Minutes of the Board of Studies held on November 1, 2007 at 10.30 a.m. in Room no. 105, Department of Bioscience and Biotechnology, Banasthali Vidyapith

Present

1. Prof. Suresh Chand	External Member
2. Prof. A. L. Bhatia	External Member
3. Prof. T. C. Bhalla	External Member
4. Prof. Savita Pareek	Internal Member
5. Dr. Veena Garg	Internal Member
6. Dr. Veena Sharma	Internal Member
7. Dr. Jyoti Saxena	Internal Member
8. Dr. Ashok Kumar	Internal Member
9. Dr. Parvesh Babber	Internal Member
10. Mrs. Mamta Baunthiyal	Internal Member
11. Mrs. Indu Ravi	Internal Member
12. Dr. Nilima Kumari	Internal Member
13. Dr. G. S. Shekhawat	Internal Member
14. Dr. Suman Gupta	Internal Member
15. Dr. Archna Kumari	Internal Member
16. Dr. Anubhuti Sharma	Internal Member
17. Mr. Asheesh Shanker Sharma	Internal Member
18. Mrs. Suphiya Khan	Internal Member
19. Mr. Ashutosh Singh	Internal Member
20. Mr. Atul Grover	Internal Member
21. Mrs. Jyoti Srivastava	Internal Member
22. Prof. Vinay Sharma	Convener

Prof. P. C. Sharma, External Member, Ms. Renu Bist and Mr. Pramod Katara Internal Members could not attend the meeting.

Prof. Vinay Sharma welcomed all the members.

1. The board confirmed the minutes of last meeting held on 08.10.2006.

2. The board updated the panel of examiners and added a few more names as given in Appendix I, for various examinations at Bachelor's and Master's degree in accordance with the Byelaws 15.02.02 of the Vidyapith. The already existing panel will continue to be retained.

The external members were also of the opinion that the examiners working as scientists in research institutes may not be suitable for the preparation of UG & PG questions papers, as they do not have any teaching experience. Therefore, to the extent possible, the examiners' panel may contain the names mainly from the teaching institutions.

3. **The board recommended introduction of semester scheme in various B.Sc. courses as per the scheme given in Appendix II.**

One external member was of the opinion that the nomenclature and course contents of the Paper 5.1- Angiosperm Taxonomy and Economic Botany and Paper 6.2- Plant Biotechnology and Experimental Embryology may be reviewed. The convener constituted a committee (Prof. Savita Pareek, Dr. Jyoti Saxena, Mrs. Mamta Baunthiyal and Dr. G. S. Shekhawat) to look into the matter and submit its report within a fortnight.

4. The board recommended the Scheme of examination and course of study curricula of the following examinations:

I. B.Sc. Examination:

i) First Semester Examination, December, 2008
ii) Second Semester Examination, May, 2009
iii) Third Semester Examination, December, 2009
iv) Fourth Semester Examination, May, 2010
v) Fifth Semester Examination, December, 2010
vi) Sixth Semester Examination, May, 2011

The recommended scheme of examination and the detailed syllabi is enclosed as Appendix II.

II. B. Tech. (Biotechnology) Examination:

i) First Semester Examination, December, 2008
ii) Second Semester Examination, May, 2009

iii) Third Semester Examination, December, 2009

iv) Fourth Semester Examination, May, 2010

v) Fifth Semester Examination, December, 2010

vi) Sixth Semester Examination, May, 2011

vii) Seventh Semester Examination, December, 2010

viii) Eighth Semester Examination, May, 2011

The recommended scheme of examination and the detailed syllabi are enclosed as Appendix III.

III. M. Sc. (Bioscience/ Biotechnology/ Applied Microbiology & Biotechnology) Examination:

The board recommended a few modifications in the course content in various PG courses that are given in the prescribed format as Appendix IV.

5. The board considered the reports of examiners in various examinations of 2006-2007. Most of the examiners found the content of answers satisfactory or good and overall were quite satisfied with the performance of the students. In a few cases, the reports were brought to the notice of concerned teachers so that corrective measures could be taken. There were a few other noteworthy points that are given as below:

- One examiner suggested that the candidates should not use red/pink pen anywhere in their answers (even underlining or making diagrams).

  The Board recommended that necessary written instructions be issued to the candidates on the main answer sheets not to use red/pink pen anywhere in the answer copies.

- One examiner also suggested that there should be sufficient number of columns for making the entries of the marks on the main answer sheet for evaluation purpose.

  The Board recommended that the main answer sheets may contain more columns for making the entries of the marks.

B.Tech.-BT (Biotechnology)

Year	First Semester	L+T	P	Second Semester	L+T	P
I	1. Inorganic & Physical chemistry #	3+1	4	1. Organic Chemistry 🏛	3+1	4
	2. Physics-I #	3+1	4	2. Physics-II #	3+1	4
	3. Mathematics I / Life science I ❐*	3+1*		3. Mathematics-II / Life Science-II ❐*	3+1*	
	4. Computer fundamentals and programming 🏛	3+1	4	4. Analytical Techniques #	3+1	
	5. Bioenergetics	3+1		5. Introduction to Chemical Engineering #	3+1	
	6. Modern Language			6. Engineering Graphics & Drawing #		4
				7. Women Studies in India		
	Total	**16**	**12**		**16**	**12**
	Third Semester	**L+T**	**P**	**Fourth Semester**	**L+T**	**P**
II	1. Structural Biology	3+1		1. Microbiology ❐	3+1	
	2. Biochemistry ❐	3+1		2. Immunology	3+1	
	3. Cell and Molecular Biology	3+1		3. Genetics	3+1	
	4. Principles of Chemical Processes #	3+1	4	4. Biophysics	3+1	
	5. Communication skills #	2		5. Bioinformatics	3+1	
	6. Laboratory I	-	8	6. Laboratory II	-	12
	7. Environmental Studies			7. Indian Heritage		
	Total	**18**	**12**		**20**	**12**
	Fifth Semester	**L+T**	**P**	**Sixth Semester**	**L+T**	**P**
III	1. Metabolic Engineering	3+1		1. Bioprocess Engineering	3+1	
	2. Enzyme Engineering & Technology	3+1		2. Animal Cell & Tissue Culture	3+1	
	3. Genetic Engineering	3+1		3. Plant Biotechnology	3+1	
	4. Plant Cell & Tissue Culture Technology	3+1		4. Biomedical Engineering	3+1	
				5. Laboratory IV	-	12
	5. Laboratory III	-	12	6. Analytical Lab. Practice	-	8
	6. Parenthood and Family Relation			7. Selected writings of Great Authors		
	7. Selected writings of Great Authors					
	Total	**16**	**12**		**16**	**20**
	Seventh Semester	**L+T**	**P**	**Eighth Semester**		
IV	1. Molecular Modeling and Drug designing	3+1		Project		
	2. Recombinant DNA technology	3+1				
	3. Bioethics and Biosafety	3+1				
	4. Environmental Biotechnology	3+1				
	5. Electives •					
	6. Laboratory V	3+1				
		-	12			
	Total	**20**	**12**			

*** Non credit courses**

Electives •

E1	**Plant Genetic Engineering**	**E2**	**Immuno-technology**
E3	**Food and Dairy Biotechnology**	**E4**	**Genomics and Proteomics**
E5	**Nanotechnology**	**E6**	**Plant Secondary Metabolites**
E7	**Animal Biotechnology**		

🏛 Course common in B. Tech. CE and BPH.

Course common in B. Tech. CE

❐ Course common in BPH.

Banasthali Vidyapith

Minutes of the Board of Studies in B.Tech.

(CSE/IT/ECE/EIE/EEE/MCTR/BT/CHE) 03.01.2019 at 11.00 A.M in the CMS Conference Hall, Banasthali Vidyapith

1. The Board took up the minutes of its last meeting held on **May 2, 2013** and resolved that the minutes to be confirmed.

2. The board examined and reviewed the existing panel of examiners for B.Tech. (CSE/IT/ECE/EIE/EEE/MCTR/BT/CHE) examination keeping in view the byelaw 15.03.2002 of the Vidyapith and panel of examiners will be submitted to the secrecy section.

3. The board reviewed the courses of study, curricula and scheme of examination for the following examination.

B.Tech. Examination (CSE/IT/ECE/EIE/EEE/MCTR/BT/CHE)

- First Semester Examination, December, 2019
- Second Semester Examination, April/May, 2020
- Third Semester Examination, December, 2020
- Fourth Semester Examination, April/May, 2021
- Fifth Semester Examination, December, 2021
- Sixth Semester Examination, April/May, 2022
- Seventh Semester Examination, December, 2022
- Eighth Semester Examination, April/May, 2023

3. I (A) B.Tech. CSE Examination Scheme (w. e. f. 2019-20)

S.No.	B.Tech. CSE Examination Scheme	Remarks
i.	First Semester Examination, December, 2019	Revised
ii.	Second Semester Examination, April/May, 2020	Revised
iii.	Third Semester Examination, December, 2020	Revised
iv.	Fourth Semester Examination, April/May, 2021	Revised
v.	Fifth Semester Examination, December, 2021	Revised
vi.	Sixth Semester Examination, April/May, 2022	Revised
vii.	Seventh Semester Examination, December, 2022	Revised
viii.	Eighth Semester Examination, April/May 2023	Revised

(a) The board has reviewed the existing B.Tech. curriculum in view of foundation, basic sciences, core engineering and electives courses and proposed revisions in all B. Tech. programmes by making significant changes to enhance the value based education and meet international standards.

(b) The board reviewed examination scheme of B.Tech. I Year 2017-18 (I and II Semesters) and revised the scheme in 2019-20 for all branches, i.e. B.Tech. (CSE/IT/ECE/EIE/EEE/MCTR/BT/CHE) I Year.

(c) The board has reviewed and revised the *number of credits* of the Mathematics courses to *4* for all B.Tech. programme.

(d) Board proposed new foundation courses - *General Hindi* and *General English* for B.Tech. I Year 2019-20 and agreed to incorporate one Core Foundation course one Elective Foundation course from the session 2019-20.

(e) The board also reviewed syllabi of the courses of B.Tech. I Year (I and II Semesters) and suggested minor changes in the syllabi of *Biology* and *Measurement Techniques Lab* courses. It has been suggested by the board to incorporate learning outcomes e-resources and to use prescribed format for references and the same has been followed.

(f) The board reviewed and revised the examination scheme of B.Tech. CSE II Year 2018-19 (III and IV Semesters). Courses *Introduction to Discrete Mathematics* and *Software Engineering* have been included in B.Tech. III and IV Semesters respectively with the recommendation of the Board and to be followed from 2020-21.

(g) The board reviewed the existing examination scheme of B.Tech. CSE III Year (V and VI Semesters) and proposed the changes in the existing scheme. Two vocational courses have been proposed in B.Tech. CSE III Year by the board including one core and one elective foundation courses. Board recommended to adopt new scheme from 2021-22.

(h) The board also reviewed syllabus of the courses of B.Tech. CSE III Year (V and VI Semesters) and proposed some minor changes in the syllabi of *Data Communication and Networks* and *Operating Systems* courses. Board proposed new courses in B.Tech. CSE VI Semester: *Artificial Intelligence and Machine Learning* and *Artificial Intelligence and Machine Learning Lab*.

(i) The board reviewed the existing examination scheme of B.Tech. IV Year (VII and VIII Semesters) and proposed new scheme with discipline and open electives to be adopted for B. Tech. IV Year 2022-23.

(j) Board proposed to rename the title of the course *Pattern Recognition and Image Processing* as *Digital Image Processing*.

(k) Board proposed some new reading electives for B.Tech. CSE VII Semester.

- Agile Software Development
- Organizational Behavior
- Software as a Service
- Blockchain

(l) Board proposed to start course, *Data Analytics* with its lab in B.Tech. CSE VIII Semester and suggested following new electives for the same.

- Computer Vision
- Pattern Recognition
- Internet of Things
- Robotics and Automation
- Modeling and Simulation

Proposed examination scheme of B.Tech. CSE programme with learning outcomes and new syllabi are enclosed in **Annexure-I(A)**.

3. I (B) B.Tech. CSE Examination Scheme (w. e. f. 2017-18 & 2018-19)

S.No.	B.Tech. CSE Examination Scheme	Remarks
i.	Third Semester Examination, December, 2018/2019	Revised
ii.	Fourth Semester Examination, April/May, 2019/2020	Revised
iii.	Fifth Semester Examination, December,2019/ 2020	Revised
iv.	Sixth Semester Examination, April/May, 2020/2021	Revised
v.	Seventh Semester Examination, December, 2020/2021	Revised
vi.	Eighth Semester Examination, April/May 2021/2022	Revised

(a) The board reviewed examination scheme of B.Tech. II Year (III and IV Semesters) 2017-18 and 2018-19 (I and II Semesters) and agreed to follow the same scheme in 2019-20.

(b) The board also reviewed syllabus of the courses of B.Tech. II CSE Year (III and IV Semesters) and proposed revision in the syllabi of *Entrepreneurship* and *Technical Report Writing* courses for existing scheme i.e. 2019-20.

(c) The board reviewed the existing examination scheme of B.Tech. CSE III Year (V and VI Semesters) and proposed the changes in the existing scheme. Board recommended to adopt new scheme for sessions 2019-20 and 2020-21 for B.Tech. programmes effective from sessions 2017-18 and 2018-19.

(d) The board also reviewed syllabus of the courses of B.Tech. CSE III Year (V and VI Semesters) and agreed to include revised courses *Data Communication and Networks*, *Operating Systems*, *Artificial Intelligence and Machine Learning* and *Artificial Intelligence and Machine Learning Lab* in B.Tech. CSE III Year for sessions 2019-20 and 2020-21.

(e) The board reviewed the existing examination scheme of B.Tech. IV Year (VII and VIII Semesters) and proposed new scheme to be adopted for B. Tech. IV Year 2020-21 and 2021-22.

(f) Board agreed to include *Digital Image Processing* in B. Tech. IV year for sessions 2020-21 and 2021-22.

(g) Board also agreed to include following reading electives for B.Tech. CSE VII Semester as proposed in B. Tech. new scheme.

- Agile Software Development
- Organizational Behavior
- Software as a Service
- Blockchain

(h) Board included *Data Analytics* and *Data Analytics Lab* B.Tech. CSE VIII Semester and agreed to follow as proposed in B. Tech. new scheme.

- Computer Vision
- Pattern Recognition
- Internet of Things
- Robotics and Automation
- Modeling and Simulation

Proposed examination scheme of B.Tech. CSE programme with learning outcomes and new syllabi are enclosed in **Annexure-I(B)**.

3. I (C) B.Tech. CSE Examination Scheme (w. e. f. 2016-17)

S.No.	B.Tech. CSE Examination Scheme	Remarks
i.	Seventh Semester Examination, December, 2019	Revised
ii.	Eighth Semester Examination, April/May 2020	Revised

(a) The board reviewed examination scheme of B.Tech. CSE IV Year (VII and VIII Semesters) 2018-19 and agreed to follow the same scheme in 2019-20. However, board has recommended to include learning outcomes, suggested books and e-resources in prescribed format as discussed in the meeting.

Proposed examination scheme of B.Tech. CSE programme with learning outcomes and new syllabi are enclosed in **Annexure-I(C)**.

3. II (A) B.Tech. IT Examination Scheme (w. e. f. 2019-20)

S.No.	B.Tech. IT Examination Scheme	Remarks
i.	First Semester Examination, December, 2019	Revised
ii.	Second Semester Examination, April/May, 2020	Revised
iii.	Third Semester Examination, December, 2020	Revised
iv.	Fourth Semester Examination, April/May, 2021	Revised
v.	Fifth Semester Examination, December, 2021	Revised
vi.	Sixth Semester Examination, April/May, 2022	Revised
vii.	Seventh Semester Examination, December, 2022	Revised
viii.	Eighth Semester Examination, April/May 2023	Revised

(a) The board reviewed and revised the examination scheme of B.Tech. IT II Year 2018-19 (III and IV Semesters) and agreed to follow the revised scheme in 2020-21 with additional one core and one elective foundation course.

(b) The board reviewed and recommended to include *Introduction to Discrete Mathematics* and *Software Engineering* have been included in B.Tech. III and IV Semesters respectively with the recommendation of the Board and to be followed from 2020-21.

(c) The board reviewed the existing examination scheme of B.Tech. IT III Year (V and VI Semesters) and proposed the changes in the existing scheme. Board suggested adopting new scheme from session 2021-22. Two vocational courses have been proposed in B.Tech. IT III Year by the board including one core and one elective foundation courses. Board recommended to adopt new scheme from 2021-22.

(d) The board recommended adopting revised courses *Data Communication and Networks*, *Internet and Web Technology*, *Operating Systems*, *Artificial Intelligence and Machine Learning* and *Artificial Intelligence and Machine Learning Lab* in B. Tech. IT III Year from 2021-22.

(e) The board reviewed the existing examination scheme of B.Tech. IV Year (VII and VIII Semesters) and proposed new scheme with discipline and open electives to be adopted for B. Tech. IV Year 2022-23.

(f) Board suggested to include revised course *Digital Image Processing* and following new courses as electives for B.Tech. IT VII Semester.

- Computer Vision
- Pattern Recognition
- Data Analytics
- Internet of Things
- Robotics and Automation
- Modeling and Simulation

(g) Board also agreed to include new reading electives for B.Tech. IT VIII Semester as proposed for B. Tech. CSE programme.

- Agile Software Development
- Organizational Behavior
- Software as a Service
- Blockchain

Proposed examination scheme of B.Tech. IT programme with learning outcomes and new syllabi are enclosed in **Annexure-II(A)**.

3. II (B) B.Tech. IT Examination Scheme (w. e. f. 2017-18 & 2018-19)

S.No.	B.Tech. IT Examination Scheme	Remarks
i.	Third Semester Examination, December, 2018/2019	Revised
ii.	Fourth Semester Examination, April/May, 2019/2020	Revised
iii.	Fifth Semester Examination, December,2019/ 2020	Revised
iv.	Sixth Semester Examination, April/May, 2020/2021	Revised
v.	Seventh Semester Examination, December, 2020/2021	Revised
vi.	Eighth Semester Examination, April/May 2021/2022	Revised

(a) The board reviewed examination scheme of B.Tech. IT II Year (III and IV Semesters) 2018-19 and agreed to follow the same scheme in 2019-20.

(b) The board agreed to include revised *Entrepreneurship* and *Technical Report Writing* courses for proposed scheme 2019-20.

(c) The board reviewed the existing examination scheme of B.Tech. IT III Year (V and VI Semesters) and proposed the changes in the existing scheme. Board recommended to adopt new scheme for sessions 2019-20 and 2020-21 for B.Tech. programmes effective from sessions 2017-18 and 2018-19.

(d) The board included courses *Data Communication and Networks*, *Internet and Web Technology*, *Operating Systems*, *Artificial Intelligence and Machine Learning* and *Artificial Intelligence and Machine Learning Lab* in B. Tech. IT III Year for sessions 2019-20 and 2020-21.

(h) The board reviewed the existing examination scheme of B.Tech. IT IV Year (VII and VIII Semesters) and proposed new scheme with discipline and open electives to be adopted for B. Tech. IV Year 2020-21/2021-22.

(i) Board included revised course *Digital Image Processing* and following new courses as electives for B.Tech. IT VII Semester.

- Computer Vision
- Pattern Recognition

- Data Analytics
- Internet of Things
- Robotics and Automation
- Modeling and Simulation

(j) Board also agreed to include new reading electives for B.Tech. IT VIII Semester.

- Agile Software Development
- Organizational Behavior
- Software as a Service
- Blockchain

Proposed examination scheme of B.Tech. IT programme with learning outcomes and new syllabi are enclosed in **Annexure-II(B)**.

3. II (C) B.Tech. IT Examination Scheme (w. e. f. 2016-17)

S.No.	B.Tech. IT Examination Scheme	Remarks
i.	Seventh Semester Examination, December, 2019	Revised
ii.	Eighth Semester Examination, April/May 2020	Revised

(a) The board reviewed examination scheme of B.Tech. IT IV Year (VII and VIII Semesters) 2018-19 and agreed to follow the same scheme in 2019-20. However, board has recommended to include learning outcomes, suggested books and e-resources in prescribed format as discussed in the meeting.

Proposed examination scheme of B.Tech. IT programme with learning outcomes and new syllabi are enclosed in **Annexure-II(C)**.

3.III. (A) B.Tech. ECE Examination Scheme (w. e. f. 2019-20)

S.No.	B.Tech. ECE Examination Scheme	Remarks
i.	First Semester Examination, December, 2019	Revised
ii.	Second Semester Examination, April/May, 2020	Revised
iii.	Third Semester Examination, December, 2020	Revised
iv.	Fourth Semester Examination, April/May, 2021	Revised
v.	Fifth Semester Examination, December, 2021	Revised
vi.	Sixth Semester Examination, April/May, 2022	Revised
vii.	Seventh Semester Examination, December, 2022	Revised
viii.	Eighth Semester Examination, April/May, 2023	Revised

(a) The board reviewed and revised the examination scheme of B.Tech. ECE II Year 2018-19 (III and IV Semesters) and agreed to follow the revised scheme in 2020-21 with additional one core and one elective foundation course.

(b) The board reviewed the existing examination scheme of B.Tech. ECE III Year (V and VI Semesters) and proposed the changes in the existing scheme and syllabi of *Analog Communication, Analog Electronics, Microwave Engineering, Digital Communication, Control systems. Microwave Electronics* and *Analog Integrated Circuits* have been

renamed as *Microwave Engineering* and *Analog Electronics*, respectively. Board suggested adopting new scheme from session 2021-22. Two vocational courses have been proposed in B.Tech. ECE III Year by the board including one core and one elective foundation courses. Board recommended to adopt new scheme from 2021-22.

(c) The board reviewed and revised the examination scheme of B.Tech. ECE IV Year 2018-19 (VII and VIII Semesters) and agreed to follow the revised scheme in 2022-23. Board agreed to include course *Antenna Analysis* in place of *Antenna and Radar* from session 2022-23.

(d) Board has agreed to shift UIL project from VII semester to VIII semester and will be effective from session 2019-20.

(e) Board suggested and agreed to include two new elective courses *Mechatronics* and *Robotics and Automation* from the session 2022-2023 in the curriculum keeping in view of interdisciplinary approach of curriculum structure.

(f) Board proposed some new reading electives from the session 2022- 2023 in the curriculum as follows:

- *Telecommunication Switching Systems and Networks*
- *Multimedia Compression and Communication*
- *Electronic Packaging*
- *Human Values*
- *Professional Ethics.*

(g) Board proposed inclusion of few online courses as reading elective from the session 2022- 2023 in the curriculum as follows:

- *Electric Vehicles*
- *IoT Sensors and Devices*
- *Electromagnetic Compatibility.*

Proposed examination scheme of B.Tech. ECE programme with learning outcomes and new syllabi are enclosed in **Annexure-III(A)**.

3.III. (B) B.Tech. ECE Examination Scheme (w. e. f. 2017-18 & 2018-19)

S.No.	B.Tech.ECE Examination Scheme	Remarks
i.	Third Semester Examination, December, 2018/2019	Revised
ii.	Fourth Semester Examination, April/May, 2019/2020	Revised
iii.	Fifth Semester Examination, December,2019/ 2020	Revised
iv.	Sixth Semester Examination, April/May, 2020/2021	Revised
v.	Seventh Semester Examination, December, 2020/2021	Revised
vi.	Eighth Semester Examination, April/May 2021/2022	Revised

(a) The board reviewed and revised the examination scheme of B.Tech. ECE II Year 2018-19 (III and IV Semesters) and agreed to follow the revised scheme in 2019-20 with additional one core and one elective foundation course.

(b) The board agreed to include revised Entrepreneurship and Technical Report Writing courses for proposed scheme 2019-20.

(c) The board reviewed and revised the existing examination scheme of B.Tech. ECE III Year (V and VI Semesters) and agreed to include revised syllabi of *Analog Communication, Analog Electronics, Microwave Engineering, Digital Communication, Control systems* from session 2019-20 and 2020-21. Board also approved the changes in the names of the courses from *Microwave Engineering* and *Analog Electronic* to *Microwave Electronics* and *Analog Integrated Circuits*, respectively from sessions 2019-20 and 2020-21.

(h) Board revised and reviewed the examination scheme of B.Tech. ECE IV Year (VII and VIII Semesters) and agreed to shift UIL project from VII to VIII Semester from sessions 2020-21 and 2021-22. Board agreed to include course *Antenna Analysis* in place of *Antenna and Radar* from session 2020-21 and 2021-22.

(i) Board suggested and agreed to include two new elective courses *Mechatronics* and *Robotics and Automation* from the session 2020-2021 and 2021-22 in the curriculum keeping in view of interdisciplinary approach of curriculum structure.

(j) Board proposed some new reading electives from the sessions 2020-2021 and 2021-22 in the curriculum as follows:

- *Telecommunication Switching Systems and Networks*
- *Multimedia Compression and Communication*
- *Electronic Packaging*
- *Human Values*
- *Professional Ethics.*

(k) Board proposed inclusion of few online courses as reading elective from the sessions 2020-2021 and 2021-22 in the curriculum as follows:

- *Electric Vehicles*
- *IoT Sensors and Devices*
- *Electromagnetic Compatibility.*

Proposed examination scheme of B.Tech. ECE programme with learning outcomes and new syllabi are enclosed in **Annexure-III(B)**.

3.III. (C) B.Tech. ECE Examination Scheme (w. e. f. 2016-17)

S.No.	B.Tech. ECE Examination Scheme	Remarks
i.	Seventh Semester Examination, December, 2019	Revised
ii.	Eighth Semester Examination, April/May 2020	Revised

(a) The board reviewed and revised examination scheme of B.Tech. ECE IV Year (VII and VIII Semesters) 2018-19 and agreed to follow the same scheme in 2019-20. UIL project has been shifted to VIII Semester for session 2019-20 with the approval of the Board. The board has recommended to include learning outcomes, suggested books and e-resources in prescribed format as discussed in the meeting.

Proposed examination scheme of B.Tech. ECE programme with learning outcomes and new syllabi are enclosed in **Annexure-III(C)**.

3. IV. (A) B.Tech. EIE Examination Scheme (w. e. f. 2019-20)

S.No.	B.Tech. EIE Examination Scheme	Remarks
i.	First Semester Examination, December, 2019	Revised
ii.	Second Semester Examination, April/May, 2020	Revised
iii.	Third Semester Examination, December, 2020	Revised
iv.	Fourth Semester Examination, April/May, 2021	Revised
v.	Fifth Semester Examination, December, 2021	Revised
vi.	Sixth Semester Examination, April/May, 2022	Revised
vii.	Seventh Semester Examination, December, 2022	Revised
viii.	Eighth Semester Examination, April/May 2023	Revised

(a) The board reviewed and revised the examination scheme of B.Tech. EIE II Year 2018-19 (III and IV Semesters) and agreed to follow the revised scheme in 2020-21 with additional one core and one elective foundation course.

(b) The board reviewed the existing examination scheme of B.Tech. EIE III Year (V and VI Semesters) and agreed to follow the revised scheme from 2021-22. Board proposed the changes in the existing syllabi of Power Electronics Lab and approves the revised experiment list of the same. Board proposed that the courses *Control System* (Theory and Lab), *Transducers* (Theory and Lab) should be replaced with *Linear Control System* (Theory and Lab), *Industrial Instrumentation* (Theory and Lab) respectively. The Board discussed the proposed syllabi and approved the same. Board agreed to introduce new course Industrial *Automation* (Theory and Lab) in VI Semester.

