Course Contents

Integrated B.Tech.-M.Tech. (Biotechnology)

Batch 2019-2020 Onward

Semester 1

B.Tech (I & II semester common to all branches)

Engineering Chemistry: CY101. **(3-1-0)**

UNIT- I **(10 L+ 5 T)**

Water – Introduction, Specification for water, Impurities in water, Hardness of water, Numerical problems based on Hardness, Analysis of water: alkalinity, Numerical problems based on alkalinity Dissolved Oxygen, Boiler feed water, boiler problems-scale, sludge, priming and foaming, caustic embittlerment and corrosion, their causes and prevention, Water softening processes: External treatment(Lime – Soda process, Numerical problems based on Lime-soda Process, Zeolite process ,Ion exchange Process) and Internal treatment (Colloidal conditioning, carbonate conditioning, calgon conditioning and phosphate conditioning), Domestic water treatment: sedimentation, coagulation, Filtration, Disinfection, chlorination, break point chlorination, Ozonization.

UNIT-II **(5 L+ 1T)**

Corrosion and its control- Introduction, Types of corrosion- Dry, Wet, Galvanic , Pitting, Water line and Stress corrosion, Mechanism of corrosion- Dry or Chemical, Wet or Electrochemical, Pilling-Bedworth rule, Galvanic series, Factors influencing corrosion, Corrosion control- Modification of environment, corrosion inhibitor and Metallic coatings.

UNIT- III **(10 L+ 4 T)**

Fuel – Classification, Characteristics of fuel, Characteristic of good fuel, Calorific Value, Determination of Calorific Value by bomb calorimeter, Analysis of coal –Proximate and Ultimate analysis, Numerical problems based on Proximate and Ultimate analysis, Carbonization-Types of Carbonization of coal, Manufacture of Metallurgical coke by Otto Hoffman process, Conversion of Coal into Liquid Fuels by Fischer-tropsch process and Bergius Process, Liquid Fuels- Petroleum-Refining of crude oil, Cracking of heavy oil residues – thermal and catalytic cracking, Cracking of heavy oil residues – thermal and catalytic cracking, Gaseous Fuels - Natural gas, Water gas, Producer gas, Coal gas.

UNIT- IV **(10 L+ 2 T)**

Polymers-Introduction, Classification(based on origin, structure, intermolecular forces, tacticity, type of monomer, response to temperature, conductance and synthesis), Polymerization- Condensation(step growth), Addition (chain growth), Conducting polymer and Biopolymers, Introduction to polymeric composites, Types of composite materials.

UNIT-V (3 L+ 1 T)

Phase Rule – The Phase Rule, Explanation of terms, Advantages and limitations of Phase Rule, Phase rule for one component system (The water system).

UNIT-VI (4 L+ 1 T)

Lubricants - Introduction, Functions, Classification of Lubricants, Mechanism of Lubrication, Properties- Viscosity and viscosity index, Flash and fire point, Aniline point, Neutralization number, Saponification Number and Iodine Number.

UNIT-VII (3L+ 1 T)

Insulators- Introduction, Thermal insulators-Organic and Inorganic insulators, Electrical Insulators.

Books (Text Books & Reference books)

1. J.C. Kuriacose & J. Rajaram, Chemistry in Engineering & Technology ,Vol I & II, By Tata McGraw-Hill Education, 1984.
2. Dr S.S. Dara,S.S. Umare,Engineering Chemistry (Latest ed.), By S.S. Dara S. Chand & Company Ltd., 2013.
3. Jain & Jain , Engineering Chemistry 15th ed., Dhanpat Rai Publications,2006.
4. V.R.Gowarikar, V.Viswanatha,Jayadev Sreedhar, Polymer Science, New Age International, 1986.
5. G. T. Austin, Shreve's Chemical Process Industries 5th ed. Mc-Graw-Hill New York, 1984.

MA 103 (Mathematics-I)

Credit (L-T-P) : 4 (3- 1- 0)

Unit I

Sets and their representations, operations on sets, Cartesian product of sets, relations, functions, algebraic and transcendental function, Principle of Mathematical induction, Solution of quadratic equations. Permutation and Combination, Binomial Theorem.

Unit II

Straight Lines, slope of a line and angle between two lines, various forms of equations of a line: parallel to axes, point-slope form, slope-intercept form, two point forms, intercepts form and normal form, general equation of a line, distance of a point from a line. Introductory idea of Ellipse, Circle, parabola and Hyperbola.

Unit III

Trigonometric functions, positive and negative angles, Measuring angle in radians & in degree and conversion from one measure to another. Definition of trigonometric with the help of unit circle. Trigonometric identities. Complex numbers, algebraic properties of complex numbers, Argand plane and polar representation of complex numbers, Fundamental theorem of algebra.

Unit IV

Vectors and scalars, magnitude and direction of a vector, direction cosines (and ratios) of vectors, Types of vectors, position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio. Scalar product of vectors, projection of a vector on a line, vector product of vectors.

Unit V

Matrices and determinants: definition of a matrix, various types of matrices, addition, subtraction, multiplication of matrices, inverse of matrix, determinant of matrices, expansion of determinant, properties of determinants, solution of linear system of equations, Cramer rule.

Textbook *Mathematics Part I and Part II - Textbook for Class XI and XII*, NCERT.

Reference Books

[1] H. S. Hall and S.R. Knight, *Higher Algebra*. Arihant, 2010.

[2] J. Stewart, *Calculus*, Cengage Learning, Sixth Edition.

R. D. Sharma

BATCH 2019

Life Sciences [BT 101]

1.The Root System: Organization and anatomy of root in Monocotyledons and Dicotyledons, **The Shoot System**: Organization and anatomy of shoot in Monocotyledons and Dicotyledons; Primary and Secondary growth in Plants, **Leaf**: Anatomy of Leaf in Monocotyledons and Dicotyledons.

2.Reproduction in Angiosperms: Morphology of Flower; Microsporogenesis: Formation of Pollen grains. (Male gametophyte); Megasporogenesis: Development of Embryo Sac (Female Gametophyte); Pollination: Types, Carriers and Development of Pollen Tube, Division of Male Nucleus; double fertilization and triple fusion. **Embryology**: Types of Endosperm and Development of Embryo

3. An introduction to Evolution

Animals:

4. Digestive System and Respiratory System: Comparative morphology of Digestive System: Outline of Morphological and anatomical Structure of Digestive System of mammals. Comparative morphology of Respiratory System: Outline of Morphological Structure of Respiratory System of mammals.

5. Blood Circulatory System: Comparative morphology of Blood Circulatory System: Outline of Morphological and anatomical Structure of Blood Circulatory System of mammals.

6.Urino-Genital System, Reproductive system and Embryogenesis: Comparative morphology of Urinogenital System: Outline of Morphological and anatomical Structure of Urinogenital System of mammals.

Physiology of Reproductive System of mammal; Spermatogenesis and Oogenesis in mammals; Typical mammalian egg structure; Fertilization in Mammals- Sperm egg encounter, Capacitation and Sperm transport; Acrosomal reaction, Cleavage- Salient features and Types of Cleavage; Types of Placenta in mammals.

Text Books/References

A Class Book of Botany by A. C. Dutta

A Textbook of Botany by Gopinath Hait

Animal Physiology by by Schmidt-Nielsen

Guyton and Hall Textbook of Medical Physiology by John E. Hall

The Ecology Book by Tom Hennigan

Ecology And Environment by PD Sharma

FUNDAMENTALS OF COMPUTER PROGRAMMING

Course Code: CS101
No. of Lectures (Hrs/Week): 4
Total No. of Lectures: 60

Credits: 3-1-0

End Sem Exam Hours: 3

UNIT I INTRODUCTION TO COMPUTER AND PROGRAMMING CONCEPTS

Definition, characteristic, generation of computers, basic components of a computer system, memory, input, output and storage units, high level language and low level language, Software: system software, application software, hardware, firmware, Operating System, compiler, interpreter and assembler, linker, loader, debugger, IDE. Introduction to algorithm and flow chart; representation of algorithm using flow chart symbol, pseudo code, basic algorithm design, characteristics of good algorithm, development of algorithm.

UNIT II INTRODUCTION TO C PROGRAMMING LANGUAGE

Introduction to C programming language , Declaring variables, preprocessor statements, arithmetic operators, programming style, keyboard input , relational operators, introduction, feature of C language, concepts, uses, basic program structure, simple data types, variables, constants, operators, comments, control flow statement :if, while, for, do-while, switch.

UNIT III DATA TYPES AND STRUCTURES

bitwise operators, Pre defined and User defined data types, arrays, declaration and operations on arrays, searching and sorting on arrays, types of sorting, 2D arrays, Passing 2D arrays to functions, structure, member accessing, structure and union, array of structures, functions, declaration and use of functions, parameter passing, recurssion .

UNIT IV FUNDAMENTALS OF POINTERS

Introduction to pointers, pointer notations in C,Declaration and usages of pointers, operations that can be performed on computers, use of pointers in programming exercises, parameter passing in pointers, call by value, call by references, array and characters using pointers, dynamic memory allocation

UNIT V FILE HANDLING IN C AND ENUM

Introduction to file handling, file operations in C , defining and opening in file, reading a file, closing a file, input output operations on file, counting: characters, tabs , spaces, file opening modes, error handling in input/output operations.
sEnumerated data types, use of Enum, declaration of Enum.

08/08/18

Fee Deposition on 16th July, 2019 in respective

Students shall deposit required fee i.e. Academic Fee, Hostel Fee and Mess Advances, on or before Date of Registration and submit 'No Dues' at [illegible] ration in respective schools. Students without fee deposition receipt will not be [illegible] either by **Demand Draft** in favour of **GAUTAM** [illegible] **/GREATER NOIDA**

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Text Books:

1. C Programming, Herbert Shield
2. C Programming Language 2nd Edition by Brian, W Kernighan Pearson Education.

Reference Books:

3. Programming in ANSI C by E. Balagurusamy, Tata Mgraw Hill
4. C Puzzle Book: Puzzles For The C. Programming Language by Alan R Feuer Prentice Hall-Gale
5. Expert C Programming: Deep C Secrets (s) by Peter Van Der Linden Dorling Kindersley India.
6. Introduction To UNIX System by Morgan Rachel Tata Mcgraw Hill Education.
7. C: A Reference Manual (5th Edition) by Samuel P. Harbison&Samuel P. Harbison.
8. Programming Using the C Language by Hutchison,R.C, Mcgraw Hill Book Company, New York
9. Fundamentals of computers and programming with C, A.K. SHARMA

06/08/18

Raj

BATCH 2019

Introduction to Biotechnology [BT 103]

Unit 1 – History and milestones in genetic engineering, Scope of genetic engineering, Genetic engineering guidelines, gene Cloning, Cloning and patenting of life forms.

Unit 2 – Nucleic acid, Nucleic acid purification, Yield analysis, DNA primers and their chemical synthesis, DNA amplification and its applications, Restriction enzymes, DNA modifying enzymes, Linkers, Adaptors, Restriction mapping of DNA fragments and Map construction.

Unit 3 – mRNA enrichment, mRNA amplification, Reverse transcription, cDNA synthesis based cloning, Heterologous gene expression and purification of recombinant protein.

Unit 4 – DNA synthesis and mutation, DNA and Protein sequencing, DNA separation and detection, Molecular markers (DNA, RNA and protein).

Unit 5 – Vectors: Plasmids, Bacteriophages, Phagemids, Cosmids and Artificial chromosomes.

Unit 6 – Alternate strategies of gene cloning: cloning interacting genes – Two and three hybrid systems, Library construction and Screening, cloning differentially expressed genes and DNA microarrays.

Text Books/References:

- Developmental Biology, 6th Edition, Scott F. Gilbert.
- Recombinant DNA, J.D. Watson et al, W.H. Freeman and Company.
- Principles of Gene Manipulation: An Introduction to Genetic Engineering, R.W. Old and S. B Primrose, Blackwell Science Inc.

Core Course

Paper Code: **EN-101**
Paper Name: **English Proficiency**
Credit: **02**
Level: **Undergraduate**

Unit 1 **Functional Grammar:** Form and Functions; Sentences: Simple, Complex, and Compound; Tense, Mood, an Aspect; Sub-Verb Agreement and Concord; Common Errors; Vocabulary Building: Inflection and Derivation; Conversions, Idioms and Phrases, Words in Context

Unit 2 **Language Skills (LSRW):** Listening Skills: Activity based, Speaking Skills: Activity based, Introduction to IPA, Use of Dictionary, Word stress, Reading Skills: Skimming and Scanning, Reading Comprehension, Writing Skills: Paragraph, Précis and Compositions, Note Making and Note Taking, Logical Ordering of Ideas and Contents, Figures of Speech

Unit 3 **Learning through thematic Texts:**

- *My Visions for India* Dr. Abdul Kalam
- From *In an Antique Land* Amitav Ghosh
- *The Gift of Magi* O' Henry
- *Master and Man* Leo N. Tolstoy
- *If* Rudyard Kipling
- *The Solitary Reaper* William Wordsworth

Suggested Books:

1. *Word for Word*, Pointon & Clark, Oxford University Press
2. Carter, Ronald; McCarthy, Michael (2006). *Cambridge Grammar of English: A Comprehensive Guide*. Cambridge University Press.
3. *An English Pronouncing Dictionary*, London: Dent, rpt in facsimile in Jones (2002). 17th edn, P. Roach, J. Hartman and J. Setter (eds), Cambridge: CUP, 2006.
4. Redman, Stuart. 2011 English Vocabulary I Use: Pre-intermediate and intermediate. Cambridge: CUP *Cambridge Phrasal Verbs Dictionary* Second edition, Cambridge University Press

Course Name: Human Values & Buddhist Ethics
Code of Course: BS 101
No. of Credits: 2

Unit 1:
Life of Gautam Buddha
Origin of Buddhism
Buddhist Ethics
Buddhist Literature (Pāli Canonical Literature)
Unit 2:
Basic Tenets of Buddhism:
Cattāri-Ariya-Saccāni (The Four Noble Truths)
Ariyo-Aṭṭhaṅgiko-Maggo (The Eightfold Path or The Middle Path)
Brahma-Vihāra-Bhāvanā (Four Sublime States)
Pañcasīla (The Five Precepts)
Unit 3:
Socially Engaged Buddhism
Ten Wholesome Deeds (Dasa Kusala Kamma)
Ten Unwholesome Deeds (Dasa Akusala Kamma)
Unit 4:
Buddhist View on Environmental Crisis
Buddhist View on Human Rights
Buddhist Economic Theory

Suggested Readings:

- Ambedkar, Bhim Rao, *The Buddha and His Dhamma*, Nagpur: Buddha Bhoomi Prakashan, 1997.
- Bapat, P. V., *2500 Years of Buddhism*, Delhi: Publications Division, Ministry of Information and Broadcasting, Goverment of India, 1997.
- Bhikkhu Dr. Beligalle Dhammajoti, *Buddhism & Modern World*, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2011.
- Bhikshu Dharmarakshita, *Pāli Sāhitya Kā Itihās*, Varanasi: Gyanamandala Limited, 1988.
- Bhikshu Dharmarakshita, *Sukhī Grihastha Ke Liye Buddha Upadesh*, New Delhi: Samyaka Prakashana, 2011.
- *Buddhist Dictionary - Manual of Buddhist Terms and Doctrines* (Ed.) Nyanaponika, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2012.
- Chan Khoon San, *Buddhism Course*, Kuala Lumpur: Majujaya Indah Sdn. Bhd., 2012.
- Dharmkirti, *Buddha Ka Nitishashtra*, New Delhi: Samyaka Prakashana, 2012.
- Dharmkirti, *Buddha Ka Samayadarshana*, New Delhi: Samyaka Prakashana, 2012.
- K.Sri Dhammananada, *Gems of Buddhist Wisdom*, Malaysia: Buddhist Missionary Society, 1996.
- K.Sri Dhammananda, *Meditation the Only Way*, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2006
- K.Sri Dhammananda, *What Buddhists Believe*, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2006.
- Keown, D., *The Nature of Buddhist Ethics*, London: Macmillan, 1992.
- Law, Bimala Churn, *A History of Pāli Literature*, Delhi: Indological Book House, 1983.
- Misra, G.S.P., *Development of Buddhist Ethics*, New Delhi: Munshi Ram Manohar Lal Private Limited, 1984.
- Nārada Thera, *A Manual of Buddhism*, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2005.
- Narada, *The Buddha and His Teachings*, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2005.
- Narasu, P.Lakshmi, *The Essence of Buddhism*, Madras: Asian Educational Services, 1993.
- Paul Carus, *The Gospel of Buddha*, Nagpur: Kashinath Meshram, Buddha Bhoomi Prakashan, 1997.
- Pyinnyāthīha, *The Triple Gem and The Way to Social Harmony*, Taipei: The Corporate Body of the Buddha Educational Foundation, 2002
- Rahula, Walpola, *What The Buddha Taught*, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2003.
- Samdhong Rinpoche, *The Social Philosophy of Buddhism*, Varanasi: The Central Institute of Higher Tibetan Studies, 1972.
- Sankrityana, Rahula, *Bauddha Darshana*, Allahabad: Kitab Mahal, 1992.
- Sarao, K.T.S & Arvind Kumar Singh (Eds.), *A Text Book of the History of Theravada Buddhism*, Delhi: Department of Buddhist Studies, Delhi University, 2006.
- Sarao, K.T.S., *Origin and Nature of Ancient Indian Buddhism*, New Delhi: Munshiram Manoharlal, 2009.
- Sayagyi U Ko Lay, *Guide to Tipitaka*, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2002.
- Shakya, Gyanaditya, *Bauddha Dharma Darshana Mein Brahma-Vihāra-Bhāvanā*, Ahmadabad: Reliable Publishing House, 2013.
- Shakya, Rajendra Prasad, *Bauddha Darshan*, Madhya Pradesh Hindi Academy, Bhopal, 2001.
- Singh, Anand, *Business Ethics and Indian Value System*, Himalayana Publication, Delhi, 2010.
- *The Dhammapada* (Ed. & Tr.) K. Sri Dhammananda, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2006
- Thera Piyadassi, *The Buddha's Ancient Path*, Taiwan: The Corporate Body of the Buddha Educational Foundation, 2003
- Upadhayaya, Bharat Singh, *Pāli Sāhitya Kā Itihās*, Prayag: Hindi Sahitya Sammelan, 2005.
- Upadhyaya, Baladeva, *Bauddha Dharma Darshan Mimamsa*, Varanasi: Chaukhamba Vidya Bhawan, 1999.

