



## Koneru Lakshmaiah Education Foundation

(Category -1, Deemed to be University estd. u/s. 3 of the UGC Act, 1956)

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Campus: Green Fields, Vaddeswaram - 522 302, Guntur District, Andhra Pradesh, INDIA.

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### XXXV ACADEMIC COUNCIL-ANNEXURE 2.10

Date: 29/05/2022

#### DEPARTMENT OF BIOTECHNOLOGY

#### MINUTES OF XXXI BOARD OF STUDIES MEETING

The Department Board of Studies meeting was conducted on 29/05/2022 in online mode from 10:00 AM to 12:30 PM, with Dr. K Giridhar, HoD-BT, as a chair.

The following members were present for the XXXI BoS meeting

1. Dr.K Giridhar, Assoc. Professor, HoD-BT, Chairman
2. Dr. B Sridhar, Professor, Forest College and Research Institute-Mulguru-Telangana -External Member
3. Dr.Ratna Sudha, Managing Director, Unique Biotech-Hyderabad -External Member
4. Mrs.Sarada Gandhi, Clinical Scientist-Next Generation Sequencing, Master Misericordiae University Hospital-Ireland -External Member
5. Dr. V. Praveen Kumar, Assoc.Professor, Deputy HoD-Member
6. Dr.K.Shrinivaslu, Professor-Member
7. Dr.JayaKumar Singh, Professor-Member
8. Dr.BVLS Prasad, Professor-Member
9. Dr.M.Sudhamani, Assoc.Professor-Member
10. Dr.M.Maheswara Reddy, Asst.Professor-Member
11. Dr.G.Siva Reddy, Asst.Professor-Member
12. Dr. Nadeem Siddiqui, Asst.Professor-Member
13. Dr.Sarada Prasanna Mallick, Asst.Professor-Member

#### Member's Absent-NIL

Dr. K Giridhar, Chairman of BoS, initiated the meeting by welcoming and introducing the external members to the internal and special invitee members and thanking them for accepting to become members of the Board of Studies. Further, the Chairman put forward the Agenda items before members of BoS.

The following items of the agenda were placed for consideration before the Board of Studies in Biotechnology at its present meeting.

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Department of Biotechnology  
Koneru Lakshmaiah Education Foundation  
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### AGENDA and RESOLUTIONS

#### AGENDA ITEM-I

To consider and approve the curriculum for the 2022-23 admitted batch of B.Tech & M.Tech and the minor changes proposed in curriculum of 2021-22 admitted batch of B.Tech as per the suggestions and feedback received from stake holders discussed in DAC.	Approved and recommended to Academic Council
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**RESOLUTION:** Curriculum for 2022-23 B.Tech & M.Tech and the minor changes proposed in curriculum of the 2021-22 admitted batches have been approved by BoS members and recommended to the Academic council. The Course structure of 2022-23 and 2021-22, batches have been furnished in **(Annexure: I)**.

#### AGENDA ITEM-II

To consider and approve the revisions proposed by the course coordinators in syllabus / Course Outcomes /experiments / teaching pedagogies for the courses to be offered in 2022-2023 academic year.	Approved and recommended to Academic Council
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**RESOLUTION:** The revisions proposed by the stakeholders and course coordinators in syllabus/Course Outcomes /experiments / teaching pedagogies for the courses to be offered in 2022-2023 admitted batch have been approved by BoS members and recommended to the Academic council. Syllabi of 2022-2023 batches have been furnished in **(Annexure: II)**.

#### AGENDA ITEM-III

To consider and approve the resolutions made by XXXI DAC conducted on 17 <sup>th</sup> May 2022.	Approved and recommended to Academic Council
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**RESOLUTION:** The points discussed in the DAC meeting were approved by BoS members and recommended to Academic Council. DAC minutes and proofs are mentioned in (Annexure: III).

### AGENDA ITEM-IV

To approve the feedback from stakeholders regarding 2022-23 batch of admitted students	Approved and recommended to Academic Council
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**RESOLUTION:** Feedback from stakeholders regarding the upcoming 2022-23 batch has been approved by BoS members and recommended to the Academic Council. Action Taken Report has been attached as **Annexure-IV**.

### AGENDA ITEM-V

To consider and approve the pre-Ph.D courses for the July-2022 admitted batch of Ph.D	Approved and recommended to Academic Council
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**RESOLUTION:** Pre Ph.D courses and syllabi for the July-2022 admitted batch of Ph.D have been approved by BoS members and recommended to the Academic Council and the corresponding proofs have been attached in **Annexure -V**.

### AGENDA ITEM-VI

To consider and approve the incorporation of Professional Electives and professional core courses into the M.Tech Biotechnology curriculum for the A.Y. 2022-2023 admitted batch.	Approved and recommended to Academic Council
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### DISCUSSION:

- ❖ Dr. Nadeem Siddiqui, Associate Professor has suggested to incorporate subjects related to Medical Biotechnology such as Advanced Nanobiotechnology, Regulatory affairs and clinical trials, Stem cell Technology and following a

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thorough discussion, the resolution was successfully passed, subsequently recommending it to the academic council for approval as a new course.

- ❖ Dr. Divakar, Scientist from Biocon Pvt.Ltd, Bangalore has suggested to include subjects related to Industry like as Enzyme Technology, Intellectual Property Rights, Bio safety and Bioethics, Bioprocess Technology, Bioreactor operations and Bioprocess validation and CGMP and following a thorough discussion, the resolution was successfully passed, subsequently recommending it to the academic council for approval as a new course.
- ❖ Dr. Sirsendu Sekhar Ray Professor from NIT Rourkela has suggested to incorporate subjects related to Bioinformatics such as Bio mining, Molecular Modelling and Drug Design, Methods in genomics, transcriptomics, proteomics and metabolomics and following a thorough discussion, the resolution was successfully passed, subsequently recommending it to the academic council for approval as a new course.

**RESOLUTION:** Upon discussion, all the BOS members approved the incorporation of the following Professional electives and professional core courses into the M.Tech Biotechnology curriculum from the Academic Year 2022-2023 which improves the Industrial Biotechnology skills of students in Bioreactor Operations, Enzyme Technology, Bio mining, Bioprocess Technology, Bioprocess Validation & cGMP, Environmental Biotechnology, Advanced Bioprocess Economics and Plant design, Advanced Biocatalysts & Catalysis, Further, Student will able to gain the various skills in Medical Biotechnology, Bioinformatics and Genetic Engineering by learning the Genetics, Advanced Nano Biotechnology, Advanced Regulatory Affairs & Clinical Trials, Medical Biotechnology, Stem cell Technology, Advanced Molecular Modelling Drug design, Computational Programming for Biologists, Advanced Nano Biotechnology, Intellectual Property Rights, Biosafety and Bioethics, Methods in genomics, transcriptomics, proteomics, and metabolomics.

1. Advanced Nano Biotechnology
2. Regulatory affairs & Clinical trials

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3. Enzyme Technology
4. Medical Biotechnology
5. Stem cell technology
6. Molecular Modelling and Drug Design
7. Bioreactor Operations
8. Bio mining
9. Bioprocess validation and cGMP
10. Computational programming for Biologists
11. Bioprocess Technology
12. Environmental Biotechnology
13. Intellectual Property Rights, Bio safety and Bioethics
14. Bioprocess economics and plant design
15. Methods in genomics, transcriptomics, proteomics and metabolomics
16. Advanced Biocatalyst and Biocatalysis

The syllabus of the new courses have been depicted in **Annexure-VI**

### AGENDA ITEM-VII

To consider and approve the incorporation of Agri Biotechnology Specialization and professional core courses into the B.Tech Biotechnology curriculum for the A.Y. 2022-2023 admitted batch.	Approved and recommended to Academic Council
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### DISCUSSION:

- ❖ Dr. Ayan Sadhu Khan, Associate Professor, IIT Jodhpur, Rajasthan, has suggested to incorporate subjects related to Agri Biotechnology such as Molecular Plant Virology, Crop Science and Production, Molecular pathology and pest

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management, GMOs, Biosafety and Bioethics, Agribusiness and Entrepreneurship, Molecular breeding in field crops, Introduction to plant breeding and Agricultural informatics following a thorough discussion, the resolution was successfully passed, subsequently recommending it to the academic council for approval as new courses.

**RESOLUTION:** Upon discussion, all the BOS members approved the incorporation of Agri Biotechnology Specialization and basic science courses into the curriculum from the Academic Year 2022-2023 which improve the employability options of the students in various agriculture industries. The list of courses under agri biotechnology specialization is mentioned in below.

1. Molecular Plant Virology
2. Crop Science and Production
3. Molecular pathology and pest management
4. GMOs, Biosafety and Bioethics
5. Agribusiness and Entrepreneurship
6. Molecular breeding in field crops
7. Introduction to plant breeding
8. Agricultural informatics
9. Genetics

The syllabus of the new courses has been depicted in **Annexure-VII**.

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The following members have attended the XXXI Board of studies (BOS) meeting held on 29/05/2022 at C501 from 10:00 am to 12:30 pm

S.No	FULL NAME	DESIGNATION	ORGANIZATION	POSITION IN THE MEETING	SIGNATURE OF THE MEMBER
1	Dr.M Ratna Sudha	Managing Director	Unique Biotech Ltd-Telangana	External	
2	Dr.B Sridhar	Professor	Forest College and Research Institute-Mulguru-Telangana	External	
3	Mrs.Saradagandhi Kolli	Clinical Scientist-Next Generation Sequencing	Master Misericordiae University Hospital-Ireland	External	
4	Dr.K.Giridhar	Associate Professor & HOD	Biotechnology	Chairman	
5	Dr.V.Praveen Kumar	Alternate Head & Assoc. Professor	Biotechnology	Secretary	
6	Dr. Jaya Kumar Singh	Professor & Assoc. Dean	Biotechnology	Internal member	
7	Dr.K.Shrinivasulu	Professor	Biotechnology	Internal member	
8	Dr.BVLS Prasad	Professor	Biotechnology	Internal member	
9	Dr.Ashish Runthala	Assoc. Professor &	Biotechnology	Special Invitee	
10	Dr.M.Sudhamani	Assoc. Professor & Research Group Head	Biotechnology	Internal member	

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11	Dr.M.Maheswara Reddy	Asst. Professor	Biotechnology	Internal member	
12	Dr.G.Siva Reddy	Asst. Professor- Professor incharge Academics	Biotechnology	Internal member	G.Si
13	Dr.Y V Rajesh	Asst. Professor-R Pac chairman	Biotechnology	Internal member	Rajesh
14	Dr.Nadeem Siddiqui	Assoc. Professor	Biotechnology	Special Invitee	N.S.
15	Dr.Sarada Prasanna Mallick	Asst. Professor	Biotechnology	Special Invitee	Sarada
16	180010049- Ms.Polladi Bhavana	IV th Year	Biotechnology	Special Invitee	P. Bhavana
17	180010059- Ms.Vemuri Sarvani	IV th Year	Biotechnology	Special Invitee	Ms.Vemuri Sarvani
18	190010067- Varugu Lasya Sri Yadav	IIIrd Year	Biotechnology	Special Invitee	Lasya
19	190010122-Nair Ayush Sasi Kumar	IIIrd Year	Biotechnology	Special Invitee	Ayush
20	2000010060- Aarya Harshal Suryawanshi	IInd Year	Biotechnology	Special Invitee	Aarya
21	2000010092- Cherkuri Anupama	IInd Year	Biotechnology	Special Invitee	Anupama

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### Annexure-I: Program structure (with all Courses) containing following categorization

S.No.	Course Code	Course Title	Category	L	T	P	S	Cr	Pre-Requisite	New/ Revised/ Retained Course	Stakeholder feedback based on which change was proposed	Focused on Employability/ Entrepreneurship/ Skill Development or Career Advancement
1	22UC1101	Integrated Professional English	HSS	0	0	4	0	2	Nil			Employability
2	22UC1202	English Proficiency	HSS	0	0	4	0	2	Nil			Employability
3	22UC2203	Essential Skills for Employability	HSS	0	0	4	0	2	Nil			Employability
4	22UC2204	Corporate Readiness Skills	HSS	0	0	4	0	2	Nil			Employability
5	22UC0010	Universal Human Values & Professional Ethics	HSS	2	0	0	0	2	Nil			Employability
6	22UC0007	Indian Heritage and Culture	HSS	2	0	0	0	0	Nil			Employability
7	22UC0008	Indian Constitution	HSS	2	0	0	0	0	Nil			Employability
8	22UC0009	Ecology & Environment	HSS	2	0	0	0	0	Nil			Employability
9	22UC0011	Gender Sensitization	HSS	2	0	0	0	2	Nil			Employability
10	22MT1101	Mathematics for Computing	BS	2	2	0	4	5	Nil			Employability
11	22MT1011	Mathematical Methods	BS	2	1	0	0	3	Nil			Employability
12	22MT2011	Biostatistics	BS	2	1	0	0	3	Nil	Revised Course	Industrial peer	Employability
13	22UC1203	Design Thinking and Innovation	BS	1	0	4	0	3	Nil	Revised Course	Academic Peer	Skill Development
14	22SC1203	Object Oriented programming	ES	3	0	2	0	4	Nil			Employability
15	22PH1005	Engineering Physics	BS	3	0	2	0	4	Nil			Employability
16	22CY1001	Engineering Chemistry	BS	3	0	2	0	4	Nil			Employability
17	22UC3105	Problem Solving Skills-I	BS	0	0	2	2	1.5	Nil			Skill Development
18	22UC3206	Problem Solving Skills-II	BS	0	0	2	2	1.5	Nil			Skill Development

  
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19	22SC1101	Computational Thinking for Structured Design	ES	2	0	2	4	4	Nil			Skill Development
20	22ME1103	Design Tools Workshop - I	ES	0	0	4	0	2	Nil			Employability
21	22SC1209	Design Tools Workshop - II	ES	0	0	4	0	2	Nil			Employability
22	22SC1202	Design of Data Structures	ES	3	0	2	4	5	22SC1101	Revised Course	Academic Peer	Skill Development
23	22ES2103	Biochemical Thermodynamics	ES	3	1	0	0	4	Nil	Revised Course	Industrial peer	Employability
24	22ES2101	Process Engineering Principles	ES	2	1	2	0	4	Nil	Revised Course	Industrial peer	Employability
25	22ES2102	Transport Process in Biological Systems	ES	3	0	2	0	4	Nil	Revised Course	Industrial peer	Employability
26	22BT1211	Cell Biology	PC	3	0	0	0	3	Nil	Revised Course	Industrial peer	Employability
27	22BT2105	Biochemistry	PC	3	0	2	0	4	Nil	Revised Course	Industrial peer	Employability
28	22BT2108	Molecular Biology	PC	3	0	0	0	3	Nil	Revised Course	Industrial peer	Employability
29	22BT2109	Immunology	PC	3	0	2	0	4	Nil	Revised Course	Academic Peer	Employability
30	22BT3110	Bioinformatics	PC	3	0	2	0	4	Nil	Revised Course	Academic Peer	Employability
31	22BT3111	Genetic Engineering	PC	3	0	2	0	4	Nil	Revised Course	Academic Peer	Employability
32	22BT3112	Fermentation Technology	PC	3	0	2	0	4	Nil	Revised Course	Academic Peer	Employability
33	22BT3113	Biochemical Reaction Engineering	PC	3	0	2	0	4	Nil	Revised Course	Academic Peer	Employability
34	22BT3211	Plant and Animal Biotechnology	PC	3	0	2	0	4	Nil	Revised Course	Academic Peer	Employability
35	22BT3212	Downstream Processing	PC	3	0	2	0	4	Nil	Revised Course	Academic Peer	Employability
36	22BT3213	Genetics	PC	3	0	0	0	3	Nil	New Course	Industrial peer	Employability

*Handwritten signature and date: 20/5/2022*

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37	22BT2106	Microbiology	PC	3	0	2	0	4	Nil	Revised Course	Alumni	Employability
38	22BT2107	Bio analytical Techniques	PC	3	0	2	0	4	Nil	Revised Course	Alumni	Employability
39	22IE2040	Social Internship	PR	0	0	0	4	1	Nil			Skill Development
40	22IE3041	Technical Internship	PR	0	0	0	4	1	Nil			Skill Development
41	22IE4042	Industry Internship	PR	0	0	0	4	1	Nil			Skill Development
42	22IE2046	Project Based Learning -1	PR	0	0	0	6	1.5	Nil			Skill Development
43	22IE2047	Project based learning -2	PR	0	0	0	6	1.5	Nil			Skill Development
44	22IE3043	Term paper	PR	0	0	0	4	1	Nil			Skill Development
45	22IE3044	Mid Grad Capstone Project - I	PR	0	0	0	8	2	Nil			Skill Development
46	22IE3045	Mid Grad Capstone Project - II	PR	0	0	0	8	2	Nil			Skill Development
47	22IE4048/ 22IE4051/ 22IE4050	Project / Internship -1/Practice School	PR	0	0	0	16	4	Nil			Skill Development
48	22IE4049/ 22IE4052/ 22IE4050	Project / Internship 2/Practice School	PR	0	0	0	16	4	Nil			Skill Development
49	22IE4051	Research Project	PR	0	0	6	12	6	Relevant Course			Skill Development
50	22IE3042	Research Seminar	PR	0	0	2	4	2	Relevant Course			Skill Development
51	22BT3051	Molecular Genetics	PE	3	0	0	0	3	22BT3111	Revised Course	Alumni	Employability
52	22BT3052	Transgenic Technology	PE	3	0	2	0	4	22BT3111	Revised Course	Alumni	Employability
53	22BT3053	Molecular Expression Technology	PE	3	0	0	0	3	22BT3111	Revised Course	Alumni	Employability

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54	22BT3054	Genomics and Proteomics	PE	3	0	0	0	3	22BT3111	Revised Course	Alumni	Employability
55	22BT3055	Molecular markers and Diagnostics	PE	3	0	2	0	4	22BT3111	Revised Course	Alumni	Employability
56	22BT3056	Gene and the Environment	PE	3	0	0	0	3	22BT3111	Revised Course	Alumni	Employability
57	22BT3057	Microbial Genetics	PE	3	0	0	0	3	22BT3111	Revised Course	Alumni	Employability
58	22BT3058	DNA Forensics	PE	3	0	0	0	3	22BT3111	Revised Course	Alumni	Employability
59	22BT3061	Microbial Technology	PE	3	0	0	0	3	22BT2106	Revised Course	Alumni	Employability
60	22BT3062	Pharmaceutical Biotechnology	PE	3	0	0	0	3	22BT2106	Revised Course	Alumni	Employability
61	22BT3063	Metabolic Engineering	PE	3	0	0	0	3	22BT2106	Revised Course	Alumni	Employability
62	22BT3064	Bio resource Technology	PE	3	0	0	0	3	22BT2106	Revised Course	Alumni	Employability
63	22BT3065	Bioprocess Economics and Plant Design	PE	3	0	2	0	4	22BT2106	Revised Course	Alumni	Employability
64	22BT3066	Enzyme Engineering	PE	3	0	2	0	4	22BT2106	Revised Course	Industrial peer	Employability
65	22BT3067	Bioprocess Validation and cGMP	PE	3	0	0	0	3	22BT2106	Revised Course	Industrial peer	Employability
66	22BT3068	Food Technology	PE	3	0	0	0	3	22BT2106	Revised Course	Industrial peer	Employability
67	22BT3069	Pharmacovigilance and Safety	PE	3	0	0	0	3	22BT2106	Revised Course	Industrial peer	Employability
68	22BT3079	NGS sequencing and data analysis	PE	3	0	0	0	3	22BT3110	Revised Course	Industrial peer	Employability
69	22BT3072	Biomedical Informatics	PE	3	0	0	0	3	22BT3110	Revised Course	Industrial peer	Employability
70	22BT3073	Molecular Modelling and Drug Design	PE	3	0	2	0	4	22BT3110	Revised Course	Industrial peer	Employability

