Department of Biotechnology

II विद्या विनयेन शोभतेII

Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: Masters in Science (M. Sc.)

SYLLABUS

(Approved in the Academic council meeting held on 27-06-2023)

M.Sc.-I Biotechnology

As per National Education Policy
Choice Based Credit & Grading System (60:40)
w. e. f. Academic Year 2023-24

Department of Biotechnology

Program Outcomes for M.Sc. Degree Program

Sr. No.	OUTCOME FOR M.SC. PROGRAM	Graduate Attribute
After completion of B.Sc. program students will acquire:		
PO-1	The ability to identify and describe broadly accepted methodologies of science, and different modes of reasoning.	Disciplinary knowledge
PO-2	An ability to demonstrate proficiency in various instrumentation, modern tools, and advancedtechniques to meet industrial expectations and research outputs.	Disciplinary knowledge
PO-3	Ability to identify problems, formulate, and prove hypotheses by applying theoretical knowledge and skills relevant to the discipline.	Problem-solving
PO-4	The ability to articulate thoughts, research ideas, information, scientific outcomes in oral and in written presentation to range of audience.	Communication skills
PO-5	A capacity for independent, conceptual, and creative thinking, and critical analysis through the existing methods of enquiry.	Critical thinking
PO-6	Acquisition of skills required for cutting edge research, investigations, field study, documentation, networking, and ability to build logical arguments using scholarly evidence.	Research skills
PO-7	An ability to portray good interpersonal skills with the ability to work collaboratively as part of a team undertaking a range of different team roles	Teamwork
PO-8	The ability to understand ethical responsibilities and impact of scientific solutions in global, societal, and environmental context and contribute to sustainable development.	Moral and ethical awareness/ multicultural competence
PO-9	An openness to and interest in, life-long learning through directed and self-directed study.	self-directed learning
PO-10	The ability to translate the knowledge and demonstrate the skills required to be employed and successful professional development.	Life-long learning

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Masters in Science in Biotechnology
Syllabus for Semester I and II

Preamble:

Master of Science (M.Sc.) Programme in Biotechnology is a P.G. Programme of Department of Biotechnology, Changu Kana Thakur Arts, Commerce & Science College, New Panvel, affiliated to University of Mumbai with an Autonomous status. Biotechnology is technology based on biology. Biotechnology harnesses cellular and bio-molecular processes to develop technologies and products that help to improve our lives and the health. Modern biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, cleaner energy, and have safer, cleaner, and more efficient industrial manufacturing processes.

The Choice Based Credit and Grading System (CBCGS) to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. The proposed credit-based curriculum and grading system will even add much more to the existing interdisciplinary nature of biotechnology.

Under the 'autonomy' we have made an attempt to design Master's in Biotechnology course syllabus as per national education policy to cater to the needs of credit based-semester and grading system. The changing scenario of higher education in India and abroad is taken into consideration to make this syllabus more oriented towards current need of modern research and industrial sectors.

The present M.Sc. Biotechnology Second Year (Semester-I and II) syllabus is based on the remodeled M.Sc. Biotechnology Curriculum, May 2017, Department of Biotechnology, Ministry of Science and Technology, Government of India and revised syllabus of University of Mumbai. Syllabus is robust and well-designed to enable students to pursue high quality research or increase employability of the students.

It is hoped that the revised syllabus shall serve its objective of promoting outcome-based learning to meet the changing needs of the biotechnology sector.

Scheme of Examination (Amended)
Faculty of Science
(Post-graduate Programmes)

Choice Based Credit System (CBCS)

❖ **Revised Scheme of Examination**

1. For 4 Credit Courses (Discipline Specific Courses (DSC)) (100 Marks)

The performance of the learners shall be evaluated into two components, as the first component by 'Continuous Internal Assessment (CIA)' with 40% marks and as the second component by conducting the 'Semester End Examinations (SEE)' with 60% marks. The allocation of marks for the Continuous Internal Assessment (CIA) and Semester End Examinations are as shown below:

A) Continuous Internal Assessment (CIA): 40 % 40 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Test on Practical Skills/ Case studies /Group/ Individual Survey Project/Presentation and write up on the selected units of the courses/ Book Review / Open Book Test	15 Marks
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibition of leadership qualities in organizing related academic activities	05 Marks

Question Paper Pattern
(Periodical Class Test)

Maximum Marks: 20 Duration: 40 Minutes
Questions to be set: 02
All Questions are Compulsory

Question No.	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/True or False/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination (SEE): 60 % 60 Marks

- Duration: The examination shall be of $2\frac{1}{2}$ hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be five questions each of 12 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

2. For 2 Credit Courses (Theory 50 Marks)

The performance of the learners shall be evaluated into two components, as the first component by 'Continuous Internal Assessment (CIA)' with 40% marks and as the second component by conducting the 'Semester End Examinations (SEE)' with 60% marks. The allocation of marks for the Continuous Internal Assessment (CIA) and Semester End Examinations are as shown below:

A) Continuous Internal Assessment (CIA): 40 % 20 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks

Question Paper Pattern
(Periodical Class Test)

Maximum Marks: 20 Duration: 40 Minutes
Questions to be set: 02
All Questions are Compulsory

Question No.	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination (SEE): 60 % 30 Marks

- Duration: The examination shall be of 1 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be two or three questions each of 15/10 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

3. For 2 Credit Courses (Practical 100 Marks)

- The Practical Examination (PE) shall be of 100 marks for 2 credit course.

- **For Research Methodology (RM):** The writing of research proposal shall be considered for internal assessment 40 Marks.
- **For 6 credits Research Project (RP) Semester IV (150 Marks)**

The performance of the learners shall be evaluated into two components. The allocation of marks are as shown below:

A) The Project guide should evaluate the learner based on overall performance as a part of internal assessment for 50 Marks.

B) External assessment for 100 Marks

❖ **Passing Standard**

The learners shall obtain minimum of 40% marks (i.e. 16 out of 40 or 8 out of 20) in the Continuous Internal Assessment (CIA) and 40% marks in Semester End Examination (SEE) (i.e. 24 out of 60 or 12 out of 30) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Continuous Internal Assessment (CIA) and Semester End Examination (SEE).

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M.Sc. Biotechnology Course Structure
Semester-I

Course	Course Type	Course code	Hrs./ week	Credits
Biochemistry	Course-1	PBT1BIO	04	04
Cell Biology and Genetics	Course-2	PBT1CBG	04	04
Molecular Biology	Course-3	PBT1MOB	04	04
Practical of Course 1 and 3	Course-4	PBT1PR1	04	02
Nutraceutical and Nutrigenomics/ Marine Biotechnology	Elective-1	PBT1NCN/ PBT1MBT	02	02+02
Practical of Course 2 and Elective-1	Practical	PBT1PR2	04	
Research methodology	Minor-1	PBT1RME	04	04
			26	**22**

Semester-II

Course	Course Type	Course code	Hrs./ week	Credits
Immunology and Medical Microbiology	Course-5	PBT2IMM	04	04
Advanced Techniques in Biotechnology	Course-6	PBT2ATB	04	04
Bioinformatics and Biostatistics	Course-7	PBT2BIB	04	04
Practical of Course 5 and 7	Course-8	PBT2PR1	04	02
Nanobiotechnology/ Forensic Science	Elective-2	PBT2NBT /PBT2FSC	02	02
Practical of Course 6 and Elective-2	Practical	PBT2PR2	04	02
On job training	OJT/FP/ CEP/RP		04	04
			26	**22**

SEMESTER-I

Course Description-	
Semester	**I**
Course Name	**Course-1 Biochemistry**
Course Code	**PBT1BIO**
Credit	**04**
Hours	**04**

Course Objectives:

- Students will develop the knowledge about major metabolic pathways of the biomolecules and its physiological significance.

Course Outcomes: After completion of this course students will be able to:

CO1-Illustrate major metabolic pathways with Principles of Metabolic regulations.

CO2-Discuss protein structure, folding pathways and diseases within the context.

CO3-Justify the role of amino-acid and nucleic acid metabolic pathways in various disease pathologies.

CO4-Importance of different adaptations in plants with respect to carbon assimilation.

Units	Course Description	Hrs.
Unit –I Carbohydrate and Lipid Metabolism	• Carbohydrates- Classification and structure of carbohydrates, glycoproteins and Proteoglycans • Metabolism- Glycolysis, TCA cycle- Amphibolic reactions, Oxidative phosphorylation, HMP and Uronic acidpathways with their significance. • Coordinated regulation of glycogen breakdown and synthesis with disorders. • Biosynthesis of essential fatty acids.	15h
Unit –II Protein Structure and Folding	• Primary, Secondary and Tertiary structure of Proteins (Overview). Ramachandran Plot. • Quaternary Structure of the Proteins- Structure of Myoglobin and Hemoglobin, functional mechanism of oxygen transport, allosteric regulation and Hemoglobinopathies. • Protein folding: Protein stability,Denaturation and Renaturation of proteins. Basic concepts of protein folding, Proteinfolding pathways, role of accessory proteins in protein folding and protein misfolding diseases.	15h

Unit –III Amino acids and Nucleic Acid Metabolism	• Biosynthesis of essential amino acids. Metabolic breakdown of amino acids leading to Krebs cycle intermediate. Disorders of amino acid metabolism. • Nucleic acid metabolism Biosynthesis and degradation of purines and pyrimidine with regulation, disorders of Nucleic acid metabolism.	15h
Unit –IV Plant metabolism	• Photosynthesis- Light reactions and calvin cycle, synthesis of starch and sugars. Ecological adaptations- C-4 cycles, CAM, glyoxylate pathway. • Nitrogen fixation and role of nitrogenase,Annamox reactions. Stress Biology- The basic concepts of plant stress, acclimation, and adaptation	15h

References:

1.	Lehninger, Principles of Biochemistry. 7th Edition (2008), David Nelson& Michael Cox,W.H. Freeman and company, NY
2.	Phytochemical Method, 3rd edition (1998), A.J. Harborne, Springer, UK.
3.	Pharmacognosy, 14th edition, (2008), Dr. C. K. Kokate, A. P. Purohit, S. B. Gokhale, NiraliPrakashan, India
4.	Biochemistry: 7th Edition, (2012), Jeremy Berg, Lubert Stryer, W.H. Freeman and company, NY
5.	Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons
6.	Harper's Biochemistry- 27th edition
7.	Devlin, Thomas M.: Textbook of biochemistry with clinical correlations. [ed. by] (7th ed.) Hoboken. John Wiley & Sons, Inc., 2011. 978-0-470-28173-4--(612.015Dev
8.	Buchanan B; Gruissem W et al (2nd Ed.) Biochemistry and Molecular Biology of Plants John Wiley & Sons 2015.
9.	Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co.Ltd.