BT105 Laboratory I: Basic Biotechnology

1. Safety in Biotechnology Lab
2. Math Skills in Lab
3. Documentation & Lab Notebook
4. Basic Tools in the Biotechnology Laboratory
5. Using a Micropipetter
6. Use of microscope
7. Use of pH meter
8. Calibrating Lab Instruments
9. Molar Solutions and Dilutions
10. Sterilization techniques
11. Preparation of media
12. Isolation, enumeration and Purification of microbes from a Given sample
13. Simple staining & Gram staining
14. Preparation of stock solutions/dilution

Engineering chemistry lab (CY103) 0-0-2

List of Experiments

1. To determine the total hardness of the water sample
2. To determine the alkalinity of the water sample
3. To determine the total residual chlorine in the given water sample.
4. To determine the of dissolved Oxygen in given sample of water
5. To determine the total iron (Fe^{+2} and Fe^{+3} ion) in the given mixture solution by $KMnO_4$.
6. To determine the Ferrous (Fe^{+2}) and Ferric ions(Fe^{+3}) in the given mixture solution by $K_2Cr_2O_7$ using external indicator method.
7. To determine the Ferrous (Fe^{+2}) and Ferric ions(Fe^{+3}) in the given mixture solution by $K_2Cr_2O_7$ using internal indicator method.
8. To determine the Saponification value of an oil
9. To determine the Iodine value of a given lubricating oil
10. To determine the Acid value of an oil
11. Determine the amount of Cu by iodometric titration
12. To find the normality of an acid solution by condutometrically
13. To determine the molarity of HCl by pH-metrically
14. Preparation of PMMA
15. Preparation of urea-formaldehyde resin

Out of fifteen experiments, ten experiments are to be performed

REFERENCE BOOKS:

1. O.P. Vermani and A.K. Narula Applied Chemistry: Theory and Practice New Age International Pvt Ltd Publishers , 2008.
2. G.H. Jeffery, J. Bassett, J. Mendham and R.C. Denney, Vogel's Textbook of Quatitative Chemical Analysis, 5th ed. John Wiley & Sons Inc; 1989.
3. Laboratory Manual on Engg. Chemistry by S.K. Bhasin and Sudha Rani.

I-YEAR (I-SEMESTER)

(Effective from session: 2016-17)

COMPUTER PROGRAMMING LAB - I		Course Code: CS181	Credits: 1
No. of Lab (Hrs./Week): 2	No. of Lab Sessions (Sem.):15	Mid Sem. Exam (Hrs.):0	End Sem. Exam (Hrs.):2

NOTE: Suggested list of experiments but not limited to these only.
List of Experiments:

1. Write a C program to reverse a given number, find the sum of digits of the number.
2. Write a C program to concatenate two strings.
3. Write a C program to take marks of a student as input and print the his/her grade bases on following criteria using if – else statements

   Marks < 40 FAIL
   40<= Marks < 59 GOOD
   59<= Marks < 80 Excellent
   80 <= Marks Outstanding

4. Perform experiment 3 using switch case statement.
5. Write a C program to compute the length of a string using while loop.
6. Write a C program to convert all the lowercase letter to uppercase letter and all uppercase letters to lower case letter given a string as input.
7. Write a C program to compute the roots of a quadratic equation.
8. Write a C program to check whether a given number is prime or not, also check whether it is divisible by a number k or not.
9. Write a C program to check whether a given year is leap year or not.
10. Write a C program to take two matrixes as input and print the sum of two matrixes.
11. Write a C program to display the address of a variable using pointer.
12. Write a C program to compute the length of a string using pointer.
13. Create a structure called STUDENT having name, registration number, class, session as its field. Compute the size of structure STUDENT.
14. Write a C program to check weather a given string is palindrome or not.
15. Write a C program to generate following patterns.

```
        1
      2   2
    3   3   3
  4   4   4   4
```

```
        A
      B   B
    C   C   C
  D   D   D   D
```

Course Contents

Integrated B.Tech.-M.Tech. (Biotechnology)

Batch 2019-2020 Onward

Semester 2

Engineering Physics (PH102) course will be common for all branches of SoE (CE, EE, ME), and SoICT (CS, EC), and will remain same as approved previously. Bio-Technology/Food Technology students will have common Physics course, namely **Applied Physics (PH-101). Engineering Physics Laboratory (PH104)** course will be common for all branches of SoE, SoICT, SoBT and SoVSAS. The changes will be effective from Session 2014-2015.

PH101-APPLIED PHYSICS
(Food/Bio Technology)
4-Credits (3-1-0)

Module I-Optics: Sinusoidal wave propagation: One dimensional wave equation, Light as Electromagnetic wave, Superposition of waves: Interference of light, Coherent sources, Division of wavefront: Young's fringes, Fresnel's bi-prism; Division of amplitude: Uniform thin films, Newton's rings; Diffraction of light: Types, Fraunhofer diffraction of Single and double slits; Diffraction grating and resolving power; Polarization of light, Malus' and Brewster's laws, Concept of double refraction, Nicol prism, Quarter and half wave plates, Production of circularly and elliptically polarized light, Rotatory polarization, Optical Activity, Polarimeters.

Module II: Application of Optics: Optical imaging devices, Holographic principles: Recording and reconstruction of holograms; Lasers: spontaneous and stimulated emissions, main components of laser, three level laser system; Optical fibers: Total internal reflection, numerical aperture, Attenuation, optical fiber sensors and their applications.

Module III-Quantum Theory Fundamentals: Particle nature of waves: Photo-electric and Compton effect, Wave nature of particles: De-Broglie waves; Davisson-Germer Experiment; Wave-packet, Heisenberg's Uncertainty principle; wave-function and its physical interpretation; Schrodinger wave equation; particle in a box (One dimensional), Concept of tunneling effect.

Module IV-Solid state physics: Bonding in solids, Lattice and crystal structures, Band theory of solids: classification, Solid State Devices.

V-Nanotechnology: Properties of nanoparticles; carbon nanotubes (CNT); Applications of nanotechnology in Bio and Food Science, Measurement Techniques: X-Ray Diffraction (XRD), Spectroscopy, Scanning electron microscope (SEM), Atomic force microscope (AFM).

Texts/References

1. Ajoy Ghatak, Optics, Tata McGraw Hill Eduacation Pvt. Ltd., (2009)
2. Arthur Beiser, Concepts of Modern Physics, Tata McGraw-Hill Education Pvt Ltd., (2006)
3. K. K. Chattopadhyay & A. N. Banerjee, Introduction to Nanoscience and Nanotechnology, PHI Learning Pvt Ltd. (2009)

PH104-ENGINEERING PHYSICS LABORATRY
~~1.5 Credit (0-0-3)~~ 1 Credit (0-0-2)

List of Experiments *

1. Measurement of basic constants: Length, Weight & Time.
2. Study of current balance/ force acting on a current carrying conductor.
3. To study the magnetic field variation of paired coils in a Helmholtz arrangement
4. To study Interference due to division of wavefront with double and multiple slits
5. To study Fraunhofer diffraction of light using a single slit and circular hole.
6. To study the interference of light by Fresnel's Biprism and find the fringe width.
7. To determine the Cauchy' constant using Prism and spectrometer
8. To find wavelengths of Mercury light source using Plane Transmission Diffraction Grating
9. To study the Polarization of light and verify Malus's Law
10. Study of Photoelectric effect and calculate the Planck's Constant
11. To determine the wavelength of light by Newton's Rings.
12. To determine the energy band gap of a given semiconductor material using Four-Probe method.
13. To find the e/m of electron by Thomson's method.
14. To study the characteristics of Solar Cell.
15. To calculate the wavelength of sodium light using Fresnel's biprism.
16. To determine specific rotation of sugar using half shade polarimeter.
17. To study the Coupled Pendulum
18. Study of Electron Diffraction (Dual Nature of Electron)
19. To study Faraday's law of Induction
20. To study the B-H curve of magnetic materials
21. To study the concept of quantization of energy levels by using Franck-Hertz experiment

Note: The courses not mentioned here will remain same as approved previously.

* Students will perform 8-10 experiments from the list of experiments.

26/7

26/9/18

26/9/18

MA 104 (Mathematics-II)

Credit (L-T-P) : 4 (3- 1- 0)

Unit I

Limit, continuity and differentiability of functions, Derivatives of elementary functions, rules of differentiation, Derivatives of polynomial and trigonometric functions, derivative of composite functions, chain rule, derivatives of inverse trigonometric functions, derivative of implicit function, logarithmic differentiation. Derivative of functions expressed in parametric forms, successive differentiation

Unit II

Successive differentiation, Leibnitz Theorem, Partial differentiation, Euler Theorem, Taylors series (Single Variable), Maxima and Minima (Single Variables),

Unit III

Integration as inverse process of differentiation, Integration of elementary functions, integration by substitution, by partial fractions and by parts, Fundamental theorem of calculus, Basic properties of definite integrals and evaluation of definite integrals, definite integral as limit of sum, Application to areas and curves

Unit IV

Definition of ordinary differential equations, order and degree, general and particular solutions of a differential equation, Formation of differential equation, solution of differential equations of first order and first degree: solution by method of separation of variables, homogeneous differential equations, linear differential equations, exact differential equations, Solution of second order differential equations with constant coefficients.

Unit V

Introduction to mathematical modeling, modeling of Simple elementary biological system, population growth model, exponential models, logarithmic models

Textbook *Mathematics Part I and Part II - Textbook for Class XI and XII*, NCERT.

Reference Books

[1] G. B. Thomas and R. L. Finney, *Calculus and Analytical Geometry*, Pearson Education.

[2] J. N. Kapoor, *Mathematical Modeling*, New Age International.

[3] J. Stewart, *Calculus*, Cengage Learning, Sixth Edition.

R. D. Shah

BT205: Biomolecules

Unit 1

Chemistry and biology: Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pK values for acid and bases, pH, preparation of buffers, Handerson-Hasselbalch equation and calculation of acid base for buffers, physiological buffers, fitness of the aqueous environment for living organism, biochemical reactions, buffering capacity, buffers used in biochemistry. Preparation of solutions, Molarity, Normality and percent solutions, calculation of ionic strength of solutions. properties and structure of water, hydrogen bond, ionic interactions, van der waals force and hydrophobic effect.

Unit 2

Carbohydrates: Introduction & Occurrence, Classification of Mono-, Di- and Polysaccharides, Reducing & Non-reducing Sugars, Constitution of Glucose & Fructose, Osazone formation, Pyranose & Furanose forms, Determination of ring size, Inter-conversion of monosaccharides.

Unit 3.

Lipids: General introduction, Classification & Structure of Simple & Compound lipids, Properties of Lipid aggregates (elementary idea), Biological membrane, Lipoproteins. Vitamins (water and fat soluble) and minerals.

Unit 4 Proteins: General introduction, Classification & General characteristics, Structure of Primary, Secondary, Tertiary & Quaternary proteins (elementary idea), Classification of Amino acids. Membrane proteins. Haemoglobin and myoglobin.

Unit 5

Nucleic acids: Components of DNA and RNA, Nucleosides & Nucleotides (introduction, structure & bonding), Double helical structure of DNA (Watson-Crick model), various forms of DNA.

Unit 6

Enzymes: History, general characteristics, nomenclature, IUB enzyme classification, Definition with examples of holoenzyme, apoenzyme, coenzymes, cofactors activators, inhibitors, active site (identification of groups excluded), metalloenzymes, units of enzyme activity, specificenzymes, isoenzymes, monomeric enzymes, oligomeric enzymes and multienzyme complexes, enzyme specificity. Nature of non enzymatic and enzymatic catalysis, measurement and expression of enzyme activity-enzyme assays, Definition of IU, Katal, enzyme turn over number and specific activity, role of non protein organic molecules and inorganic ions, coenzyme, prosthetic groups, role of vitamins as coenzymes.

Core Course

Paper Code: **EN-102**
Paper Name: **Professional Communication**
Credit: **02**
Level: **Undergraduate**

Unit 1 **Introduction to Communication:** Communication: Definition, Nature and Scope, Types: Verbal and Non Verbal Communication, Barriers to Effective Communication, Attributes to Effective Communication, Communication in Professional Domain, Oral Presentations, Group Discussions, Job Interviews, Conducting Meetings/Seminars, Agenda and Minutes

Unit 2 **Correspondence and Written Communication**

Report Writing, Research Articles, Business Proposals, Writing Résumé, Job Applications, Letters: Order Letter, Complaint Letter, Apology, Persuasive, Other tools of Correspondences: Notice, Circular, Memos, Office Order, Tender Notices, e- mails Etiquettes, etc.

Unit 3 **Learning through Thematic Texts**

- *Literature and Science* — Aldous Huxley
- *The Man Who Knew Too Much* — Alexander Baron
- *An Astrologer's Day* — R. K. Narayan
- *The Sniper* — Liam O' Flaherty
- *Road Not Taken* — Robert Frost
- *A refusal to mourn the Death by Fire of a Child in London* — Dylan Thomas

Suggested Books:

1. Business Correspondence and Report Writing, Sharma and Mohan, TMH
2. Business Communication, Meenakshi Raman,Prakash Singh, Oxford Higher Education
3. An English Pronouncing Dictionary, London: Dent, rpt in facsimile in Jones (2002). 17th edn, P. Roach, J. Hartman and J. Setter (eds), Cambridge: CUP, 2006.
4. McC Arthy Michael and Felicity O'Dell, English Vocabulary in Use CUP.2002

Ability Enhancement Compulsory Courses (AECC – Environmental Studies)

Unit 1: Introduction to environmental studies

- Multidisciplinary nature of environmental studies; components of environment – atmosphere, hydrosphere, lithosphere and biosphere.
- Scope and importance; Concept of sustainability and sustainable development.

(2 Lectures)

Unit 2: Ecosystems

- What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chain, food web and ecological succession. Case studies of the following ecosystems:
  a) Forest ecosystem
  b) Grassland ecosystem
  c) Desert ecosystem
  d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

(6 Lectures)

Unit 3: Natural Resources: Renewable and Non-renewable Resources

- Land Resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).
- Heating of earth and circulation of air; air mass formation and precipitation.
- Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

(8 Lectures)

Unit 4: Biodiversity and Conservation

- Levels of biological diversity :genetic, species and ecosystem diversity; Biogeography zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

(8 Lectures)

Unit 5: Environmental Pollution

- Environmental pollution : types, causes, effects and controls; Air, water, soil, chemical and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste..
- Pollution case studies.

(8 Lectures)

Unit 6: Environmental Policies & Practices

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.
- Environment Laws : Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements; Montreal and Kyoto protocols and conservation on Biological Diversity (CBD). The Chemical Weapons Convention (CWC).
- Nature reserves, tribal population and rights, and human, wildlife conflicts in Indian context

(7 Lectures)

Unit 7: Human Communities and the Environment

- Human population and growth: Impacts on environment, human health and welfares.
- Carbon foot-print.
- Resettlement and rehabilitation of project affected persons; case studies.
- Disaster management: floods, earthquakes, cyclones and landslides.
- Environmental movements: Chipko, Silent valley, Bishnios of Rajasthan.
- Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
- Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

(6 Lectures)

Unit 8: Field work

- Visit to an area to document environmental assets; river/forest/flora/fauna, etc.
- Visit to a local polluted site – Urban/Rural/Industrial/Agricultural.
- Study of common plants, insects, birds and basic principles of identification.
- Study of simple ecosystems-pond, river, Delhi Ridge, etc.

(Equal to 5 Lectures)

Suggested Readings:

1. Carson, R. *2002. Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R.1993. This *Fissured Land:* An Ecological History of India. Univ. of California Press.
3. Gleeson,B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P.H. 1993. Water in *Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J. Gary K. Meffe, and Carl Ronald carroll. *Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
7. McCully, P.1996. *Rivers no more: the environmental effects of dams*(pp. 29-64). Zed Books.
8. McNeil, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.

9. Odum, E.P., Odum, h.T. & Andrews, J.1971. *Fundamentals of Ecology*. Philadelphia: Saunders.
10. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
11. Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatement*. Oxford and IBH Publishing Co. Pvt. Ltd.
12. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. *Environment*. 8th edition. John Wiley & Sons.
13. Rosencranz, A., Divan, S., & Noble, M.L. 2001. *Environmental law and policy in India*. Tripathi 1992.
14. Sengupta, R. 2003.*Ecology and economics:* An approach to sustainable development. OUP.
15. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
16. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology: Voices from the Tropics*. John Wiley & Sons.
17. Thapar, V. 1998. *Land of the Tiger: A Natural History of the Indian Subcontinent*.
18. Warren, C.E. 1971. *Biology and Water Pollution Control*. WB Saunders.
19. Wilson, E.O. 2006. *The Creation: An appeal to save life on earth*. New York: Norton.
20. World Commission on environment and Development. 1987. *Our Common Future*. Oxford University Press.
21. www.nacwc.nic.in
22. www.opcw.org

Open Elective Course

Course Name: **Introduction to Language Culture and Society**
Course Code: **EN – 111**
Credits: **02**
Level: **Undergraduate**

Unit 1 Language as a System; Design Features; Language and Culture; Language, Gender and Identity; Language Myths

Unit 2 Social Functions of Language; Language: Standard and Vernacular; Language, Dialects, Sociolect, and Registers; Language Acquisition Theories; Bilingualism and Multilingualism; Code Switching and Code Mixing;

Unit 3 Language Families of India; Language policy and planning in India; Language and Constitutional Provisions; English in India

Suggested Readings:

1. **Crystal, David**. 2010. *The Cambridge Encyclopedia of Language.* Third Edition. Cambridge University Press.
2. **Fasold, Ralph. W.** (1990) *The Sociolinguistics of Language*, Oxford: Blackwell.
3. **Fromkin, Victoria, Robert Rodman, & Nina Hyams**. 10th Edition. *An Introduction to Language*. Cengage Learning.
4. **Hudson, R. A.** (2011). *Sociolinguistics*. Cambridge. Cambridge University Press 2nd Edition.
5. **Lyons, John** (the 15th Edition reprinted 2014) *Language and Linguistics:An Introduction*, Cambridge University Press.

