CMR COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous Institution)

ACADEMIC REGULATIONS FOR M. TECH. (REGULAR) DEGREE COURSE

Applicable for the students of M. Tech. (Regular) Course from the Academic Year 2014-15 and onwards

The M. Tech. degree shall be conferred on candidates who are admitted to the program and who fulfil all the requirements for the award of the degree.

1.0 Eligibility for Admissions

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the State Government from time to time.

2.0 Award of M. Tech. degree

2.1 A student shall be declared eligible for the award of the M. Tech. Degree, if he pursues a course of study in not less than two and not more than four academic years.

2.2 A student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the year of his admission, shall forfeit his seat in M. Tech. course.

2.3 The student shall register for all 88 credits and secure all the 88 credits.

2.4 The minimum instruction days in each semester are 90.

2.5 The medium of instruction and examination shall be English.

3.0 A. Courses of Study

The following specializations are offered at present for the M. Tech. course of study.

1. Bio-Technology
2. Embedded Systems
3. Power Electronics
4. Structural Engineering
5. Computer Science & Engineering
6. Machine Design

and any other course as approved by the College/ University/AICTE from time to time.

B. Departments offering M.Tech. programmes with specializations mentioned below:

Sl. No.	Department	M.Tech Course
1	Bio-Technology	Bio-Technology
2	ECE	Embedded Systems
3	EEE	Power Electronics
4	Civil	Structural Engineering
5	CSE	Computer Science & Engineering
6	Mechanical	Machine Design

4.0 <u>Minimum Instructional Days and Attendance</u>

The programs are offered on a unit basis with each subject being considered a unit.

4.1 The minimum instruction period for each semester shall be 90 clear instruction days.

4.2. A student shall be eligible to write semester end examinations if he acquires a minimum of 75% of attendance **in each of all the subjects**.

4.3. Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester shall be granted by the Institute Academic Committee.

4.4 Shortage of attendance below 65% in aggregate shall not be condoned.

4.5 Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of subjects of the corresponding semester and their registration shall stand cancelled.

4.6. A fee as prescribed by the Institute Academic Committee shall be payable towards condonation of shortage of attendance.

4.7. A candidate shall put in a minimum required attendance, in at least 50% of the theory subjects in the present semester to get promoted to the next semester. In order to qualify for the award of the M. Tech. Degree, the candidate shall complete all the academic requirements of the subjects, as per the course structure.

4.8. A student will be promoted to the next semester if he satisfies the attendance requirement of the present semester including the days of attendance in sports, games, NCC and NSS activities subject to a maximum of 15 instructional days in a semester. Prior permission of the Head of the Department in writing shall be obtained by the students to avail the attendance from above mentioned activities.

5. Evaluation

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals, on the basis of

Internal Evaluation and End Semester Examination.
For the theory subjects 60 marks shall be awarded based on the performance in the End Semester Examination and 40 marks shall be awarded based on the Internal Evaluation. For internal evaluation there shall be the two internal examinations conducted-one in the middle of the semester and the other immediately after the completion of instruction. Each internal examination shall be conducted for a total duration of 120 minutes. The final marks secured by each candidate in the internal evaluation is arrived at by giving a weightage of 70% to the best secured internal examination and 30% weightage to the least secured internal examination. A student who is absent for any internal examination for any reason what so ever shall be deemed to have secured „zero" marks in the test/ examination and no makeup test/ examination shall be conducted.

5.1

Internal Examination

Part A (20 Marks)

4 questions of 5 marks each (All questions are compulsory).

Part B (20 Marks)

4 questions to be answered out of 6 questions, each question carry 5 marks.

External Examination

Part A (20 Marks)

5 questions (1 question from each unit) of 4 marks each (Compulsory questions)

Part B (40 Marks)

5 questions (1 question from each unit with internal choice) each question carries 8 marks.

5.2 For practical subjects, 60 marks shall be awarded based on the performance in the End Semester Examinations. 40 marks shall be awarded in internal evaluation out of which 20 marks shall be for day to day evaluation and 20 marks shall be for internal examination.

5.3 There shall be seminar presentation each during of I semester as well as II semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Departmental Academic Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.4 There shall be a Comprehensive Viva-Voce in III Semester. The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and two Senior Faculty members of the Department. The Comprehensive Viva-Voce is intended to assess the students" understanding of various subjects he has studied during the M. Tech. course of study. The Comprehensive Viva-Voce is evaluated for 100 marks by the Committee. There are no internal marks for the Comprehensive Viva-Voce. A candidate has to secure a minimum of 50% of marks

to be declared successful.

5.5 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

5.6 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.5) he has to reappear for the End semester Examination in that subject. A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and so has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate‟s attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled.

5.7 In case the candidate secures less than the required attendance in any subject, he shall not be permitted to write the End Examination in that subject. He shall re-register the subject when next offered.

5.8 Laboratory examination for M. Tech. courses for 60 marks must be conducted with two Examiners, one of them being the Laboratory Class Teacher and the second examiner shall be appointed by the Controller of Examinations in consultation with the HOD.

6.0 Evaluation of Project / Dissertation Work:

The work on the project shall be initiated in the beginning of the III semester and the duration of the project is for two semesters. A Project Review Committee (PRC) shall be constituted comprising of Head of the Department and three other senior faculty members concerned with the M.Tech programme. The student can initiate the Project work only after obtaining the approval of PRC. This process is to be completed within four weeks of commencement of III semester.

6.1. The candidate shall be required to submit thesis or dissertation after taking up a topic approved by the Project Review Committee.

6.2 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the previous semesters and after obtaining the approval of the Institute Academic Committee.

6.3 After satisfying 6.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the PRC for its approval.

6.4 If the candidate wishes to change his supervisor or topic of the project he can do so with approval of PRC. However, the PRC shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project proposal. If so his

date of registration for the project work starts from the date of change of supervisor or topic as the case may be.

6.7 Project work and Dissertation:

A candidate is permitted to submit project dissertation only after successful completion of all subjects (theory and practical), seminars, comprehensive viva-voce, and after the approval of PRC, not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC, the candidate shall submit the draft copy of thesis to the Head of the Department and shall make an oral presentation before the PRC. Along with the draft thesis the candidate shall submit draft copy of a paper in standard format fit for publication in Journal / Conference, based on the project thesis, to the Head of the Department with due recommendation of the supervisor.

6.7.1 Four copies of the Project Dissertation certified by the Supervisor and Head of the Department shall be submitted to the College.

6.7.2 The dissertation shall be adjudicated by one examiner selected by the College. In case the thesis is found to be acceptable; viva-voce will be arranged. For this, Head of Department shall submit a panel of 3 examiners, who are eminent in that field, with the help of the PRC. The Controller of Examinations of the college in consultation with the College Academic Committee shall nominate the examiner.

6.7.3 If the report of the examiner is not favourable, the candidate shall revise and resubmit the dissertation, in the time frame as prescribed by PRC. If the report of the examiner is unfavourable again, the thesis shall be summarily rejected. The candidate can re-register only once for conduct of project and evaluation of dissertation, and will go through the entire process as mentioned above. The total duration for the M.Tech program is limited to four years.

6.7.4 If the report of the examiner is favourable, viva-voce examination shall be conducted by a Board consisting of the Head of the Department, Supervisor and the Examiner who adjudicated the Dissertation. The Board shall jointly report the student‟s performance in the project work as –

(a) Excellent, or

(b) Good, or

(c) Satisfactory, or

(d) Unsatisfactory,

as the case may be. In case, the student fails in the viva-voce examination, or gets the Unsatisfactory grade, he can re-appear only once for the viva-voce examination, as per the recommendations of the Board. If he fails at the second viva-voce examination, the candidate can re-register only once for conduct of project and evaluation of Dissertation, and will go through the entire process as mentioned above. The total duration for the M.Tech program is limited to four years.

7.0 Award of Degree and Class

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree he shall be placed in one of the following four classes:

Class Awarded	% of marks to be secured
First Class with Distinction	70% and above
First Class	Below 70% but not less than 60%
Second Class	Below 60% but not less than 50%

The marks in internal evaluation and end examination shall be shown separately in the memorandum of marks.

8. Withholding of Results

If the student has not paid the dues, if any, to the institution or if any case of indiscipline is pending against him, the result of the student will be withheld and he will not be allowed into the next semester. His degree will be withheld in such cases.

9. Transitory Regulations

9.1 Discontinued, detained, or failed candidates are eligible for admission to two earlier or equivalent subjects at a time as and when offered.

9.2 The candidate who fails in any subject will be given two chances to pass the same subject; otherwise, he has to identify an equivalent subject as per the academic regulations.

10. General

10.1 Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

10.2 .The academic regulation should be read as a whole for the purpose of any interpretation.

10.3 .In the case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Academic Council is final.

10.4 .The college may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the college.

MALPRACTICES RULES
DISCIPLINARY ACTION FOR
IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/ Improper conduct	Punishment
1.(a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate Who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work)

		already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all end semester examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles the answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all end semester Examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks	Cancellation of the performance in that subject
6.	Refuses to obey the orders of the Chief Superintendent/Assistant– Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the or organizes a walk out or instigates others **to** examination hall walk out, or threatens the officer- in-charge or any person on duty in or outside the examination hall of any injury**,** to his	case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall

	person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer- in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates are also debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
6.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of That semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a	If the student belongs to the

	candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	college, expulsion from the examination performance in that subject and all other subjects hall and cancellation of the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for other remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the College Academic Committee for further action to award suitable punishment.	

Malpractices identified by squad or special invigilators

Punishments to the candidates as per the above guidelines.

Malpractice identified at Spot center during valuation

The following procedure is to be followed in the case of malpractice cases detected during valuation, scrutiny etc. at spot center.

