



Revised and Approved syllabus for B.Sc (Bachelor of Science) Department of Biotechnology

B.Sc 3Year (Semester 5) Biotechnology

Paper1 Biostatistics and Bioinformatics (Theory)

Programme/Class: Degree	Year:3	Semester:5
Subject:Biotechnology		
CourseCode:B100501T	Course Title: Biostatistics and Bioinformatics (Theory)	
Course outcomes:		Bloom's taxonomy
• CO1-Learn the need of statistical approach, identify the different axiomatic approach. • Learn to study the variability of observation.		K4, K5
• CO2 Know effective use of Office package – word, excel, ppt and publisher etc • Understand simple calculation using excel		K1, K4
• CO3-Understand the basic theories and practicals of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts		K3, K4
• CO4-Critically analyse and interpret results of their studies with the help of bioinformatical and biostatistical tools..		K2, K5



Credits:4		Core Compulsory
Max.Marks:25+75		Min. Passing Marks:33
Total No. of Lectures-60		
Unit	Topics	No. of Lecture
I	History and introduction to Bioinformatics: ● Introduction and applications of bioinformatics ● Datageneration;Generationoflargscalemolecular biologydata.(ThroughGenometranscriptomic sequencing.	7
II	Databases, Datageneration, Datastorageand retrieval: ● GeneralIntroductionofBiologicalDatabases;Nucleic acid databases(NCBI,DDBJ,andEMBL),Protein databases (Primary, Composite, and Secondary). ● Structuredatabases(CATH,SCOP,andPDB) ● FileFormat(Genbank,DDBJ,FASTA,PDB, SwissProt).	8
III	.SequenceandPhylogenyanalysis: ● IntroductiontoSequences,alignmentsandDynamic Programming;LocalalignmentandGlobalalignment (algorithmandexample),Pairwisealignment(BLASTand FASTAAlgorithm)andmultiple sequencealignment (Clustal W algorithm). ● IntroductiontoBLAST,usingitontheweb, Interpreting results, Phylogenetic Analysis. ● PCRprimerdesigning etc.	8
IV	SearchingDatabases: ● SRS,Entrez,SequenceSimilaritySearches-BLAST, FASTA, . ● GenomeAnnotation:Patternandrepeathfinding, Gene identification tools.	7
V	TypesandCollectionofdata: ● Primaryand Secondary data, Classification and Graphical representation of Statistical data. ● Measuresof central tendencyand Dispersion. ● MeasuresofSkewnessandKurtosis.	7
VI	Probability: ● Probability. ● ElementaryideasofBinomial,PoissonandNormal distributions.	8



VII	Hypothesistesting: ● testingofhypothesis ● Problemsontestofsignificance,t-test, and analysis of variance (ANOVA)	8
VIII	CorrelationandRegression: ● Types,Karl-Pearson'scorrelation,Spearman'sRank correlation, Regression equation and fitting ● Mainfeaturesofregressionanalysis-simpleand multiple regression analysis ● Differencesbetweenecorrelationandregression analysis	7

SuggestedReadings:

1. Lesk, A.M.(2002). IntroductiontoBioinformatics.Oxford:OxfordUniversityPress.
2. Mount,D.W.(2001).Bioinformatics:SequenceandGenomeAnalysis.ColdSpring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis,A.D.,&Ouellette,B.F.(2001).Bioinformatics:aPracticalGuidetothe Analysis of Genes and Proteins. New York: Wiley-Interscience.
4. Pevsner,J.(2015).BioinformaticsandFunctionalGenomics.Hoboken,NJ.: WileyBlackwell.
5. Bourne,P.E.,&Gu,J.(2009).StructuralBioinformatics.Hoboken,NJ:Wiley-Liss.
6. SharmaV.MunjalA.ShankerA.(2018).ATextbookofBioinformatics.(2nd Edition). Rastogi Publication.
7. ChoudhuriS.(2014) Bioinformaticsforbeginners. (1stedition)Elsevier.
8. HarishaS.(2019)FundamentalsofBioinformatics.DreamtechPress
9. RastogiSC.MendirattaN.RastogiP.(2013).BioinformaticsMethodsandApplications Genomics Proteomics and Drug Discovery.(4th edition).Prentice Hall India Learning Private Limited
10. GhoshZ. MallickB.(2008).Bioinformatics:PrinciplesandApplications.OUPIndia
11. Rosner,B.(2000).FundamentalsofBiostatistics.Boston,MA:DuxburyPress.