Course Description-	
Semester	**I**
Course Name	**Course-2 Cell Biology and Genetics**
Course Code	**PBT1CBG**
Credit	**04**
Hours	**04**

Course Objectives:
The aim of this course is to provide knowledge about structure and functions of cells and cellular components.

Course Outcomes: After completion of this course students will be able to:

CO1-Outline the concept of regulation of cell cycle and cell death.

CO2-Discuss cell-cell interactions, transport, and trafficking in the maintenance of cellular integrity and functions.

CO3-Explain chromatin structure and organization of chromosomes.

CO4-Elaborate on karyotyping and mapping of the genome.

Units	Course Description	Hrs.
Unit I Organizationof cells and Cellular Processes	• Cell: structural and functional organization (basic information about cell organelles functions and cytoskeleton); Isolation and growth of cells. • Molecular aspects of normal and cancer cell division: cell cycle stages, cyclins, cyclin dependent kinases, Cdk inhibitors, transcription factors, tumor suppressors, checkpoints proteins. • Cell death: different modes of cell death and their regulation.	15h
Unit-II Membrane Transport	• Cell to cell interactions, cell adhesion- integrins, selectins, cadherins. Cell junction-tight and gap junctions, synapse,desmosomes, plasmodesmata. • Membrane transport: Transport across membrane- passive diffusion, osmosis, active transport, ion channels, ABC transporters, Na+ and K+ pump, Ca2+ ATPase pump, co-transport, symport, antiport, endocytosis and exocytosis. Membrane vesicular traffic.	15h

Unit-III Chromatin structure and Organization	**Chromatin structure:** Histones, DNA, nucleosome morphologyand higher-level organization; Functional states of chromatin and alterations in chromatin organization **Chromosome organization** Centromere and kinetochore, telomere and its maintenance, Heterochromatinand euchromatin, Chromosomal domains (matrix, loop domains) and their functional significance. • **Giant chromosomes:** Polytene and lampbrush chromosomes.	15h
Unit-IV Karyotyping and Chromosome mapping	**Techniques to study chromosomes:** Karyotyping, Chromosome banding, G- banding Chromosome painting, **Mapping Genome** • Physical Mapping- Restriction Mapping, In situ hybridization (FISH and GISH), STS Mapping. • Genetic Mapping- DNA Markers and Linkage Analysis	15h

	References
1.	Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (5th Ed.). New York: Garland Science.
2.	Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman.
3.	Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning.
4.	Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland
5.	Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings.
6.	Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.
7.	Stem Cell Biology, Daniel Marshak, Richard L. Gardener and David Gottlieb, Cold Spring Harbour Laboratory Press
8.	Stem cell biology and gene therapy, Booth C., Cell Biology International, Academic Press
9.	Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer
11.	Stem cell biology and Gene Therapy by Peter Quesenberry., First Edition, Wiley-Liss, 1998.
12.	Stem cells in clinic and Research by Ali Gholamrezanezhad., Intech, 2013

Course Description-	
Semester	**I**
Course Name	**Course-3 Molecular Biology**
Course Code	**PBT1MOB**
Credit	**04**
Hours	**04**

Course Objectives:

- The aim of this course is to build firm foundation on concepts of Molecular Biology including replication, recombination, transcription, and translation.

Course Outcomes: After completion of this course students will be able to:

CO1-Compare the mechanism of replication in prokaryotes and eukaryotes.

CO2-Elaborate on transcription in Prokaryotes & Eukaryotes.

CO3-Explain the different DNA damage and repair systems.

CO4-Discuss the mechanism of translation, gene expression and transposition.

Units	Course Description	Hrs.
Unit- I Replication, Repair and Recombination	• **DNA structure**, features of the double helix, various forms of DNA, denaturation and re-association of DNA, kinetics (Cot curve analysis). DNA Topology and role of topoisomerases. • Replication mechanism in prokaryotes and eukaryotes. • DNA repair- enzymes; Photo- reactivation; Excision repair; Mismatch correction; SOS repair. • Recombination: Homologous and non-homologous; Site specific recombination.	15h
Unit- II Prokaryotic transcription and regulation	• Mechanism and Regulation of Prokaryotic Transcription. • Transcriptional regulation-Positive and negative; Operon concept-lac, trp and ara operons • Transcriptional control in lambda phage.	15h

Unit-III Eukaryotic Transcription and regulation	• Eukaryotic transcription and regulation • Post Transcriptional Modifications- Processing of hnRNA, tRNA, rRNA; capping and polyadenylation; Splicing; Transcriptional and post- transcriptional gene silencing, RNA editing; Nuclear export of mRNA; mRNAstability; Catalytic RNA. • Regulatory RNA and RNA interference mechanisms.	15h
Unit-IV Translation and Transposition	• Protein degradation: Ubiquitin- Proteasome pathway and lysosomal proteolysis. • Transposition- Transposable genetic elements in prokaryotes andeukaryotes; Mechanisms of transposition; Role of transposons in mutation.	15h

Reference	
1	Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
2	J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levin, R. Losick. (2013). Molecular Biology of the Gene (7th edition). Benjamin Cummings, San Francisco, USA.
3	S.B Primrose, R M Twyman, Principles of Gene Manipulation and Genomics, Blackwell Science (Asia Pvt Ltd).
4	R.F. Weaver (2007). Molecular Biology. (4th edition). McGraw Hill. New York. USA.
5	T.A. Brown, Principles of Gene Manipulation and Genomics, Wiley Blackwell Publishers (Asia Pvt Ltd)
6	Bernard R. R. Glick, Jack J. Pasternak, Jack J. Pasternak, Jack J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press, U.S.A.
7	Richard J. Reece, Analysis of gene and genome, John Wiley and sons (Asia Pvt Ltd)
8	Genome 3 T.A Brown
9	i Genetics A Molecular Approach Third Edition, Peter J. Russell

Course Description-	
Semester	**I**
Course Name	**Course 4 – Practical of Course 1 and 3**
Course Code	**PBT1PR1**
Credit	**02**
Hours	**02**

Course Outcomes: After completion of this course students will be able to:

CO1-Estimate the concentrations of different biomolecules.

CO2-Conduct Experiments related to Molecular Biology.

	Course 4 – Practical of Course PBT1BIO and PBT1MOB	Hrs.
1.	Study of Henderson-Hasselbalch Equation and calculations for Buffer preparation.	**04**
2.	Viscosity study of protein.	**04**
3.	Titration of amino acids and calculation of pK value.	**04**
4.	Extraction of proteins from given source and its Estimation by Lowry method.	**04**
5.	Estimation of carbohydrates by Nelson Somogyi method.	**04**
6.	Isolation of starch from potato and its estimation by Anthrone method.	**04**
7.	The isolation and assay of glycogen from liver and skeletal muscles of bird/mammal.	**04**
8.	Estimation of urate/creatinine ratio to diagnose Lesch Nyhan syndrome.	**04**
9.	SDS PAGE of given protein sample.	**08**
10.	Protein gel staining techniques: Coomassie brilliant blue, Silver Staining.	
11.	Determination of the concentration and purity of extracted DNA using UV Spectrophotometer.	**04**
12.	Determination of DNA melting temperature and GC content percentage.	**04**
13.	Extraction of Genomic DNA from Bacteria. DAY-01	**04**
14.	Separation of isolated DNA by Agarose gel electrophoresis DAY-02	**04**
15.	Recovery of DNA from low melting Temperature by Agarose gel	**04**

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Course Description-	
Semester	**I**
Course Name	**Elective-1 - Nutraceuticals and Nutrigenomics**
Course Code	**PBT1NCN**
Credit	**02**
Hours	**02**

Course Objectives:

- Students will able to classify different nutraceuticals and its significance in diseases management.

Course Outcomes: After completion of this course students will be able to:

CO1-Explain characteristics features, classification and application of nutraceuticals.

CO2-Elaborate on significance of nutraceuticals and nutrigenomics for health management.

Units	Course Description	Hrs.
Unit-I Introduction and application of Nutraceuticals	• Nutraceuticals and functional foods Definition, characteristic features, and classification • Phyto –nutraceuticals • Prebiotics and Probiotics, Sources (with examples e.g. microbes, plants, algae, animals), Marine Nutraceuticals • Food security, Food preservation, Chemo Preservation. Food processing (animal and seafood), Food packaging • Nutraceuticals adjuvants	15h
Unit- II Nutrigenomics	• Nutraceuticals in management of health and disease • Development of designer foods for specific chronic diseases • Gene- environment interaction; gene- diet interaction; principles and practice behind dietary management of genetically transmitted disorders. • Importance of nutrigenomics: Bioactive components of food; nutraceuticals; effective gene expression; epigenetic process; recent developments in the field of nutrigenomics.	15h

References:	
1.	Jim Kaput, Raymond L. Rodriguez, (2006), Nutritional Genomics, John Wiley & Sons.
2.	Regina Brigelius-Flohé, Hans-Georg Joost, (2006), Nutritional Genomics: Impact on Health and Disease, Wiley-Blackwell.
3.	Simopoulos A.P., Ordovas J.M., (2004), Nutrigenetics and Nutrigenomics. KragerPublications.
4.	Wildman, R. E. (2016). Handbook of Nutraceuticals and Functional Foods. CRC Press
5.	Gibson, G. R. and Williams, M. C. (2001). Functional Foods Concept to Product. CRC Press.
6.	Vattem, D.A. and Maitin V. (2016). Functional Foods, Nutraceuticals and Natural Products, Concepts and Applications. DEStech Publications, Inc
7.	Nutrigenomics: concept, advances and applications JagishKourReen*, Alok Kumar Yadav and Jitendra Singh, Asian J. Dairy & Food Res, 34(3) 2015: 205-212 2.
8.	Mathers, J.C., (2017). Nutrigenomics in the modern era. Proceedings of the Nutrition Society. 76(3), 265-275.

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Course Description-	
Semester	**I**
Course Name	**Elective 1 –Marine Biotechnology**
Course Code	**PBT1MIB**
Credit	**02**
Hours	**02**

Course Objectives:

- The aim of this course is that students will gain valuable insights about marine biotechnology and its related products.

Course Outcomes: After completion of this course students will be able to:

CO1-Outline the classification of marine environment and its bioprospecting.

CO2-Discuss the commercial utility of marine products and marine food processing.