BT104 Biomolecules Lab

1. Preparation of Buffers- Citrate /Phosphate/acetate
2. Qualitative estimation of carbohydrates
3. Qualitative estimation of proteins/amino acids
4. Qualitative estimation of lipids & fats
5. Iodine test for polysaccharides
6. DNA estimation
8. RNA estimation
9. Acid-Base Titration

Course Content

Integrated B.Tech.-M.Tech. (Biotechnology)
[Batch 2019-20 Onwards]

Semester 3

BT 201 Cell Biology and Genetics

Cell Biology

Nucleus and Cytoskeleton: Organization and Packaging bacterial genome, Chromosomal DNA, Euchromatin and heterochromatin; histone proteins: structure properties and function, Organization and packaging of eukaryotic genome, Nature of the Cytoskeleton, Micro filaments, Intermediate Filaments, Microtubules, Cilia and Centrioles, Actin Filaments, Cell Junctions, Cell-Cell Adhesion, The Extracellular Matrix of Animals, Extracellular Matrix Receptors on Animal Cells- the Integrins, The PlantCell Wall.

Protein Sorting and Vesicular Trafficking in the Cell: The Transport of Molecules into and out of the Nucleus, Mitochondria, Chloroplasts, Peroxisomes, and The endoplasmic reticulum. Transport from theER through the Golgi Apparatus, Endocytosis

Cell Signalling and cell cycle : General Principles of Cell Signalling, Signalling via G-Protein-linked Cell-Surface Receptors, Kinase Receptors and Hormone Receptor, Cell- Cycle control and checkpointgenes in eukaryotes.

Genetics

Mendelian principles and Chromosome Theory of Inheritance: Mendel's laws of inheritance, Codominance, incomplete dominance, Genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism. The chromosome theory of heredity, Sex chromosomes, Sexlinkage, sex limited and sex influenced characters Mendelian principles in human genetics, Pedigree analysis, genetic disorders and Inborn errors of metabolism, The discovery of linkage, Linkage of genes on X chromosomes, Linkage maps and linkage mapping, Linkage disequilibrium, Calculating recombinant frequencies from selfed dihybrids. Haploid mapping (2 point & 3 point cross), Diploidmapping (Tetrad analysis).

The Extranuclear Genome and inheritance: The concept of extranuclear genome in higher plants and animals. Extranuclear inheritance (mitochondrial, chloroplast), Kappa particles in Paramecium, Sigma factor in Drosophila, Cytoplamic Male Sterility (CMS) in crop plants and its applications in plantbreeding.

Chromosomal variation in Number & Structure – Euploidy, Non-disjunction & Aneuploidy, Aneuploid in plants and Humans, Polyploidy in Plants and Animals and its applications, Chromosomal Mosaics, Deletion, Duplication, Inversion, Translocation, Transposable Genetic Elements.

Population Genetics:, Hardy Weinberg law; Migration; Gene flow and Genetic drift.

Text/Reference Books:-

Essential Cell Biology : An Introduction to the Molecular Biology of the Cell, B. Alberts, D. Bray, A. Johnson, J. Lewis, M. Roff, K. Robert, P. Walter and K. Roberts, Garland Publishing Company.

Cell and Molecular Biology, DeRobertis, B .I. Publication Pvt. Ltd.

The Cell, Alberts et al, 5th edition, Garland science.

Principles of Genetics, E J Gardner, John Wiley & Sons Inc.

Principles of Genetics, D.P. Snustad & M.J. Simmons, John Wiley and Sons Inc.

BT203 Fundamentals of Biochemistry

UNIT 1

Fundamentals of metabolism and thermodynamics: Laws of thermodynamics, thermodynamic parameters, enzyme catalysed reactions, Catabolism and anabolism, concept of Gibbs free energy, Enthalpy, Entropy, phosphate group transfer and nucleotide phosphates, biological oxidation-reduction reactions, cofactors and co enzymes in biological transfer reactions.

UNIT 2

Carbohydrates metabolism – Metabolism of saccharides– Glycolysis & oxidation of Pyruvate, TCA cycle, Gluconeogenesis, Pentose Phosphate Pathway, Oxidative phosphorylation, Disorder/ diseases of carbohydrate metabolism. Regulation of carbohydrate metablosm.

UNIT 3

Fats and lipids metabolism –Fatty acid synthesis, origin of acetyl-Co A for fat synthesis, Elongation & desaturation of Fatty Acids. Activation & transport of fatty acid from cytosol to mitochondria for oxidation. Oxidation of saturated & unsaturated fatty acids. β, α, ω oxidation. Formation and utilization of ketone bodies. Disorder/ diseases and regulation of lipid metabolism.

UNIT 4

Amino acids and proteins - Biosynthesis of amino acids from intermediates of Citric Acid Cycle & other major pathways. Biodegradation of amino acids: Deamination, transamination. Urea Cycle, Glucose-Alanine cycle. Disorder/ diseases and regulation of amino acids metabolism.

UNIT 5

Nucleic acid metabolism – Structure and properties. Metabolism of Nucleotides: Purines & Pyrimidines synthesis : de Novo & salvage pathway, Conversion of nucleoside monophosphates to nucleoside triphosphates, Formation of deoxyribonucleotides. Catabolism & salvage of Purine and Pyrimidine nucleotides. Disorder associated with purines and pyrimidines metabolism, regulation of nucleotides metabolism.

UNIT 6

Oxidative phosphorylation and photophosphorylation: Electron transfer reactions in mitochondria, ATP synthesis, regulation of oxidative phosphorylation, roles of mitochondria in thermogenesis,steroid synthesis and apoptosis. Light absoraption and photophosphorylation, Photochemical events and ATP synthesis.by photophosphorylation

Text books:

1. Principles of Biochemistry: A.L. Lehninger, Nelson and Cox, McMillan Worth Publishers.
2. Harper's Biochemistry-Rober K. Murray, Daryl K. Grammer, McGraw Hill, Lange. Medical Books. 25th edition.
3. Biochemistry : S.C. Rastogi – Third Edition ; Tata McGraw Hill Education Pvt. Ltd. New Delhi.

BT205 Fundamentals of Microbiology

Unit 1

Introduction and Scope of Microbiology: Definition and history of microbiology, contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert; Theory of spontaneous generation, Importance and scope of Microbiology as a modern Science, Branches of microbiology.

Unit 2

General Account of Bacteria and Viruses: Structure, Ultrastructure of bacteria cell (both Gram positive and Gram negative) including endospore and capsule, Disease epidemiology, Bacterial diseases of man – Tetanus, Tuberculosis, . Viruses – Structure and classification. Plant Viruses –CaMV, Animal viruses – Hepatitis B, Bacterial Virus – Lambda Phage Viral diseases: AIDS (HIV).

Unit 3

Microbial Techniques: Sterilization: Physical Methods: Autoclave, Hot air oven, Laminar airflow, Seitz filter, Sintered glass filter, and membrane filter; Chemical Methods: Alcohol, Aldehydes, Phenols, Halogens and Gaseous agents, Antibiotics. Radiation Methods: UV rays and Gamma rays. Principles of staining, Types of stains – simple stains, structural stains and Differential stains.

Unit 4

Microbial Taxonomy: Concept of microbial species and strains, classification of bacteria based on – morphology (shape and flagella), nutrition and extreme environment; Salient features, classification and reproduction of fungi, mycoplasma and algae.

Unit 5

Microbial growth and reproduction: Growth Curve (normal and biphasic) and generation time, Batch and Continuous culture, Methods of isolation of Pure culture and Measurement of bacterial growth, Reproduction . Bacterial recombination, transformation, transduction and conjugation. Endospores formation.

Ref. Books:

1. Bacterial Systematics, by Logan, A., Niall A. Logan , Wiley-blackwell; 1994
2. Principles of Microbiology by R.M. Atlas , Mosby publishers, St. Louis; 1995
3. Microbiology : An Introduction by Gerard J Tortora ,Berdell R Funke, Christine L Case Benjamin-Cummings Publishing Company ; 2008.
4. Michael J. Pelczar is the author of Microbiology
5. Microbiology – L. M. Prescott

BT207 Introductory Bioinformatics

Unit 1

Introduction to Bioinformatics: Bioinformatics and its applications in different areas ofbiological sciences, Skills required for Bioinformatics, Use of Bioinformatics in the laboratoryindustry.

Unit 2

Databases: Introduction to Databases, Biological databases:- Sequence databases- Nucleotidesequence database, Protein sequence databases, Protein Family Databases, Structural databases, Enzymes and metabolic pathways databases, Disease databases, Literature databasesPubmed).

Unit 3

Tools: Examples of Formats of databases, Information retrieval system: Search enginesEntrez), Information retrieval system : SRS. Sequence retrieval, submission and alignment tools.

Unit 4

Sequence analysis and alignment: Introduction to sequence alignment, Significance of sequence alignment, Pairwise sequence alignments: basic concepts of sequence alignment: local and global alignments,Basic concepts of Multiple Sequence Alignment:

Books/References:

- Introduction to Bioinformatics by Arthur C. Lesk
- Introduction to Bioinformatics by T.Attawood and D. Parry-Smith

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MA203 Quantitative Techniques in Biotechnology

Unit I

Frequency Distribution, Graphic representation of a frequency distribution, Measures of Central tendency, Moments, moment generating functions, Central Moments, Non- Central Moments, Measures of Dispersion, Measures of Skewness, Measures of Kurtosis

Unit II

Curve fitting, Method of Least squares, Fitting of Straight lines, Polynomials, Exponential Curves, Linear Correlation, Correlation Coefficient, Properties of Correlation Coefficient, Rank Correlation Coefficient, Regression Analysis: Linear & Non linear. Time series and forecasting.

Unit III

Introduction, Experiments, Outcomes, Events, Definition of Probability, Conditional Probability, Independent Events, Total Probability, Bayes' Theorem.

Unit IV

Random Variable, Discrete Random Variable, Probability Function, Continuous Random Variable, Probability Density Function, Discrete Distributions, Continuous Distributions, Mathematical Expectation, properties of Expectation, Two Dimensional Random Variables, Joint Probability Density Functions, Marginal Probability Distribution, Conditional Probability Distribution.

Unit V

Binomial Distribution, Poisson Distribution, Normal Distribution Sampling theory, Tests of significations, Chi-square test, t-test, Analysis of variance (one way), Statistical quality control methods, Control charts, R, p, np, and c charts.

Textbook: J. N. Kapoor, Mathematical Statistics, S. Chand Publication, 2004.

Reference Books

[1] V. K Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, John Wiely & Sons 1976.

[2] Marylees Miller, John E. Freund, Irwin Miller, Mathematical Statistics: With Applications, Prentice Hall 2003.

[3] Gupta, S.C. and Kapoor, V.K. (2007): Fundamentals of Mathematical Statistics, 11th Edn.,(Reprint), Sultan Chand and Sons.

[4] S. M. Ross, Introduction to Probability and Statistics for Engineers & Scientists Elsevier, Academic press, 2004.

Open Elective
BT211 Ecology and Environment

Unit 1:

Autecology and Genecology: Concept of Species and Population; Ecological amplitude, Ecads, Ecotypes and Ecospecies; Ecological Equivalents; Concept of habitat and niche; Characteristics of a population; Population growth curves and life history strategies (*r* and *K* selection); Demes, Dispersal and Age structured populations; Ecotones and Edge Effect.

Unit 2:

Agricultural Ecology and Biotechnology: Introduction to Agricultural Ecology; Weeds and Pests as Ecological Challenges in Agriculture; Outline of Weed biology and Pest biology; Role of Biotechnology in Management of Weeds and Pests; Ecological Impacts of Agricultural Biotechnology.

Unit 3:

Environmental Management and Biotechnology: Role of Soil Microorganisms In Soil Fertility; Role of microbial communities and plant communities in bio-degradation and bio-remediation.

Unit 4:

Environmental Impact Assessment and Policies: Overview of Environmental Impact Assessment (EIA), General guidelines for the preparation of Environmental Impact Statement (EIS) and Environmental Management Plan (EMP); Outline of International Environmental Laws and Environmental Policy and Laws in India `

Unit 5:

Unit Environment and Society: Socio-Economic Impact of Agroforestry, Eco-tourism, Marine exotics; Economic importance of medicinal plants.

References/ Text Books:

- P. Leelakrishnan: Environmental and the last (Bullorthworths, Latold, edn.).
- Basic environmental technology: Jerry; A. Nathanson.
- Handbook of environmental management and technology: Gwendolyn Holmes,Ben Ramnarine Singh, and Louis Theodore.
- Azam-Ali, 2006. Principles of Agronomy. Publisher: Agrosciences book centre, Ansari Road, New Delhi.
- Gupta. O. P. 2007. Fundamentals of Weed Science: A Text Book, Jodhpur, Agrobios, xviii, 380 p., tables, figs., ISBN 81-7754-307-5.

Laboratory I: BT213 Cell Biology, Microbiology and Biochemistry

Cell Biology

1. Study of tissues/cells through microscopy (Light, Fluorescent/confocal/DIC)
2. Study of cell division mitosis in onion root tips & Measurement of cell size
3. Study of meiosis in pollen mother cells/Grasshopper Testis
4. Cell count using hemocytometer

Microbiology

1. Laboratory rules, safety & regulation, and study of instruments and apparatus used in microbiology.
2. To study different methods of sterilization.
3. Preparation of LB/NB agar media and plate pouring.
4. To streak bacterial culture on LB agar plate and isolation & preservation of single bacterial colony.
5. Preparation of LB agar plates containing the antibiotics for selection.

Biochemistry

1. Calibration curve for carbohydrates/Protein
2. Estimation of reducing/non-reducing sugars
3. Estimation of proteins/amino acids
4. Isolation and determination of chlorophyll, and enzymes' activity
5. Separation of amino acids on thin layer chromatography

Laboratory II: BT215 Basic Bioinformatics

1. Information Retrieval for Scientific literature and their practical usage: PubMed
2. Biological Databases: Study of different Biological databases
   Uses and Applications:
   Sequence databases: EMBL, DDBJ, GenBank, Uniprot, PIR, TrembL
   Domain database: Prosite, PRINT, Pfam, BLOCK
   Structure database: PDB, CATH , SCOP
   Specialised database: KEGG, OMIM etc.
   Retrieving a sequence from database
3. Translation of Nucleic acid sequence to protein sequence
4. Finding Open Reading Frame
5. Determination of physicochemical properties of proteins
6. Pair wise sequence alignment: BLAST, FASTA
7. Multiple Sequence alignment: CLUSTALW
8. Determination of domains, motifs.
9. Visualisation and analysis of 3D-structures of Proteins and protein-ligand interactions using graphics tool.

Course Content

Integrated B.Tech.-M.Tech. (Biotechnology)
[Batch 2019-20 Onwards]

Semester 4

BT202 Molecular Dynamics & Bioenergetics

Unit 1

Biological membrane: structure, permeability, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of Na+/ K+, glucose and amino acidtransport; Organization of transport activity in cell; Active potentials; Role of transport in signal transduction processes, Signal Tansduction.

Unit 2

Cell Movement: Structure and organization of Actin Filament. Association of actin filament with Plasma Membrane. Protrusions of cell surface Actin, Myosin and Cell Movement, Muscle Contraction, Cell Crawling

Unit 3

Metabolism and bioenergetics; Generation and utilization of ATP; Metabolism of Nitrogen containing compounds, nitrogen fixation, amino acids and nucleotides; Energetics of Metabolic Pathways; Electron-Transferring Reactions, Energy Coupling (ATP & NADH).

UNIT 4

Stoichiometry and energetic analysis of Cell Growth and Product Formation, Electron Flow as source of ATP Energy, Site of Oxidative Phosphorylation, ATP synthetase, Electron- Transferring Reactions, Standard Oxidation, Electron Carrier, electron transport, Complexes Incomplete reduction of Oxygen, Mechanism of Oxidative Phosphorylation

Text books:

1-Cell – A molecular approach: Geoffrey M. Cooper.
2-Biochemical Engineering Fundamentals: Bailey & Ollis, Tata McGraw –Hill.

Reference books & web sources:

1. Biochemistry: Stryer, W. H. Freeman
2. Biochemistry: Voet and Voet, John Wiley and Sons, Inc. USA
3. Cell: Bruice Albert.
4. Biiochemistry: Garrett and Grisham, Harcourt.
5. http://themedicalbiochemistrypage.org
6. ull.chemistry.uakron.edu/biochem

BT204 Enzymology

Unit 1

Purification of enzymes

Extraction of soluble and membrane bound enzymes from animal, microbial and plant tissues. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes. Few examples of enzyme purification and extraction. Large scale production of enzymes including genetic engineering, modification of catalytic activities.

Unit 2

Immobilization of enzymes

Physical and chemicaltechniques of enzyme immobilization; advantages, carriers, adsorption , covalent coupling, cross-linking and entrapment methods, micro-environmental effect, Mass transfer in enzyme reactors, Analysis of Film and Pore Diffusion Effects on Kinetics of immobilized enzyme reactions; calculation of Effectiveness Factors of immobilized enzyme systems; Steady state analysis of mass transfer and biochemical reaction in enzyme reactors. Applications of immobilized enzyme.