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80	22BT3074	Structural Biology	PE	3	0	0	0	3	22BT3110	Revised Course	Industrial peer	Employability
81	22BT3075	Systems Biology	PE	3	0	0	0	3	22BT3110	Revised Course	Industrial peer	Employability
82	22BT3076	Applied Bioinformatics	PE	3	0	0	0	3	22BT3110	Revised Course	Industrial peer	Employability
83	22BT3077	Python and R Programming	PE	3	0	2	0	4	22BT3110	Revised Course	Industrial peer	Employability
84	22BT3078	Data Base Management System	PE	3	0	0	0	3	22BT3110	Revised Course	Industrial peer	Employability
85	22BT3081	Stem cell technology	PE	3	0	2	0	4	22BT1211			Employability
86	22BT3082	Healthcare Biotechnology	PE	3	0	0	0	3	22BT1211			Employability
87	22BT3083	Cancer Biology	PE	3	0	0	0	3	22BT1211			Employability
88	22BT3084	Neurobiology	PE	3	0	0	0	3	22BT1211			Employability
89	22BT3085	Bioelectronics & Biosensors	PE	3	0	0	0	3	22BT1211			Employability
90	22BT3086	Tissue Engineering	PE	3	0	2	0	4	22BT1211			Employability
91	22BT3087	Virology	PE	3	0	0	0	3	22BT1211			Employability
92	22BT3088	Nano biotechnology	PE	3	0	0	0	3	22BT1211			Employability
93	20BT3089	Molecular Plant Virology	PE	3	0	0	0	3	22BT2108	New Course	Academic Peer	Employability
94	20BT3090	Crop science and Production	PE	3	0	0	0	3	22BT2108	New Course	Academic Peer	Employability
95	20BT3091	Molecular pathology and pest management	PE	3	0	0	0	3	22BT2108	New Course	Academic Peer	Employability
96	20BT3092	GMOs, Bio safety and Bioethics	PE	3	0	2	0	4	22BT2108	New Course	Academic Peer	Employability
97	20BT3093	Agribusiness and Entrepreneurship	PE	3	0	2	0	4	22BT2108	New Course	Academic Peer	Employability
98	20BT3094	Molecular breeding in field crops	PE	3	0	0	0	3	22BT2108	New Course	Academic Peer	Employability
99	20BT3095	Introduction to plant breeding	PE	3	0	0	0	3	22BT2108	New Course	Academic Peer	Employability

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100	20BT3096	Agricultural informatics	PE	3	0	2	0	4	22BT2108	New Course	Academic Peer	Employability
101	OE	Open Elective - 1	OE	3	0	0	0	3	Nil			Entrepreneurship
102	OE	Open Elective - 2	OE	3	0	0	0	3	Nil			Entrepreneurship
103	OE	Open Elective - 3	OE	3	0	0	0	3	Nil			Entrepreneurship
104	OE	Management Elective(OE-4)	OE	3	0	0	0	3	Nil			Entrepreneurship
105	OE	Foreign Language Elective(OE-5)	OE	2	0	0	0	2	Nil			Entrepreneurship

Percentage of Syllabus Revision= $52 \times 100 / 94 = 55.29\%$

Percentage of Courses focusing on Employability=  $74 / 94 = 78.72\%$

Percentage of Courses focusing on Entrepreneurship=  $5 / 94 = 5.31\%$

Percentage of Courses focusing on Skill Development =  $15 / 94 = 15.95\%$

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### Annexure-I: Program structure (with all Courses) containing following categorization

S.No.	Course Code	Course Title	Category	L	T	P	S	Cr	Pre-Requisite	New/ Revised/ Retained Course	Stakeholder feedback based on which change was proposed	Focused on Employability/ Entrepreneurship/ Skill Development or Career Advancement
1	22BT5101	Mathematics and Biostatistics	PCC	3	1	0	0	4	Nil			Employability
2	22BT5102	Biochemical Engineering	PCC	3	0	2	0	4	Nil			Employability
3	22BT5103	Molecular Biology and r-DNA Technology	PCC	3	0	2	0	4	Nil			Employability
4	22BT5104	Applied Bioinformatics	PCC	3	0	2	0	4	Nil			Employability
5	22IE5149	Seminar	PR	0	0	4	0	2	Nil			Employability
6	22BT5105	Plant and Animal Biotechnology	PCC	3	0	2	0	4	Nil			Employability
7	22BT5106	Immunotechnology	PCC	3	0	2	0	4	Nil			Employability
8	22BT5107	Bioreactor modelling and Simulation	PCC	3	2	0	0	4	Nil			Employability
9	22BT5108	Downstream Processing	PCC	3	0	2	0	4	Nil			Employability
10	22IE5250	Term paper	PR	0	0	4	0	2	Nil			Employability
11	22IE6149	Research Project (Part-1)	PR	0	0	36	0	18	Nil			Employability
12	22IE6249	Research Project (Part-2)	PR	0	0	36	0	18	Nil			Employability
13	22BT51A1	Protein Engineering	PE	3	0	0	0	3	Nil	Retained course		Employability

*[Handwritten Signature]*  
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14	22BT51A2	Enzyme Technology	PE	3	0	0	0	3	Nil	New course	Industrial Peer	Employability
15	22BT51A3	Medical Biotechnology	PE	3	0	0	0	3	Nil	New course	Academic Peer	Employability
16	22BT51A4	Stem cell technology	PE	3	0	0	0	3	Nil	New course	Alumni	Employability
17	22BT51A5	Molecular Modelling and Drug Design	PE	3	0	0	0	3	Nil	New course	Industrial Peer	Employability
18	22BT51B1	Food Technology	PE	3	0	0	0	3	Nil	Retained course		Employability
19	22BT51B2	Bioreactor Operations	PE	3	0	0	0	3	Nil	New course	Industrial Peer	Employability
20	22BT51B3	Bio mining	PE	3	0	0	0	3	Nil	New course	Academic Peer	Employability
21	22BT51B4	Bioprocess validation and cGMP	PE	3	0	0	0	3	Nil	New course	Alumni	Employability
22	22BT52C6	Computational programming for Biologists	PE	3	0	0	0	3	Nil	New course	Industrial Peer	Employability
23	22BT52C2	Bioprocess Technology	PE	3	0	0	0	3	Nil	New course	Academic Peer	Employability
24	22BT52C3	Environmental Biotechnology	PE	3	0	0	0	3	Nil	New course	Alumni	Employability
25	22BT52C4	Advanced Nano Biotechnology	PE	3	0	0	0	3	Nil	New course	Industrial Peer	Employability
26	22BT52C7	Intellectual Property Rights, Biosafety and Bioethics	PE	3	0	0	0	3	Nil	New course	Academic Peer	Employability
27	22BT52D1	Regulatory affairs & Clinical trials	PE	3	0	0	0	3	Nil	New course	Alumni	Employability

*[Handwritten Signature]*  
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28	22BT52D2	Bioprocess economics and plant design	PE	3	0	0	0	3	Nil	New course	Industrial Peer	Employability
29	22BT52D5	Methods in genomics, transcriptomics, proteomics and metabolomics	PE	3	0	0	0	3	Nil	New course	Academic Peer	Employability
30	22BT52D6	Advanced Biocatalyst and Biocatalysis	PE	3	0	0	0	3	Nil	New course	Alumni	Employability

Percentage of Syllabus Revision= $15 \times 100 / 30 = 50\%$

  
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### Annexure-II: Course wise Syllabus revision of approved structure as mentioned in Annexure-I

Course Code	Course Title	Course Category	Existing Syllabus	New Syllabus	Topics added/ removed/ replaced	Changes in Course Outcome (s)	Justification for the modifications	Revision (%)
22BT1211	Cell Biology	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/Ea9HIE6P77NBsdClwDile0cByBZSnfFziCr29KQq8ORgqg?e=jzk0dY">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/Ea9HIE6P77NBsdClwDile0cByBZSnfFziCr29KQq8ORgqg?e=jzk0dY</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/Ea9HIE6P77NBsdClwDile0cByBZSnfFziCr29KQq8ORgqg?e=jzk0dY">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/Ea9HIE6P77NBsdClwDile0cByBZSnfFziCr29KQq8ORgqg?e=jzk0dY</a>	<b>Tissues &amp; Receptors-</b> Meristems, Simple, complex and special tissues. Growth patterns, Cell growth and mechanisms. Embryonic development, Organogenesis, metamorphosis, Cell signaling–Membrane receptors, Cell – Cell interactions.	CO3	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	10

  
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22BT2105	Biochemistry	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/EXeDT5x0mXIMqua3o6g7v-oB1Mj3v5P99ss8USIaBruRKA?e=R9566s">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/EXeDT5x0mXIMqua3o6g7v-oB1Mj3v5P99ss8USIaBruRKA?e=R9566s</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/EYeJue2v7Z5Pq1LA7BbPtCkB4XX--EY-EtTqUVBsI5VWCQ?e=dgq9xd">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/EYeJue2v7Z5Pq1LA7BbPtCkB4XX--EY-EtTqUVBsI5VWCQ?e=dgq9xd</a>	Enzymes, Carbohydrates and Bioenergetics	C04	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	10
22BT2108	Molecular Biology	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/ERRYsGuLExOnk-AbVAzAccBPO7Ww4Y7m-ppesVT5dt3g?e=fahrTM">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/ERRYsGuLExOnk-AbVAzAccBPO7Ww4Y7m-ppesVT5dt3g?e=fahrTM</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/Ec7g5OIgLtNqu60VSdXz5UB9av-dgwIjebdncEIM9PNag?e=KYdbx1">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversity_in/Ec7g5OIgLtNqu60VSdXz5UB9av-dgwIjebdncEIM9PNag?e=KYdbx1</a>	Repair Mechanisms- Direct Repair, Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair	C03	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	10

  
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22BT2109	Immunology	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EUhSGjgWb-ZKmm7InWr12uUBSgXT9-MXgbOa9a6VcHz8Q?e=wSzGUZ">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EUhSGjgWb-ZKmm7InWr12uUBSgXT9-MXgbOa9a6VcHz8Q?e=wSzGUZ</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ERBkmMghwUIPpY4MzRVIZowBxUfY8jgoSazNz7UVzPI-Q?e=094ziW">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ERBkmMghwUIPpY4MzRVIZowBxUfY8jgoSazNz7UVzPI-Q?e=094ziW</a>	Immunoglobulin's- Structure, types, subtypes and functions. Antibody genes and generation of diversity, Production of monoclonal antibodies	C03	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	10
22BT3110	Bioinformatics	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EVIDbimNPv90jGALdeKDWiYBRSPkW Ry_Rdyk0D2r0LaI8w?e=YYNoBa">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EVIDbimNPv90jGALdeKDWiYBRSPkW Ry_Rdyk0D2r0LaI8w?e=YYNoBa</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EYibhFHmX7tHjCaX9QkkM-sBTtmDwL979-Iiu-0LoIq4ww?e=tWC5yt">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EYibhFHmX7tHjCaX9QkkM-sBTtmDwL979-Iiu-0LoIq4ww?e=tWC5yt</a>	machine learning: classification, regression, svm, decision trees, artificial neural networks, big data in biology. Genome informatics: genome sequencing technologies and analysis methods; human genome project, application of genome mapping, DNA microarrays.	C04	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	10

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22BT3111	Genetic Engineering	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EcXTA-ItW-ZGtTDfRJurFZUBQ5kMXUDdzcKd5TegdzXpIA?e=HPueeK">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EcXTA-ItW-ZGtTDfRJurFZUBQ5kMXUDdzcKd5TegdzXpIA?e=HPueeK</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ERVW6nEMEGBPi84rJmfnWmQBV-wVPwSNNIhmTdArnkCXkg?e=2H2p1B">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ERVW6nEMEGBPi84rJmfnWmQBV-wVPwSNNIhmTdArnkCXkg?e=2H2p1B</a>	Screening of clones - Genetic methods, Immunological methods, Hybridization methods.	CO2	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	10
22BT3112	Fermentation Technology	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ETHkRkEe tNIsRz0XJInSXMBm-j4pXLeGSzSpmZzNM7n5A?e=1czjiP">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ETHkRkEe tNIsRz0XJInSXMBm-j4pXLeGSzSpmZzNM7n5A?e=1czjiP</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbB8ycjCjpdKmsbMZCXEE7EB9LUC78chz-20txdf3BzOiA?e=Qh7YND">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbB8ycjCjpdKmsbMZCXEE7EB9LUC78chz-20txdf3BzOiA?e=Qh7YND</a>	Rheology of fermentation broths; Rheological models; Measurement of rheological parameters	CO4	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5

  
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22BT3113	Biochemical Reaction Engineering	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EdaKYgDg8x5PjOxFA-4jToB8NDdL81SbEbZyY2Hwjt8g?e=N9C9yi">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EdaKYgDg8x5PjOxFA-4jToB8NDdL81SbEbZyY2Hwjt8g?e=N9C9yi</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EaTuxamf5d9LmSZQr30XsQB VaT9bVSN6GMboQqH1eew?e=WS8cJz">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EaTuxamf5d9LmSZQr30XsQB VaT9bVSN6GMboQqH1eew?e=WS8cJz</a>	Design equations for enzyme reactors Estimation of kinetic parameters	CO4	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5
22BT3211	Plant and Animal Biotechnology	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EZYgbA32QuJEinoD1YrePhcBnKCcYsw28Q7MOhfRSm-Q?e=EGjvrV">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EZYgbA32QuJEinoD1YrePhcBnKCcYsw28Q7MOhfRSm-Q?e=EGjvrV</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/ETgJinrf6SFLklm3Tk0mBboBL261Zfdoga2Hfc8v-vN30w?e=WDeuk6">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/ETgJinrf6SFLklm3Tk0mBboBL261Zfdoga2Hfc8v-vN30w?e=WDeuk6</a>	Animal Cell Culture, Growth and Scale Up, Transgenic Animals and Recombinant DNA Technology, Tissue Engineering and Regenerative Medicine:	CO3,CO4,	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	10

  
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22BT3212	Downstream Processing	PC	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EdW5QuHcl4lOgE23GkbIH8Be491R2MhGtbVFfv7A-J8TQ?e=zScTw2">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EdW5QuHcl4lOgE23GkbIH8Be491R2MhGtbVFfv7A-J8TQ?e=zScTw2</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EUrDI4IwFwNHm5PDPPrsS93gBCzK1iE-u-3-aDuMs6FVf2Q?e=cs47Jb">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EUrDI4IwFwNHm5PDPPrsS93gBCzK1iE-u-3-aDuMs6FVf2Q?e=cs47Jb</a>	<b>Product Enrichment Operations:</b> <b>Aqueous two-phase extraction process:</b> Applications of aqueous two-phase extraction, reversed micelles extraction principle, reversed micellar extraction principle, micelle structures, critical micelle concentration. Protein solubilization, limitation of reversed micelles. Precipitations of proteins with salts and organic solvents, kinetics of protein aggregation	CO1,CO2, CO3,CO4	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	10
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22ES2103	Biochemical Thermodynamics	ES	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ER9ujdcp7XVMhmgRt00EVU8BEQzBCrE6cyZVuIDQ1E-lSg?e=QIxSkd">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ER9ujdcp7XVMhmgRt00EVU8BEQzBCrE6cyZVuIDQ1E-lSg?e=QIxSkd</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ER4tSFv8LEhPpMclPdQADSkBK81MVp62BBerwqZigs-Ksg?e=ABEirQ">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ER4tSFv8LEhPpMclPdQADSkBK81MVp62BBerwqZigs-Ksg?e=ABEirQ</a>	<b>Biochemical thermodynamics:</b> Energetics of metabolic pathways, Energy coupling (ATP &NADH), Energetic analysis of cell growth and product formation. Thermodynamics of microbial growth, oxygen consumption and heat evolution in aerobic cultures, energy balance equation for cell culture, reaction thermodynamics.	C04	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	10
22ES2101	Process Engineering Principles	ES	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EeLfyE0-GslFtUjSN1tOYwBBO-F4rjPxxkKMl7Si">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EeLfyE0-GslFtUjSN1tOYwBBO-F4rjPxxkKMl7Si</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/Ecv2lJGrSv1Pq9HJYlowcEoBACAwQvRkCe8pGHZnE7j9mQ?e=cp7fSR">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/Ecv2lJGrSv1Pq9HJYlowcEoBACAwQvRkCe8pGHZnE7j9mQ?e=cp7fSR</a>	Overall and Component Balance : Evaporator, Distillation, Extraction, Drying, Crystallization, Filtration and Mixing	C04	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	10

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			<a href="#">OLJ2rg?e=0ntACh</a>					
22ES2102	Transport Process in Biological Systems	ES	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsva_kluniversity_in/ETjTQ6zvZ4oBF11knjKo3CIxuInj-UkLJA?e=xhARCY">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsva_kluniversity_in/ETjTQ6zvZ4oBF11knjKo3CIxuInj-UkLJA?e=xhARCY</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsva_kluniversity_in/EazmKsSsQgNHgLvRSh2RzxsByzZwX2vPJ8cRIABK0ht1SQ?e=du2sQE">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsva_kluniversity_in/EazmKsSsQgNHgLvRSh2RzxsByzZwX2vPJ8cRIABK0ht1SQ?e=du2sQE</a>	Oxygen requirement of microbial cultures. Oxygen transfer by aeration and agitation. Determination of oxygen mass transfer coefficient by various methods.	CO4	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	10
22BT1001	Biology for Engineers	BS	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsva_kluniversity_in/EZGZsxW7utBPoNZvenUOGE4BS2iSxKqH_CSkQw0">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsva_kluniversity_in/EZGZsxW7utBPoNZvenUOGE4BS2iSxKqH_CSkQw0</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsva_kluniversity_in/EQKL2bT5xxLr1f5hjhzyI4BJYYduCzRufjhNkkJpRjcMg?e=9EMxoz">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsva_kluniversity_in/EQKL2bT5xxLr1f5hjhzyI4BJYYduCzRufjhNkkJpRjcMg?e=9EMxoz</a>	Thermodynamics of biological systems, Requirement of ATP, Glycolysis, Krebs cycle, Photosynthesis, Identification and classification of microbes, Microbial	CO4	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	10

