

B.Sc. Biotechnology Syllabus (2008-09)

Total Marks = 3100 [1200 (F.Y.) + 1000 (S.Y.) + 900 (T.Y.)]

Course structure

First Year

Course Code	Title of the Course	Theory/ Practical	Marks	Lecture/ Practical
Bb- 101	Fundamentals of Chemistry	Theory	100	90L
Bb- 102	Fundamentals of Physics	Theory	100	90L
Bb- 103	Basic Biosciences	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	Use of Computers	Theory	100	90L
Bb- 109	Techniques in Chemistry & Biochemistry	Practical	100	30 P
Bb- 110	Techniques in Physics, Biophysics & Instrumentation	Practical	100	30 P
Bb- 111	Laboratory Exercises in Biosciences	Practical	100	30 P
Bb- 112	Quantitative Methods in Biology	Practical	100	30 P

Second Year

Course code	Title of the Course	Theory/ Practical	Marks	Lecture/ Practical
	Semester I			
Bb- 211	Genetics & Immunology	Theory	100	90L
Bb- 212	Cell Biology	Theory	100	90L
Bb- 213	Molecular Biology	Theory	100	90L
Bb- 214	Techniques in Molecular Biology	Practical	100	30P
Bb- 215	Exercises in Cell Biology & Genetics	Practical	100	30P
	Semester II			
Bb- 221	Environmental Biology and Biotechnology	Theory	100	90L
Bb- 222	Plant & Animal Tissue Culture	Theory	100	90L
Bb- 223	English	Theory	100	90L
Bb- 224	Metabolic Pathways	Theory	100	90L
Bb- 225	Tissue Culture Techniques	Practical	100	30P

Third Year

Course Code	Title of the course	Theory/ Practical	Marks	Lecture/ Practical
Semester III				
Bb- 331	Microbial Biotechnology	Theory	100	90L
Bb- 332	Animal & Plant Development	Theory	100	90L
Bb- 333	Biodiversity & Systematics	Theory	100	90L
Bb- 334	Developmental Biology & Microbial Biotechnology	Practical	100	30P
Bb- 335	Project (to be continued in semester IV)		50	
Semester IV				
Bb-341	Large scale Manufacturing process	Theory	100	90L
Bb- 342	Biotechnology in Agriculture & Health	Theory	100	90L
Bb- 343	Recombinant DNA Technology	Theory	100	90L
Bb- 344	Techniques in Genetic Engineering & Fermentation	Practical	100	30P
Bb- 345	Project		50	

N.B. For assessment of each course, 80% will be for Semester-end examination and 20% for internal assessment. Internal assessment will be continuous throughout the semester, and the marks should be submitted to the Examination section before the commencement of Semester-end examination.

B. Sc. Biotechnology Third Year

Course structure

Course Code	Title of the course	Theory/ Practical	Marks	Lecture/ Practical
Semester III				
Bb-331	Microbial Biotechnology	Theory	100	90L
Bb-332	Animal & Plant Development	Theory	100	90L
Bb-333	Biodiversity & Systematics	Theory	100	90L
Bb-334	Developmental Biology & Microbial Biotechnology	Practical	100	30P
Bb-335	Project (to be continued in semester IV)		50	
Semester IV				
Bb-341	Large scale Manufacturing process	Theory	100	90L
Bb-342	Biotechnology in Agriculture & Health	Theory	100	90L
Bb-343	Recombinant DNA Technology	Theory	100	90L
Bb-344	Techniques in Genetic Engineering & Fermentation	Practical	100	30P
Bb-345	Project		50	

Detailed Syllabus (Semester III)

Bb- 331 Microbial Biotechnology

Sr. No.	Topic	Lecture
1	Microbial Biotechnology –Historical perspectives	1
2	Microbial growth kinetics Continuous culture, Batch fed culture, Cell constituents, quantification of growth, Thermodynamics of Growth, YATP, Y _{x/s} , Y _{O2} Effect of different factors on growth Study of growth with respect to product formation Fermentation concept and types	12
3	Basic nutrition & metabolism. Novel pathways of microorganisms	6
4	Microbial strain improvement Bacterial genetics Operon concept with examples (lac, tryptophan, arabinose) Gene mapping–Transformation, conjugation & transduction	10
5	Microbial & Viral diseases Normal flora of the body Infection of different systems Chemotherapy –use of antibiotics, antiviral agents	20

6	Food & Dairy Microbiology $\frac{3}{4}$ Microbial flora $\frac{3}{4}$ Microbial spoilage $\frac{3}{4}$ Preservation Microbes as single cell proteins	15
7	Treatment schemes of Waste water Assessment of waste water (water potability) Sewage treatment plants Aerobic & anaerobic treatment processes	20
8	Integration of genetic engineering & applied microbiology Uses of genetically engineered microbes in Agriculture Industries Medicine	6