Unit 3

Enzyme Kinetics

Mechanism and kinetics of enzyme action: Concept of active site and energetics of enzyme substrate complex formation, specificity of enzyme action. Michaelis-Menton Equation. Importance of $K_{M,}$ kinetics of single substrate reactions; turn over number, Hofstee plot, L and B plots. Bisubstrate reactions- ordered and random sequential mechanism, Ping pong mechanism. Introductionreversible inhibition-competitive, uncompetitive, non competitive. Irreversible inhibition, Allosteric inhibition.Regulation of enzyme activity, feedback regulation.

Unit 4

Medical application of enzymes

Importance of enzymes in diagnostics**,** Isoenzymes (CK, LD). Use of isozymes as markers in cancer. Converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, serum enzymes in health and diseases.

Unit 5

Industrial enzymes

Enzymes used in detergents, use of proteases in food, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes), production of maltose and sucrose, uses of lactase in dairy industry, Industrial application of carbohydrates - proteolytic enzyme - lignocellulose degrading enzyme, pectin and pectic enzyme, application of enzymes in food industry. Use of enzymes in analysis-types of sensing-gadgetry and methods.

BT206 Bioanalytical Techniques

Unit 1

Spectroscopies: Overview of UV- and visible Spectroscopy, Spectrofluorimetry, Mass Spectrophotometry , Infrared-, FT-IR, Raman-Spectroscopy, ESR, Theory and application of Circular Dichroism; ORD

Unit 2

Microscopy: Optical and Electron Microscopy, Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic force Microscopy, Polarization and Fluorescence Microscopy, confocal microscopy.

Unit 3

Centrifugation: Principles of Centrifugation Mathematics & theory (RCF, Sedimentation coefficient etc), Types of centrifuge -Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods. Ultracentrifugation – velocity and buoyant density determination, and molecular weight determination.

Unit4

Radioactivity based techniques: Stable isotopes, Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay.

Text Books/References:

- Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.
- Essentials of Biophysics, P. Narayanan, New Age International Publishers.
- Advanced Instrumentation, Data Interprtation, and Control of Biotechnological Processes, J.F. Van Impe, Kluwer Academic.

BT208 Immunobiology

Unit 1

Overview of the immune system: History Perspective, Early studies of the Humoral and cellular Immunity, Theoretical challenges, Infection and Immunity, Innate and adaptive immunity, Immune dysfunction and its consequences.

Unit 2

Cells and the organs of the immune system: Hematopoiesis, Cells of the Immune system, Organs of the the immune system, Lymphoid cells and Organs-Evolutionary comparison

Unit 3

Innate Immunity: Anatomical barrier, Connection between innate and adaptive immunity, Inflammation, Soluble and Membrane-associated Receptors, Toll-like receptors, Cells type of innate immunity, Signal Transduction pathways, Ubiquity of Innate Immunity.

Unit 4

Antigens and Antibody: Immunogenicity Versus Antigenicity, Epitopes, Basic structure of an antibody, Antibody binding site, Antibody-mediated effector function, Antibody classes and biological activity, Antigenic determinants on immunoglobulins, B cell receptors, Immunoglobulin superfamily, Monoclonal antibody

Text/Reference Books

- Kuby Immunology by R.A. Goldsby, T.J. Kindt and B.A. Obsorne, Freeman.
- Basic Immunology by A.K. Abbas and A.H. Lichtman, Saunders W.B. Company.
- Immunology (Sixth Edition) by Roitt, Brostoff, Male, Panima Publication.
- Fundamentals of Immunology by W. Paul, Lippincot Williams and Wilkins

BT210 Bimolecular Fluid Mechanics & Biotrafficking

Unit 1

Basic concepts of fluid mechanics, Classification of fluids, Newtonian & non-Newtonian fluids, basic equation of fluid flow, Continuity equation, Momentum balance equation, Bernoulli equation, Incompressible laminar flow in pipes, Hagen-Poiseuille equation, Friction factor, Flow through packed-bed, Fundamentals of fluidization.

Life and its physical basis, length force and time scales in living systems, chemical bonding and stability of molecules, forces and energies at nanometer scale: Intermolecular interactions, electrostatic screening, chemical composition of living systems.

Unit 2

Transport at low Reynold numbers: Friction in fluids, Reynold number, significance of low Reynolds numbers, The time reversal properties of a dynamical law, Applications: Swimming and pumping - Bacterial motion, vascular networks.

Unit 3

Molecular motors and nerve impulses: Electro-osmotic effects, ion pumping, mitochondria, nerve impulses and their electrical network equivalence, mechanism of the action potential, Applications: synapses in nerves and muscles, neuromuscular junctions.

Unit 4

Endomembrane systems and peroxisomes, Structure of E R and glogi complex. Role of E R and golgi complex in protein glycosylation, secretary pathways, protein trafficking, exocytosis, endocytosis, coated vesicles in cellular transport processes. Lysosomes and cellular digestion. Role of plant vacuole and peroxisomes.

Text books:

1. P. Nelson, Biological Physics: Energy, information, life, Freeman, 1st edition (2013)
2. Rodney M.J. Cotterill, Biophysics: An Introduction, Wiley, Ist Edition (2002)
3. Jeff Hardin, Gregory Paul Bertoni, Lewis J. Kleinsmith(2011) Becker's World of the Cell (8th Ed) Pearson Publ.

BT212 Cell Physiology

Plant Physiology

Unit 1

Photosynthesis: Light signaling, pigment organization in thyllakoid membrane. RUBISCO and PEPCase enzymes. Organization and regulation of C3, C4 and CAM pathways.
Respiration: Regulation of glycolysis, Pentose phosphate pathway and TCA Cycle, Evolution and regulation of electron transport chain.
Water relation and Nutrition: Transpiration. Absorption and assimilation of nutrients, Nitrogen fixation.
Flowering: Hormone signaling, Phase changes, Biological rhythms, Flower development and Sex determination.
Plant defense: Abiotic and Biotic Stress, Signaling of cold, Drought, Temperature, and Pathogen. **Senescence and Programmed Cell Death**.
Basic plant physiological process and their integration with recombinant DNA technology for crop improvement, Climate change and crop productivity.

Animal Physiology
Unit 2
General & Cellular Physiology: Homeostasis, Control systems,
Renal Physiology & Fluid Balance: Body fluid compartments; Water balance; regulation of fluid balance; Regulation of extracellular sodium & osmolarity, Renal mechanisms for the control of blood volume, blood pressure & ionic composition, Regulation of acid-base balance, Microturition, Diuretics
Cardio-Pulmo Physiology: Properties of cardiac muscle, Nutrition & metabolism of heart, Generation & conduction of cardiac impulse, Principles of Hemodynamics, Respiratory system and respiratory medicine.
Nerve & Muscle Physiology: Resting membrane potential, Action potential, Nerve conduction, Degeneration and regeneration in nerves, Functional anatomy of skeletal muscle, Neuro-muscular transmission and blockers, Excitation-contraction coupling
Gastro-intestinal System: General principles of G-I function, Digestion & absorption, Liver functions.
Environmental Physiology: Physiology of hot environment, Physiology of cold environment, High altitude, Aviation physiology, Space physiology, Deep sea diving

Text Books/References:

- Hopkins, W. C. (1995): Introduction to Plant Physiology.
- Taiz, L. and Ziegler, F. (1998): The Plant Physiology.
- Salisbury, F. B. and Ross, C.W.(1992): Plant Physiology IV ed.
- Henry T. Nguyen, Abraham Blum (CRC Press, (2004)Physiology and biotechnology integration for plant breeding .
- Arthur C Guyton, John E. Hall Textbook Of Medical Physiology.
- Richard W. Hill, Gordon A. Wyse, Margaret Anderson Animal Physiology.

BT214 Medical LabTechnology

Unit I

Introduction to Medical Laboratory Technology: Define laboratory, Identify and enumerate the different kinds of medical laboratories. State the laboratory rules, ethics, professional code of conduct and polices. Describe and practice collection, handling and shipment of medical laboratory specimens. Explain the general cleaning and care of laboratory wares. Sterilization and disinfection, Laboratory accidents and safety, Quality assurance: Accuracy.

Unit II

Hematology: Composition of Blood, Function of blood, Describe the formation of blood cells. Explain the regulatory mechanisms in hemopoiesis. List the possible source of blood samples for hematological investigation, the mechanism for preventing hemolysis. Define anticoagulants. Describe the proportion, mechanism of anticoagulation and advantages of EDTA, trisodium citrate, double oxalates and heparin anticoagulants.

Unit III

Serology: In vitro antigen antibody reactions i.e. precipitation reaction, agglutination reaction, complement fixation reaction, Enzyme Immuno Assay (EIA), Radio Immuno Assay (RIA) and their role in the diagnosis of disease. Serology of rheumatoid factor, C- reactive protein, serology of Streptolysin O (SLO),Serology of Human Immunodeficiency virus (HIV).

Unit IV

Structure of bacterial cell, differential staining methods of bacteria, the type of specimen, its collection's time. Preservatives and transport media for microbiological specimen, Infection of skin and wound, Infection of respiratory tract, Infection of gastrointestinal tract, Infection of urinary tract, Infection of genital tract, Infection of blood.

Unit V

Urinalysis: Physiology of the Kidney & Formation of Urine, The Composition of Urine, Renal clearance and renal threshold, Preservation of urine specimen, Types of Examination in Routine Urinalysis. Physical and chemical analysis of urine. Determination of Urinary Sugar, Determination of Ketone Bodies, Determination of Urinary Protein, Determination of Bilirubin, Determination of Hemoglobin, Determination of Calcium.

Text Books:

1. Medical Laboratory Technology (Volume III): Procedure Manual for Routine Diagnostic Tests Paperback by Kanai, L Mukherjee and Swarajit Ghosh , Volume III, Second Edition.
2. Textbook of Medical Laboratory Technology: Clinical Laboratory Science and Molecular Diagnosis by Praful B. Godkar, Darshan P. Godkar, Volume I, Third Edition, Bhalani Publishing House.
3. Medical Laboratory Technology: Methods and Interpretation by Ramnik Sood, Volume I, Sixth Edition.
4. Lecture Notes on Clinical Medicine, 1980 by Rubestein, Devid, Sixth Edition.
5. Basic Clinical Laboratory Techniques, by Anna Reynolds and Barbara H. Estridge, 2007.
6. Introduction to Medical Laboratory Technology by Chris Pallister, R. E. Silverton, F. J. Baker, 7th Edition.

BT216 Medical LabTechnology Lab

1. To make familiar with the laboratory equipments and bio safety.
2. To make students familiar with the sterilization techniques.
3. To estimate presence of glucose in urine/blood using Benedict's test.
4. Identification of animal and plant tissue (permanent slides) using microscopy.
5. Identification of different blood cells using Leishman Staining.
6. To perform Gram's staining using unknown sample.
7. To perform histopathology technique using animal tissues.
8. To perform agarose gel electrophoresis.
9. To determine the blood group.
10. To design PCR primers using bioinformatics tools

BT218 Bioenergetics Lab

1. Selective Permeability of an Artificial Membrane.

2. Demonstration of the process of Active Transport.

3. To study the Demonstration of osmosis.

4. Effect of molecular size on permeability of the cell membrane.

5. Observation of osmosis under microscope.

6. Identifying the conditions needed for photosynthesis.

7. To study the extraction of starch. by green leaves.

8. Investigating factors affecting the rate of photosynthesis.

9. Investigating the light dependent reaction in photosynthesis.

10. To study the Isolation of Chloroplasts from spinach Leaves.

11. To study the structure & Function of refrigerated centrifuge

12. To study the structure & Function of Phase contrast microscope.

Course Content

Integrated B.Tech.-M.Tech. (Biotechnology)
[Batch 2019-20 Onwards]

Semester 5

BT301 Molecular Biology

UNIT 1

INTRODUCTION TO MOLECULAR BIOLOGY - DNA AND RNA: Scope and History. Structure of DNA- Nucleoside, Nucleotide, Base pairing, Base stacking, Double Helix, features of Watson and Crick model, major and minor groove, Supercoiling- twist, writhe and linking number. Forms of DNA- A, B, Z. Structure and function of mRNA, rRNA, tRNA. Secondary structures in RNA.

UNIT 2

REPLICATION AND REPAIR: Types and functions of DNA polymerases in Prokaryote and Eukaryote. Replication in prokaryote and Eukaryote. Proof reading activity, 5'Æ 3' exonuclease activity, topoisomerase activity, Telomeric DNA replication and Plasmid Replication-theta model, strand displacement model and rolling circle model. DNA Repair- Nucleotide excision repair, base excision repair, mismatch repair, photo-reactivation, recombination repair and SOS repair.

UNIT 3

TRANSCRIPTION AND POST TRANSCRIPTIONAL MODIFICATIONS: Fine structure of prokaryotic and eukaryotic gene, structure and function of the promoters in mRNA, rRNA, tRNA genes. RNA polymerases in prokaryote and eukaryote, types and function. Transcription of mRNA, rRNA, and tRNA genes in Prokaryote and eukaryote. Post transcriptional processing of mRNA – 5'capping, splicing (including different types), polyadenylation and RNA editing Nuclear export of mRNA.

UNIT 4

TRANSLATION AND POST TRANSLATIONAL PROCESSING: Genetic code and Wobble hypothesis. Translation in prokaryote and eukaryote. Post translational modifications. Principles protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast, and nucleus.

UNIT 5

GENE REGULATION: Principles of gene regulation- Transcriptional and post transcriptional gene regulation- activators, co-activators, suppressors, co-suppressors, moderators, silencers, insulators, enhancers. Operon-lac operon, trp operon, ara operon and gal operon. Gene silencing: transcriptional and post-transcriptional gene silencing, Antisense RNA, Ribozymes..

TEXT BOOKS:

1. Molecular Biology of Gene – Watson
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland Science.
4. Cell and molecular biology, Gerald Karp, 6th edition, 2011, John Wiley and Sons.

BT303 Biophysical Chemistry

Unit 1

Interactions in Biological Systems: Intra and inter molecular forces, electrostatic and Hydrogen bonding interactions, dipole moments, covalent bond distances, van der Waals and Hydrophobic interactions, Disulphide bridges, Role of water and weak interactions, conformational entropy.

Unit 2

Structural organization of Proteins: Conformational properties of polypeptides, Primary and secondary structure α-helix, β-sheet structures etc. Tertiary and quarternary structures, Structural features of membrane proteins, Secondary and tertiary structure prediction of proteins conformations, pH titration of amino acids and proteins, peptide bond, synthesis and sequencing of proteins, structural organization of proteins, folded conformation of globular proteins, Steric contour diagrams,

Unit 3

Multiple Equilibrium: Titration of proteins to evaluate net and total charge, Equilibrium dialysis, Scatchard and Hill plots, study of protein-ligand interactions, Surface Plasmon resonance, Folding-unfolding equilbrium and denaturation of proteins, Effect of temperature and solvent conditions on the thermodynamics of protein folding-unfolding equilibrium, Kinetics of protein folding

Unit 4

Molecular Biophysics: Techniques to study macromolecular structures, Analytical Ultracentrifugation: Sedimentation velocity and equilibrium, determination of molecular weights, Micro calorimetry (DSC and ITC) and its applications, Circular Dichroism spectroscopy, UV, visible and Fluorescence spectroscopy, principle of X-ray Diffraction and crystallography, Nuclear Magnetic Resonance (NMR), Mass Spectrometry

Text/Reference Books

- Biophysical chemistry by Canter and Schimmel, W. H. freeman and company.
- Introduction to protein structure by Carl Branden & Tooze, Garland publishing.
- Principles of Biochemistry by A.L. Lehninger, D.L. Nelson, M.M. Cox. , Worth Publishing.
- Biochemistry by Lubert Stryer, W H Freeman and company
- Biochemical calculations by Segel, John Willey and sons.
- Biochemistry: molecular basis of life (Colour edition) by McKee
- Biochemistry by Mathews, van Holde , Ahern
- Modern experimental biochemistry by R.F. Boyer, Pearson

BT305 Developmental Biotechnology

Unit 1: History & Basic Concepts: The origins and importance of developmental biology, principles of developmental biology, evolution of developmental patterns. Identification of developmental genes, Cell commitment & differentiation, Determination & induction of cell fate, Genomic equivalence. Cell-cell communication in development (paracrine factors, juxtacrine signaling and signal transduction cascades).

Unit 2: Animal Developmental Biology: Introduction of model vertebrate and invertebrate animals used for development studies (*X. laevis*, Chicken, Mouse, Zebrafish, *D. melanogaster, C. elegans*), advantages of each system with special emphasis on model animal: Mouse.

Unit 3: Features of development – Gametogenesis, Fertilization, Cleavage, Morulation and Blastulation, Phenomenon of the organization with respect to morphogenesis, cell differentiation & migration and organogenesis.

Unit 4: Signals in development: Developmental signals in cell division, migration, proliferation & differentiation, embryonic induction and formation of neural crest cells, role of gene expression in development, Hox genes. Cell commitment & differentiation, Determination & induction of cell fates. Anterior/posterior, Dorsal/ventral polarity development. Cell-cell communication in development (paracrine factors, juxtacrine signaling and signal transduction cascades).

Unit 5: Clinical relevance of development biology: Medical implication of development biology with respect to teratogenesis, infertility, genetic errors of human development, regeneration, growth and aging.

Text/Reference Books

1. Developmental Biology, By Scott F Gilbert, Sinauer associates Inc
2. Developmental Biology Paperback – 2008, by Werner A. Muller, Springer

BT307 Food Biotechnology

Unit 1

Introduction to Industrial Biotechnology: Introduction and scope of industrial biotechnology, Types of biotechnology industry, Impact of industrial biotechnology on science and society.