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			<a href="#">r97efvg?e=VU19Va</a>		growth kinetic, sterilization and sterilization techniques			
22BT3051	Molecular Genetics	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/g/siva_kluniversity_in/ERef6mMGB7dLoyhmJfkcaXEBuYVVfv6IMjqdFfCaOjWqwg?e=NQ1PFA">https://kluniversityin-my.sharepoint.com/:w:/g/person/g/siva_kluniversity_in/ERef6mMGB7dLoyhmJfkcaXEBuYVVfv6IMjqdFfCaOjWqwg?e=NQ1PFA</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/g/siva_kluniversity_in/EQo1PXPToj9Li0W3Cc2kMUB4pig5NhxkLkSCMoOSQP9kw?e=P64egz">https://kluniversityin-my.sharepoint.com/:w:/g/person/g/siva_kluniversity_in/EQo1PXPToj9Li0W3Cc2kMUB4pig5NhxkLkSCMoOSQP9kw?e=P64egz</a>	Different models of homologous recombination. Molecular mechanisms of recombination: Base pairing, Nick initiation, Homologous recombination, Cross strand exchange, Site specific recombination, Transpositional recombination	CO3	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	10

  
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22BT3052	Transgenic Technology	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EQNcqaMAu9DhWf032Z-QMoBXDFXtuBEZMBNTdv hT-1Ug?e=7dhgvI">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EQNcqaMAu9DhWf032Z-QMoBXDFXtuBEZMBNTdv hT-1Ug?e=7dhgvI</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EZyC2qEfgTlIqMhX2kF6VUQBrTotvJ7UUamOjrHMqiRs0w?e=MoU3yK">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EZyC2qEfgTlIqMhX2kF6VUQBrTotvJ7UUamOjrHMqiRs0w?e=MoU3yK</a>	Gene Therapy Approaches to Duchenne Muscular Dystrophy	C03	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5
22BT3053	Molecular Expression Technology	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/ES5d8z_okoVBv07I52giewSByd76Q939QvdjwIebBH6iZQ?e=uXPE9L">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/ES5d8z_okoVBv07I52giewSByd76Q939QvdjwIebBH6iZQ?e=uXPE9L</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/ETVi9TQVZjZENlCgu114UYcBBXTZ8VYwu2r0isCYugRTHA?e=LLyOwr">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/ETVi9TQVZjZENlCgu114UYcBBXTZ8VYwu2r0isCYugRTHA?e=LLyOwr</a>	His-tag, GST-tag, MBP-tag. Factor X, Enterokinase signal cleavage.	C03	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5

  
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22BT3054	Genomics and Proteomics	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversity_in/EXs986IHH290hhJfIJXT7aABTG8QujCRmTev8cHzaMzqpw?e=KUc800">https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversity_in/EXs986IHH290hhJfIJXT7aABTG8QujCRmTev8cHzaMzqpw?e=KUc800</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversity_in/ER8p2sJkuvRNq9D SKDnTAN0Bv9BINUnlX wGK4YXZSDpLA?e=AhI6YG">https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversity_in/ER8p2sJkuvRNq9D SKDnTAN0Bv9BINUnlX wGK4YXZSDpLA?e=AhI6YG</a>	Pharmacogenomics, Genomics in relation to molecular Diagnosis, Role of genomics in Drug discovery and development	CO4	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5
22BT3055	Molecular markers and Diagnostics	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversity_in/EeNoIWliQpVApR1qNV4 C58B7 oiljat2 VXyZ044Z93Wjw?e=bGvdGn">https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversity_in/EeNoIWliQpVApR1qNV4 C58B7 oiljat2 VXyZ044Z93Wjw?e=bGvdGn</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversity_in/EbU9Q1SjZlIPo3l2d Cn7NKsBBMbnYH8RFnN5fclsBhBw?e=7YjMf3">https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversity_in/EbU9Q1SjZlIPo3l2d Cn7NKsBBMbnYH8RFnN5fclsBhBw?e=7YjMf3</a>	2D analysis of such proteins by sequencing individual spots by Mass Spectrometry, ELISA and Western blot	CO4	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5

  
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22BT3056	Gene and the Environment	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EfHlP5IyyEdFhDN423UmelcBCIP2D9Rf24KaLGB1P-LduQ?e=uWL0pt">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EfHlP5IyyEdFhDN423UmelcBCIP2D9Rf24KaLGB1P-LduQ?e=uWL0pt</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EaNOihkktYtNns1hDAXUSN8Bgc2HtqtQ5AMwjPvNNH4ozw?e=8Piz2z">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EaNOihkktYtNns1hDAXUSN8Bgc2HtqtQ5AMwjPvNNH4ozw?e=8Piz2z</a>	The potential for superoxide, hydrogen peroxide and nitric oxide to cause DNA damage, Chemical Stress Nutrient Stress Pathogen and Wounding Stress	CO4	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5
22BT3057	Microbial Genetics	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/ET0cNlpYsmdlp4DnSqTAGtsBcBVgrklfkWZZBkwGYDyCYg?e=gqMub3">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/ET0cNlpYsmdlp4DnSqTAGtsBcBVgrklfkWZZBkwGYDyCYg?e=gqMub3</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EVCbesUlh0xJmPZTDgVxe84BnH0cGuy8oKBpvALYADmxqQ?e=7VEkkL">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversityin/EVCbesUlh0xJmPZTDgVxe84BnH0cGuy8oKBpvALYADmxqQ?e=7VEkkL</a>	gene expression and genome organization, λphage - replication, lytic and lysogenic cycles, transcription of phage genes, mechanisms of repressor synthesis and its control	CO4	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5

  
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22BT3058	DNA Forensics	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversityin/EUPmXDSXanpCiO23FeEMlCIBHlkQbmL25IF0xMy1iNB91w?e=KWcdgk">https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversityin/EUPmXDSXanpCiO23FeEMlCIBHlkQbmL25IF0xMy1iNB91w?e=KWcdgk</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversityin/EYBAaBgh8GRGsGTL3lM58BABIbNBofuYTCXjilE7lapNQ?e=joWryf">https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversityin/EYBAaBgh8GRGsGTL3lM58BABIbNBofuYTCXjilE7lapNQ?e=joWryf</a>	VNTR, SNP, SINES, LINES, SSR, STR, Mini and Micro Satellites	CO4	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5
22BT3061	Microbial Technology	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversityin/Edzu-3SdJHRHguhDturxJ-QBtxohuT8cl-R5vaaQOsyn5Q?e=NlmpV">https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversityin/Edzu-3SdJHRHguhDturxJ-QBtxohuT8cl-R5vaaQOsyn5Q?e=NlmpV</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversityin/EfxxR2VC_ZpKq27TmXACQOAB-dG3aJd3Tk0xpfoK2o-CQ?e=h3Lfi9">https://kluniversityin-my.sharepoint.com/:w:/g/person/gsva_kluniversityin/EfxxR2VC_ZpKq27TmXACQOAB-dG3aJd3Tk0xpfoK2o-CQ?e=h3Lfi9</a>	Amino acids (Glutamic Acid, Lysine, Aspartic Acid and Phenylalanine); and Alcohols (Ethanol, 2,3-butanediol)	CO4	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5

  
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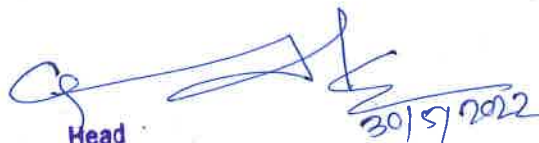
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22BT3062	Pharmaceutica I Biotechnology	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EehN5b-zwX7VOI3rZFAEArLQBfk78rIXUgdSnIWNVIvwWVw?e=z5gDdy">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EehN5b-zwX7VOI3rZFAEArLQBfk78rIXUgdSnIWNVIvwWVw?e=z5gDdy</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbsbTk6ThtpJvIz9m68UBKMBbmLjexfQU8fexK6N9CeA?e=UW0WPV">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbsbTk6ThtpJvIz9m68UBKMBbmLjexfQU8fexK6N9CeA?e=UW0WPV</a>	Concentrated human RBC Control of Blood products; Transfusion products.	CO3	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5
22BT3063	Metabolic Engineering	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbI-39A00LVJiMMiPq6g4cBqE6zZTyP1UH2TvuzFR2NYA?e=f1AVg6">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbI-39A00LVJiMMiPq6g4cBqE6zZTyP1UH2TvuzFR2NYA?e=f1AVg6</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EQfu9kqnk tGpzAyFcU8T3QB jST5dx tNe5GBsKAOajqqw?e=vRE320">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EQfu9kqnk tGpzAyFcU8T3QB jST5dx tNe5GBsKAOajqqw?e=vRE320</a>	metabolic pathway, manipulations to improve fermentation, Feedback repression, Catabolite, Repression, optimization and control of metabolic activities	CO3	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5

  
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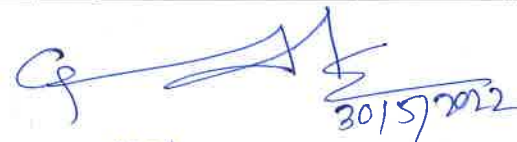
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22BT3064	Bioresource Technology	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EXNOVAdDUmVEpinvxCxTX2wBSCYKpsPyDPFb3Cd2i3bEWw?e=Pcoz8U">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EXNOVAdDUmVEpinvxCxTX2wBSCYKpsPyDPFb3Cd2i3bEWw?e=Pcoz8U</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EWV4VRtDoH9EnrcN9L-9pYEBHRkiH1bH4dNhQCESHVEGEw?e=yZHXC">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EWV4VRtDoH9EnrcN9L-9pYEBHRkiH1bH4dNhQCESHVEGEw?e=yZHXC</a>	ethanol recovery - Biobutanol production, energy content and effects on fuel economy - Octane rating, air fuel ratio, specific energy, viscosity, heat of vaporization - Butanol fuel mixtures	C03	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5
22BT3065	Bioprocess Economics and Plant Design	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EW3LaG03tAhKt3B8aRV5t8BVforjq6YxPRTR7PLRIXWDA?e=FdCYNb">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EW3LaG03tAhKt3B8aRV5t8BVforjq6YxPRTR7PLRIXWDA?e=FdCYNb</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ETBvSTX5eBLtkxZTygKktsBmwfXuDde4c-0Sj-5e8TIXA?e=TzVZ6L">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ETBvSTX5eBLtkxZTygKktsBmwfXuDde4c-0Sj-5e8TIXA?e=TzVZ6L</a>	capital cost estimates large-scale equipment and utilities case studies of antibiotics, recombinant products, single cell protein. Design calculations for immobilized enzyme kinetics	C03	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5

  
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22BT3066	Enzyme Engineering	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbwW0gttuR5Aq-UAton0UIUBrxE-iEbBM6VFBmQXqiT8xA?e=5gBjDn">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbwW0gttuR5Aq-UAton0UIUBrxE-iEbBM6VFBmQXqiT8xA?e=5gBjDn</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EfuYvKMyzvVGmuTn4I2S8A8B-Orc1xDcgEY4ApoN0U-81w?e=wNqgFX">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EfuYvKMyzvVGmuTn4I2S8A8B-Orc1xDcgEY4ApoN0U-81w?e=wNqgFX</a>	Kinetics of a single-substrate enzyme catalysed reaction Reversible Covalent Modification and Proteolytic Activation. Organisation of enzymes in the cell ELISA. Biosensors	CO3	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5
22BT3067	Bioprocess Validation and cGMP	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EeNzORJXY45Mvw7DR07FbBoBsc1bw5maEG3RZK5wqCn1xw?e=YOpELD">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EeNzORJXY45Mvw7DR07FbBoBsc1bw5maEG3RZK5wqCn1xw?e=YOpELD</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/Ee5nfnqIGY5DkGfAKfvXtAB4GviEtME nE1ZTf HBWGEgg?e=4llZoB">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/Ee5nfnqIGY5DkGfAKfvXtAB4GviEtME nE1ZTf HBWGEgg?e=4llZoB</a>	Guidelines and regulation of FDA and ICH for GLP. Good Manufacturing Practices Quality control of a product, Good manufacturing practices, cGMP, GMP of industries, Sanitation & Hygiene, Control of finished products, Maintenance of materials in laboratories, Zero contamination	CO3	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5

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22BT3068	Food Technology	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EX0TE-TEkMVDiX7SNTLQzmIBXstAsWIU94qb5ILRqkWctQ?e=sFmsGc">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EX0TE-TEkMVDiX7SNTLQzmIBXstAsWIU94qb5ILRqkWctQ?e=sFmsGc</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EcW5IH8o6qtEhadmof4nQkwBS4_dDDSXMl02vc8f89VUgg?e=g4wVdm">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EcW5IH8o6qtEhadmof4nQkwBS4_dDDSXMl02vc8f89VUgg?e=g4wVdm</a>	Emerging processing and preservation technologies for milk and dairy products. Food preservation: Food preservation using irradiation, Characteristics of Radiations of interest in food preservation. Principles underlying the destruction of Microorganisms by irradiation, processing of foods for irradiation	CO3	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5
22BT3079	NGS Sequencing and Data analysis	PE	REFERENCE SYLLABUS: AICTE MODEL CURRICULUM	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ETwX5vhyN49Oo6Ual6yXZ9gBxD0lv7ifaMHNq-Vyy2vffQ?e=G05Fpi">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ETwX5vhyN49Oo6Ual6yXZ9gBxD0lv7ifaMHNq-Vyy2vffQ?e=G05Fpi</a>	NEW COURSE	CO1,CO2, CO3,CO4	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	100

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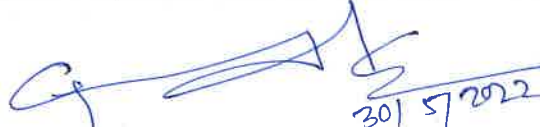
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22BT3072	Biomedical Informatics	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversityin/EY6xeeBrxeBMuuOR6PPdH1oBb09YeefS3SCvQU504NJDqw?e=kVzq3Z">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversityin/EY6xeeBrxeBMuuOR6PPdH1oBb09YeefS3SCvQU504NJDqw?e=kVzq3Z</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversityin/ET2n0Szz0b5Ag4ALIM51qDUBnyDFEBu62k2ipzHccbwc1Q?e=rXwXYx">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversityin/ET2n0Szz0b5Ag4ALIM51qDUBnyDFEBu62k2ipzHccbwc1Q?e=rXwXYx</a>	Symbolic biomedical knowledge Web 3.0. Ontologies as formal and explicit specification of objects, properties and relations in organizing biomedical data	CO3	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	5
22BT3073	Molecular Modelling and Drug Design	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversityin/EeRw87ZIn5xOgz4W0Ba3WRgBLhM4XPP0Z507FlpXGMuNTg?e=rcBaAp">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversityin/EeRw87ZIn5xOgz4W0Ba3WRgBLhM4XPP0Z507FlpXGMuNTg?e=rcBaAp</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversityin/EcyQ8qCIKFMusmS1Jnteb8Bm9q3frf45pczhRjmtzL5rg?e=qOs8vV">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsviva_kluniversityin/EcyQ8qCIKFMusmS1Jnteb8Bm9q3frf45pczhRjmtzL5rg?e=qOs8vV</a>	<b>Protein structure Determination</b>	CO3	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	20

  
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22BT3074	Structural Biology	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/Eb6tb5wvJSFct46dFCbnWRwBTD1yQjJzqAjVvgE-Tkq28A?e=DL2dHg">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/Eb6tb5wvJSFct46dFCbnWRwBTD1yQjJzqAjVvgE-Tkq28A?e=DL2dHg</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EUwD3mHrbdNnNiN2rgxIQsB9hamo13PR38sAluTdCrLzw?e=HSg3Q4">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EUwD3mHrbdNnNiN2rgxIQsB9hamo13PR38sAluTdCrLzw?e=HSg3Q4</a>	Concepts in 3D structure comparison, purpose of structure comparison, Algorithms for structure comparison (FSSP, VAST & DALI), Structure-function relation, Function inference from structure.	C03	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5
22BT3075	Systems Biology	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbKrym0UxEFLmfNNn4BYhKkBXu21qGX3VEQBazwdlWuJg?e=QlJn9x">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EbKrym0UxEFLmfNNn4BYhKkBXu21qGX3VEQBazwdlWuJg?e=QlJn9x</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EewpvEqXaVVDnxo30UnM5SUBNrlEq5tHYZ0HQLN0FEL0A?e=50lovH">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EewpvEqXaVVDnxo30UnM5SUBNrlEq5tHYZ0HQLN0FEL0A?e=50lovH</a>	COMPUTER SIMULATIONS OF DYNAMIC NETWORKS.	C04	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5

  
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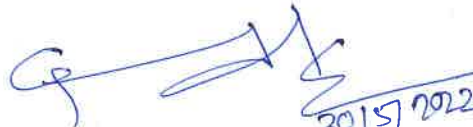
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22BT3076	Applied Bioinformatics	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ESuWu1TdyUlPii2Q7x_nB_wBUvVZCoKfCZNf40VFEweXQ?e=CYZA1o">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ESuWu1TdyUlPii2Q7x_nB_wBUvVZCoKfCZNf40VFEweXQ?e=CYZA1o</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EQEJVF5n8gRBr2669UpuTFEBMrpp8svPIVXSnmqlhXnw?e=Gm4DZl">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EQEJVF5n8gRBr2669UpuTFEBMrpp8svPIVXSnmqlhXnw?e=Gm4DZl</a>	Network Mapping; Biological Pathway dbs - EcoCyc, KEGG; Pathway prediction; Metabolic pathway reconstruction	C01	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	5
22BT3077	Python and R Programming	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EYvIGTBPQvtEhLO1Oo_oQzXUBEKfjREF_9nHgrPF3K1emqw?e=Lar1AN">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EYvIGTBPQvtEhLO1Oo_oQzXUBEKfjREF_9nHgrPF3K1emqw?e=Lar1AN</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ESD0RqphoYF0jnIsELPmJjYBw5l67ZqrhajTemSh89pI1w?e=QCFixV">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/ESD0RqphoYF0jnIsELPmJjYBw5l67ZqrhajTemSh89pI1w?e=QCFixV</a>	principal component analysis, fourier transforms, numerical sequence alignment	C02	As per the feedback received from the stake holders we have revised the syllabus for 2022-23 batch.	10