(c) The board reviewed the existing examination scheme of B.Tech. EIE IV Year (VII and VIII Semesters) and agreed to follow the revised scheme from 2022-23. Board suggested and agreed to introduce courses *Process Control*, *Communication Engineering* and *Mechatronics Systems* in the VII Semester.

(d) Board revised the elective courses and following courses have been proposed as electives for B.Tech. EIE VII Semester.

- Artificial Neural Network and Fuzzy Logic
- Energy Efficiency and Conservation
- Non Linear Control System
- Digital Control System
- Analytical Instrumentation
- Fiber Optic and Laser Instrumentation
- Biomedical Instrumentation
- Virtual Instrumentation
- Power Plant Engineering

(e) Board suggested and agreed to include following new online reading elective courses for B.Tech. EIE VIII Semester.

- Fundamental of Semiconductor Devices
- Principles of Signals and Systems
- Electromagnetic Compatibility
- Antennas
- Introduction to Photonics

- Electromagnetic Waves in guided and wireless media
- Advanced IOT Applications
- Quality Control
- Industry 4.0
- Biomedical signal processing
- Interfacing with Arduino
- Robotica
- Mathematical methods and techniques in signal processing
- Electronics Modules for industrial applications using Opamp
- Industrial Automation and Control
- Control Engineering
- Analyzing data with Python
- SCADA
- PLC
- Internet of Things
- Industrial Robotics
- Chemical Process Instrumentation

Proposed examination scheme of B.Tech. EIE programme with learning outcomes and new syllabi are enclosed in **Annexure-IV(A)**.

3.IV. (B) B.Tech. EIE Examination Scheme (w. e. f. 2017-18 & 2018-19)

S.No.	B.Tech.EIE Examination Scheme	Remarks
i.	Third Semester Examination, December, 2018/2019	Revised
ii.	Fourth Semester Examination, April/May, 2019/2020	Revised
iii.	Fifth Semester Examination, December,2019/ 2020	Revised
iv.	Sixth Semester Examination, April/May, 2020/2021	Revised
v.	Seventh Semester Examination, December, 2020/2021	Revised
vi.	Eighth Semester Examination, April/May 2021/2022	Revised

(a) The board reviewed and revised the examination scheme of B.Tech. EIE II Year 2018-19 (III and IV Semesters) and agreed to follow the revised scheme in 2019-20.

(b) The board reviewed the existing examination scheme of B.Tech. EIE III Year (V and VI Semesters) and agreed to follow the revised scheme for sessions 2019-20 and 2020-21. Board proposed the changes in the existing syllabi of *Power Electronics Lab* and approves the revised experiment list of the same. Board proposed that the courses *Control System* (Theory and Lab), *Transducers* (Theory and Lab) should be replaced with *Linear Control System* (Theory and Lab), *Industrial Instrumentation* (Theory and Lab) respectively. The Board discussed the proposed syllabi and approved the same. Board agreed to introduce new course Industrial *Automation* (Theory and Lab) in VI Semester.

(c) The board reviewed the existing examination scheme of B.Tech. EIE IV Year (VII and VIII Semesters) and agreed to follow the revised scheme for sessions 2020-21 and 2021-22. Board suggested and agreed to introduce courses Process Control, Communication Engineering and Mechatronics Systems in the VII Semester.

(d) Board revised the elective courses and following courses have been proposed as electives for B.Tech. EIE VII Semester.

- Artificial Neural Network and Fuzzy Logic
- Energy Efficiency and Conservation
- Non Linear Control System
- Digital Control System
- Analytical Instrumentation
- Fiber Optic and Laser Instrumentation
- Biomedical Instrumentation
- Virtual Instrumentation
- Power Plant Engineering

(e) Board suggested and agreed to include following new online reading elective courses for B.Tech. EIE VIII Semester.

- Fundamental of Semiconductor Devices
- Principles of Signals and Systems
- Electromagnetic Compatibility
- Antennas
- Introduction to Photonics
- Electromagnetic Waves in guided and wireless media
- Advanced IOT Applications
- Quality Control
- Industry 4.0
- Biomedical signal processing
- Interfacing with Arduino
- Robotica
- Mathematical methods and techniques in signal processing
- Electronics Modules for industrial applications using Opamp
- Industrial Automation and Control
- Control Engineering
- Analyzing data with Python
- SCADA
- PLC
- Internet of Things
- Industrial Robotics
- Chemical Process Instrumentation

Proposed examination scheme of B.Tech. EIE programme with learning outcomes and new syllabi are enclosed in **Annexure-IV(B)**.

3.IV. (C) B.Tech. EIE Examination Scheme (w. e. f. 2016-17)

S.No.	B.Tech. EIE Examination Scheme	Remarks
i.	Seventh Semester Examination, December, 2019	Revised
ii.	Eighth Semester Examination, April/May 2020	Revised

(a) The board reviewed and revised examination scheme of B.Tech. EIE IV Year (VII and VIII Semesters) 2018-19 and agreed to follow the same scheme in 2019-20. The board has recommended to include learning outcomes, suggested books and e-resources in prescribed format as discussed in the meeting.

Proposed examination scheme of B.Tech. EIE programme with learning outcomes and new syllabi are enclosed in **Annexure-IV(C)**.

3. V. (A) B.Tech. EEE Examination Scheme (w. e. f. 2019-20)

S.No.	B.Tech. EEE Examination Scheme	Remarks
i.	First Semester Examination, December, 2019	Revised
ii.	Second Semester Examination, April/May, 2020	Revised
iii.	Third Semester Examination, December, 2020	Revised
iv.	Fourth Semester Examination, April/May, 2021	Revised
v.	Fifth Semester Examination, December, 2021	Revised
vi.	Sixth Semester Examination, April/May, 2022	Revised
vii.	Seventh Semester Examination, December, 2022	Revised
viii.	Eighth Semester Examination, April/May 2023	Revised

(a) The board reviewed and revised the examination scheme of B.Tech. EIE II Year 2018-19 (III and IV Semesters) and agreed to follow the revised scheme in 2020-21 with additional one core and one elective foundation course.

(b) The board reviewed the existing examination scheme of B.Tech. EIE III Year (V and VI Semesters) and agreed to follow the revised scheme from 2021-22. Board proposed the changes in the existing syllabi of *Electrical Machines-I Lab* and *Power Electronics Lab* and approves the revised experiment list of the same. Board proposed that the courses *Control System* (Theory and Lab), should be replaced with *Linear Control System* (Theory and Lab). The Board discussed the proposed syllabi and approved the same.

(c) The syllabi of Elements of *Power System* (Theory and Lab) has been modified and renamed as *Power System-I* (Theory and Lab) and syllabi of *Power System Analysis* (Theory and Lab) has been modified and renamed as *Power System-II* (Theory and Lab). The Board discussed the proposed syllabus and approved the same.

(d) The board reviewed the existing examination scheme of B.Tech. EEE IV Year (VII and VIII Semesters) and agreed to follow the revised scheme from 2022-23. Board introduced the course *Switchgear and Protection* (Theory and Lab) in B.Tech. EEE VII Semester.

(e) Board proposed to consider the following papers as elective courses in B.Tech. EEE VII Semester.

- Electric Drives and Control
- Mechatronics
- Robotics and Automation
- Process Control
- Industrial Automation

- Power System Operation and Control
- Power System Restructuring and Deregulation

(f) Board proposed following online courses with source as reading elective course for B.Tech. VIII Semester in addition to existing reading elective paper.

- Fundamental of Semiconductor Devices
- Principles of Signals and Systems
- Computer Aided Power System Analysis
- Power System Dynamics, Control and Monitoring
- Advance Power Electronics and Control
- Electromagnetic Compatibility
- Antennas
- Introduction to Photonics
- Electromagnetic Waves in guided and wireless media
- Biomedical signal processing
- Advances in UHV transmission and distribution
- Advanced IOT Applications
- Mathematical methods and techniques in signal processing
- Electronics Modules for industrial applications using Opamp
- Industrial Automation and Control
- Control Engineering
- Chemical Process Instrumentation
- Quality Control
- Interfacing with Arduino
- Robotica
- Analyzing data with Python
- Industry 4.0
- Internet of Things
- Industrial Robotics
- SCADA
- PLC

Proposed examination scheme of B.Tech. EEE programme with learning outcomes and new syllabi are enclosed in **Annexure-V(A)**.

3.V. (B) B.Tech. EEE Examination Scheme (w. e. f. 2017-18 & 2018-19)

S.No.	B.Tech.EEE Examination Scheme	Remarks
i.	Third Semester Examination, December, 2018/2019	Revised
ii.	Fourth Semester Examination, April/May, 2019/2020	Revised
iii.	Fifth Semester Examination, December,2019/ 2020	Revised
iv.	Sixth Semester Examination, April/May, 2020/2021	Revised
v.	Seventh Semester Examination, December, 2020/2021	Revised
vi.	Eighth Semester Examination, April/May 2021/2022	Revised

(a) The board reviewed and revised the examination scheme of B.Tech. EIE II Year 2018-19 (III and IV Semesters) and agreed to follow the revised scheme in 2019-20 with additional one core and one elective foundation course.

(b) The board reviewed the existing examination scheme of B.Tech. EIE III Year (V and VI Semesters) and agreed to follow the revised scheme for sessions 2019-20 and 2020-21. Board proposed the changes in the existing syllabi of *Electrical Machines-I Lab* and *Power Electronics Lab* and approves the revised experiment list of the same. Board proposed that the courses *Control System* (Theory and Lab) should be replaced with *Linear Control System* (Theory and Lab).

(c) The syllabi of Elements of *Power System* (Theory and Lab) has been modified and renamed as *Power System-I* (Theory and Lab) and syllabi of *Power System Analysis* (Theory and Lab) has been modified and renamed as *Power System-II* (Theory and Lab). The Board discussed the proposed syllabus and approved the same.

(d) The board reviewed the existing examination scheme of B.Tech. EEE IV Year (VII and VIII Semesters) and agreed to follow the revised scheme from 2020-21 and 2021-22. Board introduced the course *Switchgear and Protection* (Theory and Lab) in B.Tech. EEE VII Semester.

(e) Board proposed to consider the following papers as elective courses in B.Tech. EEE VII Semester.

- Electric Drives and Control
- Mechatronics
- Robotics and Automation
- Process Control
- Industrial Automation
- Power System Operation and Control
- Power System Restructuring and Deregulation

(f) Board proposed following online courses with source as reading elective course for B.Tech. VIII Semester in addition to existing reading elective paper.

- Fundamental of Semiconductor Devices
- Principles of Signals and Systems
- Computer Aided Power System Analysis
- Power System Dynamics, Control and Monitoring
- Advance Power Electronics and Control
- Electromagnetic Compatibility
- Antennas
- Introduction to Photonics
- Electromagnetic Waves in guided and wireless media
- Biomedical signal processing
- Advances in UHV transmission and distribution
- Advanced IOT Applications
- Mathematical methods and techniques in signal processing
- Electronics Modules for industrial applications using Opamp
- Industrial Automation and Control

- Control Engineering
- Chemical Process Instrumentation
- Quality Control
- Interfacing with Arduino
- Robotica
- Analyzing data with Python
- Industry 4.0
- Internet of Things
- Industrial Robotics
- SCADA
- PLC

Proposed examination scheme of B.Tech. EEE programme with learning outcomes and new syllabi are enclosed in **Annexure-V(B)**.

3.V. (C) B.Tech. EEE Examination Scheme (w. e. f. 2016-17)

S.No.	B.Tech. EEE Examination Scheme	Remarks
i.	Seventh Semester Examination, December, 2019	Revised
ii.	Eighth Semester Examination, April/May 2020	Revised

(a) The board reviewed and revised examination scheme of B.Tech. EIE IV Year (VII and VIII Semesters) 2018-19 and agreed to follow the same scheme in 2019-20. The board has recommended to include learning outcomes, suggested books and e-resources in prescribed format as discussed in the meeting.

Proposed examination scheme of B.Tech. EEE programme with learning outcomes and new syllabi are enclosed in **Annexure-V(C)**.

3. VI. (A) B.Tech. MCTR Examination Scheme (w. e. f. 2019-20)

S.No.	B.Tech. MCTR Examination Scheme	Remarks
i.	First Semester Examination, December, 2019	Revised
ii.	Second Semester Examination, April/May, 2020	Revised
iii.	Third Semester Examination, December, 2020	Revised
iv.	Fourth Semester Examination, April/May, 2021	Revised
v.	Fifth Semester Examination, December, 2021	Revised
vi.	Sixth Semester Examination, April/May, 2022	Revised
vii.	Seventh Semester Examination, December, 2022	Revised
viii.	Eighth Semester Examination, April/May 2023	Revised

(a) The board reviewed and revised the examination scheme of B.Tech. MCTR II Year 2018-19 (III and IV Semesters) and agreed to follow the revised scheme from 2020-21 with additional one core and one elective foundation course. Board suggested and approved revision in the course *Electrical Machine-I Lab*.

(b) Board reviewed and revised the examination scheme of B.Tech. MCTR III Year (V and VI Semesters) and agreed to follow the same from 2021-22. Board suggested and

proposed the course *Robotics and Control* in B.Tech. MCTRVI Semester and *Robotics and Automation* as elective courses for other B. Tech. programmes.

(c) The board reviewed the existing examination scheme of B.Tech. MCTR IV Year (VII and VIII Semesters) and agreed to follow the revised scheme from 2022-23.

(d) Board proposed following online courses with source as reading elective course for B.Tech. MCTR VII Semester.

- Fundamental of Semiconductor Devices
- Principles of Signals and Systems distribution
- Advanced IOT Applications
- Mathematical methods and techniques in signal processing
- Electronics Modules for industrial applications using Opamp
- Industrial Automation and Control
- Control Engineering
- Chemical Process Instrumentation
- Quality Control
- Interfacing with Arduino
- Robotica
- Analyzing data with Python
- Industry 4.0
- CNC Machining Turning
- Solar PV Technology
- Internet of Things
- Autocad
- Industrial Robotics
- SCADA
- PLC

(e) Board proposed and agreed to introduce the course Mechatronics Systems in B.Tech. MCTR VIII Semester and one elective course Mechatronics for other B. Tech. programmes. Board also proposed the course *Computer Integrated Manufacturing System* (Theory and Lab) and approved the same.

(f) Board proposed to consider the following papers as elective courses in B.Tech. MCTR VIII Semester.

- Biomedical Instrumentation
- Energy Efficiency and Conservation
- Power Plant Engineering
- Operation Research
- Industrial Engineering
- Manufacturing Science
- Production Technology

Proposed examination scheme of B.Tech. MCTR programme with learning outcomes and new syllabi are enclosed in **Annexure-VI(A)**.

3.VI. (B) B.Tech. MCTR Examination Scheme (w. e. f. 2017-18 & 2018-19)

S.No.	B.Tech. MCTR Examination Scheme	Remarks
i.	Third Semester Examination, December, 2018/2019	Revised
ii.	Fourth Semester Examination, April/May, 2019/2020	Revised
iii.	Fifth Semester Examination, December,2019/ 2020	Revised
iv.	Sixth Semester Examination, April/May, 2020/2021	Revised
v.	Seventh Semester Examination, December, 2020/2021	Revised
vi.	Eighth Semester Examination, April/May 2021/2022	Revised

(a) The board reviewed and revised the examination scheme of B.Tech. MCTR II Year 2018-19 (III and IV Semesters) and agreed to follow the revised scheme for session 2019-20. Board suggested and approved revision in the course *Electrical Machine-I Lab*.

(b) Board reviewed and revised the examination scheme of B.Tech. MCTR III Year (V and VI Semesters) and agreed to follow the same for sessions 2019-20 and 2020-21. Board suggested and proposed the course *Robotics and Control* in B.Tech. MCTRVI Semester and *Robotics and Automation* as elective courses for other B. Tech. programmes.

(c) The board reviewed the existing examination scheme of B.Tech. MCTR IV Year (VII and VIII Semesters) and agreed to follow the revised scheme for sessions 2020-21 and 2021-22.

(d) Board proposed following online courses with source as reading elective course for B.Tech. MCTR VII Semester.

- Fundamental of Semiconductor Devices
- Principles of Signals and Systems distribution
- Advanced IOT Applications
- Mathematical methods and techniques in signal processing
- Electronics Modules for industrial applications using Opamp
- Industrial Automation and Control
- Control Engineering
- Chemical Process Instrumentation
- Quality Control
- Interfacing with Arduino
- Robotica
- Analyzing data with Python
- Industry 4.0
- CNC Machining Turning
- Solar PV Technology
- Internet of Things
- Autocad
- Industrial Robotics
- SCADA
- PLC

(e) Board proposed and agreed to introduce the course Mechatronics Systems in B.Tech. MCTR VIII Semester and one elective course Mechatronics for other B. Tech. programmes. Board also proposed the course *Computer Integrated Manufacturing System* (Theory and Lab) and approved the same.

(f) Board proposed to consider the following papers as elective courses in B.Tech. MCTR VIII Semester.

- Biomedical Instrumentation
- Energy Efficiency and Conservation
- Power Plant Engineering
- Operation Research
- Industrial Engineering
- Manufacturing Science
- Production Technology

Proposed examination scheme of B.Tech. MCTR programme with learning outcomes and new syllabi are enclosed in **Annexure-VI(B)**.

3.VI. (C) B.Tech. MCTR Examination Scheme (w. e. f. 2016-17)

S.No.	B.Tech. MCTR Examination Scheme	Remarks
i.	Seventh Semester Examination, December, 2019	Revised
ii.	Eighth Semester Examination, April/May 2020	Revised

(a) The board reviewed and revised examination scheme of B.Tech. MCTR IV Year (VII and VIII Semesters) 2018-19 and agreed to follow the same scheme in 2019-20. The board has recommended to include learning outcomes, suggested books and e-resources in prescribed format as discussed in the meeting.

Proposed examination scheme of B.Tech. MCTR programme with learning outcomes and new syllabi are enclosed in **Annexure-VI(C)**.

3. VII. (A) B.Tech. Biotechnology Examination Scheme (w. e. f. 2019-20)

S.No.	B.Tech. Biotechnology Examination Scheme	Remarks
i.	First Semester Examination, December, 2019	Revised
ii.	Second Semester Examination, April/May, 2020	Revised
iii.	Third Semester Examination, December, 2020	Revised
iv.	Fourth Semester Examination, April/May, 2021	Revised
v.	Fifth Semester Examination, December, 2021	Revised
vi.	Sixth Semester Examination, April/May, 2022	Revised
vii.	Seventh Semester Examination, December, 2022	Revised
viii.	Eighth Semester Examination, April/May 2023	Revised

(a) The board reviewed and revised the examination scheme of B. Tech. Biotechnology I Year (I and II Semesters) and agreed to follow the same from 2019-20.

(b) The contents of BIO101: Biology and ENGG 102L: *Measurement Technique Lab* is proposed to be revised by adding relevant topics/experiments.

(c) The board reviewed and revised the examination scheme of B. Tech. Biotechnology II Year (III and IV Semesters) and agreed to follow the same from 2020-21 with additional one core and one elective foundation course.

(d) Board agreed to introduce new experiments in the course BT 204L: *Biotechnology Lab-I* of III Semester.

(e) Board proposed and approved revised courses BT 203: *Biophysics and Structural Biology* and BT 205L: *Biotechnology Lab-II*. *Seminar* (BT 208S) is proposed to be shifted from the V semester to the III semester from the permission of the Board.

(f) The board reviewed and revised the examination scheme of B. Tech. Biotechnology III Year (V and VI Semesters) and agreed to follow the same from 2021-22. In the V Semester, the course '*Probability and Statistics'* is proposed to be introduced. Some experiments of the course BT 303L: *Biotechnology Lab-III* are proposed to be incorporated in the IV Semester laboratory course.

(g) In the VI semester, some modifications are proposed in the topics of the course BIN 301: *Basic Bioinformatics*. The course BT 305: *Cell and Tissue Culture Technology* is proposed to be dropped and contents incorporated in other relevant courses. The contents of the course BT 311: *Recombinant DNA Technology*, CHEM 301: *Analytical Techniques* and BT 304L: *Biotechnology Lab-IV* are proposed to be revised and updated.

(h) The board reviewed and revised the examination scheme of B. Tech. Biotechnology IV Year (VII and VIII Semesters) and agreed to follow the same from 2022-23. In the VII Semester, the reading electives *Plant Genetic Engineering* and *Renewable Energy Resources* are proposed to be replaced with following three newly introduced and more relevant/updated reading electives:

- Molecular Diagnostics,
- Biodiversity and Conservation,
- Emerging Trends in Biofuel

Additionally, the following online reading elective courses are also proposed to be offered in the seventh semester:

- Drug Discovery
  https://www.coursera.org/learn/drug-discovery
- Proteins and Gel-Based Proteomics
  https://swayam.gov.in/course/1386-proteins-and-gel-based-proteomics
- Online course on IPR
  http://www.ili.ac.in/e-learnIPR.htm

(i) In the VIII Semester, the courses *Animal Biotechnology* and *Plant Biotechnology* and laboratory course: *Biotechnology Lab V* are proposed to be revised.

The contents of elective course *Food and Dairy Biotechnology* are proposed to be revised and updated, and a course *Geoinformatics* is proposed to be introduced by the board.

The complete lists of electives proposed to be offered in the eighth semester are as follows:

- Biomedicial Engineering,
- Food and Dairy Biotechnology,

- Genomics and Proteomics,
- Immunotechnology,
- Microbial Technology,
- Molecular Modelling and Drug Designing,
- Nanotechnology,
- Plant Secondary Metabolites,
- Geoinformatics

Additionally, the following online elective courses are also proposed to be offered in the VIII Semester:

- Bioreactor
  https://swayam.gov.in/course/1339-bioreactors
- Principles of Downstream techniques in Bioprocess
  http://nptel.ac.in/syllabus/102106048/
- Industrial Biotechnology
  https://www.coursera.org/learn/industrial-biotech

Proposed examination scheme of B.Tech. Biotechnology programme with learning outcomes and new syllabi are enclosed in **Annexure-VII(A)**.

3.VII. (B) B.Tech. Biotechnology Examination Scheme (w. e. f. 2017-18 & 2018-19)

S.No.	B.Tech. Biotechnology Examination Scheme	Remarks
i.	Third Semester Examination, December, 2018/2019	Revised
ii.	Fourth Semester Examination, April/May, 2019/2020	Revised
iii.	Fifth Semester Examination, December,2019/ 2020	Revised
iv.	Sixth Semester Examination, April/May, 2020/2021	Revised
v.	Seventh Semester Examination, December, 2020/2021	Revised
vi.	Eighth Semester Examination, April/May 2021/2022	Revised

(a) The board reviewed the examination scheme of B. Tech. Biotechnology II Year (III and IV Semesters) 2018-19 and agreed to follow the same for 2019-20.

(b) The board reviewed and revised the examination scheme of B. Tech. Biotechnology III Year (V and VI Semesters) and agreed to follow the same for sessions 2019-20 and 2020-21. In the V Semester, the course *Probability and Statistics* is proposed to be introduced. Some experiments of the course BT 303L: *Biotechnology Lab-III* are proposed to be incorporated in the IV Semester laboratory course.

(c) In the VI semester, some modifications are proposed in the topics of the course BIN 301: *Basic Bioinformatics*. The course BT 305: *Cell and Tissue Culture Technology* is proposed to be dropped and contents incorporated in other relevant courses. The contents of the course BT 311: *Recombinant DNA Technology*, CHEM 301: *Analytical Techniques* and BT 304L: *Biotechnology Lab-IV* are proposed to be revised and updated.

(d) The board reviewed and revised the examination scheme of B. Tech. Biotechnology IV Year (VII and VIII Semesters) and agreed to follow for sessions 2020-21 and 2021-22. In the VII Semester, the reading electives *Plant Genetic Engineering* and *Renewable Energy*

Resources are proposed to be replaced with following three newly introduced and more relevant/updated reading electives:

- Molecular Diagnostics,
- Biodiversity and Conservation,
- Emerging Trends in Biofuel

Additionally, the following online reading elective courses are also proposed to be offered in the seventh semester:

- Drug Discovery
  https://www.coursera.org/learn/drug-discovery
- Proteins and Gel-Based Proteomics
  https://swayam.gov.in/course/1386-proteins-and-gel-based-proteomics
- Online course on IPR
  http://www.ili.ac.in/e-learnIPR.htm

(e) In the VIII Semester, the courses *Animal Biotechnology* and *Plant Biotechnology* and laboratory course: *Biotechnology Lab V* are proposed to be revised.

The contents of elective course *Food and Dairy Biotechnology* are proposed to be revised and updated, and a course *Geoinformatics* is proposed to be introduced by the board.

The complete lists of electives proposed to be offered in the eighth semester are as follows:

- Biomedicial Engineering,
- Food and Dairy Biotechnology,
- Genomics and Proteomics,
- Immunotechnology,
- Microbial Technology,
- Molecular Modelling and Drug Designing,
- Nanotechnology,
- Plant Secondary Metabolites,
- Geoinformatics

Additionally, the following online elective courses are also proposed to be offered in the VIII Semester:

- Bioreactor
  https://swayam.gov.in/course/1339-bioreactors
- Principles of Downstream techniques in Bioprocess
  http://nptel.ac.in/syllabus/102106048/
- Industrial Biotechnology
  https://www.coursera.org/learn/industrial-biotech

Proposed examination scheme of B.Tech. Biotechnology programme with learning outcomes and new syllabi are enclosed in **Annexure-VII(B)**.

3.VII. (C) B.Tech. Biotechnology Examination Scheme (w. e. f. 2016-17)

S.No.	B.Tech. Biotechnology Examination Scheme	Remarks
i.	Seventh Semester Examination, December, 2019	Revised

ii.	Eighth Semester Examination, April/May 2020	Revised

(a) The board reviewed and revised examination scheme of B.Tech. Biotechnology IV Year (VII and VIII Semesters) 2018-19 and agreed to follow the same scheme in 2019-20. The board has recommended to include learning outcomes, suggested books and e-resources in prescribed format as discussed in the meeting.

Proposed examination scheme of B.Tech. Biotechnology programme with learning outcomes and new syllabi are enclosed in **Annexure-VII(C)**.

3. VIII. (A) B.Tech. CHE Examination Scheme (w. e. f. 2019-20)

S.No.	B.Tech. CHE Examination Scheme	Remarks
i.	First Semester Examination, December, 2019	Revised
ii.	Second Semester Examination, April/May, 2020	Revised
iii.	Third Semester Examination, December, 2020	Revised
iv.	Fourth Semester Examination, April/May, 2021	Revised
v.	Fifth Semester Examination, December, 2021	Revised
vi.	Sixth Semester Examination, April/May, 2022	Revised
vii.	Seventh Semester Examination, December, 2022	Revised
viii.	Eighth Semester Examination, April/May 2023	Revised

(a) The board reviewed and revised the examination scheme of B. Tech. CHE II Year (III and IV Semesters) and agreed to follow the same from 2020-21 with additional one core and one elective foundation course.

