 Chemistry

3 1 0

(Same as COE 104, EE 104 and IC 104)

Chemical Kinetics: Rate constant, order and molecularity of a reaction, 1st, 2nd, 3rd order reactions, Methods of determining order of reactions, effect of catalyst on reaction rate, activating energy, Industrial applications of catalysts.

Electro-Chemistry: Transport number, Galvanic Cells, E.M.F. and its measurements, Nearest equation of electrode potentials, Reference and Indicator electrodes at measurements, solar energy.

Phase Rule: Phase diagrams and phase transformations in Pb-Ag and Cu-Ni systems.

Thermal Methods of Analysis: Elementary discussions of thermogravimetric analysis, Differential thermal analysis and differential scanning calorimetry.

Metals and Non-Metals of Elements: S and P block elements, Bonding in complexes, Molecular explanations for magnetic properties and colour, extraction and technical applications of titanium, Vanadium, zirconium, Tungsten and Uranium.

Alloys Classification: Necessity for making alloys, composition, properties and uses of following alloys - Brass, Bronze, Gun metal, Duralumin, Effect of alloying elements like C, Ni, Mn, Si, V, Mo, W and Co on the properties of steel.

Electronic Effects: Inductive effect, conjugation and resonance and their effect on physical and chemical properties of molecules, carbanion and carboniumions and free radicals.

Organic Polymer: Polymerization, Effect of polymer structure on properties, production, properties and technical applications of some important thermoelastics and thermosetting resins, Natural rubber and elastomers (SNR, GR. I, GR-P polyurethane and silicon) Molecular weights.

Oils, Fats, Waxes and Detergents: Production and physico-chemical properties of fatty acids and Glycerides, Manufacture of edible fats, soap, Glycerin, waxes, essential oils, perfumes and cosmetics.

Reading materials

1. Chemical Kinetics by K.J. Laidler. Publisher : Addison-Wesley Publishing.
2. Concise Inorganic Chemistry by J.D. Lee. Publisher : Stanley Thornes Publishing.
3. Engineering Chemistry by P.C. Jain. Publisher : Dhanpat Rai Publishing Company.
4. Organic Chemistry by I.L. Finar. Publisher: Longman Publishing Group.
5. Physical Chemistry for Engineering by Jain and Jain. Publisher : Dhanpat Rai Publishing Company.

B.E. (Bio-technology): I Year: I Semester

Examination Theory

L T P

Paper V BT 105 Manufacturing Processes

3 1 0

Materials: Compositions, Properties and uses of wrought iron, pig iron, cast iron, malleable iron, S.G. Iron, carbon and alloy steels. Copper, Aluminium, Lead, Brass, Bronze, Duralumin, Bearing metals, High temperature metals, Cutting tools materials.

Casting Processes: Principles of metal casting, pattern materials, Types and allowance, Study of moulding, Sand moulding tools, moulding materials, classification of moulds, Description and operation of cupola : special casting processes e.g. die casting, permanent mould casting, centrifugal casting, investment casting.

Smithy and Forging: Basic operations e.g. upsetting, fullering, flatterring, drawing, swaging, tools and appliances, drop forging, press forging.

Metal Joining: Welding principles, classification of welding techniques; Oxyacetylene Gas Welding, equipment and field of application, Arcwelding, metal Arc, Carbon Arc, submerged arc and atomic hydrogen arc welding, Electric resistance welding : spot, seam, Butt, Butt seam and percussion welding, Flux; composition, properties and function, Electrodes, Types of joints and edge preparation, Brazing and soldering.

Sheet Metal Work: Common processes, tools and equipment; metals uses for sheets, standard specification for sheets.

Bench Work and Fitting: Fitting, sewing, chipping, thread cutting (die), tapping study of hand tools, marking and marking tools.

Reading materials

1. A Textbook Of Workshop Technology (Manufacturing Processes) by R.S. Khurmi. Publisher : S. Chand and Company.
2. Elements of Workshop Technology Vol: 1 Manufacturing Processes by S.K. Hajra Choudhury. Publisher : Media Promoters and Publishers Pvt. Ltd.
3. Fundamentals of Modern Manufacturing: Materials, Processes and Systems by M. P. Groover. Publisher : John Wiley and Sons Inc.
4. Manufacturing Technology: Foundary, Forming and Welding by P.N. Rao. Publisher : Tata McGraw Hill.
5. Principles of Metal Casting by R.W. Heine. Publisher: McGraw Hill Text.
6. Sheet Metal by L.A. Meyer. Publisher : American Technical Publishers Inc.

7. Welding Engineering and Technology by R.S. Parmar. Publisher : Khanna Publishers.

B.E. (Bio-technology): I Year: I Semester

Examination Practical

L T P

Paper I BT 106 Engineering Drawing I Lab.

0 0 3

Introduction: Instruments and their uses : letterings construction and uses of various scales : dimensioning as per I.S.I. 696-1972.

Engineering Curves: Parabola; Hyperbola; Ellipses; Cycloid, Involute; Spiral; Helix and loci of points of simple moving mechanism (4 bars chain).

Projections: Straight lines; Planes and solids; Development of surfaces of right and oblique solids; section of solids, interpenetration and intersection of solids; isometric and oblique parallel projection of solids.

Reading materials

1. AutoCAD for Windows Express by T. McCarthy. Publisher : Springer Verlag.
2. Engineering Drawing and graphics + Auto CAD by K.Venugopal. Publisher : New Age International.
3. Engineering Drawing by N.D. Bhatt. Publisher : Chardoor Publishers.
4. Engineering Drawing by P.S. Gill. Publisher : Kataria and Sons.

B.E. (Bio-technology): I Year: I Semester

Examination Practical

L T P

Paper II BT 107 Physics I Lab.

0 0 2

(Based on course work corresponding to BT 103 Physics I)

1. Determination of the value of 'g' by Bar Pendulum and find the radius of gyration
2. Study of the moment of inertia of a fly-wheel.
3. Study of the mass spring system.
4. Determination of the resolving power of Telescope.
5. Wavelength determination of sodium light by Newton rings.
6. Wavelength determination of sodium light by biprism
7. Wavelength determination of Mercury green line by diffraction grating using spectrometer.
8. Determination of the focal length of combination of two Lenses by Nodal slide assembly and verify the Formula.
9. Study of sugar cane solutions concentration.

B.E. (Bio-technology): I Year: I Semester

Examination Practical

L T P

Paper III BT 108 Chemistry Lab.

0 0 3

(Based on course work corresponding to BT 104 Chemistry)

1. Estimation of Iron in ferrous ammonium sulfate using an intermediate of known normality.
2. Iodometric titration of a given copper sulfate solution.
3. Estimation of strength of a given potassium dichromate solution using external indicator.

4. Estimation of strength of a given potassium permanganate solution using ferrous ammonium sulfate as intermediate.
5. Volumetric titration of potassium dichromate with ferrous ammonium sulfate using N-phenyl anthranilic acid as internal indicator.
6. Determination of strength of sulfuric acid and oxalic acid in a given solution.
7. To determine the chemical composition of a given solution of commercial caustic soda
8. Estimation of Silver nitrate against a known normality of potassium thiocyanate using ferric indicator.
9. Estimation of strength of barium chloride in a given solution using sodium carbonate and hydrochloric acid solutions.
10. To determine the chemical composition of Chalk.

B.E. (Bio-technology): I Year: I Semester

Examination Practical

L T P

Paper IV BT 109 Workshop I

0 0 2

(Practicals based on course work corresponding to BT 105 Manufacturing Processes)

B.E. (Bio-technology): I Year: II Semester

Examination Theory

L T P

Paper I BT 111 Introduction to Biotechnology

3 1 0

Introduction and scope of Biotechnology – historical perspectives, Biotechnology as an integrated discipline, its applications, future directions.

Introduction to general biology - cell as unit of living matter, living systems : organization and function, living systems as a source for biomaterials.

Basic concepts of molecular biology – Gene Structure, function and organization. Concept of Gene manipulation.

Biological variation–mutation, recombination and adaptation. The concept of evolution.

Commercial applications – Biotechnology in Industry, food, agriculture and healthcare.

Ethical and regulatory issues.

Reading materials

1. Agriscience and Technology by B.L. De Vere. Publisher : Delmar Publishers.
2. Agriscience Fundamentals and Applications by Walter and York. Publisher : Delmar Publishers.
3. Biotechnology Unzipped by E.S. Grace. Publisher: Joseph Henry Press/ National Academy Press.
4. Biotechnology: An Introduction by S.R. Barnum. Publisher: Wadsworth Publishing Company.
5. Biotechnology-Demystifying the Concepts by D. Bourgaize, T.R. Jewell and R.G. Buiser. Publisher : Addison-Wesley Longman.
6. Eighth Day of Creation : Makers of the Revolution in Biology by H.F. Judson. Publisher : Cold Spring Harbor Laboratory.
7. In Praise of Imperfection by R.L. Montalcini. Publisher : Basic Books.
8. Molecular Biology of the Gene by J.D. Watson and J. Steitz. Publisher : Addison-Wesley Publishing.

9. Principles of Biotechnology - http://www.biotech.iastate.edu/biotech_info_series/bio1.html
10. The Double Helix : A Personal Account of the Discovery of the Structure of DNA by J.D. Watson. Publisher: Touchstone Books.
11. The Lives of a Cell : Notes of a biology watcher by L. Thomas. Publisher : Penguin USA.
12. The Science of Agriculture, A Biological Approach. by R.V. Herren. Publisher : Delmar Publishers.
13. Biology by K.R. Miller and J. Levine. Publisher : Prentice Hall.
14. Understanding DNA and Gene Cloning by K. Drlica. Publisher : Wiley and Sons Company.

(New course : Content developed by Prof. A.K. Dubey and Dr. Sonika Bhatnagar, NSIT with inputs from all the members of the expert committee).

B.E. (Bio-technology): I Year: II Semester

Examination Theory

L T P

Paper II BT 112 Physics II

3 1 0

Quantum Mechanics: Matter Waves and de- Broglie Hypothesis, Uncertainty Principle, Wave packets, Schroedinger`s wave equation, Interpretation of wave function, Simple Eigen value problems and degeneracy.

Metallic Conductors: Fermi electron model, Energy distribution, Fermi energy, Fermi-Dirac probability function, Fermi level, Conduction process, effect of temperatures and impurities.

Semiconductor : Band Theory of Solids, types of semiconductors, statistics of holes and electrons, Hall effect, Effect of temperature on conductivity, life time and recombination , drift and diffusion , p-n junction.

Superconductors: Types of super conductors, Meissner effect, Josephson effect, High temperature superconductors.

Dielectric and Magnetic Materials: Polarization of dielectric and its break down. Piezoelectricity, Ferroelectricity, Electrets, Ceramic; Dia, Para, Ferro-magnetism

Laser : Principle, Einstein`s A and B coefficients, He-Ne LASER, Semiconductor LASER, Applications.

Statistical Physics: Maxwell classical distribution law, degree of freedom and law of equipartition of energy, mean free path. Quantum statistics: Fermi-Dirac and Bose-Einstein distribution, fermi-Dirac probability function fermi-level.

Nuclear Physics: Structure of nucleus, binding energy, nuclear models, discovery of neutrons, particle detectors and accelerators, artificial radioactivity, fission and fusion, nuclear reactors.

Radiation physics : Elements of radioactivity, dosimetry, radiation hazards on biosystems and the remedies, applications of radioactivity in biosystems.

Reading materials

1. Advances in Statistical Physics of Solids and Liquids by S. Prakash. Publisher : New Age International.

2. College Practical Physics by D.R. Khanna and H.R. Gulati. Publisher : R. Chand and Company.
3. Elements of Properties of Matter by D.S. Mathur. Publisher : S. Chand and Company.
4. Fundamentals of Optics by D.R. Khanna and H.R. Gulati. Publisher : R. Chand and Company.
5. Introduction to Solid State Physics: A Short Course by C. Kittel. Publisher: John Wiley and Sons Inc.
6. Introduction to Special Relativity by R. Resnick. Publisher : John Wiley and Sons Inc.
7. Introductory Nuclear Physics by K.S. Krane. Publisher : John Wiley and Sons Inc.
8. Laser by R.S. Sirohi. Publisher : New Age International.
9. Physics by A. Beiser. Publisher: Addison-Wesley Publishing.
10. Physics by R. Resnick and D. Halliday. Publisher : John Wiley and Sons Inc.
11. Quantum Mechanics by B. Crasemann and J.L.Powell. Publisher : Addison-Wesley Publishing.
12. Solid State Physics by S.O. Pillai. Publisher : New Age International.
13. Waves and Oscillation by B.L. Subrahmanyam. Publisher : Vikas Publishing House.

(New Course - Content developed by :

- Prof. R.G. Mendiratta, Emeritus Professor of Physics at IIT, Delhi
- Dr. O.P. Thakur Senior Lecturer in Physics, NSIT
- Prof. V. P. Bhatnagar, retired professor of Physics, DCE)

B.E. (Bio-technology) I Year II Semester

Examination Theory

L T P

Paper III BT 113 Chemistry II

3 1 0

Reaction mechanisms—Nucleophilic and electrophilic aliphatic and aromatic substitution reactions, elimination reactions, inductive effect, electromeric effect, mesomeric effect, hyperconjugation

Reaction Intermediates- biradicals, enamines, carbenes, nitrenes, benzyne and their reactions, energetics of organic reactions.

Alicyclic compounds –classification, synthesis of alicyclic compounds, physical and chemical properties, Baeyer’s strain theory, strainless or puckered theory, relative stability of chair and boat form, relative stability of cycloalkanes in terms of M.O. theory, medium ring compounds, large ring compounds, natural compounds with large rings (civetone and muscone)

Stereochemistry – Enantiomers, diastereomers, fischer projection formula, optical isomerism in compounds containing no chiral carbon atom, racemic modification, resolution of racemic modification, asymmetric synthesis, stereochemistry and reaction mechanism, relative and absolute configuration, modern interpretation of geometrical isomerism, interconversion of geometrical isomers, stereochemistry of cycloparaffins, stereochemistry of nitrogen, phosphorous, sulphur and arsenic compounds.

Tautomerism- Classification, dyad system, triad system, ring chain tautomerism, valence tautomerism.

Conformational analysis– Conformations, conformations of ethane, substituted ethanes, cyclohexane, substituted cyclohexanes, cyclohexene, cyclohexanone, fused ring compounds, other ring systems, conformations and chemical reactivity of acyclic compounds and cyclic compounds.

Pericyclic reactions -Mechanism and stereochemistry of pericyclic reactions, types of pericyclic reactions (cycloadditions, electrocyclic reactions, sigmatropic rearrangements), (4+2) cycloadditions, (2+2) cycloadditions, electrocyclic reactions, woodward hoffmann rule and orbital symmetry, sigmatropic rearrangement.

Non benzenoid aromatic system-Ferrocene, fulvene, tropylium cation, tropone and tropolone, azulene, annulenes, heterocyclic compounds, sydnones.

Reading materials

1. A Concise Introduction to Organic Chemistry by A. Zlatkis. Publisher : McGraw-Hill Companies.
2. A Guide Book to Mechanism in Organic Chemistry by P. Sykes. Publisher : Longmans.
3. Advanced Organic Chemistry - Reactions, Mechanisms and Structure by J. March. Publisher : McGraw Hill Text.
4. Introduction to Organic Chemistry by D.E. Applequist, C.H. Depuy and K.L. Rinehart, Jr. Publisher : John Wiley and Sons Inc.
5. Organic Chemistry by F.A. Carey and R.J. Sundberg. Publisher : Plenum Publishing Corporation.
6. Organic Chemistry by J. B. Hendrickson, S.H. Pine, D.J. Cram and G.S. Hammond. Publisher : McGraw Hill.
7. Organic Chemistry by R.T. Morrison and R.N. Boyd. Publisher : Prentice Hall College Division.
8. Organic Chemistry : The Basis of Life by B. Miller. Publisher : Addison-Wesley Publishing Company.
9. Practical Organic Chemistry by F.G. Mann and B.C. Saunders. Publisher : Longman.
10. Vogel's Textbook of Practical Organic Chemistry by A.I. Vogel, B.S. Furniss, and A.R. Tatchell. Publisher : Addison-Wesley Publishing Company.