Reference Books :

- 1 Microbiology - Pelczar
- 2 General Microbiology - Stanier
- 3 Food Microbiology -Frazier
- 4 Principles of Fermentation Technology - Whitaker, A. 2nd edition

Bb-332 Animal and Plant Development

Sr. No.	Topic	Lecture
1.	Gametogenesis, Fertilization, Development	7
2.	Types and patterns of cleavage, blastulation	5
3.	Gastrulation in frog and chick up to formation of three germinal layers	5
4.	Concepts of competence, determination, commitment and differentiation, dedifferentiation, redifferentiation, transdifferentiation, developmental plasticity in plant (7L) and animal (8L) development	15
5.	Role of gene/s in patterning and development. Concept of Stem cells, Progenitor cells, cell lineages in plants and animals	8
6.	Ageing and apoptosis, abnormal development and teratogenesis in plants and animals: cancer	10
7.	Cloning in mammals, transgenic technology in plants and animals.	8
8.	Cell fusion and somatic cell genetics, hybridomas, Immunoglobulin genes and antibody diversity	8
9.	Embryogenesis in plants (monocotyledons and dicotyledons), Meristem structure and activity, Plant hormones- role in development	8
10.	Organogenesis, somatic embryogenesis, regeneration of plants.	8
11.	<i>Arabidopsis</i> - as a plant development model system- shoot and root patterning, floral patterning	8

Reference Books:

1. An Introduction to Embryology - B.I. Balinsky
2. Development Biology - S.F. Gillbert
3. Developmental Biology - K.V. Rao
4. Developmental Biology - S.C. Goel
5. Developmental Biology – Wolpert
6. Embryology of Angiosperms – S.S. Bhojwani and S.P. Bhatnagar
7. An Introduction to Plant Cell Development – J. Burgess

Bb- 333 Biodiversity & Systematics

Sr. No.	Topic	Lecture
1	a) Biodiversity – Concept, definition, species diversity, ecosystem diversity, genetic diversity, Magnitude of biodiversity, distribution of biodiversity, assessment of biodiversity, utilization of biodiversity, conservation of biodiversity	10
2	Population dynamics a) Population density & relative abundance b) Population age distribution c) Growth forms & carrying capacity d) Population structure : isolation & territoriality e) Interactions	5
3	The species & individual in the ecosystem a) Habitat & niche b) Ecological equivalence c) Biological clock d) Basic behavioral patterns	
4	Biodiversity & major biomes of world Biogeography : Specific flora & fauna	5
5	Conservation of Biodiversity a) Importance b) Conservation strategies – <i>in situ</i> and <i>ex situ</i> methods – advantages, limitations and applications.	10
6	Conservation laws, policies & organizations	4
7	Bioprospecting (microbes, plants and animals)	6
8	Biological systematics – principles and practices a) Aims & objective Tools & techniques of biological systematics [systematics of microorganisms (10L), plants (10L) & animals (10L)] w.r.t. following sources of data as applicable for the group a) Morphology b) Anatomy c) Histology d) Chemistry e) Cytology f) Molecular biology g) Micromorphology h) Palenology	30

	i) Embryology	
9	Biosystematics	10
10	Analysis of Biodiversity a) biodiversity indices b) Mathematical modeling for analysis of population, variation	10

Reference Books:

1. Ecology : Begon & Hareper
2. The biology of biodiversity : M.Kato
3. Biodiversity : E.O. Willson
4. Evolution : Stearns & Hoekstra
5. Animal behaviour : Alcock
6. Ecological analysis : Freeman & Herron
7. Elements of taxonomy : E. Mayor
8. Plant Taxonomy & Biodiversity : Stace
9. Fundamentals of Plant Systematics : Radford
10. Taxonomy of Angiosperms : Naik, V.N.