(b) The board reviewed and revised the examination scheme of B. Tech. CHE III Year (V and VI Semesters) and agreed to follow the same from 2021-22. Board proposed two new courses *Numerical Methods* and *Probability & Statistics* in III Year. *Chemical Reaction Engineering* course has been shifted from V Semester to VI Semester.

(c) The board reviewed and revised the examination scheme of B. Tech. CHE IV Year (VII and VIII Semesters) and agreed to follow the same from 2022-23.

(d) Board agreed to adopt following courses as reading electives for VII Semester.

- Membrane Separation Technology
- Corrosion Engineering
- Enzyme Engineering
- Renewable Energy Resources
- Computer Aided Process Plant Design

(e) Board agreed to introduce *Advanced Chemical Reaction Engineering*, *Optimization of Chemical Processes* and *Advanced Mass Transfer* as elective courses. B. Tech. VIII semester examination scheme will consist of two elective courses (which can be either open or disciplinary) and three compulsory courses. *Environmental Pollution Control* course has been shifted to VIII Semester. In B. Tech. VIII Semester *Chemical Plant Simulation* course has been shifted from elective to compulsory course.

(f) The complete list of elective courses are as follows:

- Petroleum Refining Technology
- Polymer Science and Technology
- Advanced Heat Transfer
- Advanced Chemical Reaction Engineering,
- Advanced Mass Transfer,
- Optimization of Chemical Processes,
- Nanoscience and Technology
- Food Processing and Engineering
- Analytical Techniques,
- Robotics and Automation,
- Artificial Intelligence
- Cloud Computing.

Proposed examination scheme of B.Tech. CHE programme with learning outcomes and new syllabi are enclosed in **Annexure-VIII(A)**.

VIII. (B) B.Tech. CHE Examination Scheme (w. e. f. 2017-18 & 2018-19)

S.No.	B.Tech. CHE Examination Scheme	Remarks
i.	Third Semester Examination, December, 2018/2019	Revised
ii.	Fourth Semester Examination, April/May, 2019/2020	Revised
iii.	Fifth Semester Examination, December,2019/ 2020	Revised
iv.	Sixth Semester Examination, April/May, 2020/2021	Revised
v.	Seventh Semester Examination, December, 2020/2021	Revised
vi.	Eighth Semester Examination, April/May 2021/2022	Revised

(a) The board reviewed and revised the examination scheme of B. Tech. CHE II Year (III and IV Semesters) 2018-19 and agreed to follow the same in 2019-20.

(b) The board reviewed and revised the examination scheme of B. Tech. CHE III Year (V and VI Semesters) and agreed to follow the same for sessions 2019-20 and 2020-21. Board proposed two new courses *Numerical Methods* and *Probability & Statistics* in III Year. *Chemical Reaction Engineering* course has been shifted from V Semester to VI Semester.

(c) The board reviewed and revised the examination scheme of B. Tech. CHE IV Year (VII and VIII Semesters) and agreed to follow the same for sessions 2020-21 and 2021-22.

(d) Board agreed to adopt following courses as reading electives for VII Semester.
- Membrane Separation Technology
- Corrosion Engineering
- Enzyme Engineering

- Renewable Energy Resources
- Computer Aided Process Plant Design

(e) Board agreed to introduce *Advanced Chemical Reaction Engineering*, *Optimization of Chemical Processes* and *Advanced Mass Transfer* as elective courses. B. Tech. VIII semester examination scheme will consist of two elective courses (which can be either open or disciplinary) and three compulsory courses. *Environmental Pollution Control* course has been shifted to VIII Semester. In B. Tech. VIII Semester *Chemical Plant Simulation* course has been shifted from elective to compulsory course.

(f) The complete list of elective courses are as follows:

- Petroleum Refining Technology
- Polymer Science and Technology
- Advanced Heat Transfer
- Advanced Chemical Reaction Engineering,
- Advanced Mass Transfer,
- Optimization of Chemical Processes,
- Nanoscience and Technology
- Food Processing and Engineering
- Analytical Techniques,
- Robotics and Automation,
- Artificial Intelligence
- Cloud Computing.

Proposed examination scheme of B.Tech. CHE programme with learning outcomes and new syllabi are enclosed in **Annexure-VIII(B)**.

3.VIII. (C) B.Tech. CHE Examination Scheme (w. e. f. 2016-17)

S.No.	B.Tech. CHE Examination Scheme	Remarks
i.	Seventh Semester Examination, December, 2019	Revised
ii.	Eighth Semester Examination, April/May 2020	Revised

(a) The board reviewed and revised examination scheme of B.Tech. CHE IV Year (VII and VIII Semesters) 2018-19 and agreed to follow the same scheme in 2019-20. The board has recommended to include learning outcomes, suggested books and e-resources in prescribed format as discussed in the meeting.

Proposed examination scheme of B.Tech. CHE programme with learning outcomes and new syllabi are enclosed in **Annexure-VIII(C)**.

4. The BOS received and reviewed the reports of examiners for different examination from 2014 onwards. All the reports were found to be with good remarks. Only some reports were having poor remarks. The information about such reports has been conveyed to the respective Heads for necessary action. Analysis of reports will be submitted by the concerned Heads.

5. The board critically analyzed the question papers of B.Tech. (CSE/IT/ECE/EIE/EEE/MCTR/BT/CHE) and observed that all the question papers were balanced on the basis of desired parameters (Analytical, Descriptive, Thought provoking and Application based) and considering the nature of individual courses.

6. Board reviewed UIL Project Guidelines-2011 (**Annexure-IX**). Board gave consensus on the existing guidelines except the submission of synopsis in the hard copy. Board suggested submission of synopsis in soft copy may also be accepted. Guidelines for UIL project also require fresh look considering Choice Based Credit System and accordingly proposed evaluation scheme of semester project of B.Tech.(CSE/IT/ECE/EIE/EEE/MCTR/BT/CHE) students given in **Annexure-X**.

Department of Bioscience and Biotechnology, Banasthali Vidyapith
B.Tech. Biotechnology

Existing					
B. Tech. Biotechnology I Sem.		**L**	**T**	**P**	**C**
BVF 002	Environmental Studies	2	0	0	2
	Or				
BVF 003	Indian Haritage	2	0	0	2
MATH 103	Calculus	3	1	0	4
	Or				
Math 107	Linear Algebra	3	1	0	4
PHY 101	Applied Optics	3	1	0	4
	Or				
PHY106	Modern Physics	3	1	0	4
CHEM 101	Chemistry	3	1	0	4
	Or				
BIO 101	Biology	3	1	0	4
CHEM 101	Thermodynamics	3	1	0	4
	Or				
PHY 105	Engineering Mechanics	4	0	0	4
CS 109	Computer Fundamentals and Programming	4	0	0	4
CS 109L	Computer Fundamentals and Programming Lab	0	0	4	2
	Or				
EEE 101	Electrical Engineering	4	0	0	4
EEE 101L	Electrical Engineering Lab	0	0	4	2
ENGG 101L	Engineering Drawing and Graphics Lab	0	0	6	3
	Or				
ENGG 102L	Measurement Techniques Lab	0	0	6	3
		19	**4**	**10**	**27**

Proposed					
B. Tech. Biotechnology I Sem.		**L**	**T**	**P**	**C**
BVF 002	Environmental Studies	2	0	0	2
	Or				
BVF 003	Indian Heritage	2	0	0	2
MATH 103	Calculus	3	1	0	4
	Or				
Math 107	Linear Algebra	3	1	0	4
PHY 101	Applied Optics	3	1	0	4
	Or				
PHY106	Modern Physics	3	1	0	4
CHEM 101	Chemistry	3	1	0	4
	Or				
BIO	Biology	3	1	0	4
CHEM 101	Thermodynamics	3	1	0	4
	Or				
PHY 105	Engineering Mechanics	4	0	0	4
CS 109	Computer Fundamentals and Programming	4	0	0	4
CS 109L	Computer Fundamentals and Programming Lab	0	0	4	2
	Or				
EEE 101	Electrical Engineering	4	0	0	4
EEE 101L	Electrical Engineering Lab	0	0	4	2
ENGG 101L	Engineering Drawing and Graphics Lab	0	0	6	3
	Or				
ENGG	Measurement Techniques Lab	0	0	6	3
		19	**4**	**10**	**27**

Existing					
B. Tech. Biotechnology II Sem.		**L**	**T**	**P**	**C**
BVF 003	Indian Heritage	2	0	0	2
	Or				
BVF 002	Environmental Studies	2	0	0	2
Math 107	Linear Algebra	3	1	0	4
	Or				
MATH 103	Calculus	3	1	0	4
PHY106	Modern Physics	3	1	0	4
	Or				
PHY 101	Applied Optics	3	1	0	4
BIO 101	Biology	3	1	0	4
	Or				
CHEM 101	Chemistry	3	1	0	4
PHY 105	Engineering Mechanics	4	0	0	4
	Or				
CHEM 101	Thermodynamics	3	1	0	4
EEE 101	Electrical Engineering	4	0	0	4
EEE 101L	Electrical Engineering Lab	0	0	4	2
	Or				
CS 109	Computer Fundamenals and Programming	4	0	0	4
CS 109L	Computer Fundamenals and Programming Lab	0	0	4	2
ENGG 102L	Measurement Techniques Lab	0	0	6	3
	Or				
ENGG 101L	Engineering Drawing and Graphics Lab	0	0	6	3
		19	**4**	**10**	**27**

Proposed					
B. Tech. Biotechnology II Sem.		**L**	**T**	**P**	**C**
BVF 003	Indian Heritage	2	0	0	2
	Or				
BVF 002	Environmental Studies	2	0	0	2
Math 107	Linear Algebra	3	1	0	4
	Or				
MATH 103	Calculus	3	1	0	4
PHY106	Modern Physics	3	1	0	4
	Or				
PHY 101	Applied Optics	3	1	0	4
BIO	Biology	3	1	0	4
	Or				
CHEM 101	Chemistry	3	1	0	4
PHY 105	Engineering Mechanics	4	0	0	4
	Or				
CHEM 101	Thermodynamics	3	1	0	4
EEE 101	Electrical Engineering	4	0	0	4
EEE 101L	Electrical Engineering Lab	0	0	4	2
	Or				
CS 109	Computer Fundamenals and Programming	4	0	0	4
CS 109L	Computer Fundamenals and Programming Lab	0	0	4	2
ENGG	Measurement Techniques Lab	0	0	6	3
	Or				
ENGG 101L	Engineering Drawing and Graphics Lab	0	0	6	3
		19	**4**	**10**	**27**

Existing					
B. Tech. III Sem.		**L**	**T**	**P**	**C**
BVF 007R	Selected Writing for Self Study -I	2	0	0	2
	Course Choice - 1	3/4	0	0	3/4
	Course Choice - 2	4	0	0	4
	Course Choice - 3	3	0	0	3
CHEM 202	Principles of Chemical Processes	3	1	0	4
BT 201	Biochemistry	3	1	0	4
BT 204L	Biotechnology Lab-I	0	0	4	2
BT208S	Seminar	0	0	2	1
CS 209	Data Structure	4	0	0	4
CS 209L	Data Structure Lab	0	0	4	2
		22/23	**2**	**10**	**29/30**

Proposed					
B. Tech. III Sem.		**L**	**T**	**P**	**C**
BVF 007R	Selected Writing for Self Study -I	2	0	0	2
	Course Choice - 1	3/4	0	0	3/4
	Course Choice - 2	4	0	0	4
	Course Choice - 3	3	0	0	3
CHEM 202	Principles of Chemical Processes	3	1	0	4
BT 201	Biochemistry	3	1	0	4
BT	Biotechnology Lab-I	0	0	4	2
BT208S	Seminar	0	0	2	1
CS 209	Data Structure	4	0	0	4
CS 209L	Data Structure Lab	0	0	4	2
		22/23	**2**	**10**	**29/30**

Existing					
B. Tech. IV Sem.		**L**	**T**	**P**	**C**
BVF 008R	Selected Writing for Self Study -I	2	0	0	2
	Course Choice - 1	4/3	0	0	4/3
	Course Choice - 2	4	0	0	4
	Course Choice - 3	3	0	0	3
BT 203	Biophysics and Structural Biology	3	1	0	4
BT 206	Cell and Molecular Biology-II	3	1	0	2
BT 205L	Biotechnology Lab-II	0	0	4	2
CS 214	Object Oriented Programming	4	0	0	4
CS 214L	Object Oriented Programming Lab	0	0	4	2
		23/22	**2**	**8**	**29/28**
	Course Choice - 1				
MATH 207	Complex Variables	3	0	0	3
Math 208	Differential Equations	4	0	0	4
	Course Choice - 2				
ENGG 201	Structure and Properties of Materials	4	0	0	4
ENGG 202	Basic Electronics	4	0	0	4
	Course Choice - 3				
MGMT 209	Entrepreneurship	3	0	0	3
TSKL 203	Technical Report Writing	3	0	0	3
	Course Choice - 1				
Math 208	Differential Equations	4	0	0	4
MATH 207	Complex Variables	3	0	0	3
	Course Choice - 2				
ENGG 202	Basic Electronics	4	0	0	4
ENGG 201	Structure and Properties of Materials	4	0	0	4
	Course Choice - 3				
TSKL 203	Technical Report Writing	3	0	0	3
MGMT 209	Entrepreneurship	3	0	0	3

Proposed					
B. Tech. IV Sem.		**L**	**T**	**P**	**C**
BVF 008R	Selected Writing for Self Study -I	2	0	0	2
	Course Choice - 1	4/3	0	0	4/3
	Course Choice - 2	4	0	0	4
	Course Choice - 3	3	0	0	3
BT 203	Biophysics and Structural Biology	3	1	0	4
BT 206	Cell and Molecular Biology-II	3	1	0	2
BT 205L	Biotechnology Lab-II	0	0	4	2
CS 214	Object Oriented Programming	4	0	0	4
CS 214L	Object Oriented Programming Lab	0	0	4	2
		23/22	**2**	**8**	**29/28**
	Course Choice - 1				
MATH 207	Complex Variables	3	0	0	3
Math 208	Differential Equations	4	0	0	4
	Course Choice - 2				
ENGG 201	Structure and Properties of Materials	4	0	0	4
ENGG 202	Basic Electronics	4	0	0	4
	Course Choice - 3				
MGMT 209	Entrepreneurship	3	0	0	3
TSKL 203	Technical Report Writing	3	0	0	3
	Course Choice - 1				
Math 208	Differential Equations	4	0	0	4
MATH 207	Complex Variables	3	0	0	3
	Course Choice - 2				
ENGG 202	Basic Electronics	4	0	0	4
ENGG 201	Structure and Properties of Materials	4	0	0	4
	Course Choice - 3				
TSKL 203	Technical Report Writing	3	0	0	3
MGMT 209	Entrepreneurship	3	0	0	3

Existing					
B. Tech. V Sem.		**L**	**T**	**P**	**C**
FC 5.1	Course Choice -1	3	0	0	3
BT 5.1	Course Choice -2	3	0	0	3
BT 5.6	Microbiology & Immunology	3	1	0	4
BT 5.5	Metabolic Engineering	3	1	0	4
BT 5.4	Genetics & Genetic Engineering	3	1	0	4
BT 5.3	Enzyme Engineering & Technology	3	1	0	4
BT 5.7	Seminar	0	0	4	2
BT 5.2	Biotechnology Lab-III	0	0	8	4
		18	**4**	**12**	**28**
	Course Choice - 1				
FC 5.1	Parenthood and Family Relation	3	0	0	3
FC 5.2	Women in Indian Society	3	0	0	3
	Course Choice - 2				
BT 5.8	Economics For Engineers	3	0	0	3
BT 5.9	Principles for Management	3	0	0	3

Proposed					
B. Tech. V Sem.		**L**	**T**	**P**	**C**
	Course Choice -1	3	0	0	3
	Course Choice -2	3	0	0	3
BT 310	Microbiology & Immunology	3	1	0	4
BT 309	Metabolic Engineering	3	1	0	4
BT 308	Genetics & Genetic Engineering	3	1	0	4
BT 306	Enzyme Engineering & Technology	3	1	0	4
MATH	Probability & Statistical Methods	4	0	0	4
BT 303L	Biotechnology Lab-III	0	0	8	4
		22	**4**	**8**	**30**
	Course Choice - 1				
BVF 006	Parenthood and Family Relation	0	0	0	0
BVF 009	Women in Indian Society	0	0	0	0
	Course Choice - 2				
ECO 302	Economics	0	0	0	0
MGMT 310	Principles for Management	0	0	0	0

Existing					
B. Tech. VI Sem.		**L**	**T**	**P**	**C**
FC 6.1	Course Choice -3	3	0	0	3
BT 6.1	Course Choice -4	3	0	0	3
BT 6.2	Basic Bioinformatics	3	1	0	4
BT 6.3	Bioprocess Engineering	3	1	0	4
BT 6.5	Cell and Tissue Culture Technology	3	1	0	4
BT 6.6	Recombinant DNA Technology	3	1	0	4
BT 6.4	Biotechnology Lab-IV	0	0	8	4
BT 6.7	Analytical Techniques	3	1	0	4
BT 6.8	Analytical Techniques Lab	0	0	4	2
		21	**5**	**12**	**32**
	Course Choice - 3				
FC 5.2	Women in Indian Society	3	0	0	3

Proposed					
B. Tech. VI Sem.		**L**	**T**	**P**	**C**
	Course Choice -3	3	0	0	3
	Course Choice -4	3	0	0	3
BIN 301	Basic Bioinformatics	3	1	0	4
BT 302	Bioprocess Engineering	3	1	0	4
BT 311	Recombinant DNA Technology	3	1	0	4
BT 304L	Biotechnology Lab-IV	0	0	8	4
CHEM 301	Analytical Techniques	3	1	0	4
CHEM 301L	Analytical Techniques Lab	0	0	4	2
		18	**4**	**12**	**28**
	Course Choice - 3				
BVF 009	Women in Indian Society	3	0	0	3

FC 5.1	Parenthood and Family Relation	3	0	0	3
	Course Choice - 4				
BT 5.9	Principles for Management	3	0	0	3
BT 5.8	Economics For Engineers	3	0	0	3
Existing					
B. Tech. VII Sem.					
BT7.1	Reading Elective*	0	2	0	2
BT7.2	Project	0	0	50	25
		0	**2**	**50**	**27**
	Reading Elective*				
BT 7.1 1.	Plant Genetic Engineering*	0	2	0	2
BT 7.1.2	Renewable Energy Resources*	0	2	0	2

BVF 006	Parenthood and Family Relation	3	0	0	3
	Course Choice - 4				
MGMT 310	Principles for Management	3	0	0	3
ECO 302	Economics	3	0	0	3
Proposed					
B. Tech. VII Sem.					
BT	Reading Elective	0	2	0	2
BT	Project	0	0	40	20
		0	**2**	**40**	**22**
	Reading Elective				
BT	Molecular Diagnostics	0	2	0	2
BT	Biodiversity and conservation	0	2	0	2
BT	Emerging Trends in Biofuel Technology	0	2	0	2
	Online Reading elective courses				
	Drug Discovery https://www.coursera.org/learn/drug-discovery				
	Proteins and Gel-Based Proteomics https://swayam.gov.in/course/1386-proteins-and-gel-based-proteomics				
	Online course on IPR http://www.ili.ac.in/e-learnIPR.htm				

Existing					
B. Tech. VIII Sem.		**L**	**T**	**P**	**C**
BT 8.1	Animal Biotechnology	3	1	0	4
BT 8.2	Bioethics and Biosafety	3	1	0	4
BT 8.4	Environmental Biotechnology	3	1	0	4
BT 8.5	Plant Biotechnology	3	1	0	4
BT 8.6	Elective*	3	1	0	4
BT 8.3	Biotechnology Lab-V	0	0	8	4
		15	**5**	**8**	**24**
	Elective*				
BT 8.6	1. Biomedicial Engineering*	3	1	0	4
BT 8.6	2. Food and Dairy Biotechnology*	3	1	0	4
BT 8.6	3. Genomics and Proteomics*	3	1	0	4

Proposed					
B. Tech. VIII Sem.		**L**	**T**	**P**	**C**
BT	Animal Biotechnology	3	1	0	4
BT	Bioethics and Biosafety	3	1	0	4
BT	Environmental Biotechnology	3	1	0	4
BT	Plant Biotechnology	3	1	0	4
BT	Elective	3	1	0	4
BT	Biotechnology Lab-V	0	0	8	4
		15	**5**	**8**	**24**
	Elective				
BT	1. Biomedicial Engineering	3	1	0	4
BT	2. Food and Dairy Biotechnology	3	1	0	4
BT	3. Genomics and Proteomics	3	1	0	4

BT 8.6	4. Immuno - Technology*	3	1	0	4
BT 8.6	5. Microbial Technology*	3	1	0	4
BT 8.6	6. Molecular Modelling and Drug Designing*	3	1	0	4
BT 8.6	7. Nanotechnology*	3	1	0	4
BT 8.6	8. Plant Secondary Metabolites*	3	1	0	4

BT	4. Immunotechnology	3	1	0	4
BT	5. Microbial Technology	3	1	0	4
BT	6. Molecular Modelling and Drug Designing	3	1	0	4
BT	7. Nanotechnology	3	1	0	4
BT	8. Plant Secondary Metabolites	3	1	0	4
	9. Geoinformatics	4	0	0	4
	Online elective courses				
	Bioreactor https://swayam.gov.in/course/1339-bioreactors				2
	Principles of Downstream techniques in Bioprocess http://nptel.ac.in/syllabus/102106048/				2
	Industrial Biotechnology https://www.coursera.org/learn/industrial-biotech				4

	Course discontinued
	Course revised
	Course shifted to/ from different semester
	New Course introduced

Comparative Table: B.Tech. Biotechnology: Existing and Modified syllabus, Suggested Books and Suggested E-Resources

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
	Ist/ IInd Sem.				
1.	**BIO 101** Biology	After successful completion of the course, students should be able to: • Understand the basic organization and classification of living organisms • Describe fundamental cellular functions • Learn the basic concept of molecular biology and recombinant DNA technology	**Section A** **Brief idea of origin of life: ~~Living Organisms:~~** Classification, Five kingdoms, Viruses, (TMV, HIV, Bacteriophages), Prokaryote (Bacteria, cell structure, ~~nutrition~~); Protista, Plantae (~~Bryophyte, Pteridophyte Gymnosperm and Angiosperm~~) and Animalia. **~~Structural Organization in Plants and Animals~~**: Morphology, ~~anatomy~~ and functions of different parts of flowering plants: Root, stem, leaf, inflorescence, flower, fruit and seed. ~~Morphology, anatomy~~ and functions of different systems of humans. **Section B** **~~Cell :~~** The cell concept, prokaryotic and eukaryotic cell, plant and animal cell. Cell organelles and their functions **~~Biomolecules :~~** Brief introduction and significance of Carbohydrates, lipids, proteins and enzymes. **~~Genetics:~~** Mendelian inheritance. Chromosome theory of inheritance, deviations from mendelian ratio (~~gene-gene interaction~~-Incomplete dominance, co-dominance, complementary genes, multiple alleles). Linkage and crossing over, Sex determination, Sex linked inheritance, genetic counseling. **Section C** **~~Molecular Biology:~~** Structure and replication of DNA, Structure of RNA. A brief concept of transcription and translation in prokaryotes and comparison with eukaryotes. Genetic code, ~~Genomics~~ and Human Genome Project. ~~DNA fingerprinting~~. Applications of Recombinant DNA Technology ~~in Health, Agriculture and Industries, Genetically modified (GM) organisms.~~ Biosafety issues.	**Section A** • Brief idea of origin of life, Viruses (TMV, HIV, Bacteriophages), overview and brief introduction to five kingdom classification, characteristic features of Protista, Plantae and Animalia. • Morphology and functions of different parts of flowering plants: Root, stem, leaf, major inflorescence (Spike, Raceme, Corymb and Umbel), flower, fruit and seed. • Brief about the components and functions of different systems of humans. **Section B** • The cell concept, prokaryotic (Bacteria, cell structure) and eukaryotic cell (plant and animal cell). Cell organelles and their functions. • Brief introduction and significance of carbohydrates, lipids, proteins and enzymes. • Mendelian inheritance chromosome theory of inheritance, deviations from mendelian ratio (Incomplete dominance, co-dominance, complementary genes, multiple alleles). Linkage and crossing over, sex determination, sex linked inheritance, genetic counseling. **Section C** • Structure and replication of DNA, structure of RNA and brief concept of transcription and translation in prokaryotes and comparison with eukaryotes, Genetic code, Basic concept of recombinant DNA Technology and its applications. Overview of Human Genome Project, Biosafety issues.	The content of the Section A has been streamlined because earlier it was quite lengthy. The topics have been sub-categorized. Topics shifted from Section A Contents have been rearranged properly.