  
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22BT3078	Data Base Management System	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EfW802fYRN5MiGn_Nio0DUBL19u7dbF65LSCdEztcorQ?e=lj4TaF">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EfW802fYRN5MiGn_Nio0DUBL19u7dbF65LSCdEztcorQ?e=lj4TaF</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EUzCo82w8zBARxa61COgIDABbE4wkV71FhpGtLRXkAIRA?e=zNB1Rt">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EUzCo82w8zBARxa61COgIDABbE4wkV71FhpGtLRXkAIRA?e=zNB1Rt</a>	Different types of Indexes- B-Tree - B+Tree - Query Processing Deferred Update - Shadow Paging XML - Structure of XML	CO2	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	10
22BT3081	Stem cell technology	PE	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EWj5J4QYZKpGko1Gz4hM97MB-xKgK9P7eMdhgYu1WqNr5g?e=svocPd">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/EWj5J4QYZKpGko1Gz4hM97MB-xKgK9P7eMdhgYu1WqNr5g?e=svocPd</a>	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/Ebuy-00fte1LkxbOrrHFALEB53FFWVggsikkEkgSixvm5g?e=UHNWBg">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiva_kluniversity_in/Ebuy-00fte1LkxbOrrHFALEB53FFWVggsikkEkgSixvm5g?e=UHNWBg</a>	Genetic manipulation of Embryonic Stem cell, homologous recombination of stem cells	CO2	As per the feedback received from the stakeholders we have revised the syllabus for 2022-23 batch.	10

  
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22BT40A9	Biomaterials	PE	REFERENCE SYLABUS: AICTE MODEL CURRICULUM	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiiva_kluniversityin/EeNxq0dthgBDR6Osksw2aUEByE1MdyxbM-irMvflIryoCA?e=jpNMaZ">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiiva_kluniversityin/EeNxq0dthgBDR6Osksw2aUEByE1MdyxbM-irMvflIryoCA?e=jpNMaZ</a>	NEW COURSE	CO1,CO2, CO3,CO4	As per the feedback received from the stake holders we have Introduced new course in 2022-23 batch.	100
22BT40C5	Computer Aided drug design	PE	REFERENCE SYLABUS: AICTE MODEL CURRICULUM	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiiva_kluniversityin/ERE3l9xfGsRptkhM8UUD-yYB0PRjdI8tI0CadkCZvjzmtg?e=SoEQPv">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiiva_kluniversityin/ERE3l9xfGsRptkhM8UUD-yYB0PRjdI8tI0CadkCZvjzmtg?e=SoEQPv</a>	NEW COURSE	CO1,CO2, CO3,CO4	As per the feedback received from the stake holders we have Introduced new course in 2022-23 batch.	100
22 BT 51B5	Bioreactor Operations	PE	REFERENCE SYLABUS: DBT MODEL CURRICULUM	<a href="https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiiva_kluniversityin/EVtorrU5aHRLgGBNA-">https://kluniversityin-my.sharepoint.com/:w:/g/personal/gsiiva_kluniversityin/EVtorrU5aHRLgGBNA-</a>	NEW COURSE	CO1,CO2, CO3,CO4	As per the feedback received from the stake holders we have Introduced new	100

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				<a href="https://kluniversity.in-my.sharepoint.com/:w:/g/personal/gsi-va_kluniversity_in/EQxdkMIEp4VFrG59-YybDSwBPmA_Kuq_tg7iDwiHEoStC3w?e=6DecRs">OWKKcBdHihXiZR kHYeyJ1HJljlQ?e= A4g7Kf</a>			course in 2022-23 batch.	
22 BT 52C7	Intellectual Property Rights, Biosafety and Bioethics	PE	REFERENCE SYLABUS: DBT MODEL CURRICULUM	<a href="https://kluniversity.in-my.sharepoint.com/:w:/g/personal/gsi-va_kluniversity_in/EQxdkMIEp4VFrG59-YybDSwBPmA_Kuq_tg7iDwiHEoStC3w?e=6DecRs">https://kluniversity.in- my.sharepoint.com /:w:/g/personal/gsi- va_kluniversity_in/ ETPOHPavSqpFiK 6fLEzBOD4ByM44 AFdEtKpozVCIT8n 5Bw?e=NYulcX</a>	NEW COURSE	CO1,CO2, CO3,CO4	As per the feedback received from the stake holders we have Introduced new course in 2022-23 batch.	100
22 BT 52D5	Methods in genomics, transcriptomics, proteomics and metabolomics	PE	REFERENCE SYLABUS: DBT MODEL CURRICULUM	<a href="https://kluniversity.in-my.sharepoint.com/:w:/g/personal/gsi-va_kluniversity_in/EQxdkMIEp4VFrG59-YybDSwBPmA_Kuq_tg7iDwiHEoStC3w?e=6DecRs">https://kluniversity.in- my.sharepoint.com / :w:/g/personal/gsi- va_kluniversity_in/ EQxdkMIEp4VFrG5 9- YybDSwBPmA_Kuq tg7iDwiHEoStC3w? e=6DecRs</a>	NEW COURSE	CO1,CO2, CO3,CO4	As per the feedback received from the stake holders we have Introduced new course in 2022-23 batch.	100

  
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### Annexure III

#### Minutes of the XXXI DAC meeting-Department of Biotechnology held on 15-05-2022 in online mode from 10:00 AM to 11:30 AM

##### Agenda Item-I

PDD of new program Structure highlighting, Local/Regional/National/Global needs and Mapping to courses.	Approved
---	----------

**Resolution:** PDD of new program Structure highlighting Local/Regional/National/Global needs and Mapping to courses has been approved and recommended to BoS by DAC.

##### Agenda Item-II

To consider the approval of proposal for launching certificate courses for 2022-23 admitted batch.	Approved
--	----------

**Resolution:** The following value added courses for Y22 batch have been introduced, approved and recommended by DAC to BoS.

1. Base SAS
2. Clinical data management
3. Regulatory affairs
4. Sports

##### Agenda Item-III

Proposal of B.Tech and M.Tech Y22 batch structure along with Employability, Entrepreneurship and skill development categorizations.	Approved
---	----------

**Resolution:** For the A.Y. 2022-23 curriculum, Basic Mathematics course should be mandatory for students with PCB background. Similarly, Basic biology should be mandatory for students with PCM background joining in B.Tech Biotechnology.

The same resolution of Basic mathematics and Basic biology courses for PCB and PCM students has been accepted by the Department Academic Council (DAC).

As per the feedback from stakeholders, Basic mathematics course has been renamed as mathematical methods.

Further, change in the course titles and syllabi of Genetic Engineering, Process Engineering principles and Microbial Technology have been recommended by DAC committee to BoS.

The same resolution of modifying the syllabi of Genetic Engineering, Process Engineering principles and Microbial Technology has been accepted by the Department Academic Council (DAC).

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By implementing the proposed modifications, course structure of 2022-23 admitted batches is under the categories of Employability, Entrepreneurship and skill development and the same will be recommended to BoS.

### Agenda Item-IV

Restructuring of existing curriculum and syllabi for the year Y22 and Y21 batches.
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Approved
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**Resolution:** As per the suggestions of DAC members, the existing course structures of Y22 and Y21 has been modified and recommended to BoS.

DAC has approved the revised course structures of Y22 and Y21 and the amended structures attached in **Annexure-I**.

The following courses of Y22 and Y21 batches have undergone the changes in their syllabi

1. Biochemistry
2. Microbiology
3. Molecular Biology
4. Cell Biology
5. Biochemical Thermodynamics
6. Downstream Processing
7. Metabolic Engineering
8. Single variable calculus and Matrix Algebra

The following courses of Y20 batch have undergone the changes in their syllabi

1. Tissue Engineering
2. Bioprocess Economics and Plant design
3. Biochemical reaction Engineering

The following courses of Y19 batch have undergone the changes in their syllabi

1. Molecular Expression Technology

DAC has approved the revised syllabi of above mentioned course recommended to BoS.

### Vote of thanks:

The chair has thanked all the DAC members for their efforts and active participation

  
Professor in charge Academics

  
Head of the Department

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### Annexure-IV: Feedback from Various stake holders

Stakeholder Category	Stakeholder Feedback / Recommendation	Action Taken in BOS	Name of the Programme	Academic Year	Department	Date of BOS
Industry Personnel	Dr. Ratna Sudha, MD, Unique Biotech Pvt.ltd, Hyderabad, Telangana, Suggested to add Few topics like chemistry, manufacturing and control of Biotechnological products and quality assurance can be added for M.Tech and PhD courses	As per the suggestions, we have incorporated the mentioned topics in M.Tech and PhD courses and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Industry Personnel	Dr. Indrani, Research Head, Unique Biotech Pvt.ltd, Hyderabad, Telangana, Suggested to include Manufacturing 4.0 can be introduced including the online data management for Product quality	As per the instructions, series of webinars were planned for UG and PG students, approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Industry Personnel	Dr. Rajesh, Scientist E, Sanofi Biotech, Medchal, Telangana, Suggested to change Syllabus as per the requirements of an industry. However, much focus should be given on documentation too.	As per the suggestions of Industry peer, techniques in documentation were added in Term paper & Social internship and the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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Industry Personnel	Dr. Alok Kumar, Sanofi Biotech, Medchal, Telangana, Suggested to increase practical sessions for core courses	Practical sessions for the core and specialization courses have been incorporated in to UG syllabus as per the suggestions approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Industry Personnel	Dr. Easwaran, Biocon Research Academy, Banglore , Suggested to include skill based experiments in curriculum.	As per the comments, skill based experiments were added in PEP, Immunology, DSP & PABT and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Industry Personnel	Dr. Ramgopal; Biocon Research Academy, Banglore , Suggested to include cell culture techniques in plant and animal biotechnology course	Cell culture techniques for the mentioned subjects were added as per the suggestions received and the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Miss. Rishitha Challagulla, NorthCarolina, USA, In the course entitled Pharmaceutical biotechnology, suggested to include production and purification of biopharmaceuticals such as vaccine and therapeutic products	Production and purification of biopahrma and therapeutic products were added as per the suggestions in Pharmaceutical Biotechnology course approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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Alumni	Miss. Pavitra Etukuri Challagulla, North Carolina, USA, In Industrial Biotechnology specialization, advances in vaccine production process (Covid-19 vaccine) to be included	As per the suggestions received, advances in vaccine production has been added to the course and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Mr. Nikhil Reddy, Maryland, USA, Suggested to enrich information about cGMP procedures followed in industries	cGMP procedures were incorporated in Industrial specialization courses as per the suggestions from Alumni and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Mr. Divyanshu Dhakate, Ottawa, Canada, Include certain topics such as Quality assurance and regulatory guidelines followed in industries	As per the comments, industry oriented topics such as QA and regulatory guidelines were added and the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Miss. Kamujula Vandana, Ottawa, Canada, In Fermentation Technology, suggested to include DoE with various concepts like statistical design (RSM, TAGUCHI, BB AND AI)	As per the comments received, statistical design models like in RSM, TAGUCHI, BB AND AI were added and the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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Alumni	Mr. Nizamuddin Syed, Sydney, Australia, Suggested to include concept of NMR in the course namely Bio analytical techniques	BAT subject was enriched with the concepts NMR as per the suggestions of alumni and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Mr. Mohd. Anjum, Kaulalampur, Malaysia, Suggested to incorporate advanced microscopic concepts such as SEM and TEM in Microbiology.	Advanced microscopic topics such as SEM and TEM were added in Microbiology as per the suggestions in Pharmaceutical Biotechnology course	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Miss. Vyshnavi Davulri, South Carolina, USA, Suggested to include concepts of aseptic process simulations and handling procedures	As per the suggestions of alumni, aseptic process simulations and handling procedures were added and the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Miss. Bhavana Poladi, NIH, USA, suggested to add classification of MO's handling techniques (BSL-1, 2, 3, 4 etc)	Classification of Bio safety levels (1-4) were incorporated as handling of microbes based on the suggestions approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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Alumni	Miss. Tatineni Jahnvi, Harward, USA, recommended to include safety procedures to be followed in handling of MO's (Bacteria, Yeast and Virus) and animal models	As per the recommendation, safety procedures while handling Microbes were incorporated as per the suggestions approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Miss. Vyshnavi Reddy, Dana-Faber Cancer Research Center, USA, advised to introduce or increase the duration of foreign internship for at least 6 months for M.Tech students	As per the advice, the internship period was increased to 1 year for both UG and PG students approved by BoS and eventually recommended to the Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Mr. Hemanth Pula, USA, Suggested to increase the Participation of UG and PG students in international conferences	Students will be given with more opportunities to attend international conferences so as to gain exposure and the same was approved by BoS and recommended to Academic ehcouncil.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Mr. Yashwanth Gouda, AZT Biotech park, Vizag, AndhraPradesh , Advised to increase the number of Industrial visits and industry exposure for B.Tech and M.Tech students on regular basis	As per the suggestions, number of industrial visits has been increased to 2 from 1 per year for UG and PG and the same were approved by BoS and recommended to the Academic Council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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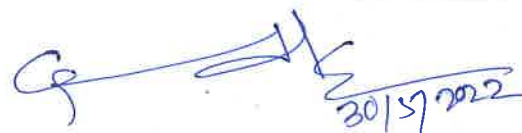
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Alumni	Miss. Ankita Kunta, USA, Advised to increase the number of reference books in the library should be increased for core courses	Reference books in the library were increased for students approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Miss. Neeha Sultana, Banglore, India, Suggested incorporating advanced topics of vaccine development should in Industrial Biotechnology specialization	As per the suggestions received, advances in vaccine production has been added to Industrial Biotechnology and the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Mr. Uduta Hasha, USA, Recommended to mandate at least 2 international certificate courses for UG students	For UG students, 3 certificate courses have been mandated as per the comments approved by BoS and eventually recommended to Academic council.	B.Tech	+2022-2023	Biotechnology	29/05/2022
Alumni	Miss.Sindhu Mulpuri, USA, Advised to add few topics related to CRSIPR-Cas9, recombinant proteins as therapeutics and MABs in UG curriculum	As per the suggestions, topics such as CRSIPR-Cas9, recombinant proteins as therapeutics and MABs were added in UG syllabus approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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Alumni	Miss. Braja Kishori Panigrahi, Oxford University, USA , Advised to increase the number of guest lecturers in the areas of Recombinant protein production, vaccine development strategies etc	Number of guest lectures will be improved as per the comments received from alumni the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Mr. Sudhanshu Sekhar, Vizag, USA , Suggested to involve and make use of industry persons even in specialization courses	As per the advice, utilization of industry persons were enhanced in the form of organizing guest lectures approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Mr. Pradyumna Irugavarapu, Cancer research Institute, USA, Advised to include Plant biotechnology along with the existing 4 specialization courses for B.Tech students where as introduction of IPR, bio safety and Bioethics courses for M.Tech students	As per the suggestions, along with the existing specialization courses, Plant Biotechnology has been added approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Alumni	Miss. Elizabeth from Canada Suggested to include lab component for the course namely Process Engineering Principles	Lab component for the subject entitled Process Engineering Principles was added as per the comments the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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Students	Miss. Bhavana , Suggested to introduce team based activities and outdoor visits to industries	Team based activities such as Term paper, project expo and number of industrial visits have been incorporated as per the suggestions of current students exist in our department the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Mr. Salman Khan, Advised to increase Industrial visits for B.Tech students	Industrial visits have been improved for UG students from 1 to 2 per year the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Miss. Pushpa Suggested to design the course in such as way that internships can be easily grabbed	As per the suggestions received, the courses have been modified as per the requirement of internships the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Mr. Srinivas Bandi Advised to increase the number of industry for placements	Number of industries were increased so as to place more students in industrial sector and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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Students	Miss. Suhana Kousar Suggested to provide projects in CSIR labs for M.Tech students	Students have been encouraged to carry out their projects in CSIR labs as per the suggestions received and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Miss. Afeefah Farheen Advised to provide opportunities for more fellowships or fellowships in reputed companies	Opportunity to explore Number of Fellowships in various companies have been encouraged for 3rd and 4th year student projects	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Mr. Suresh Kancham Suggested to include job related courses for M.Tech	M.Tech course has been modified as per the suggestions received so as to meet industrial requirements the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Mr. Naveen poturi Advised to introduce labs for specialization courses	As per the suggestion, labs have been incorporated for specialization courses the same were approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Miss. Rachel Kocherla Suggested to increase the interactions with industry and alumni	As per the recommendation, industrial experts and alumni meeting have been planned for discussions and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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Students	Miss. Sunandini Vedigandla Advised to include topics such as Aquaculture, horticulture and Fish breeding	As per the suggestion, topics like Aquaculture, horticulture and Fish breeding were added in courses related to Agriculture specialization approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Mr. Hussain Shaikh Suggested to provide more number of text books and involve students in research from the initial stages itself	Number of text books have been increased and students were encouraged to initiate their research from the moment they enter into the department by selecting certain faculty as their mentors and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Mr. Narsimha Rao Advised to increase the number of technical workshops for B.Tech students	As per the suggestions, number of technical workshops have been increased for UG and PG students	B.Tech	2022-2023	Biotechnology	29/05/2022
Students	Mr. Pavan Kalyan Suggested to appoint a faculty for guiding them to select a particular specialization to avoid any confusion among students	Orientation lectures have been planned for the students in their 3rd Year so as they get benefit and clarify their doubts regarding selection of specialization and the same was approved by BoS and recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

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Parents	Mr. Chandraseskhar Suggested to encourage students in participating various international conferences	As per the suggestion received from the parents, Students will be given with more opportunities to attend international conferences so as to gain exposure approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Parents	Mr. Subhash pal Advised to allow students to go for more industrial exposure	Number of industrial visits have been increased for the students as per the suggestions received from parents approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Parents	Mrs. Sukanya Vemuri Recommended to increase foreign internships for UG students as well	As per the recommendation, number of foreign internships for UG students have been increased approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Parents	Mrs. Fareeha shaikh Suggested to introduce clubs for study and research	Various clubs for study and research have been added to give proper guidance to the students approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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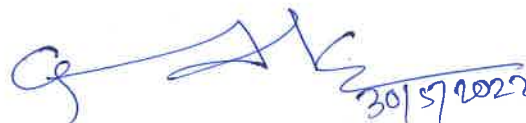
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Parents	Mr. Jonnalgadda Vinay Advised to provide text books for students so as to reduce the stress on eyes while preparing for the exams	Number of text books have been increased and students were encouraged to update their knowledge approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Parents	Mr. Umesh Raj Suggested to conduct more workshops and allow students for more industrial or field visits	Number of industrial visits have been increased for the students as per the suggestions received from parents approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Parents	Mrs. Siddiqua Begum Suggested to counsel the students on regular basis and should be monitored	Counseling has been made a mandate for every faculty and it will be monitored to observe the overall progress of the student approved by BoS and eventually recommended to the Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022
Parents	Mr. Saleem Khan Advised to introduce awareness among students in selecting the specialization courses	Orientation lectures have been planned for the students in their 2nd and 3rd Year so that they get benefit and get clarifications from the concerned faculty members approved by BoS and eventually recommended to Academic council.	B.Tech	2022-2023	Biotechnology	29/05/2022

  
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## Annexure-V: Pre Ph.D Courses

S.NO.	COURSE CODE	NAME OF THE COURSE	PAPER NUMBER
1	22BT201	Bioanalytical Techniques	PAPER-2
2	22BT202	Plant Biotechnology	PAPER-3
3	22BT203	Genetic Engineering	PAPER-3
4	22BT204	Microbial Technology	PAPER-3
5	22BT205	Biochemistry	PAPER-3
6	22BT206	Molecular Modelling and Drug Design	PAPER-3
7	22BT207	Bioprocess Engineering	PAPER-3
8	22BT208	Immunotechnology	PAPER-3

  
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### Annexure-VI: New Courses Syllabus

21BT3213: GENETICS

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: Nil

**Course Objectives:** To acquire knowledge on Mendel's laws of inheritance, interaction of Genes and inheritance, Gene linkage, crossing over and mapping, and understanding sex determination and linkage and population genetics.

