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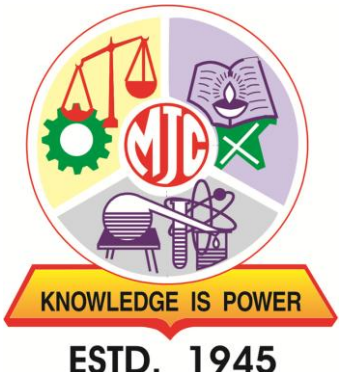
An "Autonomous College" Affiliated to

KBC North Maharashtra University, Jalgaon



SYLLABUS

Biotechnology

M.Sc.

(Semester III & IV)

Under Choice Based Credit System (CBCS)

[w. e. f. Academic Year: 2020-21]

Course Structure: MSc (Biotechnology)

Duration: The duration of M.Sc. (Biotechnology) degree program shall be TWO years.

Semester	Course Module	Subject Code	Title of Paper	Credit	Hours per Week
III	**DSC**	**BT-301**	Advanced environmental biotechnology	4	4
	DSC	**BT- 302**	Recombinant DNA technology	4	4
	DSC	**BT -303**	Lab course V on Environmental biotechnology	4	8
	DSC	**BT-304**	Lab course VI on Food biotechnology	4	8
	SEC	**BT--305**	Research methodology	4	4
	DSE	**BT- 306**	Food technology and neutrigenomics	4	4
IV	**DSC**	**BT- 401**	Advanced pharma and process biotechnology	4	4
	DSC	**BT- 402**	Genomics and proteomics	4	4
	DSC	**BT- 403**	Lab course – VII on methods in biotechnology	4	8
	DSC	**BT- 404**	Lab course – VIII Project dissertation	4	4
	GE	**BT- 405**	Biostatistics and bioinformatics	4	4
	DSE	**BT- 406**	Bio entrepreneurship	4	4

DSC: Discipline Specific Elective Core Course; **SEC**: Skill Enhancement Course;
DSE: Discipline Specific Elective (DSE) Course; **GE**: Generic Elective Course
BT-YSC : Biotechnology (Y-year; S-Semester; C-Course number)

Examination Pattern for M.Sc.

Nature	Marks
External Marks	**60**
Internal Marks	**40**
Total Marks	**100**

Program Specific Outcomes (PSO)

Students who graduate with a Master of Science in Biotechnology will:

- **PSO 1**: Become eligible to take doctoral education in various fields of life sciences inclining biotechnology, biochemistry, genetic engineering, forensic science, molecular biology and agriculture biotechnology.
- **PSO 2:** Serve as junior research fellow in government and private institutes for government or NGO sanctioned projects.
- **PSO 3:** Serve as administrators, researchers, investigators, assistant, and data scientist in pharmacy, qualitative manager, production manager, researcher for scientific, food, agriculture and in sterile plants of various industries.
- **PSO 4:** Can serve as entrepreneur in industries like plant tissue culture, food, mineral water packaging, in agriculture sector by producing vermicompost, bio-fertilizer, bio-pesticides etc.

M.Sc. (Biotechnology): Semester-III

BT-301 - Advanced Environmental Biotechnology

Hours: 60 **Credits: 4**

Course objectives:

- To acquaint the student with importance of environmental
- To inculcate techniques to treat various environmental issue
- To introduce with technique for monitoring environmental problem

Course outcome:

The student will be able to:

- Apply the knowledge again to treat various waste
- Understand the current environment issues.
- Will acquaint knowledge about environmental law and acts.

Unit I - Bio waste &waste water treatment **12h**

- Solid wastes: Sources and management, waste as a source of energy. Production of oils and fuels from solid waste, composting, vermiculture, Biogas production, methanol production from organic wastes, by-products of sugar industries.
- Water as a scarce natural resource, water management including rain water harvesting. Waste water characteristics, waste water treatment physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors. Reverse osmosis and ultrafiltration. Treatment of industrial effluents.

Unit II - Bioremediation and biodegradation **12h**

- **Bioremediation:** Characterization of site for bioremediation, factors, engineered in situ and Intrinsic in situ bioremediation, Ex situ bioremediation, Evaluation of bioremediation, Bioremediation of soil contaminated with oils pills.
- **Biodegradation:** Assimilation, Detoxification, Activation, Bio- availability, Recalcitrance, Co-metabolism and Biotransformation. Factors affecting biodegradation, Predicting products of biodegradation, Biodegradation of environmental contaminants (Pesticides, Lignin, Halogenated hydrocarbons)

Unit III - Environmental Monitoring **12h**

- Environmental monitoring and sample analysis: Sampling of air and water pollutants;
- Monitoring techniques and methodology: TDS, pH, Dissolved Oxygen (DO); Chemical oxygen demand (COD); Biological Oxygen Demand (BOD); Speculation of metals, monitoring and analysis of CO, NO_2, CO_2, SO_2; Pesticide residue; Phenols and petrochemicals.
- **Biosensors**: Types of biosensor, Working mechanism and examples of biosensors based on DNA, antibodies, enzymes, microorganisms. Applications of biosensors in the monitoring of heavy metals, BOD, nitrogen compounds, polychlorinated biphenyls, phenolics and organophosphorus compounds.