Units	Course Description	Hrs.
Unit- I Marine Microbiology & Ecology	**Classification of the marine environment** • Introduction to Marine microbial habitats, Estuarine Ecosystems. • Diversity of Marine microorganisms Characteristics of marine microorganisms. (E.g. barophiles, thermophiles, psychrophiles, halophiles actinomycetes, polyextremophiles,anaerobes) • Marine Bio prospecting, phenotypic and genotypic testing, polyphasic methods of identification. Chemotaxonomy,Metagenomics • Biomass productivity – Freshwater, Marine and polar habitats.	15h

Unit- II Marine Products and Processing	• Bioprospecting of algae; Commercial utility of algae • Microalgal Isolation and Strain Selection Techniques • Industrial applications of microalgae, Economic importance of Algae. • Instrumentation and theory of food processing Marinated and fermented fish products Value added marine products Fish products for human consumption • Fish processing by traditional methods**:** Salting, sun drying, smoking,marinating and fermentation, freezing	15h

References:

1	Munn, C.B., (2004) Marine Microbiology: Ecology and Applications, BIOS Scientific Publisher.
2	Krichman, D.L., (2000), Microbial Ecology of the Oceans. Wiley-Liss, New York.
3	Paul,J.,(2001) Methods in Microbiology : marine Microbiology, Academic Press
4	Horikoshi K, Antranikian G, Bull A T, Robb F T and Stetter, K O (2011) Extremophiles Handbook, Springer
5	Josep M Gasol and David L Kirchman (2018) Marine ecology of the oceans, (3rd edition), John Wiley and Sons. Inc
6	Surajit Das Hirak Dash (2018) Microbial Diversity in the Genomic Era, Elsevier
7	Becker and E. Wolfgang (2008). Microalgae: biotechnology and microbiology, Cambridge University Press.
8	Alam, Md. Asraful, Wang, Zhongming (2019). Microalgae Biotechnology for Development of Biofuel and Wastewater Treatment
9	Fabris, M., Abbriano, R. M., Pernice, M., Sutherland, D. L., Commault, A. S., Hall, C. C., & Ralph, P. J. (2020). Emerging technologies in algal biotechnology: Toward the establishment of a sustainable, algae-based bioeconomy. Frontiers in plant science, 11, 279.
10	Eduardo Jacob-Lopes (2018) Microalgal Biotechnology Intech Open. https://www.intechopen.com/books/6541

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Course Description-	
Semester	**I**
Course Name	**Practical: Practical of Course 2 and Elective-1**
Course Code	**PBT1PR2**
Credit	**02**
Hours	**02**

Course Outcomes: After completion of this course students will be able to:

CO1-Conduct Experiments related to Cell Biology.

CO2-Analyse the nutritive value and functional food.

	Course IV – Practical of PBT1CBG and PBT1NCN	**Hrs.**
1.	Isolation of chloroplast.	**04**
2.	Isolation of mitochondrial DNA and determination of succinate Dehydrogenase activity.	**04**
3.	Separation of chloroplast proteins on SDS PAGE.	**08**
4.	Mitosis study using onion root tip.	**02**
5.	Vital Staining of Mitochondria with Janus green B.	**04**
6.	Permanent slides of cancerous cells and cell division.	**02**
7.	Shelf-life calculations for food products.	**04**
8.	Estimation of chemical preservatives by TLC.	**04**
9.	Determination of acid value of natural fats and oils.	**04**
10.	Determination of iodine number of fats and oils.	**04**
11.	Study of nutraceuticals important plants like Zinziber, Curcuma, Alovera, Asparagus, Ocimum etc.	**03**
12.	Estimation of antioxidant properties of phytochemicals by DPPH.	**04**
13.	Estimation of nutritive value of any one food item.	**04**
14.	Preparation of Probiotic food.	**03**
15.	Isolation and enumeration of probiotics from food sample.	**06**

Course Description-	
Semester	**I**
Course Name	**Minor – Research Methodology**
Course Code	**PBT1RME**
Credit	**04**
Hours	**04**

Course Objectives:

- The aim of this course is to develop the skills related to scientific research and methodology.

Course Outcomes: After completion of this course students will be able to:

CO1-Explain various scientific research and methodology.

CO2-Elaborate on different academic database, search engines and research metrics.

CO3-Outline the different mode of scientific communication.

CO4-Discuss various research ethics and scientific misconduct.

Units	Course Description	Hrs.
Unit-I Scientific Research and Research Methodology	• **Scientific Research:** Meaning of Scientific Research, Definition, Characteristics, Types of Research, and Need of research. • **Identification of the problem:** assessing the status of the problem, formulating the objectives, Hypotheses, • **Research Methods and Methodology:** Selecting & defining Research problem, Research Process • **Research Design/Plan:** PreparingResearch design (experimental or otherwise), Actual investigation, Surveys - Case Study - Field Studies & others.	15h

Unit-II Research publication, Data bases and research metrics	• **Academic Databases and Research** Bibliographic Databases, General Search Engines, Metasearch Engines, **AcademicSearch Engines**-Google Scholar, Entrez, Microsoft Academic, Research Gate • **Citation Indexes**-Web of Science, Scopus, Citation **Analysis** • **Impact Factor** Journal Impact Factor Cite Score SC Imago Journal Rank (SJR) NAAS Rating of Journals • **Author Impact Factor-**h-index, i10- Index, g-index, Cited References • **Referencing software:** Mendeley, Endnote. • **Open access publication-** SHERPA/ROMEO online resources to check publishers copyright and self- archiving policies Software tool to identify predatory publications developed by SPPU • Journal finder/journal suggestions tools • viz JANE, ELSEVIER journal finder, springer journal suggester etc.	15h
Unit-III Scientific communication	• **Scientific Communication:** Importance of scientific communication, Types of scientificcommunications, Logical organization of scientific data and documentation Different modes of scientificcommunication • **Scientific Writing** Good Scientific Writing Skills • **Research Proposal writing:** Formaand layout • **Research Paper writing:** Format andlayout • **Report Writing:** Format and layout • **Thesis writing:** (Introduction, Literature review, Materials and Methods, Results, Discussion, Conclusion and Implications, conflict ofinterest) • **Presentation skills -** formal presentation skills; preparing and presenting using overhead projector, PowerPoint; scientific posterpreparation & presentation.	15h

Unit-IV **Research Ethics**	• **Research Ethics:** Social implications of research, biosafety issues Animal experimentation ethics, wild-life ethics and human experimentation ethics. **Scientific misconducts: Falsification,Fabrication & Plagiarism** • **Plagiarism:** Definition, Common types of plagiarism, Intentional and Unintentional plagiarism, Detection of plagiarism by anti-plagiarism tools (Turnitin, Duplichecker, Viper, Copyleaks), Use of URKUND, Turnitin and iThenticate software, Penalties for Plagiarism, Avoiding plagiarism. • **Redundant Publication:** duplicate and overlapping publication, salami slicing • **Publication ethics** -Definition-Best practices/Standards /guidelines (COPE, WAME etc) - Conflict of interest: Violation of publication ethics, authorship - Identification of publication misconduct, complaints and appeals examples and frauds from India & abroad - Predatory publishersand journals.	15h

References	
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SEMESTER-II

Course Description-	
Semester	**II**
Course Name	**Course 5 – Immunology and Medical Microbiology**
Course Code	**PBT2IMM**
Credit	**04**
Hours	**04**

Course Objectives:

- Students will be able to describe the structural features and functions of immune system components, as well as understand cytokines, hypersensitivity reactions, and autoimmunity. Additionally, they will gain insights into tumor immunology, immunodeficiency, transplantation, and vaccine technology, including various types of vaccines and disease-specific vaccine design.

Course Outcomes: After completion of this course students will be able to:

CO1-Discuss structural features of components of the immune system as well as their function.

CO2-Explain the concept of cytokines, hypersensitivity reactions and Autoimmunity.

CO3-Elaborate tumor immunology, immunodeficiency and Transplantation.

CO4-Explain the Types of Vaccine, concept of Vaccine technology, disease specific vaccine design.

Units	Course Description	Hrs.
Unit -I Overview of The Immune System	Overview of the Immune System-Cells andOrgans of Immune System • **Humoral Immunology** Immunoglobulin: fine structure and superfamily Multi- gene organization of Ig gene, Variable region gene rearrangement and generation of antibody diversity, Class switching among the constant region Synthesis, assembly, and secretion of Immunoglobulins, B-cell development, activation, differentiation and memory. • **Cellular Immunology** Components of cell mediated Immunity, T-cell development (Early thymocyte development, Positive and negative selection, Apoptosis), T-cell activation, differentiation and memory, Role of macrophages, cell-mediated immune responses.	15h

Unit –II Immune effector Mechanism	• **Cytokines:** Properties, receptor, cytokine related diseases and cytokine- based therapies. • **Hypersensitivity Reactions**: Type I –IV. • **Autoimmunity:** types of autoimmune diseases; mechanism for Induction of Autoimmunity; treatment of autoimmune diseases.	15h
Unit -III Clinical Immunology	• **Immunodeficiency:** Primary immunodeficiency, acquired or secondary immunodeficiency. **Tumor immunology:** tumour antigens;immune response to tumors and tumor evasion of the immune system, cancerimmunotherapy. • **Transplantation:** immunological basisof graft rejection; clinical transplantation and immunesuppressive therapy.	15h
Unit- IV Vaccinology	History of vaccine development, Active and passive immunization; live, killed, attenuated, subunit vaccines. • **Vaccine technology**: role and properties of adjuvants, recombinant DNA, and plant- based vaccines, reversevaccinology; peptide vaccines and conjugate vaccines. • **Disease specific vaccine design:** Tuberculosis Vaccine; Malaria Vaccine; Cancer vaccine, HIV/AIDS vaccine, new emerging diseases and vaccine needs (Ebola, Zika). • T cell-based vaccine. Phage display as a tool for vaccine and immunotherapydevelopment.	15h

	References
1.	Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
2.	Brostoff, J., Seaddin, J. K., Male, D., & Roitt, I. M. (2002). Clinical Immunology. London: Gower Medical Pub.
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8.	Medical Microbiology by Anantnarayan.
9.	Ian R Tizard: Immunology, An introduction, fourth edition, Thomson.

Course Description-	
Semester	**II**
Course Name	**Course-06 Advanced Techniques in Biotechnology**
Course Code	**PBT2ATB**
Credit	**04**
Hours	**04**

Course Objectives:

- Students will be able to demonstrate various instruments in biotechnology and develop the skillsets in advanced techniques.

Course Outcomes: After completion of this course students will be able to:

CO1-Illustrate the principle, instrumentation, and applications of various advanced spectroscopic techniques.

CO2-Elaborate on emerging techniques in Genomics & Transcriptomics.

CO3-Discuss the advanced techniques used in molecular cytogenetics.

CO4-Illustrate the principle underlying various advance microscopy & spectroscopy and proteomics techniques.