1) Malpractice is detected at the spot valuation. The case is to be referred to the malpractice committee. Malpractice committee will meet and discuss/question the candidate and based on the evidences, the committee will recommend suitable action

on the candidate.

2) A notice is to be served to the candidate(s) involved through the Principal to his address and to the candidate(s) permanent address regarding the malpractice and seek explanations.
3) The involvement of staff who are in charge of conducting examinations, invigilators valuing examination papers and preparing / keeping records of documents relating to the examinations in such acts (inclusive of providing in correct or misleading information) that infringe upon the course of natural justice to one and all concerned at the examinations shall be viewed seriously and recommended for award of appropriate punishment after thorough enquire.
4) Based on the explanation and recommendation of the committee action may be initiated.

5) Malpractice committee:

i. Controller of Examinations	Chairman
ii. Assistant controller of Evaluation	Member
iii. Chief Examiner of the subject/ subject expert	Member
iv. Concerned Head of the Department	Member
v. Concerned Invigilator	Member

CMR College of Engineering & Technology
Department of Biotechnology

COURSE STRUCTURE FOR P.G. PROGRAMME

SEMESTER I

		L	P	C
Core Course I:		4	--	4
B1BT01	**Microbial Engineering**			
Core Course II:		4	--	4
B1BT02	**Molecular Biology and Genetic Engineering**			
Core Course III:		4	--	4
B1BT03	**Enzyme Engineering and Technology**			
Core Elective I (based on the educational background)		4	--	4
B1BT04	Basic Engineering Mathematics			
B1BT05	Bioethics			
B1BT06	Biochemical and Biophysical Techniques			
Core Elective II (based on the educational background)		4	--	4
B1BT07	Process Engineering Principles			
B1BT08	Biochemistry and Metabolic Regulation			
B1BT09	Computational Biology			
Open Elective I		4	--	4
B1BT10	Environmental Biotechnology			
B1BT11	Biobusiness Management			
B1BT12	Computer Aided Learning of structure and Function of Protein			
B1BT13	Process Engineering Principles and Molecular Biology Lab	--	4	2
B1BT14	**Seminar**	--	4	2
Total Credits		**24**	**8**	**28**

SEMESTER II

		L	P	C
Core Course IV:		4	0	4
B1BT15	Bioreactor Engineering			

Core Course V:		4	0	4
B1BT16	Immunology and Immunotechnology			
Core Course VI:		4	0	4
B1BT17	Downstream Processing			
Core Elective III:		4	0	4
B1BT18	Plant Biotechnology			
B1BT19	Applied Food Biotechnology			
B1BT20	Bio Catalysts and Enzyme Technology			
Core Elective IV:		4	0	4
B1BT21	Animal Cell Science and Technology			
B1BT22	Advance Genetic Engineering			
B1BT23	Bioinformatics and Systems Biology			
Open Elective II:		4	0	4
B1BT24	Bioethics, Bio-safety and Intellectual Property Rights			
B1BT25	Pharmaceutical Biotechnology			
B1BT26	Entrepreneurship, IPR and Bio Safety			
B1BT27	Bioprocess Engineering and Cell culture Techniques Lab	0	4	2
B1BT28	**Seminar II**	--	4	2
Total Credits		**24**	**8**	**28**

SEMESTER III

		L	**P**	**C**
B1BT29	Comprehensive Viva-Voce	--	--	4
B1BT30	Project Work Review I	--	24	12
Total Credits		--	**24**	**16**

SEMESTER IV

		L	**P**	**C**
B1BT31	Project Work Review II	--	8	4
B1BT32	Project Evaluation (Viva-Voce)	--	16	12
Total Credits		--	**24**	**16**

Core Course I

B1BT01 - MICROBIAL ENGINEERING

UNIT-I MATERIAL BALANCES:
Introduction to engineering Calculations, Thermodynamics preliminaries, Law of conservation of mass, Procedure for Material Balance calculations, Material Balance worked examples, Material Balances with Recycle, Bypass and Purge streams, Stoichiometry of cell growth and product formation.

UNIT-II ENERGY BALANCES:
Basic Energy concepts, General Energy Balance Equations, Enthalpy calculation procedures, Enthalpy change in Non reactive processes, procedure or Energy Balance calculations without reaction. Energy Balance worked Examples without reaction, Enthalpy change due to reaction, Heat of reaction for process with biomass production, Energy Balance calculation for cell culture, cell culture Energy Balance worked Examples.

UNIT-III MEDIA OPTIMIZATION AND STERILIZATION
MEDIA OPTIMIZATION: Optimization techniques with special emphasis on statistical techniques, Placket-Burman design, ANOVA, central composite design, response surface methodology.
STERLIZATION: Media sterilization, Kinetics of thermal death of cells & spores, design of batch and continuous thermal sterilization, coupling of Arrhenius equation and cell death kinetics, sterilization of air and filter design, Radiation and Chemical sterilization.

UNIT-IV UNSTRUCTED MODEL FOR MICROBIAL GROWTH:
The development of different microbial growth kinetics like Malthus, Pearl and reed, Monad Model, Konark Model. The limitation of Monod model and development of other constitutive models of growth. Multi-substrate models, inhibition models for substrate, Product and toxic substances. Development of logistic equation. Maintenance and endogenous metabolism kinetics.

UNIT-V STRUCTURED MODELS OF MICROBIAL GROWTH:
Kinetics based on molecular mechanism, Compartmental models, Model of Cellular Energetics and Metabolism, Models of product formation, single cell model, Models of gene expression and regulation, Plasmid Expression and Replication, Model of plasmid stability, parameter estimation, Model validation and bioprocess optimization.

BOOKS:

1. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker (1987)
2. Pauline M. Doran: Bioprocess Engineering Principles, Elsevier Publications.

REFERENCE BOOKS:

1. Biochemical Engineering Principles and functions by Syed Trnveer Ahmed Inamdar, PHI
   Learning Private limited.

2. Wiseman, A: Handbook of Enzyme Biotechnology, 3rd Edition, Ellis Horwood Publication
(1999)
3. Moser, A; Bioprocess technology, kinetics and reactors; Springer Verlag, (1988)
4. Schugerl K: Bellgart K H (Eds); Bioreaction Engineering, Modeling and control; Springer –
verlog, berlin (2000)
5. Introduction to Biochemical Engineering by D G Rao. Tata, Mc Graw Hill, New Delhi.
6. Bailey JE, Ollis DF; Biochemical Engineering fundamentals (1986)

Core Course II

B1BT02 - MOLECULAR BIOLOGY AND GENETIC ENGINEERING

UNIT-I BASICS OF MOLECULAR BIOLOGY: DNA replication and Regulation, Gene expression (Transcription, Translation) and Regulation (operons, post-transcriptional), Repair mechanisms. RNA: Different classes of RNA and their functions.
REGULATION OF GENE EXPRESSION: RNA synthesis and other post transcriptional modifications, Regulation of gene expression in prokaryotes (Lac. Ara and His operons). Transcriptional controls in Eukaryotes (Complexity of genome organization, Regulatory elements, Motifs of protein secondary structure/Transacting elements); Post transcriptional and post-translational modifications.
TRANSLATION: Protein synthesis and translational modifications, translational controls and inhibitors of polypeptide synthesis, transport mechanisms (exportins & importins).

UNIT-II: INTRODUCTION TO GENETIC ENGINEERING: MOLECULAR TOOLS IN GENETIC ENGINEERING - Restriction enzymes and DNA Modifying enzymes (Polymerases, Reverse Transcriptase, Ligases, Alkaline phosphatase, Recombinases, Terminal deoxy-ribo nucleotide transferases, Nucleases - S1 nucleases etc.).
PLASMIDS & TRANSPOSONS: Plasmids, Types of plasmids, Ecological advantage, applications as vectors in gene therapy and genetic transformations.
Mobile elements in bacteria, Drosophila, yeast, maize and human. DNA transposons and Retrotransposons. Features and Transposition of TY elements.
Nucleic Acid Isolation and Purification, Yield analysis, Gel electrophoresis, DNA and RNA markers. Restriction mapping of DNA fragments and Map construction, Nucleic acid Amplification (PCR analysis) and its applications.

UNIT-III GENE CLONING: Gene Cloning vectors (Plasmids, bacteriophages, cosmids, phagemids, Artificial chromosomes), Gene Cloning strategies, Transformation and selection of recombinants; Construction of DNA libraries (Genomic library and cDNA library preparations –mRNA enrichment, reverse transcription, use of linkers and adaptors); and their screening; Alternative strategies of Gene cloning; RACE-PCR technique, Map based cloning, Cloning of differentially expressed genes.

UNIT-IV GENE EXPRESSION AND PROTEIN ENGINEERING: GENE EXPRESSION: Study of introduced Gene expression – Hybridization techniques, Northern blot analysis, Real-time PCR analysis, Primer extension, S1 mapping, Rnase protection assays, Reporter assays, Nucleic acid microarrays.
Gene expression in bacteria and Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants – characterization of recombinant proteins, stabilization of proteins; Phage display, Yeast Two- and three Hybrid system.
PROTEIN ENGINEERING Site-directed Mutagenesis and Protein Engineering.

UNIT-V TRANSGENICS, ANTISENSE AND RIBOZYMES: TRANSGENIC TECHNOLOGY: Gene tagging (T-DNA tagging and Transposon tagging) in gene analysis (identification and isolation of gene), Transgenic and Gene Knockouts and Gene knock down Technologies - Targeted gene replacement, Chromosome engineering, Gene

Therapy, Strategies of gene delivery, gene replacement/ augmentation, gene correction, gene editing and silencing.

ANTISENSE TECHNOLOGY: Comparisons of different antisense strategies (antisense oligo nucleotides, ribozymes and siRNAs). Molecular mechanisms of antisense molecules. RNA interference induced by siRNA molecules. Applications and challenges of antisense strategies (antisense oligo nucleotides, ribozyme technologies and RNAi) in gene silencing, mi RNAs.