Unit 2

Production of modern biotechnology products: General aspects of the production of: biofertilisers, biopolymers (xanthan gum, PHB etc), monoclonal antibodies, industrial enzymes, organic acids,secondary metabolites, bioplastics and antibiotics.

Unit 3

Development of industrial food Ingredients: Production of biopreservatives (Nisin), cheese, polysaccharides, low calorie sweeteners, naturally produced flavor modifiers, amino acids, vitamins, food supplements, food coloring, nutraceuticals, water binding agents, single cell protein, mycoproteins.

Unit 4

Food spoilage and preservation: General principle of spoilage, microbial toxins (endotoxins and exotoxins), contamination and preservation, factors affecting spoilage. Methods of food preservation (thermal processing, cold preservation, chemical preservatives & food dehydration). Food preservation using irradiation, Characteristics of radiations of interest in Food preservation, Principle underlying the destruction of microorganisms by irradiation, Indicator and food- borne pathogens, Food borne diseases,
Consumer perspective and future of food biotechnology

Unit 5

Food Processing: Types of food processing: Bioprocessing of meat, poultry, fisheries, vegetables, dairy products, enzymes and chemicals used for food processing, Newer concepts in food processing including organic foods, processing of organic raw material, genetically modified foods, Fermented and functional foods.

Text/Reference Books

1. Food Microbiology by Frazier, W.C. and Westhoff, D.C., Tata Mc-Graw Hill.
2. Biotechnology by Gupta, P.K., Rastogi Publication
3. Industrial Microbiology by Casida Jr, L.E., New Age International (P) Ltd.
4. Industrial Microbiology by Presscott Dunn, Agrobios (India).

BT309 Environmental Biotechnology

Unit 1

Environment: Basic concepts and issues; Management and remediation of soil problems; Toxicants, Bioaccumulation (characteristics, evolutionary concept, factors affecting bioaccumulation of toxicants, measurement and kinetic modelling of bioaccumulation). Role of genetically engineered microbes in environmental management, recycling & up gradation technologies, production of products.

Unit 2

Biological Treatment of Waste water (Aerobic System): Biological processes for domestic and industrial waste water treatments; activated sludge process, trickling filters, biological filters, rotating biological contractors (RBC), Fluidized bed reactor (FBR), expanded bed reactor, Inverse fluidized bed bio-film reactor (IFBBR) packed bed reactors air spared reactors.Biological Treatment of Wastewater (Anaerobic System): Anaerobic biological treatment - contact digesters, packed column reactors.

Unit 3

Bioremediation and Metal Biotechnology: Introduction, constraints and priorities of Bioremediation, Bio-stimulation of naturally occurring microbial activities, Bio-augmentation, in-situ, ex-situ, intrinsic & engineered bioremediation; Phytoremediation; Environmental monitoring through microorganism, microbial biosensors in environmental monitoring. Metal Biotechnology (Mining with special reference to Copper & Iron, Microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects)

Unit 4

Bio Fuels: Production of nonconventional fuels - Methane (Biogas), Hydrogen, Alcohols and algal hydrocarbons, Use of microorganisms in augmentation of petroleum recovery. Biogas technology, plant design, construction, operation, biogas form organic wastes, water weeds, land fills, microbiology of anaerobic fermentation.

Unit 5

Hazardous Waste Management: Introduction, Xenobiotic compounds, recalcitrance, biodegradation of Xeno-biotics, biological detoxification, Microbes assisted waste bio-treatment, market for hazardous waste management; biotechnology application to hazardous waste management. Energy form waste.

Unit 6

Novel Methods for Pollution Control: Vermitechnology, waste water treatment using aquatic plants, root zone treatment. Aiming for biodegradable and ecofriendly products.

Text Books/References:

- Chatterji A.K.(2002),Introduction to Environmental Biotechnology, Prentice Hall of India Pvt. Ltd ,New Delhi.
- Biodegradation & Bioremediation (1999), Martin Alexander, Academic press.
- Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 1987.
- Evan G.M.and Furlong J.C (2003), Environmental Biotechnology: Theory and Applications, John Wiley and Sons Ltd., England.
- Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London, 1989.
- T. cookson, Bioremediation engineering: design and application (1995) John. Jr. Mc Graw Hill, Inc.
- Kalaichelvan P.T., I Arul Pandi (2007), Bioprocess Technology, MJP Publishers, Chennai.

Generic Elective 1
BT311 Developments in Therapeutics

Unit 1

Principles of drug design and action: Agonists, antagonists, potency and efficacy. Drug-receptor interactions, stereospecificity and selectivity in drug action and design. Identification of therapeutic targets and rational drug design. Pharmacokinetics, pharmacodynamics, pharmacogenetics and pharmacogenomics. Case studies on drug action and design.

Unit 2

Gene and protein therapy: Vector engineering, viral vectors, strategies of gene delivery, gene replacement, gene correction, gene editing, gene regulation and silencing. MicroRNAs as therapeutic targets. Immunological approaches: Immunomodulation and immunotherapy. Translational medicine: New approaches, Disease models (in vitro, in vivo and in silico), Biomarkers.

Unit 3

Molecular pharmacology: Targeted therapy – development of new drugs: identification of new molecular targets, high-throughput screening, risk/benefit ratio, economical and ethical aspects in the development of new drugs. Principles of biological therapy – monoclonal antibodies, small inhibitors – rational drug design, drug transport (liposomes, immunoglobulins, nano-technologies and supramolecular systems). Strategies for immunotherapy (cytokine and vaccine therapy). Antiviral chemotherapy. Actions of cytotoxic drugs: alkylating agents, antimetabolites, antibiotics, mitotic inhibitors, enzymes and hormones.

Unit 4

Cancer immunotherapy: Essentials and basic principles of cancer immunotherapy, cancer antigens peptides, dendritic cells vaccine, tumor infiltrating lymphocytes. Approaches in cancer immunotherapy: Immunomodulation (definition and concept), Immune adjuvant and tumor vaccine therapy, Biological Response Modifiers (BRMs) and their application in cancer therapy and in other diseases.

Unit 5

Stem cell therapeutics: Stem Cells in therapy: Introduction, cellular and molecular aspects of adult and embryonic stem cells, concepts of tissue engineering and clinical applications, Nuclear reprogramming and induced pluripotent stem cells.

Generic Elective 2
BT313 Microbiology Quality Control in Pharma and Food Industry

Unit-1

Role of microbiology in quality control and waste management in food industry, food safety and regulations, Concept of quality assurance, Regulatory control of food quality: FDA, Codex Alimentarius, BIS, ISO, Agmark, Food Safety and Standards Act (FSSA) 2006, Hazard Analysis Critical Care Points (HACCP), Food Safety Management System.

Unit-2

Bacterial Food borne infections and intoxicants, fungal mycotoxins in food products, Microbiological methods of Quality control of food products, Biosensors applications in Food Quality control.

Unit-3

Microbial production and contamination of pharmaceuticals products, Microbial Limit test of Pharma products, Sterility testing, pyrogen testing and LAL test of Pharma products, Sterilization- heat, D- value, Z-value and survival curve, radioactive, gaseous and filtration.

Unit-4

Basic idea about pharmaceutical products (bulk drugs/ dosage forms, vaccines, diagnostics) and quality requirements. Significance of IP, BP and USP, Quality Assurance (QA) and validation in Pharmaceutical Industry. Good Laboratory Practice (GLP), Good Manufacturing Practice (GMP), Quality Control (QC), Quality Management System, ISO, WHO, USFDA certification.

Text/ Reference Books:

- Vyas S. P and Dixit V. R. (2002), Pharmaceutical Biotechnology, CBS Publishers and Distributors,New Delhi.
- W.B.Hugo & A.D.Russell Pharmaceutical Microbiology , Sixth edition. Blackwell scientific Publications.Rahman M.S. and Ahmed J. (2012) Handbook of Food Process Design, Volume 1 and 2 John Wiley & Sons, USA (2012).

Laboratory I
BT315 Molecular Biology

1. Agarose gel electrophoresis, preparation of buffers, loading dye and gel
2. Isolation of protein from plant/animal/microbial samples.
3. SDS-PAGE for separation of proteins
4. Isolation of genomic DNA from animal/plant tissue.
5. DNA estimation (Qualitative and Quantitative)
6. E coli culture and plasmid isolation
7. Restriction Digestion of plasmid/Genomic DNA
8. Primer designing for PCR amplification
9. Polymerase Chain reaction
10. Restriction digestion analysis of the PCR product

Laboratory II
BT317 Environmental Biotechnology

1. Determination of BOD
2. Determination of COD
3. Determination of Nitrogen Organic and Ammonical nitrogen
4. Determination of orthophosphates
5. Bacteriological quality measurement: MPN, plate count
6. Determination of Oil & Grease in wastewater
7. Determination of cations Ca+, Mg+, Na+ and Ni by Flame Photometer
8. Color Measurement

Course Content

Integrated B.Tech.-M.Tech. (Biotechnology)
[Batch 2019-20 Onwards]

Semester 6

BT302 Genomics and Proteomics

GENOMICS

Unit 1

Functional Genomics: Transcriptome analysis: (ESTs, SAGE, MPSS, Fluorescent differential display, SSH, microarray). AFLP-Based RNA Fingerprinting, Gene Identification Signature-Paired End diTagging (GIS-PET). Microarray technology introduction, Types of DNA-microarrays- cDNAs and Oligonucleotides spotted chips. Quantitative real-time PCR; Taqman, SYBR Green systems, Applications of quantitative RT-PCR. Emerging Technologies:Nanotechnologies and Fluorescent Proteins for *in planta* functional genomics; Next Generation Sequencing Technologies: 454, Illumina-Solexa, SOLiD. RNA sequencing, Chip-sequencing. TILLING as a functional genomics tool. Introduction to *in silico* genomics and metabolomics.

Unit 2

Comparative genomics: Sizes and organization of genomes. Comparative genomics of bacteria, organelles and eukaryotes. Variation at the level of individual nucleotides, duplications, comparisons at chromosome level (synteny). Sequence similarities across organisms and conserved sequences (Genomes of chimpanzees and humans). Evolution and phylogenetic relationships of genomes in prokaryotes and eukaryotes.

Unit 3

Gene mapping and sequencing: DNA sequencing methods, Genetic mapping (introduction), physical and cytological mapping (chromosome walking, FISH, Radiation hybrid, Chromosome banding pattern maps etc). Sequence Mapping (STS). High-resolution maps based on DNA sequences, restriction maps, SNPs, haplotypes and SNP genotyping. Organizing large sale genomic projects (BAC to BAC genome sequencing, whole genome physical mapping and shotgun sequencing, contig assembly. Human genome project, Integration of Physical and Genetic Maps. Genome annotation and gene clustering. Applications of genomics.

PROTEOMICS

Unit 1

Methods of quantitation of proteins. Calculation of extinction coefficients. Extraction and handling of membrane proteins. Stabilizing forces for enzymes and proteins. Salting out and salting in phenomena. Precipitation of proteins.

Unit 2

Differential expression proteomics: gel and non gel-based methods, Two dimensional gel electrophoresis, DIGE, ICAT, MudPIT, ITRAQ, SILAC, Mass Spectrometry. Recent developments in the use of mass spectrometry coupled with purification techniques to identify proteins and their interactions with other molecules. Peptide mass fingerprinting (PMF) using enzymatic fragmentation of proteins, Matrix assisted Laser desorption Ionization Time of Flight Mass Spectrometry (MALDI-TOFMS), LC-MS/MS, SELDI-TOF. Introduction, different types of protein chips, detection and quantification of proteins bound to protein chips, emerging protein chips technologies. Chromatographic techniques used in protein purification: Size exclusion, Ion exchange, IMAC, RPC, HPLC etc. and their application in proteomics

Unit 3

Bioinformatics tools for proteomics, Techniques for detection of protein-ligand interactions: two-hybrid systems, ITC, Dynamic light scattering, fluorescence spectroscopy, Surface Plasmon Resonance, gel filtration, x-ray crystallography and sedimentation velocity method.

Text Books/References:

- Functional Genomics: A Practical Approach (Practical Approach Series) by Stephen P. Hunt, Rick Livesey.
- PCR Applications: Protocols for Functional Genomics By Innis, Michael A. (Sninsky, John J. , Gelfand, David.
- Introduction to Genomics, 2007. Arthur Lesk, Oxford University press.
- Principles of gene manipulation and genomics, 2008. Primrose and Twyman, Blackwell publishing.
- Gibson G, Muse SV. A primer of genome science (3rd ed.). Sunderland, MA: Sinauer Associates.
- Mapping Genomes - From Genomes by T. A. Brown, 2002.
- The Handbook of Plant Genome Mapping: Genetic and Physical Mapping, 2005.Editor(s): Khalid Meksem, Günter Kahl, Wiley publishers.
- The Handbook of Plant Functional Genomics: Concepts and Protocols Guenter Kahl (Editor), Khalid Meksem (Editor), Wiley publishers.
- Protein Engineering, H. J. Gross, Caroline Köhrer, Uttam L. RajBhandary.
- Proteomics and Protein-Protein Interaction,s Gabriel Waksman.
- Introduction to protein structure, Carl Branden & Tooze, Garland publishing.
- Protein structure, Creighton, Oxford
- Protein Engineering, H. J. Gross, Caroline Köhrer, Uttam L. Raj Bhandary.
- Principles of Protein X-Ray Crystallography, by j. Drenth
- Protein Analysis and Purification, Ian M. Rosenberg
- Protein Folding Kinetics, Bengt Nölting

BT304 Plant & Animal Biotechnology

Unit I

Plant tissue culture and animal cell culture: Plant tissue culture: historical perspective; totipotency; organogenesis; Somatic embryogenesis; establishment of cultures – callus culture, cell suspension culture, media preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production. Animal cell culture: brief history of animal cell culture; cell culture media and reagents; culture of mammalian cells, tissues and organs; primary culture, secondary culture, continuous cell lines, suspension cultures; application of animal cell culture for virus isolation and in vitro testing of drugs, testing of toxicity of environmental pollutants in cell culture, application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

Unit II

Plant genetic manipulation: Genetic engineering: Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers; characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing; molecular pharming - concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds.

Unit III

Animal reproductive biotechnology and vaccinology: Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation for conservation endangered species; Vaccinology: history of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.

Unit IV

Plant and animal genomics: Overview of genomics – definition, complexity and classification; need for genomics level analysis; methods of analyzing genome at various levels – DNA, RNA, protein, metabolites and phenotype; genome projects and bioinformatics resources for genome research – databases; overview of forward and reverse genetics for assigning function for genes.

Unit V

Molecular mapping and marker assisted selection : Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications; introduction to mapping of genes/QTLs; marker-assisted selection - strategies for Introducing genes of biotic

and abiotic stress resistance in plants: genetic basis for disease resistance in animals; molecular diagnostics of pathogens in plants and animals; detection of meat adulteration using DNA based methods.

Recommended Textbooks and References:

1. Chawla, H. S. (2000). Introduction to Plant Biotechnology. Enfield, NH: Science.
2. Razdan, M. K. (2003). Introduction to Plant Tissue Culture. Enfield, NH: Science.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press.
4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons.
5. Umesha, S. (2013). Plant Biotechnology. The Energy And Resources.
6. Glick, B. R., & Pasternak, J. J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.: ASM Press.
7. Brown, T. A. (2006). Gene Cloning and DNA Analysis: an Introduction. Oxford: Blackwell Pub.
8. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
9. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant Biotechnology: The Genetic Manipulation of Plants. Oxford: Oxford University Press.
10. Gordon, I. (2005). Reproductive Techniques in Farm Animals. Oxford: CAB International.
11. Levine, M. M. (2004). New Generation Vaccines. New York: M. Dekker. 12. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.

BT306 Vaccine Biotechnology

Unit 1

History and Relevance of Immunology, Components of Innate and acquired immunity, Organs and cells of immune system, Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT);, Antigens- immunogens, haptens; antigenic determinants/epitopes, Antibody structure and function, Immunoglobulins-basic structure, classes and subclasses of immunoglobulins. Connection between innate and acquired immunity, Inflammation, soluble and membrane associated receptor, Toll Like Receptor (TLR). cells type of innate immunity, signal transduction pathway (TLR only)

Unit 2

Overview of Vaccine Strategies: History of vaccines, bacterial, viral and parasitic vaccines, overview of conventional vaccine strategies, designing of live attenuated or killed whole organism-based vaccines sub-unit vaccines, DNA vaccines, recombinant vaccines, adjuvants, peptides, immune-modulators (cytokines). Vaccine delivery systems, mucosal vaccines, parental vaccines, edible vaccines, monoclonal antibodies as vaccines. The advantages and disadvantages of each approach, eluding to various considerations, such as efficacy, safety and cost of production. General specifications and pharmaceuticals release criteria for the existing vaccines, Cold chain management of vaccines.

Unit3

Genetic engineering in vaccine designing, Designing of peptide/epitope-based vaccines, T cell and B cell epitope prediction, screening and selection of the vaccine composition, structural approaches for vaccine designing, Reverse vaccinology and immunoinformatics, Databases in Immunology, Principles of B-cell and T-cell epitope prediction

Unit 4

Novel approaches in designing of glyco-conjugate vaccines, cancer vaccines, use of bacterial toxins as vaccines, adjuvants, vaccines against opportunistic pathogens, vaccines for neglected diseases.

Unit 5

Vaccines Against Viral Diseases: Hepatitis-B, Herpes simplex virus, Zika, and influenza virus. Designing Bacterial vaccines for: TB, pneumococcal, malaria, cholera, streptococcal.

Unit 6

New strategies for vaccine development**:** Reverse genetic and temperature-sensitive mutation, reassortment, Viral recombinant and deletion mutants, codon deoptimization, increased replication fidelity, replication vector recombined with gene from pathogens, Replication-defective VLPs, DNA plasmid, reverse vaccinology, Prime boost, Fusion proteins, Gene delivery by invasive bacteria,, Inmmune refococusing, Transcriptomics, proteomics, DNA shuffling, transcutaneous vaccination, adjuvant.