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Books Recommended: ➢ Campbell, Biology, Pearson Education. ➢ J. W. Stroke, L. P. Renouf, Fundamental of Biology. ➢ N. B. Inamdar, P. J. Dyeash, Fundamental of Life Sciences	**Suggested Books:** ➢ Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Jackson, R.B. (2013). *Campbell Biology*. Pearson Publisher, India. ➢ Green, N. P. O., Stout, G. W., Taylor, D. J. & Soper, R. (2005). *Biological Sciences*. Cambridge University Press. **Suggested e-Resources:** ➢ **Structural organization of plants and animals** https://www.emedicalprep.com/study-material/biology/structural-organization-in-plants-and-animals/ ➢ **Morphology, anatomy and functions of different systems of humans:** https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-body-structure-and-homeostasis/a/tissues-organs-organ-systems ➢ **Basic concept of cell** https://biologydictionary.net/cell/ ➢ **Gene-gene interaction** http://www.biologydiscussion.com/genetics/gene-interactions/gene-interactions-allelic-and-non-allelic-cell-biology/38795 ➢ **Human genome project** https://www.genome.gov/12011238/an-overview-of-the-human-genome-project/ ➢ **Application of recombinant DNA technology:** https://medcraveonline.com/JABB/JABB-01-00013	
2.	**ENGG 102L** Measurement Technique Lab	After successful completion of the course, students should be able to:	**Biology** 1. To test for adulteration in turmeric, wheat flour, ghee and milk. 2. Qualitative analysis of nitrate, carbonate and	**Biology** 1. To test for adulteration in turmeric, wheat flour, ghee and milk. 2. Qualitative analysis of nitrate, carbonate and	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		• Demonstrate an understanding of different adulteration and qualitative analysis of biomolecules • Develop understanding working with microscope • Learn a basic concept of plant identification and vegetational analysis • Gain hand on training to check purity of biomolecules	replaceable base deficiency in soil samples. 3. Determination of soil pH. 4. Biochemical test for sugar, albumin and ketone bodies in urine samples. 5. ~~Tests for Proteins: Biuret's Test, Million's Test, Ninhydrin Test~~ 6. Detection of Vitamin A in the given sample. 7. Study of typical prokaryotic and eukaryotic cells with the help of a microscope. 8. ~~Study of different cell organelles with the aid of prepared slides: nucleus, mitochondria, golgi bodies, endoplasmic reticulum, ribosomes, polytene and lampbrush chromosomes.~~ 9. Gram staining to identify gram positive and gram negative bacteria 10. Description of plant identification. 11. Vegetational analysis by Quadrat method. 12. ~~Determination of blood group and Rh factor.~~ 13. ~~Determination of total R.B.C. and W.B.C.~~ 14. ~~Haemoglobin estimation.~~	replaceable base deficiency in soil samples. 3. Determination of soil pH. 4. Biochemical test for sugar, albumin and ketone bodies in urine samples. 5. Biochemical tests for lipids and cholesterol. 6. Detection of Vitamin A in the given sample. 7. Study of typical prokaryotic and eukaryotic cells with the help of a microscope. 8. Gram staining to identify gram positive and gram negative bacteria 9. Description of plant identification (Neem, Babool, Peeli Kaner, Tulsi & Chandani, Aak/ Madar). 10. Vegetational analysis by Quadrat method. 11. Determination of concentration and purity of DNA 12. Determination of concentration and purity of RNA 13. Preparation of stained temporary mount of onion peel **Suggested Books:** ➢ Yadav, V.K., & Yadav, N. (2018). *Biochemistry & Biotechnology: A Laboratory Manual*. Jaipur: Pointer Publisher. ➢ Vats, S. (2015). A laboratory Text book of Biochemistry, Molecular Biology and Microbiology. Germany: GRIN Verlag. ➢ Sharma, S., & Sharma, R. (2016). *Practical Manual of Biochemistry* (2nd ed.). New Delhi: Medtech. ➢ Biradar, V.K., & Samshe, A. (2016). *Practical Biochemistry*. New Delhi: APH Publishing Corporation.	More relevant experiments have been added.
	IIIrd Sem				
3.	**BT 201** Biochemistry	After successful completion of the course, students should be able to:	**Section A** Carbohydrates: Classification, structure and properties, glycolysis and fermentation and their regulations, gluconeogenesis and glycogenolysis, metabolism of	**Section A** • Carbohydrates: Classification, structure and properties, glycolysis and fermentation and their regulations, gluconeogenesis and glycogenolysis, metabolism of	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		• Learn about the biomolecules forming the cellular structure • Identify and compare the various biochemical pathways and their use • Translate skills in research, quality control, production and diagnostics	galactose and galactosemia, pentosephosphate pathway. Citric Acid Cycle: Significance, reactions and energetics of the cycle, amphibolic role of the cycle. Glyoxylic acid cycle Enzymes: Nomenclature, classification, characteristics, enzyme kinetics and its mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis. Co-enzymes and Cofactors: Role of Vitamins, metals ions, significance. **Section B** Lipids: Classification, structure and properties of lipids. Oxidation of fatty acids, α-oxidation and its energetics, α-oxidation of fatty acids, α-oxidation. Biosynthesis of ketone bodies and their utilization, biosynthesis of saturated and unsaturated fatty acids, control of lipid metabolism, essential fatty acids and eicosanoids, phospholipids and sphingolipids. Proteins and Metabolism of Amino acids: Classification, structure and properties, Nitrogen balance, biosynthesis of amino acids, catabolism of amino acids, conversion of amino acids to specialized products. Biological Oxidation: Redox-potential, the respiratory chain, its role in energy capture and its control. Energetics of oxidative phosphorylation, inhibitors of respiratory chain and oxidative phosphorylation, Chemiosmotic coupling theory and mechanism of ATP production in oxidative phosphorylation. **Section C** Metabolism of Ammonia and Nitrogen containing Monomers: Assimilation of ammonia, urea cycle, metabolic disorders of urea cycle, porphyrin biosynthesis, formation of bile pigments, hyperbilirubinemia, purine	galactose and galactosemia, pentosephosphate pathway. • Citric Acid Cycle: Significance, reactions and energetics of the cycle, amphibolic role of the cycle. Glyoxylic acid cycle • Enzymes: Nomenclature, classification, characteristics, enzyme kinetics and its mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis. Co-enzymes and Cofactors: Role of Vitamins, metals ions, significance. **Section B** • Lipids: Classification, structure and properties of lipids. Oxidation of fatty acids, beta oxidation and its energetics, alpha oxidation of fatty acids, omega oxidation. Biosynthesis of ketone bodies and their utilization, biosynthesis of saturated and unsaturated fatty acids, control of lipid metabolism, essential fatty acids and eicosanoids, phospholipids and sphingolipids. • Proteins and Metabolism of Amino acids: Classification, structure and properties, Nitrogen balance, biosynthesis of amino acids, catabolism of amino acids, conversion of amino acids to specialized products. • Biological Oxidation: Redox-potential, the respiratory chain, its role in energy capture and its control. Energetics of oxidative phosphorylation, inhibitors of respiratory chain and oxidative phosphorylation, Chemiosmotic coupling theory and mechanism of ATP production in oxidative phosphorylation. **Section C** • Metabolism of Ammonia and Nitrogen containing Monomers: Assimilation of ammonia, urea cycle, metabolic disorders of urea cycle, porphyrin biosynthesis, formation of bile pigments, hyperbilirubinemia, purine	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			biosynthesis, purine nucleotides interconversion, pyrimidine biosynthesis, formation of deoxyribonucleotides. Nucleic acids: Structure of DNA and RNA, Brief introduction of genetic organization of the mammalian genome, alteration and rearrangements of genetic material, Genetic code, transcription and translation, replication of DNA, mutation, physical and chemical mutagenesis / carcinogenesis, DNA repair mechanism, biosynthesis of tRNA and rRNA. **Books Recommended:** ➢ Principles of Biochemistry: A.L. Lehninger, Nelson and Cox, McMillan Worth Publishers. ➢ Biochemistry: Voet and Voet, John Wiley and Sons, Inc. USA. ➢ Biophysical Chemistry Vol. I, II & III: Cantor and Schimel, Freeman. ➢ Biochemistry: Zubey, WCB. ➢ Biochemistry: Garrett and Grisham, Harcourt. ➢ Biochemistry: Stryer, W. H. Freeman. ➢ Understanding Enzymes: T. Palmer, Horwood. ➢ Harper's review of Biochemistry: R.K. Murray et al., Prentice-Hall International Inc. ➢ Fundamentals of Biochemistry: Cohn and Stumf.	biosynthesis, purine nucleotides interconversion, pyrimidine biosynthesis, formation of deoxyribonucleotides. • Nucleic acids: Structure of DNA and RNA, Brief introduction of genetic organization of the mammalian genome, alteration and rearrangements of genetic material, Genetic code, transcription and translation, replication of DNA, mutation, physical and chemical mutagenesis / carcinogenesis, DNA repair mechanism, biosynthesis of tRNA and rRNA. **Suggested Books:** ➢ Nelson, D. L. & Cox, M.M. (2012). *Lehninger Principles of Biochemistry* (6th ed.). W.H. Freeman. ➢ Rodwell, V.W., Bender, D., Botham, K.M., Kenelly, P.J., & Weil., P.A. (2018). *Harper's illustrated Biochemistry* (31st ed.). McGraw-Hill Education / Medical. ➢ Voet, D. & Voet, J.G.(2010). *Biochemistry* (4th ed). Wiley. ➢ Berg, J.M., Tymoczko, J.L., Gatto Jr., G.J & Stryer, L. (2015). *Biochemistry* (8th ed.). W.H. Freeman and Company. ➢ Garrett, R. H. & Grisham, C. M. (2012). *Biochemistry* (5th ed.).Wadsworth Publishing Co Inc. ➢ Palmer, T (2004). Enzymes: *Biochemistry, Biotechnology and Clinical Chemistry* (Horwood Chemical Science) Reprint Edition. Albion. **Suggested e-Resources** ➢ **Metabolic pathways, Biomolecules** https://epgp.inflibnet.ac.in/ahl.php?csrno=2 ➢ **Glycolysis** https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/glycolysis/a/glycolysis	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				➢ **Mechanism of enzyme action** http://www.biologydiscussion.com/enzymes/enzymes-properties-and-mechanism-of-enzyme-action/6145 ➢ **Enzyme action** http://chemistry.elmhurst.edu/vchembook/571lockkey.html	
4.	**CHEM 203** Principles of Chemical Processes	After successful completion of the course, students should be able to: • Understand basic concept of biochemical equation and material balance • Develop concept of energy balance, thermodynamic approaches, unit operations • Apply the gained knowledge in bioprocess industries	**Section A** Basic Concepts, Units and Dimensions, Basic chemical calculations, Steady state and dynamic processes, Lumped and distributed processes, Single and multiphase systems. Types of Variables, Intensive and extensive variables, Specific properties, State Variables. Types of Equation: Mass and energy conservation, equilibrium relations. **Section B** Process Classification, material balances for steady state processes, properties of gases, liquids and solids, equations of state, phase equilibria for ideal mixtures, Reactions and stoichiometry, Non-Reacting single phase systems; Single and multiple units without recycle, with recycle, bypass and purge, Non-Reacting multiphase systems. **Section C** Processes involving vaporization and condensation, reacting systems. Energy Balances for Steady State Processes: Specific heat capacity, Enthalpy, Heat of reaction, Thermo chemistry, Isothermal systems, Adiabatic Systems, Simultaneous material and energy balances. Unsteady State Material Balances, Reaction rate laws, Introduction to Modeling simulation for chemical processes: Basic idea about Model representation, types of modeling equations, types of mathematical models: Linear model vs nonlinear model, Static model vs dynamic model, Lumped parameter model vs Distributed model and	**Section A** • Basic Concepts, Units and Dimensions, Basic chemical calculations, Steady state and dynamic processes, Lumped and distributed processes, Single and multiphase systems. • Types of Variables, Intensive and extensive variables, Specific properties, State Variables. Types of Equation: Mass and energy conservation, equilibrium relations. **Section B** • Process Classification, material balances for steady state processes, properties of gases, liquids and solids, equations of state, phase equilibria for ideal mixtures. • Reactions and stoichiometry, Non-Reacting single phase systems; Single and multiple units without recycle, with recycle, bypass and purge, Non-Reacting multiphase systems. **Section C** • Processes involving vaporization and condensation, reacting systems. • Energy Balances for Steady State Processes: Specific heat capacity, Enthalpy, Heat of reaction, thermo chemistry, Isothermal systems, Adiabatic Systems, Simultaneous material and energy balances. • Unsteady State Material Balances, Reaction rate laws, Introduction to Modeling simulation for chemical processes: Basic idea about Model representation, types of modeling equations, types of mathematical models: Linear model vs nonlinear model, Static model vs	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Fundamental model vs empirical model, role of computer simulation in chemical processes. **Books Recommended:** ➢ Chemical Process Principles (Vol. 1): Hougan D. A., Watson K.M. and Ragatz R. A., Asia Publishing House. ➢ Basic Principles and Calculation in Chemical Engineering: Himmelblau, D.M, Prentice Hall ➢ Stoichimetry: Bhatt B.L.Vora, S.M, Tata McGraw Hill Publishing Co. Ltd., New Delhi ➢ Process Calculations for chemical engineers Chemical Engineering development Centre, Madras ➢ Elementary Principles of Chemical Processes, 2nd Ed.: Felder, R.M. Rousseau, R.W., John Wiley & Sons. ➢ Introduction to Material and energy balances: Reklaitis, G.V., John Wiley & sons ➢ Industrial Stoichimetry: Lewis, W.K. Radasch, A.H. Lewis, HC, McGraw Hil ➢ Chemical Process Analysis Mass and Energy Balance: Luben W.L. and Wenzel, L.A., Prentice Hall.	dynamic model, Lumped parameter model vs Distributed model and Fundamental model vs empirical model, role of computer simulation in chemical processes. **Suggested Books:** ➢ Bhatt, B.I., & Vora, S.M. (2008). *Stoichiometry* (4th ed.). New Delhi: Tata McGraw-Hill Publishing Company Limited. ➢ Bailey, J.E., & Ollis, D.F. (1944). *Biochemical Engineering Fundamentals* (2nd ed.). New York: McGraw-Hill Book company. ➢ Felder, R.M., & Rousseau, R.W. (2000). *Elementary Principles of Chemical Processes* (3rd ed.). Wiley India. ➢ Dutta, R. (2007). *Fundamentals of Biochemical Engineering*. Ane Books India. ➢ Jana, A.K. (2008). *Chemical process Modelling and computer Simulation*. New Delhi: Prentice Hall of India private Limited. **Suggested e-Resources:** ➢ **Energy Balance** https://www.che.iitb.ac.in/faculty/madhu/CL152/Handouts/Handout%206.pdf ➢ **Lumped and Distributed model** http://web.engr.oregonstate.edu/~traylor/ece391/Andreas_slides/ECE391-S14-Lect1-web.pd	
5.	**BT 204L** Biotechnology Lab-I	After successful completion of the course, students should be able to: • Gain hand on training to quantitavely analyze biomolecules • Demonstrate an	**Biochemistry** 1. Estimation of proteins by Lowry's and TCA methods. 2. Estimation of carbohydrates : Total sugars by Anthrone method 3. Reducing sugars by Nelson Somogyi method 4. Estimation of serum cholesterol. 5. Preparation and purification of casein from buffalo milk. ~~6. Determination of Logic properties (pH value of~~	**Biochemistry** 1. Estimation of proteins by Lowry's and TCA methods. 2. Estimation of carbohydrates : Total sugars by Anthrone method 3. Reducing sugars by Nelson Somogyi method 4. Estimation of serum cholesterol. 5. Preparation and purification of casein from buffalo milk. 6. Determination of titrable acidity of milk	The practical is

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		understanding analyze biomolecules spectrophotometrically • Hands on training on measuring techniques • Solve problems for mass balance and energy balance and equations numerically	~~blysine by titration).~~ 7. To find λmax for proteins. 8. To find λmax for nucleic acids. **Principles of Chemical Processes Lab** 9. Experiments based on measuring techniques – 10. Measurement of temperature by Thermocouple 11. Measurement of pressure by Manometer 12. Measurement of RPM 13. Determination of mass flow rate. 14. Calculation of TOC and ThOD of organic compounds present in the solution. 15. Mass balance problems. 16. Energy balance problems. ~~17. Computer aided programme based on~~ Newton-Raphson ~~method.~~	7. To find λ_{max} for proteins. 8. To find λ_{max} for nucleic acids. **Principles of Chemical Processes Lab** Experiments based on measuring techniques 9. Measurement of temperature by Thermocouple 10. Measurement of pressure by Manometer 11. Measurement of RPM 12. Determination of mass flow rate. 13. Calculation of TOC and ThOD of organic compounds present in the solution. 14. Mass balance problems. 15. Energy balance problems. 16. Newton Raphson (NR) optimization **Suggested Books:** ➢ Yadav, V.K., & Yadav, N. (2018). *Biochemistry & Biotechnology: A Laboratory Manual*. Jaipur: Pointer Publisher. ➢ Vats, S. (2015). *A laboratory Text book of Biochemistry, Molecular Biology and Microbiology*. Germany: GRIN Verlag. ➢ Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers. ➢ Sharma, S., & Sharma, R. (2016). *Practical Manual of Biochemistry* (II Ed.). New Delhi: Medtech. ➢ Kumar, A., Garg, S., & Garg, N. (2017). *Biochemical Tests: Principles & Protocols*. New Delhi: Viva Books.-all ➢ Biradar, V.K., & Samshe, A. (2016). *Practical Biochemistry*. New Delhi: APH Publishing Corporation. ➢ Shuler, M.L., & Kargi, F. (2002). *Bioprocess Engineering Basic Concepts* (2nd ed,). Prentice Hall PTR	shifted to the IV Semester and new experiment has been added Experiment has been revised

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				Upper Saddle River, NJ, USA.	
	IVth Sem				
6.	**BT 203** Biophysics and Structural Biology	After successful completion of the course, students should be able to: • Develop a basic understanding of molecular and quantum mechanics in studying biomolecules • Solve questions of macromolecular folding and interactions. • Understand the molecular processes behind locomotion, neuronal signaling and vision.	**Section A** • Elements of Quantum Mechanics: Quantization of energy, Atomic structure wave equation, Quantum Mechanical Tunnelling. • Energies, Forces and Bonds: ~~Intraatomic~~ Potentials for strong and weak bonds, non central forces, Bond energies, spring constant. • Basic principle of protein structure: Ramachandran plot, motifs, folds, fibrous proteins, membrane proteins. **Section B** • Configuration of DNA, RNA, Glycosidic bond rotation and base stacking. • Zwitterionic properties of amino acids, peptide bonds, disulfide cross links, ~~Helix-coil transition.~~ • Basic principles of X-Ray diffraction studies, Calculation and interpretation of electron density map~~, Electron crystallography of proteins~~ • Protein secondary structure prediction methods: Chou and Fasman, Garnier-Osguthorpe-Robson. • Classification of three-dimensional structure of protein: HSSP, SCOP. **Section C** • Muscular movement: Molecular structure of skeletal muscle, Mechanical events of muscle contraction, Force velocity, Power velocity and Tension- length relationship curves. • Neuronal Physics: Ion channels, Structure of Neurons, Synapse, Action potential and its propagation through nerve fiber. Post synaptic potential and Neural networking.	**Section A** • Elements of Quantum Mechanics: Quantization of energy, Atomic structure wave equation, Quantum Mechanical Tunnelling. • Energies, forces and Bonds: inter-atomic potentials for strong and weak bonds, non central forces, bond energies, spring constant. • Basic principle of protein structure: Ramachandran plot, motifs, folds, fibrous proteins, membrane proteins. **Section B** • Configuration of DNA, RNA, Glycosidic bond rotation and base stacking. • Zwitterionic properties of amino acids, peptide bonds, and disulfide cross links. • Basic principles of X-ray diffraction studies, calculation and interpretation of electron density map • Protein secondary structure prediction methods: Chou and Fasman, Garnier-Osguthorpe-Robson. • Classification of three-dimensional structure of protein: HSSP, SCOP. **Section C** • Muscular movement: molecular structure of skeletal muscle, mechanical events of muscle contraction, force velocity, power velocity and tension- length relationship curves. • Neuronal physics: Ion channels, structure of Neurons, Synapse, Action potential and its propagation through nerve fiber. Post synaptic potential and Neural networking.	Interatomic is the correct term. Helix coil transition is part of statistical mechanics and cannot be introduced here without a background. Electron Crystallography is misleading terminology.