Units	Course Description	Hrs.
Unit-I Spectroscopy Techniques	**Spectroscopy-** Basic principles, instrumentation and applications of IR, Raman, ORD, CD spectroscopy, NMR, ESR and X-ray Crystallography. **Mass spectrometry-** Introduction, Ionisation, Mass analysers ,Detectors , Structural information by tandem mass spectrometry	15h

Unit-II Techniques in proteomics	**Techniques of Protein Purification, Separation and identification** • Chromatographic Techniques- Gel filtration, Ion exchange, Affinity, HPLC and FPLC • 2D-PAGE, isoelectric focusing. Peptide mass fingerprinting. **Expression Profiling-** • Protein Microarrays/ Protein chips: Types and applications • Gel-based quantitative proteomics: DIGE • Gel-free based quantitative proteomic: Surface Plasmon resonance • Stable-isotope tagging, In vivo labelling-SILAC • In-vitro labelling- ICAT	15h
Unit-III Techniques in Genomics	• Genomics Gene expression by SAGE • Functional Microarrays- Construction of microarrays –Genomic arrays, cDNA arrays, oligo arrays and its applications, NGS platforms. • Gene amplification technique PCR and its types (nested, arms, inverse, real time, SSCP, Error prone PCR, CRISPER CAS Technology with applications	15h
Unit-IV Diagnostic Techniques /Methods	**Microscopy- Principle and application-** • TEM and SEM • Advanced fluorescence techniques: FLIM, FRET, and FCS. • Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM). • Metagenomics –for bacterial and fungalPathogens • Clinical utility of molecular diagnostics tests (NAAT) for Hepatitis and AIDS andSARS. • Immuno-techniques- Immuno-sensors, • CRISPR/Cas System-BasedImmuno-detection	15h

References	
1.	Campbell, I. D. (2012). Biophysical Techniques. Oxford: Oxford University Press
2.	Molecular Imaging Theranostics, 4(4), 386-398. doi:10.7150/thno.8006 Coleman, W. B., & Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press
3.	Molecular biology of the cell by Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Rafi, Keith Roberts, and Peter Walter. 5th ed. 2008
4.	Microarray and Microplates: Applications in biomedical sciences Shu Ye, Ian Day, 2003, Bios Scientific Ltd, oxford.
5.	Principles and techniques of Biochemistry and molecular biology (7th Ed, 2010) Keith Wilson and John Walker, Cambridge university Press.
6.	Physical Biochemistry: Principles and Applications Physical Biochemistry: by David Sheehan-Wiley Publication

Course Description-	
Semester	**II**
Course Name	**Course 7 – Bioinformatics and Biostatistics**
Course Code	**PBT2BIB**
Credit	**04**
Hours	**04**

Course Objectives:

- Students will gain an insight on application and use of Bioinformatics and Biostatistics.

Course Outcomes: After completion of this course students will be able to:

CO1-Explain types of databases and sequence analysis.

CO2-Discuss various methods for protein modeling and sequence analysis and alignment.

CO3-Solve problems based on central tendency, dispersion, parametric and non-parametric tests.

CO4-Apply the various statistical tools like ANOVA, correlation, regression and probability for analysis of biological data.

Units	Course Description	Hrs.
Unit-I Basics of Bioinformatics and sequence analysis	**Database concepts;** Nucleic acid and Protein databases; Structural databases; Biological XML DTD's; pattern matching algorithm basics; NCBI and publicly available tools; EBI and resources; Database mining tools. **DNA sequence analysis:** gene bank sequence database; submitting DNA sequences to databases and database searching; sequence alignment; pairwise alignment techniques; motif discovery and gene prediction; Structural variants of DNA.	15h
Unit-II Multiple sequence alignments andprotein modelling	**Multiple sequence analysis**; multiple sequence alignment; flexible sequence similarity searching with the FASTA3program package; use of CLUSTALW and CLUSTALX for multiple sequence alignment; submitting DNA protein sequence to databases: where and how to submit, SEQUIN, genome centres; submitting aligned sets of sequences, updating	15h

	submitted sequences, methods of phylogenetic analysis. **Protein modelling:** introduction; force field methods; energy, buried and exposed residues; side chains and neighbors; fixed regions; hydrogen bonds; mapping properties onto surfaces; fitting monomers; RMS fit of conformers; assigning secondary structures; sequence alignment- methods,evaluation, scoring; protein completion: backbone construction and side chain addition; small peptide methodology; protein displays; substructuremanipulations, annealing.	
Unit-III Introduction To Biostatistics	Importance of Statistics in Biology, Sources and Types of data, Representation of data, Sampling strategies Measure of central tendency, Measure of dispersion Steps in Testing Statistical Hypothesis Theory of errors- Type I and Type II errors, Parametric Tests: Z-test, t-Test Non-Parametric Tests: Chi-Square Test, Sign, Wilcoxon, and Mann- Whitney test, Krushkal-Whllis test	15h
Unit-IV Applied Biostatistics	Comparing three or more groups- Introduction to ANOVA, One way ANOVA, repeated measures ANOVA,Friedman Test. Theory and Problems based on: Correlation and Regression analysis Probability and its laws Standard Statistical Distributions (Normal, Poisson, Binomial) and theiruses	15h

References	
1.	Lesk, A. M. (2002): Introduction to Bioinformatics. Oxford: Oxford University Press.
2.	Baxevanis, A. D. & Ouellette, B. F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Inter- science.
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4.	David W. Mount Bioinformatics: Sequence and Genome Analysis (Second Edition 2004). Cold spring Harbor Laboratory Press
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6.	Wayne W. Daniel Biostatistics: A foundation For Analysis in Health Sciences (7th Edition 1999) John Wiley & Sons Inc.
7.	N. Gurumani: A Introduction to Biostatistics (Second Edition-2005) M J P Publishers
8.	Bourne, P. E., &Gu, J. (2009). Structural Bioinformatics, Hoboken, NJ: Wiley-Liss.
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10.	Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

Department of Biotechnology

Course Description-	
Semester	**II**
Course Name	**Course-8: Practical of Course 5 and Course 7**
Course Code	**PBT2PR1**
Credit	**02**
Hours	**02**

Course Outcomes: After completion of this course students will be able to:

CO1- Apply the immunological Techniques.

CO2- Make use of Bioinformatics tools in Biotechnology.

	Practical of PBT2IMM and PBT2BIB	**Hrs.**
1.	Preparation of TAB Vaccine.	**08**
	Sterility testing of TAB Vaccine.	
2.	A. Perform serum electrophoresis (horizontal)	**08**
	B. Staining with amido black and CBB.	
3.	To check antibody titer by Tube precipitation test	**04**
4.	In-vitro demonstration of phagocytosis and calculating phagocytic index	**04**
5.	Latex bead agglutination / precipitation test for detection of (RF).	**04**
6.	Complement fixation test	**03**
7.	Similarity searches using tools like BLAST and interpretation of results.	**03**
8.	Use of gene prediction methods (GRAIL/Genscan /Glimmer).	**04**
9.	Multiple sequence alignment using ClustalW.	**03**
10.	Phylogenetic analysis of protein and nucleotide sequences.	**03**
11.	Use of different protein structure prediction databases (PDB, SCOP, and CATH).	**04**
12.	Construction and study of protein structures using RASMOL/Deep view/PyMol.	**04**
13.	Use of in-built statistical functions for computations of mean, S.D., correlation, regression coefficient etc.	**04**
14.	Graphical representation of data	**04**

Course Name	Elective 2 – Nanobiotechnology
Course Code	PBT2NBT
Credit	02
Hours	02

Course Objective:

- The objective of this course is to provide a comprehensive understanding about fundamentals of nanoscience and nanomaterials and their potential applications in various field.

Course Outcomes: After completion of this course students will be able to:

CO1- Explain different nanomaterials synthesis and its characterization.

CO2- Elaborate on application of nanomaterials and mechanism of nanotoxicity.

Units	Course Description	Hrs.
Unit I Introduction to Nanoscience and Nanomaterials	Definitions of nanosciences **Nanomaterial-** classifications andApplications **Nanomaterial synthesis:** Overview of synthetic methods Surfactants, polymers, emulsions. Micelles/reverse micelles and colloids Top-down and bottom-up approaches. Biological Methods. Growth and stabilization. **Characterization of nanomaterials:** Electron microscopy, Zeta Potential,FTIR, AFM, STM. SEM.	15h
Unit II Applications of nanomaterials and Nanotoxicity	**Applications of Nanomaterials in -**Medicine, Agriculture, food industry and environment **Nanotoxicology:** Unique Properties, Toxicity of Nanomaterials, Factors Responsible for the Nanomaterial Toxicity, Routes of Exposure, Mechanismsof Nanoparticle Toxicity, In vivo tests/assays	15h

References	
1.	N. Yao And Zhong Lin Wang, Handbook Of Microscopy For Nanotechnology Kluwer Academic Publishers, 2005.
2.	T.Pradeep, Nano, The Essentials, Understanding Nanoscience and Nanotechnology, Tata McGraw-Hill Publishing Company Limited, 2007.
3.	Textbook of Nanoscience and Nanotechnology by B.S. Murty, P. Shankar, BaldevRaj, B B Rath, James Murday
4.	Wiley Interdisciplinary Reviews: Nanomedicine and Nanobiotechnology, John Wiley and Sons Inc, 2009.
5.	Poinern, Gerrard Eddy Jai. A laboratory course in nanoscience and nanotechnology. CRC Press, 2014.
6.	Arun Kumar - Nanomedicine in drug delivery-CRC Press _ Taylor & Francis (2013).
7.	J. W. M. Bulte, M.M.J. Modo, Nanoparticles in Biomedical Imaging: Emerging Technologies and Applications, Springer Science Business Media, LLC, 2008.
8.	Yuliang Zhao, Zhiyong Zhang, and Weiyue Feng - Toxicology of Nanomaterials-Wiley- VCH (2016)

Course Description-	
Semester	**II**
Course Name	**Elective 2 – Forensic Science**
Course Code	**PBT2FSC**
Credit	**02**
Hours	**02**

Course Objective:

- Students will gain a comprehensive understanding about forensic science and forensic toxicology

Course Outcomes: After completion of this course students will be able to:

CO1-Explain Tools and techniques used in forensic science.

CO2-Elaborate on Forensic Toxicology.

Units	Course Description	Hrs.
Unit- I Introduction to Forensic science	**Introduction of Forensic Science**: Scope of forensic science. Need forensic science. Branches of forensic science. Forensic Data depiction, Investigation and Report writing. **Tools and techniques in forensic science:** • Forensic applications of (SEM), Microscope (TEM). • Introduction to chromatographic techniques and its Forensic Applications: TLC, GC, HPLC • Inductive Coupled Plasma Spectroscopy: Principles and Instrumentation, Forensic Applications. Thermal methods: TGA,DTA, DSC. • Atomic Absorption Spectrometry: Forensic applications	15h
Unit- II Forensic Toxicology	**Forensic Toxicology** • Classification of Poisons, Types of Poisoning, • Collection and Preservation of Toxicological Exhibits in Fatal and Survival Cases, • Signs and Symptoms of Poisoning, • Mode of Action and its effect on vital functions, • detection of poisons, interpretation of analytical data	15h

References	
1.	Gennard, D. (2013). Forensic entomology: an introduction. Wiley.
2.	Gunn. A (2006). Essentials of Forensic Biology, Chichester: John Wiley & Sons, Ltd
3.	MaThew E. Johll (2009) Investigating Chemistry: A Forensic Science Perspective
4.	Forensic Biology, Second edition by Richard Li
5.	Principle of Forensic toxicology 5th edition 2020 by Barry S. Levine and Sarah K
6.	Forensic Toxicology, Principle and Concepts by Nicholas T Lappas

Units	Course Description
Semester	II
Course Name	Practical: Practical of Course PBT2ATB and PBT2NBT
Course Code	PBT2PR2
Credit	02

Course Outcomes: After completion of this course students will be able to:

CO1-Apply advanced techniques such as 2D PAGE, affinity chromatography, SDS-PAGE, and immunoassays.