Text Books/References:

- Vaccine Design: Innovative Approaches and Novel Strategies Publisher: Caister Academic Press, Editor: Rino Rappuoli and Fabio
- Vaccines, 4th Edition by Stanley A. Plotkin, Elsevier publication
- Vaccines and Immunotherapy by Stanley J. Cryz Elsevier science publishing co.
- Review: Vaccines: the fourth century by Stanley Plotkin

BT308 Virology

Unit 1

Introduction: History and principles of virology. Virus structure and morphology, viruses of veterinary importance and plant viruses. The Function and Formation of Virus Particles. Capsid Symmetry and Virus Architecture. Enveloped Viruses. Complex Virus Structures. Protein-Nucleic Acid Interactions and Genome Packaging.

Viral Genomes: The Structure and Complexity of virus Genomes. Viral Genetics. Virus Mutants. Genetic Interactions between Viruses. Non-genetic Interactions between Viruses. Positive-Strand RNA Viruses. Negative-Strand RNA Viruses. Segmented and multipartite Virus Genomes. Baltimore Classification

Unit 2

Virus-cell Interaction: Cellular receptors and virus entry: Definition, structure and methods of discovery of viral receptors (polio, herpes, VSV, HIV). Cellular interactions—clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms Nuclear localization signals and nuclear pore transit, virus – cytoskeletal interactions, chaperons.

Unit 3

Viral Replication: General strategies, replication of plus stranded RNA virus (polio), negative strandRNA viruses (VSV and influenza).Replication of double stranded RNA virus (rota), andretroviruses (HIV and HTLV). DNA viruses Replication of double stranded DNA viruses (SV40, pox), ssDNA virus (AAV) proteins, replication of plant virus.

Unit 4

Viral gene expression: Initiation of transcription,Viral regulation of transcription, capping and tailing, pre-mRNA splicing. Post-transcriptional Gene Silencing, Regulation of translation during viral infection

Unit 5

Intracellular trafficking and exit of virus: Import of viral proteins, assembly, selective packaging, release of virus particle

Unit 6

Viral Diseases: Viral Diarrhoea: Clinical course, disease burden, risk factors, epidemiology, prevention, and treatment. Rotavirus.

Viral Cancers: Role of papilloma, HIV, Epstein Barr Virus, HTLV and herpes in pathogenesis of cancers, diagnosis, prevention.

Viral Hepatitis: Structure & genomic organization, Viral respiratory diseases (Biology of respiratory viruses). HIV-AIDS, Genetic Engineering Plants for Virus Resistance

TextBooks:

1. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka Latest edition / Pub. Date: December 2003 Publisher: American Society Microbiology.

Generic Elective 1
BT310 Material Science & Biomaterials

Unit 1

Introduction: Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials- Synthetic polymers, Biopolymers, Bioresorbable & bioerodible materials, metals, thin film grafts & coating, biological functional materials

Unit 2

Metals and Ceramics in Medicine : Structure and properties of metals and ceramics, Applications of metals and ceramics in medicine

Unit 3

Polymers in Medicine : Structure and properties of polymers and hydrogels , Degradable and natural polymers , Applications polymers and hydrogels in medicine

Unit 4

Tissue-Material Interactions : Definition of biocompatibility, Effects of physiological fluid on the properties of biomaterials, blood compatibility and tissue compatibility, Wound healing and immune response , Host reaction to biomaterials, Implants, Polymers used in vascular prosthesis, Contact lense, Rconstructive materials, Cellular response to foreign materials.

Unit 5

Toxicological screening of biomaterials: Toxicity tests: acute and chronic toxicity studies sensitization, carcinogenicity, mutagenicity and special tests.

Unit 6

Applications in Tissue Engineering and Drug Delivery : Tissue engineering , Drug delivery

Text Books:

1. Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press,
2. Sujata V. Bhat, Biomaterials, Narosa Publishing House.
3. J B Park, Biomaterials – Science and Engineering, Plenum Press.
4. Biomaterial & Bioengineering Handbook by Donald L. Wise

Generic Elective 2
BT312 Pharmaceutical Biotechnology

Unit 1

Introduction to concepts and technologies in pharmaceutical biotechnology, current status and future prospects

Unit 2

DRUG ACTION, METABOLISM AND PHARMACOKINETICS: Formulation of biotech products, Pharmacokinetics and pharmacodynamics of biological products, Immunogenicity to therapeutic proteins**:** Mechanism of drug action; physico-chemical principles of drug metabolism, radioactivity; pharmacokinetics.

Unit 3

Gene therapy, Biogeneric drugs, monoclonal antibody based pharmaceuticals and their therapeutic applications, Vaccines, Pharmacogenetics.

Unit 4

Regulatory Issues and Drug Approval for Biopharmaceuticals.

Text Books

1. Pharmaceutical Biotechnology: Fundamentals and Applications Editors: Crommelin, Daan J. A., Sindelar, Robert D., Meibohm, Bernd (Eds.) ,2007, 3rd Edition
2. Pharmaceutical Biotechnology, Drug Discovery and Clinical Applications .Edited by O.Kayser and R.H.Muller. 2004 Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim
3. Katzung B.G.(1995), Basic and Clinical Pharmacology,(6th Ed) Prentice Hall of Intl.

Generic Elective 3
BT314 Biofuel and Alcohol Technology

Unit 1

Introduction to Alcohol Technology, Raw Material of Alcohol Industry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Study of yeast production as single protein cell.

Unit 2

Study of different alcoholic fermentation techniques, Batch fermentation, Continuous fermentation, Modem techniques of Continuous fermentation, Bio still fermentation, Encillium process, Wet milling of grain for alcohol production, Grain dry milling cooking for alcohol production, Use of cellulosic feed stocks for alcohol production, Scaling in distilleries, Fusel oil separation

Unit 3

Study of different recycling process, Biochemistry of alcohol production, The management of fermentation in the production of alcohol. Alcohol distillation-The fundamental, Parameters & affecting alcoholic fermentations, By product of alcoholic fermentation, Distillery quality control, Alcoholometry

Unit 4

Various biofuels/ bioenergy from biomass. Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion. Biomass conversion to biofuel: thermochemical conversion, syngas fermentation.

Text Books

1. Chemical Process Principles – Part I, Material and Energy Balances by Olaf A Hougen, Kwenneth M. Watson, and Roland A Ragatz, CBS Publishers and Distributors (1995).
2. Text books of alcohol tech by T. P. Lyons.
3. Product Recovery in Bioprocess Technology ", BIOTOL Series, VCH, 1990
4. Shreve's Chemical Process Industries , 5th Ed. Reference
5. Out lines of Chemical Technology by Chmles E.
6. Chemical Process Industries, 4th Ed. By shieve, Mc.Graw

Laboratory I
BT318 Genomics and Proteomics

1. RNA pre-amplification
2. Real-time PCR using different dyes
3. Data analysis of Real-time PCR (methodological steps in quantitative RT-PCR, Cycle threshold (CT), delta (CT)
4. Designing a DNA-microarray experiment. Analysis of a given microarray data through computational methods
5. DNA sequencing by Sanger or alternative methods.
6. Analysis of gene expression in single cells using three prime end amplification PCR
7. To identify single nucleotide polymorphisms in a candidate gene in a relevant group of study
8. To study biomarkers and/or differential gene expression in a gene in a relevant group of study
9. Protein isolation for proteomic analysis.
10. Protein fractionation by ion exchange chromatography
11. Protein fractionation using gel filtration chromatography
12. Silver staining/ponceau staining of proteins.
13. Quality analysis of protein samples for proteomic analysis
14. Sample preparation for the MALDI-TOF MS analysis
15. Analysis of the MALDI-TOF peptide mass fingerprinting data

Laboratory II

BT320 Plant & Animal Biotechnology

Plant Biotechnology

1. Organizing Plant tissue culture Laboratory
2. Preparation of Tissue Culture Media
3. Prepare explants for inoculation under aseptic conditions.
4. Callus Induction
5. Shoot tip culture / Organogenesis
6. Somatic Embryogenesis
7. Isolate plant protoplast by enzymatic and mechanical methods and attempt fusion by PEG (available material).
8. Culture Agrobacterium tumefaciens and attempt transformation of any dicot species.
9. Hardening and Planting in field
10. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometeric methods.

Animal Biotechnology

1. GLP and Ethics in Animal Biotechnology

2. Aseptic techniques: Sterilization techniques, Contamination and Trouble shooting in animal cell culture

3. Demonstration of equipments/devices in animal cell culture: their usage and precautions

4. Introduction to animal cell culture technique: use of media, serum, trypsin

5. Isolation of PBMC/Initiation of primary animal cell culture

6. Observation, monitoring and maintenance of animal cell culture

7. Case study 1: Experiment designing for gene transfer by transfection in animal cell line

8. Case study 2: Experiment designing for studying anti-cancer/anti-inflammatroy effect of a drug/compound in animal cell line

9. Case study 3: Experiment designing for studying gene/protein expression profile in animal cell line and detection by immunocytochemical assay

10. Cell fractionation experiments

Course Content

Integrated B.Tech.-M.Tech. (Biotechnology)
[Batch 2019-20 Onwards]

Semester 7

BT507 Microbiology

Unit 1

Genomics and metagenomics of microbes: Genetics of microbes, annotation, sequencing and expression of genes, various tools for genetic manipulation of microbial DNA and proteins, Microbial Expression hosts , Understanding metagenomics, preparation of metagenomic library, sequence and function based metagenomics, its application, cloning of 16S RNA from unculturable microbial community, Analysis of 16S libraries usingRDB Project2, Phylogenetic analysis and applications.

Unit 2

Molecular interactions in microbial pathogenesis: Molecular pathogenesis of microbes-molecular aspects of interaction of microbes with host and among themselves, Pathogen recognition receptor, pathogen associated molecular pattern, cell signalling, ability to survive in host, bacterialcommunication, biofilms, bacteriocins, persister cells.

Unit 3

Molecular aspects of drug resistance: Identification of Drug targets, multidrug resistance, effluxpumps, evolution of drug resistance and molecular mechanism of antibiotic resistance with examples Alternative therapies

Unit 4

Microbes in human therapeutics: Microbes as model system, Application of Microbes in human therapeutics, cancer, vaccine and introduction of microbial synthetic biology for human therapeutics, Role of CRISPERS
intherapeutics**.**

Unit 5

Production of industrial metabolites: Microorganisms with biotechnological applications. Production of industrial metabolites: Microbial production of industrial enzymes (glucose isomerase, pectinase, amylase, lipase, protease), organic acids and secondary metabolites (tetracyclins, alkaloids and aromatic antibiotics) biopolymers, bioplastics, amino acids and antibiotics, Production of microbialpesticides, bacteriocins, biofuels and bioremediation.

BT509 Plant and Animal Cell Culture Technology

Unit 1

Animal cell culture: Animal cell culture; media composition and growth conditions; Animal cell and tissue preservation; Anchorage and non-anchorage dependent cell culture; Primary and secondary culture; Animal cell growth characteristics and kinetics; Micro & macrocarrier culture; Hybridoma technology; Stem cell technology; Transgenic animals; Animal cloning; Mechanisms of drug resistance and cell death. Unit I Animal cell culture 15 lectures

Unit 2

Plant cell culture: Totipotency; Plant growth regulators; Regeneration and micropropagation of plants: clonal propagation, organogenesis, shoot-tip and meristem culture, haploid culture, triploid culture, protoplast culture; Somaclonal variation; Tissue culture and Cell suspension culture system: methodology, growth kinetics and nutrient optimization; Precursors and elicitors; Plant Transformation methods (emphasis on Agrobacterium mediated transformation); Hairy root culture; Plant products of industrial importance, Production of secondary metabolites.

Unit 3

Secondary metabolite production: Principles, design and operation of bioreactors: specific design criteria for mammalian and plant systems; Strategies for fermentation with recombinant organisms; Isolation, characterization and production of secondary metabolites from different plant cell types; Bioprocess monitoring and control: current practices in the bioprocess industries, advanced methodologies; Overview of downstream processing: centrifugation, filtration and chromatographic techniques.

Recommended Textbooks:

1. Butterworth Heinemann Ltd., (1994) Biotol Series, In vitro Cultivation of Plant cell.
2. Bhojwani S.S. and Razdan M.K. (1996) Plant Tissue Culture: Theory and Practice, a Revised Edition, Elsevier Science
3. T. A. Brown, (2001) Gene Cloning and DNA Analysis: an Introduction, Blackwell Science.
4. M. L Shuler and F. Kargi. (2002), Bioprocess Engineering, Prentice Hall Inc.
5. A. Slater, N. Scott and M. Fowler (2003), Plant Biotechnology: the Genetic Manipulation of Plants, Oxford University Press.
6. M. M. Ranga (2007), Animal Biotechnology, 3rd Revised Edition, Agrobios.
7. Freshney. (2016) Culture of Animal Cells.
8. Meyer, Handschel, Wiesmann (2009). Fundamentals of Tissue Engineering and Regenerative Medicine.

BT517 Principles of Bioreaction Engineering

Unit 1

History of bioreaction engineering and its applications; different products obtained from bioreaction engineering; different modes of industrial production of chemicals and their comparative analysis

Unit 2

Introduction to engineering calculations; unit conversion; introduction to thermodynamic principles; problems based on material and energy balancing; steady state and equilibrium; law of conservation of mass; Electron Balances; Biomass Yield; Product Stoichiometry; Theoretical Oxygen Demand; Maximum Possible Yield; unsteady state material and energy balances; problems based on above concepts.

Unit 3

Growth kinetics; Quantitative measurement of bacterial growth, use of various equations to calculate growth rate; batch culture; fed-batch culture; continuous culture; comparison of batch and continuous culture in industrial processes; growth models.

Unit 4

Enyme kinetics and metabolic control analysis; Enzyme Kinetics Derived from the Model
of Michaelis–Menten; More Complicated Enzyme Kinetics; Variants of Michaelis–Menten Kinetics; Cooperativity and Allosteric Enzymes; Immobilized Enzymes and Diffusion Resistance; Choice of Reactor Type; Definition of Control Coefficients for Linear Pathways; Using Connectivity Theorems to Calculate Control Coefficients; The Influence of Effectors; Approximate Methods for Determination of the C J i (Flux control coefficient with respect to the activity of the ith enzyme).

Unit 5

Outline of physical processes like fluid flow, mixing, heat transfer and mass transfer; Outline of scale-Up of Bioprocesses; Scale-Up Issues for Large Industrial Bioreactors; Modeling the Large Reactor Through Studies in Small Scale; Scale-Up in Practice: The Desirable and the Compromises.

MA415 Biostatistics

Unit I

Descriptive Statistics: Application of statistics in managerial decision-making, Collection of data, Tabulation and graphic presentation of data, Measures of Central tendency (Mean, Median and Mode), Measuring the variation in Data, Standard Deviation, Population Variance, Sample Variance, Significance of Standard Deviation; Percentiles, Quartiles, Skewness. Distribution of sample means, standard error and confidence interval.

Unit II

Correlation and Regression: Correlation: Meaning and uses, Methods of correlation, Regression: Meaning and uses, Regression equations, Time series: Concepts, Components of time series, Measurement of trend. Scatter plot, multiple regressions.

Unit III

Probability: Permutation and combination, Sample space and events, probability concepts, addition theorem, multiplication theorem, Conditional probability.

Unit IV

Probability Distributions: Discrete Random Variables, Continuous Random Variables, Expected Value, Variance, Introduction to one way and two-way analysis of variance; Data transformations. Binomial Distribution, Poisson distribution, Normal Distribution.

Reference Books

[1] Wayne W. Daniel, Biostatistics : Basic Concepts and Methodology for the Health Sciences, 9th edition, Wiley India Pvt Ltd, 2008

[2] Sheldon Ross, A First Course in Probability, 9th Edition, , 2014.

[3] Edward Batschelet, Introduction to Mathematics for Life Scientists, 3rd Edition, Springer-Verlag, 1992.

[4] S.P. Gordon and F.S. Gordon, Contemporary Statistics:A Computer Approach, McGraw-Hill Publishing Company, New York, 1994.

Discipline Specific Elective 1

BT519 Nanobiotechnology

Unit 1

Introduction to nanotechnology and nanobiotechnology, development of nanotechnology - timelines and progress, overview. Nanomaterial in biotechnology - nanoparticles, quantum dots, fullerenes, nanotubes and nanowires, nanocomposites etc. Synthesis of nanaomaterial methodology: plasma arcing, ball milling, sol-gel, Micromulsion, CVD, PVD, molecular beam epitaxy, vapor (solution)-liquid-solid growth, (VLS or SLS), spary pyrolysis, lithography , plant and microbial basedsynthesis, magnetototac bacterial based natural synthesis of magnetic nanoparticle. **(12 Hrs)**

Unit 2

Characterization of nanostructures by transmission electron microscopic, scanning tunneling microscopy, auger electron microscopy, X-ray, photoelectron spectroscopy; Nano-biosafety **(6 Hrs)**

Unit 3

Introduction to nano-fabrications, (Bio-MEMS/NEMS/ AFM/SAM), nano-fluidics (LOC, Bio-fluidic devices), nano-medicine, nano-biosensor, interaction between bio-molecules and nano-particle surface, molecular self assembly, intelligent drug delivery system (DDS), microchip for drug delivery,bio-electronic sensor, electrochemical DNA sensor, nanomachine. **(9 Hrs)**

Unit 4

Molecular mimics: Catenanes & rotaxanes, molecular switches, molecular shuttle switch, chemical rotors, prodders, flippers, atomic shuttles, actuators; nano-biometrics & its biological functions.**(6 Hrs)**

Unit 5

Medical applications of nanobiotechnology: nanoparticles cytotoxicity; Applications of nanostructures in drug: discovery, delivery, and controlled release; Nanostructures in cancer research: Examples of nanostructures in research and therapy; Nanotechnology for tissue engineering: applicationsin regenerative therapy. **(7 Hrs)**

Text/ReferenceBooks

1. Nanobiotechnology: Concepts, Applications and Perspectives by Christof M.Niemeyer, Chad A. Mirkin, Wiley VCH.
2. Nanobiotechnology - II more concepts and applications by Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
3. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Guozhong Cao, Imperial College Press.