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			• Photoreception: Structure of photoreceptors and photo chemical events of vision. • Molecular interaction: Protein-Protein interactions, Protein-DNA interactions. • Techniques for the studies of these interactions. **Books Recommended:** ➢ Principles of Biochemistry: A.L. Lehninger, Nelson and Cox, McMillan Worth Publishers. ➢ Biochemistry: Stryer. ➢ Biophysical Chemistry Vol. I, II & III: Cantor and Schimmel, Freeman. ➢ Practical Biochemistry: Wilson and Walker. ➢ Bioinformatics-Sequence and Genome analysis: David W. Mount. ➢ Structural Bioinformatics: Philip E.Bourne and Helge Weissig. ➢ Introduction to protein structure: C. Brandon and J. Tooze, International Garland. ➢ Proteins: Structure and molecular properties: Creighton, W.H. Freeman. ➢ Biophysics- An introduction: Kluwer, Dordrechrt ➢ Biophysical Chemistry Vol. I, II & III: Cantor and Schimmel, Freeman. ➢ Biophysics- An Introduction: Rodney Cotton II ➢ An introduction to Neural computing: Aleksander & Morten ➢ Biological membranes: architecture and function: Hand book of biological physics: Lipowsky & sackmann all volumes techniques & methods.	• Photoreception: Structure of photoreceptors and photo chemical events of vision. • Molecular interaction: Protein-Protein interactions, Protein-DNA interactions. • Techniques for the studies of these interactions. **Suggested Books:** ➢ Nelson, D. L., & Cox, M.M. (2017). *Lehninger Principles of Biochemistry* (7th ed.) WH Freeman &Co. ➢ Voet, D., Voet, J.D., & Pratt, C.W. (2016). *Fundamentals of Biochemistry* (5th ed.). John Wiley. ➢ Brenden, C., & Tooze, J. (1998). *Introduction to Protein Structure* (2nd ed.) Garland Science. ➢ Ber, J.M., Tymoczko, J.L., Gatto, G.J.. & Stryer, L. (2015). *Biochemistry* (8th ed.) WH Freeman &Co. ➢ Creighton, T.E. (1992). *Proteins: Structures and Molecular Properties*. WH Freeman &Co. ➢ Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press. ➢ Cotterill, R. (2002). *Biophysics: An Introduction*. Wiley Press. ➢ Atkins, P., & Paula, J.D. (2009). *Atkins Physical Chemistry* (9th ed.). OUP Oxford. ➢ Hall, J.E. (2015). *Guyton and Hall Textbook of Medical Physiology* (13th ed.). Saunders Press. **Suggested e-Resources:** ➢ **Muscular and Neuronal Physiology** ➢ https://www.khanacademy.org/science/biology/human-biology ➢ **Proteins** ➢ https://study.com/academy/lesson/proteins-structure-function-types.html ➢ **Nucleic Acids**	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				➢ https://chemistry.tutorvista.com/biochemistry/nucleic-acid-function.html	
7.	**BT 206** Cell and Molecular Biology – II	After successful completion of the course, students should be able to: • Understand functions of cell organelles and regulation of cellular processes • Explain the role and mechanism of cell signaling • Develop detailed understanding of fundamental processes viz., replication, transcription and translation	**Section A** • Cell: Prokaryotic and eukaryotic cell, a macromolecular assembly, cell compartmentalization, cytoskeleton. • Molecular structure and functional aspects of plasma membrane, carrier proteins and active membrane transport. • Endocytosis and Exocytosis. • ~~Cell signaling,~~ autocrine, paracrine and endocrine stimulation. • Cell Signaling: G-protein linked receptors, enzyme linked cell surface receptors (tyrosine kinases), structural features of trans membrane receptors, secondary messengers, role of Ca^{+2} ions, MAP Kinase cascade. • Cell cycle and division. **Section B** • The Nucleus, Nucleolus, structure of chromosomes, Nucleosomes, chromosomal DNA and its packaging. • Mitochondria and chloroplast organization, transport of proteins, genome of mitochondria and chloroplast. • Endoplasmic reticulum, golgi apparatus, role in protein processing and transport. • Lysosomes, intracellular digestion, sorting of lysosomal enzymes in golgi, lysosomal storage diseases. **Section C** • Central Dogma and genetic code. • DNA replication • Transcription: The transfer of DNA sequence information to RNA, exon, intron, tRNA and rRNA, mRNA processing.	**Section A** • Cell: Prokaryotic and eukaryotic cell, cell compartmentalization, cytoskeleton. • Molecular structure and functional aspects of plasma membrane, carrier proteins and active membrane transport. • Endocytosis and exocytosis. • Autocrine, paracrine and endocrine stimulation. • Cell Signaling: G-protein linked receptors, enzyme linked cell surface receptors (tyrosine kinases), structural features of trans membrane receptors, secondary messengers, role of Ca^{2+} ions, MAP kinase cascade. • Cell cycle and division. **Section B** • The Nucleus, nucleolus, structure of chromosomes, nucleosomes, chromosomal DNA and its packaging. • Mitochondria and chloroplast organization transport of proteins, genome of mitochondria and chloroplast. • Endoplasmic reticulum, golgi apparatus, role in protein processing and transport. • Lysosomes, intracellular digestion, sorting of lysosomal enzymes in golgi, lysosomal storage diseases. **Section C** • Central dogma and genetic code. • DNA replication • Transcription: The transfer of DNA sequence information to RNA, exon, intron, tRNA and rRNA, mRNA processing.	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			• Translation: mRNA translation in prokaryotes and eukaryotes, notable features of the translation process. • Inhibitors of transcription and translation. • The fate of newly synthesized protein. **Books Recommended:** ➢ Cell and molecular Biology: De Robertis & De Roberties, B.I. Waverly Pvt. Ltd., New Delhi. ➢ The World of the Cell: W.M. Becker, Pearson Education. ➢ Cell and Molecular Biology: G. Karp, John Wiley & Sons. ➢ The Cell – A molecular Approach: Cooper, Sinauer. ➢ Cell and Molecular Biology: P.K. Gupta, Rastogi Publications. ➢ Molecular Cell Biology: Lodish, Baltimore, W.H. Freeman & Co. ➢ Molecular Biology of the Cell: Bruce Albert, Garlend Publication, NY. ➢ Essential of Cytology: C.B. Powar, Himalaya Publications. ➢ Principles of Genetics 4th Ed: Snustad and Simmons, John Wiley & Sons. ➢ Gene VIII: Lewin, Pearson Education. ➢ Molecular Biology of Gene: J.D. Watson, Pearson Education. ➢ Molecular Biology: David Freifelder, Narosa Publishing House, New Delhi. ➢ Molecular Biology: R. Weaver, WCB Mc Graw Hill.	• Translation: mRNA translation in prokaryotes and eukaryotes, notable features of the translation process. • Inhibitors of transcription and translation. • The fate of newly synthesized protein. **Suggested Books:** ➢ Karp, G. (2008). *Cell and molecular biology: Concepts and experiments*. John New Jersey: Wiley and Sons ➢ Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). *Becker's World of the Cell. Boston* (8th ed.). Benjamin Cummings. ➢ Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th ed.). Washington: ASM; Sunderland. ➢ Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th ed.). New York: Garland Science. ➢ Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's Genes XI. Burlington*, MA: Jones & Bartlett Learning. ➢ Watson, J. D. (2008). *Molecular Biology of the Gene* (5th ed.). Menlo Park, CA: Benjamin/Cummings. ➢ Lodish, H. F. (2016). *Molecular Cell Biology* (8th ed.). New York: W.H. Freeman. **Suggested e-Resources:** ➢ **Macromolecular assembly** https://www.sciencedirect.com/science/article/pii/B9780323341264000050 ➢ **Cell division** https://www2.le.ac.uk/projects/vgec/highereducation/topics/cellcycle-mitosis-meiosis ➢ **Lysosomal storage disorders** https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1365-2141.2004.05293.x	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
8.	**BT 205L** Biotechnology Lab-II	After successful completion of the course, students should be able to: • Learn techniques related to histochemical localization of biomolecules • Gain hand on training to analyze stages of cell division • Predict structure of biomolecules using bioinformatics tools	**Cell and Molecular Biology** ~~1. Study of cell organelles by permanent slides~~ ~~2.~~ Study of cell division (mitotic and meiotic) ~~in plants and animals.~~ 3. Separation of different organelles/molecules by sucrose density gradient/differential gradient. 4. Histochemical localization of biomolecules (protein, carbohydrate or any other). **Biophysics** 5. Download PDB files for protein complexes with proteins (Haemoglobin, Myoglobin, Insulin), nucleic acid and do various exercises using : Rasmol SPDBV	**Cell and Molecular Biology** 1. Estimation of DNA by DPA method. 2. Determination of Logic properties (pH value of glycine by titration). 3. Study of the stages of mitotic and meiotic cell division. 4. Separation of different organelles/molecules by sucrose density gradient/differential gradient. 5. Histochemical localization of biomolecules (protein, carbohydrate or any other). **Biophysics** 6. Download PDB files for protein complexes with proteins (haemoglobin, myoglobin, insulin), nucleic acid and do various exercises using : - Rasmol - SPDBV **Suggested Books:** ➢ Saxena, J., Baunthiyal, M. & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers. ➢ Swamy, P.M. *Laboratory Manual on Biotechnology* (1st ed.). Meerut: Rastogi Publication. ➢ Sharma, R.K., Sangha, S.P.S. (2009). *Basic Techniques in Biochemistry & Molecular Biology*. New Delhi: I.K. International Publisher.	More practical exercises have been added, which are more relevant
	Vth Sem				
9.	**BT 306** Enzyme Engineering and Technology	After successful completion of the course, students should be able to: • Describe structure, functions and the mechanisms of action of enzymes	**BT 5.3** **Section – A** • Brief history of enzymes, nomenclature and classification of enzymes. • Specificity of Enzymes: Types of specificity, the Koshland "induced fit" hypothesis. • Strain or transition – state stabilization hypothesis. • Mechanism of enzyme action: Chymotrypsin and	**Section – A** • Brief history of enzymes, nomenclature and classification of enzymes. • Specificity of enzymes: Types of specificity, the Koshland "induced fit" hypothesis. • Strain or transition – state stabilization hypothesis. • Mechanism of enzyme action: Chymotrypsin and	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		• Develop concept of regulation of enzyme activity • Identify industrially relevant enzymes and describe their application	Carboxypeptidase A. • Enzyme Catalysis and Kinetics: Factors affecting the rate of chemical reactions, kinetics of enzyme-catalyzed reaction, Michaelis-Menten laws, importance and determination of Vmax and Km values, Hofstee's plot, L & B plots, Methods for investigating the kinetics of enzyme-catalyzed reactions (single and bisubstrate), nature of enzyme catalysis. • Enzyme inhibition: types and their Kinetics. **Section – B** • Extraction of soluble and membrane bound enzymes. • Purification of enzymes: salt precipitation, gel filtration, ion exchange and affinity chromatography. • Regulation of enzyme activity, various controls (metabolic compartmentation, covalent modifications and others), feedback regulation, allosteric enzymes. • The Investigation of Active Site Structure and Chemical nature of Enzyme Catalysis: The identification of binding sites and catalytic site, three dimensional structure of active site, mechanism of catalysis, mechanism of reaction catalyzed by enzyme without cofactors, metal-activated enzyme and metalloenzyme, coenzymes in enzyme catalyzed reactions. • The impact of genetic engineering on enzyme production, Modification of structural and catalytic properties by chemical methods and genetic engineering, enzymes from extremophiles, enzymes in organic solvent. **Section – C** • Immobilization of Enzymes: Concept, methods of immobilization, Kinetics of immobilized enzymes, effect of solute partition and diffusion on kinetics of immobilized enzymes, bioreactors using immobilized	carboxypeptidase A. • Enzyme catalysis and kinetics: Factors affecting the rate of chemical reactions, kinetics of enzyme-catalyzed reaction, Michaelis-Menten laws, importance and determination of V_{max} and K_m values, Hofstee's plot, L & B plots, Methods for investigating the kinetics of enzyme-catalyzed reactions (single and bisubstrate), nature of enzyme catalysis. • Enzyme inhibition: types and their kinetics. **Section – B** • Extraction of soluble and membrane bound enzymes. • Purification of enzymes: salt precipitation, gel filtration, ion exchange and affinity chromatography. • Regulation of enzyme activity, various controls (metabolic compartmentation, covalent modifications and others), feedback regulation, allosteric enzymes. • The investigation of active site structure and chemical nature of enzyme catalysis: The identification of binding sites and catalytic site, three dimensional structure of active site, mechanism of catalysis, mechanism of reaction catalyzed by enzyme without cofactors, metal-activated enzyme and metalloenzyme, coenzymes in enzyme catalyzed reactions. • The impact of genetic engineering on enzyme production, modification of structural and catalytic properties by chemical methods and genetic engineering, enzymes from extremophiles, enzymes in organic solvent. **Section – C** • Immobilization of enzymes: Concept, methods of immobilization, kinetics of immobilized enzymes, effect of solute partition and diffusion on kinetics of immobilized enzymes, bioreactors using immobilized	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			enzyme. • Industrial enzymes: traditional (non-recombinant) sources of industrial enzymes, • Proteases and carbohydrases: Proteolytic enzymes, Carbohydrases, Lignocellulose degrading enzymes, Pectin and pectic enzymes. • Additional industrial enzymes: Lipases, Penicillin acylase, Amino acylase and amino acid production, cyclodextrins and cyclodextrin glycosyl transferase, enzymes in animal nutrition, Oxidoreductases. • Enzymes in molecular biology and clinical diagnostics. **Books Recommended:** ➢ Enzymes: Palmer, Horwood Publishing Series. ➢ Fundamentals of Enzymology: Price and Stevens, Oxford University Press. ➢ Enzyme Technology: Helmut Uhling, John Wiley ➢ Introduction to Proteins Structure: Branden and Tooze, Garland Publishing Group.	enzyme. • Industrial enzymes: traditional (non-recombinant) sources of industrial enzymes, • Proteases and carbohydrases: Proteolytic enzymes, carbohydrases, lignocellulose degrading enzymes, pectin and pectic enzymes. • Additional industrial enzymes: Lipases, penicillin acylase, amino acylase and amino acid production, cyclodextrins and cyclodextrin glycosyl transferase, enzymes in animal nutrition, oxidoreductases. • Enzymes in molecular biology and clinical diagnostics. **Suggested Books:** ➢ Segel, I. H. (2010). *Biochemical Calculations* (Second Edition). India: Wiley India Pvt. Ltd. ➢ Bhaskar, A., Vidhya, V. G. (2014). *Enzyme Technology*. India: Mjp Publishers. ➢ Palmer, T., & Bonner, P. (2008). *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry* (2nd ed.). India: East West Publications. ➢ Copeland, R. A. (2000). *Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis*. USA: John Wiley & Sons. ➢ Devasena, T. (2010). *Enzymology* (3rd ed.). UK: Oxford University Press. ➢ Scopes, R. K. (2013). *Protein Purification: Principles and Practice* (3rd ed.). USA: Springer. ➢ Meena, M., & Chauhan, D. (2009). *Fundamentals of Enzymology*. Jaipur, India: Aavishkar publishers. **Suggested e-Resources:** ➢ **Mechanism of chymotrypsin** https://slideplayer.com/slide/5116894/ ➢ **Factors affecting rate of chemical reaction** https://www.adichemistry.com/physical/kinetics/factors/	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				factors-affecting-rate-reaction.html ➢ **Extraction and purification of enzyme** http://chemsites.chem.rutgers.edu/~kyc/Teaching/Files/543-05/09%20544-10%20ppt.pdf	
10.	**BT 308** Genetics and Genetic Engineering	After successful completion of the course, students should be able to: • Explain the theoretical and experimental foundation of classical and molecular genetics • Develop comprehensive concept of genetic engineering including vectors and techniques • Identify various application of genetics and genetic engineering	**BT 5.4** **Section-A** • Mendel's laws of inheritance • Gene-Gene interaction, Multiple alleles, Lethal alleles • Linkage and crossing over, Linkage maps, three point testcross, Interference, Calculating recombinant frequencies. • Sex-determination: Chromosomes theory, Genic balance theory and hormone theory, other factors affecting sex determination, Lyon's Hypothesis, Dosage compensation, Sex-linked inheritance. • Chromosomal aberrations: Structural and Numerical Mutation: Spontaneous and Induced, Chemical and Physical mutagens, Induced mutations in plants, animals and microbes for economic benefit of man **Section-B** • Vector systems: *E. coli*-the host cells plasmids structural and functional organization replication, classification, incompatibility groups, construction of an ideal plasmid vector pBR322 • Phage-biology, construction of vector other phages and cosmids. • Direct gene delivery methods-Biolistics, Electroporation, Liposome mediated, Microinjection. • Construction, cloning and selection inserts ligation, infection, transfection and cloning • Synthesis and cloning of cDNA, cDNA library. • Enzymes used in molecular cloning: Nucleases, Restriction Endonucleases, phosphodiesterase	**Section-A** • Mendel's laws of inheritance • Gene-Gene interaction, multiple alleles, methal alleles • Linkage and crossing over, linkage maps, three point testcross, Interference, calculating recombinant frequencies. • Sex-determination: Chromosomes theory, Genic balance theory and hormone theory, other factors affecting sex determination, Lyon's hypothesis, dosage compensation, sex-linked inheritance. • Chromosomal aberrations: Structural and numerical mutation: spontaneous and induced, chemical and physical mutagens, induced mutations in plants, animals and microbes for economic benefit of man **Section-B** • Vector systems: *E. coli*-the host cell plasmids structural and functional organization replication, classification, incompatibility groups, construction of an ideal plasmid vector pBR322 • Phage biology, construction of vector other phages and cosmids. • Direct gene delivery methods- Biolistics, electroporation, iposome mediated, microinjection. • Construction, cloning and selection inserts ligation, infection, transfection and cloning • Synthesis and cloning of cDNA, cDNA library. • Enzymes used in molecular cloning: Nucleases, restriction Endonucleases, phosphodiesterase	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			polynucleotide kinase, DNA ligase, DNA polymerase, reverse transcriptase, terminal deoxynucleotidyl transferase. • Isolation of DNA, RNA: bacteriophage, prokaryotic and eukaryotic. **Section-C** • Inborn errors of metabolism, autosomal and sex linked diseases. • One gene-one enzyme, one gene-one protein, one gene-one polypeptide hypothesis, • Heredity and Environment with special reference to the study of twins. • Human Genome Project: Genetic diseases in humans, Genetics and society. • Current techniques of genetic analysis. • Important discoveries of genetic engineering. • Identification and analysis of recombinant clones. **Books Recommended:** ➢ Principles of Genetics 4th Ed: Snustad and Simmons, John Wiley & Sons. ➢ Genetics: P.K. Gupta, Rastogi Publications. ➢ Genetics - A molecular approach: T.A. Brown, Chapman and Hall. ➢ Concepts of Genetics 7th Ed.: William S. Klug, Pearson Education. ➢ Molecular Cloning Vol. 1, 2 and 3: Sambrook and Russell, Cold Spring Harber laboratory, 2001. ➢ Molecular Biology of Gene: J.D. Watson, Pearson Education. ➢ An Introduction to Gene Technology-From genes to clones: Winnacker, VCH. ➢ Principles of Gene Manipulation: Old and Primrose. ➢ Molecular Biotechnology: B.R. Glick and J.J.	polynucleotide kinase, DNA ligase, DNA polymerase, reverse transcriptase, terminal deoxynucleotidyl transferase. • Isolation of DNA, RNA: bacteriophage, prokaryotic and eukaryotic. **Section-C** • Inborn errors of metabolism, autosomal and sex linked diseases. • One gene-one enzyme, one gene-one protein, one gene-one polypeptide hypothesis, • Heredity and environment with special reference to the study of twins. • Human Genome Project: Genetic diseases in humans, genetics and society. • Current techniques of genetic analysis. • Important discoveries of genetic engineering. • Identification and analysis of recombinant clones. **Suggested Books:** ➢ Snustad, D. P., & Simmons, M. J. (2008). *Principles of Genetics* (5th ed.). USA: John Wiley & Sons. ➢ Primrose, S. B., Twyman, R., & Old, B. (2001). *Principles of Gene Manipulation* (6th ed.). USA: Wiley-Blackwell. ➢ Brown, T. A. (1990). *Genetics: A molecular approach* (3rd ed.). UK: Chapman and Hall. ➢ Sambrook, J. F., & Russell, D. W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.). USA: Cold Spring Harbor Laboratory Press.**:** ➢ Gupta, P. K. (2005). *Biotechnology and Genomics*. India: Rastogi Publications. ➢ Russel, P. J. (1996). *Genetics*. USA: Addison-Wesley. ➢ Singh, B. D. (2015). *Biotechnology*. Kolkata, India: Kalyani Publishers.	

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			Pasternak, ASM Press, Washington, USA.	**Suggested e-Resources:** ➢ **Linkage and crossing over** http://classpages.warnerpacific.edu/bdupriest/BIO%20250/Lecture%207%20Linkage%20&%20Mapping.pdf ➢ **Sex determination theory** http://www.biologydiscussion.com/genetics/modern-theories-of-sex-determination-with-diagrams/5257 ➢ **Plasmid vector** https://nptel.ac.in/courses/102103045/module3/lec17/3.html ➢ **Direct gene delivery methods** https://www.slideshare.net/saugatbhatt/methods-27443684 ➢ **cDNA library** https://nptel.ac.in/courses/102103013/19 ➢ **Enzymes used in molecular cloning** http://www.biologydiscussion.com/enzymes/types-of-enzymes-involved-in-dna-synthesis-and-cloning-7-types/12075 ➢ **One gene one enzyme hypothesis** http://www.biologydiscussion.com/genetics/one-gene-one-enzyme-hypothesis-genetics/59768 ➢ **Techniques of genetic analysis** http://psych.colorado.edu/~carey/hgss/hgsschapters/HGSS_Chapter07.pdf ➢ **Important discoveries of genetic engineering** https://www.genome.gov/pages/education/genetictimeline.pdf	
11.	**BT 309** Metabolic Engineering	After successful completion of the course, students should be able to: • Provide basic	**BT 5.5** **Section – A** • Basic concepts of Metabolic Engineering- Overview of cellular metabolism. Introduction to various pathways. • Primary and Secondary metabolites.	**Section – A** • Basic concepts of metabolic engineering, overview of cellular metabolism. Introduction to various pathways. • Primary and secondary metabolites.	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		concept about cellular metabolism, pathway design and bioenergetics • Understand regulatory mechanisms and metabolic modeling • Develop analytical skills to address metabolic engineering problems	• Medical and agricultural importance of secondary metabolites. • Different models for cellular reactions. Flexible and rigid in metabolic pathways. • Metabolic regulation network at enzyme level and whole cell level- Examples of metabolic pathway manipulations. **Section – B** • Metabolic pathway synthesis algorithms. • Metabolic flux analysis and its applications. • Mathematical calculation for the flow of carbon and nitrogen fluxes. • Methods for experimental determination of metabolic fluxes by isotope labeling. • Stereochemistry of regulatory molecules. • Concepts of regulatory analogs. **Section – C** • Genetic regulation of metabolic fluxes. • Gene expression in response to environmental stimuli. • Regulation of gene expression. • Analysis of metabolic control and the structure of metabolic networks. • Thermodynamics of cellular processes – New concepts for quantitative bioprocess research and development. **Books Recommended:** ➢ Computational Modeling of Genetic and Biochemical Networks: James M. Bower & Hamid Bolouri. ➢ Metabolic Flux Analysi: Valino. ➢ Comprehensive Biotechnology (Vol. 3): Moo & Young. ➢ Fundamentals of Biochemical Engineering: Bailey and Olis	• Medical and agricultural importance of secondary metabolites. • Different models for cellular reactions, flexible and rigid in metabolic pathways. • Metabolic regulation network at enzyme level and whole cell level, examples of metabolic pathway manipulations. **Section – B** • Metabolic pathway synthesis algorithms. • Metabolic flux analysis and its applications. • Mathematical calculation for the flow of carbon and nitrogen fluxes. • Methods for experimental determination of metabolic fluxes by isotope labeling. • Stereochemistry of regulatory molecules. • Concepts of regulatory analogs. **Section – C** • Genetic regulation of metabolic fluxes. • Gene expression in response to environmental stimuli. • Regulation of gene expression. • Analysis of metabolic control and the structure of metabolic networks. • Thermodynamics of cellular processes – New concepts for quantitative bioprocess research and development. **Suggested Books:** ➢ Bower, J.M., & Bolouri, H., (2001). Computational Modeling of Genetic and Biochemical Networks (1st ed.). MIT Press. ➢ Bailey, J.E., & Ollis, D.F. (1986). *Biochemical Engineering fundamentals* (2nd ed). McGraw-Hill. ➢ Stephanopoulos, G.N., Aristidou, A.A., & Nilsen, J., (1998). *Metabolic Engineering-Principles and*	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				Methodologies. Academic Press. **Suggested e-Resources:** ➢ **Metabolites** http://lifeofplant.blogspot.in/2011/03/metabolites-primary-vs-secondary.html http://www.bio21.bas.bg/ipp/gapbfiles/v-34_pisa-08/08_pisa_1-2_67-78.pdf ➢ **Metabolic engineering file** https://biotechnologyforbiofuels.biomedcentral.com/track/pdf/10.1186/s13068-017-0791-3	
12.	**BT 310** Microbiology & Immunology	After successful completion of the course, students should be able to: • Explain bacterial and fungal classification and ultra structure • Discuss different techniques related to isolation, staining and maintenance of microbes • Understand fundamental concept of immunology	**BT 5.6** **Section – A** • Discovery of microorganisms and their significance. • Bacteria: Classification, structural organization, composition of cell wall, cell membrane, capsule, nutrition, respiration, methods of recombination and asexual reproduction. • Fungi- classification, ultra structure and characteristics, nutrition and reproduction. • Viruses: Plant, Animal and Bacteriophages, nature, organization, replication classification. **Section – B** • Sterlization techniques: Physical and Chemical methods. • Techniques in Microbiology: Media preparation, isolation and pure culture techniques, staining techniques, preservation and maintenance of culture. • Industrial applications of microorganisms in food and medicines. • Introduction to Immunology: Innate and Acquired immunity, Active and Passive immunity, Organs and Cells of Immune system • Antigen and Antigenicity: Concept of Immunogens,	**Section – A** • Discovery of microorganisms and their significance. • Bacteria: Classification, structural organization, composition of cell wall, cell membrane, capsule, nutrition, respiration, methods of recombination and asexual reproduction. • Fungi- classification, ultra structure and characteristics, nutrition and reproduction. • Nature, organization, classification and replication of Plant and animal viruses and bacteriophages. **Section – B** • Sterilization techniques: Physical and Chemical methods. • Techniques in Microbiology: Media preparation, isolation and pure culture techniques, staining techniques, preservation and maintenance of culture. • Industrial applications of microorganisms in food and medicines. • Introduction to Immunology: Innate and acquired immunity, active and passive immunity, organs and cells of immune system • Antigen and antigenicity: Concept of immunogens,	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Antigens, Haptens, Characteristic properties of Antigens. **Section-C** • Immunoglobulins: Molecular structure, properties, classification and significance of Immunoglobulin. Immunoglobulin as Antigens – Isotypes, Allotypes and Idiotypes. • Cell mediated and Humoral immune response. • General idea of Major Histocompatibility Complex, Complement System • Hypersensitive reactions: (Type I, II, III and delayed type IV). • Monoclonal antibody (Production and their applications.) **Books Recommended:** ➢ Introductory Microbiology: F.C. Ross, Columbus Charles E. Mehrill. ➢ Microbiology – Fundamentals and Applications: S.S. Purohit, Agro Botanical Publishers, Bikaner. ➢ Modern Concepts of Microbiology: H.D. Kumar and S. Kumar, Vikas Publishing House, New Delhi. ➢ Microbiology: M.J. Pelczar, C.E. Sun and N.R. Krieg, Tata Mc Graw Hill, New Delhi. ➢ A Textbook of Microbiology: R.C. Dubey and D.K. Maheshwari, S. Chand and Company. ➢ Principal of Fermentation Technology: P.F. Stanbury and A. Whittaker, Pegamon Press. ➢ Fundamental Principles of Bacteriology: A.J. Salle, Tata McGraw Hill. ➢ T.D. Book's World of Microbiology: Madigan ➢ Microbiology: Prescott. ➢ Essential of Immunology: W.H. Hildemann, Elservier Scientific Publishing Co. Inc.	antigens, haptens, characteristic properties of antigens. **Section-C** • Immunoglobulins: Molecular structure, properties, classification and significance of immunoglobulin. immunoglobulin as antigens– isotypes, allotypes and idiotypes. • Cell mediated and humoral immune response. • General idea of Major Histocompatibility Complex, complement system • Hypersensitive reactions: (Type I, II, III and delayed type IV). • Monoclonal antibody (production and their applications). **Suggested Books:** ➢ Pelczar, M.J., Sun, C.E., & Krieg, N.R. (2002). *Microbiology* (5th ed.). New Delhi: Tata Mc Graw Hill. ➢ Willey, J. M., Sherwood, L.M. & Woolverton, C.J. (2014). *Prescott's Microbiology* (9th ed.). McGraw-Hill Education. ➢ *Madigan, M., Martinko, J., Stahl, D. & Clark, D.* (2010). *Brock Biology of Microorganisms* (13th ed.). Pearson ➢ Goldsby, R. A., Kindt, T.J., & Osborne, B. A. (2006). *Kuby Immunology* (6th ed.). New York: W.H. Freeman & Co. Ltd. ➢ Paul, W.E. (1999). Fundamental Immunology (14th ed.). Lippincott-Raven. **Suggested e-Resources:** ➢ **Bacteria structure** http://www.biologydiscussion.com/bacteria/cell-structure-of-bacteria-with-diagram/47058 ➢ **Bacterial growth & nutrition** ➢ http://www.biologydiscussion.com/bacteria/nutrition-	

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			➢ Immunology 5th Ed: Richard A. Goldsby et al., W.H. Freeman and Co., NY 2003. ➢ Immunology-Understanding of Immune System: Klans D.Elgret, Wiley-Liss.NY ➢ Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York. ➢ Antibodies- A laboratory Manual: Harlow and David Lane, Cold Spring Harbor Laboratory.	and-growth-in-bacteria/47001 ➢ **Basic Immunology** ➢ http://pdffavor.info/the-tao-of-immunology-a-revolutionary-new-understanding-of-our-body-s-defenses-openlibra-free-books-marc-lapp.pdf	
13.	**BT 303L** Biotechnology Lab-III	After successful completion of the course, students should be able to: • Demonstrate microbial and immunological techniques • Understand chromosome structure and solve genetic problems • Learn various techniques of genetic Engineering • Gain hands on training for experiments related to properties of enzyme	**BT 5.2** **Microbiology** 1. Preparation of media for fungal and bacterial culture and their sterilization, slant preparation. 2. Streak ~~plate~~ technique, ~~pour plate technique and surface plate technique~~ 3. Isolation and enumeration of microbes from air/soil by serial dilution/agar plating method. 4. Antibiotic sensitivity test. ~~5. Lactic acid production and estimation~~ **Immunology** 6. Blood film preparation and identification of leucocytes. ~~7. Lymphoid organs (Thymus and Spleen) and their microscopic examination.~~ 8. ~~Aseptic collection of serum for immunological assays.~~ 9. Double diffusion and immuno-electrophoresis. 10. ELISA: Determination of antibody titre. **Genetics** 11. ~~Preparation of metaphase chromosomes~~. ~~12. Study of ADH activity in tissue/cells by cytochemical staining using Drosophila.~~ 13. ~~Study of~~ Giant chromosomes. 14. Genetic problem and Genetic traits. **Genetic Engineering** 15. ~~Isolation of plasmid DNA from E. coli~~ and its	**Microbiology** 1. Preparation of media for fungal and bacterial culture and their sterilization, slant preparation. 2. Streaking technique, spread plate technique 3. Isolation and enumeration of microbes from air/soil by serial dilution/agar plating method. 4. Antibiotic sensitivity test. **Immunology** 5. Blood film preparation and identification of leucocytes. 6. Ouchterlony double diffusion and immuno-electrophoresis. 7. ELISA: Determination of antibody titre. **Genetics** 8. Microscopic examination of Giant chromosomes 9. Genetic problem and Genetic traits. **Genetic Engineering** 10. Isolation of genomic DNA and its electrophoretic	Practical shifted to B.Tech VI Sem Practical shifted to Sem VIII

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			electrophoretic separation. 16. Extraction of RNA and its estimation by orcinol method. ~~17. Estimation of DNA by DPA method.~~ ~~18. To determine the melting curve and base composition of DNA.~~ 19. Amplification of a gene fragment using PCR. **Enzyme Engineering and Technology** 20. To obtain standard curve of p-nitrophenol solution. 21. To determine activity of acid phosphatase from peas/moong seedlings. 22. Purification of an enzymatic protein by salt precipitation. 23. Determination of kinetic properties (Km and Vmax values) of an enzyme. 24. To check time and protein linearity of an enzymatic reaction. 25. Immobilization of an enzyme	separation. 11. Extraction of RNA and its estimation by orcinol method. 12. Amplification of a gene fragment using PCR. **Enzyme Engineering and Technology** 13. To obtain standard curve of p-nitrophenol solution. 14. To determine activity of acid phosphatase from mung bean seeds. 15. Purification of an enzymatic protein by salt precipitation. 16. Determination of kinetic properties (K_m and V_{max} values) of an enzyme. 17. To check time and protein linearity of an enzymatic reaction. 18. Immobilization of an enzyme. **Suggested Books:** ➢ Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers. ➢ Cappuccino, J. G., & Welsh, C. (2016). *Microbiology: a Laboratory Manual*.Benjamin-Cummings Publishing Company. ➢ Vats, S. (2015). *A laboratory Text book of Biochemistry, Molecular Biology and Microbiology*. Germany: GRIN Verlag. ➢ Mahajan, R., Sharma, J., & Mahajan, R.K. (2010). *Practical Manual of Biotechnology* (1st ed.). New Delhi: Vayu Education of India. ➢ Kumar, V. (2011). *Laboratory Manual of Microbiology*. New Delhi: Scientific Publishers.	The practical is there in the B.Tech IV Semester

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
	VIth Sem				
14.	**BIN 301** Basic Bioinformatics	After successful completion of the course, students should be able to: • Demonstrate basic skills in information retrieval, programming languages and operating systems • Identify various biological databases and develop data mining methods • Predict 3D structure of proteins and their regular structural elements for the integrity of the structure.	**BT 6.2** **Section-A** • Bioinformatics: Introduction and Historical background. • Information Retrieval: LAN, WAN, Introduction to Internet, WWW, NICNET, ERNET, VSNL, ISDN,. Introduction to FTP, login and other network services, Publication on worldwide web, on-line publishing ventures e.g. Biomed, online international database access. • ~~Introduction and applications of programming languages, C++, Perl.~~ • Conceptual understanding of assemblers, Operating Systems (DOS, Windows, UNIX, LINUX). **Section-B** • Concept of CD-ROM, e-mail, Websites, Internet, Networking, Databases. • Biological Databases: Primary Sequence databases (Protein and DNA databases), Secondary databases, Composite databases. • Sequence format i.e. genbank and FASTA format • Sequence Alignment and Databases searching: Evolutionary basis of sequence alignment, Optimal alignment methods, Substitution Scores and Gap penalties. **Section-C** • Statistical significance of alignment, Similarity searching tools: FASTA, BLAST. • Pair wise database searching: EMBOSS, Multiple Sequence alignment: CLUSTAL W. • Protein structure prediction method- Homology modeling, ab-initio method and threading method	**Section-A** • Bioinformatics: Introduction and historical background. • Information retrieval: LAN, WAN, introduction to internet, WWW, NICNET, ERNET, VSNL, ISDN, introduction to FTP, login and other network services, publication on worldwide web, on-line publishing ventures e.g. biomed, online international database access. • Conceptual understanding of assemblers, operating systems (DOS, Windows, UNIX, LINUX). **Section-B** • Concept of CD-ROM, e-mail, websites, internet, networking, databases. • Biological databases: Primary sequence databases (Protein and DNA databases), secondary databases, composite databases. • Sequence format i.e. genbank and FASTA format • Sequence alignment and databases searching: Evolutionary basis of sequence alignment, optimal alignment methods, substitution scores and gap penalties. **Section-C** • Statistical significance of alignment, similarity searching tools: FASTA, BLAST. • Pair wise database searching: EMBOSS, multiple Sequence alignment: CLUSTAL W. • Protein structure prediction method- Homology modeling, ab-initio method and threading method	Programming languages have been removed as the content cannot be justified for a introductory course.