Suggestedigitalplatformsweblinks-

SwayamPortal,<http://heecontent.upsdc.gov.in/Home.aspx>

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Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:Openforall

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SuggestedContinuousEvaluationMethods:

- Seminaronanytopicoftheabovesyllabus.
- Testwithmultiplechoicequestions/shortandlonganswerquestions.
- Subjectivelongquestions
- Attendance.

Courseprerequisites:The candidate shouldhave passed (10+2)examinationin science stream with PCB(Physics,Chemistry, Biologyand/or Biotechnology)or PCM(Physics,ChemistryandMaths) or any other science subject.

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B.Sc3rdYear (Semester5)Biotechnology

Paper2AnimalandPlantBiotechnology(Theory)

Programme/Class:Degree		Year:3	Semester:5
Subject:Biotechnology			
CourseCode:B100502T		CourseTitle:AnimalandPlantBiotechnology(Theory)	
Courseoutcomes:			Bloom's taxonomy
● CO1-Understandtheprinciples,practicesandapplicationof animalbiotechnologyin ● Transgenesis,TissueEngineering,andbiopharmaceuticals.			K4, K5
● CO2Understandtheprinciples,practicesandapplicationsofplant biotechnology,transgenic plantgeneration,planttissueculture,plantgenomics,andgenetic transformation.			K1, K4
● CO3-Understandapplicationsofstemcellsandtissuesengineering. ● Learndifferentgenedeliverymethodstodeliverforeigngenein plants and animals			K3,K4
● CO4-Knowaboutdifferentproductsoftransgenicanimals,plants and microbes.			K2, K5
Credits: 4		CoreCompulsory	
Max.Marks:25+75		Min.PassingMarks:33	
TotalNo.ofLectures-60			
Unit	Topic		No.of Lectures
I	Transgenesis: ● Introductiontotransgenesis.TransgenicAnimals Mice,Sheep ● AnimaldiseasesneedhelpofBiotechnology Foot-andmouthdisease,Coccidiosis, Trypanosomiasis, Theileriosis.		7
II	Genedeliverymethodsforanimals: ● Viralvectors ● Vectorless or direct DNA transfer, particle bombardment,electroporation, microinjection& chemicalmethods,creationofanimalmodelsof humandiseases.		8



III	Animalpropagation: - Artificialinsemination,animalClones. - ConservationBiology–embryotransfer techniques.	6
IV	GeneticmodificationinMedicine: - Genetherapy,typesofgenetherapy,vectorsin gene therapy, molecular engineering, - Humangeneticengineering,problems& ethics - IntroductiontoStemCellTechnologyandits applications	7
V	Introduction,Cryoandorganogenicdifferentiation: - Typesofculture:Seed,Embryo,Callus, and Protoplast culture. - MicropopagationAxillarybudproliferation, advantagesanddisadvantagesofmicropropagation. - Protoplastisolationandfusion,methodsof protoplastisolation,Protoplastdevelopment, Somaticybridization,identificationandselection ofhybridcells,Cybrids,Potentialofsomatic hybridization limitations. - Somaclonalvariationnomenclature,methods, applications basis and disadvantages	7
VI	InvitrohaploidproductionAndrogenicmethods: - Antherculture,Microsporecultureandrogenesis - Significanceanduseofhaploids,Ploidylevel and chromosomedoubling,diploidization,Gynogenic haploids, factors effecting gynogenesis - Chromosome elimination techniques for production of haploids in cereals.	8
VII	PlantGrowthPromoting bacteria: - Nitrogenfixation, - Nitrogenase,Hydrogenase,Nodulation - Biocontrolofpathogens - Growthpromotionbyfree-livingbacteria.	8
VIII	Transgenesis: - Planttransformationtechnologies <i>Agrobacteriumtumefaciens</i>infection,basisof tumorformation,featuresofTi&Ri plasmids, mechanismsofDNAtransfer,role ofvirulence genes, use of Ti plasmid asvector, binary vectors - Application of plant transformation for productivity andperformance:Herbicides resistance,insectresistance,Btgenes,non-Bt like protease inhibitors, virus resistance, long	8



