

University of Pune

Three Year B. Sc. Degree Course in

BIOTECHNOLOGY

T.Y.B.Sc. BIOTECHNOLOGY

Syllabus

(To be implemented from Academic Year 2015-16)

Course structure: First Year B.Sc. Biotechnology

Course Code and Course Name	Theory/ Practical	Marks	Lecture/ Practical
Bb- 101 Fundamentals of Chemistry	Theory	100	90L
Bb- 102 Fundamentals of Physics	Theory	100	90L
Bb- 103 Basics of plant and animal sciences	Theory	100	90L
Bb- 104 Mathematics & Statistical Methods for Biologists	Theory	100	90L
Bb- 105 Fundamentals of Biological Chemistry	Theory	100	90L
Bb- 106 Biophysics & Instrumentation	Theory	100	90L
Bb- 107 Microbiology	Theory	100	90L
Bb- 108 Computers and application	Theory	100	90L
Bb- 109 Practicals in Chemistry and Biochemistry	Practical	100	30 P
Bb- 110 Practicals in Physics, Biophysics and Instrumentation	Practical	100	30 P
Bb- 111 Practicals in Biosciences	Practical	100	30 P
Bb- 112 Quantitative Methods in Biology	Practical	100	30 P

Course structure: Second Year B.Sc. Biotechnology

Course Code and Course Name	Theory/ Practical	Marks	Lecture/ Practical
Semester I			
Bb- 211 A Genetics & B Immunology	Theory	75 25	45L 15L
Bb- 212 Cell Biology	Theory	100	60L
Bb- 213 Environmental Biology and Biotechnology	Theory	100	60L
Bb- 214 Practicals in Environmental Biotechnology	Practical	100	30P
Bb- 215 Practicals in Cell Biology & Genetics	Practical	100	30P
Semester II			
Bb- 221 Molecular biology	Theory	100	60L
Bb- 222 Animal and Plant development	Theory	100	60
Bb- 223 Scientific writing and communication	Theory	50	30L
Bb- 224 Metabolic Pathways	Theory	50	30L
Bb- 225 Practicals in Molecular biology	Practical	100	30 P
Bb-226 Practicals in Developmental biology	Practical	100	30 P

Course structure: Third Year B.Sc. Biotechnology

Course Code and Course Name	Theory/ Practical	Marks	Lecture/ Practical
Semester I			
Bb-331 Microbial Biotechnology	Theory	100	60L
Bb-332 Plant and animal tissue culture	Theory	100	60L
Bb- 333 Biodiversity & Systematics	Theory	100	60L
Bb-334 Practicals in Tissue culture	Practical	100	30P
Bb- 335 A Practicals in Microbial biotechnology B Practicals in Field studies and report writing	Practical	75 25	30P
Semester II			
Bb-341 Large scale Manufacturing process	Theory	100	60L
Bb- 342 Biochemical and biophysical techniques	Theory	100	60L
Bb- 343 Practicals in Recombinant DNA Technology	Theory	100	60L
Bb -344 Techniques in Genetic Engineering	Practical	100	30P
Bb- 345 A Practicals of large scale manufacturing process B Practicals in biochemical and Biophysical techniques	Practical	50 50	30P

Bb-331: Microbial biotechnology (60L)