Discipline Specific Elective 1

BT521 Molecular Medicine

Unit 1

Advanced Molecular and Cellular Biology Technologies: Nucleic acids, RNA transcription, protein synthesis and processing, Vectors, Polymerase chain reaction (PCR) and DNA sequencing, Gene mapping technologies. Animal model system, Knock-out technology, Cell culture Technology , Stem Cell Therapeutics, Regenerative Medicine (**15hours)**

Unit 2

Gene Expression and Disease: GeneExpression of Complement, Growth Factors, Differentiation factors, Cytokines, Hormones, Regulatory Peptides, Viral Expression, Oncogenes, Tumour suppressors, Cell cycle control, Signalling pathways, Apoptosis.**(15 Hours)**

Unit 3

Molecular Genetics and Disease: Genetic Basis of Cancer, Viruses in Cancer, Leukaemia, Haemophilia, Breast Cancer, Colon Cancer, Invasiveness, Cancer Vaccines and Gene Therapy, Diabetes, Muscle Cell Disease, Lipoprotein Metabolism, Endocrine disorders, Genome structure and Inherited disorders, Gene targeting, viral diseases. **(15hours)**

Recommended Books

- Principles of Molecular Medicine by Runge and Patterson, Springer 2006
- Animal Cell Technology by Asok Mukhopadhyay, 2008
- T.A. Brown – Gene cloning and DNA analysis – An introduction, 2012
- Animal Cell Biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press.
- Benjamin Lewin, Gene X, Jones and Barlett Publishers, 2007.
- Alberts et al; Molecular Biology of the Cell, 4th edition, Garland Science.
- Principles of Gene Manipulation: An Introduction to Genetic Engineering, R.W. Old and S. B Primrose, Blackwell Science Inc.

Discipline Specific Elective 2

BT523 Molecular Modeling & Drug Design

Unit 1

Drug Designing: Introduction to drug discovery process, Strategies for drug design, Target identification and validation techniques, Brief overview of pharmacokinetics. Building Biological Molecules, Conformational Search Techniques

Unit 2

Molecular Modeling: Basic principles of theoretical modeling, Empirical forcefields for biomolecular simulations, Energy minimization, Molecular dynamics, Monte Carlo simulation

Unit 3

Protein Structure Prediction Methods: Tertiary Structure; Threading techniques; Homology Modeling and Abinitio methods

Unit 4

Structure Based Drug Design: Target Structure Based Drug Design (Active site identification, Characterization of target site, etc.), Denovo methods, Docking techniques, Free Energy

Unit 5

Analogue based drug design: QSAR (Quantitative Structural Activity Relationship) -2D QSAR, 3D QSAR, Pharmacophore

References:

- Guide book on Molecular Modeling in Drug design, by Cohen N. Claude
- Molecular modeling: Principles and Applications, by A. Leach

Discipline Specific Elective 2

BT525 Molecular Toxicology

Unit 1

General concepts in Toxicology: Introduction, Passage of chemical through the body, Absorption, Distribution, Metabolism, Excretion.

Unit 2

Phase I Metabolism in Toxicology: Introduction, Cytochrome P450 in toxicology, Nomenclature of cytochrome P450, pharamacogenetics of cytochrome P450, Flavin mono-oxygenase-mediated toxicity.

Unit 3

Phase II Metabolism in Toxicology: Introduction, Glucuronide conjugation, Sulphate conjugation, Glutathione conjugation, Glutathione transferase pharmacogenetics, Glutathione transferase-mediated toxicity.

Unit 4

Response to toxicity: Immediate response to toxic insult, Chemical-mediated signaling, Genotoxicity, Repair of cellular damage (DNA and protein repair), Apoptosis and Necrosis, Nephrotoxicity, Hepatotoxicity, Neurotoxicity, Teratogenesis.

Text/ Reference Books:

- Molecular Toxicology. By David Josephy and Bengt Mannervik. Oxford University Press, 2006.
- Molecular Toxicology. By Nick Plant. BIOS Scientific Publishers. Taylor and Francis group. 2003.
- Essential Concepts in Toxicology by Prof P K Gupta. PharmaMed Press.2014

Laboratory I

BT527 Cell Culture Technology

1: To prepare the materials required for various cell culture practices in sterile condition.

2: Preparation of media for cell culture and its sterilization.

3. Routine cell culture and its maintenance.

4: Isolation of Peripheral blood mononuclear cells (PBMCs) from human whole blood sample.

5: Sectioning and staining of the animal tissues samples.

6: Identification of different blood cells by using Leishman's stain method.

7: Microscopic analysis of permanent tissue's slides.

8: Study of microbial contamination in cell culture medium (RPMI-1640/DMEM).

9.Counting cells (HepG2) and cell viability assay by Trypan blue exclusion test.

10. To preserve the cells in viable condition for future works by using proper preservative

Laboratory II

BT529 Microbiology & Bioprocessing Technology

Microbiology

1a. Sterilization Techniques: Dry heat, moist heat
1b. Media preparation: nutrient broth and nutrient agar
2. Culturing of microorganisms: in broth and in plates (pour plates, streak plates, isolation and preservation of bacterial cultures)
3. Pure culture techniques
4. Staining of isolated organisms (Gram staining, methylene blue). Structural Stains (Endospore, Capsule, Flagella)
5. Determination of a Bacterial Growth Curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
6. Inhibition and Destruction of Microorganisms (chemical/physical means).
7. Assay of antibiotics production and demonstration of antibiotic resistance.
8. Determination of thermal death point and thermal death time of microorganisms.
9. Culture Techniques for Anaerobic Bacteria
10. Isolation of microflora from the body (throat, teeth)
11. Biochemical testing of isolates
12. Isolation of fungus from environment, identification of fungal strain using cotton blue

Bioprocessing Technology

1. Demonstration of working of laboratory scale fermenter.
2. Production and purification of alkaline protease and determination of its kinetic constants.
3. Production and estimation of Lactic acid through Sauer Kraut fermentation.
4. Extraction of amylase from sprouted grains and immobilization of enzyme using sodium-alginate method.
5. Production and estimation of alcohol through different substrates.
6. Comparison of aerobic and anaerobic process.
7. Determination of mixing time of provided medium.
8. Determination of volumetric mass transfer coefficient of fermentation broth.
9. Estimation of growth kinetics of microbe.
10. . Measuring time course of an enzyme
11. Effect of varying enzyme concentration
12. Estimation of Km and Vmax for an enzyme
13. Effect of temperature on enzyme activity
14. Effect of pH on enzyme activity
15. Enzyme inhibition

Course Content

Integrated B.Tech.-M.Tech. (Biotechnology)
[Batch 2019-20 Onwards]

Semester 8

Genetic Engineering

Credits

3

Course Objectives

The objectives of this course are to teach various approaches to conducting genetic engineering and their applications in biological research as well as in biotechnology industries. Genetic engineering is a technology that has been developed based on our fundamental understanding of principles of molecular biology and this is reflected in contents of this course.

Student Learning Outcomes

Given the impact of genetic engineering in modern society, the students should be endowed with strong theoretical knowledge of this technology. In conjunction with practicals in molecular biology and genetic engineering, students should be able to take up biological research as well as placement in relevant biotech industry.

Unit I

Introduction and tools for genetic engineering

6 lectures

Impact of genetic engineering in modern society; general requirements for performing a genetic engineering experiment; restriction endonucleases and methylases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes; hybridization techniques: northern, southern, south-western and far-western and colony hybridization, fluorescence *in situ* hybridization.

Unit II

Different types of vectors

7 lectures

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression: expression vectors, pMal, GST, pET-based vectors; Protein purification: His-tag; GST-tag; MBP-tag *etc.*

Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; mammalian expression and replicating vectors; Baculovirus and *Pichia* vectors system, plant based vectors, Ti and Ri plasmids as vectors, yeast vectors, shuttle vectors.

Unit III

Different types of PCR techniques

7 lectures

Principles of PCR: primer design; fidelity of thermostable enzymes; DNA polymerases; types of PCR – multiplex, nested; reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR, cloning of PCR products; TA cloning vectors; proof reading enzymes; PCR based site specific mutagenesis; PCR in molecular diagnostics; viral and bacterial detection; sequencing methods; enzymatic DNA sequencing; chemical sequencing of DNA; automated DNA sequencing; RNA sequencing; chemical synthesis of oligonucleotides; mutation detection: SSCP, DGGE, RFLP.

Unit IV

cDNA analysis

7 lectures

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; study of protein-DNA interactions: electrophoretic mobility shift assay; DNaseI footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Unit V

Gene silencing and genome editing technologies

13 lectures

Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems *e.g.* fruit flies (*Drosophila*), worms (*C. elegans*), frogs (*Xenopus*), fish (zebra fish) and chick; Transgenics - gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model; introduction to genome editing by CRISPR-CAS with specific emphasis on Chinese and American clinical trials.

Recommended Textbooks and References:

1. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub
2. S. Primrose, R. Twyman, B. Old, and G. Bertola (2006), *Principles of Gene Manipulation and Genomics*, Blackwell Publishing Limited; 7th Edition
3. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
4. Selected Papers from Scientific Journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*

Immunology

Credits

3

Course Objectives

The objectives of this course are to learn about structural features of components of immune system as well as their function. The major emphasis of this course will be on development of immune system and mechanisms by which our body elicits immune response. This will be imperative for students as it will help them to predict about nature of immune response that develops against bacterial, viral or parasitic infection, and prove it by designing new experiments.

Student Learning Outcomes

On completion of this course, students should be able to:

- Evaluate usefulness of immunology in different pharmaceutical companies;
- Identify proper research lab working in area of their own interests;
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out kind of immune responses in the setting of infection (viral or bacterial).

Unit I

Immunology: fundamental concepts and anatomy of the immune system

5 lectures

Components of innate and acquired immunity; phagocytosis; complement and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); innate immune response; mucosal immunity; antigens: immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility.

Unit II

Immune responses generated by B and T lymphocytes

8 lectures

Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; principles of cell signaling; basis of self & non-self discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; functional T Cell subsets; cell-mediated immune responses, ADCC; cytokines: properties, receptors and therapeutic uses; antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system.

Unit III

Antigen-antibody interactions

6 lectures

Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence microscopy, flow cytometry and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand –receptor interaction; CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

Unit IV

Vaccinology

8 lectures

Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology: role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; peptide vaccines, conjugate vaccines; antibody genes and antibody engineering:chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine, edible vaccine and therapeutic vaccine.

Unit V

Clinical immunology

8 lectures

Immunity to infection: bacteria, viral, fungal and parasitic infections (with examples from each group); hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; tumor immunology: tumor antigens; immune response to tumors and tumor evasion of the immune system, cancer immunotherapy; immunodeficiency: primary immunodeficiencies, acquired or secondary immunodeficiencies, autoimmune disorder, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy.

Unit VI

Immunogenetics

5 lectures

Major histocompatibility complex genes and their role in autoimmune and infectious diseases, HLA typing, human major histocompatibility complex (MHC), Complement genes of the human major histocompatibility complex: implication for linkage disequilibrium and disease associations, genetic studies of rheumatoid arthritis, systemic lupus erythematosus and multiple sclerosis, genetics of human immunoglobulin, immunogenetics of spontaneous control of HIV, KIR complex.

Recommended Textbooks and References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). *Clinical Immunology*. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). *Janeway's Immunobiology*. New York: Garland Science.
4. Paul, W. E. (1993). *Fundamental Immunology*. New York: Raven Press.
5. Goding, J. W. (1986). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology.* London: Academic Press.
6. Parham, P. (2005). *The Immune System*. New York: Garland Science.

Bioprocess Engineering & Technology

Credits

3

Course Objectives

The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.

Student Learning Outcomes

Students should be able to:

- Appreciate relevance of microorganisms from industrial context;
- Carry out stoichiometric calculations and specify models of their growth;
- Give an account of design and operations of various fermenters;
- Present unit operations together with the fundamental principles for basic methods in production technique for bio-based products;
- Calculate yield and production rates in a biological production process, and also interpret data;
- Calculate the need for oxygen and oxygen transfer in a bioproduction process;
- Critically analyze any bioprocess from an economics/market point of view;
- Give an account of important microbial/enzymatic industrial processes in food and fuel industry.

Unit I

Basic principles of biochemical engineering

4 lectures

Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.

Unit II

Stoichiometry and models of microbial growth

6 lectures

Elemental balance equations; metabolic coupling – ATP and NAD+; yield coefficients; unstructured models of microbial growth; structured models of microbial growth, MATLAB basics for modelling and solving the equations.

Unit III

Bioreactor design and analysis

8 lectures

Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation *vs* biotransformations; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.

Unit IV

Downstream processing and process economics

4 lectures

Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.

Unit V

Applications of enzyme technology in food processing

4 lectures

Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions *e.g.* starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein *etc.* and their downstream processing; baking by amylases, deoxygenation and desugaring by glucose oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

Unit VI

Applications of microbial technology in food processing and biorefineries

4 lectures

Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria: production and applications in food preservation; biofuels and biorefinery; production of antibiotics in a reactor; single cell protein; probiotics and prebiotics.

Unit VII

Applications of biotechnology in production of biologicals

12 lectures

Industrial production of penicillin via fungal route, insulin from recombinant E. coli; Production of metabolites such as shikonin using plant cell culture, astaxanthin from algae, and biotransformation routes for novel/specialty chemicals; Production of HBsAg using yeast cultures, erythropoietin using CHO cells, monoclonal antibodies such as Humira using mammalian cells.

Recommended Textbooks and References:

1. Shuler, M. L., & Kargi, F. (2002). *Bioprocess Engineering: Basic Concepts*. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (1997). *Principles of Fermentation Technology*. Oxford: Pergamon Press.
3. Pauline Doran (1995) *Bioprocess Engineering Principles*. Elsevier Science & Technology Books
4. Mansi EMTEL, Bryce CFA. *Fermentation Microbiology and Biotechnology*, 2nd Edition, Taylor & Francis Ltd, UK, 2007
5. Harrison, R.G., Todd, P., Rudge, S.R., and Petrides, D.P. (2015). *Bioseparations Science and Engineering*. 2nd Edition. Oxford University Press.)

Downstream Processing in Biotechnology

Credits

3

Course Objectives

The objective of this course is to provide an overview of various aspects of recovery and processing of biological products.

Student Learning Outcomes

Students should be able to identify and design relevant unit operations for recovery of a biological product.

Unit I
Biomass removal
3 lectures

Characteristics of biological materials: pretreatment methods; Separation of cell mass: centrifugation, sedimentation, flocculation and filtration; Continuous operation.

Unit II
Cell disruption
4 lectures

Mechanical approaches: sonication, bead mills, homogenizers; non-mechanical approaches: freeze/thaw, osmotic shock, chemical lysis, enzymatic lysis; measurement of cell disruption.

Unit III
Membrane processes
3 lectures

Filtration theory; Micro and ultrafiltration; Reverse osmosis; dialysis; electrodialysis, diafiltration; pervaporation; perstraction; Multistage and continuous operation.

Unit IV
Adsorption and chromatography
5 lectures

Adsorption equilibrium, Van Deemter equation; Chromatography: size, charge, polarity, shape, hydrophobic interactions; Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds).

Unit V
Extraction processes
5 lectures

Solvent extraction: phase equilibrium and distribution, counter-current operation, dissociative extraction, multiple stage analysis; Reciprocating-plate and centrifugal extractors; Reverse micellar extraction; Aqueous two phase, Supercritical fluid extraction; Aqueous two-phase extraction.

Unit VI
Concentration steps
8 lectures

Precipitation: effect of size and charge, solvent effects, ionic strength effects, precipitate growth and aging models. Crystallization: nucleation and growth aspects; Drying: solvent removal aspects, dryers (vacuum, freeze, spray); Scale up aspects.

Unit VII
Product characterization
4 lectures

Biophysical characterization, chemical characterization, modern spectroscopy, QbD, stability Bioassays: Cell based assay, receptor mediated assay, *in vivo* evaluation, immunogenicity.

Unit VIII
Process design
8 lectures

Process synthesis: Identification and ordering of unit operations relevant for a case study. Analysis: comparison of different process synthesis steps. Case studies such as production and recovery of therapeutics, metabolites and antibodies.

Recommended Textbooks and References:

1. Harrison, R.G., Todd, P., Rudge, S.R., and Petrides, D.P. (2015). *Bioseparations Science and Engineering*. 2nd Edition. Oxford University Press.
2. Ladisch, M. (2000). *Bioseparations Engineering: Principles, Practice, and Economics*. Wiley.
3. Doran P. (2013). *Bioprocess Engineering Principles*. 2nd Edition. Oxford. Academic Press.
4. P.A. Belter, E.L. Cussler and Wei-Shou Hu., (1988), *Bioseparations-Downstream Processing for Biotechnology,* Wiley-Interscience Publication.

Bioreactor Operations

Course Objectives

The course is an overview on biological reactions, elements of bioreactor design, and fundamentals of mass and energy balances in biological reactions. It gives an idea on various types of important

Student Learning Outcomes

Student should be able to gain strong understanding on design and applications of various bioreactors. They will be able to analyse bioprocess from an economics/ market point of view.

Credits

3

bioreactors for microbial, animal and plant cell processes. It covers mechanical design considerations for various kinds of bioreactors.

Unit I

Introduction to bioreactor design

3 lectures

Introduction; General design information; Material and energy balance calculations; Process Flow.