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SuggestedReadings:

1. Razdan,M.K.(2003). IntroductiontoPlantTissueCulture.Enfield,NH:Science
2. Chawla,H.S.(2000). IntroductiontoPlantBiotechnology.Enfield,NH:Science.
3. SmithR(2012).PlantTissueCulture(3rdEdition)AcademicPress.
4. Slater,A.,Scott,N.W.,&Fowler,M.R.(2008).PlantBiotechnology:an Introduction to Genetic Engineering. Oxford: Oxford University Press.
5. Buchanan,B.B.,Gruissem,W.,&Jones,R.L.(2015).Biochemistry&Molecular Biology of Plants. Chichester, West Sussex: John Wiley & Sons.
6. Umesha,S.(2013).PlantBiotechnology.TheEnergyandResources.
7. Glick,B.R.,&Pasternak,J.J.(2010).MolecularBiotechnology:Principlesand Applications of Recombinant DNA. Washington, D.C.: ASM Press.
8. Brown,T.A.(2006).GeneCloningandDNAAnalysis:anIntroduction.Oxford: Blackwell Pub.
9. Primrose,S.B.,&Twyman,R.M.(2006).PrinciplesofGeneManipulationand Genomics. Malden, MA: Blackwell Pub.
10. Slater,A.,Scott,N.W.,& Fowler,M.R.(2003).PlantBiotechnology:The Genetic Manipulation of Plants. Oxford: Oxford University Press.
11. Levine,M.M.(2004). NewGenerationVaccines.NewYork:M.Dekker.
12. Pörtner,R.(2007).AnimalCellBiotechnology:MethodsandProtocols.Totowa, NJ: Humana Press
13. SinghB.GautamSK(2013).Textbookofanimalbiotechnology.TheEnergy and Resources Institute, TERI
14. GuptaPK.(2018)AnimalBiotechnology.RastogiPublications
15. SinghBD.(2015).PlantBiotechnology(3rdedition).KalyaniPublishers
16. ChawlaHS.(2020)IntroductiontoPlantBiotechnology(3rdedition)OXFORD & IBH Publishing
17. SatyanarayanaU(2020).Biotechnology.BooksandAllied(P) Ltd
18. SinghBD.(2015).Biotechnology:ExpandingHorizons(4thedition).Kalyani Publishers
19. DubeyRC.(2014) ATextbookofBiotechnology(5thedition)SChandandCompany Ltd.

Suggestedigitalplatformsweblinks

- <https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=stemcells>
- <https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-forbiomedical-applications-spring-2006/lecture-notes/lecture13.pdf>
- <https://ocw.mit.edu/courses/biological-engineering/20-109-laboratory-fundamentals-inbiological-engineering-fall-2007/lecture-notes/>
- <https://ocw.mit.edu/courses/health-sciences-and-technology/hst-535-principles-andpractice-of-tissue-engineering-fall-2004/>

Thiscoursecanbeoptedasanelectivebythestudentsoffollowingsubjects:Tostudythiscourse,student must have passed semester V.



Suggested Continuous Evaluation Methods:

- Seminar on any topic of the above syllabus.
- Test with multiple choice questions/short and long answer questions.

- Attendance.

Course prerequisites: The candidate should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject.....

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B.Sc 3rd Year (Semester 5) Biotechnology

Paper 3 Bioinformatics, Biostatistics Tissue culture Lab (Practical)

Programme/Class:Degree	Year:3	Semester:5
Subject:Biotechnology		
CourseCode:B100503P	CourseTitle:Bioinformatics,BiostatisticsTissuecultureLab (Practical)	
Courseoutcomes:		Bloom'staxonomy
● CO1-Applybasicbioinformaticstoolsforthestudiesand researchinotherareasoftheir biotechnologyand microbiologyprograms, suchas finding		K4, K5
● CO2Gene/proteinhomologs,designingprimers,identifying mutations, etc.		K1, K4
● CO3-Docleaning,sterilizationoflaboratory,plasticand glasswares.		K3,K4
CO4 -Understandandsolvetheproblemsinthearea of animalandplantBiotechnology		K2, K5
Credit-2		CoreCompulsory
Max.Marks:25+75		Min.PassingMarks:40
TotalNo.oflab.periods30(60hours)		
	Topic	No.of lab.periods