Sr. No.	Topic	Lecture
1	Microbial Biotechnology- History and Scope	1
2	<p>a. Microbial Growth Kinetics: Batch (Monod's equation), Fed Batch and continuous culture.</p> <p>b. Yield Coefficients: (Definition and Concept) $Y_{x/s}$, $Y_{p/s}$, $Y_{p/x}$, Y_{ATP}, Respiratory quotient (RQ)</p> <p>c. Growth Growth in relation to product formation (Growth linked and non-growthlinked products)</p> <p>d. Classification of microorganisms on the basis of their environmental requirements such as: pH, Temperature, oxygen, salt, sugar, moisture and their molecular adaptations to extreme environments.</p>	8
3	Immobilization of enzymes: Methods, Properties, Applications, Advantages and Disadvantages of Immobilization, Biosensors and Biochips-Types and applications	4
4	Medical Microbiology: Normal flora, diseases of various systems (Tuberculosis, SARS, Typhoid, Polio, Syphilis, Tetanus, Anthrax, Leprosy), causative agent, symptoms, morphology, pathogenesis, diagnosis & treatment	8
5	<p>Food and Dairy Microbiology</p> <p>A) Food Microbiology:</p> <ol style="list-style-type: none"> Food as a substrate (Intrinsic and extrinsic factors) Microbiological spoilages and sources of microorganisms, Spoilage of foods- Meat and poultry products, bread, fruits and vegetables, eggs, canned foods. Food Preservation: General principles and methods of food preservation, Use of Chemicals (Added and Developed Preservatives) Canning, Radiations, Low and High Temperature Concept of TDP, TDT, D, F and Z values. HACCP (Hazard Analysis and Critical Control Points) Different types of fermented foods produced from microorganisms- Idli, Dhokla, Soysauce, Sauerkraut <p>B) Dairy Microbiology:</p> <ol style="list-style-type: none"> Definitions of milk and milk products, composition of milk and factors affecting composition Sources of contamination of milk Flavour and Colour defects, Sweet curdling, and Stormy fermentation, Ropiness Preservation- Pasteurization (LTH, HTST, UHT), phosphatase test. Grading of milk (Direct and indirect tests), Brucella ring and Mastitis tests Fermented dairy foods- Curd, yoghurt, kefir, butter and cheese and their spoilages 	20

	<p>C) Food sanitation and Food borne diseases: Intoxications and Infections <i>(Staphylococcus aureus, Clostridium botulinum Salmonella, pathogenic E. coli, Aspergillus flavus)</i></p>	
6	<p>Water and Waste water:</p> <p>i) Water : Indicators of faecal pollution, Routine bacteriological analysis of water for potability: Presumptive, Confirmed, Completed test, Membrane Filter Technique and Eijkman tests. Bacteriological standards of drinking water.(WHO, BSI) ii) Drinking Water purification methods: Sedimentation, coagulation, flocculation, Filtration (Slow sand and Rapid Sand),disinfection.</p> <p>ii) Sewage and Industrial waste water: Types of wastes, relevance of COD and BOD determination in analysis of waste water,</p> <p>iii) Methods and principles of treatment of sewage (primary, secondary and tertiary treatment methods- Effluent treatment (Distillery and Textile) Microbial consortium for effluent treatment.</p>	15
6.	<p>Applications of microorganisms:</p> <p>i) Geomicrobiology-Ore leaching (methods and examples), MEOR, Microorganisms in extraterrestrial life studies ii) Alcoholic beverages: Wine, Beer iii) Biofertilizers and Biopesticides and Microbial plant growth Promoters(gibberellins and IAA) iv) GMOs-Norms and applications v) Microbial Sweeteners (Thaumatococcus, Monelin) , Flavour enhancers and microbial toxin production and their applications vi) Microbial Polysaccharide production: Xanthan, Dextran, Alginate, Scleroglucan, Gellan, Pullulan, Curdlan vii) Bioplastic-Biopol, Microbial rubber and adhesive polymers viii) Biotransformations-Indigo and glycerol to dihydroxy acetone ix) Biotechnology biosafety –Norms and measures</p>	12

References:

1. Microbiology – 5th Edition (1993), Pelczar M.J., Chan E.C.S., Krieg N.R., The McGraw Hill Companies Inc. NY, USA
2. General Microbiology - Stanier R.Y., 5th edition, (1987)Macmillan Publication, UK.
3. Food Microbiology –Frazier W. C., 4th edition (2008) The McGraw Hill Companies Inc. NY, USA

Bb-332 Plant and Animal Tissue Culture (60L)