CO2-Develop expertise in techniques of nanobiotechnology such as, synthesis and characterization of nanoparticles, antimicrobial testing.

	Practical of PBT2ATB and PBT2NBT	Hrs.
1.	Demonstration/ video of 2D PAGE	**02**
2.	Demonstration of Affinity chromatography	**06**
3.	Separation of Proteins on SDS PAGE.	**06**
4.	Immunoassay for detection of antigens by HEPAELISA	**04**
5.	DNA amplification by PCR	**08**
6.	Biosynthesis and characterization of eco-friendly silver nanoparticles by using plant/leaf extracts/green tea	**04**
7.	Synthesis and characterization of zinc sulfide nanoparticles by chemical method	**04**
8.	Antimicrobial activity testing of Nanoparticles/nanocomposites	**02**
9.	Synthesis of alginate beads and entrapment of citric acid	**04**
10.	Identification and analysis of the given nanomaterial by FTIR spectroscopy	**04**
11.	Synthesis of Iron oxide nanoparticles by chemical method.	**04**
12.	Biosynthesis and characterization of eco-friendly silver nanoparticles by using plant/leaf extracts/green tea	**04**

II विद्या विनयेन शोभतेII

Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR
ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL
(AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: Master's in Science (M. Sc.)

SYLLABUS

(Approved in the Academic council meeting held on)

M.Sc. Part-II Biotechnology

Revised as per
As per National Education Policy
Choice Based Credit & Grading System (60:40)
w. e. f. Academic Year 2024-25

MASTER'S IN SCIENCE (M. Sc.)

Department of Biotechnology

Programme Outcomes

S. N.	After completion of M.Sc. program students will acquire	Post-Graduate Attribute
PO1	The knowledge of the disciplines and in-depth and extensive knowledge, understanding and skills in a specific field of interest.	Disciplinary knowledge
PO2	An ability to develop and conduct experiments, analyze, and interpret data and use scientific judgment to draw conclusions	Scientific reasoning
PO3	An ability to use current technology, and modern tools necessary for creation, analysis, dissemination of information.	Digital literacy
PO4	Innovative, professional, and entrepreneurial skills needed in various disciplines of science.	Life-long learning
PO5	An ability to achieve high order communication skills.	Communication skills
PO6	An ability to collect, analyze and evaluate information and ideas and apply them in problem solving using conventional as well as modern approaches	Problem solving
PO7	A sense of social responsibility; intellectual and practical skills and demonstration of ability to apply it in real-world settings.	Reflective thinking
PO8	An ability to engage in independent and life-long learning through openness, curiosity, and a desire to meet new challenges.	Life-long learning
PO9	A capacity to relate, collaborate, and lead others, and to exchange views and ideas to work in a team to achieve desired outcomes	Teamwork
PO10	An ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	Leadership
PO11	An ability to understanding values, ethics, and morality in a multidisciplinary context.	Moral and ethical awareness

Department of Biotechnology

Preamble:

Master of Science (M.Sc.) Programme in Biotechnology is a P.G. Programme of the Department of Biotechnology, Changu Kana Thakur Arts, Commerce & Science College, New Panvel, affiliated with the University of Mumbai with an Autonomous status. Biotechnology is technology based on biology. Biotechnology harnesses cellular and bio-molecular processes to develop technologies and products that help to improve our lives and health. Modern biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, cleaner energy, and have safer, cleaner, and more efficient industrial manufacturing processes.

The Choice Based Credit and Grading System (CBCGS) to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. The proposed credit-based curriculum and grading system will even add much more to the existing interdisciplinary nature of biotechnology.

Under the 'autonomy' we have made an attempt to design a Master's in Biotechnology course syllabus to cater to the needs of a credit-based- semester and grading system. The changing scenario of higher education in India and abroad is taken into consideration to make this syllabus more oriented towards the current need of modern research and industrial sectors.

The present M.Sc. Biotechnology Second Year (Semester III and IV) syllabus is based on the remodelled M.Sc. Biotechnology Curriculum, May 2017, Department of Biotechnology, Ministry of Science and Technology, Government of India and revised syllabus of University of Mumbai. The syllabus is robust and well-designed to enable students to pursue high-quality research or increase employability of the students. An online course component has been introduced in the curriculum in keeping with the digital initiatives of MHRD to provide good quality self-learning content through MOOCs under SWAYAM and allied platforms. It is hoped that the revised syllabus shall serve its objective of promoting outcome-based learning to meet the changing needs of the biotechnology sector.

Department of Biotechnology

Semester - III

Course	Course Type	Course code	Hrs/week	Credits
Industrial Biotechnology	Course-1	PBT3IBI	04	04
Biosafety, IPR and Bio entrepreneurship	Course-2	PBT3BIB	04	04
Genetic Engineering	Course-3	PBT3GEN	04	04
Practical-I (PBT3IBI and PBT3BIB)	Course-4	PBT3PR1	04	02
Enzyme Technology/ Developmental Biology	Elective-3	PBT3ENT/ PBT3DBI	02	02 + 02
Practical- II (PBT3GEN and PBT3ENT)	Practical	PBT3PR2	04	
Research Project			08	04
			30	**22**

Semester - IV

Course	Course Type	Course code	Hrs/week	Credits
Environmental Biotechnology	Course-5	PBT4EBT	04	04
Omics and Drug Discovery	Course-6	PBT4ODD	04	04
Plant and Animal Biotechnology	Course-7	PBT4PAB	04	04
Practical-I (PBT4 and PBT4)	Course-8	PBT4PR1	04	02
Mushroom Cultivation and Bio-business/ Molecular Diagnosis	Elective-4	PBT4/MBB PBT4MOD	02	02
Research Project			12	06
			30	**22**

Department of Biotechnology

Examination Scheme

1. For 4 Credit Courses (Discipline Specific courses) (100Marks)

A) Continuous Internal Assessment (CIA): 40 % 40 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Test on Practical Skills/ Case studies /Group/ Individual Survey Project/Presentation and write up on the selected units of the courses / Test based on tutorials /Book Review / Open Book Test	15 Marks
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibition of leadership qualities in organizing related academic activities	05 Marks

Question Paper Pattern
(Periodical Class Test)

Maximum Marks: 20 Duration: 40 minutes
Questions to be set: 02
All Questions are Compulsory

Question No.	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination (SEE): 60 % 60 Marks

- Duration: The examination shall be of 2½ hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be five questions each of 12 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

2. For 2 Credit Courses (Theory 50 Marks)

A) Continuous Internal Assessment (CIA): 40 % 20 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks

Question Paper Pattern
(Periodical Class Test)

Maximum Marks: 20 Duration: 40 Minutes
Questions to be set: 02
All Questions are Compulsory

Question No.	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1 Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination (SEE): 60 % 30 Marks

- Duration: The examination shall be of 2½ hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be two or three questions each of 15/10 marks.
2. All questions shall be compulsory with internal options.
3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

3. For 2 Credit Courses (Practical) (100 Marks)

- The practical examination (PE) shall be of 100 marks for 2 credit course.

4. For 6 credits Research Project (RP) Semester IV (150 Marks)

The performance of the learners shall be evaluated into two components. The allocation of marks is as shown below:

A) The Project guide should evaluate the learner based on overall performance as a part of internal assessment for 50 Marks.

B) External assessment for 100 Marks

Passing Standard:

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment (IA) and Semester End Examination (SEE). The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal/Practical Assessment and 40% marks in Semester End Examination (i.e. 24 out of 60, or 12 out of 30) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment (IA) and Semester End Examination (SEE).

Semester -III

Department of Biotechnology

Course Description	
Semester	**III**
Course Name	**Industrial Biotechnology**
Course Code	**PBT3IBI**
Credit	**4**
Hours	**60**

Course Objectives:

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

Course Outcomes

CO1- Analyze relevance of microorganisms from industrial context
CO2- Elaborate design and operations of various fermenters
CO3- Calculate yield and production rates in a biological production process, interpret data and need for oxygen and oxygen transfer
CO-4 Discuss important microbial/enzymatic industrial processes in the food and fuel industry.

Unit	Course Description	Hrs.
UNIT I Basic principles of biochemical engineering	**Sources of Microorganisms Used in Biotechnology-** Literature search and culture collection supply, Isolation de novo of organisms producing **Strain Improvement-** Selection from naturally occurring variants, Manipulation of the genome of industrial organisms in strain improvement **Bioreactor design and analysis-** Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation.	15h
UNIT II Upstream processing	**Upstream processing:** media formulation; sterilization; aeration and agitation in bioprocess; Estimation of oxygen transfer rates Measurement and control of bioprocess parameters; Scale up and scale down process. fermentation economics. Kinetics of Enzyme catalyzed reactions Immobilization – Kinetics of immobilized enzyme catalyzed reactions Kinetics of balanced growth - Transient growth kinetics. Gas-liquid mass transfer in cellular systems	15h

UNIT III Downstream processing, Industrial Production and Recovery processes	**Downstream processing and product recovery** **Separation of insoluble products** filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and microfiltration, electrophoresis; final purification: drying; crystallization; storage and packaging. **Industrial Production and Recovery process of following** (with one example each): Vitamins, Amino acids, Enzymes (Extra and Intra cellular), Antibiotics, Organic acids, Production of recombinant pharmaceuticals, Human growth hormone, and Interferon vaccines.	15h
Unit- IV Applications of microbial technology in food process operations	**Microbial biomass production** - mushrooms, SCP **Fermented foods and beverages**- Sauerkraut production, soya bean fermentations, coffee, cocoa and tea fermentations **Food additives and supplements –**Lipids, Nucleosides, nucleotides and related compounds – Vitamins **Natural food preservatives** - bacteriocins from lactic acid bacteria – production and applications e.g., Nisin **Microbial production of colours and flavours**.**Polyhydric alcohols**: low -calorie sweetener particularly useful for sweetening food products for diabetics Microbial exo-polysaccharides - Xanthan gum **Process Food wastes**- for bioconversion to useful products (Compost, biomass cheap source of raw material in fermentation etc.)	15h

References:

1	Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2	Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.
4	Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
5	El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
6	Alexander N. Glazer and Hiroshi Nikaido -Microbial Biotechnology: Fundamentals of Applied Microbiology, 2ndEdition
7	Michael Waites and Morgan , Rockney and Highton -Industrial microbiology : An Introduction
8	Nduka Okafor Modern industrial microbiology and biotechnology Science Publishers, Enfield
9	Lee, Y. K. (2013). Microbial Biotechnology: Principles and Applications. Hackensack,NJ: World Scientific.