Unit IV Regulation and Environmental management **12h**

- Environmental Audit: Need, proclamation and advantage
- Environment management system: Significance of EMP, environment impact assessment – objectives, participating international organizations, processes, ISO 14000, and ethics, laws and policies in India.
- Environmental Impact Assessment: Introduction, Objectives, Classification, Guidelines. Case Study.
- Biosafety: Biosafety guidelines and regulations with special reference to India, Biosafety and environmental concerns of transgenic plants, animals and nanotechnology.

Unit V - Global Environmental Problems and Remote sensing **12h**

- Global warming, ozone depletion, UV-B
- Greenhouse effect and acid rain, their impact and management.
- Biodiversity and its conservation, status of biodiversity,
- Hotspot
- Red Book data
- Remote sensing and GIS- Principal, terminologies and objectives, Energy sources for remote sensing, Types of remote sensing, Applications- Agricultural, Forestry, Water Resource, Urban Planning, Wildlife Ecology, Disaster Assessment.

M.Sc. (Biotechnology): Semester-III

BT-302 Recombinant DNA technology

Hours: 60 **Credits: 4**

Course objectives:

- To impact fundamental and applied aspects of Recombinant DNA technology.
- To understand the mechanisms and process of gene transfer.
- To understand the principles and methods of gene cloning and recombinant selection
- To understand the principles of gene sequencing and other methods of rDNAtechnology.
- To study the basics of gene expression

Course outcomes: On completion of this course, the student will be able to:

- Learn basics in recombinant DNA Technology.
- Learn basics about r-DNA technology from gene insertion to expression strategies of recombinant genes in various hosts.
- Productively translate both basic and frontier research concepts regarding Recombinant DNA technology.

Unit I : Introduction to Recombinant DNA Technology

- Historical perspective of r- DNA technology. **12h**
- Endonucleases and exonucleases - Classification and mode of action.
- Mechanism of Enzymes used in r-DNA technology and their applications: Polynucleotide phosphorylase, DNases, Methylases, phosphatases,

polynucleotidekinase,ligases,S1Nuclease, RNase.

- Types of vectors in r-DNA technology and their salient features: plasmids; pBR322, pUC18 cosmids, phages; and M13, SV40 vector, Artificial vectors - BAC, YAC and PAC
- Shuttle vectors, Expression vectors, Selectable vectors, Genomic library and cDNAlibrary.

Unit II : Gene Transfer **12h**

- Biological methods – Conjugation, transformation, transduction and transfection.
- Physical methods - Electroporation, micro-projectile system, gene gun andbiolistics.
- Chemical methods- Liposome mediated transfer, calcium phosphate method and DEAE-dextran.
- Molecular methods - molecular mechanism of antisense technology, Advanced Tools in genetic engineering: CRISPR, Genome re-coding, lentivirus and Cre/ loxP system.

Unit III : Gene cloning and recombinant selection **12h**

- Gene cloning, Cells for cloning; *E. coli*, *S. cerevisiae*, mammalian fertilized egg cells and Chinese hamster ovary cultured cells.
- Steps in gene cloning
- Direct screening and direct selection.
- Indirect screening techniques; HAT (Hybrid Arrested Translation), HST(Hybrid Selected released Translation),Colony hybridization, Dot Blot Hybridization, Immunological assay, Nucleic acid hybridization; DNA Probes, cDNA Probes, RNAProbes.

Unit IV : Analytical Techniques in r-DNA technology **12h**

- Sequencing methods- Maxam Gibert method, Sanger's method, automated DNA sequencing, NGS methods- pyro-sequencing and ABi- solid method.
- Genetic mapping- basic of genetic mapping, Linkage analysis, DNA markers for genetic mapping- RFLP, SSLP,SNP.
- Physical mapping- Restriction maps, Radiant hybrid maps and STS maps.

Unit V : Expression strategies and applications of r-DNA technology **12h**

- Expression strategies for heterologous genes- Expression in plants, Bacteria and Yeast.
- Application of r-DNA technology - DNA fingerprinting. Genetic disease-Detection and Diagnosis Gene therapy, gene delivery systems, viral and non-viral. Bio-pharming and recombinant vaccines. CRISPR technology, DNA marker technology in plants

References:

1. Dale, J. and Schantz, M. (2008) From Genes to Genomes, 2nd edition, John Wiley and Son Ltd.
2. Brown, T. A. (2010) Gene Cloning and DNA Analysis: An introduction, 6th edition, Wiley- Blackwell Publisher, UK.
3. Winnacker, E. (2003) From Gene to Clones; Introduction to gene technology, 4th

edition, Panima Publisher, India.
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5. Watson, James D., Baker, Tania A., Bell, Stephen P., Gann, Alexander, Levine, Michael, Losick, Richard, CSHLP Inglis (2008) Molecular Biology of the Gene, 6th Edition, Cold Springer Harbor Laboratory.
6. Glick, B. R., Pasternak, J. J. and Patten C. L. (2010) Molecular Biotechnology, 4th edition, ASM Press, USA

