Syllabus

For

B.Sc. (Hons.)BIOTECHNOLOGY

THREE YEAR FULL TIME PROGRAMME UNDER CBCS

RANI DURGAVATI UNIVERSITY

JABALPUR-482001

Syllabus For

B.Sc. (Hons.) BIOTECHNOLOGY

(CBCS Pattern)

ACADEMIC YEAR 2016-17 Onwards

The B.Sc. (Hons.) Biotechnology course would be of three years duration, divided into six semesters. Semester I to V would comprise of three core theory courses, two core practicals courses and one Elective course out of two choices, making a total of 30 courses in five semesters. Students will carry out Research work and submit a Dissertation in Semester VI. The course will commence from the academic session 2016-17. The syllabus has been prepared keeping in view the unique requirements of B.Sc. (Hons.) Biotechnology students under CBCS Programme. The contents have been drawn to accommodate the widening horizons of the Biotechnology discipline. It reflects the changing needs of the students, pertaining to the fields of Chemistry, Bioinformatics and Computational skills. The detailed syllabus for each paper is appended with a list of suggested readings. Teaching time allotted for each course shall be 3 hours for each theory course and 4 hours for each practical course per week, and 1 tutorial period for per week. Each practical batch should not have more than 20 students. Any number exceeding 20 will be divided into two equal batches. This is because biotechnology practicals require individual attention for imparting correct and adequate hands – on training to the students.

One short educational trip will be planned to industry/national/research institutes in the $5^{th}/6^{th}$ semester to keep the students abreast with latest developments in the field of biotechnology.

BACHELOR OF SCIENCE IN BIOTECHNOLOGY

THREE YEAR FULL TIME PROGRAMME

PROGRAMME STRUCTURE

PART I	Semester-1	PAPER
	UBC 101 UBC 102 UBC 103 UBE 101/ UBE 102	Botany Zoology Chemistry I Communicative English Fundamentals of Statistics
	Semester-2 UBC 201 UBC 202 UBC 203 UBE 201/ UBE 202	 Chemistry-II Microbiology Basics of Computers Fundamentals of Biochemistry Bioanalytical Techniques
PART II	Semester-3 UBC 301 UBC 302 UBC 303 UBE 301/ UBE 302	 Cell Biology-I Molecular Biology-I Recombinant DNA Technology Fundamentals of Biophysics Fermentation Technology
	Semester- 4 UBC 401 UBC 402 UBC 403 UBE 401/ UBE 402	 Immunology Cell Biology-II Molecular Biology-II Genetics and Genomics-I Bioinformatics
PART III	Semester-5 UBC 501 UBC 502 UBC 503 UBE 501/ UBE 502	 Plant Biotechnology Environmental Biotechnology Animal Biotechnology Entrepreneurship and IPR Genetics & Genomics-II
	Semester-6 DISSERTATION	

(B) SCHEME OF EXAMINATION

FIRST SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	Course Title				
Core Courses					
UBC 101	Botany	03	40	60	100
UBC 102	Zoology	03	40	60	100
UBC 103	Chemistry-I	03	40	60	100
Practical core courses					
UBC 104	Practical based on UBC 101 and UBC 102	04	40	60	100
UBC 105	Practical based OnUBC103and UBE 104 or UBE 105	04	40	60	100
Elective Courses (Any one to choose)		03	40	60	100
UBE 101	Communicative English				
UBE 102	Fundamentals of Statistics				
(B) Comprehensive viva voce (Virtual credits)		04			50

SECOND SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	Course Title				
Core Courses					
UBC 201	Chemistry-II	03	40	60	100
UBC 202	Microbiology	03	40	60	100
UBC 203	Basics of Computers	03	40	60	100
Practical core courses					
UBC 204	Practical based on UBC 201 and UBC 202	04	40	60	100
UBC 205	Practical based on UBC 203 and UBE 201/ UBE 202	04	40	60	100
Elective Courses (Any one to choose)		03	40	60	100
UBE 201	Fundamentals of Biochemistry				
UBE 202	Bioanalytical Techniques				
(B) Comprehensive viva voce (Virtual credits)		04			50

THIRD SEMESTER

(A)Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	Course Title				
Core Courses					
UBC 301	Cell Biology-I	03	40	60	100
UBC 302	Molecular Biology-I	03	40	60	100
UBC 303	Recombinant DNA Technology	03	40	60	100
Practical core courses					
UBC 304	Practical based on UBC 301 and UBC 302	04	40	60	100
UBC 305	Practical based on UBC 303and UBE 301or UBE 302	04	40	60	100
Elective Courses (Any one to choose)		03	40	60	100
UBE 301	Fundamentals of Biophysics				
UBE 302	Fermentation Technology				
(B)Comprehensive viva voce (Virtual credits)		04			50

FOURTH SEMESTER

(A)Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	Course Title				
Core Courses					
UBC 401	Immunology	03	40	60	100
UBC 402	Cell Biology-II	03	40	60	100
UBC 403	Molecular Biology-II	03	40	60	100
Practical core courses					
UBC 404	Practical based on UBC 401 and UBC 402	04	40	60	100
UBC 405	Practical based on UBC 403and UBE 401or UBE 402	04	40	60	100
UBE Elective Courses (Any one to choose)		03	40	60	100
UBE 401	Genetics and Genomics-I				
UBE 402	Bioinformatics				
(B)Comprehensive viva voce (Virtual credits)		04			50

FIFTH SEMESTER

(A)Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	Course Title				
Core Courses					
UBC 501	Plant Biotechnology	03	40	60	100
UBC 502	Environmental Biotechnology	03	40	60	100
UBC 503	Animal Biotechnology	03	40	60	100
Practical core courses					
UBC 104	Practical based on UBC 501 and UBC 502	04	40	60	100
UBC 105	Practical based on UBC 503and UBE 501or UBE 502	04	40	60	100
UBE Elective Courses (Any one to choose)		03	40	60	100
UBE 501	Entrepreneurship and IPR				
UBE 502	Genetics and Genomics-II				
(B)Comprehensive viva voce (Virtual credits)		04			50

SIXTH SEMESTER

DISSERTATION	Credits	Maximum Marks
A. Valuation		
i. Language & Presentation ii. Review of Literature iii. Methodology iv.	18	300

FIRST SEMESTER
Course code UBC 101 BOTANY (Total credit= 03)

UNIT I

Algae: Fritsch Classification, occurrence, structure, systematic position mode of reproduction and economic importance of the following generaChlamydomonas,,Chara, Sargassum, Polysiphonia, Nostoc.

UNIT II

Fungi: Outlines of classification of fungi, position, occurrence, structure and mode of reproduction in fungi, based on the following representatives:, Eurotium, Morchella, Agaricus and Alternaria, Economic importance of fungi, Lichens: Classification, occurrence, systematic position, mode of nutrition, reproduction and economic importance.