	1. An introduction to Computers, MS-Word, MS Excel, MS Power Point. 2. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissprot/ TrEMBL, UniProt. 3. Similarity searches using tools like BLAST and interpretation of results. 4. Multiple sequence alignment using ClustalW and interpretation of results. 5. Use of gene prediction methods (GRAIL, Genscan, Glimmer). 6. Use of various primer designing and restriction site prediction tools. 7. Use of different protein structure prediction databases (PDB, SCOP, CATH etc.). 8. Exercise to data entry, edit, copy, move etc. using MS EXCEL spreadsheet 9. Computational analysis of biological data by Mean, Median, Mode, S.D., Correlation, regression Analysis, Chi square test, Student t test, ANOVA 10. Designing of bar diagram, pie chart, histogram, scatter plots, in EXCEL for presentation of data. 11. Measure of skewness and kurtosis 12. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization 13. Sources of contamination and decontamination measures. 14. Preparation of Hanks Balanced salt solution 15. Preparation of Minimal Essential Growth medium 16. Preparation of simple growth nutrient (Knop's medium), full strength, half strength, solid and liquid. 17. Preparation of complex nutrient medium (Murashige & Skoog's medium) 18. Tissue selection, Pruning, sterilization and preparation of explant for culture. 19. Significance of growth hormones in culture medium. 20. To demonstrate various steps of Micropropagation.	60
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Suggested Readings:

1. Lesk, A.M. (2002). Introduction to Bioinformatics. Oxford: Oxford University Press.
2. Mount, D.W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Baxevanis, A.D., & Ouellette, B.F. (2001). Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins. New York: Wiley-Interscience.
4. Pevsner, J. (2015). Bioinformatics and Functional Genomics. Hoboken, NJ: Wiley Blackwell.
5. Bourne, P.E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
6. Sharma V. Munjal A. Shanker A. (2018). A Textbook of Bioinformatics. (2nd Edition). Rastogi Publication.
7. Choudhuri S. (2014) Bioinformatics for beginners. (1st edition) Elsevier.
8. Harisha S. (2019) Fundamentals of Bioinformatics. Dreamtech Press
9. Rastogi SC. Mendiratta N. Rastogi P. (2013). Bioinformatics Methods and Applications Genomics Proteomics and Drug Discovery. (4th edition). Prentice Hall India Learning Private Limited
10. Ghosh Z. Mallick B. (2008). Bioinformatics: Principles and Applications. OUP India

Suggested digital platforms weblinks-

This course can be opted as an elective by the students of following subjects: To study this course, student must have passed semester IV.

Suggested Continuous Evaluation Methods:

- Test
- presentation along with assignment
- Attendance.

Course prerequisites: The candidate should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject.....

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B.Sc 3rd(Semester 6)Biotechnology
Paper1IndustrialandEnvironmental
Biotechnology (Theory)

Programme/Class: Degree	Year:3	Semester:6
Subject:Biotechnology		
CourseCode:B100601T	CourseTitle:IndustrialandEnvironmental Biotechnology	
Courseoutcomes:		Bloom's taxonomy
CO1- Understandtheproblemsin isolation, strainimprovementandgrowth ofmicroorganismsinindustrialprocesses		K4, K5
● CO2Isolate andimprove theindustriallyimportantmicroorganisms. ● Understandtodesignandtypesoffermentersandoperationoffermenters.		K1, K4
● CO3-Understandthebasictheoriesandpracticalsofcommon computational tools and databases whichfacilitateinvestigationofmolecularbiologyandevolution- related concepts		K3,K4
● CO4- Understandtheimportanceofclean(pollutionfree)environment Understandbiotechnologicalsolutions to address environmental issuesincluding pollution,		K2, K5
● CO5-Understandbiotechnologicalsolutions to address environmental issuesincludingpollution,mineralresourcewinning,renewableenergy and water recycling. ● UnderstandtheregulationofbioethicsandpoliciesofIPRand entrepreneurship.		K2,K4
Credits:4		CoreCompulsory
Max.Marks:25+75		Min.PassingMarks:33
TotalNo.ofLectures-60		
Unit	Topics	No. ofLectures