Department of Biotechnology

Course Description	
Semester	**III**
Course Name	**Biosafety, IPR and Bioentrepreneurship**
Course Code	**PBT3BIB**
Credit	**4**
Hours	**60**

Course Objectives:

The objective of this course is to gain an insight into the biosafety and bioethical guidelines, IPR and systematically apply an Entrepreneurial way of thinking that will allow identification and creation of Business Opportunities

Course Outcomes:

CO1- Outline fundamental concept of biosafety and regulations in Biotechnology laboratory and bioethics.
CO2- Explain IPR and International convention and treaties.
CO3- Develop an understanding of the systematic process and to select and screen a business idea.
CO4- Build the insights and knowledge in Marketing and Business management.

Unit	Course Description	Hrs.
UNIT I: Biosafety and Bioethics	**Biosafety-**Introduction and Development of Biosafety Practices, Principles, General Lab requirement. **Definitions:** Biosafety and Biosafety levels 1,2,3,4, Summery**,** Biological safety cabinets: centrifuges, Shipment of biological specimens, Biological waste management, Decontamination. **Introduction to Bioethics in health care-** Euthanasia, artificial reproductive technologies, Prenatal diagnosis, Genetic screening, gene therapy, organ transplantation. Ethics of clinical research. **Bioethics in research–** Cloning and stem cell research, Human and Animal experimentation.	15h

UNIT II: **IPR**	**Introduction to Intellectual property-** **Types of IP:** Patents, Trademarks, Trade secrets, Copyright & related rights, Industrial design, Geographical indications, Biodiversity importance and legislation. **International convention and treaties-** Plant variety protection and Farmer's rights act., Traditional knowledge. Patentability of Biotechnology Inventions in India, Patent Agents.	15h
UNIT III: **Introduction to Entrepreneurship**	**Introduction to Entrepreneurship** - Meaning Knowledge and concept of entrepreneurship, Need and Importance of entrepreneurship The history of entrepreneurship development, Skills and characteristic of successful entrepreneurs; **Entrepreneurship process-** Factors impacting emergence of entrepreneurship Role of entrepreneurship in economic development Evolution and Growth of Entrepreneurship in India **Types of Entrepreneurs-** Ethical Entrepreneurship Entrepreneurial Value: Values, Attitudes and Motivation	15h
UNIT IV: **Bioentrepreneurship**	**Innovation & Entrepreneurship in Bio-business** Bioentrepreneurship: Introduction, scope and Characteristics of Biotechnology Industry Entrepreneurship in the context of Biotechnology Profiling the Bioentrepreneur **Business idea** Sources of new ideas and Methods of generating ideas Creative problem solving, Opportunity recognition and assessment Environmental scanning & Competitor and industry analysis **Feasibility study** **Market feasibility:** Marketing plan: marketing research for the new venture, Steps in preparing marketing plan, Technical/operational feasibility, financial feasibility.	15h

References:

1. Padma Nambisan (Auth.) - An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology- Academic Press (2017)
2. Kshitij Kumar Singh (auth.) - Biotechnology and Intellectual Property Rights_ Legal and Social Implications-Springer India (2015)
3. David Castle - The Role of Intellectual Property Rights in Biotechnology Innovation (2011)
4. Biosafety and Bioethics : Joshi
5. Introduction to Bioethics : Bryant
6. Goel, D., & Parashar, S. (2013). *IPR, Biosafety and Bioethics*. Pearson Education India.
7. Talwar Shabana; *Intellectual Property Rights in WTO and Developing Countries*, Edition 2010,Serials Publications, New Delhi.
8. Helga Kuhse_ Udo Schüklenk_ Peter Singer_ (eds.) - Bioethics_ An Anthology-Wiley-Blackwell (2016)
9. National Guidelines for Biomedical and Health Research on Human Participants (ICMR – 2017)
10. ICMR-DBT National Guidelines for Stem Cell Research - 2017
11. A Book of Entrepreneurship - Kurup
12. Handbook of Entrepreneurship development- Basotia and Sharma
13. Entrepreneurship, Hisrich, Robert D., Michael Peters and Dean Shepherded, , Tata McGraw Hill, ND
14. Entrepreneurship,, Brace R., and R., Duane Ireland, , Pearson Prentice Hall, New Jersy (USA). Entrepreneurship, Lall, Madhurima, and ShikhaSahai, , Excel Book, New Delhi.
15. Entrepreneurship Development and Small Business Enterprises, Charantimath, Poornima, Pearson Education, New Delhi.
16. Entrepreneurship: New Venture Creation – David H. Holt
17. Entrepreneurship: Hisrich Peters
18. The Culture of Entrepreneurship- Brigitter Berger
19. Dynamics of Entrepreneurship development and Management: Entrepreneurship, Project Management, Finances, Programmes, and Problems – Vasant Desai (2009)
20. Entrepreneurship Development – Dr. P.C. Shejwalkar
21. Thought Leader: Shrinevas Pandit
22. Leadership and new Science: Margrat wheatly
23. Handbook of Entrepreneurship Research: An Interdisciplinary Survey and Introduction (International handbook series on Entrepreneurship) (2003) : Zolten J ACs, David B. Audretch
24. Knowledge-Driven Entrepreneurship (2009) : The Key to Social and Economic Transformation By Martin Curley, Piero Formica and Thomas Anderson
25. Entrepreneurship (3rd ed) Steven Brandt
26. The Entrepreneurial Connection – Gurmit Narula
27. Business Guru Speak –S.N. Cnary
28. Dhirubhai Ambani: Against All Odds: A Story of Courage, Perseverance and Hope Paperback – 1 July 2017: by A G Krishnamurthy
29. Mythbreaker: Kiran Mazumdar-Shaw and the Story of Indian Biotech Hardcover – 29 April 2016 by Seema Singh
30. The Entrepreneur's Guide to a Biotech Startup: Peter Kolchinsky
31. The Anotomy of your Creativity: Chris Grady

Department of Biotechnology

Course Description	
Semester	**III**
Course Name	**Genetic Engineering**
Course Code	**PBT3GEN**
Credit	**4**
Hours	**60**

Course Objectives:

The objective of this course is to familiarize students with key enzymes and vectors in genetic engineering and their practical applications in DNA manipulation techniques, enabling proficiency in molecular biology experimentation.

Course Outcomes:

CO1- Identify and explain the functions of key enzymes used in genetic engineering processes.
CO2- Analyse vector characteristics and select appropriate vectors for specific genetic engineering applications
CO3- Design and execute gene manipulation experiments, including the construction of DNA libraries, isolation of nucleic acids, and screening methods for identifying specific DNA sequences.
CO4- Apply gene silencing and genome editing techniques to modify gene expression and investigate gene function in various model systems.

Unit	Course Description	Hrs.
UNIT I **Enzymes used in Genetic Engineering**	**Enzymes used in Genetic Engineering:** Restriction endonucleases; DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; nucleases, Topoisomerase, thermostable polymerase, Terminal deoxynucleotide polymerase and others. Cohesive and blunt end ligation; linkers; adaptors; homopolymer tailing; Labelling of DNA: nick translation, Random priming, radioactive and non-radioactive probes,	15h
Unit II: **Vectors used in Genetic Engineering**	**Vectors used in genetic Engineering** Plasmids; Bacteriophages; M13mp vectors; pUC19 and pBluescript vectors, phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Principles for maximizing gene expression vectors; pMal; GST; pET-based vectors;	15h

	Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; methodologies to reduce formation of inclusion bodies; Mammalian expression and replicating vectors; Baculovirus and Pichia vectors system, Plant based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors.	
Unit III: Gene manipulation and protein-DNA interaction	Construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; Screening methods Study of protein - DNA interactions: Electrophoretic mobility shift assay; DNase I foot printing; methyl interference assay, chromatin immunoprecipitation; Protein-protein interactions using yeast two-hybrid system; phage display.	15h
UNIT IV: Gene silencing and genome editing technologies	Gene silencing techniques; introduction to siRNA; siRNA technology; Micro RNA; construction of siRNA vectors; principle and application of gene silencing; gene knockouts and gene therapy; Creation of transgenic plants; debate over GM crops; introduction to methods of genetic manipulation in different model systems e.g. fruit flies (Drosophila), worms (C. elegans), frogs (Xenopus), fish (zebra fish) and chick; Transgenics gene replacement; gene targeting; creation of transgenic and knock-out mice; disease model;	15h

References

1.	iGenetics A Molecular Approach 3rd Edition Peter J. Russell
2.	Molecular Biotechnology-Principles and Applications of Recombinant DNA Technology 4th Edition Glick B.R., Pasternak J.J., Patten C.L.
3.	Principles of Gene Manipulation 7th Edition Primrose S.B., Twyman R.M.
4.	Biotechnology 3rd Edition S.S. Purohit.
5.	Genomes 3rd Edition T.A. Brown.
6.	Biotechnology B.D. Singh
7.	Gene Cloning and DNA Analysis 6th Edition T.A. Brown.
8.	Genomics Cantor C.R., and Smith C.L. John Wiley & Sons. (1999)

Department of Biotechnology

Course Description	
Semester	**III**
Course Name	**Enzyme Technology**
Course Code	**PBT3ETB**
Credit	**2**
Hours	**60**

Course Objectives

The objectives of this course are to get familiarity with the basic concepts of enzymes and their purification techniques and apply enzymes as a diagnostic tool

Course Outcomes:

CO1- Explain enzyme production and its purification.
CO2- Elaborate on trends in Enzymology and its application.

Unit	Course Description	Hrs.
UNIT I: Enzyme Production and Purification	Industrial production of enzymes Basic concept of industrial scale and optimization Amylase, lipase, protease production and their uses. Techniques for Purification and Characterization of Enzymes. Diagnostic Enzymes	15h
UNIT II: Future trends in Enzymology	Catalytic antibodies, non-protein biomolecules as catalysts Biosensors- Introduction, instrumentation, Types, and applications of enzymes-based sensors. Tools and techniques for discovery/identification of novel enzymes.	15h

References:

1.	Understanding enzymes (3rd edition). Edited by Trevor Palmer, Ellis Horwood, Chichester, 1991
2.	Protein purification principles, High Resolution Methods, and Applications, 3rd Edition, Jan-Christer Janson, John Wiley & Sons, Inc., Hoboken, New Jersey.
3.	Protein_purification_methods overview, _29155460.pd
4.	https://www.researchgate.net/publication/281102215
5.	Enzyme-based Sensors, article link: https: https://www.researchgate.net/publication n/318158771
6.	https://www.creativeenzymes.com/service/enzymepurification307.html

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Course Description	
Semester	**III**
Course Name	**Developmental Biology**
Course Code	**PBT3DBI**
Credit	**4**
Hours	**60**

Course Objectives:

The objectives of this course are to get knowledge of developmental biology which includes stages, mechanisms and patterns of embryonic development, plant developmental biology and stem cell biology.