RIBOZYMES: Biochemistry of ribozymes – hammer-head, hairpin and other ribozymes,

TEXT BOOKS:

1. "Molecular Biology of the gene" by Waston et al 4th edition.
2. "Genes VII" by Benjamin Lewis
3. Biochemistry and Molecular biology, William H. Elliott and Daphne C. Elliott, Third Edition, Indian edition, Oxford University press, 2005.
4. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
5. DNA Cloning: a Practical Approach, .M. Glover and B.D. Hames, IRL Press, Oxford, 1995.
6. Principles of Gene manipulation, Introduction to Genetic Engineering : R W Old, S B Primrose

REFERENCE BOOKS:

1. "Genetics" by Ursula Goodenough
2. "Cytogenetics" by lGarl P. Swanson, Mertz & Young
3. "General Virology" by Luria & Darnell
4. "Biochemistry" by Stryer.
5. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J; Cseke, CRC Press, Florida, 1995.
6. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd., Oxford, 1997.
7. Methods in Enzymology vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego, 1998
8. Methods in Enzymology Vol 185, Gene Expression Technology, D.V. Goeddel, Academic Press, Inc., San Diego, 1990
9. DNA Science. A First Course in Recombinant Technology, D, A. Mickloss and G.A. Froyer. Cold Spring Harbor Laboratory Press, New YorK, 1990.
10. Molecular Biotechnology (2nd Edn.), S.B. Primrose. Blackwell Scientific Publishers, Oxford, 1994
11. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.

Core Course III

B1BT03 - ENZYME ENGINEERING AND TECHNOLOGY

UNIT-I INTRODUCTION TO ENZYMES: INTRODUCTION: Introduction, Nomenclature and Classification of enzymes. Applications in Industrial, Medical, Analytical, Chemical, Pharmaceutical and Food Sectors. Enzyme isolation and purification.
SPECIFICITY OF ENZYME CATALYZED REACTIONS: Type of specificity, Active sites, Principles of catalysis- Collision theory, Activation energy and Transition state theory.

UNIT-II ENZYME KINETICS: KINETICS: Kinetics of single-substrate enzyme catalyzed reactions, Michaelis - Menten equations, Brigg‟s Haldane equation & estimation of constants using graphical techniques, Turnover number (k_{cat}). Kinetics for reversible reactions, Enzyme inhibition kinetics: reversible and irreversible inhibition, substrate, product and toxic substances inhibition.

UNIT-III PRE-STEADY–STATE AND MULTI-SUBSTRATE ENZYME KINETICS: PRE-STEADY–STATE KINETICS: Rapid mixing, Stopped flow and Relaxation techniques, Determination of the number of active sites of enzyme and determination of rate constants. Enzyme kinetics at limiting conditions: Dilute substrates, solid substrates and enzyme activity at interfaces.
KINETICS OF MULTI-SUBSTRATE REACTIONS: Mechanism for two substrates reactions, compulsory order, random order reactions and Ping-Pong mechanism. Kinetics of biphasic liquid systems, stabilization of biphasic aqueous-organic systems and equilibrium in biphasic aqueous-organic systems

UNIT-IV FACTORS AFFECTING ENZYME ACTIVITY & ACTIVE SITE STUDIES: FACTORS AFFECTING ENZYME ACTIVITY: Temperature and pH effects, thermal deactivation of enzymes. pH dependence: Ionization of Acids and Bases.
ACTIVE SITE STUDIES: The identification of binding sites and catalytic sites, Trapping the enzyme substrate complex, The use of Substrate analogues, Enzyme modification by chemical procedures affecting amino acids side chains, the enzyme modification by treatment with proteases and site-directed mutagenesis.

UNIT-V ENZYME IMMOBILIZATION & KINETICS OF IMMOBILIZATION: ENZYME IMMOBILIZATION & KINETICS OF IMMOBILIZATION: Immobilization of Biocatalysts an Introduction, Electrostatic effect, Effect of charged and uncharged support, Effect of external and internal mass transfer, Effect of Intra-particle diffusion with uncharged supports, Simultaneous external and internal mass transfer resistances and partitioning effects. Dam Kohler number and effectiveness factor.

TEXT BOOKS:

1. Blanch HW and Clark DS: Biochemical Engineering Marcel Decker 1987.
2. Enzymes ,Biochemistry , Biotechnology Clinical Chemistry : Trevor Palmer.2001

REFERENCE BOOKS:

1. Bailey JE, Ollis, DF: Biochemical Engineering Fundamentals, Prace and Stevens,
2. Handbook of Enzyme Biotechnlogy, 3rd Edition, Ellis Horwood Publication
3. Moser, A: Bioprocess technology, kinetics and reactors: Springer Verlag
4. Biochemical Engineering Principles and functions by Syed Trnveer Ahmed Inamdar, PHI Learning Private limited.

Core Elective I (Based on the educational background)

B1BT04 - BASIC ENGINEERING MATHEMATICS

UNIT-I QUADRATIC EQUATION: Roots of quadratic equation of the forms $ax^2+bx+c=0$ and simple properties of the quadratic roots.
THEORY OF EQUATIONS: Polynomial function, polynomial equation, reminder theorem, synthetic division, relation between the roots and coefficients of f(x) = 0, Transformation equations, Partial fractions.

UNIT-II TRIGONOMETRY: Relations related to compound angles, multiple and sub-multiples, transformations, hyperbolic functions

UNIT-III DIFFERENTIATION AND ITS APPLICATION: Concepts of limit, Continuity, Differentiation, Product and quotient rule, differentiation of Trigonometric, inverse trigonometric, logarithmic and exponential functions.
Applications of differentiation – problems on tangent, sub tangent normal, sub normal. Maxima and minima. Introduction to partial differentiation - Euler‟s theorem on Homogenous functions, errors and approximations.

UNIT-IV INTEGRATION AND ITS APPLICATION: Integration Basics, Methods of Integration, Methods of substitution, Integration by parts, Definite integrals and their properties, Application of definite integrals – Areas and lengths (Cartesian and Parametic). Trapezoidal rule and simpsons 1/3 rule.

UNIT-V ORDINARY DIFFERENTIAL EQUATIONS: Order and degree of a differential equation. Formation of and ODE by eliminating arbitary contants. Solution of First order and First degree differential equation. Method of variable separables, homogenous exact, linear and Bernoullis Equation. Application of differential Equations – Newton Law of cooling – Growth and decay – Logistics.

TEXTBOOKS:

1. Engineering Mathematics - N.P. Bali.
2. Engineering Mathematics - B.V. Ramana
3. Intermediate Maths Vol. I & II - Krishna Murthy, S. Chand

REFERENCE BOOKS:

1. Differential Calculus - Shanthi Narayana
2. Integral Calculus - Shanthi Narayana

Core Elective I

B1BT05 - BIOETHICS

OBJECTIVES

The course will provide Fundamental ethical to advanced clinical trial management Including drug development and trial planning; Project management in clinical trials; Consent and data protection; Quality assurance and governance

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UNIT I INTRODUCTION TO CLINICAL TRIALS

Fundamentals of clinical trials; Basic statistics for clinical trials; Clinical trials in practice;Reporting and reviewing clinical trials; Legislation and good clinical practice - overviewof the European directives and legislation governing clinical trials in the 21st century;International perspectives; Principles of the International Committee on Harmonisation(ICH)-GCP.33

UNIT II REGULATIONS OF CLINICAL TRIALS

Drug development and trial planning - pre-study requirements for clinical trials;Regulatory approvals for clinical trials; Consort statement; Trial responsibilities andprotocols - roles and responsibilities of investigators, sponsors and others;Requirements of clinical trials protocols; Legislative requirements for investigationalmedicinal products.

UNIT III MANAGEMENT AND ETHICS OF CLINICAL TRIALS

Project management in clinical trials - principles of project management; Application inclinical trial management; Risk assessment; Research ethics and Bioethics - Principlesof research ethics; Ethical issues in clinical trials; Use of humans in ScientificExperiments; Ethical committee system including a historical overview; the informedconsent; Introduction to ethical codes and conduct; Introduction to animal ethics;Animal rights and use of animals in the advancement of medical technology;Introduction to laws and regulation regarding use of animals in research.

UNIT IV INFORMED CONSENT

Consent and data protection- the principles of informed consent; Consent processes;Data protection; Legislation and its application; Data management – Introduction to trialmaster files and essential documents; Data management.

UNIT V QUALITY CONTROL AND GUIDELINES

Quality assurance and governance - quality control in clinical trials; Monitoring andaudit; Inspections; Pharmacovigilance; Research governance; Trial closure and pitfallstrialclosure; Reporting and legal requirements; Common pitfalls in clinical trialmanagement.

OUTCOME

The students will acquire knowledge in all aspect of clinical trials, management and ethical standards required to conduct clinical trials.

REFERENCES

1. Lee, Chi-Jen; etal., “Clinical Trials or Drugs and Biopharmaceuticals.” CRC / Taylor & Francis, 2011.
2. Matoren, Gary M. “The Clinical Research Process in the Pharmaceutical Industry.”Marcel Dekker, 1984.

Core Elective I (Based on the educational background)

B1BT06 - BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES

UNIT-I COLLOIDS OF BIOPOLYMERS AND THEIR PROPERTIES: Colloidal solutions of biopolymers and their electrochemical properties. Hydrodynamic properties: Viscosity, diffusion etc. of biopolymers; Molecular weight determination, osmotic pressure, reverse osmosis, and Donnan effect. Structure of Biomembranes and their electrochemical properties, membrane potential, action potential and propagation of impulses.

UNIT-II MICROSCOPY: Introduction to principles and working of light & Electron Microscope, Scanning Tunneling Microcopy, SEM, TEM, AIM, Sample preparation for Electron Microscopy.