Sr. No.	Topic	Lecture
	A. Plant Tissue Culture:	
1	Concepts of Cell theory & Cellular totipotency, Landmarks in plant tissue culture.	1
2	Infrastructure & Organization of plant tissue culture laboratory – General & aseptic laboratory, different work areas, equipments & instruments required.	2
3	Aseptic techniques – Washing & preparation of glassware, packing & sterilization, media sterilization, surface sterilization, aseptic work station, precautions to maintain aseptic conditions.	2
4	Culture Media – Nutritional requirements of the explants, PGRs and their <i>in vitro</i> roles, media preparation.	3
5	‘Explant’ for plant tissue culture Response of explants <i>in vitro</i> – Dedifferentiation and redifferentiation a) callus formation b) organogenesis (direct and indirect) c) embryogenesis (direct and indirect)	4
6	Callus culture technique– Introduction, principle, , factors affecting, Morphology & internal structure	2
7	Suspension culture technique – Introduction, principle, types, synchronization	2
8	Organ culture technique – Introduction, principle, factors affecting w.r.t. root tip culture, leaf culture, shoot tip & meristem culture,	2
9	Anther & pollen culture – Introduction, principle, , factors affecting,	2
10	Ovary, ovule, embryo and endosperm culture.	2
11	Protoplast –isolation, culture and fusion	3
12	Parameters to assess growth and development <i>in vitro</i>	1
13	Somaclonal variation – Introduction, terminology, origin	1
14	Applications of plant tissue culture	3
	B. Animal Tissue culture	
1	a. Introduction: Comparison with bacterial culture b. <i>In vivo</i> verses <i>in vitro</i> growth conditions for cells of multicellular organisms c. Concept of monolayer, suspension, histotypic/ organotypic, organ culture d. Maintenance of aseptic conditions	5
2	Equipment and infrastructure a. Laboratory design b. Instruments used in ATC c. Labware: TC flasks .	4
3	Nutrition & Physiology	4

	a. Rationale behind medium formulation with examples b. Advantages and disadvantages of serum. Serum free media c. Balanced salt solutions,	
4	Primary cell culture a. Source selection, different methods of establishing primary cell culture b. Special reference to fibroblast culture and lymphocyte culture	3
5	Cell lines a. Evolution of cell line b. Finite and transformed cell lines c. Mammalian and insect cell line growth conditions d. Subculture	6
6	Characterization of cell lines a. Need for characterization b. Karyotyping, biochemical & genetic characterization of cell lines.	4
7	Cell storage and distribution a. Cryopreservation b. Cell repositories	2
8	Application of Animal cell cultures.	2

Reference Books:

1. R. Ian Freshney. Culture of animal cells, 6th Edition, 2010. A John Wiley & Sons, Inc., USA
2. R.W.Masters. Animal Cell Culture- Practical Approach, 3rd Edithion,2000, Oxford University Press. USA
3. Principles And Practice Of Animals Tissue Culture, Sudha Gangal, 2nd edition, (), University Press, India
4. Razdan M.K. (2009) - Introduction to Plant Tissue culture (Oxford & IBH Publ, New Delhi)
5. Bhojwani S.S. & Razdan M.K. (1996) - Plant Tissue Culture : Theory & Practice (Elsevier, New Delhi)
6. Jha TB & Ghosh B (2007) – Plant tissue culture: Basic and applied (Universities Press, Hyderabad)

Bb-333 Biodiversity and Systematics (60L)

Sr. No.	Topic	Lectures
I	Biodiversity	45
1	Understanding Biodiversity	13
1.1	Concept of Biodiversity, Definitions, Taxonomic, ecological and genetic perspectives of biodiversity, Change in Biodiversity over time and space, Magnitude.	7
1.2	Ecosystem diversity, Species diversity, Genetic diversity, Indices of biodiversity analysis. (Plant, Animal and Microbial)	6
2	Biodiversity in Ecosystems	6
2.1	Biomes of the world	2
2.2	Biodiversity in India: Habitats, Niche	2
2.3	Behaviour patterns of animals- Habits	2
3	Population Interactions	10
3.1	Population growth forms, age class distribution and carrying capacity	2
3.2	Population density, abundance and richness	3
3.3	Population Structure and interactions	2
3.4	Mathematical modeling- of Logistic growth, competition and prey-predator dynamics	3
4	Conservation of Biodiversity	9
4.1	Status of biodiversity and need for conservations	2
4.2	Strategies for Conservation, methods for conservation- <i>Ex situ</i> and <i>In situ</i>	4
4.3	Conservation policies, laws and organization- Rio Conference, Earth Summit, Conservation efforts in India- Governmental and NGOs	3
5	Biodiversity Utilization	7
5.1	Management, documentation and databases of biodiversity (Biodiversity Informatics)	2
5.2	Domesticated animal and agricultural diversity	3
5.3	Socio- economic importance of biodiversity	2
II	Systematics	15
6	Biological Systematics	7
6.1	Concept of species and variation	4
6.2	Need for taxonomy and nomenclature	2
6.3	Introduction to classification systems	1

7	Important Tools and techniques in Systematics	8
7.1	Techniques in morphological, histological, embryology and anatomical analysis	4
7.2	Molecular tools in taxonomy	4

Reference Books:

1. A Text Book of the Plant Geography Of India (1983) Bharucha F R OUP India
2. An Advanced Text Book On- Biodiversity- Principle And Practices (2004) Krishnamurthy K V Oxford and IBH Publishing, Delhi
3. Biological Systematics: Principles And Applications (2002) Randall T. Schuh Cornell University Press, USA
4. Biotechnology Applications (2009) C S K Mishra I K Interntional Pvt Ltd, New Delhi
5. Communities And Ecosystems (1975) Whittaker R H Macmillan Pvt Ltd, NewYork
6. Ecology: Principles and Applications (1998) J. L. Chapman, M. J. Reiss Cambridge University Press, Cambridge
7. Environmental biotechnology(2010) Rana Rastogi Publications, Meerut
8. Environmental Science (2011) Santra S.C. New Central Book Agency, Kolkata
9. Evolution (2005) Douglas J. Futuyma Sinauer Associates, Inc. Publishers, Sunderland
10. Fundamentals of Ecology (2009) Dash 3rd edition, Tata McGraw-Hill Education, New Delhi
11. Fundamentals of Molecular Biology (2009) Pal & Ghaskadbi Oxford University Press, New Delhi
12. Fundamentals of Plant Systematics (1986) Radford A E Harper and Row, New York
13. Genetic Engineering: Principles And Practice (1996) Sandhya Mitra Macmillan Pvt Ltd India, Bangalore
14. Genetics Of Populations (2011) Philip Hedrick Jones & Bartlett Learning, Burlington, MA
15. Global Biodiversity Strategies (1992) Courier Kathleen (Editor) World Resource Institute,USA
16. Introduction To Microbiology (2004) John and Catherin Ingraham Brooks/Cole Pub, USA
17. Living In The Environment (2012) G. Tyler Miller, Jr., Scott E. Spoolman Brooks and Coel, CengageBrain learning, USA

18. Mathematical Biology (1989) Murray J D Springer, New York
19. Modern Text Book of Zoology-Vertebrates (2010) Kotpal R E Rastogi
Publication, New Delhi
20. Phylogenetic Systematics (1999) W Hennings, D Dwight Davis, R Zangerl
University of Illinois Press, Champaign, IL

21. Plant Systematics (2010) Michael G. Simpson Academic Press, Salt lake city,
UT, USA
22. Plant Systematics- A Phylogenetic Approach (2008) Walter S Judd Sinauer
Associates, Sunderland
23. Population Genetics (2011) Hamilton M Wiley Publisher, New Delhi
24. Principles Of Gene Manipulation And Genomics (2009) S. Primrose and R.
Twyman Blackwell Publishing House, New Jersey
25. Systematics And Biogeography (2010) David M. Williams, Malte C. Ebach
Springer, New York
26. Systematics And The Origin Of Species, From The Viewpoint Of A Zoologist
(1942) Meyer E Harvard University Press, Cambridge, MA
27. Systematics: A Course Of Lectures (2012) Ward C. Wheeler Wiley-Blackwell
Publishing, New Jersey
28. Text Book of Biodiversity (2003) Krishnamurthy K V Science Publishers,
Jodhpur
29. <http://www.earthsummit.info/>
30. <http://www.un.org/geninfo/bp/enviro.html>

Bb-334 Practicals in Tissue Culture (30P)

Sr. No.	Topic	Practical (Total 30 P)
1	ATC laboratory design and equipment used in ATC	1
2	Familiarity to Aseptic conditions	2
3	Animal cell culture media preparation, sterilization, washing, packing	2
4	Observation of cells in culture – Principles & practice	1
5	Isolation of Lymphocyte for culture: Ficoll-hypaque density gradient separation	2
6.	Maintenance of cell lines (Sp2O)	3
7	Cell staining methods viz. Giemsa	1
8	Viable cell count and growth studies	2
9	PTC Laboratory : organization of facility and equipment	1
10	Aseptic manipulation – washing, capping, packing & sterilization, laminarflow operation and safety precautions	2
11	Stock solutions & media preparation	2
12	Callus culture technique-Initiation of culture, callus morphology & internal structure	2
13	Suspension culture technique–Initiation of culture, sub culture and growth measurement	2
14	Effect of plant growth regulators on <i>in vitro</i> response of explants.	2
15	Initiation of shoot tip & axillary bud culture	2
16	Anther and/ embryo culture	2