M.Sc. (Biotechnology): Semester-III

BT-303 Lab course – V on Environmental biotechnology

Hours: 120 **Credits: 4**

Course objectives:

- To acquaint the student with environmental related problem
- To inculcate techniques to treat various environmental issue
- To introduce with technique for monitoring environmental problem

Course outcomes: On completion of this course, the student will be able to:

- Apply the knowledge gain to treat various waste
- Understand the current environment issues.
- Gain skill to estimate various parameter of soil and water

1.	Determination of acidity and alkalinity of water/soil.
2.	Determination of salinity of water/soil sample
3.	Determination of COD of sewage/industrial waste water
4.	Determination of BOD of sewage waste water
5.	Estimation of total nitrogen of soil (Kjeldahl's method)
6.	Estimation of chemical parameters of vermicompost viz. C:N ratio, P, K
7.	Determination of soil microbial activity by CO2 evolution method
8.	Determination of MIC of pesticide / heavy metal against bacterial culture
9.	Testing of cytotoxicity of pesticides polluted water using onion root tip assay/pollen germination
10.	Biosorption of dyes or metals using dead biomass of *Aspergillusniger*or brewer's Yeast (heat killed) examined for biosorption (Congo Red).
11.	Synthesis of nano-particles using Biological process
12.	Detection of nanoparticles in colloidal solutions using UV-Vis absorption
13.	Comet assay to assess the DNA damage due to pesticide exposure
14.	Estimation of metal content in soil, compost, vegetables, drinking water and waste waters using atomic absorption spectroscopy
15.	Estimation of Biodiversity Index of particular habitat
Note: Mandatory to perform any 12 -13 experiments	

References:

1. Glick B.R., Pasternak J.J., Patten C. L. (2010) Molecular Biotechnology, 4thedition, ASM Press, USA
2. Sulabha K. Kulkarni, (2009) Nanotechnology; Principals and Practices, Capital Publishing Company, New Delhi.
3. Michael A. Stroscio and Mitra Dutta. (2004) Biological Nanostructures and Application of Nanostructures in Biology, Kulwer Academic Publishers, UK.
4. Kenneth Sauer, (1995) Biochemical Spectroscopy. Methods in Enzymology Vol 46, Academic Press, USA.
5. Rodney Boyer, (2000) Modern Experimental Biochemistry. 3rdedition, Prentice Hall Publisher, USA.

M.Sc. (Biotechnology): Semester-III

BT-304 Lab course VI on Food Biotechnology

Hours: 120 **Credits: 4**

Course objectives:

- To acquaint the student with changes occurring in raw food
- To inculcate techniques to estimate protein, carbohydrate in food item

Course outcomes: On completion of this course, the student will be able to:

- Gain skill required to work in food industries.
- Learn various microbial techniques used in food industries.
- Gain knowledge about upsteam and downsteam process used in fermentation industries

1.	Proximate analysis of food: Estimation of moisture, dietary fiber and ash content
2.	Estimation of carbohydrate content of food materials
3.	Estimation of protein content of milk/food materials
4.	Estimation of fat content of food samples
5.	Determination of microbial count in the food sample by DMC/SPC method
6.	Determination of the quality of milk by MBRT assay
7.	Determination of efficiency of pasteurization by phosphatase assay
8.	Estimation of mycotoxin in food sample by Thin layer chromatography
9.	Calorific estimation of food samples by Bomb calorimetric method.
10.	Determination of antioxidant property of naturally occurring food additives
11.	Determination of probiotic/prebiotic properties of pickle/buttermilk by suitable assay
12.	Isolation of milk/meat products spoiling microorganism by suitable culture techniques
13.	Isolation of microorganism from fermented food sample
14.	Fermentative production of acetic acid at laboratory scale fermentation
15.	Fermentative production of alcohol at laboratory scale
Note: Mandatory to perform any 12 -13 experiments	

References:

1. Osborne, D.R. and Voogt, P.I., 1978. The analysis of nutrients in foods. Academic Press Inc.(London) Ltd., 24/28 Oval Road, London NW1 7DX..
2. Barbosa-Canovas, G., 2017. Food engineering laboratory manual. Routledge.
3. Shen, C. and Zhang, Y., 2017. Food Microbiology Laboratory for the Food Science Student. Food Microbiology Laboratory for the Food Science Student, pp.25-30.
4. Cappuccino, J.G. and Welsh, C.T., 2017. Microbiology: A laboratory manual. Pearson Education.
5. Erkmen, O. and Bozoglu, T.F., 2016. Food microbiology: Principles into practice. John Wiley & Sons.
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7. Mahon, C.R., Lehman, D.C. and Manuselis, G., 2018. Textbook of diagnostic microbiology-e-book. Elsevier Health Sciences.