UNIT-III: ELECTROPHORESIS & ADVANCED IMMUNO TECHNIQUES: Different methods of electrophoresis for protein, nucleic acids, small molecular weight compounds. Peptide mapping and combination of electro focusing and SDS-PAGE, Comet assay, Karyotyping, FISH, Rocket Immunoelectrophoresis, ELISA, RIA, western blot.

UNIT-IV SPECTROPHOTOMETRY AND RADIO ACTIVITY: Introduction to principles and applications of (a) spectroscopic methods (UV, Vis, IR, Fluorescence, ORD, CD & PAS) (b) NMR, ESR & Mass spectrometry. Uses of radioactive and stable isotopes and their detection in biological systems.

UNIT-V SEPARATION AND SEQUENCING TECHNIQUES: Automatic analyzer for amino acids, HPLC, UPLC (Reverse phase, ion exchange, size exclusion), cell sorters and their applications.

TEXT BOOKS:

1. Introduction to Biophysics by Pranab Kumar Banerjee, S Chand and company, 2008.
2. Instrumental methods of chemical analysis by G. R Chatwal and S .K Anand, Himalaya publishing house, 2008.

REFERENCE BOOKS:

1. Biotechnology Procedures and Experiments handbook by S. Harisha, Infinity Science Press LIC, 2008.

Core Elective II (Based on the educational background)

B1BT07 - PROCESS ENGINEERING PRINCIPLES

UNIT-I Process Calculations & Thermodynamics: Overview of Chemical Engineering, Concepts of Unit operations & Unit processes with examples, Units & Dimensions, Stoichiometric principles, Law of conservation of mass.
Thermodynamics: Scope of Thermodynamics, Force, Temperature, Volume, Pressure, Work, Energy, Heat, Heat capacities, Enthalpy, Law of thermodynamics.

UNIT-II Unit Operation & Fluid Mechanics: Introduction, Characterization of solid particles, Screen analysis, Size reduction – law of crushing, various types of size reduction equipment.
Fluid Mechanics: Fluid Flow, Newton‟s law of viscosity, Classification of Fluids, Hydrostatic Pressure, Manometers, Continuity equation, Bernoulli‟s equation & Its applications, Metering & Transportation of fluids using orifice meter, venture meter & Rota meter.

UNIT-III Heat Transfer: Modes of heat transfer with examples, Conduction – Fourier‟s law, one dimensional conduction through plane wall, composite wall, cylinder and spherical system.
Convection: Introduction, natural and forced convection, Concept of heat transfer coefficient, relationship between Individual and overall heat transfer coefficient.

UNIT-IV Radiation & Heat Transfer Equipment:
Radiation: Introduction, Black body, Laws of black body radiation; Kirchoff‟s law, Stefan-Boltzmann law, Wein‟s displacement law.
Heat Transfer Equipment: Overview of heat exchangers-types and temperature area graphs, Concept of LMTD. Concepts of Boiling & evaporation-types of boiling & its mechanism, types of evaporators.

UNIT-V Mass Transfer: Introduction, Molecular diffusion, Fick‟s law of diffusion, diffusivities of gases and liquids, Theories of mass transfer, Concept of mass transfer coefficients, Principles of Absorption, Adsorption, extraction, Distillation and Drying.

TEXT BOOKS:

1. Unit operations of Chemical Engineering, by W.L. McCabe, J.C. Simth and Harriott, McGraw Hill publishers.

REFERENCE BOOKS:

1. Bioprocess Engineering principles By Pauline M Doran, Academic Press.
2. Unit Operations-1, K. A. Gavhane, Nirali Prakashan Publication.
3. Introduction to Biochemical Engineering, Second edition, By D.G. Rao, Tata McGraw Hill Publications.

Core Elective II (Based on the educational background)

B1BT08 - BIOCHEMISTRY AND METABOLIC REGULATION

UNIT-I FUNDAMENTALS OF BIOCHEMISTRY AND BIOENERGETICS:
Fundamentals: Water, pH, pK, buffers, covalent bond, non-covalent interactions. **Bioenergetics:** free energy, enthalpy, entropy, laws of thermodynamics, high energy compounds.

UNIT-II BIOMOLECULES: Classification, physical and chemical properties of carbohydrates, lipids, amino acids and proteins; protein structural hierarchy, Ramachandran plot; nucleotides and nucleic acids; Pigments and storage materials.

UNIT-III METABOLISM: Catabolism of biomolecules: Carbohydrate metabolism - (GLYCOLYSIS, TCA cycle, Pentose phosphate pathway, HMP shunt, glycogen metabolism). Lipids - Fatty acid oxidation – saturated and unsaturated, fatty acids with even and odd no of carbon atoms. Proteins - deamination, transamination of amino acids – eg; L-Aspargine, L-valine, L-phenyl alanine.
Anabolism of biomolecules: Gluconeogenesis, Biosynthesis of lipids, Biosynthesis of amino acids – Glutamate, Tyrosine, Proline. Regulation of important metabolic pathways, role of key enzymes in metabolic control.

UNIT-IV MEMBRANE TRANSPORT AND SIGNAL TRANSDUCTION:
PLASMA MEMBRANE: Structure of plasma membranes. Transportation of molecules across plasma membrane.
SIGNAL TRANSDUCTION: Modes of cell signalling, Types of receptors used for cell signalling, pathway of intracellular signal transduction using secondary messengers.

UNIT-V STRATEGIES FOR METABOLIC CONTROL: Metabolic control: Need for control, control of enzyme activities, allosteric control and control by phosphorylation. Hormonal control of metabolism.

TEXT BOOKS:

1. Principles of Biochemistry A. Lehninger
2. Biochemistry and Molecular Biology, Third Edition by William H. Elliott and Daphne C. Elliott, Oxford University press.
3. Biochemistry L. Stryer Third Edition

REFERENCE BOOKS:

1. Biochemistry White, Handler and R.B. Smith 7th Ed.
2. Fundamentals of Biochemistry by J.L. Jain, Sunjay Jain AND Nitin Jain, S. Chand and Company Ltd.

Core Elective II (Based on the educational background)

B1BT09 - COMPUTATIONAL BIOLOGY

OBJECTIVE:
The course introduces students to biological data, tools and analysis. PERL programming language is introduced to provide skills in generating user defined scripts.

UNIT I : INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS
Molecular sequences, Genome sequencing: pipeline and data, Next generationsequencing data, Biological databases: Protein and Nucleotide databases, SequenceAlignment, Dynamic Programming for computing edit distance and string similarity,Local and Global Alignment, Needleman Wunsch Algorithm, Smith WatermanAlgorithm, BLAST family of programs, FASTA algorithm, Functional Annotation,Progressive and Iterative Methods for Multiple sequence alignment, Applications.

UNIT II PHYLOGENETICS
Introduction to Phylogenetics, Distance and Character based methods for phylogenetictree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees,Parsimonous trees, Additive trees, Bootstrapping.

UNIT III PROTEIN STRUCTURE, MODELLING AND SIMULATIONS
Protein Structure Basics, Visualization, Prediction of Secondary Structure and TertiaryStructure, Homology Modeling, Structural Genomics, Molecular Docking principles andapplications, Molecular dynamics simulations.

UNIT IV MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED TOPICS
Machine learning techniques: Artificial Neural Networks and Hidden Markov Models:Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays andClustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA computing.

UNIT V PERL FOR BIOINFORMATICS
Variables, Data types, control flow constructs, Pattern Matching, String manipulation,12 arrays, lists and hashes, File handling, Programs to handle biological data and parseoutput files for interpretationLaboratory Demonstrations forBiological Databases, Sequence alignment: BLAST family of programs, FASTA,ClustalW for multiple sequence alignment, Phylogenetics software, Homology Modelingand Model evaluation, AutoDock, GROMACS, Prokaryotic and Eukaryotic Gene findingsoftware, Programs in PERL.

OUTCOME:
At the end of the course, the student will acquire skills required for analysis of biological data and preparation of results. The skills acquired will help in interdisciplinary research.

TEXT BOOKS
1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge UniversityPress.

2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold SpringHarbor Laboratory Press, Second Edition, 2004.
3. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
4. Tisdall, James, Beginning PERL for Bioinformatics, O"Reilley Publications, 2001.
5. Andrew R. Leach, Molecular Modeling Principles And Applications, SecondEdition, Prentice Hall.

REFERENCES

1. Baldi, P., Brunak, S. Bioinformatics: The Machine Learning Approach, 2nd ed., EastWest Press, 2003
2. Baxevanis A.D. and Oullette, B.F.F. A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley, 2002
3. Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis:Probabilistic
4. Models of Proteins and Nucleic Acids. Cambridge University Press, 1998.
5. Proteomics from protein sequence to function: Edited by S.R.Pennington andM.J.Dunn, Taylor and Francis Group, 2001.

Open Elective I:

B1BT10 - ENVIRONMENTAL BIOTECHNOLOGY

UNIT-I INTRODUCTION TO AIR POLLUTION: Introduction to Environmental pollution, Air, water and soil pollution-common effects and control measures and monitoring of pollutants.
AIR POLLUTION TREATMENT: Treatment technologies, Biofilters and Bioscrubbers for treatment of industrial waste:

UNIT-II WASTE WATER TREATMENT: WATER: Water Pollution and treatment technologies (clean technology). Waste water types, major contaminants in waste water. Physical, chemical and biological methods of waste water treatment.
AEROBIC: Activated Sludge Process, Trickling Filters, Biological Filters, Rotating Biological Contractors, Fluidized Bed Reactor.
ANAEROBIC: Contact Digesters, Packed Column Reactors, UASB biological treatment process

UNIT-III WASTE MANAGEMENT: Management of Contaminated land**,** lake sediments and Solid Waste, Anaerobic digestion, Biostimulation, Bioaugmentation, Phytoremediation, Natural attenuation, Vermicomposting

UNIT-IV BIOREMEDIATION: Bioremediation Technologies: Definition, constraints and priorities of bioremediation, Types of bioremediation, *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation. Bioremediation of Hydrocarbons and lignocellulosic Compounds.