(*New Course – content developed by:*

- *Dr. Anjana Sarkar, Senior Lecturer in Chemistry, NSIT*
- *Ms. Deepa Srivastava, School of Applied Science, NSIT)*

B.E. (Bio-technology) I Year: II Semester

Examination Theory

L T P

Paper IV BT 114 Mechanical Sciences

3 1 0

Applied Mechanics – basic laws: force, moment of a force, couple, equivalent force system, equation of equilibrium, applications of structural mechanics, friction and its applications

Simple stresses and strains – Description of tensile, compressive shear and volumetric stresses and strains, complementary shear stress, lateral strain and Poisson's ratio
Bending moment and shear force diagrams – Cantilevers and simply supported beams carrying various types of loads

Theory of simple bending – Determination of bending stresses, deflection of beams

Torsion : Stresses and strains in pure torsion for solid and hollow circular shaft : power transmitted by shaft.

Combined stresses and strains : Principal stresses, strains, combined torsion, bending and direct stresses, strains, combined torsion, bending and direct stresses.

Fluid mechanics – Fluid and flow, fluid properties, pressure variation in a static fluid, hydrostatic forces on plane and curved surfaces, stability of submerged and floating bodies. Properties of fluids, classification of fluids, forces on fluids. Normal forces on fluids, forces on submerged bodies, hydrostatic forces on plane and curved surfaces.

General description of fluid motion, streamlines, continuity equation, particle acceleration, velocity gradient, rotation and rate of strain.

Thermodynamics – Concepts of system, properties, equilibrium, zeroth law, heat and work, first law of thermodynamics, nonflow and steady flow energy equations, second law of thermodynamics, reversibility, entropy, properties of ideal gases, various thermodynamic processes. Properties of air, water, vapour mixtures, introduction to psychrometry.

Introduction of heat transfer modes, concept of driving potential, thermal resistance and overall heat transfer coefficient.

Reading materials

1. A Text Book of Fluid Mechanics and Hydraulic Machines (For Degree, U.P.S.C., A.M.I.E. Classes) by R.K. Bansal. Publisher : Laxmi Publications Pvt. Ltd.
2. Applied Mechanics by F.P. Beer and E.R. Johnston. Publisher: McGraw-Hill Science/Engineering/Math.
3. Basic and Applied Thermodynamics by P.K. Nag. Publisher : Tata McGraw Hill Publishing Company.
4. Engineering Mechanics , Statics by I.H. Shames. Publisher : Pearson education.
5. Engineering Mechanics, Statics by J.L. Meriam. L.G. Kraige and J. William III. Publisher : John Wiley and Sons Inc.
6. Fundamentals of Fluid Mechanics by B.R. Munson, D.F. Young and T.H. Okiishi. Publisher : John Wiley and Sons Inc.
7. Fundamentals of Thermodynamics by G. Van Wylen and R.E. Sonntag. Publisher : John Wiley and Sons Inc.
8. Mechanics of Fluids by I.H. Shames. Publisher: McGraw-Hill Science/Engineering/Math.
9. Thermodynamics : Principles Characterizing Physical and Chemical Processes by J.Honig, M. Honig and M. Jurgen. Publisher : Academic Press.

(Course content developed using IT 112 Mechanical Sciences at NSIT as framework and modifications incorporated as per suggestions from:

- Prof. B.C. Nakra, Emeritus Professor, IIT, Delhi
- Dr. Sachin Maheshwari, Assistant Professor, MPA Division, NSIT

B.E. (Bio-technology): I Year: II Semester

Examination Theory

L T P

Paper V BT 115 Engineering Mathematics

3 1 0

Differential Equations: General linear differential equations with constant coefficients, Operator D, Complementary function, particular integral, Wronskian, Simultaneous linear differential equations, Solution of differential equations in power series, Frobenius method.

Fourier Series: Fourier Series, Euler's Formula, Even and odd-functions, functions having arbitrary periods, half range expansions, Harmonic Analysis.

Laplace Transform: Laplace Transformation, Inverse Laplace Transformation, Convolution Theorem, Application to Linear differential equations with constant coefficient, Unit step function, Impulse function, Periodic function.

Functions of Complex Variable: Analytic Functions, Harmonic Conjugate, Conformal Mapping, Cauchy's Integral theorem, Cauchy's Integral Formula, Residue Theorem, Evaluation of real integrals.

Vector Analysis: The operators gradient, divergence and curl and their geometrical significance, Integration of vectors, Work done in vector fields, Green's, Stokes and Gauss divergence theorem.

Partial Differential Equations: Linear Partial Differential Equations. Applications of Partial Differential equations, Method of Separation of Variables, Heat equation, Wave Equation, Laplace Equation and their solutions.

Numerical Methods: Solution of system of Linear equations, Solution of Algebraic and Transcendental Equations, Interpolation and Approximation, Numerical Integration, Numerical Solutions to Differential Equations. Dynamics and initial value problems Integrators - Euler method, Runge-Kutta, Verlet, Harmonic Oscillator, Monte Carlo simulation on a 2D lattice: chain collapse and protein folding. Optimization- Steepest Descent, Conjugate gradient, Discrete optimization by Monte Carlo: Design of an optimal sequence

Reading materials

1. Advance Engineering Mathematics by E. Kreyszig. Publisher : John Wiley and Sons Inc.
2. Calculus by G.B. Thomas and R.L. Finney. Publisher: Addison-Wesley Publishing.
3. Elements of Partial Differential Equations by I.N. Sneddon.
4. Schaum's Outline of Fourier Analysis with Applications to Boundary Value Problems by M.R. Spiegel. Publisher : McGraw Hill Trade.
5. Schaum's Outline of Laplace Transforms by M.R. Spiegel. Publisher : McGraw Hill Trade.

(New Course – Content developed by:

- *Dr. Vijay Gupta, Assistant Professor in Mathematics, NSIT*
- *Dr. J. Jena, Lecturer in Mathematics, NSIT and modified with suggestions from Professor R. Ramaswamy, Dean, School of Information Technology, JNU)*

B.E. (Bio-technology): I Year: II Semester

Examination Practical

L T P

Paper I BT 116 Introduction to Biotechnology Lab.

0 0 3

(Practicals based on course work corresponding to BT 111)

1. Biotechnology lab. orientation and safety guidelines
2. Use of microscopes to examine various cell types, characteristics of cell structure and function, a study of scale and number.
3. Create Three-dimensional model of DNA molecule using molecule building kit.
4. DNA Electrophoresis – submarine gel electrophoresis and visualization of bands.
5. Restriction analysis of DNA
6. Ligation of DNA to construct a recombinant molecule
7. Transformation and screening of recombinant colonies.

B.E. (Bio-technology): I Year: II Semester

Examination Practical

L T P

Paper II BT 117 Physics II Lab.

0 0 2

(Practicals based on course work corresponding to BT 112)

1. Measurement of Planck's constant and work function.
2. Measurement of resistivity of a semi conductor using four probe method.
3. Wave length of laser light from the diffraction of pattern from a slit.
4. Diffraction of laser light from a plane grating.
5. Hall effect experiment.
6. P vs E plot for a dielectric.
7. B-H loop of a ferromagnetic material
8. GM tube characteristics
9. Statistical analysis of data , β -count using GM tube
10. Experiments with γ - rays using Na-I detector.

B.E. (Bio-technology): I Year: II Semester

Examination Practical

L T P

Paper III BT 118 Chemistry II Lab.

0 0 3

(Practicals based on course work corresponding to BT 113)

1. Qualitative organic analysis - Analysis of binary organic mixtures- Tests with the mixture, Separation of the mixture, Purification of the separated compounds, Identification of components.
2. Qualitative organic analysis - Element detection, Detection of functional groups, Determination of melting and boiling points, Specific or confirmatory tests, Preparation of suitable derivatives.
3. Quantitative organic analysis - Estimation of sulphur, nitrogen, halogens, aniline, glycine, phenol, glucose, determination of molecular weight.
4. Chemical hydrolysis of a protein, carbohydrate, lipid and characterization of the products.

B.E. (Bio-technology): I Year: II Semester

Examination Practical

L T P

Paper IV BT 119 Mechanical Sciences Lab.

0 0 2

(Practicals based on course work corresponding to BT 114)

1. To verify the law of moments by using bell crank lever.
2. To conduct experiment on simply supported beam for verification of law of moments.
3. To verify the law of polygon of forces by using force table.
4. To find the coefficient of friction between glass and wood.
5. To determine the coefficient of discharge Cd, velocity Cv and contraction Cc of various types of orifices, such as circular square, triangular of various dimensions.
6. To determine the discharge coefficient of various notches such as V-notch, Rectangular notch, trapezoidal notch.
7. To verify the forces in shear legs by graphical method.
8. To study the laminar flow and plot the velocity distribution profile for laminar flow in pipes.
9. To find the forces in various members of truss.
10. To find friction factor for pipes of different diameters of same material.
11. To calibrate venturi meter by establishing the relationship between flow rate and pressure differences and to find its coefficient of discharge.

B.E. (Bio-technology): II Year : III Semester

Examination Theory

L T P

Paper I BT 201 Cell Biology

3 1 0

Cell Theory

Diversity of cell size, shape and structure

Cell cycle – molecular events and model systems

Cellular organelles – Plasma membrane, cell wall and their structural organization, Mitochondria, Chloroplast, Nucleus and other organelles – organization, structure and function, biogenesis of cellular organelles.

Transport of nutrients, ions and macromolecules across membranes

Cell motility – cilia, flagella of prokaryotes and eukaryotes, role of microfilaments and microtubules

Cellular signalling – mechanism of signal transduction, mechanism of cell to cell signaling and intracellular signalling events with special reference to hormones and receptors.

Biology of cancer

Cellular basis of differentiation and development – cell division, gametogenesis, and fertilization

Apoptosis

Reading materials

1. Cell in Development and Inheritance by E.B. Wilson. Publisher : Macmillan.
2. Developmental Biology by S.F. Gilbert. Publisher: Sinauer Associates Inc.
3. Essential Cell Biology : An Introduction to the Molecular Biology of the Cell by B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Roff, K. Robert, P. Walter and K. Roberts. Publisher: Garland Publishers.
4. Fertilization by F.T. Longo. Publisher : Chapman and Hall.

5. Molecular Biology of Steroid and Nuclear Hormone Receptors by L.P. Freedman
Publisher : Birkhuser.
6. Molecular Biology of the Cell by B. Alberts, D. Bray, J. Lewis, M. Roff, K. Roberts and J.D. Watson. Publisher : Garland Publishing Company.
7. Molecular Cell Biology by H. Lodish, A. Berk, S.L. Zipursky, P. Matsudaira, D. Baltimore and J. Darnell. Publisher: W H Freeman and Company.
8. Reproduction in Eukaryotic Cells by D.M Prescott. Publisher : Academic press.
9. The Coiled Spring by Ethan Bier. Publisher : Cold Spring Harbor Press.
10. URL : <http://www.cellbio.com>

(Adapted from UGC model curriculum for Biotechnology, 2001 and modified with suggestions from:

- Prof. P.C. Ghosh, Head, Deptt. Of Biochemistry, Delhi University, South Campus
- Prof. Debi Sarkar, Professor of Biochemistry, Delhi University, South Campus)

B.E. (Bio-technology) II Year : III Semester

Examination Theory

L T P

Paper II BT 202 Biochemistry

3 1 0

Introduction, aims and scope

Chemical foundations of Biology—Properties of water, acids, bases and buffers, covalent bonds, Non-covalent interactions in biological systems.

Introduction to biomolecules -

Carbohydrates – Sugars; Polysaccharides; Glycoproteins - structure and function

Vitamins and Coenzymes

Lipids – classification, structure and function. Lipids and biological membranes, Transport across cell membranes; Lipid linked proteins and lipoproteins.

Proteins - Amino acids and peptides – classification, chemical reactions and physical properties. Introduction to protein structure and function. Enzymes - Introduction to kinetic and catalytic mechanisms of enzymes; Regulation of enzyme activity; Effects of physical parameters on enzyme activity.

Nucleic acids – nitrogenous bases, nucleotides, types, structure and properties of nucleic acids

Separation techniques for biomolecules.

Metabolism and bioenergetics - First and second law, free energy and chemical equilibrium, Organic reaction mechanisms, Design of metabolism - concept of ΔG° , ATP-ADP cycle. Cellular energy transactions – role of mitochondria and chloroplast

Carbohydrate metabolism – glycolysis pathway and reactions, Glycogen breakdown and synthesis, control of glycogen metabolism, glycogen storage and its disease

Citric acid cycle – Overview, Metabolic sources of Acetyl Co-A, enzymes and regulation, The amphibolic nature of the Citric acid cycle

Electron transport chain and oxidative photophosphorylation – mitochondrion and electron transport, phosphorylation and control of ATP production

Gluconeogenesis, The glyoxylate pathway, Biosynthesis of Oligosaccharides and glycoproteins, Pentose phosphate pathway

Lipid metabolism—Lipid digestion, absorption and transport, fatty acid oxidation, ketone bodies, fatty acid biosynthesis, regulation of fatty acid metabolism. Cholesterol and Arachidonic Acid metabolism, Phospholipids, Sphingolipids and Glycolipids

Amino acid metabolism – Amino acid deamination, urea cycle, amino acids as biosynthetic precursors, amino acid biosynthesis, Specialized Products of Amino Acids, Nitrogen fixation

Nucleotide Metabolism - structure and metabolism of purines and pyrimidines, biosynthesis of nucleotide coenzymes ; Heme and Porphyrin Metabolism

Reading materials

1. A Biologist's Guide to Principles and Techniques of Practical Biochemistry by K. Wilson and K.H. Goulding. Publisher : Print India.
2. Biochemical Calculations by I.H. Segal. Publisher : John Wiley and Sons.
3. Biochemistry by C.K. Mathews, K.E. Van Holde and K.G. Ahern. Publisher: Benjamin/Cummings.
4. Biochemistry by L. Stryer. Publishers : W.H. Freeman and Company.
5. Devlin's Textbook of Biochemistry with Clinical correlations. Publisher : John Wiley and Sons Inc.
6. Harper's Biochemistry by K. Robert, M.D. Murray, D.K. Granner, P.A. Mayes and V.I. Rodwell. Publisher: McGraw-Hill/Appleton and Lange.
7. Laboratory Techniques in Biochemistry and Molecular Biology by Work and Work. Publisher : Elsevier Science.
8. Principles of Biochemistry by A.L. Lehninger, D.L. Nelson, M.M. Cox. Publisher: Worth Publishing.
9. Principles of Physical Biochemistry by K.E. Van Holde, W.C. Johnson. Publisher: Prentice Hall.
10. Tools of Biochemistry by T.G. Cooper. Publisher : John Wiley and Sons Inc.

(New course : content developed by Prof. A.K. Dubey and Dr. Sonika Bhatnagar in consultation with Biomolecules course form UGC model curriculum, 2001 and BE201F Biochemistry I course, IIT, Delhi)

B.E. (Bio-technology) II Year : III Semester

Examination Theory

L T P

Paper III BT 203 Microbiology

3 1 0

Introduction and historical perspective – Discovery of the microbial world, controversy over spontaneous generation, role of microorganisms in transformation of organic matter and in the causation of diseases, development of pure culture methods, enrichment culture methods, Milestones of microbiology before and after 20th century.