I	Introduction of Industrial microbiology and Bioprocess technology: ● History-Introduction, scope and relation with other sciences. ● Screening for new metabolites: primary and secondary products. ● Strain development through selection, mutations and recombination, and other recent methods	7
II	Bioprocess technology: ● Introduction to bioprocess technology. ● Design and working of a typical bioreactor ● Range of bioprocess technology and its chronological development. ● Basic principle component of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture.	9
III	Energy Metabolism ● Production of alcohols, antibiotic and enzymes: ● Production of alcohols (Ethanol) and organic acids (citric and acetic). ● Production of biologically active compounds: antibiotics (penicillin) and enzymes (amylase, protease). ● Production of microbial food and single cell proteins ● Bioreactor for immobilized cells/enzyme system ● Biosensors and their applications	9



IV	Environment and pollution: • Physico-chemical and biological characteristics of environment. • Water, soil and air as a component of environment. • Pollutants: Nature, origin, source, monitoring and their impacts. • Air, Water and Noise pollution • Conventional fuels and their environmental impact	8
V	Bioremediation: • Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. • Degradation of lignin and cellulose using microbes. Phyto-remediation. • Degradation of pesticides and other toxic chemicals by micro-organisms-degradation of aromatic and chlorinated hydrocarbons and petroleum products.	8
VI	Sewage treatment and biofertilizers: • Treatment of municipal waste and industrial effluents. • Bio-fertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. • Algal and fungal biofertilizers (VAM)	6
VII	Bioleaching and genetically modified organisms: • Enrichment of ores by microorganisms (Gold, Copper and Uranium). • Environmental significance of genetically modified microbes, plants and animals.	6
VIII	Bioethics, IPR, Entrepreneurship: • Importance of Bioethics, IPR and entrepreneurship • Introduction to Intellectual Property Rights (IPR)- World Intellectual properties, Indian Intellectual properties • Entrepreneurship in India	6
Suggested Readings: 1. Glazier AN and Nikaido H (2007). Microbial Biotechnology – Fundamental & Applied Microbiology – Second Edition. Cambridge University Press. 2. Casida LE (2019) Industrial Microbiology. Second Edition, New Age International Publisher. 3. Stanbury PF and Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press 4. Shuler ML and Kargi F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall. 5. Crueger W and Crueger A (2002) Cruegers Biotechnology: A Textbook of Industrial Microbiology. Third Edition, Panima Publishing Corp., New Delhi. 6. Blanch HW and Clark DS. (1997). Biochemical Engineering. New York: M. Dekker. 7. Bailey JE and Ollis DF. (1986). Biochemical Engineering Fundamentals.		



New York: McGraw-Hill. 8. Richard HB, Julian ED, Arnold LD. (2010) Manual of Industrial Microbiology and Biotechnology, 3 rd Edition 9. Thakur IS. (2011) Environmental Biotechnology basic concepts and applications. I. K. International Publishing House Pvt. Limited 10. Evans GM and J. C. Furlong (2003). Environmental Biotechnology: Theory and Applications. Wiley Publishers. 11. Ritmann R and McCarty PL (2000). Environmental Biotechnology: Principle & Applications. 2nd Ed., McGraw Hill Science.
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This course can be opted as an elective by the students of following subjects: To study this course, a student must have passed semester V.
Suggested Continuous Evaluation Methods: • Test with multiple choice questions/short and long answer questions • Seminar on any above topics
Course prerequisites: The candidate should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject/certificate/diploma.
Suggested equivalent online courses: IGNOU and other centrally/state operated Universities/MOOC platformssuchas “SWAYAM” in India and abroad http://heecontent.upsdc.gov.in/Home.aspx
Further Suggestions:

At the End of the whole syllabus any remarks/suggestions:

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**B.Sc^{3rd}Year(Semester6)BiotechnologyPaper2 Food
Biotechnology (Theory)**