UNIT-V BIOENERGY & BIOMINING: BIO ENERGY: Energy and Biomass Production from wastes, biofuels, bio hydrogen and biomass.
BIOMINING: Bioleaching, microbial enhanced oil recovery, microbial fuel cells.

TEXT BOOKS:

1. Wastewater Engineering - Treatment, Disposal, and Resuse, Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.
2. Industrial Pollution Control Engineering- AVN Swamy., Galgotia Publication, (2006).
3. Environmental Biotechnology - Allan Stagg.

Open Elective II

B1BT11 - BIOBUSINESS MANAGEMENT

UNIT I: INTRODUCTION TO BIOBUSINESS: Principles of business management and concept of Biobusiness, SWOT analysis of Indian Biobusiness. **Project formulation** Project formulation and selection based on size, technological assessment, technical report, feasibility and commercial viability of project.

UNIT II: PROJECT COST AND MARKET POTENTIAL: Total product cost, capital investment and profitability, manufacturing cost estimation, capital investment estimation, Risk capital and working capital, manufacturing cost estimation for an intracellular protein, using cost analysis for R& D decision making.

UNIT III: LEGAL PROTECTION IN BIOTECHNOLOGY: Regulatory and IPR issues in Biotechnology, Intellectual Property Protection (IPP), Trade secret protection, licensing of bio-product, procedure for obtaining US patent, characteristics of the disclosure for a biotechnology invention, marketing a biotechnology invention, trade regulations.

UNIT IV: BIO-SAFETY: General guidelines (GLP, GMP), containment facilities, types of containment, guidelines for recombinant DNA research, release of genetically modified organisms (GMOs), ISO Series, GATT.

UNIT V: INDUSTRIAL SICKNESS: Symptoms, Control and rehabilitation and sick units. **Ethics in Biotechnology:** Statutory requirements of social responsibility and entrepreneurial discipline.

BOOKS:

1. Patent Law - P. Narayan
2. Economic reforms and Indian markets - S. L Rao
3. Manual of Industrial Microbiology and Biotechnology - A. L. Demain and N.A. Solomon

Open Elective II

B1BT12 - COMPUTER AIDED LEARNING OF STRUCTURE AND FUNCTION OF PROTEINS

UNIT I COMPONENTS OF PROTEIN STRUCTURE Introduction to Proteins, structure and properties of amino acids, the building blocks of Proteins, Molecular Interactions and their roles in protein structure and function,Primary Structure – methods to determine and synthesis

UNIT II PROTEIN BIOINFORMATICS
Protein sequence and structural databases, Multiple sequence alignment, Secondary, Tertiary and Quaternary Structure of Proteins; Sequence and Structural Motifs; Protein folding

UNIT III OVERVIEW OF STRUCTURAL AND FUNCTIONAL PROTEINS
Classes of Proteins and their Structure Function Relationships – alpha, beta, alpha/beta proteins, DNA-binding proteins, Enzymes, IgG, membrane proteins

UNIT IV PROTEIN STRUCTURAL CLASSIFICATION DATABASES
SCOP and CATH. Evolutionary relationships and Phylogenetic Studies

UNIT V PROTEIN MODIFICATIONS
Post translational modifications, Engineering of proteins, Site directed mutagenesis, Fusion Proteins, Chemical derivatization.

REFERENCES
1. Biochemistry, 3rd Edition by Donald J. Voet, Judith G. Voet, 2004 John Wiley & Sons Publishers, Inc
2. Introduction to Protein Structure, 2nd Edition, Carl Branden and John Tooze, 1999, Garland Publications, New York
3. Proteins – Structures and Molecular Properties, 2nd Edition, Thomas E. Creighton, W. H. Freeman and Company, New York

B1BT13 - PROCESS ENGINEERING PRINCIPLES AND MOLECULAR BIOLOGY LAB

LIST OF EXPERIMENTS:

PART-A

Fluid Mechanics

1. Reynold‟s apparatus (Demo)
2. Bernouli‟s Theorem (Verification)
3. Determination of friction factor of Pipeline
4. Determination of Coefficient of Discharge by venturimeter, orifice meter and notch
5. Flow measurement with Rotameter

Heat Transfer

1. Thermal Conductivity of insulating material
    a. Searles‟ apparatus
    b. Concentric sphere
    c. Lee‟s disc apparatus
    d. Lagged pipe
2. Heat Transfer coefficient from a vertical tube and free convection

PART-B

1. Isolation of Chromosomal DNA from E.coli
2. Isolation and analysis of Plasmid DNA
3. Restriction digestion
4. Ligation
5. Preparation of competent cells
6. Transformation & checking for transformants
7. Electrophoresis of nucleic acid DNA
8. Isolation of Auxotrophic mutants by replica plate methods.

SEMESTER II

Core Course IV

B1BT15 - BIOREACTOR ENGINEERING

UNIT-I: BIOREACTORS: Different types of Bioreactor, Different modes of operation, Main components of the bioreactor and their functions. Bioreactor design: Batch reactor, cell death in batch reactor, chemostat, endogenous metabolism, maintenance, product & substrate inhibition on chemostat, multiple steady state analysis, enzyme catalysis in CSTR, cascade reactor, plug flow reactor, fed batch reactor, Chemostat with cell recycle and feed forward control.

UNIT-II: MASS TRANSPORT IN BIOREACTORS: Introduction of mass transfers, Gas-liquid mass transfer in cellular systems, basics mass transfer concepts, solubility of gases (O_2, CO_2) in biological media, Mass balance for two-phase bioreactor. Bubble column, bubble generation at an orifice, bubble coalescence and breakup, Gas holdup, interfacial area, Immobile and mobile gas liquid interface, Regimes of bubbles, Design of bubble columns. Experiment determination of k_La, static method, dynamic method and chemical method. Oxygen uptake by cell cultures.

UNIT-III: MOMENTUM TRANSPORT IN BIOREACTORS: Rheology of Fermentation Broths: Rheology Properties, Factors affecting broth viscosity, mixing equipment, Flow patterns in agitated tanks, Mechanism of Mixing, Assessing Mixing effectiveness Power requirement for mixing: Ungassed Newtonian fluids, Ungassed Non-Newtonian fluids.

Momentum transport in Stirred tank Bioreator: Agitator Design & Operation- Radial flow impellers, Axial flow impellers, Agitator design for low Viscous and High Viscous fluids. Laminar and turbulent flow in stirred tank bioreactors, Kolmogorov eddy size, preventing vortex formation, off centre impellers, baffles. Oxygen delivery systems: Sparger design, Effect of impeller speed.

UNIT-IV :CASE STUDIES: Introduction, Design of Packed Bed Bioreactor: Design of a packed bed reactor for a bio-film growth on support system, Specific design, Design of packed bed bioreactor packed with immobilized whole cell catalysts; Airlift Bioreactors: Classification, Type of analysis and parameters to measure; Hollow Fiber Bioreactor (HFBR), Plant Cell Bioreactor: Classes and Design of Bioreactor, Design of Bioreactors for Solid State Fermentaion (SSF), Mammalian Cell Bioreactor Design: Fermentor balancing for semi-continuous multi-tank mammalian cell culture process.

UNIT-V NON IDEAL REACTORS AND SCALE UP & SCALE DOWN OF BIOREACTORS: Introduction, Non ideal parameters, Residence Time Distribution, E(t) or F(t) and the bioreactor design, Models for Non ideal flow, Application of RTD based models to Non ideal bioreactors.

SCALE-UP & DOWN OF BIOREACTOR AND CONTROL OF BIOREACTOR: Scaling up and down of bioreactors, based on rules-of-thumbviz., constant (P/V), K_La etc., Control of bioreactor, Sensor used in the bioreactor, pH, O_2, CO_2 electode. Online sensors for cell properties, Direct regulatory control and cascade control mechanisms.

TEXT BOOKS:

1) Blanch HW and Clark DS: Biochemical Engineering Marcel Decker Year of Publication 1987
2) Bioreactors Analysis and Design: Tapobrata Panda, Tata McGraw Hill Year of publication 2011

REFERENCE BOOKS:

1) Bailey JE, Ollis DF; Biochemical Engineering fundamentals Year of Publication 1986
2) Pauline M. Doran: Bioprocess Engineering Principles, Elsevier Publications.

Core course V

B1BT16 - IMMUNOLOGY AND IMMUNOTECHNOLOGY

UNIT-I INTRODUCTION : **Immune system and organs of the immune system:** Phylogeny of Immune System - Innate and acquired immunity - Clonal nature of immune response, antigens, immunogens, super antigens. **Lymphoid organs:** Lymphoid follicle, Thymus, Lymph node, Spleen, MALT, GALT, SALT. **Cells of the immune system:** Hematopoiesis and differentiation, Macrophages, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast-Cells.

UNIT-II: HUMORAL IMMUNITY AND APPLICATIONS:
B cell types, B cell receptors and activation, Immunoglobulin diversity, Antibody structure and function, Antigen- antibody interactions (including ADCC), antibodies in diagnosis, Hybridoma technology, B cell memory.

UNIT-III: T CELLS AND CELL MEDIATED IMMUNITY:
MHC restriction, Antigen presentation, T cell subsets and functions of each, T cell activation and regulation, Cell mediated immune functions- cytotoxicity, interferon; T cell memory - Central and peripheral.