Unit II

Scale up and scale down processes

12 lectures

Scale up and scale down issues: Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply; Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. Scale-up of downstream processes: Adsorption (LUB method); Chromatography (constant resolution *etc.*); Filtration (constant resistance *etc.*); Centrifugation (equivalent times *etc.*); Extractors (geometry based rules). Scale-down related aspects.

Unit III

Bioreactor equipment

11 lectures

Selection of bioprocess equipment (upstream and downstream); Specifications of bioprocess equipment; Mechanical design of reactors, heat transfer and mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment; Piping and instrumentation; Materials of construction for bioprocess plants.

Unit IV

Basic bioreactor operations

8 lectures

Spectrum of basic bioreactor operations: immobilized cell system, animal cells, plant cell cultures and waste management; Enzyme immobilization techniques; Bioconversion using immobilized enzyme preparation; Bioconversion in batch, Fed-batch and continuous bioreactors; Mass transfer in immobilized cell/enzyme reactor.

Unit V

Bioreactor facility design

6 lectures

Facility design aspects; Utility supply aspects; Equipment cleaning aspects; Culture cell banks; cGMP guidelines; Validation; Safety; Process economics; Case studies.

Recommended Textbooks and References:

1. Roger Harrison *et al.*, (2003), *Bioseparations Science and Engineering*, Oxford University Press.
2. Michael Shuler and Fikret Kargi, (2002), *Bioprocess Engineering: Basic Concepts*, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ.
3. Michael R. Ladisch, (2001), *Bioseparations Engineering: Principles, Practice and Economics*, 1st Edition, Wiley.
4. M. V. Joshi and V.V.Mahajani., (2000). *Process Equipment Design*, 3rd Edition, Macmillan India Ltd
5. Robert H. Perry and Don W. Green (eds.), (1997), *Perry's Chemical Engineers' Handbook,* 7th Edition, McGraw Hill Book Co.
6. Max S. Peters and Klaus, D. Timmerhaus, (1991). *Plant Design and Economics for Chemical Engineers*, 4th Edition, McGrawHill Book Co.
7. J. Bailey and D.Ollis, (1986), *Biochemical Engineering Fundamentals*; McGraw Hill.
8. Relevant articles from Bioprocess Journals.

Computational Biology

Credits

3

Course Objectives

The objective of this course is to provide students with theory and practical experience of essentials to aid for genomic, proteomic and metabolomics courses and drug design program.

Student Learning Outcomes

On completion of this course, the students are expected to:

- Develop an understanding of the basic theory of these computational tools;
- Develop required database extraction, integration, coding for computational tools and methods necessary for all Omics;
- Create hypothesis for investigating specific contemporary biological questions, provide help to experiment with or develop appropriate tools;
- Critically analyze and interpret results of their study with respect to whole systems.

Unit I

Introduction to computational biology basics and biological databases

4 lectures

Computers in biology and medicine; Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification database, Sequence formats & storage, Access databases, Extract and create sub databases, limitations of existing databases.

Unit II

Pairwise and multiple sequence alignments

5 lectures

Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA. Building Profiles, Profile based functional identification.

Unit III

Genome analysis

6 lectures

Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, Human genome project, Genomics and crop improvement. Study available GWAS, ENCODE, HUGO projects, extract and build sub databases; Visualization tools including Artemis and Vista for genome comparison; Functional genomics case studies.

Unit IV

Structure visualization

3 lectures

Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD.

Unit V

Molecular modelling

6 lectures

Significance and need, force field methods, energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; RMS fit of conformers and protein chains, assigning secondary structures; sequence alignment: methods, evaluation, scoring; protein curation: backbone construction and side chain addition; different types of protein chain modelling: *ab initio*, homology, hybrid, loop; Template recognition and alignments; Modelling parameters and considerations; Model analysis and validation; Model optimization; Substructure manipulations, annealing, protein folding and model generation; loop generating methods; loop analysis; Analysis of active sites using different methods in studying protein–protein Interactions.

Unit VI

Structure-based drug development

6 lectures

Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information. Extra-precision docking platforms, Use of Small-molecule libraries, Natural compound libraries for virtual high throughput screenings.

Unit VII

Ligand-based drug development

6 lectures

Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based; Radar plots and contribution plots and Activity predictions, Pharmacophore modeling, Pharmacophore-based screenings of compound library, analysis and experimental validation.

Recommended Textbooks and References:

1. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
3. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.
4. Campbell, M & Heyer, L. J. (2006), *Discovering Genomics, Proteomics and Bioinformatics*, Pearson Education.
5. Oprea, T. (2005). *Chemoinformatics in Drug Discovery*, Volume 23. Wiley Online Library.
6. Gasteiger, J. & Engel,T. (2003), *Chemoinformatics: a Textbook*, Wiley Online Library.

Laboratory III: Techniques in Molecular Biology and Genetic Engineering

Credits

Course Objectives

The objectives of this course are to provide students with the experimental knowledge of molecular biology and genetic engineering.

Student Learning Outcomes

Students should be able to gain hands-on experience on gene cloning, protein expression and purification. This experience would enable them to begin a career in industry.

Syllabus

1. Concept of lac-operon:
   a. lactose induction of β-galactosidase.
   b. Glucose Repression.
   c. Diauxic growth curve of *E. coli.*
2. UV mutagenesis to isolate amino acid auxotroph.
3. Phage titre with λ phage/M13.
4. Genetic Transfer-Conjugation, gene mapping.
5. Plasmid DNA isolation and DNA quantitation.
6. Restriction Enzyme digestion of plasmid DNA.
7. Agarose gel electrophoresis.
8. Polymerase Chain reaction.
9. DNA Ligation.

10. Preparation of competent cells.
11. Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency.
12. Confirmation of the insert, Miniprep of recombinant plasmid DNA, Restriction mapping.
13. Expression of recombinant protein, concept of soluble proteins and inclusion body formation in *E.coli*, SDS-PAGE analysis
14. Purification of His-Tagged protein on Ni-NTA columns
    a. Random Primer labeling
    b. Southern hybridization.

Laboratory IV: Immunology

Credits

Course Objectives

The objectives of this laboratory course are to develop an understanding about practical aspects of components of immune system as well as their function. Basic as well as advanced methods will be taught to detect different antigen and antibody interactions, isolation of different lymphocyte cells *etc.* and how they can be used in respective research work.

Student Learning Outcomes

On completion of this course, students should be able to:

- Evaluate the usefulness of immunology in different pharmaceutical companies;
- Identify proper research lab working in the area of their own interests;
- Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses and figure out the kind of immune responses in the setting of infection (viral or bacterial) by looking at cytokine profile.

Syllabus

1. Handling of animals like rabbits, mice.
2. Preparation of antigens, immunization and methods of blood collection, serum separation and storage.
3. Antibody titre by ELISA method.
4. Double diffusion, Immunoelectrophoresis and Radial Immuno diffusion.
5. Complement fixation test.
6. Isolation and purification of IgG from serum or IgY from chicken egg.
7. SDS-PAGE, Immunoblotting, Dot blot assays.
8. Blood smear identification of leucocytes by Giemsa stain.
9. Culture of Hela/J774 cells and phagocytosis.
10. Separation of mononuclear cells by Ficoll-Hypaque.
11. Differential leucocyte count under a microscope.
12. Cryopreservation of cells.

Course Content

Integrated B.Tech.-M.Tech. (Biotechnology)
[Batch 2019-20 Onwards]

Semester 9

Bioprocess Equipment Design and Economics

Credits

3

Course Objectives

This is an introductory course to aspects of equipment design and process economics and follows coursework on reactor design and downstream processing.

Student Learning Outcomes

Students should be able to become proficient in applying basic design principles towards implementing bioprocess manufacturing systems.

Unit I
Introduction
4 lectures

Mechanical design of process equipment: pressure vessels, process piping design; Materials and Fabrication Selection.

Unit II
Economics
10 lectures

Design Strategy and Optimum Equipment Design: Economic Design criteria; Cost and Asset Accounting; Cost Estimation; Interest and Investment Costs; Taxes and Insurance; Depreciation; Profitability, Alternative Investments and Replacement.

Unit III
Case studies
14 lectures

Case Study in Process Equipment Design and Costing of Equipment in each of the following categories: Material Transfer, Handling and Treatment Equipment.

Unit IV
Heat transfer equipment
7 lectures

Shell and tube heat exchangers (Kern and Bell-Delaware design methods), Plate heat exchangers, Evaporators.

Unit V
Mass transfer equipment
7 lectures

Absorption/ Stripping columns (packed/tray), Multicomponent distillation column (Fenske-Underwood-Gilliland correlations).

Unit VI
Reaction equipment
7 lectures

Choice of reactors, non-isothermal reactors, reactor configuration, interstage heating/ cooling, multi-tubular reactors, catalyst deactivation.

Recommended Textbooks and References:

1. M.S. Peters and K.D. Timmerhaus, (1991), *Plant Design and Economics for Chemical Engineers*, McGraw Hill.
2. D.F. Rudd and C.C. Watson, (1969), *Strategy of Process Engineering*, John Wiley.
3. F.C. Jelen and J.H. Black., (1992), *Cost and Optimization Engineering.* 3rd ed, McGraw Hill.
4. Harrison, R.G., Todd, P., Rudge, S.R., and Petrides, D.P. (2015). *Bioseparations Science and Engineering*. 2nd Edition. Oxford University Press.
5. M.V. Joshi, (1976), *Process Equipment Design*, McMillan India, New Delhi.
6. R.K. Sinnot, (1989), *An Introduction to Chemical Engineering Design*,

Pergamon Press, Oxford.
7. R. Smith, (1995), *Chemical Process Design*, McGraw Hill.

Bioentrepreneurship

Credits

2

Course Objectives

Research and business belong together and both are needed. In a rapidly developing life science industry, there is an urgent need for people who combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Student Learning Outcomes

Students should be able to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.

Unit I

Innovation and entrepreneurship in bio-business

8 lectures

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

Unit II

Bio markets: business strategy and marketing

8 lectures

Negotiating the road from lab to the market (strategies and processes of negotiation with financers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

Unit III

Finance and accounting

8 lectures

Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

Unit IV

Technology management

8 lectures

Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Recommended Textbooks and References:

1. Adams, D. J., & Sparrow, J. C. (2008). *Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences*. Bloxham: Scion.

2. Shimasaki, C. D. (2014). *Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies*. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
3. Onetti, A., & Zucchella, A. (n.d.). *Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge*. Routledge.
4. Jordan, J. F. (2014). *Innovation, Commercialization, and Start-Ups in Life Sciences*. London: CRC Press.
5. Desai, V. (2009). *The Dynamics of Entrepreneurial Development and Management*. New Delhi: Himalaya Pub. House.

Instrumentation and Control

Credits

3

Course Objectives

This is an introductory course to aspects of process control and instrumentation.

Student Learning Outcomes

Students should be able to become proficient in applying the fundamental concepts of process control towards the modeling and control of practical processes.

Unit I
Introduction
4 lectures

Essentials of mathematical models and modeling considerations.

Unit II
Dynamic processes
10 lectures

Linearization of non-linear systems; Laplace transforms; Transfer functions and input-output models; Analysis of first, second, and higher-order systems.

Unit III
Feedback control
10 lectures

Dynamics of feedback-controlled processes; Stability analysis; Controller design; Frequency response analysis and its application.

Unit IV
Advanced control schemes
7 lectures

Dead time or inverse response systems; Systems with multiple loops; Feedforward and ratio control.

Unit V
Instrumentation
7 lectures

Devices for measurement of flow, temperature, pH, pressure and liquid level.

Recommended Textbooks and References:

1. D.E. Seborg, T.F. Edgar, D. A. Mellichamp. (2004), *Process Dynamics and Control*, 2nd ed, John Wiley and Sons.
2. B.W. Bequette, (2003), *Process Control: Modeling, Design and Simulation*, Prentice Hall, New Delhi.
3. W.L. Luyben, (1990). *Process Modeling Simulation and Control for Chemical Engineers*, 2nd ed., McGraw Hill.
4. G. Stephanopoulos, (1984), *Chemical Process Control: an Introduction to Theory and Practice*, Prentice Hall, New Delhi.

5. Smith, C.A. and Corripio, A.B. (1997). *Principles and Practice of Automatic Process Control*, Wiley, New York.
6. Johnson, C.D. (2006). *Process Control Instrumentation Technology*, Prentice-Hall, New Delhi

Research Methodology and Scientific Communication Skills

Credits

3

Course Objectives

The objectives of this course are to give background on history of science, emphasizing methodologies used to do research, use framework of these methodologies for understanding effective lab practices and scientific communication and appreciate scientific ethics.

Student Learning Outcomes

Students should be able to:

- Understand history and methodologies of scientific research, applying these to recent published papers;
- Understand and practice scientific reading, writing and presentations;
- Appreciate scientific ethics through case studies.

Unit I

History of science and science methodologies

8 lectures

Empirical science; scientific method; manipulative experiments and controls; deductive and inductive reasoning; descriptive science; reductionist *vs* holistic biology.

Unit II

Preparation for research

2 lectures

Choosing a mentor, lab and research question; maintaining a lab notebook.

Unit III

Process of communication

5 lectures

Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness.

Unit IV

Scientific communication

9 lectures

Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Recommended Textbooks and References:

1. Valiela, I. (2001). *Doing Science: Design, Analysis, and Communication of Scientific Research.* Oxford: Oxford University Press.
2. *On Being a Scientist: a Guide to Responsible Conduct in Research*. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. *The Science of Scientific Writing*. American Scientist, 78(Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). *Speaking English Effectively.* Delhi: Macmillan India.
5. Movie: Naturally Obsessed, The Making of a Scientist.

Intellectual Property Rights, Biosafety and Bioethics

Credits

3

Course Objectives

The objectives of this course are:

- To provide basic knowledge on intellectual property rights and their implications in biological research and product development;
- To become familiar with India's IPR Policy;
- To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products;
- To become familiar with ethical issues in biological research.

Student Learning Outcomes

On completion of this course, students should be able to:

- Understand the rationale for and against IPR and especially patents;
- Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations;
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents;
- Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations;
- Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

Unit I

Introduction to IPR

5 lectures

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

Unit II

Patenting

5 lectures

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples;

commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

Unit III
Biosafety
5 lectures

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools.

Unit IV
National and international regulations
5 lectures

International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

Unit V
Bioethics
5 lectures

Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

Recommended Textbooks and References:

1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* New Delhi: Tata McGraw-Hill Pub.
2. *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
5. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
6. Karen F. Greif and Jon F. Merz, *Current Controversies in the Biological Sciences -Case Studies of Policy Challenges from New Technologies*, MIT Press
7. World Trade Organisation. http://www.wto.org
8. World Intellectual Property Organisation. http://www.wipo.int
9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
10. National Portal of India. http://www.archive.india.gov.in
11. National Biodiversity Authority. http://www.nbaindia.org
12. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/divisions/csurv/geac/annex-5.pdf
13. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). *Problem Formulation in theEnvironmental Risk Assessment for Genetically*

Modified Plants. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
14. Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). *An Overview of General Features of Risk Assessments of Genetically Modified Crops*. Euphytica, 164(3), 853-880. doi:10.1007/s10681-007-9643-8
15. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
16. Guidelines and Standard Operating procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/ guidelines1.asp
17. Alonso, G. M. (2013). *Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments*. Retrieved from http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews.

Project Proposal Preparation & Presentation

Credits

2

Course Objectives

The purpose of this course is to help students organize ideas, material and objectives for their dissertation and to begin development of communication skills and to prepare the students to present their topic of research and explain its importance to their fellow classmates and teachers.

Student Learning Outcomes

Students should be able to demonstrate the following abilities:

- Formulate a scientific question;
- Present scientific approach to solve the problem;
- Interpret, discuss and communicate scientific results in written form;
- Gain experience in writing a scientific proposal;
- Learn how to present and explain their research findings to the audience effectively.

Syllabus

Project Proposal Preparation

Selection of research lab and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven.
Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources.
Writing Research Proposal: With the help of the senior researchers, students should be able to discuss the research questions, goals, approach, methodology, data collection, *etc.* Students should be able to construct a logical outline for the project including analysis steps and expected outcomes and prepare a complete proposal in scientific proposal format for dissertation.

Syllabus

Poster Presentation

Students will have to present the topic of their project proposal after few months of their selection of the topic. They should be able to explain the novelty and importance of their research topic.

Syllabus

Oral Presentation

At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work.

Laboratory V: Downstream Processing in Biotechnology

Credits

Course Objectives

The objectives of this course are to provide students with hands on knowledge of primary unit operations involved in downstream processing.

Student Learning Outcomes

Students should be able to gain hands-on experience on approaches to cell disruption, centrifugation, filtration, and precipitation.

Syllabus

1. Conventional filtration
2. Centrifugation in batch and continuous centrifuges
3. Cell disruption
4. Protein precipitation and its recovery
5. Ion-exchange chromatography
6. Membrane based filtration-ultra filtration in cross flow modules and micro filtration
7. Adsorption in batch and continuous mode.

Recommended Textbooks and References:

1. Desai, M. (2000) *Downstream Processing of Proteins: Methods and Protocols*, Humana Press.

Course Content

Integrated B.Tech.-M.Tech. (Biotechnology)
[Batch 2019-20 Onwards]

Semester 10

Dissertation

Course Objectives

The objectives of this course are to prepare the students to adapt to the research environment and understand how projects are executed in a research laboratory. It will also enable students to learn practical aspects of research and train students in the art of analysis and thesis writing.

Student Learning Outcomes

Students should be able to learn how to select and defend a topic of their research, how to effectively plan, execute, evaluate and discuss their experiments. Students should be able to demonstrate considerable improvement in the following areas:

- In-depth knowledge of the chosen area of research.
- Capability to critically and systematically integrate knowledge to identify issues that must be addressed within framework of specific thesis.
- Competence in research design and planning.
- Capability to create, analyse and critically evaluate different technical solutions.
- Ability to conduct research independently.
- Ability to perform analytical