BT 335 a Practicals in Microbial Biotechnology

Sr. No.	Practical Title	Practicals (23P)
1	Study of Growth Curve and Generation time of Bacteria/ Yeast using turbidometry	1
2	Effect of Environmental factors on growth of bacteria (pH, Temperature, salt and Sugar)	2
3	Immobilization of whole yeast cells/ enzyme by suitable method and determination of stability of immobilized enzyme.	2
4	Isolation and identification (Genus level) of spoilage causing microorganisms from spoiled foods.	2
5	Detection of Aflatoxin in foods	1
6	Isolation and identification of starter organisms from Idli batter/ Dahi	2
7	Grading of raw milk (Dye reduction test, DMC)	2
8	Determination of efficiency of Pasteurization by quantitative phosphatase test.	1
9	Assessment of potability of water a.Presumptive b.Confirmed and c.Completed test. d. Eijkman's test e. IMViC tests	3
10	Preparation and Efficiency testing of Biofertilizer/ Biopesticide.	2
11	Production of microbial Polysaccharide.	3
12	Visit to Dairy/ Effluent treatment plant / Sewage Treatment plant.	2

Bb-335 b Practicals in Field studies (7P)

One day field visit to local forest ecosystem to conduct following Practicals-

Quadrat/transact methods for plant diversity analysis

Point count for bird/butterfly/insect diversity

Calculation of species diversity, richness and abundance from the field visit data

Report writing of the field visit with photo documentation.

Bb341 Large Scale Manufacturing Process (60L)

Sr.No.	Topic	Lectures
1	a. Fermentation - Definition, Historical perspective, Lay out of a typical fermentation unit. b. Definition and Concept of Bioprocess Engineering, Various components of Bioprocess. c. Types of fermentations: Submerged, Surface, Solid State, Dual, Batch, Continuous, Fed Batch.	4
2	a. Screening - Definition and Objectives: Primary and Secondary Screening b. Strain Improvement : Objectives, Methods for strain improvement with examples (mutant selection, mutants with altered permeability, auxotrophic mutants, analogue resistant DNA technology) c. Microbes of industrial importance, Culture collection centers of industrially important microorganisms. d. Inoculum build up for Industrial fermentations : Bacteria and Fungi	5
3	a. Bioreactor Design : Characteristics of an ideal Fermenter, Construction material used, surface treatment of material Design of a typical Batch Fermenter Aerator and Agitator- types, Baffles, Seals and valves used, steam traps. Additional accessories and peripherals. b. Different designs of bioreactors : Mechanically agitated and non-mechanically agitated <ul style="list-style-type: none"> • Bubble column • Bubble Cap • Air Lift (internal and external loop) • Packed Bed reactor • Fluidized bed reactor • Pressure cycle • Animal and Plant cell Bioreactors 	8
4	Media components and optimization : Media used for large scale production: Carbon sources : Cane and Beet molasses, Malt, Corn, Starch, oils, hydrocarbons, alcohols. Nitrogen sources : Corn steep liquor, Soybean meal, peanut meal Buffers Chelators Water Precursors, Inhibitors, Inducers Antifoams- types, mode of action, advantages and disadvantages. Inoculum and Production media Media for animal cell culture. Medium Optimization <ul style="list-style-type: none"> • Classical Approach 	5