UNIT III

Bryophytes: Outlines of classification and importance of bryophytes, Systematic position occurrence, morphology, anatomy and reproduction in, Marchantia, Anthoceros (Development of Sporophyte only).

UNIT IV

Pteridophytes: Systematic Position, occurrence, morphology, anatomy and development of reproductive structures of Selaginella, Equisetum and Marsilea, Stelar system and its evolution in Pteridophytes, Heterospory and seed habit.

UNIT V

Gymnosperms & Taxonomy of Angiosperms

General characteristics, affinities and classification of Gymnospermsm(Chamberlains' and D.D Pant's classification) Systematic position, occurrence, morphology and development of reproductive structures and Economic importance of the following taxa- Cycas, Pinus, Ephedra, of Cycas, Pinus and Ephedra. Classification as proposed by Bentham and Hooker and Hutchinson, merits, demerits and comparison. Binomial Nomenclature and elementary knowledge of International Code of Botanical Nomenclature.Systematic position, distinguishing characters and economic importance of family: Rutaceae, Cucurbitaceae, Rosaceae, Apiaceae, Apocynaceae, Asclepiadaceae, Lamiaceae, Euphorbiaceae, and Poaceae.

Suggested Readings:

• College Botany Vol. I and II, Ganguli and Kar
• A Text Book of Botany, V. Singh, P.C. Pande & D.K. Jain
• Modern Plant Taxonomy, N.S. Subrahmanyam, Vikas Publishing House.
• A Text Book of Botany, V. Singh, P.C. Pande & D.K. Jain, Rastogi Publication.
• The Algae, V. J. Chapman and D. J. Chapman.
• Introductory Phycology, H. D. Kumar.
• A Text Book of Algae, H. D. Kumar and H.N. Singh.
• Introductory Mycology, Alexopaulos and Mims
• Cryptogamic Botany, G. M. Smith.
• A Text book of Algae, B. R. Vashishtha

• Bryophytes, N. S. Parihar
• Pteridophytes, N. S. Parihar
• An Introduction to Pteridophytes, A. Rashid. Plant Systematics Theory & Practice, Gurcharan Singh, Oxford & IBH Publishing Co.
• Taxonomy, V. Singh & D. K. Jain, Rastogi Publications.
• Botany for degree students – Gymnosperms, P.C. Vashishtha, S. Chand & Co.
• Gymnosperm, S. P. Bhatnagar & A. Moitra, New Age.
• College Botary Vol.2, B.P. Pandey, S. Chand & Co.
• Systematic Botany, S.C. Datta, New Age.
• Text Book of Botany Vol. II. S. N. Pandey, S. P Misra, P. S. Trivedi, Vikas Publishing House.

FIRST SEMESTER
Course code UBC 102: ZOOLOGY (Total credit= 03)

UNIT I

Invertebrata: Protozoa to Annelida, arthropoda to echinodermata, Classification of each phylum upto class level with examples, comparative study: parasitic protozoans canal system in sponges.

UNIT II

Chordata: Characteristics and systematic position, Agantha, Pisces: organization of shark, importance of fishes and their biological significance, Amphibia: classification and parental care. Impact of terrestrialisation, Arcade and fosage of repltilian skull in classification of repltiles, identification of poisonous snake, poison apparatus, biting mechanism and snake venom. Organization of pigeon, flightless birds, migration of birds; Organization of rat; Classification of living mammals upto order level, Dentition, Aquatic and flying mammals, Fate of aortic arches in chordates, Jaw suspension among vertebrates, Fate of urogenital organs in vertebrates.

UNIT III

Respiratory System: Organs, transport of gases, control of respiration. Digestive system: digestive organs. Circulation and Excretion, Osmotic and ionic regulation, Physiology: Composition of skeletal muscle, electrical activity of the heart. Blood its Function and composition of blood, formation of blood cells, blood clotting mechanism, type of blood cells & blood groups.

UNIT IV

Neuron structure, nerve impulse transmission (Myelinated & Non Myelinated), Neurotransmitters, Muscle-Types, Neuromuscular junction, sliding filament theory, Nutrition, Feeding mechanisms, Enzymes, Metabolism and energy production from carbohydrates, proteins and lipids. Sense organs, endocrine glands and hormone regulation.

UNIT V

Human reproduction: Male and Female reproductive organ, Female reproductive cycle, The human sexual response, Fertilization and implantation of embryo, Maternal change during pregnancy, Labor, Physiology of Lactation, Methods of birth control.

Practicals

Dissection:

1. Shark: External characters, Digestive system, Urinogenital system, Mounting: Placoid scale,Ampulla of Lorenzini
2. Calotes: External characters, Digestive system, Reproductive system,Nervous system,Mounting :Hyoid apparatus,Pectin,Columella auris, Muscle and nerve fibre.
3. Study of Paramoecium behaviour (Thigmotrophism,Thermotaxis, Chemotaxis)
4. Study of endangered species of Gujarat through chart or visit to zoo/sanctuary/national park
5. Listing of all the animals found in and around your house/zoo/ sanctuary/national park

Suggested reading

• Mordern textbook of Zoology-Invertebrate by R.L.Kotpal
• Mordern textbook of Zoology-Vertebrate by R.L.Kotpal
• Invertebrate Zoology by Dhami & Dhami
• Chordate Zoology by Dhami & Dhami
• Invertebrate Zoology by Jordan & Verma
• Chordrate Zoology by Jordan & Verma
• Animal Behaviour by Reena Mathur

FIRST SEMESTER

Course Code UBC 103 : CHEMISTRY-I (Total credit= 03)

Section A: Inorganic Chemistry

UNIT I

Atomic Structure: Recapitulation of Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Need of a new approach to Atomic structure. What is Quantum mechanics, Time independent Schrodinger equation and meaning of various terms in it. Schrodinger equation for hydrogen atom in Cartesian coordinates (x,y,z). Need of polar coordinates, transformation of Cartesian coordinates (x,y,z) into polar oordinates (r,_,_). Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals. (Only graphical representation), Radial and angular nodes and their significance. Radial distribution functions and the concept of the most probable distances with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers mr and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms). Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT II

Chemical Bonding and Molecular Structure: General characteristics of ionic bonding, Energy considerations in ionic bonding, lattice energy and salvation energy and their importance in the context of stability and solubility of ionic compounds, Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character. VB Approach Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of, linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements, Concept of resonance and resonating structures.