UNIT-IV: AUTOIMMUNITY AND TRANSPLANTATION IMMUNOLOGY:
Autoimmune disorders: Rheumatoid arthritis, Insulin dependent Diabetes Mellitus
Transplantation: Transplantation

UNIT V: IMMUNOTHERAPY, VACCINES AND ADJUVANTS:
Immune response to infectious diseases (humoral, cell-mediated, examples), Vaccines – Types , technologies, Adjuvants – Function, mechanism of action, new generation adjuvants, Immunotherapy – antibodies (polyclonal, monoclonal), cytokines, cell therapy, diseases (HIV, HCV).

TEXT BOOKS:

1. Kuby Immunology (Kindt, Kuby Immunology) - Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, publisher: W. H. Freeman, 2006
2. Immunology- David Male, Jonathan Brostoff, David Roth, Ivan Roitt, publisher: Mosby, 2006

REFERENCE BOOKS:

1. Fundamental Immunology- William E Paul, publisher: Lippincott Williams & Wilkins, 2008
2. Immunology, Infection, and Immunity - Gerald B. Pier, Jeffrey B. Lyczak, Lee M. Wetzler, publisher: ASM Press, 2004
3. Lecture Notes: Immunology, 5th Edition- Ian Todd, Gavin Spickett, publisher: Wiley-Blackwell, 2005
4. Immunology: A Short Course- Richard Coico, Geoffrey Sunshine, publisher: Wiley-Blackwell, 2009

5. Cellular and Molecular Immunology- Abul K. Abbas MBBS, Andrew H. Lichtman MD PhD, Shiv Pillai MD, publisher: Saunders, 2007
6. Roitt's Essential Immunology (Essentials) - Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt, publisher: Wiley-Blackwell, 2006
7. Schaum's Outline of Immunology- George Pinchuk, publisher: McGraw-Hill, 2001.

Core Course VI

B1BT17 - DOWNSTREAM PROCESSING

UNIT-I: SCOPE OF DOWNSTREAM PROCESSING: Importance of Down Stream Processing (DSP) in Biotechnology, characteristics of products, criteria for selection of bio-separation techniques. Role of DSP methods in bioprocess economics. **Cell Disruption Methods:** Various cell disruption methods, need for cell disruption for intracellular products (Homogenizer, French press & Dynomill), cell disruption equipment. Applications in bio-processing. **Flocculation:** Principles of flocculation, various flocculating agents, applications in bio-processing. **Coagulation:** Principles of coagulations and its applications in bio-processing.

UNIT-II SOLID- LIQUID SEPARATION:
Filtration: Principles, filter aids, Types of filtrations, constant and continuous (TFF), depth filtration, constant volume filtration, constant pressure filtration, specific cake resistance, equivalent cake thickness, filtration equipments viz; plate and frame filter press, vacuum filters, leaf filters. **Sedimentation:** Principles of particle settling, batch sedimentation equipment viz., thickener. **Centrifugation:** Principles of centrifugation, centrifuge effect, g-number, sigma factor, various centrifuges viz., basket centrifuge, tabular centrifuge, disc-bowl centrifuge, scale –up of centrifuges.

UNIT-III: ADSORPTION: adsorption equilibria and isotherms, principles of adsorption, adsorption equipment, applications. **Precipitation:** Principles of precipitation, precipitation equipment, applications in bio-processing. **Foaming:** Principles of foaming, various foaming agents and their interaction with the products, applications in bioprocess. **Liquid-liquid Extraction;** Extraction process and principles, phase equilibrium and distribution, batch and continuous extraction, co-current and counter current extraction processes, L-L-E equipment. Applications in bio-technology.

UNIT-IV: SEPARATION AND PURIFICATION PROCESSES: Basic principles of membrane separation, membrane characteristics, different types of membranes, criteria for selection of membranes.
Chromatographic and Electrophoresis Methods: Principles of chromatographic separation methods, different types of chromatographic methods, viz., adsorption chromatography, ion – exchange chromatography, gel chromatography, affinity chromatography etc. with applications in bio-processing.
Principles of electrophoresis, SDS- PAGE, Hydrophobic chromatography, 2D gel electrophoresis, capillary electrophoresis.

UNIT-V: SCALE-UP AND SCALE DOWN OF DOWNSTREAM UNIT OPERATIONS:
Crystallization: Principles of crystallization, crystallization equipment. Applications in bio-processing. **Drying:** Various types of drying methods, principles of drying, EMC-RH data, drying curves, various types of industrial dryers and their criteria for choice. Freeze drying technique and its advantages over other methods. Applications in bio-processing. Overview.

TEXT BOOKS:

1. Genekopolis, Transport phenomena and Unit Process.
2. Bailey and Ollis, Biochemical Engineering Principles
3. Blanch, Biochemical Engineering
4. Mc Cabe and Smith, Unit Operations in chemical Engineering
5. Principles of Fermentation Technology by Peter F Stan bury, Allan Whitaker and Stephen J Hall, Pergamon Publications.

REFERENCE BOOKS:

1. Separation Process in Biotechnology edited by Juan A. Asenjo, Taylor & Francis Group
2. Comprehensive Biotechnology Vol.2 Edition, M. Moo –young (1985).
3. Product Recovery in Bioprocess technology, BIOTOL series, Butterworth – Heinemann.

Core Elective III

B1BT18 - PLANT BIOTECHNOLOGY

UNIT-I PLANT TISSUE CULTURE & TOTIPOTENCY: Totipotency, Biotechnological applications of plant tissue culture, Establishment of aseptic cultures, Initiation of callus and suspension cultures, Nutritional components of tissue culture media.

UNIT-II TISSUE CULTURE TECHNIQUES-I: Regeneration of plants, Organogenesis, Micropropagation with shoot apex cultures (Clonal Propagation), Somatic Embryogenesis. Anther and Pollen culture, Production of haploids and their application, Storage of plant genetic resources (Cryopreservation), Somaclonal variation, Commercial production of plants – Automation. Selection of callus, cell lines – Utilization of artificial, neural networks.

UNIT-III TISSUE CULTURE TECHNIQUES-II: Isolation and culture of protoplasts, protoplast fusion and somatic hybridization, Selection systems for somatic hybrids / Cybrids and their characterization, Production of Secondary metabolites by plant cell cultures, commercial production of secondary metabolites, Technology for yield enhancement and bioreactor system and models for mass cultivation of plant cells. Biotransformations using plant cell cultures, Elicitation, permeabilization, immobilization and in situ product recovery.

UNIT-IV TRANSGENIC TECHNOLOGY-I: Genetic Transformation methods for production of transgenic plants (Direct, Indirect), In planta genetic transformation, Direct Gene Transfer (DGT) methods, Agrobacterium mediated genetic transformation (Indirect), Chloroplast transformation and production of transplastomics.

UNIT-V TRANSGENIC TECHNOLOGY-II: Production of genetically modified plants/crops for agronomic traits, transgenic plants for biotic and abiotic stress tolerance, transgenic plants for quality traits, Industrial enzymes, Molecular farming for therapeutic protein (Plantibodies, Plantigens, Edible Vaccines).

TEXT BOOKS:

1. “Plant Cell, Tissue, and Organ culture” by J Reinert and Y P S Bajaj.
2. Plant Tissue Culture Theory and Applications Bhojwani SS and Razdan ,Elsevier Publication.

REFERENCE BOOKS:

1. Plant Biotechnology New Products and Applications. Hammond PM and Yusibov V. Springer
International Edition.
2. “Plant Tissue Culture” Thorpe, T.A. (Ed.).
3. “Handbook of Plant Cell Culture” Eds. Sharp et al.
4. “Plant Biotechnology” Eds. Mantell & Smith

Core Elective III

B1BT19 - APPLIED FOOD BIOTECHNOLOGY

Unit I

Food Biotechnology: Introduction & Applications; Methods for the microbiological examination of water and foods; Control of Microbiological quality and safety; Food borne illnesses and diseases; Microbial cultures for food fermentation, their maintenance, strain development

Unit II

Starter cultures–types, designing and development, micro encapsulation and packaging, scopes and challenge; Development and formulation of novel products such as probiotic foods. Nutrogenomics-concept, working, significance and relevance. Biosensors and novel tools and their application in food science & Technology

Unit III

GM foods: Introduction and controversies related to GMOs. Ethical issues concerning GM foods; testing for GMOs; current guidelines for the production, release and movement of GMOs; labelling and traceability; trade related aspects; biosafety; risk assessment and risk management. Public perception of GM foods. IPR. GMO Act–2004. New products and processes in various food commodities including plant and animal products.

Unit IV

Production of organic acids (vinegar, lactic acid), alcoholic beverages (beer, wine, and distilled alcoholic beverages such as whiskey, rum, vodka), glycerol; Propagation of baker's yeasts;

Unit V

Microbial production of vitamins (B2 and B12), antibiotics (penicillin, streptomycin, tetracycline); Enzymatic production of glucose, fructose, starch, SCP and mushrooms

Text/References:

1. Industrial Microbiology Prescott & Dunn, CBS Publishers
2. Modern Food Microbiology by Jay JM, CBS Publishers
3. Comprehensive Biotechnology by Murray & Mooyoung, Academic press
4. Industrial Microbiology by Casida L.R., New Age International Pvt. Ltd.
5. Food Microbiology; Frazier WC; 4th ed, Tata-McGrowhill Pub.
6. Microbiology by Pelczar, Chan, and Krieg, TMH
7. Fermentation Biotechnology, Principles, Processed Products by Ward OP, Open University Press.
8. Lee, B. H. Fundamentals of Food Biotechnology.VCH. 2006

Core Elective III

B1BT20 - BIOCATALYSTS AND ENZYME TECHNOLOGY

OBJECTIVES

The course intends to give advanced knowledge about Biocatalysts, Enzyme kinetics, immobilization and enzymatic biotransformation of drugs

UNIT I BASICS OF ENZYMES AS BIOCATALYSIS

Introduction to enzymes, Classification, Sources, Mechanism of enzyme action.Strategies of purification of enzymes, criteria of purity, molecular weight determinationand characterization of enzymes , Enzymes of biological importance -Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG CoA reductase inhibitors, pseudocholinesterase, 5 -nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes

UNIT II KINETICS OF ENZYME ACTION

Methods for investigating the kinetics of Enzyme catalysed reactions – Initial velocityStudies, Estimation of Michaelis Menten parameters, Effect of pH and temperature onenzymeactivity, kinetics of inhibition. Modeling of rate equations for single and multiplesubstrate reactions.