	<ul style="list-style-type: none"> • Plackett and Burman design • Response Surface Methodology (RSM) 	
5	<p>Air and Media Sterilization: Concept of Aseptic Operations and Containment.</p> <p>Air sterilization: Principles, Mechanism of capture of particles in air, Fixed (absolute) and non-fixed pore (depth) filters, Filter sterilization of air, Theory of depth filter, Validation of air filters.</p> <p>Media Sterilization: Principles, Thermal Death time, Decimal reduction time, Del factor, Indicator organism, Designing of sterilization cycle using thermal death of microbes, loss of nutrient quality during sterilization, Equipments used in sterilization: Batch and Continuous, Use of Non sterilized media.</p>	4
6	<p>a. Measurement and Control of different Bioprocess parameters: (Physical and Chemical Parameters): Temperature, pH, Dissolved oxygen, Microbial biomass, Fluid flow, Pressure, Weight, In let and exit gas, foam, CO₂, Use of computers in Bioprocess</p> <p>b. Oxygen Uptake rate, Oxygen transfer rate, Concept and importance of K_{La}, Determination of K_{La} values, Different rheologies of fermentation media, Factors affecting K_{La} values</p> <p>c. Scale Up and Scale down.</p>	10
7	<p>Methods and equipments used in Downstream processing:</p> <ol style="list-style-type: none"> Definition: Unit operations and downstream processing, General strategy of product recovery. Precipitation (Agents used :Salts, Organic solvents, polyelectrolytes, acids and bases) Filtration (Plate Frame. Rotary Vacuum, Filter Aids, Flocculating agents) Centrifugation (types used in Industry: basket, tubular bowl, Scroll, multichamber, disc bowl) Cell Disruption (Physico – mechanical and chemical methods). Liquid- Liquid extraction(Principle, Co and counter current extraction) Chromatography (one example each of use of Adsorption, Ion exchange, Gel and Affinity in product recovery can be explained along with manufacturing process of antibiotics, enzymes and vaccines). Membrane Processes (Ultra filtration, Reverse Osmosis) Drying (Drum and Spray Drying) Whole broth Processing. 	8
8	<p>Large Scale Manufacturing Process of:</p> <ol style="list-style-type: none"> Biomass based Products: Baker's Yeast, Single cell Protein Enzymes: Amylase, Restriction Enzymes Antibiotics: Penicillin, Streptomycin Vitamins: B12, Riboflavin 	10

	e. Amino acids: Glutamic acid, Lysine f. Vaccines: DPT, Polio g. Biotransformation Products : Steroids, Ascorbic acid	
9	a. Concept of Good Manufacturing Practices(GMP),Standard Operating Practices(SOP) b. Quality Control and Quality Assurance (Definition, Functions and Responsibilities) c. Tests Used for Quality Assurance of finished product: i. Sterility Testing ii. Pyrogen testing iii. Bacterial endotoxin (LAL test) iv. Ames Test.	4
10	Bioprocess Economics: Basic objectives in developing economically viable process, Market Potential, Fixed and Variable costs, Depreciation, Amortization, and Selection of Pricing.	2

Reference Books:

1. Principles of Fermentation Technology, 2nd edition, (2003), Whittaker & Stan bury, Butterworth-Heinemann, An imprint of Elsevier Science, UK
2. Practical fermentation technology, 1st edition, (2008), BRIAN MCNEIL & LINDA M. HARVEY, John Wiley & Sons, USA
3. Industrial Microbiology: An Introduction, 1st edition, (2007), Waits and Morgan, Blackwell Science Ltd USA.
4. Morden Industrial Microbiology and biotechnology, 1st edition, (2007), Nduka Okafor, Science Publishers, USA
5. Industrial Biotechnology, 1st edition, (2009), Abilasha Mathuriya, Ane books Pvt.Ltd, India

Bb-342 Biochemical & Biophysical Techniques

Sr. No.	Topic	Lecture
1	Introduction, Lab safety, Scientific notation & Units, errors & accuracy in experimentation, understanding of concentration of solutions, Strong acids and bases, weak acids and bases, polyprotic acids, buffers, biological buffers, pH metry.	10
2	Microscopy: Introduction to different types of microscopy, con focal microscopy, phase contrast, fluorescence microscopy, inverted microscopy. preparation of specimens for different types of microscopy	10
3	Spectrophotometry: Electromagmantic radiations(dual nature) wavelength, frequency, properties of Electromagnetic radiation, electromagnetic spectra, light absorption and excitations of electrons. Beer-Lambert's Law, UV-visible spectroscopy (chromophores in proteins), instrumentation(spectrophotometer and colorimeter), molecular extinction coefficient, fluorescence spectroscopy	10
4	Centrifugation: Introduction, basic principle of sedimatation, angular velocity & centrifugal field, g & RPM conversion - preparative & analytical centrifugation, [ultracentrifuge], density gradient centrifugation, rotor types , care maintenance & safety.	10
5	Chromatography: Introduction, principles- distribution coefficient, RF value Types of chromatographs a) Thin layer, HPTLC, paper chromatography b) Column chromatography – gel filtration, ion-exchange, affinity chromatography, c) adsorption chromatography	10
6	Electrophoresis: Introduction, Theory, principles, supporting matrices, capillary electrophoresis. Electrophoresis of proteins- SDS, native, activity staining Nucleic acids – Agarose, Pulse field gel electrophoresis.	10

Reference Books:

1. Biophysics, an introduction. 1st edition. (2002) Cotteril R. John Willey and Sons Ltd., USA
2. Biophysics. 1st edition (2002), Pattabhi V and Gautham N. Kluwer Academic Publisher, USA.
3. Textbook of optics and atomic physics – P.P. Khandelwal (Himlaya Publishing House.)
4. Instrumentation measurements and analysis – 2nd edition (2003). Nakra and Choudhari, Tata Mc Graw Hill, India.
5. Nuclear Physics: An Introduction. 2nd edition (2011). S. B. Patel. Anshan Publication, India

Bb 343: Recombinant DNA Technology (60L)

Sr. No	Topic	Lecture
1	Milestones of genetic engineering- Historical perspective. Recombinant DNA Technology- Introduction	2
2	Molecular tools and applications -restriction enzymes, ligases, polymerases, alkaline phosphatase.	5
3	Gene cloning Vehicles- vector: plasmids, cosmids, phage vectors- λ and M13, YACs, BACs, expression vectors, Agrobacterial vectors host – properties of host	10
4	Transformation- techniques of introducing DNA in bacteria, animal and plant cells Selection of transformants & characterization	8
5	Nucleic acid purification, yield, yield analysis, plasmid characterization, isolation strategies.	5
6	DNA sequencing techniques– Maxam-Gilbert's method, Sanger's Dideoxy method, Automated DNA sequencing, Next generation sequencing	4
7	Restriction enzyme digestion and restriction mapping Southern and northern analyses.	4
8	Genomic library-screening of recombinants	4
9	Gene manipulations by site-directed mutagenesis -PCR Technology cDNA library, reverse transcription, comparison between genomic and cDNA library	7
10	Genome mapping, DNA fingerprinting	5
11	Applications of Genetic Engineering, Recombinant DNA guidelines	6

Reference Books:

1. Molecular Biology of the Gene, 6th Edition (2008), James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc. USA
2. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
3. Principles of Gene Manipulation & Genomics, 7th Edition (2006), Primrose and Twyman, Blackwell Publishing, USA.
4. Molecular cloning – a laboratory manual – (Vol. 1-3), 4rd edition, (2012), Green and Sambrook, Cold Spring Harbor Laboratory Press, USA

Bb-344 Practicals in Recombinant DNA Technology (30P)

Sr. No.	Topic	Practical (30P)
1	Isolation of plasmid DNA & Gel electrophoresis	3
2	Genomic (Plant andAnimal) DNA- Isolation and	4
3	Genomic (bacterial) DNA- Isolation and quantitation	3
4	DNA Ligation	2
5	Preparation of competent Cells	1
6	Transformation of <i>E. coli</i> and selection of recombinants.	4
7	Colony PCR of recombinant and analysis	2
8	Restriction mapping of recombinant DNA	4
9	Southern blotting techniques	4
10	Western blotting technique	3

Bb-345 A Practicals in large scale manufacturing process**Bb-345 B Practicals in Biochemistry & Biophysical Techniques**

Sr. No.	Topic	Practicals (30P)
	Bb- 345 A Practicals in large scale manufacturing process	(15P)
1	a. Screening and isolation of antibiotic producing organism from soil (Crowded plate/ Giant colony method) b. Isolation of auxotrophic mutants by Gradient plate technique.	3
2	Production, Recovery (Filtration, Precipitation) and estimation (Titrimetric or colorimetric) a of Primary metabolite (Organic acid)	3
	Production, Recovery (Filtration, Solvent extraction) and estimation (Bioassay) a of Secondary metabolite (Antibiotic)	3
4	Preparation of wine	2
5	Laboratory Scale Production, Recovery and estimation of Ethanol	2
6	Determination of Minimum inhibitory Concentration (MIC) of antibacterial compound	1
7	Sterility testing of injectables/autoclave	1
8	Visit to a Fermentation Units	
	Bb-345 B Biochemistry & Biophysical Techniques	(15P)
9	Preparation of buffer.	1
10	Laboratory safety, preparation of solutions, calibration of pipette.	1
11	Thin layer chromatography – sugar , amino acids	2
12	Paper chromatography – amino acids	1
13	Estimation of cholesterol	1
14	Spectrophotometry – Estimation of ascorbic acid – DCPIP method	1
15	Spectrophotometry – A spectra of Protein, nucleic acid.	2
1	Chromatography – Ion-exchange –separation of compounds	2
17	Electrophoresis – separation of mixture of proteins – Native PAGE and activity staining	2
18	Demonstration of HPLC and GC	2