Methods in Microbiology – Principles of microbial nutrition, Culture media, Theory and practice of sterilization, Pure culture techniques, Enrichment culture techniques for isolation of chemoautotroph, chemoheterotrophs and photosynthetic microorganisms.

Prokaryotic structure and function– functional anatomy of bacteria : cell envelope, cell wall, cytoplasmic membrane, capsule, surface appendages, cytoplasm and cytoplasmic inclusions.

Microbial nutrition and growth – The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen, culture collection and maintenance of cultures.

Overview of basic metabolism and microbial nutrition

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; hydrogen-iron-nitrite-oxidizing bacteria; nitrate and sulfate reduction; methanogenesis and acetogenesis; Fermentations - diversity, syntrophy, role of anoxic decompositions; nitrogen metabolism; nitrogen fixation; hydrocarbon transformation.

Microbial evolution, systematics and taxonomy – evolution of Earth and earliest life forms, primitive organisms and their metabolic strategies and molecular coding – new approaches to bacterial taxonomy, classification including ribotyping, ribosomal RNA sequencing, characteristics of primary domains, taxonomy, nomenclature and Bergey's manual

Prokaryotic diversity - **Bacteria**: purple and green bacteria; Cyanobacteria; Homoacetogenic bacteria, Acetic acid bacteria, Budding and appendaged bacteria; Spirilla; Spirochetes, Gliding and sheathed bacteria; Pseudomonads, Lactic acid and propionic acid bacteria, Endospore forming rods and cocci; Mycobacteria; Rickettsias, Chlamydias, Mycoplasmas. **Archaea**: Archae as earliest life forms, thallopiles, methanogens, hyperthermophilic archae, thermoplasma. **Eukarya**: Algae, fungi, slime molds and protozoa. **Viruses**: Bacterial, plant, animal and tumor viruses; Discovery, classification and structure of viruses; Reproduction and life cycle of RNA and DNA viruses; Virioids and prions

Host-parasite relationship–Normal microflora of skin, oral cavity, gastrointestinal tract; entry of pathogens into the host, colonization factors predisposing to infections, types of toxins (Exo, endo, entro) and their structure, mode of actions, vigilance and pathogenesis. Plant – Microbe Interactions.

Microbial pathogenesis– Disease reservoirs; Epidemiological terminologies; Infectious disease transmission; Respiratory infections caused by bacteria and viruses, Tuberculosis; Sexually transmitted disease including AIDS, Disease transmitted by animals (rabies and plague) and insects and ticks (rickettsias, lyme disease and malaria); Food and water-borne diseases ; Public health and water quality, pathogenic fungi, emerging and resurgent infectious diseases.

Chemotherapy/antibiotics – Antimicrobial agents, sulfa drugs, antibiotics – penicillins and cephalosporins, broad spectrum antibiotics, antibiotics from prokaryotes, antifungal antibiotics; mode of action, resistance to antibiotics

Reading materials

1. Brock Biology of Microorganisms by M.T. Madigan, J.M. Martinko and J. Parker. Publisher : Prentice-Hall, Inc.
2. General microbiology by R.Y. Stanier, J.L. Ingraham, M.L. Wheelis and P.R. Painter. Publisher : Macmillan.
3. Microbial genetics by S.R. Maloy, J.E. Cronan and J.D. Freifelder. Publisher : Bartlett Publishers.

4. Microbiology – A Laboratory Manual by J.G. Cappuccino and N. Sherman. Publisher : Addison-Wesley.
5. Microbiology Applications – (A Laboratory Manual in General Microbiology) by H.J. Benson. Publisher: Wm C Brown Publishers.
6. Microbiology by M.J. Pelczar, E.C.S. Chan and N.R. Kreig. Publisher : Tata McGraw Hill.
7. Principles of Microbiology by R.M. Atlas. Publisher : Wm C. Brown Publishers.
8. The Microbes – An Introduction to their Nature and Importance by P.V. Vandemark and B.L. Batzing. Publishers : Benjamin Cummings.
9. The Microbial World by Roger Y. Stanier. Publisher: Prentice Hall.

(Course content developed in consultation with Microbial physiology and genetics course, UGC model curriculum, 2001 by :

- *Prof. A.K. Dubey, Professor of Biotechnology, NSIT*
- *Prof. R.K. Saxena, Head of Microbiology, Delhi University, South Campus)*

B.E. (Bio-technology) II Year : III Semester

Examination Theory

L T P

Paper IV BT 204 Basics of Computer Systems and Programming 3 1 0

Introduction to computer science– Overview and history of computing; Data storage; Data manipulation; Operating systems and networks.

Introduction to programming – Programming languages; Type of languages; Introduction to number of systems: binary, Octal, Hexadecimal; Introduction to C and C++, Control structures, Data files, Functions, Arrays, Character data, Introduction to object oriented programming.

Reading materials

1. A Book on C by Kelley : Programming in C. Publisher : Addison-Wesley Publishing.
2. Computer Science by J. G. Brookshear. Publisher : Pearson, Addison Wesley.
3. Introduction to C++ for Engineers and Scientists. Publisher : Prentice-Hall
4. Let us C by Y. Kanitker.
5. Schaum's Outline of Introduction to Computer Science by P. Cushman and R. Mata-Toledo. Publisher : McGraw Hill Trade.
6. The Practice of Programming by B.W. Kernighan and R. Pike. Publisher : Addison-Wesley Publishing Company.
7. Programming Languages : Concepts and Constructs by R. Sethi and T. Stone. Publisher : Addison-Wesley Publishing Company.

(Adapted from COE 114 Introduction to programming with modifications suggested by –

- *Faculty members, Computer Engineering Division, NSIT*
- *Professor Ramaswamy, Dean, School of Information Technology, JNU)*

B.E. (Bio-technology) II Year : III Semester

Examination Theory

L T P

Paper V BT 205 Basic Electronics and Instrumentation

3 1 0

Basics of circuit analysis and electrical machines–Circuit elements (R,L, C), Important network theorems (Thevenin, Norton, Superposition), AC circuits, Introduction to DC machines, AC machines and transformer

Electronic devices and circuits–p-n junction diode, BJT, FET and MOSFET, Characteristics and single-stage amplifiers (biasing and frequency response), feedback, stability).

Differential amplifier, Operational amplifier and its linear and non-linear applications.

Electronic instrumentation–Transducers and sensors usually used in bio-medical applications, instrumentation amplifiers, filters (passive and active), oscillators

Waveform generators/oscillators–Waveform generation using Op-Amp comparator, 555 timer IC and its applications – Astable and Monostable

Digital electronics–Logic-gates, Flip-Flops, counters and shift registers, ALU and memories.

Interfacing circuits–Analog to digital and digital to analog converters.

Reading materials

1. Electronic Instrumentation and Measurement Techniques by W.D. Cooper, Helfrick. Publisher : Prentice Hall.
2. Laboratory manual for Microelectronic Circuits by A.S. Sedra and K.C. Smith Publisher : Saunders College Publishing.
3. Microelectronic Circuits (Oxford Series in Electrical Engineering) by A.S. Sedra and K.C. Smith. Publisher : Oxford University Press.
4. Microelectronics by J. Millman and A. Grabel. Publisher: McGraw Hill College Division.

(New Course: The content developed by Mr. R. K. Sharma and Professor Raj Senani, Head, Division of Electronics and Communication Engineering, NSIT)

B.E. (Bio-technology) II Year : III Semester

Examination Practical

L T P

Paper I BT 206 Cell Biology Lab.

0 0 3

(Based on course work corresponding to BT 201)

1. Microscopy: Bright field, phase contrast and fluorescence microscopy.
2. Microtomy
3. Instrumental methods for Cell Biology
4. Subcellular fractionation and marker enzymes
5. Histochemical techniques
6. Mitosis and meiosis

B.E. (Bio-technology) II Year : III Semester

Examination Practical

L T P

Paper II BT 207 Biochemistry and Microbiology Lab.

0 0 3

(Based on course work corresponding to BT 202 and BT 203)

1. Colorimetric determination of pK.
2. Reactions of sugars.

3. Isolation, purity determination and quantitation of DNA.
4. Quantitation of proteins.
5. Preparation of liquid and solid media. Isolation and maintenance of organisms by plating, streaking and serial dilution. Slants and slab cultures. Storage of microorganisms.
6. Growth – growth curve – measurement of bacterial population by turbidometry and dilution methods. Effect of temperature, pH and carbon and nitrogen sources.
7. Microscopic examination of bacteria, yeast and molds and study of organisms by gram stain, acid fast stain and staining for spores

B.E. (Bio-technology) II Year : III Semester

Examination Practical

L T P

**Paper III BT 208 Basics of Computer Systems
and Programming Lab.**

0 0 2

(Based on course work corresponding to BT 204)

1. Simple programs for matrix addition, multiplication, transposition, string searching, binary conversion.
2. Programming for control structures – use of control structures in relevant mathematical problems.
3. Memory reallocation – programming to interchange the values of certain integers.
4. Creation of classes of objects and to use that class to regenerate another class.
5. Inheritance and polymorphism - Creation of abstract classes
6. Data hiding
7. Virtual functions

B.E. (Bio-technology) II Year : III Semester

Examination Practical

L T P

Paper IV BT 209 Basic Electronics and Instrumentation Lab.

0 0 2

(Based on course work corresponding to BT 205)

1. Familiarization with electronic equipments and instruments – measurements of voltage (D.C.,A.C.), Resistance, frequency/time.
2. R.C. low pass, high pass circuits, testing the differentiation and integration.
3. P-N Junction diode, half wave and full wave rectifier with capacitor filter.
4. CE amplifier, frequency response of single stage amplifier,
5. Differential amplifier
6. Applications of operational amplifier
7. Operational amplifier oscillator (Wein bridge)
8. 555 timer IC as a stable multi vibrator
9. Logic gates (verification of truth table of various logic gates)
10. Seven-segment decoder

B.E. (Bio-technology): II Year: IV Semester

Examination Theory

L T P

**Paper I BT 211 Molecular Biology
Introduction to Molecular Biology**

3 1 0

DNA Replication: Prokaryotic and Eukaryotic DNA replication, Mechanism of DNA Replication, Enzymes and accessory proteins involved in DNA replication

DNA repair and recombination; Gene Concepts in Molecular Biology

Transcription: Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements and mechanism of transcription regulation, transcriptional and post-transcriptional gene silencing

Modifications in RNA: 5'-cap formation, transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA and mRNA stability; Ribosome; Genetic Code;

Translation: Prokaryotic and Eukaryotic translation, the translation Machinery; Mechanisms of initiation, elongation and termination, regulation of translation, co- and post-translational modifications of proteins

Protein targetting - synthesis of secretory and membrane proteins, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis;

Regulation of Gene Expression in prokaryotic and eukaryotic systems - Transposons and Retrotransposons

Oncogenes and Tumor Suppressor Genes: Viral and cellular oncogenes, tumor suppressor genes from humans, structure, function and mechanism of action of pRB and p53 tumor suppressor proteins

Antisense and Ribozyme technology – Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of Ribozyme; Hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies.

Homologous recombination – Holliday Junction, gene targeting and gene disruption, FLP/FRT and Cre/Lox recombination, Rec A and other recombinases

Genome sequencing – Genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, strategies for sequencing genome, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes.

Reading materials

1. Gene VII by B. Lewin. Publisher : Oxford University Press.
2. Genomes by T.A. Brown. Publisher : John Wiley and Sons Inc.
3. Introduction to Practical Molecular Biology by P.D. Dabre. Publisher : John Wiley and Sons Inc.
4. Molecular Biology LabFax by T.A. Brown. Publisher : Bios Scientific Ltd. Oxford.
5. Molecular Biology of the Cell by B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Publisher: Garland Publishing.
6. Molecular Biology of the Gene by J.D. Watson, A.M. Weiner and N.H. Hopkins. Publisher: Addison-Wesley Publishing.
7. Molecular Cell Biology by H. Lodish, A. Berk, S. Zipursky, P. Matsudaira, D. Baltimore and J.E Darnell. Publisher: W.H. Freeman and Company.
8. Molecular Cloning : A Laboratory Manual (3-Volume Set) by J. Sambrook, E.F. Fritsch and T. Maniatis. Publisher : Cold spring Harbor Laboratory Press.

(Course content discussed with Prof. R.K. Bhatnagar, Chairman, Center for Biotechnology, JNU and adopted from UGC model curriculum, Biotechnology 2001 with a few modifications.)

B.E. (Bio-technology) II Year : IV Semester

Examination Theory

L T P

Paper II BT 212 Genetics

3 1 0

The science of genetics – introduction, history, classical and molecular genetics, role of genetics in medicine, agriculture and society.

Reproduction – The basis of heredity, chromosomes, cell cycle, mitosis and meiosis, oogenesis, spermatogenesis, gamete formation in plants, life cycle of some genetically important organisms – *E.Coli*, *yeast* and *drosophila*.

Mendelism – Mendelian inheritance and its applications, Mendelian principles in human genetics and in agriculture.

Extension of Mendelism - Allelic variations, influence of environment on expression, penetrance and expressivity, epistasis, pleiotropy, genetic basis of continuous phenotypic variety.

Chromosomal basis of inheritance ; sex linkage, linkage, crossing over and chromosome mapping in eukaryotes.

Molecular mapping of the genome – genetic and physical maps, physical mapping and map based cloning, choice of mapping population, simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis; RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes; Applications of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. Animal trafficking and poaching, germplasm maintenance, taxonomy and biodiversity

Mechanism of genetic change – mutation and mutagenesis, recombination and transposable elements

Microbial genetics – bacterial genetic system, mechanism of gene transfer in bacteria, recombination, plasmids and transposons, bacterial genetic map with reference to *E.Coli*. Viruses and their genetic system, extrachromosomal inheritance in microbial systems.

Fine structure and Definition of the gene

Genetics of Population – Hardy- Weinburg Law and its deviations

Extranuclear Inheritance in Higher Plants. Overview of the mitochondrial and chloroplast Genome.

Principles of Plant Breeding: Objectives, Selfing and Crossing Techniques. Male sterility, incompatibility, Hybrid vigour

Reading materials

1. Genetics by M.W. Strickberger. Publisher: Prentice Hall College Division.
2. Genetics by R. Levine. Publisher : International Thomson Publishing.
3. Genetics by U. Goodenough. Publisher : International Thomson Publishing.
4. Introduction to Genetic Analysis by A.J.F. Griffiths. Publisher : W.H. Freeman and Company.

5. Modern Genetic Analysis: Integrating Genes and Genomes by A.J. F. Griffiths, W.M. Gelbart, R.C. Lewontin and J.H. Miller. Publisher: W.H. Freeman and Company.
6. Primer on Molecular Genetics by D. Casey.
<http://www.genome.iastate.edu/edu/doe/>
7. Principles of Genetics by D.P. Snustad and M.J. Simmons. Publisher: John Wiley and Sons Inc.

(New Course – content developed by :

- Prof. Sheela Srivastava, Head of Genetics and Dean, Faculty of interdisciplinary and applied sciences, University of Delhi South Campus
- Prof. Akshay Pradhan, Professor of Genetics, University of Delhi, South Campus and
- Dr. Pradeep Burma, Reader of Genetics, University of Delhi, South Campus)

B.E. (Bio-technology) II Year : IV Semester

Examination Theory

L T P

Paper III BT 213 Methods and Instrumentation in Biotechnology 3 1 0

Ultracentrifugation: Viscosity and diffusion, Sedimentation equilibrium and sedimentation velocity methods, Analytical and Preparative centrifuges, application of density gradient and differential centrifugation.

Electrophoresis: Paper and gel electrophoresis, Immuno electrophoresis, isoelectric focussing, two - dimensional electrophoresis, capillary electrophoresis.