#### **Mapping of Course outcomes (CO) with program outcomes (PO):**

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Acquire the knowledge of Mendel's law of inheritance and the interaction of Genes and inheritance	PO6	1
CO 2	Acquire the knowledge of Gene linkage, crossing over, and mapping	PO6	1
CO 3	Understand the Sex Linked Inheritance and Sex Determination and extrachromosomal inheritance	PO7	2
CO 4	Understand the population genetics.	PO7	2

**Syllabus:** Mendelian inheritance and its extensions: Mendel's experiments; Law of segregation, monohybrid cross, reciprocal cross, back cross, test cross; Law of independent assortment, dihybrid cross; Chromosomal Theory of Inheritance. Variations to dominance- Co-dominance and Incomplete dominance; Lethal and Sub-lethal genes, Penetrance and Expressivity; Pleiotropism; Multiple alleles- Eye color in Drosophila, ABO blood groups in human; Rh Blood group incompatibility; Self incompatibility in plants. Gene interactions- types of epistasis (9:7; 9:3:4; 9:6:1; 12:3:1; 15:1). Multifactorial inheritance: Features of quantitative inheritance- additive effect, Kernel colour and size in wheat /maize, skin color in man. Sex linked inheritance - X-linked and Y-linked traits - holandric genes, SRY gene; Sex limited and sex influenced traits; Sex determination - mechanisms of sex determination in Drosophila and Human. Non-mendelian inheritance: Plastid inheritance - Variegation in *Mirabilis jalapa*; Maternal effects and inheritance - Shell coiling in snails, Poky mutants in *Neurospora*.

**Linkage, Crossing over and Gene mapping:** Discovery of linkage-Phases of linkage; Chiasmata and Crossing over formation-Recombination Cytological proof for crossing over- Curt Stern and McClintock experiments Linkage analysis - Recombination frequencies, Two-point and Three-point crosses Gene mapping-Coincidence and Interference, Determination of gene order Gene mapping in *Neurospora* - Tetrad analysis; Mitotic recombination in *Aspergillus* and *Drosophila*.

**Sex Linked Inheritance and Sex Determination:** Sex Linked Inheritance - Sex linked inheritance in *Drosophila* and human; Sex limited and Sex influenced inheritance; Sex Determination - Sex determination in *Drosophila*-Genic balance theory; Sex determination in eukaryotes-heterogametic, homogametic, haplodiploidy, role of environmental factors, mosaics; Sex determination in mammals- and role of human Y chromosome Extrachromosomal Inheritance- Mitochondrial inheritance (petite

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mutations); Mitochondrial inheritance in man; Epigenetics and genome imprinting in humans

**Population Genetics:** Principles of Population genetics Population structure, Random mating population, Concepts of a population (gene pool, deme and panmictic unit) Genetic and phenotypic variation in a population, allele frequencies and genotype frequencies at a locus Hardy-Weinberg Law- assumptions and implications, establishment of Hardy Weinberg equilibrium for single gene locus Extension of Hardy-Weinberg Law for multiple alleles Establishment of Hardy-Weinberg Law for X- linked genes Linkage disequilibrium – haplotypes, coefficient of linkage disequilibrium, coupling gametes and repulsion gametes.

Text books:

1. Genetics, by P.K.Gupta, Rastogi Publications
2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, by P.S.Verma and V.K. Agarwal, S. Chand & Company

Reference book:

1. Principles of Genetics, by E.J. Gardner, M.J.Simmons & D.Peter Snustard, John Wiley and Sons, INC.

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Course Code-20BT3089

Course Name: Molecular Plant Virology

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: 22BT2108

**Course Rationale:** A course in Molecular Plant Virology provides a strong rationale for employability and skill development by preparing students to address challenges posed by plant viruses through molecular insights. Graduates are well-equipped to contribute to virus management, develop resistant crop varieties, and drive innovations in sustainable agriculture.

**Course Objective:** The course objectives of a Molecular Plant Virology program aim to provide students with a comprehensive understanding of the principles, methodologies, and applications of molecular techniques in studying plant viruses.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Classification and taxonomy of plant viruses	PO3, PO5&PS01	3
CO 2	Genome structure and organization of plant viruses	PO2, PO3, PO5&PS02	3
CO 3	Methods for plant virus infection, detection and diagnosis	PO2, PO3&PS01, PS02	3
CO 4	Epidemiology of plant viruses	PO2,PO3, PO5, PO6&PS01	3

**Syllabus:** Definition of plant viruses, Classification and taxonomy of plant viruses, Structure and properties of plant viruses, Transmission and spread of plant viruses, Genome structure and organization of plant viruses, Replication strategies of plant viruses, Viral gene expression and protein synthesis, Interactions between plant viruses and host plants, Methods for plant virus detection and diagnosis, Mechanisms of plant virus entry and intracellular movement, Virus-induced changes in host plant physiology and metabolism, Plant defense responses to viral infection, Molecular basis of viral pathogenesis and symptom development, Insect vectors of plant viruses, Transmission mechanisms and vector specificity, Epidemiology of plant viruses, Plant quarantine and regulatory measures, Integrated disease management strategies for plant viruses, Molecular cloning and genetic engineering for virus studies, Generation and analysis of virus-resistant transgenic plants, RNA interference (RNAi) as a tool for virus control, Genomic and proteomic approaches in plant virology research, Novel viral pathogens and diseases, RNA viroids and viroid-like satellite RNAs, Virus-derived small RNAs and their regulatory roles, Applications of plant virus-based vectors in biotechnology

### Text books:

1. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius, Bettina R. Riebel, VCH.

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Course Code-20BT3090

Course Name: Crop Science and Production

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: 22BT2108

**Course Rationale:** a course in Crop Science Production provides a strong rationale for employability and skill development by preparing students to contribute to efficient and sustainable crop production. Graduates are well-equipped to work in agricultural companies, research institutions, and organizations focused on improving agricultural practices, food security, and environmental sustainability.

**Course Objective:** The course objectives of a Crop Science Production program aim to provide students with a comprehensive understanding of the principles, techniques, and applications of crop science for efficient and sustainable crop production.

**Mapping of Course outcomes (CO) with program outcomes (PO):**

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Understand and apply knowledge on agriculture and crop production	PO3, PO5&PSO1	3
CO 2	Understand and apply knowledge on agronomy and tillage	PO2, PO3, PO5&PSO2	3
CO 3	Apply different agronomic methods for growth and development of crops	PO2, PO3&PSO1, PSO2	3
CO 4	Understand and apply knowledge on plant ideotypes and plant protection	PO2,PO3, PO5, PO6&PSO1	3

### Syllabus

Overview of crop production: Importance of agriculture, Food and nutritional requirements and crop supply, overview of crop production in India and the world. Crop terminology and classification: agronomic classifications, speciality and miscellaneous classifications Agronomy: Definition meaning and scope. Agroclimatic zones of India, major sources of irrigation and ground water potential. Tillage & Tillth: Definition, Objectives, characteristics of a good seedbed, Effect of tillage on soil properties- pore space, structure bulk density, particle density and colour of the soil. Types of tillage - Primary tillage, secondary tillage & intercultural operations. Preparatory tillage- factors effecting preparatory cultivation, after cultivation, puddling. Sowing: Methods of sowing-time and depth of sowing for major agricultural crops- Cereals, Pulses, Oil seeds and forage. Crop Stand establishment, Factors effecting optimum stand establishment. Crop density - Planting geometry, Competition, Types of competition, intra and inter plant competition, plant population, effect of plant population on growth and yield, Optimum plant density and planting pattern. Soil fertility- soil fertility and soil productivity - fertility losses- maintenance of soil fertility soil organic matter- uses of organic matter.

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Weed Control-Definition of weed, Weeds- importance, classification, crop weed competition, concepts of weed management-principles and methods, herbicides-classification, selectivity and resistance, allelopathy. Irrigation management: Importance of irrigation- Objectives of irrigation-methods of irrigation- drainage and its advantage. Crop nutrition- Essential elements – Importance of major, secondary and micro nutrients. Manures and fertilizers- Classification – Nutrient content- Nutrient use efficiency – Factors affecting nutrient use efficiency. Growth and development of crops- factors effecting growth and development.

### Text books:

2. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius, Bettina R. Riebel, VCH.
2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin.

### Reference books:

1. Enzymes by Palmer, 2. Enzymes in Industry by Wolfgang Aehle, Wiley-VCH.

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Course Code-20BT3091

Course Name: Molecular Plant Virology

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: 22BT2108

**Course Rationale:** A course in Molecular Plant Virology provides a strong rationale by preparing students to address challenges posed by plant viruses through molecular insights. Graduates are well-equipped to contribute to virus management, develop resistant crop varieties, and drive innovations in sustainable agriculture.

**Course Objective:** The course objectives of a Molecular Plant Virology program aim to provide students with a comprehensive understanding of the principles, methodologies, and applications of molecular techniques in studying plant viruses.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Classification and taxonomy of plant viruses	PO3, PO5&PSO1	2
CO 2	Genome structure and organization of plant viruses	PO2, PO3, PO5&PSO2	2
CO 3	Methods for plant virus infection, detection and diagnosis	PO2, PO3&PSO1, PSO2	2
CO 4	Epidemiology of plant viruses	PO2,PO3, PO5, PO6&PSO1	2

### Syllabus

Definition of plant viruses, Classification and taxonomy of plant viruses, Structure and properties of plant viruses, Transmission and spread of plant viruses, Genome structure and organization of plant viruses, Replication strategies of plant viruses, Viral gene expression and protein synthesis, Interactions between plant viruses and host plants, Methods for plant virus detection and diagnosis, Mechanisms of plant virus entry and intracellular movement, Virus-induced changes in host plant physiology and metabolism, Plant defense responses to viral infection, Molecular basis of viral pathogenesis and symptom development, Insect vectors of plant viruses, Transmission mechanisms and vector specificity, Epidemiology of plant viruses, Plant quarantine and regulatory measures, Integrated disease management strategies for plant viruses, Molecular cloning and genetic engineering for virus studies, Generation and analysis of virus-resistant transgenic plants, RNA interference (RNAi) as a tool for virus control, Genomic and proteomic approaches in plant virology research, Novel viral pathogens and diseases, RNA viroids and viroid-like satellite RNAs, Virus-derived small RNAs and their regulatory roles, Applications of plant virus-based vectors in biotechnology

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### Text books:

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2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin.

### Reference books:

1. Enzymes by Palmer
2. 2. Enzymes in Industry by Wolfgang Aehle, Wiley-VCH.

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Course Code-20BT3092

Course Name: GMOs, Biosafety and Bioethics

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: 22BT2108

**Course Rationale:** A course in GMOs, Biosafety, and Bioethics provides a strong rationale for employability and skill development by preparing students to navigate the complexities of GMO development, biosafety regulations, and ethical considerations. Graduates are well-equipped to work in regulatory agencies, biotechnology companies, research institutions, and organizations focused on responsible biotechnology innovation.

**Course Objective:** The course objectives of a GMOs, Biosafety, and Bioethics program aim to provide students with a comprehensive understanding of the principles, regulations, and ethical considerations surrounding GMOs and their safe deployment.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Understand the role of different Biosafety levels and identify the best BSL labs suited for handling different Microorganisms and for GMO research	PO3, PO5&PSO1	2
CO 2	Understand how to distinguish between different types of IPRs	PO2, PO3, PO5&PSO2	2
CO 3	Understand the varied types of patents and acquire knowledge about patent filing	PO2, PO3&PSO1, PSO2	2
CO 4	Understand and identify Copyright law and the consequences of Copyright violations	PO2,PO3, PO5, PO6&PSO1	2

### Syllabus

Introduction to biosafety; biosafety guidelines in India; biosafety levels; Cartagena Protocol on Biosafety; implementation of biosafety guidelines; institutional biosafety committee; biosafety implications in GMO research. Introduction to intellectual property rights; requirements and utility of IPRs; different types of IPRs; features of World Intellectual Property Organization (WIPO); TRIPS agreement; international treaties and conventions on intellectual property. Fundamentals of the patent; conditions for the grant of patents; what can be and what cannot be patented; types of patents; patenting agencies; filing patents in India; procedure for grant of patents; patenting of biological material; patenting of transgenic, isolated genes and DNA sequences. Introduction to copyright and its applicability; copyright registration in India; laws and policies regarding copyright (Berne convention and Copyright (Amendment) Act, 2012);

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fundamental concepts and importance of trademark; relevance of geographical indication"

### Textbooks:

1. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius, Bettina R. Riebel, VCH.
2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin.

### Reference books:

1. Enzymes by Palmer,
2. Enzymes in Industry by Wolfgang Aehle, Wiley-VCH.

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Course Code-20BT3093

Course Name: Agribusiness and Entrepreneurship

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: 22BT2108

**Course Rationale:** A course in Agribusiness and Entrepreneurship provides a strong rationale for employability, skill development, and entrepreneurship by preparing students to navigate the dynamic landscape of the agricultural industry, create innovative solutions, and drive economic growth through agricultural ventures. Graduates are well-equipped to pursue careers in agribusiness management, agricultural startups, and agricultural value chain development.

**Course Objective:** A course in Agribusiness and Entrepreneurship offers a strong rationale concerning employability, skill development, and entrepreneurship, as it equips students with the knowledge and practical skills necessary to navigate the complexities of the agricultural industry while fostering innovation and business development. Agribusiness involves the application of business principles to agriculture, and entrepreneurship in this context focuses on creating and managing agricultural enterprises.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Apply entrepreneurship principles to agribusiness challenges.	PO3, PO5&PSO1	3
CO 2	Apply sustainable farming practices in agribusiness ventures.	PO2, PO3, PO5&PSO2	3
CO 3	Apply emerging technologies to enhance agribusiness operations.	PO2, PO3&PSO1, PSO2	3
CO 4	Apply business planning and financing to agribusiness ventures.	PO2,PO3, PO5, PO6&PSO1	3

### Syllabus

Principles of Entrepreneurship and Opportunity Recognition in Agribusiness: Introduction to entrepreneurship principles; identifying opportunities in the agribusiness sector; evaluating market demand for agricultural products and services; conducting market research and analysis.

Business planning and Financing in Agribusiness: Developing a business plan for an agribusiness venture; financial management and accounting principles for agribusiness; sources of financing for agribusiness ventures; financial risk management and mitigation in agribusiness."

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Sustainable Agriculture Practices in Agribusiness: Principles of sustainable agriculture; sustainable farming practices and technologies; environmental impact assessment and mitigation in agribusiness; sustainable supply chain management for agribusiness.

Emerging Technologies in Agribusiness: Overview of emerging technologies in agriculture; precision agriculture and the use of data analytics in agribusiness; drones and robotics in agriculture; applications of biotechnology in agriculture and agribusiness.

### Textbooks:

1. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius, Bettina R. Riebel, VCH.
2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin.

### Reference books:

1. Enzymes by Palmer,
2. Enzymes in Industry by Wolfgang Aehle, Wiley-VCH.

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Course Code-20BT3094

Course Name: Molecular Breeding in Field Crops

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: 22BT2108

**Course Rationale:** a course in Molecular Breeding in Field Crops provides a strong rationale for employability and skill development by preparing students to contribute to the development of genetically improved crop varieties. Graduates are well-equipped to work in research institutions, agricultural companies, and organizations focused on advancing crop production and sustainability through molecular techniques.

**Course Objective:** The course objectives of a Molecular Breeding in Field Crops program aim to provide students with a comprehensive understanding of the principles, methodologies, and applications of molecular techniques in crop breeding.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Understand and apply knowledge of genome organization	PO1	3
CO 2	Understand and apply knowledge on molecular markers and assessment of genetic diversity	PO1	3
CO 3	Understand and apply knowledge on mapping field crop populations	PO1	3
CO 4	Apply different molecular methods to genotyping	PO3, PSO2	3

**Syllabus:** Genome Organization: Organellar genome and Nuclear Genome: Unique sequences, Repeat DNA sequences, Classification of Repeat DNA (Tandem repeats, Interspersed repeats, Micro-satellites, Mini-satellites, midi-satellites, VNTRs) The dynamic genome: Polymorphisms and Sources of Genetic variation. Overview of Genetic Markers: Phenotypic Markers, Biochemical markers, DNA based markers Molecular marker and DNA fingerprinting techniques: Concepts, classification, and methodologies: Hybridization based markers (viz. Restriction Fragment Length Polymorphism, Oligonucleotide fingerprinting), PCR based markers (viz. DNA Amplification Fingerprinting, Arbitrarily Primed PCR, Randomly Amplified Polymorphic DNA, SSRs, STMS, SCARs, Inter-SSRs, Multiple Arbitrary Amplicon Profiling, Amplified Fragment Length Polymorphism, Selectively Amplified Microsatellite Polymorphic Loci, Inter retrotransposon amplified polymorphism, retrotransposon-microsatellite amplified polymorphism, Diversity Array Technology (DARTs), SNPs and SNP based assays for highthroughput genotyping, EST based markers, Sequencing by Hybridization (SBH).

Molecular Markers and Assessment of genetic diversity: Principles of Numerical taxonomy, binary matrix to phenetic dendograms, Structure analysis, Case Studies and examples Molecular Markers for genome mapping: Principles of Genetics: Laws of

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inheritance, Linkage and crossing-over, Recombination analysis Genotyping, Concepts for Genetic mapping, Construction of genetic linkage maps for gene and QTL mapping, positional cloning for gene identification, Introduction to

linkage mapping software packages and interfaces. Breeding by design: Marker Assisted Selection (MAS), gene introgression and pyramiding, BSAGenotyping for Physical mapping:Fingerprinting for BAC assembly.Types of Mapping populations in field crops: F2 populations, RILs (recombinant inbred lines), Backcross lines, NILS (Near Isogenic Lines), HIF (Heterogenous Inbred Families), AILs (Advanced Intercross Lines)."