M.Sc. (Biotechnology): Semester-III
BT-305 Research methodology

Hours: 60 **Credits: 4**

Course objectives:

- To acquaint the student with fundamental research
- To inculcate techniques of research process
- To introduce with technique of research documentation and anti-plagiarism

Course outcomes: On completion of this course, the student will be able to:

- Perform the research with systematic and scientific approach
- Understand research process, formulate research plan and analyse the data
- Use the methods of report writing and checking plagiarism

Unit I : Fundamentals of research 12h

- Objectives of research
- Type of research:
    - Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Experimental Research Exploring or Formulative Research, Diagnostic Research/Study, Surveys, Case Study, Field Studies
- Criteria for good research
- General research process
- Define the research problem, literature survey, formulating hypotheses, research design, data collection and analysis, interpretation and preparation of the report

Unit II : Research problems and review of literature 12h

- Defining and selection of problem, necessity and techniques.
- Need of research review
- Sources of literature and search strategies
- Research reading and note taking
- Bibliography, webliography and literature citation

Unit III : Research design and hypothesis 12h

- Concepts: types of variables, hypothesis, control, treatment, experimental units etc.
- Types of research design: exploratory, descriptive and diagnostic, hypothesis-testing
- Basic principles of experimental designs
- Important experimental designs: Informal and formal
- Hypothesis: Concept, need, characterization, testing, decision rule, two-tailed and one-tailed test

Unit IV : Data collection and analysis 12h

- Sampling: steps, types, criteria of section of technique, errors
- Measurement of scales and indices
- Methods and tools of data collection (primary, secondary),
- Case study, field study, survey
- Processing of data: editing, coding, classification and tabulation
- Statistics in research: central tendency, dispersion, skewness, measures of relation

Unit V : Interpretation, Discussion and report writing 12h

- Interpretation: meaning, importance, technique and precaution
- Structure and content of Discussion
- Numbering and caption of figures
- Report writing: steps, type, components and formatting
- Presentation of research : oral and research paper
- Plagiarism: Concept, prevalence, factors, strategies to tackle and detection

References:

1. Ramamurthy G.C. (2011). Research methodology, kogent learning solution.inc Dreamtech Press
2. Joshua O. Miluwi and Hina Rashid R. M (2015). Principle method and practices, Mangalam Publication
3. Krishnaswamy O.P., Reddy D. Obul (2010) Research Methodology and Statistical Analysis, Himalaya Publishing House **ISBN-10:** 8184885970
4. Venkatamunireddy R. (2011) Fundamental of research, Deep amd Deep publication
5. Wilson, P. D. K., Wilson, K., & Walker, J. (Eds.). (2000). Principles and techniques of practical biochemistry. Cambridge University Press.
6. Gurumani, N. (2019). Scientific thesis writing and paper presentation. MJP Publisher, Chennai
7. Gurumani, N. (2014). Research methodology for biological science, MJP Publisher, Chennai
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M.Sc. (Biotechnology): Semester-III
BT-306 Food technology and Neutrigenomics

Hours: 60 **Credits: 4**

Course objectives:

- To acquaint the student with changes occurring in raw food
- To inculcate techniques to preserve food for spoilage.
- To introduce concept of food legislation

Course outcomes: On completion of this course, the student will be able to:

- Understand the role of microorganism in food spoilage.
- Learn about nutraceutical and neutrigenomics.

Get aware of role of neutrigenomics for disease prevention

Unit I : Biochemical changes in raw food • **Cereals and legumes:** Cereal grain structure, composition, mobilization of cereal starches by alpha amylase, alpha amylase activity in germinated seeds. • **Legumes:** Legume seed structure, Composition, effects of germination • **Fruits and vegetables**: Respiration, initiation of ripening, color changes, texture • **Meat and fish:** Nature of muscle, conversion of muscle to meat • **Browning reactions in food:** Non-enzymatic browning, pigment formation, heterocyclic compounds, Ascorbic acid oxidation, inhibition of non-enzymatic browning	**12h**
Unit II : Food Microbiology • Microbial growth in food: Intrinsic and extrinsic factors (in brief). • Food spoilage: Contributing factors, Spoilage bacteria, Microbial spoilage of milk and milk products, meat and meat products • Foodborne disease: Toxins produced by Staphylococcus, Clostridium and Aspergillus; Bacterial pathogens: Salmonella, Bacillus, Listeria, Escherichia coli, Shigella, Campylobacter • Fermented food: Buttermilk, yoghurt, cheese, alcoholic beverage, vinegar, sauerkraut and soya sauce.	**12h**
Unit III : Food processing • **Raw material preparation:** cooling crops and carcasses, cleaning foods, sorting and grading and peeling • **Extraction and separation of food components:** centrifugation, filtration, extraction using solvents, membrane separation, effects on food and microorganisms • **Size reduction: solid foods and liquid foods**	**12h**