Chromatography: Paper, TLC gas chromatography, gel filtration, ion-exchange chromatography, affinity chromatography and HPLC, FPLC, adsorption and desorption.

Spectroscopies : UV and visible, spectrofluorimetry, Atomic absorption spectrophotometry, Mass Spectrometry, Infrared and Raman Spectroscopy, Mossbauer, MALDITOF, ORD and Circular Dichorism, Nuclear Magnetic Resonance and Electron Spin Resonance spectroscopy, Magnetic Resonance Imaging.

Microscopy : Optical and Electron Microscopy, Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Polarization and Fluorescence microscopy

Diffraction techniques - X - Ray diffraction, Electron diffraction, Neutron Diffraction.

Lasers and holography

Radioisotope Techniques : Radio tracers, GM Counter, Proportional and Scintillation Counters, autoradiography, radio - immunoassay.

Cell disruption Techniques, Dialysis and ultrafiltration.

Reading materials

1. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes by J.F. Van Impe. Publisher : Kluwer Academic.
2. Biophysical Chemistry : The conformation of Biological Macromolecules by C.R. Cantor and P.R. Schimmel. Publisher : W.H. Freeman.
3. Crystal Structure Analysis by J.P. Glusker and K.N. Trueblood. Publisher: Oxford University Press.

4. Crystallography made Crystal Clear by G. Rhodes. Publisher : Academic Press.
 5. Elements of X-Ray Diffraction by B.D. Cullity, S.R. Stock and S. Stock. Publisher : Prentice Hall College Division.
 6. Essentials of Biophysics by P. Narayanan. Publishers : New Age International Publishers.
 7. Introduction to Spectroscopy by D.L. Pavia, G.M. Lampman and G. S. Kriz. Publisher: Brooks Cole.
 8. Modern Spectroscopy by J. M. Hollas. Publisher: John Wiley and Son Ltd.
 9. Molecular Spectroscopy by J. L. McHale. Publisher : Prentice Hall.
 10. NMR Spectroscopy: Basic Principles, Concepts, and Applications in Chemistry, by H. Günther. Publisher : John Wiley and Sons Ltd.
 11. Physical Chemistry by D. Freifelder. Publisher : Freeman
 12. Physical Chemistry of Macromolecules by C. Tanford. Publisher : John Wiley and Sons Inc.
 13. Physical Methods In Bioinorganic Chemistry: Spectroscopy and Magnetism by L. Que. Publisher : Junior University Science Books.
 14. Practical Protein Crystallography by D.E. McRee and P.R. David. Publisher : Academic Press.
 15. Principles of Physical Biochemistry by K.E. Van Holde. Publisher: Prentice Hall.
 16. Principles of Protein X-Ray Crystallography (Springer Advanced Texts in Chemistry) by J. Drenth. Publisher : Springer Verlag.
- (*New course – content developed by :*
- *Prof. A.K. Dubey, Professor of Biotechnology, NSIT*
 - *Dr. Sonika Bhatnagar, Lecturer, School of Applied Science, NSIT*
 - *Dr. Ravi Tiwari, Lecturer, Instrumentation and Control Engineering, NSIT)*

B.E. (Bio-technology) II Year : IV Semester

Examination Theory

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Paper IV BT 214 Statistics for Biology

3 1 0

Introduction: Types of study designs, Concept of Bios, confounding, interaction and role of chance. Probability calculation: (Classical and Axiomatic definition of probability), Theorems of addition and Compound probability, Conditional probability, Expectation, Baye's theorem, Bayesian analysis. Continuous frequency distribution: Moments, Rectangular distribution, Exponential Distribution, Beta distribution of first and second kind, Gamma distribution, Marginal and conditional probabilities, Tchebycheff's and Markov's inequalities. Markov chains and random walk; Important theoretical distributions: Binomial, Poisson, Normal and Multinomial distributions and their properties, Fitting of Normal distribution by method of areas and method of ordinates. Dirichlet distributions. Moment generating functions and cumulants, Weak law of large numbers, Central limit theorem. Method of least square: Fitting of straight lines, parabola and exponential curves. Bivariate distribution, Correlation and Regression, Probable error, Rank correlation. Simple sampling of attributes: Large samples, mean and S.D. in simple sampling of attributes, Test of significance for large samples, Standard error, Null hypothesis, Confidence limits, Chi-Square distribution, Degree of freedom, m.g.f. of Chi square distribution, Level of significance, Test of goodness of fit, Test of independence, Coefficient of contingency, Yate's correction for continuity. Sampling of variables: Small

samples, t-distribution, test of significance of the mean of random sample from normal population, F-distribution, ANOVA.

Information theory - Information and Uncertainty, Entropy, Applications to molecular biology, pitfalls in information theory, consensus sequences, sequence logos, theory of molecular machines, nanotechnology.

Reading materials

1. Data Analysis and Classification for Bioinformatics by A. Jagota. Publisher: Bioinformatics By The Bay Press.
2. Introduction to Probability Theory by P.G. Hoel. Publisher: Houghton Mifflin College.
3. Introduction to Statistical Theory by P.G. Hoel, S.C. Port, C.J. Stone. Publisher: Houghton Mifflin College.
4. Schaum's Outline of Probability and Statistics by M.R. Spiegel, J.J. Schiller, R. A. Srinivasan, A. Srinivasan. Publisher: McGraw-Hill Trade.
5. Schaum's Outline of Probability, Random Variables and Random Processes by H.P. Hsu. Publisher: McGraw-Hill Trade.
6. Statistical Inference (The Wadsworth and Brooks/Cole Statistics/Probability Series) by G. Casella and R.L. Berger. Publisher: Brooks/Cole Pub Company.
7. Statistical Methods in Bioinformatics: An Introduction by G.R. Grant, W.J. Ewens. Publisher : Springer Verlag.
8. Statistics of Extremes by E.J. Gumbel. Publisher :Columbia University Press.

(Course content : developed by Dr. Sonika Bhatnagar, Lecturer in Biotechnology, NSIT in consultation with the Biostatistics course at A.I.I.M.S., statistics course at J.N.U. and inputs from Prof. R. Ramaswamy, Dean, School of Information Technology, J.N.U.)

B.E. (Bio-technology) II Year : IV Semester

Examination Theory

L T P

Paper V BT 215 Data Structures and Algorithms

3 1 0

Introduction

Programming strategies – Objects and ADTs with example, Constructors and destructors, Data structure, methods, Pre and post conditions, C conventions, Error handling, Some programming language notes.

Data structures – Arrays ; lists; stacks and stack frames; Recursion – Recursive functions with example of factorial.

Searching – Sequential and binary search, Trees.

Complexity - Complexity (PS)

Queues – Priority queues and heaps

Sorting – Bubble, Heap, Quick, Bin, Radix

Searching revisited – Red-Black trees, AVL trees, General n-ary trees, hash tables;

Dynamic algorithm – Fibonacci numbers, binomial coefficients, optimal binary search trees, matrix chain multiplication, longest common subsequence, optimal triangulation.

Graphs – Minimum spanning tree and Dijkstra's algorithm.

Huffman encoding

FFT

Hard or intractable problems – Eulerian or Hamiltonian paths, Travelling salesman problem

Reading materials

1. Data Structures and Algorithms by A.V. Aho, J.E. Hopcroft and J. Ullman. Publisher: Addison-Wesley Publishing.
2. Database Design, Development and Deployment with Student CD by P. Rob and E. Semaan. Publisher: McGraw-Hill/Irwin.
3. Database system concepts by A. Silberschatz, P.B. Galvin and G. Gagne. Publisher : John Wiley and Sons Inc.
4. Introduction to Data Structures and Application by J. Tremblay and P.G.Sorensen. Publisher : McGraw Hill College Division.
5. Schaum's Outline of Data Structures with C++ by J.R. Hubbard. Publisher : McGrawHill Trade.

(Adapted from COE 213 Data structure at NSIT with modifications incorporated by:

- *Ms. Anubha Gupta, Assistant Professor, Division of Computer Engineering, NSIT*
- *Anand Gupta, Lecturer, Division of Computer Engineering, NSIT)*

B.E. (Bio-technology) II Year : IV Semester

Examination Practical

L T P

Paper I BT 216 Molecular Biology and Genetics Lab.

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(Based on course work corresponding to BT 211 and BT 212)

1. Preparation of DNA : genomic, plasmid and lambda Phage
2. Isolation of RNA : total RNA and mRNA.
3. RFLP analysis
4. Mutation: Isolation and screening of mutants, e.g., colour mutation in fungi, Aspergillus; Bacterial mutation involving antibiotic resistance
5. Bacterial transformation, transduction and conjugation
6. Recombination Experiments: Linkage analysis in Drosophila
7. Karyotype- discussion of human genetic disorders – Staining of plant cells to study chromosomes.

B.E. (Bio-technology) II Year : IV Semester

Examination Practical

L T P

Paper II BT 217 Methods and Instrumentation in Biotechnology Lab

0 0 3

(Based on course work corresponding to BT 213)

1. Cell disruption techniques
2. Centrifugation – low speed and high speed.
3. Spectrophotometric techniques
4. Chromatography – ion exchange, gel filtration and affinity columns - sample application, fraction collection, monitoring UV absorbance. Applications in enzyme purification

5. Techniques for removal of salt/solvent from a sample – desalting, dialysis, ultrafiltration, speedvac, lyophilization etc.
6. Electrophoresis – 1D and 2D. Isoelectric focusing
7. Polarization and fluorescence microscopy

B.E. (Bio-technology) II Year : IV Semester

Examination Practical

L T P

Paper III BT 218 Data Structure Lab.

0 0 3

(Based on course work corresponding to BT 215)

1. Stack implementation through arrays, link list
2. Programs for recursion functions
3. Implementation of queues and leap structures
4. Application of binary trees in pre-order, post-order and in-order evaluation
5. Implementation of hash tables in strings and sequences
6. AVL tree implementation
7. Implementation of optimal binary search
8. Optimal matrix multiplication
9. Computation of binary coefficients of an expression.
10. Finding the minimum spanning graph – depth first and breadth first.

B.E. (Bio-technology) II Year : IV Semester

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Sessional Paper

Paper I BT 219 Project

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B.E. (Bio-technology) III Year : V Semester

Examination Theory

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Paper I BT 301 Structural Biology

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Chemistry of amino acids and peptides (side chain structure and function in protein folding and functionality): Secondary structure of proteins - helices, sheets, loops and turns ; Structural and functional proteins. Tertiary structure of proteins, homo and hetero-dimers, trimers and tetramers; forces governing protein-protein interactions; open tertiary structure; Classification of proteins; Structure and function of an antibody; structure of hemoglobin, muscle proteins; Sequence and structural motifs in proteins.

Protein-ligand interactions: Lock and key versus handshake mechanism of substrate recognition; structural basis of recognition ; reaction mechanisms of enzymes, G-Protein coupled receptors.

Protein solubility, protein stability and stabilization: salting in and salting out, Parameters affecting; enthalpic and entropic stabilization, mutations increasing stability, helix capping; Native, partially denatured and denatured proteins; Protein denaturation, Physical and chemical denaturants; Refolding

DNA structure: covalent structure of DNA, base pairing, hydrogen bonding, DNA melting and annealing, difference between AT and GC pairing, DNA models, The Watson Crick model; Crystal structure of B-DNA, major and minor grooves, dyad symmetry, base pair stacking, propellor twist, A and Z- DNA, triple stranded DNA, telomeric sequences and structure, G-quartets, palindromic and tandem sequences, Base pair flipping and DNA bulges, DNA methylation; Protein-DNA interactions; drug-DNA

interactions; Databases of sequences and structure for protein and DNA, public domain softwares for visualizing and modeling biomolecules – Rasmol, Deepview, Whatif.

Reading materials

1. Biochemistry by R.H. Abeles, P.A. Frey and W.A. Jencks. Publisher : Jones and Bartlett Publications
2. Crystallization by J. W. Mullin. Publisher : Butterworth Heinemann Publications
Crystallization of Biological Macromolecules by A. McPherson. Publisher : Cold Spring Harbor Laboratory Press.
3. Essentials of Molecular Biology by D. Freifelder. Publisher : Jones and Bartlett Publications.
4. Genes VII by B. Lewin. Publisher : Oxford University Press.
5. Introduction to Protein Architecture: The Structural Biology of Proteins by A.M. Lesk. Publisher : Oxford University Press.
6. Introduction to Protein Structure by C. Branden and J. Tooze. Publisher : Garland Publishing Company.
7. Physical Chemistry by C.R. Cantor and P.R. Schimmel. Publisher : W.H Freeman.
8. Protein Structure by M. Perutz. Publisher : Oxford University Press.
9. Proteins (Structures and Molecular Properties) by T.E. Creighton. Publishers : W.H. Freeman and Company.

(New course – content developed by Dr. Sonika Bhatnagar, Lecturer, School of Applied Science in keeping with suggestions received from :

- Prof. T.P. Singh, Head, Department of Biophysics, A.I.I.M.S.
- Dr. A. Srinivasan, Assistant Professor, Department of Biophysics, A.I.I.M.S.)

B.E. (Bio-technology) III Year: V Semester

Examination Theory

L T P

Paper II BT 302 Immunology and Immuno-Technology

3 1 0

Introduction: Phylogeny of Immune System, Innate and acquired immunity, clonal nature of immune response

Organization and structure of lymphoid organs

Nature and Biology of antigens and super antigens

Antibody structure and function

Antigen antibody interactions; Types of immunity- innate, acquired, active and passive, antigen - antibody reactions,

Major histocompatibility complex

BCR and TCR, generation of diversity

Complement system

Cells of the immune system ; hematopoiesis and differentiation, lymphocyte trafficking, B-Lymphocytes, T-Lymphocytes, macrophages, dendritic cells, natural killer, lymphokines and lymphokine activated killer cells, eosinophils, neutrophils and mast cells

Regulation of immune response - antigen processing and presentation, generation of humoral and cell mediated immune responses, activation of B and T lymphocytes, cytokines and their role in immune regulation, T cell regulation and MHC restriction, immunological tolerance

Cell mediated toxicity - mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated toxicity, cytotoxicity and macrophage mediated cytotoxicity.

Hypersensitivity.

Autoimmunity

Tumor immunology

Immunity to infectious agents

Tissue and organ transplant

Synthetic vaccines - ideotype network hypothesis, epitope mapping

Immunological Techniques: Immuno diffusion, immuno-electrophoresis, ELISA, RIA, fluorescence activated cell sorter

Hybridoma technology - Fusion of myeloma cells with lymphocytes

Production of monoclonal antibodies and their application.

Reading materials

1. Basic Immunology by A.K. Abbas and A.H. Lichtman. Publisher : Saunders W.B. Company.
2. Basic Immunology by A.K. Abbas and A.H. Lichtman. Publisher : Saunders W.B. Company.
3. Fundamentals of Immunology by W. Paul. Publisher : Lippincott Williams and Wilkins.
4. Immunology by W.L. Anderson. Publisher : Fence Creek Publishing (Blackwell).
5. Immunology : A Short Course by E. Benjamin, R. Coico and G. Sunshine. Publisher : Wiley-Leiss Inc.
6. Immunology by Roitt. Publisher : Mosby – Yearbook Inc.
7. Kuby Immunology by R.A. Goldsby, T.J. Kindt, and B.A. Osborne. Publisher : Freeman.
8. Perkin Elmer Antibody Manual.
9. Production of Monoclonal Antibodies - Detailed Protocol by G.K. Lewis, University of Maryland.