### Text books:

1. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius , Bettina R. Riebel, VCH.
2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin.

### Reference books:

1. Enzymes by Palmer,
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Course Code-20BT3095

Course Name: Introduction to Plant Breeding

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: 22BT2108

**Course Rationale:** a course in Introduction to Plant Breeding provides a strong rationale for employability and skill development by preparing students to contribute to the development of improved crop varieties and address challenges in agriculture. Graduates are well-equipped to work in plant breeding research, agricultural companies, and organizations focused on improving global food production and sustainability.

**Course Objective:** The course objectives of an Introduction to Plant Breeding program aim to provide students with foundational knowledge and skills to understand the principles, techniques, and significance of plant breeding in agriculture.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Plant breeding, Genetic variation and breeding strategy and selection	PO1	2
CO 2	Pollination mechanisms and strategies, Strategies for getting the increased yield	PO1	3
CO 3	Hybridization and hybrid breeding, Traditional and molecular breeding approaches	PO1	3
CO 4	Seed production techniques and regulations, Seed testing and quality control measures, Breeding for improved yield and nutritional enhancement	PO3, PSO2	3

### Syllabus

History and importance of plant breeding, Objectives and goals of plant breeding, Overview of plant breeding methods and techniques, Basic principles of plant genetics, Mendelian inheritance and genetic variation, Molecular genetics and genomics in plant breeding, Introduction to DNA markers and marker-assisted selection, Genetic variation and gene action, Breeding value and selection methods, Genotype-by-environment interactions.

Reproductive biology of plants, Pollination mechanisms and strategies, Cross-pollination vs. self-pollination, Techniques for controlled pollination, Strategies for getting the increased yield

Hybridization and hybrid breeding, Population improvement and recurrent selection, Mutation breeding and polyploidy breeding, Genetic engineering and genetically modified organisms (GMOs), Data analysis and interpretation of breeding experiments, Genomic selection and high-throughput phenotyping, Climate change and its impact on

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breeding strategies, Integration of traditional and molecular breeding approaches

Seed production techniques and regulations, Seed testing and quality control measures, Seed certification and varietal release procedures, Breeding for disease resistance, Breeding for abiotic stress tolerance (e.g., drought, heat), Breeding for improved yield and quality traits, Breeding for nutritional enhancement, Ethical considerations in plant breeding

### Text books:

3. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius, Bettina R. Riebel, VCH.
2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin.

### Reference books:

1. Enzymes by Palmer, 2. Enzymes in Industry by Wolfgang Ahle, Wiley-VCH.

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Course Code-20BT3096

Course Name: Agriculture informatics

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: 22BT2108

**Course Rationale:** A course in Agriculture Informatics provides a strong rationale for employability and skill development by preparing students to leverage information technology for sustainable and efficient agricultural practices. Graduates are well-equipped to contribute to the adoption of technology in agriculture, enhance productivity, and drive innovation in the industry.

**Course Objective:** The course objectives of an Agriculture Informatics program aim to provide students with a comprehensive understanding of the principles, techniques, and applications of information technology in agriculture.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Introduction to Agricultural Informatics, Data Collection and Analysis	PO1	2
CO 2	Applications of MS Office for document creation, editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, uses of DBMS in Agriculture	PO1	3
CO 3	Computer Models for understanding plant processes	PO1	3
CO 4	Geospatial technology for generating valuable agri-information. Decision support systems, concepts	PO3, PSO2	3

### Syllabus

An overview of the field, its significance, and the role of information technology in agriculture, Techniques for collecting and analyzing agricultural data, including sensor technologies, remote sensing, and statistical analysis Integration of informatics with agronomy, crop science, soil science, and other agricultural disciplines. Applying big data analytics techniques to extract valuable insights from large-scale agricultural datasets, Design and development of decision support systems to assist farmers and stakeholders in making informed decisions. Introduction to various information systems used in agriculture, such as farm management systems, geographic information systems (GIS), and decision support systems, Application of informatics and technology for precision agriculture, including topics like yield.

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### Text books:

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2. Biotransformation in Organic Chemistry by Kurt Faber, Springer Berlin.

### Reference books:

1. Enzymes by Palmer, 2. Enzymes in Industry by Wolfgang Aehle, Wiley-VCH.

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Course Code-22BT51A2

Course Name: Enzyme Technology

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL


**Course Rationale:** An enzyme technology course provides students with a unique blend of scientific knowledge, practical skills, and problem-solving abilities that are highly sought after in today's job market. It prepares them for a diverse range of careers, fosters innovation, and contributes to the growth of industries with a focus on sustainability and efficiency.

**Course Objective:** The objective of enzyme technology is to leverage the remarkable properties of enzymes to revolutionize industrial processes, making them more efficient, environmentally friendly, and economically viable. This field holds significant potential for addressing global challenges and contributing to sustainable development.

CO#	Course Outcome (CO)	PO	PSO	BTL
CO1	Use various purification methods for purification of enzymes	PO1,	PSO1	3
CO2	Apply different kinetic methods for enzyme-substrate reaction.	PO1	PSO1	2
CO3	Use various models for identification of enzyme-substrate mechanism.	PO1	PSO1	2
CO4	Apply principles of mass transfer in immobilized systems.	PO1, PO3	PSO1	3

**Syllabus: Introduction to enzyme technology:** Source of enzymes; Production, isolation and purification of enzymes; Characterization in terms of pH, temperature, ionic strength, substrate and product tolerance, effects of metal ions etc.; Various production methods for commercial enzymes; Large scale production of enzymes. Production of recombinant proteins (Insulin, Interleukin, Interferon); important commercial enzymes; Amylases; Proteases; Lipases; Cellulases. **Enzyme Kinetics:** Michaelis-Menten equation, alterations and significance. General mechanisms of enzyme regulation, Types of inhibition; Irreversible inhibition (proteases), Reversible (glutamine synthase & phosphorylase), competitive inhibition, Non & Un-competitive, mixed inhibition, and substrate & product inhibition; Allosteric enzymes, qualitative description of concerted & sequential models for allosteric enzymes. Allo-steric regulation of enzymes; Deactivation kinetics. Feed back inhibition and feed forward stimulation. Half site reactivity, Flipflop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamoylase. Protein-ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots. **Enzyme Engineering:** Enzymes as biological catalysts; Active site, Functional group, Enzyme substrate complex, Cofactors; Acidbase catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Chemical modification of active site groups. Random and rational approach of protein engineering; Directed evolution and its applications in the field of biocatalysis; various approaches of creating variant enzyme molecules; Site directed mutagenesis of

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enzymes. Mechanism of action of chymotrypsin, lysozyme, carboxypeptidase and alcohol dehydrogenase. **Enzyme immobilization and applications:** Introduction to enzyme immobilization; various immobilization methods; physical and chemical techniques for enzyme immobilization – adsorption; Matrix entrapment, encapsulation; Cross-linking; Covalent binding; Medical and analytical applications of immobilized enzymes; Design of enzyme electrode & their application in clinical diagnostics. Role of enzymes in recombinant DNA technology; Enzymes for diagnostic and analytical purposes. Use of enzymes in analysis-types of sensing-gadgetry and methods. Case studies on application – chiral conversion, esterification. **Mass transfer effects in immobilized systems:** Analysis of Film and Pore Diffusion Effects on kinetics of Immobilized Enzyme Reactions; Calculations of diffusional resistances and Thiele's modulus; Multi step immobilized enzyme systems; Solutions of numerical problems; Application and future of immobilized enzyme technology. Concentration gradients and Reaction rates in solid catalysts; Internal mass transfer and reaction; Steady state Shell Mass balance; Formulation of dimensionless groups and calculation of Effectiveness factors.

### Recommended Textbooks;

1. Nelson and Cox, Principles of Biochemistry, 4th Edition, W. H. Freeman, 2004.
2. J. Rehm and G. Reed, Enzyme Technology, Vol. 7a, VCH-Verlag.
3. Trevor Palmer: ENZYMES – Biochemistry, Biotechnology, Clinical chemistry. Horwood Publishing Ltd. Affiliated East – West Press Pvt. Ltd. New Delhi.

### Reference Text Books:

1. Biotol Series (This series has many volumes pertaining to different subjects including white, red, blue and green biotechnology).

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Course Code-22BT51A3

Course Name: Medical Biotechnology

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in medical biotechnology offers a compelling rationale for employability by providing students with the specialized knowledge and skills needed to contribute to advancements in healthcare, pharmaceuticals, diagnostics, and research. The intersection of biology, technology, and medicine positions graduates to play a crucial role in addressing healthcare challenges and improving patient outcomes.

**Course Objective:** The course objectives of medical biotechnology are designed to prepare students for careers at the intersection of biology, technology, and medicine. Graduates of such programs are equipped to contribute to advancements in healthcare by developing new medical products, therapies, and diagnostics, and by applying biotechnological principles to address medical challenges.

CO#	Course Outcome (CO)	PO	PSO	BTL
CO1	Understand the significance of biotechnology in medical field	PO1, PO3	PSO1	2
CO2	Understand the therapeutic methodologies against genetic disorders	PO8, PO9	PSO1	2
CO3	Understand and identify potential stem cell technologies for medical application	PO3, PO8, PO9	PSO1	2
CO4	Apply the biotechnological tools in medical diagnosis and analyze the outcomes	PO3, PO8, PO9	PSO2	3

### Introduction to medical technology

Introduction and applications of medical Biotechnology. Artificial organs– Methods and production principles. Production of Biotherapeutics: Therapeutic proteins (interferons, cytokinins, insulin), vaccine, antibodies (polyclonal and monoclonal) etc.

### Gene transfer technology

Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy, Retro and adeno virus mediated gene transfer. Liposome and nanoparticles mediated gene delivery Cellular therapy, Ethics in gene therapy.

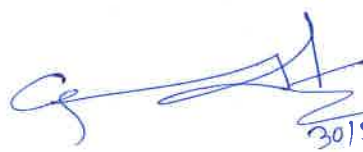
### Stem cell technology

Stem cells: definition, properties and potency of stem cells; Stem cell niches; Cell cycles regulators in stem cells, embryonic and adult stem cells; Concept of tissue engineering; Scaffolds: properties, type and role; Growth factors and signaling cascade (BMP, Nodal, Wnt, Notch and Retenoid signaling); Clinical applications; Ethical issues.

### Medical diagnosis

Biochemical diagnostics: inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, and glycogen storage disorders. Immunodiagnostic techniques: ELISA, RIA, Western blot and immunohistochemistry. PCR and Array based

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diagnostic techniques, DNA sequencing and diagnosis; Diagnostic imaging: CT, MRI, PET;  
Ethics in Molecular Diagnosis

### Recommended text books (Latest Edition);

1. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
2. Pratibha Nallari, V. Venugopal Rao; Medical Biotechnology, oxford University press, 2010.

### Reference text books:

1. James W. Goding , Monoclonal antibodies; Principles and Practice , 3rd Edition , Academic Press 1996.
2. George Patrinos and Wilhelm Ansonage, Molecular Diagnostics, 1st Edition , Academic Press, 2005.

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Course Code-22BT51A4

Course Name: Stem cell Technology

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in stem cell technology offers a compelling rationale for employability by providing students with specialized knowledge and skills that are essential for contributing to advancements in regenerative medicine, biotechnology, and research. The potential of stem cell technology to transform healthcare and address medical challenges makes graduates valuable assets in multiple sectors, driving innovation and improving patient outcomes.

**Course Objective:** The course objectives of a stem cell technology program aim to provide students with a solid foundation in stem cell biology, research techniques, clinical applications, and ethical considerations. Graduates of such programs are well-equipped to contribute to advancements in regenerative medicine, biotechnology, and scientific research related to stem cells.

CO#	Course Outcome (CO)	PO	PSO	BTL
CO1	Acquire the knowledge of stem cell technology	PO2	PSO1	2
CO2	Understand stem cell characterization and tissue engineering	PO2	PSO1	2
CO3	Illustrate various strategies involved in regulation and stem cell ethics.	PO3	PSO1	2
CO4	Apply various principles involved in stem cell therapies.	PO1	PSO1	3

### Introduction

What are stem cells, types, origin and nature of stem cells? Characteristic features, pluripotent stem cells and its types, Molecular basis of pluripotency. Cell surface markers of stem cells. Embryonic stem cells, factors requirements for maintain stem cells. Differences between human and mouse stem cells. Development of epithelial stem cell concept. Stem cell niches. **Stem cell characterization:** Cell cycle regulation in stem cell. Mechanism of stem cell renewal, Changes of phenotypic characters, Characterization of human embryonic stem cells, Isolation and maintenance of Stem cell. Genetic manipulation of Embryonic Stem cell, homologous recombination of stem cells. Surface antigenic markers, lineage marking, Genomic reprogramming. Microarray analysis of stem cells & differentiation. Zebra fish and Stem cell research. **Tissue engineering:** Neural stem cells and applications in neurodegenerative diseases, Treatment of heart diseases, diabetes, burns & skin ulcers, muscular dystrophy, regeneration of epidermis, orthopedic applications. Embryonic applications in tissue engineering. Novel sources of multipotent stem cells. Adult stem cells, Stem cell gene therapy. **Regulations and Ethics:** Ethics of human cell research-immortal cells and moral selves, Ethical considerations, stem cell based therapies. FDA products and preclinical regulatory considerations. Patent advocacy, Science policies, ethics in stem cell research, primordial germ cells and germ

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cell development epigenetics and reprogramming in stem cell biology, norms in clean room.

### Books recommended:

1. Rober Lanza, Essentials of Stem cell biology, Elsevier academic press, 2009
2. Joseph D. Bronzino Tissue engineering and artificial organs, Biomedical engineering hand book. volume -2, 3rd edition, CRC press, Taylor & Francis publications, 2006

### Reference book:

1. Daniel R. Marshak, Stem Cell Biology, *Johns Hopkins University and Cambrex Corp.*; Richard L. Gardner, *University of Oxford*; David Gottlieb, *Washington University, St. Louis*, 2001.
2. George Patrinos and Wilhelm Ansorage, Molecular Diagnostics, 1st Edition, Academic Press, 2005.

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Course Code-22BT51A5  
Design

Course Name: Molecular Modelling and Drug

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in molecular modelling and drug design provides a compelling rationale for employability by equipping students with specialized computational skills that are essential for drug discovery, development, and research. Graduates are well-prepared to contribute to the creation of innovative therapies and solutions for medical challenges.

**Course Objective:** The course objectives of a molecular modelling and drug design program aim to prepare students for careers in pharmaceutical research, biotechnology, and computational chemistry. Graduates with expertise in these areas are well-equipped to contribute to drug discovery projects, optimize drug candidates, and utilize computational tools to advance medical science and innovation.

CO#	Course Outcome (CO)	PO	PSO	BTL
CO1	Apply the knowledge of drug discovery methods and introduction to molecular modeling and simulation	PO2, PO3	PSO1	3
CO2	Apply the knowledge of Protein function and structural prediction by computer-based modeling	PO2,, PO5	PSO2,	3
CO3	Apply the knowledge of bimolecular interactions	PO3, PO5	PSO1	3
CO4	Apply the role of modeling and drug design methods with case studies	PO3, PO5	PSO2	3

**INTRODUCTION TO MOLECULAR MODELING AND DRUG DESIGN:** Drug- Definition, history and types; Overview of drug discovery and development I; Methodologies and strategies in molecular modelling and Drug Design - Structure and ligand-based drug design; Drug targets in Diseases - Enzymes and Receptors; Phases of Computer aided drug design (Target and Lead Discovery); Biomolecular interactions; Importance of Molecular Modelling and Drug Design in novel Drug discoveryDiagnostics.

**PREDICTION AND STRUCTURAL ANALYSIS OF MACROMOLECULES :** Macromolecular structure databases - Protein Data bank, structural classification of protein; Bioanalytical methods to determine protein structure - X Ray diffractions, NMR and Cryo-electron methods; Protein Structure and Function-Hierarchy of protein structures, Concept of Protein Folding, Interactions Forces; Protein structure prediction - Concept of protein modelling, structure validation methods; Optimization of protein structure - Preparation and Refinement methods; Introduction to Transmembrane Proteins - Structure, function and prediction; Mutational Effects on protein structure - Calculation of free energy, Prediction of deleterious mutations

**BIOMOLECULAR INTERACTIONS AND DRUG DISCOVERY METHODS:** Small Molecule Analysis - Structural analysis, Physico-Chemical analysis, prediction of ADMET properties

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and biological activity; Introduction to chemical pharmacophore; Principles of biomolecular interactions - Molecular Docking, Molecular Dynamics simulations, ranking and scoring; Concepts of Virtual screening in drug discovery; Introduction to Quantitative structure activity relationships in drug design.

APPLICATIONS AND ADVANCEMENTS IN MOLECULAR MODELING: Drug Target prediction - methods and applications; Introduction to Biological Networks – protein-protein Interaction analysis; Fundamentals of network pharmacology; Principles of Pharmacogenetics; Sequence analysis of biomolecules - Prediction of Protein Parameters, Secondary structure, Hydrophobicity, trafficking, phosphorylation, Disordered regions; Advancements in Molecular modelling and drug design - New technologies and innovations in drug design; Application of Computer aided drug design with real world examples

### Textbooks:

1. Molecular modeling basic principles and applications –Hans-Dieter Holtje and Gerd Folkera, Wiley, 2003.
2. Molecular modeling of proteins. By Andreas Kukol, Humana Press, 2008.

### Reference books:

1. Molecular Modelling Principles and Applications. A. R. Leach, Longman, 1996

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Course Code-22BT51B2

Course Name: Bioreactor Operations

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in bioreactor operations provides a compelling rationale for employability by equipping students with specialized skills in bioprocess development, biopharmaceutical production, environmental applications, and more. Graduates are well-prepared to contribute to diverse industries, drive innovation, and address global challenges through biotechnological solutions.

**Course Objective:** The course objectives of a bioreactor operations program aim to prepare students for careers in bioprocessing, biopharmaceutical production, and related industries. Graduates are equipped with the practical skills and theoretical knowledge needed to operate bioreactors, optimize processes, and contribute to the efficient and safe production of various bio products.