Section B: Physical Chemistry

UNIT III

Chemical Thermodynamics: What is thermodynamics, State of a system, state variables, intensive and extensive variables, concept of heat and work, thermodynamic equilibrium, thermodynamic properties, various types of systems and processes, First Law of thermodynamics. Calculation of work (w), heat (q), changes in internal energy (KU) and enthalpy (KH) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes, Calculation of w, q, KU and KH for processes involving changes in physical states,

UNIT IV

Principle and definitions of thermochemistry, Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, Variation of enthalpy of a reaction with temperature –Kirchhoff's equation. Various statements of Second

Law of thermodynamics, Carnot cycle, concept of entropy, Gibbs free energy and Helmholtz energy, Calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions, Criteria of spontaneity, Gibbs - Helmholtz equation, Maxwell's relations, Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Unit V

Ionic Equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water, Ionization of weak acids and bases, pH scale, common ion effect, Salt hydrolysis, calculation of hydrolysis constant, degree of hydrolysis and pH for different salts, Buffer solutions, Solubility and solubility product of sparingly soluble salts -applications of solubility product principle. Qualitative treatment of acid base titration curves (calculation of pH at various stages of HCl –NaOH titration only), Theory of acid – base indicators.

PRACTICALS

Section A: Inorganic Chemistry

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with KMnO4.
3. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.
4. Estimation of Fe(II) ions by titrating it with K2Cr2O7 using internal indicator.
5. Estimation of Cu(II) ions iodometrically using Na2S2O3.
6. Estimation of (i) Mg2+ or (ii) Zn2+ by complexometric titrations using EDTA.

Section B: Physical Chemistry

I. Surface tension measurement (use of organic solvents excluded) Determination of the surface tension of a liquid or a dilute solution using a stalagmometer.

II. Viscosity measurement (use of organic solvents excluded) Determination of the relative and absolute viscosity of a liquid or dilute solution using an Ostwald's viscometer.

III. Kinetic studies: Study of the kinetics of the following reaction by integrated rate method: Acid hydrolysis of methyl acetate with hydrochloric acid volumetrically

Suggested Reading

• Barrow GM. (2007). Physical Chemistry. Tata McGraw_Hill.
• Castellan GW. (2004). Physical Chemistry. 4th edition. Narosa.
• Cotton FA and Wilkinson G. (Year). Basic Inorganic Chemistry. John Wiley.
• Douglas, McDaniel and Alexader. (Year). Concepts and Models in Inorganic Chemistry. John Wiley.
• Huheey JE, Keiter E and Keiter R. (Year). Inorganic Chemistry: Principles of Structure and Reactivity. Pearson Publication.
• Khosla B.D. Senior Practical Physical Chemistry. R. Chand & Co.
• Kotz JC, Treichel PM and Townsend JR. (2009). General Chemistry. Cengage Learning India Pvt. Ltd., New Delhi.
• Lee JD. (Year). A New Concise Inorganic Chemistry, E L. B. S.
• Mahan BH. (1998). University Chemistry. 3rd edition. Narosa
• Vogel A.I. Vogel's Qualitative Inorganic Analysis. 7th edition. Prentice Hall
• Vogel A.I. Vogel's Quantitative Chemical Analysis. 6th edition. Prentice Hall

Elective Paper

FIRST SEMESTER
Course Code UBE 101: COMMUNICATIONIVE ENGLISH

UNIT I

Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing. Speech drills, pronunciation and ascent, stress and intonation.

UNIT II

Writing Skills; Selection of topic, thesis statement, developing the thesis, introductory, developmental, transitional and concluding paragraphs. Articles, parts of speech, tenses, sentence structure, subject- verb agreement, punctuation.

UNIT III

Use of dictionary. Use of words: Diminutives, Homonyms and Homophones. Linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

UNIT IV

Effective writing skills, avoiding common errors. Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, writing assignments.

UNIT V

Purpose and scope of Report, Memo, Agenda and Minutes. Notice, Letters; types and minutes, Manuals.

Suggested reading:

• M. Frank. Writing as thinking: A guided process approach, Englewood Cliffs, Prentice Hall Reagents.
• L. Hamp-Lyons and B. Heasely: Study Writing; A course in written English. For academic and professional purposes, Cambridge Univ. Press.
• R. Quirk, S. Greenbaum, G. Leech and J. Svartik: A comprehensive grammar of the English language, Longman, London.
• Daniel G. Riordan & Steven A. Panley: “Technical Report Writing Today” -Biztaantra.
• Daniel G. Riordan, Steven E. Pauley, Biztantra (2004).: Technical Report Writing Today, 8th edition
• Contemporary Business Communication, Scot Ober, Biztantra, 5th Edition (2004).

Elective Paper

FIRST SEMESTER
Course Code UBE 102: FUNDAMENTALS OF STATISTICS (Total Credits = 03)

UNIT I
Sets, Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions, Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and, periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits.

UNIT II
Intuitive idea of algebraic relationships and convergence, Infinite Geometric Series, Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

UNIT III
Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

UNIT IV
Points in plane and space and coordinate form. Examples of matrices inducing Dilation, Rotation, Reflection and System of linear equations. Examples of matrices arising in Physical, Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

UNIT V
Measures of central tendency. Measures of dispersion; skewness, kurtosis. Elementary Probabilityand basic laws. Discrete and Continuous Random variable, Mathematical Expectation, Mean and Variance of Binomial, Poisson and Normal distribution. Sample mean and Sampling variance. Hypothesis testing using standard normal variate. Curve Fitting. Correlation and Regression. Emphasis on examples from Biological Sciences.

Suggested reading
• H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.
• E. Batschelet : Introduction to Mathematics for Life Scientists,S pringer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)
• A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.
• W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.
Note: It is desirable that softwares should be used for demonstrating visual, graphical and application oriented approaches.

SECOND- SEMESTER
Course Code UBC 201: CHEMISTRY-II (Total Credits = 03)

Section A: Basic Organic Chemistry

UNIT I

Fundamentals of Organic Chemistry: Concept of hybridization of carbon. Cleavage of a covalent bond: homolysis and heterolysis, Electronic effects and their applications (inductive, electromeric, hyperconjugation and resonance), Structure and stability of reactive intermediates (carbocations, carbanions and free radicals), Relative strength of carboxylic acids (aliphatic, aromatic and halosubstituted aliphatic), alcohols, phenols and nitro-phenols, Relative basic strength of amines (aliphatic and aromatic) Intermolecular and intramolecular forces: types of intermolecular forces and their characteristics (iondipole, dipole-dipole, dipole-induced dipole and dispersion forces), Intermolecular and intramolecular hydrogen bonding, Effect of intermolecular and intramolecular forces on properties such as solubility, vapour pressure, melting and boiling points of organic compounds.

UNIT II

Stereochemistry: Conformations w.r.t. ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newman, Sawhorse and Fischer representations, Concept of chirality (upto two carbon atoms), Configuration: Geometrical and Optical isomerism: Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E/Z Nomenclature (for upto two C=C systems).

Section B: Chemistry of Biomolecules

UNIT III

Carbohydrates: Classification, and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of disaccharides (sucrose, cellobiose, maltose, lactose) and polysaccharides (starch and cellulose) excluding their structure elucidation.