(Course content - compiled by Prof. A. K. Dubey, Professor of Biotechnology, NSIT in consultation with UGC model curriculum and inputs from :

- Prof. R.K. Bhatnagar, Chairman, Center for Biotechnology, JNU
- Dr. J.S. Viridi, Reader, Department of Microbiology, Delhi University, South Campus)

B.E. (Bio-technology) III Year : V Semester

Examination Theory

Paper III BT 303 Recombinant DNA Technology I

Introduction to Recombinant-DNA technology

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Milestones - Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression, cloning and patenting of life forms, genetic engineering guidelines

Tools used in r-DNA technology - Restriction endonucleases, methyltransferases, Ligases, Polymerases, Kinase, Phosphatase, Nucleases; DNA and RNA markers, Lambda and M13 phage - molecular Biology

Nucleic acid amplification and its applications

Gene cloning vectors – Plasmids, bacteriophages, phagemids, cosmids, artificial chromosomes

Restriction mapping of DNA fragments and map construction

cDNA synthesis and cloning – mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis, Construction of cDNA and Genomic libraries

Alternative Cloning Strategies – cloning interacting genes, two and three hybrid systems, cloning differentially expressed genes, nucleic acid microarrays, Screening of recombinant clones PCR.

Reading materials

1. A Guide to Molecular Cloning Techniques by S.L. Berger and A.R. Kimmel in Methods in Enzymology –Vol 152. Publisher : Academic Press Inc.
2. DNA Cloning : A Practical Approach by D.M. Glover and B.D. Hames. Publisher : IRL Press.
3. DNA Science: A First Course in Recombinant DNA Technology by D. Micklos. Publisher : Carolina Biological Supply Company.
4. Gene Expression Technology by D.V. Goeddel in Methods in Enzymology Vol. 185. Publisher : Academic Press Inc.
5. Laboratory DNA Science: An Introduction to Recombinant DNA Techniques and Methods of Genome Analysis by M.V. Bloom. Publisher : Addison-Wesley Publishing.
6. Milestones in Biotechnology : Classic Papers on Genetic Engineering by J.A. Davies and W.S. Reznikoff. Publisher : Butterworth Heinemann.
7. Molecular and Cellular Methods in Biology and Medicine by P.B. Kaufman, W. Wu, D. Kim and C.J. Cseke. Publisher : CRC Press.
8. Molecular Biotechnology: Principles and Applications of Recombinant DNA by B.R. Glick and J.J. Pasternak. Publisher : ASM Press.
9. Molecular Cloning: A Laboratory Manual (3-Volume Set) by J. Sambrook, E.F. Fritsch and T. Maniatis. Publisher : Cold spring Harbor Laboratory Press.
10. Principles of Gene Manipulation: An Introduction to Genetic Engineering (Studies in Microbiology) by R. W. Old and S. B. Primrose. Publisher : Blackwell Science Inc.
11. Recombinant DNA by J.D. Watson et al. Publisher : W.H. Freeman and Company.
12. Route Maps in Gene Technology by M.R. Walker and R. Rapley. Publisher : Blackwell Science Ltd.

(Adopted from Genetic Engineering course from UGC model curriculum for Biotechnology, 2001.)

B.E. (Bio-technology) III Year : V Semester

Examination Theory

L T P

Paper IV BT 304 Database Management Systems

3 1 0

Overview and historical perspective - file systems vs. DBMS, advantages of DBMS; **Describing and storing data in DBMS** – levels of abstraction and data independence; Data models and their comparison; Entity relationship model – concepts, design, keys and features; Relational model – introduction, structure of the relational databases, integrity constraints, Relational algebra and calculus – selection and projection, set operations, renaming, Joins, Division etc.

SQL and Perl

Database design – Pitfalls in database design, decomposition, functional dependencies, Normal forms ; Concurrency control and database discovery – concept of transaction : atomicity, consistency, isolation and durability, transactions and schedules, concurrent execution of transactions, Lock based concurrency control, Database recovery

Current trends -Distributed databases and multimedia databases ;

Data warehousing – The evolution of Data management paradigms, Data warehouses; The data warehouse development lifecycle; Dimensional data modeling; Data Warehouse architecture and physical design; Data preparation and design

Data mining – Data mining primitives, languages and system architecture; Concept description-characterization and comparison; Mining complex types of data, Applications.

Reading materials

1. Data Mining : Concept and techniques by J. Han and M. Kamber. Publisher : Morgan Kaufman.
2. Data Mining by A.K. Pujari. Publisher : Sangam Books Ltd.
3. Database Management by P.C. Desai
4. Introduction to Database Systems by C.J. Date. Publisher : Addison Wesley Publishing.
5. Principles of Database and Knowledge Based systems by J.D. Ullman. Publisher : Computer Science Press.
6. The Data Warehouse Lifecycle Toolkit. Publisher : John Wiley and Sons Inc.
7. The Data Warehouse Toolkit by R. Kimball et al. Publisher : John Wiley and Sons Inc.

(New course : designed by Mr. Anand Gupta, Lecturer, Division of Computer engineering in consultation with Prof. S. Gupta, Department of Computer Science and engineering, Indian Institute of Technology-Delhi)

B.E. (Bio-technology) III Year : V Semester

Examination Theory

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Paper V BT 305 Chemical Engineering Principles

3 1 0

Material and Energy Balances – Units and dimensions, Dimensional analysis; Simple problems on material balance calculations involving unit processes and reactive systems; Available electron balances.

Basic energy concepts – enthalpy changes in chemical / biochemical reactions and in non-reactive processes, Energy balance calculations, Use of Steam tables; Heat of reaction and energy balance for microbial processes.

Chemical reaction engineering – Kinetics of homogenous reactions : Concepts of reaction rate, order of reaction and molecularity, Analysis of batch reactors for kinetic interpretation of data and isothermal reactor design for single and multiple reactions, Design equations for CSTR and plug flow reactors.

Introduction to design of heterogenous reacting systems, Concepts of non-ideality, Age distribution function and inter-relationship.

Instrumentation and process control – Principles of measurement: error, accuracy and sensitivity; Measurement of flow, pressure, temperature, level, pH, viscosity and chemical composition.

Basic concepts of feedback control, control loop and its elements, Dynamic behaviour of first, second and higher order physical systems, controller hardware, choice of controllers and settings. Introduction to advanced control systems: feed forward, cascade and ratio control.

Reading materials

1. Basic Principles and Calculations in Chemical Engineering by D.M. Himmelblau. Publisher :Prentice Hall.
2. Basic Principles of Chemical Engineering by E.I. Shaheen. Publisher : Houghton Mifflin.
3. Chemical Process Control, An introduction to Theory and Practice by G. Stephanopoulos. Publisher : Prentice Hall Inc.
4. Chemical Reaction Engineering by O.Levenspiel. Publisher : John Wiley and Sons Inc.
5. Coulson's and Richardson's Chemical Engineering by J.F. Richardson and D.G. Peacock. Publisher : Asian Books.
6. Elementary Principles of Chemical Processes by R.M. Felder and R.W. Rousseau. Publisher : John Wiley and Sons Inc.
7. Fundamentals of Chemical Reaction Engineering, by C.D Holland and R.G. Anthony. Publisher : Prentice Hall Inc.
8. Process Modelling, Simulation and Control for Chemical Engineers by W.L. Luyben. Publisher : McGraw Hill.

(New course : Content provided by Prof. Subhash Chand, Professor, Deptt. of Biochemical Engineering and Biotechnology, IIT, Delhi)

B.E. (Bio-technology) III Year : V Semester

Examination Practical

Paper I BT 306 Structural Biology Lab.

(Based on course work corresponding to BT 301)

1. Chemical modification of proteins

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2. Peptide mapping
3. Analysis of amino acid composition.
4. Analysis and interpretation of Spectrophotometric data for denaturation studies.
5. Analysis of CD data
6. Analysis and interpretation of NMR data
7. Crystallization of Lysozyme – pH driven and salt driven crystallization. Effect of concentration. BMCD
8. Analysis and interpretation of X-Ray crystallographic data
9. Public domain software for structure modeling and visualization.

B.E. (Bio-technology) III Year : V Semester

Examination Practical

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Paper II BT 307 Immunology and Immuno-Technology Lab.

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(Based on course work corresponding to BT 302)

1. Blood film preparation and identification of cells .
2. Lymphoid organs and their microscopic organization.
3. Immunization , collection of serum.
4. Purification of IgG from serum.
5. Separation of mononuclear cells by Ficoll-Hypaque.
6. Con-A induced proliferation of thymocytes (by MTT method).
7. Elisa.
8. Hapten conjugation and quantitation.

B.E. (Bio-technology) III Year : V Semester

Examination Practical

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Paper III BT 308 Recombinant-DNA Technology I Lab.

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(Based on course work corresponding to BT 303)

1. Quantitation of nucleic acids.
2. Construction of restriction map of plasmid DNA.
3. Cloning in plasmid /phagemid vectors.
4. Preparation of probes.
5. Blotting and Hybridization techniques.
6. PCR amplification.

B.E. (Bio-technology) III Year : V Semester

Examination Practical

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Paper IV BT 309 Database Management Lab.

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(Based on the course work BT 304)

1. Database creation using DDL and DML.
2. Defining the primary and secondary keys.
3. Implementation of selection, projection and joins (internal and external) with SQL and Perl
4. Normalization of databases with SQL and Perl
5. Implementation of transactions and schedules.
6. Detection of association rules and knowledge recovery.
7. Using genetic algorithm and neural networks for knowledge extraction
8. Implementation of anomaly detection/ knowledge detection algorithms.

9. Physical design of data warehouse.

B.E. (Bio-technology) III Year : V Semester **L T P**
Sessional Paper **0 0 2**
Sessional I BT 310 Term paper and seminar

B.E. (Bio-technology) III Year : VI Semester
Examination Theory **L T P**
Paper I BT 311 Recombinant DNA Technology II **3 1 0**
Site Directed Mutagenesis and protein engineering

Expression systems

How to study gene regulation – DNA transfection, Northern Blot, Primer extension, S1 mapping, RNAase

Cloning in mammalian and plant systems

Expression strategies for heterologous genes – vector engineering and codon optimization, host engineering, In vitro transcription and Translation, expression in bacteria, expression in yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants

Phage display

T-DNA and transposon tagging – Role of gene tagging in gene analysis, T-DNA and transposon tagging, identification and isolation of genes through T-DNA or transposon

Transgenics and gene knockout technologies – targeted gene replacement, chromosome engineering

Gene therapy – vector engineering, strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing

Tissue Engineering

Reading materials

1. A guide to Molecular cloning techniques by S.L. Berger and A.R. Kimmel in Methods in Enzymology –Vol 152. Publisher : Academic Press Inc.
2. DNA Cloning : A Practical Approach by D.M. Glover and B.D. Hames. Publisher : IRL Press.
3. DNA Science: A First Course in Recombinant DNA Technology by D. Micklos. Publisher : Carolina Biological supply Company
4. Gene expression Technology by D.V. Goeddel in Methods in Enzymology Vol. 185. Publisher : Academic Press Inc.
5. Laboratory DNA Science: An Introduction to Recombinant DNA Techniques and Methods of Genome Analysis by M.V. Bloom. Publisher : Addison-Wesley Publication Company
6. Milestones in Biotechnology : Classic Papers on Genetic Engineering by J.A. Davies and W.S. Reznikoff. Publisher : Butterworth Heinemann.
7. Molecular and Cellular methods in Biology and Medicine by P.B. Kaufman, W. Wu, D. Kim and C.J. Cseke. Publisher : CRC Press.
8. Molecular Biotechnology: Principles and Applications of Recombinant DNA, by B.R. Glick and J.J. Pasternak. Publisher : ASM Press.

9. Molecular Cloning: A Laboratory Manual (3-Volume Set) by J. Sambrook, E.F. Fritsch and T. Maniatis. Publisher : Cold spring Harbor Laboratory Press.
10. Principles of Gene Manipulation: An Introduction to Genetic Engineering (Studies in Microbiology) by R. W. Old and S. B. Primrose. Publisher : Blackwell Science Inc.
11. Recombinant DNA by J.D. Watson et al. Publisher : W.H. Freeman and Company.
12. Route Maps in Gene Technology by M.R. Walker and R. Rapley. Publisher : Blackwell Science Ltd.

(Adopted from Genetic Engineering course from UGC model curriculum for Biotechnology, 2001.)

B.E. (Bio-technology) III Year : VI Semester

Examination Theory

L T P

Paper II BT 312 Enzymology and Enzyme Technology

3 1 0

Enzymes: Introduction and scope, Nomenclature, Mechanism of Catalysis, Industrial applications.

Enzyme Kinetics: Single substrate steady state kinetics; King-Altman's method; Inhibitors and activators; Multi-substrate systems; Effect of pH and temperature; Allosteric enzymes.

Immobilization of Enzymes: Advantages, Carriers, adsorption, covalent coupling, cross-linking and entrapment methods, Micro-environmental effects

Enzyme Reactors: reactors for batch/continuous enzymatic processing, Choice of reactor type: idealized enzyme reactor systems; Mass Transfer in Enzyme Reactors: Steady state analysis of mass transfer and biochemical reaction in enzyme reactors.

Bio-process Design: Physical parameters, reactor operational stability; Immobilized cells.

Challenges and future trends : Enzyme catalysis in organic media; Catalytic antibodies and Non-protein biomolecules as catalysts, Biocatalysts from Extreme Thermophilic and Hyperthermophilic Archaea and Bacteria.

Reading materials

1. Biotechnological Innovations in Chemical Synthesis by R.C.B. Currell, V.D. Mieras, Biotol Partners Staff. Publisher : Butterworth Heinemann.
2. Enzyme Kinetics : Behavior and Analysis of Rapid Equilibrium and Steady-State Enzyme Systems by I.H. Segel. Publisher : Wiley-Interscience.
3. Enzyme Technology by M.F. Chaplin and C. Bucke. Publisher : Cambridge University Press.
4. Enzymes : A Practical Introduction to Structure, Mechanism, and Data Analysis by R.A. Copeland. Publisher : John Wiley and Sons Inc.
5. Industrial Enzymes and their Applications by H. Uhlig. Publisher : John Wiley and Sons Inc.
6. Introduction to Biocatalysis using Enzymes and Micro-Organisms by S.M. Roberts, N.J. Turner and A.J. Willetts. Publisher : Cambridge University Press.

7. Introduction to Protein Structure by C. Branden and J. Tooze. Publisher : Garland.
8. Proteins – Structure and Molecular properties by T.E. Creighton. Publisher : W.H. Freeman and Company.
9. Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding by A. Fersht. Publisher : W.H. Freeman and Company.

(Course content : developed by Professor A. K. Dubey, Professor of Biotechnology in using the contents of BE403F Enzyme engineering and Technology at IIT, Delhi and in consultation with :

- Prof. M.N. Gupta, Professor of Chemistry, IIT, Delhi.
- Prof. R.K. Saxena, Head, Department of Microbiology, Delhi University, South Campus)

B.E. (Bio-technology) III Year : VI Semester

Examination Theory

L T P

Paper III BT 313 Plant and Animal Biotechnology

3 1 0

Plant Biotechnology – Historical perspectives, tissue culture lab. Organization, sterilization techniques, nutrient media, culture techniques- callus cultures, cell cultures and protoplast cultures, plant regeneration pathways – role of phytohormones, organogenesis and somatic embryogenesis, applications of plant tissue and cell culture- micropropagation, pathogen free plants, secondary metabolites, production of haploids, somaclonal variation, preservation of germplasm, Genetic engineering in plants- transformation vectors, Gene transfer techniques – vector mediated and vectorless gene transfer, transgenic plants – trans gene integration and expression, trans gene silencing, protein targeting, chloroplast transformation, targeted gene transfer, transgenic crops with new traits – herbicide tolerance, insect and disease resistance, nutrient quality, post harvest quality traits, metabolic engineering – therapeutic proteins and compounds, oral vaccines, antibodies and secondary products, bioethics of plant genetic engineering

Animal Biotechnology - Historical perspectives, sterilization methods, organ culture – culture techniques, plasma clot, raft methods, agar gel, grid method, organ engineering, cell culture substrates, cultural media, natural and artificial media, initiation and maintenance of cell cultures, immobilized cultures, cell culture products, stem cell research, cryopreservation techniques, in vitro fertilization and embryo transfer, somatic cell hybridization, hybridoma technology, organismal cloning, embryo split and nuclear transplantation, Animal genetic engineering – vectors, gene transfer methods – microinjection, virus mediated and other methods of gene transfer, targeted gene transfer, molecular characterization of transformants, transgenic animals with new traits, transgenic animals as bioreactors for producing pharmaceutically important compounds and therapeutic etc. Bioethical issues related to animal biotechnology, molecular markers.