Bb- 334 Developmental Biology & Microbial Biotechnology (Practical)

Sr. No.	Topic	Practical (30P)
1.	Study of different types of eggs	1P
2.	Study of staging & staining of Chick embryos	2P
3.	Study of frog development, observation of frog embryo different development stages	2P
4.	Study of different types of sperms by smear preparation.	2P
5.	Frequency of genetic traits in human	1P
6.	Sex-linked inheritance	1P
7.	Multiple allelism	1P
8.	Study of plant development. <ul style="list-style-type: none"> ▪ Microsporogenesis ▪ Development of male and female gametophytes ▪ Developmental stages during plant Embryogenesis ▪ Analysis of histochemical changes during transition of vegetative shoot to reproductive apex ▪ Histochemical analysis of the activity of cambium 	1P 2P 3P 2P 2P
9	a) Study of growth curve in microorganism (Bacteria and/or Yeast) By Turbidometry or viable count and gravimetry or PCV b) Study of Effect of growth conditions	3P
10	Isolation of mutants (UV survival or any other)	1P

11	Isolation and identification of microorganism from fermented or spoiled foods	2P
12	Study of Normal flora of humans (Skin or oral cavity or any other body part)	1P
13	Assessment of potability of water (MPN test) (IMVIC test can be demonstrated)	2P
14	Preservation and maintenance of microbial cultures for industrial use	1P
15	Visit to a dairy industry and ETP or WTP	1P

Note:- The Practical exam is to be conducted for 2 days.

Semester IV

Bb- 341 Large scale Manufacturing process

Sr. No.	Topic	Lecture
1	Introduction to Concepts of Bioprocess engineering Definition of Bioprocesses engineering Overview of Bioprocesses with their various components Scales of operation & their global impact on Bioprocesses	2
2	Introduction to Simple engineering calculations, Mass & Energy Balances	3
3	Fermenters, Bioreactors : Construction, Design & Operation Materials of Constructions, Welding, Surface treatment Components of the fermenters & their specifications	8
4	Air & Media sterilization : Air Sterilization Principles, Mechanisms of capture of particles in Air, Depth & Screen Filters, Sizing, Testing & validation of filters for air sterilization Principles of Media Sterilization, Decimal reduction, Design of sterilization cycle using kinetics of thermal death of microbes Equipments used in sterilization; Batch & Continuous	4
5	Media for large-scale processes & their optimization : Constituents of media, their estimation & quantification. Design of media. Costing of media	3
6	Types of Bioprocesses : Biotransformations (enzyme, whole cell), Batch Fed-batch, Cell recycle & continuous	10

	fermentation processes. Monod model & constitutive equations used for expressing growth, substrate consumption & product formation, Solid State fermentation	
7	Enzyme & cell immobilization (industrial aspects) Properties of enzymes to be immobilized. Adsorption, Covalent binding, Entrapment or encapsulation. Properties of immobilized enzymes (K_m , K_s , cycle time half life). Inactivation kinetics.	5
8	Measurement & Control of Bioprocesses Parameters. Cell growth. pH, temperature, Substrate consumption, product formation, Measurement of O ₂ /CO ₂ uptake, evolution. Specific rates of consumption substrate & formation of product. Strategies for fermentation control. Computer controlled fermentations. Formation of heat, cooling requirements, Foam & its control. Oxygen uptake rate (OUR), K_a , Viscosity & its control. Scale up in Bioprocesses fermentations, Factors used in scale up	10
9	Quality Control, Quality assurance, Standard Operating Procedures (SOP) & Good Manufacturing Practices (GMP)	5
10	Product Recovery & Down Stream Processing in Fermentation & Bioprocess Technology. Solid-liquid separation (Flocculation, Filtration, Centrifugation), Cell disruption (Solid & liquid shear), Extraction, Precipitation, Distillation, Evaporation, Chromatographic separation, Adsorption, Concentration, Lyophilization, spray drying.	10
11	Industrial processes & applications; description of manufacture of enzymes (lipase, protease & nucleases), Antibiotics, amino acids, vitamins, ethanol, vaccines (FMD, DTP, New Castle disease), Single cell protein (Methanolic yeast, Spirulina).	20
12	Bioprocess Economics, Choice of process, process analysis, fixed & variable cost, Depreciation, Amortized costs, Selection of Pricing, Profitability, Scales of operations etc.	10

Reference Books:

- 1 Principles of Fermentation Technology - Whittaker & Stanbury, Pergamon Press
- 2 Bioprocess Engineering Principles - Pauline Doran, Academic Press 1995
- 3 Operational Modes of Bioreactors, BIOTOL series - Butterworth, Heinemann 1992
- 4 Bioreactor Design & Product Yield, BIOTOL series - Butterworth Heinemann 1992
5. Bioprocess Engineering : Systems, Equipment & Facilities - Ed. B. Lydersen, N.A. Delia & K.M. Nelson, John Wiley & Sons Inc, 1993
- 6 Bioseparation & Bioprocessing - Ed. G. Subramaniam, Wiley -VCH, 1998
- 7 Product Recovery in Bioprocess Technology, 'BIOTOL series, Butterworth Heinemann 1992
- 8 Bioseparation : Downstream Processing for Biotechnology - Paul A. Belter, E.L. Cussler, Wei-Shou Hu, Academic Press
- 9 Solvent Extraction in Biotechnology - Larl Schuger, Springer Verlag, 1994