UNIT IV

Amino Acids, Peptides and Proteins: Preparation of Amino Acids: Strecker synthesis, using Gabriel's phthalimide synthesis. Zwitter ion, Isoelectric point and Electrophoresis. Reactions of Amino acids: ester of –COOH group, acetylation of –NH2 group, complexation with Cu2+ ions, ninhydrin test, Overview of Primary, Secondary, Tertiary and Quaternary Structure of proteins.

UNIT V

Determination of Primary structure of Peptides by degradation Edmann degradation (N-terminal) and C–terminal (thiohydantoin and with carboxypeptidase enzyme), Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid-phase synthesis.

PRACTICALS

Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing up to two extra elements).
2. Systematic Qualitative Organic Analysis of Organic Compounds possessing monofunctional groups (-COOH, phenolic, aldehydic, ketonic, amide, nitro, 1o amines) and preparation of one derivative.

Suggested reading

• T. W. Graham Solomons. Organic Chemistry, John Wiley and Sons.
• Bahl A and Bahl BS. Advanced Organic Chemistry. S. Chand.
• Eliel EL. Stereochemistry of Carbon Compounds, Tata McGraw Hill.
• Finar L. Organic Chemistry (Vol. I & II), E. L. B. S.
• Morrison RT and Boyd RN. Organic Chemistry, Prentice Hall.
• Vogel A.I. Textbook of Practical Organic Chemistry. 5th edition. Prentice Hall.
• Mann FG and Saunders BC. (1960). Practical Organic Chemistry. Orient Longman.

SECOND- SEMESTER
Course Code UBC 202: MICROBIOLOGY (Total Credits = 03)

UNIT I

Introduction to Microbiology: History, scope and development of Microbiology; Applications of Microbiology in human welfare. Development of Microbiology in India & Abroad: Antony van Leeuwenhoek, Alexander Fleming, Edward Jenner, Louis Pasteur, Robert Koch, Selman Waksman, Joseph Lister, M.S. Swaminathan, G.P.Talwar, T.S. Sadasivan, C.V.Subramaniyam & R.N.Singh.

UNIT II

Pure culture techniques, Physical and chemical methods of sterilization. Diversity of Microbial World A: Classification, general characteristics and structure of Bacteria-(eubacteria & archaebacteria), Cyanobacteria, Actinomycetes, Mycoplasma, Rickettsia & Chlamydia with emphasis on function of each part & components.

UNIT III

Diversity of Microbial World B: Classification, general characteristics, structure with emphasis on Mucor, Rhizopus, Puccinia, Cercospora, Aspergillus, Penicillium Alternaria and Curvularia, function of each part & components of cell. reproduction & economic importance of Fungi.

UNIT IV

Diversity of Microbial World C: Classification, general characteristics and structure of Viruses (Prions, Virions, Virusoids & Viroids) Virus host, General features of virus reproduction. DNA & RNA Viruses with the example of T4, TMV & Pox Virus.

UNIT V

Growth and growth measurement: Definition of growth, mathematical expression of growth. Growth curve, Growth yield, Effect of nutrient concentration on growth. Factors affecting growth: nutrients, temperature, oxygen, pH, osmotic pressure. Measurement of growth by measuring cell number, cell mass and cell activity Cell count, direct and indirect method, turbidometric method. Plate count method, membrane filter count method, dry weight and wet weight method by measurement of cellular activity.Synchronous culture, continuous culture and batch culture.

Practicals

1. Isolation of bacteria and fungi from soil, water and air. Morphological, cultural and biochemical identification.
2. Isolation and identification of pathogenic bacteria from sewage and waste water.
3. Determination of Plague Forming Unit (PFU/ml).
4. Determination of photosynthetic pigments in cyanobacteria.
5. Determination of growth curve and generation time of E. coli

Suggested readings

• Powar C. B. and H. F. Daginawala (2003).General Microbiology Vol.II; Himalaya Publishing House.
• Dubey R. C. and D. K. Maheshwari (2004). A Text book of microbiology, 1st Edition; S. Chand and Company Ltd.
• H.C. Dube (2005)A Textbook of Fungi, Vikas Publishing House.
• A Textbook of Fungi- Vashistha (2003) S. Chand and Company Ltd.
• Davis and Harper, General Microbiology
• Alexopoulos C. J. and C. W. Mims (1996). Introductory Mycology, 4th Edition; John Wiley and Sons, Inc. USA.
• Stanier, R.Y., J.L. Ingraham, M.L. Wheelis and P.R. Painter (1987) Vth edition. General Microbiology, Macmillan Press Ltd.
• Wiestrich G. A. and M. D. Lechtman (1988). Microbiology, 5th Edition; Macmillan Pulishing Company, New York.
• Trivedi, P.C. (2004) 1st Edition. Microbial Biotechnology, Aavishkar Publisher.
• Sharma, P.D. (2005) 2nd Edition. Microbiology, Rastogi Publications.
• Pelczar M. J., E. C. S. Chan and N. R. Krieg (2003) Microbiology, 5th Edition; Tata McGraw Hill Publishing Company , New Delhi

SECOND- SEMESTER
Course Code UBC 203: BASICS OF COMPUTERS (Total Credits = 03)

UNIT I
Computer Fundamentals: Introduction to Computers, Characteristics of Computers, Uses of computers, Types and generations of Computers, Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices, User Interface with the Operating System, System Tools

UNIT II
Data Representation: Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of bi. Networks terminology: Types of networks, router, switch, server-client architecture

UNIT III
Multimedia: Introduction, Characteristics, Elements, Applications

UNIT IV
Problem Solving: Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet

UNIT V
General Awareness: IT Act, System Security (virus/firewall etc.) I-Tax, Reservations, Banking

Practical
1. Defined projects will be done by the students and evaluated by the instructor.
2. Document Preparation
3. Presentation Software
4. Familiarizing with the Operating System, Control Panel, Networking Configuration, Firewall setting
5. Spreadsheet Handing, Working with worksheets, Creating a spreadsheet, entering and formatting information, basic functions and formulas, creating charts, tables and graphs.

Suggested reading

• V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.
• Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson-Education

Note: Use of Open Office/Star Office is recommended, as they are freely downloadable.
Reference manual for Open Office available at: http://www.openffice.org
Reference manual for Star Office available at: http://www.sun.com/software/staroffice/

Elective Papers

SECOND- SEMESTER

Course Code UBE 201: FUNDAMENTALS OF BIOCHEMISTRY (Total credit= 03)

UNIT I

Basic building blocks: Biochemistry as molecular logic of living beings, Axioms of living matter, Major organic compounds of animate objects a general view. Chemical elements, structure of atoms, molecules and chemical bonds.Ionic, covalent, coordinate and hydrogen bonds. Structure, function and properties of water, Water as universal solvent, Acids, bases and salts, pH and buffers.