Reading materials

1. An Introduction to Plant Tissue Culture by M.K. Razdan. Publisher : Oxford and IBH Publishing.

2. Animal cell culture – A Practical approach by J.R.W. Masters. Publisher : Oxford.
3. Animal Cell Culture Techniques by M. Clynes. Publisher : Springer Verlag.
4. Cell culture LabFAX by M. Butler and M. Dawson. Publisher : Bios scientific Publications Ltd.
5. Cell Growth and Division – A Practical approach by R.Basega. Publisher : IRL Press.
6. Culture of Animal Cells by R.I. Freshney. Publishers : Wiley-Leiss.
7. Experiments in Plant Tissue Culture by J.H. Dodds and L.W. Roberts. Publisher : Cambridge University Press.
8. Genetic Transformation in Plants by R. Walden. Publisher : Prentice Hall.
9. Methods in Cell Biology - Animal cell culture methods by J.P. Mather and D. Barnes. Publisher : Academic Press.
10. Plant Biotechnology and Transgenic Plants by K.M.O. Caldentey, W.H. Barz and H.L. Willis. Publisher: Marcel Dekker.
11. Plant Biotechnology by J. Hammond, P. McGarvy and V. Yusibov. Publisher : Springer Verlag.
12. Plant Biotechnology in Agriculture (Biotechnology Series) by K. Lindsey and M.G.K. Jones. Publisher : Prentice Hall.
13. Plant Cell and Tissue culture for the Production of Food Ingredients by T-J Fu, G. Singh and W.R. Curtis. Publisher : Kluwer Academic/ Plenum Press.
14. Plant Cell Tissue and Organ Culture by O.L. Gamborg and G.C. Phillips. Publishers : Narosa Publications.
15. Plant Tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan. Publisher : Elsevier Health Sciences.
16. Plants, Genes and Crop Biotechnology by M.J. Chrispeels, D.E. Sadava and M.J. Chrispeels. Publisher: Jones and Bartlett Publications.
17. Practical Application of Plant Molecular Biology by R.J. Henry. Publisher : Chapman and Hall.

(New course : content developed by Dr. M.V. Rajam, Reader, Department of Genetics, Delhi University South Campus)

B.E. (Bio-technology) III Year : VI Semester

Examination Theory

L T P

Paper IV BT 314 Computational Biology I

3 1 0

Introduction and overview - The NCBI data model; sequence databases, sequence retrieval, sequence file formats, submitting DNA and protein sequences.

Mathematics, statistics and computer science; Complexity of gene structure and function; Restriction maps and multiple maps – introduction, double digest problem, classifying multiple solutions; Algorithms for DDP- Integer programming, partition problem and traveling salesman problem, simulated annealing , mapping with real data; Cloning and clone libraries – libraries by complete and partial digestion; Physical genome maps – mapping by fingerprinting and mapping by anchoring, clone overlap and sequence assembly; Shotgun sequencing, sequencing by hybridization.

Database searching – Exact string matching – classical comparison based methods, seminumerical string matching, suffix trees – construction and application, Databases and rapid sequence analysis – Tree representation of a sequence, hashing a sequence,

repeats in a sequence, sequence comparison by hashing, sequence comparison by at most l mismatches, sequence comparison by statistical content; Dynamic programming alignment – The number of alignments, shortest and longest paths in a network, global distance and similarity alignments, Fitting one sequence onto the other, local alignment and clumps, linear space algorithms, tracebacks, inversions, map alignment, parametric sequence comparison.

Multiple sequence alignment – global and local alignments, statistical significance of alignments, database searching algorithms and artifacts, scoring matrices and gap penalties, filtering, position specific scoring matrices, internet resources, uses of multiple sequence alignment, programs and methods for multiple sequence alignment, pattern searching programs, family and superfamily representation, structural inference, dynamic programming in r -dimensions, weighted average sequences, profile analysis, alignment by hidden Markov models, consensus word analysis, more complex scoring.

Probability and statistics for sequence alignment – global and local alignment, extreme value distributions, Chain Stein method, Poisson approximation and long matches, Sequence alignment with scores; Probability and statistics for sequence patterns – central limit theorem, nonoverlapping pattern counts, Poisson approximation site distribution and intersite distances

Reading materials

1. Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology by D. Gusfield. Publisher: Cambridge University Press.
2. Biocomputing Hypertext Coursebook at <http://www.techfak.uni-bielefeld.de/bcd/Curric/welcome.html>
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by A.D. Baxevanis and B.F.F. Ouellette. Publisher : Wiley-interscience.
4. Bioinformatics: Sequence and Genome Analysis by D.W.Mount. Publisher : Cold Spring Harbor Laboratory Press.
5. Computer Methods for Macromolecular Sequence Analysis by R.F. Doolittle, J.N. Abelson and M.I. Simon. Publisher : Academic Press.
6. Essentials of Genomics and Bioinformatics - by C. W. Sensen. Publisher : John Wiley and Sons.
7. European Biotechnology Information Project (Ebip): Business Information Sources in Biotechnology Publisher: British Library Publications.
8. Information Sources in Biotechnology by A.Crafts-Lighty. Publisher: Grove's Dictionaries.
9. Introduction to Bioinformatics by T. Attwood and D. Parry-Smith. Publisher : Prentice Hall.
10. Introduction to Computational Biology : Maps, sequences and Genomes by M. Waterman. Publisher : Chapman and Hall.
11. Sequence Analysis in Molecular Biology: Treasure Trove or Trivial Pursuit by G. Von Heijne and G. Von Heijne. Publisher : Academic Press

(Course content as suggested by: Professor R. Ramaswamy, Dean, School of Information Technology, JNU)

B.E. (Bio-technology) III Year : VI Semester

Examination Theory

L T P

Paper V BT 315 Fundamentals of Biochemical Engineering

3 1 0

Kinetics of enzyme catalyzed reactions; Immobilized enzymes; Kinetics of microbial growth, substrate utilization and product formation; Sterilization of air and medium; Batch, continuous and fed batch reactors; Mass and energy balance in microbial processes; Mass transfer in Biological reactions; Scale-up principles; Instrumentation and control of bioprocesses.

Reading materials

1. Biochemical Engineering – Kinetics, Mass Transport, Reactors and Gene Expression by W.F. Veith. Publisher : John Wiley and Sons Inc.
2. Biochemical Engineering by S. Aiba, A.E. Humphrey and N.F. Millis. Publisher : University of Tokyo Press.
3. Biochemical Engineering Fundamentals by J.E. Baily and D.F. Ollis. Publisher : McGraw Hill.
4. Bioprocess Engineering Basic Concepts by M.L. Shuler and F. Kargi. Publisher : Prentice Hall.
5. Bioprocess Engineering Principles by P. Doran. Publisher : Academic Press.
6. Bioreaction Engineering Principles by J. Nielson and J. Villadsen Publisher : Plenum Press.
7. Chemical Engineering by J.M. Coulson, and J.F. Richardson. Publisher : Butterworth Heinemann.
8. Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment by H.C. Vogel, C.L. Todaro, C.C. Todaro. Publisher : Noyes Data Corporation/ Noyes Publications.
9. Introduction to Chemical Engineering by W.L. Badger, and J.T. Banchero, Publisher : Tata McGraw Hill.
10. New Products and New Areas of Bioprocess Engineering (Advances in Biochemical Engineering/Biotechnology, 68) by T. Scheper. Publisher : Springer Verlag.
11. Process Engineering in Biotechnology by A.T. Jackson. Publisher : Prentice Hall.

(Adopted from the model curriculum document provided by Prof. Subhash Chand, Professor, Deptt. of Biochemical Engineering and Biotechnology, IIT, Delhi)

B.E. (Bio-technology) III Year : VI Semester

Examination Practical

L T P

Paper I BT 316 Recombinant DNA Technology II Lab.

0 0 3

(Based on the course work BT 311)

1. Gene expression in E.coli,
2. Analysis of gene product.
3. Site directed mutagenesis
4. Optimization of cloned-gene expression.
5. Purification of the expressed product.
6. Reporter Gene assay(Gus/CAT/b-GAL)

B.E. (Bio-technology) III Year : VI Semester

Examination Practical

L T P

Paper II BT 317 Enzymology and Enzyme Technology Lab.

0 0 3

(Based on course work corresponding to BT 312)

1. Assay of Enzymes
2. Substrate specificity and efficiency of enzymatic catalysis
3. Kinetics of enzyme catalyzed reactions.
4. Immobilization of enzymes.
5. Microenvironmental effects in immobilized enzymes.
6. Mass transfer and biochemical reactions in continuous flow enzyme reactors.
7. Immobilized cells.

B.E. (Bio-technology) III Year : VI Semester

Examination Practical

L T P

Paper III BT 318 Plant and Animal Biotechnology Lab.

0 0 3

(Based on course work corresponding to BT 313)

1. Sterilization techniques and preparation media. Membrane filtration.
2. Surface sterilization
3. Callus propagation, organogenesis, transfer of plants to soil.
4. Protoplast isolation and culture.
5. Anther culture, production of haploids
6. Cell counting and cell viability
7. Macrophage monolayer from PEC and measurement of phagocytic activity
8. Trypsinization of monolayer and subculturing
9. Cryopreservation and thawing
10. Measurement of doubling time
11. Role of serum in cell culture
12. Cell fusion with PEG

B.E. (Bio-technology) III Year : VI Semester

Examination Practical

L T P

Paper IV BT 319 Computational Biology I Lab.

0 0 3

(Based on course work BT 314)

1. Statistics of a blast search – online tutorial
2. Alignment of whole genomes
3. Use of fasta searching - effect of different substitution matrices, change in gap penalties, different ktup values. Comparison of the same search with Blast.
4. Implementation of a selected sequence alignment algorithm
5. Sequence alignment of two given sequences with fasta and blast. Evaluate the statistical significance of the match with a web program. Effect of presence of low complexity regions in the sequence and filtering.
6. Writing a sequence assembly program
7. HMM for sequence analysis.
8. To develop a simple “gene finder program” for identifying introns and exons.

B.E. (Bio-technology) IV Year : VII Semester

Examination Theory

L T P

Paper I BT 401 Computational Biology II

3 1 0

Phylogenetic prediction- Trees-splits and metrics on trees, tree interpretation, Distance - additive, ultrametric and nonadditive distances, tree building methods, phylogenetic analysis, parsimony, tree evaluation, maximum likelihood trees – continuous time markov chains, estimating the rate of change, likelihood and trees; analysis software.

Predictive methods using DNA sequences - annotation, comparison of different methods; ESTs – databases, clustering, gene discovery and identification, gene prediction, sequence polymorphisms, level of gene expression;

Comparative genome analysis - reconstruction of metabolic pathways; Genome analysis, genome anatomy, genome rearrangements with inversions, signed inversions, gene identification, gene expression, expression analysis, gene identification and functional classification

Soft computation - Neural networks and Machine learning, support vector machines, fuzzy logic, Evolutionary computing and genetic algorithms – applications to data mining and bioinformatics

Predictive methods using protein sequences – protein identification, physical properties, motifs and patterns, structure, folding classes, structure classification;

Structure databases – PDB and MMDB, structure file formats, visualizing structural information, advance structure modeling, Internal and external co-ordinate system, cartesian and cylindrical polar co-ordinate system, Potential energy calculations using semiempirical potential energy function, Electrostatic energy surface generation, three dimensional structure using dynamic programming methods, Molecular mechanics and dynamics, Docking of Molecules, Knowledge base structure prediction, Molecular Design, structure similarity searching; Secondary structure prediction in proteins, prediction of buried residues in proteins;

RNA secondary structure – combinatorics, minimum free-energy structures, consensus folding

Reading materials

1. Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology by D. Gusfield. Publisher: Cambridge University Press.
2. Biocomputing hypertext coursebook at <http://www.techfak.uni-bielefeld.de/bcd/Curric/welcome.html>
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins A.D. Baxevanis and B.F. F. Ouellette. Publisher : Wiley-interscience.
4. Bioinformatics: Sequence and Genome Analysis by D.W. Mount. Publisher : Cold Spring Harbor Laboratory Press.
5. Computational Modeling of Genetic and Biochemical Networks by J.M. Bower and H. Bolouri . Publisher: MIT Press.
6. Computational Molecular Biology : An Algorithmic Approach by P. A. Pevzner. Publisher: MIT Press.
7. Computer Methods for Macromolecular Sequence Analysis by R.F. Doolittle, J.N. Abelson, M.I. Simon. Publisher : Academic press.
8. Essentials of Genomics and Bioinformatics by C.W. Sensen. Publisher : John Wiley and Sons Inc.

9. European Biotechnology Information Project (EbiP): Business Information Sources in Biotechnology. Publisher: British Library Publications.
10. Information Sources in Biotechnology by A. Crafts-Lighty. Publisher: Grove's Dictionaries.
11. Introduction to Bioinformatics by T. Attwood and D. Parry-Smith. Publisher : Prentice Hall
12. Introduction to Computational Biology : Maps, Sequences and Genomes by M. Waterman. Publisher : Chapman and Hall.
13. Introduction to Computational Molecular Biology by J.C. Setubal and J. Meidanis. Publisher: Brooks/Cole Publishing Company
14. Sequence Analysis in Molecular Biology: Treasure Trove or Trivial Pursuit by G. V. Heijne and G.V. Heijne. Publisher : Academic Press.

(Course content as suggested by: Professor R. Ramaswamy, Dean, School of Information Technology, JNU)

B.E. (Bio-technology) IV Year : VII Semester

Examination Theory

L T P

Paper II BT 402 Bioprocess Technology

3 1 0

Bioprocessing vs. chemical processing; Substrates for bioconversion processes and design of media ; Cell culture techniques; Inoculum development and aseptic transfers; Process technology for the production of primary metabolites, eg. Baker's yeast, ethanol, acetone-butanol, citric acid, amino acids, polysaccharides and plastics; Microbial production of industrial enzymes – glucose isomerase, penicillin acylase, cellulase, amylase, lipase, protease etc. Production of secondary metabolites – penicillin, cephalosporins, streptomycin, etc.; Metabolites from plant and animal cell culture; Biomass (mushrooms) production from agro-residues; Biofertilizers and biopesticides.

Reading materials

1. Biochemical Engineering – Kinetics, Mass Transport, Reactors and Gene Expression by W.F. Veith. Publisher : John Wiley and Sons Inc.
2. Biochemical Engineering by S. Aiba, A.E. Humphrey and N.F. Millis. Publisher : University of Tokyo Press.
3. Biochemical Engineering Fundamentals by J.E. Baily and D.F. Ollis. Publisher : McGraw Hill.
4. Biochemical reactors by B. Atkinson. Publisher : Pion Limited.
5. Bioprocess Engineering Basic Concepts by M.L.Shuler and F.Kargi. Publisher : Prentice Hall.
6. Bioprocess Engineering by B.K. Lydersen, K.L. Nelson, B.K. Lyderson and N. D'Elia. Publisher : John Wiley and Sons Inc.
7. Bioprocess Engineering Principles by P. Doran. Publisher : Academic Press.
8. Bioreaction Engineering Principles by J. Nielson and J. Villadsen Publisher : Plenum Press.
9. Biotechnology. A Textbook of Industrial Microbiology, by W. Crueger and A.Crueger. Publisher : Sinauer Associates.