• **Minimal processing methods:** high pressure processing, irradiation, ozone, pulse electric field processing, processing by removal of heat • **Post processing:** packaging, filling and sealing of containers, material handling, storage and distribution	
Unit IV : Food biotechnology and Food legislation • **Recombinant DNA technologies**: Effective gene expression in crop plants, insect resistant modified crops, herbicide tolerant crops, pathogen derived virus resistant crops • **Commercial enzymes and proteins in food industry derived from genetically modified microorganism:** amylases, asparaginase, proteinase, cellulase, lipase, phytases • **Food legislation:** Compulsory and voluntary trade and Company standards. FDA, US FDA, FPO. • Overview of Current status, growth rate and economics of food industry in India	**12h**
Unit V : Nutraceuticals and Nutrigenomics • Concept of nutraceuticals, infant and baby foods, adolescent/ teen age foods, foods for pregnant ladies and nursing mothers, geriatric foods • Concept of nutrigenomics • Food recommended and restricted in metabolic disorders and disturbances: gastrointestinal disorders; fever and infection; liver, gall, bladder and pancreatic disturbances; blood, circulatory and cardiac diseases; urinary and musculoskeletal diseases; allergies. • Nutrigenomics aspect in vitamins and trace metals • Application of neutrigenomics for disease prevention and better health	**12h**

References:

1) Eskin, N. M., &Shahidi, F. (2012). Biochemistry of foods. Academic Press.
2) P.J. Fellows (2017). Food processing technology (Fourth edition), Woodhead publishing.
3) Nollet, L. M., Toldrá, F., Benjakul, S., Paliyath, G., &Hui, Y. H. (2012). Food biochemistry and food processing. John Wiley & Sons.
4) Raffaele De Caterina, Martin Kohlmeier (2020) Principles of Nutrigenetics and Nutrigenomics, Academic Press.
5) Pathak, Y. V., &Ardekani, A. M. (Eds.). (2017). Nutrigenomics and Nutraceuticals: Clinical Relevance and Disease Prevention. CRC Press.

M.Sc. (Biotechnology): Semester-IV

BT-401 Advanced pharma and process biotechnology

Hours: 60 **Credits: 4**

Course objectives:

- To acquaint the student with knowledge of products produced in pharmaceutical industries
- To inculcate techniques used for vaccine production.
- To introduce concept of therapeutic protein.

Course outcomes: On completion of this course, the student will be able to:

- Understand the technique used for analysis of clinical product.
- Learn about therapeutic protein production.
- Get aware of different tool s and technique use for drug designing.

Unit I : Vaccine Production **12h**

- History of vaccinology
- Conventional approaches to vaccine development, live attenuated and killed vaccines, adjuvants, quality control, preservation and monitoring of microorganisms in seed lot systems.
- Introduction to newer vaccine approaches namely sub-unit vaccines,synthetic vaccines, DNA vaccines, virus like particles, recombinant vaccines, edible vaccines, Nano particles in vaccine delivery systems,

Unit II : Clinical trial and final product analysis **12h**

- Preclinical trials: Pharmacokinetics and Pharmacodynamics of Peptide and Proteindrugs,
- Estimation of toxicity: Concept of LD50 and ED50 and their significance
- Analysis of final product: Protein and DNA based contaminants, Endotoxin detection, Pyrogen detection, Microbial and viral contaminants, Validation studies
- Bioassay for detecting toxicity of toxins fro microorganism: Colorimetric yeast assay for detecting trichothecenemycotoxins, MTT assay for detecting fusariummycotoxins
- Toxicity bioassay for chemicals: Lux-floro assay, ALIC based assay, pnar-gfp assay
- Antiviral and anticancer assay: DNA polymerase lyase assay, HIV -1 Protease and reverse transcriptase kinetic assay

Unit III : Therapeutic proteins **12h**

- Cytokines: features, physiological roles, application for therapy
- Lymphokines:preparation from Natural sources, by r-DNA Technology, therapeutic use
- Interferons:production and purification, application
- Interleukins: types, cellular source and application
- CSF: types and application
- Market for therapeutic proteins
- Product Development Strategies and challenges.

Unit IV : Transgenic production of Biopharmaceuticals **12h**

- Concept and advantage
- Progress in transgenic animal producing biopharmaceuticals
- Selected tissue and expression
- Challenges and issues
- Animals of interest for transgenesis
- Transgenic plant for production of biopharmaceuticals
- Status of transgenics

Unit V : Drug designing and Biopharmaceutical Industry **12h**

- Concept of Drug discovery
- Tools and techniques in drug designing: computer aided drug designing, role of bioinformatics in genome based therapy, antisense DNA technology, role of genomics research
- Biopharmaceutical industry: Definition and characteristics
- Scenario of Biopharmaceutical Market, products, manufacturing and research

References:

1. Belits H.-D. and Grosch W. (1999) Food Chemistry, 2nd Edition, Springer Verlag,Germany
2. Bielecki S., Tramper J. and Polak J. (2000) Food Biotechnology,Elsevier
3. Earrly,R.(1998)TheTechnologyofDairyProducts,2ndEdn,BlackieAcademicandProfessional, UK
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14. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3rd Ed. Informa Healthcare.