UNIT II

Carbohydrates: Classification of carbohydrates. Chemical structure and properties of monosaccharide, disaccharides, oligosaccharides and polysaccharides- Starch, cellulose and glycogen. Lipids: Saturated and unsaturated fatty acids.

UNIT III

Purines and Pyrimidines: structure and properties of Purines and Pyrimidines. Proteins: Structure and Classification of amino acids. Acid –base properties and solubilities. Amino acid sequencing of proteins. Primary, secondary and tertiary structure of proteins.

UNIT IV

Enzymes: General characteristics of enzymes Classification of enzymes, Co-enzymes and cofactors .Kinetics and Mechanism of enzyme action. Competitive and non competitive inhibition. Allosteric regulation of enzymes. Isoenzymes. Factors contributing to catalytic efficiency of enzymes.

UNIT V

Biological membranes and Transport: membrane dynamics, solute transport across membranes. Biosignaling, signaling in microorganisms and plants, Bioenergetics and Metabolism; bioenergetics and thermodynamics, phosphoryl group transfers and ATP.

Practicals

1. Laboratory Instrument and Definition
2. Quantitative estimation of reducing and non reducing sugars.
3. Detection of water alkalinity and water acidity
4. Separation of amino acid by Paper chromatography and TLC.
5. Verification of Beer’s law
6. Identification of biological compound: Carbohydrate (Glucose, fructose, Galatose, Sucrose, Lactose, Maltose), Protein (color reaction and precipitation reaction), Lipid.

Suggested reading

• Analytical Biochemistry 3rd Ed. by Holme, D. J. & Peck, H.
• Basic Concepts in Biochemistry A Student's Survival Guide by Gilbert, H. F.
• Biochemistry (3rd ed. 1994) by Rawn J. D.

• Biochemistry and Molecular Biology of Antimicrobial Drug Action by Franklin, T. J. & Snow, J. A.
• Biochemistry by Champe
• Biochemistry by Todd, W. B., Mason, M., Bruggen, R. V. & Macmillan.
• Biochemistry by Voet & Voet
• Biochemistry by Mathews 3rd Ed.
• Biochemistry The Chemical Reactions of Living Cells 2d Ed Vols 1&2 by Metzler, D. E.
• Biochemistry with Clinical Correlation by Devlin, T. M.
• Biochemistry: (3rd ed. Vol.1, 2, 3, 1993) by Zubay, J.
• Biochemistry2ed by Stryer

Elective Papers

SECOND- SEMESTER
Course code UBE 202: BIOANALYTICAL TECHNIQUES (Total credit= 03)

UNIT I
Instruments, basic principles and usage: pH meter, absorption and emission spectroscopy, Principle and law of absorption, fluorimetry, colorimetry,

UNIT II
Instruments, basic principles and usage: Spectrophotometry (visible, UV, infra-red), polarography, centrifugation, atomic absorption, NMR, X-ray crystallography.

UNIT III
Chromatography techniques: Paper chromatography, thin layer chromatography, column chromatography, gas chromatography, gel filtration and ion exchange chromatography,

UNIT IV
Electrophoresis: SDS polyacrylamide electrophoresis, immunoelectrophoresis, Isoelectric focusing. MALDI-TOF, ESI

UNIT V
Radioisotope tracer techniques and autoradiography

Suggested reading
• Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
• Bioinstrumentation, Webster
• Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
• Crystal Structure Analysis, J.P. Glusker and K.N. Trueblood, Oxford University Press
• Modern Spectroscopy, J.M. Hollas, John Wiley and Son Ltd.
• NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, H. Gunther, John Wiley and Sons Ltd.
• Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.
• Principles and Practice of Bioanalysis, Richard F. Venn
• Microscopic Techniques in Biotechnology, Michael Hoppert
• Principles of Fermentation Technology, P.F. Stanbury, A. Whitaker, S.J. Hall

THIRD - SEMESTER
Course code UBC 301: CELL BIOLOGY I (Total credit= 03)

UNIT I

An Overview of Cells (Ch 1 Cooper et al./ Ch 1 Karp): Overview of prokaryotic and eukaryotic cells, cell size and shape, Phages, Viriods, Mycoplasma and Escherichia coli.

UNIT II

Tools and techniques of Cell Biology (Ch 1 Cooper et al./ Ch 18 Karp/ Ch 3 De Robertis: Microscopic-Principles of Light microscopy; Phase contrast microscopy; Confocal microscopy;Electron microscopy (EM)- scanning EM and scanning transmission EM (STEM); Fluorescence microscopy; Analytical: Flow cytometry- flurochromes, fluorescent probe and working principle; Spectrophotometry; Mass spectrometry; X-ray diffraction analysis. Separation: Sub-cellular fractionation- differential and density gradient centrifugation; Chromatography- paper, thin-layer, gel-filtration, ion-exchange, affinity and High-Performance Liquid Chromatography (HPLC).

UNIT III

Composition of Cells: Molecules of cell, cell membranes and cell Proteins. The Nucleus: Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromatin: molecular organization, Nucleolus and rRNA Processing.

UNIT IV

Mitochondria, Chloroplasts and Peroxisomes: Structural organization, Function, Marker enzymes,Mitochondrial biogenesis, Protein import in mitochondria, Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisomes'assembly

UNIT V

Protein Sorting and Transport: The Endoplasmic reticulum, The Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes. Cytoskelton and Cell Movement: Structure and organization of actin filaments; actin, myosin and cell movement ,intermediate filaments; microtubules.

Practicals

1. Separation of nucleic acid bases by paper chromatography.
2. Microscopy- Theoretical knowledge of Light and Electron microscope.
3.Study of the following techniques through electron / photo micrographs: Fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting.
4. Study of structure of cell organelles through electron micrographs.

Permanent slide preparation:

1. Cytochemical staining of DNA-Feulgen.
2. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).
3. Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).
4. Cytochemical staining of Total proteins- Bromophenol blue.

5. Cytochemical staining of Histones -Fast Green.

Suggested reading

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
• Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

THIRD - SEMESTER
Course code UBC 302: MOLECULAR BIOLOGY I (Total credit= 03)

UNIT I

Nucleic Acids convey Genetic Information: DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.

UNIT II

The Structures of DNA and RNA / Genetic Material: DNA Structure: Miescher to Watson and Crickhistoric perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology-linking number, topoisomerases; Organization of DNAProkaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA – mitochondria and chloroplast DNA.

UNIT III

Genome Structure, Chromatin and the Nucleosome: Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome Chromatin structure-Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Regulation of Chromatin Structure and Nucleosome Assembly. Organization of Chromosomes

UNIT IV

The Replication of DNA (Prokaryotes and Eukaryotes): Chemistry of DNA synthesis, general principles - bidirectional replication, Semiconservative, Semi discontinuous,RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), □ (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins

UNIT V

The Mutability and Repair of DNA: Replication Errors, DNA Damage and their repair.