10. Fermentation and Biochemical Engineering Handbook: Principles, Process Design, and Equipment by H.C. Vogel, C.L. Todaro, C.C. Todaro. Publisher : Noyes Data Corporation/ Noyes Publications.
11. New Products and New Areas of Bioprocess Engineering (Advances in Biochemical Engineering/Biotechnology, 68) by T. Scheper. Publisher : Springer Verlag.
12. Principles of Fermentation Technology by P.F. Stanbury and A. Whitaker. Publisher : Pergamon Press.
13. Process Engineering in Biotechnology by A.T. Jackson. Publisher : Prentice Hall.

(Adopted from the model curriculum document provided by Prof. Subhash Chand, Professor, Deptt. of Biochemical Engineering and Biotechnology, IIT, Delhi)

B.E. (Bio-technology) IV Year : VII Semester

Examination Theory

L T P

Paper III BT 403 Downstream Processing

3 1 0

Characteristics of Bioproducts; Flocculation and conditioning of broth; Mechanical separation; Cell disruption; protein precipitation and its separation; Aqueous two phase extraction; Adsorption-desorption processes; Chromatographic methods of separation based on size, charge, hydrophobic interactions, biological affinity methods etc.; Membrane based separation; Electrophoresis; Electrodialysis; Crystallization; Case studies.

Reading materials

1. Biochemical Engineering Fundamentals by J.E. Bailey and D.F. Ollis. Publisher : McGraw-Hill.
2. Bioseparations by P.A. Belter, E.L. Cussler and W.S. Hu. Publisher: John Wiley and Sons Inc.
3. Bioseparations: Downstream Processing for Biotechnology by P.A. Belter et al. Publisher: John Wiley and Sons Inc.
4. Biotreatment, Downstream Processing and Modelling (Advances in Biochemical Engineering/Biotechnology, Vol 56) by T. Scheper et al. Publisher: Springer Verlag.
5. Chromatographic and Membrane Processes in Biotechnology by C.A. Costa and J.S. Cabral. Publisher: Kluwer Academic Publishers.
6. Downstream Processing by J.P. Hamel, J.B. Hunter and S.K. Sikdar. Publisher: American Chemical Society.
7. Protein Purification by M.R. Ladisch, R.C. Willson, C.C. Painton and S.E. Builder. Publisher: American Chemical Society.

(Course content adopted from the model curriculum document provided by Prof. Subhash Chand, Professor, Deptt. of Biochemical Engineering and Biotechnology, IIT, Delhi)

B.E. (Bio-technology) IV Year : VII Semester

Examination Theory

L T P

Paper IV BT 404 Elective I

3 1 0

B.E. (Bio-technology) IV Year : VII Semester

Examination Theory

L T P

Paper V BT 405 Management Accounting and Cost Control

3 1 0

Understanding of cost-volume profit analysis, Cost behavior / classification, Forecasting cost of a product, Measurement of cost of a product, Cost control: at the product level and at the firm level, certain managerial tools for efficient decision making, zero base budgeting, JIT approach.

Management Accounting - Management Accounting and the Business Organization, Cost Behavior and Cost-Volume Relationships, Measurement of Cost Behavior, Cost Management Systems and Activity-Based Costing, Decision-Making: Marketing and 6. Relevant Information and Production Decisions, Master Budget, Flexible Budgets and Variance Analysis, Control Systems and Responsibility Accounting, Capital Budgeting, Cost Allocation, Job-Costing and Process-Costing Systems, Overhead Application: Variable and Absorption Costing, Basic Accounting: Concepts, Techniques, and Conventions, Understanding Corporate Annual Reports: Basic Financial Statements.

Cost accounting - Cost Accounting Fundamentals, Tools for Planning and Control, Cost Information for Decisions, Cost Allocation and Revenues, Quality and JIT, Capital Budgeting, Management Control Systems

Reading materials

1. Cost Accounting by C. Horngreen. Publisher : Prentice Hall.
2. Cost and Managerial Accounting by J.O. Cherrington, E.D. Hubbard and D.H. Luthy. Publisher : WCB Publications.
3. Management Accounting by C. Horngreen. Publisher : Prentice Hall.

(Course content developed by Prof. R.S. Dhankar, Professor, Faculty of Management Studies, Delhi University South Campus)

B.E. (Bio-technology) IV Year : VII Semester

Examination Practical

L T P

Paper I BT 406 Computational Biology II Lab.

0 0 3

(Based on course work corresponding to BT 401)

1. Motif and pattern searching
2. Phylogenetic prediction and analysis
3. Cn3D, Deepview and Whatif
4. Demonstration of Tripos, Insight II
5. Structure prediction.
6. Protein structure classification resources
7. Structure superposition tools
8. Energy minimization and Simulated annealing.
9. Docking small molecules/ peptides in active site of protein. Use of automated docking procedures. Free energy calculation.
10. Finding transcription regulatory signals

B.E. (Bio-technology) IV Year : VII Semester

Examination Practical

L T P

Paper II BT 407 Bioprocess Technology Lab.**0 0 3**

(Based on course work corresponding to BT 402).

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of Thermal Death Point and Thermal death time of microorganisms for design of a sterilizer
3. Determination of growth curve of a supplied microorganism and also determine substrate degradation profile and to compute specific growth rate and growth yield from the data obtained.
4. Comparative studies of ethanol production using different substrates.
5. Microbial production of antibiotics (Penicillin).
6. Production and estimation of alkaline protease.
7. Sauer Krant fermentation.
8. Use of alginate for cell immobilization.

B.E. (Bio-technology) IV Year : VII Semester**Examination Practical****L T P****Paper III BT 408 Downstream Processing Lab.****0 0 3**

(Based on course work corresponding to BT 403).

1. Conventional filtration
2. Protein precipitation and recovery
3. Aqueous two-phase separation
4. Ion exchange chromatography
5. Gel filtration
6. Membrane based filtration i.e. Microfiltration and cross filtration in cross flow modules

B.E. (Bio-technology) IV Year : VII Semester**Examination Practical****L T P****Paper IV BT 409 Practical training (After VIth Semester)****0 0 4****B.E. (Bio-technology) IV Year : VII Semester****Examination Sessional****L T P****Sessional Paper I BT 410 Seminar (International economic environment/ IPR)****0 0 2**

(Course suggested by Prof. R.S. Dhankar, Professor, Faculty of Management Studies, Delhi University, South Campus)

B.E. (Bio-technology) IV Year : VIII Semester**Examination Theory****L T P****Paper I BT 411 Genomics and Proteomics****3 1 0**

Genome evolution and phylogenetics- origin of genomes, Acquisition of new genes, DNA sequencing- chemical and enzymatic methods, The origins of introns, DNA and RNA fingerprinting, The human genome.

Structural Genomics, Technology, Data Bases (NCBI and Plant Databases), Sequence Comparison Techniques (BLAST etc.), Genome, Annotation.

Comparative Genomics, Phylogeny, Synteny (comparison of grass genomes), COGS (Clusters of orthologous genes, NCBI web site), Metabolic Reconstruction, The Basic Principles and Methodology, Pathway.

Functional Genomics, ESTs, Digital Northern, SAGE, Relational Data Base Basics, cDNA Microarrays, Oligonucleotide Microarray Chips, Cancer and genomic microarrays, Examples for Application of Microarrays, Microarray Data Analysis; Gene finding tools.

Genotyping Background and SNPs, SNPs II and TOGA, AFLP and RFLP analysis, Arabidopsis KO Strategies; Pharmacogenomics; Ethical considerations of genetic testing. Introduction to proteomics; protein function and expression; essential proteins; Protein function from structure; Rational drug design; Lethal mutants.

Interaction networks - yeast genome-wide interaction studies

Introduction to proteomics

How to analyze a Proteome - 2D-gel electrophoresis, high-throughput proteome analysis with 2D-IEF, Current concepts of co-immunoprecipitation for protein interaction analysis, chromatography, amino acid sequencing, Current concepts of peptide sequencing with MS-MS methods, MALDI-TOF mass spectrometry and nanospray MS, Phage Display, Protein chips; Two-hybrid methods, Synthetic lethal screens, Proteome-wide interaction maps, TAP tags, GFP tags, Synthetic Lethal Screens, Inteins and Protein Splicing for interaction analysis; Micro Arrays-Affimetrics and spotted array concepts

Protein Structure and Function

Structure function relationship

Protein-protein interactions - Large molecular complexes- RNA polymerase II, ribosome; Unstructured proteins- Current concepts and examples, the fly-casting mechanism; Current Degradation Concept, The N-end rule and PEST sequences, control of ubiquitination, the proteasome, SUMO Protein-protein interactions in health and disease; Molecular mechanisms in disease

Postranslational modifications - concepts of how protein function is rapidly and dynamically modulated through posttranslational modifications, how posttranslational modifications precede altered transcription levels.

Structure determination – experimental and theoretical methods

Evolution and Design of Protein Function

Metabolic networks - Metabolic pathways, Metabolic regulation, Genome-Proteome Connection, DNA microarrays and Analysis of metabolic control

Reading materials

1. Bioinformatics: A practical guide to the analysis of genes and proteins by A.D. Baxevanis and B.F.F. Ouellette. Publisher : John Wiley and Sons Inc.
2. Bioinformatics: From Genomes to Drugs by T. Lengauer. Publisher: John Wiley and Sons Inc.
3. Bioinformatics: Sequence and Genome Analysis by D.W. Mount. Publisher: Cold Spring Harbor Laboratory Press.
4. DNA Microarrays : A Practical Approach by M. Schlena. Publisher : Oxford University press.

5. Essentials of Genomics and Bioinformatics by C. W. Sensen. Publisher: John Wiley and Sons Inc.
6. Functional Genomics – A Practical Approach by S.P. Hunt and R. Livesey. Publisher : Oxford University Press.
7. Genes VII by B. Lewin. Publisher: Oxford University Press.
8. Internet and New Biology : Tools for Genomic and Molecular Research by Jr. Peruski, A.S.M. Peruski and V. Muse. Publisher : Amer Society of Microbiology.
9. Journal articles and web materials
10. Posttranslational Modifications of Proteins: Tools for Functional Proteomics (Methods in Molecular Biology, Vol 194) by C. Kannicht. Publisher: Himana Press.
11. Primer of Genome Science by G. Gibson and S.V. Muse. Publisher: Sinauer Associates.
12. Proteomics by T. Palzkill. Publisher: Kluwer Academic Publishers.
13. Proteomics: From Protein Sequence to Function by S. Pennington and M.J. Dunn. Publisher : Springer Verlag.
14. Statistical Genomics: Linkage, Mapping, and QTL Analysis by B. Liu. Publisher: CRC Press.
15. Structural Bioinformatics by P.E. Bourne and H. Weissig. Publisher: Wiley-Liss.

(The genomics course was adapted from the Genomics course at the Michigan State University, Michigan and the proteomics course was adopted from the proteomics and bioinformatics course at University of Toronto, Canada.

B.E. (Bio-technology) IV Year : VIII Semester

Examination Theory

L T P

Paper II BT 412 Elective II

3 1 0

B.E. (Bio-technology) IV Year : VIII Semester

Examination Theory

L T P

Paper III BT 413 Project management

3 1 0

Introduction - Conceiving a project, Strategic Management and Project Selection,
Project Planning - Conflict and Negotiation Developing a project, Appraisal of project – financial, marketing appraisal, technology appraisal and HRD appraisal, Managing the project, Termination/ Replacement of project , Project in Contemporary Organizations.

Project initiation

Project implementation - Scheduling, Resource Allocation, Monitoring and Information, Project Control.

Project Termination - Project Auditing and Termination.

Reading materials

1. Project Management : A Managerial Approach by J.P. Meredith and S.J. Mantel. Publisher : John Wiley and Sons Inc.

(Course content developed by Prof. R.S. Dhankar, Professor, Faculty of Management Studies, Delhi University South Campus)

B.E. (Bio-technology) IV Year: VIII Semester

Examination Theory

L T P

Paper IV BT 414 Principles of Management and Entrepreneurship 3 1 0

Development

Basic management skills – Planning, Organizing, Developing, Controlling, Performance Appraisal, Regulatory issues, Environmental issues, Interpersonal skills and Wealth Creation Process.

Reading materials

1. Essentials of Management by H. Koontz, H. Weihrich and C. O'Donnell. Publisher: McGraw-Hill/Irwin.
2. The Practice of Management by P. Drucker. Publisher: Harper Business.

(Course suggested by Prof. V. K. Vinayak, Advisor, DBT, Govt. of India, and the contents developed by Prof. R.S. Dhankar, Professor, Faculty of Management Studies, Delhi University, South Campus)

B.E. (Bio-technology) IV Year : VIII Semester

Examination Practical

L T P

Paper I BT 415 Genomics and Proteomics Lab.

0 0 3

(Based on course work corresponding to BT 411)

1. Three dimensional Structures - In silico study – large molecular complexes RNA polymerase II, ribosome, unstructured proteins.
2. DNA sequencing methods.
3. Gene finding tools and Genome annotation
4. Comparison of two given genomes
5. Analysis of 2D - IEF data
6. Microarray and Microarray data analysis
7. Inference of protein function from structure
8. Phage display
9. Two-hybrid methods

B.E. (Bio-technology) IV Year : VIII Semester

Examination Practical

L T P

Paper II BT 416 Major project

0 0 8

B.E. (Bio-technology) IV Year : VIII Semester

Examination Practical

L T P

Paper III BT 417 Practical training / Project

0 0 4

ELECTIVE COURSES:

Examination Theory

L T P

Any one of the following courses:

Thermodynamics of Biological Systems

Energy, thermodynamics and living processes

Energetic processes in the biosphere : The ecosystem.

Thermodynamic systems : equilibrium, activity coefficients and phase equilibrium functions of state, cyclic processes, work, energy and metabolic heat; Mechanical equivalent of heat, energy as a function of state.

The laws of thermodynamics : Second law; Reversible vs. irreversible processes, entropy, work; Combination of the first and second law, Free energy, useful work and delta G. Entropy: Ideality and Molecular Cohesion, Probabilistic nature of Entropy, Order and Disorder.

Biological systems as open, non-equilibrium systems : failure of classical thermodynamics in describing biological processes, Standard free energy changes and equilibrium constants, direction and rate.

Chemical potential : Visualization of the potential, Steady velocity and steady flow; Fick's law and diffusion. Local Equilibria and Steady State: Energy vs. Power; Transducers in biological states, Constitutive equations, Dynamic efficiency and Onsager (nonequilibrium thermodynamics), Prigogine's principle, Spontaneous coupling and entropy production.

Non-equilibrium thermodynamics : reversible work, exact differentials and function of state, first and second law, The electrochemical potential, External forces and steady state, Fick's Law, chemical reactions in the steady state, internal entropy production, cells as non-equilibrium stationary states; Diffusion and membrane transport.

Thermodynamic analysis of oxidative photophosphorylation, stability of non-equilibrium stationary states, ordering in time and space far from equilibrium, glycolytic oscillations, biological clocks, routes to chaos.

Reading materials

1. Bioenergetics by A.L. Lehninger. Publisher : W.A. Benjamin Inc.
2. Biological Thermodynamics by D.T. Haynie. Publisher : Cambridge University Press.
3. Biophysical Chemistry by C.R. Cantor and P.R. Schimmel. Publisher : Freeman
4. Physical Chemistry : Principles and Applications in Biological Sciences by I. Tinoco, K. Sauer and J.C. Wang. Publisher : Prentice Hall College Division.
5. Physical Chemistry for the Chemical and Biological Sciences by R.Chang. Publisher : University Science Books.
6. Physical Chemistry by R.J. Silbey and R.A. Alberty. Publisher : John Wiley and Sons Inc.
7. Principles of Physical Chemistry, with Applications in the Biological Sciences by D. Freifelder. Publisher : Jones and Bartlett.
8. Thermodynamics and Kinetics for the Biological Sciences by G.G. Hammes. Publisher : John Wiley and Sons Inc.