M.Sc. (Biotechnology): Semester-IV

BT - 402: Genomics and Proteomics

Hours: 60 **Credits: 4**

Course Objectives:

- To acquaint the student with knowledge of Genomics and proteomics
- To inculcate techniques used for large scale DNA Sequencing.
- To introduce the concept and technique used for protein sequence and analysis.

Course Outcomes: On completion of this course, the student will be able to:

- Understand the concept and applications of genomics and proteomics .
- Get aware techniques and application of comparative genomics.
- Learn the techniques used for gene expression and function

Unit I : Basic concept of Genomics **12h**

- Genome overview at the level of Chromosome (with model organisms example)
- Concept of Genomics
- The impact of bioinformatics and functional genomics on biology in the 'Post genomic era'
- Strategies for large scale DNA sequencing- Whole genome analysis techniques,
- Next generation sequencing methods; Organization, structure and mapping of genomes (with model organisms example)
- Structural and functional genomics –Goals, methods, applications

Unit II : Comparative Genomics **12h**

- Concept of Comparative Genomics, orthologues and paralogues
- Techniques in comparative genomics: Exon shuffling, horizontal gene transfers, genomes similarity, SNPs, phylogenetic footprinting
- Computational tools for comparative genomics
- Application of comparative genomics

Unit III : Transciptomics and Microarray **12h**

- Introduction to transcriptomics and expression profiling
- DNA and RNA Microarray –Preparation, working and analysis.
- Microarray databases and bioinformatics tools.
- Investigative techniques –EST, SAGE, SNP

Unit IV : Basic concept of Proteomics **12h**

- Concept Proteomics
- Type of proteomics: Structural and functional Proteomics with at least one explanatory example for each
- application, advantages and limitations of Proteomics
- Protein Microarray-Preparation, working and analysis.
- Proteomics and Microarray databases and allied bioinformatics tools.

Unit V : Techniques in Proteomics **12h**

- Protein separation techniques,
- Strategies in protein identification,
- 2D Gel electrophoresis, Isoelectric Focusing (IEF).
- Mass spectrometry in proteomics –Principle, techniques, components and variations (HPLC, ESI, MALDITOF,FT-MS, MS/MS, Quadrupole) and analysis, applications.
- Protein- Protein interactions- experimental and computational- Yeast and Bacterial 2-hybrid systems, Protein-ligand interactions and Protein fragment complement assays

References:

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M.Sc. (Biotechnology): Semester-IV
BT- 403: Methods in Biotechnology

Hours: 120 **Credits: 4**

Course objectives:

- To acquaint the student with various methods in Biotechnologyi
- To inculcate techniques used for isolation and identification of microorganism

Course outcomes: On completion of this course, the student will be able to:

- Gain skill required for production of various enzyme of industrial application.
- Learn about nucleic acid and protein databank
- Gain knowledge about software used for phylogenetic analysis

1	Validation of autoclave/ Laminar air flow.
2	Analysis of milk and milk products – Lactose/ Protein/ Phosphorus and Calcium content of milk powder
3	To check the preparations) sterility of pharmaceutical product. (Injectable/ Parental/ Ophthalmic
4	Isolation and biochemical testing of probiotic cultures (Lactobacilli) from food samples (curd, intestine, sauerkraut, dosa, etc.)
5	Aflatoxin testing in ground nut / maize
6	Microbial assay of vitamin /antibiotics
7	Production and isolation of bacterial exo-polysaccharides from bacteria
8	Production and estimation of alkaline protease from bacterial source
9	Production and estimation of bacterial/ fungal lipase
10	Chi-squared test for goodness of fit
11	Biological databases – NCBI, Protein Data Bank and ExPasy
12	Pair wise alignment of DNA and Protein
13	Multiple sequence alignment of DNA and Protein
14	Secondary structure prediction of proteins
15	Perform phylogenetic analysis using clustral W
Note; Mandatory to perform 12-13 experiments	

References:

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M.Sc. (Biotechnology): Semester-IV

BT-404: Lab course –VIII Project dissertation

Hours: 120 **Credits: 4**

Course objectives:

- To give exposure to the students to research methodology
- To introduce criteria for selection of research topic, plan and perform experiments, collect and analyse the data
- To foster independent thinking

Course outcomes: On completion of this course, the student will be able to:

- Carry out comprehensive survey of literature and comprehend a problem based on review
- Plan experimental framework for research and present the work in written format.
- Present the research with ICT tools and face viva voce

The project is allotted during the Forth semester. The students will get an opportunity to become a part of ongoing research activities in the respective College. The student will explore and gain experience in different sectors of biotechnology viz agriculture, food, medicine and pharmaceutical. The students will acquire skill towrite,compileandanalyzedata,andpresentthedetailedtechnical/scientificreport.Atthe end of successful project semester training, potentially the students become employable in the industries/organizations.