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			• Scope of Bioinformatics, BTIS Network in India, Centers for Bioinformatics (DICs and sub DICs) in India. **Books Recommended:** ➢ Fundamental of computer: P.K. Sinha ➢ Introduction to Bioinformatics: Parrysmith and Attwood ➢ Introduction to Bioinformatics: Baxevenis and Oulette ➢ Internet for Molecular Biologist: Swindell ➢ Molecular Databases for Protein Sequences and Structure Studies - An Introduction Silence: J., Sillince M., Springerberlagd, Berlin 1972 ➢ Leaping from Basic to C++ : Robert J. Traister, A.P. Professional Cambridge ➢ Perl 5 Unleashed: Kamran Husain & Robert F Breedlore SAMS Publishing. ➢ Bioinformatics: David Mount. ➢ Text book of Bioinformatics: Vinay Sharma, Ashok Munjal and Asheesh Shanker, Rastogi publications	• Scope of bioinformatics, BTIS Network in India, centers for bioinformatics (DICs and sub DICs) in India. **Suggested Books:** ➢ Sinha, P.K & Sinha, P. (2016). *Computer Fundamentals* (6th ed.). New Delhi: BPB publication. ➢ Baxevanis, A.D. & Ouellette, B.F.F. (2004). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (3rd ed.). Wiley. ➢ Bosu, O. & Thukral, S.K. (2007). *Bioinformatics: database, tools and algorithms* (1st ed.). Oxford University Press. ➢ Sharma, V., Munjal, A., & Shanker, A. (2017). *A Text Book of Bioinformatics* (2nd ed.). Meerut: Rastogi Publications. **Suggested e-Resources:** ➢ **Chou-Fasman Method for protein secondary structure prediction** https://pdfs.semanticscholar.org/fd8c/c95aec2d7af19ed28eea3688b3c231d0e745.pdf ➢ **Homology modeling** https://proteinstructures.com/Modeling/homology-modeling.html ➢ **ExPASy** https://www.expasy.org/	
15.	**BT 302** Bioprocess Engineering	After successful completion of the course, students should be able to: • Develop comprehensive concepts on various processes in	**BT 6.3** **Section – A** • Growth kinetics and death kinetics • Microbial growth: structured and unstructured • Kinetics of Batch, Fed-batch and Continuous processes • Mass balance, energy balance • Maintenance coefficient and yield concept • Mass transfer, Volumetric mass transfer coefficient,	**Section – A** • Growth kinetics and death kinetics • Microbial growth: structured and unstructured • Kinetics of batch, fed-batch and continuous processes • Mass balance, energy balance • Maintenance coefficient and yield concept • Mass transfer, volumetric mass transfer coefficient,	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		bioreactors mediated microbial process • Apply engineering principles to address issues in bioprocesses and delineate problems associated with production of biomolecules in bioreactor. • Plan a career in research field in the biotechnology industry.	aeration and agitation • Media sterilization and medium rheology **Section – B** • Bioreactors: components and control of process parameters • Types of bioreactors: CSTR, Airlift, Fluidized bed, Plug flow reactor, Photobioreactor, Bubble column, advances in bioreactor designing. • Down stream processing : recovery and purification of fermentation products • Upscaling of bioprocess **Section – C** ~~**Fermentative production of:**~~ • Organic solvents: acetone, ethanol, butanol • Organic acids: lactic acid, citric acid and acetic acid • Enzymes: Proteases, Lipases and alpha-amylase • Antibiotics: Penicillin, Streptomycin and Tetracycline • Amino acids: L-glutamic acid, phenylalamine and L-lysine **Books Recommended:** ➢ Biochemical Engineering: J.M. Lee, Prentice Hall. ➢ Bioprocess Engineering: M. Shuler and F. Kargi, Pretice Hall. ➢ Comprehensive Biotechnology: M. MooYoung, Editor. ➢ Biotechnology: H.J. Rehm and G. Reed, VCH.	aeration and agitation • Media sterilization and medium rheology **Section – B** • Bioreactors: components and control of process parameters • Types of bioreactors: CSTR, airlift, fluidized bed, plug flow reactor, photobioreactor, bubble column, advances in bioreactor designing. • Down stream processing : recovery and purification of fermentation products • Upscaling of bioprocess **Section – C** Fermentative production of: • Organic solvents: acetone, ethanol, butanol • Organic acids: lactic acid, citric acid and acetic acid • Enzymes: Proteases, lipases and alpha-amylase • Antibiotics: Penicillin, streptomycin and tetracycline • Amino acids: L-glutamic acid, phenylalamine and L-lysine **Suggested Books:** ➢ Stanbury, P.F., Whitaker, A., & Hall S.J. (1995).*Principles of Fermentation Technology* (2nd & 3rd ed.). Elsevier Science Ltd. ➢ Crueger, W., & Crueger, A. (1990). *Biotechnology, A Text Book of Industrial Microbiology* (2nd ed.). USA: Sinauer Associates Inc., ➢ Shuler, M.L., & Kargi, F. (2002). *Bioprocess Engineering Basic Concepts* (2nd ed,). USA: Prentice Hall PTR Upper Saddle River. ➢ Bailey, J.E., & Ollis, D.F. (1986). *Biochemical Engineering fundamentals* (2nd ed). McGraw-Hill College. ➢ Clark,D.S., & Blanch, H.W. (1997). *Biochemical*	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				Engineering. CRC Press. **Suggested e-Resources:** ➢ **Application of microbial enzymes** ➢ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5387804/pdf/BMRI2017-2195808.pdf ➢ **Acetone-Butanol-Ethanol fermentation** ➢ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4894279/pdf/fnw134.pdf ➢ **Microbial culture fermentation** ➢ https://pdfs.semanticscholar.org/b4d3/7ed66ef2e37ce22ff7a3be09e3df7568fe49.pdf	
~~16.~~	BT 305 ~~Cell and Tissue Culture Technology~~		~~BT 6.5~~ ~~**Section – A**~~ • ~~Historical background and terminology used in cell and tissue culture.~~ • ~~Basic techniques, surface sterilization, aseptic tissue transfer, concept of totipotency.~~ • ~~Nutritional requirement of cells in vitro, various types of nutrient media.~~ • ~~Somatic embryogenesis and organogenesis in plants.~~ • ~~Variability in tissue cultures, somaclonal and other variations.~~ • ~~Isolation of cells, single cell cultures and cloning.~~ ~~**Section – B**~~ • ~~Production of disease free plants by tissue culture methods.~~ • ~~Protoplast isolation and culture, viability test, techniques of protoplast fusion.~~ • ~~Somatic hybrids, selection methods, gene expression in somatic hybrids.~~ • ~~Haploid Production: Introduction, Techniques, plant regeneration from pollen embryo.~~ • ~~Plant cell culture products: Secondary Metabolites.~~		This course is proposed to be discontinued and relevant contents incorporated in the Papers of B.Tech VIII Semester (Animal Biotechnology & Plant Biotechnology)

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			~~**Section- C**~~ • ~~Maintenance and propagation of animal cell and tissue culture: Disaggreagation techniques and primary culture.~~ • ~~Preservation of cell lines: cryopreservation, cell banks, transporting cells.~~ • ~~Somatic Hybridization: Fusogens, basis of somatic hybridization technology, storage of hybridoma cells, Productions of monoclonal antibodies.~~ • ~~Animal cell culture products.~~ ~~**Books Recommended:**~~ ➢ ~~Plant Tissue Culture: S.S. Bhojwani and M.K. Razdan, Elsevier Science, The Netherlands.~~ ➢ ~~An Introduction to Plant Tissue Culture: M.K. Razdan.~~ ➢ ~~Biotechnology in Agriculture and Forestry: Y.P.S. Bajaj, Narosa.~~ ➢ ~~Plant Cell and Tissue Culture: Butenko.~~ ➢ ~~Plant Tissue Culture Methods and Application in Agriculture: T.A. Thorpe, Academic Press Inc.~~ ➢ ~~Cell and Tissue Culture: Lab Procedures in Biotechnology, Alan Doyal (ed) J.Bryan Griffth (ed.)~~ ➢ ~~Micropropagation Tech. and Applications: P.C. Dobergh & R.H. Zimmerman, Kluwer Academic Pub. Dordrecht.~~ ➢ ~~Introduction to Cell and Tissue Culture: Jennie P. Methew and Penelpoe E. Rohes.~~ ➢ ~~Animal Cell Culture: John R.W. Masters.~~ ➢ ~~Cell and Tissue Culture: Lab procedure in biotechnology Alan Doxal (ed) J. Bryan 6th ed.~~ ➢ ~~Animal Cell Culture a Practical Approach: R.I. Freshney, wiley Liss.~~		
17.	**BT 311** Recombinant	After successful completion of the	**BT 6.6** **Section – A**	**Section A**	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
	DNA Technology	course, students should be able to: • Understand the concept of DNA synthesis, amplification and sequencing • Apply strategies of cloning in both prokaryotes and eukaryotes • Explain use of molecular probes and DNA finger printing for relevant applications.	• Chemical synthesis of DNA: Phosphodiester, triester approaches, phosphoramidite method, solid phase automated synthesis of DNA. • Sequencing of DNA: Chemical and dideoxy methods, random and directed approaches, automated DNA sequencing, improved gel-based sequencers, mass spectrometry based sequencing, pyrosequencing. • Polymerase chain reaction (PCR) – Basic principles, modifications and applications. • Site directed mutagenesis; ~~various approaches~~. **Section – B** • ~~Direct gene transfer methods~~ • Cloning in plants. • Cloning in Bacillus subtilis and yeast. • Artificial chromosomes (YACs, ~~BACs, MACs~~). • Cloning in mammalian cells using SV-40 vectors. **Section – C** • Molecular probes – DNA, RNA probes, Applications, radioactive and non-radioactive labeling of probes. • Eukaryotic selectable markers.	• Chemical synthesis of DNA: Phosphodiester, triester approaches, phosphoramidite method, solid phase automated synthesis of DNA. • Sequencing of DNA: Chemical and dideoxy method, random and directed approaches, automated DNA sequencing, improved gel based sequencers, mass spectrometry based sequencing, pyrosequencing • Polymerase chain reaction (PCR)- Basic principle, modifications: multiplex, nested, hot start, reverse transcriptase, real time, inverse, anchored, touch down and applications • Site directed mutagenesis: Oligonucleotide directed mutagenesis using M13 DNA, oligonucleotide directed mutagenesis using plasmid DNA, PCR based oligonucleotide directed mutagenesis, deletion mutagenesis. **Section – B** • Gene expression analysis: Northern blot, primer extension, SI mapping, RNase protection assays, reporter assays. • Cloning in *Bacillus subtilis* • Cloning in yeast: YEPs, YIPs, YRP, YAC • Cloning in plants-*Agrobacterium tumefaciens* mediated gene transfer: Binary vector, cointegrate vector; viral vector mediated gene transfer, direct gene transfer methods • Cloning in mammalian cell using SV-40 vector- Early replacement and late replacement vector. **Section – C** • Molecular probes- DNA, RNA probes, application, radioactive and non-radioactive labeling of probes • Eukaryotic selectable markers	Subtopics have been introduced to make the content precise. Gene transfer methods already covered in Genetics and Genetic engineering syllabus. Thus, new and relevant topics have been introduced.

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			• DNA fingerprinting; Various molecular markers: RAPD, AFLP, SNP's, SSR, ARDRA • Antisense RNA Technology, RNAi. • Gene Therapy. • Detection of genetic disorders. **Books Recommended:** ➢ Molecular Cloning Vol. 1, 2 and 3: Sambrook and Russell, Cold Spring Harber laboratory, 2001. ➢ Molecular Biology of Gene: J.D. Watson, Pearson Education. ➢ An Introduction to Gene Technology-From genes to clones: Winnacker, VCH. ➢ Principles of Gene Manipulation: Old and Primrose. ➢ Molecular Biotechnology: B.R. Glick and J.J. Pasternak, ASM Press, Washington, USA. ➢ Genetic Engineering: Science and ethics on new frontier: Michael Boylan, Pearson Education. ➢ An Introduction to Genetic Engineering: S.T. Nicholl, Cambridge University Press. ➢ Recombinant DNA Methodology: Grossman and Noldave, Academic Press. ➢ Recombinant DNA: J.D. Watson, W.H. Freeman. ➢ Nucleic acid and Biotechnology: H.D. Kumar. ➢ Understanding DNA and Gene Cloning : Darlica, John Wiley and Sons.	• Various molecular markers: RAPD, AFLP, SNPs, SSR, ARDRA • DNA fingerprinting- Principle of technique, Basic DNA fingerprinting procedure • Antisense RNA technology, RNAi, siRNA • Gene therapy • Methods of detection of genetic disorders: Cytogenetic testing, biochemical testing, molecular testing. **Suggested Books:** ➢ Glick, B.R., Pasternak, J.J. & Patten, C.L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (4th ed.). American Society for Microbiology. ➢ Winnacker, E.L. (1987). *From genes to clones: Introduction to gene technology*. Wiley VCH. ➢ Primrose, S. B., & Old, R.W. (2001). *Principles of Gene Manipulation* (6th ed.).Wiley-Blackwell. ➢ Kumar, H.D. (1990). *Nucleic acid and biotechnology*. Vikas Publication. ➢ Sambrook, J.F. & Russell, D.W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.) Vol. 1, 2 and 3. Cold Spring Harbor laboratory. **Suggested e-Resources:** ➢ **Solid phase oligonucleotide synthesis** https://www.atdbio.com/content/17/Solid-phase-oligonucleotide-synthesis ➢ **Antisense Technology** https://www.ukessays.com/essays/sciences/antisense-technology-applications-7151.php ➢ **SV40 vector** https://www.ncbi.nlm.nih.gov/pmc/articles/PMC322153/pdf/nar00317-0279.pdf	Subtopics have been introduced to make the content precise.
18.	**BT 304L**	After successful	**BT 6.4**		

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
	Biotechnology Lab-IV	completion of the course, students should be able to: • Demonstrate an understanding of production and estimation of commercially important molecules • Hands on training related to genetic manipulation techniques • Learn sequence alignment of biomolecules using bioinformatic tools	**Bioprocess Engineering** 1. Demonstration of Bioreactor. ~~2. Estimation of Biomass.~~ 3. Estimation of growth and product yield in a Bioconversion process. 4. Comparison between aerobic and anaerobic process. **Plant cell and tissue culture** ~~5. Tissue culture media preparation-MS/White media, Slant preparation~~ ~~6. Sterilization techniques~~ ~~7. Culture of axillary meristems for clonal multiplication.~~ ~~8. Embryo culture.~~ **Animal Cell and Tissue Culture** ~~9. Peripheral Blood culture preparation of metaphase chromosomes.~~ ~~10. Cell separation by enzymatic and mechanical methods.~~ ~~11. Counting and cell viability tests.~~ **Recombinant DNA Technology** ~~12. Isolation of genomic DNA and its electrophoretic separation.~~ 13. Restriction digestion of plasmid DNA. ~~14. To obtain transposon Tn5 insertion into the genome of AK 631 strain of Rhizobium meliloti using suicide plasmid vector pGS 9.~~ 15. To transfer plasmid pJB3JI from J53 strain of E. coli to HB101 strain of E. coli. **Bioinformatics** 16. To check similarity between DNA and Protein sequence using DOT PLOT method. 17. To check sequence alignment of DNA and Protein sequence using dynamic ~~sequencing~~. 18. Various exercises of in silico functional and comparative genomics in downloaded DNA and	**Bioprocess Engineering** 1. Determination of growth kinetics of *E. coli* 2. Demonstration of Bioreactor. 3. Estimation of growth and product yield in a Bioconversion process. 4. Comparison between aerobic and anaerobic process. 5. Lactic acid production and estimation by titration **Recombinant DNA Technology** 19. Isolation of plasmid DNA from *E. coli.* 20. Restriction digestion of plasmid DNA and its electrophoretic separation 6. To transfer plasmid pJB3JI from J53 strain of *E. coli* to HB101 strain of *E. coli.* **Bioinformatics** 7. To check similarity between DNA and Protein sequence using DOT PLOT method. 8. To check sequence alignment of DNA and Protein sequence using dynamic programming. 9. Various exercises of *in silico* functional and comparative genomics in downloaded DNA and Protein	The theory paper Cell and Tissue Culture Technology has been merged with Plant & Animal Biotechnology paper. Thus, the practicals are Shifted to the VIII Semester which coincides with the theory paper Relevant practical introduced

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Protein sequences using: a. BLAST b. FASTA ~~c. ClustalW~~	sequences using: a. BLAST b. FASTA c. ClustalX **Suggested Books:** ➢ Swamy, P.M. *Laboratory Manual on Biotechnology* (I Ed.). Meerut: Rastogi Publication. ➢ Mahajan, R., Sharma, J., & Mahajan, R.K. (2010). *Practical Manual of Biotechnology* (I Ed.). New Delhi: Vayu Education of India. ➢ Vats, S. (2015). *A Laboratory Text book of Biochemistry, Molecular Biology and Microbiology*. Germany: GRIN Verlag. ➢ Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual.*Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.	
~~**19.**~~	~~**Reading Elective** **BT 7.1** **1. Plant Genetic Engineering**~~	~~After successful completion of the course, students will be able to:~~ ~~• Understand the various gene delivery system and vectors~~ ~~• Develop concept of gene cloning in plants.~~ ~~• Learn application of genetic modified plants~~	~~**Section A**~~ ~~• Direct gene delivery systems Biolistics, electroporation, microinjection and liposome mediated gene transfer.~~ ~~• Vectors used for gene transfer in plants: Ti and Ri plasmid based vectors.~~ ~~• Gemini virus, cauliflower mosaic virus.~~ ~~• Cloning vectors for plant genes: pUC vectors.~~ ~~• Other possible vectors maize mitochondrial elements, nuclear genomic components, RNA viruses.~~ ~~**Section B**~~ ~~• Gene cloning strategies in plants cloning plastid and mitochondrial genes.~~ ~~• Molecular markers for plants.~~ ~~• Plant gene expression signals and genetic markers.~~ ~~• Study of structure and function of representative plant genomes viz. Chloroplast, mitochondrial and nuclear.~~		This course is proposed to be discontinued.

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			~~**Section – C**~~ • ~~Antisense RNA technology, use of RNAi.~~ • ~~Arabidopsis as a model plant for genetic engineering.~~ • ~~Gene tagging.~~ • ~~Improvement of seed storage proteins.~~ • ~~Transgenic plants with resistance against herbicide, pesticide and disease resistance, stress tolerance.~~ • ~~Manipulation of photosynthetic carbon metabolism (Rubisco) in transgenic plants.~~ ~~**Books Recommended:**~~ ➢ ~~Transgenic plants: Promise or danger by B.L. Kakralya and Ishita Ahuja (Agrobios, India).~~ ➢ ~~Plant Biotechnology by Ignacimuthu, S.J. (Oxford and IBH publishing Co. PVT. Ltd.).~~ ➢ ~~Applied Plant Biotechnology by S. Ignacimuthu S.J. (Tata Mc Graw Hill Publishing Co. Ltd. New Delhi).~~		
20.	**Reading Elective** ~~**BT 7.1**~~ ~~**2. Renewable Energy Resources**~~	~~After successful completion of the course, students will be able to:~~ • ~~Understand the various forms of conventional and non conventional energy resources~~ • ~~Environmental aspects of these energy sources~~ • ~~Learn the present energy scenario and the need for energy conservation~~	**Section -A** ~~Energy and power, conventional energy sources. Renewable energy sources, solar energy alternatives, optimal tilt for solar equipments. Solar photovoltaic technologies, solar photovoltaic systems and their components. Wind energy, wind flow, power in the wind, types of wind turbines, wind turbine sizing and systems design.~~ **Section -B** Biomass energy, introduction, types of biomass and their ~~applications, energy content of biomass, biomass as a source of energy, biomass-based fuels, structure of a biogas plant, design of a biogas plant, costing and payback period. Chemical energy sources, hydrogen energy technology, production storage transportation alternate fuel for motor vehicles, safety and management.~~ **Section -C**		This course is proposed to be discontinued.

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			~~Magneto hydro dynamic power, thermo electric power, thermionic generation, thermonuclear fusion energy, Energy storage and distribution Energy conservation concept, principles technologies involved. Co-generation, waste heat utilization heat recuperators, regenerators, heat pipes & pumps. Renewable energy sources and devices and their instrumentation and control.~~ **Books Recommended:** **Text Book:** ➢ G. D. Rai, "Non conventional energy sources", Khanna Publishers, New Delhi 2007. **Reference Books:** ➢ Singhal R. K. "Non conventional energy sources" Katson publishers. New Delhi 2009. ➢ M. Chiogioji, "Industrial Energy Conservation", McGraw Hill, New York, 1979. ➢ Chetan Singh Solanki, "Renewable energy technologies" PHI, New Delhi, 2009.		
21.	**Molecular Diagnostics**	After successful completion of the course the students will be able to: • Comprehend techniques used to diagnose diseases • Use the gained knowledge in pursuing career in diagnostic labs and related research areas.		The successful treatment of diseases essentially depends on the early and accurate detection of pathogens. Conventional methods are available for detection of infectious agents but often they are time consuming and costly. Over the last decade, molecular diagnostics has become the gold standard to detect genetic disorders and infectious disease. These techniques are sensitive and allow detection of even lower amounts of infectious agents, thus, allowing early detection of infections. Molecular diagnostic methods include: immunological (ELISA), Monoclonal Antibodies, biofluorescent and bioluminescent systems (Colored fluorescent proteins, luciferase and microbial biosensors), nucleic acid diagnostic systems (hybridization probes, molecular beacons, DNA fingerprinting, RAPD, Real-Time PCR, Immunoquantitative Real-Time PCR and automated	New course proposed to be introduced

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				DNA analysis). Further, for the detection of genetic disorders like cystic fibrosis and sickle-cell anemia methods viz., PCR/OLA, padlock probes, genotyping with fluorescence labelled PCR primers and TaqMan assay and mutation detection (PCR-Single strand conformation polymorphism, PCR-denaturing gradient gel electrophoresis and mismatch chemical cleavage) are generally employed. **Suggested Books:** ➢ Glick B.R., Pasternak J.J., & Patten C.L. (2010). *Molecular Biotechnology: Principles and applications of recombinant DNA* (4th ed). American Society for Microbiology. ➢ Primrose, S.B., Twyman R.H., & Old R.W. (2001). *Principles of Gene Manipulation* (6th ed). Wiley-Blackwell. **Suggested e-resources** ➢ **PCR-Denatured gradient gel electrophoresis** https://www.scq.ubc.ca/denaturing-gradient-gel-electrophoresis-dgge-an-overview/ ➢ **PCR-Single strand conformation polymorphism** https://genome.cshlp.org/content/1/1/34.long ➢ **Mismatch chemical cleavage** http://www.livingnaturally.com/ns/DisplayMonograph.asp?StoreID=3ED1FF6A18BD42979FFF73C8E8CD4512&DocID=genomic-ccm	
22.	**Biodiversity and Conservation**	After completing this course, students will be able to: • Understand the importance and gain knowledge of various aspects of ecosystems		India is considered as a mega diversity zone and falls among the major biodiversity hot spots of the world. It is necessary to understand distribution and types of biodiversity seen in India especially with respect to ecological diversity, species diversity and genetic diversity. However, due to several reasons, there has been severe biodiversity loss not only in India but globally. Thus, study of species extinction (local, ecological, biological, background extinction, anthropogenic	New course proposed to be introduced

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		• Describe the physiological and ecological adaptations of different organisms for survival and growth in various types of natural and engineered ecosystems		extinction) based on IUCN status categories and Red Data Book is necessary to plan biodiversity preservation and conservation strategies. The knowledge of endangered species in India and various conservation strategies both *in situ* (biosphere reserve, national park, wildlife sanctuaries, sacred forests) and *ex situ* (cryo-preservation, Gene banks, DNA banks) are important aspects to maintain biodiversity. **Books Recommended:** ➢ Krishnamurthy, K.V. (2003). *Textbook of Biodiversity* (1st ed). USA:CRC Press publisher. ➢ Wilson, E.O., Peter, F.M. (1988). *Biodiversity*. Washington, D.C., USA: National Academy press. ➢ Sharma, A.K., Ray, D., Ghosh, S.N. (2012). *Biological Diversity: Origin, Evolution and Conservation*, New Delhi: Viva Books publisher. **Suggested e-Resources:** ➢ **Biodiversity conservation** https://link.springer.com/content/pdf/10.1007%2Fs10531-015-0860-5.pdf ➢ **Biodiversity** http://ncert.nic.in/ncerts/l/lebo115.pdf ➢ **Conservation** http://download.nos.org/333courseE/15.pdf http://www.rgmcet.edu.in/wp-content/uploads/2017/03/IV.BIODIVERSITY-AND-ITS-CONSERVATION.pdf	
23.	**Emerging Trends in Biofuel Technology**	After successful completion of the course, students will be able to: • Understand the production of different types of		Globally, fuel from biomass has immense potential as a commercially viable renewable energy source. Three generations of biomass identified for energy use have been described (crop plants, lingo-cellulosic material and microbial systems). Biomass can be converted to fuels, electricity, and process heat. The study of different methodologies for biomass extraction (anaerobic digestion,	New course proposed to be introduced

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		biofuel • Describe the environmental and social sustainability aspects of biofuel • Learn the present energy scenario and the need for energy conservation		gasification, fermentation, liquefaction) and their conversion to various fuels like biodiesel, bio-hydrogen, bio-ethanol and biogas is important. Considering the environmental ramifications, the study of biomass based energy is important for achieving environmental and social sustainability. **Suggested Books:** ➢ Chiogioji, M. (1979). *Industrial Energy Conservation*. New York, USA: McGraw Hill. ➢ Singhal, R. K. (2013). *Non -conventional energy sources*. New Delhi: S.K. Kataria & Sons publishers. ➢ Gude, V. G. (2018). *Green chemistry for sustainable biofuel production*. Oakville, ON Waretown, NJ AAP, Apple Academic Press [Boca Raton] CRC Press, Taylor & Francis Group. ➢ In Gikonyo, B. (2015). *Efficiency and sustainability in biofuel production: Environmental and land-use research*. Oakville, ON Canada ; Waretown, NJ, USA : Apple Academic Press **Suggested e-Resources:** ➢ **Technology for biofuel** https://nptel.ac.in/courses/108108078/7 ➢ **Biofuel** http://www.teriin.org/policybrief/docs/biofuel.pdf ➢ **Biogas plant** http://cdn.intechopen.com/pdfs/31334/InTech-Biogas_plant_constructions.pdf	
	VIIIth Sem				
24.	**BT 8.1** Animal Biotechnology	After successful completion of the course, students should be able to: • Develop	**Section - A** • ~~Gene transfer techniques.~~ • In vitro fertilization and Embryo ~~Transfer: Composition of IVF media, steps involved in IVF, Fertilization by means of Micro insemination, PZD, ICSI, SUZI and~~	**Section - A** • Animal cell culture: brief history of animal cell culture, cell culture media and reagents, animal cell growth characteristics • Disaggregation techniques, primary cell cultures,	Contents of 'Cell and Tissue Culture Technology' in the