UNIT III IMMOBILIZED ENZYMES

Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect ofsolute,partition & diffusion on the kinetics of immobilized enzymes, design andconfiguration of immobilized enzyme reactors; applications of immobilized enzymetechnology, Economic argument for immobilization

UNIT IV ENZYMES IN FUNCTIONAL GROUP TRANSFORMATION

Functional group interconversion using enzymes (hydrolysis reaction,oxidation/reduction reactions, C-C bond formations), Retrosynthetic biocatalysis,Chemoenzymatic synthesis of natural products. Industrial process using enzymes forproduction of drugs, fine chemicals and chiral intermediates.20

UNIT V ENZYMATIC TRANSFORMATION

Reaction engineering for enzyme-catalyzed biotransformation. Catalytic antibodies.Biocatalysts from extreme Thermophilic and Hyperthermophilic microorganisms (extremozymes). The design and construction of novel enzymes, artificial enzymes,Biotransformation of drugs (hydroxylation of Steroids), Host Guest Complexationchemistry, enzyme design using steroid templates, enzymes for production of drugs,fine chemicals and chiral intermediates.

OUTCOME

The students will acquire knowledge in all aspect of Biocatalysis, enzyme kinetics and immobilization. The enzymatic transformation will give theoretical idea about drugbiotransformation.

TEXT BOOKS / REFERENCES

1. Blanch, H.W., Clark, D.S. Biochemical Engineering, Marcel Dekker, 1997
2. Lee, James M. Biochemical Engineering, PHI, USA, 1982.

3. Bailey J.E. & Ollis, D.F. Biochemical Engineering Fundamentals, 2nd Ed., McGraw Hill, 1986
4. Faber, Kurt “Biotransformations in organic chemistry : A Textbook” 5th Edition. Springer 2008.
5. Enzyme catalysis in organic synthesis (Vol I-III); Eds by K.Drauz and H. Waldmann. Willey-VCH (ISBN: 3-527-29949-1)
6. Hydrolases in organic synthesis (regio and stereoselective biotransformations). U. T. Bornscheuer and R. J. Kazlauskas. Willey-VCH. (ISBN: 3-527-30104-6).
7. Stereoselective biocatalysis. Ed. R.N. Patel. Marcel Dekker. (ISBN: 0-8247- 8282-8

Core Elective IV

B1BT21 - ANIMAL CELL SCIENCE AND TECHNOLOGY

UNIT-I BASICS OF ANIMAL CELL AND ITS CULTURING: Structure and organization of an animal cell, Types of animal cell culture – cell culture, organ/tissue culture, organotypic culture and histotypic culture, Equipments and materials needed for animal cell culture technology.

UNIT-II ANIMAL CELL CULTURE MEDIUM AND ITS COMPONENTS AND THEIR SIGNIFICANCE: Introduction to the balanced salt solutions and growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium, Role of carbon-di-oxide and role of serum and its supplements in maintaining cells in culture medium, Serum and protein free defined media and their application

UNIT-III BASIC TECHNIQUES OF MAMMALIAN CELL CULTURE *in vitro*: Primary and established cell lines, Biology and characterization of the cultured cells, measuring parameters of growth. Maintenance of cell culture, Cell separation, Cell transformation, Cell synchronization, Measurement of viability and cytotoxicity, Apoptosis – characteristic features and molecular mechanisms, Measurement of cell death.

UNIT-IV ENGINEERING ANIMAL CELLS: Somatic cell genetics, Cell culture based vaccines, Genetic engineering of mammalian cells in culture, Scaling up of animal cell culture, Stem cell cultures – embryonic and adult stem cells and their applications.

UNIT-V APPLICATIONS OF ANIMAL CELL CULTURE: Three dimensional culture and tissue engineering, Applications of animal cell culture technology (heterologous, Primary culture/CEF culturing, Protein Expression).

BOOKS:

1. Culture of Animal Cells, (3rd Edition), Fl. !an Froshney. Wiley-Liss.
2. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD,
3. Cell Growth and Division: A Practical Approach. Ed. R. Basega, IRL Press.
4. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd..Oxford.
5. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P Mather and David Barnes. Academic Press.

Core Elective IV

B1BT22 - ADVANCED GENETIC ENGINEERING

OBJECTIVE

This course provides conceptual knowledge in the Cloning and Expression of genes,but alsofor knowledge for the construction of DNA libraries and Sequencing of DNA,PCR and mutagenesis Gene transfer and Gene therapy to students.

UNIT I CLONING AND EXPRESSION OF GENES

Overview of Restriction and Modification system. Cloning vehicles: Plasmids – Host range,Copy number control, Compatibility. λ phage – Insertional and Replacement vectors, in vitro packaging. Single strand DNA vector – M13 Phage. Cosmids, Phasmids, PAC,BAC and YAC. Expression vector – Characteristics, RNA probe synthesis, High level expression of proteins, Protein solubilization, purification and export.

UNIT II CONSTRUCTION OF DNA LIBRARIES

DNA library – Types and importance. cDNA library: Conventional cloning strategies –Oligo dT priming, self priming and its limitations. Full length cDNA cloning – CAPturemethod and Oligo capping. Strategies for gDNA library construction – Chromosomewalking. Differences between gDNA and cDNA library. Screening strategies –Hybridization, PCR,Immunoscreening, South-western and North-Western. Functionalcloning – Functional complementation and gain of function. Difference cloning:Differential screening, Subtracted DNA library, differential display by PCR. Overview on microarray and its applications.

UNIT III DNA SEQUENCING

DNA sequencing – Importance, Chemical and Enzymatic methods, Pyrosequencing,Automated sequence, Genome sequencing methods – top down approach, bottom up approach.

UNIT IV PCR AND MUTAGENESIS

PCR – Principle and applications. Different types of PCR – Hot start PCR, Touchdown PCR, Multiplex PCR, Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR,Assembly PCR, Asymmetric PCR, LATE-PCR, Colony PCR, in situ PCR, Long PCR.Real-time PCR – SYBR Green assay, Taqman Probes, Molecular beacons.Mutagenesis and chimeric protein engineering by PCR, RACE, Kuntels‟ method of mutagenesis.

UNIT V GENE TRANSFER AND GENE THERAPY

Introduction of foreign genes into animal cells and Importance, DNA Microinjection.Retroviral vectors, Trasnsfection of Embryonic stem cells and recombination.Transgenic plants and their Importance, Ti Plasmid, Cointegrate and Binary vectors. Anoverview of Gene therapy.

OUTCOME

Having studied this course the students will gave the skills and state-of-art advanced molecular methods to help them design and execute complex molecular Biology experiments and design of transgenics and novel recombinant protein.

TEXT BOOKS / REFERENCES:

1. Primrose S.B., Twyman R.H., and Old R.W. “Principles of Gene Manipulation”. 6th Edition. Blackwell Science, 2001
2. Winnacker E.L. “From Genes to clones: Introduction to Gene Technology”.Panima, 2003
3. Glick B.R. and Pasternak J.J. “Molecular Biotechnology: Principles and applications of recombinant DNA” 3rd Edition, ASM Press, 2003
4. Lemonie, N.R. and Cooper, D.N. Gene Therapy, BIOS, 1996.

Core Elective IV:

B1BT23 - BIOINFORMATICS AND SYSTEMS BIOLOGY

UNIT-I INTRODUCTION TO BIOINFORMATICS & SEQUENCING ALIGNMENT CONCEPTS:
Need of Computers in Biotechnology Research; File Transfer Protocol (FTP), TELNET,HTTP; Bioinformatics- Introduction, Scope, Applications; Strings, Edit distance, Pair wise Alignment-Local, Global alignment; Gap- Gap penalty; Comparison of Pair wise and Multiple alignment.

UNIT-II BIOLOGICAL DATABASES AND DATAMINING: Biological Information on the web, Introduction to databases; Classification of Biological databases; Information retrieval from Databases; Sequence database search- FASTA, BLAST; Amino acid substitution matrices- PAM and BLOSUM; Data Mining and Visualization (RASMOL). **PHYLOGENETIC ANALYSIS AND PREDICTION:** Understanding Evolutionary process; Origins of Molecular Phylogenetics; Common Multiple Sequence alignment methods; Phylogenetic analysis: Methods, Tools & Problems (Clustal W).

UNIT-III: GENOME MAPPING AND PREDICTION: Genome sequencing; Genome Mapping; Comparative Sequence Analysis; Gene Prediction Methods &Tools, Gene Annotation; Human Genome Mapping (HGP). **RNA SEQUENCE AND STRUCTURE ANALYSIS** - si-RNA design and development, micro RNA identification strategies, RNA secondary structure, RNA structure Prediction Methods.

UNIT-IV PROTEIN STRUCTURE PREDICTION METHODS: Basics of Protein biology (Classification, Structural Organization, Domains & Motifs); Protein Structure Prediction Concepts : Secondary & Tertiary Structure Predictions (Chou-Fasman Method, GOR Method, Neural Network method, Homology Modeling, Abintio method, Threading methods).

UNIT V: INTRODUCTION TO SYSTEMS AND SYNTHETIC BIOLOGY: Genomics, transcriptomics, proteomics and metabolomics as a foundation for Systems Biology, Objectives of Systems Biology – holistic approach to solve biological problems, Strategies relating to *in silico* modeling of biological processes, Gene, protein and metabolic networks, Signal transduction pathways, Gene expression patterns, Synthetic Biology – Introduction and Artificial synthesis of DNA, peptides and chromosomes – Applications.