Practicals

1. Preparation of Polytene chromosome from Chironomous larva/Drosophila larva
2. Demonstration of mammalian sex chromatin.
3. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip).
4. Perform Southern Blot Hybridization (Restrict DNA for Southern Blot electrophoresis, perform electrophoresis of restricted DNA, perform southern transfer, hybridization and detection of gene of interest)
5. Demonstration of Northern Blotting.
6. Demonstration of Western Blotting.
7. Perform DNA amplification by PCR.
8. Study of semi-conservative replication of DNA through micrographs/schematic representations.

Suggested reading

• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition.John Wiley & Sons. Inc.
• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology.VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
• Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008)
• 5.Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

THIRD - SEMESTER
Course code UBC 303: RECOMBINANT DNA TECHNOLOGY (Total credit= 03)

Unit I

Introduction to basic biotechnology: Milestones in genetic engineering and biotechnology, Tools of recombinant DNA technology, Hosts, E. coli strains; Yeast (Saccharomyces cerevisiae, Pichia pastoris); Fungi (Penicillium, Aspergillus), Mammalian cell lines - names and genotypes, Enzymes Restriction modification systems:Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications, Cloning Vectors- Definition and Properties. Plasmid vectors.

Unit II

Mammalian Expression Vectors: SV40, Vaccinia, Retroviral promoter based vectors, Basic DNA Cloning, Simple cloning of DNA fragments, Vectors: Definition and properties. E. coli expression vectors-lac, tac and T7 promoter based vectors. Yeast expression vectors, Ti based vectors (Binary and Cointegrated vectors) and cloning using linkers and adaptors. Transformation of DNA by chemical method and electroporation

Unit III

Methods of gene delivery in plants and animals: Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium-mediated delivery, Methods of DNA, RNA and Protein analysis and DNA typing: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot and colony hybridizations. Chromosome walking and jumping. DNA fingerprinting by RFLP and RAPD. Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis. SDS-PAGE and Western blotting. Phage display

Unit IV

Amplification of nucleic acids: Polymerase chain reaction - enzymes used, primer design. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction, Construction of Genomic and cDNA libraries, Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony PCR

Unit V

DNA sequencing and synthesis: Maxam-Gilbert's and Sanger's method. Automated sequencing. Human genome sequencing project, Product of DNA technology: Human protein replacementsinsulin, hGH and Factor VIII. Human therapies - tPA, interferon, antisense molecules. Bt transgenics-rice, cotton, brinjal

Practicals

1. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
2. Ligation of DNA fragments.
3. Demonstration of PCR.
4. Interpretation of sequencing gel electropherograms.

Suggested reading

• Alcamo IE. (2001). DNA Technology: The Awesome Skill. 2nd edition. Elsevier Academic Press, USA.
• Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
• Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
• Glick BR and Pasternak JJ. (2003). Molecular Biotechnology. 3rd edition. ASM Press Washington D.C.
• Nigam A and Ayyagari A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill, India.
• Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
• Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
• Willey JM, Sherwood LM, and Woolverton CJ. (2008) Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

Elective Papers

THIRD - SEMESTER

Course code UBE 301: FUNDAMENTALS OF BIOPHYSICS (Total credit= 03)

UNIT I

Introduction to Biophysics: Molecular organization, different level, organization of proteinprimary, secondary, tertiary and quaternary structure, Biophysics of Water: Molecular structure of water, hydrogen bonds and physical properties of water.

UNIT II

Bio-energetic: Laws of thermodynamics (1st & 2nd laws), electrical properties of biological compartments; electrochemical gradients, membrane potential, chemiosmotic hypothesis.

UNIT III

Energetic of a living body: Primary events in photosynthesis; strategies of light reception in microbes, plants and animals. Correction of vision faults, generation and reception of sonic vibrations.

UNIT IV

Electrical properties of biological compartments: Electricity as a potential signal, Neurotrasmitters, Intra and intermolecular interactions in biological system Spatial and charge compatibility as determinant of such interactions.

UNIT V

Principle, Instrument design, methods and application of UV spectroscopy; circular Dichroism and optical rotatory dispersion(ORD); Flurescence spectroscopy; Infrared spectroscopy; NMR and ESR spectroscopy, Chromatography, Electrophoresis and Centrifugation.

Practicals

1. Meaurement of pH using pH paper and pH meter-minor
2. Centrifugation – cell fractionation and separation of nuclei
3. Colorimetry – (a) Preparation of standard curve and estimate the concentration of solute in an unknown sample, (b) Determination of absorption maxima-minor
4. Chromatography – Determination of Rf value of amino acid and identification of amino acid.
5. Gel electrophoresis – demonstration.
6. Microscopy- Examination and study of parts of compound microscope, Camera lucida and its uses; micrometry- Calibration of microscope using stage and ocular micrometers, measurement of microscopic objects-minor

Elective Papers

THIRD - SEMESTER
Course code UBE 302: FERMENTATION TECHNOLOGY (Total credit= 03)

UNIT I

Definition, equipments and production process; Fermentation processes, Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatch and continuous fermentations

UNIT II

Bioreactors/fermenters , Components of a typical bioreactor, types of bioreactors-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

UNIT III

Control parameters, industrially important strains, media ingredients Measurement and control of fermentation parameters, Control and monitoring of different parameters in a bioreactor; pH, temperature, dissolved oxygen, foaming and aeration Isolation of industrially important microbial strain, Primary and secondary screening, strain development, preservation and maintenance of industrial strains Media and ingredients for industrial fermentations Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.

UNIT IV

Down-stream Processing , Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.

UNIT V

Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses), Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase), wine, beer, bioinsecticides (Bt) and Steroid transformations. Enzyme immobilization, Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

List of Practicals:

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)

Suggested Readings

Sullia S. B& Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Bisen P.S (1994) Frontiers in Microbial Technology, 1st Edition, CBS Publishers.
3. Glaser A.N & Nilaido.H (1995) Microbial Biotechnology,W.H Freeman & Co.
4. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
5. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
6. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, Panima Publishing Corp.
7. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology., Aditya Books (P) Ltd. REFERENCE BOOKS:
8. Pauline.M.Doran ., "Bioprocess Engineering Principles";Academic press ..
9. Peter F.Stanbury, Allan Whitaker, "Principles of Fermentation Technology"
10. Michael L.Shuler and Fikret Kargi, "Bioprocess Engineering Basic concepts", Prentice Hall, 1992.