Programme/Class:Degree	Year:3	Semester:6
Subject:Biotechnology		
CourseCode:B100602T	CourseTitle:FoodBiotechnology(Theory)	
Courseoutcomes:		Bloom's taxonomy
CO1 -Understandthehistoryandevolutionoffoodtechnologyand processing		K4, K5
● CO2 Understandtheimportancemicroorganismsinfood preservation		K1, K4
CO3 -Learnvariousfoodprocessingandpreservation technologies.Value addition products		K3,K4
CO4 -Understandtheimportanceofmicroorganismsinfoodand diseases caused thereby		K2, K5
Credits:4		CoreCompulsory
Max.Marks:25+75		Min.PassingMarks:33
TotalNo.ofLectures-Tutorials-60Lectures		
Unit	Topic	No.of Lectures
	PART A	
I	IntroductiontoFood Biotechnology ● HistoricalBackgroundofFoodtechnology ● Traditionalfermentedfoods(meat, sauerkraut, , coffee, cocoa, tea) ● Codexguidelines, nutritionallabellinginIndia,FSSAIGuidelines ● ImprovementsthroughBiotechnology(e.g.Golden Rice, Potato, Flavr Savr Tomato etc.)	7



II	Enzymes in Food Industry: ● Carbohydrases ● Protease ● Lipases ● Modification of food using enzymes: ● Role of endogenous enzymes in food quality, ● Enzymes used as processing aid and ingredients	8
III	Food Fermentations: ● Common fermented foods - Cheese, Butter, Yoghurt, ● Alcoholic beverages (Beer, Wine, Whisky), ● Pickles, kimchi etc.	7
IV	Food preservation: ● Food adulteration and prevailing food standards in India. ● Source of microorganisms in milk and their types. ● Microbiological examination of milk (standard plate count, direct microscopic count, reductase and phosphatase test). ● Dehydration and pasteurization of milk.	7
V	Value addition products: ● Value addition products like high Fructose Syrup, Invert Sugar etc. SCPs (e.g. Spirulina, Yeast etc.) as food supplements, ● Edible fungus: Mushrooms. Potential of probiotics. ● Flavour enhancers: Nucleosides, nucleotides and related compounds. Organic acids (Citric acid, Acetic acid) and their uses in foods/food products.	7
VI	Vitamins and Minerals: ● Importance of Vitamins and their supplementation in foods and feedstock. ● Food preservation and storage. Food Processing ● Important minerals and their function in body and deficiency conditions ● Requirements, allowances, enrichment, restorations, fortifications, losses of minerals, optimization and retention of minerals	7



VII	Growth of microorganisms in food: ● Intrinsic and extrinsic factors. ● Food Spoilage (microbial and non-microbial) Control mechanisms of food spoilage: Physical and Chemical. ● Microbial spoilage of food and factors affecting them: Spoilage of various kinds of foods: fish, meat, poultry, sea foods, bread and dairy products). ● Food adulteration and prevailing food standards in India. ● Indicator Microorganisms: As an indicator of good quality	8
VIII	Food and water borne diseases: ● Gastroenteritis, Diarrhoea, Shigellosis, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Dental Infections, etc. ● Foodborne intoxications: Staphylococcal, Bacillus, Clostridium etc. ● Detection of food-borne pathogens.	9
Suggested Readings: 1. Ray B and Bhunia A. 2008. Fundamental Food Microbiology, 4th Ed., CRC Press, Taylor and Francis Group, USA. 2. Martin RA and Maurice OM. 2008. Food Microbiology, 3rd Ed., The Royal Society of Chemistry, Cambridge, UK. 3. James MJ. 2000. Modern Food Microbiology, 6th Ed. Aspen Publishers, Inc., Gaithersburg, Maryland, USA. 4. Frazier WC, and Westhoff DC. Food Microbiology. Fourth edition, MacGraw Hills publication 5. Lopez GFG, Canaas G, Nathan EV. Food Sciences and Food biotechnology. 6. Adams AR, and Moss MO. Food Microbiology. Third edition, Royal Society of Chemistry publishing . 7. Hohn T and Leisinger KM. Biotechnology of Food Crops in Developing Countries. 8. Doyle MP, Beuchat LR and Montville TJ. Food Microbiology Fundamentals and Frontiers. ASM Press. 9. Schwartzberg HG, Rao MA. (Eds.) Biotechnology and Food Process Engineering. Suggested digital platforms weblinks-e-PG Pathshala-Inflibnet		
This course can be opted as an elective by the students of following subjects: To study this course, student must have passed semester V.		