TEXT BOOKS:

1. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta & P Rastogi.
2. Bioinformatics Basics, Applications in Biological Science and Medicine- Hooman
3. Bioinformatics: Genome and sequence analysis by David W Mount.
4. Bioinformatics: A practical guide to analysis of genes and proteins by Baxevanis, Andreas D Wiley – Interscience publishers.
5. Principles of biological Databases by P. B. Kavi kishor and L.N. Chavali.

REFERENCE BOOKS:

1. Computational Molecular Biology – An Introduction by Peter Clote, Rolf Backofen, John Wiley & Sons.
2. Essential Bioinformatics: by Jin Xiong, Cambridge University Press
3. Bioinformatics Principles & Applicatrions by Zhumur Ghosh, Oxford University Press

Open Elective II

B1BT24 - BIO ETHICS , BIOSAFETY & INTELLECTUAL PROPERTY RIGHTS

UNIT I: BIOETHICS: PRINCIPLES OF BIOETHICS, ETHICS IN CLINICAL RESEARCH: History structure regulation impact of Ethics in all aspects of health care, historical cases, negligence, informed consent, mental competence, Bioethics in Microbial (Bioterrorism), Plant (GMO) & Animal (Stem Cells, Cloning, human embryos and IVF), shared responsibilities for decisions and the understanding of the risk.

UNIT II: BIOSAFETY CONCEPTS & REGULATIONS: Definition of Biosafety, Biosafety for human health and environment, Assessment of Biological hazard, Levels of biosafety for microbes, plants & animals, Cartagena protocol, Use of genetically modified organisms and their release in to the environment.Special procedures for r-DNA based products. International dimensions in Biosafety. Biotechnology and food safety. Case study – Bt Cotton, Bt Brinjal

UNIT III: INTRODUCTION TO IPR & PATENTS: Discovery, Creativity, Innovation, Invention, Need for IPR, Types of IPR, Genesis & development of IPR in India, Definition, Scope, Protection, Patentability Criteria, Types of Patents (Process, Product & Utility Models), Software Patenting. Types of searching, public & private searching Databases. Drafting & Filing of Patent applications, Patent Cooperation Treaty (PCT). Patent infringement.

UNIT IV: OTHER TYPES OF IPR: Copyrights – Definition, granting, infringement, searching & filing, distinction between copy rights and related rights; Trade Marks - role in commerce, importance, protection, registration, domain names; Trade Secrets, Unfair competition; Industrial Designs – Scope, protection, filing, infringement; Semiconductors, Integrated Circuits & Layout design; Geographical Indications & Appellations of Origin; Case Studies.

UNIT V: IPRS AND BIOTECHNOLOGY: Plant variety Protection, Farmers & Breeders Rights, Indian Biodiversity Act, Protection of Traditional Knowledge, Biopiracy & Bioprospecting, ITPGRFA, Budapest Treaty & IDA, Biotechnology Patenting issues, Gene Patenting, Case studies (Diamond vs Chakravarthy, Dimminaco AG vs. Controller of Patents, Basmati Rice, Turmeric, Neem, Harvard Oncomouse, Transgenic Plant Patents)

TEXT BOOKS:

1. Bioethics – Shaleesha A Stanley, Wisdom Educational Service, Chennai, 2008
2. V Sree Krishna. Bioethics & Biosafety in Biotechnology. New age International Publications, 2007.
3. Deborah E. Bouchoux, Intellectual Property for Paralegals – The law of Trademarks, Copyrights,
4. Patents & Trade secrets, 3rd Edition, Cengage learning, 2012
5. N.S. Gopalakrishnan & T.G. Agitha, Principles of Intellectual Property, Eastern Book Company, Lucknow, 2009.

REFERENCES:

1. Singer, Peter A.; Viens, A.M. (2008), Cambridge Textbook of Bioethics, Cambridge: Cambridge University Press, ISBN 978-0-521-69443-8
2. Anitha Rao R & Bhanoji Rao "Intellectual Property Rights – A Primer", Eastern Book Company, 2008.
3. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.
4. M. M. S. Karki , Intellectual Property Rights: Basic Concepts, Atlantic Publishers, 2009
5. Neeraj Pandey & Khushdeep Dharni, Intellectual Property Rights, Phi Learning Pvt. Ltd
6. Ajit Parulekar and Sarita D‟ Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd, 2006.
7. B. L. Wadehra. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000.
8. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010

Open Elective II

B1BT25 - PHARMACEUTICAL BIOTECHNOLOGY

UNIT I: PROKARYOTIC AND EUKARYOTIC CELLS IN BIOTECH PRODUCTION: Actinomycetes in Biotech Production, *Saccharomyces cerevisiae* and Other Fungi in Biotech Production, Plants in Biotech Production, Transgenic Plants as Functional Foods or Neutraceuticals Transgenic Plants and Plant Cell Culture as Bioreactors of Secondary Metabolites, Transgenic Plants as Bioreactors of Recombinant Protein.

UNIT II: DRUG MODIFICATIONS: Pharmacodynamics of protein therapeutics; Chemical modification of proteins/ therapeutics; Immuno suppressor in antibody therapy; Pharmaco Genomics.**,**Molecular modification of lead compounds; Assay systems and models (e.g., Knockout Mice). Antisense technology as cell based therapeutics.

UNIT III: PHARMACEUTICALS PRODUCTION IN PLANTS: Drugs derived from plants, , Antitumor agent - Etoposide, Colchicine, Taxol, Vinblastine, Vincristine. Cardiotonic – Convallatoxin, Acetyldigoxin, Adoniside, Antiinflammatory – Aescin, Bromelain, Choleretic – Curcumin, Biopharmaceuticals Expressed in Plants Alternative Expression Systems, Three Promising Examples: Tobacco (Rhizosecretion, Transfection) and Moss (Glycosylation).

UNIT IV: DNA VACCINES AND ANTIBODY DRUG: DNA Vaccine Construction and Immunology DNA Vaccine Expression Plasmids Delivery of DNA Vaccines. Peptide vaccine, Gene Pharming, Cytokines as biopharmaceuticals, Rituximab, therapeutic enzymes.

UNIT V: BIOGENERIC DRUGS RECOMBINANT THERAPEUTIC PROTEINS: Erythropoietin (EPO), Colonystimulating Factors (CSFs), Human Growth Hormone (hGH), Insulins, Hepatitis B Vaccine, Factor VIII (FVIII), Interferons (IFN) **.**Therapeutic hormone- insulin production through recombinant DNA technology.

BOOKS:

1. Pharmaceutical Biotechnology; Oliver Kayser, Rainer H. Müller, Wiley Publishers, 2005.
2. Drug Discovery and Clinical Applications; Heinrich Klefenz, 2002.
3. Industrial Pharmaceutical Biotechnology, WILEY-VCH Publication, Germany. Daan Crommelin, Robert D Sindelar, 2002.
4. Pharmaceutical Biotechnology; Tailor and Francis Publications, Newyork. Jay P Rho, Stan G Louie, 2003, Hand.

Open Elective II

B1BT26 - ENTREPRENEURSHIP, IPR AND BIOSAFETY

OBJECTIVE:
To prepare the students to consider Entrepreneurship as a career option and also a tool for Nation building.

UNIT I ENTREPRENEURSHIP
Definition, functions and kinds of entrepreneurs, intrapreneur-entrepreneurship and economic development, entrepreneurial competencies-traits, developing competencies, project identification, selection and financing. Project report- content and significance, Planning Commission‟s guidelines for formulating project reports-methods of project appraisals.

UNIT II INTRODUCTION TO INTELLECTUAL PROPERTY
Types of Intellectual property (IP): Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology Agreements and Treaties History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement;WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments Case Studies.

UNIT III BASICS OF PATENTS AND CONCEPT OF PRIOR ART
Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO,esp@cenet(EPO),PATENTS cope(WIPO), IPO, etc.).

UNIT IV PATENTING PROCEDURES
National and PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement-meaning, scope, litigation, case studies

UNIT V BIOSAFETY
Introduction; Historical Back ground; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs and LMOs;Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications infood and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol

OUTCOME:
Once the student has been introduced to not only entrepreneurship he or she will understand the importance of intellectual property and Its protection in the global world and its procedures and also become aware of biosafety issues either in one‟s own industry, or any industry he or she is employed in .

TEXT BOOKS / REFERENCES

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing
2. Co. Pvt. Ltd., 2007
3. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007
4. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 1997

B1BT27 - BIOPROCESS ENGINEERING AND CELL CULTURE TECHNIQUES LAB

LIST OF EXPERIMENTS:

PART-A

1. Growth kinetics in Batch culture.
2. Study of Enzyme kinetics of INVERTASE.
3. Determination of Enzyme activity for CELLULASE.
4. Effect of pH on Enzyme kinetics.
5. Enzyme inhibition.
6. Enzyme immobilization by different methods.
7. Medium Design – a) PLACKETT – BUKMAN design for media.

   b) Response surface methodology for media design
8. Sodium sulphite oxidation method for determination of Mass Transfer coefficient.
9. Dynamic gassing method for determination of Mass Transfer coefficient.
10. Ethanol production from ***Saccharomyces cerevesiae.***
11. Pre-treatment technique for ligno – cellulosic biomass for ETHANOL PRODUCTION.

PART-B

1. Preparation of medium.
2. Surface sterilization.
3. Organ culture.
4. Cell suspension cultures.
5. Growth and production kinetics for secondary metabolite production and quantification.
6. Genetic transformation studies using ***Agrobacterium***.
7. Preparation of Culture medium (Animal Cell Culture).
8. Cell counting and Cell viability.
9. Trypsinization of Monolayer and Subculturing.
10. Cryopreservation and Thawing.