It is expected that the students will design experiments and collect experimental data to deduce conclusions. At the end, they will submit a detailed thesis for evaluation. The students should be introduced to research methodology in the beginning through few lectures.
The approach towards the execution of project should be as follows:

1. Selection of topic relevant to priority areas of biotechnology.
2. Collectionofliteratureonthetopicofresearchfromlibraries,internet,on-linejournals,Planning of research experiments
3. Performing the experiments with scientific and statistical acceptability.
4. Presentation of observations and results.
5. Interpretation of results and drawing important conclusions.
6. Discussion of obtained results with respect to literature reports.

7. Writing monthly progress report
8. Preparation of report (Dissertation) containing introduction, materials and methods, results and discussion, conclusions, bibliography and submission of at least 3 copies (1 copy retained in the department and after examination submitted to Library, 1copysubmittedtotheguideand1copy kept with the candidate).

Presentation of research data during examination and submission of project dissertation in a bound form.

1. **Internal examination (40 marks):** Components of continuous internal assessment

   Submission of monthly progress report and signed by supervisor (at least 4 reports) (2 marks per report = 8 marks), Literature collected, experiment planning and design (10 marks), Experiments conducted (10marks), outcome of the experiments and viva (8marks) and regular attendance (4marks) recorded: Research Supervisor
2. **External examination (60 marks):** Components of external assessment:
   Subject matter (5 marks), Review of literature (10 marks), Writing of dissertation submitted in bound form at the time of examination (Title page, Certificate, Main content: Abstract, Introduction, Literature, Materials and methods, results and discussion and conclusion with relevant References) (15 marks), Presentation structure (PPT format) (8 marks), Overall presentation reflecting contribution of work (4 marks), Response to questions (15 marks).

Suggested readings: Refer to the journals, reference books, abstracts etc. related to topic

M.Sc. (Biotechnology): Semester-IV

BT - 405: Biostatistics and bioinformatics

Hours: 60 **Credits: 4**

Course objectives:

- To impart understanding of elementary aspects of bio statistics
- To introduce overview of bioinformatics viz. data sequencing and mining
- To analyse the output data to predict a biologically relevant function

Course outcomes:

The student will be able to:

- Practice biostatistics for interpretation of experimental data
- Understand fundamentals of database bioinformatics
- Access information from databases and interpret phylogenetic tree to gain insight into evolutionary path

Unit I : Sampling and central tendency (theoretical concepts) **12h**

- Applications of bio statistics to biological database
- **Concepts**: population, sample, probability, central tendency, dispersion, variance
- **Sampling** types: simple random, stratified, systematic, cluster
- **Data**: collection (primary and secondary), classification and tabulation of data

- Graphical techniques: one dimensional, two dimensional, pictograms
- Graphical presentation of data: histogram, frequency polygon, frequency curve, ogive curve
- **Measures of Central tendency**: Mean, Mode, Median
- **Measures of dispersion:** range, mean deviation, standard deviation, coefficient of variation, skewness.

Unit II : Correlation, Regression, probability, ANOVA (theoretical concepts) **12h**

- **Correlation**: definition, types, methods of measuring
- **Regression**: definition, equation, coefficient, Simple linear regression,
- **Analysis of Variance:** One and two way analysis of variance, Intro experiments, Multivariate statistical analysis
- **Probability:** Definition, concepts: experiment, event (simple, compound, mutually exclusive, independent, dependent)
- **Discrete distributions**: Bernoulli, Binomial, Poisson. Continuous: Normal, Exponential, sigma limits and probability coverage.
- Concepts: Hypothesis testing, t test, F test, Chi square test, Design of experiments, multivariate statistics.

Unit III : Overview of Bioinformatics **12h**

- Concept of Bioinformatics: definition, scope, application and Limitation.
- Introduction to biological databases – Primary, (GenBank, EMBL, SWISS-PROT), Secondary (PROSITE and pfam) and Specialized (EST database and Microarray Gene Expression database)
- UNIPROT database
- Structural databases: PDB, MMDB
- Sequence retrieval system - SRS, ENTREZ, EXPASY
- Bioinformatics servers in India.

Unit IV : Sequence analysis and phylogeny **12h**

- Sequence analysis: Concept of % Identity, Twilight zone and mid night zone
- Concept of homology, analogy, othology and paralogy
- Sequence alignment: Pair wise alignment (Global and Local) and multiple sequence alignment –Clustal W- editing and interpretation
- Gap Penalties
- Introduction to scoring matrices-PAMs Matrices and BLOSSUM Matrices
- Database Similarity searching: BLAST, its Variants and statistical Significance , FASTA and Statistical Significance
- Phylogenetic analysis: Definition, Terminology that characterizes phylogenetic tree, Choice of Molecular Markers, Phylogenetic tree construction method: Maximum Parsimony and Maximum Likelihood Method, Phylogenetic trees Evaluation: Bootstrapping and Jackknifing, Phylogenetic Programs.