Suggested Continuous Evaluation Methods:

- Seminar/Presentation on any topic of the above syllabus
- Test with multiple choice questions/short and long answer questions
- Attendance

- Course prerequisites: The candidates should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject.

Suggested equivalent online courses:

- IGNOU & Other centrally/state operated Universities/MOOC platforms such as “SWAYAM” in India and Abroad.

Further Suggestions:

It widens the scope for students to join Government and Non-Government organization upskilling the people at different levels as per their socio-economic structure.

At the End of the whole syllabus any remarks/suggestions:

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B.Sc3rd Year (Semester6)Biotechnology Paper3
IndustrialandEnvironmentalBiotechnologyLab(Practical)

Programme/Class: Degree	Year:3	Semester:6
Subject:Biotechnology(Practical)		
CourseCode:B100603P		Course Title: Industrial and EnvironmentalBiotechnology Lab
Courseoutcomes:		Bloom'staxonomy
● CO1- Understand variousmethodsofscreeningof industriallyimportant microorganismsfromdifferent sources.		K4, K5
● CO2Understandtheworkingofsmallscalefermenter andalsodeterminetheaeration efficiency of the fermenter		K1, K4
CO3-Understandthetechniqueofimmobilizationofcells likeyeastand E.coli.		K3,K4
Credits:2		CoreCompulsory
Max.Marks:25+75		Min.PassingMarks:40
TotalNo.oflab.periods-30(60hours)		
	Topic	No.oflab.periods
	1. Calculationofbacterialgrowthcurve. 2. Calculationthermaldeathpoint(TDP)of microbial sample. 3. Productionandanalysisofethanol. 4. Productionandanalysisofamylase.. 5. Productionandanalysisoflacticacid. 6. Isolationofindustriallyimportant microorganism from natural resource. 7. CalculationofTotalDissolvedSolids (TDS) of water sample. 8. CalculationofBODofwatersample. 9. CalculationofCODofwatersample. 10. BacterialExaminationofWaterbyMPN Method.	60



Suggested Readings:

1. Glazier AN and Nikaido H (2007). Microbial Biotechnology – Fundamental & Applied Microbiology – Second Edition. Cambridge University Press.

2. Casida LE (2019) Industrial Microbiology. Second Edition, New Age International Publisher.
3. Stanbury PF and Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press
4. Crueger W and Crueger A (2002) Crueger's Biotechnology: A Textbook of Industrial Microbiology. Third Edition, Panima Publishing Corp., New Delhi.
5. Blanch HW and Clark DS. (1997). Biochemical Engineering. New York: M. Dekker.
6. Bailey JE and Ollis DF. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
7. Richard HB, Julian ED, Arnold LD. (2010) Manual of Industrial Microbiology and Biotechnology, 3rd Edition
8. Thakur IS. (2011) Environmental Biotechnology basic concepts and applications. I. K. International Publishing House Pvt. Limited
9. Evans GM and J. C. Furlong (2003). Environmental Biotechnology: Theory and Applications. Wiley Publishers. International Pvt. Ltd, New Delhi, 6th Edition (2018).

This course can be opted as a selective by the students of following subjects: To study this course, student must have passed semester V.

Suggested Continuous Evaluation Methods:

- Test with multiple choice questions/short and long answer questions
- Presentation

Course prerequisites: The candidates should have passed (10+2) examination in science stream with PCB (Physics, Chemistry, Biology and/or Biotechnology) or PCM (Physics, Chemistry and Maths) or any other science subject/certificate/diploma.

Suggested equivalent online courses:

IGNOU and other centrally/state operated Universities/MOOC platformssuchas "SWAYAM" in India and abroad Swayam Portal,
<http://heecontent.upsdc.gov.in/Home.aspx>

Further Suggestions:

Students can opt. dietitian, nutrition advisor/ Nutritionist as a career in private and government sector as well as extend knowledge by joining advance course in same discipline.