CO#	Course Outcome (CO)	PO	PSO	BTL
CO1	Acquire the knowledge of bioreactor design, scale up and scale down processes.	PO1,PO3	PSO1	2
CO2	Understand the basic operation of various bioreactors used in the animal and plant cells.	PO1,PO3	PSO2	2
CO3	Understand the various facilities required for designing of bioreactor.	PO1,PO3	PSO1	2
CO4	Apply principles of various heat and mass transfer principles on designing of bioreactor	PO1,PO3	PSO2	3

### Syllabus:

**Introduction to bioreactor design:** Introduction; General design information; Material and energy balance calculations; Process Flow, **Scale up and scale down processes:** Scale up and scale down issues: Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply; Bioreactor scaleup based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. **Scale-up of downstream processes:** Adsorption (LUB method); Chromatography (constant resolution etc.); Filtration (constant resistance etc.); Centrifugation (equivalent times etc.); Extractors (geometry based rules). Scale-down related aspects. **Basic bioreactor operations:** Spectrum of basic bioreactor operations: immobilized cell system, animal cells, plant cell cultures and waste management; Enzyme immobilization techniques; Bioconversion using immobilized enzyme preparation; Bioconversion in batch, Fed-batch and continuous bioreactors; Mass transfer in immobilized cell/enzyme reactor. **Bioreactor facility design:** Facility design aspects; Utility supply aspects; Equipment cleaning aspects; Culture cell banks; cGMP guidelines; Validation; Safety; Process economics; Case studies. **Bioreactor equipment:** Selection of bioprocess equipment (upstream and downstream); Specifications of bioprocess equipment; Mechanical design of reactors, heat transfer and

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mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment; Piping and instrumentation; Materials of construction for bioprocess plants.

### Recommended Textbook:

1. Roger Harrison et al., (2003), Bioseparations Science and Engineering, Oxford University Press.
2. Michael Shuler and Fikret Kargi, (2002), Bioprocess Engineering: Basic Concepts, 2nd Edition, Prentice Hall, Englewood Cliffs, NJ.
3. Michael R. Ladisch, (2001), Bioseparations Engineering: Principles, Practice and Economics, 1st Edition, Wiley.
4. M. V. Joshi and V.V.Mahajani., (2000). Process Equipment Design, 3rd Edition, Macmillan India Ltd
5. Robert H. Perry and Don W. Green (eds.), (1997), Perry's Chemical Engineers' Handbook, 7th Edition, McGraw Hill Book Co.
6. Max S. Peters and Klaus, D. Timmerhaus, (1991). Plant Design and Economics for Chemical Engineers, 4th Edition, McGrawHill Book Co.
7. J. Bailey and D.Ollis, (1986), Biochemical Engineering Fundamentals; McGraw Hill. 8. Relevant articles from Bioprocess Journals.

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Course Code-22BT51B3

Course Name: Bio mining

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in bio mining provides a strong rationale for employability by equipping students with specialized skills in resource extraction, biotechnology, and environmental sustainability. Graduates are well-prepared to contribute to the advancement of bio mining technologies, address environmental challenges, and provide innovative solutions to the mining and biotechnology industries.

**Course Objective:** The course objectives of a biomining program aim to prepare students for careers in resource extraction, environmental management, and biotechnology. Graduates with expertise in biomining are well-equipped to contribute to sustainable mining practices, environmental remediation efforts, and innovative biotechnological solutions.

CO#	Course Outcome (CO)	PO	PSO	BTL
CO1	To provide basic concept and history of biomining highlighting the microorganisms and reactors	PO1	PSO1	2
CO2	Understand the concept and application of microorganisms in biomining of base metal sulphides	PO2	PSO2	2
CO3	Understand the concept and application of microorganisms in biomining of nuclear and precious metals	PO1, PO2	PSO1	2
CO4	Understand the role of microorganisms in pollution control and bioremediation	PO1, PO2	PSO2	3

### Syllabus:

**Basic concept and introduction to bioleaching: History of bioleaching, biogenesis of metals and minerals, microorganisms in biohydrometallurgy, reactor bioleaching and developments in bioleaching of concentrates, bioleaching mechanisms, bacterial attachment to minerals, metal toxicity in leaching bacteria, development of metal-tolerant Acidithiobacillus ferrooxidans.**

**Bioleaching of base metal sulfides:** Biohydrometallurgy of copper – general principles, mechanisms and microorganisms, biohydrometallurgy of copper – dump and heap leaching, biohydrometallurgy of copper – modern developments, bioleaching of nickel from sulfides

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and laterites, heap bioleaching technology for nickel, bioleaching of zinc sulfide ores and concentrates.

**Bioleaching of nuclear and precious metals:** Biohydrometallurgy of uranium, Microorganisms and mechanisms, – Dump, heap and insitu leaching, industrial aspects and remediation, biotechnology for gold – biogenesis, microorganisms and gold nanobiotechnology, biooxidation of refractory sulfidic concentrates, recent developments, bioprocessing of industrial wastes

**Microbiological aspects of environmental pollution and control:** Acid mine drainage – mechanisms and control, bioremediation technologies in mining, industrial aspects and in situ remediation experimental determination of acid mine drainage, bioremediation using Sulfate – Reducing – Bacteria – Copper, iron, zinc and arsenic.

### Recommended textbooks:

1. Mitchell, M., 1998, an Introduction to Genetic Algorithms, Prentice-Hall.
2. Lau C., (Ed), 1992, Neural Networks, IEEE Press.

### Reference textbooks:

1. Freeman, J. and Skapura, D., 1991 Neural Networks: Algorithms, Applications and Programming Techniques, Addison-Wesley. Klir, G.J. and Folger, T.A., 1988, Fuzzy Sets, Uncertainty, and Information, PHI.

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Course Code-22BT51B4

Course Name: Bioprocess Validation and cGMP

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in bioprocess validation and cGMP provides a strong rationale for employability by equipping students with specialized knowledge and skills that are crucial for ensuring product quality, regulatory compliance, and patient safety in the biopharmaceutical and related industries. Graduates are well-prepared to contribute to the production of safe and effective biopharmaceutical products while adhering to strict regulatory standards.

**Course Objective:** The course objectives of a Bioprocess Validation and cGMP program aim to prepare students for careers in roles related to product quality, regulatory compliance, and validation in the biopharmaceutical, biotechnology, and related industries. Graduates are equipped with the skills and knowledge necessary to contribute to the production of safe, effective, and compliant biopharmaceutical products while upholding ethical and professional standards.

CO#	Course Outcome (CO)	PO	PSO	BTL
C01	Remembering the basics of bioprocess validation and its importance.	PO1	PSO1	2
C02	Understand the concept of quality assurance and SOPs for various bioprocess systems.	PO2	PSO2	2
C03	Understand the principles of Good Manufacturing Practices and their importance in bioprocess.	PO2	PSO1	2
C04	Apply the bioprocess validation and cGMP principles in clinical research based studies and protocol development.	PO4	PSO2	3

### Syllabus:

#### Bioprocess Validations

Definition of Calibration, Qualification and Validation-Scope, frequency and importance, Difference between calibration and validation, Calibration of weights and measures, Advantage of Validation, Scope of Validation, Organization for Validation, Validation Master plan, Types of Validation, Streamlining of Qualification & Validation process, Validation Master Plan.

  
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### Quality Assurance

Quality Assurance, Quality control, Quality management, Responsibilities of quality management in laboratories, Development of quality records, Deviations of quality product process, Good laboratory practices, Responsibilities in GLP, Computational processes in GLP. Standard Operating Procedures - SOP of immunological industries, SOP of tissue culture, Deviations of SOP, Revision occurrence in SOP, Authorized control of SOP, Guidelines and regulation of FDA and ICH for GLP.

**Good Manufacturing Practices** cGMP guidelines according to schedule M, USFDA (inclusive of CDER and CBER), Pharmaceutical Inspection Convention(PIC), WHO and EMEA covering: Organization and personnel responsibilities, training, hygiene and personal records, drug industry location, design, construction and plant lay out, maintenance, sanitation, environmental control, utilities and maintenance of sterile areas, Control of contamination, Good Warehousing Practice

### Clinical research

Introduction and importance of clinical research, Drug development and phases of clinical trials: Designing clinical trials, Protocol designing, Ethical, safety and regulatory issues in clinical research, Drug regulatory concepts and accrediting agencies of the world (USFDA, TGA, ICH, WHO, ISO etc.), ICH-GCP Guidelines, Informed consent process, Role of CRC and CRA in clinical trials, Standard operating procedures, Guidelines to undertake clinical trials in India.

### Recommended Textbooks:

1. P. P. Sharma, How to Practice GMP's
2. ICH Guidelines - USFDA Hand book

### Reference textbook:

1. J. Seiler, Good Laboratory Practices

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Course Code-22BT52C2

Course Name: Bioprocess Technology

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in bioprocess technology provides a compelling rationale for employability by preparing students with specialized skills and knowledge that are applicable to a wide range of industries. Graduates are well-equipped to contribute to biopharmaceutical production, food and beverage processing, environmental applications, and other biotechnology-related fields.

**Course Objective:** The course objectives of a bioprocess technology program aim to prepare students for careers in biopharmaceuticals, biotechnology, food production, and environmental applications. Graduates are equipped with the skills and knowledge necessary to contribute to the development, optimization, and efficient operation of bioprocesses while adhering to ethical, regulatory, and quality standards.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	CO Outcome	POs/PEOs	BTL Level
CO1	Remembering the basics of bioreactor operational modes and microbial growth kinetics.	P01	1
CO2	Understand the reactor consideration and kinetics of immobilized enzyme systems.	P03	2
CO3	Understand the concept of mass transfer coefficient and bioreactor scale up process.	P05	2
CO4	Apply the principles of bioprocess for the design consideration of different recombinant based cultivation systems.	P03/PS01	3

**Syllabus: Operational modes and kinetics of microbial growth:** Batch, continuous and Fed batch cultivation, Cell recycle cultivation, Simple unstructured models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics  
**Bioreactor consideration in enzyme systems :** Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions, formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors  
**Bioreactor scale – up:** Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors – microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.  
**Recombinant cell cultivation :** Different host vector system for recombinant cell

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cultivation strategies and advantages, Animal cell cultivation, plant cell cultivation, Insect cell cultivation; High cell density cultivation, process strategies, reactor considerations in the above system

### Recommended Textbooks:

1. Industrial Microbiology & Biotechnology by Arnold L. demain & Julian E. Davis. (2004) ASM Press.
2. Fermentation Microbiology & Biotechnology by Emt.el-Mansi & CFA. Bryce (2004). Taylor & Francis Ltd.

### REFERENCE BOOKS:

3. Principles of fermentation technology by P.F. Stanbury, A. Whitaker & S.J. Hall(1997). Oxford.
4. The Bacterial Vol. III by Gungalus, I.C. and stainer. RY. (Eds.) Academic press. New York.
5. Bacterial physiology and metabolism by Sala Teh JR - Academic press, New York..
6. Chemical Engineering by J.M. Coulson and J.F. Richardson (1984) Pergamon Press.

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Course Code-22BT52C3

Course Name: Environmental Biotechnology

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in environmental biotechnology provides a strong rationale for employability and skill development by preparing students to address critical environmental issues using biotechnological methods. Graduates are well-equipped to contribute to sustainable practices, innovative solutions, and environmental stewardship in various industries and sectors.

**Course Objective:** The course objectives of an environmental biotechnology program aim to prepare students for careers in environmental management, biotechnological innovation, and sustainable resource utilization. Graduates are equipped with the skills and knowledge necessary to contribute to addressing pressing environmental challenges and advancing sustainable practices using biotechnological methods.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO	COURSE OUTCOME DESCRIPTION	Mapped PO/PSO	BTL
CO 1	Outline various environmental pollution problems in the ecosystem	PO1	1
CO 2	Illustrating different biotechnological solution for environmental problems in industrial sector	PO7	2
CO 3	Interpreting the application of bio-oxidation and bio leaching process.	PO7,PSO2	3
CO 4	Summarize the formulation of sustainable process and product	PO7,PSO2	3

### Syllabus:

**Environmental Pollution:** Types, Environmental pollution (water, soil, air), Noise & Thermal pollution, sources, and control. Reduction of environmental impact of industrial effluents, chemical herbicides and fertilizers. Xenobiotic compounds: Aliphatic, Aromatics, Polyaromatic Hydrocarbons, Polycyclic aromatic compounds, Pesticides, persistent organic pollutants, Biomedical waste. Global Environmental problems (Ozone depletion, UV-B, Greenhouse effect), National policy on environment. **Bioremediation:** Bioremediation of surface soil and sludge's, Bioremediation of subsurface material, In situ technologies, Ex-situ technologies, Biological Treatment of anaerobic and aerobic; methanogenesis, methanogenic, acetogenic, and fermentative bacteria- technical process and conditions; Use of Genetically Engineered Organisms and R-DNA Technology in Bioremediation. Emerging biotechnological processes in waste – water treatment; Applications include treatment of municipal and industrial wastewaters (Dairy, Distillery, Pharma and Tannery industries), Use of Genetically Engineered Organisms and R-DNA Technology and Phytoremediation. **Bio-oxidation & Microbial Leaching:** Bio-oxidation – Direct and Indirect Mechanisms – Bio-oxidation Kinetics; Bacterial oxidation of Sphalerite, Chalcopyrite and Pyrite.; Extraction of metals from ores; Recovery of metals from solutions, Microbial desulfurization of coal,

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gene cloning – use of genetically altered microorganisms for field biodegradation of hazardous materials, Bio Mining and Bio-hydrometallurgy application. **Eco friendly Products and Process:** Green economy and sustainable future- Bio-fertilizers, Bio control and Integrated Pest management, Composting, Vermi culture, Bio energy and Bio fuel, Bio plastics, Biosurfactants Bio piles, Bio venting, Bio enzyme , Bio reactors for bioremediation, Biotransformation mechanisms, Green synthesis of Bio nano particle used in environmental applications.

### Recommended textbooks:

1. T. Srinivas, Environmental Biotechnology, New-Age Publications, New Delhi (2008)
2. Bru E. Rittmann and Perry L. Mc Carty, Environmental Biotechnology: Principles and Applications, Mc Graw Hill Company (2001).

### Reference textbooks:

1. Howard S. Peavy, Donal R. Rowe and George Tchobanoglous, Environmental Engineering, Mc Graw Hill Company (1985).

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Campus: Green Fields, Vaddeswaram - 522 302, Guntur District, Andhra Pradesh, INDIA.

Phone No. 08645 - 350200; www.klof.ac.in; www.klef.edu.in; www.kluniversity.in

Admin Off: 29-36-38, Museum Road, Governorpet, Vijayawada - 520 002. Ph: +91 - 866 - 3500122, 2577715, 2576129

Course Code-22BT52C4

Course Name: Advanced Nano biotechnology

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in nanobiotechnology provides a compelling rationale for employability, skill development, and entrepreneurship by preparing students to develop innovative solutions at the nanoscale for addressing challenges in biotechnology, medicine, and various industries. Graduates are well-equipped to contribute to groundbreaking advancements, establish their own ventures, and make a positive impact on society through nanobiotechnological innovations.

**Course Objective:** The course objectives of a nano biotechnology program aim to prepare students for careers in nanotechnology applications within the field of biotechnology. Graduates are equipped with the skills and knowledge necessary to contribute to innovative solutions, address complex challenges, and make advancements in areas such as healthcare, medicine, materials science, and beyond.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Acquire the knowledge of nanomaterials and their properties in biological systems	PO1	1
CO 2	Understand the underlying principles of synthesis and techniques involved in characterization of nanomaterials	PO2	2
CO 3	Applications of nanomaterials in medicine and targeted drug delivery	PO3	3
CO 4	Applications of nanomaterials in agriculture and environment	PO3	3

### Syllabus:

**Introduction to nanobiotechnology:** Definition of nanoscale with reference to physics and bio-systems. Crystal Structure, Unit Cells, Bravais Lattices, Crystallographic Directions, Crystallographic Planes, Miller Indices, Bragg's Law. Types of Material -Different types of materials: Metals, Semiconductors, Composite materials, Ceramics, Alloys, Polymers and Bio Polymer composites. Fundamentals terms in biotechnology, Biological building blocks: Sizes of building blocks and Nanostructures, nucleic acids, genetic code and protein synthesis, DNA double nano wires, protein nanoparticles and polypeptide nanowires. Biological Nanostructures: Bio-mimetics with examples, Bio mineralization, Bio compatible Bio sensors, Examples of proteins, micelles, vesicles, bilayers, and Multilayer films, application of bio- nanotechnology: bio nano machines, molecular modeling. **Nano materials synthesis and Characterization:** Nano material Synthesis: Top-Down Approach. Physical methods - Inert gas condensation, aerosol method, Arc discharge, RF-plasma technique, laser ablation,

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Spray Pyrolysis, Ball Milling. Bottom-up approach - Chemical Methods - Metal nanocrystals by reduction, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Sonochemical routes, Solvated metal atom dispersion, Sol-gel technique. Biological methods- use of bacteria, fungi, actinomycetes for nanoparticle synthesis-magnetotactic bacteria for natural synthesis of magnetic nano-particle, role of plants in nanoparticle synthesis. Microscopy-Electron Microscopy, AFM, STM; Lithography-e beam lithography. Optical absorption spectrometer, UV-Vis-NIR spectrometer, x-ray Diffraction. **Medical Applications:** Biomolecular sensing for cancer diagnostics using carbon nanotubes, nano devices in biomedical applications, nanoscale polymer fabrication for biomedical application, Nanotechnology in cancer drug therapy: A biocomputational approach. Introduction to drugs, Classification of drugs, Encapsulation of drugs, Nano drug delivery: Conventional drug delivery, targeted drug delivery, chemistry of drug delivery, role of nanotechnology in drug delivery, bionanoimaging, magnetic nanoparticles for MR imaging, Magnetic hyperthermia in cancer treatment. **Agriculture and environmental applications:** Nanoformulations of agrochemicals for applying pesticides and fertilizers for crop improvement; the application of nanosensors in crop protection for the identification of diseases and residues of agrochemicals; nanodevices for the genetic engineering of plants; plant disease diagnostics; animal health, animal breeding, poultry production; and postharvest management. Nanomembranes- Nanomembranes in Drinking water treatment, Nanomembranes in Sea desalination, Microfiltration, Nano filtration, Nano filters in drinking water. Environmental Risks of Nanomaterials: Routes of NMS into the Water environment, Hazardous effects of NMs on Human and Animal Health, Risk Management.

### Recommended text books:

1. Carl.C.Koch, "Nanostructured materials, processing, properties and applications, NFL publications, 2007.
2. Hari Singh Nalwa - Handbook of nanostructured materials and nanotechnology: Synthesis and processing, ASP, 2004.
3. Stephen Elliott & S. R. Elliott The Physics and Chemistry of Solids, John Wiley & Sons, 1998.

### Recommended Reference:

1. Charles Kittel, Introduction to Solid State Physics, John Wiley & Sons, 2004
2. Van Vlack, Elements materials science, Addison-Wesley, 1964
3. Zhong Lin Wang, "Characterization of Nanophase Materials", Wiley-VCH, 2001
4. T.J.Chung, P.M. Anderson, M.K.Wu and S.Hsieh, "Nanomechanics of materials and structures, Springer, 2006.
5. Jackie Ying. Ed "Nanostructured Materials", Academic Press, 2001. A small edited volume with some good articles on some specialized topics such as adsorption in nanoporous materials
6. R. Haynes, "Optical Microscopy of Materials, International Textbook Company, Glasgow, 1984.
7. John J. Bozzola and Lonnie D. Russel, "Electron Microscopy", Jones and Bartlett Publishers Inc., USA, 1999.