FOURTH- SEMESTER
Course code UBC 401: IMMUNOLOGY (Total credit= 03)

UNIT I

Introduction: Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa, Immune Cells and Organs: Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs: Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

UNIT II

Antigens: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Haptens, Epitopes (T & B cell epitopes); T-dependent and T-independent antigens, Adjuvants, Antibodies: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

UNIT III

Major Histocompatibility Complex: Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways), Complement System: Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement activation

UNIT IV

Generation of Immune Response: Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells), Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals), Killing Mechanisms by CTL and NK cells, Introduction to tolerance

UNIT V

Immunological Disorders and Tumor Immunity: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies- Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak-Higashi syndrome, Leukocyte adhesion deficiency, CGD; Characteristics of tumor antigens, Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy, RIST, RAST, MLR.

List of Practicals

1. Identification of human blood groups.
2. To perform Total Leukocyte Count of the given blood sample.
3. To perform Differential Leukocyte Count of the given blood sample.
4. To separate serum from the blood sample (demonstration).
5. To perform immunodiffusion by Ouchterlony method.

6. To perform DOT ELISA.
7. To perform immunoelectrophoresis.

Suggested reading

• Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
• Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
• Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
• Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
• Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
• Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

FOURTH- SEMESTER
Course code UBC 402: CELL BIOLOGY II (Total credit= 03)

UNIT I
The cell theory and precellular evolution. The Plasma Membrane: Structure; Transport of small molecules, Endocytosis.

UNIT II
Cell Wall, the Extracellular Matrix and Cell Interactions: Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions.

UNIT III
Cell Signaling: Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks.

UNIT IV
The Cell Cycle & Cell Death and Cell Renewal: Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization. Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning.

UNIT V
Cancer: Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach.

Practicals
1. To demonstrate the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.
2. Study of polyploidy in Onion root tip by colchicine treatment.
3. Preparations of temporary mount of Grasshopper testis / onion flower bud anthers and study the different stages of Meiosis.
4. Study of mitosis and meiosis from permanent slides.
5. Identification and study of cancer cells- Slides/Photomicrographs.

Suggested reading
• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
• Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

FOURTH- SEMESTER
Course code UBC 403: MOLECULAR BIOLOGY II (Total credit= 03)

UNIT I
Mechanism of Transcription: RNA Polymerase and the transcription unit, Transcription in Prokaryotes and Transcription in Eukaryotes

UNIT II
RNA Modifications: Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.

UNIT III
Translation (Prokaryotes and Eukaryotes): Assembly line of polypeptide synthesis ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis, Regulation of translation, Translation-dependent regulation of mRNA and Protein Stability.

UNIT IV
Transcription Regulation in Prokaryotes: Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons

UNITVI
Transcription Regulation in Eukaryotes & Regulatory RNAs: Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X inactivation

List of Practicals
1. Preparation of culture medium (LB) for E.coli (both solid and liquid) and raise culture of E.coli.
2. Demonstration of antibiotic resistance. (Culture of E.coli containing plasmid (pUC 18/19) in LB medium with/without antibiotic pressure and interpretation of results).
3. Isolation and quantitative estimation of salmon sperm / calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).
4. To perform Ames test in Salmonella / E.coli to study mutagenicity.

SUGGESTED READINGS
• Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
• De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
• Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
• Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008)
• Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

Elective Papers

FOURTH- SEMESTER
Course code UBE 401: GENETICS & GENOMICS I (Total credit= 03)

Unit I

Introduction to Genetics: Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. Mitosis and Meiosis: Interrelation between the cell structure and the genetics function, Mitosis, Meiosis (explaining Mendel's ratios).

Unit II

Mendelian Genetics and its Extension: Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

Unit III

Linkage, Crossing Over and Chromosomal Mapping: Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics an alternative approach to gene mapping.

Unit IV

Mutations: Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms.

Unit V

Sex Determination: Chromosomal mechanisms, Environmental factors determining sex determination, Barr bodies, Dosage compensation. Extrachromosomal Inheritance: Chloroplast mutation/Variegation in Four o' clock plant and Chlymodomonas, Mitochondrial mutations in Neurospora and yeast, Maternal effects, Infective heredity- Kappa particles in Paramecium. Quantitative Genetics: Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

List of Practicals:

- Mendelian laws and gene interaction using Drosophila crosses.
- 2. Chi-square and probability.

Elective Papers

FOURTH- SEMESTER
Course code UBE 402: BIOINFORMATICS (Total credit= 03)

Unit I

Computers: General introduction (characteristics, capabilities, generations), software, hardware: organization of hardware (input devices, memory, control unit arithmetic logic unit, output devices); software : (System software; application software, languages -low level, high level), interpreter, compiler, data processing; batch, on-line, real-time (examples from bioindustries; e.g. application of computers in co-ordination of solute concentration, pH, temperature, etc., of a fermenter in operation); internet application.

Unit II

Basic Bioinformatics: Introduction to Internet, Search Engines (Google, Yahoo, Entrez etc)

Unit III

Biological Databases: Sequence databases (EMBL, GenBank, DDBJ, -UNIPROT, PIR, TrEMBL), Protein family/domain databases (PROSITE, PRINTS, Pfam, BLOCK, etc), Cluster databases-An Introduction, Specialised databases (KEGG, etc), Database technologies (Flat-file), Structural databases (PDB)

Unit IV

Phylogenetic Analysis: Trees-splits and metrices on trees, tree interpretation, Distance – additive, ultrameric and nonadditive distances, tree building methods, phylogenetic analysis, parsimony, tree evaluation, maximum likelihood trees – continuous time markov chains, estimating the rate of change, likelihood and trees; analysis software. Annotation, comparison of different methods; ESTs – databases, clustering, gene discovery and identification, and functional classification.

Unit V

Genome analysis: Annotation, comparison of different methods; ESTs – databases, clustering, gene discovery and identification, and functional classification. Reconstruction of metabolic pathways; Genome analysis, genome anatomy, genome rearrangements with inversions, signed inversions, identification and functional classification.

Suggested reading

• Computer Science, J.G. Brookshear, Pearson, Addison Wesley
• Introduction to Bioinformation – T.Attawood
• A book on C by Kelley : Programming in C, Addison-Wesley Publishing
• Introduction to C++ for Engineers and Scientists, Prentice-Hall
• Schaum's Outline of Introduction of Computer Science, P. Cushman and R. Mata-Toledo, McGraw Hill Trade
• Bioinformatics – Managing Scientific Data, Zoe' Lacroix and Terence Critchlow
• Bioinformatics – Sequence, Structure and Databanks, Des Higgins & Willie Taylor
• Structural Bioinformatics, Philip E. Bourne, Helge Weissig 2003
• Statistical Methods in Bioinformatics: An Introduction, G.R. Grant, W.J. Ewens, Springer

FIFTH- SEMESTER
Course code UBC 501 : PLANT BIOTECHNOLOGY (Total credit= 03)

UNIT I

Terms and definitions. Beginning of in vitro cultures in our country (ovary and ovule culture, in vitro pollination and fertilization. Embryo culture, embryo rescue after wide hybridization, and its applications, Endosperm culture and production of triploids.