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		comprehensive concepts of cell and tissue culture techniques and methodology • Gain fundamental concepts of in vitro fertilization and animal cloning • Explain applications of cell and tissue culture in pharmaceutical industry	~~MESA.~~ • ~~Cryopreservation: Need of cryopreservation, nature of assay~~, viability of assay, survival assay, ~~microtitration assay~~ and transformation assay. **Section - B** • Animal cell culture products ~~and their applications.~~ • ~~Transgenic animal: Methodology, Embryonic stem cell method, Microinjection and Retroviral vector method.~~ • Applications of transgenic animal. **Section - C** • ~~Gene therapy: Ex- vivo gene therapy, in vivo gene therapy, viral gene delivery system, Retrovirus vector system, Adenovirus vector system, Adeno-associated virus vector system, herpes simplex virus vector system, Non viral gene delivery system, Prodrug activation therapy, Nucleic acid as therapeutic agents.~~ **Books Recommended:** ➢ Molecular Biotechnology: Primrose ➢ Animal Cell Biotechnology: R.E. Spies and J.B. Griffiths (1988), Academic Press. ➢ Stem Cell Biology by Marshak (2001), Cold Spring Harbor symposium publication. ➢ Animal Cell Culture by John R.W. Masters	secondary culture, continuous cell lines, suspension cultures, establishment and maintenance of cell cultures • Cell viability assays, cytotoxicity assays, survival assay and transformation assay **Section - B** • Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and *in vitro* fertilization • Culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos. • Animal cloning: Basic concept; cloning for conservation of endangered species **Section - C** • Vaccinology: History of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines. • Somatic Hybridization: Fusogens, basis of somatic hybridization technology, storage of hybridoma cells, productions of monoclonal antibodies. • General overview of applications of transgenic animal technology and animal cell culture products. **Suggested Books:** ➢ John, R. W. (2000). *Animal Cell Culture: a Practical Approach* (3rd ed.). UK: Oxford Unievrsity Press. ➢ Freshney, R. I. (2011). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications* (6th ed.). USA: Wiley-Blackwell. ➢ Butler, M. (2004). *Animal Cell Culture & Technology* (2nd ed.). UK: Taylor & Francis. ➢ Davis, J. M. (2011). *Animal Cell Culture: Essential*	VII Sem has been incorporated with addition of some latest topics. Contents have been replaced with latest topics 'Gene therapy' is taught in VI Semester. Thus, it has been replaced with relevant topics

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				Methods. USA: John Wiley & Sons Ltd. ➢ Bernard, R., Glick, Jack, J., Pasternak, Cheryl, L, &. Patten. (2009). Molecular Biotechnology Principles and Applications of Recombinant DNA (4th ed.). ASM press. ➢ Levine, M. M. (2004). *New Generation Vaccines*. New York: M. Dekker. ➢ Pörtner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Totowa, NJ: Humana Press. ➢ Gordon, I. (2005). *Reproductive Techniques in Farm Animals*. Oxford: CAB International. **Suggested e-Resources:** ➢ **Animal cell culture products** http://www.biologydiscussion.com/biotechnology/animal-biotechnology/applications-of-animal-cell-cultures/10457 ➢ **Artificial Insemination** https://fertilityfirst.com.au/wp-content/uploads/2017/02/intrauterine-insemination-iui.pdf ➢ **Intracytoplasmic Sperm Injection (ICSI)** https://www.intechopen.com/books/advances-in-embryo-transfer/new-advances-in-intracytoplasmic-sperm-injection-icsi-	
25.	**BT 8.2** Bioethics and Biosafety	After successful completion of the course, students should be able to: • Explain role of biotechnology in sustainable research and various ethical implications	**Section - A** 1. (i) Introduction to science, technology and society, (ii) Socio-economic impacts of biotechnology. 2. (i) Global biotech issues; major categories and impact (ii) Biodiversity: concept and importance, main features of Indian Biodiversity Act. (iii) Traditional knowledge. (iv) Access and benefit sharing (ABS): concept,	**Section – A** • Introduction to science, technology and society, socio-economic impacts of biotechnology. Global biotech issues; major categories and impact. • Biodiversity: concept and importance, main features of Indian Biodiversity Act. Traditional knowledge. Access and benefit sharing (ABS): concept, convention on biological diversity and its impact on ABS, regulation of ABS and impact on developed and developing countries.	Typographical Corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		• Understand biosafety –objective, implementation, necessity and legislations • Develop preliminary understanding of Intellectual Property with emphasis on patents	convention on biological diversity and its impact on ABS, regulation of ABS and impact on developed and developing countries. (v) Environmental sustainability: concept of sustainable development types and factors, significance for developed and developing countries. 3. (i) Globalization : concept, impact in biotechnology. (ii) Development divide. 4. (i) Concept of legality, morality and ethics. (ii) Concept and Principles of bioethics: expanding scope of ethics from biomedical practice to biotechnology. (iii) Ethical conflicts in biotechnology: interference with nature, fear of the unknown, unequal distribution of risks and benefits of biotechnology; bioethics vs. business ethics. (iv) Case studies of relevance - ethical aspects of human genome project prenatal diagnosis and xenotransplantation. **Section - B** 5. (i) Biosafelty: concept definition of risks, hazards and various terminologies asssociated with hazard assessment and managment. (ii) Public acceptance in biotechnology (based on rationalsvs subjective perception of riks and benefits.) 6. (i) Biotechnology and biosafety concerns at the level of individuals, institutions and country. (ii) Cartagena Protocol: history conception and implementation of the protocal, impact on nations, main areas covered. 7. (i) Levels of Biosafety: concept, levels and their	• Environmental sustainability: concept of sustainable development types and factors, significance for developed and developing countries. Globalization : concept, impact in biotechnology. Development divide. • Concept of legality, morality and ethics. Concept and Principles of bioethics: expanding scope of ethics from biomedical practice to biotechnology. Ethical conflicts in biotechnology: interference with nature, fear of the unknown, unequal distribution of risks and benefits of biotechnology; bioethics vs. business ethics. Case studies of relevance - ethical aspects of human genome project prenatal diagnosis and xenotransplantation. **Section – B** • Biosafelty: concept definition of risks, hazards and various terminologies asssociated with hazard assessment and managment. Public acceptance in biotechnology (based on rationals vs subjective perception of riks and benefits. • Biotechnology and biosafety concerns at the level of individuals, institutions and country. Cartagena Protocol: history conception and implementation of the protocol, impact on nations, main areas covered. • Levels of Biosafety: concept, levels and their description (plants, animals and microbes). General .concepts: Good Lab Practices, Good Manufacturing Practices, Good	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			description (plants, animals and microbes). (ii) General .concepts: Good Lab Practices, Good Manufacturing Practices, Good Clinical Practices, Good Large Scale Practices. (iii) Chemical and biological hazards: disposal and safeguards. 8. (i) Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries- India America, European Union, China and Japan. (ii) Biosafety assessment: A general perspective. **Section - C** 9. (i) Biotechnology and food safety: The GM food debate and biosafety assessment procedures for biotech foods and related products, including transgenic food crops. (ii) Ecological safety assessment of recombinant organisms and transgenic crops, Case studies-golden rice, Bt cotton, flavr savr tomatoes, transgenic soybean. 10. International dimensions in biosafety: (i) Bioterrorism and convention on biological weapons. (ii) Biosafety assessment of biotech pharmaceutical products such as drugs/ vaccines. 11. Patents: brief description, types, basic idea of patent application and procedure, farmers rights Plant breeder's rights, international union for the protection of new varieties of plants (UPOV) 12. Intellectual Property rights: definition, origin, types, Role of GATT, WTO, WIPO and TRIPS in 1PR, ethical impacts of IPR, technology transfer (concept and significance) ownership and monopoly.	Clinical Practices, Good Large Scale Practices. Chemical and biological hazards: disposal and safeguards. • Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries- India America, European Union, China and Japan. Biosafety assessment: A general perspective. **Section - C** • Biotechnology and food safety: The GM food debate and biosafety assessment procedures for biotech foods and related products, including transgenic food crops. • Ecological safety assessment of recombinant organisms and transgenic crops, Case studies-golden rice, Bt cotton, flavr savr tomatoes, transgenic soybean. • International dimensions in biosafety: Bioterrorism and convention on biological weapons. Biosafety assessment of biotech pharmaceutical products such as drugs/ vaccines. • Intellectual Property rights: definition, origin, types, Role of GATT, WTO, WIPO and TRIPS in 1PR, ethical impacts of IPR, technology transfer (concept and significance) ownership and monopoly Patents: brief description, types, basic idea of patent application and procedure, farmers rights Plant breeder's rights, international union for the protection of new varieties of plants (UPOV) **Suggested Books:** ➢ Sateesh, M.K. (2008). *Bioethics and Biosafety*. New Delhi: I.K. International Publishing House.	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Books Recommended: ➢ Biotechnology and Safety Assessment 3rd Ed: Thomas, J.A., Fuch, R.L. Academic Press. ➢ Biological Safety Principles and Practices 3rd Ed: Fleming, D.A., Hunt, D.L., ASM Press, Washington. ➢ Biotechnology - A Comprehensive Treatise (Vol. 12). Legal Economic and Ethical Dimensions: H.J. Rehm and G. Reed, VCH. ➢ Encyclopedia of Bioethics.	➢ Rehm, H.J & Reed, G. (1995). *Biotechnology – A Comprehensive Treatise Legal, Economic and Ethical Dimensions*. Vch Verlagsgesellschaft Mbh. ➢ Ignacimuthu, S. (2008). *Bioethics*. Alpha Science International Ltd. ➢ Goel D. & Parashar S. (2013). *IPR, Biosafety and Bioethics* (1st ed.) Pearson Education India. ➢ Fleming D. O. & Hunt D. L (Eds.). (2006). *Biological Safety: Principles & Practices* (4th ed.). ASM Press ➢ Pandey, N. & Dharni, K. (2014). *Intellectual Property Rights*. PHI Learning. ➢ Ramakrishna, B. & Kumar, A. (2017). *Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers* (1st ed.). Notion Press. **Suggested e-Resources:** ➢ **Access and Benefit sharing, Convention of Biological Diversity, Cartegena Protocol** https://www.cbd.int/convention ➢ **Bioethics** http://www.unesco-chair-bioethics.org/?page_id=43 **Biosafety** https://www.nih.gov/research-training/safety-regulation-guidance http://www.dbtindia.nic.in/ https://www.who.int/csr/resources/publications/biosafety/Biosafety7.pdf ➢ **Biosafety, Risk assessment and management** http://www.fao.org/docrep/014/i1905e/i1905e02.pdf ➢ **IPR** https://www.wipo.int/portal/en/index.html	
26.	**BT 8.4** Environmental Biotechnology	After successful completion of the course, students	**Section – A** • Biological processing of sewage and wastewater treatment: Anaerobic and aerobic, conventional,	**Section – A** • Biological processing of sewage and wastewater treatment: Anaerobic and aerobic, conventional,	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		should be able to: • Understand the biological process for sewage and wastewater management • Discuss role of biology in sustainable technology development • Explain the role of microbes in environmental remediation	advanced and new emerging technology, methanogensis, methanogenic, acetogenic and fermentative bacteria – technical process and conditions. • Solid waste management: Waste monitoring, treatment and disposal of non-hazardous solid waste, general remedial measures for medical waste management and Hazardous waste. **Section – B** • Bioenergy and Biofuel**:** Advantages of Biofuels, plant derived fuels, energy crops, Biogas, Bioethanol and Biohydrogen. • Biopolymers and Bioplastics: Types of Bio-polymers, Preparation of Bio polymers and Bio-plastics, properties and practical applications of PHB, advantages and disadvantages of Bioplastics. • Biosensors: Principle and application, BOD, Ammonium, Nitrate and Sulphate. **Section – C** • Biodegradation of Xenobiotics**:** Organisms involved in degradation of chlorinated hydrocarbons, polyaromatic hydrocarbons, pesticides. • Surfactants and microbial treatment of oil pollution. • Biofertilizers and Biopesticides • Bioremediation and Biorestoration: General approaches, Reforestation through micropropagation, use of microbes for improving soil fertility, germplasm conservation (gene banks), conservation of Biodiversity (*in situ* and *ex situ*). **Books Recommended:** ➢ An Introduction to Environmental Biotechnology: Milton Wainwright, Kluwer Academic Press. ➢ Environmental Biotechnology: Alen Scragg,	advanced and new emerging technology, methanogensis, methanogenic, acetogenic and fermentative bacteria – technical process and conditions. • Solid waste management: Waste monitoring, treatment and disposal of non-hazardous solid waste, general remedial measures for medical waste management and hazardous waste. **Section – B** • Bioenergy and biofuel**:** Advantages of biofuels, plant derived fuels, energy crops, biogas, bioethanol and biohydrogen. • Biopolymers and bioplastics: Types of Bio-polymers, preparation of Bio polymers and bioplastics, properties and practical applications of PHB, advantages and disadvantages of bioplastics. • Biosensors: Principle and application, BOD, ammonium, nitrate and sulphate. **Section – C** • Biodegradation of xenobiotics**:** Organisms involved in degradation of chlorinated hydrocarbons, polyaromatic hydrocarbons, pesticides. • Surfactants and microbial treatment of oil pollution. • Biofertilizers and biopesticides • Bioremediation and biorestoration: General approaches, reforestation through micropropagation, use of microbes for improving soil fertility, germplasm conservation (gene banks), conservation of Biodiversity (*in situ* and *ex situ*). **Suggested Books:** ➢ Jogdand, S. N. (2010). *Environmental Biotechnology (Industrial pollution management)* (3rd ed.). Mumbai, India: Himalaya Publishing House.	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Longman. ➢ Encyclopedia of Pollution and its Control Vol. I-VI. ➢ Environmental Impact Assenment: Clark, Bissel & Watham. ➢ J. Winter, Environmental Processes I-III 2nd Ed. ➢ Metcalf Eddy – Waste water Biotechnology, Wiley Pub. ➢ Ted Munn, Encyclopedia of Global Environmental changes, 5 Vol. Set Wiley Pub. ➢ Metcalf Eddy – Waste water Engineering – 3 Ed.; THM Pub. ➢ Introduction to waste water treatment: R.S. Ramalho. ➢ Environmental Chemistry: Dr. A. K. ➢ Environmental Science: Miller T. G. ➢ Applications of Biotechnology: Eds. B N Tripathi, G S Shekhawat and Vinay Sharma, Aavishkar publishers	➢ Srinivasan, D. (2009). *Environmental Engineering*. New Delhi, India: PHI Learning Pvt. Ltd. ➢ Thakur, I. S. (2012). *Enviromental Biotechnology: Basic concepts and Application* (2nd ed.). New Delhi: I K International Publishing House. ➢ Modi, P. N. (2015). *Sewage treatment & disposal and waste water engineering*. New Delhi, India: Rajsons Publications Pvt. Ltd. ➢ Milton, W. (Ed.). (1999). *An Introduction to Environmental Biotechnology*. USA: Springer. ➢ Tripathi, B. N., Shekhawat, G. S., & Sharma, V. (Ed.). (2009). *Applications of Biotechnology*. Jaipur, India: Aavishkar Publishers. **Suggested e-Resources:** ➢ **Biological treatment of wastewater** http://www.neoakruthi.com/blog/biological-treatment-of-wastewater.html ➢ **Biogas** http://www.biologydiscussion.com/biomass/production-of-biogas-from-biomass/10436 ➢ **Biofuel** http://uru.ac.in/uruonlinelibrary/BioFuels/Biomass%20and%20biofuels.pdf ➢ **Biosensor** https://www.edgefx.in/biosensors-types-its-working-and-applications/ ➢ **Xenobiotic compound biodegradation** http://www.biologydiscussion.com/microbiology-2/bioremediation/xenobiotic-compounds-meaning-hazards-and-biodegradation/55625	
27.	**BT 8.5** Plant Biotechnology	After successful completion of the course, students	**Section – A** • ~~Introduction, scope and future outlook~~. • Transgenic plants - basic concept ~~and essential steps for~~	**Section – A** • Plant tissue culture: historical perspective, totipotency, media preparation – nutrients and plant hormones,	Contents of 'Cell and Tissue Culture

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		should be able to: • Develop comprehensive concepts of cell and tissue culture techniques and methodology • Understand the basic concepts of transgenic plants and molecular pharming • Comprehend the basic knowledge of chloroplast engineering and edible vaccines	~~producing transgenic plants, Examples,~~ use of suitable promoters. • ~~Development of plants for improved seed quality.~~ • Development of plants resistant to environmental stress and herbicides. • Development of pathogen resistant plants (Virus and insect resistance). **Section – B** • Artificial seeds. • Plant gene banks, germplasm collection, Cryobanks. • Plant secondary metabolites, metabolic engineering, strategies for enhancement of their production in cell and tissue culture. • Plants as Biofactories – concept, ~~production of chemicals, pigments, perfumes, flavors, insecticides, anticancer agents etc.~~ **Section – C** • Chloroplast engineering: techniques, advantages and application of chloroplast transgenics in production of biopharmaceuticals, introduction of agronomic traits, ~~viz. disease resistance, herbicide resistance, salt and drought resistance, phytoremediation etc~~. • Edible Vaccines. • ~~Radiobiology of cultured plant cells.~~ • Biotechnology of biological nitrogen fixation: *nif* genes. **Books Recommended:** ➢ Biotechnology - A laboratory Course: J. M. Becker, G.A. Cold well and E.A. Zachgo, Academic Press, New York. ➢ Genetic Engineering Technology in Industrial	• sterilization techniques, establishment of cultures – callus culture, cell suspension culture, organogenesis, somatic embryogenesis; artificial seeds • Micropropagation, somaclonal variation, somatic hybridization, cybrids • Protoplast isolation and culture, viability test, techniques of protoplast fusion, haploid production and applications **Section – B** • Transgenic plants - basic concept and use of suitable promoters • Development of plants resistant to environmental stress and herbicides. • Development of pathogen resistant plants (Virus and insect resistance). • Overview of plant secondary metabolites, metabolic engineering, strategies for enhancement of their production in cell and tissue culture. • Concept of plants as biofactories, molecular pharming **Section – C** • Chloroplast engineering: techniques, advantages and application of chloroplast transgenics in production of biopharmaceuticals and introduction of agronomic traits • Edible Vaccines • Plant gene banks, germplasm collection, cryobanks. • Biotechnology of biological nitrogen fixation: *nif* genes **Suggested Books:** ➢ Singh, B. D. (2015). *Biotechnology*. Kolkata, India: Kalyani Publishers. ➢ Gupta, P. K. (2005). *Elements of Biotechnology*. India:	Technology' in the VII Sem has been incorporated with addition of some latest topics.

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Pharmacy: Ed.- J.M. Tabor. ➢ Tissue Culture, Methods and Applications: P.F. Kruse. ➢ Applications of biotechnology: Eds. B N Tripathi, G S Shekhawat and Vinay Sharma, Aavishkar publishers.	Rastogi Publications. ➢ Bhojwani, S. S., & Razdan, M K. (1996). *Plant Tissue Culture: Theory and Practice*. Nederland: Elsevier Science. ➢ Chawla, H. S. (2000). *Introduction to Plant Biotechnology*. USA: Science Publishers. ➢ Slater, A., Scott, N., & Fowler, M. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants* (2nd edition). UK: Oxford University Press. **Suggested e-Resources:** ➢ **Background of Tissue Culture Technology** http://www.biologydiscussion.com/botany/tissue-culture/tissue-culture-definition-history-and-importance/42944 ➢ **Embryogenesis and organogenesis** https://nptel.ac.in/courses/102103016/module1/lec8/3.html ➢ **Single Cell Cultures and Cloning**: http://www.biologydiscussion.com/botany/tissue-culture/methods-for-obtaining-single-cell-clones-from-callus-culture-plant-tissue-culture/43004 ➢ **Protoplasm isolation and regeneration** https://nptel.ac.in/courses/102103016/12 ➢ **Haploid plant production** http://www.biologydiscussion.com/plants/haploid-plants/production-of-haploid-plants-with-diagram/10700 ➢ **Preservation of cell lines** https://www.ukessays.com/essays/biology/techniques-for-cell-preservation-biology-essay.php ➢ **Somatic hybridization** http://www.biologydiscussion.com/somatic-hybridization/somatic-hybridization-aspects-applications-and-limitations/10686	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
28.	**BT 8.3** Biotechnology Lab - V	After successful completion of the course, students should be able to: • Understand various techniques of plant and animal biotechnology • Learn analytical techniques to estimate toxicity of hazardous component • Demonstrate an understanding to assess water pollution • Demonstrate animal cell culture techniques	**Plant Biotechnology** ~~1. Extraction and~~ estimation of ~~phenol based secondary metabolites.~~ ~~2. Isolation of chloroplast genome.~~ ~~3. Restriction analysis of chloroplast genome.~~ 4. Isolation of plant genomic DNA. 5. Artificial seeds. 6. Shoot tip culture. 7. Isolation of protoplasts. **Environmental Biotechnology** 8. Degradation of pesticide in soil and estimation of its residue. 9. Determination of fluoride in water/soil/biosamples. 10. Determination of LD50 of common pesticides/weedicides. 11. Bacteriological Analysis of wastewater. 12. Demonstration of Biosensors, Principle and Application, eg. BOD, Nitrite, sulfite on the basis of availability. **Animal Biotechnology** ~~13. Initiation of primary cell culture and maintenance~~ ~~14. Isolation of hepatocytes~~	**Plant Biotechnology** 1. Preparation of MS medium 2. Sterilization techniques 3. Embryo culture. 4. Shoot tip culture 5. Encapsulation of embryo using sodium alginate 6. Isolation of protoplasts. 7. Estimation of total phenolic content from plant leaves **Environmental Biotechnology** 8. Degradation of pesticide in soil and estimation of its residue. 9. Determination of fluoride in water/soil/biosamples. 10. Determination of LD_{50} of common pesticides/weedicides. 11. Bacteriological Analysis of wastewater. 12. Estimation of BOD from water samples. **Animal Biotechnology** 13. Cell counting and determination of cell viability 14. Preparation of metaphase chromosomes **Suggested Books:** ➢ Trivedi, R. (2016). *Practical Manual in Microbial Physiology and Industrial Microbiology* (1st ed.). New Delhi: S. K. Book Agency. ➢ Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers. ➢ Swamy, P.M. *Laboratory Manual on Biotechnology* (1st ed.). Meerut: Rastogi Publication. ➢ Mahajan, R., Sharma, J., & Mahajan, R.K. (2010). *Practical Manual of Biotechnology* (1st ed.). New Delhi:	Practical exercises of the Paper Cell & Tissue Culture Technology, which were removed from VI Semester, are proposed to be incorporated. Feasible experiments have been included.

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				Vayu Education of India. ➢ Kumar, V. (2011). *Laboratory Manual of Microbiology*. New Delhi: Scientific Publishers. ➢ Sharma, R.K., Sangha, S.P.S. (2009). *Basic Techniques in Biochemistry & Molecular Biology*. New Delhi: I.K. International Publisher.	
	Electives				
29.	**BT 8.6 1** Biomedical Engineering	After successful completion of the course, students will be able to: • Understand different human systems and associated physiological disorders • Explain the role of recent medical advances in diagnostics and treatment • Develop high employability as a biomedical scientist	**Section – A** • An introduction to Biomedical Engineering • Applications and scope of Engineering in Medical Science • Respiratory System: Anatomy and physiology, Disorders and diagnostics. • Digestive System: Anatomy and physiology, Disorders and diagnostics. • Excretory System: renal anatomy and physiology, disorders and diagnostics **Section – B** • Electrical potentials in the human body. • Cardio Vascular System: Anatomy of heart, Cardiac Cycle and ECG or EKG, pacemaker, Heart disorders, diagnostics. • Haemodynamics: Blood flow, velocity, circulation time, Blood pressure, Resistance, blood and vascular modeling. • Muscular System: Anatomy, physiology and electrical properties of muscles. Clinical consideration and diagnostics. • Nervous System: Synapse, electrical properties of neurons, neuromuscular functions, Disorders and diagnostics. **Section - C**	**Section – A** • An introduction to biomedical engineering • Applications and scope of engineering in medical science • Respiratory system: Anatomy and physiology, disorders and diagnostics. • Digestive system: Anatomy and physiology, disorders and diagnostics. • Excretory System: renal anatomy and physiology, disorders and diagnostics **Section – B** • Electrical potentials in the human body. • Cardio vascular system: Anatomy of heart, cardiac cycle and ECG or EKG, pacemaker, heart disorders, diagnostics. • Haemodynamics: Blood flow, velocity, circulation time, blood pressure, resistance, blood and vascular modeling. • Muscular system: Anatomy, physiology and electrical properties of muscles. clinical consideration and diagnostics. • Nervous system: Synapse, electrical properties of neurons, neuromuscular functions, disorders and diagnostics. **Section - C**	Typographical Corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			• Biomaterials and Implentable sensors. • Testings of biomaterials *In vitro* and *In vivo.* • Artificial heart. • Dialysis Machine. • Medical Imaging: X- ray, design of X-ray tube. • Medical imaging processes and projections, 3D, 2D slice identification, CAT, MMR, MRI, PET / SPECT. **Books Recommended:** ➢ Principles of Anatomy and Physiology: G.M. Tortora. ➢ Human physiology Vol. I and Vol. II : C.C. Chatterjee. ➢ Introduction to Biomedical Engineering - Enderle, Blanclrard & Bronzine. ➢ Medical Instrumentation – Application & Design: John G. Webster ➢ Biomechanics: Y. C. Fung. ➢ The Essentials of Physics of Medical Imaging: J.J. Bushberg et. al.	• Biomaterials and implantable sensors. • Testing of biomaterials *in vitro* and *in vivo.* • Artificial heart. • Dialysis machine. • Medical imaging: X- ray, design of X-ray tube. • Medical imaging processes and projections, 3D, 2D slice identification, CAT, MMR, MRI, PET / SPECT. **Suggested Books:** ➢ Tortora, G. J., & Derrickson, B. (2017). *Principles of Anatomy & Physiology* John Wiley & Sons. ➢ Chatterjee, C.C. (1992). *Human Physiology* (11th ed.). Kolkata: Medical Allied Agency. ➢ Enderle, J. D., Bronzino, J. D., & Blanchard, S. M. (2005). *Introduction to Biomedical Engineering*. Amsterdam: Elsevier Academic Press. ➢ Webster, J. G., & Clark, J. W. (1998). *Medical instrumentation: Application and Design*. New York: Wiley. ➢ Fung, Y. C. (1993). *Biomechanics: Mechanical Properties of Living Tissues*. New York: Springer-Verlag. ➢ Bushberg, J. T. (2012). *The Essential Physics of Medical Imaging*. Philadelphia, PA: Wolters Kluwer / Lippincott Williams & Wilkins. **Suggested e-Resources:** ➢ **Cardiocascular and hemodynamics** https://pdfs.semanticscholar.org/a102/b25a8c6b74b97b4bfc8e6d5391aa95308925.pdf ➢ **Medical image processing** http://www.bme.teiath.gr/medisp/downloads/education/en_NOTES_IMAGE_PROCESSING_CAVOURAS.pdf ➢ **Artificial heart** https://www.heartfoundation.org.au/images/uploads/pub	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				lications/Artifical-hearts-information-sheet.pdf	
30.	**BT 8.6 2** Food and Dairy Biotechnology	After successful completion of the course, students will be able to: • Identify parameters affecting microbial growth and its effect on food • Demonstrate an understanding of various food processing and preservation methods • Describe contemporary food related policies and their implications	**Section – A** • History of microorganisms in food. • Intrinsic and extrinsic parameters that affect microbial growth. • Microbiological examination of food, enumeration and detection of food borne microorganisms. • Bioassay and related methods. • ~~Methods of~~ food preservation. **Section – B** • ~~Brewing~~: Beer, wine and distilled spirits. • ~~Micro organisms in~~ meat, ~~poultry, baked products, fermented vegetables.~~ • ~~Contemporary food related policy issues and their implications~~. • Genetically modified foods. **Section – C** • Emerging processing and preservation technologies for milk and dairy products. • Fermented Dairy products: Cheese, yogurt, ~~whey~~ and butter. • Lactose metabolism production of aroma compounds. • ~~Xanthum gum, Pullulan, Rennin, Amylase~~	**Section – A** • Introduction and history of microorganisms in food. • Intrinsic and extrinsic parameters that affect microbial growth. • Microbiological examination of food. Enumeration and detection of food borne microorganisms (conventional, immunological, molecular, biosensor). • Bioassay and related methods. • Food preservation by controlling growth of microorganisms (asepsis, low temperature, high temperature, non-thermal processes, hurdle concept) **Section – B** • Alcoholic beverages: Beer, wine and distilled spirits. • Fermented meat products: sausages, salami • Fermented vegetables products: Sauerkraut, miso, tempeh, kimchi, gundruk, khalpi. • Protein foods: Single cell proteins (SCP), mushroom, algal proteins • Overview of the International and National guidelines for safety assessment of genetically modified (GM) foods **Section – C** • Emerging processing and preservation technologies for milk and dairy products. • Fermented dairy products: Cheese, yogurt, kefir, butter. • Lactose metabolism production of aroma compounds. • Food safety acts (Indian act-Food Safety and Standards Act, 2006, Various food acts-PFA, FPO, AGMARK, MMPO, MFPO, edible oil acts, standard weight acts) and regulatory agencies monitoring safety of foods	Subtopics have been introduced to make the content precise with addition of relevant topics. Subtopics have been introduced to make the content precise with addition of relevant topics Whey is replaced by Kefir as whey is a byproduct of cheese production thus already covered there More important and relevant topics are introduced.