Unit V : Mining and Data Visualization, **12h**

- Protein structure prediction - Secondary structure prediction: Globular protein and Transmembrane protein, 3D Structure prediction: X ray Crystallography, Nuclear Magnetic Resonance Spectroscopy
- Classification of protein Structure: SCOP

- Bioinformatics in drug discovery: Target Selection, Prediction of a lead compound, Molecular Modeling
- Software for Data Visualization :CN3D, Rasmol, Pymol, Chimera, and SWISS PDB Viewer
- Application of programming Language in Biology: Bioperl and Biojava.

References:

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M.Sc. (Biotechnology): Semester-IV

BT-406: Bio entrepreneurship

Course objectives:

- To impart understanding of business management and entrepreneurship
- To introduce skills required for bio-entrepreneurship
- To understand basics of business ethics, safety and IPR

Course outcomes: On completion of this course, the student will be able to:

- Understand fundamental business, management, marketing, operation and HRM
- Able to develop skill set required for entrepreneurship in microbiology
- Address the issues related to business ethics and understand concept of safety and IPR

Unit I : Introduction to Business and management **12h**

- Management
  - Definition, concept, importance
  - Levels (individual, first, middle and top),

    - Functions (planning, organization, staffing, directing, controlling)
    - Skills (technical, human, conceptual, diagnostics, communication, political)
    - Organization types, coordination, control and decision making
    - Strategic management: characteristics, importance, SWOT analysis
- Production and operation
    - Objectives, functions
    - Planning and control, Total quality management, scale forecasting
- Marketing, Marketing research- concept and techniques
- Core concept of Market: Identification and evaluation of market potential of various bio-entrepreneur sectors
- Financial management: objective, method and importance
- Concept of capital budgeting and working capital
- Concept of human research management and planning

Unit II : Business development and entrepreneurship **12h**

- Conceptual framework and characteristics for being an entrepreneur in microbiology.
- Factors affecting microbiology/ biotechnology business:
    - Finance, infrastructure, equipment, manpower, resources, project location, end product, quality issues, etc.
- Role of government and schemes
- Financial institutions in fostering bioentrepreneurship

Unit III : Business management, skills in bio-entrepreneurship **12h**

- Personality and attitude, organizational behavior, leadership
- Principles of effective communication. Body language, public speaking, presentations,
- Business proposal writing.
- Communication aid and application of technology
- Case studies of successful and unsuccessful bio-entrepreneurship.

Unit IV : Ethics, regulation and safety **12h**

- Business ethics: meaning, principals (Integrity, Honesty, Respect and Concern, Fairness), Influential factors, ethical dilemmas in biotech industry
- Regulations related aspects and laws for industry
- Current regulatory bodies
- Translational development
- Human clinical testing phases
- Biologics License Application (BLA)
- Safety and precautions
    - Biological: microbes, sterilization, documentation, disposal, storage
    - Chemical: MSDS, cautions
    - Personal: flame, solvent, apron, mask, eyes etc.
- Biosafety: leverls (BL 1, 2, 3, 4), GMOs and risks

Unit V : Intellectual property and IPR **12h**

- IPR- Introduction, Forms of IPR: patent, copyrights, geographical indications, trademarks, trade secret, Industrial designs andPatent law
- Patentable and non-patentable items

- Legislations covering IPR's in India
- Overview of patent system: Steps in filing patent, provisional and complete specification
- Valuation of patent and business concerns
- Protection of biotechnological inventions: biological materials such aslife forms, transgenic materials, genetic resources
- Patent regulatory bodies at National and International level
- Overview of GATT, role of WTO and TRIP
- Acts: Indian patent act 2005, Indian biodiversity act

  Protection of plant varieties and farmer's rights

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Skills imparted:

the students will be equipped with knowledge in the newer areas of microbial physiology, diversity, biomolecules, basic and diagnostic Immunology, molecular biology, analytical tools and biostatistics, bioprocess technology, Biochemistry, Enzymology, and its application in Medicine, Agriculture, Industry, Proteomics, Genomics, Metabolomics, Bioinformatics, Nano-biotechnology etc. The syllabus is simplified to accommodate the present and future needs of Biotechnology in various fields such as, Agriculture, Industrial, Environmental, Pharmaceutical, Clinical and Diagnostic, Research and Development etc. Hence, more emphasis on Theory and Practical course in new restructured course is bestowed to impart skill-set essentials to further Biotechnology and build interdisciplinary approach.

Job opportunity:

Biotechnologists can work for various organizations /industries under these positions:

- Medical scientists,
- Biological technicians.
- Medical and Clinical Lab Technologists & Technicians.
- Biochemists and Biophysicists.
- Biomedical Engineers.
- Microbiologists.
- Epidemiologists.
- R&D and Process Development Scientists.
- Pursue Ph.D