Course Outcomes:

CO1- Elaborate the stages of animal development & mechanism of differentiation.

CO2- Discuss the features and stages of plant development with model organism & Stem cell biology

Unit	Course Description	Hrs
UNIT I: Fundamentals of animal development	Introduction to developmental biology, Stages of development- zygote, blastula, gastrula, neurula cell fate & commitment potency- concept of embryonic stem cells, differential gene expression, lineages of three germ layers, fate map. Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development Pattern formation- axis specification, positional Identification (regional specification), Morphogenetic movements. Model organisms in Developmental biology: Hydra, Zebra fish, C. elegans etc.	15h
Unit II: Fundamentals of plant developmenta l& stem cell biology	Overview of Plant Development: Embryogenesis and early pattern formation in plants; Plant Meristem Organization and Differentiation Organization of Shoot Apical Meristem (SAM) Organization of Root Apical Meristem (RAM) Model organisms and experimental tools in cell and developmental plant biology Arabidopsis thaliana. Definition, classification and source of stem cells; Stem cells and therapeutic cloning.	15h

References:

1.	Developmental biology Barresi, Scott F. Gilbert
2.	Essentials of developmental biology by Slack 2nd edition

Department of Biotechnology

Course Description	
Semester	**III**
Course Name	**PRACTICAL- I**
Course Code	**PBT3PR1**
Credit	**4**
Hours	**60**

Course Objectives

The objective of this course is to analysis of soil, water and compost and apply various in-vitro culture techniques

Course Outcomes:

CO1- Apply techniques in physical and chemical characterization of effluent

CO2- Develop expertise in Sterile testing methods and handling disposal of laboratory waste

1.	Maintenance of the isolated production organism (Agar slants/ glycerol stocks /soil culture/ lyophilization) at least two methods
2.	Demonstration of media optimization by Placket Burman test
3.	Immobilize an organism / enzyme and detect the conversion of substrate to product
4.	Study of Physical characterization of an industrial effluents
5.	Study of Chemical characterization of an industrial effluents
6.	Pigment production and isolation from a microbial source (yeast, fungi or bacteria) Spirulina
7.	Detection of different food enzymes by simple tests (amylase, catalase, invertase, papain, pectinase, pepsin)
8.	Study of the pickling process (sauerkraut / pickled cucumbers) with respect to physical, chemical / biochemical and biological changes occurring during the pickling process
9.	Visit to industry and Report writing
10.	Sterile testing methods for pharmaceutical products.
11.	Isolation of pathogenic bacteria from fomites on operating room of pharmaceutical industry/ Packaging material of pharmaceutical products etc.
12.	A case study on clinical trials of drugs in India with emphasis on ethical issues.
13.	A Case study on handling and disposal of laboratory waste.
14.	A Case study on medical errors and negligence and ethical issues
15.	To study a patent and to develop a patent application for a hypothetical product or process.
16.	Preparation of a business plan to establish a bio-enterprises for any biotechnological product.

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Course Description	
Semester	**III**
Course Name	**PRACTICAL- II**
Course Code	**PBT3PR2**
Credit	**4**
Hours	**60**

Course Objectives

The objectives of this course are to learn molecular biology techniques like Restriction digestion, ligation, transformation and protein purification

Course Outcomes

CO1- Apply methods of molecular biology and biochemistry

CO2- Develop skills of protein purification

1.	Isolation of Plasmid DNA
2.	Agarose gel electrophoresis
3.	Restriction Enzyme digestion of plasmid DNA
4.	Ligation
5.	Preparation of competent cells
6.	Transformation of *E.coli* with standard plasmids, Calculation of transformation efficiency
7.	Expression of recombinant protein,
8.	Western Blotting
9.	Screening & isolation of proteases producing bacteria.
10.	Screening & isolation of lipases producing bacteria
11.	Partial purification of enzymes using ammonium sulphate precipitation & Dialysis of the salt-precipitated protein
12.	Separation of the enzymes on SDS PAGE.
13.	To estimate the concentration of SGOT in the given sample.
14.	To estimate the concentration of SGPT in the given sample.
15.	To check the blood glucose using a glucometer.

Semester -IV

Department of Biotechnology

Course Description	
Semester	**III**
Course Name	**Environmental Biotechnology**
Course Code	**PBT4EBT**
Credit	**4**
Hours	**60**

Course Objectives

The objectives of this course are to introduce learners to latest concepts in environmental biotechnology, various types of pollutions, monitoring, latest mitigation strategies and management of the same.

Course Outcomes

CO1- Discuss on air pollution management in urban and rural areas,

CO2- Apply different methodologies for treatment of soil pollution.

CO3- Elaborate on different monitoring methods used for biodiversity and environmental sustainability.

CO4- Outline on different Biodiversity & Environment Monitoring methods.

Unit	Course Description	Hrs.
UNIT i: **Air pollution and Management**	Air pollution & air Quality Monitoring, Sampling, and Source Apportionment. Air Pollution Management in Urban Settlement & Rural Areas, Integrated Air Pollution Management, Green Belt. Bio scrubber. Catalytic Systems. Green Technology. Ozone Layer Depletion Atmospheric Brown Cloud Impact on Flora and Fauna Impact on Crop Yield, concept of carbon credit, footprint.	15h
UNIT II: **Soil pollution** **and** **Solid waste Management**	Causes of soil salinity; Chemical and metallic pollution of agricultural soil; Mining and soil pollution. Bioleaching of metals, bioaugmentation & biomagnification for soil remediation. Phytostabilization - Contaminant removal, Soil cover, Rhizosphere modification, Geotextile capping solid waste; Industrial solid waste; Domestic solid waste; Agricultural solid waste; Municipal solid waste; Major sources of solid wastes; Effects of solid waste generation on quality of air, water and public health; Solid waste management, Disposal of organic and medical	15h

	waste; Recovery and recycling of metallic waste; Disposal of plastic waste and hazardous wastes.	
UNIT III: **Water Pollution and Management**	Biofilms in treatment of waste water; Biofilm development and biofilm Kinetics; Aerobic Biofilms. Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial, microplastics); Biological indicators (Marine microbes, algae and crustaceans) and accumulators: Biotechnological application of hazardous waste management of water; Use of microbial systems, Phytoremediation strategies in constructed wetlands, designing constructed wetlands, Substrate, Hydraulic loading rate, Hydraulic retention time, The selection of plant species, Surface area of wetland, Mechanisms to remove pollutants from constructed wetlands	15h
UNIT IV: **Biodiversity & Environment Monitoring**	Introducing biodiversity informatics, Global patterns of distribution of biodiversity, biomes, Composition and distribution of biodiversity in India, Taxonomic Database Working Group (TDWG) standards, compatibility and interoperatability, taxonomically intelligent systems, Global biodiversity information system-Overview of the UNEP/GEF biodiversity data management project (BDM) IOT for water quality monitoring – General working, Application, water Parameters.	15h

References:

1.	Chandrappa, R., & Kulshrestha, U. C. (2015). *Sustainable air pollution management: theory and practice*. Springer. 7
2.	Karl B. Schnelle & Charles A. Brown, (2002) Air pollution control technology Handbook. CRC Press
3.	Singh, R. L. (Ed.). (2017). *Principles and applications of environmental biotechnology for a sustainable future*. Springer Singapore.
4.	Enger, E. D., Smith, B. F., & Bockarie, A. T. (2000). *Environmental science: A study of interrelationships* (p. 434). Boston, MA: McGraw-Hill
5.	Rittmann, B. E., & McCarty, P. L. (2012). *Environmental biotechnology: principles and applications*. Tata McGraw-Hill Education.
6.	Wainwright, M. (2012). *An introduction to environmental biotechnology*. Springer Science & Business Media.
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8.	Pradhan, A. K., & Pradhan, N. (2015). Microbial biosurfactant for hydrocarbons and Revised Syllabus for M.Sc. (Biotechnology) Semester III

	and IV Page 14 of 35 heavy metals bioremediation. In *Environmental Microbial Biotechnology* (pp. 91-104). Springer.
9.	Rittmann, B. E., & McCarty, P. L. (2012). *Environmental biotechnology: principles and applications*. Tata McGraw-Hill Education.
10.	Foin, T. C. (1976). *Ecological systems and the environment*. Houghton Mifflin.
11.	Wise, D. L. (1988). Biotreatment systems: Volume II, Springer.
12.	Rittmann, B. E., & McCarty, P. L. (2012). *Environmental biotechnology: principles and applications*. Tata McGraw-Hill Education.
13.	Foin, T. C. (1976). *Ecological systems and the environment*. Houghton Mifflin.
14.	Wise, D. L. (1988). Biotreatment systems: Volume II, Springer.

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Course Description	
Semester	**IV**
Course Name	**OMICS & Drug discovery**
Course Code	**PBT4ODD**
Credit	**4**
Hours	**60**

Course Objectives:

The objectives of this course are to bring awareness of the emerging fields of OMICS and Systems Biology, biological systems as a whole and how parts of a systems interact with each other to introduce the techniques involved in Genomics, Proteomics, transcriptomics, Lipidomics and Metabolomics.

Course Outcomes:

CO1- Explain OMICS technologies to contribute to different databases.

CO2- Compare the techniques involved in Genomics, Proteomics, transcriptomics, Lipidomics and Metabolomics.

CO3- Apply methods like DNA microarray, Proteomics etc.

CO4- Elaborate on applications of Bioinformatics in various fields.