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**Course Code-22BT52C6 Course Name: Computational programming for Biologists**

**L-T-P-S: 3-0-0-0**

**Credits: 3**

**Prerequisite: NIL**

**Course Rationale:** The course "Computational Programming for Biologists" offers a rationale that revolves around enhancing employability, fostering skill development, enabling data-driven research, promoting collaboration, and opening doors to diverse career opportunities in the rapidly evolving field of biology.

**Course Objective:** The course aims to empower biologists with the confidence and skills needed to leverage programming for data analysis, modeling, and problem-solving in their biological research, fostering a holistic approach that combines traditional biological knowledge with modern computational techniques.

CO#	Course Outcome (CO)	PO	PSO	BTL
CO1	Understand basic concepts of programming	PO1	PSO1	2
CO2	Use BioPerl for sequence manipulation	PO2	PSO2	3
CO3	Apply Python and BioPython programming for sequence alignment and phylogenetic tree construction	PO2	PSO1	3
CO4	Apply R programming for interpreting gene expression data.	PO4	PSO2	3

### Syllabus

**Perl programming:** an introduction to higher level programming concepts, the perl interpreter, perl variables-scalar values, arrays and hashes: array manipulation -push and pop, shift and unshift -splice-other useful array functions, hashes -maintaining a hash, control structures & string manipulation: comparisons choices- if - boolean operators- else-loops-for, foreach, while, until, loop exits; last, next and continue -array-based character manipulation, regular expressions: match, substitute and translate operations. **Perl File Handling and BioPerl:** Input and output, file handles: working with files -built-in file handles, file safety -BioPerl: accessing sequence data - using BioPerl: accessing sequence data from local and remote databases, sequence format interconversion, performing sequence analysis: global alignment, local alignment, multiple sequence alignment, parsing blast alignment report and parsing multiple sequence alignment. **Python and Biopython:** Integrated programming environments, Python fundamentals: installing python; basic usage, running programs, basic elements & syntax, strings, lists and tuples, dictionaries, loops, comparisons, definitions & functions, modules, classes, exceptions-object-oriented programming. Biological sequence analysis with Biopython: working with fasta files, parsing DNA data files, Accessing NCBI's Entrez databases, accessing pubmed, sequence alignment, dynamic programming, pairwise sequence alignment and multiple sequence alignments, phylogenetic tree construction. **R programming:** Introducing R, The big picture, the benefits of R, installation, R editor and R-GUI environment, the fundamentals

  
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of R, simple mathematics and vectors, arguments, structuring the code, comments, datatypes, control statements, looping, functions, libraries, basic plotting. R programming for gene expression analysis: Gene expression array analysis, spot finding and measurement, arrays and data displays, applications with expression arrays. R Advanced statistical analysis techniques, Correlation, Fourier transforms, Clustering, hierarchical clusters, k-means clustering, principal component analysis.

### Recommended text books:

1. Beginning Perl for Bioinformatics, James Tisdall, O'Reilly Publishers, 2001
2. Perl Programming for Biologists, D. Curtis Jamison, Wiley publishers, 2003
3. Biopython Tutorial and Cookbook, Jeff Chang, Brad Chapman, Iddo Friedberg
4. Python for bioinformatics, Jason Kinser, Jones & Bartlett publishers, 2008
5. Learning python, Mark Lutz, O'Reilly Publishers, 2007
6. R for dummies Andrie de Vries and Joris Meys 2nd edition Wiley publishers, 2015

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**Course Name: Intellectual Property Rights, Bio safety and Bioethics**

**Course Code-22BT52C7 L-T-P-S: 3-0-0-0 Credits: 3**

**Prerequisite: NIL**

**Course Rationale:** The course on Intellectual Property Rights (IPR), Biosafety, and Bioethics is designed to provide individuals in the field of biology and biotechnology with a comprehensive understanding of the legal, ethical, and safety aspects associated with their work. The rationale for offering such a course is multifaceted and closely linked to employability and skill development.

**Course Objective:** The course will be well-prepared to contribute to ethical, safe, and legally compliant practices in their biological research, while also enhancing their employability by possessing valuable skills that are highly relevant in both academic and industry settings.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Interpret basic knowledge on intellectual property rights and their implications in biological research and product development.	P01	2
CO2	Interpret the knowledge of documentation and protocols; case studies on patents and patent drafting.	P01	2
CO3	Develop the knowledge about the biosafety and risk assessment of products derived from biotechnology and regulation of such products.	P09, P011	3
CO4	Develop the knowledge about the ethical issues in biological research.	P09, P011	3

**Syllabus: Introduction to IPR:** Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.  
**Patenting:** Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications;

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procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application-forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing - outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives. **Biosafety and Its Guidelines:** Introduction; Historical Background; 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; Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements. **Bioethics:** Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons. Bioethics in research - cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labelling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity - bio piracy.

### Recommended Textbooks:

1. S. H. Willing, Good manufacturing practices for Pharmaceuticals

### Reference textbooks:

1. P. Das & Gokul Das, Protection of Industrial property Rights.

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**Course Code-22BT52D1 Course Name: Regulatory Affairs and clinical Trails**

**L-T-P-S: 3-0-0-0**

**Credits: 3**

**Prerequisite: NIL**

**Course Rationale:** A course in Regulatory Affairs and Clinical Trials offers a comprehensive educational experience that prepares students for roles in ensuring the safety, quality, and compliance of medical products. Graduates are equipped with skills to navigate regulatory processes, manage clinical trials, and contribute to the development of new treatments, enhancing their employability and contributing to advancements in healthcare.

**Course Objective:** The course objectives of a Regulatory Affairs and Clinical Trials program are designed to provide students with in-depth knowledge and practical skills necessary for successful careers in regulatory affairs, clinical research, and related fields. Here are key course

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcome (CO)	PO/PSO	Blooms Taxonomy Level (BTL)
CO1	Understand the basics and features of clinical trails	PO1	2
CO2	Patent Requirement and Clinical Trail Statistic	PO1	2
CO3	Design of Experiments and Role of It In Clinical Trails	PO3	3
CO4	Design of Experiments and Role of It In Clinical Trails	PO5	3


### Syllabus:

#### Introduction to Clinical Research

Clinical Research: An Overview, Different types of Clinical Research. Drug Development Process: Preclinical trail, Human Pharmacology (Phase-I), Therapeutic Exploratory trail (Phase-II), Therapeutic Confirmatory Trail (Phase-III) and Post marketing surveillance (Phase-IV).

#### Guidelines, Regulation and Ethics in Clinical Research

Brief History of Clinical Research: Sulphanilamide Tragedy, Thalidomide Disaster, Nazi Experiments, Tuskegee Study, Belmont report, Nuremberg code, Declaration of Helsinki principles. Guidelines in Clinical Research-International Conference on Harmonization (ICH), Guidelines for Good Clinical Practice, ICMR guidelines for Biomedical Research on Human Subjects,. Regulation in Clinical Research- Drug and cosmetic act, FDA, Schedule-Y-Ethics Committee and their responsibilities. Clinical Research Regulatory Submission&

  
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approval Process- IND, NDA and ANDA submission Procedure. DCGI submission procedure. Other Regulatory authorities- EMEA, MHRA, PhRMA.

### Clinical Research Operation, Monitoring and Clinical Evaluation:

Protocol in Clinical Research, Informed Consent, Case Report Form, Investigator's Brochure (IB), Selection of an Investigator and Site, Patient screening, Inclusion and exclusion criteria, Randomization, Blinding, Randomized Control Trials, Nonrandomized Concurrent Control Studies, Historical Controls and Databases, Cross-Over Designs, Factorial Design, adaptive designs. Recruitment Techniques, Retention and compliance of study subjects, Ethics and Regulatory submission, Monitoring Visits, Investigator Meeting, Essential Document preparation (IB, ICF, PIS, TMF, ISF, CDA CTA etc).

### Clinical Trial Management:

Sponsors perspective: Responsibility of Sponsors, Study Preparation Initial Documents and capability assessment, Study feasibility, Vendors/Service provider selection, Investigator selection, Budgeting in Clinical trial, Clinical Trial Agreement(CTA),Regulatory submission and approval, Sponsors obligation in Good Clinical Practice.

Investigator perspective: Investigators obligation outlined in Good Clinical Practice, Recruitment, Retention and Compliance of study subjects, Ethics committee submission, adverse event and safety reporting.

Responsibility of Clinical Research Professionals: Investigator, Project Manager, Regulatory Affairs Associate, Medical Writer, Clinical Research Associate, Clinical Research Coordinator and Safety Report Associate.

### Recommended Textbooks:

1. Good Clinical practices, Central Drugs Standard Control organization, Govt. of India
2. Drugs and cosmetics Act 1940.

### Reference Books:

1. International Clinical Trail, Volume 1 & 2 Dominique P. brunier and Nahler, Interpharm press, Denver, Colorado.
2. Code of Federal Regulation by USFDA-Download.

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**Course Code-22BT52D2 Course Name: Bioprocess Economics and Plant design**

**L-T-P-S: 3-0-0-0**

**Credits: 3**

**Prerequisite: NIL**

**Course Rationale:** A course in Bioprocess Economics and Plant Design provides a strong rationale for employability and skill development by preparing students to design economically feasible and efficient bioprocess plants. Graduates are well-equipped to contribute to the development, optimization, and management of bio processing operations, while ensuring economic viability and sustainability.

**Course Objective:** The course objectives of a Bioprocess Economics and Plant Design program aim to provide students with a comprehensive understanding of the principles, methodologies, and applications of designing economically viable and efficient bioprocess plants.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO	COURSE OUTCOME DESCRIPTION	Mapped PO/PSO	BTL
CO 1	Understand the Mechanical Design of Process Equipments and Economic Evaluation	PO1	2
CO 2	Apply the Costing Equipment Principles in Material Transfer, Handling and Treatment Equipment	PO1, PO2	3
CO 3	Apply the Process and Equipment Design Principles for Heat Exchangers and Evaporators	PO2	3
CO 4	Apply the Process and Equipment Design Principles for Absorption/Stripping, Distillation Columns and Reactors	PO1, PO2	3

### Syllabus:

#### Economic evaluation

Capital cost of a project. Interest calculations, nominal and effective interest rates. Basic concepts in tax and depreciation. Measures of economic performance, rate of return, payout time. Cash flow diagrams; Cost accounting-balance sheet and profit loss account. Break even and minimum cost analysis.

#### Bioprocess Economics

Introduction, elements of total production cost, outline of the total capital investment, equipment sizing, capital cost estimates large-scale equipment and utilities. Manufacturing cost estimates-Operating costs-Raw materials, utilities, fixed costs and overhead costs, case studies of antibiotics, recombinant products, single cell protein.

#### Introduction to process design

Schematic representation of unit operations, design information and flow diagrams, material and energy balances, formulation of the design problem, the Hierarchy of chemical process design and integration, optimization, Health and safety Hazards, Environment protection, plant location and lay out.

#### Basic considerations in equipment design

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General design procedure, equipment classification, materials of construction-Mechanical properties-strength, elasticity, ductility, resilience, toughness, hardness, creep, fatigue. Metals-ferrous metals, types of iron & steels, Nonferrous metals and Non-metals. Corrosion: Forms of corrosion and their presentation. Choice of materials. Design conventions.

### Basic Design Problems

Design examples on continuous fermentation, aeration and agitation. Design calculation of filter for air sterilization. Design of batch and continuous sterilizers. Design calculations for immobilized enzyme kinetics. Practical considerations in designing of Bioreactor/Fermentor construction. Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries. Design exercise on trickle flow fermenter. Problems associated with design equations.

### Recommended Text Books:

1. Peters & Timmerhaus, Plant design and Economics for Chemical Engineers -
2. M V Joshi & V V Mahajani, Process equipment design
3. Robin smith, Chemical process design and integration

  
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**Course Code-22BT52D5 Course Name: Methods in genomics, transcriptomics, proteomics and metabolomics**

**L-T-P-S: 3-0-0-0**

**Credits: 3**

**Prerequisite: NIL**

**Course Rationale:** A course in Methods in Genomics, Transcriptomics, Proteomics, and Metabolomics offers a strong rationale for employability and skill development by preparing students to work in cutting-edge fields of biological research, diagnostics, and personalized medicine. Graduates are equipped with skills to analyze omics data, contribute to advancements in life sciences, and drive innovation in various industries.

**Course Objective:** The course objectives of a Methods in Genomics, Transcriptomics, Proteomics, and Metabolomics program aim to provide students with a comprehensive understanding of the principles, techniques, and applications of these methods in biological research and industry.

**Mapping of Course outcomes (CO) with program outcomes (PO):**

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Understand the principles of various experimental and computational tools used in genomics	PO1	2
CO 2	Understand the principles of various experimental and computational tools used in transcriptomics	PO1	2
CO 3	Understand the basic methods in proteomics	PO1	2
CO 4	Understand the principles of various experimental and computational tools used in metabolomics	PO1	2

**Syllabus: Genomics and methods in genomics:** Organization and structure of genomes in prokaryotes, eukaryotes, and organelles (chloroplast, mitochondrion); Genome mapping methods (genetic and physical); RAPD, RFLP, SNP analyses; Fluorescence *in-situ* Hybridization (FISH) techniques; Advances in gene finding and functional prediction; Chain termination and chemical degradation sequencing methods. Genome-wide association (GWA) analysis; Comparative Genomic Hybridization (CGH); Massively parallel Signature Sequencing (MPSS); Whole genome shot-gun sequencing and its applications; Introduction of Next Generation Sequencing (NGS). **Transcriptomics and methods in transcriptomics:** Gene expression analysis by cDNA and oligonucleotide arrays; Micro array experimental analysis and data analysis; Bioinformatic analysis of large-scale microarray data for comparative transcriptomics. **Proteomics and methods in proteomics:** Over-view of strategies used for the identification and analysis of proteins; Protein extraction from biological samples (Mammalian Tissues, Yeast, Bacteria, and Plant Tissues); 2-DE of proteins for proteome analysis; Liquid chromatography separations in proteomics (Affinity, Ion Exchange, Reversed-phase, and size exclusion); Enzymatic cleavage of proteins. Analysis of

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complex protein mixtures using Nano-liquid chromatography (Nano-LC) coupled to Mass-spectrometry analysis. Common ionization methods for peptide/protein analysis; Introduction to Mass spectrometers; MALDI-TOF and LC-MS analyses; Comparative proteomics based on global in-vitro and in-vivo labelling of proteins/peptides followed by Mass-spectrometry. Analysis of post-translational modification (PTM) of proteins; Characterization of protein interactions using yeast two-hybrid system and Protein microarrays; Proteomics informatics and analysis of protein functions. **Metabolomics and methods in metabolomics:** Introduction to metabolic engineering, comprehensive models of cellular reactions with stoichiometry and reaction rates; metabolic flux analysis of exactly/over/under determined systems; Shadow price, sensitivity analysis; Monitoring and measuring the metabolome, Methods for the experimental determination of metabolic fluxes by isotope labelling metabolic fluxes using various separation-analytical techniques; GC-MS for metabolic flux analysis.

### Textbooks:

1. S.P. Hunt and F. J. Livesey, Functional Genomics, Oxford University press, 2000.
2. Twyman R. M. Principles of Proteomics. Taylor & Francis, 2004.

### References:

1. Voit, E.O., 2000 Computational Analysis of Biochemical Systems: a Practical Guide for Biochemists and Molecular Biologists. Cambridge University Press.
2. Alex Sánchez-Pla, Ferran Reverter, M. Carme Ruíz de Villa, Manuel Comabella, Transcriptomics: mRNA and Alternative Splicing. Journal of Neuroimmunology, Volume 248, issues 1-2, 15 July 2012, pp 23-31.

  
30/7/2022

Head  
Department of Biotechnology  
Koneru Lakshmaiah Education Foundation  
(Deemed to be University)  
VADDESWAREM, Guntur Dt.



## Koneru Lakshmaiah Education Foundation

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Course Code-22BT52D6

Course Name: Advanced Biocatalyst and Biocatalysis

L-T-P-S: 3-0-0-0

Credits: 3

Prerequisite: NIL

**Course Rationale:** A course in Advanced Biocatalyst and Biocatalysis provides a strong rationale for employability and skill development by preparing students to contribute to sustainable and efficient chemical processes. Graduates are well-equipped to work in industries that value green chemistry, biotechnology, and innovative approaches to chemical synthesis.

**Course Objective:** The course objectives of an Advanced Biocatalyst and Biocatalysis program aim to provide students with an in-depth understanding of the principles, methodologies, and applications of biocatalysis in industrial processes.

### Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Outline the characteristic and mechanisms of an enzyme	PO1	1
CO 2	Illustrating the application of an enzyme in Asymmetric synthesis	PO1	2
CO 3	Interpret the enzyme application in Non-Conventional Media	PO1	2
CO 4	Summarize the application of enzyme in industrial sector.	PO3, PSO2	2

**Syllabus : Biocatalysts – Characterization and Mechanisms (Biocatalysis) -** Biocatalysts as a technology, Green Chemistry and Biocatalyst, Comparison with other chemical Catalysts, Advantages & disadvantages. Enzyme Kinetics, Basis of Enzyme Action, Theories of Enzyme Catalysis mechanisms, Enzyme Assay, Efficiency, Stability, Selectivity of Enzymes, Screening of New Enzyme Activity. **Biocatalytic Asymmetric Synthesis:** Basic of stereochemistry; Enantiomerically pure amino acids, Hydroxy esters with carbonyl reductase, Alcohols with ADH, Penicillin G, Ephedrine, Chiral drugs, Anticholesterol drugs, Anti-infectives, Anti-AIDS drugs, Cardiovascular drugs, Applications of Lipases and Esterases in the Pharma industry, Steroids **Biocatalysis In Non-Conventional Media:** Enzymes in organic solvents, Advantages of Biocatalysis in organic media, Role of water in Enzyme reactions in Organic solvents, Substrate as solvent, Ionic liquids and Supercritical Solvents for enzymatic reactions. **Industrial Enzymes:** Enzymes in the food industry, Cell-wall degrading enzymes, Lipases, Proteases, Amylases, Xylanases, peroxidases, Enzymes in brewing, Fat splitting, Enzymes in the paper and pulp industry, Enzymes in the textile industry, Enzymes for preservation, Applications of enzymes in diagnostics, analysis, biosensors and other industrial processes and bio-transformations.

Head

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### Text books:

1. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius , Bettina R. Riebel, VCH.

2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin.

### Reference books:

1. Enzymes by Palmer, 2. Enzymes in Industry by Wolfgang Ahle, Wiley-VCH.

  
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