UNIT II

Introduction to the processes of embryogenesis and organogenesis and their practical applications: Micropropagation, axillary bud, shoot-tip and meristem culture. Haploids and their applications. Somaclonal variations and applications (Treasure your exceptions).

UNIT III

Introduction to protoplast isolation: Principles of protoplast isolation and applications, testing of viability of isolated protoplasts. Various steps in the regeneration of protoplasts.

UNIT IV

Introduction of somatic hybridization: Various methods for fusing protoplasts,chemical and electrical. Cybrids- definition and application.

UNIT V

Use of plant cell, protoplasts and tissue culture for genetic manipulation of plants: Introduction to A. tumefaciens. Tumor formation on plants using A.tumefaciens (Monocots vs. Dicots), Practicalapplication of genetic transformation.

Suggested reading

• An Introduction to Plant Tissue Culture, M.K. Razdan, Oxford and IBH Publishing
• Experiments in Plant Tissue Culture, J.H. Dodds and L.K. Roberts, Cambridge University Press
• Plant Biotechnology and Transgenic Plants, K.M.O. Caldenty, W.H. Barz and H.L. Wills, Marcel Dekker
• Plant Biotechnology, J. Hammond, P. McGarvy and V. Yusibov, Springer Verlag.
• Plant Cell & Tissue Culture for the production of Food Ingredients, T-J Fu, G. Singh and W.R. Curtis, Kluwer Academic/Plenum Press
• Plant Tissue Culture: Theory & Practice, S.S. Bhojwani and M.K. Razdan, Elsevier Health Sciences

FIFTH- SEMESTER
Course code UBC 502 : ENVIRONMENTAL BIOTECHNOLOGY(Total credit= 03)

UNIT I

Environmental components, Environmental pollution and its types, Non-renewable and renewable energy resources.

UNIT II

Conventional fuels and their major impacts: Global warming and greenhouse effect, Global Ozone Problem, Acid rain, Eutrophication, Biomagnification, Concept of clean fuel technology: Biomass energy and biofuels

UNIT III

Biodegradation and bioremediation of major pollutants, Biomineralisation: Use of microbial technology for mining

UNIT IV

Treatment of municipal solid and liquid wastes, Environmental impact assessment and Environmental audit

UNIT V

Bioassessment of Environmental Quality, Biofertilizers and Biopesticides

Suggested reading

• Environmental Science, S.C. Santra
• Environmental Biotechnology, Pradipta Kumar Mohapatra
• Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
• Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
• Agricultural Biotechnology, S.S. Purohit
• Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
• Introduction to Environmental Biotechnology, Milton Wainwright
• Principles of Environmental Engineering, Gilbert Masters
• Principles of fermentation Technology, Salisbury, Whitaker and Hall
• Industrial Microbiology – Cassida
• Agricultural Biotechnology – S.S. Purohit
• Wastewater Engineering – Metcalf & Eddy.

FIFTH- SEMESTER

Course code UBC 503 : ANIMAL BIOTECHNOLOGY (Total credit= 03)

Unit I
Introduction of animal cell culture substrate, culture media, preservation and maintenance of cell lines.

Unit II
Production of monoclonal antibodies, Bioreactors for large scale culture of cells.

Unit III
Growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, erythropoietin).

Unit IV
Transgenic animals, In-vitro fertilization and embryo transfer.

Unit V
Transplantation, Stem cells and its application,

Suggested reading

• Culture of Animal Cells, R.I Freshney, Wiley-Leiss.
• Animal Cell Culture – A Practical approach, J.R.W. Masters, Oxford.
• Animal Cell Culture Techniques, M. Clynes, Springer Verlag.
• Cell Culture Lab Fax, M. Butler and M. Dawson, Bios scientific Publications Ltd.
• Cell Growth and Division – A Practical approach, R. Basega, IRL Press.
• Comprehensive Biotechnology, Moo-Young, Alan T. Bullm Howard Dalton, Panima Publication.

Elective Papers

FIFTH- SEMESTER
Course code UBE 501 : ENTREPRENEURSHIP & IPR (Total credit= 03)

Unit I
Need, scope and characteristics of entrepreneurship management of self and understanding human behaviour, business ethics, performance appraisal, and (SWOT) analysis.

Unit II
Market survey techniques, Criteria for the principles of product selection and development, Elements of

Unit III
Marketing & Sales Management- (a) Nature of product and market strategy (b) Packaging and advertising (c) After Sales Service (d) Pricing techniques.

Unit IV
Financial institutions, financial incentives, books of accounts and financial statements.

Unit V
Technical feasibility of the project, plant layout & process planning for the product, Quality Control, Critical Path Method (CPM) and Project Evaluation Review Techniques (PERT) as planning tools for establishing SSI

Suggested reading

• Entrepreneurship: New Venture Creation, David H. Holt
• Patterns of Entrepreneurship : Jack M. Kaplan
• Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.

Elective Papers

FIFTH- SEMESTER

Course code UBE 502 : GENETICS & GENOMICS II (Total credit= 03)

Unit I

Genetic Analysis and Mapping in Bacteria and Bacteriophages: Conjugation; Transformation; Transduction, Recombination.

Unit II

Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses: Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P elements in Drosophila; Uses of transposons; Eukaryotic Viruses.

Unit III

Developmental Genetics and Model System: Study of model systems in developmental genetics- Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana, and Xenopus laevis.

Unit IV

Genomics, Bioinformatics and Proteomics: Genomes of bacteria, Drosophila and Humans; Human genome project; Evolution and Comparative Genomics. Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment; Gene feature identification. Gene Annotation and analysis of transcription and translation; Post-translational analysis- Protein interaction.

Unit V

Genomic Analysis- Dissection of Gene Function: Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology. Population Genetics: Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.Evolutionary Genetics: Genetic variation and Speciation.

Practicals

1. Genomic DNA isolation from E.coli (without plasmid).
2. Restriction enzyme digestion of genomic DNA from E.coli.
3. Isolation of plasmid DNA and genomic DNA together from E.coli. and restriction enzyme digestion.
4. Restriction enz yme digestion (EcoRI) of genomic and plasmid DNA (obtained from Expt.3).
5. Estimation of size of a DNA fragment after electrophoresis using DNA markers.
6. Construction of Restriction digestion maps from data provided.
7. Demonstration of DNA fingerprinting.

Suggested reading

• Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
• Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
• Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
• Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
• Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant
DNA. ASM Press, Washington
• Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
• Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.
• Ghosh, Z. and Mallick,V. (2008). Bioinformatics-Principles and Applications. Oxford

SIXTH SEMESTER

DISSERATION	Credits	Maximum Marks
A. Valuation 1. Language & Presentation 2. Review of Literature 3. Methodology 4. Analysis & Interpretation of Result **B. Viva –Voce**	**18**	**300**