(New course : content developed by Dr. Sonika Bhatnagar, Lecturer, School of Applied Science, NSIT with BE420N Thermodynamics of Biological systems at IIT, Delhi as framework and in consultation with Dr. Gita Subba Rao, Additional Professor, Deptt. of Biophysics, A.I.I.M.S.)

Pharmaceutical Chemistry

Introduction to and History of Pharmaceutical Chemistry

Physicochemical Properties in Relation to Biological Action - Effects of route of administration, Sites of loss, Solubilities and partition coefficients (Ferguson, Hansch), Drug-receptor interactions, Steric features of drugs, The drug receptor, Structure-Activity Relationships, Representative physicochemical properties as related to biological action

Drug Metabolism – Oxidative, Reductive, Hydrolytic, Conjugative

Drug toxicity, tolerance, dependence, addiction

Survey of Various Drug Classes - Anaesthetics (general, local), Analgesics, Neurotransmitters (adrenergic, cholinergic effects; psychopharmacology), CNS depressants (sedative/hypnotic, major/minor tranquilizers), CNS stimulants, Antibiotics (especially b-lactam), Steroids

Natural products as medicinal compounds - Nucleic acids- Synthesis of purines and pyrimidines, isolation and structure determination of nucleosides and nucleotides; Pigments- Carotenoids, Anthocyanins, Flavones, flavonols, pyrrole pigments, porphyrins, haemoglobin and chlorophyll - Structure, General properties, classification; Alkaloids and Terpenoids – Introduction, classification, properties and structure; Amino acids - Classification of amino acids, synthesis of amino acids, isolation and separation of amino acids from proteins, general physical and chemical properties of amino acids, polypeptides, general principles of polypeptide synthesis, structure of polypeptides, amino end degradation, carboxyl end degradation; Carbohydrates and lipids - Nomenclature, classification, structure and general reactions; Steroids and hormones - Diel's hydrocarbon, sterols, progesterone and androsterone. plant hormones (auxins, heteroauxins, gibberellins, kinins, ethylene, traumatin)

Reading materials

1. Foye's Principles of Medicinal Chemistry by D.A. Williams, T.L. Lemke and William O. Foye. Publisher: Lippincott Williams and Wilkins.
2. Medicinal Chemistry : An Introduction by G. Thomas. Publisher : John Wiley and Sons
3. Medicinal Chemistry: The Role of Organic Chemistry in Drug Research by C. R. Ganellin and S. M. Roberts. Publisher: Academic Press.
4. Pharmaceutical Dosage Forms and Drug Delivery Systems by H.C. Ansel, L.V. Allen, N.G. Popovich. Publisher: Lippincott Williams and Wilkins Publishers.
5. Review of Organic Functional Groups: Introduction to Medicinal Organic Chemistry by T.L. Lemke. Publisher: Lea and Febiger.
6. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry by J.N. Delgado, O. Gisvold and W.A. Remers. Publisher: Lippincott Williams and Wilkins.

(Course adapted from Medicinal Chemistry course at Eastern Illinois University, Illinois)

Bioimaging and Computer Graphics

Software and hardware for interactive computer graphics; Implementation of device drivers; Line and circle drawing algorithms; 3-D transformation, windowing, clipping, perspective, and input routines; Data structure, hidden surface removal, colour shading techniques; scaling, translation, rotation, reflection; viewing Transformations; Programming practices with standard graphics libraries like open GL; Graphical display of molecules, background objects, dihedral; Retrieving and displaying biological structures; Comparing structure, homology modeling of protein structure; Digital images and image processing

Reading materials

1. Computer Graphics : Principles and Practice in C by J.D.Foley, A. V. Dam, S.K. feiner and J.F. Hughes. Publisher: Addison-Wesley Publishing.
2. Digital Image Processing by R.C. Gonzalez, R.E. Woods. Publisher: Addison-Wesley Publishing.
3. Mathematical Elements of Computer Graphics by D.F. Rogers and J.A. Adams. Publisher: McGraw-Hill Science/Engineering/Math.
4. Procedural Elements of Computer Graphics by D.F. Rogers Publisher: McGraw-Hill Science/Engineering/Math.

(Course content provided by Prof. Alok Bhattacharya, Dean, School of Life Sciences, JNU)

Current topics in Biotechnology I – content to be decided later in keeping with current developments in the field.

Bioelectronics

Electrical Circuit treatment of biological environments: ionic conduction, the metal-electrolyte double layer, models of the cell membrane.

Electrical signal detection in biological systems: silicon, glass and metal electrodes, amplifier design. Bioelectronic device production: microelectronic fabrication methods as adapted to bioelectronics, hard and soft lithography, bio-compatibility of materials. Existing types of bio-sensors: miniaturisation and micro-systems including sensing using optical techniques, field effect transistors, ion-selective and enzymatic sensitive electrodes, as well as impedance monitoring.

Examples of industrial biosensors, e.g. for glucose monitoring and for DNA analysis.

Analysis of the neural cell impulse signal and neural signal processing. Organisation of natural optical systems: transducers and pre-processors, the optic bundle, system engineering aspects.

Reading materials

1. Bioelectronics by S. Bone and B. Zabba. Publisher : John Wiley and Sons Inc.
2. Biosensors by E.A. Hall. Publisher : John Wiley and Sons Inc.

3. Ions, Electrodes and Membranes by J. Koryta. Publisher : John Wiley and Sons Inc.

(New Course: The content developed by Professor Raj Senani, Head, Division of Electronics and Communication Engineering, NSIT)

Environmental Biotechnology

Environment : basic concepts and issues

Environmental pollution : Types of pollution, methods for the measurement of pollution; Methodology of environmental management – the problem solving approach, its limitations.

Air pollution and its control through Biotechnology

Water pollution and its control : Water as a scarce natural resource, need for water management, measurement of water pollution, sources of water pollution, waste water collection, waste water treatment – physical, chemical and biological treatment processes. Microbiology of waste water treatments, aerobic process : Activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds.

Anaerobic processes : Anaerobic digestion, anaerobic filters. Upflow anaerobic sludge blanket reactors.

Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries.

Microbiology of degradation of xenobiotics in environment – ecological considerations, decay behavior and degradative plasmids: Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.

Bioremediation of contaminated soils and waste land.

Biopesticides in integrated pest management.

Solid wastes : sources and management (composting, wormiculture and methane production)

Global environmental problems : Ozone depletion, UV – B, greenhouse effect and acid rain, their impact and biotechnological approaches for management.

Reading materials

1. Comprehensive Biotechnology by M. Moo-Young. Publisher : Pergamon Press.
2. Environmental Chemistry A.K. De . Publisher : Wiley Eastern Ltd.
3. Introduction to Biodeterioration by D. Allsopp and K.J. Seal. Publisher : ELBS/Edward Arnold.
4. Waste Water Engineering – Treatment, Disposal and Reuse by Metcalf , Eddy and G. Tchobanoglous. Publisher : Tata McGraw Hill.

(Course adopted from Environmental Biotechnology course, UGC model curriculum, 2001)

Examination Theory
BT 412 Paper II Elective II

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Any one of the following courses:

Drug Design and Development

Drug targets classification - DNA, RNA, post-translational processing enzymes, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors, neuropeptide receptors, ion channels (monomeric multi-transmembrane) proteins, ligand-gated ion channels (oligomeric transmembrane proteins), transporters (multi-transmembrane proteins);

Target discovery and validation strategies - genomics (new target discovery), biological activity directed and other types of screening, natural products, combinatorial chemistry; General overview modeling methodologies, structure based drug design, protein structure determination: X-ray, protein homology and alternative techniques, **Structure-based design** - 'de novo' design methodologies : indirect drug design, pharmacophore development and receptor mapping, 3D-database searching techniques, new strategies and recent technologies in drug design.

Design and development of combinatorial libraries for new lead generation : the molecular diversity problem, drug characterization- principles of equilibria, diffusion, and kinetics, preformulation: pKa, partition coefficient, solubility, dissolution, chemical stability, and permeability, optimization of ADME characteristics, physico-chemical properties calculation, chemometrics in drug design.

QSAR : Statistical techniques behind QSAR, classical QSAR, molecular descriptors 3D QSAR and COMFA, drug design to discovery and development, drug metabolism, toxicity and pharmacokinetics, toxicology considerations, problems and drawbacks on drug discovery and development.

Reading materials

1. Introduction to Biophysical Methods for Protein and Nucleic Acid Research by J.A. Glasel and M.P. Deutscher. Publisher : Academic Press.
2. Principles of Drug Action by W.B. Pratt and P. Taylor. Publisher : Churchill Livingstone.
3. Principles of Medicinal Chemistry by W.O. Foye, T.L. Lemke, and D.A. Williams. Publisher : Williams and Wilkins.
4. Side Effects and Drug Design by E.J. Lien. Publisher : Marcel Dekker.
5. The Anticancer Drugs by W.B. Pratt, R.W. Ruddon, W.D. Ensminger, and J. Maybaum. Oxford University Press.

(Course content developed by Dr. Sonika Bhatnagar, Lecturer, School of Applied Science, NSIT)

Bioprocess Plant Design

Introduction; general design information; Mass and energy balance; Flow sheeting; Piping and instrumentation; Materials of construction for bioprocess plants; Mechanical design of process equipment; Vessels for biotechnology application; Design of fermenters; Design considerations for maintaining sterility of process streams processing equipment; Selection and specification of equipment for handling fluids and solids; Selection, specification, design of heat and mass transfer equipment used in bioprocess

industries; Design of facilities for cleaning of process equipment used in biochemical industries; Utilities for biotechnology production plants; Process economics; Bioprocess validation; Safety considerations; Case studies.

Reading materials

1. Applied Process Design for Chemical and Petrochemical Plants by E.E. Ludwig. Publisher : Butterworth-Heinemann.
2. Chemical Engineering by R.K. Sinnott, J.M. Coulson and J.F. Richardsons. Publisher : Butterworth-Heinemann.
3. Chemical Engineers Handbook by R.H. Perry and D.W. Green. Publisher : McGraw-Hill.
4. Manufacturing Facilities Design and Material Handling by F.E. Meyers and M.P. Stephens. Publisher : Prentice Hall.
5. Plant Design and Economics for Chemical Engineers by M. Peters and K. Timmerhaus. Publisher : McGraw-Hill.
6. Process Plant Layout and Piping Design by E. Bausbacher and R. Hunt. Publisher : Prentice Hall PTR.

(Course adopted from “Model Curriculum in Biotechnology” provided by Dr. Subhash Chand, IIT-Delhi)

Drug Delivery systems

Basic concepts of Drug Delivery - Introductory lecture (1-2), Concept of Bio availability, Process of drug absorption, Pharmacokinetic processes, Timing for optimal therapy, Drug delivery considerations for the new biotherapeutics

Advanced Drug Delivery and Targeting- Basic terminologies in drug delivery and drug targeting, Drug release, Drug targeting, Doses forms, Various routes of administration of drugs (just introduction), Strategies for enhanced therapeutic efficacies (Basic principles)

Drug administration - Parenteral delivery – intravenous, intramuscular, intraperitoneal. Oral delivery and systemic delivery through oral route -Structure and physiology of Gastro Intestinal tract, Impediments against oral availability, Advantages and disadvantages of oral drug delivery

Current technologies and new and emerging technologies in oral delivery

Nasal and pulmonary delivery, Ophthalmic delivery – structure and physiology of eye, topical and intraocular drug delivery, Drug targeting to CNS – Blood –Brain barrier, physiological and physiochemical factors for delivering to CNS, current and new technologies in CNS delivery

Delivery of Genetic material - Basic principles of gene expression, Viral and nonviral vectors in gene delivery, Clinical applications of gene therapy and antisense therapy

New generation technologies in Drug delivery and targeting - Nanotechnology / Nanobiotechnology, Use of biosensors and challenge of chronopharmacology, Microchips and controlled drug delivery, Genetically engineered cell implants in drug delivery

Reading material

1. Drug Delivery and Targeting by A.M. Hillery, A.W. Lloyd and J. Swabrick. Publisher : Harwood Academic Publishers.

2. Drug Delivery: Engineering Principles for Drug Therapy (Topics in Chemical Engineering) by W.M. Saltzman. Publisher: Oxford University Press.
3. Handbook of Biodegradable Polymers (Drug Targeting and Delivery) by A. J. Domb, J. Kost and D.M. Wiseman. Publisher : Dunitz Martin Ltd.
4. Pharmaceutical Dosage Forms and Drug Delivery Systems by H.C. Ansel, L.V. Allen and N.G. Popovich. Publisher : Lippincott Williams and Wilkins Publishers.

(Course content developed by Prof. A.N. Maitra, Chemistry Department, University of Delhi)

Current topics in Biotechnology II – content to be decided later in keeping with current developments in the field.

Artificial Neural Networks

Historical background , Why is learning hard? , Memorization, generalization and function approximation , Linear Associators, Perceptrons and Capacity , Multi-layer neural networks , Maximum Likelihood and Gradient Descent learning , Stochastic gradient descent for supervised learning , The backpropagation algorithm , Aspects of Learning Theory and Generalization , Bias vs. variance , Overtraining, pruning and regularization , VC dimension and how much data is enough? , Neural networks and analog VLSI , Selected Applications

Reading materials

1. Neural Networks: A Comprehensive Foundation by S. Haykin. Publisher : Prentice Hall.
2. Neural Networks for Pattern Recognition by C. Bishop. Publisher : Oxford University Press.

(Course content provided by Prof. Raj Senani, Head Division of Electronics and Computer Engineering, NSIT)

Biosensors and Biomedical sensors and transducers

Introduction to MEMS

Biosensors

Definition, History, Properties of biosensors, Design features of Biosensors, The Biological Component, Signal Transduction : Amperometric Biosensors, Potentiometric Biosensors, Detection of H⁺ cation, Detection of NH₄⁺ cation, Detection of CN⁻ anion, Calorimetric biosensors, Optical Biosensors, Measuring the change in light reflectance, Measuring luminescence, Piezo-electric biosensors, Immunosensors, Commercial examples of biosensors. Biosensors markets- Opportunities and obstacles.

Biomedical sensors - Sensors and transducers: an overview, measurement systems, Classification of Biomedical sensors and transducers, Why do we need Biomedical sensors and Transducers? Important Design considerations and system calibration, The future of Biosensors and Transducers, Sensing Layer: The importance of computers in

sensor and Transducer technology, Recent Engineering Solutions to Health care using Biosensors and Transducers, Modern health care solutions.

Reading materials

1. Affinity Biosensors: Techniques and Protocols by K.R. Rogers and A. Mulchandani. Publisher : Humana Press.
2. Biosensors and their Applications by V.C.Yang and T.T. Ngo. Publisher : Plenum Publishing Corporation.
3. Chemical Sensors and Biosensors by B.R. Eggins. Publisher : John Wiley and Sons Inc.
4. <http://nun97.el.ub.es/~santi>
5. <http://www.bae.ncsu.edu/bae/courses/bae590f/1995/anderson>
6. <http://www.eng.rpi.edu/dept/chem-eng/Biotech-Environ/BIOSEN2>
7. <http://www.fraserclan.com>
8. <http://www.fst.rdg.ac.uk/courses/fs560/topic3>
9. <http://www.sbu.ac.uk/biology/enztech>
10. Sensors and Sensing in Biology and Engineering by F.G. Barth, et al. Publisher : Springer Verlag.

(New Course: The content developed by Dr. Sachin Maheshwari, Assistant Professor, Department of MPA Engineering, NSIT)