Unit	Course Description	Hrs
UNIT I OMICS- The OMICS Technology, A Broad Outlook	Tools of Omics-Introduction to Epigenomics Human genome project- goals, conclusions, and application. Structural and functional proteomics- protein- protein interaction and identification of interactions by various methods. Application of Proteomics and Genomics in human diseases – screening, testing and treatment of diseases. Metagenomics: concept, strategies, and applications in environmental biotechnology, agriculture and health	15h
UNIT II Transcriptomics, Lipidomics and Metabolomics	Introduction to Transcriptomics, Lipidomics and Metabolomics, Glycomics, Pharmacogenomics Techniques used in Lipidomics - Mass Spectroscopy, TLC, HPLC, GC and Capillary electrophoresis, MALDI. Technique used in Metabolomics- Mass Spectroscopy, Electrophoresis, chromatography- GC, LC & NMR. Technique used in Transcriptomics- next generation sequencing, northern blotting, DDRT-PCR, microarrays, gel free assays like biolayer interference, SPR.	15h

	Application of transcriptomics, metabolomics and lipidomics in diseases	
UNIT III Clinical Research Informatics in Drug Discovery	Introduction to the drug discovery & development: Source of drugs, Structural effects on drug action, Drugs derived from natural products, General principles of pharmacology, Drug development and testing process Approaches to new drug discovery Computer-aided drug design Identification of novel drug candidates and drug targets Construction the signaling network of a drug using integer linear programming Identification for druggable targets of a disease	15h
UNIT IV Introduction to Biologics and Biosimilars	Definition: Small molecules, large molecules/Biologics; Categories of Biologics: protein-based hormones, enzymes, monoclonal antibodies, vaccines, blood products, and gene/ cellular therapies. Similarities and Differences: Small molecules versus generics, Biologics versus Biosimilars. USFDA Approved Small Molecules, Generics, Biologics and Biosimilars. Indian Regulatory Scenario in relation to Small Molecules and Biologics Therapeutic uses of some of the Biologics/Biosimilars Acceptable quality differences between approved Biosimilar and innovator's product	15h

References

1.	Bioinformatics and functional genomics (2003). Jonathan Pevsner John wiley & sons Publications.
2.	Integration of omics approaches and systems biology for clinical applications. Antonia Vlahou, Harald Mischak, Jerome Zoidakis, Fulvio Magni. Wiley publications.
3.	Concepts and techniques in genomics and proteomics- Nachimuthu Saraswathy And Ponnusamy Ramalingam. Biohealthcare publishing (oxford) limited.
4.	Lipidomics-technologies and applications (2012) Dr. Kim Ekroos Wiley wch publications.
5.	Topics in current genetics-metabolomics- a powerful tool in systems biology Jens Nielsen Michael C. Jewett (Eds) Springer publications.

6.	Basic & Clinical Pharmacology, 2017, Fourteenth Edition, Section I, Chapter 1. Bertram G. Katzung, Editor ISBN 978-1-259-64115-2 MHID 1-259-64115-5 ISSN 0891-2033
7.	Software based approaches for drug designing and development: A systematic review on commonly used software and its applications, Bulletin of Faculty of Pharmacy, Cairo University 55 (2017) 203–210 Prasad G. Jamkhande, Mahavir H. Ghante, Balaji R. Ajgunde http://dx.doi.org/10.1016/j.bfopcu.2017.10.001
8.	Biosimilars: Regulatory, Clinical and Biopharmaceutical Development, Editors: Hiten J. Gutka, Harry Yang, Shefali Kakar, AAPS Advances in the Pharmaceutical, Sciences Series, Volume 34.

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Course Description	
Semester	**III**
Course Name	**Plant and Animal Biotechnology**
Course Code	**PBT3PAB**
Credit	**4**
Hours	**60**

Course Objectives

The objectives of this course are to introduce students to the conventional as well as modern crop improvement method to increase the crop yield and to infuse the students with the latest concepts in animal biotechnology and tissue engineering.

Course Outcomes

CO1: Explain the various methods of the crop improvements such as micropropagation, somatic embryogenesis and, synthetic seed and germplasm conservation

CO2: Contrast the conventional and modern crop improvement techniques such as metabolic engineering of plant and GM crop technology

CO3: Identify the scope and applications of stem cell tissue engineering in modern clinical sciences.

CO4: summarize the method of animal cloning technology and application of animal biotechnology in production of regenerative medicines and vaccines.

	Course Description	Hrs
UNIT I: **Plant Biotechnology-I**	Introduction and scope of Plant Biotechnology Micropropagation Somatic embryogenesis and synthetic seed production Soma-clonal variations, Androgenesis and haploid Plant production Germplasm conservation and cryopreservation Protoplast culture and somatic hybridization	15h
UNIT II: **Plant Biotechnology-II**	**Metabolic engineering of Plants** Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) GM Technology for crop improvement Stress tolerance, herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Post-harvest technology: Antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene	15h

	and polygalacturonase); delay of softening and ripening of fruits (tomato, banana, watermelons).	
Unit III: **Animal Biotechnology-I**	**Stem cells and tissue engineering:** Scope, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences. **Tissue engineering:** Biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.	15h
Unit IV: Animal Biotechnology-II	**Animal cloning:** methods of cloning and their importance with reference to domestic animals. IVF- technology for livestock. **Applications of animal biotechnology:** Improvement of biomass, disease resistance, production of recombinant vaccines and pharming products (plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons), cell culture-based vaccines.	15h

References:

1.	Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons
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12.	Sawahel W.A. Plant genetic transformation technology. Daya Publishing House, Delhi.1997.
13.	Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant Biotechnology: an Introduction to Genetic Engineering. Oxford: Oxford University Press
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Course Description	
Semester	**IV**
Course Name	**Mushroom Cultivation and Bio-business**
Course Code	**PBT4MBB**
Credit	**2**
Hours	**60**

Course Objectives:

The objectives of this course are to impart the knowledge about different type of mushrooms and the scope of its cultivation and develop the skill of making value added mushroom products and identify the Business opportunities in marketing and selling the mushroom products.

Course Outcomes

CO1- Apply the steps involved in Mushroom production, making value added mushroom products and analyse nutritive values of mushroom products

CO2- Design a business plan of Mushroom Cultivation

Unit	Course Description	Hrs.
UNIT I: **Fundamentals of mushroom cultivation**	**Introduction to mushrooms** Mushrooms- History and Scope of mushroom cultivation- Edible and Poisonous Mushrooms-Vegetative Characters. **Common edible mushrooms** Button mushroom (Agaricus bisporus), Milky mushroom (Calocybe indica), Oyster mushroom (Pleurotus sajorcaju) and paddy straw mushroom (Volvariella volvcea). **Principles of mushroom cultivation** Structure and construction of mushroom house. Sterilization of substrates. Spawn production, culture media preparation, Composting technology, mushroom bed preparation. Spawning, spawn running, harvesting. Cultivation of oyster and paddy straw mushroom. Problems in cultivation and their management strategies **Health benefits of mushrooms** Nutritional and medicinal values of mushrooms. Therapeutic aspects- antitumor effect	15h

UNIT II: **Commercialization of Mushroom Cultivation**	**Post-harvest Technology:** Important mushroom diseases, Preservation of mushrooms - freezing, dry freezing, drying, canning, packing, quality assurance and entrepreneurship. Value added products of mushrooms. **Business establishment and marketing strategies** Design and layout of mushroom farm. Equipment and tools and other infrastructure facilities required, safety measures in the farm. Approximate expenditure for establishing the production unit Market opportunities; market liabilities, exploring local and national markets, scope of exist policy/ foreign trade policy Documentation- log books/ related documents for audit	15h

References:

1. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Pandey R.K, S. K Ghosh, 1996. A Handbook on Mushroom Cultivation. Emkey Publications.
3. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
4. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
5. A handbook of edible mushrooms, S.Kannaiyan& K.Ramasamy (1980). Today & Tomorrow's printers & publishers, New Delhi.
1. Anupam Mishra, SRK Singh and MP Thakur: Training Manual on Cultivation of Tropical Mushroom and its Value addition. Agricultural Technology Application Research Institute - ICAR - Zone VII, JNKVV, Jabalpur
2. Nailoke Pauline Kadhila, Favian SInvula Mubiana, and Keumbo Lorna Halueendo, 2012: Mushroom Cultivation - A Beginners Guide; Published by University of Namibia
3. Nita Bhal. (2000). Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Pandey R.K, S. K Ghosh, 1996. A Handbook on Mushroom Cultivation. Emkey Publications.
5. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.
6. Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.
7. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
8. V.N. Pathak, Nagendra Yadav and Maneesha Gaur, Mushroom Production and Processing Technology/ Vedams Ebooks Pvt Ltd., New Delhi (2000). 9. National Institute of Open Schooling:
9. https://nios.ac.in/media/documents/vocational/mushroom_production_(revised)(618)/Practical_Manual.pdf

Department of Biotechnology

Course Description	
Semester	**IV**
Course Name	**Molecular Diagnostics**
Course Code	**PBT4MOD**
Credit	**2**
Hours	**60**

Course Objectives:

The objective of this course is learning and understanding Molecular Techniques and utilizing these techniques in Diagnosis.

Course Outcomes:

CO1- Develop the basic understanding for Principles used in Molecular Diagnosis.

CO2- Apply the knowledge and skills gained in the course should be useful in developing new Diagnostic Kits.

Unit	Course Description	Hrs.
UNIT I: Basics of Molecular Diagnostics	Overview of Molecular Diagnostics **Characterization and analysis of Nucleic Acids and Proteins**: Extraction, Isolation and Detection of DNA, RNA and Proteins; Restriction Endonucleases and Restriction Enzyme Mapping. **Hybridization Techniques:** Southern, Northern, Western and FISH; Markers, Probes and its Clinical Applications. **Target amplification:** PCR - General Principle; Components of a Typical PCR Reaction; Experimental Design; Primer Designing; Control of PCR Contamination and Mispriming; PCR Product Clean-up and Detection.	15h
UNIT II: Molecular Biology based Diagnostics	**DNA Polymorphism and Identification:** RFLP and Parentage Testing; RFLP and Sickle-Cell Anaemia. **Molecular Diagnostics for Infectious Diseases** Molecular Testing for Neisseria, Molecular Diagnosis for HIV-1; **Genetic Counseling and Molecular Diagnosis** Genetic Testing- Need and Uses; genetic counselling. **Ethical, Social and Legal** **Issues to Molecular Genetic Testing**	15h

References:

1. Molecular diagnostics- Fundamentals, methods and clinical applications – Buckingham and Flaws F.A. Davis Company Philadelphia.
2. Molecular diagnostics for the clinical laboratorian by coleman and Tsongalis , Humana press

Department of Biotechnology

Course Description	
Semester	**IV**
Course Name	**PRACTICAL- I**
Course Code	**PBT4PR1**
Credit	**2**
Hours	**60Hrs**

Course Objectives

The objective of this course is to analysis of soil, water and compost and apply various in-vitro culture techniques

Course Outcomes:

CO1- Evaluate various parameters related to soil, water and compost quality.

CO2- Organise hands-on experience in plant tissue culture techniques, including media preparation, sterilization, micropropagation and develop the skills in mushroom cultivation techniques

1.	Soil and water quality assessment (temp, pH, salinity, water holding capacity of soil etc.
2.	Study of heavy metal tolerant microorganisms from soil/water.
3.	Analysis of compost- Physical Parameters
4.	Analysis of compost- Chemical Parameters (Organic Carbon, Calcium, Phosphorous)
5.	Analysis of essential compound by using GC and its interpretation
6.	Identification of protein using analytical technique Mass spectroscopy (demonstration)
7.	Micropropagation/ Callus culture using a suitable plant species
8.	Preparation of synthetic seeds.
9.	Test for secondary metabolites identification-terpenoids, flavonoids and alkaloids
10.	Isolation and culture of animal cells (Monolayer formation) and check the viability of the cells.
11.	Preparation of spawn
12.	Mushroom bed preparation
13.	Cultivation of White button mushroom, Oyster mushroom
14.	Nutrient profiling and Medicinal value of mushrooms

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