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Books Recommended: ➢ Food Microbiology: W.C. Frazier, D.C. Westhoff, 3rd ed. Tata McGraw Hill ➢ Food Microbiology: M.R. Adams, M.O. Moss New Age international (p) Ltd. ➢ Stanbury, PF., Whitekar, A. and Hall, S.J. (1995) Principles of fermentation technology 2nd ed. Pergamon Press. ➢ Banwart, G.J. (1989) Basic Food Microbiology. CBS Publishers and Distributors, Delhi ➢ Robinson R.K. (1990) Dairy Microbiology, Elsevier Applied Sciences, London	**Suggested Books:** ➢ Frazier, W.C., & Westhoff, D.C. (2003). *Food Microbiology*. Tata McGraw Hill, Inc., New York. ➢ Adams, M. R., & Moss, M. O. (2007). *Food Microbiology*. Royal Society of Chemistry. ➢ Stanbury, P.F., Hall, S. J.,& Whitaker, A. (1999). *Principles of Fermentation Technology*. Butterworth-Heinemann, Elsevier Science Ltd. ➢ Banwart, G.J. (1989*). Basic Food Microbiology*. CBS Publishers and Distributors, Delhi ➢ Robinson, R.K. (1990). *Dairy Microbiology*. Elsevier Applied Sciences, London. ➢ Joshi, V. K., &Pandey, A. (1999). *Biotechnology: Food Fermentation*. Asiatech Publishers Inc. **Suggested e-Resources:** ➢ **History of microorganisms in food** https://faculty.weber.edu/coberg/class/3853/3853%20HistoryofFood.htm ➢ **Quality control of food detection system** https://www.engineersgarage.com/Contribution/Arduino-based-Smart-IoT-Food-Quality-Monitoring-System ➢ **Food Preservation** https://sciencesamhita.com/methods-of-food-preservation/ ➢ **Genetically modified food** http://anrcatalog.ucdavis.edu/pdf/8180.pdf	
31.	**BT 8.6 3** Genomics and Proteomics	After successful completion of the course, students will be able to: • Understand the scope of genomics with special	**Section – A** • Introduction to Genomics and Proteomics. • Gene Prediction and Counting. • Genome Similarity: SNPs and comparative genomics. • Functional Genomics: Microarray technique, Fluorescence in situ hybridization, Comparative genomic hybridization, microarray	**Section – A** • Introduction to genomics and proteomics. • Gene prediction and counting. • Genome similarity: SNPs and comparative genomics. • Functional genomics: Microarray technique, fluorescence *in situ* hybridization, comparative genomic hybridization, microarray	Typographical Corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		emphasis on functional and structural genomics • Describe role of proteomics and various techniques associated • Demonstrate practical insight of techniques and tools applied in Proteomic and genomic research	• Mapping genome modifications for crop improvement, Gene mining by transposons. **Section – B** • Proteomics and Proteome: Proteomics and the new biology, the proteome method for measurement of gene (mRNA) expression. • Analytical protein and peptide separations: Two-dimensional gel electrophoresis for proteome analysis, Image analysis of two dimensional gels, Detection of proteins in polyacrylamide gels and on electroblot membranes. • Mass-spectrometry based method for protein identification and phosphorylation site analysis. **Section – C** • Application of proteomics: Drug development and toxicology, mixing proteome, protein expression profile, identifying protein-protein interaction and protein complexes, mapping protein modifications, as tool for plant genetics and breeding. • Novel approaches to protein expression analysis. • ~~Bridging genomics and proteomics.~~ • Protein arrays: Generation of cDNA expression Libraries, use of automated technologies to generate protein arrays and chips, application of protein arrays in proteomics. • Characterization of protein complement of a specific cell type or tissue or a certain time by high-resolution 2DE. • Bridging the current proteomics and genomic approaches by mass spectrometry, Future perspective and developments. **Books Recommended:** ➢ Proteomics: from protein sequence to function. Edited	• Mapping genome modifications for crop improvement, gene mining by transposons. **Section – B** • Proteomics and proteome: Proteomics and the new biology, the proteome method for measurement of gene (mRNA) expression. • Analytical protein and peptide separations: Two-dimensional gel electrophoresis for proteome analysis, Image analysis of two dimensional gels, detection of proteins in polyacrylamide gels and on electroblot membranes. • Mass-spectrometry based method for protein identification and phosphorylation site analysis. **Section – C** • Application of proteomics: Drug development and toxicology, mixing proteome, protein expression profile, identifying protein-protein interaction and protein complexes, mapping protein modifications, as tool for plant genetics and breeding. • Novel approaches to protein expression analysis. • Protein arrays: Generation of cDNA expression Libraries, use of automated technologies to generate protein arrays and chips, application of protein arrays in proteomics. • Characterization of protein complement of a specific cell type or tissue or a certain time by high-resolution 2DE. • Bridging the current proteomics and genomic approaches by mass spectrometry, Future perspective and developments. **Suggested Books:** ➢ Pennington, S. R., Dunn, M. J., & Ebrary, Inc. (2001). *Proteomics: From protein sequence to function*. Oxford: BIOS.	**Repetition**

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			by S.R. Pennington & M.J. Dunn. Published by viva books. (2002). ➢ Introduction to proteomics: Tools for the new biology by Daniel C. Liebler published by Humana Press (2002).	➢ Brown, S.M. (2015). *Next-generation DNA sequencing Informatics* (2nd ed.). Cold Spring Harbor Press. ➢ Liebler, D. C. (2001). *Introduction to proteomics tools for the new biology*. Humana Press. ➢ Lesk, A.M. (2015). *Introduction to Genomics* (2nd ed.). Oxford University Press. ➢ Pevsner, J. (2017). *Bioinformatics and Functional Genomics* (3rd ed.). John Wiley. ➢ Twyman, R.M. (2004). *Principles of Proteomics*. CBS Publishers. ➢ Thangadurai, D. & Sangeetha, J. (2015). *Genomics and Proteomics: Principles, Technologies, and Applications*. CRC Press. **Suggested e-Resources:** ➢ **Protein array** https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3680110/pdf/nihms465562.pdf ➢ **Gene mining by transposon** http://transposonpsi.sourceforge.net/ ➢ **Applications of proteomics in drug development** https://onlinelibrary.wiley.com/doi/full/10.1002/jcb.10576	
32.	**BT 8.6 4** Immunotechnology	After successful completion of the course, students will be able to: • Explain structure and function of the immune systeme at cellular and molecular level • Describe immunization/vaccin	**Section – A** • General organization, expression and regulation of major Histocompatibility complex. Structural organization and expression of immunoglobulin genes and Generation of antibody diversity. • Genomic organization, structure and isolation of TCR. • Immune regulation, positive and negative selection in Thymus, Apoptosis. **Section – B** • Autoimmune diseases (Organspecific and Systemic autoimmune disease).	**Section – A** • General organization, expression and regulation of major histocompatibility complex. Structural organization and expression of immunoglobulin genes and generation of antibody diversity. • Genomic organization, structure and isolation of TCR. • Immune regulation, positive and negative selection in thymus, apoptosis. **Section – B** • Autoimmune diseases (organspecific and systemic autoimmune disease).	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		ation, immunological disease and immunotherapy • Develop approaches for the immune intervention of diseases	• Immune response to infectious diseases (Viral, Bacterial Protozoan and Parasitic infections). • Immunodeficiency diseases (Phagocytic, Humoral, Cell mediated, Combined cell mediated Humoral deficiencies and Complement deficiencies). • Immune System in AIDS. **Section – C** • Tumor Biology. • Transplantation Immunology. • Synthetic Vaccines. • Cloning techniques and engineered antibody production and application, T cell cloning. **Books Recommended:** ➢ Essential of Immunology: W.H. Hildemann, Elservier Scientific Publishing Co. Inc. ➢ Understanding Immunology: A.J. Connigham, Academic Press. ➢ Immunochemistry in Practice: A Johnstone and R. Thrope Blackwell Scientific Publications. ➢ Benjamin E and Leskowitz S. Immunology a short course. Wiley Liss NY to 1991. ➢ Richard A. Goldshy et al. Immunology 5th Ed. W.H. Freeman and Co., NY 2003. ➢ Pravesh C.Sen Gupta, Clinical Imunology, Oxford India. 2003 (2vol.) ➢ Klans D.Elgret (1996) Immunology-understanding of immune system.Wiley-Liss.NY ➢ Topley and Wilson's (1995) Text Book on Principles of Bacteriology, Virology and Immunology IX Ed. Edward Arnold, London. ➢ Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York, 1988. ➢ Antibodies a laboratory Manual: Harlow and David	• Immune response to infectious diseases (viral, bacterial, protozoan and parasitic infections). • Immunodeficiency diseases (phagocytic, humoral, cell mediated, combined cell mediated humoral deficiencies and complement deficiencies). • Immune System in AIDS. **Section – C** • Tumor Biology • Transplantation immunology. • Synthetic vaccines. • Cloning techniques and engineered antibody production and application, T cell cloning. **Suggested Books:** ➢ Punt, J., Stranford, S., Jones, P., & Owen, J. (2018). *Kuby Immunology* (8th ed.). W. H. Freeman and Company. ➢ Abbas, A. K., Lichtman, A. H. & Pillai, S. (2017). *Cellular and Molecular Immunology* (9th ed.). Elsevier. ➢ Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2006). *Roitt's Essential Immunology* (11th ed.). Wiley-Blackwell. ➢ Tizard, I. R. (1995). *Immunology: Introduction* (4th ed.). Philadelphia: Saunders College Publishing. **Suggested e-Resources:** ➢ **Cellular and Molecular Immunology** https://ocw.mit.edu/courses/health-sciences-and-technology/hst-176-cellular-and-molecular-immunology-fall-2005/lecture-notes/ ➢ **Immunology** https://study.com/academy/topic/immunology.html	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Lane (1988), Cold spring harbor laboratory. ➢ Cellular Interactions and Immunobiology – BIOTOL series ➢ Cellular and molecular Immunology – Abbas A.K., Lichtman A.H. and Pober, J.S. ➢ Immunobiology 3rd ed. – Janeway Travers		
33.	**BT 8.6 5** Microbial Technology	After successful completion of the course, students will be able to: • Utilize various strategies for isolation, strain improvement, maintenance and containment of microbes • Describe strategies used for large scale production from microorganisms including overexpression • Understand advances in field of microbial technology for societal benefit	**Section – A** • Biotechnological innovation in pharmaceutical health, agricultural and industrial sectors. • Strategies for selection and improvement of industrial strains. • Measurement and control of bioprocess parameters. • Metabolic pathways and metabolic control mechanism. **Section – B** • Industrial production of biofuel, steroids and single cell protein. • Biofertilizres (Rhizobium and BGA) and Biopesticides (Bt toxin) • Biosensors (NH_4, Sulphide) and Biofilms. • Biopolymers (PHB), Xanthum gum). **Section - C** • Microbial overproduction of recombinant molecules: Selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, protease cleavage sites and enzymes, plasmid copy number, inducible expression systems. • Large scale production using recombinant microorganisms. **Books Recommended:** ➢ Biotechnological innovations in chemical synthesis, BIOTOL Publisher: butterworth-Heinemann. ➢ Industrial Microbiology, G. Reed (editor), CBS	**Section – A** • Biotechnological innovation in pharmaceutical health, agricultural and industrial sectors. • Strategies for selection and improvement of industrial strains. • Measurement and control of bioprocess parameters. • Metabolic pathways and metabolic control mechanism. **Section – B** • Industrial production of biofuel, steroids and single cell protein. • Biofertilizers (*Rhizobium* and BGA) and biopesticides (Bt toxin) • Biosensors (NH_4, Sulphide) and biofilms. • Biopolymers: PHB, Xanthum gum. **Section - C** • Microbial overproduction of recombinant molecules: Selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, protease cleavage sites and enzymes, plasmid copy number, inducible expression systems. • Large scale production using recombinant microorganisms. **Suggested Books:** ➢ Glazer, A.N. Nikaido, H. (2008). *Microbial Biotechnology*. Cambridge University Press. ➢ Kun, L.Y. (Ed.) (2003). *Microbial Biotechnology:*	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			Publishers (AVI Publishing Company) ➢ Genetics and biotechnology of industrial microorganisms. C.L. Hershnergev, S. W. Queener and Q. Hegeman. Publisher: American Society of Microbiology, Ewesis. Et at., 1998. Bioremediation principles. McGraw Hill. ➢ Protein Expression: A Practical Approach edited by S.J. Higgins and B.D. Hames (OUP).	*Principles and Applications.* World Scientific Publication Co. Ptv. Ltd. ➢ Braun,V. & Gotz, F. (Eds.). (2002). *Microbial Fundamentals of Biotechnology*. Wiley-Vch. ➢ Crueger, W., & Crueger, A. (1990). *Biotechnology, A Text Book of Industrial Microbiology* (2nd ed.). U.S: Sinauer Associates Inc **Suggested e-Resources:** ➢ **Microbial Biotechnology** http://www.biologydiscussion.com/microbial-biotechnology-2/microbial-biotechnology-biotechnology-2/71609 ➢ **Biosensor** https://www.edgefx.in/biosensors-types-its-working-and-applications/ ➢ **Biofertilizer** www.krishisewa.com/articles/organic-agriculture/115-biofertilizers.html ➢ **Biopesticide** www.agriinfo.in/default.aspx?page=topic&superid=3&topicid=1950	
34.	**BT 8.6 6** Molecular Modeling and Drug Designing	After successful completion of the course, students will be able to: • Understand the scope of pharmacokinetics and computer aided drug designing. • Identify and search potential drug leads using various tools	**Section – A** • Protein conformations, folding and mutation through modeling. The multi drug resistance proteins, drug carrier affecting drug response, Pharmacokinetic basis of individual difference in response to drugs, pharmacokinetic properties, influence of structural modifications on pharmacokinetic properties, Pharmacodynamics studies. **Section – B** • Introduction to semi-empirical, molecular mechanics and ab intio techniques, potential energy surfaces, docking and modeling substrate receptor interactions,	**Section – A** • Protein conformations, folding and mutation through modeling. The multi drug resistance proteins, drug carrier affecting drug response, pharmacokinetic basis of individual difference in response to drugs, pharmacokinetic properties, influence of structural modifications on pharmacokinetic properties, pharmacodynamics studies. **Section – B** • Introduction to semi-empirical, molecular mechanics and ab intio techniques, potential energy surfaces, docking and modeling substrate receptor interactions, software	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
		of computational biology. • Understand methodologies used for drug designing	Software tools for modeling bimolecular, molecular electrostatic potentials, charge analysis. Different docking methodologies, success stories in docking. **Section – C** • A brief introduction to drug design methodologies, Structure based drug designing, Ligand based drug designing. Quantitative Structure Activity Relationship (QSAR), present and future aids to drug design, structure and confirmation of drugs and receptors, drug receptor binding forces, structural aspects of drug-nucleic acid interactions. • Pharmacopore identification, Pharmacophore modeling, Pharmacophore mapping, Pharmacophore generation, Hiphop and hypogen theories. **Books Recommended:** ➢ Molecular modeling: principles and applications 2nd Ed.: Andrew R. Leech ➢ Molecular Modeling for Beginners: Alan Hinchliffe ➢ Modeling Molecular Structures, 2nd Edition: Alan Hinchliffe ➢ Nucleic Acid Targeted Drug Design: Catherin Propst ➢ Computer-Aided Drug Design: Methods and Applications: Thomas J. Perun, Catherine Lamb Propst ➢ Structure-Based Drug Design: Pandi (EDT) Veerapandian ➢ Textbook of Drug Design and Discovery 3rd Edition: Povl Krogsgaard-Larsen, Tommy Liljefors, Ulf Madsen, U. Madse.	tools for modeling bimolecular, molecular electrostatic potentials, charge analysis. different docking methodologies, success stories in docking. **Section – C** • A brief introduction to drug design methodologies, structure based drug designing, ligand based drug designing. quantitative structure activity relationship (QSAR), present and future aids to drug design, structure and confirmation of drugs and receptors, drug receptor binding forces, structural aspects of drug-nucleic acid interactions. • Pharmacophore identification, pharmacophore modeling, pharmacophore mapping, pharmacophore generation, hiphop and hypogen theories. **Suggested Books:** ➢ Leech, A.R. (2001). *Molecular modeling: principles and applications* (2nd ed.). USA: Pearson. ➢ Hinchliffe, A. (1998). *Modelling molecular structures*. Biochemical Education ➢ Perun, T. J., & Propst, C. L. (1989). *Computer-aided drug design: Methods and applications*. New York: Marcel Dekker. ➢ Tommy, L., Larsen, P.K., & Madsen, U. (2002). *Textbook of Drug Design and Discovery* (3rd ed.). USA: CRC Press. **Suggested e-Resources:** ➢ **Drug design and Discovery** https://nptel.ac.in/courses/104103071/pdf/mod15.pdf ➢ **Bioinformatic tools** https://nptel.ac.in/courses/102103044/pdf/mod6.pdf ➢ **Pharmacophore modeling** https://www.dovepress.com/pharmacophore-modeling-advances-limitations-and-current-utility-in-dru-peer-	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				reviewed-fulltext-article-JRLCR	
35.	**BT 8.6 7** Nanotechnology	After successful completion of the course, students will be able to: • Understand the basic concepts of nanobiotechnology • Apply engineering concepts to the nano-scale domain and design processing conditions • Comprehend the legal issues in nanotechnology and environmental risk assessment	**Section – A** • Introduction to Nanotechnology. • Current and future market applications: Semiconductor manufacturing, Advanced composites, Advanced ceramics, Catalytic and photocatalytic applications, Gas sensors and other analytical devices, consumer products, drug delivery mechanisms and medical therapeutics, Micro electronic applications. • Legal considerations for nanotechnology. • Environmental risk assessment, Health risk assessment, Hazards risk assessment. **Section – B** • Prime Materials: Metals, Iron, Aluminum, Nickel, Silver, Gold, Copper and their oxides, Silica products. • Nonmaterial Types: Nanowires, Nanotubes and their synthesis, properties, applications. • Fullerenes, quantum dots, Dendrimers, Properties. • Method of preparation: Top down, bottom up, plasma orcing, chemical vapour deposition, sol – gel methods. **Section – C** • Self assembled monolayers, Bio molecular motors and their functions. • Proteins and applications, • Drug delivery systems - Nanofluidic, fluids at micro and nanometer scale, fabrication of nanoporous and nanofluidic devices, applications. **Books Recommended:** ➢ Introduction to Nanoscale science and technology. Ed. By Mosimilano Di ventra I Edition, Kluwer Academic – 2004. ➢ Nanotechnology, Grejory Timp –I Edition, Springer International – 2005.	**Section – A** • Introduction to nanotechnology. • Current and future market applications: Semiconductor manufacturing, advanced composites, advanced ceramics, catalytic and photocatalytic applications, gas sensors and other analytical devices, consumer products, drug delivery mechanisms and medical therapeutics, micro electronic applications. • Legal considerations for nanotechnology. • Environmental risk assessment, health risk assessment, hazards risk assessment. **Section – B** • Prime Materials: Metals, iron, aluminum, nickel, silver, gold, copper and their oxides, silica products. • Nonmaterial Types: Nanowires, nanotubes and their synthesis, properties, applications. • Fullerenes, quantum dots, dendrimers, Properties. • Method of preparation: Top down, bottom up, plasma orcing, chemical vapour deposition, sol – gel methods. **Section – C** • Self assembled monolayers, bio molecular motors and their functions. • Proteins and applications, • Drug delivery systems - Nanofluidic, fluids at micro and nanometer scale, fabrication of nanoporous and nanofluidic devices, applications. **Suggested Books:** ➢ Di, V. M. (2008). *Introduction to Nanoscale Science and technology*. New York, NY: Springer. ➢ Bhushan, B. (2017). *Springer Handbook of Nanotechnology*. Berlin, Heidelberg: Springer Berlin Heidelberg.	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			➢ Nanotechnology. Michel Kohler – I Edition, Wiley VCH-2004. ➢ Nanotechnology: Environmental implications and solutions by Lous Theodove & Robert A. Kung. ➢ Introduction to Nanotechnology- C.P. Poole & F.S. Owens. ➢ Nanotechnology: Basic science and emerging technologies- M.Wilsin, K. Kannaranga, G. Smith, M. Simmons & B. Raguse. ➢ An introduction to materials engineering and science for chemical and material engineers – B.S. Mitchell. ➢ Essay: The coming technological revolutions, from the websites of the center for responsible nanotechnology; www.crnano.org/magic.htm.	➢ Bhattacharya, S. (2013). *Introduction to Nanotechnology*. New Delhi: Wisdom Press. ➢ Wilson, M. (2004). *Nanotechnology: Basic Science and Emerging Technologies*. Boca Raton: Chapman & Hall/CRC. **Suggested e-Resources:** ➢ **Nanofluidic devices** https://aip.scitation.org/doi/pdf/10.1063/1.4794973?class=pdf ➢ **Preparation of Nanomaterial** https://nptel.ac.in/courses/103103033/module9/lecture2.pdf	
36.	**BT 8.6 8** Plant Secondary Metabolites	After successful completion of the course, students will be able to: • Understand isolation techniques for plant secondary metabolites and their biosynthetic pathway. • Demonstrate production of various secondary metabolites and factors affecting it • Explain large scale production of various secondary metabolites	**Section – A** • Introduction to secondary metabolites. • Plant products in nature. • Occurrence, types and uses of plant products. • Basic tools and techniques used in isolation & separations of plant secondary metabolites. • Biosynthesis of secondary metabolites- Shikimate, Acetate-malonate and acetate-mevalonate pathways. **Section – B** • Production, *In vitro* optimization. • Secondary metabolite selection, effect of metabolism on secondary metabolite production. • Production of secondary metabolites under stress factors. • Production of alkaloids, steroids & saponins. • Mechanism & control by different factors. • Detoxification of secondary metabolites. **Section – C**	**Section – A** • Introduction to secondary metabolites. • Plant products in nature. • Occurrence, types and uses of plant products. • Basic tools and techniques used in isolation & separations of plant secondary metabolites. • Biosynthesis of secondary metabolites- Shikimate, Acetate-malonate and acetate-mevalonate pathways. **Section – B** • Secondary metabolite selection, effect of metabolism on secondary metabolite production. • Production of secondary metabolites under stress factors. • Production of alkaloids, steroids & saponins. • Mechanism & control by different factors. • Detoxification of secondary metabolites. **Section – C** • Production of secondary metabolites by bioconversion.	Typographical corrections only

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
			• Production of secondary metabolites by Bioconversion. • Genetic transformation for production of secondary metabolites. • Large scale production in Bioreactors. • Sources & types of antitumour compounds. • Food additives and insecticides. **Books Recommended:** ➢ Secondary metabolites by K.C. Ramavat- Oxford Press (2000) ➢ Plant Physiology: Devlin and Witham, Van Narst. ➢ Plant Physiology: Salisburry and Ross, Prentice Hall of India. ➢ Introductory plant physiology: Noggle and Fritz, Prentice Hall of Pvt. Ltd. ➢ Plant Physiology: Taiz and Zeiger, Introduction to Plant physiology: W.G. Hopkins, John Wiley and Sons Inc. ➢ Plant Physiology: Pandey and Sinha ➢ Biochemistry and Molecular Biology of Plants: Buchanan, Gressum and Jons, I K International Publications.	• Genetic transformation for production of secondary metabolites. • Large scale production in bioreactors. • Sources & types of antitumour compounds. • Food additives and insecticides. **Suggested Books:** ➢ Ramavat, K.C. (2000). *Secondary Metabolites.* Oxford Press. ➢ Witham, F.H., Devlin, R. M., & Blaydes, D. F. (1971). *Experiments in Plant Physiology*. New York: Van Nostrand Reinhold Co. ➢ Salisbury, F.B. & Ross, C.W. (1991). *Plant Physiology* (4th ed.) Wadsworth Publishing Company. ➢ Ross, C.W. (1974). *Plant Physiology Laboratory Manual*. California: Wadsworth Publishing Company. ➢ Noggle, G.R. and Fritz, C.J. (1986). *Introductory Plant Physiology*. (2nd ed.). New Delhi: Prentice Hall *of India* Pvt. Ltd., ➢ Taiz, L., & Zeiger, E. (2010). *Plant Physiology* (5th ed.). USA: Sinauer Associates lnc., ➢ Pandey, S.N. and Sinha, B.K. (1996). *Plant Physiology* (3rd revised ed.). New Delhi: Vikas Publishing House Pvt. Ltd.. ➢ Buchanan, B. B., Gruissem, W., & Jones, R. L. (2000). *Biochemistry & molecular biology of plants.* Rockville, Md.: American Society of Plant Physiologists. **Suggested e-Resources:** ➢ **Secondary metabolites** https://nptel.ac.in/courses/102103016/module4/lec32/3.html ➢ **Tools for production of secondary metabolites** https://nptel.ac.in/courses/102103016/38	

S. No.	Course List	Learning outcomes	Existing Syllabus	Suggested Syllabus	Remarks
				➢ **Industrial application** http://www.biologydiscussion.com/biotechnology/plant-biotechnology/secondary-metabolites-in-plant-cultures-applications-and-production/10646	

* Matter in contrast (black background & white letters) is shifted to some other units, and material brought as a result of shift is also in contrast.
# Matter in square brackets, bold, italic and crossed is deleted.
@ Proposed added materials are shaded in grey.

Verified

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