Bb- 342 Biotechnology in Agriculture & Health

Sr. No.	Topic	Lecture
1	Plant Tissue Culture – Micropropagation technology Haploids in agriculture Glasshouse and precision cultivation	4
2	Cryopreservation, slow growth & DNA banking of germplasm, cybrids & hybrids	7
3	Plant transformation, Methodology of gene transfer in plants, metabolic engineering, Application of plant transformation for selection of desirable phenotypes	8
4	Transgenic plants Genetically modified crops, GM food, ethical & social aspects, IRR & patenting, Risk assessment	7
5	Molecular markers, RFLP, QTL, AFLP, Green house & green home technology	8
6	Production of secondary metabolites <i>in vitro</i> , metabolic engineering for large-scale production of plant based drugs.	
7	Application of animal cell culture, organ culture, cell cloning & micromanipulation	7
8	Growing cells in serum free media, scaling up, Hybridoma & monoclonals, tissue engineering	8
9	Vaccines – Principles & practice	7
10	Diagnostic technology – PCR, RFLP, Molecular markers	8
11	Biosensors – Principles & applications	3
12	Recombinant products for human health	8
13	Human genome mapping – its implications in health and disease	7

Reference Books :

1. Animal cell culture – J. Paul
2. Plant biotechnology - J Hammond & P. Mc Gravey, V.Yushibov, Springer-Verlag
3. Methods in cell biology - Volume 57
4. Culture of animal cells - R. Lan Freshny, Wiley less

Bb-343 Recombinant DNA Technology

Sr. No	Topic	Lecture
1.	Milestones of genetic engineering- Historical prespective. Recombinant DNA Technology- Introduction	7
2.	Molecular tools and applications -restriction enzymes, ligases, polymerases, alkaline phosphatase.	10
3.	Gene cloning Vehicles- vector, properties of plasmids and phages, host – properties of host	10

4.	Transformation- techniques of introducing DNA, Selection of transformants & characterization	5
5.	Nucleic acid purification, yield, yield analysis, plasmid characterization, isolation strategies.	10
6.	DNA sequencing techniques– Maxam-Gilbert’s method, Sanger’s Dideoxy method, Automated DNA sequencing	10
7.	Restriction enzyme digestion and restriction mapping Southern and northern analyses.	8
8.	Genomic library-screening of recombinants	5
9.	Gene manipulations by site-directed mutagenesis -PCR Technology	5
10.	cDNA library, reverse transcription, comparison between genomic and cDNA library	10
11.	Genome mapping, DNA fingerprinting	4
12.	Applications of Genetic Engineering, Recombinant DNA guidelines	6

Reference Books:

- 1 Molecular Biology of the Gene: Waston J. D.
- 2 Molecular Biotechnology: Glick
- 3 Milestones in Biotechnology : Classic papers in Genetic Engineering: J. A. Davis, W. S. Resnikoff
- 4 DNA Cloning – A Practical approach: D. M. Glover and B. D. Hames
- 5 Principles of Gene Manipulation & Genomics – Primrose and Twyman (2006, 7th Edition)
- 6 Molecular cloning – a laboratory manual – Sambrook and Russell (Vol. 1-3)

Bb- 344 Techniques in Genetic Engineering & Fermentation (Practical)

Sr. No.	Topic	Practical (30P)
1.	Isolation of plasmid DNA & Gel electrophoresis	2P
2.	Genomic (Plant/Animal) DNA- Isolation and quantitation	2P
3.	DNA Ligation	2P
4.	Preparation of Component Cells	1P
5.	Transformation of E. coil and selection of recombinants.	4P
6.	Agrobacterium-mediated transformation of plant cells	2P
7.	Colony PCR of recombinant and analysis	2P
8.	Restriction mapping of recombinant DNA	3P
9.	Southern blotting techniques	4P
10.	Searching for gene and protein sequences and accessing information from web, and databases	4P
11.	Information from genomes, BLAST, FASTA	2P
12.	Fermentative Production of primary and secondary metabolite (One organic acid and one antibiotic)	1P
13.	Fermentative Biomass production (Baker’s yeast and Spirulina)	2P

14.	Fermentative Production of beverages (alcohol, wine)	2P
15.	Immobilization of yeast on calcium alginate	1P
16.	Estimation of the fermentation products by titration or colorimetry or bioassay method (Any 2 methods)	2P
17.	Downstream Processing of fermentation products (distillation/precipitation/solvent extraction) (Any 1 Method)	1P
18.	Visit to a fermentation Industry	1P

Note- The practical exam to be conducted for 2 days.

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